WORKING GROUP OF INTERNATIONAL PELAGIC SURVEYS (WGIPS)

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Contents

i Executive summary

WGIPS met in January 2023 to combine and review the results of the annual pelagic ecosystem surveys and provide indices for the stocks of herring, sprat, mackerel, boarfish, and blue whiting in the Northeast Atlantic, Norwegian Sea, North Sea, and Western Baltic. Timing, coverage and methodologies were assessed and coordinated for the upcoming 2023 surveys

Progression on the update of the WGIPS survey manual (SISP 9) in the TIMES format continued, with an expected first draft to be submitted in spring 2023 and the completion planned within the present WGIPS reporting cycle.

The group discussed the future and development of databases used by the group (the ICES DB and the PGNAPES database). The use of StoX and progress on TAF were reviewed during a joint session with the ICES Data Centre and the StoX development team.

The biological sampling strategies in WGIPS surveys continue to be discussed and progress is being made on documenting the sampling strategies used in all WGIPS surveys in the new format of the sampling manual. The planned workshop on sampling strategies in the HERAS survey has been postponed until further progress is made on data availability for analysis.

WGIPS reviewed progress in using genetic stock separation methods for splitting survey results to component herring stocks and assessed ways forward for the development of these methods whilst maintaining the integrity of the survey indices. The group encourages continued close collaboration of the ICES survey and assessment groups and institutes carrying out the genetic analysis work.

WGIPS continues to follow progress on mesopelagic fish sampling in the International Blue Whiting Spawning Survey (IBWSS) through updates from the Ecologically and Economically Sustainable Mesopelagic Fisheries EU project (MEESO) and other developments within this area of relevance to the WGIPS surveys.

ii Expert group information

Expert group name	Working group on International Pelagic Surveys (WGIPS)
Expert group cycle	Multiannual fixed term
Year cycle started	2022
Reporting year in cycle	2/3
Chair(s)	Susan Mærsk Lusseau, Denmark
Meeting venue(s) and dates	23-27 January 2023, Belfast, Northern Ireland (28 participants)

1 Terms of Reference

ToR	Description	Background	Science plan codes	Duration	Expected Deliverables
a	Combine and review annual ecosystem survey data to provide: indices of abundance and spatial distribution for the stocks of herring, sprat, mackerel, boarfish and blue whiting in Northeast Atlantic waters.	a) Advisory Requirements b) Requirements from other EGs	3.2	years 1–3	Survey reports containing indices of stock biomass and abundance at age, spatial distributions of stocks and hydrographic conditions. Survey summary tables delivered to: HAWG, WGWIDE
b	Coordinate the timing, area and effort allocation and methodologies for individual and multinational acoustic surveys on pelagic resources in the Northeast Atlantic waters covered (Multinational surveys: IBWSS, IESNS, IESSNS, HERAS, and individual surveys: CSHAS, ISAS, ISSS, PELTIC, GERAS, WESPAS, 6aSPAWN)	a) Science Requirements b) Advisory Requirements c) Requirements from other EGs d) follow-up of WKPilot NS-FIRMOG	3.1	years 1–3	Cruise plans for international and individual surveys.
c	Adopt standardized analysis methodology and data storage format utilizing the ICES acoustic database repository for all acoustically derived abundance estimates of WGIPS coordinated surveys	a) Science Requirements b) Advisory Requirements	3.2	years 1–3	Progress on the adaption of standardized analysis methodology and data storage format utilizing the ICES pelagic acoustic database repository for WGIPS coordinated surveys.
d	Periodically review and update the WGIPS acoustic survey manual to address and maintain monitoring requirements for	a) Science requirements b) Advisory requirements	3.1	years 1–3	Updated WGIPS survey manual in TIMES format.

	pelagic ecosystem surveys				
e	Review the work, and report of workshops organised by WGIPS and develop formal ICES recommendations. This should include TIMES manual updates and adopting changes to survey coordination where deemed appropriate.	a) Science requirements b) Advisory requirements	3.1	years 1–3	Integrate results from WGIPS workshops into survey protocols where possible. Develop formal recommendations to other groups and agree answers to recommendations from other groups.
f	Review and evaluate survey designs across all WGIPS coordinated surveys to ensure the integrity of survey deliverables.	a) Science requirements b) Advisory Requirements c) Requirements from other EGs	3.1, 3.3	years 1–3	Optimize and harmonise sampling designs and precision estimates for the different surveys to ensure survey quality.
g	Assess and compare scrutinisation procedures employed for the analysis of raw acoustic data from WGIPS coordinated surveys	a) Science requirements b) Advisory requirements	3.2, 3.3	year 1-3	Documented standardised scrutinisation recommendations; Update of survey manual to address and maintain monitoring requirements for pelagic ecosystem surveys.
h	Collaborate with groups wishing to utilize available time-series from WGIPS coordinated surveys.	a) Science requirements	3.2	Years 1-3	Facilitate testing and developing forecast models provided by WGS2D. Make time-series data available for MEESO.
i	Assess developing pelagic ecosystem surveying technology (e.g. optical technology, multibeam and wideband acoustics) to: (i) achieve monitoring of different ecosystem components, and/or (ii) give input to the development of ecosystem indicators from surveys covered by WGIPS, (iii) continue to support the development of tools to	a) Science Requirements b) Advisory Requirements c) Requirements from other EGs	3.1, 3.3, 4.1	years 1–3	Update ecosystem metrics that are collected by WGIPS coordinated surveys; and protocols/recommendations for practical implementation of new technologies.

	improve the accuracy and precision of survey estimates.				
j	Continuted development of trawl sampling and hull mounted acoustic data collection during IBWSS surveys to support the routine reporting of mesopelagic fish abundance and distribution within established limitations. Leverage latest research from ongoing research projects (MEESO & SUMMMER) to improve data quality and reporting capacity	a) Science Requirements b) Advisory Requirements c) Requirements from other EGs	3.1, 3.4,	years 1–3	Ultimate goal is the routine reporting of mesopelagic fish abundance and distribution as part of the IBWSS survey and uptake by other candidate surveys within WGIPS. Upload of bioloigcal and acoustic data to the ICES trawl acoustic database. Provision of data to interested WGs and research projects.

2 Summary of Work Plan

Summary of the Work Plan

Year 1	General meeting, preceded by 3 post-cruise meetings which collate data of multinational surveys. Session to review and evaluate survey designs across all WGIPS coordinated surveys and coordinate planning and discuss designs for surveys taking place in Year 1. Review the WGIPS acoustic manual in the TIMES format. Session to assess auxiliary pelagic ecosystem surveying technology focusing on methods currently used to monitor different ecosystem components across WGIPS coordinated surveys. Session on the future and development of databases (more specifically the ICES DB and the PGNAPES database), use of StoX and progress on TAF. Session on mesopelagic sampling: Review and feedback of sampling carried out in 2021. Update on reports from MEESO and SUMMER projects and workshops. Session on stock discrimination projects and the consequences for biological sampling on WGIPS surveys. Delivery of a WD on biological sampling strategies on HERAS surveys over time. Session on biological sampling strategies in WGIPS surveys Conduct a workshop on biological sampling strategies in WGIPS surveys.
Year 2	General meeting, preceded by 3 post-cruise meetings which collate data of multinational surveys. Session to review and evaluate survey designs across all WGIPS coordinated surveys and coordinate planning and discuss designs for surveys taking place in Year 2. Review the WGIPS acoustic manual in the TIMES format, prepare for submitting for external review. Session to assess auxiliary pelagic ecosystem surveying technology focusing on methods currently used to monitor different ecosystem components across WGIPS coordinated surveys. Session on the future and development of databases (more specifically the ICES acoustic database and the PGNAPES database), use of StoX and progress on TAF. Session on mesopelagic sampling: Review and feedback progress of trawl sampling and acoustic sampling methods used. Session on stock discrimination and the consequences for biological sampling on WGIPS surveys. Session on biological sampling strategies in WGIPS surveys

Year 3	General meeting, preceded by 3 post-cruise meetings which collate data of multinational surveys. Session to review and evaluate survey designs across all WGIPS coordinated surveys and coordinate planning and discuss designs for surveys taking place in Year 3. Review the WGIPS acoustic manual in the TIMES format, submit for publishing. Session to assess auxiliary pelagic ecosystem surveying technology focusing on methods currently used to monitor different ecosystem components across WGIPS coordinated surveys. Session on the future and development of databases (more specifically the ICES acoustic database and the PGNAPES database), use of StoX and progress on TAF. Session on mesopelagic sampling. Update the group on progress of sampling and reporting of mesopelagic fish resources. Session on stock discrimination and the consequences for biological sampling on WGIPS surveys. Session on biological sampling strategies in WGIPS surveys

3 Supporting Information

Priority	The Group has a very high priority as its members have expertise in design and implementation of acoustic-trawl surveys, including sampling of additional ecosystem parameters. It will therefore directly contribute to the implementation of integrated pelagic ecosystem monitoring programmes in the ICES area. The Group's core task is the standardisation, planning, coordination, implementation, and reporting of acoustic surveys for the main pelagic fish species including herring, sprat, blue whiting, mackerel, and boarfish in Northeast Atlantic waters. The work provides essential data in the form of survey indices to WGWIDE and HAWG in the aim to perform integrated ecosystem assessment.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 20–25 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	WGWIDE, HAWG
Linkages to other committees or groups	There is a very close working relationship with other groups in EOSG and DSTSG, especially relevant links to WGAcousticGov, WGACEGG, WGALES, WGBIFS, WGFAST, WGFTFB, WGISDAA, WGISUR, WGMEGS, WGTC, WGINOR, WGINOSE, WGIAB, WKEVAL, WKMSMAC2, WKSCRUT, WKSUREQ, WGS2D, WKPilot NS-FIRMOG
Linkages to other organizations	

4 List of Outcomes and Achievements in this delivery period

Indices for the stocks of herring, sprat, mackerel, boarfish, and blue whiting in Northeast Atlantic waters from annual ecosystem surveys are used as fishery-independent data for analytical assessment purposes in HAWG and WGWIDE. The following outcomes and achievements were obtained during this delivery period:

- North Sea autumn spawning herring numbers, biomass, maturity proportion, mean weight, and length-at-age, from the ICES Coordinated Acoustic Survey in the Skagerrak and Kattegat, the North Sea, West of Scotland, and the Malin Shelf area (HERAS)
- Western Baltic spring-spawning herring numbers, biomass, mean weight, and length-at-age, from the HERAS
- West of Scotland autumn spawning herring numbers, biomass, maturity proportion, mean weight, and length-at-age, from the HERAS
- Malin Shelf herring (areas 6.a/7b,c) numbers, biomass, maturity proportion, mean weight, and length-at-age for component stocks, from the HERAS
- Sprat in the North Sea (Subarea 4) numbers, biomass, mean weight, and length-at-age, from the HERAS
- Sprat in Division 3.a numbers, biomass, mean weight, and length-at-age, from the HERAS
- Norwegian spring-spawning herring numbers, biomass, mean weight, and length-at-age, from the International Ecosystem Survey in the Nordic Sea (IESNS)
- Blue whiting numbers, biomass, mean weight, and length-at-age, from the IESNS
- Mackerel numbers, biomass, mean weight, and length-at-age, from the International Ecosystem Summer Survey in the Nordic Sea (IESSNS)
- Norwegian spring-spawning herring numbers, biomass, mean weight, and length-at-age, from the IESSNS
- Blue Whiting numbers, biomass, maturity proportion, mean weight, and length-at-age, from the ICES International Blue Whiting Spawning stock Survey (IBWSS)
- Irish Sea and North Channel (area 7.a), autumn spawning herring, numbers, biomass, distribution maturity proportion, mean weight, and length-at-age from the Irish Sea Acoustic Survey (ISAS).
- Irish Sea (area 7.a N), Industry spawning survey of herring biomass and distribution (ISSS)
- Western Baltic Spring-spawning Herring (including and excluding Central Baltic Herring) as well as sprat numbers, biomass, and mean weight-at-age by area for the Western Baltic (ICES Subdivisions 21, 22, 23, and 24) from the German Acoustic Autumn Survey (GERAS) of the Baltic International Acoustic Survey (BIAS)
- Boarfish numbers, biomass, maturity proportion, mean weight, and length-at-age, from the Western European Shelf Pelagic Acoustic Survey (WESPAS)

- Celtic Sea herring numbers, biomass, maturity proportion, mean weight, and length-at-age, from the Celtic Sea herring Acoustic Survey (CSHAS)
- 6.a herring numbers, biomass, maturity proportion, mean weight, and length-at-age, from the industry surveys in 6.a.N and 6.a.S

Other ecosystem survey-derived operational products:

- Horse Mackerel numbers, biomass, maturity proportion, mean weight, and length-at-age, from WESPAS
- Zooplankton distribution based on dry weight samples from the IESNS, IESSNS and WESPAS surveys.
- Recorded observations of marine mammals during the PELTIC, IESSNS, CSHAS and WESPAS.
- Recorded observations of seabird abundance and distribution during PELTIC, CSHAS, IBWSS and WESPAS surveys

Other outcomes and achievements:

- Comments and input to the continued development of the ICES Acoustic database;
- Overview of new and currently applied auxiliary pelagic ecosystem sampling technologies.
- Collection of genetic samples on HERAS/WESPAS/IESNS/IESSNS surveys for splitting of herring stocks
- 2023 survey plans (see Annex 14 for 2023 survey plans);
- Contributions to ICES Annual Science Conference and International Symposium on Small Pelagic Fish: New Frontiers in Science for Sustainable Management.
- Continued adoption of a common survey evaluation tool (StoX) across the surveys coordinated within WGIPS and transition to the use of the ICES acoustic database repository

Continued development of common code to aid survey planning, formatting, quality check, and plot data from acoustic surveys. Continued used of the WGIPS GitHub repository initiated https://github.com/ices-eg/WGIPS

5 Progress Report on ToRs and work plan

ToR a:

Results from the coordinated multinational ecosystem surveys conducted in 2022 were examined and combined during four post cruise meetings prior to the WGIPS meeting. Survey execution and final results from all surveys were presented at the WGIPS meeting for review. The combined results provided indices of abundance and distribution for stocks of herring, sprat, mackerel, boarfish, and blue whiting in Northeast Atlantic waters. Survey reports and survey summary tables with full details of each survey and resulting indices are in Annex 3 to 13.

ToR b:

Timing, planning, and methods applied for coordinated multinational surveys (IBWSS, IESNS, IESSNS, HERAS) and individual surveys (CSHAS, WESPAS, ISAS, ISSS, PELTIC, GERAS and 6a Industry surveys (6aSPAWN) were presented, discussed and agreed for the 2023 survey year.

Survey plans for 2023 are in Annex 14.

First point of contact regarding each survey in 2023 are listed in Table 5.1.

There were a few discussions in plenary on individual surveys.

This year participation of a CEFAS (UK) chartered vessel to IESNS was discussed in terms of how to best add the contribution to existing coverage. It was decided to fully interlace the effort with the existing vessels.

For IBWSS an issue of meaningful participation was raised. It was emphasised that participation of the internationally coordinated surveys is highly sensitive to the timing of participation and that participation outside of the agreed timings for each survey does not constitute a meaningful contribution. This lead to a specific recommendation to participants to the IBWSS, where the participation by Spain in 2023 is planned outside of the survey window (Chapter 6).

For the IESSNS there are issues with falling effort availability year on year. In 2023 there will be no participation by Greenland and some reduction in available ship time by some other nations too. For the 2023 survey this leads to a gap of approximately 15 survey days to cover the planned strata with the stated effort. Initially this will have to be absorbed in the planning for 2023 by reducing effort (dropping strata and increasing distance between stations in other strata). For the longer terms potential design changes (strata boundaries and effort within each strata) were discussed that may optimise the use of existing survey time. A recommendation to carry out analysis to inform the best way forward was agreed (chapter 6), including consideration on effect of reducing the effort within strata, but also whether it is possible to optimise by changing the strata design. The ongoing modelling work to investigate the effect of single large catches at IMR could potentially form a basis for such an exercise.

Table 5.1. WGIPS Survey coordinators contact points for 2023 surveys.

Survey	Type	Country	Coordinator	Email
HERAS	International		Matthias Schaber	matthias.schaber@thuenen.de
IBWSS	International		Åge Høiness	aage.hoines@hi.no
IESNS	International		Are Salthaug	are.salthaug@hi.no
IESSNS	International		Leif Nøttestad	leif.noettestad@hi.no
CSHAS	National	Ireland	Ciaran O'Donnell	Ciaran.odonnell@marine.ie
WESPAS	National	Ireland	Ciaran O'Donnell	Ciaran.odonnell@marine.ie
GERAS	National	Germany	Matthias Schaber	matthias.schaber@thuenen.de
PELTIC	National	UK CEFAS	Jeroen van der Kooij	jeroen.vanderkooij@cefas.gov.uk
ISAS	National	UK AFBI	Gavin McNeill	gavin.mcneill@afbini.gov.uk
ISSS	National	UK AFBI	Gavin McNeill	gavin.mcneill@afbini.gov.uk
6aSPAWN (North)	International Industry		Steve Mackinson	steve.mackinson@scottishpelagic.co.uk
6aSPAWN (South)	National Industry	Ireland	Mike O'Malley	Michael.O'Malley@Marine.ie

ToR c:

Nearly all WGIPS coordinated and individual acoustic surveys used the ICES Acoustic Trawl survey database (ICES DB) e.g. HERAS, CSHAS, WESPAS, PELTIC, IBWSS, IESNS, IESSNS and 6.aN Industry survey (6.aSPAWN) for 2022 survey data (Table 5.2). Under this ToR, the group will keep following the progress and provide guidance for the rest of the surveys coordinated by WGIPS (GERAS, ISAS and ISSS).

Many surveys have also started to upload data collected prior to adopting the ICES Database. This will be a longer process that WGIPS will continue to encourage progress on where possible.

The group actively engage with the ICES datacentre on issues relating to the ICES DB through the governance group, WGAcousticGOV, and the developers of the analysis software StoX to ensure compatibility between the data collection at sea and storage in national institutes, the ICES database, the analysis software and the end users of indices (HAWG and WGWIDE) resulting from the surveys.

Although it has now been demonstrated that all surveys can use ICES DB as repository for data, the PGNAPES database will still be maintained for IESNS, IBWSS and IESSNS. Firstly, because it is still being used for producing hydrography and mesozooplakton figures for the survey reports during the post-cruise meetings, which take place within a couple of weeks after the surveys; this time limitation prohibits calibrating hydrography data, which is needed prior to upload to the ICES hydrography database. The plankton dryweight biomass data from these surveys also cannot at the present be hosted on an ICES repository. Secondly, it is not realistic that the full time-series of biology and acoustic data will be uploaded to the ICES acoustic database in the near future, and therefore there is a wish to keep the full time series in PGNAPES for easy access to the compiled time series. To avoid two separate data upload streams for the surveys using PGNAPES, it has now been implemented that all acoustic and biotic data is uploaded to ICES DB only and the PGNAPES is populated from an ICES DB export.

ICES data centre informed the group that it is now possible to add quality flags to hydrographic data in the ICES hydrographic database so it will be possible for preliminary data to be stored, either in a closed "sandbox" partition of the database until it can be replaced by quality-checked data accessible in the public part of the database. This should in principle allow the group to use the ICES Hydrographic database as the primary repository for CTD data from the surveys. The group was assured this information will be brought to the institutes also. While these developments mature and become integrated in the dataflow from the surveys, PGNAPES database will continue to be the primary repository for CTD data from IESSNS, IESNS and IBWSS.

WGIPS recommends that all hydrographic data from the surveys are also eventually uploaded to the ICES hydrographic database once quality checking procedures are complete in the institutes (See chapter 6).

The group is predominantly using StoX to generate results from the surveys now and continue to interact closely with the StoX development team (Table 5.2, Johnsen et al. 2019). WGIPS encourage the remaining surveys to investigate if StoX can be used for the abundance estimation.

Finally, although some surveys have started to move index calculation onto the ICES TAF-framework, the progress on this has stalled to some degree due to a lack of available support. ICES datacentre informed the group that support to achieve this can now be given to individual surveys upon request in the form of help and guidance to carry out the process. WGIPS will continue to monitor and encourage progress on this.

Table 5.2. Progress of adopting the ICES DB and StoX for the coordinated and individual surveys

Survey	Database (ICES or other)	Abundance estimation software (StoX or other)
Herring Acoustic Survey (HERAS)	ICES DB	StoX
6.a/7.b/c Industry herring acoustic survey(6.aSPAWN)	ICES DB	StoX
GERAS	National Access database/Preparation underway for uploading files to ICES DB	GERIBAS II
ISSS	National SQL database//Preparation underway for uploading files to ICES DB	National R-scripts
ISAS	National SQL database/ /Preparation underway for uploading files to ICES DB	National R-scripts
WESPAS	ICES DB	StoX
PELTIC	ICES DB	EchoR, StoX
IBWSS	PGNAPES & ICES DB	StoX

IESSNS	PGNAPES & ICES DB	StoX
IESNS	PGNAPES & ICES DB	StoX
CSHAS	ICES DB	StoX

ToR d:

Progress continues to being made on updating the WGIPS survey manual (SISP 9, ICES 2015) to the TIMES format. It was agreed to work towards submitting the first draft to ICES by end of May 2023, requiring a first draft of individual survey chapters to be completed by **28th February 2023**. Survey coordinators are responsible for coordinating the update of their respective surveys within each survey group.

ToR e

Prior to the 2023 meeting WGIPS received just one recommendation from other groups and issued two recommendations to other groups through the ICES recommendations database. Details are listed in chapter 6. The group also introduced formalised "internal" recommendations to its own members with the purpose of documentation of important agreements or issues that to be addressed to continue to improve and maintain the quality of the surveys.

ToR f:

WGIPS agreed there would not be need for a workshop on **standardising biological sampling strategy** in the HERAS survey this year until the underlying data requirements are available and initial data analysis can be agreed. Instead a workplan was agreed to further this work inter-sessionally and in time for the HERAS post cruise meeting in November 2023. It was agreed that detailed description of biological sampling strategies for each cruise should be ready by end of February 2023 (for inclusion in the survey manual update). Full data back to 2010 should be uploaded to ICES DB by 30/9 2023. The HERAS group will arrange a meeting in October 2023 to discuss analysis and summaries of data collected 2010 – 2022.

A **session on stock discrimination** was held at the working group meeting in 2023 including three presentations and plenary discussion about recommendations from and to other working groups. The recommendations are detailed in chapter 6.

The first two presentations summarized the stock splitting methods and results currently applied for the Malin Shelf Herring Acoustic Survey (MSHAS) and the Herring Acoustic Survey (HERAS). The third presentation presented a new method to identify Norwegian spring-spawning herring (NSS) in the survey area of HERAS.

The stock splitting method applied for the MSHAS has been part of a larger benchmark process and was approved in 2022 (ICES, 2023). A working document detailing methods and results are included in Annex 16 and were summarized during the presentation. Since 2014 genetic samples were collected during this survey. The baseline genetic analyses indicated that herring in ICES Division 6.a comprise at least three distinct populations; 6.a.S herring, 6.a.N autumn spawning herring and 6.a./7b, c spring spawning herring (Farrell et al. 2022). The 6.a.S herring are a primarily a winter spawning population although there is a later spring spawning component present in the area also. These 6.a.S components are currently inseparable and for the purposes of stock assessment are combined as 6.a.S herring. The survey results are split into the following indices based on the genetic information: Autumn spawning 6.a.N herring (her-vian), 6.a.S,7b,c herring (her-irlw), mix of herring from 6.a. and 7b,c; i.e. unknown or below threshold fish (her.27.6a7bc) and spring spawning herring of uncertain origin, could be 6.a.N or 6.a.S/7.b,c (her-67bc).

The CVs on the split survey estimates are within expected values for acoustic surveys for herring in this area. There appears to be reasonably good age and length cohort tracking for some of the individual split components, particularly the her-67bc (spring spawning herring of uncertain origin) and her-irlw (6aS and 7.b c herring). The her-vian (6aN autumn spawning herring) cohort tracking appears to be variable, which may be linked to the low numbers of these fish in the genetic samples in some years. The her.27.6a7bc (unknown or below threshold fish) cohort tracking also appears to be variable, however, there are very low samples of these fish in the genetic samples in most years. The abundance of herring in this area have been at low levels during these years, making obtaining samples difficult on the MSHAS survey during this time. In future surveys, all fish sampled for aging should also be sampled for genetic stock identification. This will reduce the number of un-assigned fish in the estimates.

For the HERAS, stock splitting using genetic analysis was carried out in selective parts of the survey area where mixing of North Sea autumn spawning herring (NSAS) and western Baltic spring spawning herring (WBSS) is expected and where stock splitting has historically been carried out. Other areas are currently not considered in terms of stock splitting. Detailed methodology is in the HERAS survey report in Supplementary Document 3.

Since 2021 this common genetic analysis method has been applied for stock splitting, replacing the two traditional methods of otolith microstructure and shape (used in strata 21, 31, 41, 42, 151_S, 151_N, 152) or vertebrae counts (used in stratum 11 and 141, see Supplementary Document 3) (Bekkevold et al 2023). The results of the genetic analysis revealed that several populations that were previously not considered occur in the survey area. In total, 8 different herring populations have been identified (Figure 5.21 in Supplementary Document 3). Aside from the three identified with previous methods (NSAS, Downs (included in NSAS indices) and WBSS), the genetic method also identified herring from several adjacent populations in the survey area: WBSS Skagerrak herring (WBSS-SK) which can be discriminated from other WBSS herring, Norwegian Spring Spawning (NSS) herring, Central Baltic herring (CBH), Baltic Autumn Spawning (BAS) herring, and North-East Atlantic summer spawning herring (including Faroes autumn spawners, Icelandic summer spawners, or Norwegian summer spawners). In terms of consistency in the calculation of the indices for NSAS and WBSS, individuals were only assigned to either the NSAS or WBSS herring stock. Their assignments to either stock was based on the genetic result, and where this indicated a different stock than NSAS or WBSS, the assignment was mapped to how the previously used splitting methods would have assigned them (Table 5.21 in Supplementary Document 3). So, where the vertebrae counts were previously used, NSS and WBSS Skagerrak herring would be mapped to NSAS, whereas where the otolith microstructure method was used, these would be mapped to WBSS. This allows the provision of abundance estimates of NSAS and WBSS herring that are comparable to previous years and therefore compatible with the time series. With the firm evidence that these indices contain several more herring stocks than previously considered in the splitting process a way forward needs to be investigated together with the assessment working group (HAWG). The indices used for NSAS and WBSS are "contaminated" by other stocks and have likely been through the whole time series.

A working document on separating out NSS herring in the HERAS survey was also presented (Annex 18). The genetic analyses of the HERAS demonstrate that during the survey time (summer) multiple herring stocks occur in the area, for example Norwegian spring spawning (NSS) herring. Stock discrimination is applied in the north-eastern survey areas covered by Norway and Denmark, but not in the north-western part (covered by Scotland) where the highest herring abundance is observed. NSS herring are generally larger when compared to

NSAS herring of the same age. Genetic information and length-at-age data from the north-eastern survey area were combined to calculate growth curves (length-at-age) for genetically identified NSAS and NSS herring respectively. For fish aged 5 winter rings and older, clear size differences occur. This were used to identify NSS herring in the north-western part, based on individual length at age, were no genetic information were available. The results demonstrated that NSS herring were present in the HERAS data in all years from 2010-2022, but the relative abundance increased in recent years with up to 25% NSS herring in some hauls. Preliminary re-estimation of survey biomass using StoX including this separation indicated that up to 10% of the total biomass in the north-western part (stratum 111) could be NSS herring. Further studies are needed to validate the results and highlight the need for extending individual genetic sampling across the HERAS survey area.

ToR g:

The group continues to encourage that scrutinisation is compared and discussed within and between surveys. This year no formal workshops have been held, but several of the post cruise meetings dedicated time to compare and align scrutiny of the 2022 survey between participating nations. In the agreed format for the new survey manual there will be a dedicated chapter for describing the scrutiny protocol for each survey.

ToR h:

As WGS2D was dissolved this collaboration has been terminated. WGIPS had been looking into maintaining the blue whiting forecast models developed in this collaboration within WGIPS, but at the meeting in 2023 it was decided definitively not to pursue this.

During WGIPS 2020, a sub group made up of IBWSS participants met to develop acoustic scrutinisation guidelines to harmonise the reporting of mesopelagic fish from survey data following on from discussions at previous meetings and recommendations from other groups (WGMESO & WKMESOMeth). As a result of this acoustic data for mesopelagic species from the IBWSS is being uploaded to the ICES database under an independent survey tag (MEESO). In 2023 the data is not complete yet for all nations and years but is progressing and the effort continues.

In 2022 WGIPS agreed to collaborate with WGSPF to utilize HERAS time-series data to look at distribution of small pelagic fish in the North Sea in relation to hydrographic parameters. This commitment was widened in 2023 to include all surveys where possible/desirable and linkages where made between WGSPF and survey coordinators and the PGNAPES database curator. It was emphasized that the use of these data must be carried out in close collaboration with the WGIPS group to ensure correct use and interpretation.

ToR i:

Increasingly, complimentary data outside of the more traditional sources such as CTD and supplementary biological data are collected. Visual abundance surveys for marine mammals and seabirds are becoming increasingly common, as are zooplankton sampling (dry weight), in-trawl optics and broadband acoustic and sonar data. Annually, the group report these additional data sources within the Ecosystem index overview table (Annex 15). Currently such additional data sources are collected in a somewhat ad hoc fashion by national institutes. To provide meaningful on-going ecosystem metrics a more coordinated approach is required within the group. The first part of this process is to identify the end user and specific requirements. For this to be achieved successfully then support from outside this group is required to:

- Determine the final end user group, what is the (primary) use of these data?
- prioritise data types and metrics
- determine protocols and methods to provide a coordinated collection program
- define metadata standards and a data repository for these data
- identification of the costs, where applicable, and potential funding sources
- determine feedback process from final end user group

The group recognises their unique position to be able to provide ecosystem data sources alongside more traditional survey outputs and are willing to engage in a structured collection process. To this end the group looks forward to future engagement with other expert groups.

Under this ToR the group also commits to hold a session at each meeting dedicated to presenting new methods and tools being developed to survey wider ecosystem components or that aims to improve existing methods.

During the 2023 meeting there were no contributions to this session, but Annex 15 was still updated.

ToR j:

WGIPS continues to follow progress on reporting of mesopelagic fish sampling in WGIPS surveys.

During WGIPS 2020, a sub group made up of IBWSS participants met to develop acoustic scrutinisation guidelines to harmonise the reporting of mesopelagic fish from survey data. This work followed on from discussions at previous meetings and recommendations from other groups (WGMESO & WKMESOMeth).

The limitations associated with the routine reporting of the abundance of mesopelagic fish during opportunistic surveys, using hull mounted systems and new technologies were considered and outlined during as part of MEESO project work package 3 under the working title of "Protocol for abundance estimation of biomass and diversity in the mesopelagic zone" (https://www.meeso.org/). The document provides a detailed overview of acoustic and biological sampling approaches applied during dedicated mesopelagic surveys as well as surveys of opportunity and the limitations associated to each of the methodologies. It is aimed to guide future sampling efforts under considerations of their limitations, as well as how some of these limitations may be overcome through the development of novel and innovative technologies and sampling approaches. Once published this report will be circulated to the group.

Ireland has continued to progress on reporting during the IBWSS using guidelines established during WGIPS 2021. Acoustic and biotic data collected during IBWSS 2022 survey were uploaded to the ICES Trawl acoustic database. Acoustic allocation to MAV (*Maurolicus muelleri)* and MYX (lanternfish) categories are included.

Ireland carried out a dedicated mesopelagic survey over 12 days in September, 2022 and testing was carried out on trawl performance and acoustic identification. Development of a multi-frequency scrutinisation template in Echoview has made good progress for use in the identification of near surface schools with a focus on *Maurolicus muelleri.* The template was tested during a dedicated survey (M_2S_2).

A graded small mesh sampling trawl has been developed to actively target near surface layers and was tested during the pilot survey. The trawl was able to successfully and representatively sample near surface schools.

The sampling trawl and scrutinisation template will be employed during future IBWSS surveys to report fish biomass and abundance.

A separate study is underway to review the existing Irish acoustic data times series using developed methods and complemented with newly gained biological information from trawl samples.

Further updates will be provided during WGIPS 2024.

Next Meeting:

The 2024 meeting will be hosted by the Faroe Marine Research Institute (FAMRI) in Tórshavn Faroe Islands 22-26 January 2024. The meeting will be held as a hybrid meeting again.

6 Recommendations

Answers to recommendations received by WGIPS in 2022 are uploaded to the ICES recommendations database and communicate to the issuing working group chair or equivalent. This year WGIPS received one recommendation from other groups (Table 6.1).

Recommendations issued by WGIPS to other groups in 2023 have also been uploaded to the ICES recommendations database and communicated to the receiving party via chair or equivalent**.** This year WGIPS made two recommendations to other groups. (Table 6.2).

This year we also introduce a section with recommendations to national laboratories participating in WGIPS with the purpose of continuing to improve and maintain the quality of the surveys coordinated under the WGIPS umbrella. These recommendations originate through discussions in plenary at WGIPS meetings and reflect a consensus in the group.

In 2023 WGIPS had 4 recommendations to national laboratories participating in WGIPS coordinated surveys. (Table 6.3).

Table 6.1. Answers to recommendations received by WGIPS in 2022.

Recommendation ID 68 From HAWG
HAWG recommends the collection of genetic material for further analysis for all aged herring taken in survey and catch samples that are used in stock assessment. Currently genetic methods are partially used for stock discrimination, but longer time series are currently not available. To secure good time series of genetic materials when stock splitting will be implemented routinely, we therefore recommend to start collecting genetic samples as soon as possible for all aged herring.
ID 68 Reply from WGIPS: *WGIPS supports the request to begin collecting genetic samples of herring from relevant surveys and understands the reasoning behind the necessity to start collecting samples as soon as possible.* *Some surveys for instance the Malin Shelf herring survey have well developed sampling methods and protocols already in use (i.e. from 2014 – onwards), and are collecting genetic samples from all aged herring collected within the 6a and 7b c area. The HERAS survey in the North Sea in recent years is splitting NSAS and WBSS herring using genetics in some areas, in conjunction with traditional methods including vertebrate counts. Some surveys have also collected genetic samples for stock ID purposes periodically despite there not yet being a requirement from the assessment side to provide split indices (e.g. IESNS, IESSNS, CSHAS). Most other surveys within the group are willing to begin taking genetic samples, but have general concerns about the added time required to process fish on surveys and the costs involved with processing samples. Individual surveys will need to work on considerations around minimum sample numbers required, most urgent sampling areas and stocks, storage best practice, materials required, specialised sampling tools, and funding. For surveys in particular that have limited resources currently, more consideration is required around this potentially large undertaking across all WGIPS surveys.* *WGIPS suggests that sampling priority should be on areas where there is a demonstrated issue with stock mixing (e.g. HERAS strata 121 and 111). There is potential for other areas/surveys to begin collecting a small number of samples, and this could be delivered over an initial period of*

one or two years, allowing further considered investigation into the extent of stock mixing issues within an area of concern.

Table 6.2. Recommendations issued to other groups by WGIPS in 2023 and uploaded to ICES Recommendation database.

Database ID	Recipient	Recommendation
20	ICES datacentre	**WGIPS** recommends the ICES datacentre provide a common secure repository for final StoX projects. During each of the post-cruise meetings for the coordinated international pelagic surveys, an official StoX project is produced for the purpose of estimating assessment indices from the surveys. These can be used to reproduce the estimates that are presented in the cruise report, and all the settings and data used in the estimation process are documented in the project folders. Such official StoX projects have also been made for historic data as part of re-calculation processes, often in connection with benchmark assessments. Till now, all these official StoX projects have been storeSd as zip-files on the ICES share point somewhere, e.g. on the WGIPS share point. There is a need for a more general repository for the official StoX projects, to ensure transparency and reproducibility.
19	WKSIDAC2, HAWG	**Maintenance/Improvement of Genetic baseline for West of Scotland herring** Herring on the MSHAS (Malin Shelf Herring Acoustic Survey) in July can now be split into separate genetic components; 6aN (autumn spawners), 6aS (Winter spawners) and spring spawners from unknown stocks. A fourth component also exists within the greater MSHAS survey area in the summer, and these fish are from unknown stocks, thought to be made up of a number of local populations for which there is currently no genetic baseline samples. There is currently not enough genetic baseline information to confidently separate the spring and unknown spawners from other 6a and 7b, c components so they can be used in the assessment. In order to achieve this separation with more confidence, continued baseline samples of spawning herring from the whole area covered by 6a and 7b, c is required, with the spring spawning component most important currently. Once established these genetic baselines require regular updating, and this will vary depending on the stability of the genetic markers within the individual stocks. As the spring component currently represents a relatively large biomass of herring from the MSHAS compared to other stocks, it is important that genetic samples are obtained from spawning herring to facilitate separation into the relevant stocks on MSHAS. The WKNSCS benchmark (ICES, 2023) also advised that genetic sampling be undertaken from catch samples in 6a/7b, c, to facilitate greater understanding of the fishery and the stock being targeted. The fisheries in these areas may not always target discreet stocks, and therefore the degree of mixing within catch samples should also be monitored regularly through genetic stock identification. REF: ICES. 2023. Benchmark Workshop on North Sea and Celtic Sea stocks (WKNSCS). ICES Scientific Reports. 4:85. 324 pp. https://doi.org/10.17895/ices.pub.21558681

Table 6.3. Recommendations issued internally in WGIPS 2023 to survey participants.

ID	Recommendation
1.	**Ongoing meaningful contribution into the IBWSS survey program** The IBWSS relies on a coordinated spatial and temporal coverage to estimate biomass and abundance of blue whiting on the spawning grounds to the west of Ireland and the UK (ICES, 2015). The IBWSS survey time series represents the only fisheries independent data input to the assessment process within WGWIDE. To be consistent in approach and methodology including biological analysis, coordinated planning is essential to ensure area coverage and temporal alignment that meets the dynamics of this migratory stock. For long term and meaningful contribution to the existing IBWSS survey program, new entrants and existing participants must be able to provide a commitment on survey effort (number of days) and calendar availability. The window for contribution runs from the 16th March for contribution in the southern boundary region until the 12th April in the northern boundary.
2.	**CTD data to ICES Oceanographic database** CTD data from all surveys under WGIPS should be uploaded to ICES Oceanographic database. This does not replace the need to upload these data at a lower resolution to PGNAPES database immediately after cruises to enable the necessary fast reporting. The availability of high resolution calibrated and quality controlled data available in a central place facilitates detailed analytical studies and also will be a requirement in future more widespread use of broadband echosounder data.
3.	**Maintaining a meaningful IESSNS survey program** The IESSNS survey time series (2007, 2010-2022) represents an important fishery independent data input to the assessment process for NEA Mackerel within WGWIDE. Since 2019 the total commitment in terms of survey days by participating countries has been decreasing. In 2023 the effort will be 20% lower than it was in 2019. This drastic decease in effort negatively impacted the survey in 2022 both in terms of sampling effort and geographical coverage of the survey. To maintain coverage in the anticipated area of mackerel distribution during summer, some peripheral strata had to be left uncovered and the spacing between predetermined trawl stations had to be increased in most strata. There are concerns that number of survey days will continue to decline in the next years. Currently, the effects of such drastic decline in survey days to the survey and ways to mitigate them with the least impact on overall results are poorly understood. WGIPS recommends an analytical review of whether the current IESSNS strata design, currently based on EEZ boundaries, temperature of surface currents, and variability in mackerel density) effectively captures patterns in distribution and mean size and age of mackerel across the survey area and use the existing committed survey effort (days) optimally. Secondly, to ease planning decision if and when the need arises to reduce effort overall for the survey, WGIPS recommends to investigate where effort can be reduced, and by how much, to still give meaningful results with the least impact on main objectives. Finally, WGIPS also recommends that to maintain the survey in a meaningful form it is necessary to secure reliable long term commitment on number of survey days from current participants and/or to get participation from other parties. The window for contribution runs from the 1st July for contribution until the 10th August.
4.	Genetic sampling of herring in the dedicated herring surveys should be expanded where possible to include all areas in preparation for using genetic stock splitting in index calculation in the near future. This includes the IESNS, HERAS and GERAS. The goal is to collect tissue samples for genetic analysis of all herring selected for aging under the current biological sampling strategy for each survey. This may not be feasible on all cruises due to added time required to process fish and it may be necessary to carry out a more limited sampling scheme on some cruises. It is expected that genetic stock splitting will become a requirement on these surveys in the not so distant future. The availability of tissue samples for genetic analysis from across these surveys will enable analysis to inform the future optimal sampling strategies and levels as well as allow back calculation of indices back in time to when full sampling was initiated.

7 Cooperation with Advisory Structures

HAWG

Indices for the stocks of herring and sprat in North-east Atlantic waters from annual ecosystem surveys are used as fishery-independent data for analytical assessment purposes in HAWG. Communication between HAWG and WGIPS is strengthened through overlap in memberships of the two groups as well as the delivery of survey summary reports from WGIPS to stock assessors and the return of these to WGIPS with comments from stock assessors.

WGWIDE

Indices for the stocks of herring, mackerel, boarfish, and blue whiting in North-east Atlantic waters from annual ecosystem surveys are used as fishery-independent data for analytical assessment purposes in WGWIDE. The communication between the two groups benefit from overlap between members of both groups and facilitates the delivery of indices to the assessment process in-year.

ICES Acoustic Trawl Survey Data Portal

Since 2015 the ICES Data Centre has been developing ICES Acoustic Trawl Survey database and portal http://acoustic.ices.dk as part of the AtlantOS project (2015-2019). WGIPS have been involved in the development by giving input to the data structure and workflow, amongst others through several survey-specific and general work-shops, i.e. the Workshop on Evaluating Current National Abundance Estimation Methods for HERAS Surveys (WKEVAL) and the Workshop on the Review of the ICES acoustic-trawl survey database design (WKIACTDB). Additional input continues to be provided from the yearly WGIPS and survey post-cruise meetings as well as through the large overlap in members of WGIPS and the database-governing group, WGAcousticGOV.

The Acoustic Trawl Survey Data Portal is now in production being maintained and the majority of WGIPS coordinated surveys are now using the database i.e. HERAS, CSHAS, WESPAS, 6aSPAWN now exclusively use the database. IBWSS, IESSNS and IESNS have also fully adopted the database while still maintaining the timeseries of data in PGNAPES. The remaining surveys are all taking preparatory steps.

8 Revisions to the Work Plan

Two items planned for Year 1 was not completed in year two either. The WD on biological sampling strategies on HERAS surveys over time has not been completed, but the HERAS survey group has committed to completing this task before next meeting. There were also plans for conducting a workshop on biological sampling strategies in WGIPS surveys. This was postponed and it has been agreed to focus on just the HERAS survey for now and may not be necessary with a formal workshop to complete this piece of work. The HERAS survey group will evaluate in October 2023 whether a workshop during this reporting cycle will be needed

9 References

Bekkevold, D., Berg, F., Polte, P., Bartolino, V., Ojaveer, H., Mosegaard, H., et al. (2023). Mixed-stock analysis of Atlantic herring (*Clupea harengus*): a tool for identifying management units and complex migration dynamics. *ICES Journal of Marine Science* 0**,** 1-12. doi: 10.1093/icesjms/fsac223.

Farrell, E.D., Andersson, L., Bekkevold, D., Campbell, N., Carlsson, J., Clarke, M.W., et al. (2022). A baseline for the genetic stock identification of Atlantic herring, *Clupea harengus*, in ICES Divisions 6.a, 7.b–c. *Royal Society Open Science* 9**,** 220453. doi: 10.1098/rsos.220453.

ICES. 2023. Benchmark Workshop on North Sea and Celtic Sea stocks (WKNSCS). *ICES Scientific Reports*. 4:85. 1-324. doi: 10.17895/ices.pub.21558681.

Johnsen, E., Totland, A., Skålevik, Å., Holmin, A.J., Dingsør, G.E., Fuglebakk, E., et al. (2019). StoX: An open source software for marine survey analyses. *Methods in Ecology and Evolution* 10(9)**,** 1523-1528. doi: 10.1111/2041-210x.13250.

ICES. 2015. Manual for International Pelagic Surveys (IPS). Series of ICES Survey Protocols SISP 9 – IPS. 92 pp

Annex 1: List of participants

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Annex 2: Resolutions

There were no new resolutions put forward from the group in 2023.

Annex 3: Survey summary and report from the International Blue Whiting Spawning Stock Survey (IBWSS) 2022

Annex 3 contains a summary table for the International Blue Whiting Spawning Stock Survey (IBWSS) 2022.

For the full report, please see Supplementary Document 1 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGIPS 2023	
Name of the survey (abbreviation):	International blue whiting spawning stock survey (IBWSS)
Target Species:	Blue whiting
Survey dates:	21 March – 5 April 2022
Summary:	
The International Blue Whiting Spawning stock survey was carried out over 15 days and thus within the recommended 21 day time window agreed by the group. Weather conditions were regarded as exceptional compared to 2021, with no weather induced downtime recorded. The stock was regarded as suitably contained within the survey area. The total survey effort was comparable to survey effort in previous years. The survey in 2022 shows a 15% increase in TSB and a corresponding 56% increase in TSN when compared to the 2021 estimate for comparable survey effort and coverage. The estimated uncertainty around the total stock biomass was higher than in 2021, CV=0.19 compared to 0.14. In terms of abundance, 2-year-olds (2020 year-class) were most abundant (30%), followed by the 4-year-olds (17%), 3-year-olds and 5-year-olds (8%) respectively. Immature fish represented 12.6% of TSB and 23.8% of TSN and was made up of 1- and 2-year-old fish, 23% of which were found to be immature. The abundance of these two year classes (2020 and 2021) were the highest in the time series and above the numbers observed associated with the 2014 record year class.	

	Description
Survey design	Stratified systematic parallel design (15 - 35 nmi spacing) with randomised start point. Adaptive surveying was used in border areas to the west where blue whiting spawning concentrations disappear. Zigzag design in stratum 2 (the northern slope of Porcupine)

Index Calculation method	StoX (via the ICES database)
Random/systematic error issues	NA, outside of those already described in literature for standardised acoustic surveys
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	Yes, in poor weather conditions three of the four vessels use a drop keel and minimum integration is at 12 m
Extinction (shadowing)	Some issues on the shelf break but considered minor
Blind zone	NA, blue whiting distributed in deeper layers
Dead zone	Some issues on the shelf break but considered minor
Allocation of backscatter to species	Directed trawling for verification and species composition purposes and age structure.
Target strength	TS = 20 log10 (L) - 65.2 Pedersen et al. 2011
Calibration	All survey frequencies were calibrated and results were within recommended tolerances
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	The 2022 estimate of abundance is considered as robust. Good stock containment was achieved for both core and peripheral strata.
Stock ID and mixing issues	*No issues*
Measures of uncertainty (CV)	Estimated uncertainty around the total stock biomass remains low, CV=0.19 but somewhat higher than 2021 (CV=0.14).
Biological sampling	Sampling levels was considered representative and well distributed across strata, in line with previous years.
Were any concerns raised during the meeting regarding the fit-	No concerns were raised regarding the fitness of the survey for use in the assessment.

ness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)	
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	Yes

Annex 4: Survey summary and report from the International Ecosystem Survey in Nordic Sea (IESNS) 2022

Annex 4 contains a summary table for the International Ecosystem Survey in the Nordic Seas (IESNS) 2022.

For the full report, please see Supplementary Document 2 at https://doi.org/10.17895/ices.pub.23607303

<table>
<tr><th colspan="2">Survey Summary table WGIPS</th></tr>
<tr><td>Name of the survey (abbreviation):</td><td>International Ecosystem Survey in the Nordic Seas (IESNS)</td></tr>
<tr><td>Target Species:</td><td>Norwegian spring-spawning herring</td></tr>
<tr><td>Survey dates:</td><td>26 April – 30 May</td></tr>
<tr><td colspan="2">Summary:</td></tr>
<tr><td colspan="2">Survey effort, timing and area coverage in 2022 were comparable to previous years in the Norwegian Sea. Unfortunately, the Barents Sea was not covered in 2022. The zero-line of the distribution of herring was considered to be fully reached in the Norwegian Sea. It is recommended that the results from IESNS 2022 can be used for assessment purpose. The herring was primarily distributed in the central and southwestern area. In the westernmost area old herring dominated, but in general, the 2016-year-class was the most abundant year class throughout the survey area. The total estimate of herring in the Norwegian Sea from the 2022 survey was 19.8 billion in number and the biomass was 4.4 million tonnes. The biomass estimate is 13 % lower than the 2021 survey estimate and also the estimated number is about 13% lower than in 2021.The biomass estimate decreased significantly from 2009 to 2012 and has since then been rather stable at 4.2 to 5.9 million tonnes, with the lowest abundance occurring in 2017. The 2016 year class now appears to be fully recruited, distributed widely in the feeding area and more dominant than the older year classes.</td></tr>
<tr><td></td><td>Description</td></tr>
<tr><td>Survey design</td><td>Stratified systematic parallel transects design with randomised starting point of the southernmost transect within each strata. The Norwegian Sea is divided into four strata.</td></tr>
<tr><td>Index Calculation method</td><td>StoX (via the ICES database)</td></tr>
</table>

Random/systematic error issues	N/A
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	No problems due to bad weather for acoustic recordings
Extinction (shadowing)	N/A
Blind zone	Upper 8-12 m not covered by acoustics.
Dead zone	N/A
Allocation of backscatter to species	Standard TS for herring and blue whiting
Target strength	Blue whiting: TS = 20 log(L) – 65.2 dB (ICES 2012) Herring: TS = 20.0 log(L) – 71.9 dB
Calibration	OK
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	Time series: Considered to have covered the adult stock adequately 2022 survey: the entire adult stock during its migration on the feeding grounds in the Norwegian Sea.
Stock ID and mixing issues	Yes, some mixing of herring might have occurred in some of the fringe regions: in the Southeastern Icelandic zone some Icelandic summer spawners are probably included in the NSSH estimate. In the southers part of the surey area some herring of the autumn spawning type is probably included in the NSSH estimate. However, these mixing issues are not regareded as serious sources of bias. The problem of herring stock ID is currently being working on and samples were collected during the most recent years to further address this.
Measures of uncertainty (CV)	The estimated survey uncertainty (CV) for the main age groups in the sestimate was around 0.2-0.25.
Biological sampling	Sampling was considered representative and the sampling levels as adequate. In the recent years there have been concerns regarding age reading of herring, because the age distributions from the different participants have showed differences

	within the same strata. An age reading workshop, "Workshop on age reading of Norwegian Spring Spawning Herring" WKARNNSH, will take place at the Institute of Marine Research, Bergen, Norway, 17-21 April 2023.
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)	No concerns were raised (in addition to those discussed above) regarding the fitness of the survey for use in the assessment.
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	The survey summary table contained adequate information to allow for evaluation of the quality of the survey for use in assessment.

Annex 5: Survey summary and report from The ICES Coordinated Acoustic Survey in the Skagerrak and Kattegat, the North Sea, West of Scotland and the Malin Shelf area (HERAS) 2022

Annex 5 contains a summary table for the ICES Coordinated Acoustic Survey in the Skagerrak and Kattegat, the North Sea, West of Scotland and the Malin Shelf area (HERAS) 2022.

For the full report, please see Supplementary Document 3 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGIPS 2023	
Name of the survey (abbreviation):	HERAS
Target Species:	Herring and sprat
Survey dates:	22 June – 25 July 2022
Summary:	
The 2022 survey covered all but one planned strata, and survey effort, timing and coverage were largely comparable to previous years. All main aggregations of herring are considered to have been sampled sufficiently. Due to a loss of survey time originating from inclement weather and technical issues, stratum 131 could not be covered as planned, but had to be completely omitted. Parts of stratum 81 covered by the Netherlands are not accessible anymore due to the building of wind farms requiring a slight modification in transect orientation. Additionally, the southern part of stratum 81 does not allow sailing and pelagic fishing due to topographical constraints. As these restrictions are permanent it may be necessary to consider a permanent modification to this stratum in the future. Comprehensive trawling was carried out over the course of the survey providing good confidence in school recognition and supporting biological data for age stratified abundance estimation of the target species in all completed strata in the North Sea, Skagerrak, and Kattegat. On the Malin Shelf in strata 1-6, biological sampling contin-	

ues to be challenging due to low abundance and contracted distribution.

The distribution of NSAS herring was similar to that observed in the previous years with largest aggregations of adult herring in the areas to the east of the Shetland Isles, between 2°W and 2°E and app. 57.5°N - 61.5°N. Adult herring were also distributed in larger concentrations in the Norwegian Trench into the deeper parts of Skagerrak. Juvenile herring were primarily in the usual distribution in the shallower south and eastern parts of the North Sea and in the Skagerrak and Kattegat. The central North Sea (stratum 131) was not surveyed in 2022. The estimate of **North Sea** Autumn Spawning herring SSB has increased by 28% from 1.50 million tonnes in 2021 to 1.96 million tonnes this year. The abundance of mature fish has increased from 8 170 million in 2021 to 10 348 million in 2022. The mean weight of mature fish is only slightly higher than last year at 189.7g, and the increase in biomass of mature fish is due to higher abundance rather than change in condition of individual fish. At 70%, the proportion mature at 2 winter rings in 2021 is again at the high end of the time series.

The 2022 abundance estimate of **WBSS** herring showed a 6% decrease from 2021, equalling a decrease of 24% in biomass. This is again among the lowest estimates of the time series.

The **Malin Shelf** (6.a and 7.b, c) herring estimates of SSB and abundance have decreased compared to 2021. Greater than 70% of the TSB and SSB was observed north of 56°N (the geographic area that forms the historic **West of Scotland** (6.a.N) index. Herring were distributed in a few discreet areas in 2022, north west of Tory island, West of the Hebrides (south of St. Kilda) and north of Lough Swilly (Malin Head). The estimates since 2016 are still the lowest in the time series. The distribution of herring schools was broadly similar to 2021 except that the distribution was more contracted in smaller areas meaning that biological sampling was difficult. There were some herring marks found to the south of St. Kilda in 2022, but generally less than found historically in this area.

Immature herring were found north west of Tory island, north of Malin Head and west of the Hebrides, but in lower numbers than recent years. Adult herring schools were mainly found in deeper, cooler water to the north west of Tory Island and west of the Outer Hebrides. Most of the herring in Stratum 1 to the north of Scotland were found in the north east of the stratum near the 4°W line.

The Malin Shelf survey estimate was dominated by 2-, 3- and 4- winter ringers, making up 68% of the total abundance and 71% of the total biomass. Immature herring made up 10% of the total biomass.

Sprat distribution was comparable to that in previous years. Abundance and biomass estimates in the North Sea were distinctly higher than in 2021 (44% and 66%, respectively) and also higher than the long-term average of the timeseries (53%). In Div. 3.a,

sprat abundance was estimated at amongst the lowest levels of the time series and again well below the long-term average level in both abundance and biomass. It is likely that the lack of coverage of stratum 131 led to an underestimate of the sprat stock in 2022. Based on the contribution to the total sprat abundance from stratum 131 in 2016 – 2021 the abundance could be underestimated by as much as 13% (average contribution 7% for 2016 – 2021). The estimates derived from the 2022 survey are considered to be robust for all herring stocks and consistent with those in each time series. For sprat the omission of stratum 131 likely resulted in an underestimation of the abundance and biomass in 2022.	
	Description
Survey design	Stratified systematic parallel design with randomised starting point within each stratum.
Index Calculation method	StoX 3.5.2 (via ICES database) is used to provide indices of abundance.
Random/systematic error issues	No specific issues for this survey outside of those described for standardised acoustic surveys.
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	2022: OK Not generally an issue. During severe weather survey effort was paused in most strata until conditions improved.
Extinction (shadowing)	2022: OK Target species not thought to aggregate in dense enough schools to produce extinction effects.
Blind zone	2022: OK

	Target species (herring and sprat) are not found in large quantities close to the surface in most of the area. In strata 11 and 141 surveyed by Norway and the deeper part of the Skagerrak (strata 41 and 152) surveyed by Denmark, smaller aggregations of feeding herring are found high in the water column both night and day. The impact on results in the Skagerrak are partially offset by surveying with acoustic transducers mounted in a towed body at 3-4m depth rather than a drop keel at 5-8m depth. This has been consistent throughout the time series and should not be considered an issue for the indices.
Dead zone	2022: OK Target species (herring and sprat) typically not distributed tight to seabed, and thus not a problem.
Allocation of backscatter to species	2022: OK Species composition verified by directed trawling. Allocation of backscatter to non-target and target species mainly using multifrequency algorithms in LSSS and Echoview as well as based on target-species trawl catch composition. In strata covered by Denmark and Germany, clupeids often aggregate in mixed schools, and a species-specific allocation is not feasible. In these cases, mixed acoustic categories are allocated and disaggregated to species-specific backscatter based on trawl catch composition in split-NASC- modules in the combined StoX-project.
Target strength	2022: OK Standard agreed (TS = 20 log L - 71.2 dB herring and sprat)
Calibration	2022: OK Survey frequencies calibrated during survey according to SISP and results within recommended tolerances.

Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	2022: The northward extension of herring appeared to be largely contained within the survey strata Herring are encountered slightly north of the HERAS survey area in small amounts during other surveys around the same time (IESSNS, NORACU). These are potentially North Sea autumn spawning herring but is assumed not to influence our indices significantly. The extent is evaluated annually by data from the other surveys. In 2022, stratum 131 in the central survey area was not covered. While the effect on NSAS spawning stock biomass and abundance estimates is considered to be insignificant, notable contributions of S131 to the sprat (Subdivision 4) survey estimates have been shown in previous years, and given the similarities in distribution over the time series, it is assumed that the loss of S131 led to an underestimate of the total sprat abundance in 2022. There was good containment of herring within the Malin Shelf area, however there are still concerns about stock identification of herring either side of the 4 degree line border between 6a and 4a.
Stock ID and mixing issues	2022: The results of genetic analysis within the splitting area for NSAS and WBSS (strata 11, 21, 31, 41, 42, 141, 151 and 152) revealed that several other populations that were previously not considered also occur in the survey area. In total, 8 different herring populations have been identified. Aside from the 3 identified with previous methods (NSAS, Downs (included in NSAS indices) and WBSS), the genetic method also identified herring from several adjacent populations in the survey area. In terms of consistency in the calculation of the indices for NSAS and WBSS, individuals were only assigned to either the NSAS or WBSS herring stock following assignment consistent with previously used splitting methods. The indices used for NSAS and WBSS are thus “contaminated” by other stocks and have been so historically. However, we cannot estimate the

	proportions prior to the start of genetic analysis in 2021, or how variable this has been between years. **Malin Shelf (6.a/7.b, c) splitting:** A benchmark for the herring stocks contained in 6.a, 7.b, c was held in 2022 (ICES, 2023). A split index for the survey back to 2014 using results from the EASME project (Farrell et al., 2021) was accepted at the benchmark. Along with the standard Malin Shelf and West of Scotland indices, split indices based on genetic SNPs are also delivered from the MSHAS survey for the following herring stocks: - 6aN; 6aS/7b, c; spring spawning 6a/7b, c; and herring of unknown origin. Methods used to split the MSHAS index using genetics were published in Farrell et al. (2022). The splitting of the herring found on the MSHAS relies on continued maintenance of baseline spawning data from the individual 6.a.N and 6.a.S stocks, but also from other stocks known to be in the MSHAS area during the survey. For instance, there are spring spawning herring and other herring of unknown origin known to be in the MSHAS area during the summer and although these are accounted for in the split index of the MSHAS, there is a lot of uncertainty around the life history of these smaller stocks and how vulnerable they are to fishing or environmental pressures.
Measures of uncertainty (CV)	MSHAS – 0.51 HERAS – n.a.
Biological sampling	2022: OK The number of trawl stations are considered sufficient for the North Sea, Kattegat, and Skagerrak. Herring and sprat were measured and aged at a similar level as the past few years. Recent results from the herring assessment working group indicate that this may not be adequate for older North Sea autumn spawning herring. Discussions are ongoing and work to address this is being planned. It was difficult to obtain biological samples in the Malin Shelf survey area in 2022. Because the stock was so contracted in terms of area compared to recent years, opportunities to sample herring were fewer. Conditions were good on the survey and there was adequate trawling effort, however samples

	were only obtained in the areas where herring were found in high concentrations acoustically. There were samples obtained in all the relevant strata, including genetic sampling which was used for stock splitting a requirement after the 6.a benchmark (ICES, 2023).
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)	*To be answered by Assessment Working Group*
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	*To be answered by Assessment Working Group*

Annex 6: Survey summary and report from the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) 2022

Annex 6 contains a summary table for the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) 2022.

For the full report, please see Supplementary Document 4 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGIPS 2023	
Name of the survey (abbreviation):	International Ecosystem Summer Survey in the Nordic Seas (IESSNS)
Target Species:	NEA mackerel
Survey dates:	1st July – 3rd August 2022
Summary:	
The International Ecosystem Summer Survey in the Nordic Seas (IESSNS) was performed within approximately 5 weeks from July 1st to August 3rd in 2022 using six vessels from Norway (2), Iceland (1), Faroe Islands (79), Greenland (1), and Denmark (1). The survey coverage area included in calculations of the mackerel index was 2.8 million km2 in 2022, which is 25% larger coverage compared to 2021. Survey coverage increased in the western area as northern part of Greenlandic waters (strata 10) was surveyed in again 2022 after not being surveyed in 2021. Furthermore, 0.29 million km2 was surveyed in the North Sea in July 2022 but those stations are excluded from the mackerel index calculations. The total swept-area mackerel index in 2022 was 7.37 million tonnes in biomass and 17.51 billion in numbers, an increase by 43% for biomass and 43% for abundance compared to 2021. In 2022, the most abundant year classes were 2020, 2019, 2010, 2011, respectively. The cohort internal consistency improved compared to last year, particularly for ages 5-8 years. Most of the surveyed mackerel still appears to be in the Norwegian Sea. The mackerel were more westerly distributed than in the last 2 years. Mackerel distribution in the North Sea was similar to 2021, but the biomass decreased 15% compared to 2020. Zero boundaries of the summer distribution of mackerel were found in most parts of the survey area, except towards northwest in the Norwegian Sea, southward boundaries in the North Sea and west of the British Isles. Total number of NSSH recorded during IESSNS 2022 was 25.0 billion and the total biomass index was 7.14 million tonnes, or 22% (abundance) and 17% (biomass) higher than in 2021. The	

2016 year-class 6-year-olds) completely dominated in the stock and contributed to 58% and 56% to the total biomass and total abundance, respectively, whereas the 2013 year-class (9-year-olds) contributed 8% and 7% to the total biomass and total abundance, respectively. The 2016 year-class is fully recruited to the adult stock. Total biomass of blue whiting registered during IESSNS 2022 was 2.2 million tons, which is to the same as in 2021. Estimated stock abundance (ages 1+) was 27.5 billion compared to 26.2 billion in 2021. Age 1 and 2 respectively, dominated the estimate in 2022 as they contributed to 44% and 33% (abundance) and 30% and 33% (biomass), respectively. The group considered the acoustic biomass estimate of blue whiting to be of good quality in the 2022 IESSNS as in the previous survey years. As in previous years, there was overlap in the spatio-temporal distribution of mackerel and herring. This overlap occurred between mackerel and North Sea herring in major parts of the North Sea and partly in the southernmost part of the Norwegian Sea. There were also some overlapping distributions of mackerel and Norwegian spring-spawning herring (NSSH) in the western, north-western and north-eastern part of the Norwegian Sea.	

	Description
Survey design	Swept-area systematic trawl survey with a random starting point and fixed spacing between stations in each stratum. In 2022, there were six permanent and three dynamic strata. Each stratum has a random starting point and fixed spacing between stations. Permanent strata are constant between years and cover the core mackerel distribution area in the Norwegian Sea and in the Icelandic EEZ. The dynamic zones are located at westward and northward edge of the Norwegian Sea (stratum 9), and southern edges of strata west and south of Iceland (strata 5 and 6). Effort varies between strata and ranged from 35 nm to 70 nm in 2022. Effort was reduced in large part of the Norwegian Sea and west of Iceland in 2022 compared to previous years as distance between stations was increased to 70 nm in strata 2, 5, 7, and 9. A combination of spatial variance in mackerel abundance, in years 2010-2014, and available survey time determines effort. Effort increases as spatial variability in abundance increases.
Index Calculation method	Age-segregated swept-area trawl index is calculated using stratified approach. StoX v. 3.5.0. All input data to StoX extracted from the ICES acoustic database.
Random/systematic error issues	N/A
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are*

	evaluated:
Bubble sweep down	Some problems due to bad weather for acoustic recordings a few days during first part of the survey in the southern part of the Norwegian Sea, but in general favourable conditions for acoustic recordings during the IESSNS 2022
Extinction (shadowing)	N/A
Blind zone	Upper 8-12 m not covered by acoustics. No attempts made to correct for loss of herring in the blind zone.
Dead zone	N/A
Allocation of backscatter to species	Only allocated backscatter identified as herring or blue whiting using standard TS for herring and blue whiting.
Target strength	Blue whiting: TS = 20 log(L) – 65.2 dB (ICES 2012) Herring: TS = 20.0 log(L) – 71.9 dB
Calibration	OK
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	Considered to have covered the adult spawning stock adequately, with exception of northernmost area and areas west and southwest of the British Isles from 60°N and below.
Stock ID and mixing issues	N/A for mackerel Yes for NSS herring (adults): Concern of similar mixing issues as for the IESNS in May, with uncertainty whether the Icelandic summer-spawning herring southeast of Iceland and the autumn-spawning herring types (e.g. North Sea herring) in the southeast (north of Shetland).
Measures of uncertainty (CV)	The estimated survey uncertainty for the main age groups in the estimate was high in 2022, from 0.1 to 0.4
Biological sampling	Sampling levels were considered representative.
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)	*To be answered by Assessment Working Group*

Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	*To be answered by Assessment Working Group*

Annex 7: Survey summary and report from the German Acoustic Autumn Survey (GERAS) 2022

Annex 7 contains a summary table for the German Acoustic Autumn Survey (GERAS) 2022.

For the full report, please see Supplementary Document 5 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGIPS 2023	
Name of the survey (abbreviation):	GERAS/BIAS (GER, FRV "Solea" SB812)
Target Species:	Herring (*Clupea harengus*, Western Baltic Spring Spawning Herring WBSSH; Central Baltic Herring CBH), Sprat (*Sprattus sprattus*), Anchovy (*Engraulis encrasicolus*), Sardine (*Sardina pilchardus*)
Survey dates:	5 October – 24 October 2022
Summary:	
The objectives of the survey were carried out successfully and as planned in all of the covered ICES Subdivisions. Altogether, 1208 nautical miles of hydroacoustic transects (plus 175 nmi daytime/repeat transects for comparison) were covered. For species allocation and identification as well as to collect biological data for an age stratified abundance estimation of the target species herring and sprat, altogether 49 fishery hauls were conducted. Vertical hydrography profiles were measured on 74 stations. In all subdivisions covered, mean NASC values per nautical mile per ICES statistical rectangle were mostly either distinctly lower or distinctly higher than the values measured in 2021. Compared to the long-time survey mean since 1991, mean NASC values were lower in 21 out of 28 rectangles covered. On ICES subdivision scale, mean NASC values were overall distinctly higher than in the previous year in subdivisions 21 and 22, while in SD 23 and 24 lower mean NASC values were recorded. After excluding the Central Baltic Herring fraction from the estimates via the Separation Function, the present Western Spring Spawning Herring biomass estimate in 2022	

showed a significant increase from the lowest recorded value in the time series in 2021. This trend, however, was strongly driven by the large increase of 0-group herring.

	Description
Survey design	Stratified systematic (parallel where applicable) design. Start point not randomized. ICES statistical rectangles used as strata for all ICES subdivisions
Index Calculation method	GERIBAS II Software. Index based on mean NASC per ICES statistical rectangle.
Random/systematic error issues	Survey design and transects restricted by area topography. No fully systematic coverage of survey area possible. Indications of large herring aggregations outside the surveyed transects/time period are regularly registered.
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	2022: OK Bubble sweep down due to adverse weather conditions occurred and required short interruption of survey operations (SD 21). Due to the continuation of the survey in improved conditions, this is not considered to affect integration results.
Extinction (shadowing)	2022: OK No particular issues as targets are scattered in loose aggregations in most of the surveyed areas during the night-time survey operations.
Blind zone	Due to the night-time distribution of clupeids also in surface layers, registrations of clupeids occur in the blind zone but are not quantified (integration start depth 10 m). In some parts of

	the survey area, the blind zone exclusion exceeds more than half of the total water column.
Dead zone	2022: OK No particular issue as clupeids are mostly distributed pelagically and away from seafloor during night-time survey operations.
Allocation of backscatter to species	2022: OK Directed trawling. Mixed species category applied throughout survey. Species allocations and splitting of NASC values based on combined trawl haul composition per ICES statistical rectangle.
Target strength	Clupeids: TS = 20 log10 (L) - 71.2 Gadids: TS = 20 log10 (L) - 67.5 Mackerel: TS = 20 log10 (L) – 84.9 see SISP Survey manual (ICES, 2017). Clupeid TS allocated to other species included in analysis (see above).
Calibration	2022: OK All survey frequencies calibrated and results within recommended tolerances (Demer et al., 2015).
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	Time series: It is assumed that WBSSH (primary target species) is contained within the survey area. An unquantified but assumedly low degree of mixing of WBSSH and CBH (Central Baltic Herring) can occur outside of the survey area (east of SD 24). Due to transects often determined by topography/bathymetry, aggregations of WBSSH in shallower areas not sampled by the

	survey may have been missed. 2022 survey: Full coverage of the survey area
Stock ID and mixing issues	Time series: WBSSH and CBH mix at varying degrees in different parts of the survey area (especially in SD 24). Separation of stocks is achieved through application of an age-growth based stock separation function (SF) (Gröhsler et al. 2013). 2022 survey: The application of the Separation Function (SF) to remove CBH from the index calculation in SD 24 yielded robust results. The majority of WBSSH could be allocated to the corresponding stock using the SF established with parameters from 2005-2010 (Gröhsler & Schaber, 2022 WD WGIPS). Mean weights of different age groups that prior to removal showed somewhat untypical growth pattern for WBSSH became distinctly more realistic for older age groups after removing the CBH fraction. Haul 33 (41G2, SD 23) targeting a large aggregation of herring yielded a substantial sample of almost exclusively large, old herring that were had already finished spawning. Spawning herring (maturity 6) of the same size range had been sampled at the same location in 2021 and had genetically been identified as North Sea autumn spawners (NSAS). Genetic analyses of the 2022 samples are ongoing, but it was assumed that the aggregation again consisted of NSAS herring. Indices of abundance and biomass for WBSSH were derived including and excluding acoustic and biological data from this presumed NSAS fraction.
Measures of uncertainty (CV)	n.a.
Biological sampling	Time series: Based on survey design restrictions, comprehensive sampling is not feasible in all statistical rectangles surveyed. Biological information from neighbouring rectangles is used for generating estimates in these cases. This mostly applies to rectangles

	with low abundance. 2022 survey: Biological information for ICES statistical rectangles 41G2, 43G2 (SD 21) and 38G0, 39F9, 39G1 (SD 22) used/amended from neighbouring rectangles.
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)	*To be answered by Assessment Working Group*
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	*To be answered by Assessment Working Group*

Annex 8: Survey summary and report from the Irish Sea Acoustic Survey (ISAS) 2022

Annex 8 contains a summary table for the Irish Sea Acoustic Survey (ISAS) 2022.

For the full report, please see Supplementary Document 6 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGIPS 2023	
Name of the survey (abbreviation):	**Irish Sea Acoustic Survey (ISAS)**
Target Species:	**Herring**
Survey dates:	**27th August – 12th September 2022**
Summary:	
The vessel departed Belfast at 22:00 on the 25th August and proceeded to the east coast of the Isle of Man for acoustic calibration off Laxey on the 26th August. The survey started on the peripheral Irish Sea transects to the west of the Solway Firth at 05:15 on the 27th August and continued to the completion of transect 102 North of Anglsey on the 30th August. From here, the ship made way to the northeast of the Isle of Man and recommencing the survey at the start of transect 1 on the 30th August at 11:15 and ended on transect 81 to the northwest of the Mull of Galloway 02nd Sept. The survey recommenced on the morning of 03rd Sept at 05:00 on the western Irish Sea peripheral transects working south along the Northern Ireland coast, a discrete set of additional survey transecst in the vicinity of Rig Bank was conducted on 03rd Sept. The final set of transects for the first phase of the survey ended on transect 101 on 07th Sept and a further set of transects around the Isle of Man were undertaken. Sea conditions were calm throughout the duration of the survey. Herring was fairly widely distributed within mixed schools at low abundance throughout the Irish Sea area, and within fewer localised high abundance schools. The bulk of 1+ herring targets in 2022 were observed west of the Isle of Man and off the Eastern Northern Irish coast. Cohorts, ages 0 -9 are visible within the survey. The major contribution of age to the total estimates in the 2022 survey is from age 2 accounting for 47.5% of total estimates by number.	

	Description
Survey design	The survey design of systematic, parallel transects covers approximately 620 nm. The position of the set of widely-spaced (8-10 nm) transects around the periphery of the Irish Sea is randomized within +/- 4 nm of a baseline position each year and

	transect spacing is reduced to 2 nm in strata around the Isle of Man to improve precision of estimates of adult herring biomass. Survey design and methodology adheres to the methods laid out in the WGIPS acoustic survey manual.
Index Calculation method	Weighted mean TS is applied to the NASC value to give numbers per square nautical mile – further decomposed by age class according to length frequencies in relevant target identified trawls and survey age-length key.
Random/systematic error issues	NA
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	Sea conditions were very favourable throughout the duration of the survey; negating potential for sweep down.
Extinction (shadowing)	No perceived issues. Majority of target schools in mid to lower water column. For schools on or just above sea bed, negligible affects discerned.
Blind zone	Sub surface zone of 8 m applied. Majority of target schools in survey within mid to lower water column.
Dead zone	NA
Allocation of backscatter to species	Directed trawling, with 32 successful trawls completed during the course of this survey.
Target strength	Herring, sprat and horse mackerel: TS = 20log(L) -71.2 db Mackerel: TS = 20log(L) -84.9 db Gadoids: TS = 20log(L) -67.5 db
Calibration	The hull mounted Simrad EK60 acoustic system with 38 kHz split-beam was calibrated on the 26th August off Laxey on the east coast of the Isle of Man. Conditions were good and results within parameters.
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	Time series: Complete coverage 2022 survey: Complete coverage
Stock ID and mixing issues	Time series: Winter hatched fish, of which the majority are thought to be of Celtic Sea origin, are preent in the pre-spawning aggregations sampled in the Irish Sea during the acoustic survey. The presence of these winter hatched fish has

	implications for the estimates of 1-ringer+ biomass and SSB 2022 survey: No additional issues
Measures of uncertainty (CV)	CV of biomass and numbers at age
Biological sampling	2022 Survey: The biological sampling is deamed to be appropriate for the stock and area. Sampling is in line with historic levels. Biological samples are not available at the time of WGIPS to update biological data. Ages (age-length-key) and maturity data for 2021 are used for initial biomass estimates and population age structure.

Annex 9: Survey summary and report from the Irish Sea Acoustic Spawning Survey (ISSS) 2022

Annex 9 contains a summary table for the Irish Sea Acoustic Spawning Survey (ISSS) 2022.

For the full report, please see Supplementary Document 7 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGIPS 2023	
Name of the survey (abbreviation):	**Irish Sea Acoustic Spawning Survey (ISSS)**
Target Species:	**Herring**
Survey dates:	**10th October – 12th October 2022**
Summary:	
The Irish Sea Acoustic Spawning Survey (ISSS) 2022 was conducted on the FV Haviliah. The survey started on the Isle of Man grid at the start of transect 1 on 10th October and continued through to the end of transect 82 on the 12th October 2022. Sea conditions were variable during the survey, yet, no weather induced down time was recorded. Targets were identified by aimed midwater trawls, 1 successful tow was completed in 2022, which is consistent with fishing intensity for survey over time series, providing confidence in school recognition and supporting biological data for age stratified abundance estimation of target species (herring). High abundance schools of Herring were locally distributed. The bulk of 1+ herring targets in 2022 were observed east of the Isle of Man and also along the southwestern coast of the Isle of Man. Cohorts, ages 0 -9 are visible within the survey. The major contribution of age to the total estimates in the 2022 survey is from age 2 grp, accounting for 33.5% of total estimates by number. It is perceived that the pervelance of 1 and 2 year old emerging year classes (~6.5% age 1, 19% age 2) will continue to recruit to the SSB over the next 1-2 years.	
	Description

Survey design	The survey design of systematic, parallel transects covers approximately 620 nm. The position of the set of transect with spacing is reduced to 2 nm in strata around the Isle of Man. Survey design and methodology adheres to the repeats the methods laid out in the WGIPS acoustic survey manual.
Index Calculation method	Weighted mean TS is applied to the NASC value to give numbers per square nautical mile – further decomposed by age class according to length frequencies in relevant target identified trawls and survey age-length key.
Random/systematic error issues	NA
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	Sea conditions were variable during the survey; no weather induced down time was recorded.
Extinction (shadowing)	No perceived issues. Majority of target schools in mid to lower water column. For schools on or just above seabed, negligible affects discerned.
Blind zone	Sub surface zone of 8 m applied. Majority of target schools in survey within mid to lower water column.
Dead zone	NA
Allocation of backscatter to species	One dedicated trawl was conducted.
Target strength	Herring, sprat and horse mackerel: TS = 20log(L) -71.2 db Mackerel: TS = 20log(L) -84.9 db Gadoids: TS = 20log(L) -67.5 db
Calibration	The hull mounted Simrad EK60 acoustic system with 38 kHz split-beam was calibrated on the 09th October in Laxey bay off the Isle of Man. Conditions were good and the calibration results satisfactory. All procedures were according to those defined in the survey manual.
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*

Stock containment	Time series: The survey is focused on spawning aggregations with 75% coverage of main ISAS. 2022 survey: As in previous years, complete coverage.
Stock ID and mixing issues	Time series: Designed to generate an SSB index constituted from herring on or around the Irish Sea spawning ground to reduced stock mixing issues. 2022 survey: No additional issues
Measures of uncertainty (CV)	CV of biomass and numbers at age
Biological sampling	2022 Survey: The biological sampling uses biological sampling for the main Irish Sea acoustics survey and is deemed to be appropriate for the stock and area. The sampling levels are in line with historic levels. Biological samples are not available at the time of WGIPS to update biological data. Ages (age-length-key) and maturity data for 2021 are used for initial biomass estimates and population age structure.

Annex 10: Survey summary and report from the Celtic Sea Herring Acoustic Survey (CSHAS) 2022

Annex 10 contains a summary table for the Celtic Sea Herring Acoustic Survey (CSHAS) 2022.

For the full report, please see Supplementary Document 8 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGIPS 2022	
Name of the survey (abbreviation):	Celtic Sea Herring Acoustic Survey (CSHAS) 2022
Target Species:	Herring (7aS, 7g-j) and sprat (7aS, 7g-j)
Survey dates:	09 October – 29 October, 2022
Summary:	**Cruise Report Link:** pending

The primary objectives of the survey were carried out but with notable area coverage and sampling comprimises. Poor weather conditions stopped survey operations for approximately 12 hrs and a further 72 hrs was lost due to requirements of our new RV to be ashore for a state visit. Overall, geographical coverage was redcued when compared to 2021 (-21%) and acoustic sampling effort or survey miles also decreased (-28%). Core replicate surveys (Pass 1 & 2) were completed, but with reduced area coverage. Adaptive survey effort was reduced to allow for prioritisation of core effort strata. One adaptive inshore survey was undertaken along the south coast and another in Dingle Bay. Mature fish were observed offshore in a discreet location and were sampled within the core effort stratum. Immature herring (0-wr) were well represented in the wider survey area, albeit in low numbers, as part of mixed species aggregations dominated by sprat. The age profile of mature herring sampled during the survey were representative of those in landings data and from observations during the summer WESPAS survey (2022).

The 2022 TSB estimate (Pass 2: core stratum) is 12,533 t and 113 million individuals (CV 1.24) and an increase on the 2021 estimate. The very high CV is accounted for by the single high density aggregation that made up the Pass 2estimate. Age composition was dominated by 3-wr, followed by 4-wr, 5-wr and immature 0-wr fish by weight. The dominant 3-wr fish contributed 52.2% to the TSB and 50.6%, followed by 4-wr fish (40.5% TSB & 34.5% TSN), then 5-wr fish (3.8% TSB & 3.0% TSN) and 0-wr fish (1.1% TSB & 10% TSN). Mature fish (2-7-wr fish) represented 98.9% of TSB and 90% of TSN.

The biomass of sprat was higher than observed in 2021 with a more widespread distribution than observed n either 2020 or 2021 (centred inshore). The 2022 TSB estimate (Pass 1) represented a total biomass of 34,508.4 t and a total abundance of 5,235,755 (‘000s) individuals (CV 0.67).

	Description

Survey design	Stratified systematic parallel design with randomised starting point within each stratum. Replicate core surveys and adaptive survey effort. Survey estimate is generated from a single core effort strata.
Index Calculation method	StoX 3.6.0 (RStox Framework 3.6.0, RStoX Base 1.11.0, RStoX Data 1.8.0) is used to calculate abundance and biomass.
Random/systematic error issues	The mature component of the stock tend to form low numbers of highly aggregated schools offshore. The potential to miss such aggregations with a coarse transects spacing is high. Lareg area coverage and low number so identified schools results in high variance and CV. Behaviour of offshore aggregations (bottom carpeting) also provides significant challenges for quantitative assesement using acoustic techniques.
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	*12 hrs lost due to poor weather and surveying stopped when conditions deteriorated*
Extinction (shadowing)	*NA*
Blind zone	*NA*
Dead zone	*On-going issues with high desnity herring aggregations within <0.5m of the seabed in the Acoustic deadzone*
Allocation of backscat-ter to species	*Directed trawling for verification purposes*
Target strength	*Recommended values for target species:* *Herring TS = 20log10(L) – 71.2 (38 kHz)* *Sprat TS = 20log10(L) – 71.2 (38 kHz)*
Calibration	*All survey frequencies calibrated and results within recommended toler-ances*
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	It's believed that the bulk of the stock was contained during the survey. However, interplay with the Irish sea can not be ruled out and has yet to be determined. For sprat, stock containment is not possible due to large geographical extent the stock.
Stock ID and mixing issues	NA
Measures of uncertain-ty (CV)	Herring: Pass 1: TSB 1,404.9 t (CV abundance: 0.70) Pass 2: 12,533 t (CV abundance: 1.24). Calculation carried out using StoX (V3.5) and R-StoX (V1.11)

Biological sampling	Comprehensive directed trawling carried out on available schools.
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)	*To be answered by Assessment Working Group*
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	*To be answered by Assessment Working Group*

Annex 11: Survey summary and report from the Western European Shelf Pelagic Acoustic Survey (WESPAS) 2022

Annex 11 contains a summary table for the Western European Shelf Pelagic Acoustic Survey (WESPAS) 2022.

For the full report, please see Supplementary Document 9 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGACEGG 2022	
Name of the survey (abbreviation):	WESPAS / MSHAS (IRL)
Target Species:	Herring, boarfish, horse mackerel
Survey dates:	17 June – 22 July, 2022
Summary:	**Cruise Report Link:** http://hdl.handle.net/10793/1806

The objectives of the survey were carried out as planned but with reduced sampling effort compared to 2021, due to poor weather conditions and vessel issues. Survey coverage (area) and acoustic sampling (transect miles) were reduced (-17% and -10% respectively) compared to 2021. The number of trawls carried out (n=40) was comparable to previous years, although lower than the high point of 2021 (n=65).

Boarfish distribution was similar to previous years. Total stock biomass (TSB) was 2% higher than observed in 2021, while TSN was 15% lower. The decrease in abundance was largely driven by the low numbers of immature fish observed in the Celtic Sea as compared to 2021, an above average year for immature fish. Spawning stock biomass (SSB) increased by 26% compared to last year, and can be attributed to recruitment of young fish from strong 2020 and 2021 year classes to the spawning stock. Of the six survey strata, all but one saw an increase in biomass compared to 2021. The Celtic Sea saw a decrease of 16% in observed biomass. Reports from the PEL-GAS survey indicate increased numbers of boarfish in the mid and northern Bay of Biscay, indicating the stock was not fully contained on the southern boundary. The 3-year age class dominated the 2022 estimate contributing over 32% of TSB and 40.5% of TSN. Ranked second and third were the 4-year old and 2-year old fish (27.2% TSB & 22.9% TSN and 9.3% TSB & 17.4% TSN respectively). Combined these three age classes represented 68.6% of TSB and 80.7% of TSN. The 15+ age class, once dominant in the survey time series, represented 3% of TSB and 0.8% of TSN. Maturity analysis of boarfish indicated 94.9% of observed biomass was mature (98.1% total abundance). Immature fish were under represented during the 2022 survey.

Aggregations of Celtic Sea herring were encountered around the Labadie Bank and composed of several high density aggregations. Four winter ring fish dominated the total estimate, representing 32.2% of TSB and 35.4% of total abundance. Five winter ring fish ranked second contributing 31.8% and 31.2% respectively. Ranked third were 6 winter ring fish (16.1% TSB & 14.6% TSN). In terms of age structure, the survey has tracked the strong 2018-year class successfully into 2022. Maturity analysis of Celtic Sea herring samples indicated 100% of fish sampled were mature.

Horse mackerel were found distributed along the Irish west coast and Celtic Sea. Geographical distribution was comparable to previous years. However, the number of echotraces and acoustic density remains low. The 2022 estimate was 21% lower in terms of biomass and 22% lower in terms of abundance compared to 2021. The 2022 estimate is the lowest in the current time series and the downward trend within the survey continues. No monospecific echotraces of horse mackerel were observed during the survey and biological samples were taken as part of mixed species by-catch. Aging was applied using survey sampes this year and will continue going forward. The 8-year-old fish dominated the estimate representing 36.9% of TSB and 36.3% of TSN. Fourteen -year-old fish ranked second (7.6% of TSB and 7.8% of TSN) and 5-year-old fish ranked third (5.5% to TSB & 7.6% TSN), Combined these three age classes represented 56.8% of TSB and 56% of TSN. All individuals were mature.

The same vessel and sampling equipment (transducers and trawl) were used.

	Description
Survey design	Stratified systematic parallel design with randomised starting point within each stratum. Zig-zag transects in the Minch strata.
Index Calculation method	StoX (V3.5.0and RStoX 1.10.0) Data uploaded to the ICES Trawl acoustic portal
Random/systematic error issues	NA, outside of those already described in literature for standardised acoustic surveys
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	Poor weather was an issue during the survey. Transducer placement is 8.8m below the sea surface (drop keel), combined with the near-field exclusion, data integration takes place below 12m
Extinction (shadowing)	Yes, in some areas in the southwest Celtic Sea and northwest IRL/SCO
Blind zone	Aggregations of immature boarfish tend to be located above the thermocline in near surface waters and so it is likely that an unknown proportion was unaccounted for in the estimate
Dead zone	Some shelf slope areas
Allocation of backscatter to species	Directed trawling for verification purposes
Target strength	Herring TS = 20log10(L) – 71.2 (38 kHz) Boarfish TS = 20log10(L) – 66.2 (38 kHz) Horse Mackerel TS = 20log10(L) – 67.5 (38 kHz)

Calibration	All survey frequencies calibrated and results within recommended tolerances (RMS <0.4)
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	Herring (Celtic Sea); Yes Boarfish and horse mackerel; Good geographical alignment on the southern boundary (Fra: PELGAS) No survey coverage in the western Channel area.
Stock ID and mixing issues	Herring (Celtic Sea); Potential mixing with unidientified stocks on the feeding grounds. Genetic sampling underway.
Measures of uncertainty (CV)	*CV on abundance* Boarfish: 0.24 Horse mackerel: 0.40 Herring (Celtic Sea): 0.91 Herring (Malin Shelf): 0.43 *Calculation carried out using StoX (V3.5.0) and R-StoX (V1.10.0)
Biological sampling	Good sampling carried out for boarfish and herring (Celtic Sea & Malin Shelf). Poor sampling of horse mackerel (by-catch only).
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)	*To be answered by Assessment Working Group*
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	*To be answered by Assessment Working Group*

Annex 12: Survey summary and report from the Pelagic Ecosystem Survey in the Western Channel and eastern Celtic Sea (PELTIC) 2022

Annex 12 contains a summary table for the Pelagic Ecosystem Survey in the Western Channel and eastern Celtic Sea (PELTIC) 2022.

For the full report, please see Supplementary Document 10 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGIPS 2023	
Name of the survey (abbreviation):	PELTIC
Target Species:	Sprat, Sardine (ICES HAWG and WGHANSA)
Survey dates:	16– 28th October, 2022
Summary:	**Survey Report Link:**
Significant issues, including catastrophic engine failure, reduced the survey from its scheduled 35 days to 13. As a result survey coverage (area) was reduced to less than 30% compared to 2021. The number of trawls carried out (n=12) was lower than planned and (further) compromised because of technical, safety and staffing issues. While this is not thought to have affected the species ID of the acoustic targets significantly, length and age information should be used with caution. Area covered corresponds to "Western Channel" stratum used in sprat in 7de stock assessment. Incomplete coverage of the strata used in the sardine stock assessment in area 7. The same vessel and sampling equipment (transducers and trawl) were used.	

	Description
Survey design	Systematic parallel design. Adjusted from historic design following significant reduction in available survey time. Primary focus was western Channel stratum.
Index Calculation method	StoX (V3.5.0and RStoX 1.10.0) Data uploaded to the ICES Trawl acoustic portal
Random/systematic error issues	NA, outside of those already described in literature for standardised acoustic surveys

Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	Transects surveyed during poorest of weather were repeated and bubble sweepdown is not thought to be a major issue.
Extinction (shadowing)	Not dealt with as generally schools not too dense to be an issue
Blind zone	Transducer placement is 8.8m below the sea surface (drop keel), combined with the near-field exclusion, data integration takes place below 12m. Daytime surveying only to avoid effects of DVM. Perception of increase in (shallow) surface feeding birds during the survey which appeared to be targeted small sprat; may suggest undersampling although unquantified.
Dead zone	1m –possible issues with horse mackerel; other species thought to be above 1m
Allocation of backscatter to species	Backscatter allocated to several echotypes, which is further partitioned by the acoustic equivalent of the directed trawl catch composition (Doray et al., 2022)
Target strength	@ 38kHz: Herring, sprat, sardine and anchovy: -71.2; boarfish = -66.2; horse mackerel = -68.9; gadoids = -67.4 @200 kHz: mackerel = -81.9 (under review)
Calibration	All survey frequencies calibrated at start of the survey and results of key frequencies within recommended tolerances (RMS <0.4)
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	Sprat in 7de; Yes, the area used in the assessment was covered well. Sardine in 7: No, most important area covered but whole of historic PELTIC survey areas is assessed to be important for sardine.
Stock ID and mixing issues	Sprat in 7de: population and stock structure still very much unknown despite ongoing genetic (and other) studies Sardine in 7: population structure still unknown
Measures of uncertainty (CV)	*CV on abundance* Sprat: 0.29 Sardine: 0.26
Biological sampling	Moderate to poor trawl sampling (qualitatively quantitatively) for both species although less of an issue for sprat.
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please	*To be answered by Assessment Working Group*

specify)	
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	*To be answered by Assessment Working Group*

Annex 13: Survey summaries and report from herring acoustic industry surveys in 6aN and 6aS/7b,c (6aSPAWN) 2022

Annex 13 contains summary tables for the herring acoustic industry surveys in 6aN and 6aS/7b,c (6aSPAWN) 2022.

For the full report, please see Supplementary Document 11 at https://doi.org/10.17895/ices.pub.23607303

Survey Summary table WGIPS 2023	
Name of the survey (abbreviation):	6aN industry survey (6aSPAWN)
Target Species:	Herring
Survey dates:	12th-19th September (FV Resolute).
Summary:	

2022 was the seventh industry-led surveys of herring in 6a.7bc. This summary refers to the survey in 6aN only, since from 2022 onward surveys in 6aN and 6aS7bc will be reported separately.

The aim of the survey is to maintain and improve the knowledge base of the genetic identity of herring stock components in 6aN and provide an age-disaggregated acoustic abundance index that may be used by ICES to assist in assessing the herring stocks and establishing a rebuilding plan.

One Scottish vessel equipped with a hull mounted calibrated 38KhZ Simrad EK80 echosounder was deployed for 8 days. Unexpected maintenance needs due to mechanical issues delayed the start date by 1 week and cut the duration by 3 days. Weather was fair-good throughout the survey and the vessel provided a stable platform for data recording. Following the guidance arising from WKHASS, the survey again focussed on two principal spawning areas, with timing planned to coincide with the known spawning period. Marks of sprat were abundant throughout the area in larger schools than seen since 2016. Norway pout were present throughout the area also. Only one herring mark was detected and verified during the survey period. The mark was caught opportunistically during a trawl directed at other marks. It contained spawning herring, which were sampled for genetics. A few 0-group herring were found mixed with sprat from one haul and were measured and sampled for genetics.

Despite concerted searching, efforts to obtain a commercial catch of 6aN herring as payment for the survey was unsuccessful, so no commercial sample is available for use in assessment.

	Description
Survey design	Two strata centred on known spawning areas. Stratified systematic parallel design (2 nmi spacing) with randomised start point. One vessel surveyed each strata over 10 days. Strata 1 was surveyed twice.
Index Calculation method	StoX (via the ICES acoustic database)
Random/systematic error issues	NA, outside of those already described in literature for standardised acoustic surveys
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	No issue. Weather conditions fair-good.
Extinction (shadowing)	No ocurrences recorded. Can occur with spawning aggregations, but no issues in 2022. Dense schools on rocky outcroppings can be subject to side lobes, but these were not classified as herring.
Blind zone	Surface exclusion 7-9m applied. Not a problem for herring schools that are found at significant depth, mostly near bottom. Some sprat schools will be partly excluded but these are not quantified in this survey anyway.
Dead zone	One dense herring school tight to the bottom making exact delineation more difficult, but any schools are scrutinized in detail to resolve any such issues.
Allocation of backscatter to species	Directed trawling for verification and species composition purposes and age structure. Near -absence of herring marks combined with two biological samples means inference of herring abundnance over the strata is not advisable in 2022.
Target strength	TS = 20log10(L) – 71.2 (38 kHz)
Calibration	38kHz calibrated in Scapa flow (April 2022). Delays caused by mechanical issues prior to the survey meant a previous calibration was used.
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	Following the guidance arising from WKHASS, the survey area focussed on two principal spawning areas, with timing planned to coincide with the known spawning period.
Stock ID and mixing issues	No issues – the survey is conducted at times and in areas when stocks are expected to be geographically separated, but genetic samples were taken to investigate this.
Measures of uncertainty (CV)	A stox project is available, but an abundance estimate is not appropriate and therefore not reported due to the near-abcence of herring in 2022.

Biological sampling	Biological data to allocate to acoustic marks identified as herring was satisfactory unsatisfactory for strata 1 and strata 2. Sufficient trawl stations were conducted but herring were not available to be sampled.
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)	*To be answered by Assessment Working Group*
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	*To be answered by Assessment Working Group*

Survey Summary table WGIPS 2023	
Name of the survey (abbreviation):	6aS/7b,c herring industry survey - 6aSPAWN (6aS)
Target Species:	Herring
Survey dates:	2nd Dec (Ros Ard), 3rd Dec (Girl Kate), 16th Dec (K-Mar-K), 17th Dec (Rachel D) 2021 and 11th January 2022 (Crystal Dawn)
Summary: **6aS/7b,c Cruise Report Link:** http://hdl.handle.net/10793/1742	

An acoustic survey of herring was conducted in 6aS/7b,c in December 2021 and January 2022. The survey was conducted using five vessels: MFVs Crystal Dawn WD201, Ros Ard SO745, K-Mar-K SO965, Rachel D SO976, and Girl Kate SO427. The survey design was similar to 2020 in that only core areas with prior knowledge of herring distribution from the monitoring fishery were targeted for surveying. Approximately 300nmi of transects were completed using 102 transects. This resulted in a total area coverage of approximately 65.04 nmi², similar to 2020 (66.26 nmi²), but a significant reduction compared to previous survey (2016 – 2019). A pole-mounted system with a combi 38 kHz (split) 200 kHz (single) transducer was used successfully for the survey in 2021. Herring were again distributed inshore, and the improved survey design and use of small vessels for the survey resulted in a good measure of uncertainty (CV = 0.23). Very strong herring marks were evident in Lough Foyle and Lough Swilly in the channel in marks that extended for many miles. There was also a series of strong herring marks in Bruckless Bay, Fintra Bay (Inishduff) and Inver Bay in discreet areas. A replicate survey was completed in Lough Foyle in January 2022, but herring had largely migrated out of the Foyle at this time, therefore this survey was not included. The monitoring fishery was being conducted on smaller boats in the same areas and close to the same time as the survey and biological samples from some of these vessels were used. There was a good spread of length classes in all hauls, with most hauls dominated by larger (> 22 cm) mature fish. The 2- and 3-wr age class of herring accounted for 74% of the overall numbers in 2020, but the 3-wr fish were dominant overall (56%). The total stock biomass (TSB) estimate of 35,944 tonnes is considered to be a minimum estimate of herring in the 6aS/7b survey area at the time of the survey; all areas were not covered in 2021, and therefore the stock was not overall contained in the wider 6aS/7b survey area. The flexible survey design and focusing on discreet areas was generally successful.

	Description
Survey design	Stratified systematic parallel design (~1 nmi spacing) with randomised start point. High intensity zig/zag transects in Lough Swilly and Lough Foyle
Index Calculation method	StoX (via the ICES acoustic database)
Random/systematic error issues	NA, outside of those already described in literature for standardised acoustic surveys
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	6aS – not an issue with the pole mounted system used in 2021/22
Extinction (shadowing)	6aS – there was evidence of hyper-aggregating schools in all areas in 2021/22
Blind zone	6aS - Surface exclusion 3m applied – herring schools generally below this depth
Dead zone	Dense herring schools tight to the bottom in a few places making delineation more difficult, but detailed school by school scrutiny and checking to resolve any issues.

Allocation of backscatter to species	Samples used from the monitoring fishery taking place at same time and in same areas as the survey
Target strength	TS = 20log10(L) – 71.2 (38 kHz)
Calibration	38kHz calibrated on 27/10/2021 at Black Head
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	The stock was not considered to be overall contained by this survey design, particularly in the Donegal Bay area (Bruckless, Inver Bays, etc.) and more effort is required to contain the stock by targeting effort earlier and later than the survey timing in 2021. Herring appear to show up in these areas in large schools, are targeted by the monitoring fishery, and then leave these areas after spawning. There is anecdotal evidence that more herring also enter these bays prior to spawning later making containment difficult due to different waves of herring entering and leaving these inshore areas. However, the stock was most likely contained inshore on the days the core areas were covered by using smaller vessels in 2021. The surveys provide a snapshot of what is there at the time. Inshore areas were a problem in previous years, particularly 2016-2018, when it proved difficult to survey inshore when larger vessels were used for this survey. The stock appears to have been largely contained by the survey design in these core strata areas, an improvement on earlier years. There is a concern regarding containment inshore in areas not covered by the survey and particularly the Malin Beg, and West Donegal areas. It would have been preferable if surveys were completed in these areas both before and after December in 2021. Ongoing COVID-19 restrictions made surveys difficult to complete in 2021/22.
Stock ID and mixing issues	No issues –survey is conducted at times and in areas when both 6aN and 6aS stocks are expected to be geographically separated.
Measures of uncertainty (CV)	CV estimate on abundance estimate for the survey was 0.23, an improvement on the 2020 estimate of 0.34. Per strata, the CV estimate was relatively high for the Bruckless and Fintra/Teelin strata, and this had an adverse effect on the overall CV for the survey. These areas were dominated by large hyper-aggregating schools of herring. The CV on the estimates of abundance was within expected values for an acoustic survey.
Biological sampling	Biological data used from the monitoring fishery to allocate to acoustic marks identified as herring was satisfactory in 2021/22.
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for in-	*To be answered by Assessment Working Group*

dividual years? (please specify)	
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	*To be answered by Assessment Working Group*

Annex 14: Survey Plans for WGIPS coordinated surveys in 2023

1 International Blue Whiting Spawning Stock Survey (IBWSS)

Five vessels representing the Faroe Islands, the Netherlands (EU), Ireland (EU), Norway and Spain (EU) are scheduled to participate in the 2023 blue whiting spawning stock survey (Table A14.1.1).

Survey timing and design were discussed during the 2022 IBWSS post-cruise and 2023 WGIPS meetings. The group decided that in 2023, the survey design should follow the principle of the one used during the last surveys. The zig-zag design in stratum 2 will also be continued and the focus will still be on a good coverage of the shelf slope in survey areas 2 and 3 (Figure A14.1.1)

The design is based on variable transect spacing, ranging from 30 nm in areas containing less dense aggregation (area 5), to 15-20 nm in the core survey area (area 1-4 and 6) (Figure A14.1.1). The western borders of the transects in area 3 are set to 12°W in order to cover potential blue whiting aggregations extending further from the continental slope into the Rockall Trough. Transects are drawn systematically with a random start location.

The aim is to have three vessels surveying on their transects in area 3 at the same time. That way, the core survey area 3 can be covered synoptically by several vessels with similar temporal progression.

The Irish and the Dutch vessels will start the survey in the southern areas. At the same time the Norwegian vessel will start in stratum 2 (the zig-zag stratum). This will then ensure the progression of all three vessels northwards at the same time in stratum 3 (the core area). The Faroese vessel coming from the north will join the others in Stratum 3 (the core area). The Rockall area will be covered by all vessels when they progress northwards. Survey extension in terms of coverage (51–61ºN) will be in line with the previous year to ensure containment of the stock and survey timing will also remain fixed as in previous years.

The Spanish vessel coming from the south will cover the southern part of stratum 1(Southern Porcupine and the Porcupine Sea bight). Their coverage will also extend southwards covering the former Stratum 7. This coverage will be compared to the coverage by the Dutch and Irish vessels approximately one week before. Unfortunately, the Spanish coverage will only be used for process studies and will not be included in the estimate due to the late arrival of the vessel to the survey area.

If registrations of blue whiting marks are continuing at the end of any planned transects (not valid in stratum 3), the length of these transects should be extended until no more marks are registered for a distance of 5 n.m. (or 30 minutes at normal survey speed). The transect at the outer western border can be cut off, if no registration of blue whiting for 5 n.m.

Preliminary cruise tracks for the 2023 survey are presented. Detailed cruise lines for each ship are uploaded on the WGIPS sharepoint (/2023 Meeting docs/Working documents/IBWSS 2023 Post Cruise).

As the survey is planned with inter-vessel cooperation in mind it is vitally important that participants stick to the planned transect positioning. Participants are also required to use the logbook system for recording course changes, CTD stations and fishing operations. The survey will be carried out according to survey procedures described in the ICES WGIPS Manual for Acoustic Surveys.

Table A14.1.1. Individual vessel dates for the active surveying period in the 2023 International Blue Whiting Spawning Stock Survey (IBWSS).

SHIP	NATION	ACTIVE SURVEYING TIME (DAYS)	DEFINITIVE SURVEYING DATES
Celtic Explorer	Ireland (EU)	16	22.3.2023 – 7.4.2023
Vendla	Norway	13	20.3.2023 – 2.4.2023
Tridens	Netherlands (EU)	13	20.3.2023 – 2.4.2022
Jakup Sverri	Faroes	10	26.3.2023 – 5.4.2023
Visconde de Eza	Spain (EU)	8	26.3.2023 – 2.4.2023

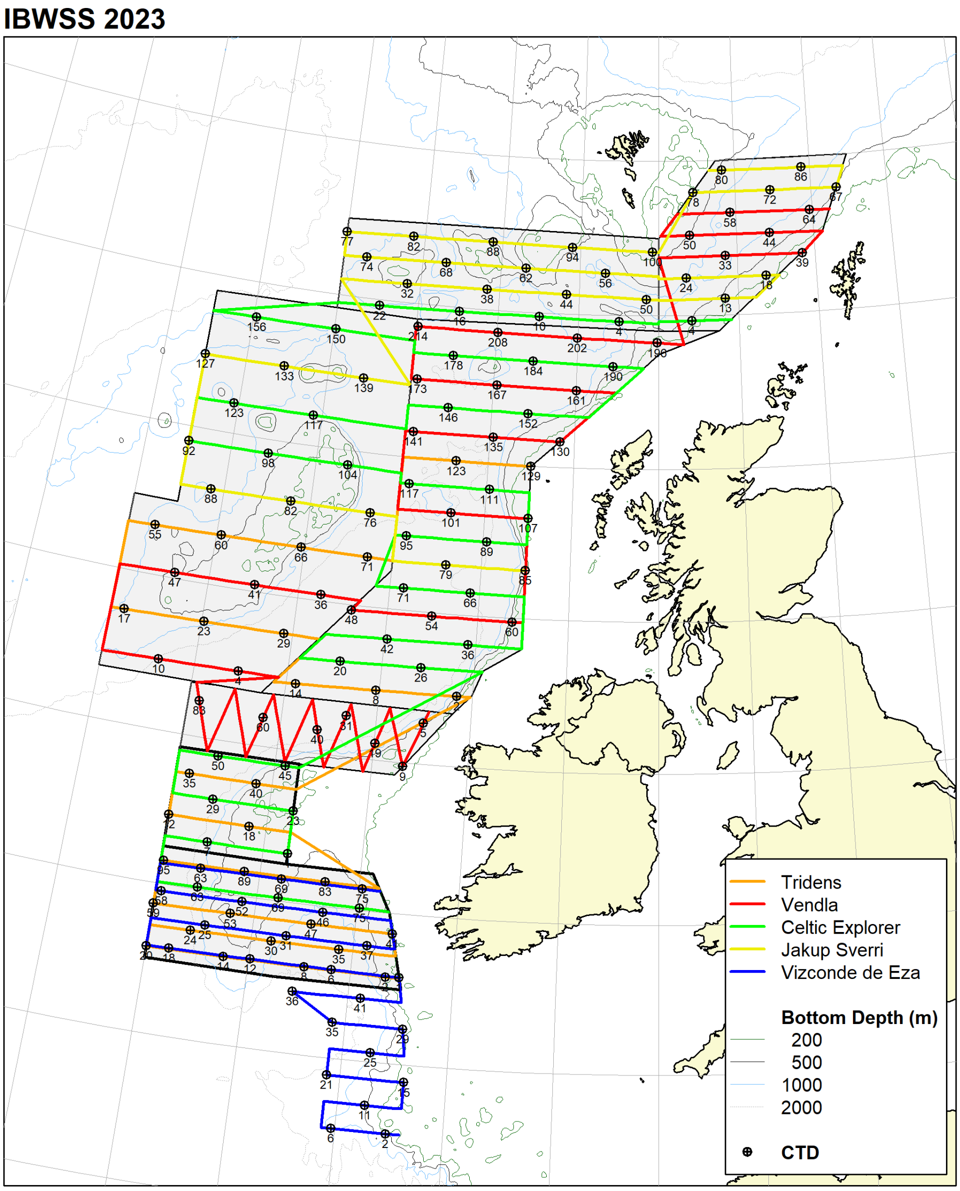


Figure A14.1.1. Planned survey tracks for the combined 2023 International Blue Whiting Spawning stock Survey (IBWSS).

2 International Ecosystem Survey in Nordic Sea (IESNS)

Denmark (EU-coordinator), Faroe Islands, Iceland, the United Kingdom and Norway will participate in the IESNS survey in April-May 2022. Currently, there is no plan for Russian participation which means that the Barents Sea will probably not be covered during IESNS 2023. Ships and preliminary dates are given in Table A14.2.1. Survey days exclude time for: hydrographic cross sections, coverage outside the IESNS area and crew change. United Kingdom's increased contribution in 2023 leads to more available effort in 2023 compared to last year, and this is used to increase the degree of coverage in the two southernmost strata. As usual, the plan is based on a stratified systematic transect design with random starting points. The suggested transects in each stratum are shown in Figure A14.2.1. The survey planner function in Rstox 1.11 was used to generate the transects. The allocation of transects to the different vessels is based on expected starting time in the survey area so that the coverage becomes synoptic from the south.

A post-cruise meeting will be held 13-15 June 2023 as webex (Teams).

Table A14.2.1. Individual vessel dates for the active surveying period in the 2023 IESNS.

Ship	Nation	Dates (harbour to harbour)	Effective survey days	Crew change
Dana	**Denmark (EU)**	**28 Apr – 24 May**	**19**	**10-11 May in Bodø**
Jakup Sverri	**Faroe Islands**	**4 May – 16 May**	**10**	
Árni Friðriksson	**Iceland**	**8 May – 27 May**	**15**	
G.O. Sars	**Norway**	**27 Apr – 1 Jun**	**29**	**16 May in Tromsø, 23-24 May in Tromsø**
Resolute	**United Kingdom**	**25 Apr – 7 May**	**10**	

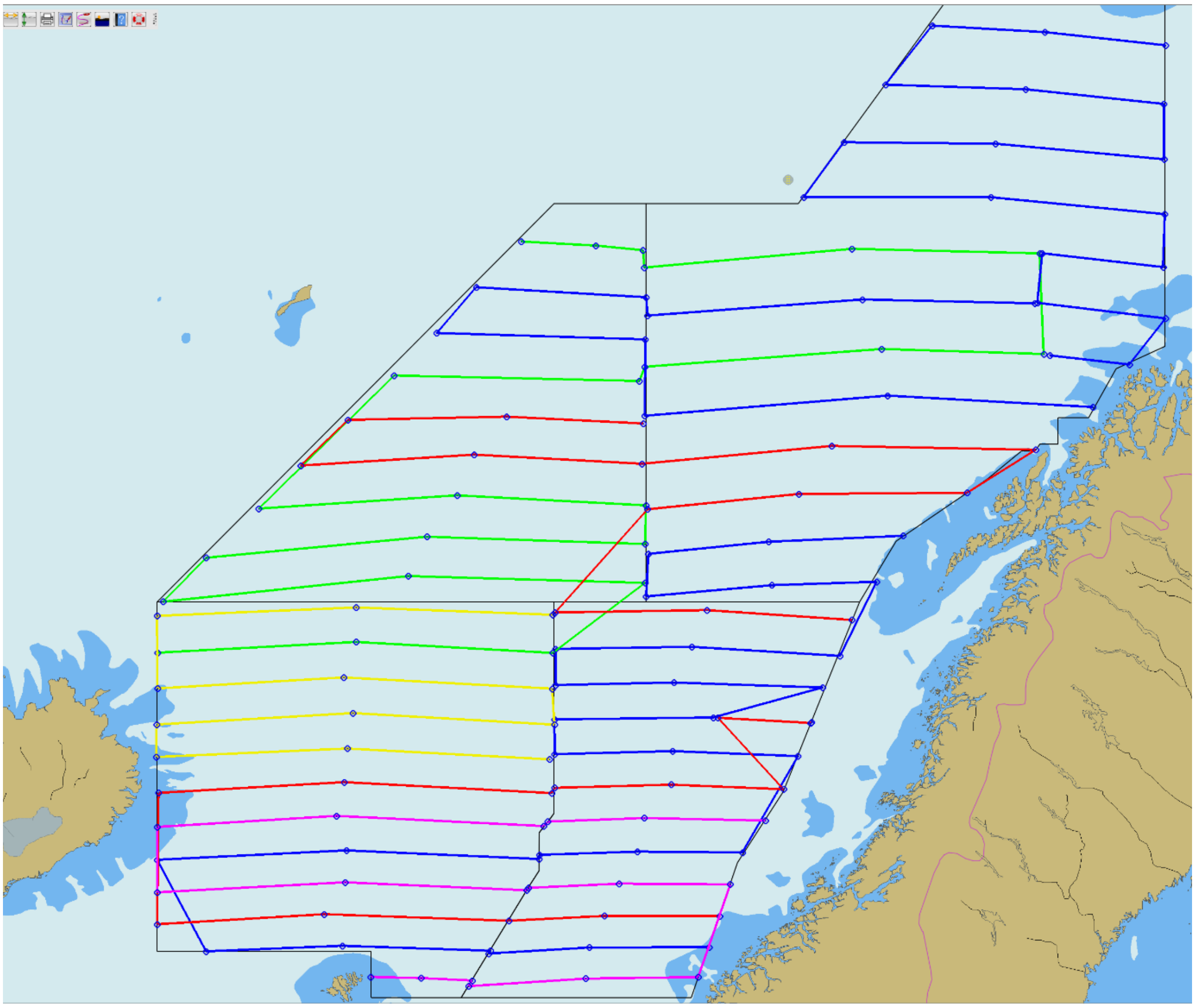


Figure A14.2.1. Planned cruise tracks and transects for the IESNS survey in 2023. Colors represent the different vessels/nations (yellow: FO, green: IS, dark blue: NO, red: EU, magenta: United Kingdom).

3 ICES Coordinated Acoustic Survey in the Skagerrak and Kattegat, the North Sea, West of Scotland and the Malin Shelf area (HERAS)

Norway, Denmark, Germany, Netherlands, Scotland and Ireland will participate in the 2023 HERAS and MSHAS surveys. Ships, preliminary dates and preliminary strata allocations are given in Table A14.3.1 below. Inshore extension is to be maintained at the 20-m contour for shallow waters regions of the Baltic and south eastern North Sea, and the 30-m contour for all other areas where applicable. The Norwegian survey is bounded a set distance from shore (5 n.mi) due to operational reasons as the 30-m contour is not practical due to the steep coastal topography. The 200-m contour marks the lower depth limit of the survey at the shelf edge and in the north-western boundary. The strata for 2023 are displayed in Figure A14.3.1 below.

The survey design has been standardised across participants and will follow best practice in terms of transect planning. The main body of the survey will utilise systematic parallel transect lines with randomised starting points and with transects running perpendicular to lines of bathymetry. Zig-zag transects are used in instances where parallel lines are not practical due to operational reasons, such as bays and inlets, or to better utilise survey time, and are stratified accordingly (Strata 2 and 81).

The survey effort in 2023, i.e. transect spacing, will be maintained at a similar level to that planned for 2022. Survey effort should also ensure adequate coverage of the North Sea sprat stock, which requires the southern boundary of the survey area to be kept at 52°N.

The survey design and the allocation of survey area and transects to vessels/nations must consider the specialist skills required to adequately cover the areas where stock splitting is carried out based on biological samples.

In all strata to the west of 4°W there is a requirement to collect tissue samples for genetic analysis, and to carry out analysis to prepare for splitting the acoustic index into 6.aN and 6.aS stock components. This sampling has been carried out by Scotland and Ireland since 2010. Genetic sampling should continue following the methods described by Farrell et al. (2022) and recommended by ICES (2023).

To the east of 2°E and north of 56°N, in the areas traditionally covered by Denmark and Norway, there is a requirement to be able to split the survey abundance into North Sea Autumn spawning herring and Western Baltic spring spawning herring. In 2022 genetic sampling for stock discrimination on individual fish level was conducted in both survey areas. Given the increased awareness of stock mixing issues throughout the survey area (6aN, 6aS, NSAS, WBSSH, NSSH) and recent developments in genetic methods it is recommended that genetic sampling of herring be carried out throughout the whole survey area including the areas were currently no stock splitting is carried out. Sampling protocols will be provided to all survey participants.

Transects have been allocated in all strata excluding the MSHAS strata west of 4°W (Figure A14.3.2) using the SurvPlan R package (Gastauer & Schaber, 2023). The final design will be amended with the MSHAS transects and confirmed over the coming weeks in discussion with participants.

Table A14.3.1. Participating countries/vessels, time periods and strata to be covered in the 2023 survey.

VESSEL	AVAILABLE DAYS FOR SURVEY	PERIOD AVAILABLE	STRATA TO COVER
Celtic Explorer (IRE)	20	29 June – 20 July	2, 3, 4, 5, 6
Scotia (GB-SCT)	18	29 June – 20 July	1, 91 (north of 58°30'N), 111, 121
Johan Hjort (NOR)	17	1 July – 18 July	11, 141
Dana (DEN)	13	24 June – 10 July	21, 31, 41, 42, 151_S, 151_N, 152
Tridens (NED)	14	27 June – 22 July	81, 91 (south of 58°30'N), 101
Solea (GER)	19	27 June – 17 July	51, 61, 71, 131

Analysis and reporting

A post-cruise meeting will be held in Bergen, Norway, November 20-24 (to be confirmed). The post-cruise meeting will allow the group to evaluate survey data, discuss issues arising from the surveys and produce the combined survey estimate. Survey data for the 2023 survey is to be uploaded to the ICES Acoustic database in the agreed format no later than **31 October 2023.**

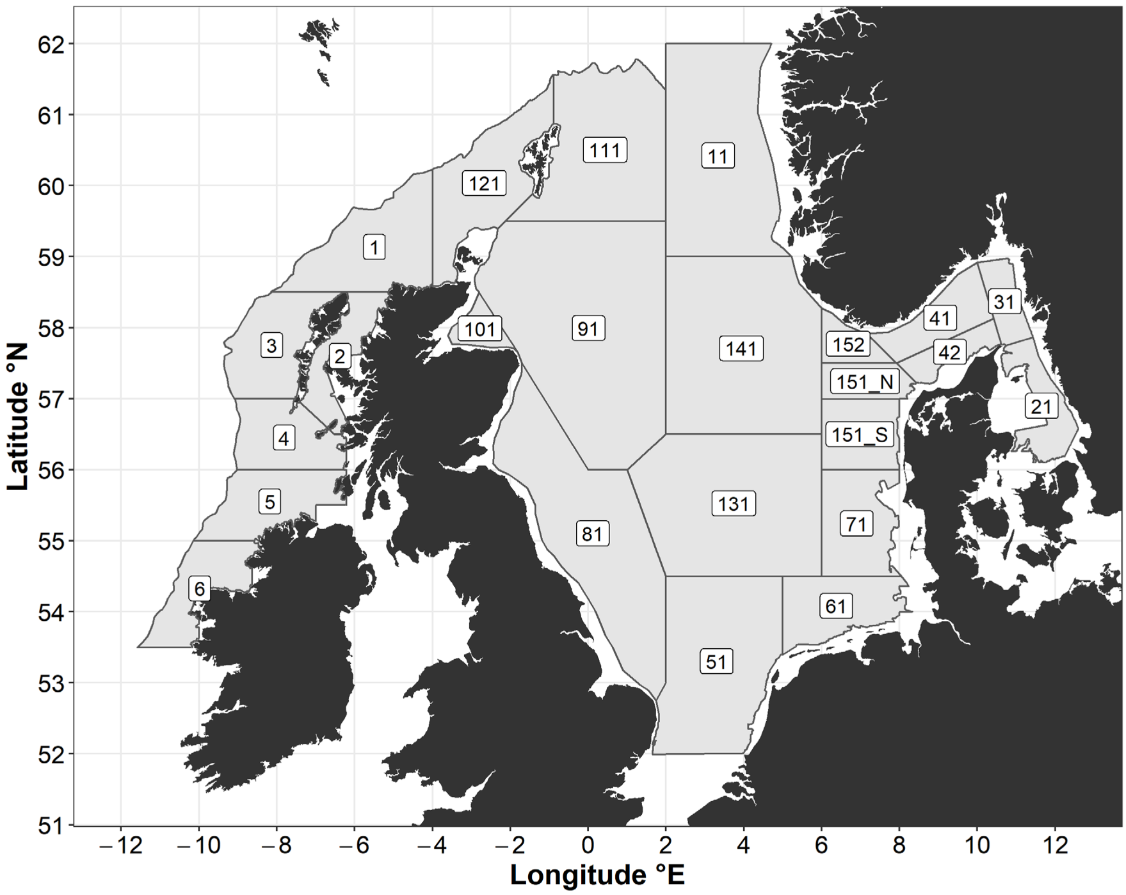


Figure A14.3.1 The 2023 ICES Coordinated Acoustic Survey in the Skagerrak and Kattegat, the North Sea, West of Scotland and the Malin Shelf area (HERAS): Strata.

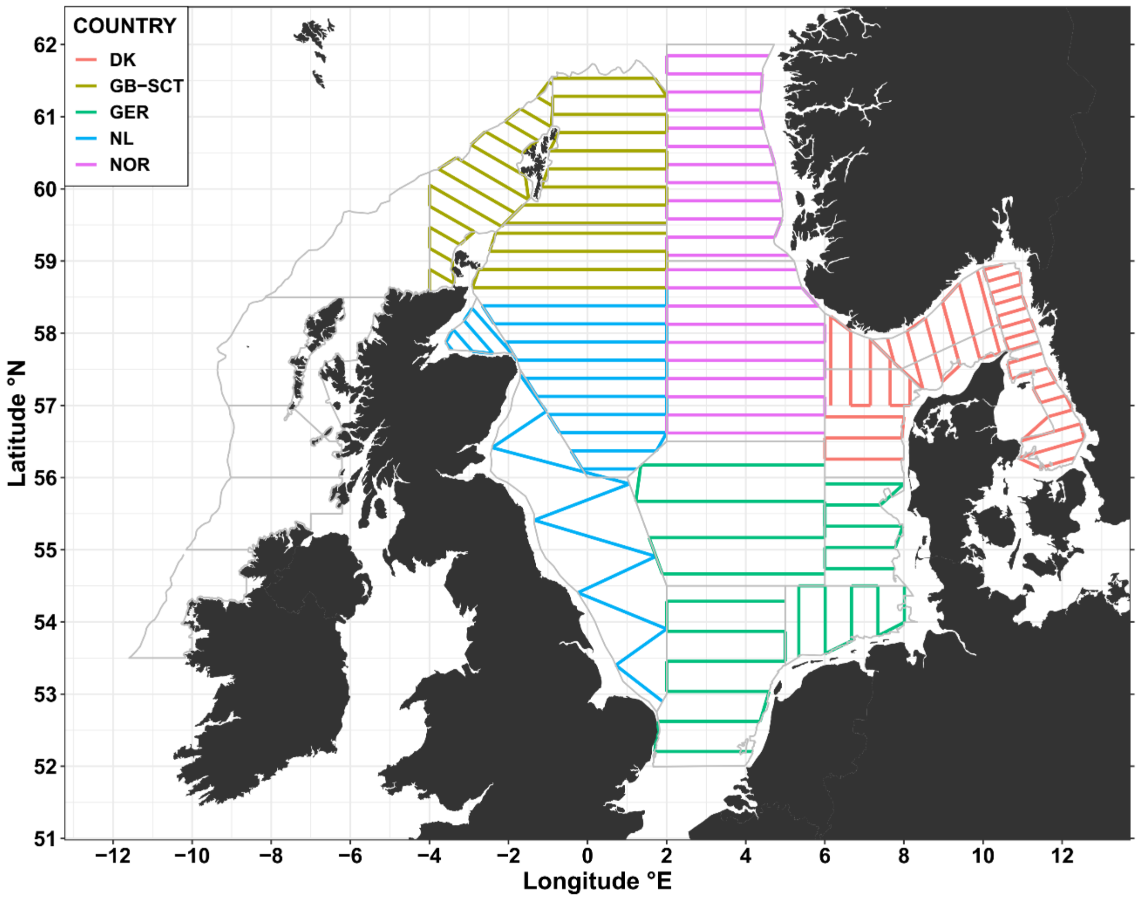


Figure A14.3.2. The 2023 ICES Coordinated Acoustic Survey in the Skagerrak and Kattegat, the North Sea, West of Scotland and the Malin Shelf area (HERAS): Strata and transects allocated to participants (excluding MSHAS transects West of 4°W)

Literature

Farrell E.D., Andersson L., Bekkevold D., Campbell N., Carlsson J., Clarke M.W., Egan A., Folkvord A., Gras M., Lusseau S.M., Mackinson S., Nolan C., O'Connell S., O'Malley M., Pastoors M., Pettersson M.E., White E., 2022. A baseline for the genetic stock identification of Atlantic herring, *Clupea harengus*, in ICES Divisions 6.a, 7.b–c. Royal Society Open Science 9:220453.

Gastauer, S., and Schaber, M. 2023. SurvPlan: Acoustic Survey Planner. R package version 0.1.0. https://github.com/SvenGastauer/SurvPlan

ICES. 2023. Benchmark Workshop on North Sea and Celtic Sea stocks (WKNSCS).ICES Scientific Reports. 5:04. 324 pp. https://doi.org/10.17895/ices.pub.21558681

4 International Ecosystem Summer Survey in the Nordic Seas (IESSNS)

The International Ecosystem Summer Survey in the Nordic Seas (IESSNS) 2023 will be conducted with five vessels from four countries during a five-week period from 29th June -5th August 2023. The survey planning for the IESSNS 2023 has mainly been done between the involved national representatives from the respective national institution by correspondence. A fruitful discussion was also conducted during the ICES WGIPS 2023 meeting. Unfortunately, not all key involved scientists were present during the WGIPS meeting, postponing the final survey planning and decision making for IESSNS 2023. There will be a total of 115 days survey period available during IESSNS 2023, which is below the required survey days to be able to have sufficient overall survey coverage. Reduced survey days during the last few years create both short-term and long-term challenges to maintain an optimal survey coverage and design for NEA mackerel as well as Norwegian spring-spawning herring and blue whiting. The survey vessels, survey periods and total days at sea for each participating country are summarized below:

Norway

- Eros (32 days, 4/7 – 20/7, 20/7 – 4/8)
- Vendla (32 days, 4/7 – 20/7, 20/7 – 4/8)

Iceland

- Árni Friðriksson (20 days, ----)

Greenland

- Not participating

Faroe Islands

- Jákup Sverri (21 days, 29/6-19/7)

Denmark

- Ceton (10 days, 3-15/7)

Permanent and dynamic stratum system during IESSNS 2023

Permanent and dynamic stratum system 1-13 planned during IESSNS 2023 are shown in Figure A14.4.1.

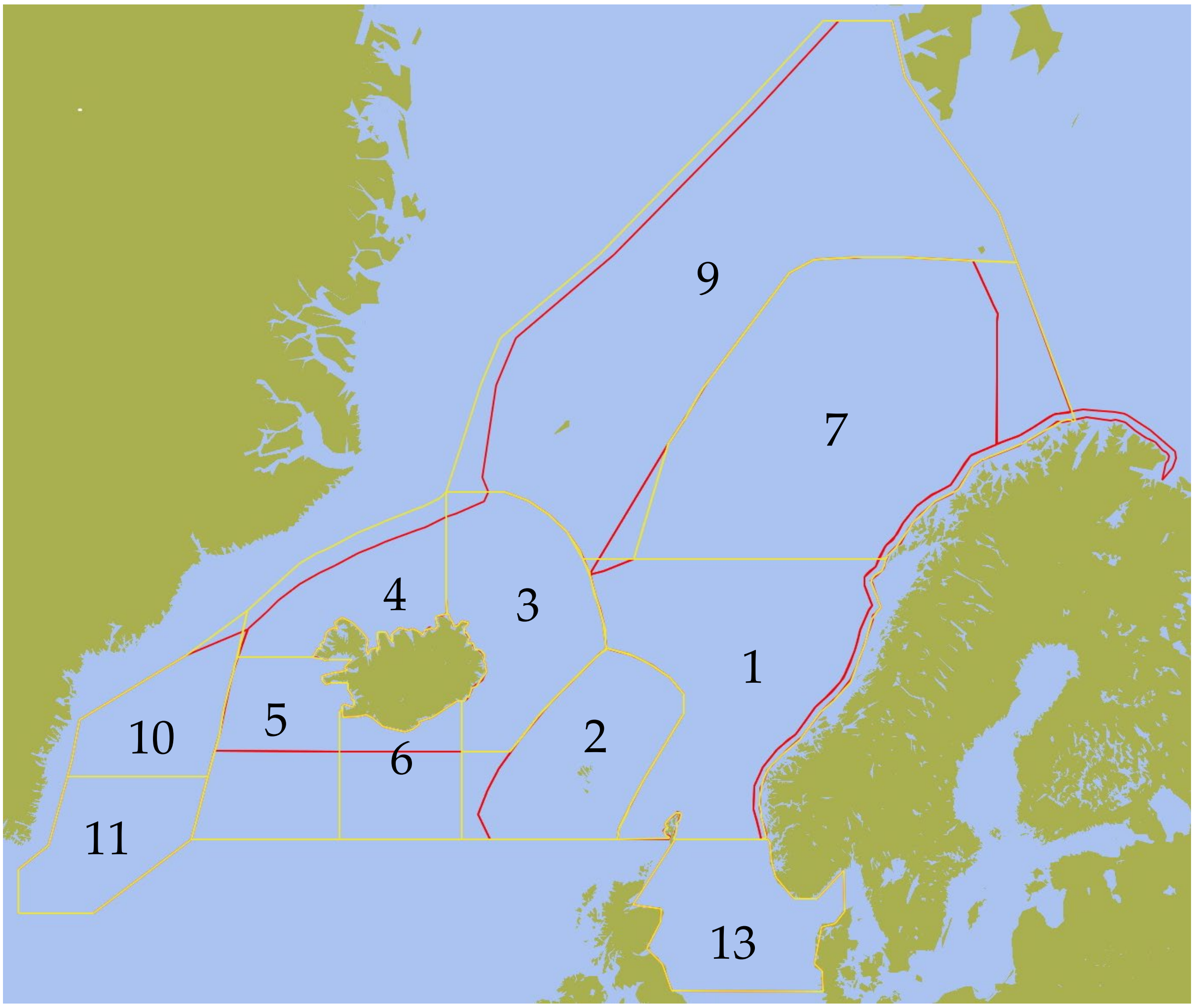


Figure A14.4.1. *Permanent and dynamic* stratum system 1-13 planned during IESSNS 2023.

1. East-west transects (70 nmi), permanent
2. East-west transects (70 nmi), permanent
3. East-west transects (70 nmi), permanent
4. North-south transects (75 nmi), dynamic northern border
5. East-west transects (70 nmi), dynamic southern border
6. North-south transects (50 nmi), dynamic southern border
7. East-west transects (70nmi), dynamic eastern border
9. East-west transects (70 nmi), dynamic eastern and western border
10. East-west transects (60 nmi), permanent
11. East-west transects (80 nmi), dynamic southern border
13. Only stations (50 nmi), no acoustic transects

IESSNS stations, transects and tracks

The IESSNS survey stations, transects and tracks are shown below in Figure A14.4.2. Due to limited survey days available for sufficient geographical coverage, the survey group decided during the WGIPS 2023 meeting to increase the distances between pre-determined pelagic trawl stations with 10 nautical miles in each stratum compared to previous version of the survey planning. This is the only way to accomplish sufficient geographical coverage of mackerel, in addition to Norwegian spring-spawning herring and blue whiting during IESSNS 2023.

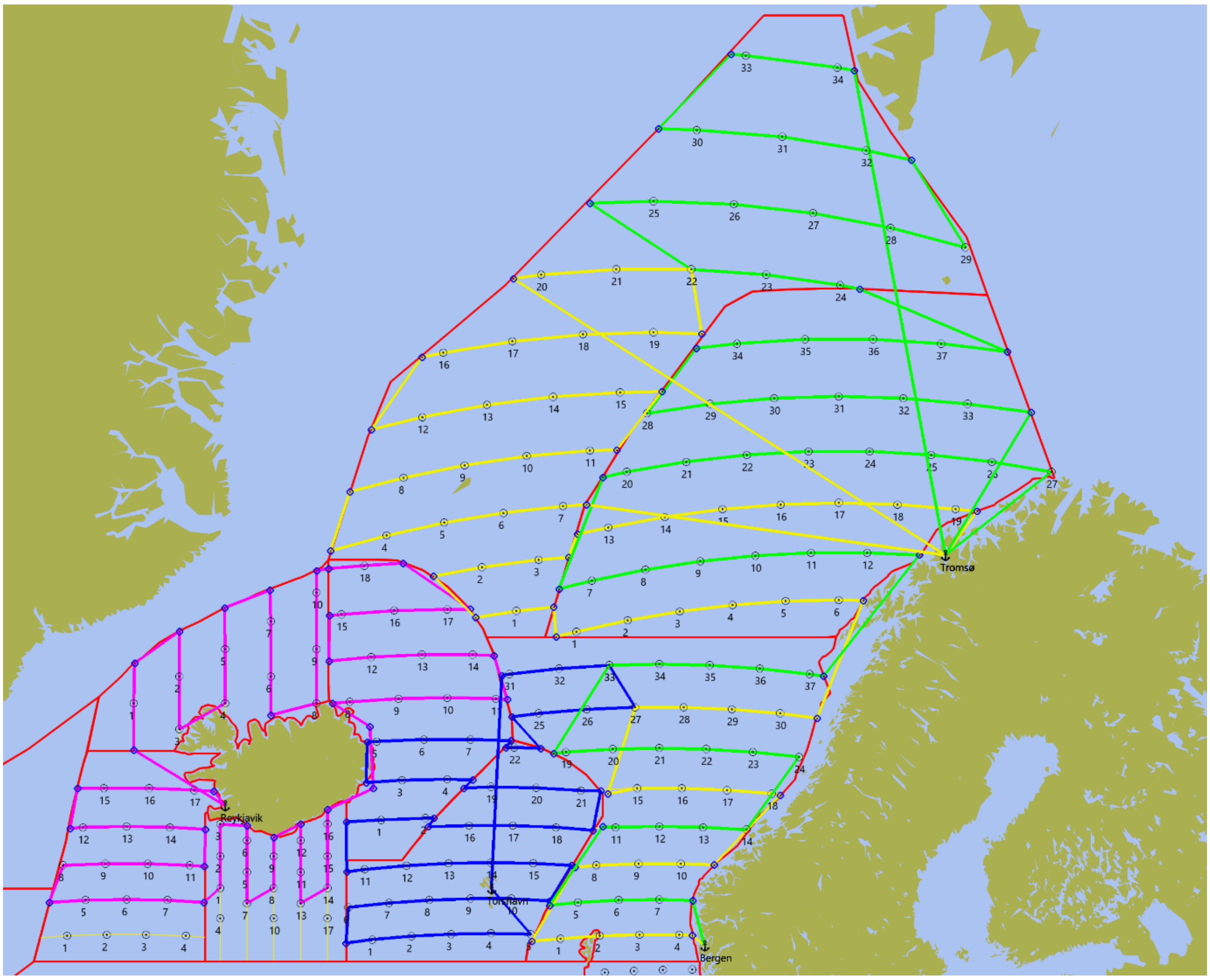


Figure A14.4.2. IESSNS 2023 planned stations, transects and tracks**.** Continuation from previous years: Evenly separated trawl stations in an equidistance principle**.** Daily progression estimated to be around 160 nmi.

The survey coverage and trawl stations for Ceton in the North Sea during IESSNS 2023 is shown below in Figure A14.4.3. The North Sea has been covered during IESSNS since 2018.

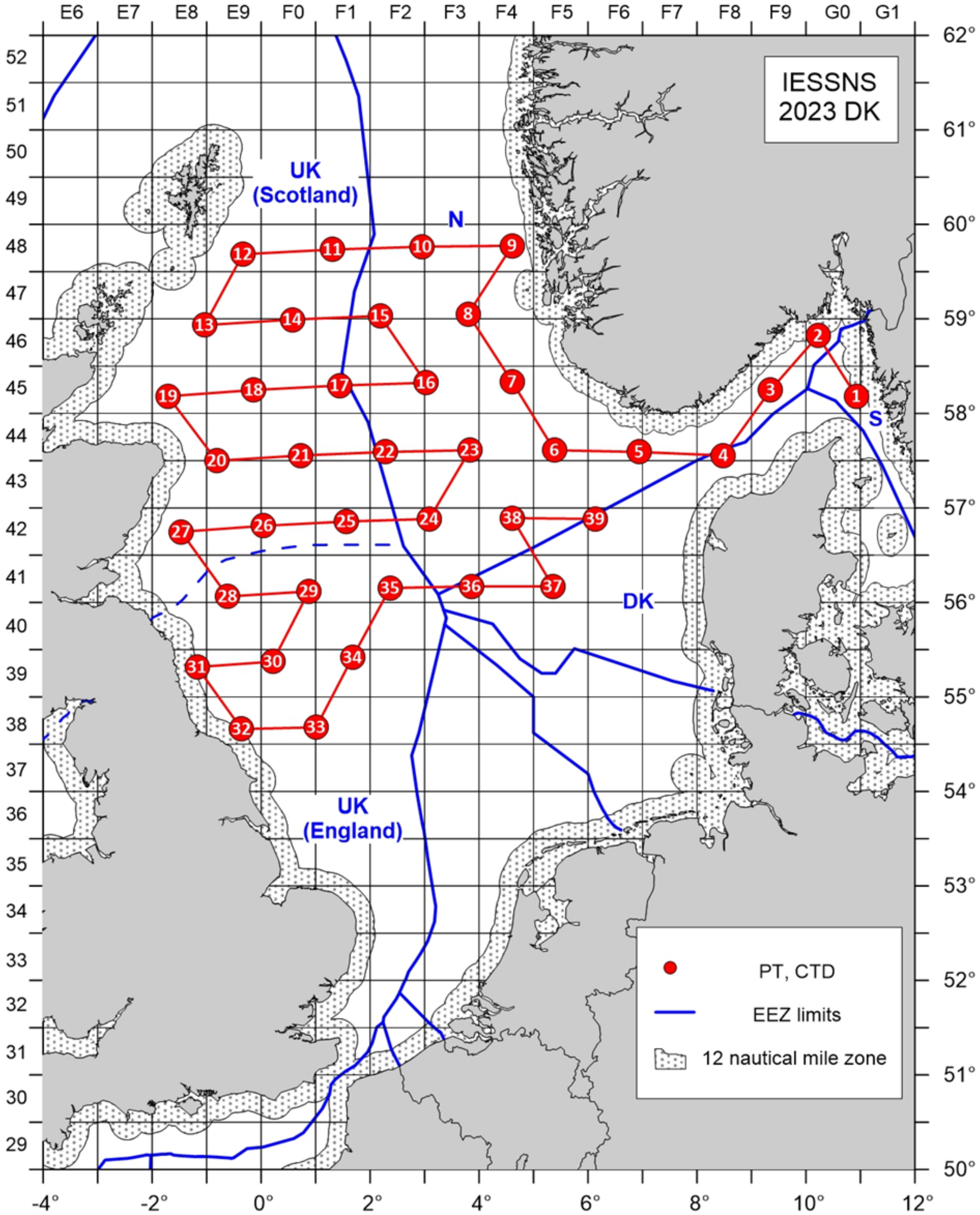


Figure A14.4.3. Survey coverage and trawl stations for Ceton in the North Sea during IESSNS 2023. Ceton will conduct the survey in 10 days, from 3/7 to 15/7 2023.

5 German Acoustic Autumn Survey (GERAS)

The German Acoustic Autumn survey (GERAS) 2023 will be carried out on board FRV *"Solea"* from October 4th until October 24th. The plan for cruise SB827 and acoustic transects to be followed follow the design adopted for the previous years (figure A14.5.1) but may be subject to change regarding recent difficulties in attaining all required permits from Swedish authorities and short-term notices of specific area closures in the Swedish survey area in preceding years.

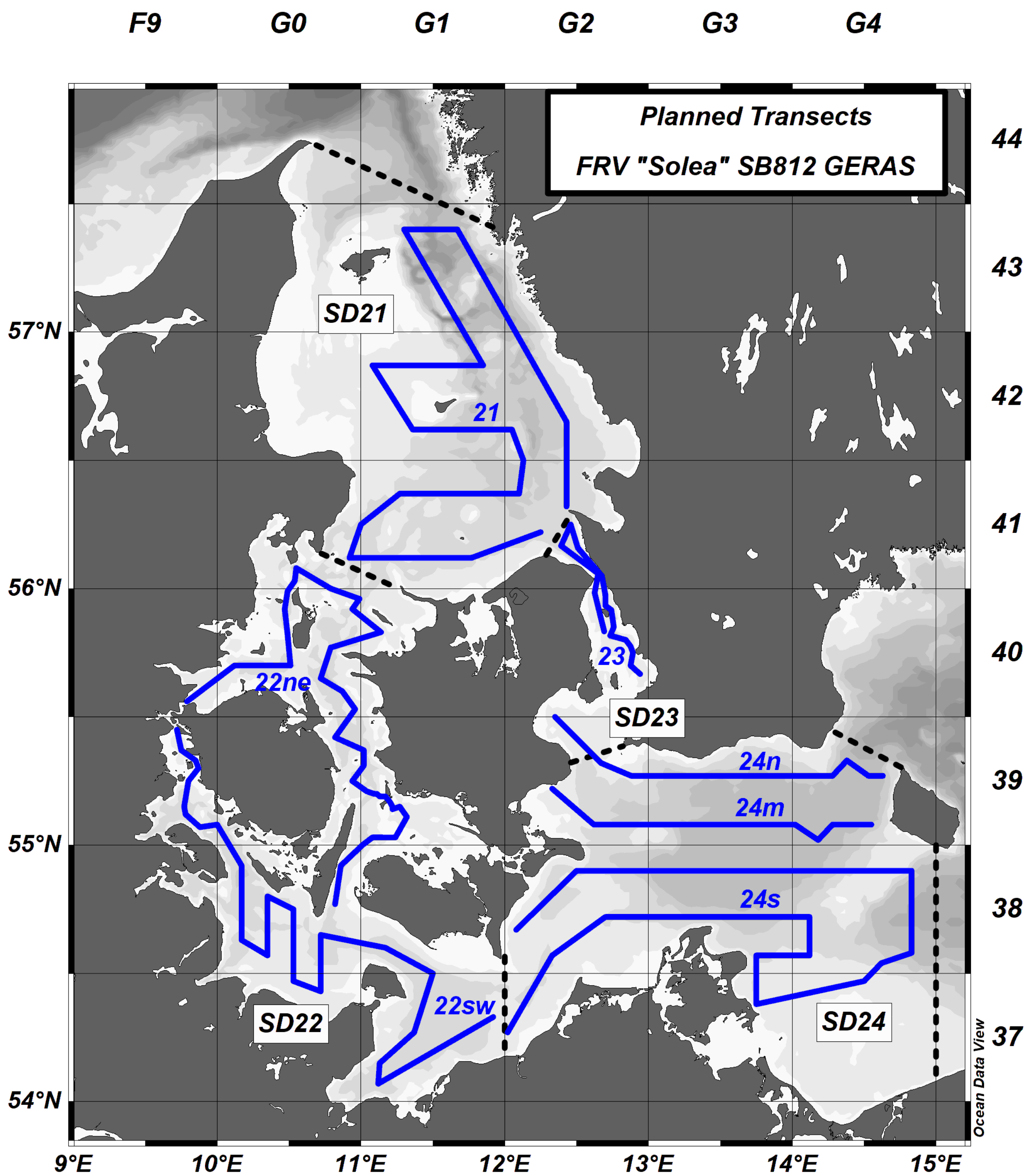


Figure A14.5.1. Map of the planned coverage in ICES Subdivisions (SD) 21-24 and acoustic transects (blue, transect ID indicated) for the German Acoustic Autumn Survey (GERAS) in 2023 (cruise SB827).

6 Irish Sea Acoustic Survey (ISAS)

The 2023 Irish Sea acoustic survey (ISAS) will be carried out onboard the RV *Corystes* between August 26th and September 14th. Figure A14.6.1 shows the plan and acoustic tracks for cruise C03523. The survey design of systematic, parallel transects covers approximately 620 nm and will be divided into two parts, transects around the periphery of the Irish Sea is randomized within +/- 4 nm of a baseline position each year with spacing set between 8-10 nm. Transect spacing is reduced to 2 nm in strata around the Isle of Man to improve precision of estimates of adult herring biomass.

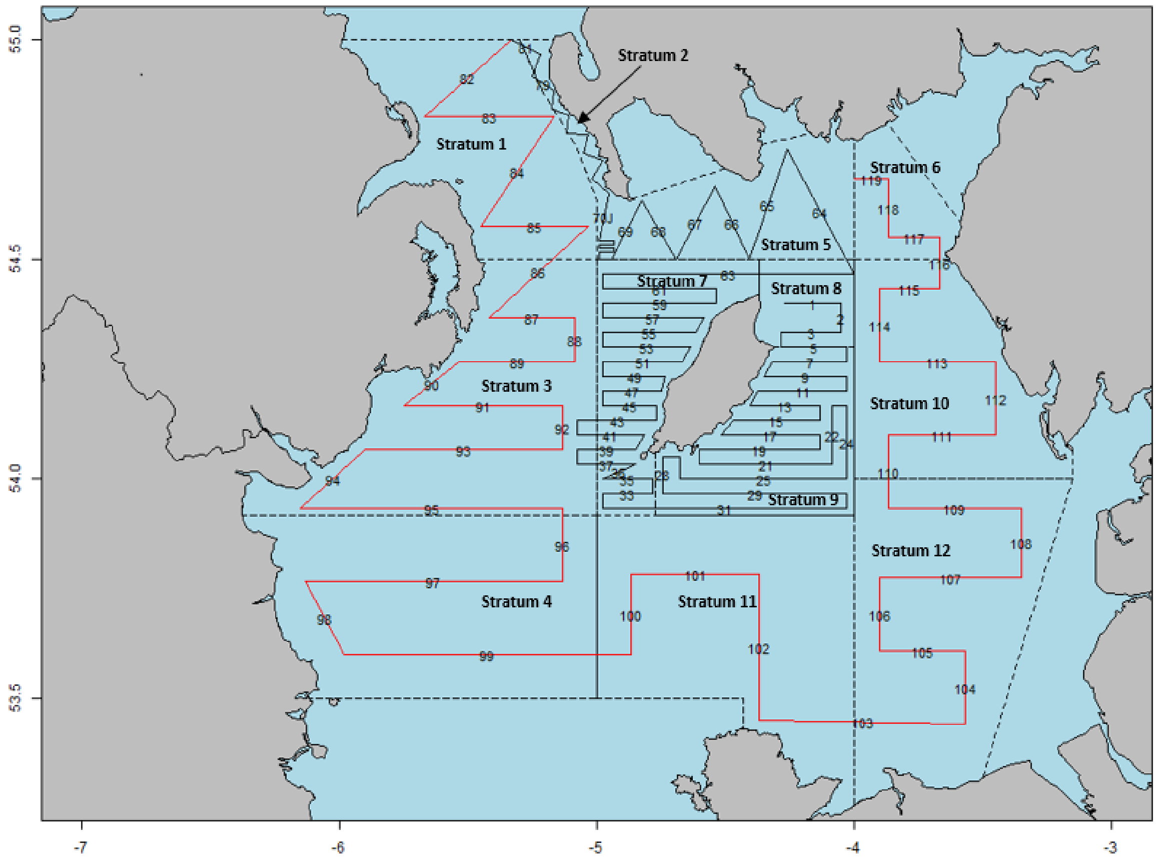


Figure A14.6.1. Map of Irish Sea and North Channel showing proposed coverage for the 2023 herring acoustic survey C03523.

7 Irish Sea Acoustic Spawning Survey

The 2023 Irish Sea Acoustic Spawning Survey (ISSS) will be carried out on-board a commercial pelagic fishing vessel to be named upon the successful completion of an AFBI initiated tender exercise. The survey will be conducted between September 24th and October 01st 2023. Figure A14.7.1 shows the plan and acoustic tracks for cruise HA3923. The survey design of systematic, parallel transects covers approximately 620 nm. The position of the set of transect with spacing is reduced to 2 nm in strata around the Isle of Man to improve precision of estimates of adult herring biomass.

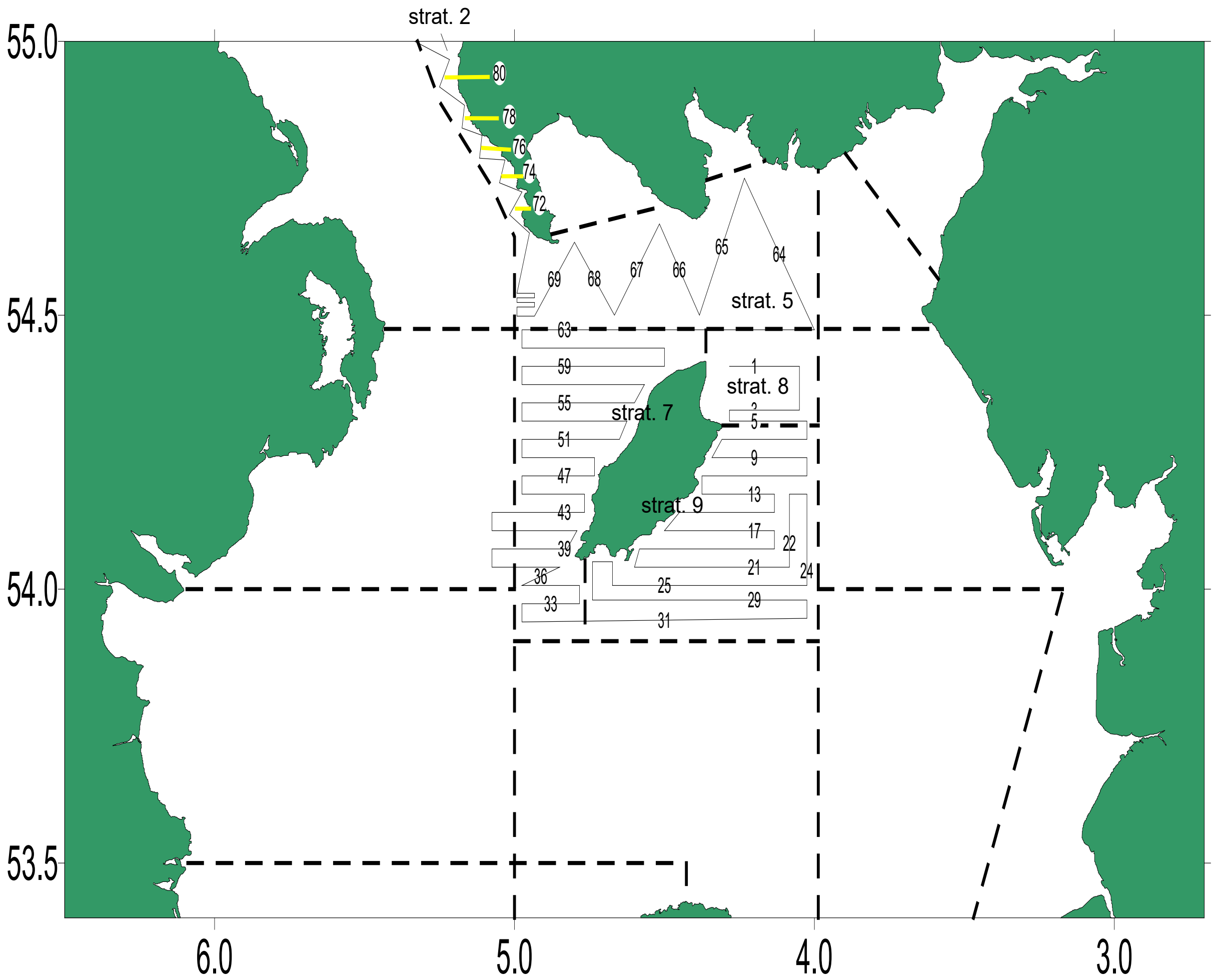


Figure A14.7.1. Map of Irish Sea and North Channel showing proposed coverage for the 2023 Irish Sea Acoustic Spawning Survey (ISSS) HA3923.

8 Celtic Sea Herring Acoustic Survey (CSHAS)

The 2023 Celtic Sea acoustic survey will be carried out on board the RV *Celtic Explorer from* the 09 – 29 October (21 days). Survey design utilises a laddered broad scale survey and focused adaptive high resolution site surveys.

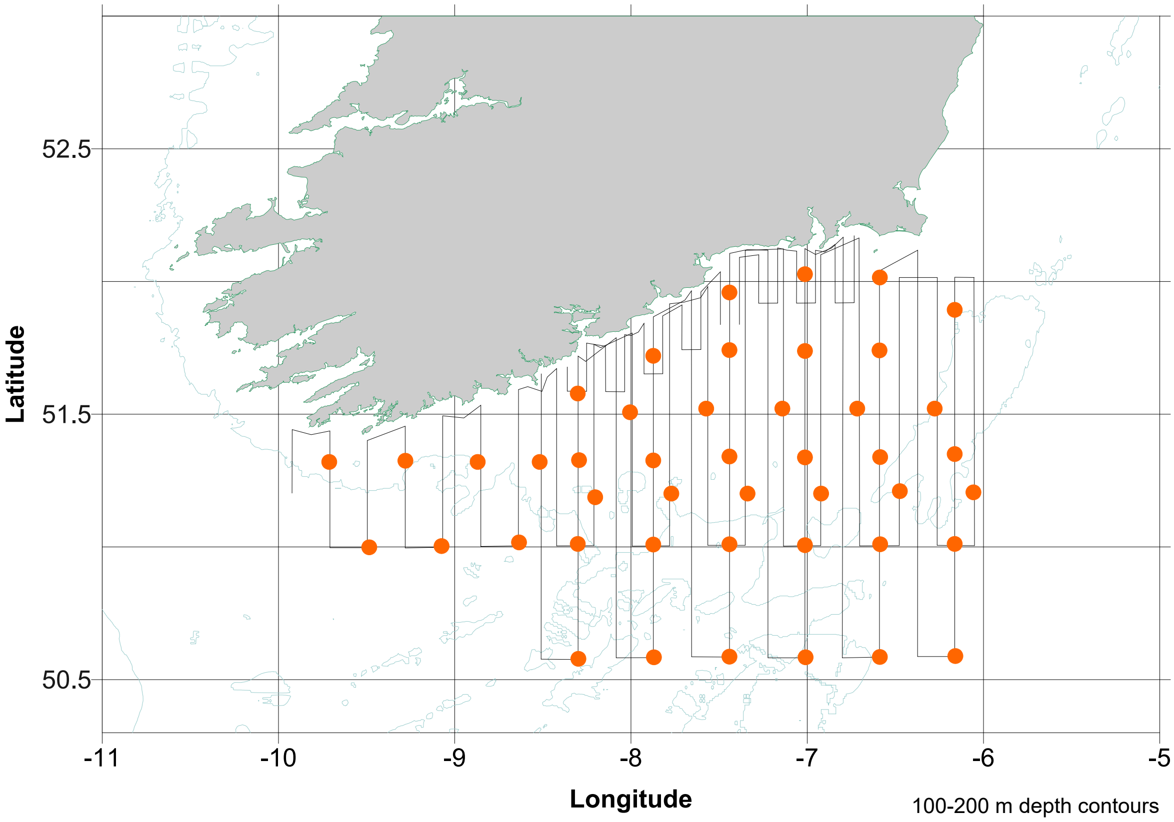


Figure A14.8.1. Proposed laddered survey design and hydrographic station layout, CSHAS 2023.

9 Western European Shelf Pelagic Acoustic Survey (WESPAS)

The 2023 WESPAS (Western European Shelf Pelagic Acoustic Survey) will be carried out on board the RV *Celtic Explorer*. The survey will begin in Northern Biscay on the 09 June and work progressively northwards over 42 days ending on the 20 July to the north of Scotland. The survey will be broken into two 3-week legs, with a 1-day break to facilitate a crew change.

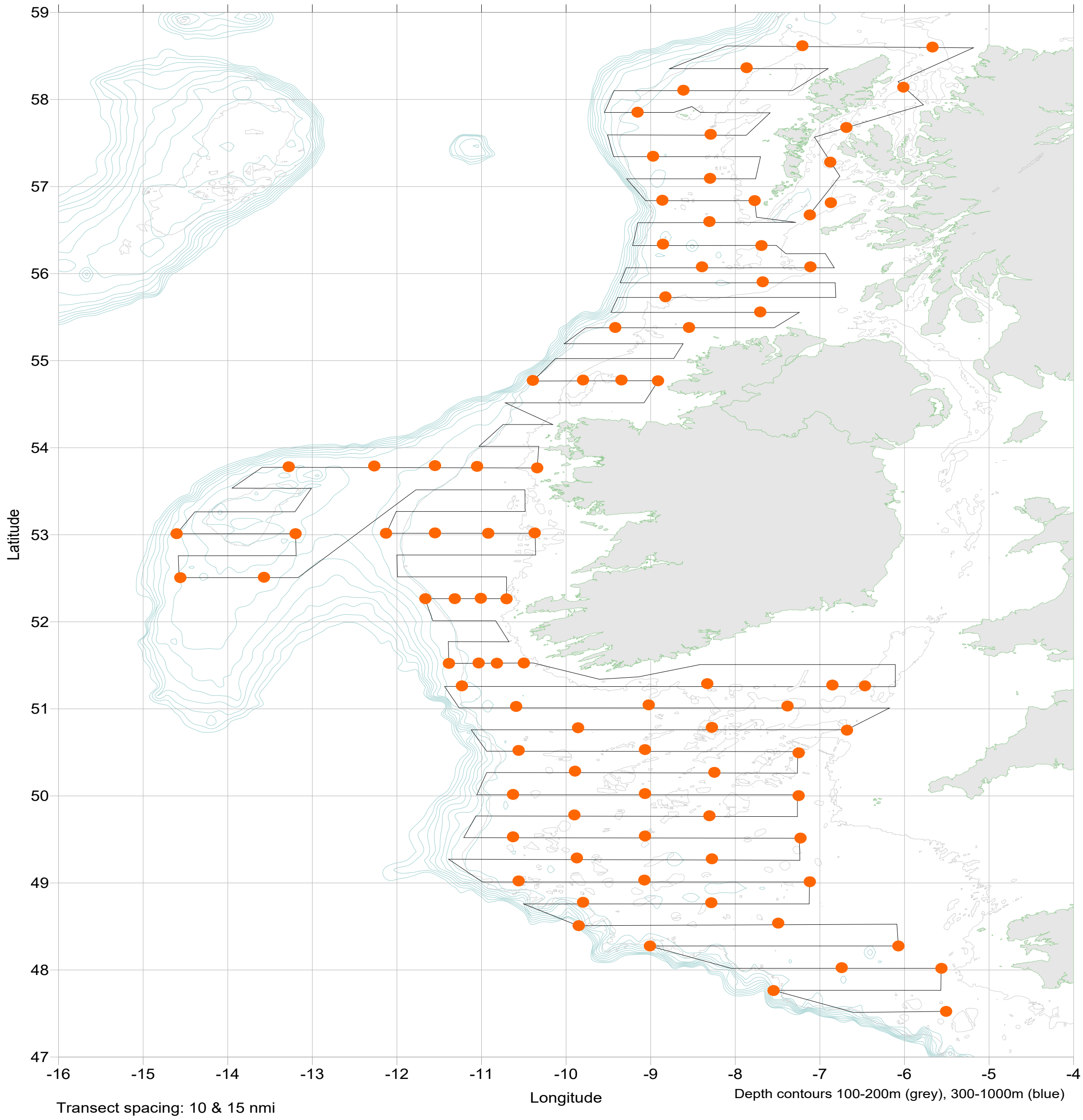


Figure A14.9.1. Proposed survey design and hydrographic station layout, WESPAS 2023.

10 Pelagic Ecosystem Survey in the Western Channel and eastern Celtic Sea (PELTIC)

In 2023, two surveys will be conducted under the PELTIC initiative (Pelagic ecosystem survey in the Western Channel and eastern Celtic Sea). The main annual autumn survey is scheduled to be carried out onboard the RV *Cefas Endeavour* from the 28th of September to the 1st November (TBC). In addition, a short 5-day survey will take place from 13-17th of March 2023 focussing solely on Cardigan Bay (transects 61-68). This was rescheduled from the 2022 PELTIC survey which was reduced from 35 to 13 days because of engine problems.

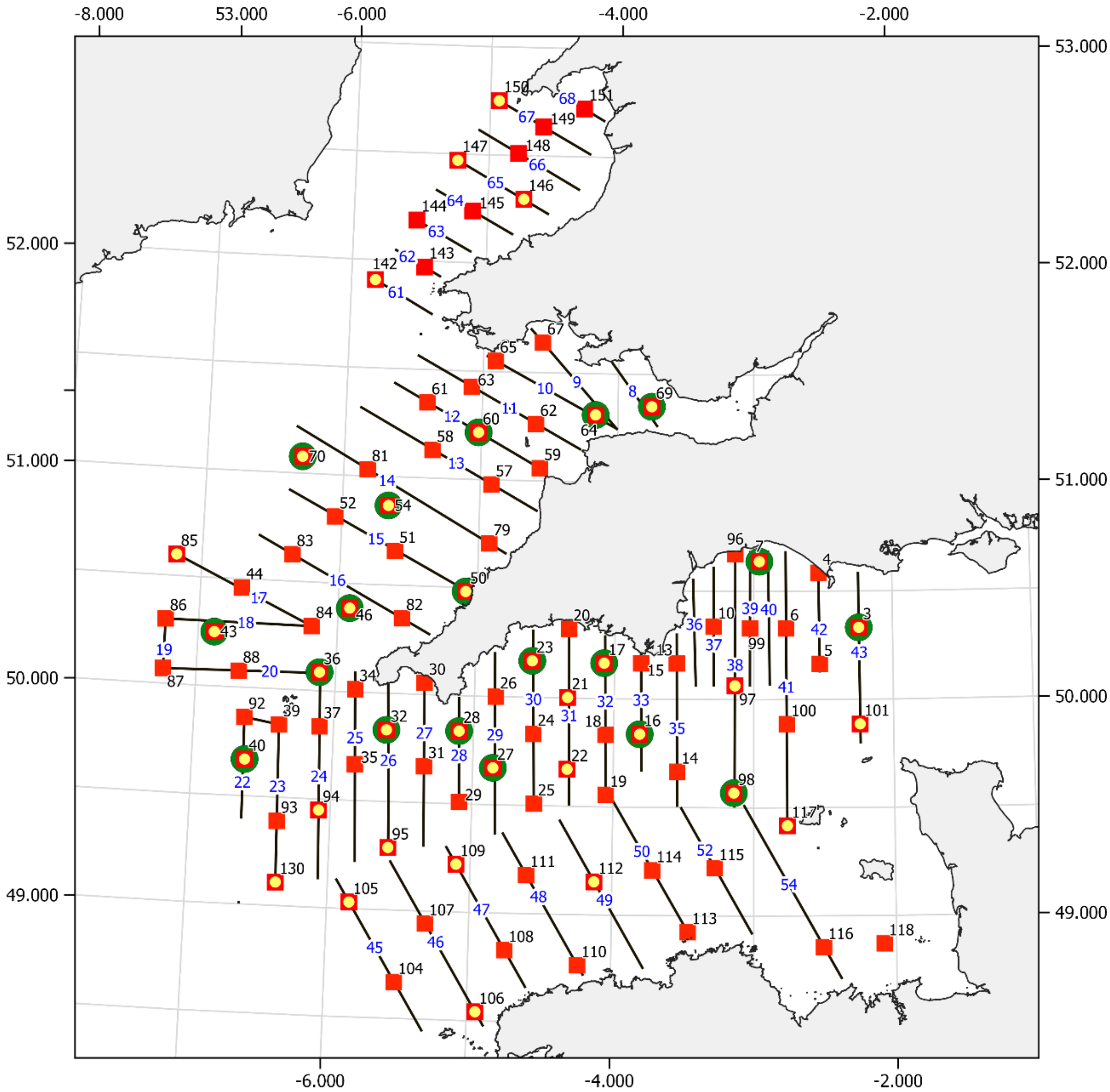


Figure A14.10.1. Overview of the planned survey area, with the acoustic transect (black lines), plankton stations (red squares) and hydrographic stations (yellow circles)., PELTIC 2022.

11 Proposal for industry surveys of herring in 6aN from 2023 (6aSPAWN)

Background

During the ICES benchmark workshop on herring west of the British Isles, the stock assessments of 6aN herring and 6aS/7bc herring were merged into one combined assessment (ICES 2015a). The reason for this is that the summer acoustic surveys and fishery occur at a time when the northern and southern components are mixed, and the baseline morphometric information required to separate the two components was found to be unreliable due to evidence of changes over time. The consequence was that from 2015 to 2022, ICES advised a zero TAC, and recommended that a rebuilding plan be developed (ICES 2017a). ICES HAWG also stated in its March 2015 report that there was (and still is) a clear need to determine the relative stock sizes (ICES 2015b).

Under the auspices of the Pelagic Advisory Council, this situation catalysed fishing industry associations representing Scottish, English, Dutch, Irish, Northern Irish and German fishery interests to set about providing the much needed evidence required to establish reliable stock assessments for the separate stocks, and develop a rebuilding plan. In response to the STECF 2015 autumn plenary recommendation that it would be beneficial to maintain an uninterrupted time series of fishery-dependent catch data, and a subsequent special request (to ICES) by the European Commission, ICES provided advice on methods for undertaking a scientific monitoring fishery for the purpose of obtaining relevant data for assessment (ICES 2016a). In particular, the advice referred to collection of data necessary to determine the identity and structure of the two stocks, collected in a way that (i) satisfies standard length, age, and reproductive monitoring purposes by EU Member States for ICES, and (ii) ensures that sufficient spawning-specific samples are available for morphometric and genetic analyses as agreed by the Pelagic Advisory Council monitoring scheme 2016 (Pelagic Advisory Council, 2016).

This advice, and a resulting EU Council regulation (EU 2016/0203) that made provision for a scientific monitoring TAC of 5 800 tonnes (4 170 t in 6aN and 1 630 t in 6aS, 7bc) were the enablers for the first industry-led survey to take place. Similar provisions were established prior to UK exit from Europe, allowing continuation of the industry-led collaborative survey. The survey provided critical data on genetic stock identity and spawning distributions of herring that was used in the ICES Benchmark Workshop on North Sea and Celtic Sea stocks (WKNSCS, ICES 2023). An important outcome of the benchmark workshop was that the combined herring assessment has been split once more into two components: 6aN autumn spawning herring and 6aS/7bc winter spawning herring, based on their genetic identity.

However, results of the Benchmark Workshop show that remaining uncertainties surrounding the identity of herring stocks in 6aN, as well as uncertainties with acoustic survey abundance indices and reliably obtaining information on commercial catch-at-age, make the use of analytical stock assessment problematic at this time. In particular, results from the EASME project, which led the genetic analysis used in the Benchmark, were not able to differentiate 6aN spring spawning fish from late-spawning 6aS fish (Farrell et al. 2021, 2022). The consequence of this is that these genetically distinct components currently sit outside of the assessment and are not accounted for in the estimation of herring abundance West of Scotland (WoS). Analysis of acoustic data undertaken as part of the international HERAS survey, and used in herring stock assessment, quantifies that this population may be of a similar size to the 6aN autumn spawning component (see 'her-67bc' in Figure A14.11.1) (O'Malley et al. 2022). The benchmark workshop concluded that, at the present time, a full analytical assessment was not possible, and a category 3 assessment method based on life-history and optimal length would be most appropriate for advice on fishing opportunities for herring in 6aN. In 2022, ICES herring assessment working group used a category 3 CHR rule to provide advice for catches in 2023 of 1,212 t. (ICES 2022a, 2022b).

During the benchmark workshop, results from the industry acoustic-trawl survey conducted in September (Mackinson and Berges 2022) were evaluated and showed evidence for cohort tracking and consistency with results from the WoS part of the HERAS survey. This indicates the potential utility of the index, but the time series was considered too short and recommended to be extended to improve tracking of the herring cohorts through their 9+ years of life. The findings of the benchmark workshop have thus been used to inform plans for the future monitoring requirements of herring stocks in 6aN and 6aS 7bc in 2022 and beyond, some of which are well suited to be undertaken by industry surveys.

Aim

The aim of future surveys in 6aN is therefore: to maintain and improve the knowledge base of the genetic identity of herring stock components in 6aN, and to provide an age-disaggregated acoustic abundance index that may be used by ICES to assist in assessing the herring stocks and establishing a rebuilding plan. Initially it is proposed that the 6aSPAWN acoustic survey in September should continue for a minimum period of 10 years (2016-2025).

Objectives

1. **Abundance estimation**: Collect acoustic data and information on the size and age of herring and use it to generate an age-disaggregated acoustic estimate of the biomass of pre-spawning/ spawning components of autumn spawning herring in 6aN. ('West of Scotland herring').
2. **Spawning stock identity separation:** Collect genetic data from spawning ready fish to maintain the genetic baseline of the autumn spawning stock currently used to split stock components in surveys and stock assessments.
3. **Age composition of the commercial catch:** Collect catch-at-age data from the monitoring fishery to provide continuous fishery-dependent time series required for future analytical stock assessment of the autumn spawning stock.
4. **Identify stock components in commercial catches.** Collect genetic data from commercial catches to determine the identity of herring stock components of catches in 6aN. This will enable stock assessments to partition fishing mortality on different stock components and provide better estimation of sustainable fishing rates.
5. **Identify stock components in 6aN.** Undertake exploratory surveys to locate and genetically identify spring spawning herring in 6aN. This is to address the significant finding of the EASME genetic work used in the benchmark (as described above), which has important implications for stock assessment and fisheries advice because these fish are not being accounted for.
6. **Evidence for a rebuilding plan:** Use the results of the surveys and data collected from commercial catches to contribute to the scientific basis for development of a rebuilding plan for herring in 6aN.

Plan for 2023 onward

Priority. Acoustic-trawl survey 6aN autumn spawning herring (i.e. continuation of the 6aSPAWN survey in September).

One Scottish RSW vessel undertakes a 10-day acoustic-trawl survey of the 2 key spawning areas (Figure A14.11.2), to further develop the established age-disaggregated acoustic abundance index spawning for potential use in future analytical stock assessments by ICES (following evaluation of its utility) (Obj 1), and to collect genetic samples. Genetic samples from spawning fish would be used to maintain the genetic baseline required to differentiate 6aN autumn spawners from other components (Obj 2). Genetic samples from non-spawning fish would be used to identify other component stocks that may be caught at this time (Obj 3). After the survey, the vessel would fish commercially for herring in 6aN under provision the allocation of monitoring quota, with samples of every haul being taken to provide biological and genetic data on commercial catches (Obj 3 & 4).

A second Scottish RSW vessel, or one Dutch freezer trawler, is deployed to undertake scouting over a wider area and extended duration covering the spawning period (total duration 10-days). The vessel will record acoustic data to identify the presence of any significant herring aggregations in 6aN that are outside the 2 key spawning areas, undertake directed commercial fishing activities to provide necessary commercial catch biological data and genetic samples (Obj 3 & 4).

Secondary. Locate and identify spring spawning fish in 6aN that are not presently accounted for in assessment and advice on fishing opportunities.

In February/March a 10-day survey is undertaken to locate pre-spawning/ spawning herring aggregations in 6aN and to take scientific sample catches required for genetic analyses and age composition. This survey is required to address the significant finding of the EASME genetic work used in the benchmark (as described above), which has important implications for stock assessment and fisheries advice because these fish are not being accounted for (Obj 5).

Monitoring quota allocation

Provision is required for the quota necessary to cover survey sample catches of herring in 6aN (typically <20t) and for commercial catches of herring in 6aN taken as compensation for the acoustic-trawl survey on the autumn spawning stock during September, plus any additional work undertaken as required to address othere objectives. Since 2020, Marine Scotland have made provision of 680 t of Western herring as compensation for the specified 10-days of survey work.

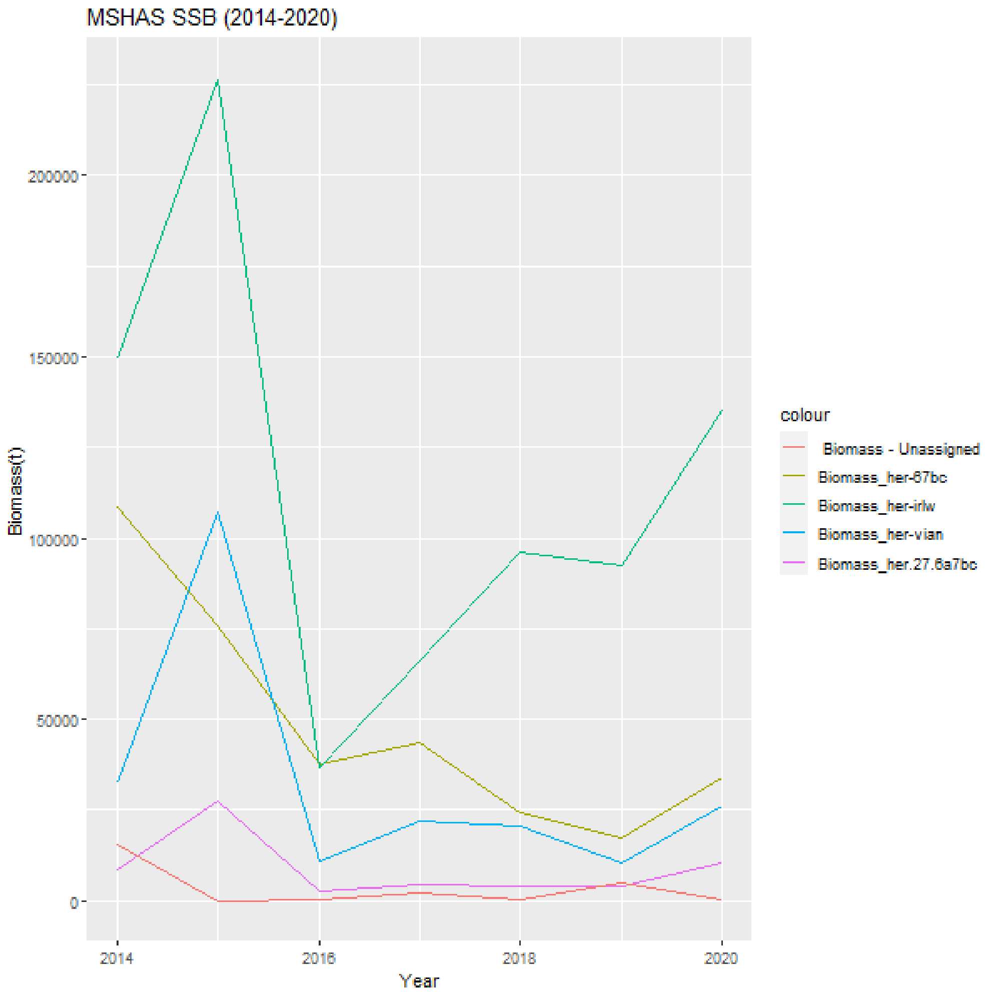


Figure A14.11.1. SSB (t) time-series for the individual split indices (2014 – 2020). (O'Malley et al. 2022). her-irlw (6aS and 7bc winter spawning herring), **her-vian** (6aN autumn spawning herring), **her-67bc** (spring spawning herring of uncertain origin) **her.27.6a7bc** (mix of herring from 6.a and 7.b, c; i.e. unknown or below threshold fish).

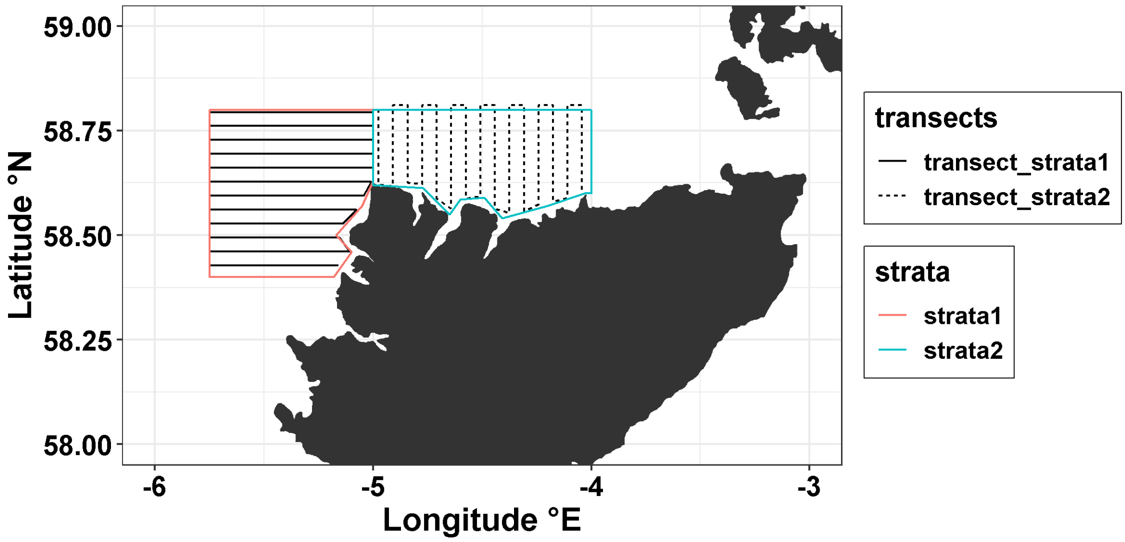


Figure A14.11.2. Survey areas for 2023 6aN surveys.

Key references

ICES 2015a. Report of the Benchmark Workshop on West of Scotland Herring (WKWEST), 2-6 February 2015, Dublin. ICES C.M. 2015 / ACOM:34.

ICES 2016a. EU request for advice on a scientific monitoring fishery for herring in ICES divisions 6.a, 7.b, and 7.c. Section 5.4.3 in ICES Special Request Advice Celtic Seas Ecoregion. 29 April 2016.

ICES. 2022a. Herring Assessment Working Group for the Area South of 62° N(HAWG).ICES Scientific Reports. 4:16. 745pp.http://doi.org/10.17895/ices.pub.10072

ICES. 2022b. Herring (Clupea harengus) in Division 6.a (North), autumn spawners (West of Scotland) In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, her.27.6aN. https://doi.org/10.17895/ices.advice.20179925.https://ices-library.figshare.com/articles/report/Herring_Clupea_harengus_in_Division_6_a_North_autumn_spawners_West_of_Scotland_/20179925?backTo=/collections/ICES_Advice_2022/5796935

ICES. 2023. Benchmark Workshop on North Sea and Celtic Sea stocks (WKNSCS).ICES Scientific Reports. 4:85. 324 pp. https://doi.org/10.17895/ices.pub.21558681.

Farrell, E.D., Andersson, L., Bekkevold, D., Campbell, N., Carlsson, J., Clarke, M.W., Egan, A., Folkvord, A., Gras, M., Lusseau, S.M., Mackinson, S., Nolan, C., O'Connell, S., et al. 2022. A baseline for the genetic stock identification of Atlantic herring, Clupea harengus, in ICES Divisions 6.a, 7.b–c. Published:07 September 2022. https://doi.org/10.1098/rsos.220453

O'Malley et al. 2022. Splitting the Malin Shelf Herring Acoustic Survey estimates (2014 – 2020) using genetic results from the EASME project. Working document for 6a7bc herring benchmark meeting, February 2022.

Mackinson, S and Berges, B. 2022. 6aSPAWN acoustic time series from industry surveys in 6aN. Working Document for 6a7bc herring benchmark meeting. February 2022.

12 6aSPAWN (Industry Survey in 6.a.S/7.b, c)

An acoustic survey of Atlantic herring will be conducted in ICES areas 6aS/7b between October 2022 and March 2023. The survey design changed in 2020 compared with previous years (2016-19) in that only core areas with prior knowledge of herring distribution from the monitoring fishery were targeted for surveying. This was largely based on the results from ICES WKHASS (ICES 2020) and from lessons learned in the previous surveys in this area from 2016-2019. This survey design will continue in 2022/23 with the continued objective to capture the distribution of winter and spring spawning herring in the core inshore areas within the greater in the 6aS/7b area (Figure A14.12.1). Parallel transects will be used in most areas where possible, and zigzags used in areas where narrow estuarine channels (Lough Foyle and Lough Swilly) makes parallel transects unworkable (Figure A14.12.2). The timing of surveys in the core areas will be flexible from the outset by design. The greater flexibility allows for a targeted spatial and temporal approach which can avoid the inevitable poor weather that can happen in this area during this time of the year. Using multiple smaller vessels will again allow surveys to be conducted in shallow inshore areas where herring are known to inhabit during this time of the year. The entire survey area will be divided up into 5 – 6 smaller strata, concentrating on areas where herring are known to occur in pre-spawning aggregations. Estimates will be generated from each strata area and replicates of some areas may be completed also if resources allow. This will require a more mobile echosounder (e.g. SIMRAD WBAT 38 kHz) that can be deployed easily from smaller vessels (10 -15m length) with minimal mob and demob time. It is hoped that many vessels can be involved in the survey with this approach, each surveying for 1-2 days covering all areas. The advantage will be that the survey design can be reactive to information coming from the fleet, poor weather can largely be avoided, and thereby improving the consistency of results and reducing bias. All the most important core inshore areas in 6aS/7b can be completed by using this approach. Information and expertise from inshore vessels will be considered in the survey. It is hoped that increased participation in the survey by the fleet that is actively fishing for herring in these areas will result in a more robust survey and therefore more accurate estimate of the stock at this time of the year. If the stock expands in areas or time in the future, the flexible approach can react to it, by adapting the survey design to include this information.

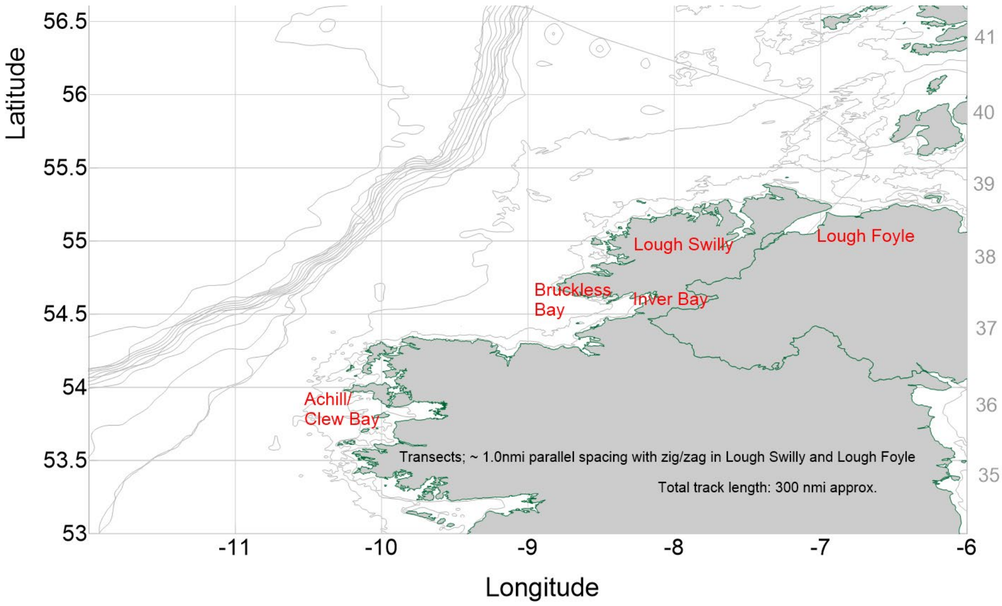
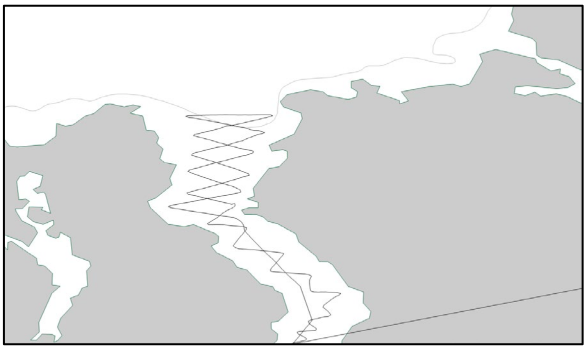


Figure A14.12.1. 6aS/7b industry acoustic survey in 2022/23: Core areas (5 – 6) will be selected for intense surveys based on information from the monitoring fishery and from previous surveys in 2016-2021. Estimates will be generated from these core areas and surveys will be replicated if possible.



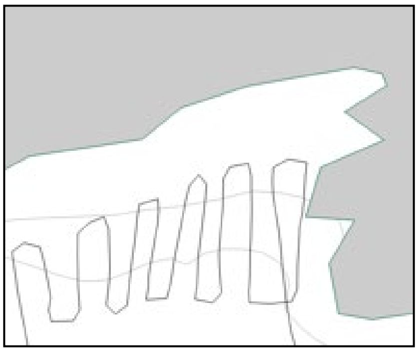


Figure A14.12.2. 6aS/7b industry acoustic survey in 2022/23: The total planned transect length is approximately 300 nmi in ~5 core areas. The survey design allows for intense surveys in areas where fish are observed and also in areas known to contain herring from information from the fleet (e.g. Lough Swilly (left) and Fintra Bay (right)).

Annex 15: Ecosystem overview table

	IBWSS					IESNS					HERAS						IESSNS			GERAS	CSHAS	WESPAS	ISAS	PELTIC
Participating countries																								
✓																								
Data type																								
fish																								
Organism collection	✓	✓				✓	✓	✓			✓				✓	✓	✓	✓		✓				
Stomach sampling	✓	✓				✓	✓	✓			(✓)						✓	✓						✓
Additional biological data (of non-target species)	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓		✓	✓	✓		✓	✓	✓	✓	✓
Disease/parasite registration											✓			✓	✓									
Genetic information					✓				✓			✓		✓	✓	(✓)				(✓)	✓	✓		
Lipid content								✓			(✓)													
Omnidirectional sonar observations of pelagic fish	✓		✓	✓		✓					✓	✓				✓	✓			✓	✓	✓		
Tagging																								
Bioactive material																								
Scientific multibeam echosounder for 3D fish school shapes/schools observations in surface 'dead zone'																	✓							
Multifrequency echosounder data for species identification, abundance and biomass estimation (number of frequencies)	5	2	4	2	5	6	2	5			4	4	2		4	4	5	2		4	4	4	2	4

Physical/chemical oceanography																								
Continuous underway measurements	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Station measurements	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Water movement						✓					✓													
Nutrients						✓		✓			✓											(✓)		✓
Biological oceanography																								
Microbiological sampling																						(✓)		
Phytoplankton sampling						✓		✓																✓
Zooplankton samples	✓	✓	✓			✓	✓	✓	✓					✓			✓	✓			✓	✓		✓
Multifrequency echosounder data for zooplankton identification & abundance estimation (number of high frequencies >=38 kHz)	4		1	1	4	5		3			2	3	1		3	4	4			4	3	3	1	3
	IBWSS					IESNS					HERAS						IESSNS			GERAS	CSHAS	WESPAS	ISAS	PELTIC
Participating countries																								
Charismatic megafauna																								
Visual observations			✓	(✓)		✓		✓			(✓)	✓				(✓)	✓				✓	✓	✓	✓
Towed hydrophones																							✓	

<u>Seabird observations</u>																								
Species counts			✓									✓									✓	✓		✓
Abundance survey (ESAS)			✓									✓									✓	✓		✓
<u>Habitat description</u>																								
Camera observations			✓									✓					✓	(✓)			✓	✓		
Sidescan sonar						✓																		
Bathymetric multibeam echosounder			✓			✓						✓									✓	✓		
Physical ground samples																								
<u>Pollution</u>																								
Litter			✓	✓		✓		✓	✓			✓		✓	✓	✓				✓	✓	✓		✓
Pollution in water column																								
Pollution in sediments																								
Pollution in organisms																								
<u>Environmental conditions</u>																								
Weather condition/sea state	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓

✓* From 2018-19

Annex 16: Working document: Splitting the Malin Shelf Herring Acoustic Survey estimates (2014 – 2022) using genetic results from the EASME project

Splitting the Malin Shelf Herring Acoustic Survey estimates (2014 – 2022) using genetic results from the EASME project

Michael O'Malley and Steven O'Connell

The Herring Assessment Working Group (HAWG) recommended to WGIPS in 2021 that the results of the EASME project (Farrell et al., 2021) on stock splitting be considered in future analysis and planning of the summer survey in 6.a.N and 6.a.S (also known as the Malin Shelf Herring Acoustic Survey, or MSHAS). The split results were accepted ICES WKNSCS benchmark on 6a herring in 2022 (ICES, 2023) and stocks are now assessed separately. The following tables contain the split results for MSHAS surveys in 2014-2022. A full description of the work is detailed in the WKNSCS benchmark report (ICES, 2023).

	Abundance (TSN x 10^6)											
Year	Age(-wr)	1	2	3	4	5	6	7	8	9+	CV	SSB (t)
2014	her.27.6a7bc	0	5.11	16.27	15.59	20.06	2.30	0.19	0.00	0.02	0.33	8855
2015	her.27.6a7bc	0	21.83	52.19	23.05	21.04	27.32	1.75	2.82	0	0.29	27610
2016	her.27.6a7bc	0	1.66	4.41	1.32	1.95	2.11	2.46	1.95	0	0.29	2848
2017	her.27.6a7bc	0	0.02	9.14	3.34	4.09	3.75	2.09	0.16	0	0.36	4392
2018	her.27.6a7bc	51.33	10.88	4.04	3.25	6.02	0.34	2.32	0.18	1.61	0.91	4213
2019	her.27.6a7bc	0	5.35	1.89	1.72	9.83	5.26	0.29	2.30	0.15	0.31	4222
2020	her.27.6a7bc	54.89	46.21	41.96	5.40	0.12	8.61	0.00	4.18	0	0.30	10387
2021	her.27.6a7bc	17.34	28.45	9.96	6.89	0	6.49	1.30	1.86	1.06	0.35	5479
2022	her.27.6a7bc	0	2.043	18.06	16.33	11.10	3.92	0	0	0	0.56	8443

	(TSN x 10^6)											
Year	Age(-wr)	1	2	3	4	5	6	7	8	9+	CV	SSB (t)
2014	her-67bc	0	28.41	98.51	174.02	182.45	68.95	8.95	15.04	5.79	0.27	108367
2015	her-67bc	0	32.05	58.13	149.78	59.96	98.61	13.07	0.79	0	0.35	76009
2016	her-67bc	0	1.38	36.89	30.65	67.03	30.81	32.14	0.75	0	0.24	37809
2017	her-67bc	0	0.08	110.48	35.95	19.95	43.89	8.43	3.96	0.89	0.34	43478
2018	her-67bc	51.47	49.45	17.38	50.49	26.06	14.28	7.18	6.58	1.05	0.48	24426
2019	her-67bc	3.16	32.91	3.68	24.38	27.12	11.88	3.80	11.09	0.77	0.33	17370
2020	her-67bc	237.73	192.58	98.09	20.75	22.23	37.74	4.59	5.05	0	0.31	33987

2021	her-67bc	16.00	250.62	110.39	23.42	1.25	0	1.95	2.28	0	0.36	38877
2022	her-67bc	46.75	101.64	100.45	77.77	12.52	5.26	1.48	12.64	2.36	0.55	44431

	(TSN x 10^6)											
Year	Age(-wr)	1	2	3	4	5	6	7	8	9+	CV	SSB (t)
2014	her-irlw	0	30.02	118.63	271.01	252.21	99.34	31.38	10.39	4.90	0.26	149270
2015	her-irlw	0	122.52	255.67	395.26	254.82	225.28	58.96	9.38	0	0.24	226293
2016	her-irlw	0	8.09	45.22	42.18	38.06	42.34	26.05	1.71	0.91	0.23	36707
2017	her-irlw	0	6.55	112.57	87.69	39.22	58.66	39.21	21.65	0.33	0.33	66342
2018	her-irlw	572.95	303.59	68.30	199.14	92.34	36.80	47.08	14.63	6.14	0.57	96138
2019	her-irlw	3.80	170.70	213.96	103.46	91.97	47.16	5.93	17.27	8.92	0.26	92364
2020	her-irlw	895.11	776.20	401.75	188.20	71.45	120.21	24.77	6.64	8.51	0.24	135335
2021	her-irlw	173.49	1389.15	532.79	105.14	66.21	27.17	46.06	12.62	12.82	0.31	189856
2022	her-irlw	175.31	174.95	382.81	210.45	118.18	45.82	15.45	22.45	1.88	0.52	147199

	(TSN x 10^6)											
Year	Age(-wr)	1	2	3	4	5	6	7	8	9+	CV	SSB (t)
2014	her-vian	0	2.75	13.50	21.36	85.13	20.39	5.35	2.41	6.65	0.35	32460
2015	her-vian	0	35.56	139.03	127.40	97.37	106.38	24.68	3.81	5.76	0.30	107113
2016	her-vian	0	5.81	15.50	13.62	11.15	8.83	5.22	0.06	0.73	0.26	10870
2017	her-vian	0	0.71	35.75	25.40	26.44	11.41	9.93	2.48	1.86	0.37	21863
2018	her-vian	92.96	41.07	14.27	48.31	16.67	3.34	10.05	5.49	2.28	0.59	20663
2019	her-vian	0	17.17	17.32	15.80	20.17	4.64	0.16	0	0.51	0.28	10508
2020	her-vian	59.05	103.81	49.51	14.96	12.44	28.21	11.01	0	0	0.26	26070
2021	her-vian	20.48	140.01	57.44	41.87	13.98	14.57	33.73	10.25	9.07	0.36	43886
2022	her-vian	8.47	37.00	41.53	57.76	20.30	8.49	11.63	5.38	0.88	0.55	33283

Table 1: Abundance (TSN x 10^6) at age, SSB (t) and CV for each of the split stocks found on the MSHAS for the years 2014 to 2022 BiologyStockCodes: her-vian = autumn spawning 6.a.N herring; her-irlw = 6.a.S,7b, c herring; her.27.6a7bc = mix of herring from 6.a. and 7b, c, i.e. unknown or below threshold fish; her-67bc = spring spawning herring of uncertain origin, could be 6.a.N or 6.a.S/7.b, c.

	Mean weight at age									
Year	Age(-wr)	1	2	3	4	5	6	7	8	9+
2014	her.27.6a7bc		122.98	130.61	179.8	200.62	212.94	218.37		232
2015	her.27.6a7bc		154.04	183.74	189.8	206.67	221.47	263.03	198.36	
2016	her.27.6a7bc		156.49	166.31	161	173.71	200.05	195.95	205.38	
2017	her.27.6a7bc		132.61	166.69	162.5	207.83	178.51	209.83	220	177
2018	her.27.6a7bc	49.48	108.85	155.62	168.6	190.89	187.87	218.45	199.65	225.2
2019	her.27.6a7bc		104.02	185.65	181.1	188.74	189.44	214.24	222.82	193
2020	her.27.6a7bc	50.94	104.59	133.67	163.4	137.77	172.61		219.13	
2021	her.27.6a7bc	71.16	102.84	165.98	148.55		212.77	187.00	191.00	243.15

2022	her.27.6a7bc		126.25	153.90	170.06	169.90	189.26			

Mean weight at age

Year	Age(-wr)	1	2	3	4	5	6	7	8	9+
2014	her-67bc		142.07	163.07	177.6	212.95	220.37	241.62	238.36	256.6
2015	her-67bc		147.57	177.89	197.1	203.42	220.09	228.78	188.15	
2016	her-67bc		157.41	128.91	179.4	203.5	214.37	215.67	214.3	
2017	her-67bc		137.39	170.1	186.9	199.97	205.04	221.08	225	231.7
2018	her-67bc	48.46	104.23	155.63	174.4	192.71	213.9	216.47	215.2	229.1
2019	her-67bc	103.68	127.7	133.15	180.4	202.27	223.03	219.98	220.74	209.8
2020	her-67bc	68.65	129.76	154.08	181	201	215.66	223.22	207.59	
2021	her-67bc	59.93	126.83	161.47	181.97	213		218.32	258	
2022	her-67bc	56.31	119.56	165.13	182.26	189.06	221.89	295	208.87	329

Mean weight at age

Year	Age(-wr)	1	2	3	4	5	6	7	8	9+
2014	her-irlw		134.74	159.19	177.5	201.06	211.04	213.03	224.16	231.2
2015	her-irlw		134.47	173.81	188	194.66	201.2	205.55	206.98	
2016	her-irlw		130.72	133.84	168.5	204.33	204.86	206.58	210.52	274.3
2017	her-irlw		133.46	161.43	172.3	185.24	196.36	194.56	202.98	177
2018	her-irlw	48.67	107.92	149.17	172.5	183.84	206.14	208.64	210.24	218.7
2019	her-irlw	86.42	116.56	153.2	167.5	190.95	182.68	189.54	220.5	218.9
2020	her-irlw	54.98	110.01	136.84	157.8	171.39	190.92	203.78	201.1	233.3
2021	her-irlw	70.22	108.67	151.23	171.12	182.24	195.80	203.31	205.02	210.58
2022	her-irlw	52.45	118.14	148.33	169.26	178.63	190.17	194.17	193.69	213.72

Mean weight at age

Year	Age(-wr)	1	2	3	4	5	6	7	8	9+
2014	her-vian		141.84	178.54	181.6	212.39	215.81	229.15	226.41	254.8
2015	her-vian		158.69	183.97	197.7	214.14	220.46	218.99	198.38	219.8
2016	her-vian		147.09	153.99	174.4	194.59	208.82	201.41	219	224.9
2017	her-vian		130.16	174.83	184.2	197.42	206.63	211.2	238.4	220.6
2018	her-vian	50.85	102.73	164.15	181.2	203.44	206.45	200.43	232.45	216.9
2019	her-vian		121.3	140.2	174.6	207.64	214.36	204		211.8
2020	her-vian	49.99	112.18	148.75	168	198.04	198.56	220.27		
2021	her-vian	63.07	109.53	160.90	166.07	197.99	272.45	248.79	269.85	239.49
2022	her-vian	68.96	127.54	159.46	174.26	192.70	198.96	253.14	222.86	252

Table 2: Mean weight at age for each of the split stocks found on the MSHAS for the years 2014 to 2022. BiologyStockCodes: her-vian = autumn spawning 6.a.N herring; her-irlw = 6.a.S,7b, c herring; her.27.6a7bc = mix of herring from 6.a. and 7b, c, i.e. unknown or below threshold fish; her-67bc = spring spawning herring of uncertain origin, could be 6.a.N or 6.a.S/7.b, c.

	Maturity ogive									
Year	Age(-wr)	1	2	3	4	5	6	7	8	9+
2014	her.27.6a7bc	0	0.52	0.51	0.92	1	1	1		1
2015	her.27.6a7bc	0	0.65	0.98	1	1	1	1	1	
2016	her.27.6a7bc	0	1	1	1	1	1	1	1	
2017	her.27.6a7bc	0	1	1	0.82	1	1	1	1	1
2018	her.27.6a7bc	0	0.77	0.96	0.95	1	1	1	1	1
2019	her.27.6a7bc	0	0.16	1	1	1	1	1	1	1
2020	her.27.6a7bc	0	0.32	0.93	1	1	1		1	
2021	her.27.6a7bc	0	0.18	1	1		1	1	1	1
2022	her.27.6a7bc		1	1	1	1	1			

	Maturity ogive									
Year	Age(-wr)	1	2	3	4	5	6	7	8	9+
2014	her-67bc	0	0.74	0.79	0.99	1	1	1	1	1
2015	her-67bc	0	0.18	0.81	0.99	1	1	1	1	
2016	her-67bc	0	1	1	1	1	1	1	1	
2017	her-67bc	0	1	0.99	1	1	1	1	1	1
2018	her-67bc	0	0.27	0.96	0.98	1	1	1	1	1
2019	her-67bc	0	0.2	0.45	1	1	1	1	1	1
2020	her-67bc	0	0.29	0.53	1	1	1	1	1	
2021	her-67bc	0	0.46	0.98	1	1		1	1	
2022	her-67bc		0.56	0.96	1	1	1	1	1	1

	Maturity ogive									
Year	Age(-wr)	1	2	3	4	5	6	7	8	9+
2014	her-irlw	0	0.85	0.81	0.99	1	1	1	1	1
2015	her-irlw	0	0.41	0.84	0.98	0.94	0.99	0.98	1	
2016	her-irlw	0	1	1	1	1	1	1	1	1
2017	her-irlw	0	1	0.99	0.99	1	1	1	1	1
2018	her-irlw	0.01	0.42	0.82	0.97	0.98	1	1	1	1
2019	her-irlw	0	0.51	0.94	1	1	1	1	1	1
2020	her-irlw	0	0.25	0.64	1	1	1	1	1	1
2021	her-irlw	0.01	0.38	0.92	1	1	1	1	1	1
2022	her-irlw	0	0.76	0.97	1	1	0.97	1	1	1

	Maturity ogive									
Year	Age(-wr)	1	2	3	4	5	6	7	8	9+
2014	her-vian	0	0.98	1	0.95	1	1	1	1	1
2015	her-vian	0	0.88	0.99	0.99	1	1	1	1	1
2016	her-vian	0	1	0.98	1	1	1	1	1	1
2017	her-vian	0	1	1	1	1	1	1	1	1
2018	her-vian	0	0.37	0.97	1	1	1	1	1	1

2019	her-vian	0	0.51	0.48	1	1	1	1		1
2020	her-vian	0	0.47	0.97	1	1	1	1		
2021	her-vian	0	0.45	1	1	1	1	1	1	1
2022	her-vian	0	.99	1	0.97	1	1	1	1	1

Table 3: Maturity ogive for each of the split stocks found on the MSHAS for the years 2014 to 2022. BiologyStockCodes: her-vian = autumn spawning 6.a.N herring; her-irlw = 6.a.S,7b, c herring; her.27.6a7bc = mix of herring from 6.a. and 7b, c, i.e. unknown or below threshold fish; her-67bc = spring spawning herring of uncertain origin, could be 6.a.N or 6.a.S/7.b, c.

References

Farrell, E.D., Campbell, N., Carlsson, J., Egan, A., Gras, M., Lusseau S.M., Nolan, C., O'Connell, S., O'Malley, M., White, E. 2021. Herring in Divisions 6.a, 7.b and 7.c: Scientific Assessment of the Identity of the Southern and Northern Stocks through Genetic and Morphometric Analysis. Final Report. European Commission. Service Contract EASME/EMFF/2017/1.3.2.1/SI2.767459. 251 pp.

ICES. 2023. Benchmark Workshop on North Sea and Celtic Sea stocks (WKNSCS). ICES Scientific Reports. 4:85. 324 pp. https://doi.org/10.17895/ices.pub.21558681

Annex 17: Working document: Effect of missing coverage of Stratum 131 in HERAS 2022

Effect of missing coverage of Stratum 131 in HERAS 2022

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Introduction

Due to a loss of survey time originating from inclement weather and technical issues, stratum 131 (Figure 1) of the HERAS survey could not be covered by RV "Solea" (Germany) as planned in 2022 and had to be completely omitted. This working document investigates the potential effect of this on the indices delivered to the stock assessments carried out by HAWG.

Although HAWG uses input data derived from the HERAS survey for several stocks, only two assessments are potentially impacted by the omission of this stratum in 2022: 1) The assessment of Herring (*Clupea harengus*) in Subarea 4 and Divisions 3.a and 7.d, autumn spawners (North Sea, Skagerrak and Kattegat, eastern English Channel), which uses inputs for abundance at age for ages 1-8+, mean weight at age and proportion mature at age derived from the HERAS survey (ICES 2022a) and 2) the assessment of Sprat (*Sprattus sprattus*) in Division 3.a and Subarea 4 (Skagerrak, Kattegat and North Sea) which uses inputs of abundance of ages 1-3 from the HERAS survey (ICES 2019a).

Method

Distribution maps of sprat and herring within the HERAS survey area in 2022 were compared to those for the latest 6 years to investigate consistent patterns of distribution. The proportional contribution of stratum 131 to the overall abundance of sprat and North Sea autumn spawning herring respectively in the years 2016 – 2021 was calculated. Finally, patterns in age composition for the sprat for 2016 -2021 were investigated. All data and maps for these comparisons were extracted from the survey reports for HERAS in the years 2016 – 2022 (ICES 2017, ICES 2018, 2019b, 2020, 2021, 2022b, 2023).

Results

North Sea Autumn Spawning Herring

In 2016, the distribution of herring in the North Sea was wide spread from North to South. In contrast, since 2017, the pattern in distribution has been very consistent with the larger aggregations found in the North-western North Sea, north of 57°N and very little herring encountered in the middle of the North Sea such as in stratum 131 (Figure 2).

Whilst stratum 131 contributed significantly to the overall stock abundance of North Sea Autumn Spawning herring in 2016, the contribution of this stratum since 2017 has been limited, ranging from 0% in 2021 to 9% in 2018 (average 4% for the 2017 - 2021 period) (Table 1). The herring encountered in stratum 131 is almost exclusively small juvenile herring with a mean weight of on average 24.2g in 2017 – 2021. Herring of this size are primarily 0-group and neither considered very reliably estimated in this survey nor used in the assessment. These fish do not contribute to the calculations of Spawning Stock Biomass.

Given the distribution of herring in the 2022 survey in the North Sea surrounding the omitted stratum, there is no indication to expect any significant deviation from this pattern. The 2022 HERAS indices for North Sea Autumn Spawning herring are therefore not considered to be significantly impacted by the loss of coverage in stratum 131. It is likely that the abundance of very small juvenile herring is underestimated in the survey. The impact on the assessment is expected to be negligible though, as the 0-ringer index is not practically used in the assessment.

Sprat in Division 3a and Subarea 4.

The distribution pattern of sprat in the HERAS surveys 2016 – 2021 is very consistent (Figure 3). Sprat is typically found in largest aggregations in the South-eastern part of the North Sea with the distribution following the outline of the Dutch, German and Danish Coastline. The distribution includes the southern part of stratum 131 in most years and the contribution to total sprat abundance from this stratum has ranged from 1% in 2018 to 13% in 2017 (average 7% in 2016 - 2021, Table 2).

In neighbouring strata, sprat distribution in 2022 is similar to previous years and it is reasonable to assume that the contribution from stratum 131 in 2022 would have been on a similar scale as in the years 2016 - 2021. The sprat in stratum 131 has in previous years been primarily larger mature individuals with an average mean weight of 10.9g (Table 2). The stratum contributes with over 5% and 10% to the overall biomass of the 2- and 3-year-old sprat respectively in most years (Figures 4 and 5). The contribution to the biomass of 1-year-olds is more variable, reflecting the large uncertainty in the estimate for this age in the survey.

In conclusion, the lack of coverage in stratum 131 in the 2022 HERAS survey will have some impact on the indices for sprat. The abundances for sprat aged 1-3 are likely underestimated in the 2022 survey. Previously the contribution from this stratum has been up to 13% and on average 7%. Given the similarities in distribution over the time series, a similar contribution from stratum 131 in the survey in 2022 would be a reasonable expectation.

Conclusion

The 2022 HERAS had no coverage of stratum 131. Despite this lack of coverage in the central North Sea, all main aggregations of mature herring are considered to have been sampled adequately.

For sprat however, the omission of the stratum is likely to have led to an underestimate of the total abundance in 2022. In recent years this stratum has contributed with up to 13% of total abundance (average 7% over the period 2016-2021).

References

ICES (2017): Interim Report of the Working Group of International Pelagic Surveys (WGIPS). ICES Expert Group reports (until 2018). Report. https://doi.org/10.17895/ices.pub.8705

ICES (2018): Report of the Working Group on International Pelagic Surveys (WGIPS). ICES Expert Group reports (until 2018). Report. https://doi.org/10.17895/ices.pub.7455

ICES (2019a). Stock Annex: Sprat (Sprattus sprattus) in Division 3.a and Subarea 4 (Skagerrak, Kattegat and North Sea). ICES Stock Annexes. Report. https://doi.org/10.17895/ices.pub.18623360.v1

ICES (2019b): Working Group of International Pelagic Surveys (WGIPS). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.5122

ICES (2020): Working Group of International Pelagic Surveys (WGIPS). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.6088

ICES (2021): Working Group of International Pelagic Surveys (WGIPS). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.8055

ICES (2022a). Stock Annex: Herring (Clupea harengus) in Subarea 4 and divisions 3.a and 7.d, autumn spawners (North Sea, Skagerrak and Kattegat, eastern English Channel). ICES Stock Annexes. 67 pp. https://doi.org/10.17895/ices.pub.18622589

ICES (2022b): Working Group on International Pelagic Surveys (WGIPS). ICES Scientific Reports. Report. https://doi.org/10.17895/ices.pub.20502822.v1

ICES (2023): Working Group on International Pelagic Surveys (WGIPS). ICES Scientific Reports. Report. (In press)

Figures and Tables

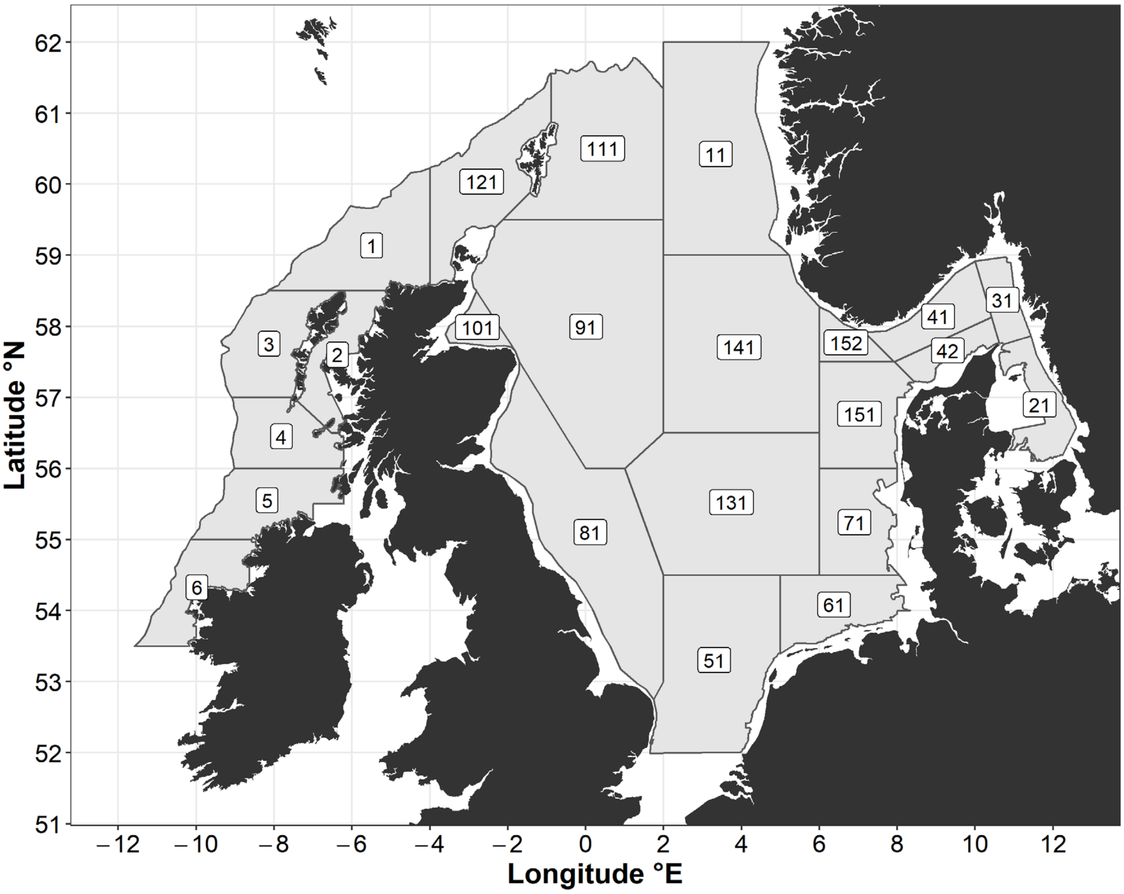

Figure 1. Strata used in the HERAS survey showing the location of stratum 131 in the central North Sea

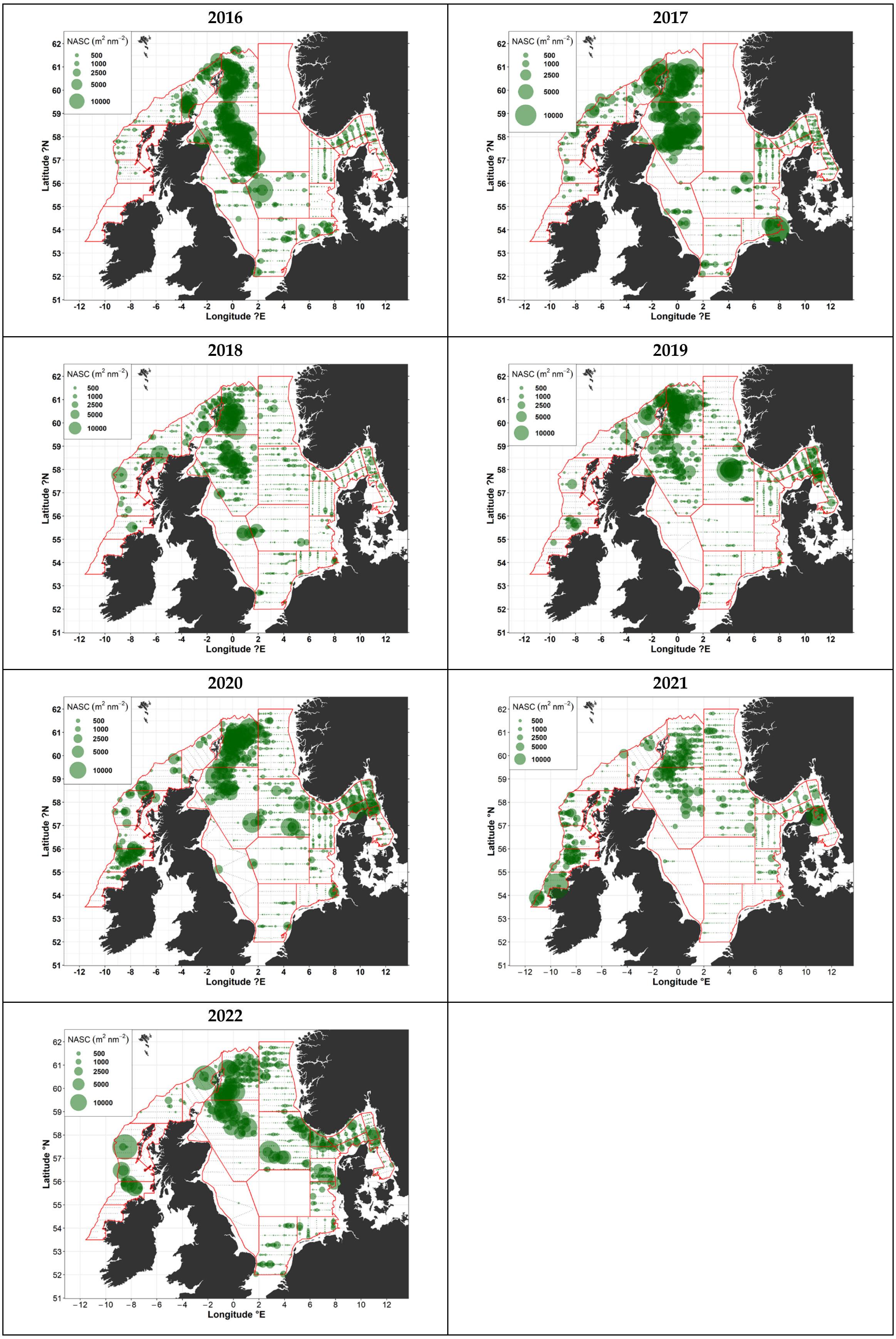

Figure 2. Distribution of NASC attributed to herring in HERAS in 2017-2022. Acoustic intervals represented by light grey dot with green circles representing size (NASC value as a proxy) and location of herring aggregations. NASC values are resampled at 5 nmi. intervals along the cruise track. The red lines, where present, show the strata system.

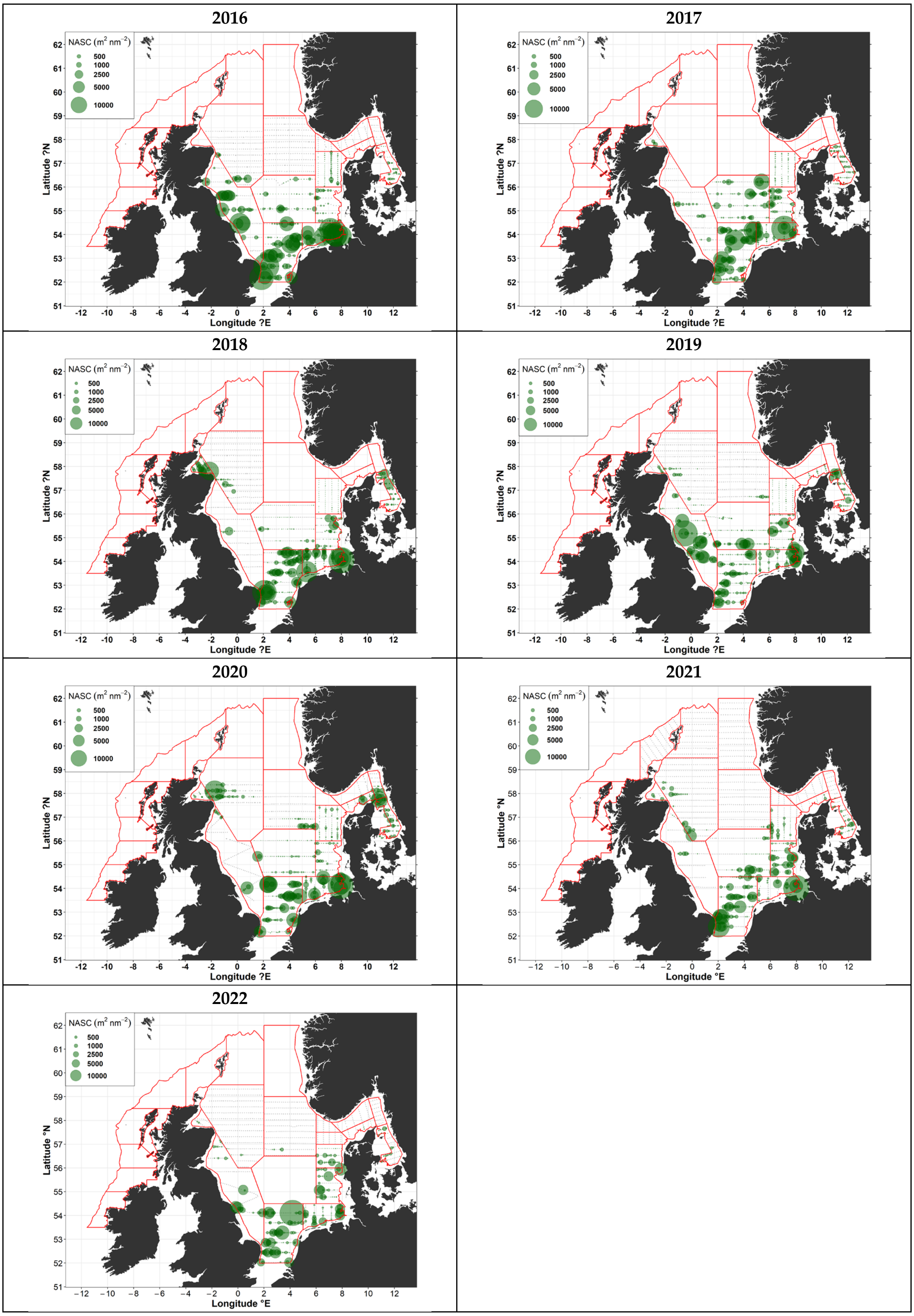

Figure 3. Distribution of NASC attributed to sprat in HERAS in 2017 - 2022. Acoustic intervals represented by light grey dot with blue circles representing size (NASC values as a proxy) and location of sprat aggregations. NASC values are resampled at 5 nmi. intervals along the cruise track. The red lines where present show the strata system.

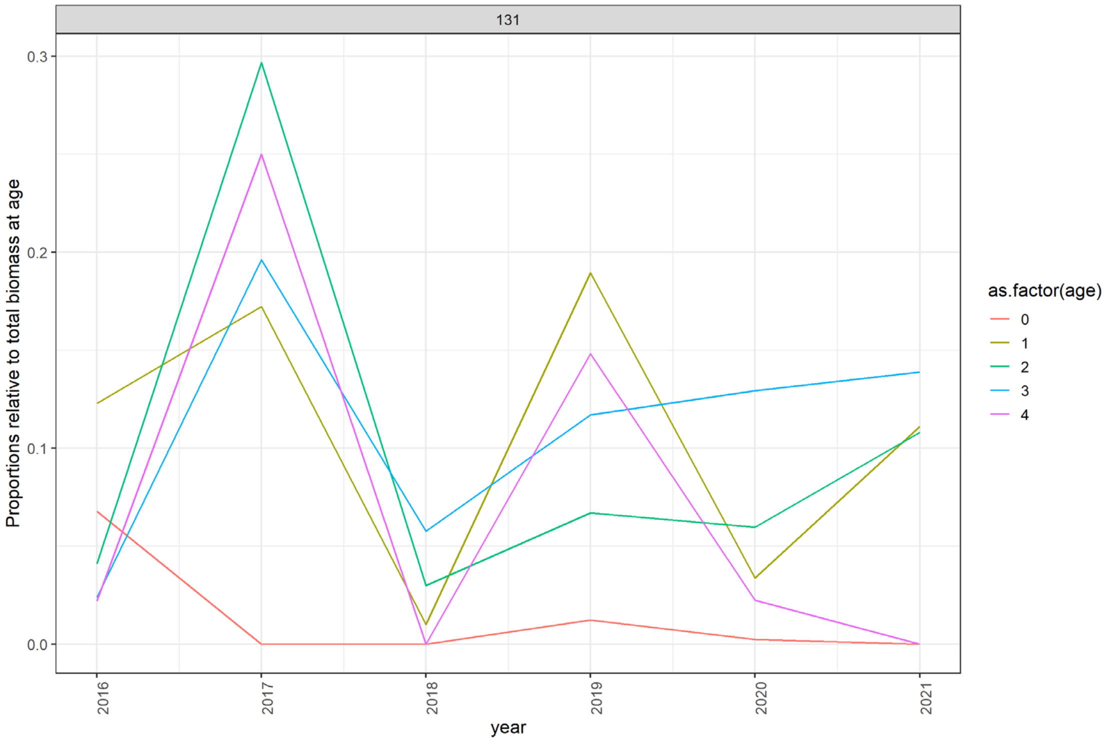

Figure 4. Sprat in Div. 3.a and Subdivision 4. Proportion of biomass in stratum 131 relative to the total age specific survey biomass for age 0 to 4.

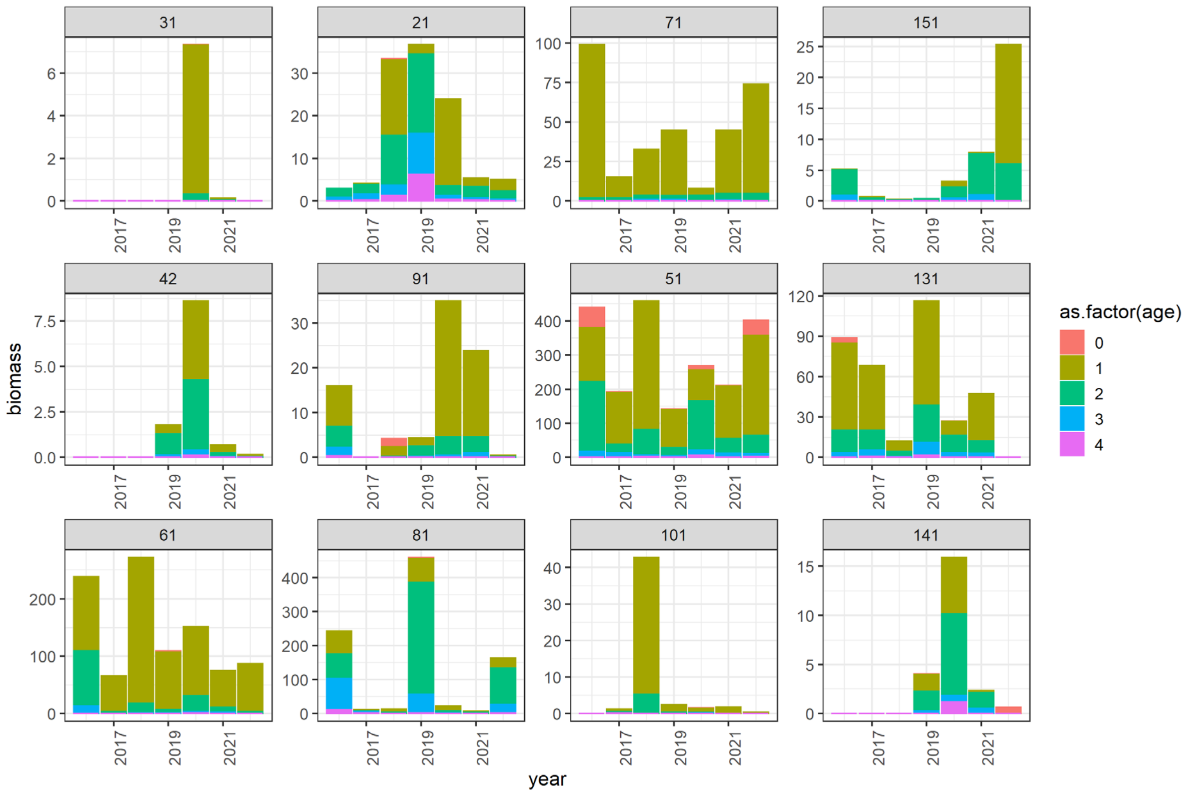

Figure 5. Sprat in Div. 3.a and Subdivision 4. Biomass at age in all strata since 2017. See figure 1 for corresponding naming of strata. Note the varying scaling of y-axis. The biomass in stratum 131 is 0 in 2022 due to the lack of coverage.

Table 1. North Sea autumn spawning herring results from stratum 131 during the HERAS survey in 2016 - 2021. Abundance, biomass, mean weight and proportion mature in the stratum as well as contribution to total abundance and biomass each year.

Year	Abundance (mill)	Biomass (kt)	Mean weight (g)	Proportion Mature	% Total Abundance	% Total Biomass
2016	12485	439	35.2	0.18	24%	12%
2017	1289	32	25.1	0.00	4%	1%
2018	3080	107	34.7	0.00	9%	4%
2019	454	6.5	14.4	0.01	2%	0%
2020	981	32	32.7	0.02	4%	2%
2021	94	1.4	14.3	0.00	0%	0%

Table 2. Results for sprat from stratum 131 during the HERAS survey in 2016 - 2021. Abundance, biomass, mean weight and proportion mature in the stratum as well as contribution to total abundance and biomass each year.

Year	Abundance (mill)	Biomass (t)	Mean weight (g)	Proportion Mature	% Total Abundance	% Total Biomass
2016	13227	88818	6.7	0.50	9%	7%
2017	6025	68315	11.3	0.98	13%	19%
2018	1022	11650	11.4	1.00	1%	1%
2019	11834	116028	9.8	0.91	9%	13%
2020	2100	26782	12.8	0.98	3%	5%
2021	5113	47408	9.3	0.99	9%	11%

Annex 18: Working document: Identifying historical catches of Norwegian spring spawning herring during the HERAS survey based on genetics and growth differences

Identifying historical catches of Norwegian spring spawning herring during the HERAS survey based on genetics and growth differences

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Abstract

The North Sea Herring Acoustic Survey (HERAS) is the most important fisheries independent data input to the stock assessments of Atlantic herring (*Clupea harengus*) in the North Sea. The survey provides abundance estimates for two herring stocks: North Sea autumn spawning (NSAS) herring and western Baltic spring spawning (WBSS) herring. Since 2021, genetic stock identification methods have been applied for the purposes of stock discrimination. These analyses demonstrate that during the survey time (summer) multiple herring stocks occur in the area, for example Norwegian spring spawning (NSS) herring. Stock discrimination is applied in the north-eastern survey areas covered by Norway and Denmark, but not in the north-western part (covered by Scotland) where the highest herring abundance is observed. NSS herring are generally larger when compared to NSAS herring of the same age. Here we combine the genetic information and length-at-age data from the north-eastern survey area to identify NSS herring in the north-western part lacking stock splitting. Growth curves (length-at-age) of genetically identified NSAS and NSS herring were calculated. For fish aged 5 winter rings and older, clear size differences occur. We used the mean length-at-age of NSAS herring plus two standard deviations (97.5% of the NSAS data is smaller) as a threshold to separate NSAS and NSS herring. We assigned all individuals larger than this threshold as NSS herring. Our result demonstrated that NSS herring were present in the HERAS data in all years from 2010-2022, but the relative abundance increased in recent years with up to 25% NSS within individual stations. NSS herring were mainly located in the northern part of the survey area.

Cross-validation using genetically identified individuals, indicated high self-assignment rates among NSAS herring but low assignment rates among NSS herring. Thus, using two standard deviations as a threshold is a conservative approach and the actual number of NSS herring are considered to be underestimated. This study shows the usefulness of individual genetic assignments. This can be used to give managers a more detailed picture of exactly what 'stocks' are to be found in their respective management areas.

Keywords: stock identification, genetics, stock discrimination, SNP, stock assessment

Introduction

Static boundaries, like the 62° N latitude separating fish stocks from the North Sea and the Norwegian Sea for management purposes, may be problematic for the assessment and management of highly migratory species such as pelagic fish. In such areas fish stocks (management units) are known to overlap in time and space. Therefore, it is crucial to identify stock mixing and/or assign individuals to their original stock for abundance estimates (Begg et al., 1999). An important data source for the stock assessments are scientific survey estimates.

For stock assessments of Atlantic herring (*Clupea harengus*) in the greater North Sea ecoregion, the "North Sea Herring Acoustic Survey" (HERAS) conducted annually in June-July, provides fisheries independent input on abundance, length, maturity and weight at age for several herring stocks in the region. The northern boundary of the survey area is 62° N (Fig. 1). Presently, herring south of this boundary in strata (121, 111 and 91) are assumed to be North Sea autumn spawning (NSAS) herring for the purpose of stock assessment index calculation. Any herring found north of this boundary are assumed to be Norwegian spring spawning (NSS) herring. Two other surveys targeting Atlantic herring are carried out North of 62° N: the "International Ecosystem Survey of the Nordic Seas" (IESNS) annually in May and the "International Ecosystem Summer Survey of the Nordic Seas" (IESSNS) annually in July. These provide input to the assessments of Norwegian Spring spawning (NSS) herring. All herring encountered north of 62° N in these surveys are assumed for index calculation purposes to be NSS herring. From the HERAS, IESNS and IESSNS surveys we know that although there is paucity between the large aggregations of herring in the HERAS survey and those encountered further north in the IESNS and IESSNS surveys, there are herring detected in the area around the 62° N indicating movement across this geographic boundary.

Furthermore, NSS herring are occasionally picked out and noted during otolith age reading of herring in these northern areas of the HERAS survey based on otolith shape, but this method has not been systematically applied and is also not robust. However, this demonstrates that NSS herring are present south of the management boundary but no methodical stock discrimination between these two stocks is applied in the scientific surveys. Since 2021 genetic stock identification has been applied in the north-eastern part of the North Sea (strata 11 and 141) and south-eastern North Sea, Skagerrak and Kattegat (strata 151,152, 41, 42, 31 and 21) allowing for individual herring to be assigned to a genetic population (Berg et al., 2021; Bekkevold et al., 2023). The main reason was to allow separating western Baltic spring spawning (WBSS) and NSAS herring in these areas for index calculation, but also allows the identification of NSS herring with high certainty, as well as the presence of herring from several other genetic populations depending on sample location. Given the advances in genetic methodology to discriminate individual herring in the survey area, discrimination between NSS and NSAS using phenotypic traits can now be corroborated by the results obtained by genetic analysis. Earlier studies show that NSAS and NSS herring have different growth patterns, with NSS typically being bigger at a given age, but due to potential mixing no direct separation could be applied (Berg et al., 2017).

We investigate the use of the length-at-age of genetically identified herring to establish a separation method for NSAS and NSS herring based on the growth differences between them. We then tested the method on a subset of HERAS survey data for which the degree of stock mixing was fully known based on genetic methods (strata 11, 141, 151, 152, 31, 41 and 42). The method was then applied to the survey data in strata, where stock separation is presently not applied, to document the prevalence of NSS herring in this area over several years, which are currently included in the NSAS stock assessment inputs. Finally, we estimate the relative abundance of NSS herring.

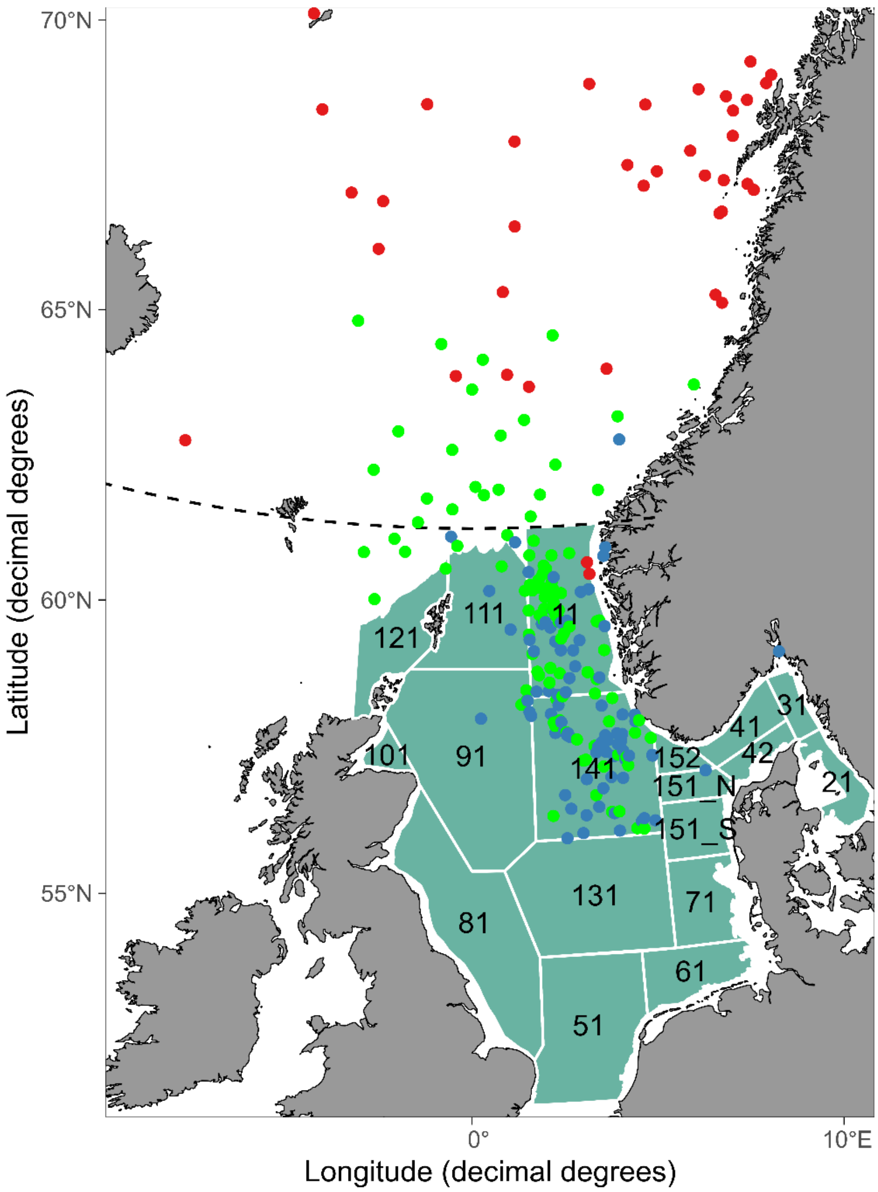


Fig. 1 Overview map of the HERAS survey area and its stratum system (green areas). Points indicate sampling location of genetically identified herring: NSAS (blue), NSS (red), both (light green). Dashed line indicates 62° N, the theoretical geographical border between the two stocks

Materials and Methods

Individual herring were sampled during the Norwegian components of the HERAS (June-July), "International Ecosystem Survey of the Nordic Seas" (IESNS) (May) and "International Ecosystem Summer Survey of the Nordic Seas" (IESSNS) (July) in 2019-2022 as well as from

Norwegian commercial catches in the North Sea in 2021 (May-July). Fin clips of herring were collected, DNA extracted and genotyped, and individual herring were assigned to a stock as described in Berg et al. (2021) and Bekkevold et al. (2023). Mean lengths-at-age and standard deviations were calculated separately for individuals genetically identified as North Sea autumn spawning and Downs herring, hereafter combined as NSAS (n = 4218), and Norwegian spring spawning (NSS, n = 1392) herring (Fig. 2). For individuals of age 5 (winter rings) and older the length-at-age differed significantly ($p<0.05$), therefore, the following growth separation was only applied for these individuals. For being conservative, we used the mean length-at-age of NSAS herring plus two standard deviations as buffer to separate NSAS and NSS herring (Table 1). By using two standard deviations we theoretically ensured that 97.5% of the NSAS data is below this threshold for each age.

Table 1 Mean length-at-age (in cm and wr = winter ring) plus two standard deviations for North Sea autumn spawning and Downs herring combined (NSAS) used as a threshold to identify Norwegian spring spawning (NSS) herring. The separation method was only applied for individuals of age 5 winter rings and older.

	NSAS				NSS		
Age (wr)	**N**	**Mean length**	**Standard deviation**	**Threshold**	**N**	**Mean length**	**Standard deviation**
1	746	17.2	2.15		12	19.3	1.12
2	1393	23.2	1.70		52	25.4	2.12
3	393	25.6	2.03		29	27.5	2.00
4	223	27.1	1.73		319	28.4	2.12
5	254	27.3	1.52	30.3	484	30.8	1.33
6	220	28.5	1.42	31.3	268	31.4	1.22
7	311	28.4	1.57	31.6	90	33.2	1.33
8	328	28.9	1.60	32.1	52	34.0	1.36
9	165	29.5	1.34	32.2	18	34.1	1.49
10	65	30.2	1.31	32.8	19	35.5	1.77
11	54	31.0	1.35	33.7	10	36.5	1.03
12	38	30.7	1.10	32.9	7	36.7	0.91
13	15	30.3	1.07	32.4	9	36.6	0.68
14	10	30.5	1.27	33.0	3	35.5	0.50

First, we applied this growth separation on the genetically identified individuals to cross-validate this method. Further, we applied this separation method on herring genetically assigned to other populations than NSAS or NSS collected during the HERAS survey to investigate potential misclassification among other herring populations. Genetically assigned herring are available for the Norwegian and Danish HERAS data from 2019 and 2021 onwards, respectively. Lastly, the growth separation was applied for the entire HERAS survey area for the years 2010-2022 to estimate the abundance of NSS herring. Proportions per station were estimated and plotted on maps to identify the spatial distribution of NSS herring (Fig. 3).

Results

In general, the mean lengths-at-age of North Sea autumn spawning (NSAS) herring are smaller than of Norwegian spring spawning (NSS; Fig. 2). However, these differences were only significant ($p<0.05$) for ages 5 and older. From age 5 onwards, the mean length of NSS herring was consistently above mean length of NSAS herring plus two standard deviations and this metric was chosen as the threshold for separating herring from the two stocks in the survey data. Below the age of 5 winter rings the separation was not as clear cut, and the separation was only carried out on herring aged 5+ winter rings.

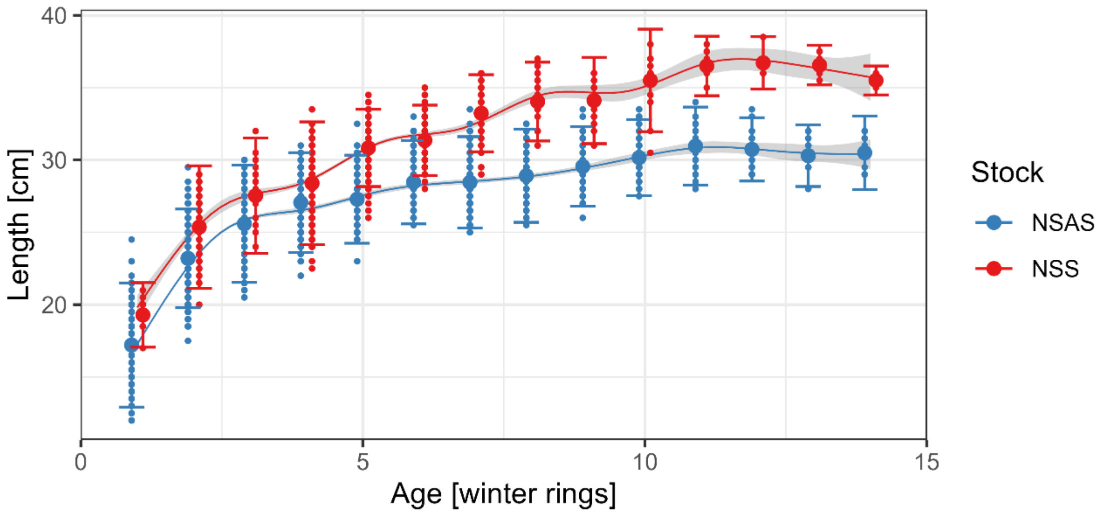


Fig. 2 Length-at-age data for genetically identified North Sea autumn spawning and Downs herring combined (NSAS) and Norwegian spring spawning (NSS) herring. Large circles indicate the mean length per age (wr, winter rings). Error bars represent two standard deviations. Lines are loess smoothers plus 95% confidence interval.

Cross-validation of genetically identified herring of age 5+ against those identified by the growth separation, including all individuals used to estimate the length-at-age differences, indicated that in general 86% are correctly assigned (Table 2). Within the genetically NSAS herring, 97.4% were correctly reassigned as NSAS herring using the growth separation, this validates the assumption that 97.25% of the NSAS herring data would be smaller than the threshold. Genetically identified NSS herring were identified correctly by the separation method for 69.2% of the individuals. Since 2019 herring during the HERAS survey are genetically identified, among those only 55 out of 116 individuals of age 5+ genetically identified NSS (47.4%) were also identified as NSS applying the growth separation (Table 3). For other genetic populations, the number of identified NSS based on the growth separation can be neglected (1.2%, Table 3).

Table 2 Cross-validation of genetically assigned North Sea autumn spawning and Downs herring combined (NSAS) and Norwegian spring spawning (NSS) herring against herring identified based on the growth separation. Only herring of age 5 and older are included.

		Growth separation		
		NSAS	NSS	Total
Genetic stock	NSAS	1425 (58.3%)	38 (1.6%)	1463
	NSS	302 (12.4%)	678 (27.7%)	980
	Total	1727	716	2443

Table 3 Total number (N) of genetically assigned herring collected during the HERAS survey 2019-2022, against herring identified based on the growth separation as Norwegian spring spawning (NSS) herring. Only herring of age 5 and older are included.

Genetic Population	**N**	**NSS**
North Sea autumn spawners (NSAS)	668	6 (0.9%)
Norwegian spring spawners (NSS)	116	55 (47.4%)
Others	506	6 (1.2%)

Applying the growth separation method, we identified NSS herring during the HERAS in all years from 2010-2022 (Fig. 3). The relative amount of NSS herring varied between years and trawl stations. For stations with identified NSS herring, 237 out of 304 (69.7%) had only 5 or less identified NSS herring. However, the relative abundance increased in 2019 with up to 25% of NSS herring per station (Table 4). In general, NSS herring were located in the northern part of the survey area and their abundance decreased further south. The most southern station with herring identified as NSS by growth separation was at 57.3° N.

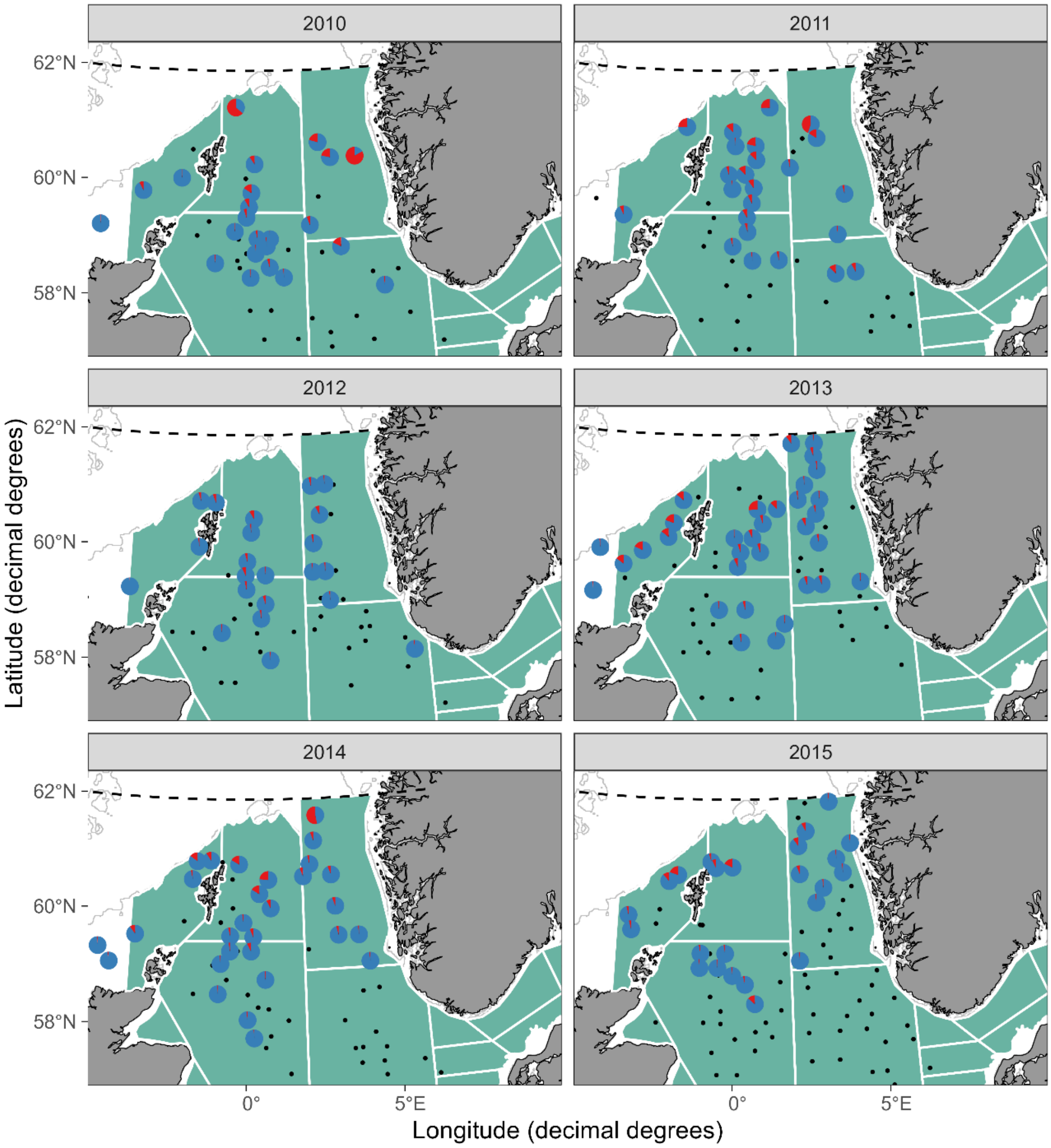
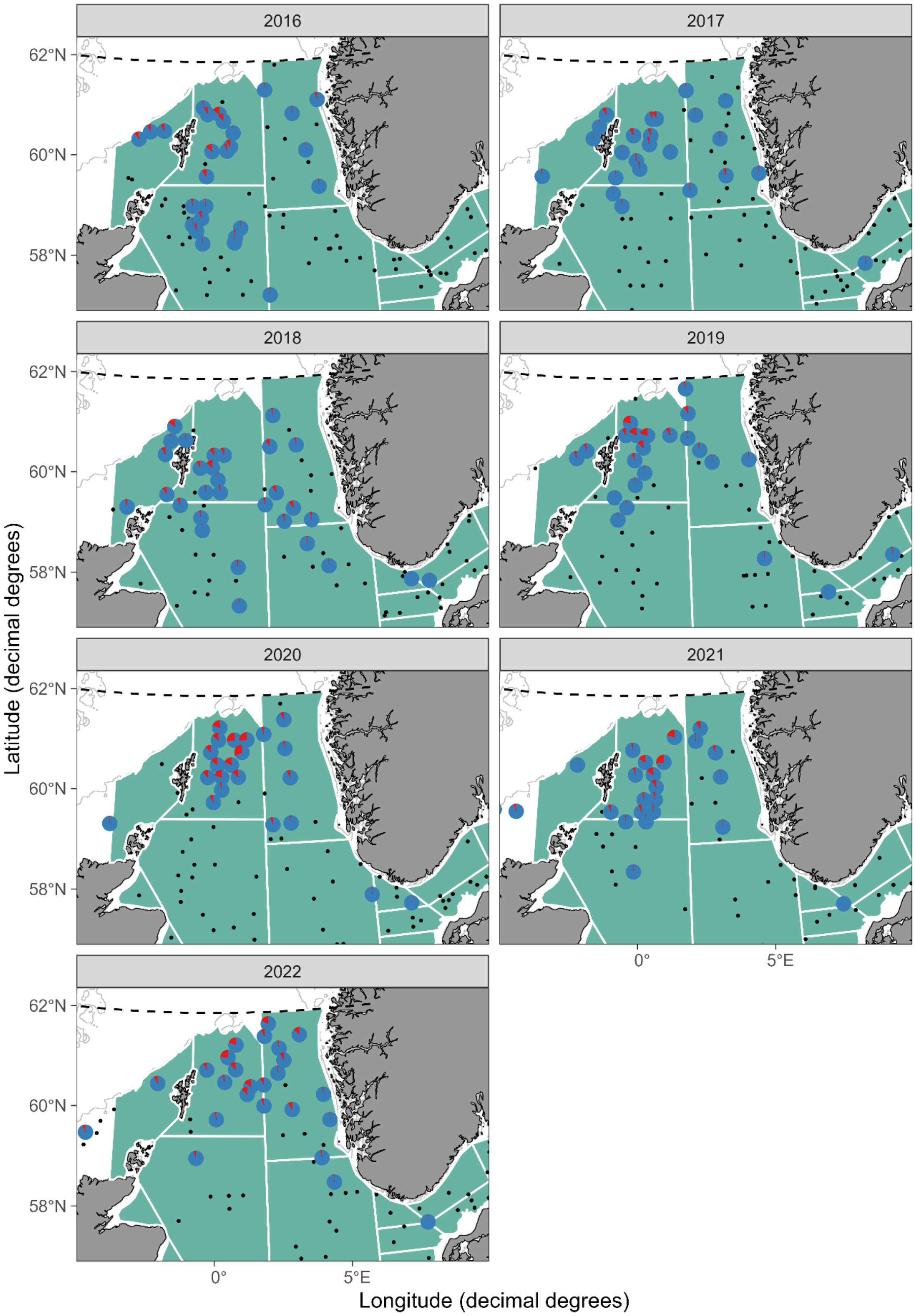


Fig. 3 Proportions of North Sea autumn spawning (blue, NSAS) and Norwegian spring spawning (red, NSS) herring for stations with at least one NSS herring collected during the HERAS survey in 2010-2022. Stations without identified NSS are indicated as black points. The map is limited to the area where NSS are identified. HERAS strata are shaded (see Fig. 1 for details). Note that the size of the circle is not linked to the actual catch size, thus the figure must be interpreted with caution.



Continue Fig. 3

Table 4 Mean proportion (Mean_prop), standard deviation (SD_prop) and maximum proportion (Max_prop) of Norwegian spring spawning herring (NSS) for all stations with more than 10 individuals (N_all) collected north of 57° N during the HERAS 2010-2022. The mean proportion of station with at least one NSS herring was also estimated (Mean_NSS) and the number of stations with at least one NSS herring (N_NSS).

Year	Mean_prop	SD_prop	Max_prop	N_all	Mean_NSS	N_NSS
2010	4.15	10.39	63.64	48	9.05	22
2011	5.34	8.91	45.00	47	10.46	24
2012	1.55	2.31	8.75	50	3.53	22
2013	3.57	5.61	25.98	63	6.61	34
2014	4.01	8.38	53.33	56	7.74	29
2015	1.70	3.90	19.83	78	5.52	24
2016	1.79	3.61	15.13	83	5.51	27
2017	1.00	2.14	9.47	86	3.45	25
2018	1.89	3.45	16.10	82	4.84	32
2019	2.03	4.68	22.52	74	6.53	23
2020	3.65	7.50	32.73	73	12.11	22
2021	2.96	5.70	27.42	58	7.14	24
2022	3.32	5.67	24.22	65	8.63	25

Discussion

Our study clearly demonstrates that NSS herring occur in higher abundance in the HERAS area than expected. Using the growth separation method, NSS herring were identified in the areas where it is assumed that all herring are NSAS herring. However, as the method can only confidently be used to identify NSS herring of ages 5 winter rings and older the likely presence of younger NSS herring will go undetected and result in an underrepresentation of NSS herring overall. Given the potential bias in survey estimates when not considering the amount of NSS herring and the high uncertainty when applying the growth separation, we highly recommend applying more precise stock identification methods, such as genetic analysis, to account for this uncertainty in survey estimates. At the same time, stock identification methods should also be applied on surveys north of 62° N to account for NSAS herring in this region.

Identified NSS herring were found in the northern part of the HERAS area which is expected because it is at the border to the management area of NSS herring. However, the growth separation was only applied for herring of age 5 and older which are typically not found in the central or southern part of the North Sea. This area as well as the Skagerrak and Kattegat is utilized as nursery grounds and mainly juvenile herring are observed. Furthermore, genetic analysis identified NSS in the central North Sea of age 1-2. Thus, the growth separation will underrepresent the actual abundance of NSS herring and other methods should be considered when stock identification is to be applied for management purposes to achieve reliable results.

The cross-validation results also demonstrated that although the growth separation method identified most of the NSAS herring it led to underestimation of the abundance of NSS herring.

Using two standard deviations as threshold was selected to identify the majority of NSAS herring rather than NSS herring. However, besides these short-comings and caveats of the growth separation methods, the relative abundance of NSS herring in the HERAS area cannot be neglected. Future studies should investigate the effects of including or excluding NSS herring for the survey estimate. Recalculating survey estimates should be conducted, implementing the results of this study to account for the actual impacts such stock mixing has.

The presented growth separation has some caveats that need to be considered. First of all, it is not applicable for herring younger than age 5. Not considering younger ages will automatically have effects on the recruitment estimates. These effects need to be further investigated. Furthermore, the separation method was established based on genetically identified herring in the eastern North Sea and Norwegian Sea. Thus, we are not accounting for NSAS herring from the western North Sea where the main abundance occurs. Genetic analyses of herring from this area are needed to validate our method. It cannot be excluded that length-at-age varies between herring in the western and eastern part of the North Sea. Furthermore, this method does not identify any other genetic populations observed in the HERAS survey area. When applying this method, it is only valid for the identification of herring populations with length-at-age larger than NSAS herring. This is also reflected in the cross-validation including other genetic populations. They are all assumed to have smaller length-at-age than NSS and possibly also NSAS. Therefore, those fish identified as NSS based on the growth separation are with high certainty NSS herring, whereas fish identified as NSAS could potentially represent other genetic populations.

In conclusion, the established growth separation highlights the need for precise stock identification methods such as genetic analysis. We identified the occurrence of NSS herring in the HERAS survey area which will have implication on the survey estimate and the assessment of the stock. We highly recommend that genetic analysis will be implemented in parts of the HERAS area which are currently not considered for stock identification. This will be crucial to document the magnitude of NSS herring prevalence and will further improve the established growth separation to include individuals throughout the entire HERAS survey area potentially allowing for back calculation of estimates.

References

Begg, G. A., Friedland, K. D., and Pearce, J. B. 1999. Stock identification and its role in stock assessment and fisheries management: an overview. Fisheries Research, 43: 1-8.

Bekkevold, D., Berg, F., Polte, P., Bartolino, V., Ojaveer, H., Mosegaard, H., Farrell, E. D., et al. 2023. Mixed-stock analysis of Atlantic herring (*Clupea harengus*): a tool for identifying management units and complex migration dynamics. ICES Journal of Marine Science, 0: 1-12.

Berg, F., Seljestad, G., Bekkevold, D., Kvamme, C., Dahle, G., and Glover, K. 2021. Stock splitting to estimate individual survey estimates for herring stocks occurring during the HERAS survey – Genetics as new method. Pages 470-477 in ICES. 2021. Working Group of International Pelagic Surveys (WGIPS). ICES Scientific Reports. 3:40. 481pp. doi: 10.17895/ices.pub.8055.

Berg, F., Slotte, A., Johannessen, A., Kvamme, C., Clausen, L. A. W., and Nash, R. D. M. 2017. Comparative biology and population mixing among local, coastal and offshore Atlantic herring (*Clupea harengus*) in the North Sea, Skagerrak, Kattegat and western Baltic. PLoS ONE, 12: e0187374.

Annex 19: Working document: Applicability of the Separation Function (SF) for Western Baltic Spring Spawning and Central Baltic herring stocks on 2022 GERAS survey results

Applicability of the Separation Function (SF) for Western Baltic Spring Spawning and Central Baltic herring stocks on 2022 GERAS survey results

by

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Abstract

Length – age data of herring sampled during the 2022 German Autumn Acoustic Survey (GERAS) in SD 21 and 23 as well as data from the German Baltic Acoustic Spring Survey (GERBASS) in SDs 28-29 were used to estimate parameters of the von Bertalanffy growth functions (BGF) for Western Baltic Spring Spawning herring (WBSSH) and Central Baltic herring (CBH) in 2022. The present results support the continued applicability of $SF_{2005\text{-}2010}$ for splitting both stocks based on growth parameters in 2022 despite the occurrence of some CBH in the GERAS baseline samples of WBSSH in SD 21 and in SD 23.

Introduction

The aim of this WD is to estimate parameters of the von Bertalanffy growth function (BGF) for Western Baltic Spring Spawning herring (WBSSH) and Central Baltic herring (CBH) based on new baseline samples from the German Autumn Acoustic Survey (GERAS) in SD 21 and 23 (WBSSH) and German BASS in SDs 28-29 (CBH) in 2022. Results were compared with the ones estimated for 2005 – 2010 to check the applicability of the $SF_{2005\text{-}2010}$ (Gröhsler *et al.*, 2013) on the latest survey samples for splitting WBSSH and CBH stocks in the survey estimate.

Material and Methods

Parameters of BGF for WBSSH

In 2022, 871 herring from SD 21 and SD 23 were sampled (GERAS) and used to estimate 2022 BGF parameters for WBSSH.

Parameters of BGF for CBH

Length and age data of herring captured during the German BASS in SDs 28-29 in 2022 (N = 572) were used to estimate 2022 BGF parameters for CBH.

Individual herring were allocated to a defined 0.5 cm length class by adding half of the length class to the measured total length TL (e.g. TL 20.5 cm = length class 20.75 cm). Age (winter rings, A_{WR}) was converted to age in months, A_M (with a "theoretical birthday" of January 1st), by the following equation:

$$A_M = A_{WR} \times 12 + T \quad (1)$$

with T representing survey / sampling month. The German acoustic surveys were conducted in May (GERBASS, T = 5), in October (GERAS, T = 10).

Individual age and length data from the baseline samples were used to derive growth patterns and parameters for both WBSSH and CBH using the von Bertalanffy growth equation

$$L_{S,A_M} = L_{\infty,S}(1 - e^{[+k_S(\frac{A_M}{12} - t_{0,S})]}) \quad (2)$$

where L_{S,A_M} denotes length of an individual of the corresponding stock S at age A_M, $L_{\infty,S}$ symbolizes mean maximum length, k_S represents growth parameter and $t_{0,S}$ stands for theoretical age at length zero of the corresponding stock.

Results

As in previous years, some individuals of the baseline sample of WBSSH were smaller than SF lengths (Fig. 1). The WBSSH BGF function in 2022 show a decreasing trend compared to BGF function estimated for the period 2005-2010, which can be explained by a far lower contribution of older/larger herring in 2022 together with some contribution CBH in the baseline sample. However, the majority of WBSSH could be allocated to the corresponding stock using the SF established with BGF parameters from 2005-2010. The L_∞ and k values of the BGF in 2022 were still within the range of previous years (Fig. 3).

In CBH, the length of individuals from the baseline samples was in all cases equal or smaller than the $SF_{2005\text{-}2010}$, also validating the applicability of the SF on this years´ samples (Fig. 2). The combination of L_∞ and k values was also within the range of earlier years (Fig. 3).

Conclusions

The estimates of BGF with baseline samples of WBSSH and CBH in 2022 support the continued applicability of SF for splitting the stocks in the survey estimate based on parameters derived from 2005 to 2010.

References

Gröhsler, T., Oeberst, R., Schaber, M., Larson, N. and Kornilovs, G. 2013. Discrimination of western Baltic spring-spawning and central Baltic herring (*Clupea harengus* L.) based on growth vs. natural tag information. – ICES Journal of Marine Science, 70: 1108–1117.

FIGURES

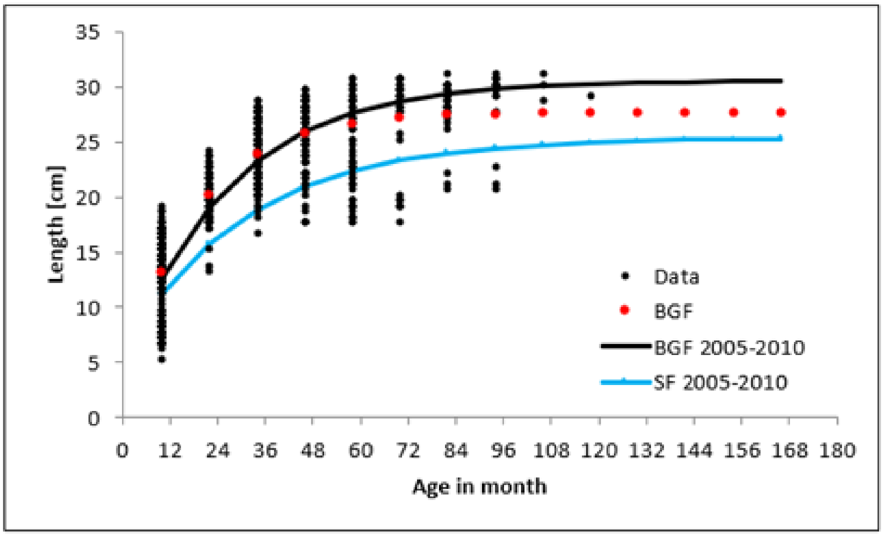

Figure 1: Length and age data of herring captured during German GERAS in SD 21 & 23 in 2022 (N = 871, black dots), corresponding von Bertalanffy growth function (BGF, red dots), mean length at age estimated with the mean BGF of WBSSH 2005 – 2010 (black line) and estimates of Separation Function (SF) 2005 – 2010 (blue line).

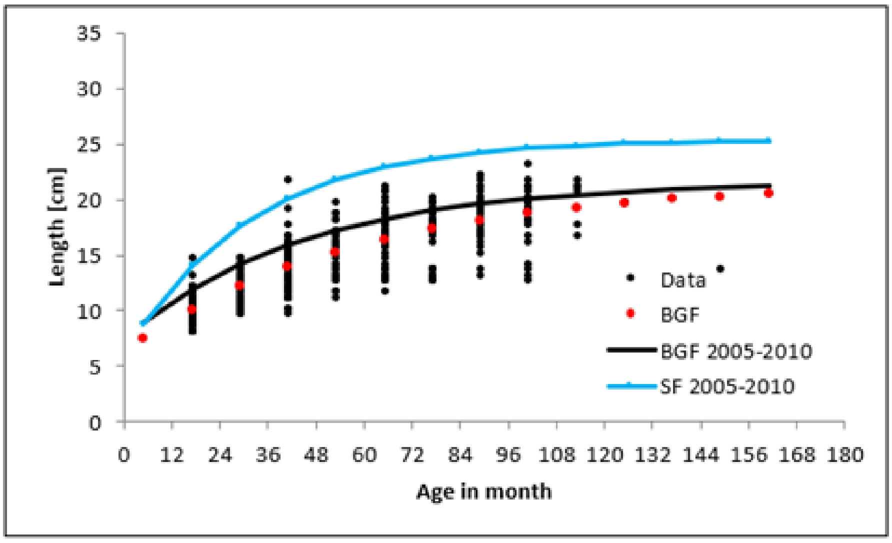

Figure 2: Length and age data of herring captured during German BASS in SDs 27-29 in 2021 (N = 572, black dots), corresponding Bertalanffy growth function (BGF), red dots), mean length at age estimated with the mean BGF of CBH 2005 – 2010 (black line) and estimates of Separation Function (SF) 2005 – 2010 (blue line).

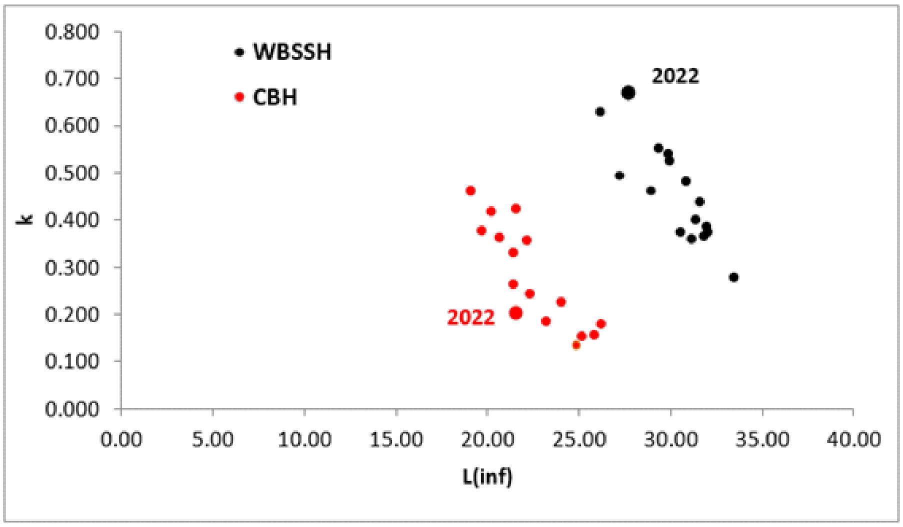

Figure 3: Relation of Bertalanffy growth parameters L(inf) and k for WBSSH (●) and CBH (●) in 2005-2021 (small dots) and 2022 (large dots).