

CRUISE REPORT
Cruise no. 9, 1995
R/V "G.O.Sars", 26/5 - 22/6.

Introduction

On October 19th 1994, representatives from the marine research institutes in the Faroes, Iceland, Russia and Norway met in Copenhagen to discuss how the institutes could coordinate their investigations in the Norwegian Sea in 1995, with particular emphasis on the distribution of the Norwegian Spring Spawning Herring Stock. It was agreed to coordinate cruise plans for 1995 to obtain the best possible coverage of the migrations and distribution of the Norwegian Spring Spawning Herring, and sampling of plankton and environmental data. A coordinating unit was established, and a meeting was held in Bergen 2-3 March to plan the surveys on the Norwegian Spring Spawning Herring and the environment in the Norwegian Sea in summer 1995. The planning group made specific decisions on survey areas, methodology, data collection and reporting which are documented in a report from the meeting (Anon. 1994).

In the period 26/5 - 22/6 the meeting decided that R/V " G.O.Sars" should cover an area off the coast of Norway limited within 74° N to 60° N, 0 ° to 19° E, and the Jan Mayen area limited within 72° N to 69° N, 10° W to 0°. The purpose of the cruise was to map the distribution of the Norwegian Spring Spawning herring within the area, collect environmental data to the Mare Cognitum programme, and conduct a sonar intercalibration exercise with research vessels from the Faroes, Iceland and Russia. The cruise report is written with a standard summary in an Appendix as drafted by the planning group

Participants

The following persons participated:

Martin Dahl	IMR, Bergen
Berit Endresen	IMR, Bergen
Ole Gullaksen	IMR, Bergen
Magnus Johannessen	IMR, Bergen
Alexander Krysov	P.I.N.R.O., Mumansk (26/5 - 18/6)
Jarle Kristiansen	IMR, Bergen
Ole Arve Misund	IMR, Bergen (cruise leader)

Leif Nøttestad	IMR, Bergen
Jostein Røttingen	IMR, Bergen

Survey Area

In the period 26/5 - 22/6, R/V " G.O.Sars" covered the area off the coast of Norway limited within 74° North to 63° North, 0° to 19° East, and the Jan Mayen area limited within 72° North to 69° North, 10° West to 0° (Fig. 1). In addition, the vessel covered the central Norwegian Sea in connection with the sonar calibration exercise in the international zone at 67° North, 4° 30' West.

Methods

Continuous acoustic recording of fish and plankton were made by a calibrated echo integration unit consisting of a 38 kHz Simrad EK500 with a range of 10 - 1000 m and a Bergen Echo Integrator for scrutinizing the recordings and allocation of area back scattering strengths (s_A) to species. A 95 kHz Simrad SA950 sonar was also continuously in operation, mostly directed 90° to either side and tilted -5° to - 10° depending on weather conditions.

Stations for fish, plankton and environmental sampling were taken approximately each 60th mile during most of the cruise (not when sailing to the calibration area and on the return to Bergen). The stations were of type "Large" or "Small".

During a "Large" station there were CTD monitoring to 1500 m (1000 m south of 66°). The light attenuation were recorded to 200 m depth. On "Small" stations CTD and light attenuation were measured to 500 m.

Water samples were taken in the "standard" depths (5, 10, 30, 50, 75, 100, 200, 300, 500, 700 ("large" station only), 1000 ("large" station only)) for monitoring of chlorophyll and nutritional

salts.

During a "Large"-station there were oblique MOCNESS -tows from 700-500 m, 500 - 400 m, 400 - 300 m, 300 - 200 m, 200 - 100 m, 100 - 50 m, 50 - 25 m, and 25 - 0 m. The MOCNESS-tows on "Small" stations were from 200 - 100 m, 100 - 50 m, 50 - 25 m, and 25 - 0 m. In addition there were WP2 net tows from 200 - 0 m and 100 - 0 m during 3 stations in rough weather.

On "Small" stations there were surface trawling (covering 10 - 40 m depth) of 30 min duration. On "Large" stations there were in addition two deep tows which consisted of one haul with 10 min in each of the depths 200 m, 250 m, 300 m, 350 m, 400 m, 450 m, 500 m 550 m, and 600 m. The other deep haul consisted of 10 min in 50 m, 100 m, and 150 m.

Occasionally, deep or surface tows were taken to identify acoustic recordings of fish.

Temperature distribution

The surface temperature in the Norwegian Sea was characterized by a distinct north east - south west front east of Jan Mayen with temperatures $> 6^{\circ}\text{C}$ in the central Norwegian Sea declining to 1°C north east of Jan Mayen (Fig. 2). The same pattern was found in the temperature distribution at 50 m depth also (Fig. 3). At 200 m depth the north east - south west front was especially clear east of Jan Mayen by a sharp drop in temperature from 4°C to the east of the front and $< 0^{\circ}\text{C}$ to the west of the front (Fig. 4).

Qualitative description of zooplankton

The zooplankton description is based on material collected on 37 stations of which 6 stations were of the "Large"-type and 31 stations of the "Small"-type. The echo quantity or area backscattering (s_A) distribution of zooplankton is given in Figure 5. To a certain extent the area backscattering reflects zooplankton biomass. However, north of 72° North, a S_V - threshold of

-85 dB was applied while the rest of the cruise was run with an S_V -threshold of -80 dB. Therefore the s_A - values is not directly comparable between the northern and southern area.

Area distribution of zooplankton

1) Northeastern area.

This area was characterized by a rather even distribution of zooplankton with especially dense concentrations along 73° North from 02° 30' East to 09° 29' East, and along 72° North from 02° 30' East to 13° 50' East. The dominating species were *Calanus finnmarchicus* and *Calanus hyperboreus*, but also Amphipods and Chaetognaths were present. There were very little krill in the area, but a few *Thysanoessa longicaudata* and *Meganyciphanes norvegica* were recorded.

2) Jan Mayen area.

Dense concentrations of zooplankton were recorded north-east and north-west of Jan Mayen, while there were less zooplankton south-east of Jan Mayen. In the eastern part of the Jan Mayen there were higher zooplankton concentrations dominated by krill, *Thysanoessa longicaudata*, and some *Thysanoessa inermis*.

3) Off Vesterålen.

Substantial quantities of zooplankton dominated by *Calanus finnmarchicus* and *Calanus hyperboreus* were recorded in the area. In coastal waters, krill < 5 mm (*Thysanoessa longicaudata*) dominated.

4. Central Norwegian Sea.

In the northern areas of the central Norwegian Sea there were substantial recordings of zooplankton dominated by *Calanus finnmarchicus* and *Calanus hyperboreus*, but also with substantial amounts of Amphipods and *Metridia*. In the eastern areas of the central Norwegian

Sea *Calanus finnmarchicus* and Amphipods dominated. In the other areas *Calanus finnmarchicus* was accompanied by *Euchaeta* and Chaetognaths. Small krill (*Thysanoessa longicaudata*) was recorded in high quantities on a few locations. The Pteropod *Limacina* seemed to occur in higher concentrations in the central Norwegian Sea than in the other areas.

Herring distribution

Herring were recorded in schools close to the bottom in shallow water (< 100 m depth) at Malangsgrunnen (approx. 70° North, 17° East). Off Vesterålen there were substantial quantities of herring in schools close to the surface (Fig. 6). Herring were also recorded in schools close to the surface along the slope of the continental shelf off western Norway between 64° North to 68° North. The larger Norwegian Spring Spawning herring were distributed between 65° 30' North to 70° 15' North and 5° 15' West to 0°. The highest concentrations of the larger Norwegian Spring Spawning herring were recorded in the south-eastern areas of the Jan Mayen zone (Fig. 6).

The horizontal guided sonar and the echo integration unit gave quite comparable results with regard to distribution and abundance of herring during most of the survey. A biomass estimate per square nautical mile calculated from the sonar recordings was 1.4 times higher than that calculated from the echo integration values. Taking account of the substantial uncertainty connected to the sonar estimate, this indicate that the echo integration gave quite representative recordings of the herring concentrations. On a cruise in the central Norwegian Sea/Jan Mayen area in June 1994 by R/V "G.O.Sars" the sonar estimate of herring was about 3 times higher than that of the echo integrator. This indicate that the herring recorded on this survey was more available to echo integration and/or performed less vessel avoidance than during the survey last year. However, there were areas during this years survey where herring schools were recorded nearly exclusively by the sonar.

Length and age distribution of herring

There was a clear east-west trend in the length and age composition of the trawl catches. In the eastern part of the Vesterålen area (PT 308, approx. 15° East) there were mainly three year old

herring (1993 year-class) of about 22 cm (Fig. 7). In the westerly sample (PT 357), 40 % of the herring were 12 year old (1983 year-class) of about 36 cm.

Off Vesterålen (PT 342, 343, 347,) and on the continental slope off western Norway (PT 348, 349), four and five year old herring of about 26 - 28 cm in length dominated the catches. In one station off Vesterålen (PT 344), three and four year old herring of 22 - 24 cm in length were most frequent.

In the south-eastern part of the Jan Mayen area (PT 331, 332, 335), five and six year old herring of 32 - 34 cm in length dominated the samples, but there were up to 20 % of 12 year old herring of about 36 cm in length (Fig. 7).

Distribution of other pelagic fish and squid

Blue whiting (*Micromesistius poutassou*) was found pelagically between 100 - 300 m depth in the central Norwegian Sea south of 69° N, and in rather dense concentrations off western Norway south of 66° North and east of 1° East (Fig. 8). The trawl samples of blue whiting was dominated by 3 - 6 year old fish of 26 - 33 cm in length (Fig. 9). Meso-pelagic species like the northern lantern fish was most frequent in the central area of the Norwegian Sea north of 70° North, and off western Norway east of 1° East. The squid, *Gonatus fabrici* was often found in substantial quantities in the trawl samples off Vesterålen and north of 70° North.

Attempts to catch salmon by a 500 m surface long-line with 50 hooks spaced about 10 m apart gave no result on five stations in the Jan Mayen area (Fig. 1). The long-line was baited with shrimp and squid, and were in the water for about 2.5 hours when conducting sampling on "Small" stations.

Sonar intercalibration

According to the distribution of the herring, the positions of the vessels, and the commitments of the persons involved, it was agreed to schedule the calibration to take place 17 - 19/6 in the

southern part of the international zone of the Norwegian Sea. The vessels R/V "G.O.Sars", R/V "Professor Marty", R/V "Magnus Heinasson" and R/V "Arni Fridriksson" therefore met in position 66° North, 5° 30' East on 17/6 at 12³⁰ UTC. The conditions for calibration in the area were not the best, however, with an easterly gale and few school recordings. During a VFH-meeting it was therefore decided to progress northwards in parallel at 8 knots. At 67° North the vessels turned east against an increasing gale and progressed with a speed just necessary to maintain heading against the wind. Between 04⁰⁰ and 07⁰⁰ UTC 18/6 the vessels organized in a calibration line in position 67° North 4°30' West. The vessels lined up in the following order: R/V "G.O. Sars", R/V "Professor Marty", R/V "Arni Fridriksson", and R/V "Magnus Heinasson". The calibration line was run with 1 nautical mile spacing between the vessels at a speed of 8 knots, and with the vessel in front 2-10° to the port or starboard bow to avoid running in each others propeller wake. The sonars were directed 90° port, tilted to -10° , and with an observation range of 50 m - 300 m. The range of the Simrad EK 500 echo sounder was set to 10 - 500 m. The calibration line was run north along 4° 30' West for 30 nautical miles, and ended at 67° 35' North. The calibration area was probably as optimal as possible at that time, because both icelandic, faroes and norwegian purse seiners operated in the area. In fact the calibration line started close to a norwegian purser with catch, were crossed by several icelandic pursers heading east, and ended in a position with fishing activity by norwegian and icelandic vessels. The calibration line was run orthogonal to the waves of 2 - 3 m height coming from the east. The -10° tilt angle avoided substantial surface reverberation and wave reflections on the sonar records.

During the calibration relatively small herring schools close to the surface and a few midwater schools were recorded by all vessels. On the Simrad SA950 sonar of R/V "G.O.Sars" about 65 schools were counted manually, but the detection programme on a HP720 work station identified 39 schools that fit the defined criteria of signal threshold, horizontal extent, and duration necessary for being categorized as a school. Onboard R/V "Professor Marty" 49 schools were counted, and "Arni Fridriksson" and "Magnus Heinasson" also recorded between 40 and 50 schools. All vessels therefore seemed to have recorded a comparable number of schools (40 -50) during the calibration. The higher manually counted numbers recorded by the Simrad SA950 sonar is most probably due to the better detection capabilities of that sonar compared to the conventional sonars of the other vessels. Consequently, on the SA950 record, several very small

schools can be identified. These schools were too small to fulfill the identification criteria of the detection programme, and were masked by noise on the other sonars.

During a VHF-meeting it was agreed that the calibration exercise was a success, and that no further exercise was necessary before the calibration results were properly analyzed. It was further agreed that an analysis of the calibration exercise should be conducted during the planned Reykjavik meeting. The participants should bring their sonar records to the meeting, agree on criteria for identifying schools and conduct a proper analysis of the calibration results.

Whale observations

Whale observations were frequently conducted visually by eye or binocular from the bridge. Identification of whale species was done by using the unique characteristics of the blow from each species when the whales were observed at long distance from the research vessel. In addition, the shape and size of the dorsal fin and fluke were used when the whales were observed close to the vessel. The whale observations were not recorded systematically and the results are therefore not usable for any quantification studies. The sector of observation was approximately 120 degrees in front of the vessel. Date and geographical position (GPS) were noted after every whale observation. Variable wind and weather conditions during the cruise including rough sea and fog made it sometimes nearly impossible to spot any whales if present. Time periods from a few hours up to two days were impossible for whale spotting.

The table below illustrates whale species observed, number of individuals within every species and group size. The number of whales observed in areas with high concentrations of herring and zooplankton, respectively, are also included in the table.

Whale species	# ind	Group size	Herring	Zooplankton
Fin whale	13	1-2	4	4
Humpback whale	3	1-2	0	0
Minke whale	25	1-3	23	2
Sperm whale	7	1-2	4	0
Pilot whale	4	4	0	0
Killer whale	4	1-3	1	0
White beaked dolphin	27	3-10	14	0

Among the various whale species, the minke whale had the strongest correlation to herring registrations. A total of 23 individuals were seen in areas with herring schools present. The fin whale was the only species which occurred in areas of high zooplankton concentrations and no fish registrations. All three humpback whales observed, one fin whale, three killer whales, all four pilot whales and three white beaked dolphins were observed migrating. Sperm whales were exclusively located above great depths (>1000 m). White beaked dolphins and pilot whales swam in groups, while the other species appeared more individually or two by two closely together.

On one occasion the sonar detected 13 pilot whales passing within 100 meters from the vessel. Only four individuals were observed visually at the same time. However, none of the larger whales observed came close enough to the vessel (within 300 m) to be recorded by the sonar, possibly because of avoidance behaviour. Counting larger whales therefore seems difficult by use of sonar. However, systematic visual whale observations could favourably be included in the scientific activity during the major cruises in the Norwegian Sea in summertime.

R/V "G.O.Sars" 22/6, 1995

Ole Arve Misund

APPENDIX

Cruise Summary Report

Name of Ship	R/V "G.O.Sars"
Call sign	LLZG
Cruise number	No. 9, 1995
Responsible laboratory	Institute of Marine Research, Bergen
Cruise leader	Ole Arve Misund
Cruise periode	26/5 - 22/6, 1995
Echo sounder equipment	Simrad EK500, 38 kHz, ES38
Echo integrator equipment	Bergen Echo Integrator (BEI)
Instrument calibration date	16/1-1995
Sampling equipment (trawls)	Åkra trawl, 150 meshes x 3200 M/M
Sampling equipment (plankton)	MOCNESS, WP2
Type of CTD sonde	Neil Brown 6000 m
Number of trawl stations	72 pelagic, 1 bottom
Number of plankton stations	53
Number of CTD stations	53
First and last log number	8050 - 12405
Cruise lines and stations	Fig. 1.
Echo integrator values	Figs. 5, 6, 8.
Sonar recordings	Appendixtable
Length distribution of pelagic fish	Figs. 7, 9.
Age distribution of pelagic fish	Figs. 7, 9.
Number of stomach samples from pelagic fish	10
Temperature and salinity	Figs. 2, 3, 4.
Plankton	In preparation

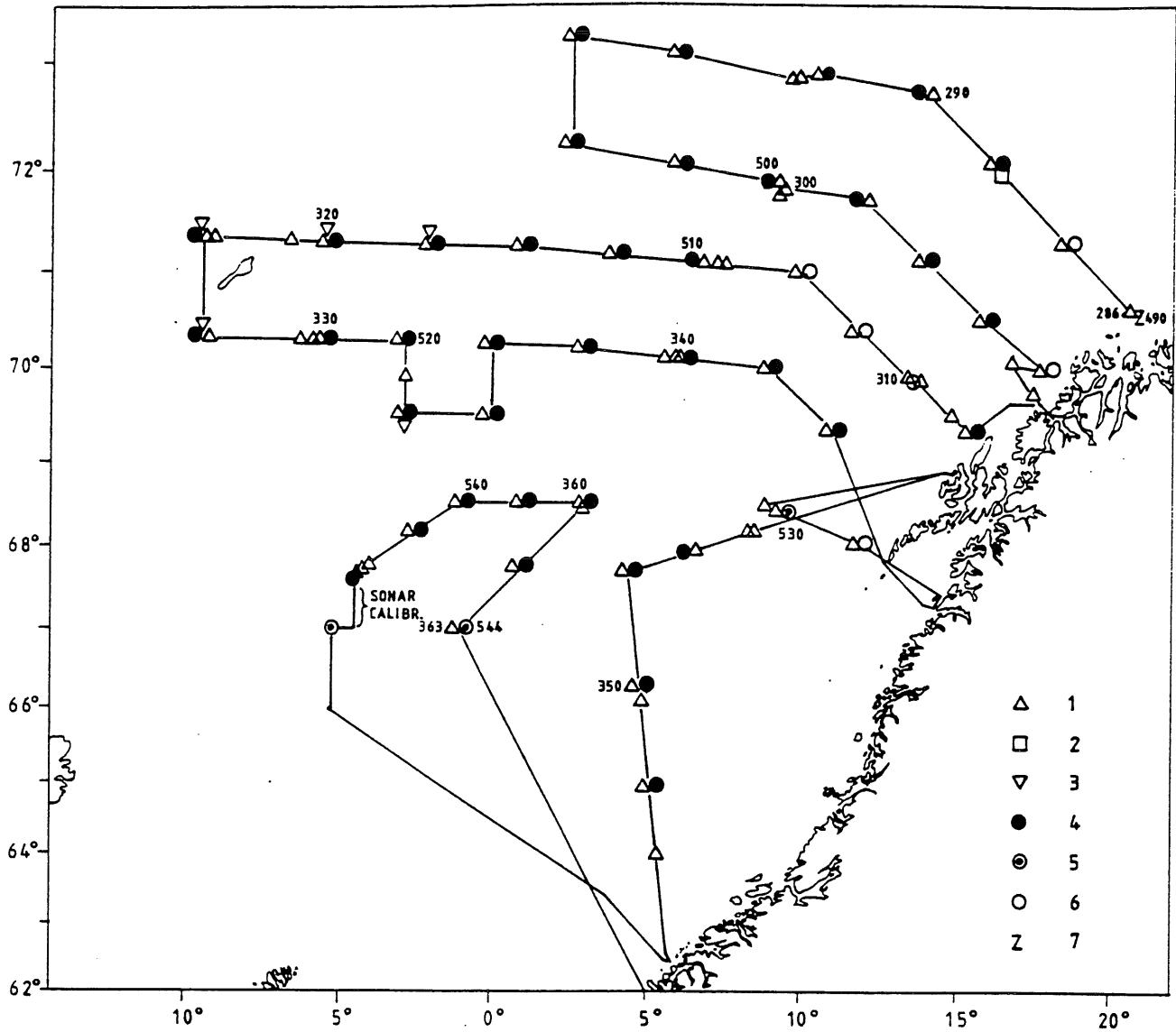


Figure 1. Survey tracks and sampling stations during cruise no. 9 by R/V "G.O. Sars" 26/5 - 22/6 1995. Symbols: 1) Pelagic trawl, 2) Bottom trawl, 3) Surface long line, 4) MOCNESS + CTD, 5) MOCNESS + CTD, 6) CTD with water sampling, 7) CTD.

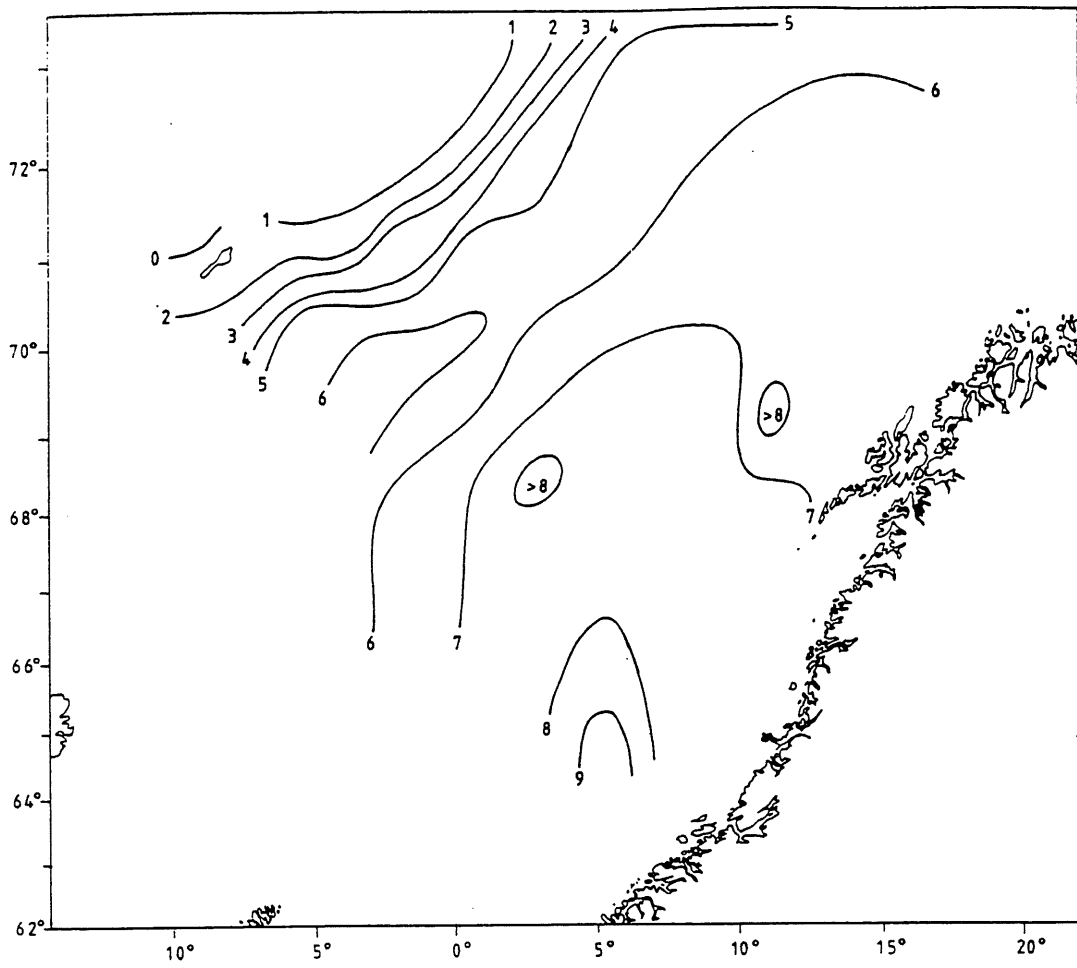


Figure 2. Sea temperature distribution, 0 m.

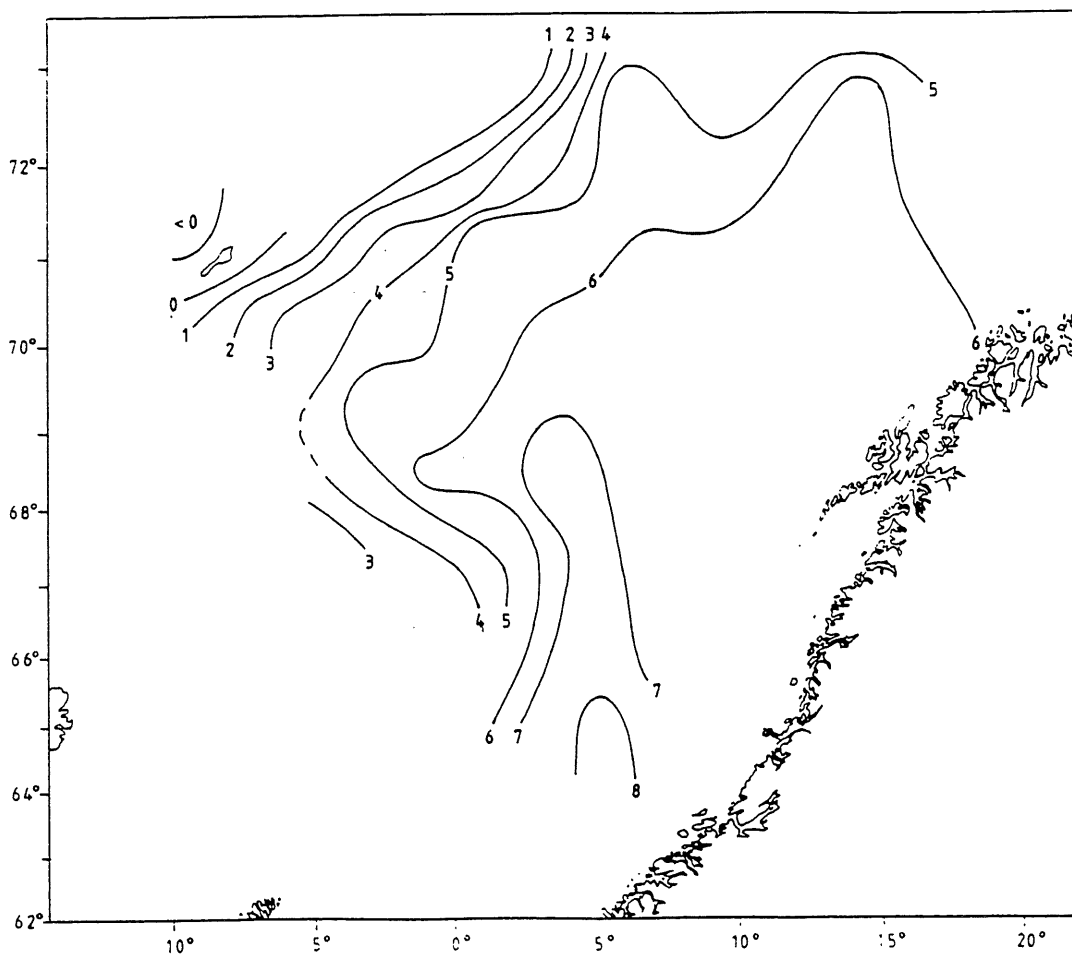


Figure 3. Sea temperature distribution, 50 m depth.

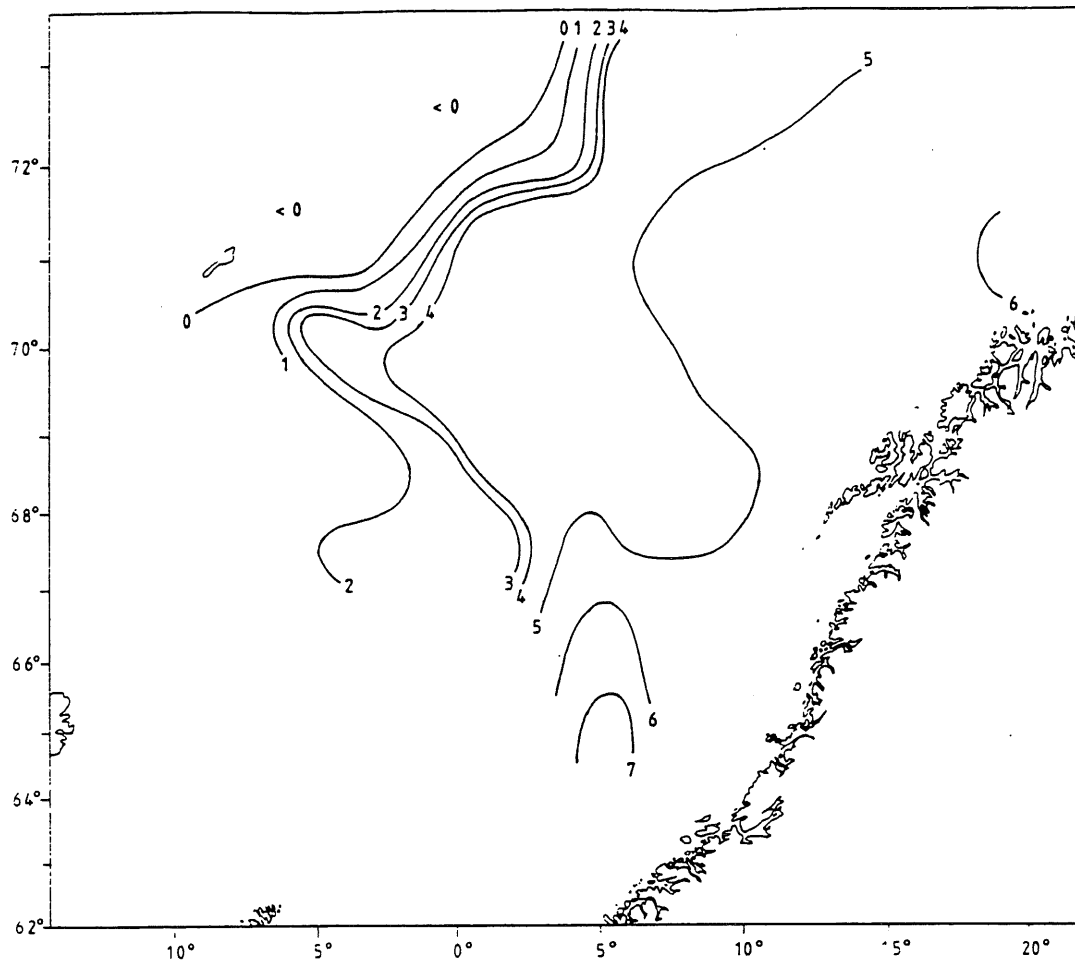


Figure 4. Sea temperature distribution, 200 m depth.

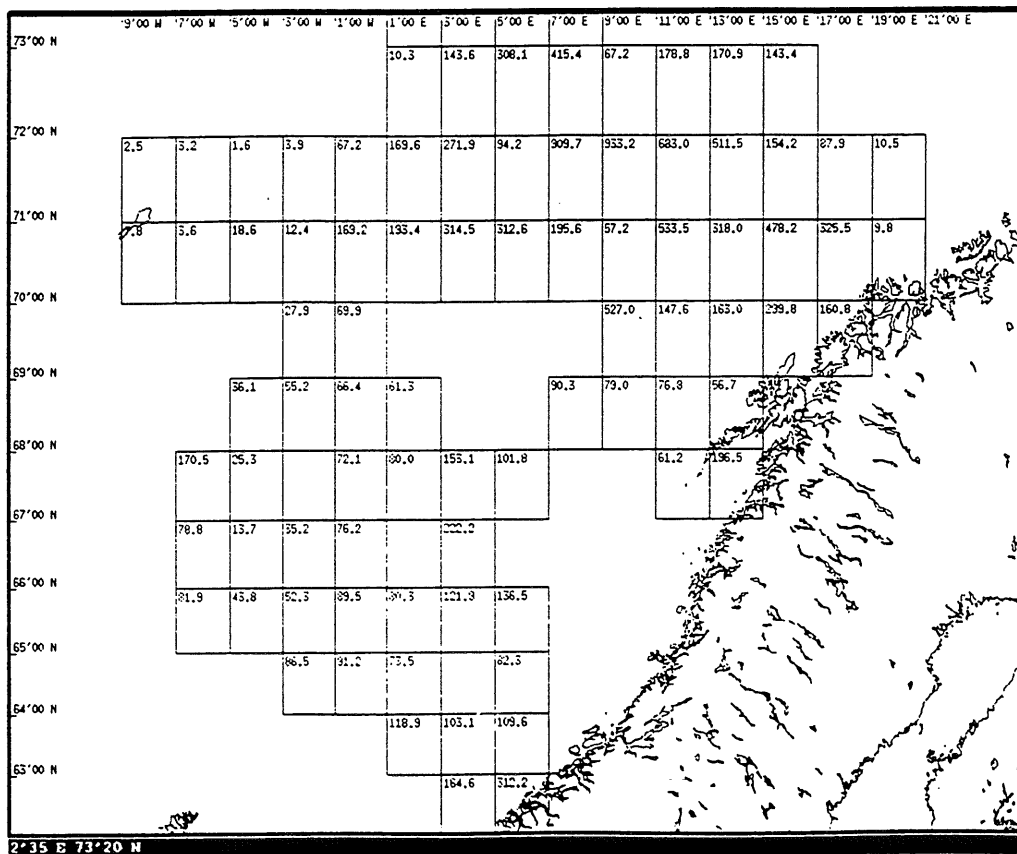


Figure 5. BEI-Map chart of s_A - distributions of zooplankton.

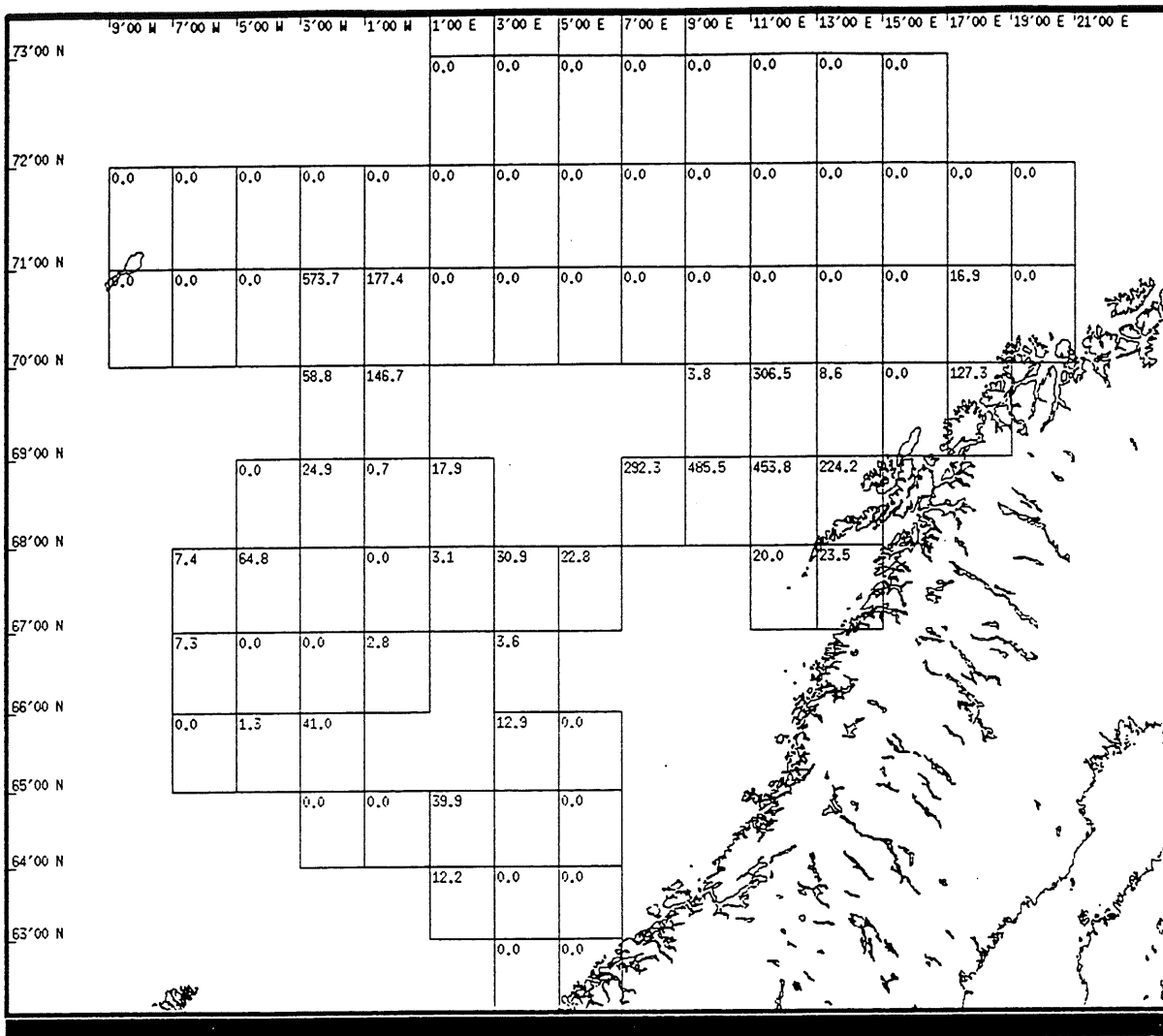


Figure 6. BEI-Map chart of s_A - distributions of herring.

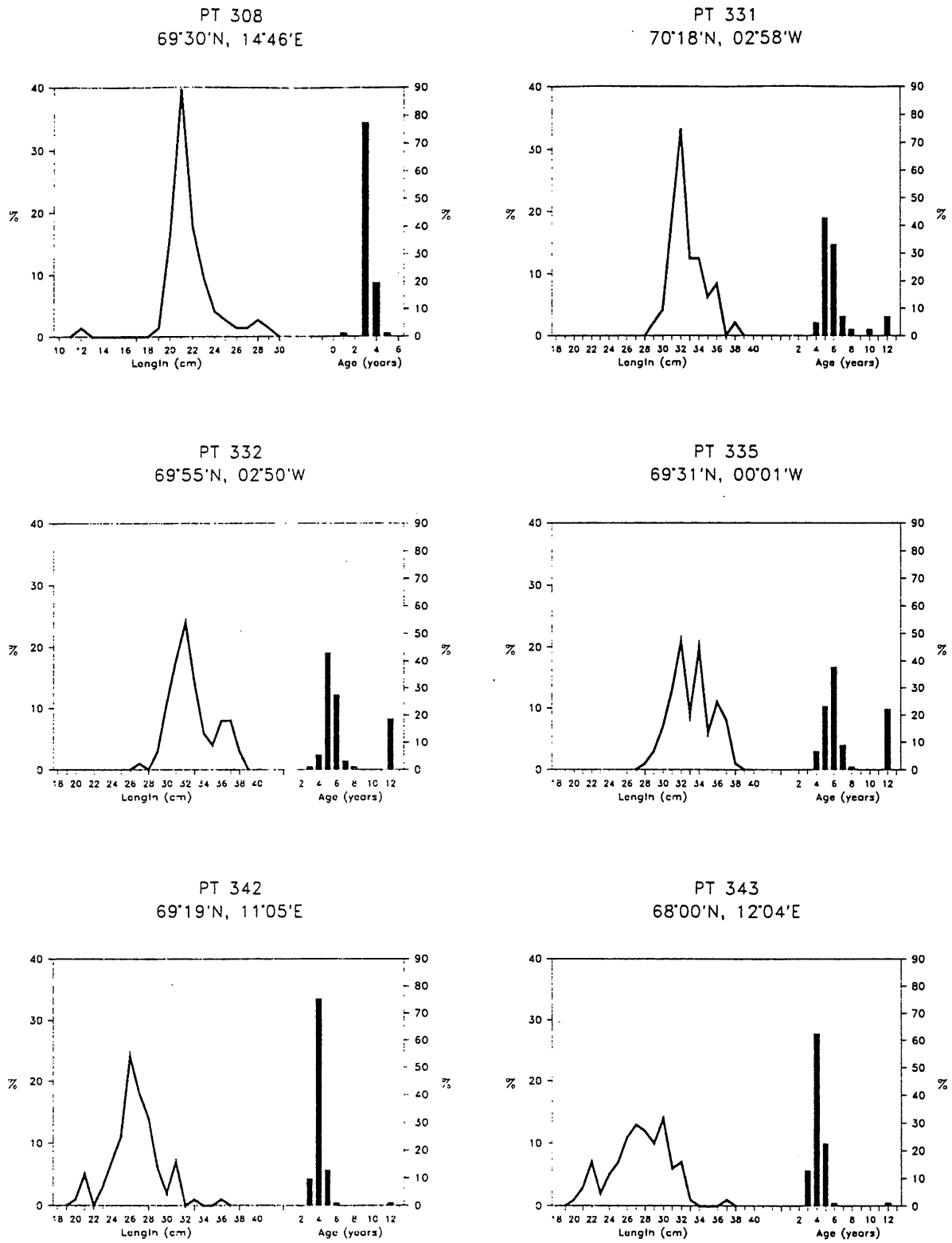


Figure 7. Length and age distribution of herring.

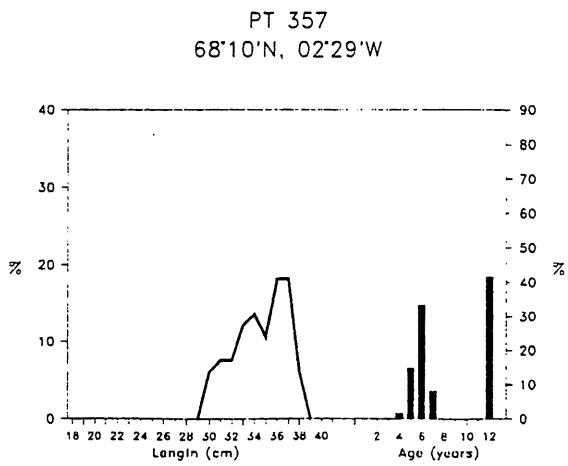
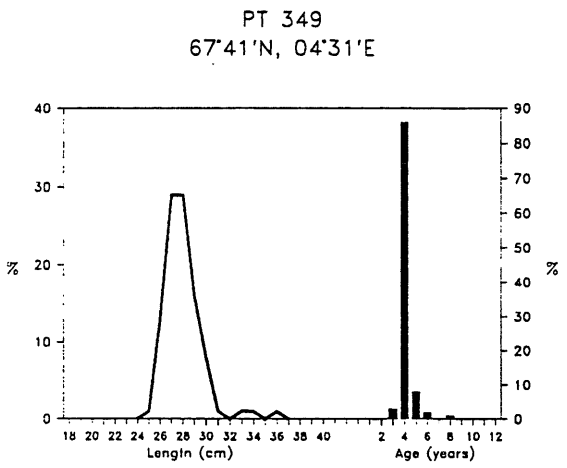
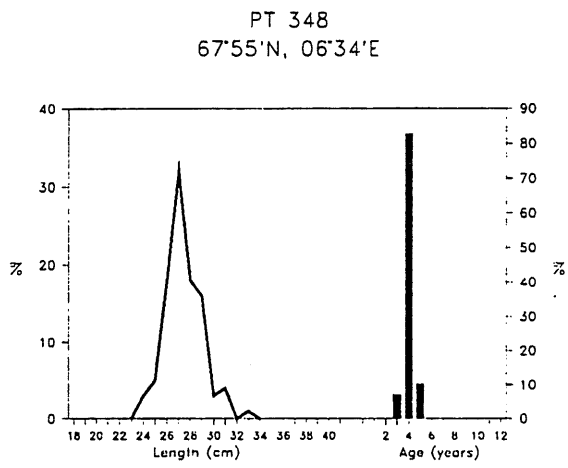
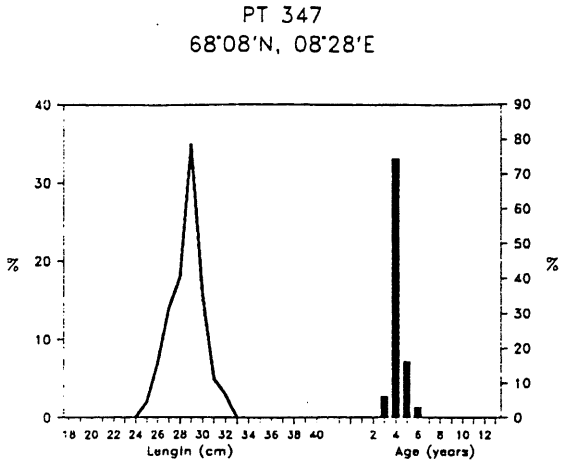
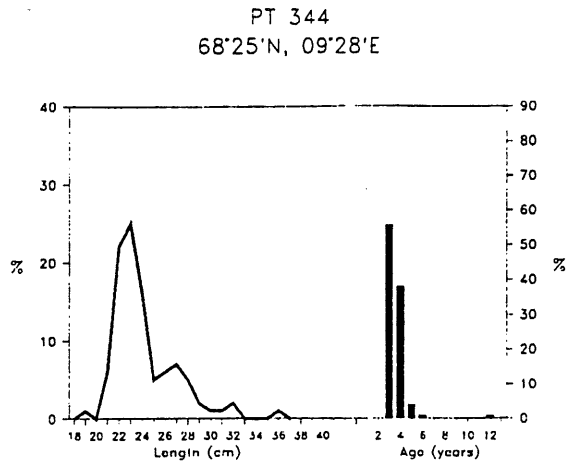


Figure 7. Length and age distribution of herring continued.

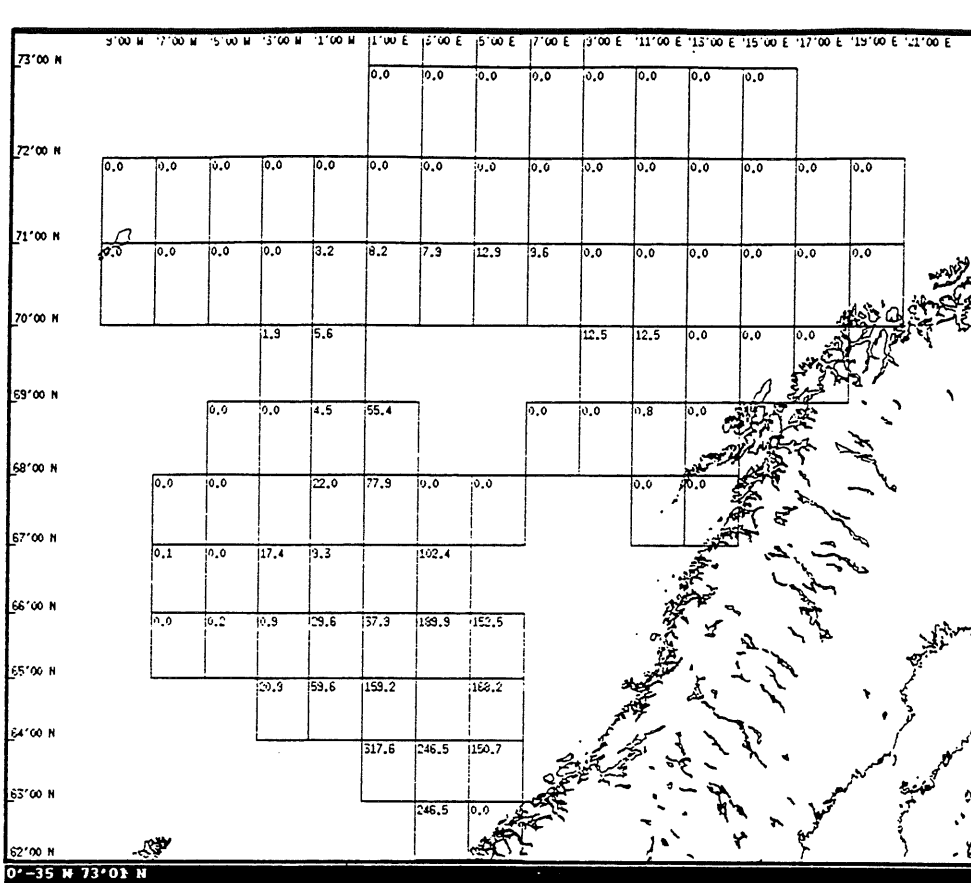


Figure 8. BEI-Map chart of s_A - distributions of blue whiting.

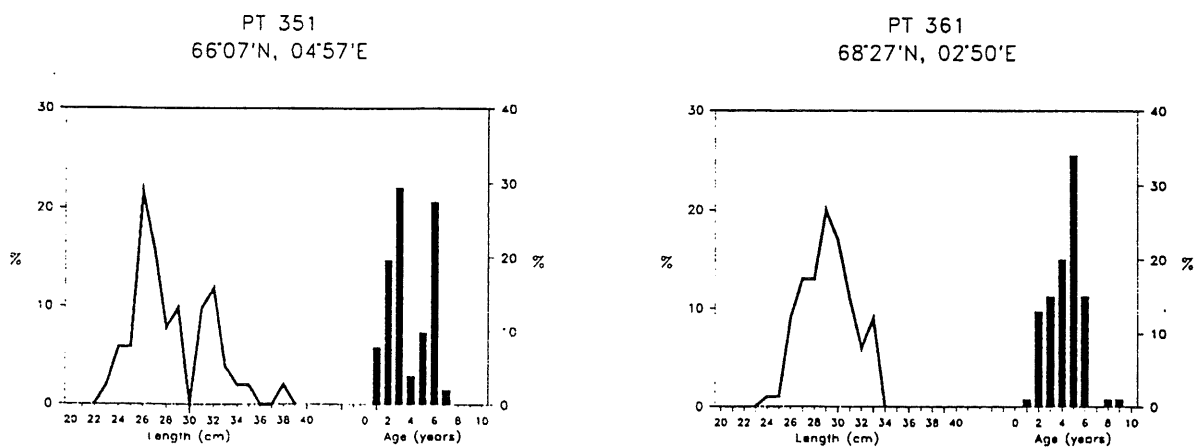


Figure 9. Length and age distribution of blue whiting.