Survey report

MS *Vendla* 04.-17.03.2019

Testing of acoustic stock estimation of spawning capelin

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Introduction

The capelin spawning takes place from the beginning of March along the coast of northern Norway between Tromsø and Varangerfjord. The abundance of the spawning stock is calculated based on the acoustic measurements obtained in autumn, during the ecosystem survey in the Barents Sea. During this period, the capelin is feeding and is found in large layers suitable for echo sounder measurements. The fishery of capelin traditionally starts at the end of February in the coast of Finnmark and could extend until late March. There are concerns about the accuracy of the estimates of the spawning stock, which determines the quota available for the fishery. At present, there is no method for estimating directly the capelin stock during the spawning season, which could provide with a more accurate estimate. However, this is challenging because the region of the main spawning and timing of this migration is unknown and can vary from a westerly distribution off Tromsø to a more easterly towards Varangerfjord.

Objective

The objective of the survey was to test a stratified survey design with zig-zag transects where the effort should reflect the expected abundance of capelin in a given stratum. The distribution of effort was based on auxiliary information both from historical data on distribution and recent information on distribution immediately prior to and during the survey.

Methodology

The fishing vessel MS Vendla was selected to carry out the acoustic survey, which started and ended in Tromsø, on 04 and 17 of March, respectively. The fishing vessel MS Rødholmen was used as a scouting vessel and started its survey on February 28 and finished March 09.

Survey design

Preliminary strata definition and effort allocation before survey

Historical data was used to define an initial system of strata and coverage within the strata. The data used was the following:

Source	Years
Surveys (winter and dedicated)	2002, 2005, 2007-2009
Capelin catch from electronic log books	2012 -2015,2018
Capelin in cod stomach	2016, 2018

Strata boundaries were drawn using software Stox (Johnsen et al., in review), and allocation of strata coverage was done using the RstoX "survey planner" R package (https://github.com/arnejohannesholmin/sonR). The method used for zig-zag transect placement was "Rectangular enclosure zigzag sampler" (Harbitz and Holmin, 2018). The starting point of the cruise line was random in all strata. The strata system used with the Rstox "survey planner" was transferred to the StoX acoustic – trawl abundance estimation project.

Auxiliary data at start and during survey

Auxiliary data regarding the presence of capelin in the study area was available right before the start and during the survey. These data were:

1. Scouting survey by fishing vessel MS Rødholmen. The vessel started from Tromsø on February 28 following a pre-defined survey design to optimize the coverage of the region from Tromsø to Varangerfjord from the coast up to 50 nmi offshore. The west to east coverage was completed in 7 days, and a return coverage east to west was completed on March 09. The acoustic measurements were done using Simrad ES70 echo sounder (38 kHz) and Simrad SX90 omni directional sonar. Raw data from the echo sounder was stored for later analysis. A protocol was established to send data on the capelin registrations to MS Vendla. Screen dumps from echosounder and sonar were taken when capelin detections were found along the transect or when the vessel left the transect to investigate schools detected by the sonar. A written log was filled with position information and comments on fish observations (size, depth, migration, etc.), images and log files were stored in a shared folder and retrieved onboard MS Vendla on a daily basis.
2. Capelin present in cod stomach. Once a week a report was available on the presence of fresh capelin in cod stomachs from the factories receiving the catch of the coastal artisanal fleet.
3. Acoustic and trawl data from the winter survey. R/V Johan Hjort carried out a demersal swept area survey in the area and provided periodic reports on acoustic measurements of capelin and presence of capelin in trawl samples. This cruise does not dedicate time for pelagic trawling, so the information available on capelin is limited.
4. Acoustic and trawl data from NSS herring spawning survey. The cruise to estimate the abundance of the spawning stock of NSS herring finished in the area of Tromsøflaket on February 25. Echo sounder and trawl data on the presence of capelin in this region was available prior the start of MS Vendla coverage.

Adaptation of the survey design

The initial system of strata and transects was modified using updated information according to these criteria:

1. If auxiliary data indicated no presence of capelin in strata in the western region, those strata will be removed from the survey. The time saved with the removal of the strata will be used to increase the coverage in the remaining easterly strata.
2. If high abundance of capelin is found during the survey in a stratum with low coverage, the stratum will be resampled using a new set of transects, in direction east to west. The new coverage will be done after the completion of the original coverage in that strata.
3. The abundance of capelin in a stratum will be evaluated primarily based on echo sounder measurements (Nautical Area Scattering Coefficient; NASC; m^2*nmi^{-2}; by transect and accumulated by stratum) and secondary by sonar measurements (aggregated school area by transect and accumulated by stratum). High abundance in either of both will determine the resample of a low coverage stratum.

Acoustic data

Echo sounder and sonar

Echo sounder data from a calibrated EK60 was collected at frequencies of 18, 38, 70, 120 and 200 kHz. Transducers were mounted in a drop keel 3 m below the vessel hull. Data was collected up to 500 m and with a ping interval of about 1 second. Raw data was scrutinized daily using LSSS software, and capelin acoustical measurements (NASC) values for every 0.1 nmi were used for biomass computations.

Sonar data from SX90 at a frequency of 30 kHz was collected continuously up to 1500 m range with a tilt of -3 deg when surveying. Outside the survey transects, the tilt and range were adjusted to ensure a better sampling of the schools either for detailed inspection or during trawling. Data was scrutinized daily using PROFOS software and school's properties were computed using ad-hoc R codes (geographical position, mean depth, mean acoustic strength, mean area, mean length along and across beams, average direction and speed).

Biological sampling

A Harstad trawl was rigged according to standard protocol (figure 1 left, appendix 1) (Havforskningsinstituttet, 2018), but some changes were made. The non-standard ET 15 m² trawl doors were used. They have a weight of 4800 kg and the spreading force of these large trawl doors must be compensated to prevent the trawl from being overspread. This was done by mounting 2 ropes of 30m length on top and bottom in the opening (figure 1 right, appendix 1) which gave a lower height such as obtained with use of standard doors. Also, a split in the codend was made to protect the trawl when catches were large. The performance of the trawl during 9 trawl hauls is listed in table 1, appendix 1.

From every trawl haul, a standard biological sampling of capelin and herring was done to obtain length, weight, stomach content and maturity state. Also, otoliths (capelin) and scales (herring) were used for age determination.

Biomass estimation

The StoX application was used to calculate a standard transect-based acoustic-trawl estimate (Johnsen E. et al., 2019 in review). Details on the estimation can be found in the project.xml file of the StoX estimation project. The StoX project is stored in the IMR repository as https://datasetexplorer.hi.no/apps/datasetexplorer/v2/navigation. The main estimation figures are attached as "Appendix 3. Summary of the abundance estimation" to this survey report.

The interpreted echosounder data from LSSS was stored at a 0.1 nautical mile resolution. This high resolution was chosen to accurately be able to exclude acoustic recordings outside the transect lines from the estimation. The vessel typically left the transect line to perform trawling on schools observed on the SX90 sonar. To get good biological samples in areas with many schools, the vessel commonly had to perform trawling on suitable schools outside the track.

An overview of some central estimation parameters is given below:

- NASC values from EK60 38 kHz and acoustic category capelin (LSSS "acocat" code 16) was used.
- The biological individual sample lengths were grouped into 1 cm interval (measured at 0.5 cm resolution)
- All biological stations within a stratum were assigned to all acoustic transect in the stratum. In addition, trawl station 37265 and 37268 were included for stratum "s5". These stations were just outside the stratum borders in an area with numerous herring schools.
- All the assigned biological stations were given equal weight for the generation of a total length distribution of the assigned stations.
- The following target strength – length relationship was applied for the density (numbers/nmi^2) calculation:

$$TS = 19.1 \log L - 74$$

For the baseline estimate, abundance by length for numbers of fish and biomass was calculated. In addition, length-based estimates by the population parameters age, sex, special stage was calculated.

Finally, the R model was executed using 500 iterations for the bootstrapping of biotic stations and acoustic transects. The R-report model was run to output reports on survey variance.

Results

Survey design

Prior to the survey, a temporary survey design was made. This design was planned to be refined just before the start of the 2019 survey, based on new input data from Rødholmen and other sources. The preliminary survey design was based on historical catches and survey data from the study area, and was divided into 6 strata, with an allocation of sampling effort proportional to the abundance of capelin (Figure 1). A higher coverage was allocated to the western strata S1 and S2, and central S4. Low efforts to S3, S5 and S6 towards the eastern border.

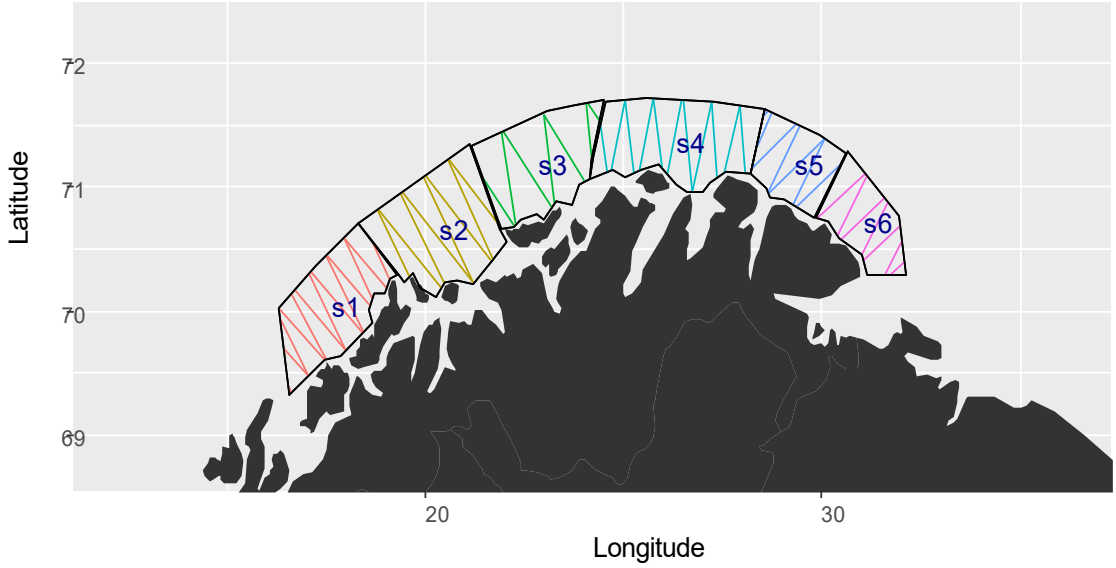


Figure 1. Original survey design based in historical catches and survey data, with 6 strata with variable coverage effort corresponding to capelin abundance.

Auxiliary data were determinant to define the final survey design. Data from the end of the NSS herring spawning survey together with the information provided by MS Rødholmen and negative presence of capelin in cod stomach from factories (Table 1), indicated that no capelin was present in strata S1 and S2 (Figure 2). The original survey design was modified accordingly, removing S1 and S2, and allocating higher and equal coverage from S3 to S6 (Figure 3). S3 was extended 20 nmi to the west and S6 was extended eastwards to cover inside Varangerfjord, as information from Johan Hjort indicated presence of capelin in the offshore eastern area close to the Russian EEZ. Also, all strata were extended up to 50 nmi offshore, based on MS Rødholmen school observations in the northern part of its coverage (examples of sonar and echo sounder from MS Rødholmen in Appendix 2). The final coverage by stratum was between 8.2 and 9.2, well above the recommended coverage value of 7 (Aglen, 1989). With the increased coverage in all strata, it was considered to be no need for resampling of any strata.

Date	Sørvær	Havøysund	Kjøllefjord	Mehamn	Båtsfjord	Vadsø
12.02.2019			x			
19.02.2019			x	x	x	
26.02.2019	x	x	x			
27.02.2019					x	x
05.03.2019	x	x	x		x	
12.03.2019	x		x	x		x
13.03.2019		x				

Table 1. Presence of fresh capelin in cod stomachs in processing plants along the coast (ordered from west to east) before and during the survey period.

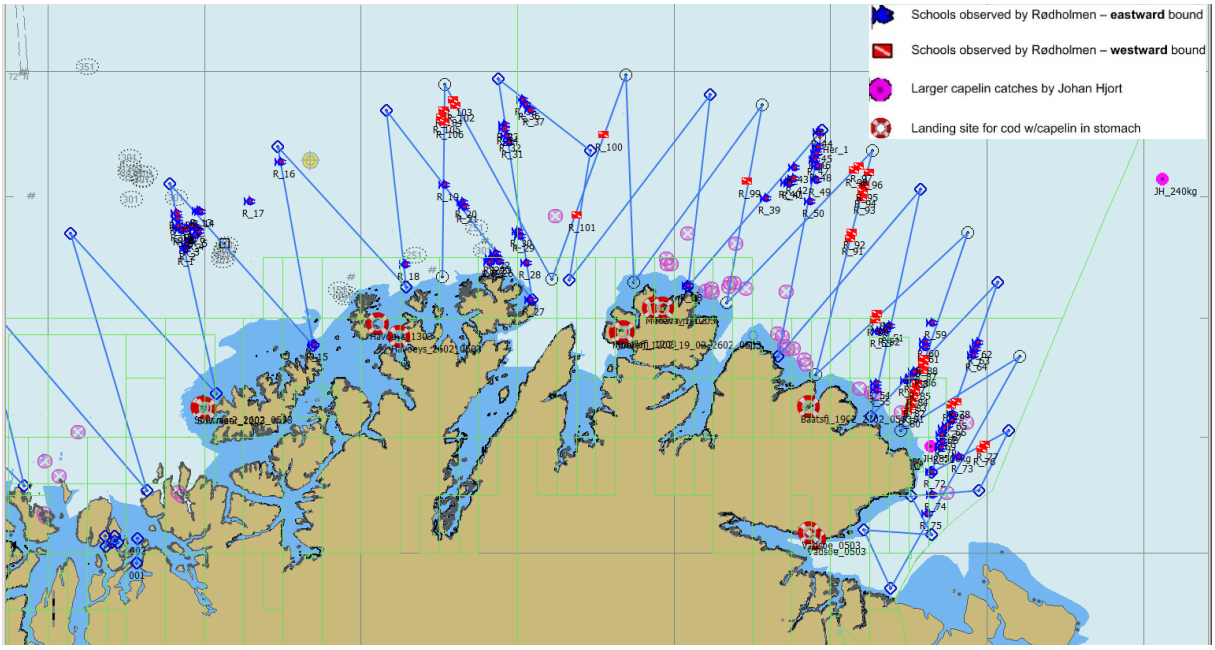


Figure 2. Summary of the auxiliary data available before and during the survey. The cruise lines of MS Rødholmen (blue lines) and the locations of schools along the track. Landing sites for cod with capelin in the stomach and trawl catches of capelin from Johan Hjort are also shown. School observations from MS Rødholmen in the northern end of transects between Gamvik and Berlevåg, correspond to NSS herring.

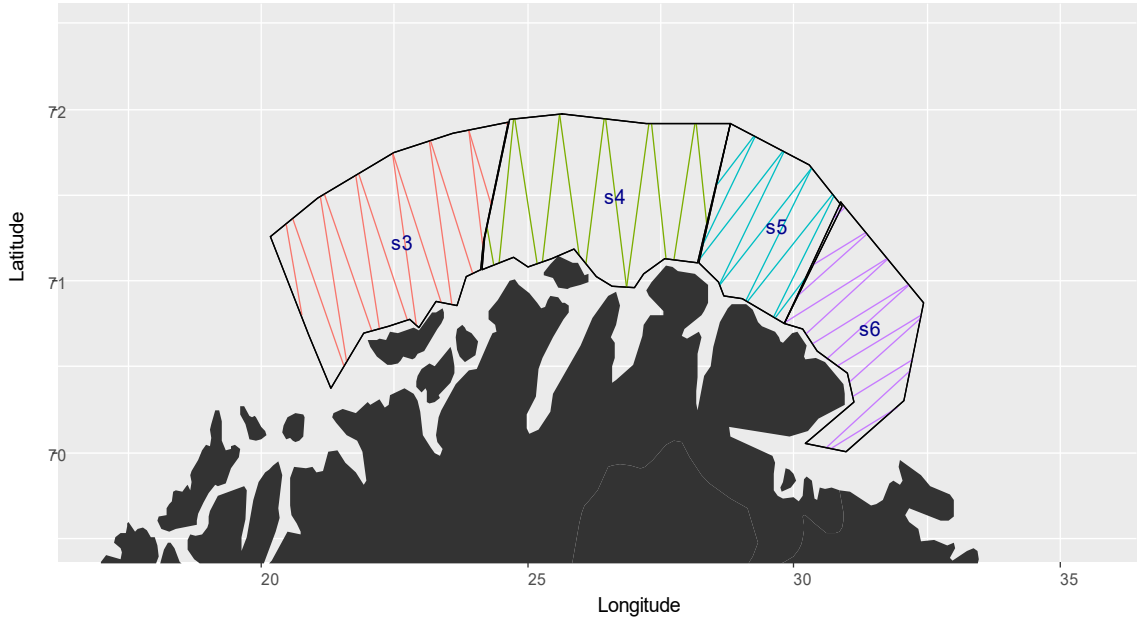


Figure 3. Final survey design with increased coverage, modified based on auxiliary data available before the survey start.

Acoustic data

Echo sounder

The first large capelin aggregations were observed in transect T6 in S3 at a distance between 25 to 50 nmi offshore, in the same region as reported by MS Rødholmen, which visited the same region 3 days earlier (Figure 4). The school size showed a high variability, and the patchiness of the schools increased with increasing school size. Recordings from the sonar was essential to find schools suitable for trawling outside the transects used for abundance estimation. The good agreement of capelin observations between Rødholmen and MS Vendla continued until the western part of S4. In the eastern part of S4 and western S5 there was also a good agreement between the two vessels, as both vessels did not register capelin in this region. It is important to note, that in the northern area of S5, herring schools were observed by both vessels.

In eastern S5 and in all S6, it was expected that MS Vendla would find the same aggregations that MS Rødholmen found 8 days earlier at about 15 nmi from the coast. However, no capelin was observed by Vendla. Once the main survey was finished inside Varangerfjord, a new investigation was conducted to see if the capelin had entered the shallow coastal zone to spawn. A 14-hour additional mini survey was conducted covering from 25 meters depth close to the coast, up to 5 nautical miles offshore (Figure 5). Two strata were made, and a standard zig-zag pattern was used. Acoustic registrations indicated hardly any presence of capelin in this coastal shallow region.

Note that trawling to a large degree was conducted outside the transect lines based on sonar recordings.

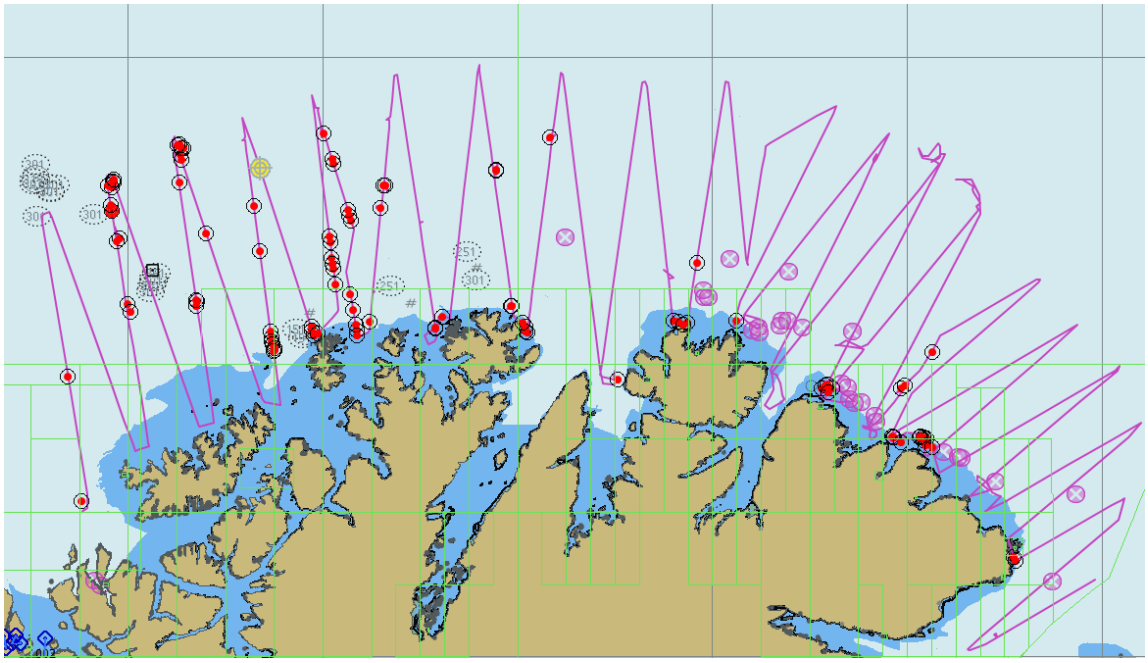


Figure 4. Distribution of the 100 highest capelin NASC values per 1 nmi (red circles) from the echo sounder which include the registrations along and outside the MS Vendla track line.

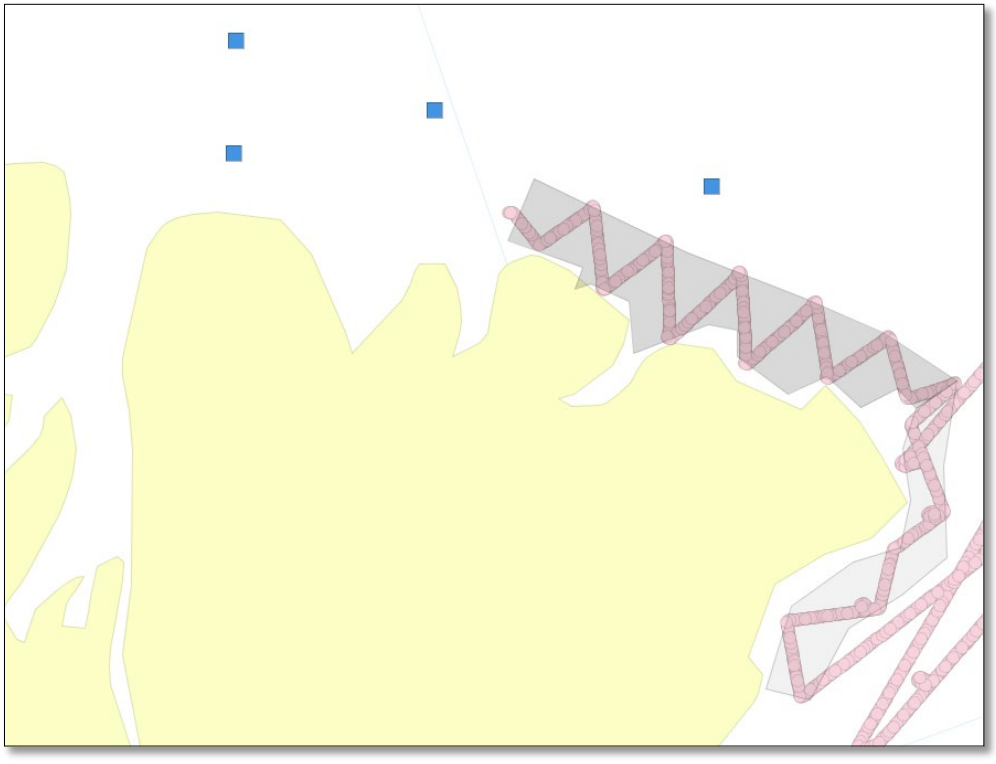


Figure 5. The coastal mini survey with acoustic zig-zag transects (pink circles) in the two strata (light grey polygons) and the closest trawl stations (blue squares) used for the biomass estimation in this coastal region.

Sonar

The continuous sonar operation during the survey provided very valuable information about density, size and patchiness of schools in a way that is not so easily derived from the echo sounder recordings alone (Figure 6). The number of schools observed in the sonar was larger than what was recorded in the echo sounder in accordance with the larger sampling volume, about 300 times. The exception was in shallow waters less than 100 m, were the bottom echoes limited the performance of the sonar.

Patchiness is also associated with school size, were the large schools are more rare than smaller schools. In this survey it was also the case, where the largest schools were scarce, but present in the survey area. Due to their low numbers, they were mainly observed in the sonar and not in the echo sounder along the transects lines. These schools were sampled by sonar and echo sounder, outside the transect line, and not included in the estimate.

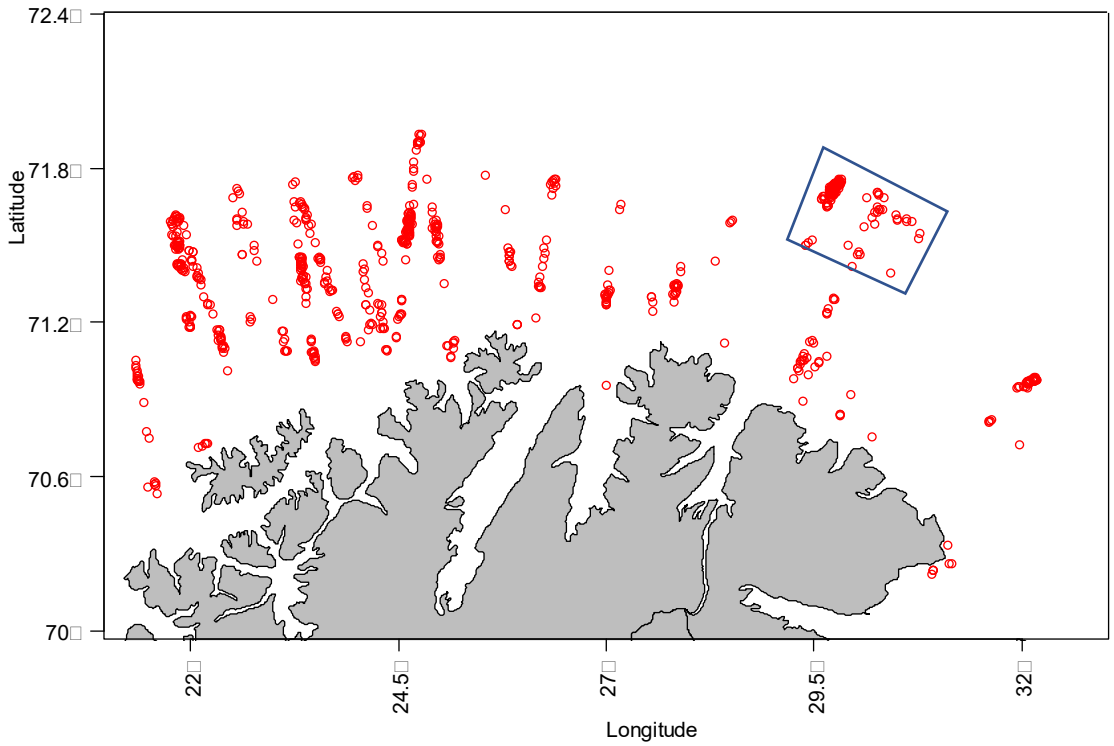


Figure 6. Schools observed with sonar in the survey area. Most schools correspond to capelin, only in the northern border of S5 they correspond to herring (blue square).

Capelin migration and speed was computed from school recordings by tracking over tens of seconds up to minutes, in particular, during trawling and detailed inspection of school outside the transects lines. The mean direction was south with an average speed of 1 knot. If we assume this value as a daily constant speed, we can compute that a fish observed at 50 nmi in the northern limit of the survey region will arrive to the coast in about 2 days. Most of the schools were detected by the sonar at ranges between 100 and 900 m, and present at a mean depth of 53.8 m. The mean school area was 5491 m^2, which correspond to a diameter of 84 m, assuming a circular school section.

More analysis from the sonar data will be finalized in a later stage and will focus on combining the echo sounder measurements and the sonar measurements along the transects and strata.

Biological sampling

A total of 22 trawl hauls were done during the survey, from surface up to 250 m depth (Figure 5). The operation of the small trawl with the vessel trawl doors and wires was easy and fast, with an average operation duration of around 40 minutes. The splitting of the cod end allowed the escape of capelin when large catches occur, retaining only enough fish for the biological sampling. Details on the trawl performance is given in Appendix 1.

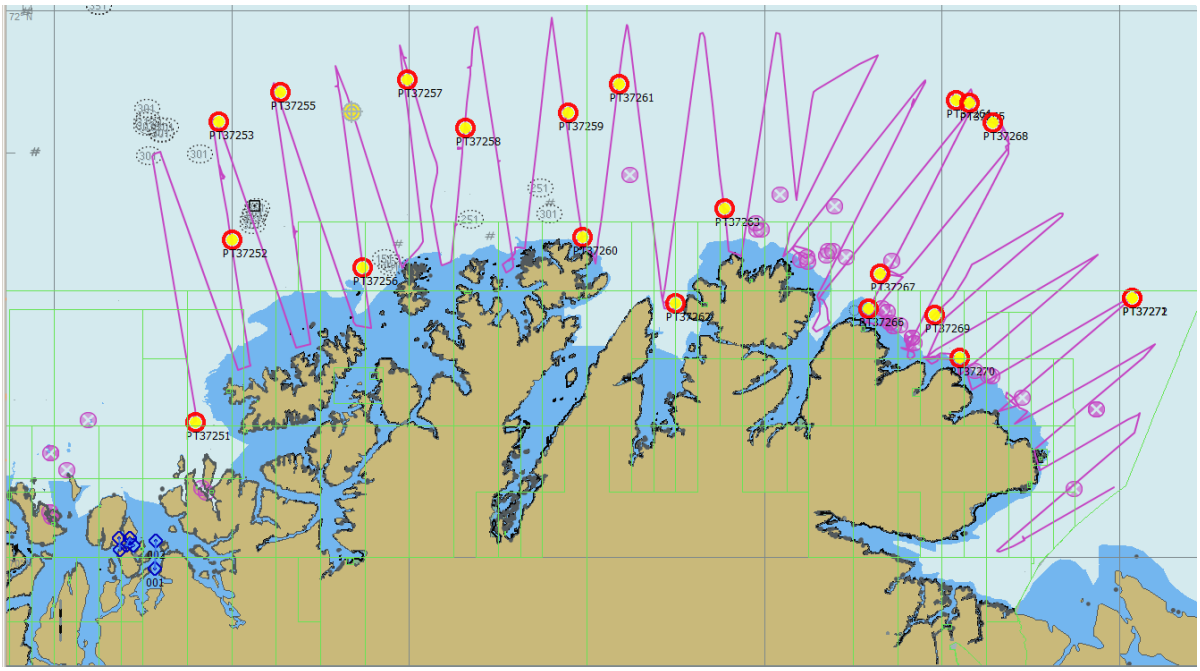


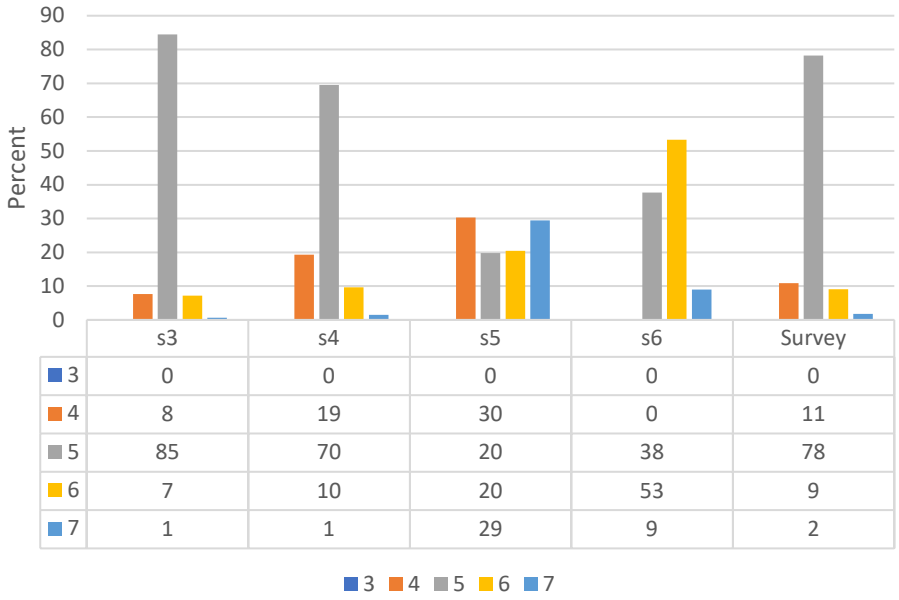
Figure 5. The survey track of MS Vendla with trawl stations marked as a yellow circle with red border. Note that the first two transects to the west are not shown.

The mean length and mean weight of capelin for the whole survey was 16.7 cm and 22 g, respectively. The length and weight by strata showed the same size and a small decrease in the weight in the strata towards the east (Table 3). Length distributions by trawl are presented in Appendix 3.

Strata	Mean length (cm)	Mean weight (g)
3	16.7	22.1
4	16.6	21.7
5	16.6	21.5
6	16.4	21.7

Table 3. Capelin mean length and weight by strata.

The maturity stage of the capelin showed a clear increasing trend towards the spawning condition to the east of the survey region with a 7% of the fish in stage 6 in S3, to end up with a 53% in S6 (Figure 6).



	s3	s4	s5	s6	Survey
3	0	0	0	0	0
4	8	19	30	0	11
5	85	70	20	38	78
6	7	10	20	53	9
7	1	1	29	9	2

Figure 6. Maturity stage of capelin by strata. Stage 6 indicate the fish are in a spawning condition, and stage 7 fish are already spent.

The herring present in the northern part of the survey area in S5 was dominated by 3-year-old individuals (2016-year class) with an average length of 21 cm.

Biomass estimation

Higher capelin aggregations were observed in S3 and with maximum NASC-values in the first transect of S4 (Figure 7).

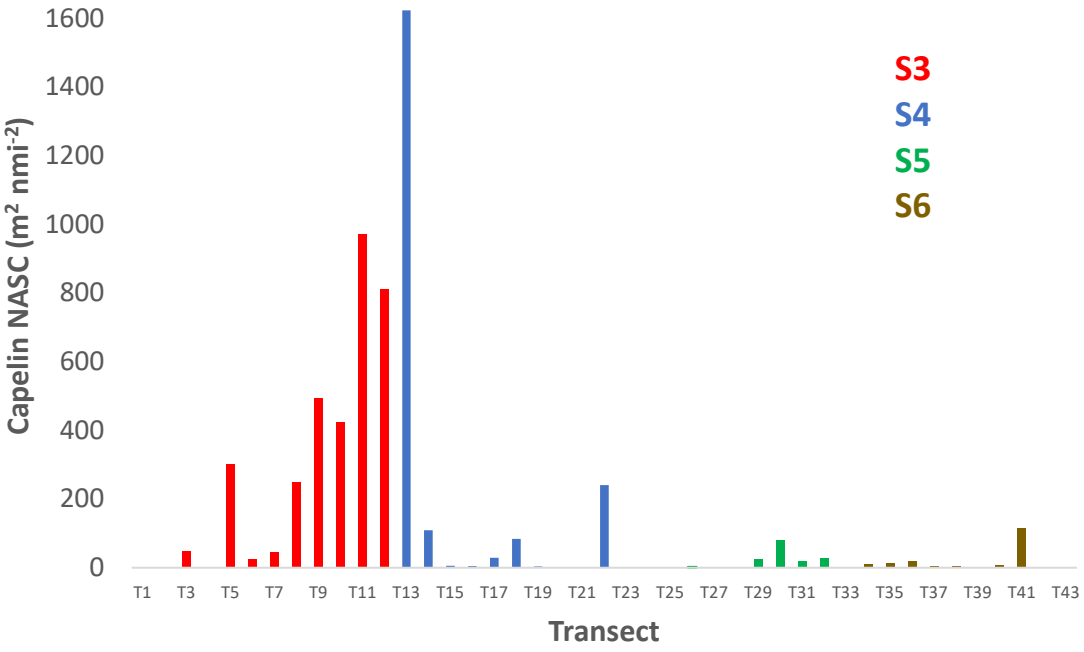


Figure 7. Capelin nautical area scattering coefficient (NASC) for each transect and by strata.

The total biomass was estimated in to 298 093 t, with a sampling variance expressed as Coefficient of Variation (CV) of 23%. These were estimated by mean and standard deviation of 500 bootstrap replicates. 90% of the bootstrap replicates were between 190 263 t and 414 150 t. Capelin average individual weight was 22 g. Fish of age 4 was dominant, followed by 3 and 5-year-olds.

Refer to the Appendix 4 for details on the capelin biomass estimate.

In the extra coastal survey, the biological data of the closest trawl were assigned to compute a biomass of 2 826 t.

Concluding remarks

1. Auxiliary information, especially data provided by scouting vessel MS Rødholmen helped to adapt and improve the original survey design. The strata limits were adjusted, and the strata coverage was increased from the original design.
2. Good agreement of school presence and absence between scouting vessel MS Rødholmen and MS Vendla when time difference between the two coverages was about 3 days. When time difference was longer, about 8 days, no agreement in school presence was observed.
3. The disagreement between the two vessels in the eastern strata (S6) may indicate that the capelin in that region was closer to the spawning grounds when MS Rødholmen measured it. When MS Vendla arrived, the fish was not found and had most likely already spawned.
4. Sonar provided valuable information on school distribution and sizes, allowing echo sounder inspection of capelin schools not detected along survey tracks. Sonar observations was very important for identifying schools suitable for trawling.
5. Capelin schools had a general migration towards the coast at an average speed of 1 knot.
6. The total biomass was estimated in to 298 093 t, with a sampling variance expressed as Coefficient of Variation (CV) of 23%. These were estimated by mean and standard deviation of 500 bootstrap replicates. 90% of the bootstrap replicates were between 190 263 t and 414 150 t. Capelin average individual weight was 22 g. Fish of age 4 was dominant, followed by 3 and 5-year-olds.
7. The valuable data collected, and the experience gained, will form the basis for a further evaluation with the aim of improving spawning surveys from next year onwards. Survey strategy, survey design, effort allocation and methodology will be among the topics in a thorough evaluation to enhance the outcome of future surveys.

Acknowledgments

Jostein Røttingen is thanked for his dedicated work with the biological sampling and age readings. Stine Karlson is thanked for the routine delivery of reports from the cod landing sites. Silje Seim, Asgeir Aglen and Edvin Fuglebakk are thanked for valuable information on capelin registration during the Winter survey. The skipper and officers onboard MS Rødholmen are thanked for they excellent cooperation and positive attitude during their participation in the scouting phase of the survey region. The skipper and crew of MS Vendla are thanked for their valuable work and engagement during the whole survey, giving all the facilities to develop our labored on board.

References

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Appendix

Appendix 1. Harstad trawl

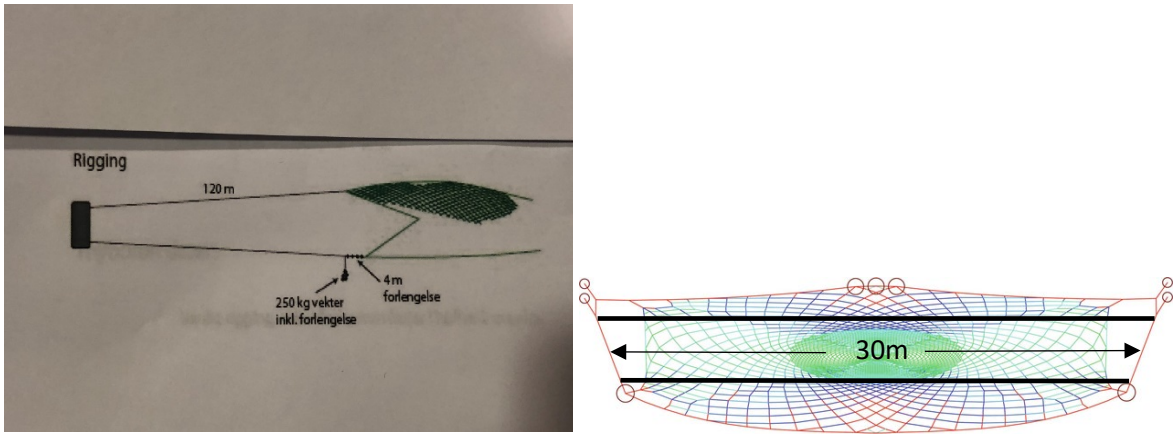
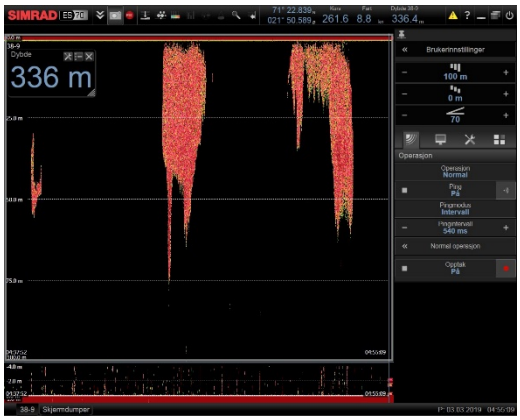


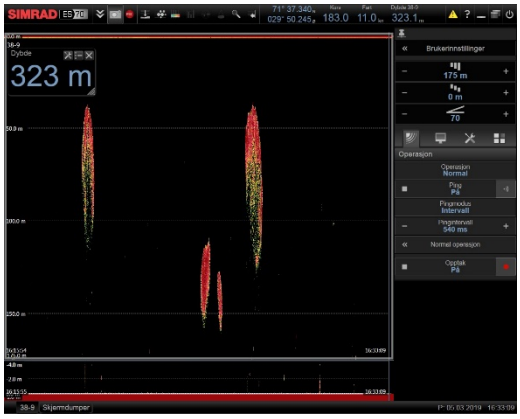
Figure 1. Rigging of Harstad trawl used during the survey (left panel) and detail of two 30 m security ropes attached to the net opening to protect damaging the trawl (right panel).

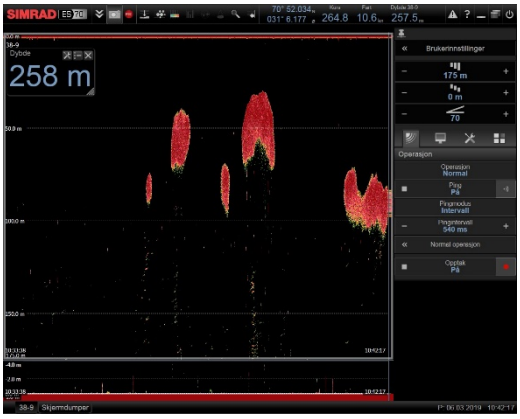
Wirelength	60	61	71	78	85	85	100	501	550
Spread	58	67	69	74	68	68	80	119	129
Height	11	12	12	12	11	11	11	9	8

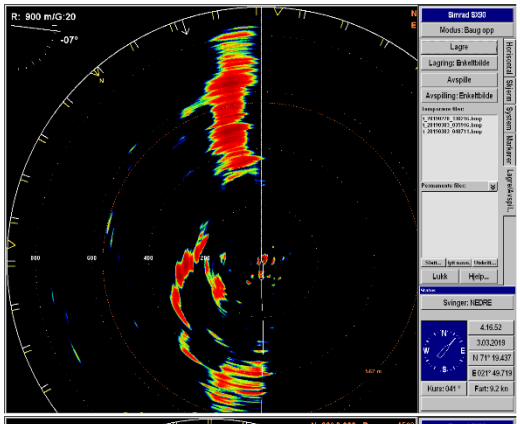
Table 1. Performance of Harstad trawl during 9 pelagic trawl hauls.

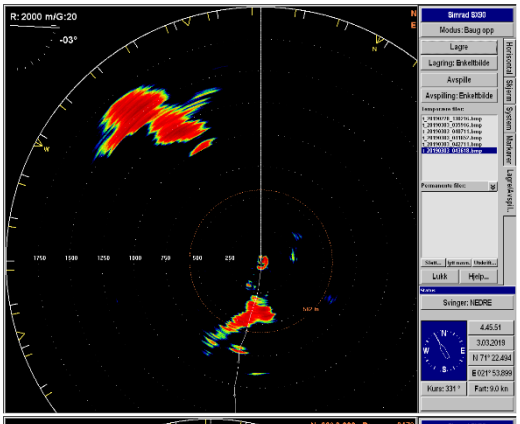
Appendix 2. Screen dumps from sonar and echo sounder from MS Rødholmen

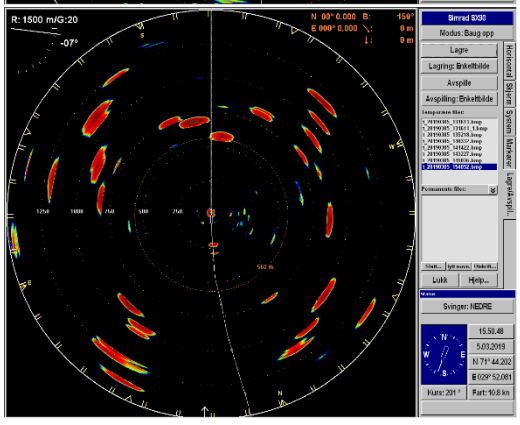


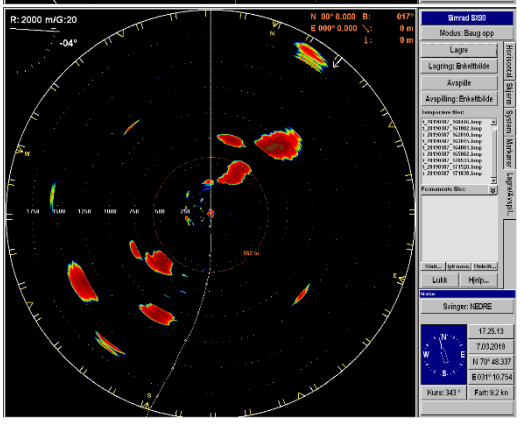






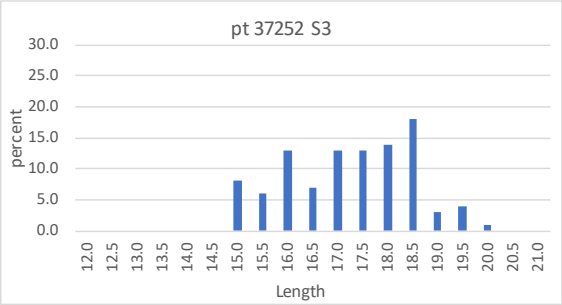


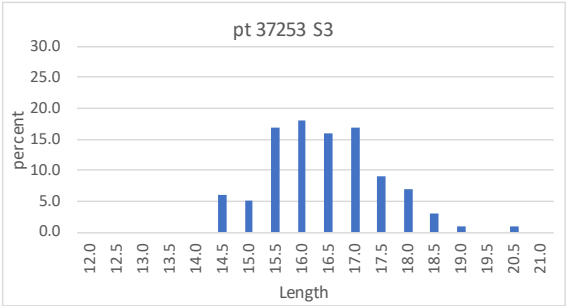


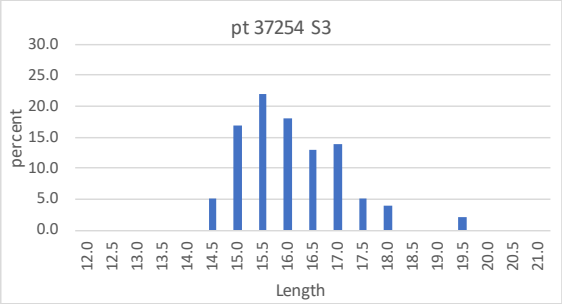


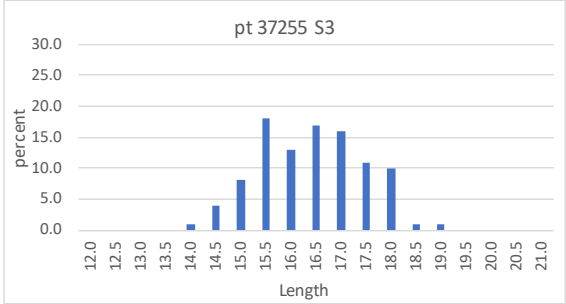
Appendix 3. Capelin length distribution by trawl station

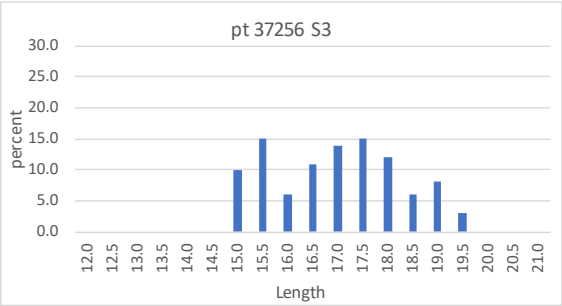
In every graph is indicated the trawl code and the stratum (i.e. pt 37252 S3)

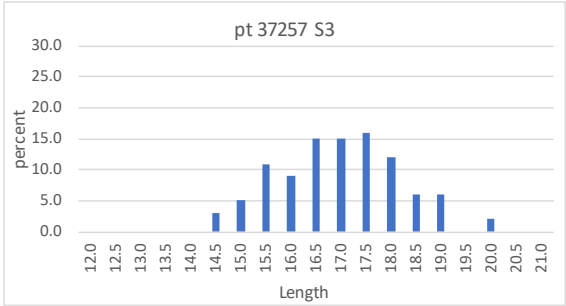


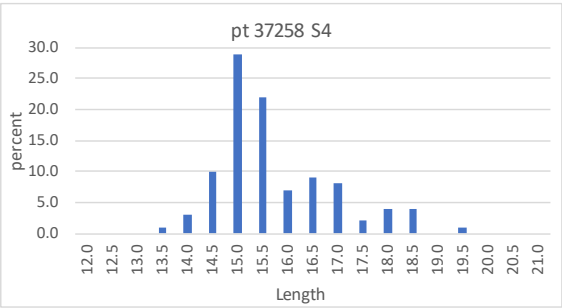


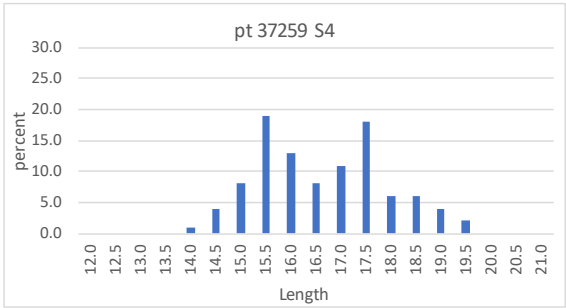


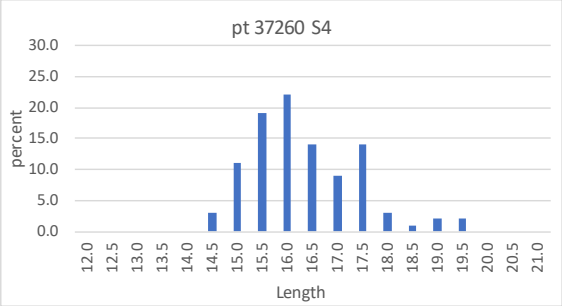








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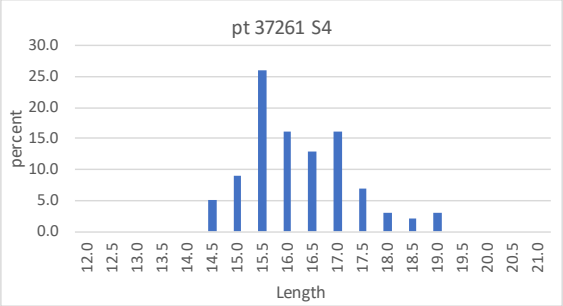
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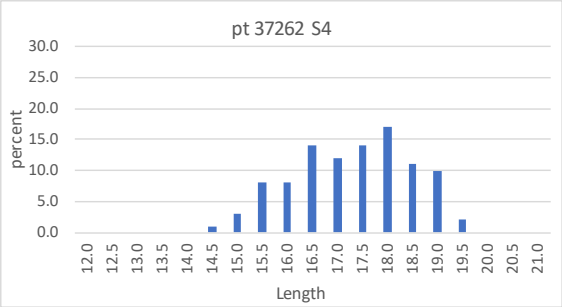
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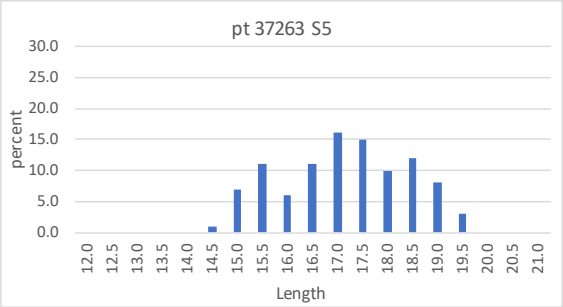
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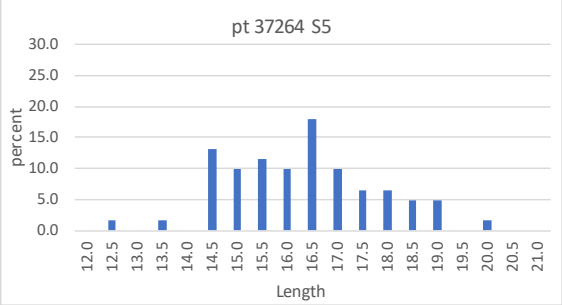
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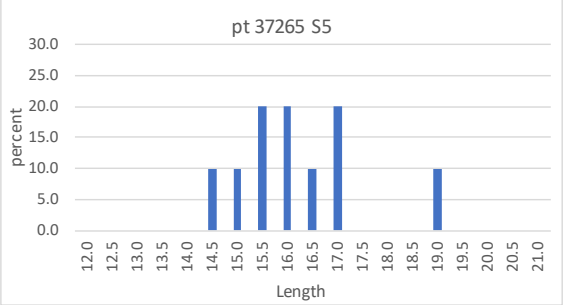
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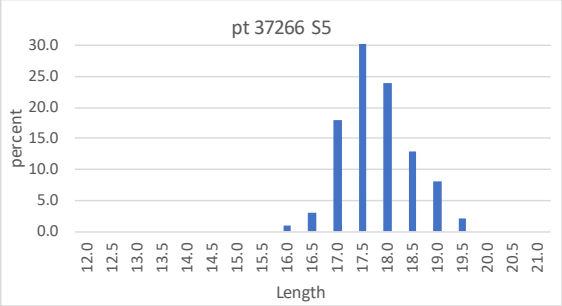
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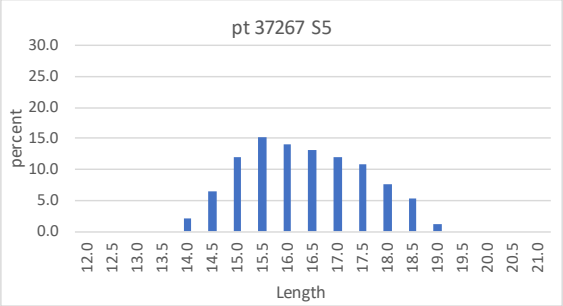
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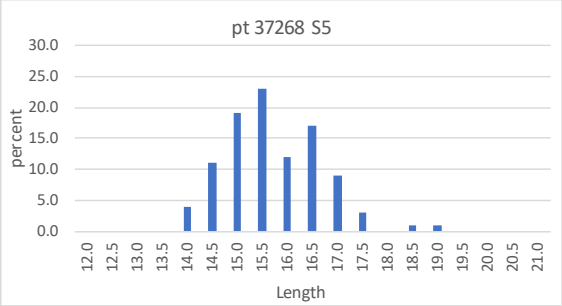
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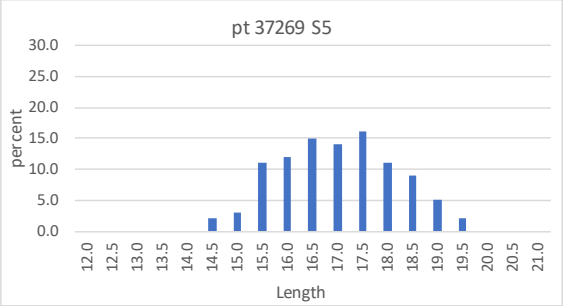
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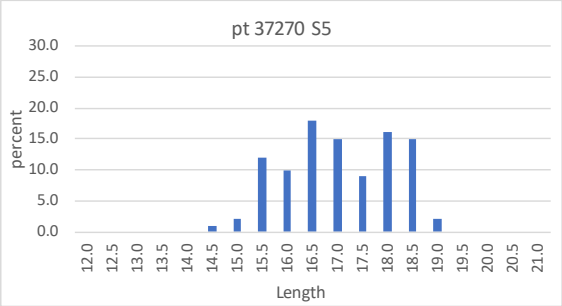
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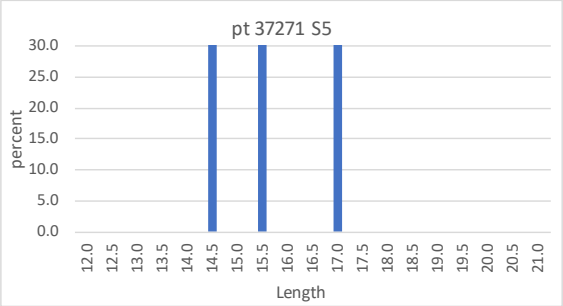
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Length

Appendix 4. Summary of the abundance estimation

Variable: Abundance
EstLayer: 1
Stratum: TOTAL

LenGrp	age 2	3	4	5	6	Number (1E3)	Biomass (1E3kg)	Mean W (g)
12-13	982	-	-	-	-	982	6.9	7.00
13-14	-	6299	-	-	-	6299	62.0	9.84
14-15	860	388772	140538	-	-	530170	6637.4	12.52
15-16	-	1759705	1432399	133626	-	3325730	50127.9	15.07
16-17	-	1049898	1796896	515781	-	3362575	63741.1	18.96
17-18	-	596079	2128463	688555	31884	3444981	85177.3	24.73
18-19	-	291366	1115979	538824	49731	1995900	61222.2	30.67
19-20	-	113330	360598	175370	16835	666134	24944.0	37.45
20-21	-	-	64722	-	-	64722	2736.2	42.28
TSN(1000)	1843	4205449	7039594	2052157	98451	13397493	-	-
TSB(1000 kg)	16.3	79413.2	160064.8	52058.0	3102.5	-	294654.9	-
Mean length (cm)	13.43	16.04	16.81	17.27	18.18	-	-	-
Mean weight (g)	8.87	18.88	22.74	25.37	31.51	-	-	21.99

The total estimate by length and age. These baseline results are used in the bootstrap computations that will provide with final estimate and the sampling variance (see "Estimate of variance" table)

Variable: Abundance
EstLayer: 1
Stratum: TOTAL

LenGrp	sex 1	2	Number (1E3)	Biomass (1E3kg)	Mean W (g)
12-13	982	-	982	6.9	7.00
13-14	6299	-	6299	62.0	9.84
14-15	530170	-	530170	6637.4	12.52
15-16	3206694	119036	3325730	50127.9	15.07
16-17	2654490	708084	3362575	63741.1	18.96
17-18	1426772	2018210	3444981	85177.3	24.73
18-19	409293	1586607	1995900	61222.2	30.67
19-20	53121	613013	666134	24944.0	37.45
20-21	-	64722	64722	2736.2	42.28
TSN(1000)	8287822	5109671	13397493	-	-
TSB(1000 kg)	152665.6	141989.3	-	294654.9	-
Mean length (cm)	16.04	17.63	-	-	-
Mean weight (g)	18.42	27.79	-	-	21.99

The total estimate by length and sex

Variable: Abundance
EstLayer: 1
Stratum: TOTAL

LenGrp	specialstage 3	4	5	6	7	Number (1E3)	Biomass (1E3kg)	Mean W (g)
12-13	982	-	-	-	-	982	6.9	7.00
13-14	-	6299	-	-	-	6299	62.0	9.84
14-15	-	32450	461829	18376	17515	530170	6637.4	12.52
15-16	-	456700	2564851	245694	58486	3325730	50127.9	15.07
16-17	-	412875	2544233	317900	87567	3362575	63741.1	18.96
17-18	-	425847	2627709	351781	39644	3444981	85177.3	24.73
18-19	-	102688	1681582	180924	30706	1995900	61222.2	30.67
19-20	-	20379	531296	105385	9074	666134	24944.0	37.45
20-21	-	982	63739	-	-	64722	2736.2	42.28
TSN(1000)	982	1458220	10475239	1220059	242992	13397493	-	-
TSB(1000 kg)	6.9	29544.2	231644.5	28626.3	4833.0	-	294654.9	-
Mean length (cm)	12.50	16.39	16.67	16.83	16.40	-	-	-
Mean weight (g)	7.00	20.26	22.11	23.46	19.89	-	-	21.99

The total estimate by length and special stage

Variable: Abundance
EstLayer: 1
Stratum: s3

LenGrp	Number (1E3)	Biomass (1E3kg)	Mean W (g)
12-13	-	-	-
13-14	-	-	-
14-15	302761	3840.3	12.68
15-16	2262743	34100.5	15.07
16-17	2485830	46991.7	18.90
17-18	2517700	61986.4	24.62
18-19	1481937	45031.8	30.39
19-20	446175	16715.6	37.46
20-21	63739	2693.0	42.25
TSN(1000)	9560885	-	-
TSB(1000 kg)	211359.3	211359.3	-
Mean length (cm)	16.69	-	-
Mean weight (g)	22.11	-	22.11

The estimate for stratum "s3" by length

Variable: Abundance
EstLayer: 1
Stratum: s4

LenGrp	Number (1E3)	Biomass (1E3kg)	Mean W (g)
12-13	-	-	-
13-14	5316	53.2	10.00
14-15	148861	1797.0	12.07
15-16	914431	13748.4	15.03
16-17	749621	14327.9	19.11
17-18	754937	18836.2	24.95
18-19	420000	13184.8	31.39
19-20	196709	7395.2	37.59
TSN(1000)	3189876	-	-
TSB(1000 kg)	69342.6	69342.6	-
Mean length (cm)	16.56	-	-
Mean weight (g)	21.74	-	21.74

The estimate for stratum "s4" by length

Variable: Abundance
EstLayer: 1
Stratum: s5

LenGrp	Number (1E3)	Biomass (1E3kg)	Mean W (g)
12-13	982	6.9	7.00
13-14	982	8.8	9.00
14-15	29251	334.7	11.44
15-16	80593	1159.9	14.39
16-17	86920	1621.7	18.66
17-18	90022	2257.1	25.07
18-19	49451	1568.3	31.71
19-20	20378	732.7	35.96
20-21	982	43.2	44.00
TSN(1000)	359563	-	-
TSB(1000 kg)	7733.3	7733.3	-
Mean length (cm)	16.57	-	-
Mean weight (g)	21.51	-	21.51

The estimate for stratum "s5" by length

Variable: Abundance
EstLayer: 1
Stratum: s6

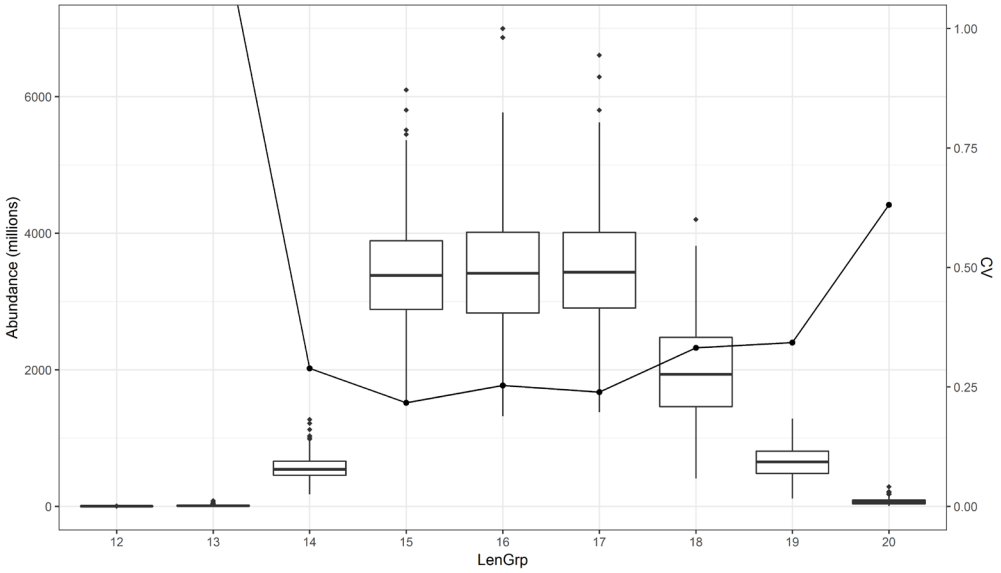
LenGrp	Number 1E3)	Biomass (1E3kg)	Mean W (g)
12-13	-	-	-
13-14	-	-	-
14-15	49297	665.5	13.50
15-16	67963	1119.1	16.47
16-17	40204	799.8	19.89
17-18	82322	2097.6	25.48
18-19	44511	1437.3	32.29
19-20	2872	100.5	35.00
TSN(1000)	287169	-	-
TSB(1000 kg)	6219.7	219.7	-
Mean length (cm)	16.37	-	-
Mean weight (g)	21.66	-	21.66

The estimate for stratum "s6" by length

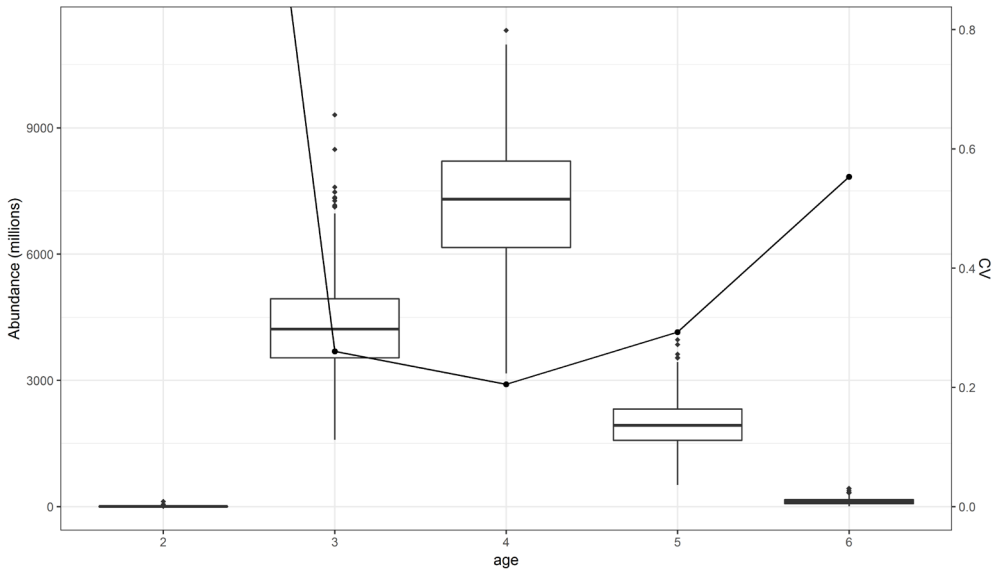
Estimate of variance

Variance in biomass abundance of capelin (ton) for the survey by 500 iterations with bootstrap of trawl stations and acoustic transects:

Abundance 5%	Abundance 50%	Abundance 95%	Abundance mean	Abundance standard deviation	Abundance coefficient of variation
190 263	295 474	414 150	298 093	69 568	0.23



Estimate of variance by length group (number of fish)



Estimate of variance by age (number of fish)