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The Norwegian fishery for northern shrimp (*Pandalus borealis*) in the Barents Sea and round Svalbard 1970-2019

by

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Abstract

The resource of northern shrimp (*Pandalus borealis*) in the Barents Sea is considered as one stock unit. The fishery is multinational. Catches have ranged between 19 000 and 128 000 tons since the mid-1970s. Historically Norway has accounted for the major part (~75-95%) of the landings, however, in the recent 5-year period the Norwegian proportion has decreased to less than 40% while EU, Russia, Greenland and Iceland shares the rest. The fishery is managed partly by TAC (Russian zone) and by effort control (Norwegian and Svalbard zone). Discard of small shrimp and by-catch of other species is believed to be low.

Overall catches have declined from 80 ktons in 2000 to 20 ktons in 2014 partly due to a downturn in market prices for shrimp products, and a major restructuring of the fleet. The bulk of the landings have been taken more easterly recent years than seen earlier in the 2000s and the recent decreases in catches can also be attributed to the displacement of shrimp biomass eastwards requiring new fishing grounds to be developed. Since 2013 catches have started to increase again and is projected to reach 78000 tons in 2019.

A standardized catch-per-unit-effort series derived from Norwegian logbook data (and used as an index of fishable stock biomass dynamics) have been fluctuating at a relatively high level since 2005 however the 2012-16 values are lower, below the average of the time series. The 2017-18 values are up again and the 2019 value, based on only partial data for the year, is the highest of the time series.

Introduction

The resource of northern shrimp (*Pandalus borealis*) in the Barents Sea and in the Svalbard zone (ICES Div. I and II) is for assessment purposes considered as one stock (Fig. 1). Norwegian and Russian vessels exploit the stock in the entire area while vessels from other nations are restricted to the Svalbard fisheries zone.

The fishery was initiated in 1970 by Norwegian vessels. As the fishery developed, vessels from several nations joined and catches reached 128 ktons in 1984 (Fig. 2). Since 2000 annual catch have declined reaching a low of 20 ktons in 2013; Norwegian vessels accounted for around 46-92% of the total catches in that period and vessels from Russia, Iceland, Greenland and the EU for the rest (Table 1). Since 2013 overall catches have started to increase again and is projected to reach about 78000 tons in 2019, Norwegian vessels now responsible for about one third of these.

The fishery is regulated by TACs in the Russian zone and effort control in the Norwegian and Svalbard zones: licenses are required for the Russian and Norwegian vessels and the fleets operating in the Svalbard zone are regulated by number of effective fishing days and number of vessels by country. Minimum cod-end mesh size is 35 mm. Other species and small shrimp are protected by mandatory sorting grids and by the temporary closing of areas with excessive by-catch of juvenile cod, haddock, Greenland halibut, redfish and shrimp <15 mm carapace length (measured in catch samples taken by independent observers).

A major restructuring of the Norwegian fleet towards fewer and larger vessels has taken place mid1990s to late 2010s. The fleet is now largely composed of a few large offshore factory trawlers (>6000HP (HP=engine horsepower)) and a small group of <500HP vessels mainly fishing inshore. Trawling is mainly performed using two or three trawls simultaneously.

The present paper updates available information derived from catch statistics, logbooks and catch sampling from the Norwegian trawl fishery for shrimp in the Barents Sea (ICES Div. I and II).

Materials and methods

Logbook data from Norwegian vessels were analyzed to show the spatial and temporal distribution of the fishery and fleet composition. Derived catch-per-unit-effort (CPUE) data were used in multiplicative models to calculate standardized annual catch rate indices (Hvingel *et al*., 2000).

The CPUE indices included the following variables: (1) vessel fishing power, (2) seasonal availability of shrimp, (3) spatial availability of shrimp, (4) gear type (single, double or triple trawl) and (5) annual mean CPUE. The calculations were done using the SAS statistical software (Anon., 1988). The area definition used is similar to the stratification used in the 1980-2004 survey (Hvingel, 2007). The multiplicative model was represented in logarithmic form as:

$$\ln\left(CPUE_{kjmhi}\right) = \ln\left(u\right) + \ln\left(V_k\right) + \ln\left(S_j\right) + \ln\left(A_m\right) + \ln(G_h) + \ln\left(Y_i\right) + e_{kjmhi}$$

Where $CPUE_{kjmhi}$ is the mean CPUE for vessel k, fishing in area m in month j during year i with geartype h (k = 1,...,n; m = 1,...,a; j = 1,...,s; i = 1,...,y; h=1,2,3); ln(u) is overall mean ln(*CPUE*); V_k is the effect of the kth vessel; S_j is the effect of the jth month; A_m is effect of the mth area; G_h is the effect of gear type h; Y_i is the effect of the ith year; e_{kjmhi} is the error term assumed to be normally distributed N(0,σ^2/n) where n is the number of observations in the cell. The standardized CPUE indices are the antilog of the year coefficients.

Results

Spatial and seasonal distribution

The fishery has mainly been conducted in the Hopen area (central Barents Sea) which, along with the Svalbard shelf, and on the Goosebank (south east Barents Sea) is considered the most important fishing ground (Fig. 1 and 3). However, since 2008 logbook data show a decreased activity in the Hopen Deep, coupled with increased effort further east in international waters in the so-called “Loop Hole”. Information from the industry points to higher densities of shrimp in this area and area closures in the traditional Hopen Deep due to bycatch of juvenile fish as the main reasons for the change in fishing pattern. In recent years, several fish stocks have increased substantially in the Barents Sea and as a consequence the by-catch restrictions (area closures) have had an increasing effect on the distribution of the shrimp fishery.

The fishery takes place in all months but may in certain years be restricted by ice conditions. The lowest intensity is generally seen in October through March, the highest in April to August (Fig. 4). In 2016-17 seasonal effort distribution is like the 2006-2015 average.

Landings

Fishery in offshore areas began in 1970 and catches increased over the following 15 years from 5 to 128 ktons (Fig 2). Catches then declined rapidly. A new peak was seen in 1990 and again in 2000 at 83 ktons. Since 2000 catches have declined to 20 ktons in 2013. Since 2013 catches have started to increase again and is projected

to reach about 78000 tons in 2019 (based on data until July, logbooks and information from the industry). The 2000 to 2013 decline in catches is partly attributed to reduced market prices for shrimp products, and a major restructuring of the fleet. The increase in catch after 2013 follows an increase in prices for shrimp products.

Discards and bycatch. Discard of shrimp cannot be quantified but is believed to be small as the fishery is not limited by quotas. Bycatch rates of other species are estimated from at-sea inspections and research surveys and are corrected for differences in gear selection pattern (AFWG 2017). Area-specific bycatch rates are then multiplied by the corresponding shrimp catches from logbooks to give an overall bycatch estimate. Revised and updated discards estimates (1983–2017) of cod, haddock and redfish juveniles in the commercial shrimp fishery in the Barents Sea were available in 2018 (Table 2, Fig. 6). Since the introduction of the Nordmøre sorting grid in 1992, only small individuals of cod, haddock, Greenland halibut, and redfish, in the 5–25 cm size range, are caught as bycatch.

Fleet composition and gear
A major restructuring of the fleet towards fewer and larger vessels has taken place from the mid-1990s to late 2010s. An average vessel had before that period around 1000 HP. By the end of the 2010s this value had increased to about 6000 HP (Fig. 5). This fishery was originally a "single-trawl-fishery". Since the early 2000s most fishery has been conducted by using two or three trawls simultaneously.

Standardized CPUE
The fishery dependent index of stock density in the fished areas – the standardized CPUE – is indicative of shrimp greater than 16 mm cpl., i.e. of the older male and the female stock combined (Hvingel and Thangstad 2008). The standardized CPUE declined by 60% from a maximum in 1984 to the lowest value of the time series in 1987 (Table 3, Fig. 7). Since then it has shown an overall increasing trend until 2010. After 2010 it decreased below the average.

The 2018 and 2019 values are record high. Input data and model diagnostics were scrutinised but there was not found anything to indicate errors or model deficiencies. It is still uncertain whether the preliminary 2018-19 standardized CPUE index value is a good reflection of stock biomass and further investigations into this question are ongoing. However, the increase seen from 2017 to 2019 is corroborated by the fishery independent trawl survey.

Details and diagnostics of the GLM model fit are given in appendix 1.

References

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Table 1. Nominal landings ('000 tons) by nation (2019 catch is estimated based on data until September).

Year	Norway	Russia	Others	Total
1970	5.508	0	0	5.508
1971	5.116	0	0.026	5.142
1972	6.772	0	0	6.772
1973	6.921	0	0	6.921
1974	8.008	0	0	8.008
1975	8.197	0	0.002	8.199
1976	9.752	0	0	9.752
1977	14.700	0	4.854	19.554
1978	20.484	18.27	0.189	38.943
1979	25.435	10.474	0.39	36.299
1980	35.061	11.219	0	46.280
1981	32.713	9.886	1.011	43.610
1982	43.451	15.552	3.835	62.838
1983	70.798	29.105	4.903	104.806
1984	76.636	43.180	8.246	128.062
1985	82.123	32.104	10.262	124.489
1986	48.569	10.216	6.538	65.323
1987	31.353	6.690	5.324	43.367
1988	32.021	12.32	4.348	48.689
1989	47.064	12.252	3.432	62.748
1990	54.182	20.295	6.687	81.164
1991	39.663	29.434	6.156	75.253
1992	39.657	20.944	8.021	68.622
1993	32.663	22.397	0.806	55.866
1994	20.162	7.108	1.063	28.333
1995	19.337	3.564	2.319	25.220
1996	25.445	5.747	3.320	34.512
1997	29.079	1.493	5.163	35.735
1998	44.792	4.895	6.103	55.790
1999	52.612	10.765	12.293	75.670
2000	55.333	19.596	5.768	80.697
2001	43.031	5.846	8.408	57.285
2002	48.799	3.790	8.899	61.488
2003	34.172	2.776	2.277	39.225
2004	35.918	2.410	4.406	42.734
2005	37.253	0.435	4.930	42.618
2006	27.352	0.004	2.271	29.627
2007	25.558	0.192	4.181	29.931
2008	20.662	0.417	7.109	28.188
2009	19.784	0.000	7.488	27.272
2010	16.779	0.000	8.419	25.198
2011	19.928	0.000	10.298	30.226
2012	14.158	0.000	10.598	24.756
2013	8.846	1.067	9.336	19.249
2014	10.234	0.741	9.989	20.964
2015	16.618	1.151	16.253	34.022
2016	10.896	2.490	17.359	30.745
2017	7.010	3.849	19.582	30.441
2018	23.100	12.561	20.25	55.911
2019	23.000	33.000	22.000	78.000

Table 2. Estimated bycatch (no. in millions) and index of bycatch (bycatch number/total shrimp catch in weight). No data for polar cod; data for Greenland halibut not updated. (Source Arctic Fisheries Working Group, ICES).

	Absolute # in millions					index (#bycatch/shrimp catch in weight)				
Year	Cod	Redfish	Haddock	Gr. Halibut	Polar cod	Cod	Redfish	Haddock	Gr. Halibut	Polar cod
1982	9.23	316.66	0.18			0.21	7.29	0.00		
1983	16.46	298.04	82.90			0.23	4.21	1.17		
1984	8.20	641.96	59.46			0.11	8.38	0.78		
1985	86.00	439.63	53.88			1.05	5.35	0.66		
1986	24.03	458.55	24.20			0.49	9.44	0.50		
1987	24.67	105.23	0.64			0.79	3.36	0.02		
1988	6.91	58.40	2.94			0.22	1.82	0.09		
1989	13.98	109.14	8.05			0.30	2.32	0.17		
1990	22.44	134.19	18.95			0.41	2.48	0.35		
1991	23.53	289.71	34.33			0.59	7.30	0.87		
1992	24.30	387.43	18.50			0.61	9.77	0.47		
1993	30.90	98.75	1.91			0.95	3.02	0.06		
1994	19.00	137.60	9.00			0.94	6.82	0.45		
1995	34.96	23.70	2.31			1.81	1.23	0.12		
1996	114.86	188.86	2.50			4.51	7.42	0.10		
1997	156.98	23.06	3.72			5.40	0.79	0.13		
1998	73.12	65.13	4.85			1.63	1.45	0.11		
1999	39.32	4.98	4.21			0.75	0.09	0.08		
2000	65.39	27.56	44.58	13.94		1.18	0.50	0.81	0.25	
2001	23.43	10.09	2.70	7.57		0.54	0.23	0.06	0.18	
2002	21.54	15.83	4.07	0.19		0.44	0.32	0.08	0.00	
2003	11.91	7.49	6.21	0.59		0.35	0.22	0.18	0.02	
2004	14.20	6.60	77.48	0.33		0.40	0.18	2.16	0.01	
2005	17.60	2.84	110.63			0.47	0.08	2.97		
2006	29.27	75.99	53.46			1.07	2.78	1.95		
2007	39.71	13.42	259.07			1.55	0.52	10.14		
2008	63.04	8.72	190.09			3.05	0.42	9.20		
2009	5.80	43.64	24.01			0.29	2.21	1.21		
2010	11.21	4.96	65.71			0.67	0.30	3.92		
2011	2.85	12.62	13.57			0.14	0.63	0.68		
2012	9.53	1.67	24.58			0.67	0.12	1.74		
2013	4.52	1.99	10.09			0.51	0.22	1.14		
2014	17.85	12.34	44.94			1.74	1.21	4.39		
2015	23.61	31.45	101.07			1.40	1.87	6.00		
2016	3.01	44.19	16.61			0.17	2.46	0.92		
2017	2.50	90.34	11.69			0.07	2.42	0.31		

Table 3. Realized catch-per-unit-effort (CPUE) and effort (hrs. trawled), and standardized (see text) CPUE and effort. Based on Norwegian logbook data; 2019 values are estimated based on data until September.

year	Absolute		Standardised	
	CPUE	Effort	CPUE	Effort
	kg/hr	'000 hrs	index	index
1980	186	189	1.00	1.00
1981	216	152	1.19	0.79
1982	198	219	1.15	1.18
1983	231	306	1.31	1.73
1984	250	306	1.38	2.01
1985	231	356	1.14	2.36
1986	154	315	0.68	2.09
1987	116	270	0.53	1.76
1988	113	282	0.57	1.83
1989	143	330	0.72	1.88
1990	150	361	0.74	2.38
1991	171	230	0.78	2.09
1992	211	188	0.90	1.64
1993	209	159	0.98	1.24
1994	173	116	0.80	0.76
1995	150	129	0.67	0.81
1996	191	133	0.84	0.89
1997	228	127	0.80	0.96
1998	294	153	0.98	1.24
1999	295	178	1.03	1.59
2000	283	195	0.91	1.91
2001	356	121	0.92	1.34
2002	412	119	0.91	1.46
2003	386	88	0.90	0.95
2004	402	89	0.76	1.21
2005	611	61	1.06	0.87
2006	754	36	1.16	0.55
2007	840	30	1.05	0.62
2008	801	26	1.09	0.56
2009	794	25	1.12	0.53
2010	841	20	1.04	0.52
2011	777	26	1.17	0.56
2012	605	23	0.84	0.64
2013	534	17	0.71	0.59
2014	478	21	0.68	0.67
2015	476	35	0.76	0.96
2016	442	25	0.70	0.95
2017	635	11	0.89	0.74
2018	671	34	1.63	0.74
2019	830	28	2.04	0.82

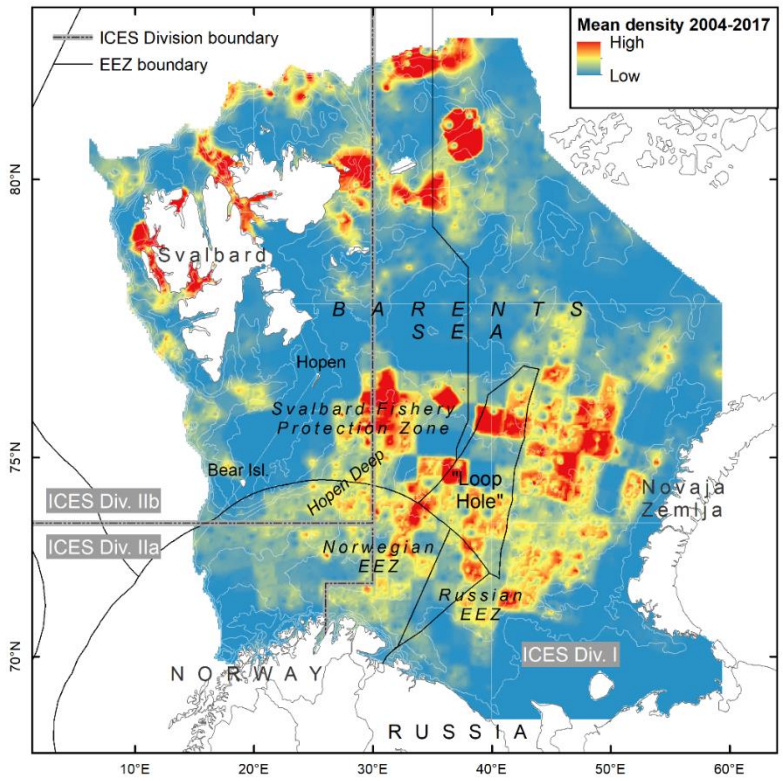

Figure 1. Shrimp in the Barents Sea: stock distribution. Survey density index (kg/km^2), mean of recent 14 years of data.

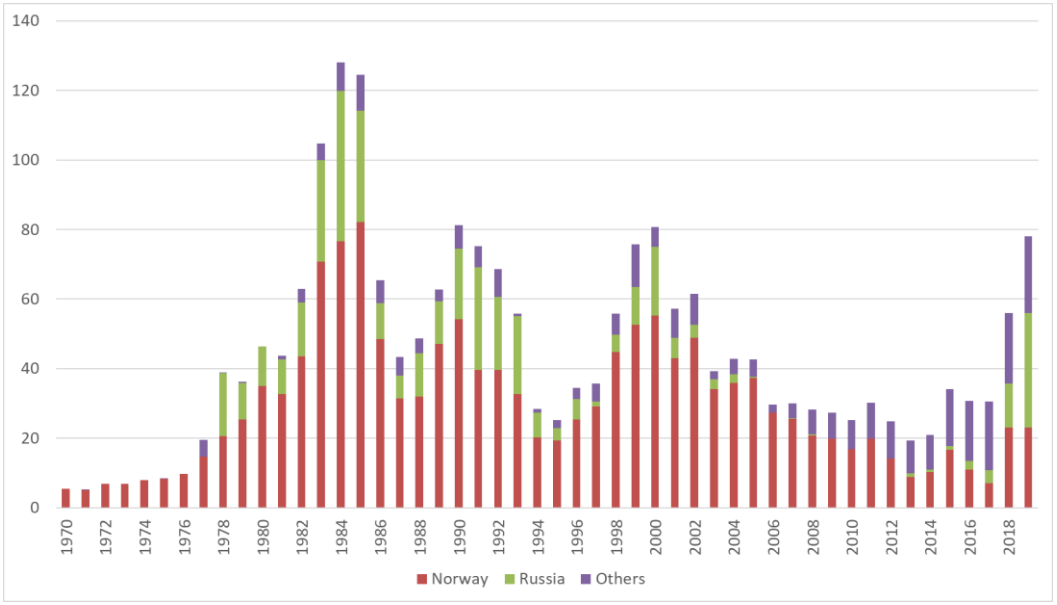

Figure 2. Shrimp in the Barents Sea: Total annual landings. The 2019 projected value is estimated based on data until July and information from the industry.

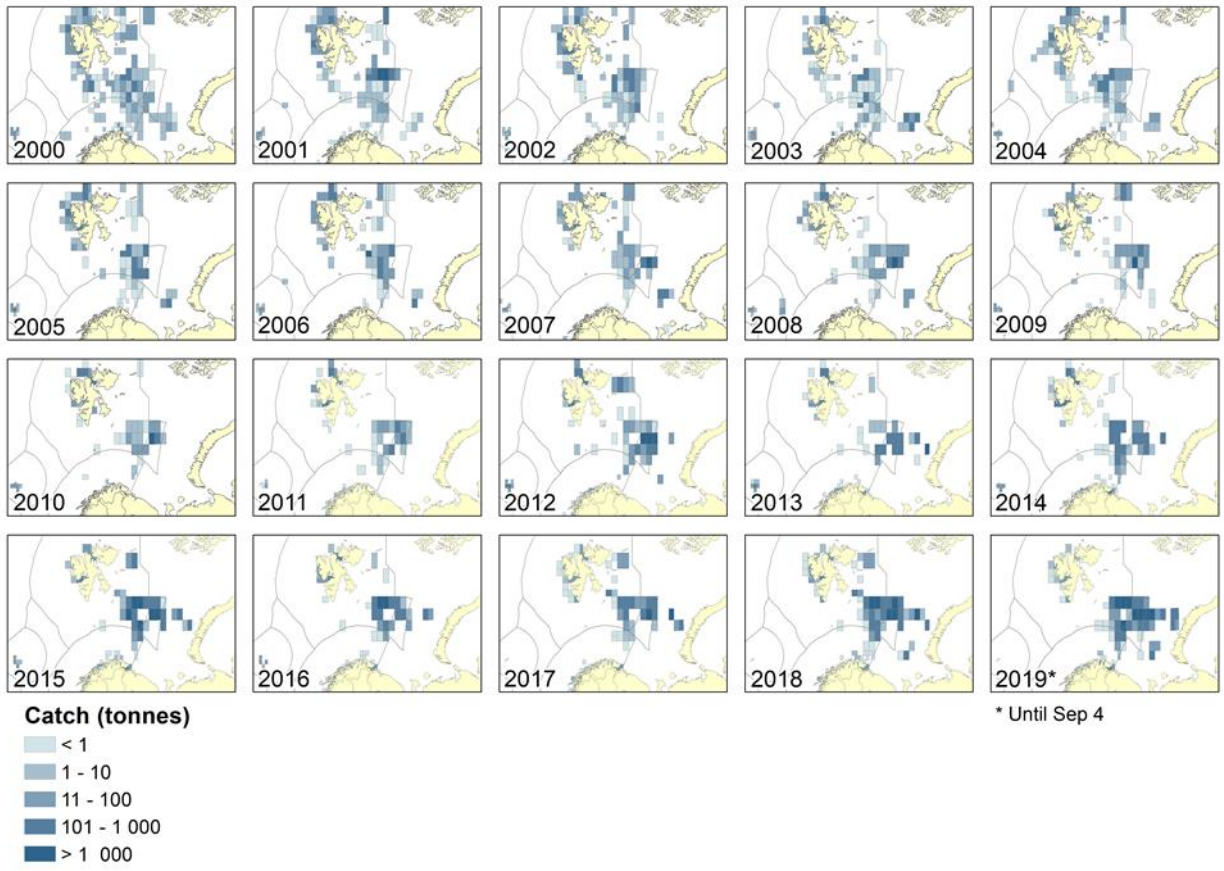

Figure 3. Distribution of catches by Norwegian vessels since 2000 based on logbook information. (*only data until September)

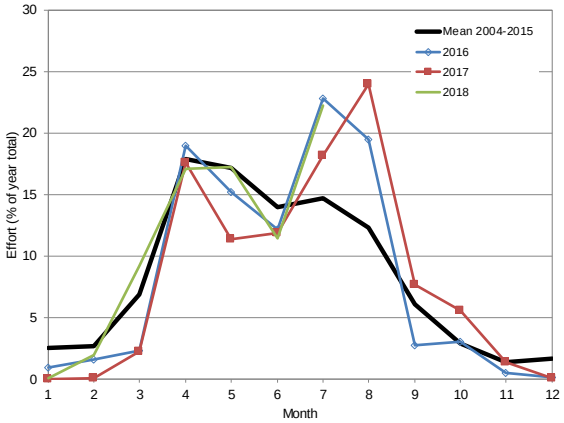

Figure 4. Shrimp in the Barents Sea: Seasonal distribution of Norwegian fishing effort (hours trawled in a month as a percentage of total effort of the year) 2016-2018 and mean 2004-2015.

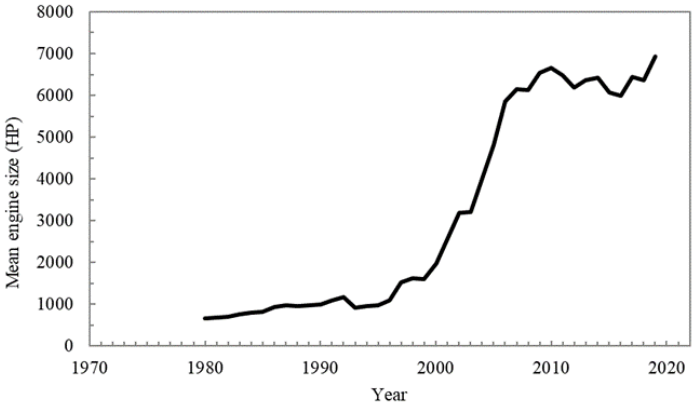

Figure 5. Shrimp in the Barents Sea: Mean engine size (horse powers) pr. hour of trawled by Norwegian vessels.

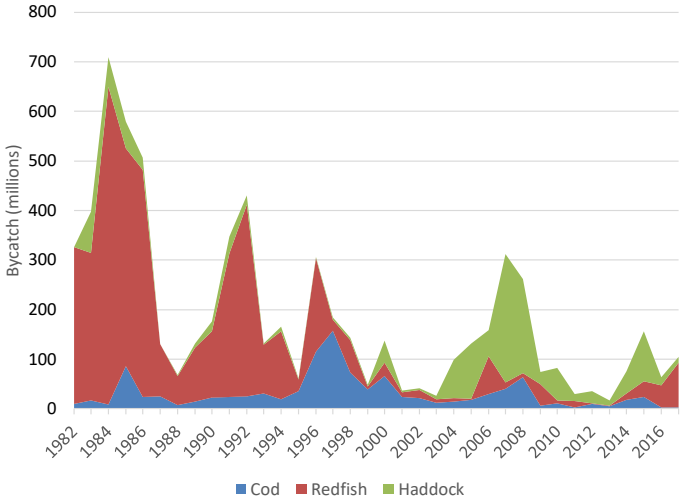

Figure 6. Shrimp in ICES SA 1 and 2: Estimated bycatch of cod, haddock and redfish in the Norwegian shrimp fishery (million individuals). The sorting grid was introduced in 1992 and has been mandatory since.

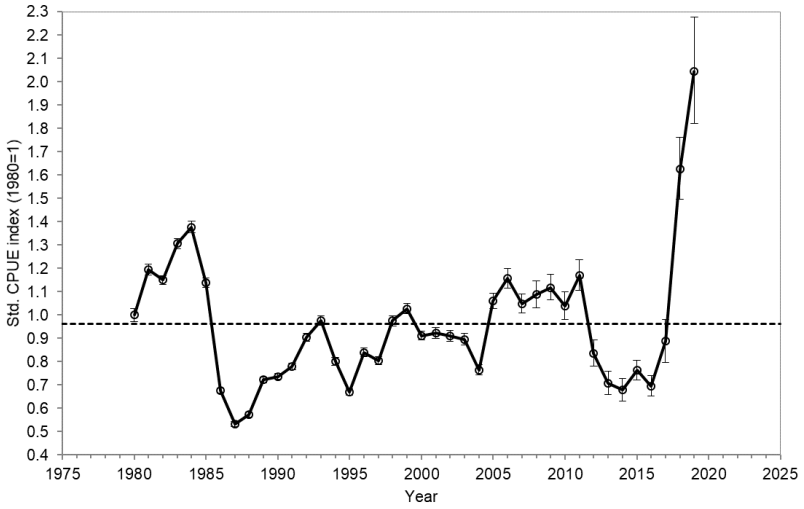

Figure 7. Shrimp in the Barents Sea: Standardized CPUE +/- one standard error.

Appendix 1. Output from GLM-run of the Barents Sea index. Gear 55=single trawl, gear 58=double trawl, gear 59= triple trawl. Strata definitions see Hvingel 2007. Vessels are individual vessel identification code.

The SAS System

The GLM Procedure

strata 8: A B C D E F G H

gear 4: 55 58 59 61

vessel 434: A 0003O AA0023HS F 0001BD F 0001BDN F 0001L F 0001SV F 0002BD F 0003V F 0004V F 0007LB F 0007M F 0009V F 0010BD F 0017BD F 0018NK F 0018NKN F 0019BD F 0020BD F 0020NK F 0023HV F 0024BD F 0025A F 0025M F 0025NK F 0026LB F 0027M F 0032BD F 0032LB F 0034BD F 0038L F 0040V F 0042NK F 0044VS F 0055G F 0056B F 0057NK F 0060NK F 0061NK F 0062HV F 0077NK F 0080G F 0086NK F 0090BDN F 0090KD F 0091LB F 0092B F 0092NK F 0096V F 0097L F 0100M F 0100NK F 0101L F 0107VS F 0109HV F 0110L F 0111H F 0112M F 0125BD F 0128NK F 0136HV F 0144H F 0144S F 0148P F 0156V F 0156V N F 0157S F 0178NK F 0180G F 0180NK F 0184VS F 0197HV F 0200SV F 0202M F 0220BD F 0220M F 0221A F 0234NK F 0250NK F 0270NK F 0300M F 0300NK F 0301L N F 0321A F 0330NK F 0394L F 0415NK F 0415NKN H 0001B H 0010FE H 0020L H 0090AV M 0001A M 0001VN M 0002HØ M 0002VD M 0003A M 0003SM M 0006MD M 0007HØ M 0008S M 0010H□N M 0014H□ M 0016A N M 0019A M 0019H□ M 0020G M 0020H□ M 0020S M 0023HØ M 0023VD M 0028VD M 0031G M 0032VD M 0033VN M 0034FI M 0037G M 0043H□ M 0043VD M 0049H M 0053H□ M 0059H M 0070M M 0071H□ M 0079HØ M 0081H□ M 0081H□N M 0081VD M 0088HØ M 0096H□ M 0099AV M 0099H□ M 0100AE M 0102S M 0106H M 0114F M 0114S□ M 0165G M 0170A M 0199H□ M 0206H M 0300HØ M 0306HØ M 0360HØ M 0402H M 0444H□ M 0450SM M 0450SMN M 0490SM M 0553H□ N 0001H N 0001□ N 0002BRN N 0002H N 0002LN N 0002V N 0004AH N 0004V N 0005BR N 0005BRN N 0006H N 0007TN N 0007VV N 0007□ N 0008A N 0009VV N 0010H N 0010MS N 0012V N 0014TS N 0014TSN N 0015TS N 0016ME N 0017BR N 0017BRN N 0017VV N 0020VR N 0021BR N 0021L N 0022V N 0025VV N 0026ME N 0026□ N 0030H N 0030H N N 0033H N 0034HR N 0035H N 0037MS N 0038V N 0041V N 0043V N 0044RT N 0045H N 0045H N N 0050H N 0055H N 0062H N 0062VV N 0068V N 0072MS N 0077F N 0077F N N 0078H N 0080A N 0081B□ N 0085□ N 0094LF N 0100□ N 0100Ø N 0110RT N 0111VR N 0111□ N 0120□ N 0148VV N 0148VVN N 0160VV N 0160VVN N 0165MS N 0173MS N 0180L N 0183ME N 0210A N 0230A N 0266V N 0271□ N 0294V N 0300VV N 0415V N 0415V N N 0431A N 0540ME N 0550SG NT0008V NT0150V NT0177V NT0444V NT0480V R 0001ESN R 0009ES R 0010ESN R 0045U R 0048U R 0051U R 0064B R 0091K R 0116K ST0041R ST0048HE ST0050R ST0086O ST0086O N ST0092O ST0183F T 0001H T 0001I N T 0001K T 0001K N T 0001S T 0001T T 0002H T 0002H N T 0002K T 0002LK T 0002LKN T 0002T T 0003LK T 0004SA T 0005K T 0005LK T 0005T T 0006L T 0006LK T 0006S T 0006T T 0006T N T 0007T T 0007TK T 0008S T 0008S N T 0008T T 0008TK T 0009LK T 0009T N T 0010LKN T 0011K T 0012I T 0012K T 0015T T 0016T T 0017T T 0017T N T 0018LK T 0018T T 0020K T 0020SA T 0022I T 0022T T 0023T T 0024T T 0028BG T 0028LK T 0028TN T 0029LK T 0029LKN T 0031I T 0031L T 0031SK T 0033B T 0033T T 0035T T 0036LK T 0036T T 0037S T 0038T T 0039H T 0039T T 0040LK T 0040T T 0041L T 0041T T 0042BG T 0042T T 0044T N T 0045T T 0046BG T 0047LK T 0048T T 0049L T 0050B T 0050K T 0050L T 0051LK T 0052S T 0055G T 0058T T 0058T N T 0060I T 0060K T 0061T T 0061T N T 0062T T 0063BG T 0064SA T 0068G T 0070LK T 0070SK T 0070T T 0070T N T 0077T T 0080LK T 0081L T 0081T T 0086T T 0088B T 0088L T 0090T T 0092S T 0092S N T 0094I T 0095LK T 0097L T 0097T T 0099T T 0099T N T 0100D T 0100D N T 0100I T 0102BG T 0106T T 0111BG T 0122LK T 0122LKN T 0124LK T 0133T T 0137BG T 0137BGN T 0138TN T 0145LK T 0150BG T 0150T T 0150T N T 0156BG T 0160L T 0161N T 0165T N T 0170L T 0170T T 0170TK T 0171K T 0181K T 0182BG T 0183T T 0195L T 0198LK T 0200N T 0201BG T 0207BG T 0225N T 0228KD T 0228LK T 0230T T 0242T N T 0245LK T 0303T T 0320S T 0320T T 0320T N T 0345LK T 0350T T 0359T T 0360LK T 0429T N T 0440K T 0566S T 0569LK T 0805T T 0854T VA0002K VA0016S VA0034K VA0041K VA0046K VA0057K VA0059S VA0066K VA0079K VA0087K VA0090FS VA0095K N VA0120K VA0156K □ 0001H □ 0061H □ 0199H

year 40: 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019

month 12: 1 2 3 4 5 6 7 8 9 10 11 12

Number of Observations Read 211003
Number of Observations Used 211003

Dependent Variable: lncpue
Weight: effort

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	495	1042957.224	2106.984	547.41	<.0001
Error	210507	810243.850	3.849		
Corrected Total	211002	1853201.074			

R-Square	Coeff Var	Root MSE	lncpue Mean
0.562787	37.62018	1.961890	5.214993

Source	DF	Type I SS	Mean Square	F Value	Pr > F
strata	7	227500.2561	32500.0366	8443.74	<.0001

year 39 472068.1242 12104.3109 3144.78 <.0001
gear 4 29644.3657 7411.0914 1925.45 <.0001
vessel 434 254524.4730 586.4619 152.37 <.0001
month 11 59220.0050 5383.6368 1398.71 <.0001

Source DF Type III SS Mean Square F Value Pr > F
strata 7 16804.3903 2400.6272 623.70 <.0001
year 39 148807.8355 3815.5855 991.32 <.0001
gear 4 0.1088 0.0272 0.01 0.9999
vessel 434 2360.2596 5.4384 1.41 <.0001
month 11 59220.0050 5383.6368 1398.71 <.0001

Parameter Estimate Standard Error t Value Pr > |t|
Intercept 3.860363581 B 8680.389232 0.00 0.9996
strata A -0.097961813 B 0.005476 -17.89 <.0001
strata B 0.056581990 B 0.004852 11.66 <.0001
strata C 0.060596016 B 0.004519 13.41 <.0001
strata D 0.013183152 B 0.009506 1.39 0.1655
strata E 0.186979533 B 0.003768 49.62 <.0001
strata F 0.024493679 B 0.009864 2.48 0.0130
strata G 0.009824577 B 0.005605 1.75 0.0796
strata H 0.000000000 B . . .
year 1981 0.177982923 B 0.009816 18.13 <.0001
year 1982 0.139764687 B 0.008600 16.25 <.0001
year 1983 0.266993913 B 0.008329 32.05 <.0001
year 1984 0.320390293 B 0.008550 37.47 <.0001
year 1985 0.130129155 B 0.008668 15.01 <.0001
year 1986 -0.391342847 B 0.008948 -43.73 <.0001
year 1987 -0.630480869 B 0.009494 -66.41 <.0001
year 1988 -0.555312226 B 0.009186 -60.45 <.0001
year 1989 -0.324576394 B 0.008841 -36.71 <.0001
year 1990 -0.304719981 B 0.008792 -34.66 <.0001
year 1991 -0.250021919 B 0.009282 -26.93 <.0001
year 1992 -0.100052344 B 0.009570 -10.45 <.0001
year 1993 -0.024504767 B 0.010030 -2.44 0.0146
year 1994 -0.222489554 B 0.011088 -20.07 <.0001
year 1995 -0.400629765 B 0.011121 -36.02 <.0001
year 1996 -0.173876715 B 0.010779 -16.13 <.0001
year 1997 -0.217576456 B 0.010978 -19.82 <.0001
year 1998 -0.025206312 B 0.010733 -2.35 0.0189
year 1999 0.026256867 B 0.010567 2.48 0.0130
year 2000 -0.091971904 B 0.011072 -8.31 <.0001
year 2001 -0.079469939 B 0.012402 -6.41 <.0001
year 2002 -0.094048930 B 0.012977 -7.25 <.0001
year 2003 -0.110754170 B 0.014070 -7.87 <.0001
year 2004 -0.267976731 B 0.014024 -19.11 <.0001
year 2005 0.058771909 B 0.015691 3.75 0.0002
year 2006 0.146825002 B 0.018213 8.06 <.0001
year 2007 0.047267849 B 0.019401 2.44 0.0148
year 2008 0.084049251 B 0.026499 3.17 0.0015
year 2009 0.111947534 B 0.024403 4.59 <.0001
year 2010 0.038816702 B 0.028050 1.38 0.1664
year 2011 0.157690735 B 0.027829 5.67 <.0001
year 2012 -0.177718691 B 0.033510 -5.30 <.0001
year 2013 -0.346186837 B 0.034990 -9.89 <.0001
year 2014 -0.386381858 B 0.035152 -10.99 <.0001
year 2015 -0.269680651 B 0.027463 -9.82 <.0001
year 2016 -0.362287607 B 0.032361 -11.20 <.0001
year 2017 -0.119197377 B 0.051826 -2.30 0.0215
year 2018 0.486473731 B 0.040759 11.94 <.0001
year 2019 0.714775302 B 0.055548 12.87 <.0001
year 2080 0.000000000 B . . .
gear 55 -0.242458207 9163.916480 -0.00 1.0000
gear 58 -0.173534885 9163.916480 -0.00 1.0000
gear 59 -0.090766504 9163.916480 -0.00 1.0000
gear 61 -0.074799398 9163.916534 -0.00 1.0000
vessel A 0003O -0.784354539 2921.189427 -0.00 0.9998
vessel AA0023HS 1.151971856 2921.189403 0.00 0.9997
vessel F 0001BD 1.347502898 2921.189402 0.00 0.9996

vessel F 0001BDN 1.566472356 2921.189402 0.00 0.9996
vessel F 0001L 2.395419622 2921.189402 0.00 0.9993
vessel F 0001SV 1.649610829 2921.189402 0.00 0.9995
vessel F 0002BD 1.699842427 2921.189402 0.00 0.9995
vessel F 0003V 1.202898697 2921.189403 0.00 0.9997
vessel F 0004V 1.144510704 2921.189402 0.00 0.9997
vessel F 0007LB 1.365511692 2921.189402 0.00 0.9996
vessel F 0007M 1.588238036 2921.189402 0.00 0.9996
vessel F 0009V 1.326978956 2921.189403 0.00 0.9996
vessel F 0010BD 2.034534542 2921.189402 0.00 0.9994
vessel F 0017BD 2.307957792 2921.189402 0.00 0.9994
vessel F 0018NK 1.390904916 2921.189403 0.00 0.9996
vessel F 0018NKN 1.086109186 2921.189403 0.00 0.9997
vessel F 0019BD 1.137484884 2921.189403 0.00 0.9997
vessel F 0020BD 0.854994482 2921.189403 0.00 0.9998
vessel F 0020NK 0.941759509 2921.189403 0.00 0.9997
vessel F 0023HV 0.863221601 2921.189403 0.00 0.9998
vessel F 0024BD 1.704090898 2921.189402 0.00 0.9995
vessel F 0025A 2.672022846 2921.189403 0.00 0.9993
vessel F 0025M 1.541074367 2921.189402 0.00 0.9996
vessel F 0025NK 0.802624370 2921.189403 0.00 0.9998
vessel F 0026LB 1.561771135 2921.189402 0.00 0.9996
vessel F 0027M 1.539532970 2921.189402 0.00 0.9996
vessel F 0032BD 1.693999938 2921.189403 0.00 0.9995
vessel F 0032LB 0.758656736 2921.189403 0.00 0.9998
vessel F 0034BD 2.178538601 2921.189403 0.00 0.9994
vessel F 0038L 1.025695105 2921.189403 0.00 0.9997
vessel F 0040V 1.258009446 2921.189402 0.00 0.9997
vessel F 0042NK 1.231273450 2921.189402 0.00 0.9997
vessel F 0044VS 1.081464909 2921.189403 0.00 0.9997
vessel F 0055G 1.389933565 2921.189402 0.00 0.9996
vessel F 0056B 1.259514209 2921.189402 0.00 0.9997
vessel F 0057NK 0.738049082 2921.189403 0.00 0.9998
vessel F 0060NK 1.411665306 2921.189402 0.00 0.9996
vessel F 0061NK 1.025144887 2921.189402 0.00 0.9997
vessel F 0062HV 1.816939875 2921.189402 0.00 0.9995
vessel F 0077NK 1.338790983 2921.189403 0.00 0.9996
vessel F 0080G 1.628468811 2921.189403 0.00 0.9996
vessel F 0086NK 1.002011638 2921.189403 0.00 0.9997
vessel F 0090BDN 1.481214238 2921.189402 0.00 0.9996
vessel F 0090KD 1.198805366 2921.189402 0.00 0.9997
vessel F 0091LB 1.105540221 2921.189402 0.00 0.9997
vessel F 0092B 1.452587380 2921.189403 0.00 0.9996
vessel F 0092NK 1.454041049 2921.189402 0.00 0.9996
vessel F 0096V 1.536529091 2921.189402 0.00 0.9996
vessel F 0097L 1.321400979 2921.189402 0.00 0.9996
vessel F 0100M 1.687057017 2921.189402 0.00 0.9995
vessel F 0100NK 1.345072084 2921.189403 0.00 0.9996
vessel F 0101L 0.989232193 2921.189403 0.00 0.9997
vessel F 0107VS 1.041678284 2921.189403 0.00 0.9997
vessel F 0109HV 1.248724580 2921.189403 0.00 0.9997
vessel F 0110L 1.257602834 2921.189402 0.00 0.9997
vessel F 0111H 1.359158016 2921.189402 0.00 0.9996
vessel F 0112M 1.148890050 2921.189403 0.00 0.9997
vessel F 0125BD 0.993941011 2921.189402 0.00 0.9997
vessel F 0128NK 1.348029956 2921.189402 0.00 0.9996
vessel F 0136HV 1.718430969 2921.189402 0.00 0.9995
vessel F 0144H 0.715753538 2921.189403 0.00 0.9998
vessel F 0144S 0.832487739 2921.189402 0.00 0.9998
vessel F 0148P 1.128481020 2921.189402 0.00 0.9997
vessel F 0156V 1.615324819 2921.189403 0.00 0.9996
vessel F 0156V N 1.566944468 2921.189402 0.00 0.9996
vessel F 0157S 1.158512306 2921.189403 0.00 0.9997
vessel F 0178NK 1.364346401 2921.189402 0.00 0.9996
vessel F 0180G 1.733943916 2921.189402 0.00 0.9995
vessel F 0180NK 1.736207484 2921.189402 0.00 0.9995
vessel F 0184VS 1.507032199 2921.189402 0.00 0.9996
vessel F 0197HV 1.046429774 2921.189403 0.00 0.9997
vessel F 0200SV 1.755793874 2921.189402 0.00 0.9995

vessel F 0202M 1.328416895 2921.189402 0.00 0.9996
vessel F 0220BD 2.261352286 2921.189402 0.00 0.9994
vessel F 0220M 1.453749181 2921.189402 0.00 0.9996
vessel F 0221A 2.369563825 2921.189402 0.00 0.9994
vessel F 0234NK 1.016634120 2921.189402 0.00 0.9997
vessel F 0250NK 0.940487593 2921.189403 0.00 0.9997
vessel F 0270NK 1.326076288 2921.189403 0.00 0.9996
vessel F 0300M 1.236871978 2921.189402 0.00 0.9997
vessel F 0300NK 1.044442072 2921.189403 0.00 0.9997
vessel F 0301L N 0.778755554 2921.189403 0.00 0.9998
vessel F 0321A 2.622241477 2921.189403 0.00 0.9993
vessel F 0330NK 0.761966098 2921.189403 0.00 0.9998
vessel F 0394L 1.392908625 2921.189402 0.00 0.9996
vessel F 0415NK 0.927785689 2921.189403 0.00 0.9997
vessel F 0415NKN 1.163146218 2921.189402 0.00 0.9997
vessel H 0001B 0.679436380 2921.189403 0.00 0.9998
vessel H 0010FE 0.844199890 2921.189403 0.00 0.9998
vessel H 0020L 1.665603225 2921.189402 0.00 0.9995
vessel H 0090AV 1.763840164 2921.189403 0.00 0.9995
vessel M 0001A 2.037250033 2921.189402 0.00 0.9994
vessel M 0001VN 1.860545945 2921.189402 0.00 0.9995
vessel M 0002HØ 2.593786610 2921.189402 0.00 0.9993
vessel M 0002VD -0.357979393 2921.189411 -0.00 0.9999
vessel M 0003A 1.634916514 2921.189402 0.00 0.9996
vessel M 0003SM 1.870777811 2921.189402 0.00 0.9995
vessel M 0006MD 1.294497550 2921.189402 0.00 0.9996
vessel M 0007HØ 2.459423793 2921.189402 0.00 0.9993
vessel M 0008S 1.451558517 2921.189402 0.00 0.9996
vessel M 0010H□N 1.526545248 2921.189403 0.00 0.9996
vessel M 0014H□ 1.896080262 2921.189402 0.00 0.9995
vessel M 0016A N 1.441085333 2921.189402 0.00 0.9996
vessel M 0019A 2.056851528 2921.189403 0.00 0.9994
vessel M 0019H□ 1.239510773 2921.189402 0.00 0.9997
vessel M 0020G 1.203961812 2921.189402 0.00 0.9997
vessel M 0020H□ 1.797888954 2921.189402 0.00 0.9995
vessel M 0020S 1.325361596 2921.189403 0.00 0.9996
vessel M 0023HØ 2.455438555 2921.189402 0.00 0.9993
vessel M 0023VD 2.275800433 2921.189402 0.00 0.9994
vessel M 0028VD 1.491147207 2921.189403 0.00 0.9996
vessel M 0031G 1.275924674 2921.189403 0.00 0.9997
vessel M 0032VD 1.559660617 2921.189402 0.00 0.9996
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vessel M 0034FI 1.178009174 2921.189403 0.00 0.9997
vessel M 0037G 2.148510240 2921.189403 0.00 0.9994
vessel M 0043H□ 2.217432193 2921.189402 0.00 0.9994
vessel M 0043VD 2.111498348 2921.189402 0.00 0.9994
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vessel M 0053H□ 1.854844698 2921.189402 0.00 0.9995
vessel M 0059H 2.390757469 2921.189402 0.00 0.9993
vessel M 0070M 1.305257059 2921.189403 0.00 0.9996
vessel M 0071H□ 0.949967671 2921.189403 0.00 0.9997
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vessel M 0081H□ 1.848641025 2921.189403 0.00 0.9995
vessel M 0081H□N 2.505759164 2921.189402 0.00 0.9993
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vessel M 0096H□ 2.074690131 2921.189402 0.00 0.9994
vessel M 0099AV 1.045934443 2921.189403 0.00 0.9997
vessel M 0099H□ 2.142781318 2921.189402 0.00 0.9994
vessel M 0100AE 1.296050791 2921.189403 0.00 0.9996
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vessel M 0106H 2.221582151 2921.189402 0.00 0.9994
vessel M 0114F 1.122966312 2921.189415 0.00 0.9997
vessel M 0114S□ 1.417812435 2921.189402 0.00 0.9996
vessel M 0165G 1.000643971 2921.189403 0.00 0.9997
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vessel M 0199H□ 1.366516725 2921.189403 0.00 0.9996
vessel M 0206H 1.716885615 2921.189402 0.00 0.9995
vessel M 0300HØ 2.583590076 2921.189402 0.00 0.9993

vessel M 0306HØ 2.578373919 2921.189402 0.00 0.9993
vessel M 0360HØ 2.432550431 2921.189402 0.00 0.9993
vessel M 0402H 1.686192280 2921.189402 0.00 0.9995
vessel M 0444H 1.523185049 2921.189402 0.00 0.9996
vessel M 0450SM 2.930911286 2921.189404 0.00 0.9992
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vessel M 0553H 1.834516222 2921.189402 0.00 0.9995
vessel N 0001H 1.218558715 2921.189402 0.00 0.9997
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vessel N 0002BRN 0.941642034 2921.189403 0.00 0.9997
vessel N 0002H 1.962857572 2921.189402 0.00 0.9995
vessel N 0002LN 1.174772628 2921.189402 0.00 0.9997
vessel N 0002V 1.151416513 2921.189403 0.00 0.9997
vessel N 0004AH 0.891632778 2921.189403 0.00 0.9998
vessel N 0004V 1.005797000 2921.189402 0.00 0.9997
vessel N 0005BR 1.349502302 2921.189402 0.00 0.9996
vessel N 0005BRN 1.188764988 2921.189402 0.00 0.9997
vessel N 0006H 0.854204046 2921.189403 0.00 0.9998
vessel N 0007TN 1.213831511 2921.189402 0.00 0.9997
vessel N 0007VV 2.261967198 2921.189402 0.00 0.9994
vessel N 0007 1.461425651 2921.189402 0.00 0.9996
vessel N 0008A 2.310703314 2921.189403 0.00 0.9994
vessel N 0009VV 1.388963623 2921.189402 0.00 0.9996
vessel N 0010H 2.244067793 2921.189403 0.00 0.9994
vessel N 0010MS 1.110993702 2921.189403 0.00 0.9997
vessel N 0012V 1.315704025 2921.189402 0.00 0.9996
vessel N 0014TS 1.525417165 2921.189402 0.00 0.9996
vessel N 0014TSN 1.767141300 2921.189402 0.00 0.9995
vessel N 0015TS 1.620769807 2921.189403 0.00 0.9996
vessel N 0016ME 1.046935050 2921.189403 0.00 0.9997
vessel N 0017BR 1.182779492 2921.189402 0.00 0.9997
vessel N 0017BRN 1.883282659 2921.189402 0.00 0.9995
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vessel N 0020VR 1.111118169 2921.189403 0.00 0.9997
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vessel 0061H 0.746173830 2921.189403 0.00 0.9998
vessel 0199H 0.232200374 2921.189422 0.00 0.9999
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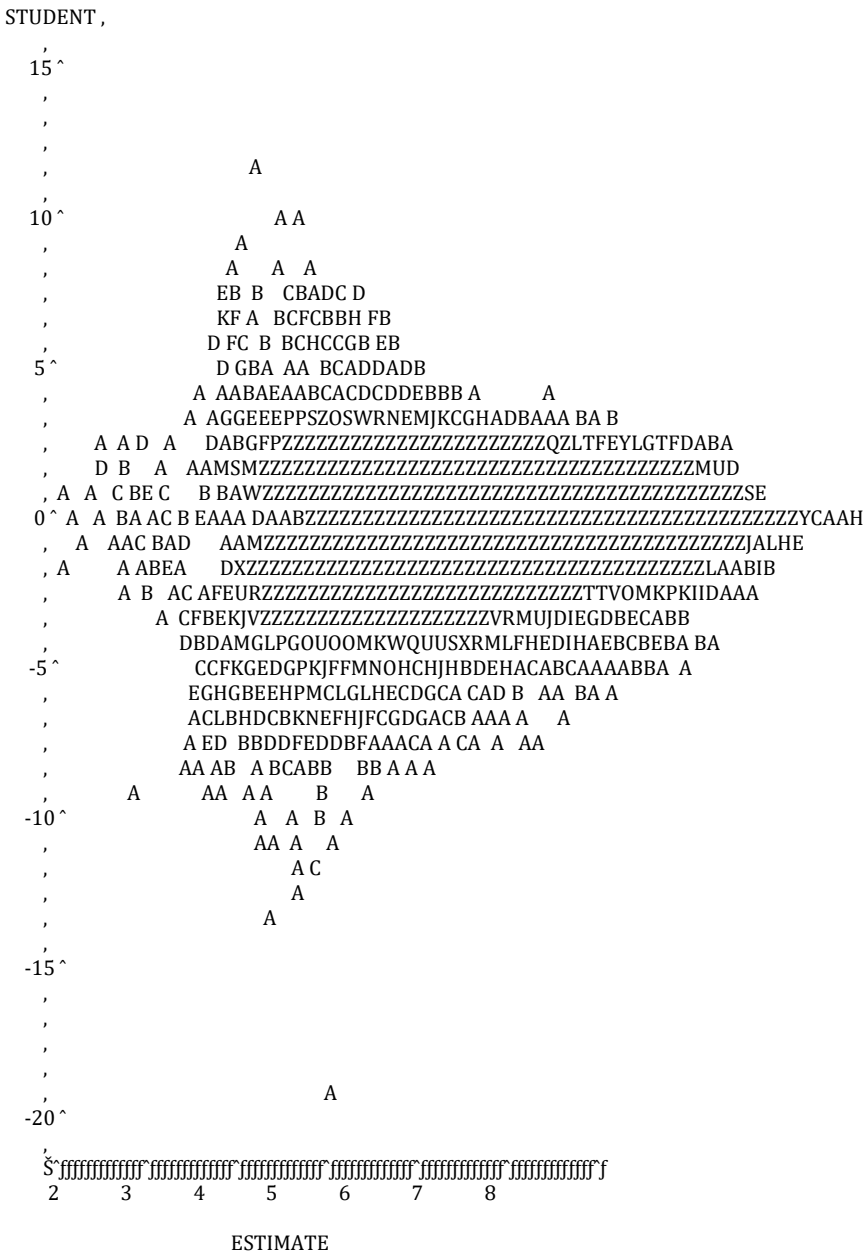
month 2 0.181890552 B 0.009550 19.05 <.0001
month 3 0.296371839 B 0.008934 33.17 <.0001
month 4 0.225023854 B 0.008086 27.83 <.0001
month 5 0.152592666 B 0.007688 19.85 <.0001
month 6 0.145598736 B 0.007658 19.01 <.0001
month 7 0.092153136 B 0.007706 11.96 <.0001
month 8 0.032389489 B 0.007740 4.18 <.0001
month 9 -0.143075656 B 0.007960 -17.97 <.0001
month 10 -0.375644677 B 0.008641 -43.47 <.0001
month 11 -0.179430040 B 0.008401 -21.36 <.0001
month 12 0.000000000 B . . .

Plot of STUDENT*ESTIMATE. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 1 obs had missing values. 201379 obs hidden.