# SEA CUCUMBER – SÆBJÚGA

## *Cucumaria frondosa*

### COMMERCIAL FISHING

An experimental fishery for sea cucumber started in Breiðafjördur in 2003, but little was landed until 2008 when fisheries started in Faxaflói with catch of 998 t. Since then the landings have increased and three areas have been demarcated as sea cucumber grounds: 1) Western area: Reykjanes to Skagatá, 2) Northern area: Skagatá to Glettinganes and 3) Southern and eastern area: Glettinganes to Reykjanes.

The main fishing areas in the last decade are Faxafloi in the Western area, off the east coast in Southern and eastern area, and Aðalvík, north-west Iceland belonging to the western area.

The main fishing areas were defined by the following coordinates in 2013 (Regulation 795/2013):

Faxaflói:

1. 64°06,00N-22°24,00V
2. 64°06,00N-22°49,20V
3. 64°21,00N-22°49,20V
4. 64°21,00N-22°24,00V
5. 64°06,00N-22°24,00V

Off the east coast:

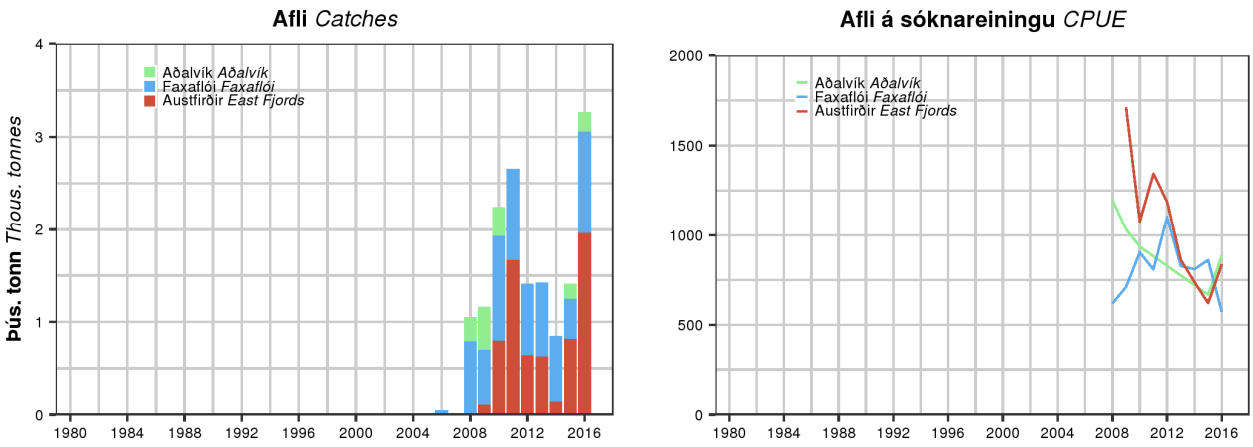
1. 65°05,40N-13°21,00V
2. 65°05,40N-13°33,00V
3. 64°43,20N-13°53,40V
4. 64°43,20N-13°41,40V
5. 65°05,40N-13°21,00V

Aðalvík:

1. 66°21,00V-23°03,00V
2. 66°21,00V-23°15,00V
3. 66°25,80V-23°15,00V
4. 66°25,80V-23°03,00V
5. 66°21,00V-23°03,00V

The annual catches have been fluctuating, mostly because of different effort in each area. The annual catch in Faxaflói has ranged from 433-1130 t, off the east coast from 108-1966 t and in Aðalvík 159-467 t. The maximum total landings were in 2016, 3266 t increasing from 1381 t of previous year. In February 2010, a small subarea (17 $km^{2)}$ within Faxaflói was closed because of overfishing and has not been reopened (Regulation 110/2010). This subarea is defined by the following coordinates:

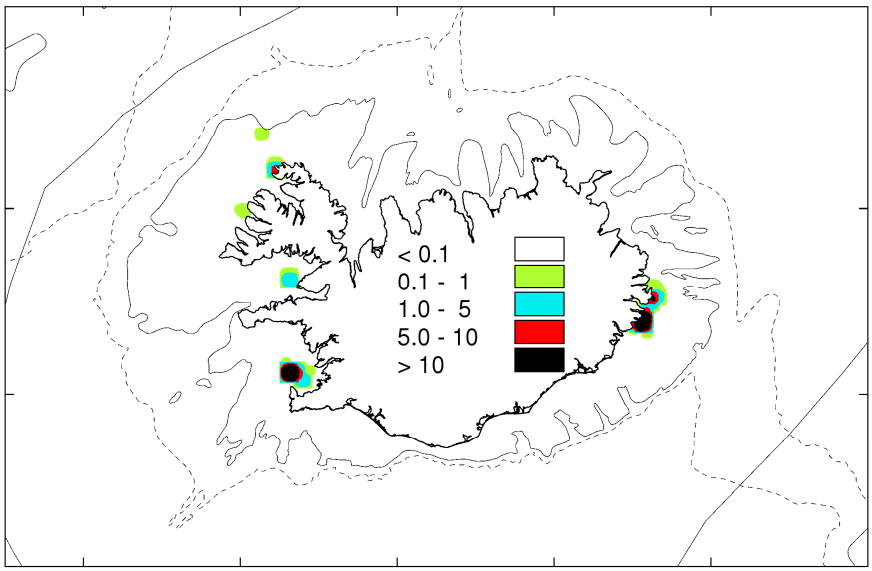
1. 64°08,91N-22°39,70V
2. 64°10,42N-22°36,87V
3. 64°09,28N-22°32,62V
4. 64°07,98N-22°35,96V
5. 64°08,91N-22°39,70V




**Sea Cucumber.** Total catch and catch per unit effort by area.

***Sæbjúga.*** *Afli og afli á sóknareiningu eftir svæðum.*

Catch per unit effort (CPUE) has differed between years, ranging from 571-1103 in Faxaflói, 620-1713 off the east coast and 667-1197 in Aðalvík. CPUE for the whole fishery has ranged from 677-1090 kg/hour fished. There is an annual variation in CPUE where catches are higher in spring and summer mostly depending on weather conditions. Sea cucumber are fished by a dredge, 250 cm in width and with minimum mesh size of 100 mm. A maximum of nine fishing licenses are issued annually in this fishery. No fishing is permitted in May and June in the Western area and in June and July in other areas due to spawning of sea cucumber.

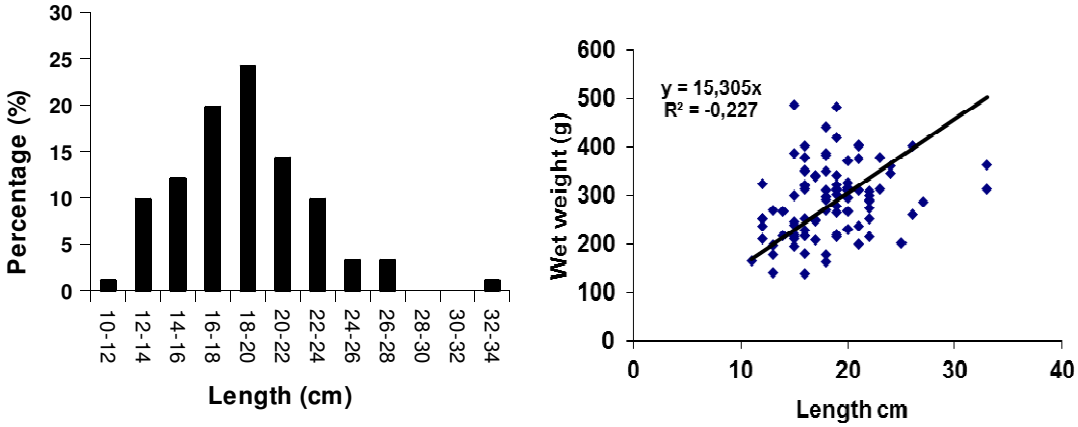



**Sea Cucumber.** Fishing grounds in 2010-2016. The coulour indicates the size of the catch (t/nm²).

***Sæbjúga.*** *Veiðisvæði við Ísland 2010-2016. Liturinn sýnir afla (t/sj m²).*

## SURVEYS

A dredge survey for sea cucumber was conducted in Aðalvík northwest Iceland in April 2008, to get information on stock size and investigate the population structure. Swept area method was used in order to determine the density/abundance of cucumbers, where each catch was weighed and the distance covered by the dredge was calculated. The total catch weight was divided by the size of the area covered in each tow to give biomass in kg/m$^2$. Biomass estimate was calculated from the mean biomass in the area multiplied by the total size of the area which was estimated to be 12 km$^2$. The density (ind./m$^2$) was calculated by dividing the mean wet weight of the individuals in an area into the abundance (kg/m$^2$) of the area. Twenty four stations were taken at 22-30 m depth. The stock in the area was assessed to be 3600 t based on biomass from the area swept (0.3 kg/m$^2$) and on 100% gear efficiency. The mean length, wet weight (drained) and the mantle weight from subsamples was measured 18.35 cm (SD=3.1), 290 g (SD=60.6), and 157 g (SD=30.4) respectively.

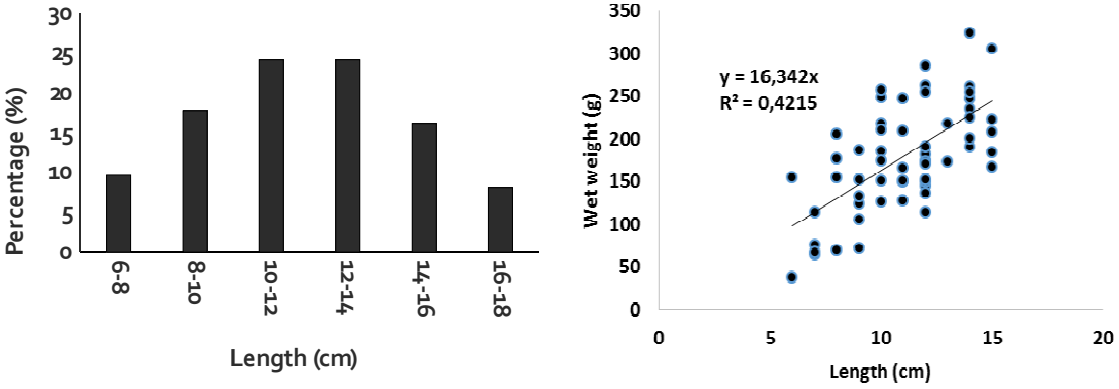



**Sea Cucumber.** Size distribution and correlation between wet weight and size in Aðalvík 2008.
***Sæbjúga.*** *Stærðardreifing og lengdar-vigtarsamband sæbjúgna í Aðalvík 2008.*

In Faxaflói, one day surveys were conducted in May, June, August and November 2008 to assess the stock in two fishing areas Vestrahraun and Syðrahraun by the swept are method. The stock at Vestrahraun was assessed to be 1200 t (based on 100% efficiency of dredge, biomass 0.13 kg/m$^2$and the size of the area 9.1 km$^2$) and at Syðrahraun 8300 t (based on 100% efficiency of dredge, biomass 0.18 kg/m$^2$and the size of the area 45.8 km$^2$). The mean size of the cucumbers in June 2008 at Syðrahraun was 16.5 cm, (SD=2.0), the whole wet weight 227.6 g (SD=44.2) and the mantle weight 128,6 g (SD=25.8). At Vestrahraun, the mean size was 15.8 cm, (SD=1.4), the whole wet weight 179 g (SD=31) and the mantle weight 93 g (SD=18.5).

In August 2009, a two days survey in Faxaflói was conducted to estimate the stock and study the population structure. Until then 2 subareas had been estimated but now they were enlarged and the stock size estimate increased to 15000 t. Swept area method was used as before and based on 100% efficiency of the dredge. The mean size of the cucumbers at Suðrahraun was now 11,1 cm (SD=2.0), wet weight 194.5 g (SD=45.8) mantle weight 111.2 g (SD=30.3).

The closed subarea in Faxaflói (from February 2010) was investigated in May 2008, August 2009, May 2012 and July 2016. In May 2008, the average size was 16.7 cm (SD=2.1), the wet weight 297 g (SD=37.9) and the mantle weight 147 g (SD=18.6). The mean biomass was estimated 0.15 kg/m² but had decreased to 0.07 kg/m² in August 2009. In 2012, the biomass had increased to 0.14 kg/m². In July 2016 the mean size of the sea cucumber was 13.6 cm (SD=1.4), the whole wet weight 275.8 g (SD=52.5) and the mantle weight 135 g. (SD=25).




**Sea Cucumber.** Size distribution and correlation between wet weight and size at Syðrahraun in Faxaflói in August 2008.
***Sæbjúga.*** *Stærðardreifing og lengdar-þyngdar samband á Syðrahrauni í Faxaflóa 2008.*

**The population structure (size, wet weight, mantle weight) and SD of Sea Cucumber in Faxaflói.**

| Area | Date | Size (cm) | SD (cm) | Wet weight (g) | SD (g) | Mantle weight (g) | SD (g) |
|---|---|---|---|---|---|---|---|
| Syðrahraun | 06.2008 | 16.5 | 2 | 227.6 | 44.2 | 128.6 | 25.8 |
| Vestrahraun | 06.2008 | 15.8 | 1.4 | 179 | 31 | 93 | 18.5 |
| Syðrahraun | 08.2009 | 11.1 | 2 | 194.5 | 45.8 | 111.2 | 30.3 |
| Closed area | 05.2008 | 16.7 | 2.1 | 297 | 37.9 | 147 | 18.6 |
| Closed area | 05.2016 | 13.6 | 1.4 | 275.8 | 52.5 | 135 | 25 |

## ADVICE

TAC was first recommended for sea cucumber by the Marine Research Institute (MRI) in 2009 for Faxaflói and Aðalvik. The advice was of 10% of estimated abundance in each known fishing area, that is 350 t in Aðalvik, 120 t in Faxaflói west, and 830 t in Faxaflói south; in total TAC of 1300 t (Anon 2009). Utilization rate of 10% has been used for many invertebrate species which have similar longevity and age at reproduction as sea cucumbers. The same advice was given for the fishing years 2010/2011 and 2011/2012 (Anon 2010, 2011). In 2009 the estimated fishing stock in Faxaflói had increased to 15000 t after a survey, leading to total advice of 1810 t in 2010/2011 and 2011/2012 in these two areas.

In 2012, the stock status in Faxaflói, Aðalvík and off the east coast was estimated, now based on measurement of the total fishing area based on logbooks locations multiplied with the average abundance derived from CPUE and based on 100% gear efficiency. The stock in Faxaflói was now estimated to be 10300 t; in Aðalvík 1700 t and off the east coast 14000 t. Harvest ratio of 10% of stock size was recommended for the quota years 2012/2013, 2013/2014 and 2014/2015.

As CPUE had declined in Faxaflói from 2012 and rather rapidly off the east coast since 2009, a the advice was changed and catches in the fishing year 2016/2017 should not exceed 644 t in Faxafloi, 623 t off the east coast and 190 t in Aðalvík. The basis for the advice was the mean catch of 2010-2015, for each fishing area. Because of decreasing CPUE and lack of knowledge about biology of this species, 20% reduction in catch was advised.

In spring 2017, the total size of the main fishing sites within each fishing area that had been demarcated (Faxaflói, east coast, and Aðalvík) was estimated based on VMS data. VMS records were extracted from the database only for combination of vessels and dates in which there are catches registered in the logbooks. Only fishing events with landings over 1 t were included. Records close to (<2km) a harbour, and erroneous records (e.g with unrealistic positions or vessel speed) were removed. Records from each vessel were classified as fishing vs. not fishing based on vessel speed, using a k-means clustering algorithm with two groups. The group with lower speed was classified as fishing, and the group with higher speed was classified as non-fishing. To avoid false positives, a minimum and maximum fishing speed were used to classify some points from the lower speed group as "fishing". The minimum fishing speed is 1 knot and the maximum fishing speed 3.5 knots.

A grid size of 400 x 400 m was used with a minimum of 4 fishing events within each grid. In total, this method gave 32 separated patches (areas) and the whole area investigated was 207 km².

**Sea Cucumber.** The three fishing areas in 2016, the east coast, Faxaflói and Aðalvík. The main fishing sites within each area assessed by VMS data in 2017 are also shown.

***Sæbjúga.*** *Veiðisvæðin 2016, við Austurland, í Faxaflóa og Aðalvík. Aðalveiðislóðir innan hvers svæðis metnar með VMS gögnum 2017 eru einnig sýndar.*

As a result, the main fishing sites off the east coast within the demarcated fishing area are estimated to be 108 km², in Faxaflói 71 km² and Aðalvík 11.2 km². The closed subarea in Faxaflói is 17 km². Based on the advice given in 2016, and the new area estimates, the advice in 2016 was 9.1 t/km² in Faxaflói, 5.8 t/km² off the east coast and 16 t/km² in Aðalvík.

**The size of the fishing sites (VMS) within each fishing area, advice and catch t/ km² in 2015 and 2016.**

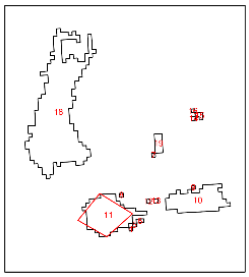
| Fishing area | Km² | Advice ´16 | Catch ´16 | Catch ´15 |
|---|---|---|---|---|
| Faxaflói | 71 | 9.1 | 13.2 | 6 |
| East coast | 108 | 5.8 | 18.1 | 7.3 |
| Aðalvík | 11.2 | 16 | 15.5 | 14.3 |

In 2017, the advice for the three areas were coordintated, based on the 2016 advice for Faxaflói (which has the longest catch history), or 9.1t/km². That yielded maximum catch of 985 t off the east coast, 644 t in Faxaflói and of 102 t in Aðalvík, for the fishing year of 2017/2018 is recommended. Additionally it is adviced that the size of the area in Faxaflói be enlarged by moving the the western line further west to include a fishing site on the boarder, which was assessed by VMS data. However, the advice from 2016 was not increased as this site was included in the VMS data in 2017.

In the same way it is advised that the fishing area off the east coast be enlarged to include a fishing site close to the south-western corner. Also here, this fishing site was included in the VMS data in 2017. The new coordinates for fishing areas in Faxaflói and off the east coast for the fishing year 2017/2018 are:

Faxaflói:

1. 64°06,00N-22°49,20V
2. 64°06,00N-22°49,20V
3. 64°21,00N-22°18,00V
4. 64°21,00N-22°18,00V
5. 64°06,00N-22°49,20V

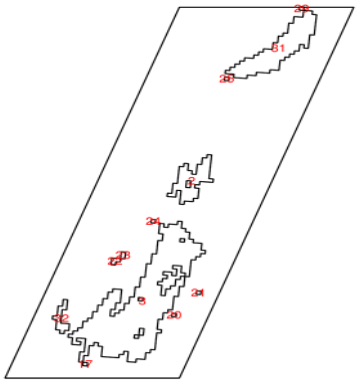



**Sea Cucumber.** The fishing area in Faxaflói for the fishing year 2017/2018. The main fishing sites assessed by VMS data in 2017 are shown inside the fishing area and the closed subarea from 2009 (red).

***Sæbjúga.*** *Veiðisvæðið í Faxaflóa fiskveiðiárið 2017/2018. Aðalveiðislóðir innan svæðis metnar með VMS gögnum 2017 eru einnig sýndar. Lokaða svæðið frá 2009 er merkt rautt*

Off the east coast:

1. 65°05,40N-13°20,00V
2. 65°05,40N-13°40,00V
3. 64°42,00N-14°00,00V
4. 64°42,00N-13°00,00V
5. 65°05,40N-13°20,00V



**Sea Cucumber**. The fishing area off the east coast for the fishing year 2017/2018. The main fishing sites assessed by VMS data in 2017 are shown inside the fishing area.

***Sæbjúga***. *Veiðisvæðið við austurland fiskveiðiárið 2017/2018. Aðalveiðislóðir innan svæðis metnar með VMS gögnum 2017 eru einnig sýndar.*

MFRI advises that when the precautionary approach is applied, catches in the fishing year 2017/2018 should not exceed 1731 tonnes in demarcated fishing areas; 644 tonnes in Faxaflói, 985 tonnes off the east coast, and 102 tonnes in Aðalvík. MFRI also recommends a change in the demarcation of fishing areas in Faxaflói and off the east coast, based on the distribution of fishing in recent years.

## REFERENCES

Anon, 2009. Hafrannsóknir nr 146. Nytjastofnar sjávar 2008/2009. Aflahorfur fiskveiðiárið 2009/2010.

Anon, 2010. Hafrannsóknir nr 153. Nytjastofnar sjávar 2009/2010. Aflahorfur fiskveiðiárið 2010/2011.

Anon, 2011. Hafrannsóknir nr 159. Nytjastofnar sjávar 2010/2011. Aflahorfur fiskveiðiárið 2011/2012.