Planning and Results of the 2016 Industry-Science Acoustic Survey of Herring in the Western British Isles (ICES div 6a, 7b,c)

Steven Mackinson¹, Martin Pastoors², Susan Lusseau³, Eric Armstrong³, Sascha Fassler⁴, Dick de Haan⁴, Raoul Kleppe², Mike O’Malley⁵, Andrew Campbell⁵, Maurice Clarke⁵

¹ Scottish Pelagic Fishermen’s Association, Scotland.
² Pelagic Freezer Trawler Association, Netherlands
³ Marine Scotland, Scotland
⁴ Wageningen Marine Research, Netherlands
⁵ Marine Institute, Ireland

Zephyr (Allister Irvine), Wiron 5&6 (Jan Melis/ Adrie Hoek), Quantus (Mark Buchan), Unity (Stephen Bellany), Atlantic Challenge (Stevie McSharry), Annie Hillina (Henk Krijgsman), Alex Wiseman (SPFA)
Objectives

• **Abundance estimation**: Collect acoustic data and information on the size and age of herring and use it to generate an age age-disaggregated acoustic estimate of the biomass of pre-spawning/spawning components of herring in 6aN North and 6aS, 7bc (‘Western herring’).

• **Stock identity separation**: Collect morphometric and genetic data to distinguish whether the 6aN stocks are different from the stocks in 6aS, 7bc.

• **Age composition of the commercial catch**: Collect catch-at-age data from the monitoring fishery to provide continuous fishery-dependent time series required for assessment.
Process

Herring in 6.a, 7.bc
Problem: Single stock status resulting in Zero catch advice
PELAC herring group formed
Monitoring TAC
Propose industry-survey

Project Partners
Project Aims
Scope, timing
Acoustic abundance estimate
Stock separation rationale

Tendering & Procurement
Knowledgebase
Survey Design
Resources
Industry
Survey Grid
Vessels
Science
Sampling
Quota
Scientific Personnel
Scientific Equipment
Data Policy
Survey Description
Recording
Protocols
Manual
Storage
Echosounder calibration
Protocols
Sharing
Echosounder operation
Biological Sampling
Morphometric Sampling
Pre-Cruise
Genetic Sampling
Mobilisation
Calibration, Testing
Vessel
Vessel
Vessel
Acoustic recording
Catch Sampling
Opportunistic Data
Catch sampling

Post Cruise
Review
Data exchange
Ageing of samples
Reading of otoliths
Acoustic Scrutinisation
Identification of herring
Haul assignment
Commercial CatchSampling
Catch Number At Age
Weight At Age
Maturity at Age
GeneAnalysis
Morphological Analysis
Photography
Identifiction of herring
Sampling
Photography
Haul assignment
Catch Number At Age
Shape Analysis
Weight At Age
Maturity at Age
Abundance at Age
Survey Report
Plan
Procedures
Results
HAWG
(Annual update assessment)
WGIPS
(Survey Group)
ICES
PECIA
(Benchmark assessment 3-5 yearly)
Annual Catch Advice

PLANNING
Analysis& Reporting
Implemention
Evaluate
Application
Evaluate

Define the evidence
Evaluate
Methods
Assigning trawls to transects - decisions

Duplicates – highest biomass chosen
Calculating acoustic abundance

Record acoustic data from calibrated echosounder, 3nmi parallel transects

Scrubination.
Herring marks identified following agreed heuristics

NASC of herring marks in each EDSU (1nmi) extracted from echoview (PRC_NASC)

Expected acoustic backscatter of each size class (Sigma_L) Where, TS for each length class herring is: \( TS(L) = 20\log_{10}(L) - 71.2 \), and the mean acoustic backscattering cross section (sigma) is \( \sigma(L) = 4\pi L^{(TS/10)} \).

Density of herring in each length group in each EDSU = herring NASC in each EDSU divided by the expected backscatter at length

Mean density at length within a transect (the basic sampling unit) = average from EDSUs

Mean density at length across all transects within the strata = mean across transects weighted by transect length

Numbers at length = mean density at length within the strata multiplied by strata area. Sum across strata for total.

Calculate uncertainty in estimate using bootstrap procedure

Numbers and biomass in each age class giving Total Stock Numbers and Total stock Biomass

Biomass and number of actively spawning herring (ICES stage 3-4)

Numbers and biomass of mature herring giving Spawning Stock Biomass & Spawning Stock Numbers
Acoustic Results  6aN
Overview of all herring acoustic data
Area 2
Area 4
For each area – Numbers and biomass by length, age and maturity stage  (example... Area 2)

<table>
<thead>
<tr>
<th>Variable: Abundance</th>
<th>EstLayer: 1</th>
<th>Stratum: TOTAL</th>
<th>specialstage: TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LenGrp</td>
<td>age</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>23.0-23.5</td>
<td></td>
<td>256</td>
<td>-</td>
</tr>
<tr>
<td>23.5-24.0</td>
<td></td>
<td>748</td>
<td>-</td>
</tr>
<tr>
<td>24.0-24.5</td>
<td></td>
<td>1298</td>
<td>-</td>
</tr>
<tr>
<td>24.5-25.0</td>
<td></td>
<td>2265</td>
<td>-</td>
</tr>
<tr>
<td>25.0-25.5</td>
<td></td>
<td>3255</td>
<td>76</td>
</tr>
<tr>
<td>25.5-26.0</td>
<td></td>
<td>3507</td>
<td>127</td>
</tr>
<tr>
<td>26.0-26.5</td>
<td></td>
<td>3552</td>
<td>314</td>
</tr>
<tr>
<td>26.5-27.0</td>
<td></td>
<td>2583</td>
<td>946</td>
</tr>
<tr>
<td>27.0-27.5</td>
<td></td>
<td>1127</td>
<td>2147</td>
</tr>
<tr>
<td>27.5-28.0</td>
<td></td>
<td>778</td>
<td>2194</td>
</tr>
<tr>
<td>28.0-28.5</td>
<td></td>
<td>34</td>
<td>1889</td>
</tr>
<tr>
<td>28.5-29.0</td>
<td></td>
<td>-</td>
<td>697</td>
</tr>
<tr>
<td>29.0-29.5</td>
<td></td>
<td>-</td>
<td>412</td>
</tr>
<tr>
<td>29.5-30.0</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>30.0-30.5</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>30.5-31.0</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>31.0-31.5</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>31.5-32.0</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>32.0-32.5</td>
<td></td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>32.5-33.0</td>
<td></td>
<td>-</td>
<td>79</td>
</tr>
<tr>
<td>33.0-33.5</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>34.0-34.5</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TSN(1000)</td>
<td></td>
<td>19406</td>
<td>8801</td>
</tr>
<tr>
<td>TSB(1000 kg)</td>
<td></td>
<td>2722.1</td>
<td>1564.4</td>
</tr>
<tr>
<td>Mean length (cm)</td>
<td></td>
<td>25.49</td>
<td>27.42</td>
</tr>
<tr>
<td>Mean weight (g)</td>
<td></td>
<td>140.27</td>
<td>177.74</td>
</tr>
</tbody>
</table>
For each area – Numbers and biomass by length, age and maturity stage (example… Area 2)

<table>
<thead>
<tr>
<th>Age</th>
<th>Abundance ('000s)</th>
<th>Mature</th>
<th>Spawning</th>
<th>Biomass (t)</th>
<th>Mean length (cm)</th>
<th>Mean weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>19406</td>
<td>99%</td>
<td>87%</td>
<td>2722</td>
<td>25.5</td>
<td>140.3</td>
</tr>
<tr>
<td>3</td>
<td>8801</td>
<td>100%</td>
<td>94%</td>
<td>1564</td>
<td>27.4</td>
<td>177.7</td>
</tr>
<tr>
<td>4</td>
<td>9620</td>
<td>100%</td>
<td>95%</td>
<td>1959</td>
<td>28.5</td>
<td>203.7</td>
</tr>
<tr>
<td>5</td>
<td>7184</td>
<td>100%</td>
<td>95%</td>
<td>1598</td>
<td>29.4</td>
<td>222.4</td>
</tr>
<tr>
<td>6</td>
<td>8473</td>
<td>100%</td>
<td>88%</td>
<td>1957</td>
<td>29.7</td>
<td>231.0</td>
</tr>
<tr>
<td>7</td>
<td>8090</td>
<td>100%</td>
<td>91%</td>
<td>1894</td>
<td>30.0</td>
<td>234.1</td>
</tr>
<tr>
<td>8</td>
<td>3335</td>
<td>100%</td>
<td>95%</td>
<td>805</td>
<td>30.4</td>
<td>241.3</td>
</tr>
<tr>
<td>9</td>
<td>1107</td>
<td>100%</td>
<td>86%</td>
<td>288</td>
<td>31.0</td>
<td>260.3</td>
</tr>
<tr>
<td>10</td>
<td>477</td>
<td>100%</td>
<td>100%</td>
<td>117</td>
<td>30.7</td>
<td>245.3</td>
</tr>
<tr>
<td>11</td>
<td>7</td>
<td>100%</td>
<td>100%</td>
<td>1</td>
<td>31.5</td>
<td>197.0</td>
</tr>
<tr>
<td>Immature</td>
<td>196</td>
<td>-</td>
<td>-</td>
<td>23</td>
<td>25.5</td>
<td>115.2</td>
</tr>
<tr>
<td>Mature</td>
<td>66295</td>
<td>-</td>
<td>-</td>
<td>12882</td>
<td>28.1</td>
<td>194.3</td>
</tr>
<tr>
<td>Spawning*</td>
<td>60460</td>
<td>-</td>
<td>-</td>
<td>11757</td>
<td>28.1</td>
<td>194.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>66500</td>
<td>100%</td>
<td>91%</td>
<td>12917</td>
<td>28.1</td>
<td>194.1</td>
</tr>
</tbody>
</table>
Acoustic abundance estimates 6aN

Area 1: NA

Area 2: 13,000t (90% spawning)

Area 3: 8,000t (60% spawning)

Area 4: 7,000t (8% spawning)

Total = 28,000t
Recommendations for data users (6aN)

6aN
The acoustic surveys in the three strata surveyed in 6aN are considered to
• Contain the principal active spawning areas advised by ICES (29 April 2016) and the locations of reported commercial fishing activity conducted in August-September in recent years.
• Provide a reliable estimate of
  • the biomass of all herring at age observed in the 3 survey areas
  • the minimum biomass of mature herring at age (Stages 2-5 on the ICES 6 pt maturity scale, ICES 2011)
  • the minimum biomass of actively spawning herring (those that we are confident are 6aN herring - stages 3-4 on the ICES 6 pt maturity scale)

The survey has particular value in relation to
• Considering the appropriateness of scientific monitoring TAC in 6aN, because the 6aN SSB estimate is a component of the estimates of the total stock estimated by the MALIN shelf/ WoS herring acoustic survey.
• Providing a new index of 6aN SSB and changes in the timing of spawning and distribution at this time of year.
• Providing a platform to continue work on stock splitting and stock ID in the greater Malin Shelf area (to be considered in ICES WKSIDAC)
• Map in detail the spawning locations in 6aN, which is useful in relation to marine spatial planning considerations.
• Promoting a positive example of industry-science and developing industry’s skills to assess pelagic stocks.
Recommendations for surveys (6aN)

- Consider evidence for timing and spawning locations since missing the peak in timing is the biggest risk.
- Allow time for adaptation of survey to map high intensity areas, particularly in the case of active spawning aggregations.
- Consider if calibration at the quay side (stern on) is an option for commercial vessels.
- Seek to ensure that industry vessels are equipped with smaller nets typically used in scientific surveys and appropriate echosounder with heave compensation.
- Ensure that any future surveys follow standard protocols whereby all fish recordings (even of non-commercial size) encountered on the echogram be sampled regularly. This is paramount to improve analysis of the acoustic data and accuracy of the estimated abundance and stock composition for different species in the survey area.
Commercial catches of each age group

6aN
• Quantus, Unity, Zephyr (Marine Scotland)
• Annie Hillina (Vti, Germany)
• Wirons (Cefas)

6aS, 7bc
• Numerous vessels (Marine Institute, Ireland)

Process
- Data from other labs will be shared as part of the ICES data call in preparation for Herring Assessment WG (March)
Genetics and morphometrics

- Genetic samples sent to Ed Farrel (see other agenda item)

- Morphometrics – identified MSS able to provide some capacity (details discussed on other agenda item)