WORKSHOP ON THE DEVELOPMENT OF QUANTITATIVE ASSESSMENT METHODOLOGIES BASED ON LIFE-HISTORY TRAITS, EXPLOITATION CHARACTERISTICS, AND OTHER RELEVANT PARAMETERS FOR DATA-LIMITED STOCKS (WKLIFE XIV)

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Contents

i Executive summary

The objective of the fourteenth Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE XIV) was to further advance methods for stock assessment, stock status evaluation, and catch advice for data-limited stocks. A central focus was on developing robust advice rules that align with the ICES advisory framework, the concept of risk-equivalence, and the principles of sustainable fisheries management.

Participants from 12 countries contributed 35 presentations, alongside discussions and focused working sessions on data-limited topics. Two promising approaches for stock status estimation and catch advice for category 4–6 stocks were further refined during the workshop. Both approaches depend on reliable catch (or landings) information and length data, either by defining rules based on observed trends in these data or by incorporating length-derived indicators as proxies for fishing mortality within biomass dynamic models. Suggested methods were applied to data from stocks with different life histories. Experts on *Nephrops* stocks highlighted challenges with the approaches used for *Nephrops* and discussions on shellfish stocks emphasized crossovers for fish and shellfish stocks and considerations of spatial indicators.

Progress was also made on harvest control rules and biomass threshold rules, confirming the recommendations from last year's workshop to use more precautionary rules for low-productivity stocks, such as deep-sea species. Participants showed the potential impact of not accounting for time-varying productivity and discussed ways these could be incorporated into biomass dynamic models. Biomass limit reference points (B_{lim}) could be improved by basing them on the time needed to rebuild. Case studies and applications from Japan provided additional perspectives on the implementation of data-limited methods in different contexts.

WKLIFE XIV also hosted a dedicated half-day session on a collaborative ICES-FAO deep-sea fisheries (DSF) project. Several case study stocks were introduced within this framework, providing a platform for shared learning and dialogue. Finally, the workshop outlined plans for the development of an open-access GitHub repository to host data-limited methods supported by WKLIFE, with the aim of increasing transparency, accessibility, and guidance for users across the ICES community and DSF project regional fisheries management organisation partners.

ii Expert group information

Expert group name	Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE XIV)
Expert group cycle	Annual
Year cycle started	2012
Reporting year in cycle	1/1
Chair(s)	Simon Fischer, United Kingdom
	Tobias Mildenberger, Denmark
Meeting venue(s) and dates	18 August 2025, online pre-meeting on MS Teams;
	1-5 September 2025, Horta, Faial Island, Azores, Portugal, with hybrid meeting access (55 participants; 28 in-person, 27 online)

1 Introduction

1.1 Terms of Reference

WKLIFE XIV: 2024/WK/FRSG32: **The Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE XIV)**

The Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE XIV), chaired by Tobias Mildenberger (Denmark) and Simon Fischer (UK) will meet online on 18 August and in Horta, Faial Island, Azores, Portugal, 1–5 September 2025. The workshop should address the following Terms of Reference:

1. Further evaluate and develop quantitative assessment methodologies for data-limited stocks in stock category 2-6, with specific emphasis on stock categories 4, 5, and 6, stock status indicators, and length information.
2. Develop data-limited stock assessment tools, harvest control rules, and simulation approaches for specific life-history strategies, specifically shellfish and *Nephrops*, deep-sea species and pelagic, and for species with different roles in the ecosystem.
3. Explore methods to estimate and improve management reference points for data-limited stocks and to provide stock status for these.
4. Explore the incorporation of ecosystem considerations in current data-limited methods and/or their testing (in MSE frameworks).
5. Further explore and develop assessment and advice methods with focus on data- and/or resource-limited fisheries together with exploring approaches of moving towards an ecosystem perspective, from both within and outside the ICES community.
6. Outline the framework and best practices for an open-access GitHub repository on data-limited methods to increase the accessibility and transparency of methods to provide guidance on the use of methods.

WKLIFE XIV will report to ACOM no later than 19 October 2025.

1.2 Background

The Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE) is the premier venue in ICES for developing, evaluating and improving the stock assessment methods and indicators that are suitable for providing advice for data-limited fish stocks.

Around 60% of the more than 260 fish stocks for which ICES provides advice are data-limited but require advice on fishing opportunities. The recent changes to the methods for assessment of data-limited stocks are the result of WKLIFE's work, and the workshop aims to help continue and expand advice provision to ensure that ICES principles are followed.

ICES is working to provide catch advice for all stocks that is in line with the Precautionary approach and, where possible, also follows the maximum sustainable yield (MSY) approach. The methods developed and tested by WKLIFE and WKDLSSLS are key to ICES' advancements in this area.

No WKLIFE meetings were held in 2021 and 2022 but there were two WKLIFE meetings in 2023 (WKLIFE XI in January 2023 and WKLIFE XII in October 2023).

Since 2024, WKLIFE follows the typical annual schedule (WKLIFE XIII in 2024, WKLIFE XIV in 2025).

WKLIFE XIV followed the Terms of Reference (ToR) detailed in the previous section.

1.3 Conduct of the meeting

The list of participants and agenda for the workshop are presented in Section 9 (Annex 1: List of participants) and Section 10 (Annex 2: Workshop agenda), respectively. WKLIFE XIII was held as a hybrid meeting at Casa Manuel de Arriaga, Horta, Faial Island, Azores, Portugal, and remote access was provided over Microsoft Teams. The meeting was well attended, with 55 participants (28 in person, 27 online).

Intersessional work had taken place ahead of the WKLIFE XIII meeting by its participants, and this was presented during the workshop in 35 plenary presentations. The meeting was mainly held with presentations and discussions in plenary. Additionally, two working sessions were held (Wednesday afternoon, Friday morning) with work in smaller subgroups.

Given ICES' role as a knowledge provider, it is essential that experts contributing to ICES' science and advice maintain scientific independence, integrity and impartiality. It is also essential that their behaviours and actions minimise any risk of actual, potential or perceived conflicts of interest. To ensure credibility, salience, legitimacy, transparency and accountability in ICES' work, to avoid conflicts of interest and to safeguard the reputation of ICES as an impartial knowledge provider, all contributors to ICES' work are required to abide by the ICES Code of Conduct. The ICES code of ethics and professional conduct from 2022 (ICES, 2022) was brought to the attention of participants at the workshop and no conflict of interest was reported.

This year, a pre-meeting was held online, two weeks before the main meeting, as an opportunity for a preview of the work (see Section 2.1).

Furthermore, Wednesday morning was dedicated to the collaborative FAO-ICES deep-sea fisheries (DSF) project (see Section 8).

1.4 Plenary presentations

35 presentations were given during the plenary sessions of WKLIFE XIV. Presenter, title, and synopsis or relevant section of the report are indicated below.

- Anne Cooper - ICES approach to advice for data-limited stocks
- Simon Fischer & Tobias Mildenberger – Introduction to WKLIFE
- Tobias Mildenberger - WKLIFE's first common paper (Section 2.3)
- Peter Kidd - Linking spatial indicators with single species operating models (ToR 1, Section 3.4)
- Nicola Walker - swaf: SWept Area Fishing mortality and exploitation status (ToR 1, Section 3.5)
- Laurie Kell – Length-based methods. Estimators vs. Indicators (ToR 1, Section 3.6)
- Laurie Kell – Hierarchical Assessment Frameworks. Risk-Equivalent Fisheries Management (ToR 1, Section 3.6)
- Simon Fischer – ICES categories 4-6 (ToR 1, Section 3.2.1)
- Marta Cousido - Ad-hoc MSE for Sole in divisions 8.c and 9.a (ToR 1, Section 3.7)
- Tanja Miethe - Spatial indicators for Northern Shelf cod substocks (ToR 1/5, Section 3.3)

- Tobias Mildenberger – Length-based SPiCT (ToR 1, Section 3.2.2)
- Liese Carleton - A framework for using available length data under biological uncertainty. Case study of razor clam in North Irish Sea (ToR 2, Section 4.3)
- Rui Vieira - WGDEEP: assessing deep-sea fisheries resources in the ICES area (ToR 2/6, Section 4.5)
- Régis Santos - Alfonsinos (*Beryx* spp.) in subareas 1–10, 12, and 14 (Northeast Atlantic and adjacent waters) (ToR 2/6, Section 4.6)
- Wendell Medeiros-Leal - Harvest control rules for data-limited deep-water fish stocks (ToR 2, Section 4.4)
- Rehab Soliman - Community-based harvest control rules for the Egyptian artisanal Red Sea fishery (ToR 5, Section 7.5)
- Hector Andrade - Geographical variations in ling life history and implications for rfb rule (ToR 1/2, Section 3.8)
- Mitsuyo Miyagawa - Assessment and categorization of Data-Limited Fishery Resources in Japan and Their Linkage to Harvest Control Rules (ToR 5, Section 7.2)
- Tatsunori Yagi - Optimizing the parameters of the data-limited HCRs in Japan and ICES according to stock dynamics (ToR 5, Section 7.3)
- Momoko Ichinokawa - Quantifying Data and Resource Limitations: A Case Study in Japanese Fisheries Stock Assessments (ToR 5, Section 7.4)
- Tony Thompson - FAO Deep-sea Fisheries project (ToR 6, Section 8.2)
- Anne Cooper - Deep-sea Fisheries Project – working with ICES (ToR 6, Section 8.3)
- Kota Sawada – NPFC. North Pacific armorhead: Biology, fisheries and assessments in NPFC (ToR 6, Section 8.5)
- Satoi Arai – NPFC. Attempts of stock assessment for Splendid alfonsino Beryx splendens in the northwestern Pacific (ToR 6, Section 8.5)
- Takehiro Okuda – SIOFA/SEAFO. Alfonsino and armourhead (ToR 6, Section 8.5)
- Takehiro Okuda – SEAFO. Patagonian toothfish fishery (ToR 6, Section 8.5)
- Tim Earl – CCAMLR. Approach to managing data limited toothfish fisheries (ToR 6, Section 8.5)
- Erich Maletzky – SEAFO. Red crab. Deep-sea red crab stock assessment (ToR 6, Section 8.5)
- Aristoteles Amaro - Data-limited methods and management in Angolan waters (ToR 5, Section 7.6)
- Marc Taylor – Estimating time-varying productivity and reference points: A case of North Sea demersal fish stocks (Tor 3/4, Section 6.2)
- Tobias Mildenberger – Implementing time-varying reference points. Stock assessment for Eastern Baltic cod (ToR 3/4, Section 6.3)
- Guldborg Søvik – Summary of data-limited work and challenges in WGNEPH (*Nephrops*) (ToR 2, Section 4.2)
- Simon Fischer - ICES Category 3. Stock status considerations (ToR 3, Section 5.2)
- Laurie Kell – Rebuilding Time. A Dynamic Approach for Verification, Validation and Calibration of Biomass Reference Points (ToR 3, Section 5.3)
- Tom Blasdale – Ling SPiCT (ToR 2, Section 4.7)

1.5 Structure of the report

The report structure follows the Terms of Reference (ToRs) of the meeting (see Section 1.1), with Sections 3-8 focussing on ToRs 1-6. Each section contains a summary of the work presented and the following discussion for the ToRs. Some presentations addressed several ToRs as indicated in the previous section.

The structure of the report is as follows:

- Section 1 provides an introduction to the meeting and the report,
- Section 2 discusses general elements of WKLIFE such as the guidelines,
- Section 3 focuses on ICES methods for data-limited stocks with specific emphasis on stock categories 4, 5, and 6, stock status indicators, and length information (ToR 1)
- Section 4 focuses on approaches for specific life histories (ToR 2),
- Section 5 focuses on reference points and stock status evaluation (ToR 3),
- Section 6 focuses on the incorporation of ecosystem considerations (ToR 4),
- Section 7 summarises anything else with relevance to data-limited stocks (ToR 5),
- Section 8 focuses on the FAO-ICES deep-sea fisheries (DSF) project (ToR 6)

Instead of providing conclusions from the workshop at the end of the report as is customary with ICES' reports, each of the Sections 3–8 provides a synthesis of the material presented within each Section. Please note that the individual sections and subsections are summaries of the work presented during the meeting and do not necessarily represent the view of WKLIFE.

In addition to the report sections, several Annexes are attached to the report:

- Annex 1: List of participants
- Annex 2: Workshop agenda
- Annex 3: Draft ToRs for the next WKLIFE meeting

1.6 Follow-up process within ICES

The participants at WKLIFE XIV agreed to provide text for the draft workshop report within two weeks by Friday, 19 September (without tracked changes) and to then comment on the compiled draft report no later than Friday 3 October, when the report can be finalised by the Chairs and formatted by the ICES Secretariat (reporting deadline 19 October).

Recommendations: The main recommendation from WKLIFE XIV is that another WKLIFE meeting (WKLIFE XV) will be held. The following table details the draft recommendations, which may be refined after the publication of this report:

Recommendation	For follow up by:
WKLIFE internal recommendation only – do not put into ICES recommendation system WKLIFE XIV recommends that there be a fifteenth meeting of WKLIFE in September/October 2026 (note: WGScallop scheduled 5 – 9 October; WGNeph 24 September – 2 October), whose draft ToRs are proposed in the WKLIFE XIV report for the consideration of ACOM.	WKLIFE
WKLIFE notes that the advice methods and categories for *Nephrops* are not consistent with those of ICES finfish stocks. For example, the data-rich category 1 *Nephrops* harvest control rule (harvest rate without a population model) is more similar to the data-limited category 3 chr rule. ICES should aim to use more consistent approaches for *Nephrops* and finfish stocks and continue to improve the advice methodology for *Nephrops* stocks, ideally using simulation testing before applying advice methods.	ACOM, WGNEPH
WKLIFE wants to communicate that WKLIFE cannot replace benchmarks. Work on the development or application of assessment methods for specific stocks may be presented at WKLIFE, but WKLIFE does not have the scope or capacity to review such work in detail; instead, stock-specific applications should be reviewed at ICES benchmarks.	ACOM, BOG

Recommendation	For follow up by:
WKLIFE recommends that advice based on the category 3 chr rule should be shown more consistently between advice sheets. WKLIFE recommends that: Instead of the length indicator, advice sheets should show a plot of the harvest rate (absolute harvest rate for stocks with a total biomass index, otherwise a relative harvest rate) on the first page, ideally with the actually harvest rate target ($HR_{MSYproxy}$ × multiplier); For stocks that apply the chr rule generically without stock-specific MSE, it may be useful to show the length indicator as an additional plot after Table 1 (e.g. dab.27.3a4, fle.27.3a4, lem.27.3a47d, mur.27.3a47d); For stocks with a stock-specific MSE (e.g. her.27.6aN, her.27.6aS7bc), $HR_{MSYproxy}$ should not be artificially inflated (doubled) by using a multiplier of $m = 0.5$ and $HR_{MSYproxy}$ should instead use the value from the MSE in Figures and Tables.	ACOM, WGNSSK, ADGNS, HAWG, ADGHERSP
WKLIFE recommends that there should be an ICES-wide definition of "vulnerable species".	???
Census of available data for ICES stocks in categories 4-6. Simon and Tobias will first discuss scope and feasibility with ICES before drafting recommendation (see Section 3.2 – next steps)	???

Once finalised, the recommendations from WKLIFE XIV will be submitted to the ICES recommendation database.

1.7 References

ICES. 2022. Code of ethics and professional conduct. Version 1. ICES Guidelines and Policies. 14 pp. https://doi.org/10.17895/ices.pub.21647825

2 General WKLIFE considerations

2.1 Introduction

This section summarises general points discussed during the WKLIFE meeting which were not directly related to any of the ToRs, including the online pre-meeting, the WKLIFE paper, ICES technical guidelines, the WKLIFE frequently asked questions (FAQ), previous recommendations to and from WKLIFE, the WKLIFE roadmap, and other work with relevance for WKLIFE.

2.2 Online pre-meeting

An online half-day pre-meeting was held two weeks prior to the main meeting on 18 August 2025 via MS Teams. This meeting was an opportunity to give a preview of the work to be presented at the main meeting. Two plenary presentations were given:

- Simon Fischer – ICES categories 4-6. Preview
- Wendell Medeiros – Harvest control rules for vulnerable species

Furthermore, participants were invited to give a brief overview of their work for WKLIFE at a round table-style session.

2.3 WKLIFE paper

This presentation introduced WKLIFE's first common paper, developed collaboratively by 21 co-authors and planned for submission to the ICES Journal of Marine Science special issue in December 2025. The paper defines and characterizes data-limited stocks in the Northeast Atlantic, noting that around 60% of ICES-advised stocks fall into categories 2-6. It presents ten core principles for data-limited research and advice, emphasizing precaution, international collaboration, and the best use of available data. Case studies illustrate how these principles have been applied in practice, such as empirical harvest control rules for data-rich stocks and the adoption of fractile rules to embed uncertainty. Looking forward, the WKLIFE roadmap identifies key priorities for advancing methods and advice, including dynamic reference points, improved length-based approaches, and the integration of emerging data sources like eDNA and electronic monitoring. The overarching aim is to strengthen ICES' capacity to deliver transparent, adaptive, and risk-equivalent advice for all stocks, ensuring sustainable fisheries management under data-limited conditions.

2.4 ICES technical guidelines

The ICES technical guidelines on "Advice rules for stocks in category 2 and 3" were reviewed during the previous WKLIFE meeting (ICES, 2024) and the guidelines were updated after WKLIFE XIII. The latest version (Version 3) was published in early 2025 (ICES, 2025b) and is available from https://doi.org/10.17895/ices.pub.28506179. The main changes were on category 2, where the text and equations were aligned with practices used in the ICES advice.

At WKLIFE XIV, only minor changes to the guidelines were suggested, based on the work on SPiCT presented in Section 3.2.2 of this report. The previous changes to the application of SPiCT to vulnerable species, based on the work presented at WKLIFE XIII (ICES, 2024), were phrased vague on purpose because the simulations did not include B_{lim}. This was addressed this year with new simulations with and without B_{lim} (Section 4.4) and the statement in the guidelines can now be made for specific.

2.5 WKLIFE FAQ

Since WKLIFE XII (ICES, 2023b), WKLIFE maintains a frequently asked questions (FAQ) document, which complement the ICES technical guidelines for advice methods for stocks in categories 2 and 3. The FAQ is currently hosted here: https://github.com/shfischer/WKLIFE-FAQ.

At WKLIFE XIII (ICES, 2024), the questions and answers were reviewed, and additional questions were added. This review was completed intersessionally after WKLIFE XIII. Since then, only one additional question was received by WKLIFE (from WGEF):

> *Based on the guidelines for the calculation of Lc, it is recommended to pool several years of length data. When the rfb rule was first used at WGEF (2022 and 2023, depending on the stock), at least 3 years of data have been considered reliable for most of the stocks. Since then, more data are available, and more years could be considered as reliable. During the 2025 meeting, and in cases when the data to calculate the LBI changed, some stock coordinators suggested to add those new years and to recalculate Lc based on a longer time-series. Discussion was undertaken on the trade-off between calculate a new Lc probably more robust as calculated on a bigger amount of data or keep the years used previously to fix the reference point through time. WGEF would like a recommendation from the WKLIFE on this issue*

There was insufficient time to answer this question during the WKLIFE meeting, but it will be added to the FAQ intersessionally. In general, the response will be along the lines of that ICES assessment expert groups should use their expert knowledge to decide, and WKLIFE does not have the capacity to respond to questions which are very specific to certain stocks.

Eventually, the aim is to move the FAQ to an official ICES GitHub repository. A product of the FAO-ICES collaborative deep-sea fisheries (DSF) project (see Section 8) is a GitHub repository with a catalogue of ICES data-limited methods. The WKLIFE FAQ could then be integrated into this platform.

2.6 Roadmap

The WKLIFE roadmap was brought to the attention of participants. WKLIFE XI (ICES, 2023a) developed the list of topic and sub-topics with relevance for WKLIFE, which was subsequently scored at WKLIFE XII (ICES, 2023b) as the basis for the roadmap. The full list of topics of the roadmap is available from the WKLIFE XI report (ICES, 2023a, Section 7.1) and the outcome of the scoring is available from the WKLIFE XII report (ICES, 2023b, Section 3).

Since the development of the roadmap, it has been used to prioritise work and topics addressed at WKLIFE and influences the drafting of the Terms of Reference (ToRs) for WKLIFE meetings.

2.7 Recommendations to and from WKLIFE

Two recommendations to WKLIFE were received since last year:

74. From WGNSSK: We recommend updating the guidelines for the chr/rfb/rb rule related to the change of reference points when the index used for advice is modelled to account for retrospective bias and to provide some extra guidance on when to use the 15% and 35% fractile rule in SPiCT forecast (cfr. Kokalis *et al*. 2024).

109. From HAWG: In the calculation of the chr and the underlying length-based indicator, current ICES Cat. 3 guidelines and the WKLIFEX report are unclear as to whether length at first capture (Lc) and target reference length (LF=M) should be fixed at time of benchmark or calculated each year with the addition of new data. Documentation for the R package cat3advice states that these values should be calculated once in the first year of the application of the chr rule. However, at least two recently benchmarked and reviewed stocks (her.27.6aS7bc and her.27.6aN) have been calculating Lc and LF=M values each year. Changing the approach would lead to a change in the reference point (Fproxy MSY) and therefore the resultant advice in some cases. HAWG recommends that ACOM reviews and clarifies the chr calculation guidelines. If a correction is required there are likely other Cat. 3 stocks affected. A more detailed explanation of this issue is available from the HAWG chairs. Package link: https://github.com/shfischer/cat3advice/blob/main/vignettes/cat3advice.md#the-chr-rule

Both recommendations were already addressed previously with the latest revision of the ICES technical guidelines (ICES, 2025b).

WKLIFE XIII (ICES, 2024) made four recommendations to ICES in 2024:

83. From WKLIFE to ACOM/FRSG/WGNEPH: WKLIFE recommends that ICES should put more effort into *Nephrops* advice methods, particularly for data-limited *Nephrops* units, and encourages any contributions from *Nephrops* experts to WKLIFE.

    Comment: *Nephrops* experts were invited to join WKLIFE XIV and a collaboration with WKLIFE has started and will continue.

84. From WKLIFE to ICES Secretariat: WKLIFE recommends that ICES set up a GitHub repository or page for WKLIFE, which will host the WKLIFE frequently asked questions (FAQ) and glossary.

    Comment: The FAQ is still on Simon's personal GitHub page but a product of the ICES-FAO deep-sea fisheries (DSF) project (see Section 8) is an ICES/WKLIFE-owned GitHub repository and the WKLIFE FAQ should be moved there eventually.

85. WKLIFE to ACOM/Secretariat: WKLIFE recommends that ICES improve CPUE standardisation capacity.

    Comment: this has been communicated but there is a lack of resources to address this.

86. WKLIFE to ACOM: WKLIFE recommends that ICES update the technical guidelines for category 2 and 3 stocks based on the suggested changes from WKLIFE XIII.

    Comment: The last revision of the guidelines was published in 2025 (ICES, 2025b).

2.8 Other work with relevance for WKLIFE

Since WKLIFE XIII, the workshop collates ongoing work in other ICES expert groups on data-limited methods with relevance for WKLIFE (ICES, 2024, Section 3.5). This mainly encompasses stock-specific management strategy evaluations (MSEs), that could be used as a template for other stocks:

- MSE for Western English Channel plaice (ple.27.7e)

  This plaice stock went to a benchmark in 2024 (WKBPLAICE; ICES, 2025a) and a stock specific MSE was conducted to tune the chr rule, a category 3 data-limited empirical harvest control rule. The work is summarised in the WKLPLAICE report (ICES, 2025a), three working documents (Fischer, 2024a,b,c) and the R code is available on GitHub at https://github.com/shfischer/WKBPLAICE2024_ple.27.7e_MSE. The meeting report summarised the work as follows (ICES, 2025a, page iii):

"The previous stock assessment for plaice in Division 7.e was classified as a category 3 stock and advice was given with the rfb rule. Due to large uncertainties in data and assumptions, the model was not moved into category 1. Instead, a stock-specific simulation (management strategy evaluation, MSE) was conducted to tune the chr rule, an empirical harvest control rule based on the relative harvest rate. Various input data were reviewed and updated, with discard survival assumed to be 50%, though different scenarios were considered. A total of 14 age-structured stochastic operating models were developed, and the chr rule was tuned using a set of seven reference models to achieve both Maximum Sustainable Yield (MSY) and a precautionary approach (keeping the stock above a critical threshold). The final tuned chr rule (MP5) provides biennial advice, uses the UK-FSP survey as a biomass index, and was found to produce high long-term catch and stock biomass. Robustness tests showed superior performance to other MPs across all scenarios. When compared to the previous rfb rule and the standard ICES MSY rule, MP5 yielded a higher catch, while the ICES MSY rule did not fully meet precautionary approach standards. No recommendations for further investigations are outlined in the reviewers' report, and the work was accepted by the whole group."

- MSE for sole in Iberian Atlantic water (sol.27.8c9a)

  Work on a stock-specific MSE for this sole stock is ongoing and progress was presented (see Section 3.8 for an update). The relevant assessment expert group suggest this stock for a benchmark last year, but the ICES benchmark oversight group (BOG) seems to have rejected a benchmark for this stock because the work is presented at WKLIFE. WKLIFE will directly communicate with BOG to clarify this situation and make a formal recommendation to ICES that WKLIFE cannot replace the work and review of an ICES benchmark for methods for specific stocks.

- Sardine in the English Channel/southern Celtic Sea

  There is ongoing work at WGHANSA on a stock-specific MSE for this stock, with operating models conditioned on life-history considerations, and with the aim to tune the chr rule. The work is currently at the stage of developing operating models. No update was presented at WKLIFE.

- SPiCT benchmark

  The next benchmark dedicated to SPiCT (WKBMSYSPiCT 4) is scheduled for 2025/2026, with the data meeting planned for December 2025. There are already several stocks earmarked for this benchmark and there will likely be no capacity add further stocks this time.

2.9 References

Fischer. 2024a. Data for plaice (Pleuronectes platessa) in Division 7.e (western English Channel – ple.27.7e) – Working document for WKBPLAICE 2024, 58 pp., https://github.com/shfischer/WKBPLAICE2024_ple.27.7e_data/blob/WKBPLAICE/WKBPLAICE2024_data.pdf

Fischer. 2024b. Operating models for plaice (Pleuronectes platessa) in Division 7.e (western English Channel – ple.27.7e) – Working document for WKBPLAICE 2024", 26 pp., https://github.com/shfischer/WKBPLAICE2024_ple.27.7e_MSE/blob/WKBPLAICE2024/WKBPLAICE2024_ple.27.7e_OM.pdf

Fischer. 2024c. Results of the management strategy evaluation for plaice (Pleuronectes platessa) in Division 7.e (western English Channel – ple.27.7e) – Working document for WKBPLAICE 2024, 55 pp., https://github.com/shfischer/WKBPLAICE2024_ple.27.7e_MSE/blob/WKBPLAICE2024/WKBPLAICE2024_ple.27.7e_MP.pdf

ICES. 2023a. Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE XI). ICES Scientific Reports. 5:21. 74 pp. https://doi.org/10.17895/ices.pub.22140260

ICES. 2023b. Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFEXII). ICES Scientific Reports. 5:103. 111 pp. https://doi.org/10.17895/ices.pub.24581343

ICES. 2024. Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFEXIII). ICES Scientific Reports. 6:95. 64 pp. https://doi.org/10.17895/ices.pub.27677745

ICES. 2025a. Benchmark Workshop for Selected Plaice Stocks (WKBPLAICE). ICES Scientific Reports. 7:41. 70 pp. https://doi.org/10.17895/ices.pub.28400255

ICES. 2025b. ICES Guidelines - Advice rules for stocks in category 2 and 3. Version 3. ICES Guidelines and Policies - Advice Technical Guidelines. 31 pp. https://doi.org/10.17895/ices.pub.28506179

3 ICES methods for data-limited stocks with specific emphasis on stock categories 4, 5, and 6, stock status indicators, and length information (ToR 1)

3.1 Introduction

This report section focuses on work relevant to ToR 1 "Further evaluate and develop quantitative assessment methodologies for data-limited stocks in stock category 2-6, with specific emphasis on stock categories 4, 5, and 6, stock status indicators, and length information". Section 3.2 describes work and progress on methods for stocks in ICES categories 5 and 6, including an empirical (model-free) and a model-based approach. The following sections cover work on spatial and other indicators, length-based approaches, a custom management strategy evaluation (MSE) for a sole stock and an evaluation of the impact of geographical variations on life-history parameters.

3.2 Work on approaches for ICES categories 4–6

Method development

Stocks in ICES categories 4, 5, and 6 are generally considered data poor. There are usually catch (or landings) data available, but there is no reliable index of stock abundance. There are currently two approaches considered by WKLIFE for data-poor stocks: the empirical HCR (see Section 3.2.1), and a model-based approach using surplus production models without a biomass index but with auxiliary length data (see Section 3.2.2). Both approaches require representative length information from catches/landings. The model-based approach is at an earlier stage and did not yet look into potential HCRs.

There was general agreement that the currently ICES approach is suboptimal and should be improved. Work on new approaches was appreciated by the group. However, there was some reluctance by the group to suggest adopting the empirical method immediately for the provision of ICES advice. Despite the need for improvements for data-poor stocks being acknowledged by WKLIFE and ICES, progress is slow because few people have capacity to work on this topic. Currently, the work is conducted by the same scientists who also developed the HCRs for categories 2 and 3.

The idea of any method would be to create a new ICES category 4 for stocks for which representative length information is available. This would allow stocks currently in categories 5 and 6 to be moved into category 4, if data quantity and quality are sufficient. This could provide an incentive to collect data, because any newly developed category 4 HCR will have the capacity to increase the catches, whereas this is not possible in the current approach for categories 5 and 6.

Data availability

WKLIFE discussed how broadly new methods could be applied by ICES. Both the empirical and the model-based approaches rely on length data, which may not be available or of sufficient quality for all data-poor ICES stocks. There was a discussion on whether it would make sense to have an ICES data call for category 5 and 6 stocks to collate what data are available. Stock coordinators may be aware of some of the data, but data are not collated internationally at the moment. A data call would likely require substantial effort from the ICES member countries, which may be infeasible because of the simultaneous move in ICES between data platforms (InterCatch to RDBES). Another option discussed was a data call light, which only requests to check what data are available without actually asking for the submission of the data. However, just because data are available, they may not be of sufficient quality. An idea of a questionnaire was raised, which could gather meta data about available data, including catch (or landings) data, effort data, (catch) length data, life history parameters and consider quality, number of years, sampling levels, and representativeness. Such a questionnaire could be structured in a way that if specific data are not available, there is no need to answer subsequent questions about their quality. Furthermore, the question of whether a dedicated workshop is needed. The workshop concluded that the chairs will first discuss this with ICES before any official WKLIFE recommendation is made.

Next steps

Before the implementation of the currently used category 2 (SPiCT) and category 3 (rfb/rb/chr rules) approaches were implemented, these were peer reviewed by inviting reviewers to WKLIFE, by publishing several articles in scientific journals (Fischer *et al*., 2020, 2021a,b, 2022, Mildenberger *et al*., 2022) and through two PhD theses (Fischer, 2022, Mildenberger, 2020). Any new data-poor HCR should also be reviewed prior to implementation and adoption by ICES.

The FAO-ICES deep-sea fisheries (DSF) project is currently collaborating with WKLIFE (see Section 8). As part of this project, there are two workshops planned for 2026, prior to WKLIFE XV. This project and the workshops will include an element of peer-review, and this may offer an opportunity for an external review of ICES approaches.

It is not expected that any new approaches will be ready for the mid-2026 ICES advice season but it may be feasible for 2027.

3.2.1 ICES categories 4-6 – empirical approach (ToR 1)

The default ICES approach to provide advice for stocks in categories 5 and 6 is to provide a constant catch advice, reduced triennially by 20% with a precautionary buffer. The number of years for which the advice is given and whether the advice reduction is carried out as intended depends on the specific stocks. WKLIFE XII (ICES, 2023) found that the management performance of this approach depends on the stock status, which is unknown. This means that the advice reduction may be too slow for overfished stock or overly precautionary if a stock is in a good condition. This approach is a type of non-adaptive management and does not necessarily follow the precautionary approach.

At WKLIFE XIII (ICES, 2024), a new principle for an empirical harvest control rule (HCR) was introduced. This HCR uses only catch data to guess the trend in the stock size, by combining the trends from time series of the (1) catch and (2) the mean catch length (the mean length of fish in the catch above the length of first capture) as a proxy for fishing pressure (Figure 3.2.1.1).

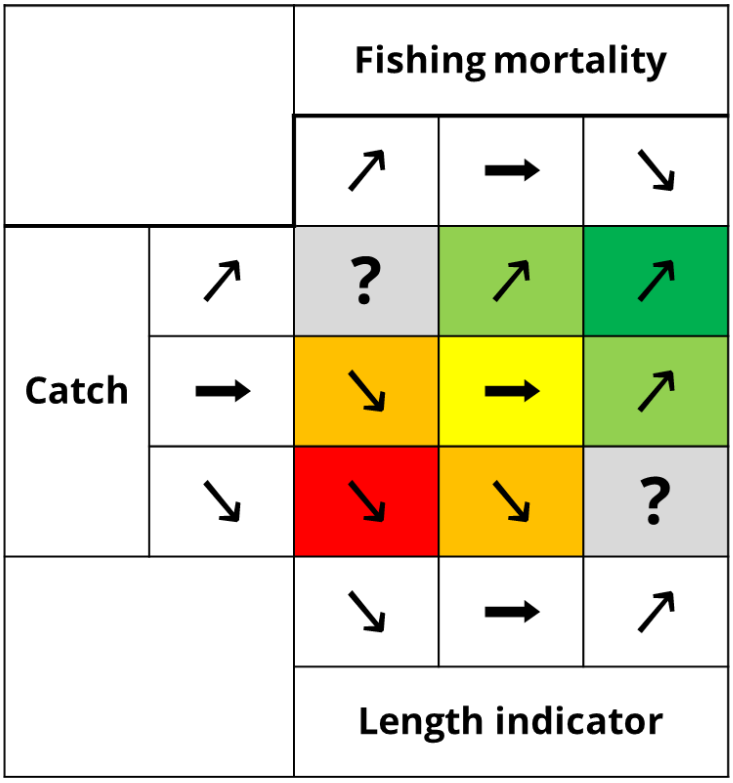

Figure 3.2.1.1. Illustration of the principle that changes in the stock size (its trend) can be inferred from the trends in the catch and a length indicator (mean catch length) as a proxy for fishing mortality. The coloured cells indicate the stock trend. See WKLIFE XIII (ICES, 2024) for details.

Preliminary simulations were conducted for WKLIFE XIII (ICES, 2024) and showed promise, but further work was required on this approach. Further simulations were conducted intersessionally and presented at this year's WKLIFE meeting (WKLIFE XIV).

Simulations were conducted with a generic MSE framework, originally created for the development of the ICES category 3 methods (rfb/rb/chr rules; Fischer *et al.*, 2020, 2021a,b, 2022, ICES, 2025), and the code is available on GitHub (https://github.com/shfischer/GA_MSE_cat456). The generic operating models covered 29 stocks and included species with various life histories, from fast-growing and short-lived to slow-growing and long-lived species. Details are available from Fischer (2022; chapter 5). The operating models were updated with a newer version of the FLR package FLife.

The harvest control rule works by turning the trend from an indicator i (mean catch length L or catch C) into a qualitative indicator (r_C, r_L) with values of -1 (decreasing), 0 (stable) or $+1$ (increasing):

$$r_i = \begin{cases} +1, & if\ s_i > \Delta_i \\ 0, & if\ -\Delta_C \leq s_i \leq \Delta_i \\ -1, & if\ s_i < -\Delta_i \end{cases}$$ **Equation 3.2.1.1**

where s_i is the slope from a linear regression of the indicator (default: 3-year linear regression) and Δ_i the threshold for detecting a trend (default: $\Delta_C = 0.05$, $\Delta_L = 0.01$). The two indicators r_C and r_L are then combined into a single indicator:

$$r = \begin{cases} -1, & \text{if } r_C = -1 \text{ or } r_L = -1 \\ \min[r_C + r_L, 1], & \text{otherwise} \end{cases}$$ **Equation 3.2.1.2**

To be more precautionary, the indicator is set to -1 if either r_C or r_L is negative. The stock trend can then be translated into a change of the catch advice α:

$$\alpha = \begin{cases} 1 + r \times \lambda_{\text{upper}}, & if\ r \geq 0 \\ 1 + r \times \lambda_{\text{lower}}, & if\ r < 0 \end{cases}$$ **Equation 3.2.1.3**

where λ_{upper} is the increase (default: $\lambda_{\text{upper}} = 0.1$) and λ_{lower} the decrease (default: $\lambda_{lower} = 0.2$). Essentially, Equation 3.2.1.3 is a step function with discrete steps where λ_{upper} and λ_{lower} define the size of the steps (increase or decrease).

Additionally, the HCR includes a breakout clause to overwrite the stock trend if the mean catch length is far away from a reference length L_{ref}:

$$A_{y+1\ldots n} = A_y \begin{cases} (1 + \gamma_{\text{upper}}), & if\ L > L_{\text{ref}}(1 + \Delta_{L_{\text{ref}}}) \\ \alpha, & if\ L_{\text{ref}}\left(1 - \Delta_{L_{ref}}\right) \leq L \leq L_{\text{ref}}(1 + \Delta_{L_{\text{ref}}}) \\ (1 - \gamma_{\text{lower}}), & if\ L < L_{\text{ref}}(1 - \Delta_{L_{\text{ref}}}) \end{cases}$$ **Equation 3.2.1.4**

where $A_{y+1\ldots n}$ is the new catch advice for years $y + 1$ until n (default: $n = 2$, i.e. biennial advice), A_y the previous catch advice value, γ_{upper} and γ_{lower} the corresponding increase and decrease in the advice (default: $\gamma_{\text{upper}} = 0.1$, $\gamma_{\text{lower}} = 0.2$), $\Delta_{L_{ref}}$ the threshold around the reference length (default: $\Delta_{L_{ref}} = 0.1$), and L_{ref} the reference length (defined in the same way as for the rfb rule, i.e. defaulting to $L_{\text{ref}} = L_{F=M} = 0.75L_c + 0.25L_\infty$, where is the length of first capture and L_∞ the asymptotic length from a von Bertalanffy individual growth model).

Lastly, the first catch advice for this HCR is limited to the 40th percentile of the historical catch values to avoid initial overfishing.

Consequently, this HCR requires the following data:

- Time series of catches – ideally as long as possible
- Time series of mean catch length (or catch length frequencies to calculate it) – at least three years
- Length at first capture (or catch length frequencies to calculate it)
- L_∞

Simulations were conducted for all 29 stocks, two fishing histories (one-way, i.e. increasing fishing mortality exponentially; random, i.e. random linear fishing mortalities), 500 simulation replicates (iterations, increased to 10,000 for simulations exploring stock status), 100 years, observation error for catches and the length index (log-normal with σ=0.1), recruitment deviations (σ_R=0.6), and with biennial catch advice.

Results for all stocks are presented in Figure 3.2.1.2. For the majority of stocks, the new empirical HCR resulted in a stock recovery in the long term by initially reducing the catch, although catch could increase slightly in the long term. Figure 3.2.1.3 shows the performance depending on the initial depletion prior to implementation the HCR. The stock size was largely unaffected irrespective of the initial depletion. However, the probability of falling below B_{lim} (B_{lim} risk) was higher when the initial depletion is high but was relatively stable at around 5% if the initial depletion was above $0.5B_{MSY}$.

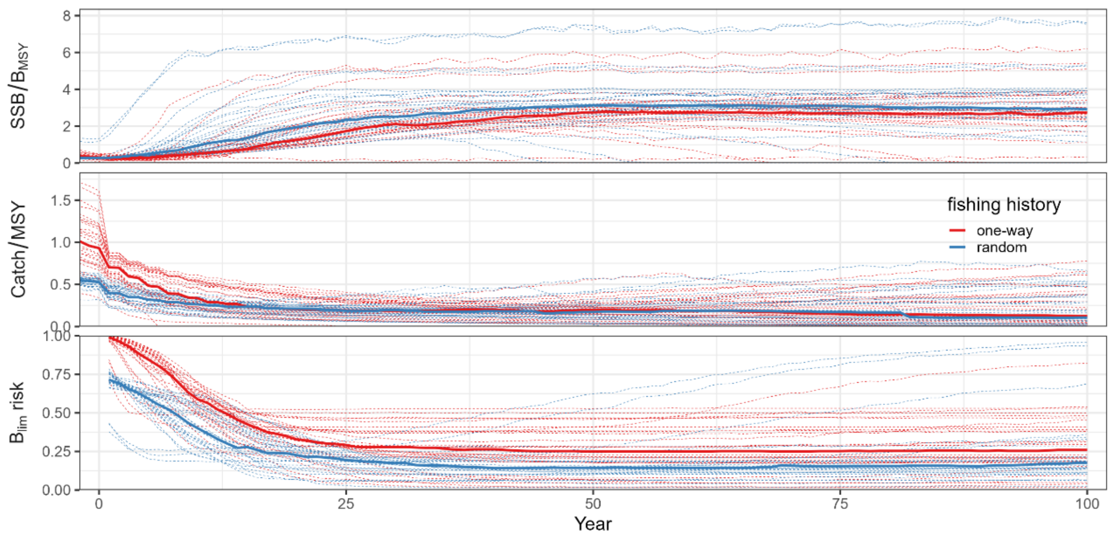

Figure 3.2.1.2. Outcomes of the simulations of the new empirical data-poor HCR. Each dashed curves corresponds to the median of one of the 29 stocks, the solid curves are the median over the stocks, and the colours represent the fishing histories defining the initial stock conditions.

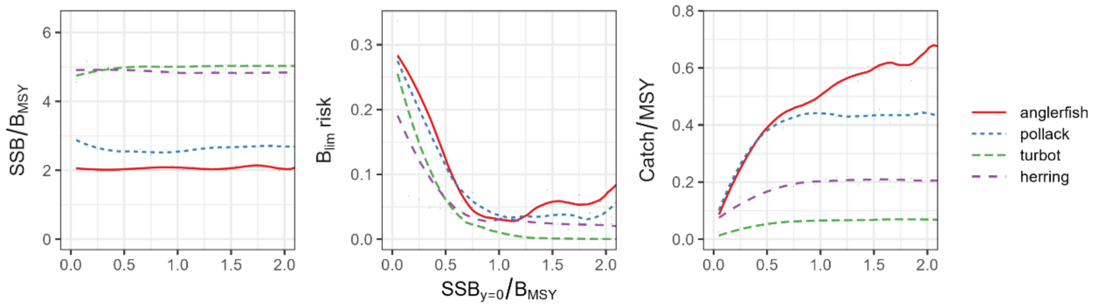

Figure 3.2.1.3. Long-term performance of the new empirical data-poor HCR for four example stocks as a function of initial depletion (x-axis). Shown is the average (median) over the 100-year projection.

One important element of a new HCR should be its ability to recover depleted stocks, and it should be better than the currently used ICES approach. Figure 3.2.1.4 shows this for four example stocks. For anglerfish and pollack, the B_{lim} risk was reduced similarly by the new HCR compared to the current ICES approach. However, for turbot and herring, the risk reduction was actually stronger and earlier.

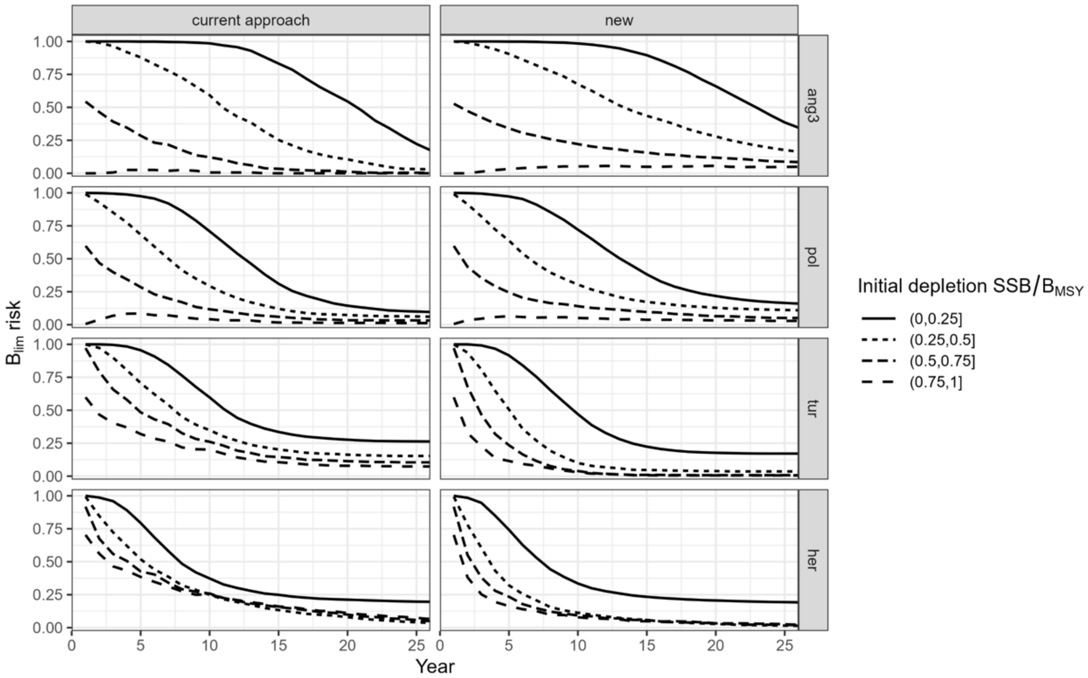

Figure 3.2.1.4. Comparison of the new HCR (right column) and the current ICES approach (left column). Shown is the change in the B_{lim} risk for four example stocks (anglerfish, ang3; pollack, pol; turbot, tur; herring, her) over time, split into depletion levels.

An alternative length indicator based on the mortality estimate from a length-converted catch curve was explored. The application of this approach to real data from an ICES stock (ple.27.7e) showed rather noise instead of trends in the mortality or stock size and was not explored further.

Application to real data

During subgroup work at WKLIFE XIV, the new HCR was applied to data from a few real ICES stocks. For most of these stocks, the new HCR would lead to a reduction in the catch advice. By default, the new HCR uses three years for the linear regression to derive the slope of the catch and mean catch length. In a linear regression of three points, only the first and last point influence the slope, whereas the point in the middle only influences the intercept but is not used here. This essentially means that the slope is defined by two data points and therefore susceptible to noise in the data. If just one point is noisy or an outlier, it will influence the slope and can lead to a false perception of the trend in the data. Consequently, it may make sense to use more data years in the linear regression. The simulations in the sections above were repeated with a 5-year linear regression instead of the default 3-year linear regression. This resulted in lower risks but also caused lower catches in the long-term. It is possible that this low catch can be increased by tuning some of the other control parameters of the HCR, such as the increase or decrease of the catch, or the thresholds.

Furthermore, length data for some of these data-poor stocks may be unrepresentative, e.g. (1) because they do not cover the full area of the stock unit, (2) they cover only a part of the fishing gears catching the stock, (3) they only cover specific sizes and not the full age or length distribution of the population, or (4) sampling levels may be too low.

In conclusion, applying the method to data from real stocks helped to consider elements which may not have been looked at in a generic simulations study.

Discussion

The new empirical data-poor HCR showed promising management performance. Compared to the current ICES approach for stocks in categories 5 and 6, it has the following benefits:

- It provides an adaptive management solution (catches are adjusted based on the perception of the stock) whereas the current ICES approach is not adaptive (catches always reduced)
- Catches can increase again whereas the current ICES approach never increases catches

Reducing the B_{lim} risk is a challenge for any data-poor HCR because the stock status is not known with confidence. The current ICES approach does not meet the 5% B_{lim} risk criterion defined by the ICES precautionary approach. On the other hand, the new HCR resulted in a long-term B_{lim} risk of around 5% for most stocks if the initial stock size was above $0.5B_{MSY}$. For stronger depleted stocks, this risk limit may not be reached, but the current ICES approach does not achieve it either. However, the new HCR appears to perform generally better, because catches can be reduced faster and earlier, leading to a stronger decline in B_{lim} risk in the short term. Furthermore, the definitions of (1) the risk threshold, (2) the biomass limit reference point B_{lim}, and (3) the time horizon over which the risk is calculated are somewhat arbitrary, particularly in generic simulations. Therefore, it makes more sense to compare different approaches, and new HCR appears superior compared to the current ICES approach. Given the scarcity of data and knowledge about data-poor stocks, it is infeasible to expect a perfect management strategy, but risk equivalence with other categories should still be considered.

3.2.2 Length-based SPiCT (ToR 1)

This presentation explored the potential of using length-frequency data to extend the applicability of the SPiCT (Surplus Production in Continuous Time) model to data-limited fish stocks that lack a relative abundance index. The standard implementation of SPiCT, typically used for ICES Category 2 stocks, requires a time series of total catches and an accompanying abundance index. When such an index is unavailable, as is the case for Category 4-6 stocks, SPiCT cannot be applied in its default form. This work investigated whether a proxy for fishing mortality (F_{proxy}), derived from length data, can effectively substitute the index input, enabling assessments for a broader set of stocks.

To address this question, length-frequency data using the FLR framework was simulated. A key step involves constructing a stochastic age-length key (ALK) to define the probability of observing a fish in a given length bin conditional on its age. This ALK is used to convert catch-at-age into catch-at-length. From the resulting length distributions, F_{proxy} was derived using a length-converted catch curve, which is then introduced into SPiCT as a proxy for effort. Specifically, F_{proxy} is incorporated into the model through the observation equation

$$log(E_t) = log(q_f) + log(F_t) + \varepsilon_t, \varepsilon_t \sim N(0, \sigma_e^2)$$

One of the main challenges identified with this approach is the lag inherent in length-based indicators. Since length distributions reflect past fishing pressure rather than the instantaneous fishing mortality, a hysteresis effect is introduced, particularly for long-lived species (Figure 3.2.2.1).

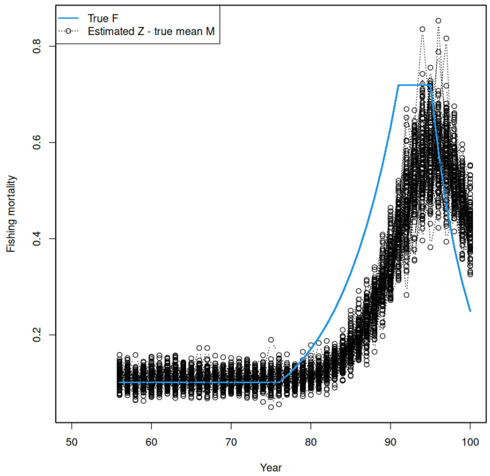

Figure 3.2.2.1: Estimated F_{proxy} (Z from the catch curve minus true mean M) and true fishing mortality.

In initial simulations with low observational noise and logistic selectivity, SPiCT models informed by a length-derived F_{proxy} were able to capture the overall trends in stock biomass and fishing mortality with reasonable accuracy, albeit with a predictable time lag. When the Fproxy time series was adjusted by a six-year lag (corresponding to the best lag given the simulated exploitation history for the specific species) the resulting relative biomass trajectories aligned well with the simulated dynamics. However, the estimated fishing mortality still deviated from the true pattern, reflecting the limitations of using length-based indicators as direct proxies for instantaneous fishing pressure (Figure 3.2.2.2).

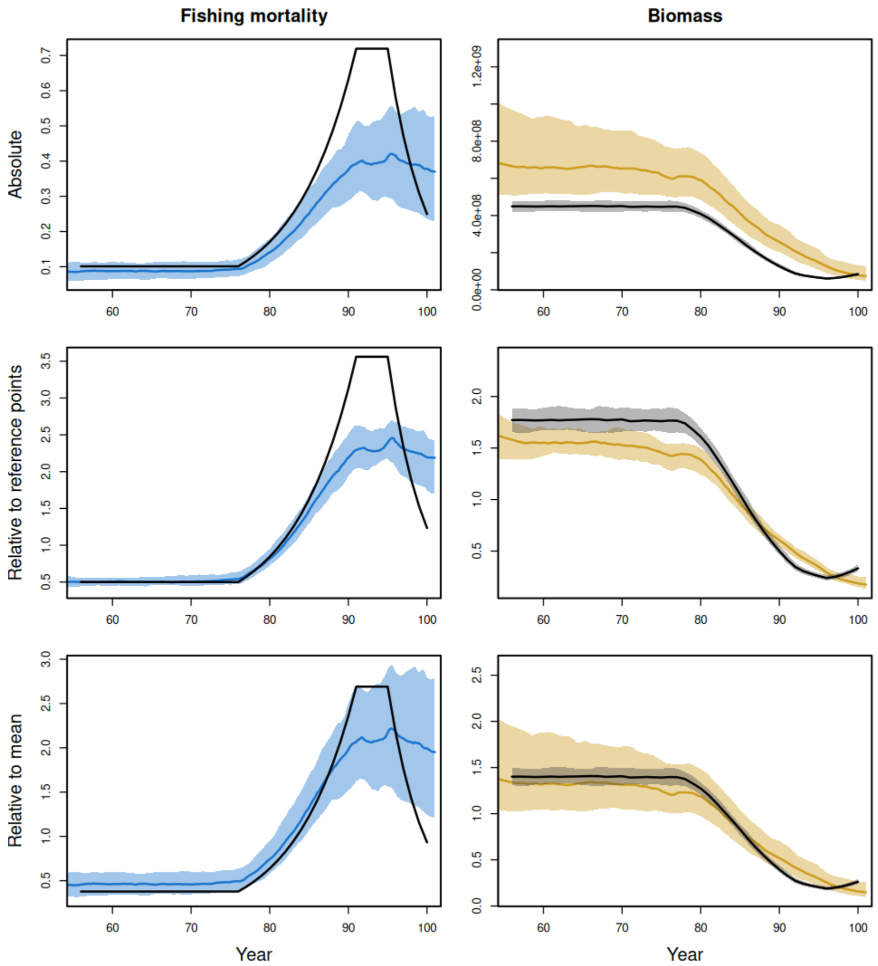

Figure 3.2.2.2: Estimated and true fishing mortality and biomass on absolute scales (top row), relative to reference points (middle row), and relative to the mean (bottom row).

Two critical challenges were identified for future methodological refinement. First, the hysteresis effect, a delayed response in the proxy signal, necessitates a more flexible functional form for the relationship between true fishing mortality and F_{proxy}. One proposed solution involves estimating a non-linear relationship where F_{proxy} responds to a power-transformed version of F. Second, the issue of time lags must be addressed more explicitly. Instead of fixing the lag to a single value, a distributed lag structure is suggested, allowing F_{proxy} to be modelled as a weighted average of fishing mortalities over previous years. This approach opens up the possibility of using life-history traits to inform the lag structure, perhaps via meta-analytic studies.

Despite these challenges, the results are encouraging. SPiCT models informed solely by catches and length data may serve as a viable tool for data-limited stock assessment, especially for deriving relative trends in stock status or for use in harvest control rules that do not rely on biomass reference points. The authors emphasize the importance of testing the method with real-world case studies, exploring its robustness across species with different life histories, and examining whether length data can add value even when an index is available.

In conclusion, this work provides a promising proof-of-concept that extends SPiCT to a broader range of data-limited contexts. While further methodological development is needed to handle lag effects, uncertainty propagation, and parameter scaling, the approach holds substantial potential for enhancing advice in situations where traditional assessment inputs are unavailable.

3.3 Spatial indicators for Northern Shelf cod substocks (ToR 1/5)

Cod is an important commercial gadoid fish species on the Northern Shelf caught by demersal fisheries and is assessed as an ICES category 1 stock. The assessment of the Northern shelf cod stock is complicated by the existence of substocks which are assumed to be mixing during part of the year (outside of quarter 1), a recruitment regime change, and by diverging trends in substocks abundances (ICES, 2020, ICES, 2023). Spatial indicators have been used to describe spatial patterns in stock distribution over time, and some may be linked to changes in stock size (Woillez *et al.*, 2007; Petitgas and Poulard, 2009; Rufino *et al.*, 2018). An application of spatial indicators was presented at WKLIFE 2025 with the example of this data-rich stock and compared to ICES assessment results (ICES, 2024). Spatial indicators for Northern shelf cod substocks were calculated, based on modelled quarter 1 survey data for adults. Many spatial indicators, such as positive area, are sensitive to low density values (Huret *et al.*, 2010, Woillez *et al.*, 2007). In modelled survey data, estimated fish density is interpolated across grid points and the limited number of zero density location may not be informative about spatio-temporal changes. Therefore, a lower threshold for non-zero density (here 0.5) was selected for spatial indicators (Crecco and Overholtz, 1990). For adults, the centre of gravity shifted northwards confirming other studies, likely related to increasing water temperature in the North Sea (Engelhard *et al.*, 2014; Ellis *et al.*, 2023). This spatial shift was accompanied by an increase in minimum latitude for all substocks. The ability of spatial indicators to predict stock size and recruitment regime as estimated by recent ICES stock assessment was tested using ROC (Receiver Operating Characteristics) curves (Puntila *et al.*, 2013). The predictive ability of spatial indicators for adults relating to occupancy (positive area) and aggregation (spreading area) was found to be excellent, in particular for Southern and Northwestern substocks. For the Viking substock, the spatial indicators did not perform as well, this may be due to the specific longish shape of its substock area and its location near the continental shelf edge with proximity to larger depths/lower temperatures. For this substock, spatial changes over time may be less pronounced and don't relate strongly to abundance changes and regime change. In summary, the application of spatial indicators was useful for this category 1 stock and can be considered also for data-limited stocks. Monitoring multiple indicators is advantageous. Considerations should be given to the spatial extent of the stock area, availability of suitable habitat, survey data quality, minimum thresholds of non-zero density, as well as substock structure and connectivity. Development of harvest control rules which include spatial indicators would require simulation testing to ensure risk equivalence.

3.4 Linking spatial indicators with single species operating models (ToR 1)

The distribution of species across space has widely been observed to positively correlate with population abundance (Gaston *et al.*, 2000). More recently, empirical survey-based indicators of species spatial distribution have been shown to signal the status of ICES data-rich fish stocks (Kidd *et al.*, 2025). Spatial indicators may therefore prove useful in empirical harvest control rules for data-limited stocks when traditional indices of abundance are lacking and stock status is unknown.

Incorporating and testing spatial indicators within data-limited HCRs requires operating models (OMs) to generate spatially disaggregated abundance so that spatial indicators can be calculated. However, spatially explicit OMs are not well suited to data-limited applications due to complexity and data requirements. To bridge this gap, a relatively simple Dirichlet-multinomial model (DMM) for distributing abundance across space was presented, which can be integrated into existing non-spatial OMs.

The DMM relies on an input of habitat suitability information, $\boldsymbol{S} = (s_1, s_2, \dots, s_M)$, across M equally sized grid cells, where $\Sigma_{i=1}^{M} s_i = 1$. A vector of probabilities is then drawn from a Dirichlet distribution,

$$\boldsymbol{p} = (p_1, p_2, \dots p_M) \sim \text{Dirichlet}(\boldsymbol{\alpha})$$

where $\boldsymbol{\alpha} = (\alpha_1, \alpha_2, \dots \alpha_M)$ is a vector of Dirichlet concentration parameters. Each concentration parameter is calculated based on cell specific habitat suitability and scaled by parameters θ and β,

$$\alpha_i = \theta \cdot s_i^{\beta}, \quad i = 1, \dots, M$$

For each cell, the expected probability drawn from the Dirichlet distribution and variance is given as,

$$\text{Exp}[p_i] = \frac{\alpha_i}{\alpha_0}, \quad \text{Var}[p_i] = \frac{\alpha_i(\alpha_0 - \alpha_i)}{\alpha_0^2(\alpha_0 + 1)}, \quad \text{where}$$

$$\alpha_0 = \sum_{i=1}^{M} \alpha_i = \theta \sum_{i=1}^{M} s_i^{\beta}$$

The variance in the probabilities drawn from the Dirichlet distribution is determined by α_0. The parameter θ uniformly scales α_0 with higher values resulting in greater variance. The parameter β modifies the relative differences between α_i, altering the expected probabilities. When $\beta < 1$, the probability surface is flattened, and the expected probabilities of occurrence are similar across grid cells. Conversely, when $\beta > 1$, the relative differences between α_i are amplified and the expected probability of occurrence will increase in grid cells with high habitat suitability and decrease in grid cells with low habitat suitability. When $\beta = 1, \text{Exp}[p_i] = s_i$.

The work presented also explored representing β as a function of total abundance, N, to account for density-dependent habitat selection,

$$\beta(N) = \frac{\beta_{\max}}{1 + e^{r\left(\frac{N}{k} - 1\right)}}$$

where $\beta_{\max}$ constrains the habitat selection strength, k is carrying capacity, and r is steepness of the density-dependent response. The value of β increases as N/k decreases, and vice versa. When abundance is below carrying capacity, the expected probabilities drawn from the Dirichlet distribution will increase in areas with high habitat suitability and decrease in areas with low habitat suitability. When abundance is above carrying capacity, the expected probabilities will become more uniform across grid cells.

Finally, given the vector of probabilities drawn from the Dirichlet distribution, $\boldsymbol{p}$, and total abundance, N, spatially disaggregated counts are drawn from the multinomial distribution,

$$\boldsymbol{X} = (X_1, X_2, \dots X_M) \sim \text{Multinomial}(N, \boldsymbol{p})$$

where X_i is the number of individuals in cell i, and $\sum_{i=1}^{M} X_i = N$.

The DMM presented can be integrated into existing non-spatial OMs, by linking the total abundance from the biological component of the OMs as an input into the DMM. Given spatial information on habitat suitability, spatial abundance can be generated within OMs and enable the calculation and testing of spatial indicators for data-limited stocks. Future work aims to (1) validate the DMM for stocks with good spatial distribution information, (2) develop an observation error model to sample spatial data from the DMM, (3) test the sensitivity of spatial indicators to components of the DMM (e.g. habitat suitability), and (4) integrate the DMM into existing OMs developed for data-limited stocks (e.g. Fischer *et al*., 2020) to test the performance of harvest control rules that are informed by spatial indicators.

3.5 swaf: SWept Area Fishing mortality and exploitation status (ToR 1)

The swaf (SWept Area Fishing mortality) package provides a data-limited approach for assessing fishing pressure and exploitation status based on the methods developed by Walker *et al.* (2019) but requires further testing prior to release. The method:

(i) Estimates fishing mortality from the spatial overlap of towed gears used in the fishery and species distributions (combined with gear efficiency if this is available).
(ii) Runs spawner-per-recruit models with the estimated F, F=0 and species' specific life history parameters as inputs to calculate the reduction in reproductive potential (%SPR) expected from fishing at the calculated F.
(iii) Compares %SPR to %SPR reference points to assess exploitation status.

Current methods for estimating proxy reference points and / or providing MSY advice for stocks in Categories 2–3 require a time-series of abundance and / or fishery length frequency data. swaf estimates exploitation status using alternative data sources, with different levels of analysis depending on data availability. Potential utility in the advisory process was demonstrated by applying swaf to VAST outputs for five North Sea species (starry ray, cod, spurdog, lesser-spotted dogfish and plaice):

- Category 3: An alternative fishing proxy *f* for use in the rfb rule (Method 2.1) for species that have an index of abundance but lack reliable fisheries dependent length data, thereby avoiding the rb rule (Method 2.3) and facilitating provision of MSY over PA advice, e.g.:

$$f = \frac{\%SPR}{\%SPR_{target}}$$

- Categories 4–6: An objective PSA-based risk assessment to determine if reductions in catch are necessary when providing PA advice (ICES, 2012)

Simulation testing swaf for use as an alternative fishing proxy in the rfb rule may be challenging due to the need for a spatial operating model. However, other potential uses discussed included:

- Using time series of %SPR outputs to define a target harvest rate for the CHR rule (Method 2.2)
- Using the outputs of swaf as auxiliary data indicative of F/F_{MSY} in biomass dynamic models such as JABBA (Winker *et al*., 2018; see Section 3.6) or SPiCT (Pedersen and Berg, 2017; see Section 3.2.2)

Because swaf models the expected reduction in reproductive output given the observed F (calculated based on effort and species distribution data), the estimated %SPR are considered representative of exploitation at the time of data collection. This is in contrast to methods based on commercial length distributions where lags may be observed between exploitation and any associated signal in the length data (see Section 3.2.2).

Work is currently underway to apply swaf in a variety of different case studies in order to test the code and ensure the package is flexible enough to work with many different stocks, varying levels of information on those stocks, in different geographic areas and with different data formats. Furthermore, results from this testing are expected to inform on the value of information of differing data and data sources and provide insights into the situations where swaf works well or not.

3.6 Length-based methods. Estimators vs. Indicators & Hierarchical Assessment Frameworks. Risk-Equivalent Fisheries Management (ToR 1)

Data and capacity limited stocks include not just the main targeted species, but include bycaught, endangered, threatened and protected populations and keystone species. The extensive datasets required for traditional quantitative stock assessments are generally unavailable for data-limited fisheries, particularly in small-scale settings or in the Global South. Length-based approaches offer a potential set of data for performing stock assessment in such cases. Especially as data from a single year, either recovered from archives or one-off sampling programmes can be used. Methods can be either empirical indicators or length-based estimators. The latter range from simple methods to complex methods that apply Bayesian Markov chain Monte Carlo, mixed-effects and maximum likelihood techniques. Model used for advice should be formally validated, therefore we used an age-structured Operating Model to compare length-based indicators and estimates to known values (Kell and Sharma, 2025). Simulations were conducted for a range of scenarios, for a range of life-history types and recruitment and natural mortality dynamics. Results reveal that while length-based approaches can effectively track trends in fishing mortality, performance varies significantly depending on species-specific life histories and assumptions about key parameters. Simple empirical indicators often matched or outperformed the complex methods, particularly when assumptions about equilibrium conditions or natural mortality were violated. The study highlights the limitations of length-based methods for classifying stock status relative to reference points but demonstrates their utility when used with historical reference periods or as part of empirical harvest control rules. The findings provide practical guidance for applying length-based approaches in data-limited fisheries management, ensuring sustainability in data- and capacity-limited situations.

Catch-only models have been applied to assess data-limited stocks; however, many studies have shown the limitations of such approaches (Sharma *et al*., 2021, Ovando, 2021a, Kell *et al*., 2023). Improvements to estimates of the state of the world's exploited fish populations depend more on efficient use of existing data and expanding the collection of new information, rather than the development of new models (Ovando *et al*., 2021b). Bayesian biomass dynamic models, such as JABBA, can be fitted to as little as two observations of annual abundance indices, thus enabling a transition from a catch-only to a data moderate assessment. Additional data sources include length data, which can be used as a proxy for fishing mortality (e.g. Miethe *et al*., 2019) or relative depletion (Froese *et al*., 2018), and survey data that can provide spatial indicators or estimates of exploitation (Kidd *et al*., 2025; Walker *et al*., 2017). Length data are potentially available for many fisheries, and even data from a single year could be used in an assessment model to provide an estimate of exploitation level. While port collection schemes could be established to monitor trend in size composition and catch-per-unit and hence exploitation and abundance indices. This way an initial catch-only model can be adapted and updated with new data as those become available and eventually be validated.

Kell *et al*., (2025) showed how empirical indicators for fishing pressure, can be used within a Bayesian state-space biomass dynamic modelling framework. An aim is to provide risk-equivalent advice to ensure that management does not penalise data-limited fisheries with undue precaution (and loss of potential yield), nor expose them to higher risk of overexploitation. To achieve this, we evaluate performance using classification skill metrics, for stock status relative to maximum sustainable yield (MSY) based target reference points. Results demonstrate that incorporating auxiliary data, particularly fishing mortality indices from periods of high exploitation, substantially improves the accuracy of stock status classification.

Hierarchical Assessment Framework provides a structured pathway for transitioning data and capacity limited stocks from basic risk assessments to more sophisticated quantitative evaluations. For example the Scientific and technical knowledge of the EU-fisheries, exploited stocks and sensitive marine habitats in the high seas and third countries waters not subject to SFPA and/or RFMOs jurisdiction (ECEEA 2024) builds on a three-tier approach (Level 1 PSA, Level 2 initial assessments with indicators, Level 3 full quantitative assessments), the framework's emphasis on progressive data collection and risk equivalence principles directly supports the integration of length-based approaches and auxiliary data sources identified as most promising for data-limited situations.

3.7 Ad-hoc MSE for Sole in divisions 8.c and 9.a (ToR 1)

The common sole (*Solea solea*) is a valuable fish species in the Iberian Atlantic Waters, but concerns have arisen regarding the performance of the advice rule currently used for this stock—the rfb rule (method 2.1 in ICES, 2025a)—as it led to substantial reductions in catch advice: 36% in 2021 and 35% in 2023. These outcomes contrast with those from various length-based data-limited assessment methods which suggested compatibility with sustainable exploitation. Consequently, in 2022, the development of an ad-hoc MSE for common sole was initiated with the aim of proposing, if possible, a new catch rule that would allow higher catches without compromising the B_{lim} risk level. Progress on this ad-hoc MSE was presented at WKLIFEXII and WKLIFEXIII (details can be consulted in Annex 6 of ICES, 2023, and Section 3.5.2 of ICES, 2024), and further progress during the last year was presented at WKLIFEXIV and is described below.

One of the tasks carried out during the last year, and a crucial step in the development of the MSE, was a thorough review of the available information for common sole. This review provided the basis for defining a set of operating models (OMs), including both reference and robustness OMs. The definitions of these OMs were presented at the Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE) 2025 and can be found in Annex 5 (WD 5) of ICES (2025b) as well as here.

After defining the OMs, the performance of several catch rules was evaluated. In addition to the rfb rule, two alternative rules incorporating the spawning potential ratio (SPR) were considered. The first, termed rfb SPR, modifies the f component of the rfb rule by replacing it with the ratio of the estimated SPR in year y-1 to an MSY SPR proxy, while the remainder of the rule follows the standard rfb formulation. A variant of this rule, termed rfb SPR fixed-constraints, applies the same modification but keeps the upper and lower constraints active even when the b component of the rule is below 1. The second alternative, termed SPR rule, calculates the next catch advice based on the previous catch advice, the SPR component described above, and the “2 over 3” r-component of the rfb rule, while applying upper and lower constraints, with the upper limit set according to historical catches.

For the four rules—rfb, rfb SPR, rfb SPR fixed-constraints and SPR—the genetic algorithm (GA; Fischer *et al*., 2021a) was implemented within the MSE framework to identify the optimal parameter values. The GA identifies parameter values that maximize a function defined as the median catch relative to MSY over the last 10 years of projection minus a penalty if the maximum probability of falling below B_{lim} during that period exceeds 0.05. This optimization was conducted using the baseline OM, and the resulting optimized rules were tested across the reference set of OMs and compared with the default rfb rule (i.e., the current rule without optimization).

Based on the results, several conclusions can be drawn. The default rfb rule shows a decreasing catch advice trend during the first half of the projection period, then stabilizes around 0.6×MSY (or lower in some OMs), and is not precautionary in the short term, despite SSB being equal to SSB_{msy} in the first projection year. The GA-optimized rfb rule shows only modest improvements, as the optimization focused on long-term performance, leaving short-term issues unresolved.

The rfb SPR rule provides higher long-term catch advice than the rfb rule in some OMs and controls B_{lim} risk over the full projection period, but short-term catch advice can decrease substantially to achieve higher long-term values. This behavior also reflects the long-term focus of the GA optimization. The rfb SPR fixed-constraints rule improves upon the rfb SPR rule by providing long-term catch advice above that of the rfb rule, controlling B_{lim} risk over the full projection period, and reducing the magnitude of short-term catch advice reductions. The SPR rule behaves similarly to rfb SPR fixed-constraints but often results in even higher long-term catch advice.

These results suggest that considering both catch and risk over the full projection period in the GA optimization could further improve the performance of all rules, and this task is currently being addressed.

Substantial progress has been made in the development of the MSE, including the implementation of the MSE framework with the GA algorithm, a thorough review of the literature for defining the OMs, and the consideration of alternative catch rules. These advances ensure that the framework is well-prepared for the benchmark, being ready to incorporate the final recommendations provided by the benchmark experts.

3.8 Geographical variations in ling life history and implications for rfb rule (ToR 1/2)

Preliminary findings were presented on the life history and reproductive phenology of ling (*Molva molva*) across several regions: the Barents and Norwegian Seas, North Sea, Icelandic grounds, Faroe Islands, Skagerrak and the West of Scotland, and Rockall. The analysis drew on data collected between 2000 and 2024 from three key institutions: the Norwegian Institute of Marine Research (IMR), the Icelandic Marine and Freshwater Research Institute (MFRI), and the Faroe Marine Research Institute (FAMRI).

Initial results revealed notable regional differences in growth parameters (L_{inf}, K) and reproductive metrics (L_{50}). When these location-specific growth parameters were applied—alongside the rfb rule—to assess the Northeast Arctic ling stock (Norwegian and Barents Seas), the resulting catch advice varied significantly.

The presentation underscored the critical importance of using stock-specific biological parameters when formulating management advice. It also highlighted the methodological challenges involved in estimating these parameters consistently across different regions and datasets. A peer-reviewed publication is expected with these findings.

3.9 References

Crecco, V., and Overholtz, W. J. 1990. Causes of density-dependent catchability for Georges Bank Haddock *Melanogrammus aeglefinus*. Canadian Journal of Fisheries and Aquatic Sciences, 47:2, 385-394. https://doi.org/10.1139/f90-040

Ellis, J. V., Schuchert, P., Scantlebury, D. M., Marshall, C. T., and Fernandes, P. G. 2023. Variable trends in the distribution of Atlantic cod (*Gadus morhua*) in the Celtic seas. Journal of Fish Biology, 105, 512-525. https://doi.org/10.1111/jfb.15715

Engelhard, G. H., Righton, D. A., and Pinnegar, J. K. 2014. Climate change and fishing: a century of shifting distribution in North Sea cod. Global Change Biology, 20:8, 2473-2483. https://doi.org/10.1111/gcb.12513

European Climate, Infrastructure and Environment Executive Agency et al., 2024. *Scientific Knowledge of EU Fisheries in High Seas and Third Country Waters: Final Report*, Publications Office of the European Union. Belgium. Retrieved from https://coilink.org/20.500.12592/tyaa7tw on 05 Sep 2025. COI: 20.500.12592/tyaa7tw.

Fischer, S. H. 2022. Developing empirical management procedures to meet management objectives for data-limited fisheries. PhD Thesis. Imperial College London. 390 pp. https://doi.org/10.25560/101851

Fischer, S. H., De Oliveira, J. A. A., and Kell, L. T. 2020. Linking the performance of a data-limited empirical catch rule to life-history traits. ICES Journal of Marine Science, 77: 1914-1926. https://doi.org/10.1093/icesjms/fsaa054

Fischer, S. H., De Oliveira, J. A. A., Mumford, J. D., and Kell, L. T. 2021a. Using a genetic algorithm to optimize a data-limited catch rule. ICES Journal of Marine Science, 78: 1311–1323. https://doi.org/10.1093/icesjms/fsab018

Fischer, S. H., De Oliveira, J. A. A., Mumford, J. D., and Kell, L. T. 2021b. Application of explicit precautionary principles in data-limited fisheries management. ICES Journal of Marine Science, 78: 2931–2942. https://doi.org/10.1093/icesjms/fsab169

Fischer, S. H., De Oliveira, J. A. A., Mumford, J. D., and Kell, L. T. 2022. Exploring a relative harvest rate strategy for moderately data-limited fisheries management. ICES Journal of Marine Science, 79: 1730–1741. https://doi.org/10.1093/icesjms/fsac103

Froese R., Winker H., Coro G., Demirel N., Tsikliras A. C., Dimarchopoulou D., et al. (2018). A New Approach for Estimating Stock Status From Length Frequency Data. ICES J. Mar. Sci. 75, 2004–2015. https://doi.org/10.1093/icesjms/fsy078

Gaston, K. J., Blackburn, T. M., Greenwood, J. J. D., Gregory, R. D., Quinn, R. M., and Lawton, J. H. 2000. Abundance–occupancy relationships. Journal of Applied Ecology, 37: 39–59. https://doi.org/10.1046/j.1365-2664.2000.00485.x

Huret, M., Petitgas, P., and Woillez, M. 2010. Dispersal kernels and their drivers captured with a hydrodynamic model and spatial indices: A case study on anchovy (*Engraulis encrasicolus*) early life stages in the Bay of Biscay. Progress in Oceanography, 87: 6-17. https://doi.org/10.1016/j.pocean.2010.09.023

ICES (2023). Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFEXII). ICES Scientific Reports. 5:103. 111 pp. https://doi.org/10.17895/ices.pub.24581343

ICES (2024). Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFEXIII). ICES Scientific Reports. 6:95. 64pp. https://doi.org/10.17895/ices.pub.27677745

ICES (2025a). ICES Guidelines - Advice rules for stocks in category 2 and 3. Version 3. ICES Guidelines and Policies - Advice Technical Guidelines. 31 pp. https://doi.org/10.17895/ices.pub.28506179

ICES (2025b). Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE). ICES Scientific Reports. 7:77. 510 pp. https://doi.org/10.17895/ices.pub.29390639

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp. https://doi.org/10.17895/ices.pub.5322

ICES. 2020. Workshop on Stock Identification of North Sea Cod (WKNSCodID). ICES Scientific Reports, 2:89, 82 pp. http://doi.org/10.17895/ices.pub.7499

ICES. 2023. Benchmark workshop on Northern Shelf cod stocks (WKBCOD). ICES Scientific Reports, 5:37, 425 pp. https://doi.org/10.17895/ices.pub.22591423

ICES. 2023. Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFEXII). ICES Scientific Reports. 5:103. 111 pp. https://doi.org/10.17895/ices.pub.24581343

ICES. 2024. Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES Scientific Reports, 6:38, 1659 pp. https://doi.org/10.17895/ices.pub.25605639

ICES. 2024. Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFEXIII). ICES Scientific Reports. 6:95. 64 pp. https://doi.org/10.17895/ices.pub.27677745

ICES. 2025. ICES Guidelines - Advice rules for stocks in category 2 and 3. Version 3. ICES Guidelines and Policies - Advice Technical Guidelines. 31 pp. https://doi.org/10.17895/ices.pub.28506179

Kell, L. T. and Sharma, R., 2025. An Evaluation of the Robustness of Length-Based Stock Assessment Approaches for Sustainable Fisheries Management in Data and Capacity Limited Situations. Sustainability, 17: 4791. https://doi.org/10.3390/su17114791

Kell, L. T., Sharma, R. and Winker, H., 2022. Artefact and artifice: Evaluation of the skill of catch-only methods for classifying stock status. Frontiers in Marine Science, 9: 762203. https://doi.org/10.3389/fmars.2022.762203

Kidd, P. J., Kell, L. T., De Oliveira, J. A. A., & Collins, A. M. 2025. Evaluating the ability of spatial indicators to classify fish stock status in the Northeast Atlantic. Ecological Indicators, 179: 114145. https://doi.org/10.1016/j.ecolind.2025.114145

Miethe T., Reecht Y., Dobby H. 2019. Reference Points for the Length-Based Indicator L_Max5 for Use in the Assessment of Data-Limited Stocks. ICES J. Mar. Sci. 76, 2125–2139. https://doi.org/10.1093/icesjms/fsz158

Mildenberger, T. K. 2020. Towards sustainable fisheries: Improving the robustness and effectiveness of management procedures for data-limited fish stocks. PhD thesis. DTU Aqua. https://orbit.dtu.dk/en/publications/towards-sustainable-fisheries-improving-the-robustness-and-effect

Mildenberger, T. K., Berg, C. W., Kokkalis, A., Hordyk, A. R., Wetzel, C., Jacobsen, N. S., Punt, A. E., and Nielsen, J. R. 2022. Implementing the precautionary approach into fisheries management: Biomass reference points and uncertainty buffers. Fish and Fisheries, 23: 73–92. https://doi.org/10.1111/faf.12599

Ovando D., Free C. M., Jensen O. P., Hilborn R. 2021a. A History and Evaluation of Catch-Only Stock Assessment Models. Fish and Fisheries, 23: 616–630. https://doi.org/10.1111/faf.12637

Ovando D., Hilborn R., Monnahan C., Rudd M., Sharma R., Thorson J. T., et al. 2021b. Improving Estimates of the State of Global Fisheries Depends on Better Data. Fish and Fisheries, 22: 1377–1391. https://doi.org/10.1111/faf.12593

Pedersen, M. W. and Berg, C. W. 2017. A stochastic surplus production model in continuous time. Fish and Fisheries. 18: 226–243. https://doi.org/10.1111/faf.12174

Petitgas, P., and Poulard, J. C. 2009. A multivariate indicator to monitor changes in spatial patterns of age-structured fish populations. Aquatic Living Resources, 22: 165-171. https://doi.org/10.1051/Alr/2009018

Puntila, R., Vilizzi, L., Lehtiniemi, M., and Copp, G. H. 2013. First Application of FISK, the Freshwater Fish Invasiveness Screening Kit, in Northern Europe: Example of Southern Finland. Risk Analysis, 33: 1397-1403. https://doi.org/10.1111/risa.12069

Rufino, M. M., Bez, N., and Brind'Amour, A. 2018. Integrating spatial indicators in the surveillance of exploited marine ecosystems. PLOS ONE, 13: e0207538. https://doi.org/10.1371/journal.pone.0207538

Walker, N. D., García-Carreras, B., Le Quesne, W.J.F., Maxwell, D.L., and Jennings, S. 2019. A data-limited approach for estimating fishing mortality rates and exploitation status of diverse target and non-target fish species impacted by mixed multispecies fisheries. ICES Journal of Marine Science. 76: 824–836. https://doi.org/10.1093/icesjms/fsy205

Walker, N. D., Maxwell, D. L., Le Quesne, W. J., and Jennings, S., 2017. Estimating efficiency of survey and commercial trawl gears from comparisons of catch-ratios. ICES Journal of Marine Science, 74: 1448-1457. https://doi.org/10.1093/icesjms/fsw250

Winker, H., Carvalho, F., and Kapur, M. 2018. JABBA: Just Another Bayesian Biomass Assessment. Fisheries Research. 204: 275–288. https://doi.org/10.1016/j.fishres.2018.03.010

Woillez, M., Poulard, J. C., Rivoirard, J., Petitgas, P., and Bez, N. 2007. Indices for capturing spatial patterns and their evolution in time, with application to European hake (*Merluccius merluccius*) in the Bay of Biscay. ICES Journal of Marine Science, 64:3, 537-550. https://doi.org/10.1093/icesjms/fsm025

4 Approaches for specific life histories (ToR 2)

4.1 Introduction

This report section focuses on ToR 2 "Develop data-limited stock assessment tools, harvest control rules, and simulation approaches for specific life-history strategies, specifically shellfish and *Nephrops*, deep-sea species and pelagic, and for species with different roles in the ecosystem." Sections 4.2–4.7 summarise plenary presentations. Additionally, there was a subgroup discussion on shellfish during WKLIFE XIV and this discussion and ideas for next steps are summarised in Section 4.8.

4.2 Summary of data-limited work and challenges in WGNEPH (*Nephrops*) (ToR 2)

Challenges in *Nephrops* assessments and data-limited approaches used for these stocks were presented. Three main biological features of *Nephrops norvegicus* present challenges in the monitoring and assessment of stock status for this species: 1) age determination is not possible as all hard parts are changed during molting; 2) the species is distributed on soft bottom consisting of sandy mud/muddy sand, resulting in a very patchy distribution and a metapopulation of partly isolated small stocks with separate quota advice; 3) the animals spend much time hiding in burrows in the bottom substrate, and emergence is influenced by season, light intensity, weather conditions, life cycle, and sex. Berried females stay in burrows (wintertime), and catches are often dominated by males. Bottom trawl surveys are therefore not optimal and standardized Under Water TV surveys (UWTV) are used to calculate fishery-independent abundance indices. Sixteen ICES stocks (functional units) are monitored by UWTV surveys. Stocks with UWTV indices are considered category 1 and their assessment is sensitive to mean weight and fishery pattern outputs based on commercial sampling and total catches from the fishery. It may be challenging to decipher whether large interannual fluctuations are counting trends or real, with lack of annual information on burrow system size from images. In recent years, several stocks have gone through benchmarks adopting a SPiCT assessment. Stock indices of some of these category 2 stocks are based on bottom trawl surveys, which is not ideal. Three category 3 stocks are assessed by the rfb rule, but will all be benchmarked next year, possibly adopting a SPiCT assessment. Three stocks are still based on a *Nephrops*-specific methodology for category 4 stocks, where advice is based on mean landings with a sensitivity analysis of a range of harvest rates based on densities from sporadic UWTV surveys. Four stocks have no, or outdated, UWTV information, and are category 5 stocks.

Considering the challenges faced, a set of work topics on data-limited approaches has been identified for *Nephrops*:

- Simulation testing of harvest control rules (HCR) for Category 1 stocks (using UWTV data):
    - Improve advice methodology using simulation with population model. Adopt a consistent approach for category 1 stocks within ICES, as the current HCR lacks an associated model.
    - Evaluate the applicability of count-based abundance indices to provide weight-based catch advice and test approaches to include uncertainty from abundance estimates into the advice.
    - Test different approaches to estimate reference points.

- MSE simulations for *Nephrops* stocks:
  Test alternative (HCRs using operating models conditioned on available life-history and fishery dynamics data.

- Consistency of stock perception using SPiCT:
  Compare input series (UWTV index, IBTS stratified mean, IBTS index-model based, commercial CPUE, length-based indicators) to validate data sources and methods. Possible case study: nep.fu.2829.

- Methods proposed for Category 4 stocks:
  Evaluate available length information and test the different methodologies presented during WKLIFE XIV.
- Alternative assessment models:
  Explore other possible category 1 approaches for *Nephrops* stocks (with or without UWTV surveys). Incorporate available male and female length data to improve species dynamics modelling (e.g. using SS3).

- Application of spatial indicators to inform *Nephrops* abundance:
  Use survey and fishery-dependent data to explore spatial patterns.

Given the specificity of the ICES category 1 advice approach adopted for *Nephrops*, research priorities should focus primarily on this topic. The approach for ICES category 4 stocks, while applied exclusively to three *Nephrops* stocks, is of lower priority due to their limited importance to the *Nephrops* fishery in ICES Divisions 4, 6, 7, 8 and 9. Other points, although not specific to *Nephrops*, are considered relevant for improving assessment quality and may serve as case studies in future WKLIFE meetings.

4.3 A framework for using available length data under biological uncertainty. Case study of razor clam in North Irish Sea (ToR 2)

Razor clam in the North Irish Sea is a productive yet data-limited species existing in a dynamic environment, resulting in high individual variability of growth parameters throughout their range. Other areas of uncertainty include the stock-recruit relationship and density-dependent natural mortality rates.

To reflect the epistemic uncertainty, a suite of operating models were formed in order to test advice rules that could be used for this species. This will be further progressed.

4.4 Harvest control rules for data-limited deep-water fish stocks (ToR 2)

The low productivity of deep-sea fishes and elasmobranch due to their high longevity, low fecundity, late maturity, and slow growth makes these resources less resilient and more vulnerable to overfishing (Large *et al*., 2013). Over the past decade, ICES introduced guidelines for category 2 stocks using the Stochastic Production Model in Continuous Time (SPiCT; Pedersen and Berg, 2017) to provide MSY-based catch advice, using the fractile rule (Mildenberger *et al*., 2022). SPiCT and this fractile rule was accepted as the management procedure for a number of stocks through the work of dedicated benchmarks assessment workshops (e.g., WKBMSYSPiCT and WKELASMO) (ICES, 2024a). However, discussions have emerged about using a lower, more risk-averse fractile of the predicted catch for advice for stocks with low productivity compared to the current ICES harvest control rule (0.35 fractile) at the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP) and on Elasmobranch Fish (WGEF). Since 2024, simulations studies have been conducted to assess whether a lower fractile (e.g. the 0.15 fractile) and biennial advice would be a more effective strategy for accounting for the reduced productivity of these vulnerable species (ICES, 2024b).

To address this question, a stock-specific Management Strategy Evaluation (MSE) framework conditioned on real SPiCT assessments was developed. The operating model was based on the best life-history information available for four deep-water species and reflect the life-history strategy of vulnerable species: (i) blackspot seabream (*Pagellus bogaraveo*; ICES stock code: sbr.27.10); (ii) red porgy (*Pagrus pagrus*); (iii) forkbeard (*Phycis phycis*), and blackbelly rosefish (*Helicolenus dactylopterus*), in the Azores ICES Subarea 10. The operating model is an age-based population model with subannual time steps described in Mildenberger *et al*. (2022) and the observation error model in ICES (2024a) and Medeiros-Leal *et al*. (2025). Based on the estimation model, the performance of four HCRs for these vulnerable stocks was compared: (1) Current ICES HCR with a biomass threshold (B_T = MSY $B_{trigger}$) equal to half of B_{MSY} and a limit (B_L) equal to 0.3*B_{MSY}; (2) an alternative rule with a higher threshold, B_T = B_{MSY} and B_L = 0.3*B_{MSY}; (3) same as (1) but without B_L; and (4) same as (2) but without B_L. In addition to the 0.35 fractile that corresponds to the current ICES HCR for category 2 stocks, a range of fractiles from 0.30 to 0.05, for biennial catch advice were tested. The performance of the study is based on 500 replicates, risk of overfishing (Prop ($B<B_{lim}$), where B_{lim} is 0.2*B_0), relative yield (long-term), interannual variability (catch and biomass).

Figure 4.4.1 illustrates the risk–yield trade-offs over the long-term simulation period (here defined as the last two of the four generation times). The results indicate that lower fractiles (0.05–0.15) in all HCRs reduce the risk of overfishing for the four stocks (risk of overfishing < 5%). In particular, the 0.15 fractile is more effective than the one currently adopted by ICES (0.35 fractile), where efficiency is defined as leading to the same or higher yield while leading to the same or lower risk. It is important to note that the 0.15 fractile performs consistently across all HCRs in the long term (Figure 4.4.1a). Regarding interannual variability in catch and biomass, the risk–yield trade-offs suggest that lower fractiles lead to more stable catch advice and reduced biomass variability for these vulnerable stocks (Figure 4.4.1b). In contrast, in the long-term forecast, the HCR using B_{MSY} as a threshold slightly outperforms the current ICES HCR, generating higher yields and a lower risk of overfishing (Figure 4.4.1).

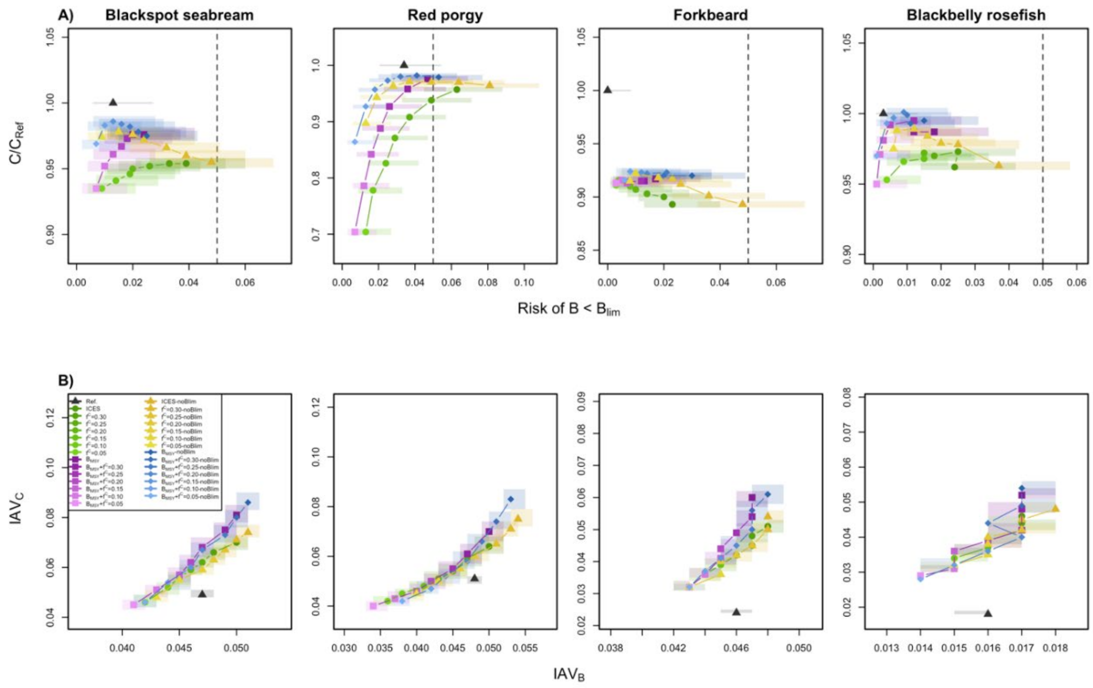

Figure 4.4.1. Long-term (here defined as the last two of the four generation times) risk-yield trade-offs for long-term simulated period (A), and (B) interannual catch and biomass variability for blackspot seabream, red porgy, forkbeard and blackbelly rosefish (columns). The vertical dashed line represents the risk of overfishing at 5%. The shaded areas around the symbols represents the 95% intervals of the metric.

Overall, the findings confirm results presented during WKLIFE XIII that fractiles lower than the current ICES HCR (0.35 fractile), particularly the 0.15 fractile, perform better for vulnerable stocks. Moreover, combining these lower fractiles into a higher biomass threshold ($B_T = B_{MSY}$) and limit ($B_L = 0.3*B_{MSY}$) reduced significantly the risk of overfishing for the four stocks analysed. The group discussed potential implications of these results not only regarding the current recommendation to use the 0.15 fractile for “vulnerable” species (which is part of the technical guidelines), but also regarding the definition of the biomass threshold (MSY $B_{trigger}$) for surplus production models. Even though the results show higher catches and lower risk for all stocks for the HCR with B_{MSY} as biomass threshold, the group concluded that the explored scenarios (4 stocks, all in highly overfished terminal state) do not suffice to change the advice rule and technical guidelines. More simulations with varying initial depletion levels and for stocks with different life history parameters were requested. These additional simulations will be performed in the future.

In conclusion, the simulations confirm that, catch advice for “vulnerable” stocks should not exceed the 15th percentile of the distribution of the predicted catch to account their reduced productivity, and this approach should be considered as a guideline in future benchmarks and assessments. The group also acknowledged the difficulty of deriving a clear definition of “vulnerable” species and recommended that experts within ICES works towards a common definition.

4.5 WGDEEP: assessing deep-sea fisheries resources in the ICES area (ToR 2/6)

The ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP) was established in 1994, initially as a study group. Increased scientific interest in the deep ocean over the past two decades has led to significant advances in ecosystem knowledge (Allcock *et al*., 2025) and stock assessment methods (Cadrin and Dickey-Collas, 2014). Currently, WGDEEP provides scientific advice on 25 assessment units including stocks of deep-water species and those on deep shelf areas. These stocks are found in all ICES ecoregions, ranging from the Barents Sea in the north, to Gibraltar in the south, and the Azores and Greenland in the west (ICES, 2025b).

The introduction of management measures, particularly since 2003, and economic factors, including low viability of deep-water fisheries, have reduced the exploitation levels observed in preceding decades. For example, catch rates of roundnose grenadier have declined and this can be attributed to the decline of the deep-water fishery overall (ICES, 2023). However, the available fisheries-independent data is not considered appropriate to assess the current stock and exploitation status of many stocks across the Northeast Atlantic and Arctic Oceans (ICES, 2025b), which limits the ability to understand the species resilience to disturbance and recoverability.

Certain ecosystem factors have been identified or hypothesised to influence biomass or size trends in some stocks. However, several aspects of life history traits, stock structures, climate variability and climate change-related effects, and multispecies interactions of deep-sea fish communities are not well understood (Vieira *et al.*, 2019; Karp *et al.*, 2023). This information is needed to improve understanding of direct and indirect effects of fisheries on fish stocks.

4.6 Alfonsinos (*Beryx* spp.) in subareas 1–10, 12, and 14 (Northeast Atlantic and adjacent waters) (ToR 2/6)

The alfonsinos stock in the Northeast Atlantic, comprising splendid alfonsino *Beryx splendens* and alfonsino *B. decadactylus*, has been classified as a Category 5 stock since 2002 and is assessed by the ICES working group on biology and assessment of deep-sea fisheries resources (WGDEEP). Since then, total allowable catches (TACs) have been set under the precautionary approach and have been subject to precautionary reductions, justified by limitations in data availability and quality. Landings reported to ICES by Member States are aggregated as *Beryx* spp. Species-specific information is available only for the Azores, which contribute on average ~60% of the total landings in the Northeast Atlantic over the period 1988–2024. Following the approach used for other ICES stock complexes, the 2024 WGDEEP proposed, for the first time, to assess the alfonsinos stock in the Northeast Atlantic by focusing on *B. splendens* and using Azorean data as the scientific basis (ICES, 2024). In this region, *B. splendens* represents on average ~70% of the combined landings of the two species, and long-term demersal longline research surveys (1995–2024) provide more realistic abundance indices for this species (Pinho *et al*., 2020). By contrast, the low number of *B. decadactylus* sampled in surveys limits the estimation of reliable indices. The proposal was to apply the rfb rule using the *B. splendens* Azorean survey index as the abundance indicator. However, external reviewers did not accept this proposal because some of the required five consecutive years of survey data were missing due to technical problems with the research vessel. Given these constraints, alternative approaches were discussed during WKLIFE XIV for providing advice on this stock. The group recommended applying the constant harvest rate (chr) rule, which uses a constant harvest rate as a proxy for F_{MSY} applied to an abundance index (ICES, 2017). The chr rule can be implemented using only a single recent index value, being considered technically appropriate for *B. splendens* (ICES, 2025a). Efforts to estimate an alternative abundance index from commercial CPUE data were also presented. The objective is to provide a continuous time-series of abundance, particularly relevant given the gaps in the survey series. Initial GAM-based standardisations showed poor diagnostic fits, but further work will test alternative approaches, including spatially explicit models, to improve robustness. Finally, the stock was identified as a valuable case study for the length-based SPiCT approach, which is still under development and in the testing and validation phase, supported by the availability of long-term length composition and catch data for this species. These efforts are expected to strengthen the analytical basis for future assessments and facilitate the progression of this stock from Category 5 towards MSY-based assessment and advice.

4.7 Development of a survey-based abundance index and SPiCT assessment for ling in ICES subareas 3, 4, 6-9, 12 and 14 (ToR 2)

Ling in ICES subareas 3, 4, 6-9 12 and 14 is categorized within the ICES advisory framework as a category 3 stock and is currently assessed using the ICES rfb rule. The abundance index used to generate advice is catch per unit effort (CPUE) in directed catches from a reference fleet of Norwegian longliners operating in subareas 4 and 6. The reliability of this index in recent years is uncertain due to changes in fishing patterns resulting from the UK leaving the EU Common Fisheries Policy and resultant changes to access agreements with Norway. The aim of this study was to generate more reliable indices and to apply a surplus production model (surplus production model in continuous time; SPiCT) with the intent to move the stock into category 2.

We identified seven survey series within the ICES DATRAS database encompassing the entire range of the stock with the exception of subareas 12 and 14, where commercial catches are negligible. To this data set, we applied a Generalized Additive Model (GAM) with a Tweedie distribution, investigating a range of different model settings and smoothing terms. The GAM produced an acceptable fit with the formulation; catch_wt ~ factor(Year) + s(Depth, k=20) + s(Latitude, k=15) + s(Longitude, k=15) and was used to generate an abundance index. We also applied the Vector Autoregressive Spatio-Temporal model (VAST; Thorson and Barnett, 2017) to the same data set. A full description of the GAM and VAST model trials was presented to WGDEEP in May 2025 (Blasdale, 2025a).

We applied SPiCT using the GAM index, the Norwegian CPUE series and both indices in combination, and with a range of different model settings. The best fit was obtained using the GAM index for the entire time series (1990 – 2023) with the prior for depletion ratio (b/k) set at 0.2, the production curve fixed to resemble Schaefer model, and the r prior set at 0.55 (taken from Fishbase) with SD = 0.25. All model diagnostics fell within the acceptance range recommended by in the ICES technical guidance (ICES, 2025). However, catch advice that would be generated using this assessment would be 26,801 tonnes, which is roughly three times the level advised under the rfb rule. A full description of the assessment was presented to WGDEEP in May 2025 (Blasdale, 2025a) and a summary is included in the 2025 report of WGDEEP.

WKLIFE XIV members noted similarities with a recent Norwegian exploratory assessment of the ling stock in subareas 1 and 2. It was suggested that this assessment would be a good candidate for inclusion in a future meeting of WKBMSYSPiCT, noting that the agenda for the 2026 meeting is already full, but it is likely there will be another meeting in the near future.

It was noted that several other stocks had seen similarly large increases in advised catch when moving to surplus production models from category 3 assessments such as the rfb rule, and that rules could be developed to allow a more gradual transition with lower risk to the stock. Development of such rules could be a ToR for a future meeting of WKLIFFE.

4.8 Subgroup on shellfish

A subgroup of seven individuals met to discuss challenges and limitations of shellfish stock assessments within northeast Atlantic waters. A key theme identified was the disparity between the data reporting requirements and the economic importance of many shellfish species, particularly given that many fleets are composed of vessels under 12 m.

Spatial Scale and Stock Boundaries

Spatial structure is a central issue for species such as whelk, razor clam, and cockle. Defining appropriate stock boundaries is critical but remains difficult due to fine-scale population structure and heterogeneous fishing patterns. In the eastern English Channel, for example, there may be as many as three distinct whelk stocks. Growth rates vary substantially between individuals, complicating the development of reliable stock-wide reference points.

Recent work is attempting to improve resolution by linking iVMS data with logbooks to capture localized depletion events. Multivariate models that account for fishers switching between métiers highlight the complexity of polyvalent fleets. Environmental sensitivity adds further uncertainty, as seen in tank studies at Bangor University showing whelk mortality at 19°C.

Fine-scale spatial structure in common whelk (*Buccinum undatum*) populations was discussed within the shellfish subgroup, emphasizing the species' complex and localized stock dynamics. The common whelk demonstrates low adult mobility and direct benthic development from egg masses, without a dispersive larval stage. As a result, connectivity between populations is likely limited, supporting the potential for stock structuring at relatively small spatial scales. Natural geographic features such as bays, estuaries, substrate types, and hydrographic conditions could further reinforce population segregation. Differences in life-history traits—such as growth rates and size at maturity—have been observed at fine spatial scales, notably in the Wales stock and the Eastern English Channel stock. While these differences may reflect underlying population structure, phenotypic plasticity driven by environmental variation could also contribute to observed patterns in size distribution and life-history parameters. Although genetic studies have revealed significant differentiation among some whelk populations, such studies remain limited and have not been conducted for the Wales or Eastern English Channel stocks. The presence of a metapopulation framework in whelk populations can present challenges for accurate stock delineation and effective management strategies.

Spatial indicators more generally raise the question of how they can be translated into advice. Should they be treated as proxies for abundance or biomass, and if so, should buffers be applied to account for uncertainty? Comparable questions were raised about why the *Nephrops* harvest rate proxy is applied directly to biomass without precautionary adjustments.

Data and Assessment Approaches

Discussions touched on a wide range of methodological approaches. Biomass indices, spatial indicators, and harvest rate simulations were all noted as possible tools, though each carries limitations.

The Rosa Lee effect was highlighted as a challenge for scallop assessments within Wales. Back-calculation of size-at-age can underestimate growth if fast-growing individuals are preferentially caught due to size selectivity. This effect means survey and commercial data may show different dynamics, complicating stock assessments regardless of the method used.

Recommendations and Next Steps

Several points for further work and questions for WKLIFE were raised:

- *Nephrops*: clarifying why harvest rate proxies are applied directly to biomass estimates.
- Defining key aspects of operating models that are relevant for shellfish stocks in simulation work. Testing the DLMs and HCRs for data-rich shellfish, potentially linking to WGScallop, *Nephrops* and/or *Pandalus* stocks for model performance comparison
- Developing the concept of using spatial indicators within an advice framework
- Considering alternative growth models, such as Gompertz-type, in future assessments.

4.9 References

Allcock, A. L., Amon, D. J., Bridges, A. E., Colaço, A., Escobar-Briones, E., Hilário, A., Howell, K. L., Mestre, N. C., … and Zwerschke, N., 2025. Deep-sea ecosystems of the North Atlantic Ocean: discovery, status, function and future challenges. Deep Sea Research Part I: Oceanographic Research Papers, p.104580. https://doi.org/10.1016/j.dsr.2025.104580

Blasdale, T. 2025a. Development of a survey-based abundance index for common ling (*Molva molva*) in ICES sub areas 3, 4, 6-9, 12 and 14. Working Document to the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP).

Blasdale, T. 2025b. Exploratory assessment of ling (*Molva molva*) in ICES subareas 3,4 6-9, 12 and 14 with the Stochastic Surplus Production model in Continuous Time (SPiCT). Working Document to the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP).

Cadrin, S. X. and Dickey-Collas, M., 2014. Stock assessment methods for sustainable fisheries. ICES Journal of Marine Science, 72: 1-6. https://doi.org/10.1093/icesjms/fsu228

ICES. 2017. Report of the Workshop on the Development of the ICES approach to providing MSY advice for category 3 and 4 stocks (WKMSYCat34), 6–10 March 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:47. 53 pp. https://doi.org/10.17895/ices.pub.19290443

ICES. 2023. EU/UK request to ICES on roundnose grenadier apportion In Report of the ICES Advisory Committee, 2023. ICES Advice 2023, sr.2023.08. https://doi.org/10.17895/ices.advice.23500812

ICES. 2024a. Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP). ICES Scientific Reports. 6:56. 1156 pp. https://doi.org/10.17895/ices.pub.25964749

ICES. 2024b. Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFEXIII). ICES Scientific Reports. 6:95. 64 pp. https://doi.org/10.17895/ices.pub.27677745

ICES. 2025a. ICES Guidelines - Advice rules for stocks in category 2 and 3. Version 3. ICES Guidelines and Policies - Advice Technical Guidelines. 31 pp. https://doi.org/10.17895/ices.pub.28506179.

ICES. 2025b. Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP). ICES Scientific Reports. 7:59. 921 pp. https://doi.org/10.17895/ices.pub.29086478

Karp, M. A., Link, J. S., Grezlik, M., Cadrin, S., Fay, G., Lynch, P., ... & Voss, R. 2023. Increasing the uptake of multispecies models in fisheries management. ICES journal of marine science, 80(2), 243-257. https://doi.org/10.1093/icesjms/fsad001

Medeiros-Leal, W., Santos, R., Sigler, M. F., and Mildenberger, T. K., 2025. Dwindling deep-water fish stocks in the Azores: The first quantitative assessment. Fisheries Research 285: 107371. https://doi.org/10.1016/j.fishres.2025.107371

Mildenberger, T. K., Berg, C. W., Kokkalis, A., Hordyk, A. R., Wetzel, C., Jacobsen, N. S., Punt, A. E., and Nielsen, J. R., 2022. Implementing the precautionary approach into fisheries management: Biomass reference points and uncertainty buffers. Fish and Fisheries 23: 73–92. https://doi.org/10.1111/faf.12599

Norse, E. A., Brooke, S., Cheung, W. W. L., Clark, M. R., Ekeland, I., Froese, R., Gjerde, K. M., Haedrich, R. L., Heppell, S. S., Morato, T., Morgan, L. E., Pauly, D., Sumaila, R., and Watson, R., 2012. Sustainability of deep-sea fisheries. Marine Policy 36: 307–320. https://doi.org/10.1016/j.marpol.2011.06.008

Pedersen, M. W., and Berg, C. W., 2017. A stochastic surplus production model in continuous time. Fish and Fisheries, 18: 226–243. https://doi.org/10.1111/faf.12174

Pinho, M., Medeiros-Leal, W., Sigler, M., Santos, R., Novoa-Pabon, A., Menezes, G., and Silva, H., 2020. Azorean demersal longline survey abundance estimates: Procedures and variability. Regional Studies in Marine Science, 39: 101443. https://doi.org/10.1016/j.rsma.2020.101443

Thorson, J. T. and Barnett, L. A. K. 2017. Comparing estimates of abundance trends and distribution shifts using single- and multispecies models of fishes and biogenic habitat. ICES Journal of Marine Science, 74: 1311–1321, https://doi.org/10.1093/icesjms/fsw193

Vieira, R. P., Trueman, C. N., Readdy, L., Kenny, A., and Pinnegar, J. K., 2019. Deep-water fisheries along the British Isles continental slopes: status, ecosystem effects and future perspectives. Journal of Fish Biology, 94: 981-992. https://doi.org/10.1111/jfb.13927

5 Reference points and stock status evaluation (ToR 3)

5.1 Introduction

This report section focuses on ToR 3 "Explore methods to estimate and improve management reference points for data-limited stocks and to provide stock status for these" and summarises considerations on the stock status for ICES category 3 stocks and basing reference points on rebuilding time. The reference point theme is continued in the following report section (Section 6).

5.2 ICES Category 3. Stock status considerations (ToR 3)

Control parameters versus MSY values

The category 3 empirical harvest control rules (HCRs), i.e. the rfb, rb, and chr rules (ICES, 2025b) are mostly applied generically to ICES stocks to provide advice on fishing opportunities. In these cases, the control parameters of the HCRs are also derived generically following ICES technical guidelines (ICES, 2025b). For example, the chr rule has two main reference points:

- I_{trigger} – a reference point for the biomass index below which the advice is reduced; usually defined as 1.4 times the lowest observed biomass index value, I_{loss}.
- $HR_{\text{MSY proxy}}$ – the target (relative) harvest rate which defines the catch advice; usually defined through reference years in the past selected by finding those years in which the mean catch length (L_{mean}) is at or above a reference length ($L_{F=M}$)

These reference points do not necessarily have a biological meaning because there is no stock assessment or biological reference points.

However, for some ICES stocks the control parameters were defined through a stock-specific management strategy evaluation (MSE), which means that reference points such as those corresponding to the maximum sustainable yield (MSY) can be calculated. An example is plaice in the Western English Channel (ple.27.7e), which underwent an ICES benchmark including MSE in 2024 (ICES, 2025a), and the ICES advice is now based on the tuned chr rule from the MSE (ICES, 2025c). The MSE framework could then also be used to derive MSY reference points (catch after fishing at F_{MSY} for 100 years) and the corresponding values for the biomass index and the (relative) harvest rate. Figure 5.2.1 shows a comparison of the control parameters of the chr rule and the actual MSY values. For this stock, the tuned $HR_{\text{MSY proxy}}$ is very close and almost indistinguishable from the (relative) harvest rate corresponding to MSY (Figure 5.2.1, left panel). On the other hand, I_{trigger} is above the biomass index value corresponding to MSY, i.e. corresponds to a biomass above B_{MSY} (Figure 5.2.1, right panel). This means that when the biomass index is at or above I_{trigger}, the stock is likely in a good condition and even above B_{MSY}.

Such a comparison of control parameters and MSY reference points is likely stock-specific and cannot be generalised. This exercise shows the challenge of classifying stock status for category 3 stocks. The "reference points" for category 3 empirical HCRs are rather control parameters and may not necessarily be useful for describing for describing stock status. However, the situation is very similar to ICES data-rich category 1 stocks, where (1) F_{MSY} is often limited by B_{lim} risk from an EqSim simulation (an ICES framework for defining reference points, which is increasingly criticised) and therefore does not represent the actual F_{MSY} of a fish stock, and (2) MSY $B_{trigger}$ is often 1.4 times the lowest observed SSB and has no correlation to B_{MSY}. Consequently, it makes sense to use the category 3 reference points to classify stock status because the same approach is used for data-rich stocks.

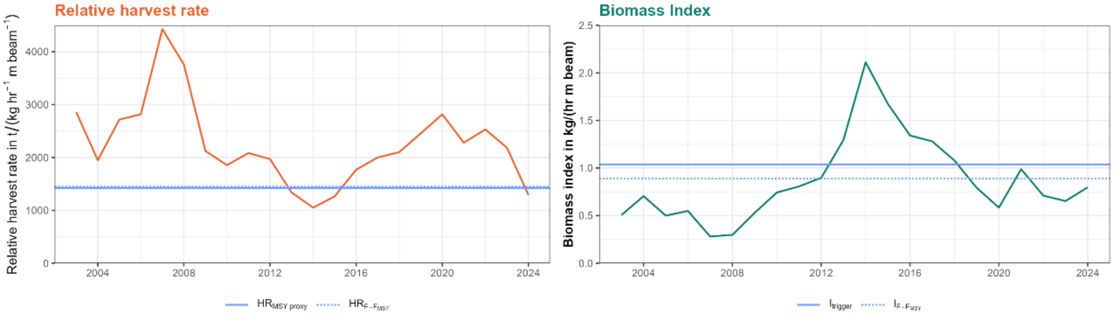

Figure 5.2.1. The relative harvest rate and the biomass index for ple.27.7e including the chr rule's control parameters (solid horizontal lines; $HR_{MSYproxy}$, $I_{trigger}$). Additionally, the figure shows the reference points corresponding to MSY from the MSY framework (dotted horizontal lines).

chr rule – fishing pressure figure

The presentation of the fishing pressure indicator with the chr rule is not consistent between ICES advice sheets (Table 5.2.1). For herring stocks (HAWG), the index is based on an acoustic survey and the advice sheets show a harvest rate. For Western English Channel plaice (WGCSE), after an MSE as part of a benchmark (see previous section), a relative harvest rate is shown. For the four WGNSSK stocks with the chr rule, a length indicator is shown instead of the harvest rate.

Table 5.2.1. ICES stocks using the chr rule in 2024 and 2025.

Year	Stock	EG	Fishing pressure indicator
2024	her.27.6aN	HAWG	Harvest rate
2024	her.27.6aS7bc	HAWG	Harvest rate
2024	lem.27.3a47d	WGNSSK	Length indicator
2025	her.27.6aN	HAWG	Harvest rate
2025	her.27.6aS7bc	HAWG	Harvest rate
2025	dab.27.3a4	WGNSSK	Length indicator
2025	fle.27.3a4	WGNSSK	Length indicator
2025	lem.27.3a47d	WGNSSK	Length indicator
2025	mur.27.3a47d	WGNSSK	Length indicator
2025	ple.27.7e	WGCSE	Harvest rate

With the chr rule, the catch advice is calculated with the following equation:

$$A_{y+1} = I \times \mathrm{HR}_{\mathrm{MSY\ proxy}} \times b \times m \quad \textbf{Equation 5.2.1}$$

where A_{y+1} is the new catch advice for year $y + 1$, I most recent biomass index, $\mathrm{HR}_{\mathrm{MSY\ proxy}}$ the target harvest rate, b the biomass safeguard ($b = min\{1,\ I/I_{\mathrm{trigger}}\}$, usually with $I_{\mathrm{trigger}} = 1.4\ I_{\mathrm{loss}}$), and m the multiplier which adjusts the target harvest rate (default: 0.5).

When the chr rule is applied generically without a stock-specific MSE, as is the case for the WGNSSK stocks, length data are used to define the target harvest when the chr rule is applied the first time (see previous section). However, length data are never used directly for the calculation of the catch advice after this. Length data are used to define a proxy indicator for the fishing pressure relative to an MSY proxy ($L_{F=M}$) in the absence of better knowledge. They are a relatively poor and indirect indicator and changes in the mean length are known to react slowly and with a time lag. Furthermore, the relationship between length indicator and the fishing pressure on the stock is not linear. If a stock is fished at the harvest rate corresponding to $HR_{\mathrm{MSY\ proxy}}$, the length indicator is not necessarily at the reference length ($L_{F=M}$) and the stock is not necessarily at MSY. However, there is an alternative to monitor the fishing pressure, i.e. using the relative harvest rate directly. Catches will directly influence the harvest rate (*Catch*/*I*) and exploitation status relative the adjusted target HR. The situation is different for the rfb rule where the length indicator is directly used in the calculation of the advice, and $L_{F=M}$ is used as a (long-term) target.

The actual target of the chr rule is the target harvest rate $HR_{\mathrm{MSY\ proxy}}$ multiplied by the multiplier m (Equation (5.2.1). This means that if the advice is followed, in the long-term, theoretically, the harvest rate should be at or below $HR_{\mathrm{MSY\ proxy}} \times m$. If the harvest rate is above that, the catch is too high and should be reduced.

For stocks with a stock-specific MSE, such as ple.27.7e, the multiplier is set to $m = 1$ and $HR_{\mathrm{MSY\ proxy}}$ shows the actual target. For the two herring stocks with chr rule (Table 5.2.1), $HR_{\mathrm{MSY\ proxy}}$ is artificially inflated (doubled) so that a multiplier of $m = 0.5$ can be used. This does not make much sense because then neither $HR_{\mathrm{MSY\ proxy}}$ or m have any meaning and the advice sheet figure does not show the target and is not useful for determining the exploitation status.

At WKLIFE XIV, there was a subgroup discussion on the presentation of the fishing pressure for the chr rule in ICES advice sheets and this discussion and the outcome are summarised in the following section.

Subgroup discussion on the presentation of the fishing pressure for the chr rule

Recommendation of what to present in advice sheets for the chr rule to reflect exploitation status

1. Need for consistency between case-specific MSE- and generic MSE-derived applications of chr, but also something that distinguishes them
   a. Show exploitation status as relative harvest rate for ALL chr-based rules, since the HCR has $HR_{\mathrm{MSY\ proxy}} \times m$ as the target in the HCR; one would show both the relative HR and $HR_{\mathrm{MSY\ proxy}} \times m$. This would allow a consistent presentation of advice sheets that apply the chr rule. Furthermore, showing the relative harvest rates reveals how we are doing relative to the target we want to achieve (broadly similar to F relative to F_{MSY}

for category 1), albeit $HR_{\text{MSY proxy}}$ may be quite conservative (given lack of data, and the way it is derived in the generic case). The plot should be labelled "Relative Harvest Rate" (unless it is an absolute harvest rate, e.g. with an acoustic total biomass index, in which case it is a "Harvest Rate").

   b. The multiplier m distinguishes whether you have a case-specific MSE or a generically-derived application, with $m = 1$ for the case-specific MSE (because MSEs generally estimate $HR_{\text{MSY proxy}}$ directly anyway following precautionary criteria), and $m = 0.5$ for the generic application (this is the tuning needed to make the rule precautionary under generic conditions).

2. So what about length data for the chr rule
   a. For the case-specific MSE, these data are not used, so it may not be appropriate to include them (e.g. may be unreliable for faster-growing species). However, the length-based indicator relative to $L_{F=M}$ could still be shown as "supplementary information", if appropriate.
   b. For the generic chr rule, length data are key to developing $HR_{\text{MSY proxy}}$, and may be useful supplementary information, so it is recommended that the length-based indicator relative to $L_{F=M}$ should be shown as supplementary information. This would be particularly important where the biomass index is uncertain and historic exploitation level is uncertain (short index time series, historically exploited likely below F_{MSY}). The length indicator represents stock-specific information on exploitation level, mean length relative to MSY proxy $L_{F=M}$, which may be in contrast to the generic multiplier m and $HR_{\text{MSY proxy}}$.
3. Need to decide whether to show actual $HR_{\text{MSY proxy}}$ in the relative harvest rate plot (i.e. without adjustment for m) or the adjusted $HR_{\text{MSY proxy}}$ (adjusted for m)
   a. It does not matter for case-specific MSE ($m = 1$)
   b. For generic applications, it makes sense to show the relative harvest rate and the (m-adjusted) $HR_{\text{MSY proxy}}$ in the same plot, as the adjusted $HR_{\text{MSY proxy}}$ is the effective target.
   c. In both cases, the proxy for exploitation status would be the relative harvest rate compared to $HR_{\text{MSY proxy}}$
   d. {Of course, this raises the question about whether something similar should be done for the rfb rule}

Rebuilding Time. A Dynamic Approach for Biomass Reference Points (ToR 3)

Traditional biomass reference points face several limitations. For example, the current ICES approach relies on segmented regression assuming abrupt changes in recruitment, is inconsistent across stock assessment categories, and fails to incorporate rebuilding timeframes. Also, the biomass limit (B_{lim}) will only be observable in the result of management failure and so is difficult to validate.

$B_{rebuild}$ offers a dynamic alternative, defined as the lowest biomass from which a stock can recover to B_{MSY} within a specified timeframe under agreed fishing scenarios. This forward-looking reference point shifts fisheries management from reactive to proactive by linking current stock status directly to future recovery outcomes.

The approach provides several improvements:

- **Universal application** across data-rich (Category 1), data-limited (Category 2), and ecosystem models
- **Risk equivalence** through consistent calibration across assessment categories
- **Observable validation** via measurable recovery trajectories, unlike traditional B_{lim}
- **Stakeholder integration** through participatory target-setting processes
- **Ecosystem compatibility** supporting predator-prey relationships and climate impacts

When stocks fall below a given $B_{rebuild}$ level, e.g. corresponding to the current $B_{trigger}$, recovery plans could be activated. Management needs to establish targets, F during rebuilding, and recovery timeframes, through a collaborative process, while also monitoring using appropriate indicators. The approach will help maintain stock protection in both data-rich and data-limited contexts while enabling adaptive management responses.

The use of $B_{rebuild}$ will help support future research priorities including integrating climate variability into recovery projections, developing ecosystem-based advice and incorporating social and economic objectives into management frameworks. Therefore, $B_{rebuild}$ represents a scientifically robust alternative to current definitions of B_{lim} that will help achieve risk equivalence across assessment categories while supporting ecosystem-based management objectives through measurable, forward-looking reference points.

5.3 References

ICES. 2025a. Benchmark Workshop for Selected Plaice Stocks (WKBPLAICE). ICES Scientific Reports. 7:41. 70 pp. https://doi.org/10.17895/ices.pub.28400255

ICES. 2025b. ICES Guidelines - Advice rules for stocks in category 2 and 3. Version 3. ICES Guidelines and Policies - Advice Technical Guidelines. 31 pp. https://doi.org/10.17895/ices.pub.28506179

ICES. 2025c. Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel). Replacing advice provided in June 2024. In Report of the ICES Advisory Committee, 2025. ICES Advice 2025, ple.27.7e. https://doi.org/10.17895/ices.advice.29412776

6 Ecosystem considerations (ToR 4)

6.1 Introduction

This report section focuses on ToR 4 "Explore the incorporation of ecosystem considerations in current data-limited methods and/or their testing (in MSE frameworks)" and summarises work on time-varying productivity and reference points and an application of this principle to an example stock. See also the previous report section (Section 5) for more on the theme of reference points.

6.2 Estimating time-varying productivity and reference points: A case of North Sea demersal fish stocks (Tor 3/4)

The presentation summarised the recently published paper by Mildenberger *et al*. (2025), which introduced various surplus production model (SPM) variants that describe changes in stock productivity by allowing both the intrinsic growth rate (r_t) and carrying capacity (K_t) to vary and co-vary over time. The work has specific relevance for the assessment of biomass-based stock dynamics (category 2 stocks), as time-varying productivity may hinder the application of traditional SPMs that assume constant parameters. This is contrary to age-based assessments, which may have more dynamically-defined values to reflect a given stock's dynamics over time (e.g., weight, maturity, and natural mortality at age), with more recent values used to reflect current productivity and in the definition of reference points. Given that SPMs may require long-time series with observations from a wider range of exploitation levels (i.e., "contrast") to provide robust assessments, data truncation to reflect a current productivity regime is impractical. The use of time-varying SPMs may provide an alternative assessment model in the future.

Kokkalis *et al*. (2024) outlined several criteria for evaluating SPM performance and acceptance, including the model's fit to data via examination of the residuals. Specifically, biomass process residuals should be independent and normally distributed, and deviations are likely to occur in the presence of time-varying processes not considered by the SPM. In the models presented by Mildenberger *et al*. (2025), as well as in standard SPiCT models generally, biomass process residuals are calculated using the 'single sample from the posteriors' method as described in (Thygesen *et al*. 2017) and the Ljung–Box test for temporal autocorrelation of the biomass process residuals. For all of the demersal stocks presented in the study, biomass process residuals showed a strong positive bias and significant auto-correlation violations when constant-parameter SPMs were used. Time-varying SPMs were found to be the best fitting model for all stocks investigated in the case study (seven demersal stocks of the North Sea). Post-hoc correlations of maximum net productivity with environmental covariates showed negative relationship with temperature and positive relationship with salinity in five of seven stocks (four roundfish and one flatfish), which may indicate either direct or indirect responses to environmental variability in the ecosystem.

During WKLIFE, discussions focussed on: 1. how the application of time-varying SPMs will work in truly data-limited situations, and 2. the interpretation and implementation of reference points derived from such models. Regarding point 1, Mildenberger *et al*. (2025) used data-rich stock assessments to derive catch and biomass indices for the SPMs. This procedure is referred to as a *known biomass production model* (KBPM) approach (MacCall 2002), which has been used to estimate and compare productivity and reference points across stocks (Free *et al*. 2019; Sparholt *et al*. 2021; Thorson *et al*. 2012). The application to raw data (e.g., survey biomass indices and catch data) still requires further evaluation, but the simulation-estimation testing used in the study indicated good performance in identifying the correct time-varying model (see also next section). Furthermore, the work emphasized the importance of using biomass indices that reflect exploitable stock biomass (rather than total biomass or spawning stock biomass) for consistency with SPM assumptions. Regarding point 2, reference points (e.g., Fmsy and Bmsy) derived from time-varying SPMs may still require some degree of subjectivity when choosing values from the historical assessment period to represent the current productivity regime. Rather than the single, most recent estimate, the co-authors suggested using an average of the recent period (e.g., 5-10 years) to prevent a continual, annual revisions. Even when a time-varying SPM was deemed superior to constant parameter SPMs, there may be cases where the described variability is on shorter time scales, and long-term average productivity and associated reference points could be just as appropriate for management advice.

6.3 Implementing time-varying reference points. Stock assessment for Eastern Baltic cod (ToR 3/4)

This presentation explored how to implement time-varying reference points in ICES stock assessments, using Eastern Baltic cod as a case study. Alternative SPiCT models with constant or time-varying parameters (intrinsic growth rate r, carrying capacity K, or both) were compared. Results show differences in model fit (AIC_c) and highlight the tension between selecting the "best" ecological model and providing precautionary management advice. The presentation raised key questions on whether ensemble approaches or new harvest control rules are needed to integrate time-varying reference points into ICES advice, and how such frameworks could support stock rebuilding and stability.

6.4 References

Free, C. M., Thorson, J. T., Pinsky, M. L., Oken, K. L., Wiedenmann, J., and Jensen, O. P., 2019. Impacts of historical warming on marine fisheries production. Science, 363: 979–983. https://doi.org/10.1126/science.aau1758

Kokkalis, A., Berg, C. W., Kapur, M.S., Winker, H., Jacobsen, N.S., Taylor, M.H., Ichinokawa, M., Miyagawa, M., Medeiros-Leal, W., Nielsen, J.R., and Mildenberger, T.K., 2024. Good practices for surplus production models. Fisheries Research, 275: 13. https://doi.org/10.1016/j.fishres.2024.107010

MacCall, A. D., 2002. Use of Known-Biomass Production Models to Determine Productivity of West Coast Groundfish Stocks. North American Journal of Fisheries Management, 22: 272–279. https://doi.org/10.1577/1548-8675(2002)022<0272:UOKBPM>2.0.CO;2

Mildenberger, T. K., Berg, C. W., Kempf, A., Rindorf, A., MacCall, A. D., and Taylor, M. H., 2025. Estimating Time-Varying Productivity and Reference Points: A Case of North Sea Demersal Fish Stocks. Fish and Fisheries 26: 745–771. https://doi.org/10.1111/faf.12910

Sparholt, H., Bogstad, B., Christensen, V., Collie, J., van Gemert, R., Hilborn, R., Horbowy, J., Howell, D., Melnychuk, M.C., Pedersen, S.A., Sparrevohn, C.R., Stefansson, G., and Steingrund, P., 2020. Estimating Fmsy from an ensemble of data sources to account for density dependence in Northeast Atlantic fish stocks. ICES Journal of Marine Science, 78: 55–69 . https://doi.org/10.1093/icesjms/fsaa175

Thorson, J. T., Cope, J. M., Branch, T. A., and Jensen, O. P., 2012. Spawning biomass reference points for exploited marine fishes, incorporating taxonomic and body size information. Canadian Journal of Fisheries and Aquatic Sciences, 69: 1556–1568. https://doi.org/10.1139/f2012-077

Thygesen, U.H., Albertsen, C.M., Berg, C.W., Kristensen, K., and Nielsen, A., 2017. Validation of ecological state space models using the Laplace approximation. Environmental and Ecological Statistics, 24: 317–339. https://doi.org/10.1007/s10651-017-0372-4

7 Other data-limited approaches (ToR 5)

7.1 Introduction

This report section focuses on ToR 5 "Further explore and develop assessment and advice methods with focus on data- and/or resource-limited fisheries together with exploring approaches of moving towards an ecosystem perspective, from both within and outside the ICES community" and presents summaries of various data-limited contributions.

7.2 Assessment and categorization of Data-Limited Fishery Resources in Japan and Their Linkage to Harvest Control Rules (ToR 5)

Since 2022, Japan has been assessing certain data-limited fishery resources – those for which only catch data and abundance indices are available –using the state-space production model SPiCT. Alongside its implementation, domestic guidelines for model application have been developed. Based on the evaluation results, assessed resources are categorized into the following three types:

1. Type 1C1: Resources for which reliable prior information on absolute biomass is available, and model diagnostics indicate no major issues.
2. Type 1C2: Resources for which estimates of absolute biomass are highly uncertain, but trends in relative biomass and/or stock status are robust and usable as indicators.
3. Type 2: Resources for which model diagnostics indicate problems, and none of the indicators provide robust results.

This classification is closely linked to the harvest control rules (HCRs) used to determine the Allowable Biological Catch (ABC). For Type 1C1 resources, an MSY-based HCR – also applied to data-rich stocks – is used. For Types 1C2 and 2, a more precautionary and empirical HCR is applied. To date, SPiCT has been applied to at least 11 fishery stocks in Japan, including 5 pelagic and 6 demersal stocks. Among these, 2 stocks were classified as Type 1C1, 3 as Type 1C2, and 6 as Type 2. Approximately 80% of the assessed stocks did not yield reliable estimates of absolute biomass, and for more than half, even the relative biomass estimates lacked sufficient reliability. Efforts to further refine and improve the application of SPiCT will continue.

7.3 Optimizing the parameters of the data-limited HCRs in Japan and ICES according to stock dynamics (ToR 5)

For sustainable fisheries, the development of appropriate management methods is essential. Harvest control rules (HCRs) are pre-agreed guidelines that determine allowable catch levels based on the status of target fish stocks, and they are widely applied in the modern management of global fisheries. While the quality and quantity of data required for fisheries management vary significantly, most previous studies and existing management have focused on data-rich stocks. However, many of the world's fish stocks are data-limited, and only a limited number of HCRs have been developed specifically for such situations. The type 2 rule in Japan and the rfb rule in ICES are examples of HCRs designed for data-limited stocks, but they differ in design due to their distinct development backgrounds. The type 2 rule aims to rapidly rebuild stocks regardless of stock dynamics (pre-management stock trends and the initial stock biomass at the start of management), or species characteristics, and uses conservative parameters. The rfb rule aims to maintain a consistent level of risk across species by adjusting parameters according to biological characteristics. Recent studies suggest that not only stock characteristics, but also stock dynamics can significantly affect management performance. This implies that optimal adjustment parameters may vary depending on stock dynamics.

In this study, we optimized the parameters of the two HCRs under 11 stock dynamics and four stocks to maximize catch while avoiding stock collapse. A genetic algorithm (GA), which efficiently explores multiple solutions and avoids local optima, was used for optimization. Avoiding stock collapse was defined as maintaining long-term spawning biomass above SB_{MSY} and keeping the probability of falling below $0.5SB_{MSY}$ under 5%. The optimized HCRs achieved higher average catches than the default parameter settings while avoiding stock collapse. We clarify the range of τ in the rfb rule and B_T in the type 2 rule, the parameters to adjust the advised catch from current biomass level according to the stock biomass index in the data-collective period, satisfying the conditions of avoiding stock collapse and long-term catch above $0.9 * \mathrm{OptimalCatch}$ from the all candidate parameters thorough the optimization. $\mathrm{OptimalCatch}$ is the maximum long-term catch for each stock dynamics with optimized parameters. The optimized values of B_T show strong dependence on initial stock biomass rather than pre-management stock trends. The optimized values of τ are robust regardless of the initial stock biomass. When initial stock biomass was high, lowering the target biomass level compared to the default settings allowed for higher sustainable catches. We will focus on which the stock trend or the initial stock biomass is the important factor to optimize the parameters according to the stock dynamics.

7.4 Quantifying Data and Resource Limitations: A Case Study in Japanese Fisheries Stock Assessments (ToR 5)

In fisheries stock assessment, data limitation is a globally recognized challenge. However, the nature and extent of these limitations vary across regions and cases. Cope *et al*. (2023) proposed a framework, DL-Mapper, to visualize specific constraints by scoring both data (precision, bias, species identification, spatial and temporal coverage) and resource dimensions (time, funding, analytical capacity, number of analysists per stock). In this presentation, we applied a modified version of DL-Mapper to 27 Japanese domestic stocks through 2024 stock assessment training course by Japan Fisheries Research and Education Agency. The results revealed that, while data availability is relatively sufficient, resource constraints—particularly in number of stock assessment analysists, funding, and analytical capacity—are more constrained in Japan. This pattern aligns with our practical experience comparing domestic and international assessments. We suggest that addressing resource limitations is essential for improving the quality and coverage of stock assessments in Japan. The case study demonstrates how quantifying limitations helps identify bottlenecks and supports strategic planning.

7.5 Community-based harvest control rules for the Egyptian artisanal Red Sea fishery (ToR 5)

Stock assessment is the first step in managing fish stocks. When data are limited, data-limited methods (DLMs) provide a way to evaluate stock status. These approaches still require some information, but when data are lacking, engagement with fishing communities becomes crucial, especially since low awareness of management implementation has been documented (Farouk-Abdelfattah *et al*., 2024). For this reason, we involved fishers in every stage of stock assessment and management—from data collection and analysis to interpreting how the results inform management measures—supported by the use of educational posters in an accessible cartoon format that directly reflected fishers' experiences. This fieldwork not only generated length-frequency data for seven fish species but also increased community awareness of stock assessment and fisheries management.

In this study, we assessed the status of eight fish species from Egyptian Red Sea fisheries with the aim of identifying appropriate management strategies. We applied four data-limited methods (DLMs): CMSY++, LIME, LBB, and LBSPR. As expected, the results were inconsistent across methods. Recognising such variation, Chong *et al*. (2020) suggested combining multiple assessment approaches rather than relying on a single DLM, although this is not always the best option (Farouk-Abdelfattah *et al*., 2025) since the probability of each method producing correct estimates differs. To address this, we validated our results against simulation outputs (ICES 2024; Farouk-Abdelfattah *et al*., 2025). Following validation, only two species—*Atule mate* and *Siganus luridus*—were found to be in good condition, while six species (*Lethrinus nebulosus*, *Plectropomus pessuliferus marisrubri*, *Aphareus rutilans*, *Priacanthus hamrur*, *Variola louti*, and *Scarus collana*) were classified as overexploited.

Engaging fishers in decision-making is essential to improve compliance (Farouk-Abdelfattah *et al*., 2024). This engagement can take several forms (Bossier et al., 2025). In this study, fishers' inputs were collected through face-to-face surveys and used to quantify management strategies. Three management procedures (MPs) were tested via 20-year simulations: combined effort and size-at-catch restrictions, effort restrictions only, and size-at-catch restrictions only. As expected, the combined MP was most effective at ensuring sustainability for all eight species, maintaining spawning potential ratio (SPR) at 0.4 (Figure 7.5.1). The results also highlighted that the success of MPs depends on species lifespan.

Overall, these results are preliminary, and further analyses are ongoing to quantify appropriate fishing effort limits that achieve FMSY while remaining acceptable to fishing communities. Additionally, one of the options suggested by fishers—compensation—is being evaluated to explore trade-offs between compensation and effort restrictions. To support sustainable fisheries management, the selection and use of DLMs should be made accessible to managers and other users to encourage informed and effective decision-making (Farouk-Abdelfattah *et al*., 2025).

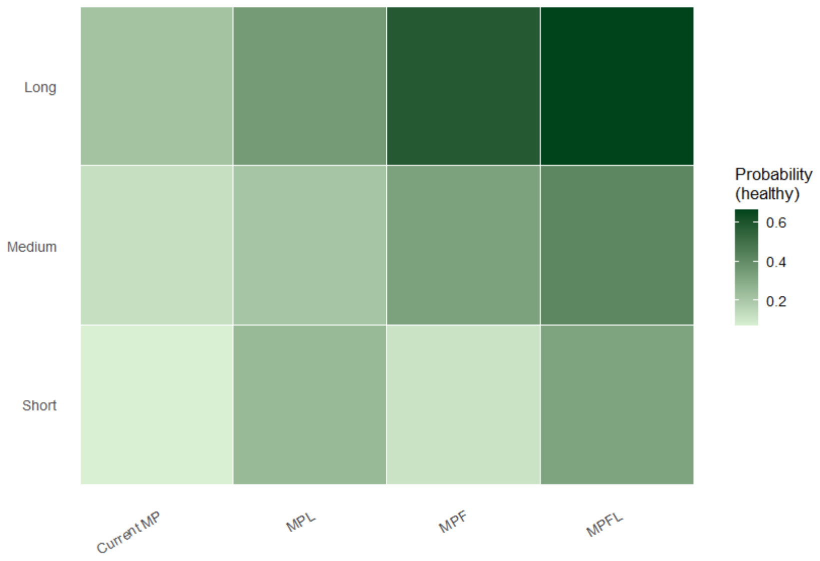

Figure 7.5.1. Probability of fish stocks being classified as healthy under different management procedures across species with short, medium, and long lifespans. MPs tested include the current management procedure (Current MP), effort restrictions only (MPF), size-at-catch restrictions only (MPL), and combined effort and size-at-catch restrictions (MPFL).

7.6 Data-limited methods and management in Angolan waters (ToR 5)

In Angola, the main fishery resources are classified into pelagic species (including sardinella, horse mackerel, and chub mackerel); demersal species, which constitute a multispecies fishery with around 10 commercially important groups of species; and crustaceans and other invertebrates. These resources are exploited by the artisanal, semi-industrial, and industrial fleets, which are primarily differentiated by vessel size. However, this complexity creates challenges for data collection and, consequently, for stock assessment.

In fact, Angola has a long time-series (1985–2024) of biomass, length-frequency, and other biological information derived from research surveys. From fisheries data, however, only landing statistics by species or groups of species are available, mainly from the industrial and semi-industrial fleets. Since 2005 there is a National Biological Sampling Programme of the Commercial Fleet (NBSP) covering only the industrial and semi-industrial fleets.

For pelagic resources, stock assessments were conducted using Length Cohort Analysis (LCA) and the Yield-per-Recruit (Y/R) model. In most cases, however, the assumption of a linear relationship between fishing mortality and yield increased the uncertainty in the model's predictive performance and reduced the robustness of the management reference points derived.

Considering the increasing range of methods and tools currently available from ICES for assessing data-limited stocks, these approaches have more recently been applied to the assessment of Angola's pelagic resources (https://dialogosue-angola.org/encerra-accao-para-apoiar-angola-na-avaliacao-de-recursos-pesqueiros/), using the LBI and LBSPR models.

The results of the models indicate that the absence of artisanal fishery data, along with biased length-distribution data from the semi-industrial and industrial fleets, undermines the robustness of the assessments. For example, for *Sardinellas*, the estimated ratio of fishing to natural mortality appears to be unrealistically high.

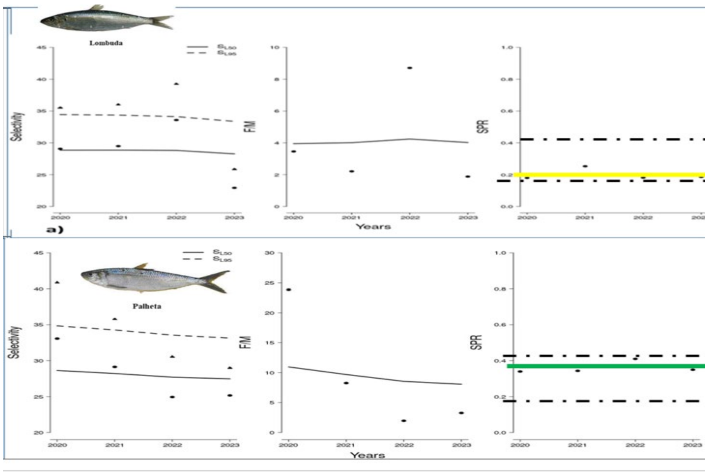

Figure 7.6.1. Data from Angola.

For demersal fish species, data collection remains a challenge, and the NBSP does not cover all species. Consequently, management advice relies primarily on biomass trends from research surveys and CPUE series, which lack proper standardization. Furthermore, because effort data are not systematically recorded, vessel horsepower per month is used as a proxy for fishing effort.

For the deep-water shrimp *Aristeus varidens*, which represents a relatively small fishery and for which the available data are comparatively robust, a biomass dynamic model has been applied as it only requires a time series of fishery catches and an index of relative abundance, a fishery-dependent catch per unit of effort (CPUE) time series.

For future research for the stock assessment, it is imperative to restructure the NBSP to cover all length population structure, ensuring the randomness of sample and thereby improving the robustness of growth, mortality, and recruitment estimates.

For pelagic resources, the next step is to apply the stock assessment model under a sensitivity analysis to evaluate how variations in input data, assumptions, and parameter values influence the outcomes of the assessment. For demersal species, a benchmark process will be applied to identify which stocks are more suitable for data-limited assessment methods, ensuring that the chosen approaches are the most appropriate to the data available.

7.7 References

Bossier, S., and Cisneros-Montemayor, A. M., 2025. Integrating equity and justice in marine ecosystem models: An incremental but meaningful approach. Ecological Modelling, 503: 111058. https://doi.org/10.1016/j.ecolmodel.2025.111058

Cope, Jason M., Natalie A. Dowling, Sybrand A. Hesp, Kristen L. Omori, Pia Bessell-Browne, Leandro Castello, Rowan Chick, et al. 2023. The Stock Assessment Theory of Relativity: Deconstructing the Term 'Data-Limited' Fisheries into Components and Guiding Principles to Support the Science of Fisheries Management. Reviews in Fish Biology and Fisheries, 33: 241–63. https://doi.org/10.1007/S11160-022-09748-1

Chong, L., Mildenberger, T. K., Rudd, M. B., Taylor, M. H., Cope, J. M., Branch, T. A., Wolff, M., and Stäbler, M. 2020. Performance evaluation of data-limited, length-based stock assessment methods. ICES Journal of Marine Science, 77: 97–108. https://doi.org/10.1093/icesjms/fsz212

Farouk-Abdelfattah, R., Schuchert, P., and Farnsworth, K. D. 2024. Pressures on Egyptian Red Sea fisheries from the artisan fishers' perspective. Ocean & Coastal Management, 258: 107406. https://doi.org/10.1016/j.ocecoaman.2024.107406

Farouk-Abdelfattah, R., Cuthbert, R. and Farnsworth, K. D., 2025. Performance-based choice of data-limited methods for small-scale fisheries on a low budget. Preprint. 58 pp. https://doi.org/10.2139/ssrn.5221553

8 FAO-ICES deep-sea fisheries (DSF) project (ToR 6)

8.1 Introduction

This report section focuses on ToR 6 "Outline the framework and best practices for an open-access GitHub repository on data-limited methods to increase the accessibility and transparency of methods to provide guidance on the use of methods ". This ToR is dedicated to an FAO-ICES collaborative deep-sea fisheries (DSF) project, and the report sections introduce the project, the expected output (a GitHub repository), and several of the case studies.

8.2 FAO Deep-sea Fisheries project (ToR 6)

The "Deep-sea Fisheries under the Ecosystem Approach" (DSF) project (2022–2027) is funded by the Global Environment Facility (GEF), implemented by the Food and Agriculture Organization of the United Nations (FAO), and executed by the General Fisheries Commission for the Mediterranean (GFCM). The project works with all the deep-sea (general) regional fisheries management organisations (RFMOs) to support their work in high seas ocean governance and managing fisheries, including data-limited stocks, deepwater sharks and vulnerable marine ecosystems. The DSF project has partnered with ICES through a letter of agreement to work on data-limited stock assessment methodologies in cooperation with its deep-sea RFMO partners. The main focus groups will be: "seamount" species: orange roughy, armourhead, alfonsino (North Pacific, North Atlantic, SE Atlantic, Indian Ocean), Demersal species caught mainly by lines: toothfish (Southern and adjoining oceans) and sablefish (NE Pacific), Small pelagic species: Pacific saury, chub mackerel, jack mackerel, mackerel, etc (North and South Pacific), and crab stocks (SE Atlantic) in the high seas.

8.3 Deep-sea Fisheries Project – working with ICES (ToR 6)

An overview of the ICES-FAO collaborative project "Participatory development of stock assessment methodologies for data-limited deep-sea fisheries stocks in the ABNJ" was presented. The letter of agreement for this project is available from the ICES website at https://www.ices.dk/about-ICES/global-cooperation/Documents/FAO_ICES_LoA.pdf. Both ACOM and SCICOM leadership as well as the General Secretary agreed to the ICES involvement and the project deliverables. The project includes funding for a consultant and the WKLIFE ToRs are tied to the project. The project is an opportunity to work on something challenging and new, develop and apply new methods, gain further support for WKLIFE work with a global reach, and build a network. The project will include two workshops organised by ICES between WKLIFE XIV in 2025 and WKLIFE XV in 2026. The first is a workshop on method development and the second on method application but dates and locations have yet to be determined. There will be an element of peer review, and this may also be an opportunity to review methods developed at WKLIFE. The final product will be a catalogue of methods and guidance (see Section 8.4), due by the end of December 2026 and the final project reporting is due by the end of January 2027.

8.4 GitHub repository (ToR 6)

As part of the recent ICES-FAO letter of agreement under the Deep-sea Fisheries Project, during WKLIFE XIV, the development of an open-access toolbox to support data-limited stock assessments, mainly for regional fisheries management organizations (RFMOs), was discussed. This toolbox will be hosted on the ICES GitHub account to maintain ICES standards and serve as a central repository for codes, methodologies, and guidance. The initial proposal focused on models and advice rules recommended or developed by WKLIFE (e.g., rfb, rb rule, SPiCT, JABBA, LBSPR, etc.), ensuring that the repository reflects the group's core contributions. It will also include the Frequently Asked Questions (FAQ) developed under WKLIFE to help users navigate the tools and apply the methods consistently. The toolbox aims to provide a simple, accessible, and transparent platform where users can find R codes and guidance for consistent implementation across RFMOs, ICES expert groups, and beyond.

Since the idea of the discussion was to gather ideas from the experts attending the meeting, several points were raised. While other toolboxes already exist, participants agreed that this repository should serve as an ICES-specific summary of methods, ensuring visibility and alignment with the approaches adopted within WKLIFE. Suggestions included documenting R code used in publications, incorporating a decision tree to help users select methods (drawing on experiences such as FishPath), and designing a "change block" to accommodate future updates. Concerns about additional workload for WKLIFE were noted, though the initiative has already been endorsed by ACOM and SCICOM as a long-term output of the group. Overall, the toolbox was recognized as a valuable platform for knowledge sharing, transparency, and reproducibility, and a key deliverable under the ICES–FAO collaboration.

8.5 Case studies presented at WKLIFE XIV (ToR 6)

NPFC – North Pacific armorhead: Biology, fisheries and assessments in NPFC

North Pacific armorhead (*Pentaceros wheeleri*) is harvested at the Emperor Seamounts area, a high-seas fisheries ground managed under North Pacific Fisheries Commission (NPFC). In a long (2.5 years) epipelagic period, individuals grow to adult size but never mature. Then they recruit to the seamount fishery grounds. The level of recruitment varies greatly and unpredictably over years. After recruitment, they do not grow (determinate growth) and live up to 4 years. During this demersal period, their body weight and body depth reduce gradually, causing the transition from "fat" to "lean" types. These life history characteristics are unique among fishes, and do not comply with assumptions of many stock assessment tools.

Fisheries in the Emperor Seamounts area started in 1968 and harvest multiple species including North Pacific armorhead and splendid alfonsino *Beryx splendens*. An analysis using the "directed CPUE" method demonstrated larger effect of target shift on the CPUE trends in alfonsino (alternative target) than in armorhead (primary target). A previous application of a surplus production model failed to predict CPUE fluctuation. The depletion model successfully estimated the amounts of recruitment and escapement. In NPFC, scientists are working toward the application of this method to the recent data. Due to the lack of agreed stock assessment, NPFC implemented a rule to modify the annual catch limit based on the recruitment level estimated from a monitoring survey by fishing vessels. It is noted that fish life history is so diverse and conventional assessment tools may not be applicable to stocks with unique strategies.

NPFC – Attempts of stock assessment for Splendid alfonsino Beryx splendens in the northwestern Pacific

Splendid alfonsino (*Beryx splendens*) is a commercially significant species in the northwestern Pacific, caught at the Southern Emperor Seamounts and North Hawaiian Ridge since the 1970s. This paper reviewed the historical attempts at stock assessment for this species within the North Pacific Fisheries Commission (NPFC) managed waters.

In this paper, two primary stock assessment approaches were examined: Surplus Production Model Analysis (Nishimura & Yatsu, 2008): This analysis, conducted prior to the NPFC's establishment, utilized catch data from 1976 to 2006. Methods included ASPIC and the Solver function in Excel. Yield Per Recruit (YPR), Spawning Biomass Per Recruit (SBPR), and Length-Based Spawning Potential Ratio (LBSPR) Analyses (Pons *et al*., 2024): These analyses evaluated stock status using life history parameters (growth, maturity, natural mortality) and length composition data by gear type (bottom trawl and gillnet).

As a result, Surplus Production Model Analysis suggested potential overfishing after 2005 and recommended a 20% reduction in fishing mortality to achieve FMSY. However, the analysis faced significant issues. It could not accommodate the full time series due to a period of high catch in the 1980s, and the estimated intrinsic natural growth rate (*r*) was unnaturally high (0.9–1.6) compared to previous studies (Wiff *et al*., 2012, $r = 0.12$), indicating a methodological or data-related problem.

And YPR, SBPR, and LBSPR Analyses indicated a high likelihood of growth overfishing and a reduced spawning potential due to the capture of immature individuals, especially by trawl nets. The LBSPR model was unable to incorporate the dome-shaped selectivity of trawl nets, and both YPR and SBPR analyses showed high sensitivity to key life history parameters, such as growth and maturity. The results were consistent with prior studies (Sawada & Yonezaki, 2019; Takahashi, 2018), confirming that current selectivity patterns may not reach the maximum sustainable yield (MSY).

While both assessment approaches pointed towards an overfished state for Splendid alfonsino, they were limited by their respective methodological constraints and data sensitivities. To address these issues, an integrated modelling approach, specifically using Stock Synthesis, is currently being developed. This new model is expected to overcome previous limitations by incorporating multiple data types (e.g., age composition, CPUE) and accounting for the effects of different fishing fleets, locations, and gear's selectivity, thus providing a more robust and comprehensive stock assessment.

SIOFA & SEAFO alfonsino and armourhead and SEAFO Patagonian toothfish

A deep-sea fisheries targeting alfonsino (*Beryx splendens*) and armourhead (*Pentacerosrichardsoni*) in SIOFA and SEAFO area was introduced.

In the SIOFA area, alfonsino fisheries have been active since 1977, primarily in the western area around seamounts. Two gear types are used: midwater trawl and benthopelagic trawl for targeting alfonsino. Stock assessments using age-structured production models, which were conducted in 2020 and 2021, suggest that alfonsino populations are at approximately 60% of their pre-exploitation biomass, with no signs of overfishing. Armourhead is mainly caught as bycatch in SIOFA fisheries, and no stock assessments have been conducted. Future plans include developing age estimation protocols and exploring acoustic survey methods for alfonsino, with the next alfonsino stock assessment scheduled for 2026–2027.

In the SEAFO area, there is no fisheries targeting alfonsino and armourhead for more than 10 years. Korean mid-water trawl caught alfonsino during 2010-2013. Stock status of both species has been evaluated by using only fishery data; alfonsino: CPUE trend in 2010-2012, armourhead: depletion model in 2010-2013. Scientific Committee of SEAFO determines TAC by harvest control rule (HCR) under data limited situation; alfonsino: average catch for three years (ICES HCR category 5 for data poor stocks), armourhead: determined by average slope of CPUE in the recent 5 years (±5% of the TAC in the preceding year).

Also, the Patagonian toothfish (*Dissostichus eleginoides*) bottom longline fisheries in SEAFO area were introduced. In SEAFO, bottom longline fisheries for Patagonian toothfish began in 2002, with recent operations by Spain, Japan, and Namibia. Catch data and biological measurements are collected with 100% observer coverage, although ageing has not been conducted. Tagging program started based on CCAMLR tagging protocol, but tagging data are not used for stock assessments due to limited recaptures. HCR, based on CPUE trends, was adopted in 2015, constraining TAC changes to ±5% annually.

CCAMLR – Approach to managing data limited toothfish fisheries in CCAMLR

The presentation outlined the approach used by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) to setting catch limits for data-limited toothfish fisheries conducted as part of short-term research plan. These research plans typically cover a three-year period (although this may be renewed at the end of the period), and relatively small bathymetric features that are likely to only represent a small fraction of the populations' spatial extent.

Toothfish (both Antarctic toothfish[1], and Patagonian toothfish[2]) are long-lived demersal fish, caught in longlines, typically at depths of 750 to 2,000m either on seamounts or the edge of continental shelves. Toothfish are suitable for tag estimates of biomass because they survive tagging well.

Initially local biomass estimates are based on catch rates relative to fully assessed fisheries (considering the relative fishable area). When sufficient recaptures occur, the Chapman estimator of abundance is likely to be a more reliable than that derived from catch rates. Initially, a precautionary harvest rate of 4% of the estimated biomass is applied based on life-history parameters and that seen in the assessed stocks. The catch limit is increased or reduced according to the level and trend of biomass estimates each year. A flow chart showing the trend rules, as well as the results for the 2024/25 season is shown in Figure 8.5.1, extracted from the CCAMLR website[3], and the R code used to generate it is available through GitHub[4]. The rule decreases catch if either the catch rates or the Chapman estimate of biomass decrease. Catch limit changes are generally capped at ±20%.

A Management Strategy Evaluation, using agent-based models is currently being developed, in order to evaluate the performance of the trend rules to achieve management objectives.

[1] https://fishdocs.ccamlr.org/SpDescr_TOA_2024.html

[2] https://fishdocs.ccamlr.org/SpDescr_TOP_2024.html

[3] https://fishdocs.ccamlr.org/TrendAnalysis_2024.htm.

[4] https://github.com/CCAMLR-Science/Trend_Analysis

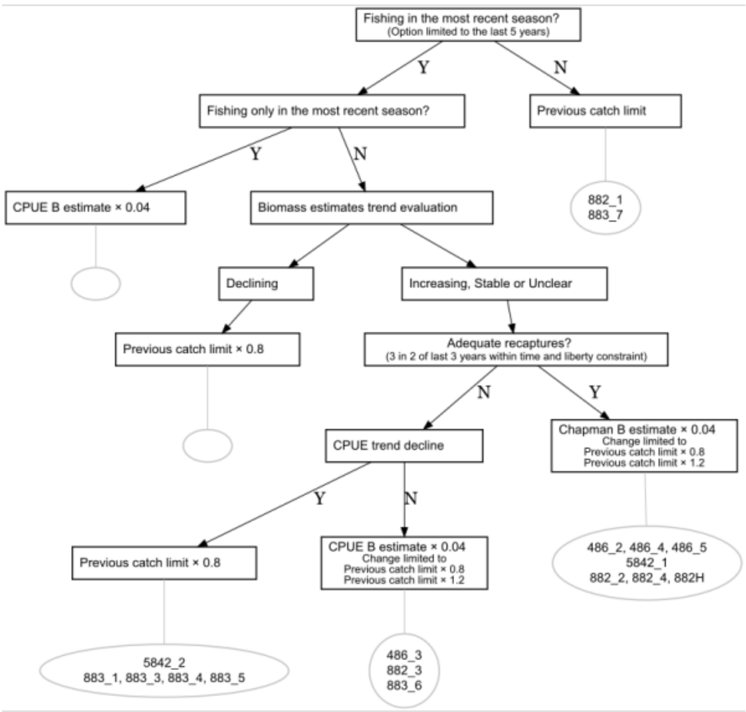

Figure 8.5.1: The decision tree of the trend analysis, showing where each Research Block requiring catch advice belongs in 2024.

SEAFO – Deep-sea red crab

An overview of the stock assessment process in the Southeast Atlantic Fisheries Organisation (SEAFO) was introduced. An overview was given of the SEAFO Convention Area (CA), SEAFO VME Closures as well as the SEAFO Convention (http://www.seafo.org/About/Convention-Text) and emphasised texts/sections that relate to the SEAFO mandate on responsible fisheries management and marine conservation within the ABNJ. This was wrapped up with the SEAFO overview with information on the TAC-managed fisheries; research cruises (2008-2022) and,relatively recent, conservation efforts within the SEAFO CA. More detailed information on the SEAFO stock assessment process were given, which entailed: [1] data validation by the SEAFO Secretariat in conjunction with the Contracting Party (CP) that provided the fishing data; [2] data analysis by the Stock Co-ordinator; and [3] updating of the respective Stock Status Reports during the Scientific Committee (SC) meetings. Lastly, an in-depth outline of the SEAFO DSRC data analysis process was presented. This covered all components of the stock assessment process from the SEAFO fleet description; data collection via daily catch (logbook) and observer reports; spatial and temporal analyses of the data to the final TAC determination on the basis of a Harvest Control Rule (HCR). As an overall conclusion it was indicated that the SEAFO DSRC fishery is relatively small (in comparison to, for example, the adjacent Namibian DSRC fishery) with very low TACs set for the entire SEAFO CA and Division B1 (which is the main area for crab fishing in the SEAFO CA).

8.6 References

Nishimura, A., and Yatsu, A. 2008. Application of surplus-production models to splendid alfonsino stock in the Southern Emperor and Northern Hawaiian Ridge (SE-NHR). NWPBT/SWG-05, 11 pp. http://www.jfa.maff.go.jp/j/study/pdf/appendix_c.pdf

Pons, M., Amoroso, R., and Sawada, K. 2024. Yield per recruit and spawning biomass per recruit analyses for Splendid Alfonsino (*Beryx splendens*) in the North Pacific, NPFC-2024-SCC BFME05-WP09 (Rev. 1)

Sawada, K. and Yonezaki, S. 2019. Yield-per-recruit analysis of splendid alfonsino in the Emperor Seamounts. NPFC-2019-SSC BF02-WP01

Takahashi, Y. 2018. A study on age, growth and harvest strategy of the alfonsino Beryx splendens in the Emperor seamounts water. Master Thesis, Tokyo Univ. Mar. Sci. Tech., 74pp. (in Japanese with English tables and figures)

Then, A. Y., Hoenig, J.M., Hall, N. G., and D. A. Hewitt. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES Journal of Marine Science, 72: 82–92. https://doi.org/10.1093/icesjms/fsu136

Wiff, R., Quiroz, J.C., Flores, A., and Gálvez, P. 2012. An overview of the alfonsino (Beryx splendens) fishery in Chile. Workshop on Management of Alfonsino Fisheries: Rome, 10-12 January 2012. FAO Technical Papers. 25 pp.

Annex 1: List of participants

Name	Institute	Country (of institute)
Ana Faria	AIR Centre	Portugal
Anne Cooper	ICES	International
Anthony Thompson	FAO	International
Aristóteles Amaro	National Institute of Fishery and Marine Research (INIPM)	Angola
Filomena Vaz Velho	National Institute of Fishery and Marine Research (INIPM)	Angola
Hector Antonio Andrade Rodriguez	IMR	Norway
Hubert Du Pontavice	Ifremer	France
José De Oliveira	Cefas	UK
Kota Sawada	Japan Fisheries Research and Education Agency (FRA)	Japan
Liese Carleton	Marine Institute	Ireland
Marc Taylor	Thuenen Institute of Sea Fisheries	Germany
Marta Cousido Rocha	IEO	Spain
Mitsuyo Miyagawa	National Research Institute of Fisheries and Education Agency	Japan
Momoko Ichinokawa	National Research Institute of Fisheries and Education Agency	Japan
Morgana Tagliarolo	Ifremer	French Guiana/France
Nicola Walker	Cefas	UK
Osman Crespo	University of the Azores	Azores
Peter Kidd	Cefas	UK
Régis Santos	University of the Azores	Portugal
Rufus Danby	Scottish White Fish Producers Association	UK
Satoi Arai	Japan Fisheries Research and Education Agency (FRA)	Japan
Simon Fischer (co-chair)	Cefas	UK
Tatsunori Yagi	National Research Institute of Fisheries and Education Agency	Japan
Tobias Mildenberger (co-chair)	DTU	Denmark

Name	Institute	Country (of institute)
Ualerson Peixoto	University of the Azores	Azores
Virgilio Estevão	National Institute of Fishery and Marine Research (INIPM)	Angola
Wendell Medeiros Leal da Silva	University of the Azores	Portugal
Guillem Martí Vila	University of the Azores	Portugal
Alex R. Casla	IMR	Norway
Bárbara Serra-Pereira	IPMA	Portugal
Christopher Gardner Ayer	Japan Fisheries Research and Education Agency (FRA)	Japan
Daisuke Goto	Bangor University	UK
Erich Maletzky	Ministry of Fisheries and Marine Resources	Namibia
Fabian Zimmermann	IMR	Norway
Félix Massiot-Granier	MNHN	France
Guldborg Søvik	IMR	Norway
Gwladys Lambert	Cefas	UK
Johanna B. Marcussen	IMR	Norway
Kotaro Ono	IMR	Norway
Laurence Kell	SEA++	UK
Luiza Prestes		Brazil
Maria Luisa Satta	?	?
Natalie Hold	Bangor University	UK
Paul Bouch	Marine Institute	Irland
Piera Carpi	IMR	Norway
Rehab Farouk Abdelfattah Soliman	Queen's University Belfast	UK
Roberto Sarralde	IEO	Spain
Rui Vieira	Cefas	UK
Sonia Sanchez-Maroño	AZTI	Spain
Takehiro Okuda	Japan Fisheries Research and Education Agency (FRA)	Japan
Tanja Miethe	Marine Directorate of the Scottish Government	UK
Timothy Earl	Cefas	UK

Name	Institute	Country (of institute)
Tom Blasdale	University of the Highlands and Islands	UK
Jonathan White	Marine Institute	Ireland
Santiago Cervino	IEO	Spain

Annex 2: Workshop agenda

Fourteenth Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks

WKLIFE XIV

1 – 5 September 2025

Horta (Casa Manuel de Arriaga, Travessa de São Francisco 2, 9900-124 Horta, Faial, Azores, Portugal) and online (MS Teams)

https://community.ices.dk/ExpertGroups/wklife/_layouts/15/start.aspx#/SitePages/HomePage.aspx

PLEASE NOTE: Time corresponds to Horta (AZOST, UTC/GMT+0)

Approximate daily schedule

09:00	start
10:45-11:00	coffee break
12:30-14:00	lunch break
15:30-15:45	coffee break
17:00	end

Draft Agenda

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1 September (Monday)

09:00 – 10:00 Introductions & meeting ToRs

10:00 – 12:30 Presentations and plenary discussions (General, ToR 1)

- **Anne Cooper** – Updates from ICES
- WKLIFE FAQ
- WKLIFE roadmap
- ICES Technical guidelines – latest updates
- Last year's recommendations
- Collate ICES work with relevance for WKLIFE (e.g. stock-specific MSEs)
- **Tobias Mildenberger** – WKLIFE paper
- **Peter Kidd** – Spatial indicators and operating models (ToR 1)
- **Nicola Walker** – SWAF updates (ToR 1)

12:30 – 14:00 Lunch break

14:00 – 17:00 Presentations and plenary discussions (ToR 1)

- **Laurie Kell** – Comparing length indicators (ToR 1)
- **Laurie Kell** – Length data in JABBA (ToR 1)
- 15:30 (after break) **Simon Fischer** – ICES categories 4-6 simulations (ToR 1)

17:00 Icebreaker with snacks and drinks at meeting venue (optional)

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2 September (Tuesday)

09:00 – 12:30 Presentations and plenary discussions (ToRs 2, 3, 4)

- **Marta Cousido – MSE for sol.27.8c9a (ToR 1/2)**
- **Tanja Miethe** – Application of spatial indicators to Northern Shelf cod (ToR 1/5)
- **Tobias Mildenberger** – data-poor SPiCT (ToR 1)
- **Liese Carleton** – Razor clam MSE (ToR 2)
- **Rui Vieira** – WGDEEP - assessing deep-sea fisheries resources in the ICES area (ToR 2/6)
- **Régis** – Alfonsino (Beryx) stock assessment (ToR 2/6)

12:30 – 14:00 Lunch break

14:00 – 17:00 Presentations and plenary discussions (ToR 5)

- **Wendell Medeiros Leal** – deep sea species and surplus production model reference points (ToR 2/3)
- **Rehab Soliman** – Community-based harvest control rules for the Egyptian artisanal Red Sea fishery (ToR 5)
- **Hector Andrade** – Geographical variations in ling life history and implications for rfb rule (ToR 1/2)
- **Mitsuyo Miyagawa** – Data-limited stock assessments and SPiCT in Japan (ToR 5)
- **Tatsunori Yagi** – Comparison of ICES and Japanese HCRs (ToR 5)
- **Momoko Ichinokawa** – Data-limited stocks in Japan (ToR 5)

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3 September (Wednesday)

09:00 – 12:30 FAO-ICES Deep Sea Fisheries (DSF) project day (ToR 6)

9:00	Introduction – Anne Cooper & Tony Thompson
9:10	Work plan
9:40	Alfonsino/armourhead assessments Kota Sawada (NPFC, in-person), Satoi Arai (NPFC, in-person), Takehiro Okuda (SEAFO, SIOFA, online)
10:30	coffee
11:00	Toothfish: Takehiro Okuda (SEAFO, online), Tim Earl (CCAMLIR, online), Alastair Dunn (CCAMLIR, SIOFA), Roberto Sarralde (SEAFO, SIOFA, SPRFMO, online), Félix Massiot-Granier (CCAMLR, online) Sablefish : Chris Rooper or Kendra Holt (NPFC)
12:00	Small pelagic species – no speakers scheduled, discussion about work and model development
12:20	Other species – Erich Maletzky (red crab – SEAFO, online)

12:30 – 14:00 Lunch break

14:00 – 17:00 DSF continuation and working session

- Buffer for DSF project day

- **Ana Faria/Filomena Vaz Velho/Virgilio Estevão/Aristóteles Amaro –** data-limited methods and management in Angolan waters (ToR 5)
- **Marc Taylor –** Time varying reference points and ecosystem considerations (ToR 3/4)
- **Tobias Mildenberger –** Implementing time-varying reference points (ToR 3/4)
- Working session

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4 September (Thursday)

09:00 – 12:30 Report writing, working session, & pop-up presentations

- **Guldborg Søvik –** Summary of data-limited work and challenges in WGNEPH (*Nephrops*) (ToR 2)
- **Simon Fischer – Category 3 stock status (ToR 3)**
- **Laurie Kell –** Rebuilding time and reference points (ToR 3) TBC
- **Tom Blasdale –** ling index
- Discussion on GitHub repository and good practices
- WKLIFE group picture

12:30 – 14:00 Lunch break

14:00 – 17:00 **No plenary – Whale watching (optional)**

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5 September (Friday)

09:00 – 12:30 Report writing, working session, & pop-up presentations

12:30 – 14:00 Lunch break

14:00 – 17:00 Wrap up report writing & meeting conclusions

- Updates from subgroups
- Adopt updates of technical guidelines, FAQ (if needed)
- Adopt executive summary
- Recommendations
- Plan for WKLIFE XV
- Any other business

19:00 Social dinner at Peter's Café Sport in Horta (optional)

Annex 3: Draft ToRs for the next WKLIFE meeting

WKLIFE XV: 2025/X/FRSXYZ: **The Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE XV)**

The **Workshop on the Development of Quantitative Assessment Methodologies based on Life-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks** (WKLIFE XV), chaired by Tobias Mildenberger (Denmark) and Simon Fischer (UK) will meet at FAO HQ in Rome, Italy (to be confirmed), 28 September – 2 October OR 5–9 October 2026 (dates to be confirmed; note: WGScallop scheduled 5 – 9 October; WGNeph 24 September – 2 October). The workshop should address the following Terms of Reference:

1. Further evaluate and develop quantitative assessment methodologies for data-limited stocks in ICES stock categories 2–6, with specific emphasis on improving the ICES advice provisions for stock categories 4, 5, and 6.
2. Examine if the ICES stocks categories and their descriptions need to be revised following methodological updates, e.g. including length data.
3. Review the outcomes of the ICES-FAO deep-sea fisheries (DSF) project, including the GitHub repository, and the integration of methods into ICES.
4. Facilitate subgroup work on various data-limited topics (e.g. shellfish, *Nephrops*, vulnerable species, reference points) to improve assessment and advice methodologies.
5. Further explore and develop assessment and advice methods with focus on data- and/or resource-limited fisheries from both within and outside the ICES community.

WKLIFE XV will report to ACOM no later than **22 November 2026**.