Centre for Environment Fisheries & Aquaculture Science

Cefas

Cruise survey report UK-IESNS 2022

24/04/2022 – 06/05/2022

M/V Resolute BF50

STAFF:

Name	Role
Fabio Campanella	SIC/Acoustics
Louise Straker Cox	2IC/Acoustics
Richard Humphreys	Fish sampling/CTD/Plankton
Samantha Barnett	Fish sampling/CTD/Plankton
Nicola Hampton	Fish sampling/CTD/Plankton
Gary Burt	Fish sampling/CTD/Plankton

Executive summary

- The UK successfully participated, for the first time independently, in the IESNS survey (hereafter termed IESNS-UK) by covering the UK EEZ within the IESNS survey area and an additional area south to 62° N, which is currently considered as the southern boundary of the Norwegian Spring-spawning herring stock.
- The main objective of IESNS-UK was to determine the distribution, abundance and age structure of herring and blue whiting in the area south of the traditional IESNS coverage and identify and quantify potential mixing between different herring stocks (e.g. NSSH, NSAS, WoS).
- Transects in the UK EEZ in the southernmost part of the IESNS survey area were also covered by Danish and Norwegian vessels for comparison. Given their high quality, only the IESNS-UK data were included in the final assessment for the wider IESNS survey area.
- IESNS-UK was conducted onboard a commercial pelagic trawler. The experience and skills of the crew were crucial to successfully complete the survey.
- IESNS-UK herring estimate of biomass was 450,258 t and abundance 2.89 billion. The IESNS-UK blue whiting estimate of biomass was 449,656 and abundance 6.4 billion.
- Herring fin clips were collected during the survey for future genetic analysis (290 samples collected across 7 locations) to characterise the different stocks and the level of mixing in the survey area.
- In 2023, IESNS-UK is planned to be integrated further in the traditional IESNS survey area north of 62° N.

Aims:

1 To carry out the first UK-lead IESNS survey (International Ecosystem Survey in the Nordic Sea), to estimate distribution, abundance and age structure of herring and blue whiting in the area south to the IESNS traditional coverage and detect and quantify potential mixing between different herring stocks (e.g. NSSH, NSAS, WoS).
   a. To carry out a fisheries acoustic survey using four operating frequencies (38, 120, 200 and 333 kHz) to map and quantify the small pelagic species community.
   b. To trawl for small pelagic species using a commercial mid-water trawl in order to obtain information on:
      - Species and size composition of acoustic marks
      - Age-composition and distribution, for small pelagic species
      - Length weight and maturity information of pelagic species

2 To collect zooplankton samples using a ring-nets with 200 µm, mesh size at fixed stations.

3 To collect water column profiles at fixed stations along the acoustic transect. A CTD (SAIV mini CTD) will be deployed to obtain measurements of environmental properties within the water column.

4 To collect 50 herring specimens on each trawl stations for a genetic study on the stock structure of this species

Materials and methods

The IESNS-UK survey was conducted onboard the commercial pelagic trawler F/V Resolute from 24/04/2022 to 06/05/2022. Fisheries acoustics were recorded along the pre-designed transects (Fig. 1) using a Simrad EK80 echosounder at two operating frequencies (38, 200). The transducers were hull-mounted. Details of the acoustic settings are listed in table 1. The data were scrutinized using Echoview, following a previously agreed protocol (ICES 2009), and "Notes from acoustic Scrutinizing workshop in relation to the IESNS", (Annex 4 in ICES 2015). Generally, acoustic recordings were scrutinized daily, which involved partitioning of acoustic backscatter using catch information, and, where possible, ascribing species identities based on schools characteristics, and relative frequency response at 38 kHz and on other frequencies. This was conducted by a scientist experienced in viewing echograms. Immediately after the 2022 survey, an online IESNS post-survey meeting (Teams 14-16/6 2022) was held to standardise the scrutiny and to discuss complex and disputed identifications with the rest of the IESNS participants.

Fish sampling was performed using a commercial pelagic Jackson trawl (trawl dimension and characteristics listed in table 1. Catches from trawl hauls were sorted, weighed and identified to species level. A subsample of herring, blue whiting and mackerel were sexed, aged, and measured for length and weight, and their maturity status was estimated using established methods. An additional sample of fish was measured for length to improve the length frequency distribution. Salient biological sampling protocols for trawl catches are listed in table 1.

Acoustic data were analysed to obtain the biomass estimates using StoX software (version 3.4.0; Johnsen et al. 2019 and https://www.hi.no/en/hi/forskning/projects/stox). Estimation of abundance from acoustic surveys with StoX is carried out according to the stratified transect design model developed by Jolly and Hampton (1990). As this method requires pre-defined strata, the survey area was split into two strata: a northern stratum that included the area north of 62° N, which overlapped with the same area covered by the RV Dana, and a southern stratum that covered the remainder of IESNS-UK (Fig. 2-a). For blue whiting, the southern stratum was further split into two additional strata to account for the habitat preferences of the species (Fig.2-b). Within each stratum, parallel transects with equal distances were used. The distance between transects was based on available survey time. In accordance with most WGIPS coordinated surveys, all trawl stations within a given stratum with catches of the target species (blue whiting and herring) were assigned to all transects within the stratum, and the length distributions were weighted equally within the stratum.

Table 1 – Details of the acoustic, biological and hydrographic sampling.

Acoustic		Sampling		Biology		
Echo sounder	Simrad EK80	**Pelagic trawl dimensions**		**Length measurements**	Herring	100
Frequency (kHz)	**38**,200	Circumference (m)	972		Blue whiting	100
Primary transducer	ES38-7	Vertical opening (m)	30-50		Blue whiting	100
Transducer installation	Hull-mounted	Mesh size in codend (mm)	50		Other fish sp.	30
Transducer depth (m)	6	Typical towing speed (kn)	3.5-5	**Weighed, sexed and maturity determination**	Herring	50
Upper integration limit (m)	10	**Plankton sampling**			Blue whiting	50
Absorption coeff. (dB/km)	10	Sampling net	WP2		Mackerel	50
Pulse length (ms)	1.024	Standard sampling depth (m)	200		Other fish sp.	0
Transmitter power (W)	2000	**Hydrographic sampling**		**Otoliths/scales collected**	Herring	50
Angle sensitivity (dB)	18	CTD unit	SAIV SD208		Blue whiting	50
2-way beam angle (dB)	-20.7	Standard sampling depth (m)	250		Mackerel	50
Ts Transducer gain (dB)	26.62				Other fish sp.	0
s_A correction (dB)	-0.04			**Genetic samples**	Herring	50
3 dB beam width (dg)						
alongship:	6.35					
athw. ship:	6.54					
Maximum range (m)	500					
Post processing software	Echoview					

The following target strength (TS)-to-fish length (L) relationships were used to convert backscatter to numbers of fish:

Blue whiting: $TS = 20 \log(L) - 65.2$ dB (ICES 2012)

Herring: $TS = 20.0 \log(L) - 71.9$ dB (Foote et al. 1987)

The hydrographical and plankton stations are shown in Figure 1. Maximum sampling depth was 250 m. Zooplankton was sampled by WPII nets on all vessels, according to the standard procedure for the surveys. Mesh sizes was 200 µm. The net was hauled vertically from 200 m to the surface or from the bottom whenever bottom depth was less than 200 m. The samples were size fractionated by sieving the samples through 2000 µm and 1000 µm sieves, giving the size fractions 180/200 – 1000 µm, 1000 – 2000 µm, and > 2000 µm. The size-fractionated samples will be processed in the lab to obtain dry weight estimates.

Results and discussion

In total nine acoustic transects were completed covering a total of 1158 nmi of acoustic sampling units. A total of 11 pelagic trawls were carried out to provide groundtruth information about species and size composition and to collect biological information (Fig. 3). In addition, CTD and plankton sampling was performed on 22 fixed stations.

Herring was patchily distributed over the whole survey area with higher densities located primarily around Shetland and at the southernmost transect of the survey, west of Orkney (Fig. 4). Herring size ranged from 21 to 33.5 cm with larger sizes found in the northern part of the survey area (Fig. 5). The total biomass estimate was 450,258 t (northern stratum: 43.550, southern stratum: 406,708) and a total number of 2.89 billion. Three-and four year old herring were the most abundant age classes in terms of numbers accounting for 23% and 21% respectively of the total estimate (Fig. 6). The relative standard error (CV) was 40 % for both the total biomass and abundance.

Blue whiting was mainly distributed over the continental slope area in the north and western parts of the survey area (Fig. 7). Blue whiting aggregations primarily consisted of continuous and dense layers distributed between 200-400 m depth in the water column. Blue whiting size ranged from 16 to 33.5 cm with an average of 22.5 cm (Fig. 8). The total biomass estimate was 449,656 t (northern stratum: 261,872 t, southern stratum: 187,784 t) and a total number of 6.4 billion. Two-years-old was the most abundant age class, accounting for 89% of the total estimate (Fig 9). The relative standard error (CV) was 24 % for both the total biomass and for the total numbers estimate.

Mackerel was caught in almost all the trawls carried out. The size ranged from 18 to 41 cm with an overall average size of 33 cm (Fig. 10). No further quantitative information can be drawn from these data as this survey was not designed to monitor mackerel.

Surface waters in the northern and eastern part of the survey area were colder than in the western area where a maximum temperature of 9.7 °C was recorded (Fig. 11). Surface salinity was similar for most of the survey area except for the area close to the Norwegian coast where lower salinity was recorded (Fig.11).

Future work

Genetic analysis is planned to be performed on herring fin clips collected during the survey (290 samples collected across 7 locations) to characterise the different stocks present in the survey area and establish the potential level of mixing with the Norwegian spring spawning herring. Plankton samples will be processed in the lab to obtain dry weights for the different size components. In 2023, IESNS-UK survey is planned to cover a larger area of the traditional IESNS survey area north of 62° N.

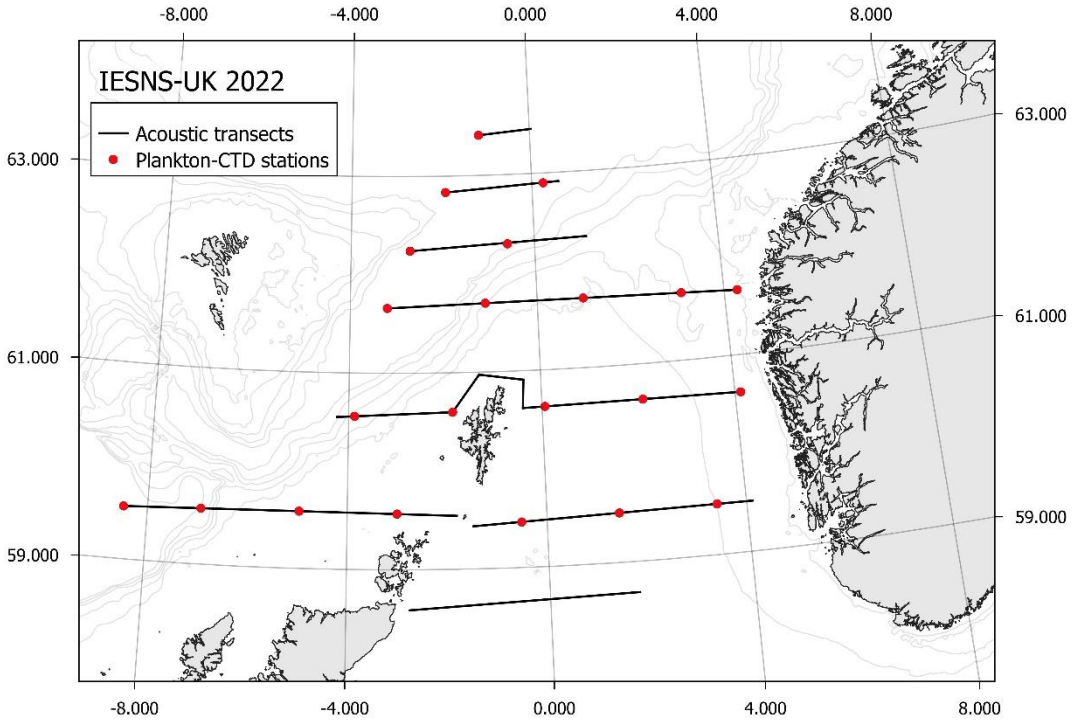

Figure 1 – Map of IESNS-UK survey area with position of acoustic transects and of hydrographic and plankton stations.

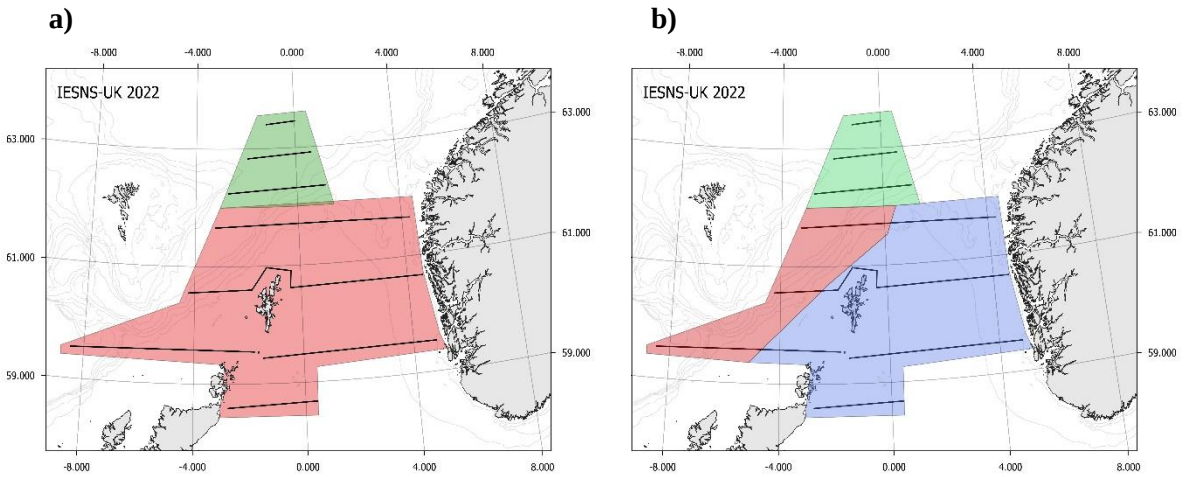

Figure 2 – Map of IESNS-UK survey area with strata used for biomass estimation for herring (a) and blue whiting (b).

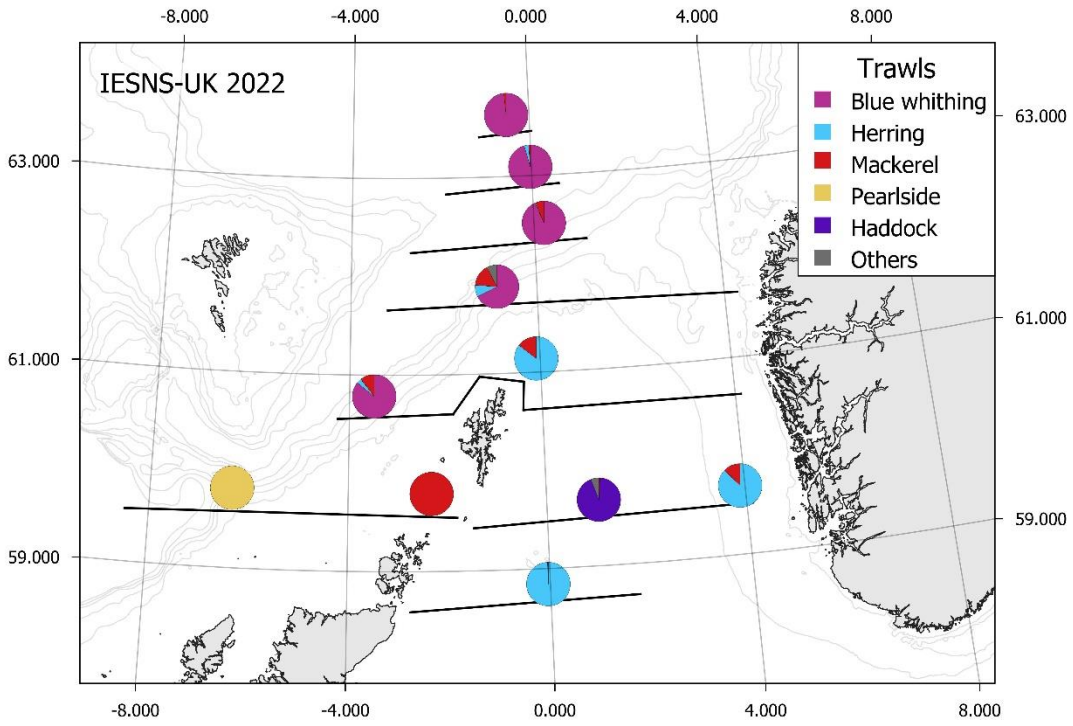

Figure 3 – Map of IESNS-UK survey area with location and catch composition of the pelagic trawl stations.

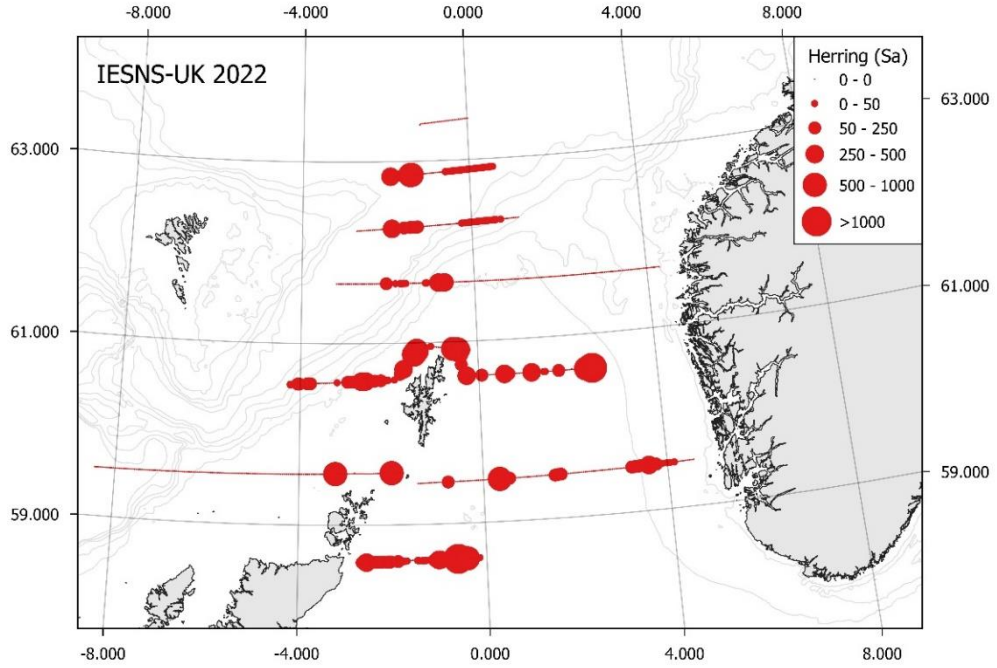

Figure 4 – Map of IESNS-UK survey area with distribution of herring expressed in NASC values (m^2/nm^2) averaged for every 1 nautical mile.

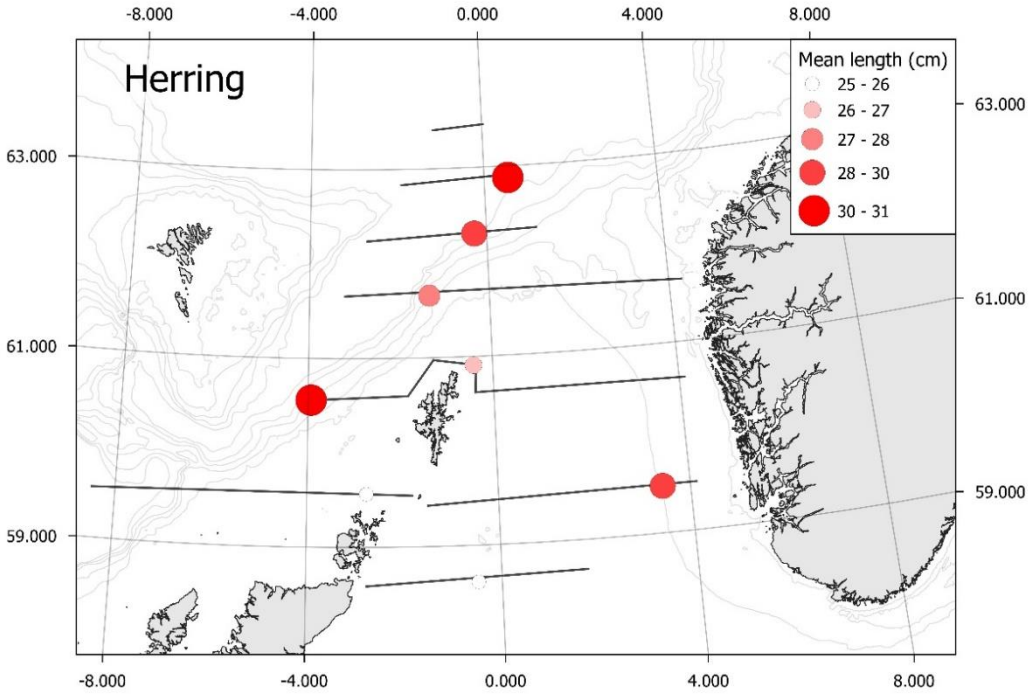

Figure 5 – Map of IESNS-UK survey area with distribution of the mean length of herring measured in the pelagic trawl catches.

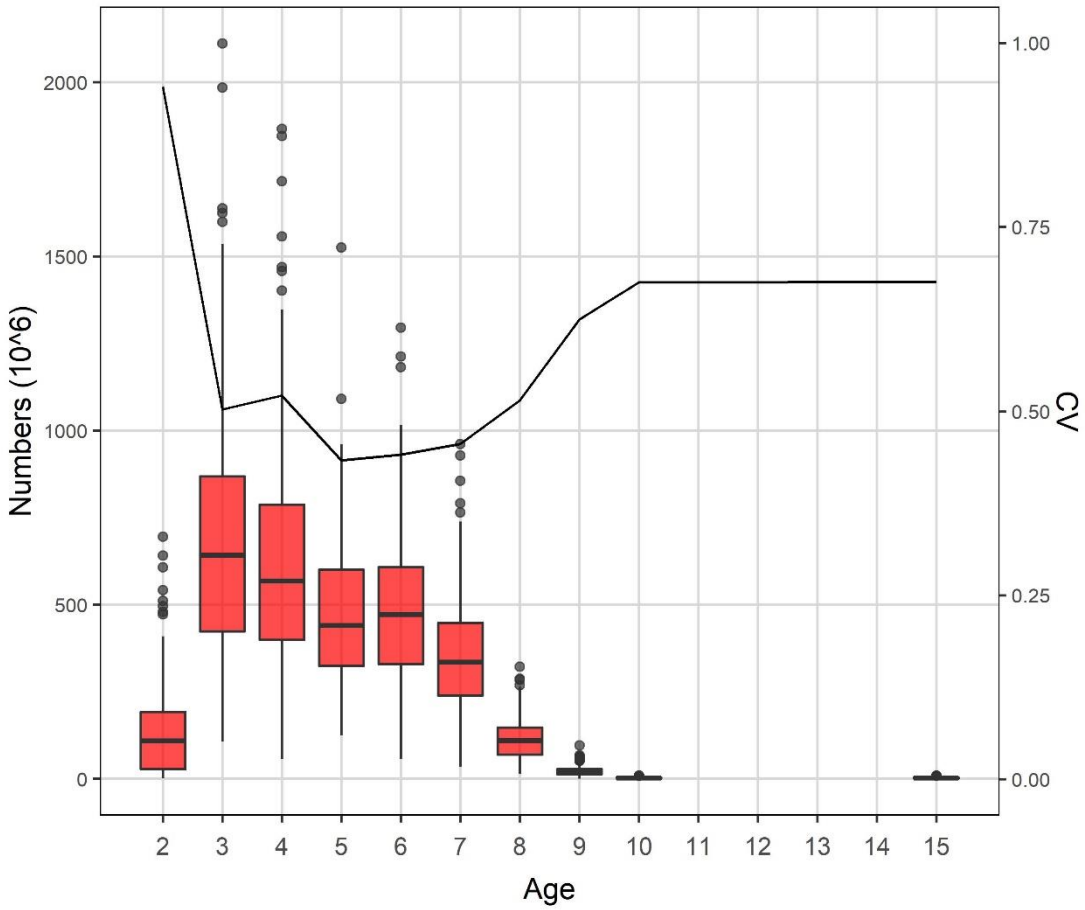

Figure 6 - Boxplot of herring abundance at age and relative standard error (CV) obtained by bootstrapping using the StoX software.

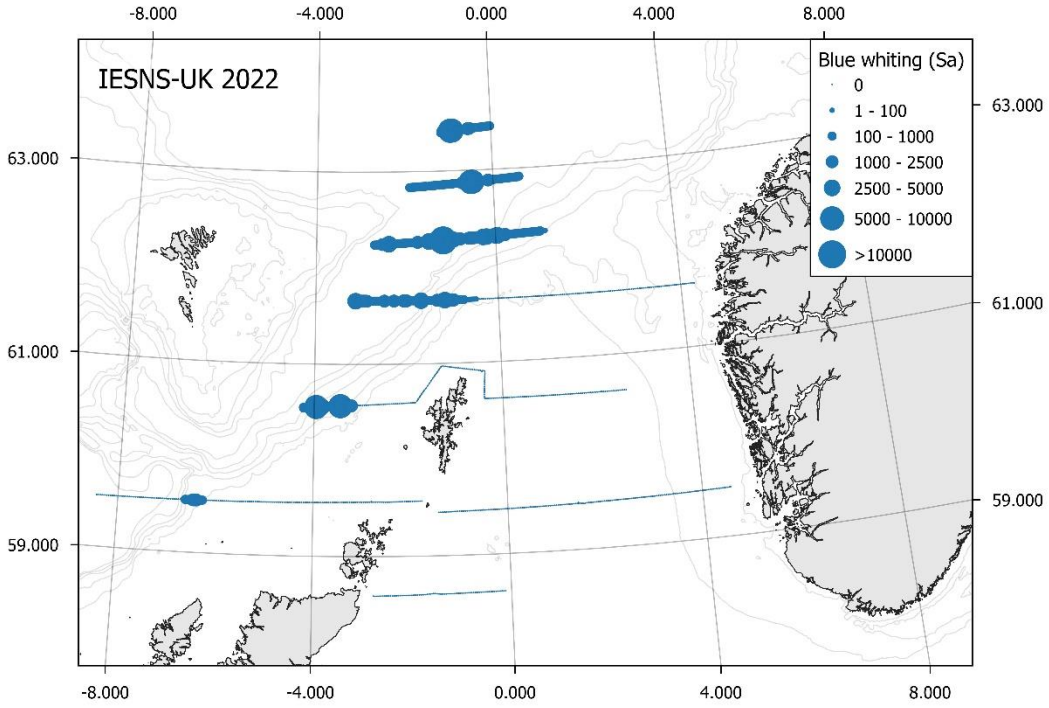

Figure 7 - Map of IESNS-UK survey area with distribution of blue whiting expressed in NASC values (m^2/nm^2) averaged for every 1 nautical mile.

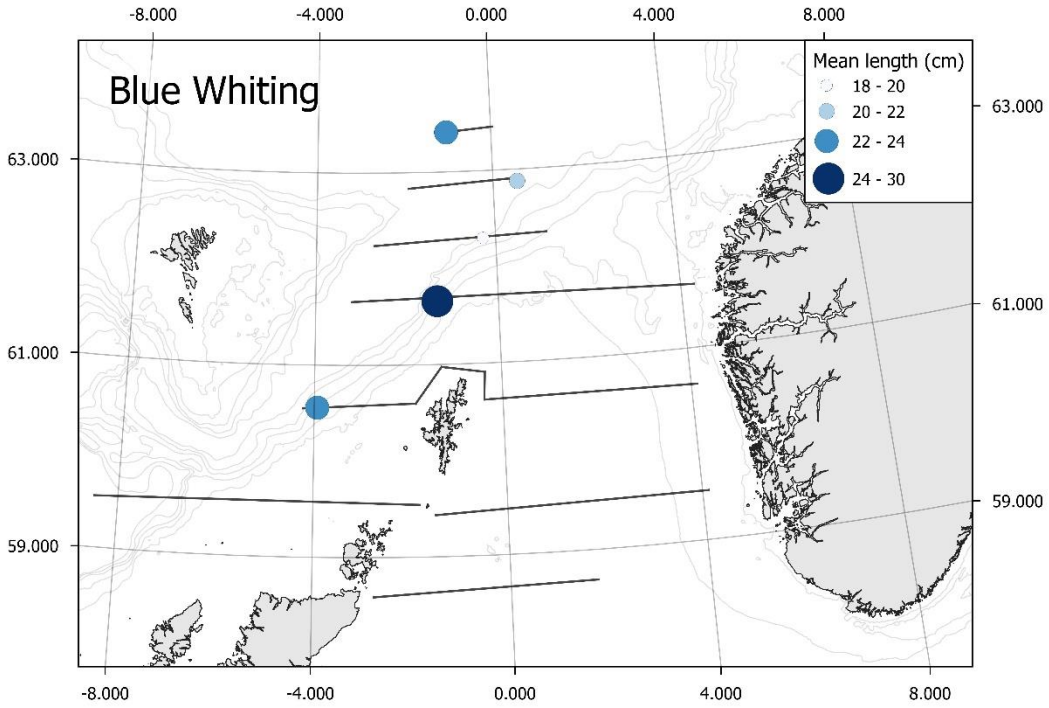

Figure 8 – Map of IESNS-UK survey area with distribution of the mean length of blue whiting measured in the pelagic trawl catches.

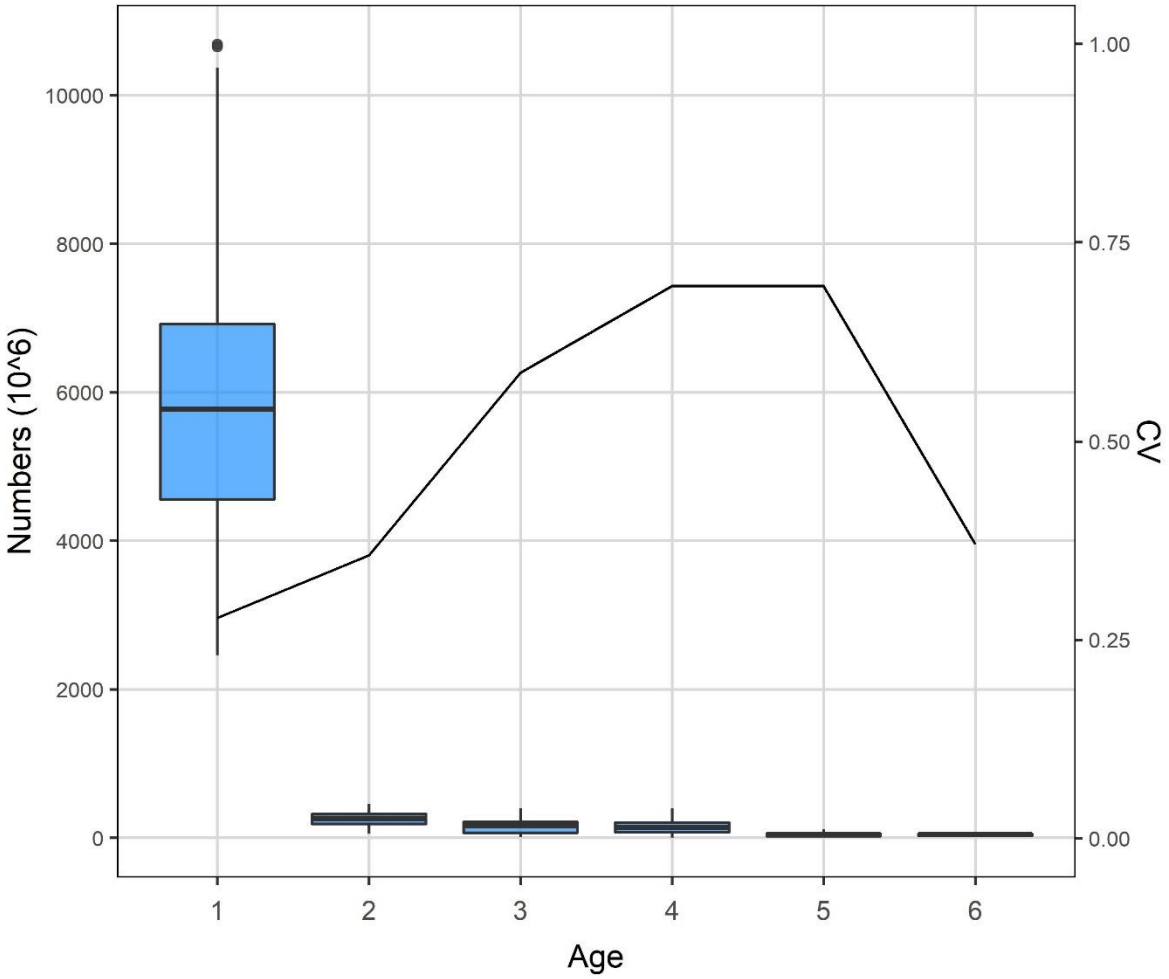

Figure 9 - Boxplot of blue whiting abundance at age and relative standard error (CV) obtained by bootstrapping using the StoX software.

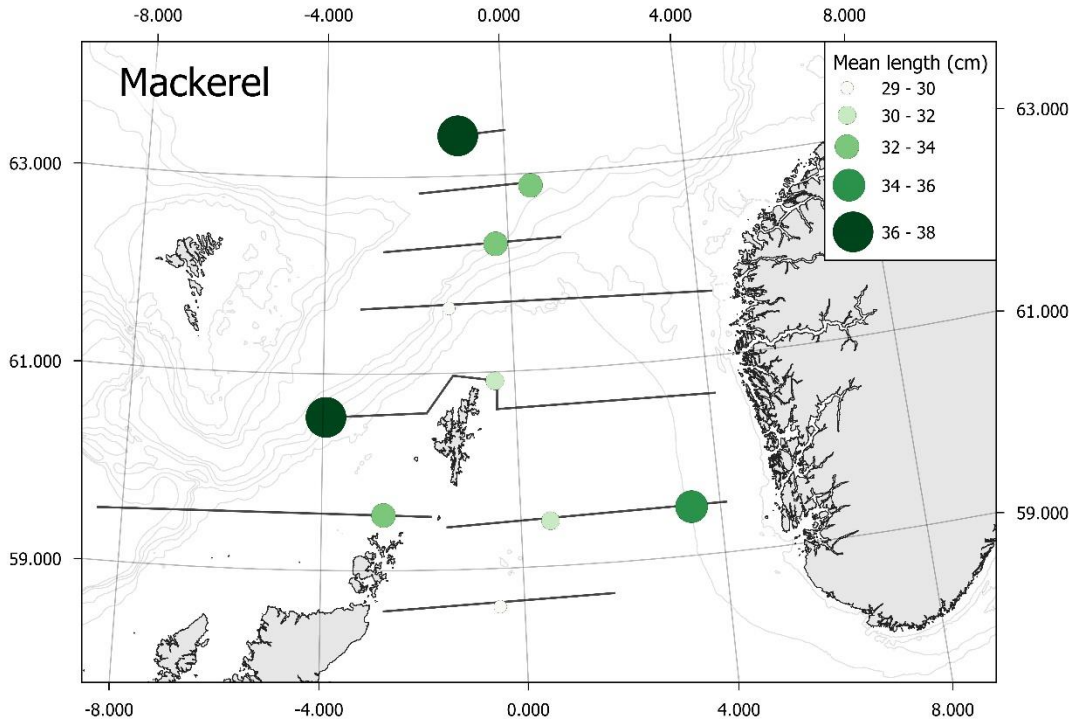

Figure 10 – Map of IESNS-UK survey area with distribution of the mean length of mackerel measured in the pelagic trawl catches.

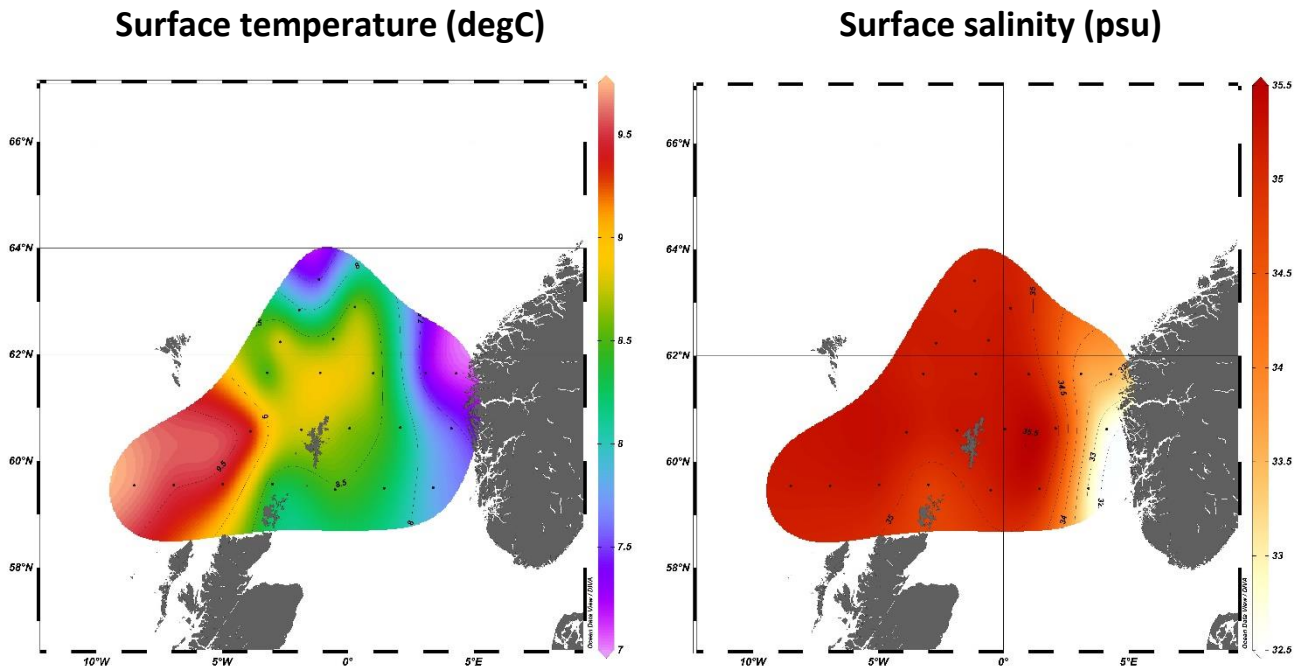

Figure 11 – Map of IESNS-UK survey area with interpolated subsurface (1-2 m depth) temperature (°C, left) and salinity (ppt, right) measured by the SAIV MiniCTD at the 21 sampling stations between 25 April and 7 May 2022.

Appendix

Narrative

24-04-2022
Staff arrived in Peterhead and joined the vessel at around 12:30. The skipper gave us a safety induction and a tour of the ship. We sailed around 15:30
25-04-2022
We transited all day toward the first station (st 1) and start of the first transect. All the gear (plankton net, Ctd, Niskin) were set up to be ready to deploy.
26-04-2022
We arrived at the first station of the survey at 01:00. Plankton net with SAIV ctd attached was deployed first (200 m deployment) followed by Niskin and SAIV ctd (400m). The SAIV ctd did not work at first and was replaced with the spare. We didn't have a way to precisely deploy the gear at a fixed depth. The first 250m of wire were marked every 10 m but the length of wire not always equal to the depth of the gear. We used the wire angle to calculate roughly the amount of wire needed to reach the depth. Considering that the deep ctd deployment was not a priority for the survey and the amount of time that the deployment would take (~2 hours on top of the time of the plankton deployment), we decided that for the following stations only the plankton net with the SAIV ctd attached would be deployed (max 200 m). We ran the first transect at 3:30 and came back at the start point after that to wait for the dispensation from Marine Scotland, which came in at 14:30. We ran again the same transect after we got the dispensation and we carried out a trawl after 20 minutes from the start. We fished on aggregations distributed between 150-300 meters. We caught 600 kg of blue whiting, 10 kg mackerel and a northern wolfish (last individual recorded on Cirolana in 1976). We resumed transect after trawl and completed it at 19:53. Transect 2 was started at 23:14.
27-04-2022
We stopped for trawling at 3:21 on dense schools at the surface. The ship had a blackout due to a generator problem and soon after we interrupted the transect. The power was restored after a few minutes and we started the trawl at 4:39 (1070 kg blue whiting, 36 kg herring and 14 kg mackerel). After the blackout the 38 kHz and 200 kHz clocks were slightly out of sync (~ 2secs). This will be adjusted in post processing. The herring genetic samples were erroneously not taken on this trawl. We continued running transect 2 and 3 and picking up the plankton stations (prime 3-5) until 22:48 when we stopped to fish on a layer in mid-water that turned out to be made of primarily blue whiting (225 kg blue whiting, 15 kg mackerel and 1 kg of herring).
28-04-2022
We completed transect 3 in the morning and move to the next one after a long steam of about 10 hours. We started transect 4 at 14:00 running it from east to west. We did not

trawl during the rest of the day because very few aggregations were detected on the sounder. 3 plankton stations were successfully completed (prime 8-10)

29-04-2022

We performed a trawl in the morning at 6:43 on a dense layer at 300 meters. When ready to haul, the hydraulic winch failed and we continued towing until it got fixed. For this reason, the trawl was hauled after 45 minutes. The total catch was fortunately not too large with 720 kg of blue whiting, 90kg of herring and 172 kg of mackerel. Transect 4 was completed in the afternoon and after that we started transiting to transect 10 (20 hours steam). Two plankton stations were completed during the day.

30-04-2022

We started transect 10 at 12:19. Along the transect no clear herring aggregations were detected and only faint midwater layers. We carried out a trawl on a layer at ~ 100 m at ~ 19:00. The codend was almost empty even though the trawl sonar showed a good amount of fish going in. We have found few small pearlside (2.5 cm) so considering the large codend mesh size (50mm) and that we don't have a cod-end liner, it was very likely they escaped through the meshes.

01-05-2022

Slightly fresher weather conditions but no effects on operations and data quality. Still on transect 10 heading east. We stopped to trawl at 7:50 and fished on a relatively dense layer at 70 meters. The catch was entirely made of mackerel (1218 kg). The transect, which was extended of about 20 nmi to the east, was completed around 12:00. We then headed to Lerwick (Shetlands) to refill freshwater and moved to transect 5 soon after that. Two plankton station were successfully completed.

02-05-2022

We started transect 5 (W-E direction) at 6:12 and decided to fish after few hours on dense schools (blue whiting – like) at 300 m. The catch comprised of 880 kg of blue whiting, 37 kg of herring and 108 of mackerel. We ran transects and plankton station until the evening when we fished again on a surface layer of scattered strong targets at 20-30 m. Mainly herring in the catch (449kg) and some mackerel (77). Two plankton station were successfully completed.

03-05-22

Beautiful sunny weather with very low wind. We completed transects 7,8,9 and 3 plankton stations. No trawls were performed. There were not enough aggregations apart from some occasional herring schools and some patchy blue whithing and/or pearlside layers.

04-05-22

We started transect 11 (E-W direction) at around midnight and carried out 2 successful pelagic trawls along the transect. The first one was carried out during the night at surface schools (~350 kg herring, 50 kg mackerel) and the second aimed at groundtruthing some herring-like schools detected during the day in midwater. The catch was mainly composed of haddock (350 kg). In addition, 2 ctd/plankton stations were successfully completed.

The transect was completed around 22:00 and soon after we headed to Scapa Flow to perform the calibration of the echosounder.

05-05-22

We arrived in Scapa Flow at ~10:00 to perform the calibration of the echosounder. This was done by 2 technicians from an external company (Echomaster) that got on board in the morning. The calibration of the echosounder was also performed before the start of the survey while docked in Peterhead by the same company but initial settings used, specifically the pulse length, were not correct. After the calibration was successfully completed (~17:00) we headed to the start of transect 12.

06-05-22

Transect 12 was run during the night and a last trawl was carried out along the transect at ~ 05:00 aiming for big aggregations in midwater. Herring was the main species caught. The total catch was estimated to be ~20 tonnes but the codend opened under the heavy weight of the catch before getting on deck. The crew was able to retain 1 ton of the catch. After the end of the transect we headed back to Fraiserburgh to demob and disembark the staff (~15:00).