Centre for Environment Fisheries & Aquaculture Science

Cefas

Developing a Harvest Standard Specification to guide future fisheries management in the UK

Part 1

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Executive summary

A Harvest Standard Specification (HSS) sets out the broad framework within which individual harvest strategies can be developed for England's fisheries, meaning that rules developed by each Fisheries Management Plan (FMP) about how many fish should be caught under certain circumstances all adhere to a common framework.

This common framework is intended to provide advice and guidance on how the objectives of the UK Fisheries Act 2020 can be translated into the operational language required for FMPs by the UK's fisheries policy authorities (FPAs), however the HSS is not a statutory document and does not create any obligations for any UK FPAs.

The HSS is an iterative, evolving document aiming to guide the design, implementation and review of fisheries management, primarily in the context of the FMPs, and it will be developed in stages. This report covers Part 1 of the HSS.

Part 1 of the HSS mainly focusses on the management of fisheries for non-quota stocks (NQS), but also includes 3 quota stocks (European plaice in ICES Divisions 4.a-c and 7.d and sole in Divisions 4.b-c and 7.d) which are, at least partially, managed by Total Allowable Catches (TACs).

Part 1 includes a technical manual providing technical information that accompanies six FMPs: Crabs & Lobsters, King Scallop, Whelk in English waters, Bass, Channel Non-Quota Demersal, Southern North Sea and Eastern Channel Mixed Flatfish. For each stock, the technical manual describes the stock identification process and provides the specifics of the assessment methods and the reference points used in the assessment.

The structure and content of the HSS will be expanded and adapted accordingly in the future, with additional Parts added in future versions. The rationale behind the development of future versions of the HSS is explained in this document.

1. Introduction

Harvest strategies are pre-agreed frameworks for making fisheries management decisions, such as setting targets and catch/effort limits, to ensure fisheries are managed sustainably (FOIF, 2019a). Harvest strategies are akin to agreeing to the rules before playing the game and shift the perspective from short-term reactive decision-making to pursuing longer-term objectives. Although different management bodies use a range of terminologies and definitions, all harvest strategies include the following basic elements (Pew et al., 2015; Dowling et al., 2015):

- management objectives;
- a monitoring programme;
- indicators of the fishery's status and population health, with associated reference points;
- a method to estimate values of indicators; and
- harvest control rules (HCRs) that set fishing opportunities, which could include catch limits and size limits, depending on the value of key indicators relative to their reference points.

Effective collection of data is often required to design and implement a harvest strategy, ensuring an evidence-based approach is taken to set regulations such as catch limits or effort restrictions. Baseline data for individual fisheries, such as fishery independent survey data and length compositions, are often used alongside annual catch statistics to guide management decisions. Furthermore, data collection programmes should be designed such that the data they collect can also be used to measure the efficacy of the strategy at meeting its ecosystem, catch or economic objectives.

The action plan from the Future of Our Inshore Fisheries (FOIF) conference in 2019 proposed a **Harvest Standard Specification** (HSS) to set out the broad framework within which individual harvest strategies can be developed for UK's inshore fisheries (FOIF, 2019b). The HSS guides the development of Defra-led Fisheries Management Plans (FMPs), particularly in supporting the sustainable fishery management for data-limited stocks. There is no expectation that other UK FPAs will produce similar documents, but it is anticipated that the HSS may be useful where stocks are jointly fished.

The overall objective of the HSS is to provide the necessary targets and limits against which to manage each fishery so that the exploitation of stocks remains sustainable. It provides a scientific and technical basis for determining default values for all stocks for:

- target reference points (TRPs),

- limit reference points (LRPs),
- minimum acceptable probability of breaching thresholds such as the LRP, and
- rebuilding timeframes and definitions of rebuilding success for depleted or overfished stocks.

2. Policy relevance of the Harvest Standard Specification

The HSS is intended to offer advice and guidance on how the objectives of the UK Fisheries Act 2020[1] can be translated into the operational language required for Fisheries Management Plans[2] (FMPs) by the UK's fisheries policy authorities (FPAs). The HSS is not a statutory document and does not create any obligations for any UK FPAs.

The HSS primarily covers the 'Sustainability' and 'Precautionary' objectives of the Fisheries Act 2020.

The Sustainability Objective requires that fisheries are environmentally sustainable in the long-term, and that the fishing capacity of fleets is such that fleets are economically viable but do not overexploit marine stocks. The HSS covers the Sustainability Objective by providing technical guidance on current stock assessment methods and reference points as a basis for making sustainable management decisions.

A challenging application relates to non-quota species which are often high value, potentially vulnerable but for which the data available for fishery management can be insufficient to undertake detailed stock assessments. Data limitations may take the form of sampling gaps in time or space, for example in catch-and-effort series, or even of a complete lack of data. The Precautionary Objective of the Fisheries Act 2020 requires that uncertainty is specifically accounted for in decision-making and provides a basis for making robust management decisions in the absence of a high standard of data availability. By providing guidance on the management methods currently in place, the HSS can inform decision-makers on how and when the precautionary approach is implemented.

[1] https://www.legislation.gov.uk/ukpga/2020/22/contents/enacted
[2] https://www.gov.uk/government/publications/fisheries-management-plans/fisheries-management-plans

3. Development of the Harvest Standard Specification

The HSS is an iterative, evolving document that will be developed in stages (Figure 1). This first version covers Part 1 of the HSS, and its contents will be expanded in future versions with the inclusion of additional Parts.

The aim of the HSS is to guide the design, implementation and review of fisheries management, primarily in the context of the FMPs. Therefore, the priority of the HSS is to cover stocks that are currently included in the list of Defra-led FMPs. The list includes both internationally shared quota and non-quota stocks (NQS), plus those species that exist entirely within UK waters and whose management is not shared. While the development of FMPs for quota stocks by the UK FPAs will follow the established advice and assessments of stock status provided by ICES (International Council for the Exploration of the Sea), the drafting of the FMPs for non-quota stocks will happen within less specific frameworks.

NQS are those for which fishery management approaches have traditionally been less well-defined due to data limitations and, thus, the HSS should have the most impact upon future fishery management for NQS and the drafting of their FMPs. Consequently, the first versions (Part 1 and Part 2) of the HSS will cover exclusively NQS (except for a few stocks managed by Total Allowable Catches that are commonly landed together with some NQS presented here, that are thus covered in this HSS to enable a regional approach to some FMPs – see Section 4.1).

Part 1 and the future Part 2 (including additional NQS stocks) of the HSS provides, and will provide, information based on existing stock assessments (Figure 1) and the guidance takes the form of a technical manual providing the specifics of the assessment methods and the reference points used in the assessment. Consequently, in its initial stages the manual will only provide guidance for NQS with an existing stock assessment; the manual will explicitly state which NQS are not currently assessed and will not provide information on targets or limits for these.

However, over time the HSS will cover all NQS included in the list of Defra-led FMPs and, will suggest guidance based on different methodologies, depending on the quantity and quality of data available for each. For those NQS that are not assessed, the HSS will aim to provide guidance informed by a species categorisation (see Section 4.3) identifying fishery management approaches that can be applied across species with common life-history traits. The categorisation will thus draw information from species that have existing fishery management strategies in place to provide management options for species that do not have any.

Additionally, while the HSS currently prioritises guidance for stocks that are included in the current list of Defra-led FMPs, in the longer term it is envisaged that the HSS

may encompass additional stocks/fisheries of interest to England now and in future (see Section 4.3).

In conclusion, the current priority of the HSS is to provide a technical manual on targets and limits against which to manage fisheries for NQS. Part 1 of the HSS provides guidance for stocks that have an existing stock assessment and that are included in the current list of Defra-led FMPs. In future versions, the manual will be incrementally updated and expanded and will eventually include guidance for all NQS covered by the Defra-led FMPs, including stocks for which a stock assessment does not exist.

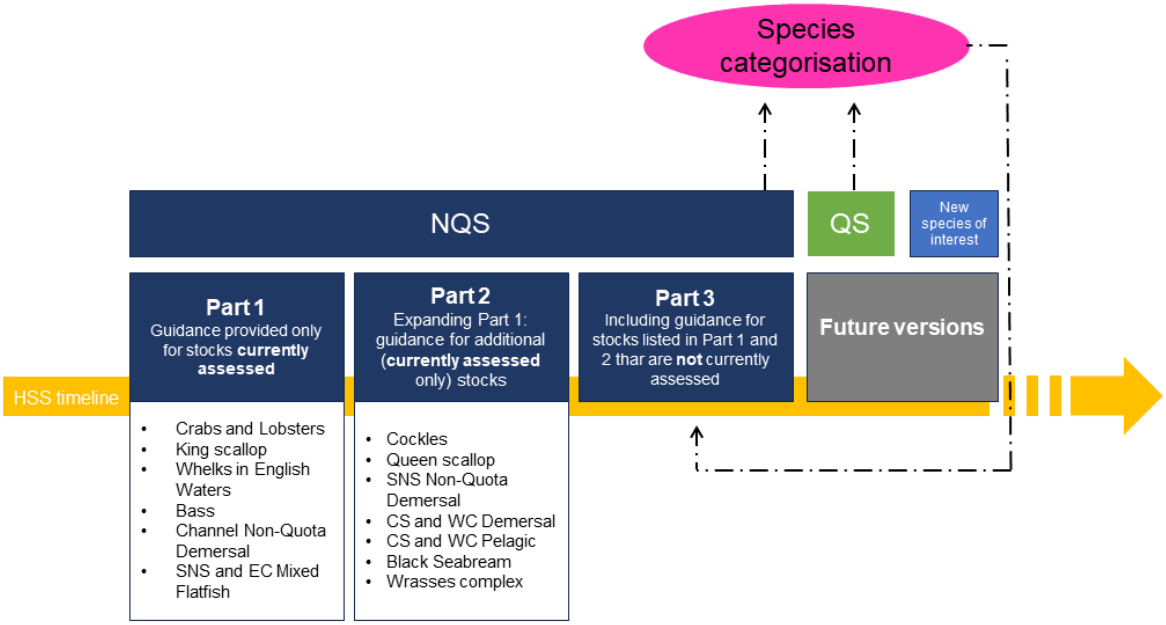

Figure 1. Timeline for the development of the Harvest Standard Specification (HSS).

Figure 1 is a flowchart, which shows that Part 1 and Part 2 of the HSS will include all non-quota stocks (NQS) included in the current list of Defra-led FMPs, but will only provide guidance for the ones with an existing stock assessment. Part 3 will aim to provide guidance for those stocks that are not assessed by applying a species categorisation that draws information from NQS and quota stocks (QS) for which management strategies exist. Subsequent versions may include stocks that are not currently covered by the FMPs. (Acronyms used in the figure – SNS: Southern North Sea; EC: Eastern Channel; CS: Celtic Sea; WC: Western Channel.)

4. Contents of the Harvest Standard Specification

4.1. Part 1

Part 1 of the HSS mainly focusses on the management of fisheries for non-quota stocks (NQS), but also includes 3 stocks (European plaice in ICES Divisions 4.a-c and 7.d and sole in Divisions 4.b-c and 7.d) which are, at least partially, managed by Total Allowable Catches (TACs).

The purpose of Part 1 is to provide a detailed technical manual (Section 5) on the current fishery management measures for stocks covered by the following FMPs[3]:

- Crabs & Lobsters
- King Scallop
- Whelk in English waters
- Bass
- Channel Non-Quota Demersal
- Southern North Sea and Eastern Channel Mixed Flatfish.

The species covered by this technical manual are listed in Section 5.

As stated in Section 3, the information provided is based on the existing stock assessments and thus, the manual will not provide information on targets or limits for stocks that are not currently assessed.

4.2. Part 2

The aim of Part 2 of the HSS will be to update the technical manual presented here in Section 5 by including technical information on current fishery management measures for additional stocks. Specifically, the updated manual will provide information for stocks covered by the following FMPs[3]:

- Cockles
- Queen Scallop
- Southern North Sea Non-Quota Demersal
- Celtic Sea and Western Channel Demersal
- Celtic Sea and Western Channel Pelagic
- Black Seabream
- Wrasses complex

[3] https://www.gov.uk/government/publications/joint-fisheries-statement-jfs

Again, the information provided will be based on existing stock assessments and thus, the manual will not provide information on targets or limits for stocks that are not currently assessed.

The release of Part 2 is planned within one year after the release of Part 1.

4.3. Future iterations

Part 3 of the HSS aims to provide guidance for NQS that do not have an assessment.

For these stocks, the HSS will aim to provide guidance informed by a species categorisation process that groups together different species with common life-history traits (such as motility, longevity, reproductive behaviour and habitat) and taxonomic lineage. Separate species may respond differently to a given management intervention, but when commonalities exist between sub-groups of commercially exploited fishes and shellfishes, management approaches across species groups can be considered, rather than at the stock/species level. For instance, static closed areas are far more likely to be effective for sessile or territorial species than for migratory species. The categories resulting from the categorisation process can inform management decisions as they help identifying where management approaches can be applied across species with common life-history traits. This is particularly useful when data are not available for a species or that are not assessed, as management approaches can be drawn from species in a comparable category. For example, the technical manual presented here in Section 5 does not include any information on the common whelk, because the stock is not currently assessed; by applying the species categorisation, future versions of the HSS will explore the identification of fishery management options in place for stocks included in a comparable category, such as other subtidal mollusc with low motility, that can thus be considered for whelk.

In subsequent stages, the HSS may also include additional NQS that might become of interest in future for varied reasons. This is particularly relevant for stocks that become economically important or for species previously absent from English waters that become part of them due to climate-driven fish migrations, unintentional introduction or other reasons.

The development of this categorisation process will enable a framework to be built that identifies fishery management options for new stocks in a timely way, and thus apply the precautionary approach.

5. Technical manual to support the Fisheries Management Plans

In Part 1 of the HSS, the technical manual provides technical information that accompanies the six FMPs listed in Section 4.1.

This technical manual covers:

- four shellfish species (brown crab, European lobster, common whelk, and king scallop),
- eight non-quota finfish species (striped red mullet, lesser spotted dogfish, starry smooth-hound, grey gurnard, tub gurnard, red gurnard, bib and John Dory),
- nine flatfish species (brill, dab, lemon sole, European flounder, European plaice, witch, sole, Atlantic halibut, turbot),
- six cephalopods species (common octopus, curled octopus, European common squid, veined squid, European squid, common cuttlefish).

For each stock, the manual includes a section describing the stock identification process and a section providing the specifics of the assessment methods and the reference points used in the assessment. The guidance provided in this manual is based on the information available up to 30th June 2023 and any changes made after this date will not be included in this version.

Table 1 below presents a summary of the key characteristics of these species, including their assessed areas as defined in the FMPs, their ICES stock assessment Category (where relevant) and the type of assessment and reference points used by ICES (where relevant).

Section 5.1 provides a summary of the different assessment categories as defined by ICES, as well as a short description of the main assessment methods used within these categories, which apply to all stocks covered by this iteration of the HSS.

Table 1. Summary of the species covered in Part 1 of the HSS

Abbreviations and technical terms used in this table are defined below the table.

Common name	Scientific name	Assessed units relevant for the FMPs	ICES stock category	Methods and indicators used for assessing the stock	Reference points*
Brown crab	Cancer pagurus	5 crab fishery units around England	Not identified	LCA	F_{MSY}, SpR
European lobster	Homarus gammarus	6 lobster fishery units around England	Not identified	LCA	F_{MSY}, SpR
Common whelk	Buccinum undatum	Not assessed	Not identified	Not assessed in English waters	Not defined
King scallop	Pecten maximus	8 assessment units in English waters	Not identified	Direct biomass estimates	F_{MSY}, SpR
Striped red mullet	Mullus surmuletus	2 stocks present in the FMP area (Western and Eastern English Channel)	Category 5	Precautionary approach for both stocks, LBIs described for the Eastern English Channel stock only	Not defined
Lesser spotted dogfish	Scyliorhinus canicula	2 stocks present in the FMP area (Western and Eastern English Channel)	Category 3	2 over 3 rule	Not defined
Starry smoothhound	Mustelus asterias	1 stock present in the FMP area (Western and Eastern English Channel)	Category 3	2 over 3 rule	Not defined
Grey gurnard	Eutrigla gurnardus	1 stock present in the FMP area (Eastern English Channel)	Category 3	rb rule	$I_{trigger}$
Tub gurnard	Chelidonichthys lucerna	Not assessed	Not identified	Not assessed	Not defined

Common name	Scientific name	Assessed units relevant for the FMPs	ICES stock category	Methods and indicators used for assessing the stock	Reference points*
Red gurnard	Chelidonichthus cuculus	1 stock present in the FMP area (Western and Eastern English Channel)	Category 3	No assessment but biomass trends available	Not defined
Bib/pouting	Trisopterus luscus	Not assessed	Not identified	Not assessed	Not defined
John dory	Zeus faber	Not assessed	Not identified	Not assessed	Not defined
Sea bass	Dicentrarchus labrax	1 stock present in the FMP areas (English waters of Divisions 4.b-c, 7.a and 7.d-h)	Category 1	SS3	F_{MSY}, B_{lim}, MSY $B_{trigger}$, B_{pa}
Brill	Scophthalmus rhombus	1 stock present in the FMP areas (English waters of Divisions 4.b-c, 7.d-e)	Category 2	SPiCT	F_{MSY}, MSY $B_{trigger}$
Dab	Limanda limanda	1 stock present in the FMP area (English waters of Divisions 4.b-c)	Category 3	chr rule, LBI	$F_{MSY\ proxy}$, $I_{trigger}$
Lemon sole	Microstomus kitt	1 stock present in the FMP area (English waters of Divisions 4.b-c, 7.d-e)	Category 3	chr rule, LBI	$F_{MSY\ proxy}$, $I_{trigger}$
European flounder	Platichthys flesus	1 stock present in the FMP area (English waters of Divisions 4.b-c; no assessment in the English Channel)	Category 3	2 over 3 rule, LBI	Not defined
European plaice	Pleuronectes platessa	2 stocks present in the FMP areas (English waters of Divisions 4.b-c and 7.d.)	Category 1	SAM (North Sea) AP (Eastern channel)	F_{MSY}, B_{lim}, MSY $B_{trigger}$, B_{pa}

Common name	Scientific name	Assessed units relevant for the FMPs	ICES stock category	Methods and indicators used for assessing the stock	Reference points*
Witch	Glyptocephalus cynoglossus	1 stock present in the FMP areas (English waters of Divisions 4.b-c and 7.d.)	Category 1	SAM	F_{MSY}, B_{lim}, MSY $B_{trigger}$, B_{pa}
Sole	Sole solea	2 stocks present in the FMP areas (English waters of Divisions 4.b-c and 7.d.)	Category 1	SAM (Eastern channel) AP (North Sea)	F_{MSY}, MSY $B_{trigger}$, B_{lim}, B_{pa}
Atlantic halibut	Hippoglossus hippoglossus	Not assessed	Not identified	Not assessed	Not defined
Turbot	Scophthalmus maximus	1 stock present in the FMP areas (English waters of Divisions 4.b-c; no assessment in the English Channel).	Category 1	SAM (North Sea)	F_{MSY}, MSY $B_{trigger}$, B_{lim}, B_{pa}
Common octopus	Octopus vulgaris	Not assessed	Not identified	Not assessed	Not defined
Curled octopus	Eledone cirrhosa	Not assessed	Not identified	Not assessed	Not defined
European common squid	Alloteuthis subulata	Not assessed	Not identified	Not assessed	Not defined
Veined squid	Loligo forbesii	Not assessed	Not identified	Not assessed	Not defined

Common name	Scientific name	Assessed units relevant for the FMPs	ICES stock category	Methods and indicators used for assessing the stock	Reference points*
European squid	Loligo vulgaris	Not assessed	Not identified	Not assessed	Not defined
Common cuttlefish	Sepia officinalis	Not assessed	Not identified	Not assessed	Not defined

Definitions of terms:

- **AP:** Age-based analytical assessment using estimated discards (Aarts and Poos, 2009)
- **B_{lim}** is defined as the biomass limit reference point, below which there might be reduced reproductive capacity
- **B_{pa}** is defined as a precautionary biomass level, above which stocks have full reproductive capacity
- **F_{MSY}** is target fishing mortality consistent with achieving Maximum Sustainable Yield
- **$F_{MSY\ proxy}$** is a proxy for the target harvest rate consistent with achieving Maximum Sustainable Yield
- **$I_{trigger}$** is the biomass index below which fishing effort should be reduced for protection of the stock
- **LCA**: length cohort analysis
- **$L_{F=M}$** a MSY proxy reference length against which the mean catch length can be compared
- **MSY $B_{trigger}$** is defined as the SSB below which fishing effort should be reduced for protection of the stock
- **rb, rfb, and chr** are precautionary advice rules used by ICES for some category 3 stocks, the rb rule follows only the ICES precautionary approach and the rfb and chr rules follow the ICES MSY and precautionary approach
- **SAM**: State-space assessment model
- **SpR**: spawning stock biomass per recruit
- **SS3**: Stock Synthesis 3

5.1. ICES assessment methods used for the stocks covered in the technical manual.

5.1.1. Category 1

Category 1 stocks are defined as data-rich stocks for which full assessments, short-term forecasts using the ICES MSY rule and references points can be produced.

The types of existing assessment for this category are:

- State-space Assessment Model (SAM)
- Age-based analytical assessment using estimated discards (AP)
- Stock Synthesis 3 (SS3)

SAM, AP and SS3 are age-based analytical assessments which rely on commercial catch data, ages and length frequencies from port observers and self-sampling by fishers, as well as catch numbers from scientific surveys. They all provide reference points for fishing pressure and biomass.

5.1.2. Category 2

Category 2 stocks are defined as data-limited stocks for which analytical assessments and short-term forecasts using the ICES MSY rule and reference points can be produced. Assessment and forecast are only treated qualitatively, meaning that they are considered indicative of trends in fishing mortality, recruitment, and biomass.

Surplus production models in continuous time (SPiCT) are used to assess category 2 stocks. SPiCT is an analytical assessment which relies on commercial catch data and catch numbers from scientific surveys.

A SPiCT provides reference points for fishing pressure and biomass, which are only treated qualitatively because the values estimated by the model are considered unreliable.

5.1.3. Category 3

Category 3 stocks are defined as data-limited stocks without full stock assessments but for which an index of stock abundance and possibly additional data such as catch length data exist and can inform on stock trends and fishing pressure.

The types of existing assessment for this category are empirical harvest control rules without full stock assessments:

- chr rule: uses a data-limited harvest rate approach that targets a proxy of a MSY harvest rate (catch divided by index) and reduces catches when the index falls below a trigger value.
- rb rule: is a precautionary advice rule that adjusts the catch advice based on the trend of a biomass index and reduces catches when the index falls below a trigger value.
- 2 over 3 rule: is an advice rule that adjusts the catch advice based on the trend of a biomass index, but without an explicit target.
- Biomass/abundance trends: no assessment and only trends are presented, if available.

These methods provide advice based on trends in an index of abundance, considering information, where available, on the productivity of the stock.

5.1.4. Data-limited stocks, such as Category 5 stocks or stocks not assessed by ICES

Data-limited stocks are defined as stocks with catch or landings data.

The types of existing assessment for data-limited stocks are:

- Length-Based Indicators (LBI): For data-limited stocks (such as Category 5 and 6), if appropriate, LBI can be used in the assessment to indicate whether the fishing mortality is above or below a particular reference point. See Table 2 and Table 3 for further details on the LBIs.
- Length Cohort Analysis (LCA; conducted by Cefas): examines the change in shape of the length-frequency (numbers of individuals at a given length) between years.
- Precautionary approach: used when only landings data are available and there is no information on stock biomass or exploitation levels. In those cases, ICES framework for Category 5 stocks (ICES, 2012) recommends a precautionary reduction of landings.

Table 2. Summary of Category 5 Length-Based reference points (ICES, 2015)

Reference point	Definition
L_{inf}	The expected maximum length of a typical individual
L_{mat}	Length at maturity
L_{opt}	Optimum harvest length at which individuals should be fished to have maximal stock size and maximal catch (Cope & Punt 2009)
$L_{F=M}$	$L_{F=M}$ gives a proxy for the mean length expected from fishing at maximum sustainable yield.

Table 3. Description of Category 5 Length-Based indicators

Indicator	Name	Description
L_c	Length at first catch	L_c is calculated as the first length class to exceed 50% of the mode. Less technically it could be considered that L_c is the smallest size caught frequently. Its reference point is L_{mat} (length at maturity): Lc must be bigger than L_{mat} to avoid overfishing of immature individuals (ICES, 2015).
$L_{25\%}$	Length of 25% of catches	Calculated as 25th percentile of the length frequency distribution. Its reference point is L_{mat} (length at maturity): $L_{25\%}$ must be bigger than L_{mat} to avoid overfishing of immature individuals (ICES, 2015).
$L_{max5\%}$	Mean length of the largest 5%	L_{max5} evaluates the exploitation status of large/old individuals; its reference point is the asymptotic length L_{inf}. If the ratio $L_{max5\%}/L_{inf}$ is > 0.8, then the population is fished sustainably (ICES, 2015).
L_{mean}	Mean length of individuals larger than the Length at first catch L_c	L_{mean} is a length indicator characterising the catch; it evaluates whether the size of the fish caught is appropriate (Froese, 2004). The ratio L_{mean}/L_{opt} (i.e. optimum harvest length) should range between 0.9 and 1.1 for sustainably exploited stocks.
P_{mega}	Proportion of catches which could be considered 'mega' spawners.	P_{mega} indicates the proportion of individuals above L_{opt}+10%. P_{mega} of >0.3 is a healthy stock indicator (Froese, 2004)

5.2. Crabs and Lobsters

5.2.1. Brown (edible) crab

5.2.1.1. Overview of the stock identification process

Brown (edible) crab (Cancer pagurus; Linnaeus, 1758; hereafter 'brown crab') stocks occur across ICES subareas 2, 4, 5, 6, 7, 8 and 9. Five crab fishery assessment units (CFU) exist for brown crab around England (Central North Sea, Southern North Sea, Eastern English Channel, Western English Channel, and Celtic Sea) and are based upon larval distributions, the hydrographic conditions, and distributions of the fisheries (Cefas, 2020a). For example, the Central North Sea and Southern North Sea units are either side of the Flamborough Front. South of the Front, the water is shallower, and currents are stronger than on the north side of the Front (Hull, 1995). These hydrographic features are apparent between April/May and October/November, meaning the north and south areas are isolated during crab spawning activity (Hormbrey, 2020). Whilst one suggestion (Hormbrey, 2020) is that the Flamborough Front implies crab populations south of Dogger Bank may be self-sustaining by providing mature female recruitment to northern areas, uncertainty exists around hen (female) crab movements to the areas of larval production.

Tagging studies in the English Channel have shown brown crab can migrate long distances (Bennett & Brown, 1983; Hunter et al., 2013). Average movement of crabs in the Eastern and Western Channel ranged from ~48 to ~64km (Hunter et al., 2013). Crabs from the Celtic Sea moved 14.5 km from the point of release predominantly westwards, although location of the fisheries in which the crabs were recaptured may have confounded these results. Male movements were proportionally more local and unidirectional, whereas rates of female movements were higher, specifically those in the Eastern Channel (Hunter et al., 2013). These patterns of movement add a level of uncertainty that makes stock boundaries more difficult to ascertain.

5.2.1.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Unlike finfish or molluscs, crabs do not have otoliths or statoliths, respectively, which can be used to ascertain age. Also, as crabs shed their shell during moulting, no hard structures are retained from which age can be easily determined. As such, brown crab stock assessments conducted by Cefas are based on a length cohort analysis (LCA) approach (Cefas, 2020a). This LCA examines the change in shape of the length-frequency (numbers of crabs at a given length) between years (Cefas,

2020a). This method uses the size distribution of landings from ports from each assessment area averaged over the last three years.

Parameters used in the assessment model include growth data from historical tagging studies, and maturity and egg numbers at size from regional sampling programmes (Bannister, 2009). Natural mortality (M) is a key parameter in the assessment model and is assumed to be 20% in current assessments; a widely accepted estimate for long-lived marine species (Johnson et al., 2015), such as crab.

An assumption of the length-based models is that the population is at equilibrium, meaning exploitation and year-class strength (the number of hatched larvae in a year; Thanessekos et al., 2016) are assumed to be constant over time, and is a limitation of this approach (Zhang & Megrey, 2010). It is also assumed the population is closed with no migration or significant changes in population structure over time. This assumption is necessary to be able to associate the decreasing cohort numbers-at-age with natural and fishing mortality, rather than migration.

Reference points are produced alongside time series of spawning stock biomass and fishing mortality as a benchmark to enable managers and policymakers to determine whether current management is effective and whether estimates of biomass and fishing rates are above, at, or below these points. Due to the difficulties in determining age of brown crab, a proxy for MSY of 35% virgin spawner-per-recruit (VSpR) ($F_{35\%SpR}$) is used as a target.

Virgin spawner-per-recruit refers to the ratio of surviving offspring of the same cohort who reach maturity, relative to the original (post-larva) number of recruits, in a situation without any fishing pressure ('virgin' = unfished). Losses to the cohort are then due to natural mortality, which includes any environmental factor (for example, pollution, parasites, prey availability, habitat loss) and predation.

A spawner-per-recruit model simulates an ensemble of scenarios for a range of fishing mortalities, starting with zero (the virgin stock). For each scenario of increasing fishing mortality, the SpR ratio is determined and compared with VSpR. That scenario is then selected as the MSY proxy (or target) reference point that results in SpR = 35% VSpR.

A limit reference point of 15% SpR is used, based on the ICES methodology for data-limited stocks (ICES, 2018a). The target fishing mortality consistent with achieving Maximum Sustainable Yield (F_{MSY}) reference point of 35% SpR is considered biologically sustainable for many stocks (Lart, 2022) and relates to the proportion of the stock that reach maturity relative to the unfished stock.

5.2.2. Lobster

5.2.2.1. Overview of the stock identification process

European lobster (Homarus gammarus; Linnaeus, 1758; hereafter 'lobster') stocks occur across ICES subareas 2, 3, 4, 5, 7, 8 and 9. Six English lobster fishery assessment units (LFU) exist for lobster (Northumberland and Durham, Yorkshire Humber, East Anglia, Southeast South Coast, and Southwest) and are based upon a combination of larval distributions, the hydrographic conditions, distributions of the fisheries (Cefas, 2020b), and operational areas of the fisheries. Historically, six LFUs were assessed, the sixth unit being Northwest, though due to insufficient data because of low levels of fishing effort and landings, assessments are not currently carried out for this unit.

English and Welsh tagging studies from wild and hatchery reared stocks showed that whilst some lobster individuals migrate along coasts of up to ~20 km, most remain local, within embayments (van der Meeren & Soldal, 1998). Hydrographic studies suggest lobster larvae are transported at the sea surface, then return near to the seabed, inshore (van der Meeren & Soldal, 1998). As lobster larvae are difficult to find, and as juveniles can escape pots, biological links between recruits and spawners are difficult to ascertain. Therefore, the LFU also considers the operational areas of the fisheries, rather than solely biological aspects.

5.2.2.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Unlike finfish or molluscs, lobsters do not have otoliths or statoliths, respectively, which can be used to estimate age and year of birth. As lobsters shed their shell during moulting, no hard structures are retained from which age can be easily determined. As such, lobster stock assessments conducted by Cefas are based on a length cohort analysis (LCA) approach (Cefas, 2020b). This LCA examines the change in shape of the length-frequency (numbers of lobsters at a given length) between years (Cefas, 2020b). This method uses the size distribution of landings from ports within each assessment area averaged over the last three years.

Parameters used in the assessment model include growth data from historical tagging studies, and maturity and egg numbers at size from regional sampling programmes (Bannister, 2009). Natural mortality (M) is a key parameter in the assessment model and is assumed to be 15% for lobsters (Sheehy et al., 1999).

An assumption of the length-based models used is that the population is at equilibrium, meaning exploitation and year-class strength are assumed to be constant over time, and is a limitation of this approach (Zhang & Megrey, 2010). It is also assumed the population is closed with no migration or significant changes in population structure over time. This assumption is necessary to be able to associate

the decreasing cohort numbers-at-age with natural and fishing mortality, rather than migration.

Reference points are produced alongside time series of spawning stock biomass and fishing mortality as a benchmark to enable managers and policymakers to determine whether current management is effective and whether estimates of biomass and fishing rates are above, at, or below these points. Due to the difficulties in determining age of lobster, a proxy for MSY of 35% virgin spawner-per-recruit (VSpR) ($F_{35\%SpR}$) is used as a target.

Virgin spawner-per-recruit (VSpR) refers to the ratio of surviving offspring of the same cohort who reach maturity, relative to the original (post-larva) number of recruits, in a situation without any fishing pressure ('virgin' = unfished). Losses to the cohort are then due to natural mortality, which includes any environmental factors (pollution, parasites, lack of food, habitat loss, etc) and predation.

A spawner per recruit model simulates an ensemble of scenarios for a range of fishing mortalities, starting with zero (the virgin stock). For each scenario of increasing fishing mortality, the SpR ratio is determined and compared with VSpR. That scenario is then selected as the MSY proxy (or target) reference point that results in SpR = 35% VSpR.

A limit reference point of 15% SpR is used, based on the ICES methodology for data-limited stocks (ICES, 2018a). The target F_{MSY} reference point is considered biologically sustainable for many stocks (Lart, 2022) and relates to the proportion of the stock that reach maturity relative to the unfished stock.

5.3. Whelks in English waters

5.3.1. Common whelk

5.3.1.1. Overview of the stock identification process

Common whelk (Buccinum undatum; Linnaeus, 1758; hereafter 'whelk') is commonly distributed around the UK; in English waters occurring across ICES subareas 4 (North Sea) and 7 (English Channel, Celtic Sea, and Irish Sea). Stock units have not been defined, primarily due to the poor understanding of stock boundaries.

5.3.1.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

The species is not currently assessed in English waters, and no time series of abundance indices are available.

5.4. King Scallop

5.4.1. Overview of the stock identification process

King scallop (Pecten maximus; Linnaeus, 1758; hereafter ‘scallop’) stocks occur around England, where eight assessment areas exist (27.7.f.I – Bristol Channel, 27.7.e.I – inshore Cornwall, 27.7.e.O - offshore, 27.7.e.L – Lyme Bay, 27.7.d.N – eastern English Channel north, 27.7.d.S – eastern English Channel south, 27.4.b.S – North Sea south, and 27.4.b.D – Dogger Bank). Of the eight assessment areas, six are surveyed regularly (exceptions of 27.7.f.I and 27.4.b.S). These assessment areas are largely based on ICES Divisions and spatial data on fishing activity, though in the case of the eastern English Channel (27.7.d.N and 27.7.d.S), areas are also defined based on landings data which separated the faster growing Baie de Seine scallop stocks from the rest of the Channel.

5.4.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Data allowed for the estimation of harvest rates (the proportion of landings relative to the harvestable biomass) that are consistent with MSY for four stocks (27.7.e.L, 27.7.e.O, 27.7.e.I, and 27.7.d.N). The harvestable biomass includes all animals that are at or above the minimum landing size (MLS). To be accurate, harvest rates should be calculated based on total removals, which includes the reported landings as well as dead discards. For scallops, discard rates of commercial fisheries are unknown, however, it is generally assumed that discard mortality is low, and therefore total catches are not significantly higher than landings.

For marine species for without adequate information to determine MSY, various proxy measure have been determined using a reduced dataset. It is assumed that for data-limited stocks, such as scallops, for which full stock assessment models cannot be implemented, these proxies are also good estimates of MSY. One of these proxies is the fishing mortality resulting in 35% of virgin spawner-per-recruit (VSpR), which has been accepted by ICES as part of the assessment methodology for data-limited stocks.

Virgin spawner-per-recruit refers to the ratio of surviving offspring of the same cohort who reach maturity, relative to the original (post-larva) number of recruits, in a situation without any fishing pressure (‘virgin’ = unfished). Losses to the cohort are then due to natural mortality, which includes any environmental factors (pollution, parasites, lack of food, habitat loss, etc) and predation.

A spawner per recruit model simulates an ensemble of scenarios for a range of fishing mortalities, starting with zero (the virgin stock). For each scenario of

increasing fishing mortality, the SpR ratio is determined and compared with VSpR. That scenario is then selected as the MSY proxy (or target) reference point that results in SpR = 35%VSpR.

A limit reference point of 15% SpR is used, based on the ICES methodology for data-limited stocks (ICES, 2018a). The target F_{MSY} reference point is considered biologically sustainable for many stocks (Lart, 2022) and relates to the proportion of the stock that reach maturity relative to the unfished number of recruits.

The assumptions of a spawner-per-recruit model is that the population is closed, with no migration, and stationary with no significant changes over time. The first assumption is necessary to be able to associate the decreasing cohort numbers-at-age with natural and fishing mortality, rather than migration. The second (stationarity) assumption is necessary to be able to compile population numbers-at-age from a superposition of subsequent cohort numbers-at-age (Zhang & Megrey, 2010).

5.5. Channel non-quota demersal: finfish stocks

5.5.1. Striped red mullet

5.5.1.1. Overview of the stock identification process

ICES currently considers two striped red mullet (Mullus surmuletus; Linnaeus, 1758; hereafter ‘red mullet’) stock units: the Western Unit (subareas 6 and 8, and Divisions 7.a–c, 7.e–k, and 9.a) and Northern Unit (Subarea 4 and Divisions 7.d and 3.a).

This separation is based on a study of otoliths and fish shapes in European waters from Benzinou et al. (2013). However, data from a recent International Bottom Trawl Survey (IBTS) suggest that the stocks in Division 3.a and the North Sea stock are separate (Ellis 2020). Information from surveys and landings also indicates that red mullets migrate between the Western English Channel and the southern North Sea, mixing in the Southern North Sea during summer.

The current HSS only concerns the stock in the Eastern English Channel (Division 7.d, within the Northern Unit) and the stock in the Western English Channel (Division 7.e, within the Western Unit).

5.5.1.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Eastern English Channel stock

Red mullet in Division 7.d (Eastern English Channel) is a stock under biennial advice. The stock was defined by ICES (2021a) as a Category 5 data-limited stock,

meaning only landings data are available. Due to incomplete survey sampling in 2020, issues with calculation of survey indices, the lack of length and age samples from the main fleets and problems with model formulation, red mullet was downgraded from Category 3 (stocks for which survey-based assessments indicate trends) to Category 5 (ICES, 2021a; ICES, 2022a).

In 2021, fishing opportunities advice was provided by ICES, using a precautionary approach. When information on abundance or exploitation of the stock is absent or there is no indication on whether the actual level of exploitation is sustainable, ICES applies a precautionary reduction of catches (ICES, 2012; Fischer et al., 2021). This approach provides catch advice by multiplying the average ICES catch between 2004 and 2020 by a precautionary buffer of 0.8, resulting in a catch advice of 1,950 tonnes for 2022 and 2023. Discarding was considered negligible, and all catches assumed to be landed.

For data-limited stocks such as Category 5 and 6 stocks, length-based indicators (LBIs) can be used to indicate whether the fishing mortality is likely to be above or below a particular reference point. For red mullet, LBI based on samples from commercial catches show that the fish is caught before it reaches its optimum harvest length, thus technical measures such as sorting grids, increased mesh size, and spatial and temporal closures could benefit the fishery by reducing catch of small fish and contribute to more stable yields (ICES, 2022a). Specifically, the following indicators were calculated for 5 years of data (2014-2016 and 2018-2021; ICES, 2021a)

1. Length at first catch, $L_{c,}$ and Length of 25% of catches, $L_{25\%}$, were above length at maturity L_{mat} (16 cm) for 2015–2016 and 2019–2021. The fact that L_c and $L_{25\%}$ are above L_{mat} indicates that individuals were able to spawn before they were captured, thus the exploitation of the stock and specifically of immature individuals is considered to be at sustainable levels.
2. The ratio L_{max5}/L_{inf} was around 0.6/0.7 for 2014-2016 and 2018-2021, showing that the number of large/old fish is low in the population due to fishing. The ratio L_{max5}/L_{inf} needs to be above 0.8 for the population to be fished sustainably.
3. The ratio L_{mean}/L_{opt} was around 0.8, showing that the size of individuals caught was smaller than the optimal harvest length; this means that the individuals fished are too small and the exploitation of the stock is not sustainable. If a stock is fished sustainably, the ratio L_{mean}/L_{opt} is expected to range between 0.9 and 1.1.
4. The ratio $L_{mean}/L_{F=M}$ was below 1 for all years except 2018, showing that the size of individuals caught was generally smaller than the length of the fish caught at maximum sustainable yield. This ratio suggests that fishing mortality

is likely to be higher than natural mortality for this stock and thus fishing is likely occurring above the maximum sustainable yield level.

Western English Channel stock

Red mullet in Division 7.e (Western English Channel) is a stock under triennial advice. It was defined by ICES (2020) as Category 5 data-limited stock, meaning that only landings data are available (no information on stock biomass or exploitation levels). In 2020, fishing opportunities advice was requested following the precautionary approach. The ICES framework for Category 5 stocks was applied (ICES, 2012), meaning that a precautionary reduction of landings was implemented: the average landings for 2018 to 2020 was multiplied by a precautionary buffer of 0.8, providing a landings advice of 1,280 tonnes for 2021, 2022 and 2023. ICES cannot quantify the corresponding catches.

Currently, two research projects are investigating this species and aim to provide results in 2023 (ICES, 2022a).

5.5.2. Lesser spotted dogfish

5.5.2.1. Overview of the stock identification process

Lesser spotted dogfish (Scyliorhinus canicula; Linnaeus 1758) distribution ranges from Norway and the British Isles to the Mediterranean Sea and Northwest Africa (Ebert and Stehmann, 2013); in English waters it occurs across ICES subareas 4 (North Sea) and 7 (English Channel, Celtic Sea, and Irish Sea).

ICES currently considers 4 stock assessment units for this species (ICES, 2022b): North Sea ecoregion (Subarea 4 and Divisions 3.a and 7.d), Celtic Seas and west of Scotland (Subarea 6 and Divisions 7.a–c and 7.e–j), northern Bay of Biscay (Divisions 8.a–b and 8.d), and Atlantic Iberian waters (Divisions 8.c and 9.a). This section concerns the two stocks found in the English Channel: syc.27.3a47d which includes the eastern Channel (7.d) and syc.27.67a-ce-j which includes the western Channel (7.e).

5.5.2.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Lesser spotted dogfish are defined by ICES as a Category 3 stock, meaning that their survey-based assessments indicate trends. ICES provides biennial advice, and the last assessments were carried out in 2021 to provide advice for 2022 and 2023.

Accurate species-specific landings data are not currently available. Some landings have previously been reported in generic ´dogfish´ categories; this fraction of the

landings has been reducing in recent years to a few percent since 2016. Some landings reported as either S. canicula or S. stellaris may comprise a fraction of the other species (ICES, 2021b, 2021c). Discard rates are unknown, but it is considered that they are generally several times higher than landed quantities, with a high discard survival rate (>90%; Revill et al., 2005; Ellis et al., 2017). Groundfish surveys provide valuable information on the spatial and temporal patterns in the species composition, size composition, sex ratio and relative abundance.

Eastern Channel stock

The ICES framework for Category 3 stocks was applied (the '2 over 3' rule), meaning that a precautionary approach was used (method 3.1 in ICES, 2012; ICES, 2018a): the advice for 2022 and 2023 was given by multiplying the most recent advised landings (for example, for 2020 and 2021) by a biomass index ratio indicating whether stock size has increased/decreased in previous years (ICES, 2021b). The index ratio is derived from stock size indices provided by five surveys. The index ratio was calculated as the mean of the stock size index for 2019-2020 (for example, last two values) divided by the mean of the stock size index for 2014-2018 (for example, the 5 preceding values).

For 2022 and 2023, the calculations of the index ratio showed a biomass increase of 0.4%. To limit the change between advised catches to no more than 20%, ICES usually applies an uncertainty cap. This fluctuation being smaller than +/- 20%, meant no uncertainty cap was applied. In addition, when information on abundance or exploitation of the stock is absent or there is no indication on whether the actual level of exploitation is sustainable, ICES applies a precautionary reduction of catches using a precautionary buffer that reduces catch advice by 20% (ICES, 2012; Fischer et al., 2021), but that can only be applied once in a three-year period. The precautionary buffer of -20% was last applied in 2019 and has therefore not been considered since.

Western Channel stock

The ICES framework for Category 3 stocks was applied (the '2 over 3' rule), meaning that a precautionary approach was used (ICES, 2012; ICES, 2018a): the advice for 2022 and 2023 was given by multiplying the most recent advised landings (for 2020 and 2021) by a biomass index ratio indicating whether stock size has increased/decreased in previous years (ICES, 2021c). The index ratio is derived from stock size indices provided by four surveys. The index ratio was calculated as the mean of the stock size index for 2019-2020 (the last two values) divided by the mean of the stock size index for 2014-2018 (the 5 preceding values). Using mean values over several years helps account for the interannual variability of the survey data used.

For 2022 and 2023, the calculations of the index ratio showed a slight biomass increase of 2%. To limit the change between advised catches to no more than 20%, ICES usually applies an uncertainty cap. The biomass index fluctuation being smaller than +/- 20%, no uncertainty cap was applied. In addition, when information on abundance or exploitation of the stock is absent or there is no indication on whether the actual level of exploitation is sustainable, ICES applies a precautionary reduction of catches using a precautionary buffer that reduces catch advice by 20% (ICES, 2012; Fischer et al., 2021), but that can only be applied once in a three-year period. The precautionary buffer of -20% was last applied in 2019 and has therefore not been considered in 2021. The resulting catch advice for 2022 and 2023 was 3,596 tonnes, corresponding to a 2% increase compared to the previous advice.

5.5.3. Starry smooth-hound

5.5.3.1. Overview of the stock identification process

Starry smooth-hound (Mustelus asterias; Cloquet 1821) is commonly distributed around the UK; in English waters it occurs across ICES subareas 4 (North Sea) and 7 (English Channel, Celtic Sea, and Irish Sea).

ICES considers a single stock unit in the continental shelf waters of ICES subareas 4, 6-8 (ICES, 2022c). However, the advice extends to the other areas where species of smooth-hounds are found and so covers ICES subareas 1–10, 12, and 14. This section only applies to fishing activity within English waters of the English Channel (Divisions 7.d and 7.e).

5.5.3.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

ICES undertakes an assessment (based on fisheries-independent survey trends) for Mustelus asterias. However, given identification problems in separating M. asterias and M. mustelus, and that data for these two species are likely confounded in some of the more southerly ICES areas, data are generally combined at the genus level. Hence, although the assessment is based on M. asterias, ICES advises that current management advice should be applied at the genus level, therefore avoiding potential identification problems and their impacts on management and enforcement. The smooth-hounds stock is defined by ICES as Category 3 (ICES, 2021d), meaning that survey-based assessments for the stock indicate trends. ICES provides biannual advice, and the last assessment was carried out in 2021 to provide advice for 2022 and 2023. The assessment was based on biomass trends for starry smooth-hound and landings data for the smooth-hound genus from the overall Northeast Atlantic, as species-specific landings data are unreliable (ICES, 2021d). An unknown proportion of landings of smooth-hounds may be reported under more generic

landings codes for dogfish and sharks, so are not included in the assessment. Discarding and discard survival have not been fully quantified.

The ICES framework for Category 3 stocks was applied (the '2 over 3' rule), meaning that a precautionary approach was used (ICES, 2012; ICES, 2018a): the advice for 2022 and 2023 was given by multiplying the most recent advised landings (for example, for 2020 and 2021) by a biomass index ratio indicating whether stock size has increased/decreased in previous years (ICES, 2021d). The biomass index ratio is derived from five surveys. This biomass index ratio was calculated as Index A/Index B, for example, the mean of the stock size index for 2019-2020 (for example, last two values) divided by the mean of the stock size index for 2014-2018 (for example, the 5 preceding values). The index ratio was 1.24, corresponding to a biomass increase of 24%.

The '2 over 3' rule states that, when the index ratio shows a biomass change below 20%, catch advice is calculated by multiplying the most recently advised landings by the biomass index ratio. When the change is above 20%, the biomass index ratio is replaced by an uncertainty cap of 1.2, which limits the change between advised catches below 20%. In addition, ICES applied a precautionary buffer that reduces catch advice by 20% (ICES, 2012; Fischer et al., 2021). This buffer is only applied once in a three-year period when information on abundance or exploitation of the stock is absent or there is no indication on whether the actual level of exploitation is sustainable. Therefore, catch advice for 2022 and 2023 was given by the formula: [Landings advice (2020, 2021)] × [uncertainty cap] × [precautionary buffer]. The resulting catch advice for each of the years 2022 and 2023 was 4,441 tonnes, corresponding to a 4% decrease compared to the previous advice (4,626 tonnes for 2020-2021).

5.5.4. Grey gurnard

5.5.4.1. Overview of the stock identification process

Grey gurnard (Eutrigla gurnardus; Linnaeus, 1758) is a widely distributed species occurring off the coasts of the Northeast Atlantic. The species is commonly distributed around the UK; in English waters it occurs across ICES subareas 4 (North Sea) and 7 (English Channel, Celtic Sea, and Irish Sea).

ICES splits the stock assessment into 3 ecoregions: North Sea including Division 7.d, Celtic Seas and South European Atlantic. Only the North Sea stock, in ICES subarea 4 and Divisions 7.d and 3.a (eastern English Channel, Skagerrak and Kattegat) is assessed by ICES.

The area covered by the FMP includes the eastern English Channel (Division 7.d), which is on the edge of the distribution for this assessment unit and will contribute a

relatively small proportion of the catches, as most of the catches are taken in subarea 4.

5.5.4.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Grey gurnard in Division 7.d is a non-target species and has biennial advice. It was defined by ICES (2015b) as a Category 3 data-limited stock, meaning survey-based indices provide reliable trends in stock mortality, recruitment, and biomass (Garcia-Isarch et al., 2016). Because official landings data did not separate gurnards at species-level in the past or did not report them at all, only survey data and limited catch data (collected between 2012a and 2021) are available for the assessment.

ICES has not been requested to provide advice on fishing opportunities for this stock for the years 2019 – 2022, but catch advice was requested for 2023 and 2024. The 2023-2024 advice was derived from a rule defined to provide precautionary advice (the 'rb' rule, ICES, 2022c). This rb rule can be used in cases where fish growth is unknown, removing the 'f' component of its counterpart 'rfb' rule. The rb rule is based on the index value derived from the North Sea International Bottom Trawl survey (NS-IBTS), an otter trawl survey that covers the North Sea, and parts of Division 7.d (ICES, 2021e). The rb rule is an empirical approach providing a catch advice value C_{y+1} using the formula:

$C_{y+1} = A_y \times r \times b \times$ m, where:

- A_y is the previous catch advice but because no catch advice was provided in recent years, the average catch of the last 3 years is used.
- r is the stock biomass trend derived from surveys; the rate of change of the biomass index based on the average of the 2 most recent years (here 2021 and 2022) relative to the 3 years prior to the most recent two (here 2018, 2019, 2020)
- b is the biomass safeguard, designed to protect a stock when the biomass index drops below a threshold (here b=1)
- m is a precautionary multiplier (here m = 0.5). This multiplier ensures the rb rule is precautionary and that the probability of the biomass declining below the biomass limit reference point B_{lim} is less than 5% in the long term. The rb rule is a method used when no catch length data is available and likely reduces the catch advice over time; otherwise, the rfb rule can be used.

5.5.5. Tub gurnard

5.5.5.1. Overview of the stock identification process

The tub gurnard (Chelidonichthys lucerna; Linnaeus, 1758) occurs in the Eastern Atlantic from Norway to Senegal, in the Mediterranean Sea and the coast of South Africa (Quero, 1984). In English waters, tub gurnards occur across ICES subareas 4 (North Sea) and 7 (English Channel, Celtic Sea, and Irish Sea). As of 2022, there is no defined stock assessment unit.

The report concerns the eastern English Channel (Division 7.d and 7.e).

5.5.5.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

The tub gurnard is a non-target species mainly taken as bycatch in mixed demersal fisheries. The North Sea and the English Channel are the most significant fishing areas, contributing to 52% and 37% of the landings respectively (ICES, 2013).

ICES does not currently assess the status of tub gurnard stock(s) because landings information is unreliable (gurnards tend to be recorded as mixed gurnards, rather than data being species-specific; ICES, 2013).

5.5.6. Red gurnard

5.5.6.1. Overview of the stock identification process

Red gurnard (Chelidonichthys cuculus; Linnaeus, 1758) stocks occur across the North-east Atlantic from South Norway and North of the British Isles to Mauritania. A compilation of datasets from bottom-trawl surveys showed that the species is abundant in the English Channel (ICES Divisions 7.d and 7.e), the shelf West of Brittany (7.h, 8.a), and west of Scotland (6.a). It is predominantly caught in Divisions 7.d, 7.e and 7.h (ICES, 2022d). Survey data showed a continuous distribution of fish crossing the Channel and the area West of Brittany, suggesting that Divisions 7.d., 7.e. and 7.h. should be considered as a single stock (ICES, 2022d).

In 2022, ICES provided a single assessment for subareas 3-8. The area concerned in this report, the English Channel (7.d and 7.e), is one of the main fishing grounds for this stock as around 80% of landings come from subareas 7.d, 7.e, 7.f, 7.g and 7.h (Celtic Sea/English Channel; ICES, 2022d).

5.5.6.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Red gurnard in Divisions 7.d and 7.e is a non-target stock and has biennial advice. In 2019, ICES provided an assessment based on a precautionary approach for

Category 6 stocks (data-limited stocks with limited landings data from by-catch and largely discarded) that reduced previously advised catch by 20% (ICES, 2019). In 2021, the benchmark workshop WKWEST (ICES, 2021f) recommended to move the stock to Category 3 (stocks for which survey-based assessments indicate trends), but the latest assessment (ICES, 2021g) led to a decision not to provide advice on fishing opportunities due to catch data issues.

Red gurnard is mainly landed as by-catch by demersal trawlers in mixed fisheries, predominantly in Divisions 7d, 7e and 7h. Discard rates are high (Reported discard rates range from 14% to 94% of the catches of specific fleets) and discard data have been provided for 2015 – 2021 by some countries. Before 1977, red gurnard was not specifically reported and currently landings of gurnards are still not always reported at a species level, but rather as mixed gurnards. International landings of mixed gurnards have fluctuated between 3,452 and 5,171 tonnes between 2006-2019, while in 2021 they were 2,903 tonnes – the lowest on record (ICES, 2022d). Gurnards are still not always reported by species, but rather as mixed gurnards. National approaches to validating the species composition of mixed gurnard landings are undocumented, other than for Portuguese landings.

DATRAS (the Database of Trawl Surveys) survey data are available for the English Channel but do not show any apparent trend since 2006. DATRAS is an online database of trawl surveys with access to standard data products used for stock assessments and fish community studies by the ICES community and public users (ICES Database on Trawl Surveys (DATRAS), 2023a).

5.5.7. Bib/pouting

5.5.7.1. Overview of the stock identification process

Bib/Pouting (Trisopterus luscus; Linnaeus, 1758; ‘bib’ hereafter) is a widely distributed species occurring off the coasts of the Northeast Atlantic, from Iceland and Norway to the English Channel, down to the Bay of Biscay and Mediterranean Sea. It is commonly distributed around the UK, mainly the English Channel, Bristol Channel, and Irish Sea, across ICES subareas 4 (North Sea) and 7 (English Channel, Celtic Sea, and Irish Sea).

There are no defined stock assessment units for this species.

5.5.7.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Bib stock(s) are not currently assessed. There is no time series of abundance indices available, nor any reference points for management. This is due to insufficient information available needed to define reference points.

5.5.8. John Dory

5.5.8.1. Overview of the stock identification process

John Dory (Zeus faber; Linnaeus, 1758) are commonly distributed around the UK across ICES subareas 4 (North Sea) and 7 (English Chanel, Celtic Sea and Irish Sea), though stocks are undefined.

5.5.8.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

There is no defined stock assessment for the Northeast Atlantic agreed at the ICES level, nor any agreed reference points for the stock.

5.6. Channel non-quota demersal: cephalopods stocks

5.6.1. Overview of the stock identification process

Common octopus (Octopus vulgaris; Cuvier, 1797), despite the name, are resident to the Channel – more so in the western Channel off the southwest coast of England. In contrast, the curled/lesser octopus (Eledone cirrhosa; Cuvier, 1797) are most abundantly captured throughout the Channel, though records exist all around the UK.

Regarding squids, European common squid (Alloteuthis subulata; Lamarck, 1798), European squid (Loligo vulgaris; Lamarck, 1798), and veined squid (Loligo forbesii; Steenstrup, 1857) all occur throughout UK waters.

Common cuttlefish (Sepia officinalis; Linnaeus, 1978) are abundant throughout the English Channel, southern North Sea, and Celtic Sea.

Stock identification is complicated by several issues. Commercial landings are often not identified to species level. For example, octopus landings are often recorded generally as ‘octopus’ rather than as either common or curled octopus. Where species are recorded as such, issues may exist around identification accuracy; identification to species level can be difficult (particularly between some squids) and would also be time consuming for fishers (Barrett et al., 2023). In recent years, advances in stock identification have allowed for the differentiation of squids A. subulata and A. media (Anderson et al., 2008; Alujevic et al., 2022); morphometric and genetic work on specimens of this genus has confirmed A. media is present in the North Sea and Celtic Sea, whereas A. subulata is not present above 50º latitude (Sheerin et al., 2023).

5.6.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

There are currently no published assessments for cephalopods in English waters. In contrast to fish, commercially caught cephalopods are generally annual species (meaning that they have a life-span of no more than one year), with some species such as common cuttlefish living for up to two years (spawning only occurs once, animals die shortly after spawning). This makes traditional fish stock assessment models based on age or length structure and long-term dynamics of landings per unit effort/catches per unit effort unsuitable (Arkhipkin et al., 2015). As cephalopod stocks are represented by one or occasionally two generations, interannual variability in recruitment has a more prominent implication on stock variability and respective in-season fisheries management.

Cephalopod life-cycles are highly flexible and are particularly responsive to sea temperature. Therefore, squid grow to and mature at different lengths, depending on environmental conditions of the year. Because of this, the entire approach of reference points elaborated for data-limited fish stocks is not applicable for them either, as squid size varies randomly between years and are generally independent from fisheries impacts.

One way to estimate cephalopod stocks would be by a pre-season survey of recruitment with following management of fisheries. For example, in the Falkland Islands the cephalopod fishery is managed based on CPUEs that are reported daily to ensure the minimum escapement biomass that would survive to reproduce in the next spawning season (Arkhipkin et al., 2015). In Japan, data on stock strength and TAC are reported to industry that ensure that stock is not overfished (Arkhipkin et al., 2015).

5.7. Bass

5.7.1. Overview of the stock identification process

The European sea bass (Dicentrarchus labrax; hereafter “sea bass”) is widely distributed across the northeast Atlantic, ranging from northwest Africa to southern Scandinavia and individuals are present in the Mediterranean and Black Sea (Vázquez and Muñoz-Cueto, 2014; Pickett and Pawson, 1994). Sea bass is distributed around the UK, but abundance varies between areas and seasons.

Currently, ICES recognises four sea bass stock units in the Atlantic (ICES, 2018b); however, this stock delineation is being reviewed as evidence from genetics, otolith and scale microchemistry, and tagging and pelagic connectivity indicated that changes to the stock delineation are needed to account for mixing between stocks

(ICES, 2023b). The evidence presented in this section applies only to fishing activity in the Northern stock as currently defined by ICES, which comprises fish in the central and southern North Sea, Irish Sea, English Channel, Bristol Channel and Celtic Sea (ICES divisions 4.b-c, 7.a and 7.d-h).

5.7.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Sea bass was defined by ICES as a category 1 stock, with a full analytical assessment and forecast (ICES, 2022h). The assessment is performed using the Stock Synthesis model (SS3; ICES, 2022h). SS3 is a framework that is used to conduct size- and age-based analytical assessments, relying on data such as commercial catch data, age and length frequencies as well as scientific survey data.

Information from six fishing fleets and three fishery-independent surveys is included in the ICES assessment (ICES, 2022h). Five of the fishing fleets are commercial fleets for which data on international commercial landings are provided. Discards are also provided for two of these fleets, while the other three assume no significant discards. The sixth fleet provides data on recreational removals. Recreational removals are defined as the retained component of the catch and the dead release (estimated at 5%; Lewin et al., 2018). They are an important component of fishing mortality (ICES, 2022h; ICES, 2022i), being about 27% of the total commercial and recreational removals in the Northern stock (Hyder et al., 2018; Radford et al., 2018).

Trends in catches, recruitment, fishing mortality, and spawning stock biomass are generated by the assessment. A detailed short-term forecast is used to generate ICES catch advice for sea bass (ICES, 2022h; ICES, 2022i). It assumes that the proportion of fishing mortality by fleet estimated in the last year of the assessment remains the same going forward, meaning that no further assumption is made on future allocation of catches between fleets that may be induced by management measures.

The assessment is based on estimated maximum sustainable yield (MSY) reference points for fishing pressure and biomass (ICES, 2021h), which are aimed at producing advice consistent with the objective of achieving MSY, that is the largest average catch that can continuously be taken from a stock under existing environmental conditions. The MSY reference points provided in the assessment are:

- F_{MSY} – the target fishing mortality expected to give MSY in the long term (ICES, 2021h);
- MSY $B_{trigger}$ – the spawning stock biomass (SSB) value below which F_{MSY} must be reduced (ICES, 2021h). In this assessment MSY $B_{trigger}$ corresponds to the precautionary approach reference point B_{pa} (see Table 1).

The assessment also provides precautionary approach (PA) reference points (ICES, 2021h) for fishing pressure and biomass (see Table 1).

5.8. Southern North Sea and Eastern Channel Mixed Flatfish

5.8.1. Brill

5.8.1.1. Overview of the stock identification process

Brill (Scophthalmus rhombus; Linnaeus, 1758) has one stock assessed area throughout Kattegat and the Skagerrak (Division 3.a), North Sea (Subarea 4) and English Channel (Divisions 7.d-e). The assessment unit is based on a single biological stock unit. This stock is included in two FMPs: Channel non-quota demersal stocks FMP (English waters within International Council for the Exploration of the Sea (ICES) Divisions 7.d (eastern channel) and 7.e (western channel) and Southern North Sea and Eastern Channel mixed flatfish FMP (English waters within International Council for the Exploration of the Sea (ICES) Divisions 4.b, 4.c and 7.d)

5.8.1.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Data to inform brill stock assessments are available from fishery-dependent and fishery-independent sources. The fishery-dependent data includes national and international landings information and additional data are collected by observers who record the retained and discarded components of catch during commercial fishing operations. These observers collect numbers at length compositions of brill taken by various fishing fleets, and onshore observers collect additional length data of brill which have been landed to fish markets (ports) around England. Fishery-independent data includes information captured during scientific trawl surveys, during which, weight, length, sex, and maturity information are recorded for brill, along with extraction of their otoliths (calcium carbonate ear stones, which can be used to ascertain brill age and growth rate).

Prior to 2023, brill was considered a data-limited Category 3 stock. Brill is now classified as a data-limited Category 2 stock, whereby there is an analytical assessment and short-term forecast that are treated qualitatively (ICES, 2022c). The assessment uses a stochastic surplus production model in continuous time (SPiCT; Pedersen and Berg, 2017), which relies on commercial landings and three survey indices (ICES, 2023c).

For brill, ICES catch advice is based on the fractile rule, whereby catch advice corresponds to the 35th percentile of the predicted catch distribution (ICES, 2022c).

The assessment provides the reference point for fishing pressure F_{MSY}, defined as the target fishing mortality consistent with achieving Maximum Sustainable Yield (MSY), and the reference point for biomass MSY $B_{trigger}$, defined as the spawning stock biomass where fisheries management action is to be taken to reduce exploitation rates (ICES, 2021h). Biomass and fishing mortality estimates are presented relative to values corresponding to the Maximum Sustainable Yield (MSY) because absolute values estimated by the SPiCT model are considered unreliable. Consequently, reference points are also presented relative to MSY reference values.

5.8.2. Common dab

5.8.2.1. Overview of the stock identification process

Common dab (Limanda limanda; Linnaeus, 1758; hereafter 'dab') has one stock assessed area throughout Kattegat and the Skagerrak (Division 3.a) and North Sea (Subarea 4), though this FMP applied to fishing activity within English waters of ICES Divisions 4.b and 4.c.

5.8.2.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Data to inform dab stock assessments are collected by fishery-dependent and fishery-independent sources. The fishery-dependent data includes national and international landings information and additional data are collected by observers who record the retained and discarded components of catch during commercial fishing operations. These observers collect numbers at length compositions of dab taken by various fishing fleets, and onshore observers collect additional length data of dab which have been landed to fish markets (ports) around England. Fishery-independent data includes information captured during scientific trawl surveys, during which, weight, length, sex, and maturity information are recorded for dab, along with extraction of their otoliths (calcium carbonate ear stones, which can be used to ascertain dab age and growth rate).

An ICES data-limited Category 3 assessment approach applies to dab, as there are no analytical assessments currently available for this stock.

The ICES advice for Category 3 stocks is based on empirical advice rules and the choice of rule depends on the stock's life-history (individual growth rate). For dab, a species with medium individual growth, a constant harvest rate (chr) rule is applied (ICES Technical Guidelines, 2022). The chr rule targets a proxy MSY harvest rate ($F_{MSY\ proxy}$, defined by the ratio of catch divided by a biomass index) and reduces the catch advice if the biomass index falls below a trigger value ($I_{trigger}$) with a biomass safeguard. The chr rule includes a multiplier to ensure that the catch advice provides long term sustainable fisheries management.

5.8.3. Lemon sole

5.8.3.1. Overview of the stock identification process

Lemon sole (Microstomus kitt; Walbaum, 1792) has one stock assessed area throughout Kattegat and the Skagerrak (Division 3.a), North Sea (Subarea 4) and English Channel (Divisions 7.d-e), though this FMP applied to fishing activity within English waters of ICES Divisions 4.b, 4.c and 7.d-e. The assessment unit is based on a single biological stock unit.

5.8.3.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Data to inform lemon sole stock assessments are collected by fishery-dependent and fishery-independent sources. The fishery-dependent data includes national and international landings information and additional data are collected by observers who record the retained and discarded components of catch during commercial fishing operations. These observers collect numbers at length compositions of lemon sole taken by various fishing fleets, and onshore observers collect additional length data of lemon sole which have been landed to fish markets (ports) around England. Fishery-independent data includes information captured during scientific trawl surveys, during which, weight, length, sex, and maturity information are recorded for lemon sole, along with extraction of their otoliths (calcium carbonate ear stones, which can be used to ascertain lemon sole age and growth rate).

An ICES data-limited Category 3 assessment approach applies to lemon sole, as there are no analytical assessments currently available for this stock.

The ICES advice for Category 3 stocks is based on empirical advice rules and the choice of rule depends on the stock's life-history (individual growth rate). For lemon sole, a species with medium individual growth, a constant harvest rate (chr) rule is applied (ICES Technical Guidelines, 2022). The chr rule targets a proxy MSY harvest rate ($F_{MSY\ proxy}$, defined by the ratio of catch divided by a biomass index) and reduces the catch advice if the biomass index falls below a trigger value ($I_{trigger}$) with a biomass safeguard. The chr rule includes a multiplier to ensure that the catch advice provides long term sustainable fisheries management.

5.8.4. European flounder

5.8.4.1. Overview of the stock identification process

European flounder (Platichthys flesus; Linnaeus, 1758; hereafter 'flounder') has one stock assessed area throughout Kattegat and the Skagerrak (Division 3.a) and North Sea (Subarea 4), though this FMP applied to fishing activity within English waters of ICES Divisions 4.b, 4.c and 7.d.

5.8.4.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Data to inform flounder stock assessments are collected by fishery-dependent and fishery-independent sources. The fishery-dependent data includes national and international landings information and additional data are collected by observers who record the retained and discarded components of catch during commercial fishing operations. These observers collect numbers at length compositions of flounder taken by various fishing fleets, and onshore observers collect additional length data of flounder which have been landed to fish markets (ports) around England. Fishery-independent data includes information captured during scientific trawl surveys, during which, weight, length, sex, and maturity information are recorded for flounder, along with extraction of their otoliths (calcium carbonate ear stones, which can be used to ascertain flounder age and growth rate).

An ICES data-limited Category 3 assessment approach applies to flounder, as there are no analytical assessments currently available for this stock.

Flounder assessments are based on biomass/abundance trends (ICES Report WKLIFE VII, 2017), most recently from a quarter 1 (Q1) North Sea International Bottom Trawl Survey (IBTS) which provided a survey index for the stock assessment. Other data have included international landings, discard estimates and length-based indicators. The ICES advice for flounder is based on the “2 over 3” rule, which adjusts the previous catch advice by the trend from a stock index (the average of the last two years’ index values divided by the average of the three preceding years values). The 2 over 3 rule includes an uncertainty cap, which limits the change in advice to no more than 20%, and in addition to this, a precautionary buffer which, if applied, reduces the advice by 20%. This buffer was applied by ICES in 2021 because it had not been applied previously.

5.8.5. European plaice

5.8.5.1. Overview of the stock identification process

European plaice (Pleuronectes platessa; Linnaeus, 1758; hereafter ‘plaice) has two stock units within the fisheries management plan (FMP); the North Sea stock (ICES Subarea 4) and northern Skagerrak (ICES Subdivision 20), and the eastern English Channel (ICES Division 7.d). The split is based on stock biology, although migration of plaice across the two stocks areas means that further research is needed to potentially review the definition of stock boundaries. The evidence presented here applies only to fishing activity across ICES Divisions 4.a, 4.b, 4.c, and 7.d.

5.8.5.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Data to inform plaice stock assessments are collected by fishery-dependent and fishery-independent sources. The fishery-dependent data includes national and international landings information and additional data are collected by observers who record the retained and discarded components of catch during commercial fishing operations. These observers can collect numbers at length compositions of plaice taken by various fishing fleets, and onshore observers collect additional length data of plaice which have been landed to fish markets (ports) around England. Fishery-independent data includes information captured during scientific trawl surveys, during which, weight, length, sex, and maturity information are recorded for plaice, along with extraction of their otoliths (calcium carbonate ear stones, which can be used to ascertain plaice age and growth rate).

Both plaice in the North Sea and northern Skagerrak, and plaice in the eastern English Channel are data rich Category 1 stocks (ICES, 2022a), whereby there is catch and survey data with an age structure, and an accepted age-structured stock assessment model (Fischer et al., 2022). In the North Sea, the assessment uses an age-based analytical assessment (State-space Assessment Model; SAM; Nielsen & Berg, 2014), which relies on commercial catch, ages, and data from five trawl surveys. In the eastern English Channel, the assessment uses an age-based analytical assessment (AP; Aarts & Poos, 2009) using commercial catch, ages, and data from two trawl surveys.

The North Sea and northern Skagerrak, and eastern English Channel assessments are both based on estimated maximum sustainable yield (MSY) reference points for fishing pressure and biomass (ICES, 2021h), which are aimed at producing advice consistent with the objective of achieving MSY, that is the largest average catch that can continuously be taken from a stock under existing environmental conditions. The MSY reference points provided in the assessment are:

- F_{MSY} – the target fishing mortality expected to give MSY in the long term (ICES, 2021h);
- MSY $B_{trigger}$ – the spawning stock biomass (SSB) value below which F_{MSY} must be reduced (ICES, 2021h). In this assessment MSY $B_{trigger}$ corresponds to the precautionary approach reference point B_{pa} (see Table 1).

  The assessment also provides precautionary approach (PA) reference points (ICES, 2021h) for fishing pressure and biomass (see Table 1).

5.8.6. Witch

5.8.6.1. Overview of the stock identification process

Witch (Glyptocephalus cynoglossus; Linnaeus, 1758) has one stock assessment unit area within the fisheries management plan (FMP) covering the North Sea (Subarea 4), eastern English Channel (Division 7.d), and Kattegat and the Skagerrak (Division 3.a). The fisheries management plan (FMP) applies to fishing activity within English waters of Divisions 4.b, 4.c and 7.d.

5.8.6.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Data to inform witch stock assessments are collected by fishery-dependent and fishery-independent sources. The fishery-dependent data includes national and international landings information and additional data are collected by observers who record the retained and discarded components of catch during commercial fishing operations. These observers collect numbers at length compositions of witch taken by various fishing fleets. In the North Sea, biological data are collected for witch during scientific trawl surveys (such as), including weight, length, sex, and maturity. Otoliths (calcium carbonate ear stones, which can be used to ascertain witch age and growth rate) are also extracted.

An ICES Category 1 assessment approach applies to witch, meaning the stock is data-rich and short-term forecasts exist with the ICES MSY rule (Fischer et al., 2022). The assessment uses an age-based analytical assessment (State-space Assessment Model; SAM; Nielsen & Berg, 2014), utilising international landings and discard estimates from commercial catch data, along with age frequencies from the primary fleets).

The assessment, which includes indices from scientific trawl surveys, is based on estimated maximum sustainable yield (MSY) reference points for fishing pressure and biomass (ICES, 2021h), which are aimed at producing advice consistent with the objective of achieving MSY, that is the largest average catch that can continuously be taken from a stock under existing environmental conditions. The MSY reference points provided in the assessment are:

- F_{MSY} – the target fishing mortality expected to give MSY in the long term (ICES, 2021h);
- MSY $B_{trigger}$ – the spawning stock biomass (SSB) value below which F_{MSY} must be reduced (ICES, 2021h). In this assessment MSY $B_{trigger}$ corresponds to the precautionary approach reference point B_{pa} (see Table 1).

The assessment also provides precautionary approach (PA) reference points (ICES, 2021h) for fishing pressure and biomass (see Table 1).

5.8.7. Sole

5.8.7.1. Overview of the stock identification process

Sole (Solea solea; Linneaus, 1758) has two stock assessment units; in the North Sea (Subarea 4) and eastern English Channel (ICES Division 7.d). The fisheries management plan (FMP) applies to fishing activity within English waters of Divisions 4.b, 4.c and 7.d. The assessment units are based on biological stock units, whereby sole occupy the same area and mix enough that they can reproduce when sexually mature (NOAA fisheries, 2012).

5.8.7.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

Data to inform sole stock assessments are collected by fishery-dependent and fishery-independent sources. The fishery-dependent data includes national and international landings information and additional data are collected by observers who record the retained and discarded components of catch during commercial fishing operations. These observers collect numbers at length compositions of lemon sole taken by various fishing fleets, and onshore observers collect additional length data of sole which have been landed to fish markets (ports) around England and Wales. Fishery-independent data includes information captured during scientific trawl surveys, during which, weight, length, sex, and maturity information are recorded for sole, along with extraction of their otoliths (calcium carbonate ear stones, which can be used to ascertain sole age and growth rate).

An ICES Category 1 assessment approach applies to sole in both the North Sea and eastern English Channel, which are data-rich stocks (ICES Report WKLIFE VII, 2017).

For North Sea sole, the assessment uses an age-based analytical assessment (AP; Aarts & Poos, 2009), utilising international landings and discard estimates from commercial catch data and two survey indices, along with age and length frequencies from the primary fleets. For the eastern English Channel sole stock, assessments use an age-based analytical assessment (State-space Assessment Model; SAM; Nielsen & Berg, 2014), which relies on commercial catch data (landings and discards), sole ages and length frequencies from the primary fleets, three survey indices, and three commercial indices.

Both the North Sea sole and the eastern English Channel sole assessment are based on estimated maximum sustainable yield (MSY) reference points for fishing pressure and biomass (ICES, 2021h), which are aimed at producing advice consistent with the objective of achieving MSY, that is the largest average catch that can continuously be taken from a stock under existing environmental conditions. The MSY reference points provided in the assessment are:

- F_{MSY} – the target fishing mortality expected to give MSY in the long term (ICES, 2021h);
- MSY $B_{trigger}$ – the spawning stock biomass (SSB) value below which F_{MSY} must be reduced (ICES, 2021h). In this assessment MSY $B_{trigger}$ corresponds to the precautionary approach reference point B_{pa} (see Table 1).

The assessment also provides precautionary approach (PA) reference points (ICES, 2021h) for fishing pressure and biomass (see Table 1).

5.8.8. Atlantic halibut

5.8.8.1. Overview of the stock identification process

Atlantic halibut (Hippoglossus hippoglossus) is distributed in the northern waters of the North Atlantic. Within the North-east Atlantic, halibut occurs off Greenland, Iceland, northern Norway, and Russia, and as far south as the British Isles and northern Bay of Biscay. Towards the south of the range, Atlantic halibut is generally confined to colder, deeper waters. Within the North Sea, Atlantic halibut is most abundant in the northern parts, and it is caught only in small quantities in the central North Sea (Division 4.b) and very occasionally in the southern North Sea (Division 4.c).

There is no assessment unit for Atlantic halibut that extends into the FMP area (English waters of ICES Divisions 4.b, 4.c and 7.d). The biological stock units are undefined. ICES do not assess Atlantic halibut and do not provide advice on its status. However, given the species distribution it is likely that any Atlantic halibut in the FMP area are individuals at the southern limits of a stock centred to the north. This species may be considered as a vagrant species to the FMP area.

5.8.8.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

The stock(s) is not currently assessed, and no time series of abundance indices or reference points are currently available.

5.8.9. Turbot

5.8.9.1. Overview of the stock identification process

Turbot (Scophthalmus maximus; Linnaeus, 1758) has a wide-ranging distribution from Iceland and northern Norway southwards to North/west Africa, including the Baltic Sea, Mediterranean Sea, and Black Sea. However, the biological stock units for turbot across the distribution area are largely undefined.

ICES splits the area into 4 stock assessment units. Two of those are currently unassessed, the northwestern stock covering ICES Divisions 6.a and 7.ab and the southwestern one that includes the English Channel covering ICES Divisions 7.d-h and 8a-d. ICES assess and provide advice for the other two stocks of turbot: one in the North Sea (Subarea 4, tur.27.4) and another in the Kattegat and the Skagerrak (Division 3.a, tur.27.3a).

Further work to investigate relevant biological unit(s) and examine potential connectivity with the English Channel could be considered, especially as the related brill has a different assessment unit.

5.8.9.2. Sustainability and Precautionary Objectives: Species-specific technical guidance

There is currently no stock-specific management plan for turbot in the English Channel.

The current ICES assessment unit of turbot relevant to the FMP area is that from the North Sea (Subarea 4). However, further work to investigate relevant biological unit(s) and examine potential connectivity with the English Channel could be considered, especially as the related brill has a different assessment unit.

Turbot in the North Sea is a data rich Category 1 stock (ICES, 2022a), whereby there is catch and survey data with an age structure, and an accepted age-structured stock assessment model (Fischer et al., 2022). In the North Sea, the assessment uses an age-based analytical assessment (State-space Assessment Model; SAM; Nielsen & Berg, 2014), which relies on commercial catch, ages, and data from two surveys.

The North Sea assessment is based on estimated maximum sustainable yield (MSY) reference points for fishing pressure and biomass (ICES, 2021h), which are aimed at producing advice consistent with the objective of achieving MSY, that is the largest average catch that can continuously be taken from a stock under existing environmental conditions. The MSY reference points provided in the assessment are:

- F_{MSY} – the target fishing mortality expected to give MSY in the long term (ICES, 2021h);
- MSY $B_{trigger}$ – the spawning stock biomass (SSB) value below which F_{MSY} must be reduced (ICES, 2021h). In this assessment MSY $B_{trigger}$ corresponds to the precautionary approach reference point B_{pa} (see Table 1).

The assessment also provides precautionary approach (PA) reference points (ICES, 2021h) for fishing pressure and biomass (see Table 1).

Turbot is a high value species and there are ongoing data collection efforts that may allow for future assessments of other stocks to take place. National and international landings data are available where turbot is caught in trawls of mixed fisheries. Commercial fisheries and at-sea observers provide additional data including numbers and length composition. Additionally, market port sampling provides additional information on the length composition of landed turbot. Otoliths are also collected for aging in the lab.

Scientific trawl surveys provide fishery-independent data on numbers at length as well as associated biological information. There are currently three main UK surveys in the English Channel. Biological data collection provides length, weight, sex, and maturity information of individual fish, with otoliths collected for age readings. However, data available on turbot in the English Channel from scientific trawls surveys is currently limited and, as such, does not provide information on changes in stock size over time.

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