NORWAY LOBSTER
Nephrops norvegicus

INTRODUCTION

Fishery of Norway lobster (*Nephrops norvegicus*) started in the early 1950s and during the first two decades it was mainly conducted by Icelandic, Belgian and French vessels (Table 1). The fishery has since 1974 only been conducted by Icelandic vessels. In the beginning Norway lobster was mainly fished during spring and summer and the fleet was large or up to 200 boats in the 1970's. In recent years, the season has been longer, as the fishery starts in the middle of March and ends in November/December. There has been a gradual decrease in number of boats participating in the *Nephrops* fishery and during the last couple of years there have been as few as seven boats active in the fishery. The species is entirely caught in *Nephrops* trawls, but through the decades there have been occasional creel trials.

Fishing grounds in Iceland are at the northernmost part of the species distributional range. For females it has been shown that there is a biennial reproductive cycle and, therefore, slower post-maturity growth than in, for example, Scottish, Irish, French, and Portuguese waters of mostly annual spawning (Eiríksson, 2014). That affects the productivity of the stock and warrants lower exploitation rate than applied in other *Nephrops* stocks.

COMMERCIAL FISHING

LANDINGS

Due to poor stock status, a monitoring fishery was conducted for the third year in 2021 and the fishing grounds Jökuldjúp southwest of Iceland and Lónsdjúp southeast of Iceland were closed for *Nephrops* fishing. As such, 107 tonnes of *Nephrops* were landed in 2021, which is a reduction of 87 tonnes from the previous year (Table 1, Figure 1). The catch has steadily declined since 2010 when it was 2540 tonnes There have been periodic fluctuations in landings since the onset of the fishery in the 1950's, which soon reached 6000 tonnes in 1963, following a few years with high catches (Eiríksson and Jónasson, 2018).

In 2021, 24.5 tonnes were landed from the southwestern grounds, a reduction of 60 tonnes from the previous year (Table 2, Figure 2). On the southern grounds only 1 tonne was landed. In the southeast area, 82.5 tonnes were landed, a decrease of 27 tonnes from previous year.

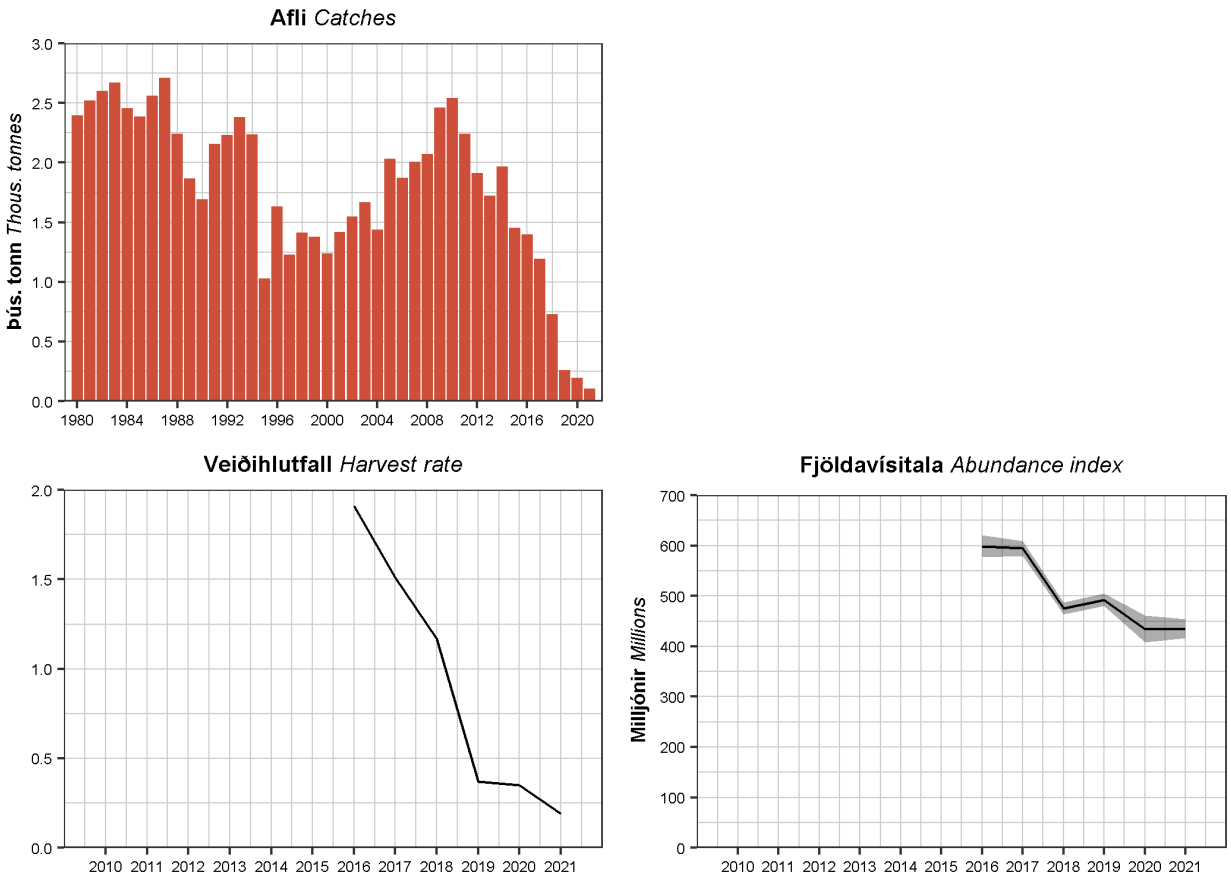

Figure 1. Norway lobster. Catches, harvest rate (sum of landings in numbers, divided by total abundance), stock abundance (Underwater TV, millions; SSB proxy, 95% confidence intervals).

CPUE AND EFFORT

Catch per unit effort (CPUE, standardized to 1 trawl and the period May–August) declined between 2020 and 2021 or from 14.8 to 9.8 kg per hour towed (Table 2). CPUE has declined drastically since the peak in 2007 and 2008 when more than 100 kg of *Nephrops* were caught per hour towed. There have been overall similar fluctuations between areas with regards to CPUE (Figure 3). CPUE has on average been higher in the southeast area, and in recent years it has been lowest in the southern area.

There was a decreasing trend in the fishing effort from 1970 to 2000-2008, but the trend differed between areas. Since 2008, there has been a decrease in effort in the southern area, an increase in southwestern area, but effort has not changed much in the southeastern area (Figure 4). In the monitoring fishery in the southeastern areas, the effort increased from 2019 to 2021.

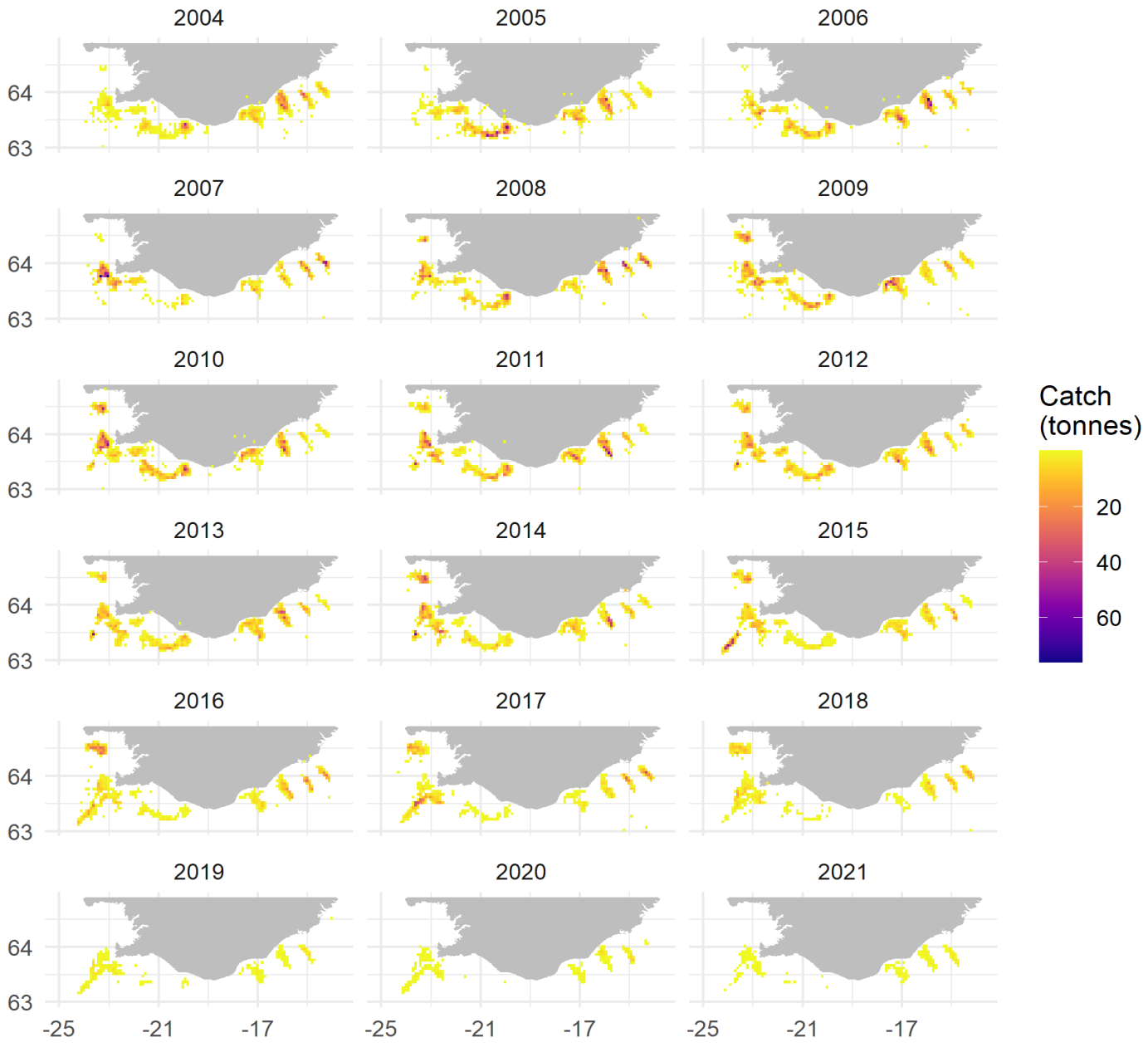

Figure 2. Norway lobster. Distribution of catches in 2004-2021.

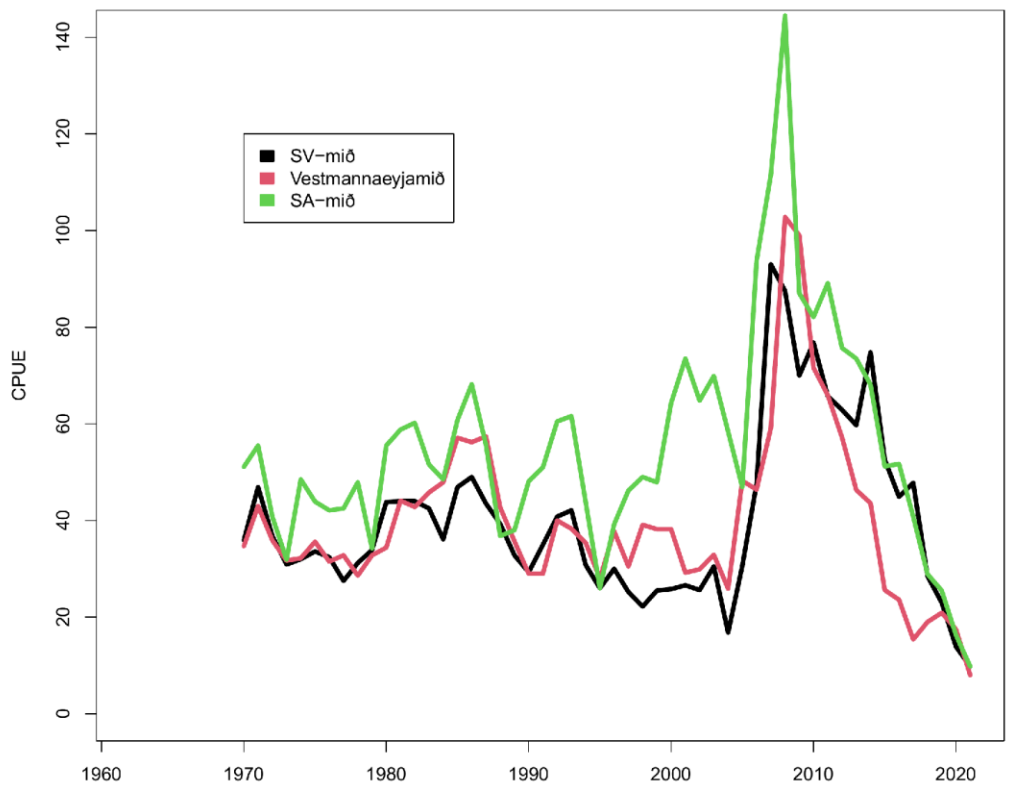

Figure 3. Norway lobster. Standardized CPUE in 1970–2021 in the SW- (black), Vestmannaeyjar- (south) (red) and SE areas (green).

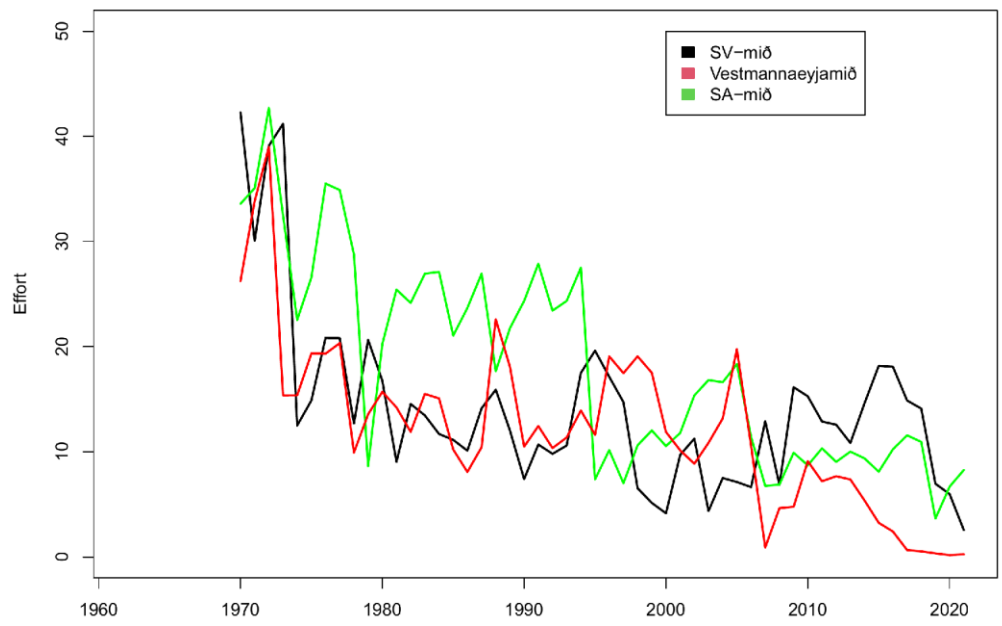

Figure 4. Norway lobster. Standardized effort in 1970–2021 in the SW- (black), Vestmannaeyjar- (south) (red) and SE-areas (green).

LENGTH DISTRIBUTIONS

In 2021, 27 length samples were obtained from the landed catch and the survey. The most frequent sizes (CL) of males in the samples in 2021 were around 57 mm (Figure 5). In recent years very few small *Nephrops* have been caught and in 2021 there was a low ratio of *Nephrops* smaller than 40 mm CL recorded. Large proportion was above 60 mm and the ratio of animals over 70 mm CL was considerable.

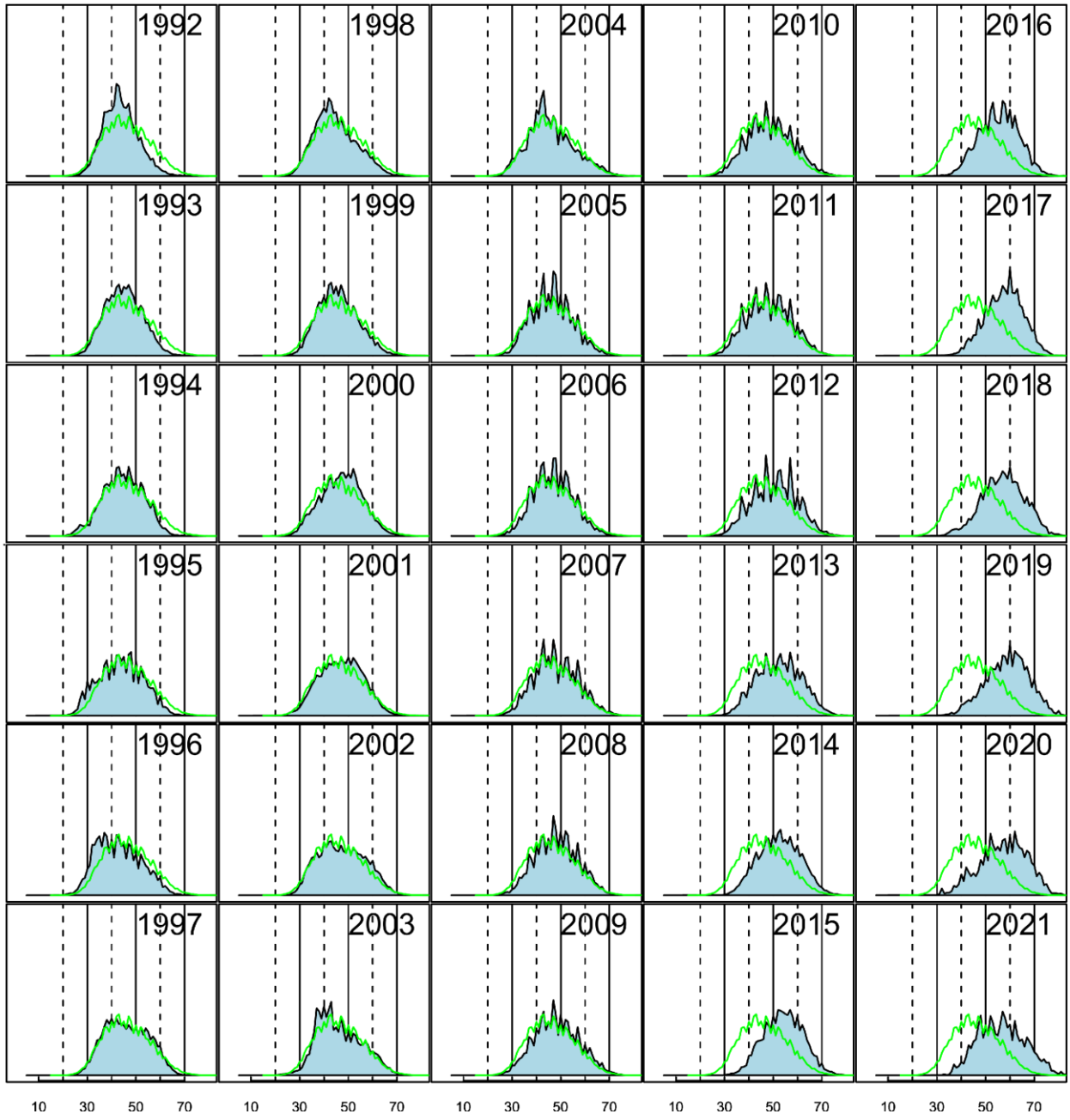

Figure 5. Norway lobster. Length frequency distribution (shaded area) of all samples 1992–2021. The green line shows the average of the years 1970–2021.

SURVEYS

Figure 6. Norway lobster. Polygons of *Nephrops* grounds (see Figure 2) based on VMS data. See name of grounds marked by the red number in Table 4.

UWTV SURVEY

The first underwater TV (UWTV) survey in Icelandic water was conducted in June 2016, following a pilot study in Jökuldjúp in April that same year. In total, 86 UWTV-stations on a roughly 4.5 nautical mile grid were completed on all known *Nephrops* grounds in 2016. The size of the *Nephrops* area was estimated from VMS data. A minimum of 6 pings from *Nephrops* vessel at fishing speed on 800*800 meters resolution grid was used as a threshold, which approximately includes 99% of the pings. Adjoining grids are then combined and fishing grounds smaller than 4 km^2 are excluded. The total size of the fishing grounds was estimated to be 5989 km^2 based on data from 2007–2016, but there was a gradual shift to fishing on new or connected grounds in 2017 and 2018, especially in the SW area. The estimated size of *Nephrops* grounds in 2018 was 6588 km^2 (Table 4, Figure 6). In total there were nine distinct areas ranging from 247 km^2 to 1400 km^2. The largest ground (Vestmannaeyjar) is in the southern part (Háfadjúp to Selvogsbanki) and the smallest one is Lónsdjúp in the east. Three grounds were split up into 2–3 patches: Vestmannaeyjar, Hornafjarðardjúp and Selvogsgrunn.

The total number of *Nephrops* in the survey conducted in June 2021 was estimated to be 435 million animals, compared to 434 million animals in 2020. Average density in 2021 was 0.066 burrows/m^2 (Table 4, Figure 7). Highest density of burrows was in Breiðamerkurdjúp; 0.095 and Lónsdjúp, 0.091 burrows/m^2 respectively (Figures 8 and 9). The lowest density or slightly below 0.06 burrows/m^2 was on the Vestmannaeyjar, Grindavíkurdýpi and Selvogur grounds, all in the southern or southwestern part. Results from 2016-2020 are shown in Figures 10 and 11.

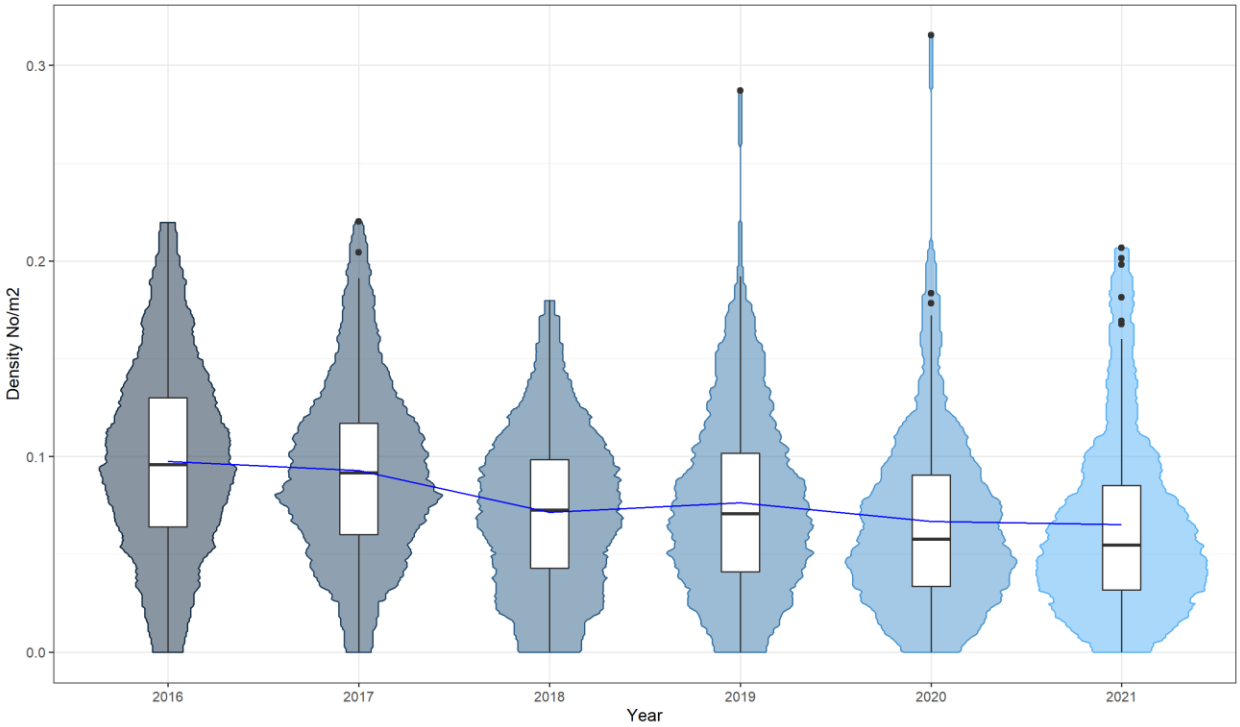

Figure 7. Norway lobster. Violin and boxplots of adjusted burrow density distributions by year 2016-2021. The blue line indicates the mean density over time. The horizontal black lines represent the median, white boxes are the inter quartile ranges, the black vertical lines show the range, and the black dots are outliers.

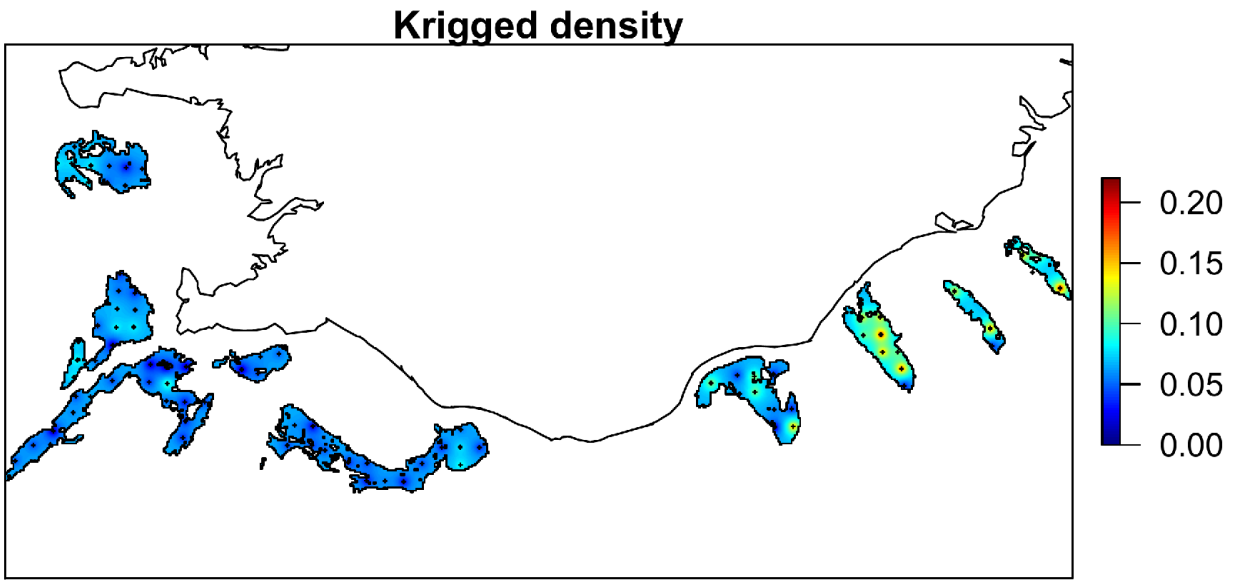

Figure 8. Norway lobster. Density of burrows (krigged density per m^2, gaussian model) on *Nephrops* grounds from the UWTV surveys conducted in 2021 The crosses represent the stations.

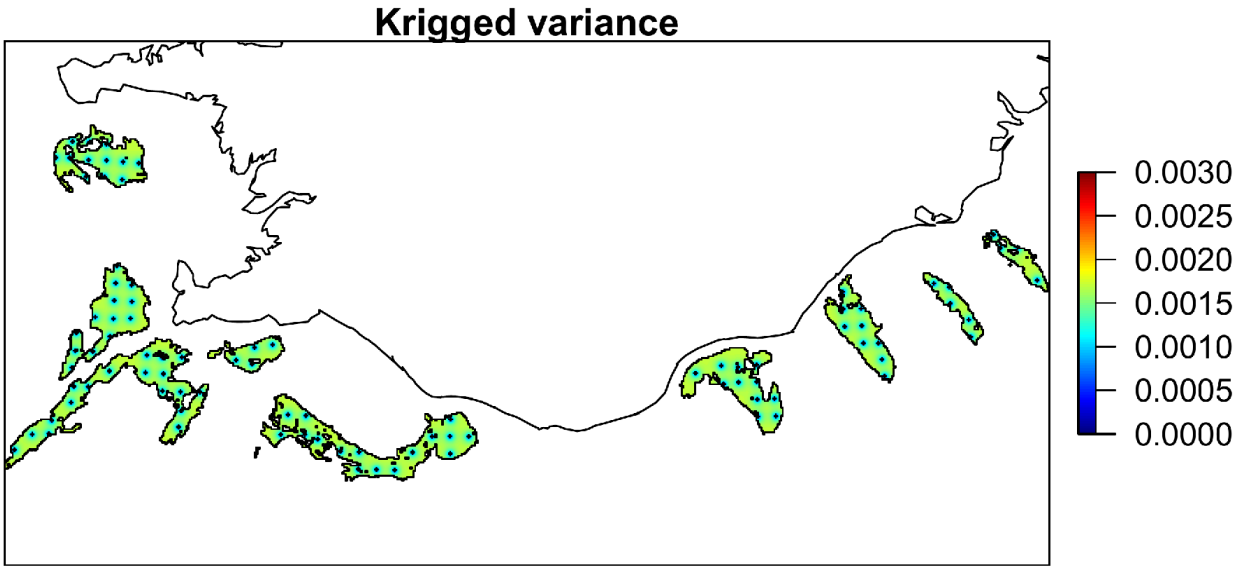

Figure 9. Norway lobster. Krigged variance of burrows density on *Nephrops* ground from the UWTV surveys conducted in 2021. The crosses represent the stations.

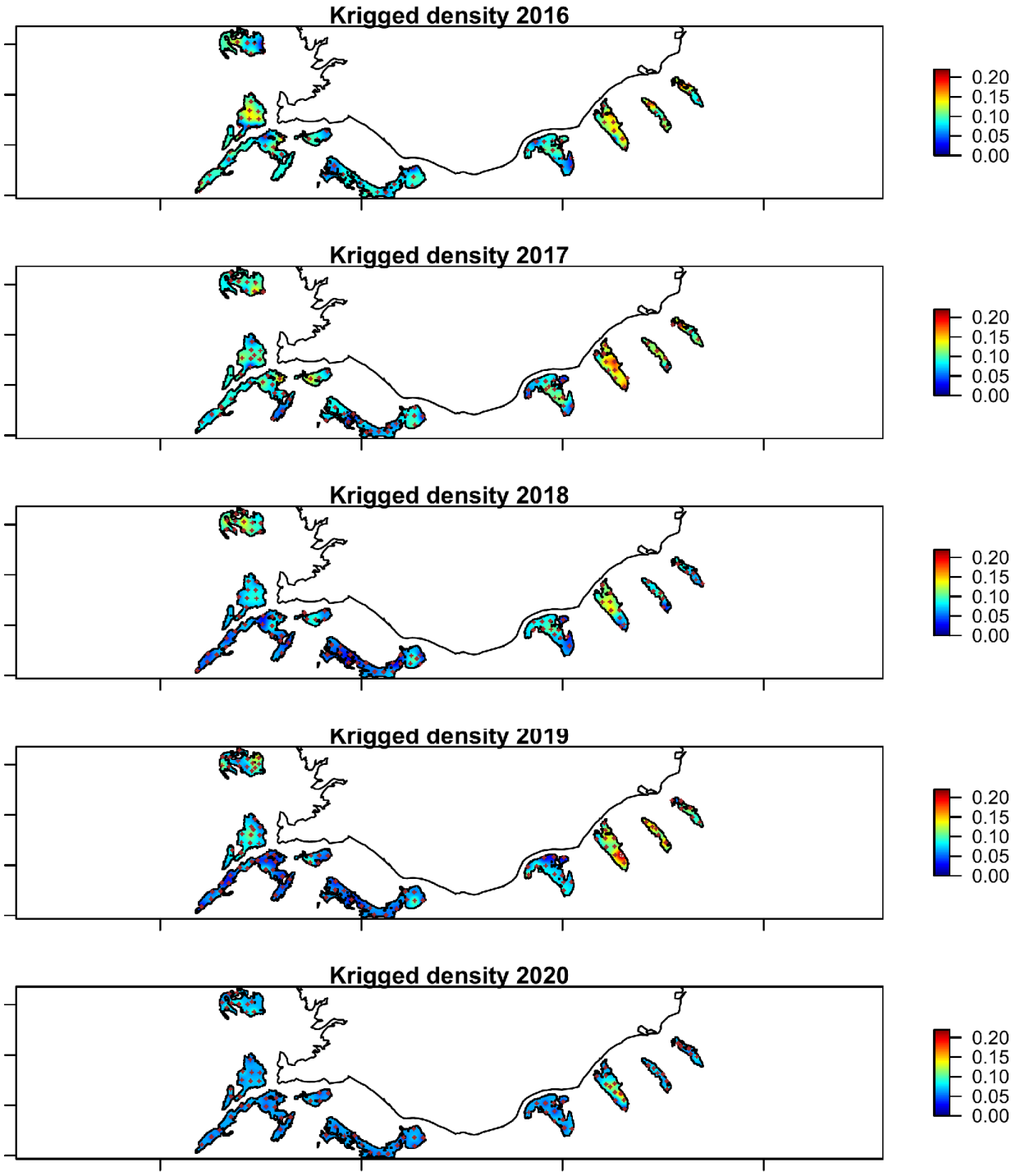

Figure 10. Norway lobster. Density of burrows (krigged density per m^2, gaussian model) on *Nephrops* grounds from the UWTV surveys conducted in 2016-2020. The brown crosses represent the stations.

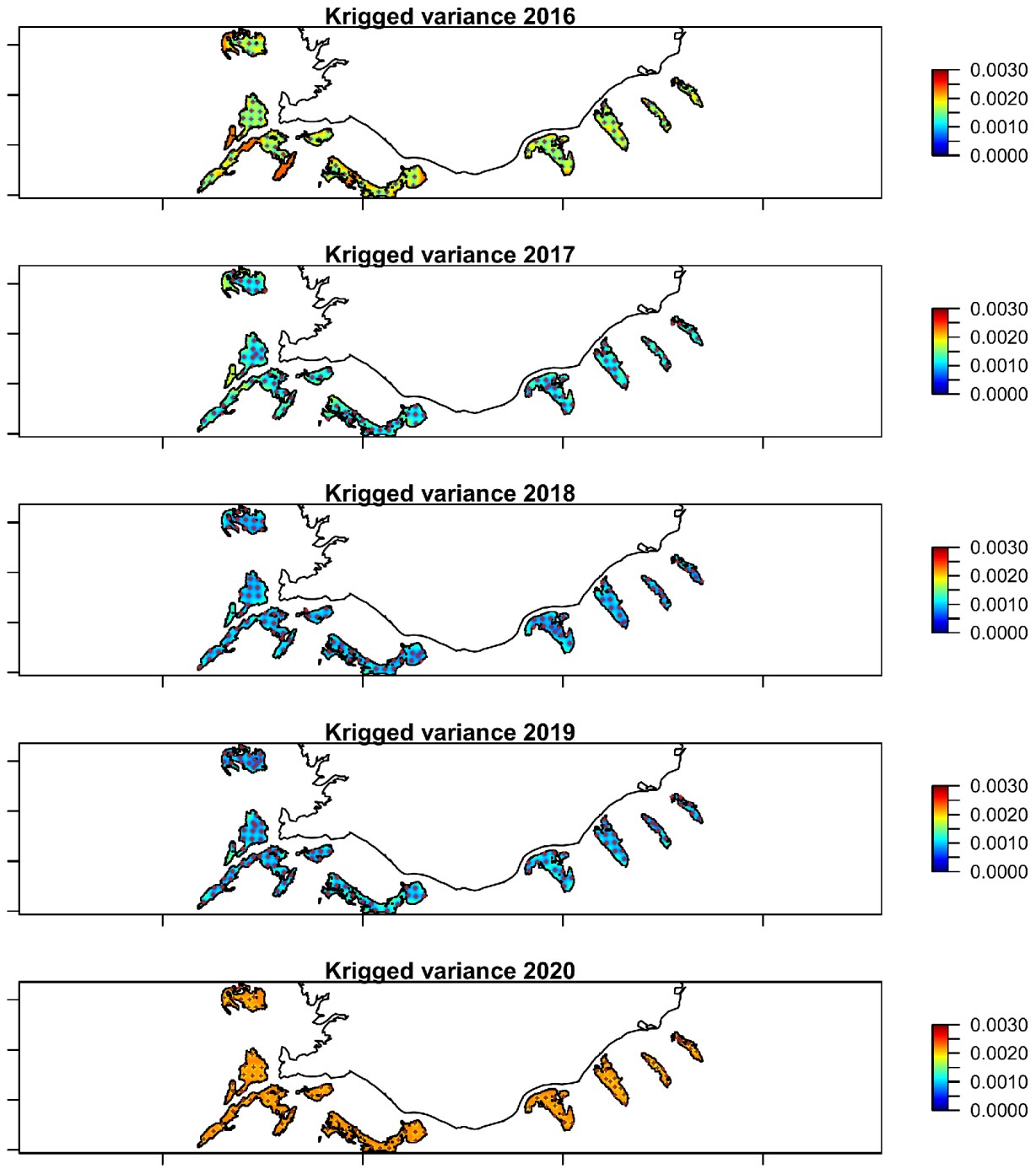

Figure 11. Norway lobster. Krigged variance of burrows density on *Nephrops* ground from the UWTV surveys conducted in 2016-2020. The brown crosses represent the stations.

LARVAE SURVEY

During the 2018 UWTV survey, 23 bongo-net stations (500 µm mesh size) were accomplished for the first time after the completion at every forth UWTV station. The objective is to estimate recruitment of *Nephrops*. The bongo-net was towed in a V–shaped manner down to 40 m and up to the surface. In 2019 to 2021, 28, 25 and 25 stations were conducted, respectively. *Nephrops* larvae were found on 10 stations in 2018, on 19 stations in 2019, on 15 stations in 2020 and on 16 stations in 2021 (Figure 12). The average density was 15.1 larvae per 1000 m^3 in 2018, 24.8 larvae in 2019, 8.1 larvae in 2020 and 11.0 larvae during the 2021 survey. The distribution was wider in the 2019-2021 surveys, compared to the 2018 survey. Through the years, it was more common to find the Zoea stages II-III in the southeast region. The information from this sampling can be indicative of future recruitment.

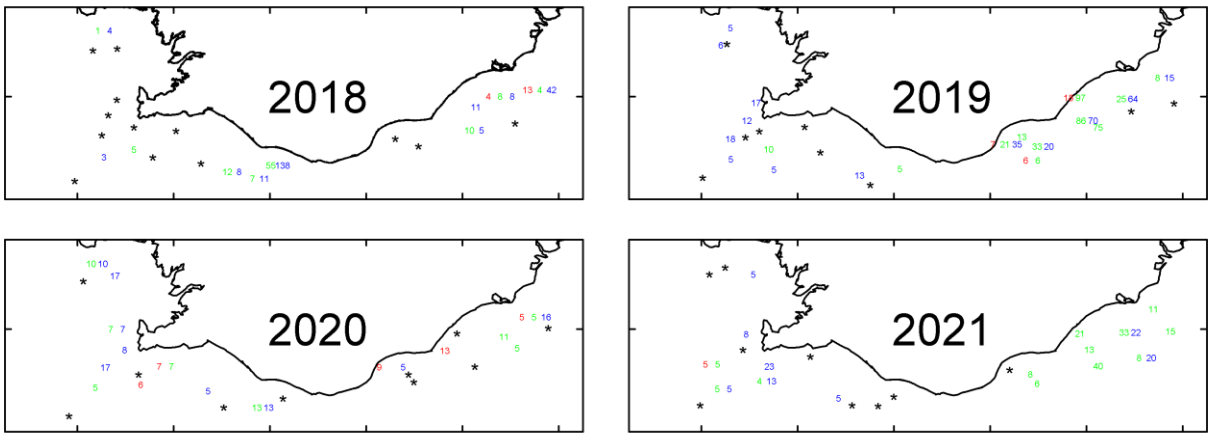

Figure 12. Norway lobster. Number of *Nephrops* larvae caught in bongo-net per 1000 m^3 from surveys conducted in 2018 to 2021. Blue numbers indicate larvae on Zoea stage 1, green Zoea stage 2, and red Zoea stage 3. Black asterisks are stations where no *Nephrops* larvae were found.

TRAWL SURVEY

A *Nephrops* trawl survey was conducted from 1973 to 2015. In the survey, 55 standardized two-hour tows were conducted on all *Nephrops* grounds. The stock abundance index declined from the peak in 2009 and reached the lowest value in 2015. There have been some similarities between the stock index and CPUE, but less in recent years and during the early years of the survey. Catchability has been related to water clarity (mainly due to phytoplankton) with generally higher catches in murkier waters, and with less *Nephrops* when groundfish numbers are high. This is reflected in the biology and the burrowing behavior of *Nephrops* as the strong temporal patterns in catch rates make the traditional trawl surveys unfeasible to estimate abundance. This led to the progress of using UWTV survey in 2016 to assess stock development and provide management advice for the *Nephrops* stock in Icelandic waters (Campbell, *et al.,* 2009).

BOTTOM TRAWLING ON *NEPHROPS* GROUNDS

TRAWLING INTENSITY

In addition to trawling with *Nephrops* trawl, a considerable amount of bottom trawling for groundfish occurs on *Nephrops* grounds. There are around 6600 towed hours annually (2014-2018) on *Nephrops* grounds (Table 5). Most of the activity is on the Vestmannaeyjar *Nephrops* ground or almost 4000 towed hours (2.4 hours annually per km^2). Slightly higher trawling activity is in Breiðamerkurdjúp or 2.5 h per km^2 and high trawling activity is also in Hornafjarðardjúp (0.9 h per km^2) and Lónsdjúp (0.7 h per km^2). On average, the CPUE of cod (*Gadus morhua*), the most important demersal fish species, south of 65°N is 0.5 tonnes per hour towed (Table 8). The CPUE of cod was high within Vestmannaeyjar grounds (1.2 t/h), but lower than average in the eastern *Nephrops* areas, i.e., Breiðamerkurdjúp, Hornafjarðardjúp and Lónsdjúp, or around 0.3 t/h in all regions (Figure 13, Table 5). CPUE of haddock (*Melanogrammus aeglefinus*) and ling (*Molva molva*) is also higher within the Vestmannaeyjar region compared to other areas south of 65°N (Table 5).

Because of poor state of the *Nephrops* stock, it is proposed to close the core *Nephrops* areas southeast of Iceland from additional disturbance of groundfish bottom trawling to protect the observed recruitment (Figure 13, Table 5). Those areas have relatively high trawling activity but are of less importance for groundfish than the Vestmannaeyjar grounds.

Recommended boundaries of closures for bottom trawling on Nephrops *grounds:*

Breiðamerkurdjúp

1. 63°52'50''N - 16°16'00''V
2. 63°35'00''N - 15°46'00''V
3. 63°37'00''N - 15°41'00''V
4. 63°57'50''N - 16°02'00''V
5. 63°52'50''N - 16°16'00''V

Hornafjarðardjúp

1. 64°00'00''N - 15°18'00''V
2. 63°43'00''N - 14°52'00''V
3. 63°46'00''N - 14°47'00''V
4. 64°00'00''N - 15°10'00''V
5. 64°00'00''N - 15°18'00''V

Lónsdjúp

1. 64°10'00''N - 14°42'00''V
2. 63°56'00''N - 14°12'00''V
3. 63°56'00''N - 14°05'00''V
4. 64°10'00''N - 14°30'00''V
5. 64°10'00''N - 14°42'00''V

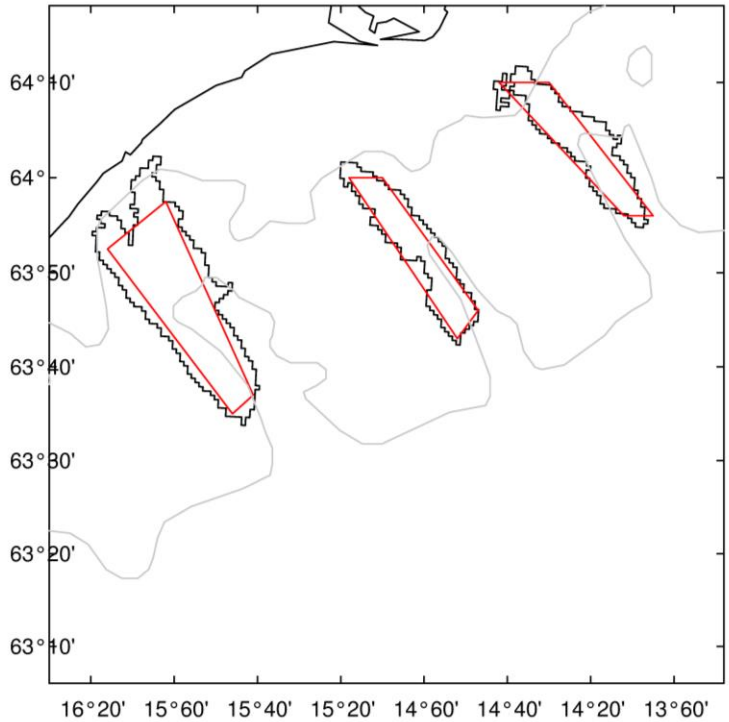

Figure 13. Norway lobster. Polygons of *Nephrops* grounds based on VMS data in southeastern Iceland. Proposed closed areas for bottom trawling within *Nephrops* areas are plotted (red lines) and depth contours (100 and 200 m, grey lines).

HARVEST RATE

According to the UWTV survey, the harvest rate in 2021 varied from 0–1.1% between grounds, with an average harvest rate of 0.19% (Table 4). Limited fisheries were on Vestmannaeyjar and Selvogsbanki with subsequently low harvest rate. The highest harvest rate was in Hornafjarðardjúp, followed by Breiðamerkurdjúp. The ratio of males in the catches was estimated to be 76–100%.

With declining catches, the harvest rate has declined from 1.91% in 2016 to 0.19% in 2021 (Figure 1). During the monitoring fishery of 2021, the harvest rate decreased on all grounds between years (Figure 14). Despite the disjointed nature of the *Nephrops* ground in Iceland and therefore relatively small number of stations on each ground, the relative abundance shows similar fluctuations on different grounds (Figures 8, 10 and 14). The trends are similar on the closed grounds Jökuldjúp and Lónsdjúp as within areas where the harvest rate is very low. Roughly 2 tonnes were caught with traps in Jökuldjúp in 2021 and 300 kg in Kolluáll (next deep north of Jökuldjúp).

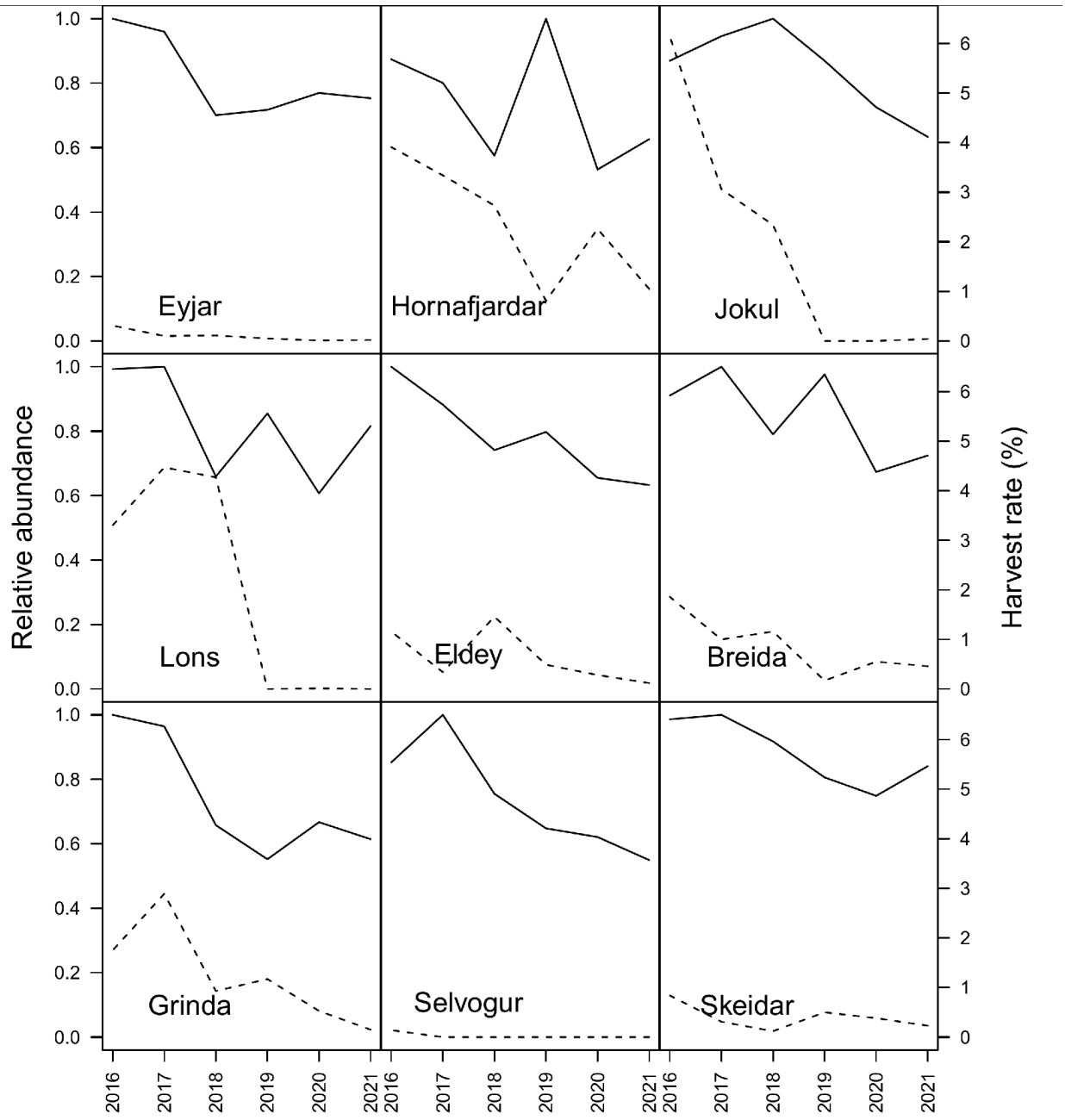

Figure 14. Norway lobster. Relative burrow abundance (solid line) and harvest rate (dotted line) in individual subareas (Eyjar–area 1, Hornafjardar – area 2, Jokul – area 3, Lons – area 4, Eldey – area 5, Breida area 6, Grinda – area 7, Selvogur – area 8 and Skeidar – area 9) during 2016 – 2021 (See Figure 6 for area id locations).

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Table 1. Norway lobster. Landings from Icelandic waters.

Year	Iceland	Other nations	Total
1951	0	26	26
1952	0	53	53
1953	0	144	144
1954	0	236	236
1955	0	203	203
1956	0	138	138
1957	0	312	312
1958	728	593	1321
1959	1404	602	2006
1960	2081	451	2532
1961	1490	322	1812
1962	2662	154	2816
1963	5550	512	6062
1964	3487	586	4073
1965	3706	409	4115
1966	3465	546	4011
1967	2731	208	2939
1968	2489	157	2646
1969	3512	189	3701
1970	4026	119	4145
1971	4657	155	4812
1972	4321	260	4581
1973	2791	5	2796
1974	1983	6	1989
1975	2357	0	2357
1976	2780	0	2780
1977	2723	0	2723
1978	2059	0	2059
1979	1440	0	1440
1980	2398	0	2398
1981	2520	0	2520
1982	2603	0	2603
1983	2672	0	2672
1984	2459	0	2459
1985	2385	0	2385
1986	2564	0	2564
1987	2712	0	2712
1988	2240	0	2240
1989	1866	0	1866
1990	1692	0	1692
1991	2157	0	2157
1992	2230	0	2230
1993	2381	0	2381
1994	2238	0	2238
1995	1027	0	1027
1996	1633	0	1633
1997	1228	0	1228
1998	1411	0	1411

Year	Iceland	Other nations	Total
1999	1376	0	1376
2000	1239	0	1239
2001	1420	0	1420
2002	1548	0	1548
2003	1666	0	1666
2004	1437	0	1437
2005	2030	0	2030
2006	1875	0	1875
2007	2006	0	2006
2008	2070	0	2070
2009	2464	0	2464
2010	2540	0	2540
2011	2240	0	2240
2012	1914	0	1914
2013	1724	0	1724
2014	1965	0	1965
2015	1454	0	1454
2016	1398	0	1398
2017	1194	0	1194
2018	728	0	728
2019	259	0	259
2020	194	0	194
2021	107	0	107

Table 2. Norway lobster. Landings (in tonnes) and CPUE (kg/hour trawled) by area.

Year	swLandings	swCPUE	sLandings	sCPUE	seLandings	seCPUE	Landings	CPUE
1970	1517	35.9	916	34.7	1593	51.1	4026	40.2
1971	1393	46.9	1446	43.0	1818	55.5	4657	48.4
1972	1500	36.8	1370	35.9	1451	40.8	4321	37.7
1973	1130	30.9	535	31.6	1126	31.9	2791	31.3
1974	408	32.0	492	32.2	1083	48.5	1983	39.4
1975	527	33.6	717	35.6	1113	43.9	2357	38.5
1976	817	32.4	608	31.5	1355	42.1	2780	36.2
1977	571	27.5	663	32.8	1489	42.5	2723	35.7
1978	395	31.2	290	28.6	1374	47.9	2059	40.0
1979	700	33.9	445	32.8	295	34.2	1440	33.6
1980	734	43.8	540	34.4	1124	55.5	2398	45.5
1981	398	44.0	627	44.1	1495	58.8	2520	51.8
1982	640	44.0	509	42.8	1454	60.2	2603	51.5
1983	572	42.5	710	45.8	1390	51.6	2672	47.8
1984	422	36.1	722	47.9	1315	48.5	2459	45.6
1985	522	46.9	583	57.1	1280	60.8	2385	56.4
1986	495	49.0	454	56.2	1615	68.2	2564	61.3
1987	615	43.5	599	57.4	1498	55.6	2712	52.6
1988	625	39.3	965	42.7	650	36.8	2240	39.9
1989	394	32.8	645	35.7	827	38.0	1866	36.0
1990	217	29.3	304	29.0	1171	48.1	1692	40.0
1991	374	35.0	361	29.0	1422	51.0	2157	42.1
1992	400	40.8	414	40.0	1417	60.5	2230	51.3
1993	446	42.1	435	38.3	1500	61.6	2381	51.4
1994	539	30.8	493	35.4	1205	43.8	2238	38.0
1995	510	26.0	325	28.0	192	26.0	1027	27.0
1996	514	30.0	721	37.8	398	39.2	1633	35.2
1997	371	25.2	533	30.5	324	46.2	1228	31.3
1998	145	22.2	746	39.1	520	49.0	1411	38.9
1999	131	25.5	669	38.2	576	47.9	1376	39.7
2000	107	25.8	454	38.2	678	64.3	1239	46.6
2001	258	26.6	296	29.2	866	73.5	1420	44.9
2002	288	25.6	265	29.9	995	64.8	1548	43.7
2003	133	30.5	357	32.9	1176	69.9	1666	52.0
2004	126	16.8	341	25.9	970	58.4	1437	38.5
2005	218	30.6	953	48.2	860	46.9	2030	44.9
2006	316	47.6	490	46.4	1069	93.7	1875	65.5
2007	1200	93.0	53	59.1	753	111.5	2006	97.6
2008	599	87.5	477	102.8	994	144.5	2070	112.7
2009	1130	70.0	472	99.8	862	86.9	2464	80.0
2010	1173	76.8	652	71.6	715	82.1	2540	75.8
2011	846	65.7	474	65.9	920	89.1	2240	71.0
2012	791	62.9	439	57.2	684	75.7	1914	63.0
2013	647	59.7	341	46.3	736	73.5	1724	60.5
2014	1093	74.8	234	43.6	638	68.1	1965	67.4
2015	956	52.6	83	25.6	415	51.2	1454	48.3
2016	812	44.9	57	23.6	529	51.7	1398	44.5
2017	711	47.8	10	15.4	472	40.8	1194	44.4
2018	402	28.5	10	19.0	316	28.9	728	28.3
2019	160	23.0	6	20.9	93	25.5	259	23.4
2020	84	13.9	1	17.5	109	16.3	194	14.8
2021	25	9.8	2	8.0	81	9.8	107	9.8

Table 3. Norway lobster. Recommended TAC, National TAC set by the Ministry and landings (tonnes). *Includes also autumn catches in 2018. #No TAC was issued in 2019 but allowed to fish quota transfers from previous years.

Year	Rec. TAC	TAC	Landings
1984	2400	2600	2500
1985	2300	2400	2400
1986	2500	2500	2600
1987	2700	2800	2700
1988	2600	2600	2200
1989	2100	2100	1900
1990	2100	2000	1700
1991	2100	2100	2200
1991/92	2100	2100	2200
1992/93	2200	2400	2400
1993/94	2200	2400	2200
1994/95	2200	2200	1000
1995/96	1500	1500	1600
1996/97	1500	1500	1200
1997/98	1500	1200	1400
1998/99	1200	1200	1400
1999/00	1200	1200	1300
2000/01	1400	1400	1400
2001/02	1500	1500	1577
2002/03	1600	1600	1687
2003/04	1600	1600	1437
2004/05	1500	1500	2035
2005/06	1600	1800	1946
2006/07	1700	1800	1946
2007/08	1900	1900	2000
2008/09	2200	2200	1999
2009/10	2200	2200	2456
2010/11	2100	2100	2259
2011/12	2000	2100	2130
2012/13	1900	1900	1965
2013/14	1750	1750	1983
2014/15	1650	1650	1425
2015/16	1500	1500	1536
2016/17	1300	1300	1186
2017/18*	1150	1150	869
2019	235	#	259
2020	214	214	194
2021	143	143	107

Table 4. Norway lobster. Summary of 2021 UWTV survey and information about the catch in 2020. Name of an area, id of area (see Figure 6), size of the area (km²), number of burrows (million), mean number of burrows per meter square, catches per area, mean weight of *Nephrops* in catch, ratio of males in the catch (%), number of animals removed (million) and harvest rate.

Area	Id	km²	Burrows	Burrows m²	Catch (t)	M.weight (g)	M%	Removals	Harvest rate
Jökuldjúp	3	737	47	0.06	2.5	0.139	100	0.02	0.04%
Eldey	5	845	54	0.06	8.9	0.136	99	0.07	0.12%
Grindav.-/Skerjadjúp	7	1307	72	0.06	13.0	0.124	92	0.10	0.15%
Selvogur	8, 11, 12	296	16	0.06	0				0%
Vestmannaeyjar	1, 10	1400.0	82	0.06	1.5	0.146	0.99	0.01	0.00%
Skeiðarárdjúp	9	859	60	0.07	14.4	0.104	97	0.14	0.23%
Breiðamerkurdjúp	6	638	61	0.10	31.8	0.113	90	0.28	0.46%
Hornafjarðardjúp	2	259	21	0.08	34.9	0.156	90	0.22	1.05%
Lónsdjúp	4,13	247	23	0.09	0				0%
Total		**6588**	**435**	**0.066**	**107**	**0.126**		**0.85**	**0.19%**

Table 5. Summary of the average (2014-2018) annual bottom trawl effort on *Nephrops* grounds and all areas south of 65°N. Effort is in hours, E / km² is the effort per km² on *Nephrops* ground. Cod, haddock and ling is the average tonnes caught per species with bottom trawl and CPUE is the tonnes caught per hour for given species.

Area	id	Effort	E / km²	Cod	C CPUE	Haddock	H CPUE	Ling	L CPUE
South of 65°N		47371		23784	0.50	7068	0.15	772	0.02
Jökuldjúp	3	53	0.07	18	0.35	3	0.06	1	0.02
Eldey	5	317	0.38	239	0.75	44	0.14	10	0.03
Grindav.-/Skerjadjúp	7	468	0.36	106	0.22	17	0.04	13	0.03
Selvogur	8	13	0.04	7	0.51	1	0.07	0	0.01
Vestmannaeyjasvæði	1	3387	2.42	3970	1.17	821	0.24	408	0.12
Skeiðarárdjúp	9	360	0.42	44	0.12	66	0.18	18	0.05
Breiðamerkurdjúp	6	1619	2.54	488	0.30	67	0.04	57	0.04
Hornafjarðardjúp	2	237	0.91	72	0.31	14	0.06	3	0.01
Lónsdjúp	4	172	0.70	60	0.35	15	0.09	2	0.01