THE GREEN SEA URCHIN – SKOLLAKOPPUR
Strongylocentrotus droebachiensis

COMMERCIAL FISHING

Dredge fishing for the green sea urchin started in 1993. Landings peaked in 1994 at about 1500 tonnes, decreased drastically until 1997 when the fishery stopped. Decreased catches can be attributed to market factors, but the main fishing areas were severely affected by the effort in those years. In these years the fishery was widely distributed around Iceland but Breiðafjörður was always the main fishing area. In 2004, fishing started again in Breiðafjörður with minor landings (30–40 tonnes) until 2007 when it reached 134 tonnes. In 2007–2014, landings were 126–146 tonnes but have increased since then. In 2019, 295 tonnes were landed from Breiðafjörður and 50 t from Húnaflói. (Fig. 1).

Standardized CPUE index in Breiðafjörður was 1.17 in 2019 and has fluctuated between 2.07–1.17 in 2006-2019 (Fig. 1). Fishing has always mainly been conducted in Breiðafjörður and one boat has been active since 2004, although in recent years several boats have participated in the fishery. The fishing is conducted from August/September to March/April, depending on the quality of the roes.

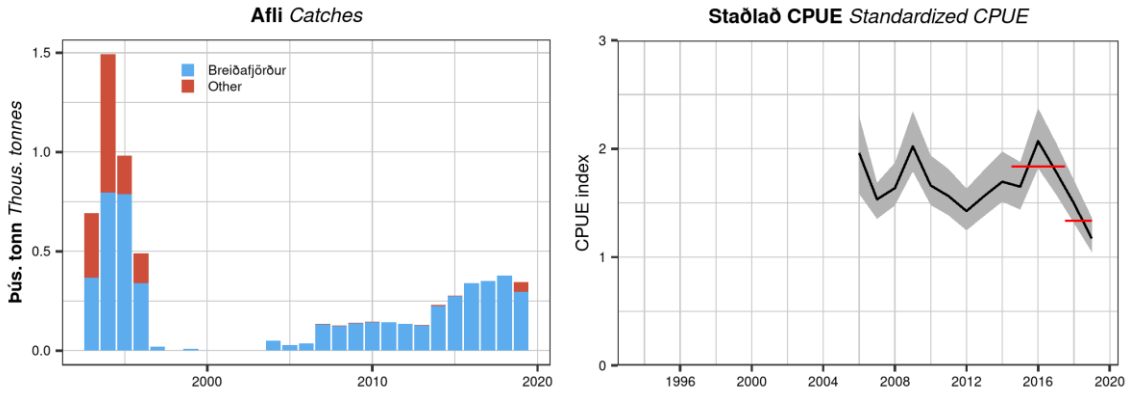

Figure 1. The green sea urchin. Catches from Breiðafjörður and other areas 1993-2019 and a standardized CPUE from Breiðafjörður 2006-2019.

Mynd 1. Skollakoppur. Afli úr Breiðafirði og af öðrum svæðum 1993-2019 og staðlaður afli á sóknareiningu í Breiðafirði 2006-2019.

Southern Breiðafjörður has always been the main fishing area for the green sea urchin. In 2016 an advice for total allowable catch (TAC) was given for the first time for a market area in the southeast but fishing outside the area was unlimited and the fishery expanded west and north (Hafrannsóknastofnun 2016). The following two years the same advice was given but now the fishing area in the southeast was divided and TAC given for each area to spread the fishing pressure inside the area (Hafrannsóknastofnun 2017

and 2018). In 2019 an advice for the fishery in the whole fjord was given and the TAC was divided between two different fishing areas, north-west and south-east. Fishing outside Breiðafjörður now needed an experimental fishing license (Hafrannsóknastofnun 2019) (Fig.).

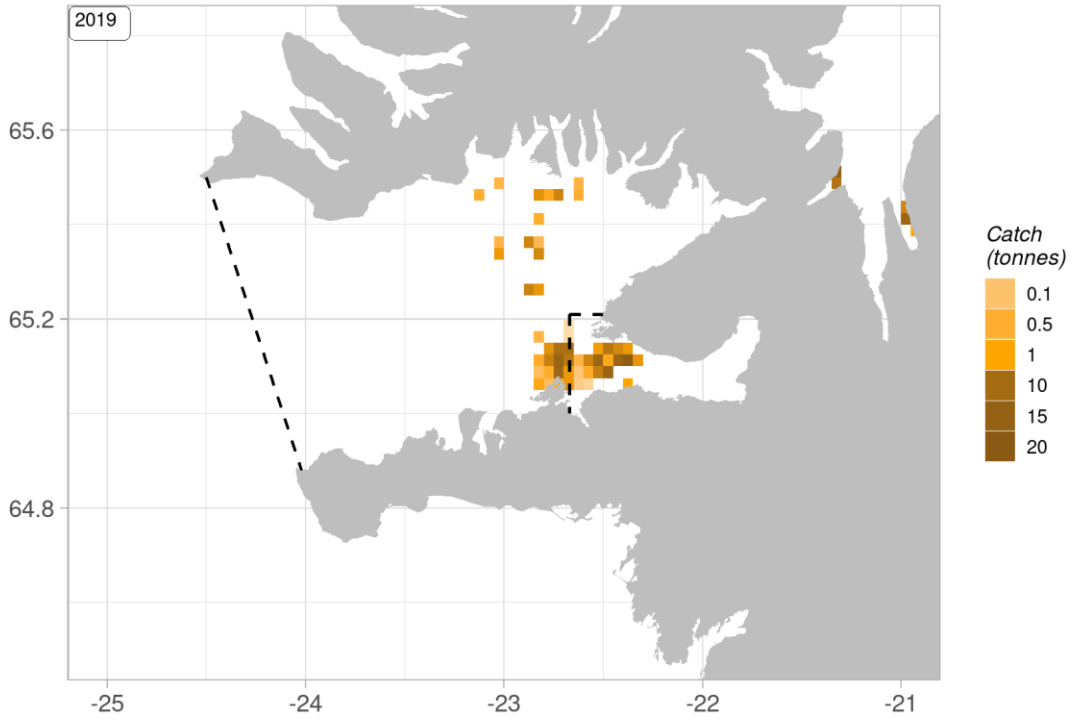

Figure 2. The green sea urchin. Distribution of catches and division of fishing grounds in 2019.

Mynd 2. Skollakoppur. Útbreiðsla veiða og skipting veiðisvæðis. 2019.

Figure 3. The green sea urchin. Distribution of catches (tonnes) by months in 2019.

Mynd 3. Skollakoppur. Útbreiðsla veiða frá janúar til desember 2019.

SEA URCHIN SURVEY

Surveys were conducted in September 2015, April 2016 and September 2018 to assess biomass of sea urchin in the main fishing area in southern Breiðafjörður south of 65°10'N and east of 22°40'W at depths of 8–60 m, by swept area method and underwater photography. Most of the tows (88%) were at depths of 8–35 m. The surveys were conducted by a commercial sea urchin fishing vessel (Fjóla SH-7). The dredge used is 250 cm in width and with 150 cm long catch–bag. The mesh size of the catch–bag is 100 mm.

To determine the density/abundance of urchins, 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 estimates for any given area were calculated from the mean biomass in that area multiplied by the total size of the area. 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 (swept area method).

An underwater camera was used to estimate the density of urchins in April 2016. Photographs were taken at 19 sites within four of the seven investigated subareas. At each site photographs were taken at several

locations, with a total of 160 photos taken. Later sea urchins from the photos were counted and the density observed (no/m^2). The results from the dredge survey from the same area at the same time were compared to the density observed from the photos before dredging to assess the efficiency of the dredge. The results showed that the distribution of the green sea urchin in Breiðafjörður is very patchy, showing smaller fishing areas, ranging in size from 0.3–3.4 km^2. The mean combined abundance in all areas investigated in September 2015 and April 2016 (91 stations) was 0,28 kg/ m^2. The stock size was assessed to be about 2700 tonnes in the area investigated. The average efficiency of the dredge was estimated 29% (Thorarinsdóttir and Guðlaugsdóttir 2018).

A survey was conducted on 3-4. September 2018 to estimate the biomass of sea urchin in the main fishing area in Breiðafjörður. Data was collected and handled in the same way as the years before. Now 40 stations were investigated, and 15 samples were taken from the catch to estimate the size and weight of sea urchins as well as the number and weight of species in bycatch. The results indicated abundance of 0,24kg/ m^2 when corrected for the average efficiency of the dredge, 29%. The stock size was assessed to be about 2300 tonnes in the area investigated.

An underwater camera survey was conducted on 24 August 2018. Photographs were taken in 30 different sites at 10 stations within each site with approximately 8 repetitions in each station. Processing of this data is still underway.

To investigate the reproductive cycle (gametogenesis and spawning), 30 samples were collected monthly from September 2016-August 2017 (except June and July), from two different fishing areas at 60 and 32 m depth, respectively. A total of 300 urchins were collected at each site. For each sample, test diameter for each urchin was measured to the nearest 0.1 mm with Vernier calipers and the total weight to the nearest 0.1 mg. The urchins were opened and drained and weighted again and the water content in each individual estimated. The gonads were removed, blotted dry, their wet weights determined, and GI was calculated as percentage of the total wet weight of the total body mass.

In 2019 two experimental fishing permits were granted to Thorisholmi ehf to look for fishable green sea urchin stocks in Ísafjarðardjúp and Húnaflói. No usable grounds were found in Ísafjarðardjúp (Guðrún Þórarinsdóttir og Steinunn H. Ólafsdóttir 2019) but fishable stock was observed in Húnaflói (Guðrún Þórarinsdóttir og Steinunn H. Ólafsdóttir 2020) and 50 tonnes where landed from there in 2019.

LENGTH DISTRIBUTION OF THE GREEN SEA URCHIN

A survey was conducted in September 2018 then the mean size was 50.0 ± 13 mm (Fig. 5). The minimal landings size of sea urchin shall not be less than 45 mm in test diameter.

The mean size (diameter) distribution for the area investigated in 2015 and 2016 combined showed that the highest proportion of the stock is 56-60 mm in diameter, ranging from 17 to 85 mm. The mean size in the catch from all fishing areas investigated in 2015 and 2016 combined was 59.3 ± 10.5 mm (Fig. 4). In the survey carried out in 2018 the highest proportion of the stock is 55-64 mm in diameter but ranged in size from 5 to 79 mm (Fig. 5).

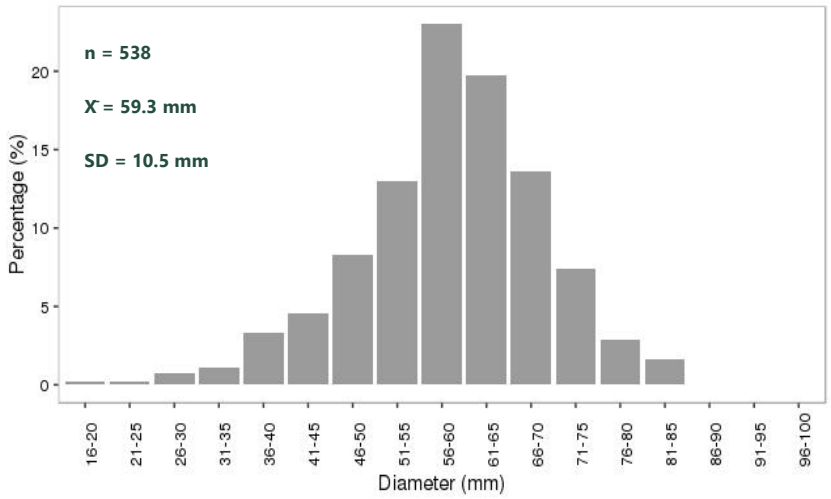

Figure 4. The green sea urchin. Size (diameter in mm) frequency distribution for all areas combined in the study areas in Breiðafjörður in September 2015 and April 2016.

Mynd 4. Skollakoppur. Stærðardreifing (þvermál í mm) á rannsóknarsvæðum í Breiðafirði árin 2015 og 2016.

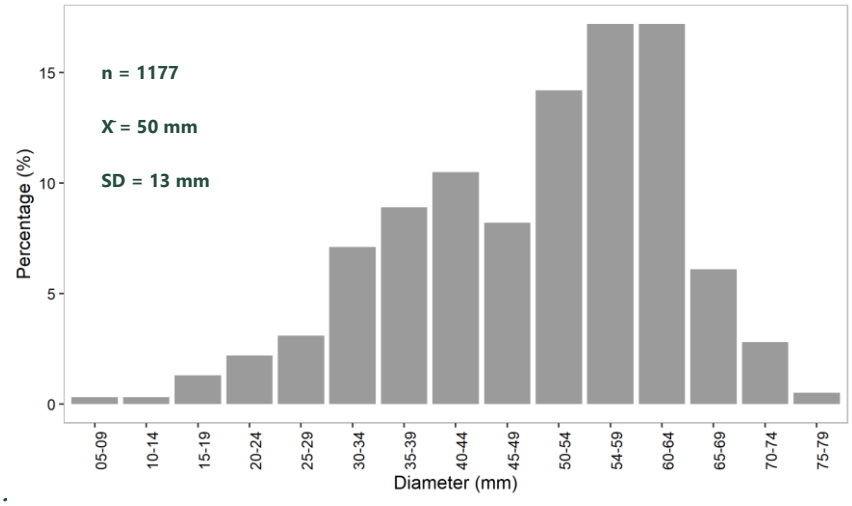

Figure 5. The green sea urchin. Size (diameter in mm) distribution in study areas in Breiðafjörður in September 2018.

Mynd 5. Skollakoppur. Stærðardreifing (þvermál mm) á rannsóknarsvæðum í Breiðafirði í September 2018.

REPRODUCTIVE CYCLE OF SEA URCHIN

The green sea urchin displays a distinct annual cycle of reproduction as indicated by temporal changes in gonad index through the year.

An investigation was carried out from September 2016-August 2017 at 32m (65°06N73-22°32W0) and 60 m depths (65°05N46-22°33W75) in Breiðafjörður. The results indicate a relatively high gonad index (GI) at both depths throughout the whole investigation period, however the gonad index was always lower at

greater depth. One spawning season in April was observed at both sites, but minor spawning continued into May at 32 m depth (Fig. 6).

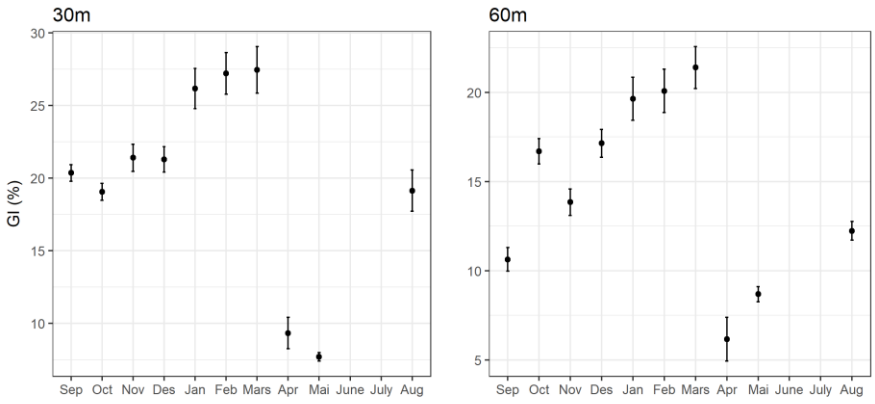

Figure 6. The green sea urchin. Gonad index ± SE from September 2016 to August 2017 at two fishing sites in Breiðafjörður (32 and 60 m depth) in September 2016-August 2017.

Mynd 6. Skollakoppur. Kynþroskastuðull (GI) ± SE á tveimur veiðisvæðum í Breiðafirði (32 og 60 m dýpi) frá september 2016-ágúst 2017.

Gonad quality was visually ranked by comparing color of roes from photos taken in the laboratory to a Pantone color chart developed for previous urchin research (Ásbjörnsson, 2011). Images were taken of each gonad sample and matched to colors on the chart. The percentages of each rank each month at each depth were then plotted in a stacked bar chart using Excel. Ranks were classified accordingly by market value into 4 ranks:

1st class- Yellow, Light Yellow, Orange, Light Orange

2nd class- Dark Yellow, Dark Orange

2nd-3rd class- Light Red, Red, Curry Yellow, Curry, Curry Brown

Unacceptable - Dark Red, Light Brown, Brown, Dark Brown, Curry Grey

At both sites, gonads were found to have a high proportion of acceptable (1st, 2nd, and 2nd-3rd rank) and a very low proportion of unacceptable colors. Roes from 60 and 32 m depth exhibited acceptable colors in 91.49 and 94.48% of all specimen respectively throughout the year. The highest proportion of unacceptable gonad colors were observed post-spawning in May at both sites, and additionally in April at 60 m. Overall, the lower depth consistently exhibited a higher percentage of 1st class roe, and a smaller percentage of unacceptable quality roe than the higher depth, with few exceptions (O´Hara, 2019) (Fig. 7).

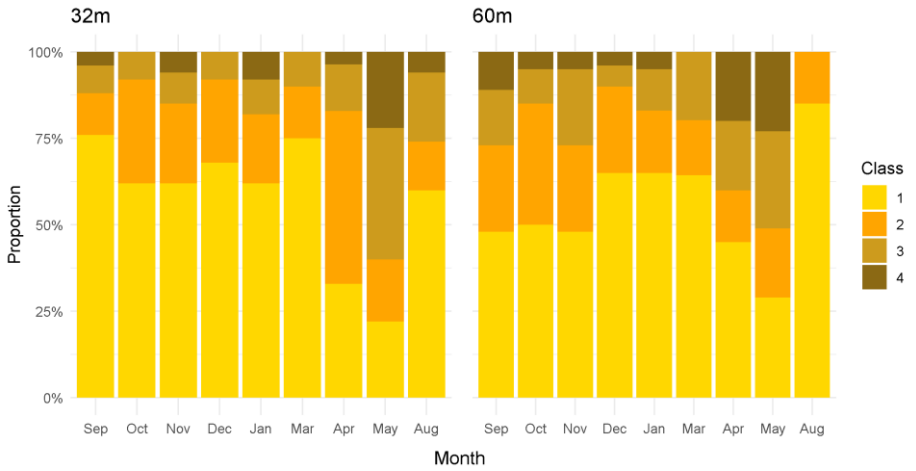

Figure 7. The green sea urchin. Stacked plot of green sea urchin roe coloration ranked visually at 32 and 60m depth. Class one is the highest quality, class 2 and 3 are acceptable and class 4 is unacceptable.

Mynd 7. Skollakoppur. Gæði ígulkerahrogna flokkuð eftir lit á 32 og 60 m dýpi. Flokkur 1 er með hæstu gæði, flokkur 2 og 3 er með meðal gæði og flokkur 4 er óásættanleg gæði.

ADVICE

The green sea urchin stock in Breiðafjörður should be considered a data limited stock and thus, follow the ICES framework for such (Category 3.2). The advice is based on the ratio of the mean of the last two standardized CPUEs (Index A) and the mean of the three preceding values (Index B) multiplied by the latest advice.

The MFRI advices that the total allowable catch for the fishing year 2020/21 is set at 220 t (275*0.8). The fishing area is within Breiðafjörður from Bjargtangar to Öndverðarnes and this area was divided into two subareas in 2019 by lines from south and east from a point 65°13´00´N, 22°40´00´W. TAC was given for each area, north-west 69 t and south-east 206 tonnes (Hafrannsóknastofnun 2019) (Fig. 2). The advice now (2020) is to keep the north-west area unchanged from last year (area A) with TAC 55 tonnes and divide the south- east area into two subareas, B and C, by a line between 65°08´N, 22°31´W and 65°04´N, 22°25´W (Fig. 8.). TAC is given for each subarea, 100 and 61 tonnes respectively to even out the fishing pressure in the areas. The division of TAC between area B and C is built on stock assessment and distribution of the stock made in this area in 2016 (Thorarinsdóttir and Guðlaugsdóttir 2018).

The width of the dredge should not exceed 2.5 m and maximum weight should be 700 kg. Only one dredge is allowed fishing onboard the same boat. The mask size (inside measurement) in the dredge should not be less than 80 mm. The minimum landing size of the sea urchins should be 45 mm in test diameter.

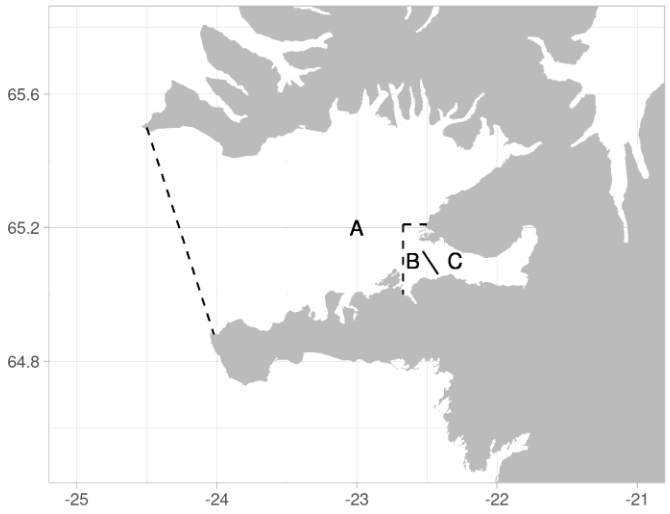

Figure 8. The green sea urchin. Division of fishing grounds in 2020.

Mynd 8. Skollakoppur. Skipting veiðisvæðis 2020.

Table 1. The green sea urchin. Recommended TAC in Breiðafjörður, total landings, the standardized CPUE index and CPUE (kg/ hour).

Tafla 1. Skollakoppur. Veiðiráðgjöf fyrir Breiðafjörð, lönduð ígulker, staðlaður afli á sóknareiningu og afli á sóknareiningu (kg/klst).

YEAR / FISHING YEAR	ADVICE	LANDINGS	CPUE INDEX	CPUE[1)]
2006/07	-	109	1.96	461.3
2007/08	-	112	1.53	381.4
2008/09	-	119	1.64	372.3
2009/10	-	150	2.02	482.7
2010/11	-	141	1.66	400.6
2011/12	-	152	1.56	381.9
2012/13	-	129	1.42	364.6
2013/14	-	149	1.56	402.2
2014/15	-	264	1.69	438.7
2015/16	-	295	1.65	339.9
2016/17	250	315	2.07	359.1
2017/18	250	376	1.79	349.5
2018/19	250	411	1.50	339.4
2019/20	275	-	1.17	341.1
2020/21	220			

[1)] Calander year

DIAGNOSTICS

Table 2. The green sea urchin. Analysis of deviance table. Response variable is log of catch per unit effort (CPUE).

Tafla 2. Skollakoppur. Tafla með niðurstöðum úr GLM líkani. Svarbreyta er lógarithminn af afla á sóknareiningu (CPUE)

	DF	DEVIANCE	RESID. DF	RESID. DEV	F	Pr(>F)
NULL			2541	710.20		
factor(Year)	14	138.78	2527	571.42	88.557	< 2.2e-16 ***
factor(Month)	8	108.25	2519	463.17	120.877	< 2.2e-16 ***
factor(Ship)	4	181.65	2515	281.53	405.679	< 2.2e-16 ***

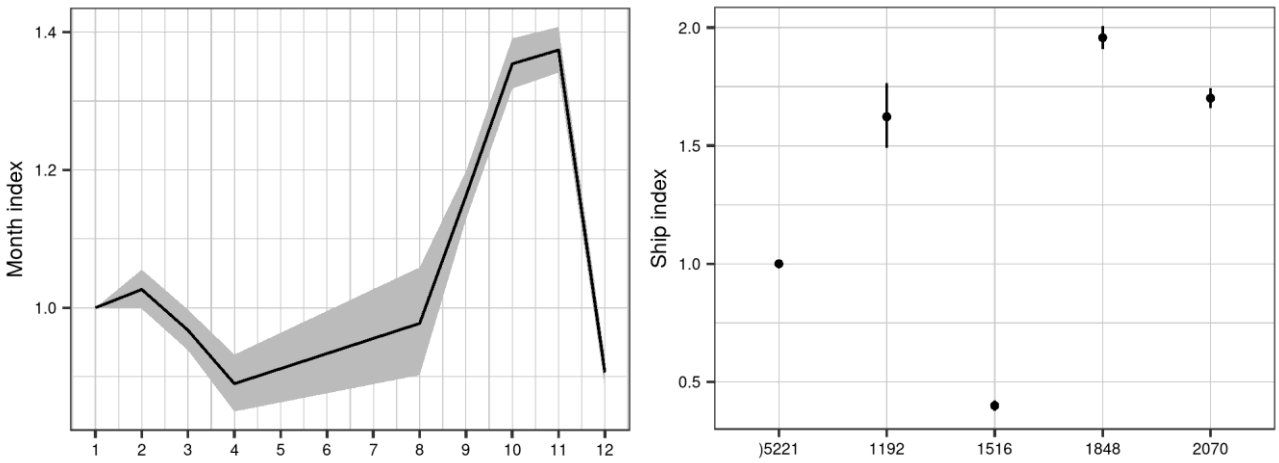

Figure 9. The green sea urchin. Month (left) and ship (right) indices from the Generalized linear model (glm).

Mynd 9. Skollakoppur. Mánaðar (vinstri) og skip (hægri) stuðlar úr líkani (glm).

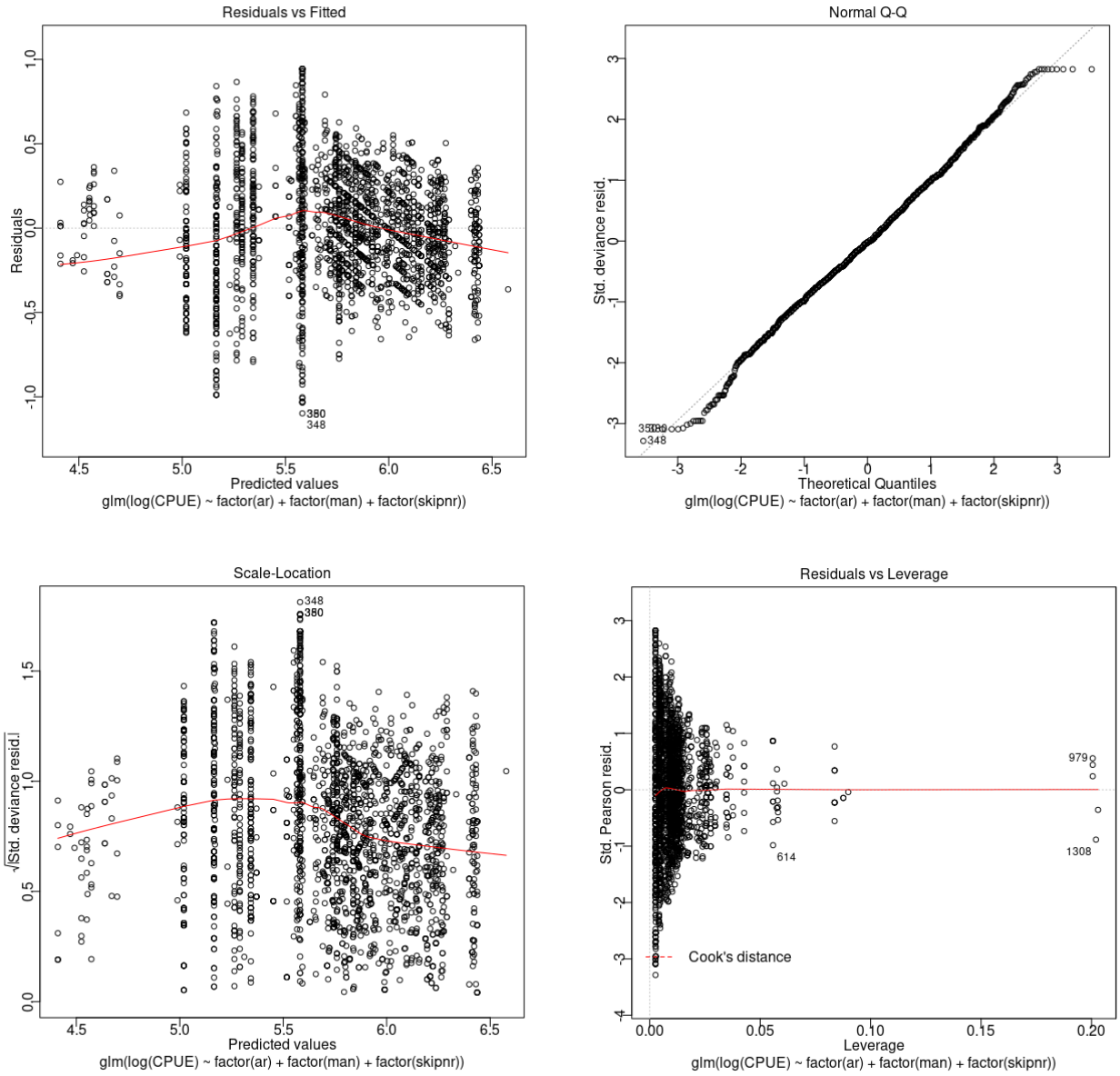

Figure 10. The green sea urchin. Diagnostics plots from the Generalized linear model (glm).

Mynd 10. Skollakoppur. Greiningarmyndir úr líkani (glm).

QUALITY OF THE ASSESSMENT

Two species of bigger sized sea urchins are found around Iceland, i.e the green sea urchin (*Strongylocentrotus droebachiensis*) and the European edible sea urchin (*Echinus esculentus),* both utilized for human consumption. The market prefers the green sea urchin and no fishery or landings are documented for the common sea urchin in Iceland. However, caution should be taken regarding landings from Breiðafjördur as some European edible sea urchin might have been landed as the green sea urchin. These species look similar as the European edible sea urchin has a violet colour (Fig. 11) that is sometimes observed in the green sea urchin stock. The colour of the green sea urchin may vary between green, brownish and violet (Fig. 12). The maximum size of these species is however not the same, 8-10 cm for the green sea urchin but 16 cm for the European edible sea urchin.

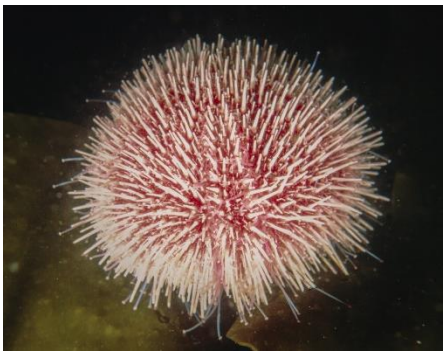

Figure 11. The European edible sea urchin.
Mynd 7. Marígull (Echinus esculentus). Ljósmynd/Photo: Karl Gunnarsson.

Figure 12. The green sea urchin. Colour variation.
Mynd 7. Skollakoppur. Litaafbrigði skollakopps. Ljósmynd/Photo: Karl Gunnarsson

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