

The Safina Center
at Stony Brook University

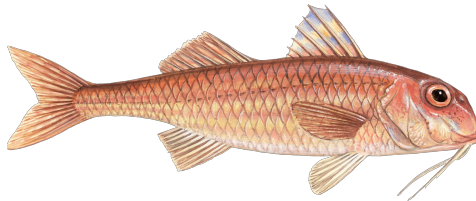
AND



Monterey Bay Aquarium Seafood Watch

Red mullet

Mullus surmuletus



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United Kingdom: Northeast Atlantic **Set gillnets, Bottom trawls, Beam trawls**

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Seafood Watch Standard used in this assessment: Fisheries Standard v3

Disclaimer

Seafood Watch and The Safina Center strive to ensure that all our Seafood Reports and recommendations contained therein are accurate and reflect the most up-to-date evidence available at the time of publication. All our reports are peer-reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science or aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch program or of The Safina Center or their recommendations on the part of the reviewing scientists. Seafood Watch and The Safina Center are solely responsible for the conclusions reached in this report. We always welcome additional or updated data that can be used for the next revision.

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.
- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.
- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished¹ or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard. Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they're caught or farmed in ways that harm other marine life or the environment.

¹ "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report provides recommendations for red mullet (*Mullus surmuletus*) captured in Cornwall, UK, in the Northeast Atlantic Ocean. Red mullet are primarily caught with beam and bottom trawls as well as bottom gillnets in this region.

Red mullet is widely distributed from the North Sea to the Mediterranean Sea in the Northeast Atlantic. Red mullet is a demersal species typically found along muddy and rocky ground, and it feeds on benthic invertebrates and fish. French trawls are the primary commercial fishery for red mullet in this region, but smaller fisheries, such as the Cornish fishery, have developed. The Cornish fishery primarily takes place in the Western English Channel, with some catches also occurring in the Celtic Sea. Abundance and fishing mortality is unknown for red mullet in this region.

Bottom gillnets targeting red mullet result in bycatch of other demersal species such as cod, pollack, horse mackerel, and lesser spotted dogfish, but most species are retained. The bottom and beam trawl fisheries capture a mix of species, including lemon sole, plaice, sole, anglerfish, brill, megrim, haddock, whiting, red gurnard, squid, and cuttlefish. There are some concerns regarding catch of rare elasmobranch species, Atlantic cod, European plaice, and European whiting in trawl fisheries and bycatch of marine mammals in the gillnet fishery. Overall, impacts on other species are of high concern because some captured species are overfished or experiencing overfishing.

The Cornwall Inshore Fisheries and Conservation Authority (CIFCA) is the managing body over red mullet in the Cornwall region within the 6 nautical mile limit. Though no regional management plan has been established, CIFCA has a minimum size limit for red mullet in addition to various gear restrictions. Minimum size limits and catch limits exist for most of the other main species caught in these fisheries.

Bottom gillnets, beam trawls, and bottom trawls all have the potential to disrupt bottom habitats, with trawl gears having the greatest potential for significant damage. Few to no measures have been put in place to reduce potential damage caused by these gear types. Managers in the Cornwall region are working toward a more ecosystem-based management approach, and these fisheries are not expected to have a detrimental effect on the surrounding ecosystem.

Overall, red mullet caught in the beam and bottom trawls are rated Red or "Avoid," whereas red mullet caught in bottom gillnet fisheries in Cornwall, UK are rated Yellow or "Good Alternative."

Final Seafood Recommendations

SPECIES FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Red mullet Northeast Atlantic Beam trawls United Kingdom	2.644	1.000	3.000	2.449	Avoid (2.099)	Unknown
Red mullet Northeast Atlantic Bottom trawls United Kingdom	2.644	1.000	3.000	2.449	Avoid (2.099)	Unknown
Red mullet Northeast Atlantic Set gillnets United Kingdom	2.644	1.000	3.000	3.000	Good Alternative (2.209)	Unknown

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2 , and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score $>2.2-3.2$, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern², and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤ 2.2 , or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

² Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report provides recommendations for red mullet (*Mullus surmuletus*) captured in Cornwall, UK, in the Northeast Atlantic Ocean. Red mullet are primarily caught with beam and bottom trawls as well as gillnets in this region.

Species Overview

Red mullet is widely distributed in the Northeast Atlantic from the North Sea to Senegal, including in the Mediterranean Sea. Genetic differentiation has been studied to determine a division between the Mediterranean and the Northeast Atlantic populations. In addition, three stocks were defined in the Northeast Atlantic: the Bay of Biscay; a mixing zone that comprises the Celtic Sea and the Western English Channel; and a northern zone that comprises the Eastern English Channel and the North Sea (Benzinou et al. 2013). For management purposes, the International Council for the Exploration of the Seas (ICES) considers there to be only two stocks, by grouping the Bay of Biscay stock with that of the Celtic Sea and Western English Channel (ICES 2016a).

Red mullet typically matures in the Northeast Atlantic at 1 year and on average reaches just over 16 cm by this time (Mahe et al. 2013). Ultimately, it can grow to over 40 cm and live more than 10 years. Red mullet is a demersal species, found at depths ranging from 3 to 90 m over muddy and rocky ground (Mahe et al. 2013){Wheeler 1969}. It feeds on benthic invertebrates and fish, utilizing two characteristic barbels on its lower jaw to detect food in the environment (Gosline 1984). These barbels are a defining feature of the Mullidae or “goat fish” family, to which red mullet belongs.

French trawlers dominate the red mullet fishery in the Northeast Atlantic, specifically targeting the Bay of Biscay, the Eastern Channel, and the southern North Sea (ICES 2015a). Smaller fisheries, such as the Cornish fishery in the Western English Channel, have developed in more recent years and supplement the larger effort in the region (ICES 2016a). The International Council for the Exploration of the Seas (ICES) provides management advice for red mullet in the Northeast Atlantic. The Cornwall Inshore Fisheries and Conservation Authority is the managing body for the Cornish fishery.

Production Statistics

Total red mullet landings have averaged 12,385 t over 2010–2014, with approximately 72% of the landings (9,000 t) coming from the Mediterranean and 27% (3,385 t) from the Northeast Atlantic (FAO 2017). Of the Northeast Atlantic landings, an average of 2,119 t has come from the Western English Channel–Celtics Sea–Bay of Biscay stock, while 1,286 t have come from the North Sea–Eastern English Channel stock. France accounts for the majority of the red mullet catches in the Northeast Atlantic, followed by the Netherlands, United Kingdom, Portugal, Spain, and Belgium (ICES 2015f)(ICES 2015g).

The UK fishery, based in Cornwall, targets red mullet from the Western English Channel and Celtic Sea stock. The majority of the catch is taken with demersal trawls in mixed species fisheries, but it is also targeted in Cornish waters with specialized red mullet gillnets (Cornwall Good Seafood Guide 2016c). Landings to Cornish ports have remained fairly steady each year, at 35.274 t in 2020 and 20.943 t in 2019 (MMO 2020).

Importance to the US/North American market.

The United States reports no imports of "mullet" from the United Kingdom (NOAA 2023).

Common and market names.

Red mullet is also known as striped red mullet and surmullet.

Primary product forms

Red mullet is typically sold as fillets or whole fish.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- **Score >3.2=Green or Low Concern**
- **Score >2.2 and ≤3.2=Yellow or Moderate Concern**
- **Score ≤2.2 = Red or High Concern**

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

RED MULLET			
REGION / METHOD	ABUNDANCE	FISHING MORTALITY	SCORE
Northeast Atlantic Beam trawls United Kingdom	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northeast Atlantic Bottom trawls United Kingdom	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northeast Atlantic Set gillnets United Kingdom	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance

Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*

- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Red mullet

Factor 1.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

Moderate Concern

The abundance of red mullet in the Northeast Atlantic Ocean is uncertain. The International Union for the Conservation of Nature (IUCN) has assessed red mullet as “Least Concern” for the global population, but as “Data Deficient” for the regional Europe assessment (Collette et al. 2015). A decline in spawning stock biomass (SSB) has been observed in the Mediterranean population, but an increase has been noted in the Northeast Atlantic that could be attributable to increased temperatures from a changing climate (Collette et al. 2015).

The Cornwall, UK fishery primarily takes place in the Western English Channel, though some catches may occur in the Celtic Sea. Red mullet in these areas is part of a larger population that includes the West of Scotland, Bay of Biscay, and Atlantic Iberian waters. The International Council for the Exploration of the Seas has provided management advice for this population in recent years, but no information on abundance is available, and no target or limit abundance reference points have been defined (ICES 2020).

Because the abundance of red mullet is unknown, a productivity-susceptibility analysis (PSA) was used to score abundance. The PSA indicates that this species has a medium vulnerability to fishing (see detailed scoring below), so we have awarded a score of moderate concern.

Justification:

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	1 year (Mahe et al. 2013)	1
Average maximum age	>10 years {Wheeler 1969}	2
Fecundity	19,640 to 83,448 eggs/spawn (Amal et al. 2016)	1
Average maximum size (fish only)	46 cm {Wheeler 1969}(Mahe et al. 2013)	1
Average size at maturity (fish only)	16–17 cm (Mahe et al. 2013)	1
Reproductive strategy	Broadcast spawner (Fishbase 2016)	1
Trophic level	3.5 (Fishbase 2016)	3
Density dependence (invertebrates only)	N/A	N/A
Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	Fished in nearly all of the species’ range	3

Vertical overlap (Considers all fisheries)	Fished in nearly all of the vertical distribution by various fisheries	3
Selectivity of fishery (Specific to fishery under assessment)	Targeted or is incidentally encountered AND is not likely to escape the gear, BUT conditions under "high risk" do not apply	2
Post-capture mortality (Specific to fishery under assessment)	Retained	3

PSA score for red mullet in Cornish fisheries is calculated as follows:

$$\text{Vulnerability (V)} = \sqrt{P^2 + S^2}$$

$$V = \sqrt{(1.571^2 + 2.325^2)}$$

$$V = 2.806$$

Factor 1.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

Moderate Concern

Fishing mortality for red mullet in the Northeast Atlantic Ocean has not been estimated and no target fishing reference points have been defined. Landings for red mullet have been officially recorded in this region since 1975. For the western stock (Western English Channel, Celtic Sea, and Bay of Biscay), landings increased from the mid-1990s to mid-2000s, but have declined in recent years (ICES 2015a)(ICES 2020). The International Council for the Exploration of the Seas (ICES) has advised that catches of red mullet for the western stock should be at or below 1,280 t for the years 2021 to 2023, but no official total allowable catch limit has been established (ICES 2020). Red mullet catches have been below the recommended level since 2013; however, preliminary landings for 2019 suggest that they were 15% higher than the advised catch (ICES 2020). Because fishing mortality for red mullet is unknown, a score of moderate concern is awarded.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- **Score >3.2=Green or Low Concern**
- **Score >2.2 and ≤3.2=Yellow or Moderate Concern**
- **Score ≤2.2 = Red or High Concern**

Rating is Critical if Factor 2.3 (Fishing Mortality) is Critical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

RED MULLET			
REGION / METHOD	SUB SCORE	DISCARD RATE/LANDINGS	SCORE
Northeast Atlantic Beam trawls United Kingdom	1.000	1.000: < 100%	Red (1.000)
Northeast Atlantic Bottom trawls United Kingdom	1.000	1.000: < 100%	Red (1.000)
Northeast Atlantic Set gillnets United Kingdom	1.000	1.000: < 100%	Red (1.000)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

NORTHEAST ATLANTIC BEAM TRAWLS UNITED KINGDOM			
SUB SCORE: 1.000		DISCARD RATE: 1.000	SCORE: 1.000
SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Atlantic cod	1.000: High Concern	1.000: High Concern	Red (1.000)
European plaice	1.000: High Concern	1.000: High Concern	Red (1.000)
Sharks	1.000: High Concern	1.000: High Concern	Red (1.000)
Brill	3.670: Low Concern	1.000: High Concern	Red (1.916)
Anglerfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blackbellied anglerfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Common cuttlefish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
European Dover sole	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
European pollock	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Red gurnard	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Red mullet	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Megrim	3.670: Low Concern	5.000: Low Concern	Green (4.284)

NORTHEAST ATLANTIC BOTTOM TRAWLS UNITED KINGDOM			
SUB SCORE: 1.000		DISCARD RATE: 1.000	SCORE: 1.000
SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Atlantic cod	1.000: High Concern	1.000: High Concern	Red (1.000)
European horse mackerel	1.000: High Concern	1.000: High Concern	Red (1.000)
European plaice	1.000: High Concern	1.000: High Concern	Red (1.000)
European whiting	1.000: High Concern	1.000: High Concern	Red (1.000)
Sharks	1.000: High Concern	1.000: High Concern	Red (1.000)
Brill	3.670: Low Concern	1.000: High Concern	Red (1.916)
Haddock	3.670: Low Concern	1.000: High Concern	Red (1.916)
Anglerfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blackbellied anglerfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Common cuttlefish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
European squid	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Lemon sole	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Red mullet	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHEAST ATLANTIC SET GILLNETS UNITED KINGDOM			
SUB SCORE: 1.000		DISCARD RATE: 1.000	SCORE: 1.000
SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
European horse mackerel	1.000: High Concern	1.000: High Concern	Red (1.000)
Marine mammals	1.000: High Concern	1.000: High Concern	Red (1.000)
European pollock	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Lesser spotted dogfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Red mullet	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Retained and bycatch species for the red mullet gillnet fishery were determined from a 2011 bycatch study on this fishery. The most common species that were caught in red mullet gillnets, with mesh sizes of <70 mm, were Atlantic cod, pollack, horse mackerel, and lesser spotted dogfish. Other species caught in low amounts (i.e., <5% of the catch) and not included in this assessment include Atlantic mackerel, whiting, wrasse, hake, and red gurnard {Foster and Smith 2011}. The lowest scoring species for the gillnet fishery are marine mammals because they are on the OSPAR List of Threatened and/or Declining species, and are

potentially highly susceptible to gillnets in the region.

The bottom and beam trawl fisheries that catch red mullet target a mix of demersal species. The beam trawl fishery targets anglerfish (monkfish), cuttlefish, gurnards, megrim, plaice, brill, and sole. The bottom trawl fishery catches anglerfish, cod, cuttlefish, haddock, horse mackerel, lemon sole, plaice, squid, and whiting (Burt et al. 2013)(Cornwall Good Seafood Guide 2016c)(MMO 2015)(UK Government 2013). The lowest scoring species in the beam trawl fisheries are Atlantic cod, because it is overfished and overfishing is occurring; sharks, because of their vulnerability and susceptibility to beam trawl nets; and plaice, because overfishing is occurring. The lowest scoring species for the bottom trawl fisheries are Atlantic cod and whiting, because of their overfishing and overfished statuses; plaice, because of its overfishing status; and sharks, because of their vulnerability and susceptibility to bottom trawl nets. Also, concern does exist for some rare elasmobranch species, such as thresher sharks, blonde ray, small-eyed ray, or thornback ray, to interact with bottom and beam trawl gear (Cornwall Good Seafood Guide 2016a)(MMO 2015).

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance

(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality

(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use

Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss.

For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

	Ratio of bait + discards/landings	Factor 2.3 score
<100%		1
>=100		0.75

Anglerfish

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

Two species of anglerfish may be caught in the Cornwall trawl fisheries: white anglerfish (*Lophius piscatorious*) and black anglerfish (*Lophius budegassa*). These species are assessed separately but managed together. In the Northeast Atlantic, there are three management units for anglerfish: a Northern shelf stock, a northern Southern shelf stock, and a southern Southern Shelf Stock. Anglerfish in the Cornwall, UK area are part of the northern Southern Shelf Stock. Target abundance reference points have not been established for this stock, but white anglerfish is believed to be above the possible limit reference points, and abundance has been increasing (ICES 2016g). Abundance information for black anglerfish is more limited and indicates fluctuation without trend (ICES 2016w). Both species have been assessed as "Least Concern" by the International Union for the Conservation of Nature (IUCN) (Fernandes et al. 2015a)(Fernandes et al. 2015b). We have therefore awarded a score of moderate concern.

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

The white anglerfish and black anglerfish are managed under a combined total allowable catch (TAC); this may prevent effective control of single-species exploitation and could lead to overfishing of either species. The total catch in the northern Southern Shelf management unit for both species was around 36,000 t per year during 2013–2015. The majority was caught with bottom trawl (80–87%), followed by beam trawl (5–11%). Fishing effort has been consistently decreasing since the 1990s, and catches of both species in recent years were around or below the recommend catch levels by the International Council for the Exploration of the Sea (ICES) (ICES 2016g)(ICES 2016w). There are no fishing mortality reference points for the black anglerfish (ICES 2016w). This is a poorly studied species that is long-lived and slow growing; it has a high value for fishers and is heavily targeted (pers. comm., M. Slater 2017). Because catch is below the recommended levels but the species is so poorly studied and fishers are nonetheless heavily targeting it, a score of moderate concern is awarded.

Atlantic cod

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

The International Union for the Conservation of Nature (IUCN) has assessed Atlantic cod (*Gadus morhua*) as “Least Concern” in the European region {Cook et al. 2015a}. For the Celtic Sea and Western English Channel cod stock, which includes the Cornwall area, abundance has fluctuated over the years. But, more recent stock assessments indicate that the spawning stock biomass has dropped below the biological target reference point $MSY B_{TRIGGER}$ and below the limit reference point B_{LM} , established by the International Council for the Exploration for the Sea (ICES) (ICES 2021)(ICES 2022). Recruitment (the number of new fish entering the population) has varied, but has remained poor in recent years; recruitment depends on seawater temperatures {ICES 2016b} (pers. comm., M. Slater 2017). Poor recruitment in recent years is most likely due to mild winters, although stocks are rebuilding farther north (pers. comm., M. Slater 2017). Because this stock appears to be overfished in this region, abundance is rated a high concern.

Justification:

Recruitment (age 1)

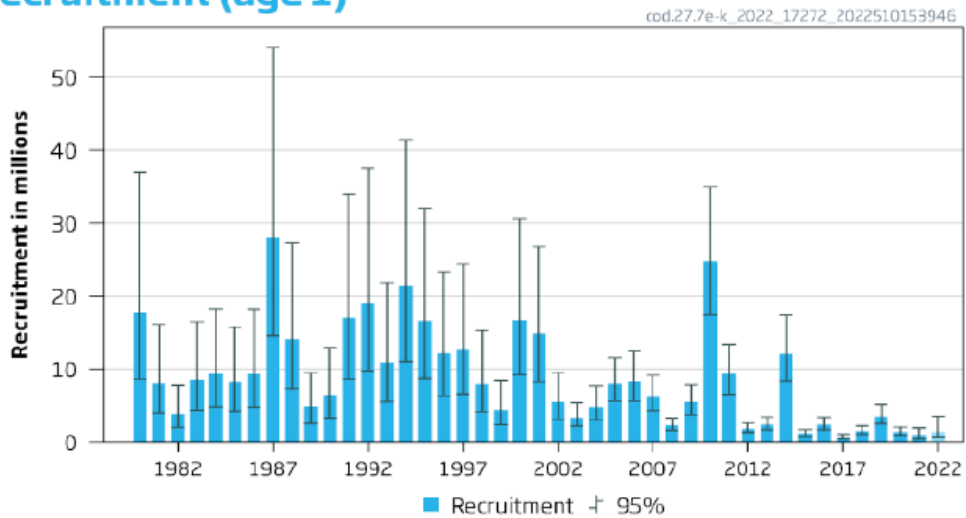


Figure 1: Recruitment for the Celtic Sea and Western English Channel Atlantic cod stock (ICES 2022).

SSB

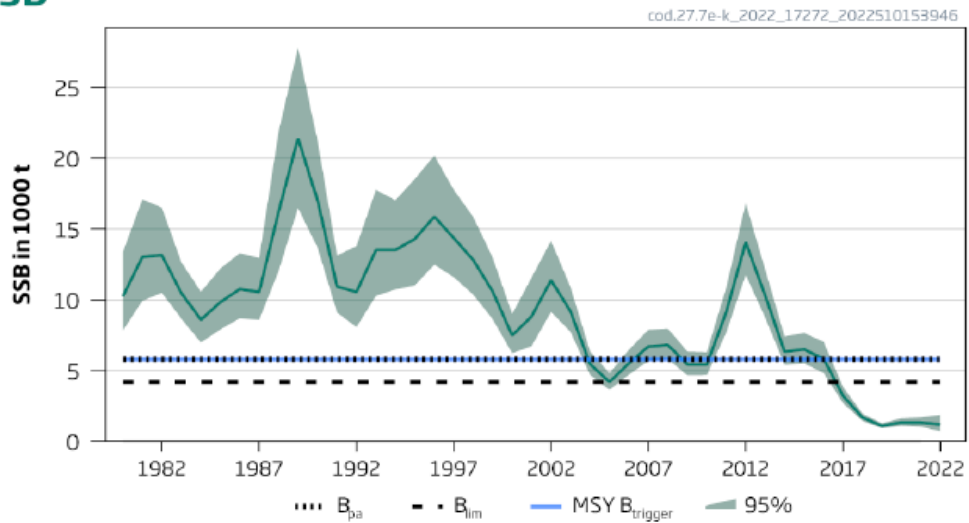


Figure 2: Spawning stock biomass (SSB) for the Celtic Sea and Western English Channel Atlantic cod stock (ICES 2022).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

Fishing mortality for Atlantic cod in 2022 (1.069) is currently above the fishing mortality at maximum sustainable yield (F_{MSY}) target, and between F_{PA} and the limit reference point F_{LIM} in this region (ICES 2022). Previous years have also shown fishing levels well above F_{MSY} . Because overfishing is occurring, a score of high concern is awarded.

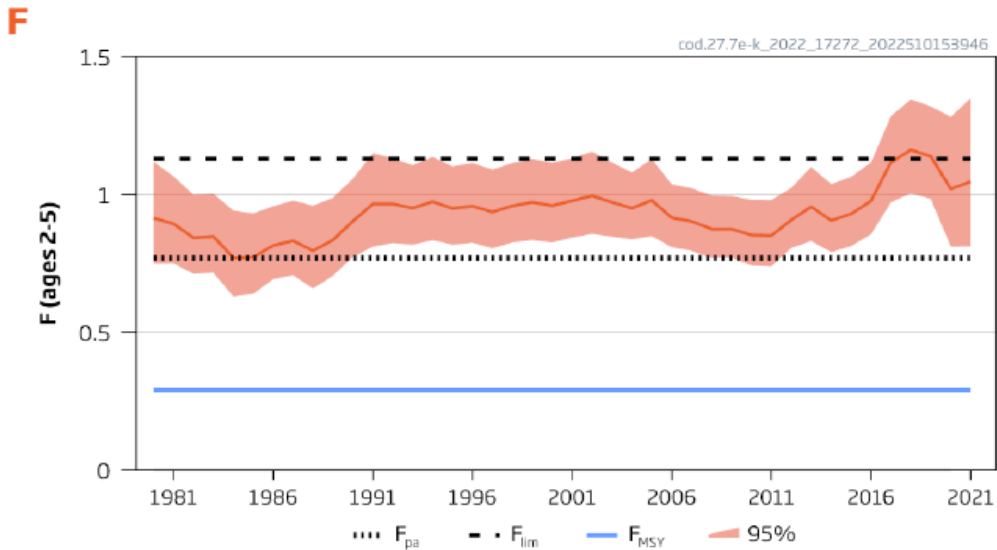


Figure 3: Fishing mortality for the Celtic Sea and Western English Channel Atlantic cod stock (ICES 2022).

Blackbellied anglerfish

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

Two species of anglerfish may be caught in the Cornwall trawl fisheries: white anglerfish (*Lophius piscatorious*) and black anglerfish (*Lophius budegassa*). These species are assessed separately but managed together. In the Northeast Atlantic, there are three management units for anglerfish: a Northern shelf stock, a northern Southern shelf stock, and a southern Southern Shelf Stock. Anglerfish in the Cornwall, UK area are part of the northern Southern Shelf Stock. Target abundance reference points have not been established for this stock, but white anglerfish is believed to be above the possible limit reference points, and abundance has been increasing (ICES 2016g). Abundance information for black anglerfish is more limited and indicates fluctuation without trend (ICES 2016w). Both species have been assessed as “Least Concern” by the International Union for the Conservation of Nature (IUCN) (Fernandes et al. 2015a)(Fernandes et al. 2015b). We have therefore awarded a score of moderate concern.

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

The white anglerfish and black anglerfish are managed under a combined total allowable catch (TAC); this may prevent effective control of single-species exploitation and could lead to overfishing of either species. The total catch in the northern Southern Shelf management unit for both species was around 36,000 t per year during 2013–2015. The majority was caught with bottom trawl (80–87%), followed by beam trawl (5–11%). Fishing effort has been consistently decreasing since the 1990s, and catches of both species in recent years were around or below the recommend catch levels by the International Council for the Exploration of the Sea (ICES) (ICES 2016g)(ICES 2016w). There are no fishing mortality reference points for the black anglerfish (ICES 2016w). This is a poorly studied species that is long-lived and slow growing; it has a high value for fishers and is heavily targeted (pers. comm., M. Slater 2017). Because catch is below the recommended levels but the species is so poorly studied and fishers are nonetheless heavily targeting it, a score of moderate concern is awarded.

Brill

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Low Concern

Brill (*Scophthalmus rhombus*) has been assessed as a species of “Least Concern” by the International Union for the Conservation of Nature (IUCN) in the European region (Golani et al. 2015). Little is known about the brill population in Cornish waters. A recent ICES stock assessment of brill including regions 7d–e indicate that the stock size is above the MSY $B_{TRIGGER}$ proxy (ICES 2022i). Because it is unknown whether or not the reference point is appropriate, but the stock appears to be healthy, abundance has been scored a low concern.

Biomass index

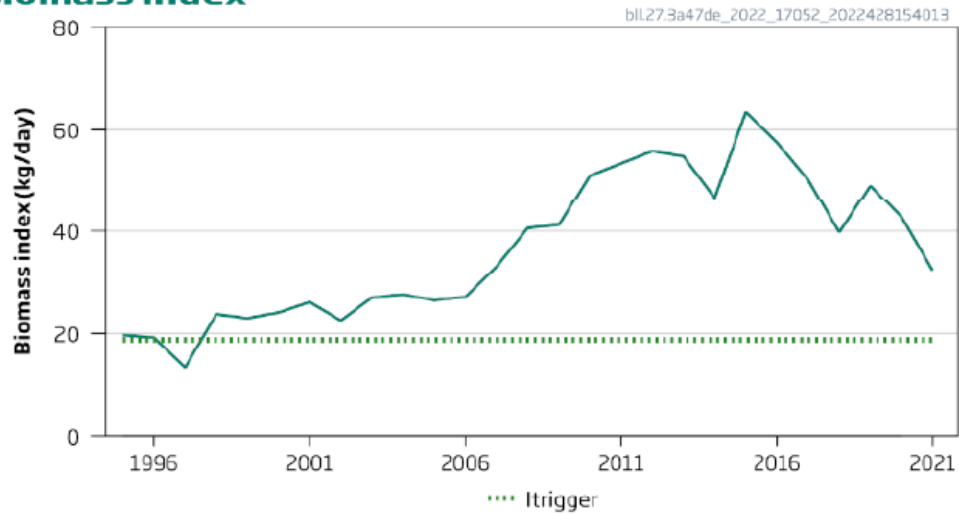


Figure 4: Biomass index of brill (in kg/day) showing that the stock is well above MSY $B_{TRIGGER}$ proxy. Taken from (ICES 2022i).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

Fishing mortality on the brill stock in regions 7d–e is above the F_{MSY} proxy (ICES 2022i). Hence, this factor has been scored a high concern.

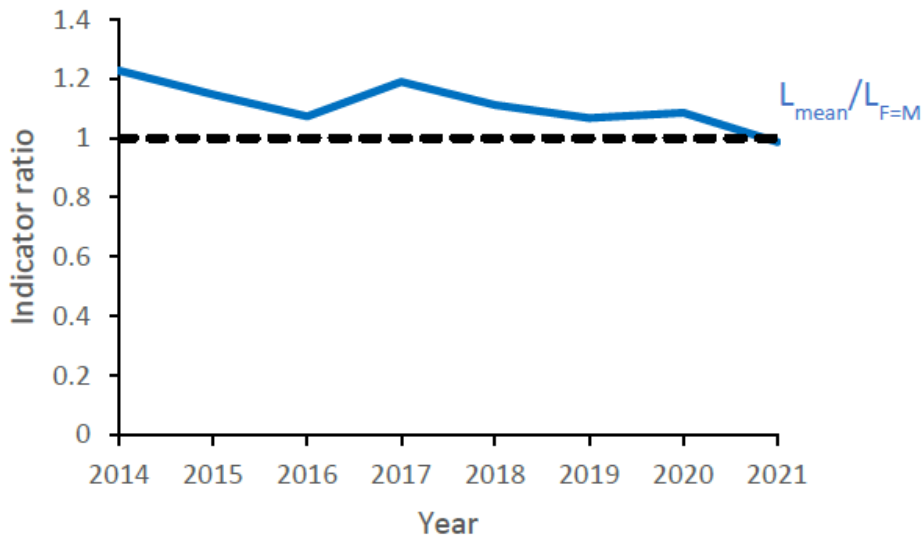


Figure 5: Brill in divisions 7d–e, where the indicator ratio $L_{\text{MEAN}}/L_F = M$ from the length-based indicator (LBI) method is used for the evaluation of the exploitation status. The exploitation status is below the F_{MSY} proxy when the indicator ratio value is higher than 1 (shown by a dashed black line). Taken from (ICES 2022i).

Common cuttlefish

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

The International Union for the Conservation of Nature (IUCN) has assessed cuttlefish (*Sepia officinalis*) as a species of “Least Concern” (Barrat and Allcock 2012). There is no formal stock assessment for this species. Although cuttlefish may be at risk of overexploitation in areas such as the Mediterranean, areas in the Northeast Atlantic have not shown similar trends (Barrat and Allcock 2012). Cuttlefish in the English Channel (southern Cornish waters) is considered one stock (Gras et al. 2014). One study worked to model abundance of cuttlefish in the English Channel and the results suggest high variability (Royer et al. 2006). Another more recent study suggests a trend of abundance decreasing from 2002 to 2008 (Gras et al. 2014). Because this species has been assessed as “Least Concern” by the IUCN but abundance relative to target reference points is unknown, a score of moderate concern is awarded.

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

Landings for cuttlefish in the English Channel averaged around 11,000 t between 2000 and 2010, with the majority of the catch taken by French and UK trawlers (Gras et al. 2014). There is no total allowable catch (TAC) for cuttlefish in this region and, because of its short lifespan and sensitivity to environmental factors, management by fishing effort has been suggested as a means to control fishing rather than a TAC (Gras et al. 2014). It was suggested that keeping exploitation rates (landings/current biomass) below 40% would allow maintenance of a healthy population (Gras et al. 2014). As of 2008, there was no evidence that cuttlefish was being overexploited (Gras et al. 2014), but recent estimates of fishing mortality are unavailable. A score of moderate concern is awarded.

European Dover sole

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Moderate Concern

The International Union for the Conservation of Nature (IUCN) has assessed sole (*Solea solea*) as "Least Concern" (Monroe et al. 2015b). There are multiple sole stocks in the Northeast Atlantic. For the Western English Channel stock (southern Cornwall), spawning stock biomass is increasing and above several limit abundance reference points defined by the International Council for the Exploration of the Sea (ICES) (ICES 2016l). For the Bristol Channel and Celtic Sea stock (northern Cornwall), spawning stock biomass is also above defined ICES limit abundance reference points (ICES 2016k). But, abundance relative to target abundance reference points, such as the biomass at maximum sustainable yield, is undefined for both sole stocks. As a result, a score of moderate concern is awarded.

Justification:

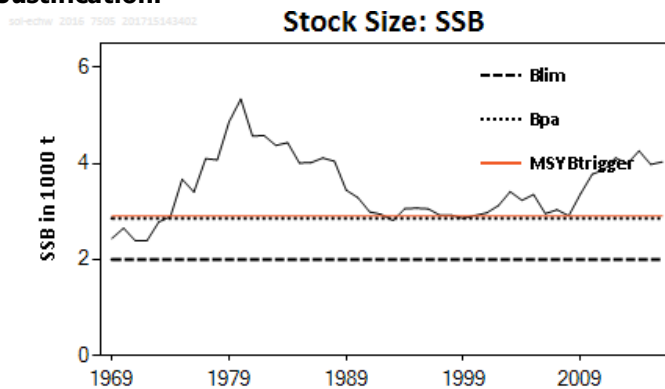


Figure 6: Recruitment and spawning stock biomass for sole in the Western English Channel (ICES 2016l).

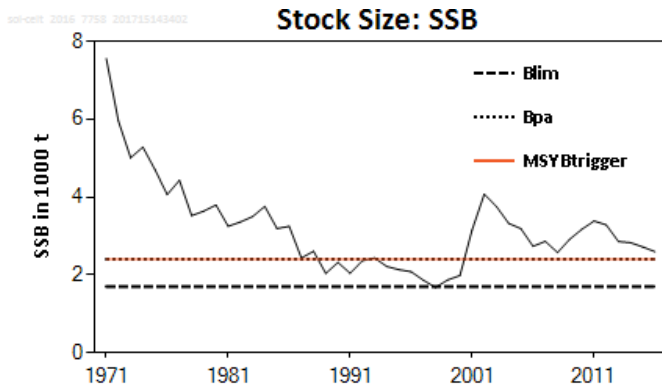


Figure 7: Recruitment and spawning stock biomass in the Celtic Sea (ICES 2016k).

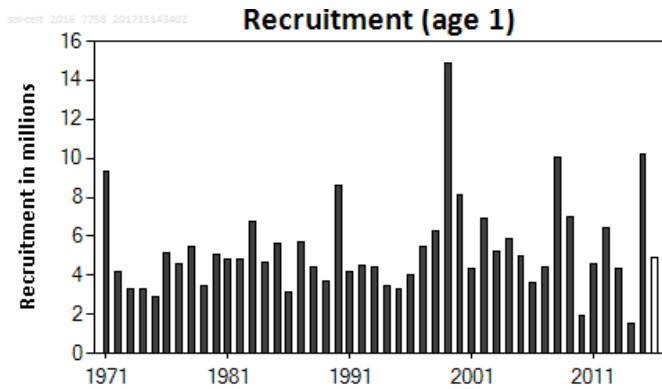


Figure 8: Recruitment and spawning stock biomass in the Celtic Sea (ICES 2016k).

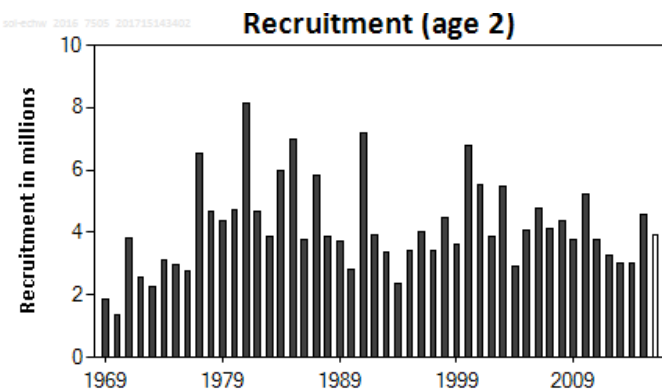


Figure 9: Recruitment and spawning stock biomass for sole in the Western English Channel (ICES 2016I).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Moderate Concern

Fishing mortality on sole in the Western English Channel is below the fishing mortality at maximum sustainable yield (F_{MSY}), so it is considered sustainable (ICES 2016l). But, fishing mortality on sole in the Bristol Channel and Celtic Sea has consistently been above F_{MSY} since the 1980s, indicating that overfishing is occurring (ICES 2016k). Most of the trawling effort that catches red mullet occurs in the Western English Channel, but because there is the potential for red mullet to be caught with Celtic Sea sole, we have awarded a score of moderate concern.

Justification:

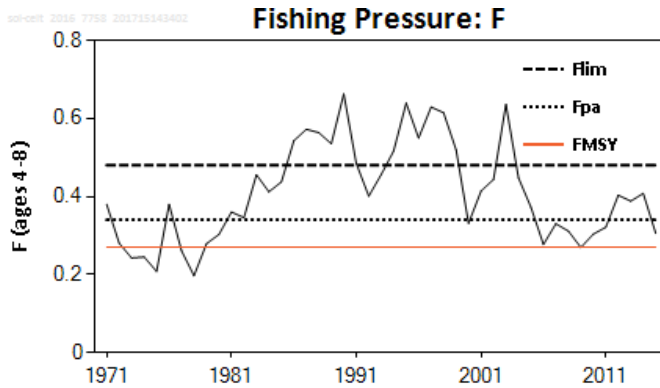


Figure 10: Fishing mortality for sole in the Celtic Sea (ICES 2016k).

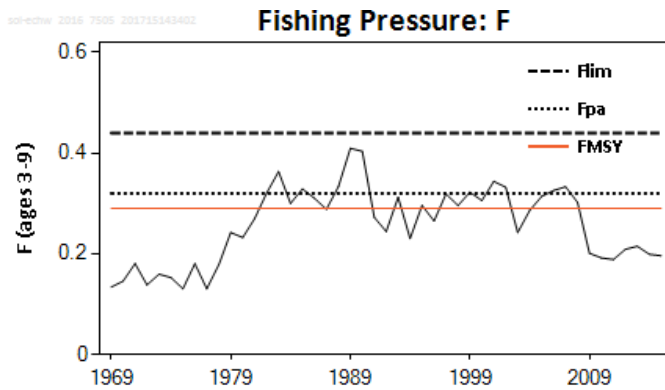


Figure 11: Fishing mortality for sole in the Western English Channel (ICES 2016l).

European horse mackerel

Factor 2.1 - Abundance

Northeast Atlantic | Bottom trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

High Concern

The International Union for the Conservation of Nature (IUCN) has assessed Atlantic horse mackerel (*Trachurus trachurus*) as "Vulnerable" globally but as "Least Concern" for the European region (Smith-Vaniz et al. 2015). Three stocks have been identified in the Northeast Atlantic: the North Sea horse mackerel, western horse mackerel, and the southern horse mackerel (Abaunza et al. 2003). The western horse mackerel encompasses this report's area of interest, covering the Norwegian Sea, northern North Sea, west and south of the British Isles, Western English Channel, and west of France (ICES 2016d). Spawning stock biomass (SSB = mature fish abundance) for the western horse mackerel stock has been declining and is currently at the lowest recorded level. Spawning stock biomass is below the biomass trigger reference point, indicating concern over the abundance of this population (ICES 2022h). Recruitment (new fish entering the population) has been low since 2002 (ICES 2016d). Because abundance is declining and is below the established reference point, abundance is rated a high concern.

Justification:

SSB

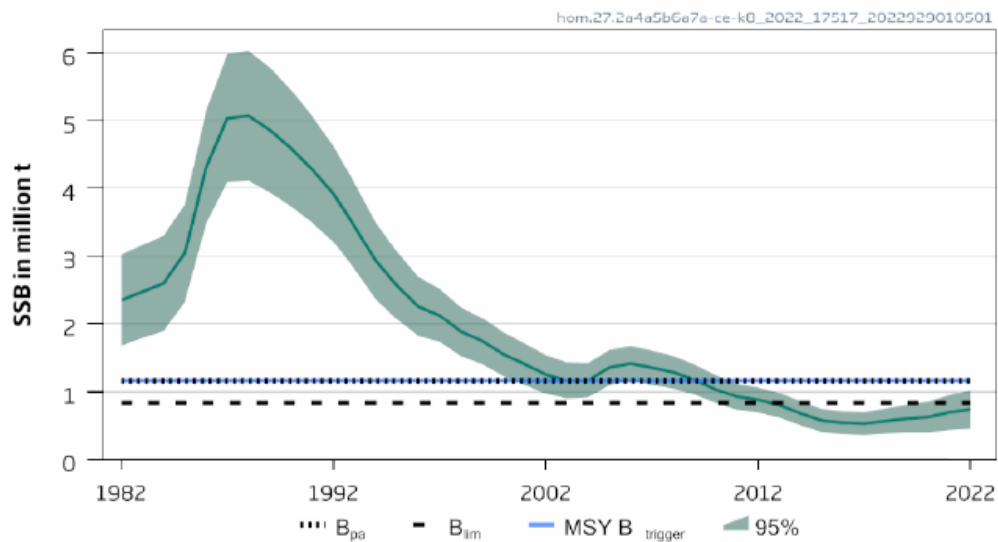


Figure 12: Recruitment and spawning stock biomass (SSB) for the Northeast Atlantic horse mackerel stock (ICES 2022h).

Recruitment (age 0)

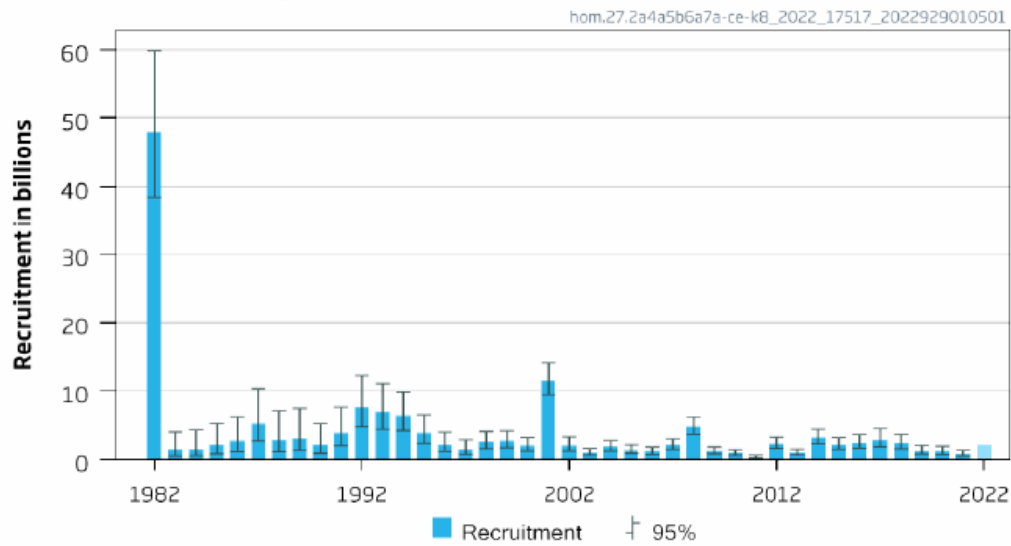


Figure 13: Recruitment for the Northeast Atlantic horse mackerel stock (ICES 2022h).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Bottom trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

High Concern

Fishing mortality on the Northeast Atlantic horse mackerel stock, which includes the Cornwall area, is currently above the fishing mortality at maximum sustainable yield (F_{MSY}), and between F_{PA} and F_{LIMIT} (ICES 2022h). Therefore, this factor has been scored a high concern.

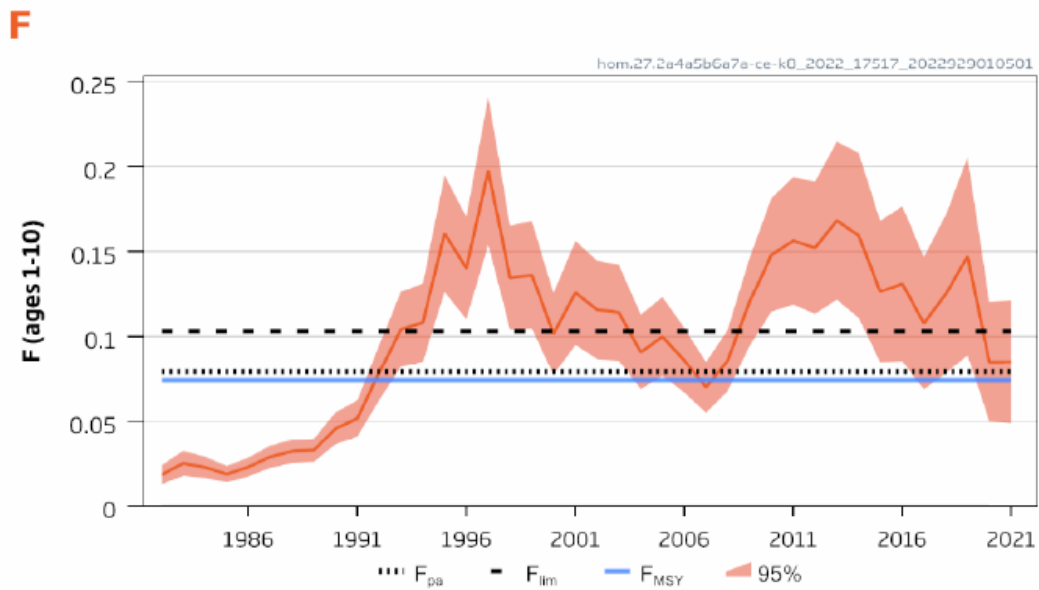


Figure 14: Fishing mortality for the Northeast Atlantic horse mackerel stock (ICES 2022h).

European plaice

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

The International Union for the Conservation of Nature has assessed European plaice (*Pleuronectes platessa*) as “Least Concern” in European waters (Freyhof 2015). The spawning stock biomass of the stock from region 7e is well above the target reference point of MSY $B_{TRIGGER}$ (ICES 2022e); however, the spawning stock biomass of the stock from regions 7f and 7g is below the target reference point of MSY $B_{TRIGGER}$ (ICES 2022f). Although it is uncertain whether or not the reference points are appropriate, because the stock in regions 7f and 7g appear to be overfished, an abundance score of high concern has been awarded.

Biomass index

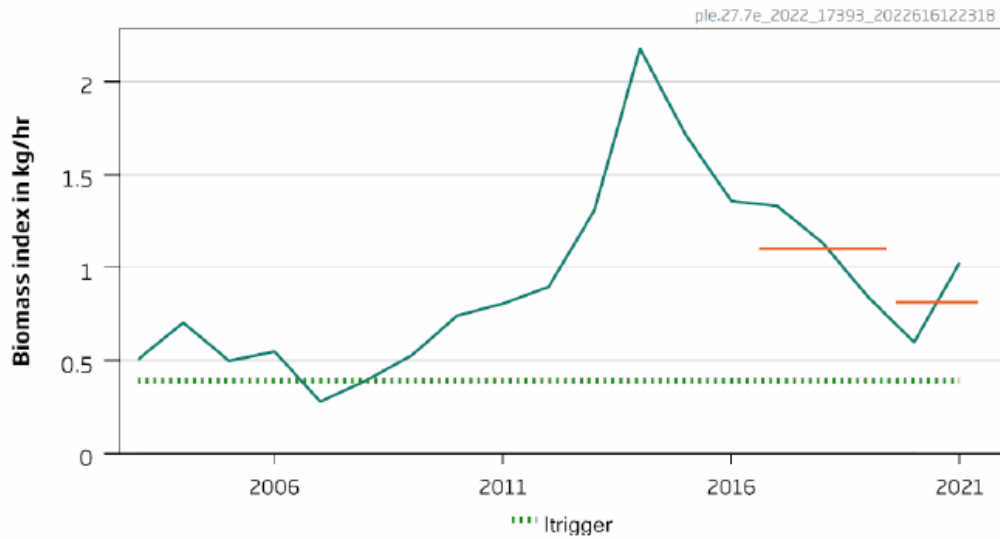


Figure 15: Spawning stock biomass of European plaice from region 7e (ICES 2022e).

Biomass index

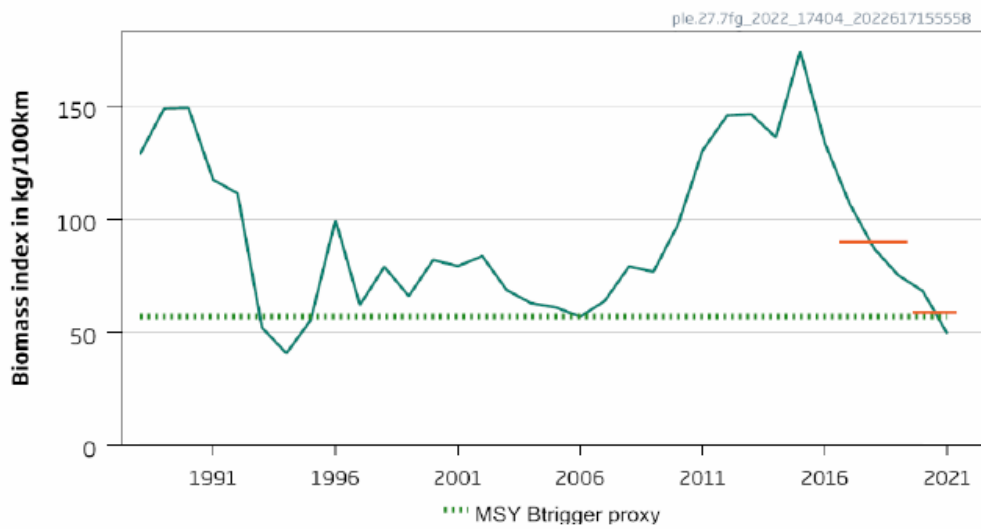


Figure 16: Spawning stock biomass of European plaice from regions 7f and 7g (ICES 2022f).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

There are two European plaice stocks in the Cornwall region: one from division 7e along the Western English Channel, and the other from division 7f and 7g along the Bristol Channel and the Celtic Sea. Fishing mortality of both stocks is above the F_{MSY} proxy, indicating that overfishing of both stocks is occurring (ICES 2022e)(ICES 2022f). Because the European plaice stock in the Western English Channel is experiencing overfishing, a fishing mortality score of high concern has been awarded.

European pollock

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

Moderate Concern

The International Union for the Conservation of Nature (IUCN) has assessed European pollock (*Pollachius pollachius*) as "Least Concern" (Cook et al. 2014). No clear distinction of stocks throughout its range in the Northeast Atlantic has been determined. Abundance seems to vary depending on region: seemingly stable in the North Sea and consistently decreasing in areas such as Skagerrak and Kattegat (Cook et al. 2014). No abundance reference points for pollock have been defined and the stock size is unknown (ICES 2022c). The species is considered data-limited but abundant in Cornish waters, and it is frequently seen by divers (pers. comm., M. Slater 2017). Because the abundance of European pollock is unknown but the species has been assessed as "Least Concern" by the IUCN and is seemingly abundant in the Cornwall region, abundance is rated a moderate concern.

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

Moderate Concern

Fishing reference points have not been determined for pollock in the Celtic Sea and Western English Channel region, but a depletion-corrected average catch (DCAC) calculation was used to estimate a maximum sustainable yield proxy and provide catch advice in 2021. Based on this calculation and the precautionary approach, the International Council for the Exploration of the Seas (ICES) recommended that annual catches not exceed 3,360 t through 2023 (ICES 2022c). Recent pollock landings were found to be below the MSY proxy and ICES advice. There are no reference points to determine whether overfishing is taking place, but landings are potentially below a sustainable level, so fishing mortality is assessed a moderate concern.

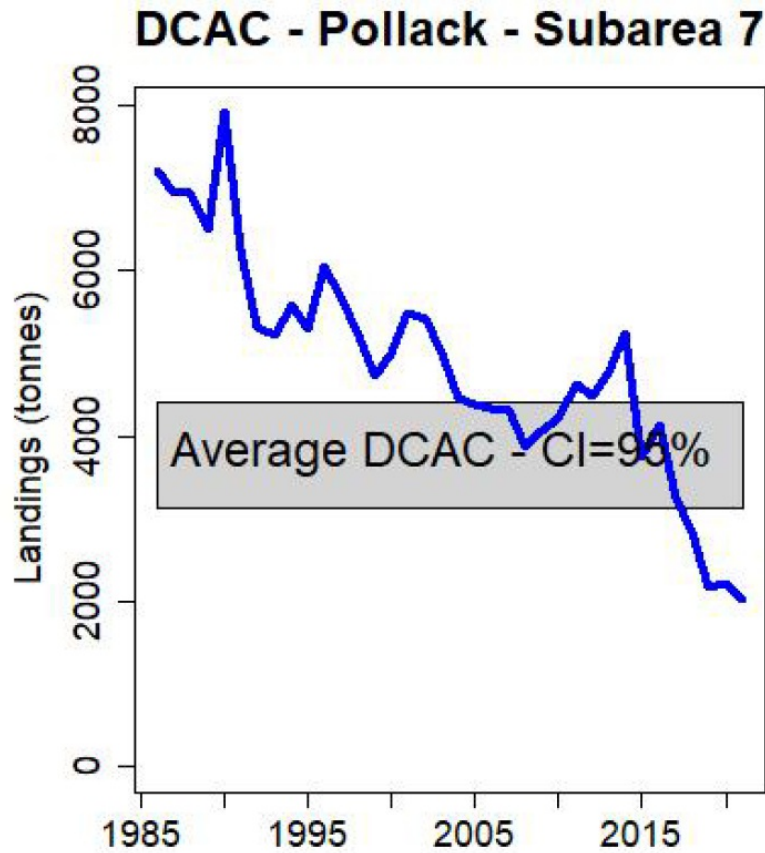


Figure 17: Results of the depletion-corrected average catch (DCAC) assessment method, applied to commercial catch data of pollack in the Celtic Seas and the English Channel, since 1986 (ICES 2022c).

European squid

Factor 2.1 - Abundance

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

Two common species of squid, *Loligo vulgaris* and *Loligo forbesii*, are caught in the Cornwall and Western English Channel region. The International Union for the Conservation of Nature (IUCN) has rated *Loligo vulgaris* as "Data Deficient" (CIFCA 2013)(Allcock, A.L. & Taite, M. 2019) and *Loligo forbesii* as "Least Concern" (Allcock, A.L. & Headlam, J. 2019); however, stock assessments have

not been conducted for these two species. Abundance of both species is thought to depend on environmental factors, specifically sea surface temperature (Chen et al. 2006). Because the abundance of squid is unknown, a productivity-susceptibility analysis (PSA) was used to score abundance. The PSA indicates that this species has a medium vulnerability (2.76) to fishing (see Justification), so we have awarded a score of moderate concern.

Justification:

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	9 months {Moreno et al. 2005}	1
Average maximum age	1 yr (Guerra and Rocha 1994), <i>L. vulgaris</i> , <i>L. forbesii</i>	1
Fecundity	10,150 and 42,000 eggs/yr (Coelho et al. 1994)(Guerra and Rocha 1994)(Laptikhovsky 2000)	2
Average maximum size (fish only)	N/A	—
Average size at maturity (fish only)	N/A	—
Reproductive strategy	Demersal egg layer (Fields 1965)(Rocha and Guerra 1996)(Ruppert et al. 2004)	2
Trophic level	Squid feed most commonly on fish, crustaceans, and other cephalopods. Fish and other cephalopods often prey on squid (Fields 1965)(Pierce et al. 1994)	2
Density dependence (invertebrates only)	None (Seafood Watch 2014)	2

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	>30% of the species concentration is fished, considering all fisheries	3
Vertical overlap (Considers all fisheries)	High degree of overlap between fishing depths and depth range of species	3
Selectivity of fishery (Specific to fishery under assessment)	Species is targeted, or is incidentally encountered AND is not likely to escape the gear BUT conditions under "high risk" do not apply	2
Post-capture mortality (Specific to fishery under assessment)	Retained	3

PSA score for squid in Cornish fisheries is calculated as follows:

$$\text{Vulnerability (V)} = \sqrt{P^2 + S^2}$$

$$V = \sqrt{1.5^2 + 2.325^2}$$

$$V = 2.76$$

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

Squid (*Loligo vulgaris* and *Loligo forbesii*) in the Cornwall and Western English Channel region are typically brought in as bycatch in a mixed bottom trawl fishery (Pierce et al. 2010). Bottom trawl landings in the UK in the Western English Channel totaled 390 t in 2015 (MMO 2015). Because fishing mortality is unknown, a score of moderate concern is awarded.

European whiting

Factor 2.1 - Abundance

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

Whiting (*Merlangius merlangus*) has been assessed as "Least Concern" globally by the International Union for the Conservation of Nature (IUCN) (Nedreaas et al. 2014). Spawning stock biomass of whiting for the Celtic Sea and Western English Channel stock (which includes Cornwall) has declined in recent years, and is estimated to be below the target reference point of $MSY B_{TRIGGER}$, B_{PA} , and the limit reference point B_{LM} (ICES 2022b). Because the Celtic Sea and Western English Channel stock appears to be overfished, abundance has been rated a high concern.

Recruitment (age 0)

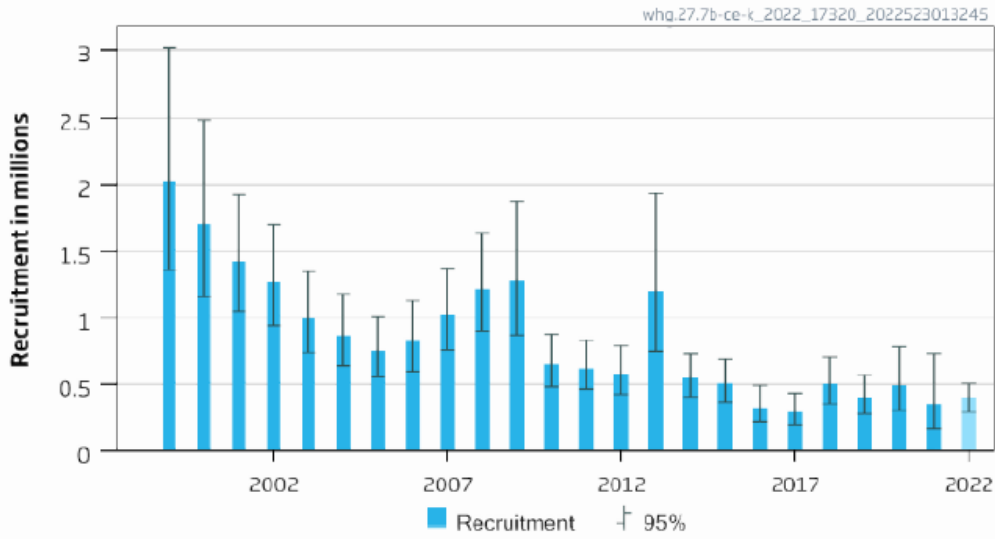


Figure 18: Recruitment of whiting in divisions 7b–c and 7e–k, including the Celtic Seas and Western English Channel (ICES 2022b).

SSB

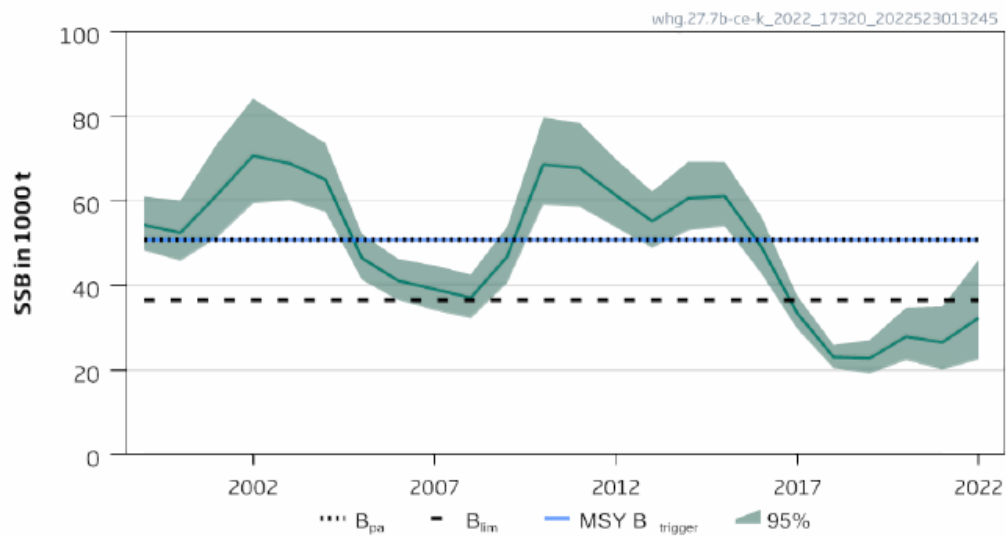


Figure 19: Spawning stock biomass of whiting in divisions 7b–c and 7e–k, including the Celtic Seas and Western English Channel (ICES 2022b).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

Fishing mortality of European whiting is above the target reference point of F_{MSY} and above F_{PA} , but below the limit reference point F_{LIM} (ICES 2022b). Because overfishing is occurring, a score of high concern has been assigned for fishing mortality.

Justification:

F

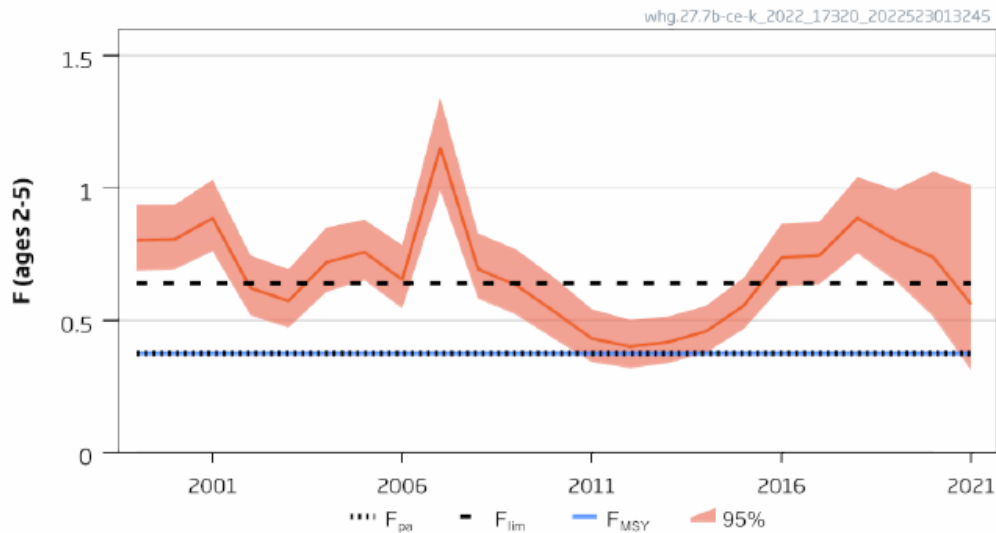


Figure 20: Fishing mortality of whiting in divisions 7b–c and 7e–k including the Celtic Seas and the Western English Channel (ICES 2022b).

Haddock

Factor 2.1 - Abundance

Northeast Atlantic | Bottom trawls | United Kingdom

Low Concern

There are several haddock stocks in the European Atlantic Ocean. For the Celtic Sea and English Channel stock, which encompasses the Cornwall region, spawning stock biomass is estimated to be well above the target reference point of MSY $B_{TRIGGER}$, B_{PA} , and the limit reference point B_{LIM} , as defined by the International Council for the Exploration of the Sea (ICES) (ICES 2022d). The current biomass relative to B_{MSY} is unknown, and the appropriateness of current biomass reference points is uncertain. As a result, a score of low concern is awarded.

SSB

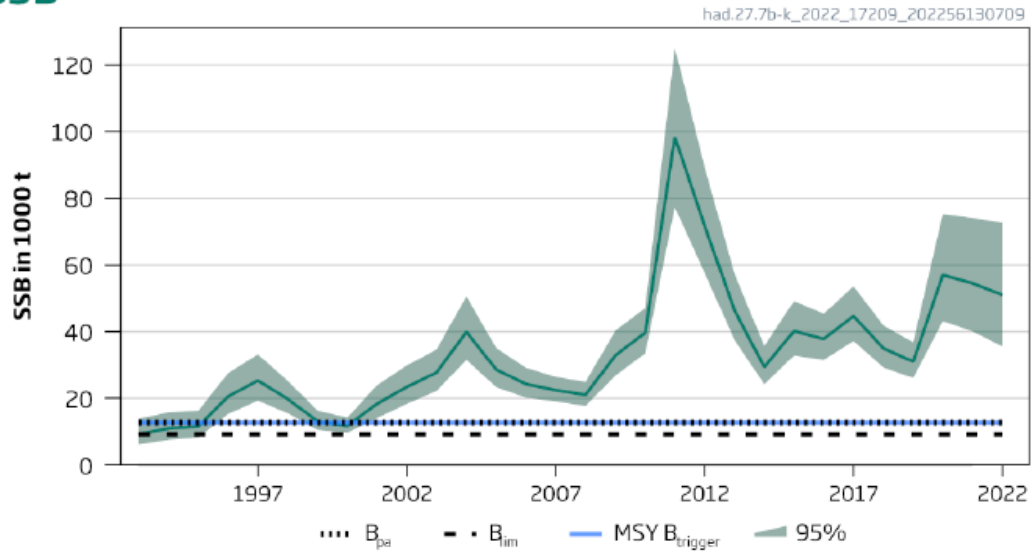


Figure 21: Spawning stock biomass of haddock (ICES 2022d).

Recruitment (age 0)

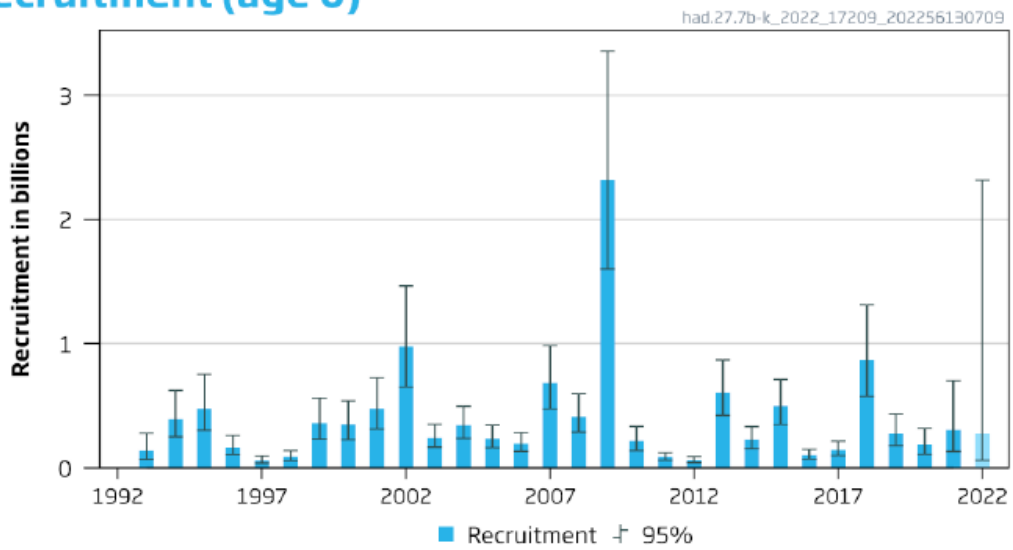


Figure 22: Recruitment of haddock in ICES areas 7b–k (ICES 2022d).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

Fishing mortality of haddock stocks in the Southern Celtic Seas and English Channel is above the target reference point of F_{MSY} (ICES 2022d). Because overfishing is occurring, and fishing pressure is below the target reference point, a score of high concern is awarded.

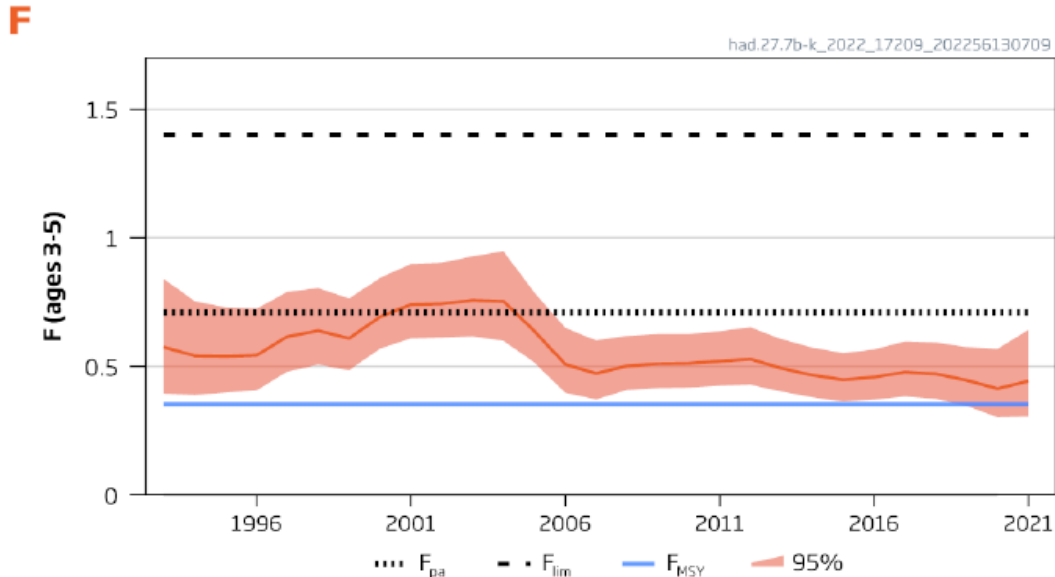


Figure 23: Fishing mortality on haddock in ICES areas 7b-k (ICES 2022d).

Lemon sole

Factor 2.1 - Abundance

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

Lemon sole (*Microstomus kitt*) has been assessed by the International Union for the Conservation of Nature (IUCN) as "Least Concern" (Monroe et al. 2015a) but little is known about the lemon sole population in Cornwall waters. There has been no stock assessment for this species, and abundance reference points have not been determined. Survey data suggest that abundance of lemon sole in the Irish and Celtic Sea has declined in recent years, while the Western English Channel has seen an increase (ICES 2013). Because the IUCN has assessed lemon sole as "Least Concern" but abundance relative to reference points is unknown, a score of moderate concern is awarded.

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Bottom trawls | United Kingdom

Moderate Concern

Lemon sole is primarily caught as bycatch by bottom and beam trawls, which account for approximately 75% and 25% of fishing mortality, respectively (Monroe et al. 2015a). Fishing

mortality on lemon sole in this area is unknown and there are no restrictions on the amount of lemon sole that can be caught. Therefore, we have awarded a score of moderate concern.

Lesser spotted dogfish

Factor 2.1 - Abundance

Northeast Atlantic | Set gillnets | United Kingdom

Moderate Concern

The International Union for the Conservation of Nature (IUCN) has assessed lesser spotted dogfish (*Scyliorhinus canicula*) in the Northeast Atlantic Ocean and European region as "Least Concern" (Serena et al. 2015). This species is one of the most abundant elasmobranchs in the region, and surveys suggest that most populations are stable or increasing (Serena et al. 2015). Survey data for the West Scotland, Irish Sea, Western English Channel, and southern Celtic Seas stock (which includes the Cornwall area) indicate an increase in the abundance of lesser spotted dogfish over the last decade (ICES 2015c). But, no abundance reference points are available for this species. Because this species has been assessed as "Least Concern" by the IUCN and abundance is increasing, a score of moderate concern is awarded.

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Set gillnets | United Kingdom

Moderate Concern

Fishing mortality is unknown for lesser spotted dogfish in this region. The lesser spotted dogfish is primarily taken as bycatch in gillnet and trawl fisheries. Discards of this species are high in some fisheries, but some larger fish are retained for consumption and some fish are used as bait (Revill et al. 2005)(Serena et al. 2015)(ICES 2015c). Because of the high but unknown discards and the fact that a substantial part of the landings are not classified to the species level, actual catches of lesser spotted dogfish remain uncertain. Because of the increasing abundance of lesser spotted dogfish for the West Scotland, Irish Sea, Western English Channel, and southern Celtic Seas stock, the International Council for the Exploration of the Seas (ICES) has advised that catches of lesser spotted dogfish in this region may be increased by no more than 18% (ICES 2015c). Because fishing mortality is unknown but there is no evidence of overfishing, a score of moderate concern is awarded.

Marine mammals

Factor 2.1 - Abundance

Northeast Atlantic | Set gillnets | United Kingdom

High Concern

Gillnets in Cornwall have proved to accidentally catch cetaceans, including common dolphin

(*Delphinus delphis*) and harbor porpoise (*Phocoena phocoena*), in addition to one species of pinniped, grey seal (*Halichoerus grypus*) (Crosby et al. 2013) (pers. comm. M. Slater, 2017) (ICES 2021g). The International Union for the Conservation of Nature (IUCN) has rated common dolphin, harbor porpoise, and grey seal as “Least Concern” on a global scale {CSG 2007a}{CSG 2007b}(EMAT 2007)(Braulik et al. 2020) (Braulik et al. 2021)(Bowen, D. 2016). But, a more regional assessment indicates that harbor porpoise has been included on the OSPAR List of Threatened and/or Declining species for the Greater North Sea and Celtic Seas region (OSPAR 2017). Because harbor porpoise is on the OSPAR List of Threatened and/or Declining species, an abundance score of high concern has been awarded.

Justification:

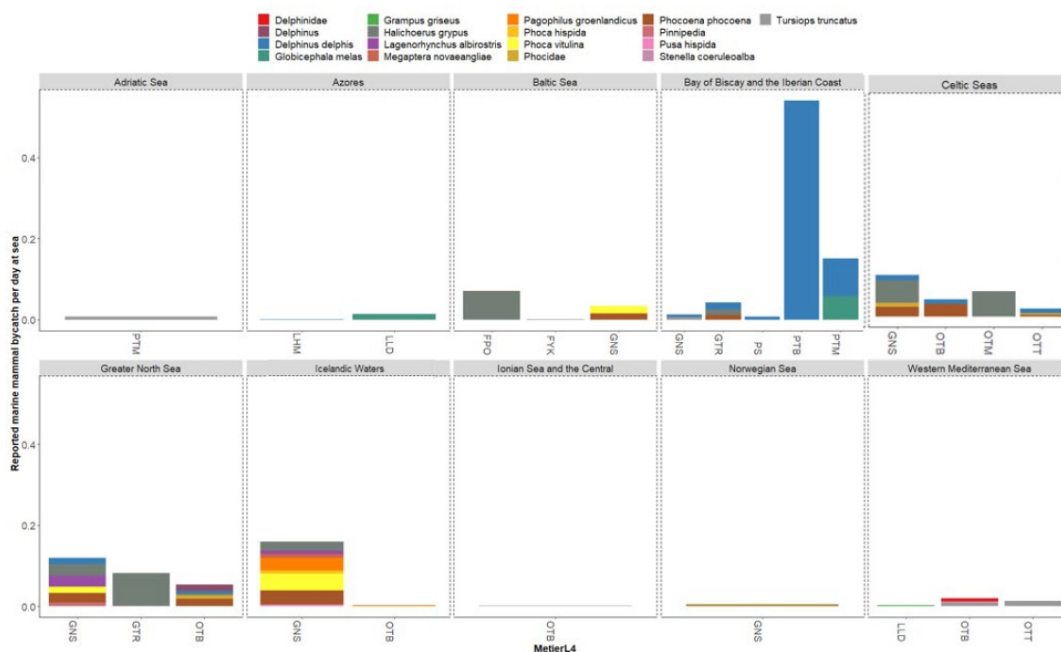


Figure 24: Marine mammal bycatch rates (specimens per monitored day at sea), showing that gillnets in the Celtic Seas result in bycatch of common dolphin, harbor porpoise, and grey seal. Taken from (ICES 2021g).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Set gillnets | United Kingdom

High Concern

In 2016, the harbor porpoise bycatch mortality due to gillnets in the Celtic Sea ecoregion (subarea 27.7) was estimated to range from 620 to 1,391 individuals, representing between 1.1% and 2.4% of the harbor porpoises present (ICES 2018)(Calderan, S. and R. Leaper 2019). The ASCOBANS threshold of acceptable take is 1.7% of the abundance, and the upper bycatch estimate exceeds this threshold (ICES 2018)(Calderan, S. and R. Leaper 2019). Hence, it is probable that fishing mortality of harbor porpoise in this region exceeded sustainable levels, and gillnets were a substantial contributor to this fishing mortality, creating localized depletion (Calderan, S. and R. Leaper 2019). For this reason, fishing mortality of marine mammals has collectively been rated a high concern.

Megrim

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Low Concern

The International Union for the Conservation of Nature (IUCN) has rated megrim (*Lepidorhombus whiffiagonis*) as "Least Concern" (Abad, E., et al. 2021). Megrim in Cornwall waters is part of a larger stock that includes the west and southwest of Ireland and the Bay of Biscay. Spawning stock biomass for this stock has been increasing since 2004 and is estimated to be well above the target reference point of MSY $B_{TRIGGER}$, B_{PA} , and the limit reference point B_{LM} , as defined by the International Council for the Exploration of the Seas (ICES) (ICES 2022g). The current biomass relative to B_{MSY} is unknown, and the appropriateness of current biomass reference points is uncertain. Despite the uncertainty of the reference points defined, the spawning stock biomass is well above all the reference points, so a score of low concern has been awarded.

Justification:

SSB

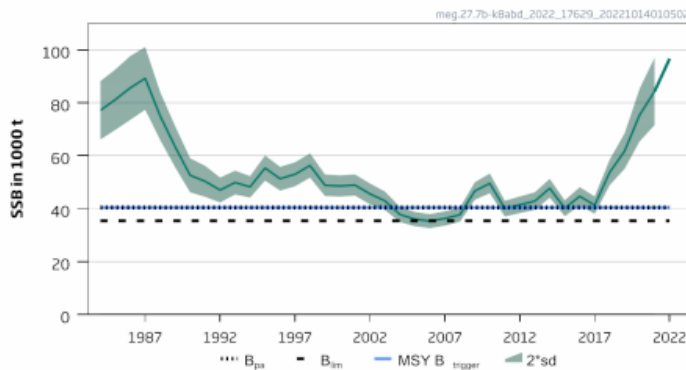


Figure 25: Spawning stock biomass of megrim in ICES areas 7b-k and 8abd (ICES 2022g).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Low Concern

According to the most recent assessment of megrim by ICES, fishing mortality has declined and has been below the fishing mortality at maximum sustainable yield (F_{MSY}) since 2019 (ICES 2022g). Because overfishing is currently not occurring, a score of low concern is awarded.

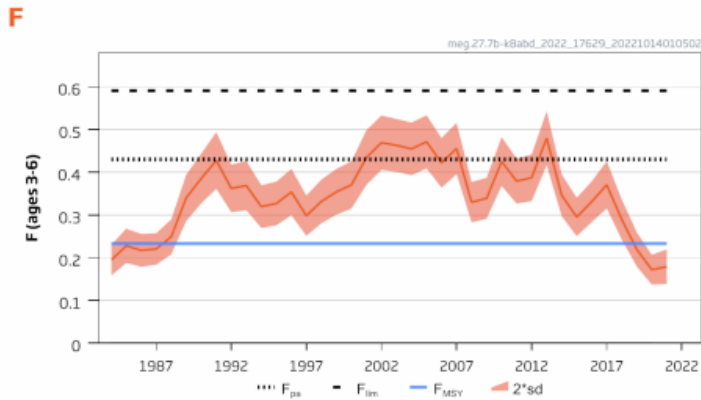


Figure 26: Megrim fishing mortality in ICES areas 7b–k and 8abd (ICES 2022g).

Red gurnard

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Moderate Concern

Red gurnard (*Chelidonichthys cuculus*) is assessed as “Least Concern” by the International Union for the Conservation of Nature (IUCN) because of its widespread and likely stable population (Lorance et al. 2015). There is currently insufficient information to evaluate red gurnard abundance relative to defined abundance reference points, but locally in the Cornwall region, it is considered abundant (ICES 2021f)(Cornwall Good Seafood Guide 2016b). Because abundance information is limited but red gurnard is not believed to be overfished, a score of moderate concern is awarded.

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Moderate Concern

Red gurnard (*Chelidonichthys cuculus*) is assessed as “Least Concern” by the International Union for the Conservation of Nature (IUCN) (Lorance et al. 2015). But, there is currently insufficient information to evaluate red gurnard fishing mortality relative to defined reference points in the Cornwall region (ICES 2021f). Because fishing mortality of red gurnard in the region is unknown, a score of moderate concern is awarded.

Sharks

Factor 2.1 - Abundance

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

On rare occasion, bottom gillnets may catch porbeagle shark (*Lamna nasus*) and spurdog (*Squalus acanthias*), and both are protected species (pers. comm., M. Slater 2017). Porbeagle shark is considered "Critically Endangered" in the European region by the International Union for the Conservation of Nature (IUCN) (Ellis et al. 2015f) and spurdog is considered "Endangered" (Ellis et al. 2015g). The North Atlantic Ocean population of spurdog has historically declined and is thought to be at a 77–81% decline from its initially recorded biomass (Ellis et al. 2015g). Porbeagle shark in the Northeast Atlantic Ocean suffered a drastic decline historically due to overexploitation, and it is estimated to be at or above an 80% decline in biomass (Ellis et al. 2015f).

Various species of elasmobranchs (skates, rays, and sharks) are caught as bycatch in bottom trawl and beam trawl fishing efforts. Species commonly caught in the Western English Channel and Celtic Sea include blonde ray (*Raja brachyura*), cuckoo ray (*Raja circularis*), small-eyed ray (*Raja microocellata*), smoothhound shark (*Mustelus mustelus*), spotted ray (*Raja montagui*), and thornback ray (*Raja clavata*). Species occasionally caught include thresher shark (*Alopias vulpinos*), blue skate (*Dipturus batis*), and white skate (*Rostoraja alba*), which are protected species.

Both cuckoo ray and spotted ray have been assessed as "Least Concern" by the International Union for the Conservation of Nature (IUCN); however, blonde ray, small-eyed ray, and thornback ray are assessed as "Near Threatened" (Ellis et al. 2015a)(Ellis et al. 2015b)(Ellis et al. 2015d)(McCully et al. 2015)(Ellis et al. 2016).

A recent French survey, reported by ICES, suggests that spotted ray and cuckoo ray abundances were highest in 2015 in the Celtic Sea region (ICES 2016o)(ICES 2016q)(ICES 2016t). An increase in abundance of blonde ray was observed in the Bristol Channel and Irish Sea until 2015, when it decreased dramatically; in the Western English Channel, blonde ray is abundant in certain areas, as is small-eyed ray (ICES 2016o). Thornback ray is considered a data-poor species and abundance is unknown (ICES 2016o).

Thresher shark is rated as "Endangered" by the IUCN in this region, and both blue skate and white skate as "Critically Endangered" in the European region (Ellis et al. 2015c)(Dulvy et al. 2015)(Ellis et al. 2015e). A single thresher shark stock is recognized from the Northeast Atlantic to the Mediterranean, and no information is available regarding current stock status (ICES 2015e). Because abundance of elasmobranchs is largely unknown in this region and the IUCN rates a number of species as "Near Threatened," "Endangered," or "Critically Endangered," a score of high concern is awarded.

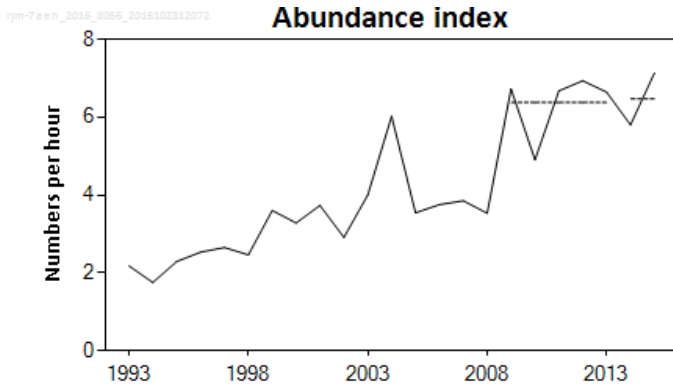


Figure 27: Abundance index of spotted ray (*Raja montagui*) in the southern Celtic Sea and Western English Channel (ICES 2016q).

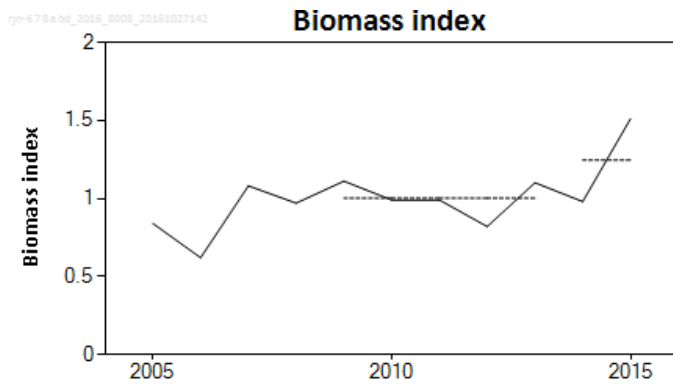


Figure 28: Biomass index of cuckoo ray (*Raja circularis*) in the Celtic Sea, Western English Channel, West of Scotland, and Bay of Biscay (ICES 2016t).

Factor 2.2 - Fishing Mortality

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

High Concern

According to the Seafood Watch Unknown Bycatch Matrix, sharks caught as bycatch in bottom trawl and beam trawl in the Northeast Atlantic are scored a 2 out of 5. Hence, fishing mortality has been scored a high concern.

Factor 2.3 - Discard Rate/Landings

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

< 100%

The “discard ban” (formerly known as the “landing obligation”) was implemented from January 1, 2015, and is currently implemented for all catches of quota species, with some exemptions (Connelly, N. 2016)(MMO 2019c)(MMO 2021). Hence, it is likely that total discards are <100% of landings.

Northeast Atlantic | Set gillnets | United Kingdom

< 100%

In a bycatch study on the Cornish red mullet gillnet fishery, a total of 1,042 fish were discarded and 9,065 were retained {Foster and Smith 2011}. Based on this study, the discard/retained catch ratio is 11%. Also, since this study, measures have been taken in this fishery to reduce unwanted catch. Therefore, it is highly likely that discards in this fishery are <100%.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- 5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.
- 4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.
- 3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.
- 2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'
- 1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'
- 0 (Critical) — Management Strategy and Implementation is 'critical'.

The Criterion 3 rating is determined as follows:

- **Score >3.2=Green or Low Concern**
- **Score >2.2 and ≤3.2=Yellow or Moderate Concern**
- **Score ≤2.2 = Red or High Concern**

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Northeast Atlantic Beam trawls United Kingdom	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	Yellow (3.000)
Northeast Atlantic Bottom trawls United Kingdom	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	Yellow (3.000)
Northeast Atlantic Set gillnets United Kingdom	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	Yellow (3.000)

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do managers follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there is a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

Moderately Effective

The Cornwall Inshore Fisheries and Conservation Authority (CIFCA) is the managing body over fisheries in the Cornwall region out to the 6 nautical mile limit. There is no regional management plan currently in place for red mullet in the Northeast Atlantic Ocean. The International Council for the Exploration of the Seas (ICES) has advised that catch of red mullet for the western stock (Western English Channel, Celtic Sea, and Bay of Biscay) should be at or below 1,280 tonnes annually in 2021, 2022, and 2023 (following a precautionary approach), and the ICES estimates that the catch of the species in 2019 was 1,855 tonnes (ICES 2020), although catches more locally in Cornwall have been small, at around 20–50 tonnes per year (Cornwall Good Seafood Guide 2022). Nevertheless, no official total allowable catch limit has been established (ICES 2015a)(ICES 2020)(Cornwall Good Seafood Guide 2016a)(Cornwall Good Seafood Guide 2022). Biological sampling of this species does occur, but is done too infrequently to determine an effective management plan.

Although there are limited regional regulations in place for red mullet, CIFCA has established a minimum size limit for red mullet of 15 cm, which is just below the size at which red mullet is estimated to reach sexual maturity (16 cm) (CIFCA 2016c). There are regulations in place that restrict mesh size for gillnets and trawls, and restrict vessel size (CIFCA 2016a){CIFCA 1996b}. For example, local regulations enforced by CIFCA prohibit the use of mesh sizes between 70 mm and 90 mm (CIFCA 2016a){CIFCA 1996b}.

Other targeted or retained species caught with red mullet in the gillnet fisheries include Atlantic cod, pollock, horse mackerel, and lesser spotted dogfish {Foster and Smith 2011}. No management plan currently exists for cod, pollock, or lesser spotted dogfish in this region. A regional management plan for horse mackerel was proposed in 2007, but ICES has not accepted this management plan because it is not considered in accordance with the precautionary approach. ICES does provide advice on catch levels for all these species, and total allowable catch limits are in place for cod, pollock, and horse mackerel. Minimum size limits are also in place for cod, pollock, and horse mackerel in the Cornwall region, and a spawning closure is in place for cod (CIFCA 2016c)(Cornwall Good Seafood Guide 2016d). No specific regulations are in place for lesser spotted dogfish.

Trawl fisheries are mixed-species fisheries and include nearly 30 different species of fish that are mostly retained in this region (pers. comm., M. Slater, Cornwall Good Seafood Guide 2016a). The main species caught in this mixed fishery include anglerfish (also called monkfish), cuttlefish, gurnard, megrim, plaice, brill, sole, cod, haddock, horse mackerel, lemon sole, squid, and whiting. Minimum size limits are in place for megrim, plaice, brill, sole, cod, haddock, horse mackerel, lemon sole, and whiting in the Cornwall region inside 6 nautical miles (CIFCA 2016c). ICES provides advice on catch levels for each main species listed except cuttlefish, squid, and lemon sole. The European Union has established catch limits for cod, plaice, whiting, pollock, sole, anglerfish, megrim, horse

mackerel, and haddock (EC 2015).

Some management strategies are in place for each main species, but more precaution should be taken. Therefore, a score of moderately effective is awarded.

Factor 3.2 - Bycatch Strategy

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Moderately Effective

Some measures have been taken to reduce nontarget catch and discards in the trawl fisheries. For example, the landing obligation was implemented from January 1, 2015, and it is currently implemented for all catches of quota species, with some exemptions (Connelly, N. 2016)(MMO 2019c)(MMO 2021). Regulations also require fishers to use mesh that is 100 mm or larger (MMO 2021). According to the Cornwall Good Seafood Guide (2016), most Cornwall bottom trawlers use 110 mm mesh, which helps to further reduce bycatch of juvenile fish. In addition, square mesh panels are required to be incorporated into any trawl in the Celtic Sea with mesh size between 100 and 120 mm, to offer escape routes for juvenile fish (MMO 2021). Some fishers outside the Celtic Sea area may voluntarily use mesh panels and may also use lower head ropes to increase the selectivity of trawls (Cornwall Good Seafood Guide 2016a). Although some efforts are being made to reduce bycatch, discards of some species are still high and there are concerns over the bycatch of several vulnerable elasmobranch species. Because the effectiveness of current bycatch efforts is uncertain and further efforts may be needed, a score of moderately effective is awarded.

Northeast Atlantic | Set gillnets | United Kingdom

Moderately Effective

Gillnets are the most selective gear used to catch red mullet in this region, but bycatch of nontarget species such as cod, hake, and whiting does occur. According to the Cornwall Inshore Fisheries and Conservation Authority (CIFCA), red mullet nets can be incredibly selective if used appropriately. Therefore, CIFCA has worked closely with fishers to develop a Code of Practice in the hope that it will reduce the amount of bycatch in the red mullet gillnet fishery (CIFCA 2016a). Specifically, the Code of Practice outlines six efforts that fishers should take to reduce unwanted bycatch: 1) limiting fishing effort to July to December because this period is when most red mullet would be caught; 2) being intentional about placement of nets and not setting nets over rocky and hard beds; 3) extending the net at least 60% of its fully stretched length, to lessen potential entanglement of other species; 4) having a net height of no more than 40 meshes, to reduce bycatch of pollack; 5) keeping the headline or top of the net quite buoyant, to keep the whole net tight and reduce entanglements; and 6) limiting the soak time of the net (CIFCA 2016a). This Code of Practice is not official legislation for fishers, but if this Code of Practice does not reduce bycatch as intended, CIFCA may decide to create official bylaws to restrict gillnet fishing. Management would like to see red mullet netters incorporate the use of pingers into their fishing practices, to prevent accidental bycatch of marine mammals. Efforts to analyze seabird interaction are also underway in specifically affected areas (Falmouth Bay to St. Austell Bay), but this is currently difficult to quantify (pers. comm., M.

Slater 2017). Because CIFCA is working with fishers to keep bycatch rates low but the effectiveness is not yet known, a score of moderately effective is awarded.

Factor 3.3 - Scientific Research And Monitoring

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

Moderately Effective

Landings of red mullet have been recorded since the 1970s, but the red mullet populations have not been formally assessed to determine abundance and fishing mortality (ICES 2015a). Also, there is limited monitoring of bycatch in the red mullet fisheries. There was one bycatch study conducted on the red mullet gillnet fishery that provided information on catch composition and selectivity for different mesh sizes {Foster and Smith 2011}. But the study was conducted outside of the main red mullet season, so it should be repeated in season for a more accurate assessment.

The Cornwall Inshore Fisheries and Conservation Authority (CIFCA) carries out a series of surveys to help ensure sustainable fisheries and a healthy ecosystem in the Cornwall region. It monitors habitat using drop-down video and stills along with side sonar to map and monitor the seafloor and habitat distribution (pers. comm., S. Davis 2017). The Centre for Environment Fisheries and Aquaculture Science (Cefas) conducts surveys for English fisheries with an objective to estimate discards and biological data for all commercial species (pers. comm., A. Santos, Cefas 2016). It collects data for any species captured and ensures that all gear types, areas fished, and seasons are accounted for in its sampling (pers. comm., A. Santos, Cefas 2016). Stock assessments have been conducted on some but not all main species in this assessment by the International Council for the Exploration of the Seas (ICES).

Some research is conducted in the area, and some stock assessments are conducted but not for all species involved in this fishery, so a score of moderately effective is awarded.

Factor 3.4 - Enforcement Of Management Regulations

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

Highly effective

The Cornwall Inshore Fisheries and Conservation Authority (CIFCA) is responsible for enforcing fishing regulations in the Cornwall district inside the 6 nautical mile limit. Major concerns with enforcement of the gillnet fishery are the utilization of legal mesh sizes and the retention of undersized fish. Major concerns with enforcement of trawl fisheries include the utilization of legal mesh size, the retention of undersized fish, and vessels that exceed the size limitation entering restricted areas. All enforcement actions are recorded by CIFCA; any subsequent prosecutions are

reported publicly. The majority of infractions in 2021 (five out of six) related to retention of undersized shellfish, and one related to obstruction of an enforcement officer (CIFCA 2021). Various repercussions for violations are administered, including official verbal and written warnings, fines, advisory letters, and destruction of fishing gear (CIFCA 2016b)(CIFCA 2021). CIFCA is in support of deploying inshore vessel monitoring systems (iVMS) on various vessels and plans to first implement this technology on vessels using bottom-towed gear. This will help with the enforcement of areas where the use of bottom-towed gear is prohibited (CIFCA 2016b). Enforcement is a priority in the Cornwall district. Many efforts are being made to enforce management regulations, and over one-half of CIFCA's annual budget is dedicated to this effort; other initiatives are in the development stages and have not yet been implemented (pers. comm., S. Davis 2017). A score of highly effective is awarded.

Factor 3.5 - Stakeholder Inclusion

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

Highly effective

The Cornwall Inshore Fishery and Conservation Authority (CIFCA) is directed and governed by a Committee that comprises a variety of stakeholders, such as commercial and recreational fishers, environmental groups, and marine researchers. CIFCA encourages stakeholder and public involvement to address fisheries concerns. For example, fishers were directly involved in the development of CIFCA's Red Mullet Netting Code of Practice, to ensure reduction of bycatch in the gillnet fishery (CIFCA 2016a). CIFCA attempts to be as transparent in its decision-making process as possible. Quarterly meetings are open to the public unless specified to be private, and meeting notes are made available for public access (CIFCA 2013). CIFCA also undertakes both informal and formal consultation on all its proposed bylaws, allowing for public comment before developing any new bylaws (CIFCA 2013). Because of the high level of stakeholder inclusion, a score of highly effective is awarded.

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- **Score >3.2=Green or Low Concern**
- **Score >2.2 and ≤3.2=Yellow or Moderate Concern**
- **Score ≤2.2 = Red or High Concern**

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Northeast Atlantic Beam trawls United Kingdom	Score: 2	Score: 0	Moderate Concern	Yellow (2.449)
Northeast Atlantic Bottom trawls United Kingdom	Score: 2	Score: 0	Moderate Concern	Yellow (2.449)
Northeast Atlantic Set gillnets United Kingdom	Score: 3	Score: 0	Moderate Concern	Yellow (3.000)

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- 5 - Fishing gear does not contact the bottom
- 4 - Vertical line gear

- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management

Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect*

species' ecological roles and ecosystem functioning.

- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Score: 2

Bottom trawls and beam trawls are large, cone-shaped nets that are dragged across the ocean floor to capture demersal species. Bottom trawls have two trawl doors—one on each side of the net—to keep the mouth of the net open, whereas beam trawls have a steel beam across the top of the net to hold it open. Bottom and beam trawling can cause significant damage to seabeds. This activity can stir up the sediment; crush or bury bottom-dwelling species; destroy structural organisms such as sponges, coral, and seagrass; and displace rocks and boulders (Morgan and Chuenpagdee 2003). Bottom trawl activity also has the potential to disrupt biogeochemical balances and food web interactions by reducing prey items for target and nontarget species (Johnson et al. 2015). In the Cornwall region, fishing typically occurs over soft, sandy substrates, which tend to recover faster from damage caused by trawling compared to hard or rocky substrates (Diesing et al. 2013)(Cornwall Good Seafood Guide 2016a). But, recovery will depend on the frequency and intensity of trawling in the area. Overall, a score of 2 was awarded for the impact of fishing gear on habitat.

Northeast Atlantic | Set gillnets | United Kingdom

Score: 3

Gillnets are net walls that are made of monofilament line and used to entangle fish by their gills. Bottom gillnets are anchored on the ocean floor. Because gillnets are merely set on but not dragged along the seafloor, disturbance to the seabed is typically low. But, concern for habitat damage exists when gillnets are pulled in because they may snag or entangle rocks and sessile organisms (Morgan and Chuenpagdee 2003). In the Red Mullet Netting Code of Practice, the Cornwall Inshore Fisheries and Conservation Authority (CIFCA) encourages fisheries to avoid setting nets over hard and/or rocky substrate (CIFCA 2016a). A score of 3 was awarded for the impact of fishing gear on habitat.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Score: 0

Some research shows that natural occurrences, such as wave action and currents, cause more disturbance than trawl fisheries in this area; however, it is well documented that trawling activity has the potential to reduce biodiversity from disturbance to the seafloor (Diesing et al. 2013). In 2013, CIFCA created a bylaw under the Marine and Coastal Access Act to protect all European Marine Site areas from any type of bottom trawling (except the regulated oyster fishery in the Fal Estuary) (CIFCA 2009). These areas are mostly closed to the use of bottom-towed gear, including trawls and dredges, thus preventing seafloor damage in these areas and allowing for healthy benthic growth. In total, one-third of English waters are part of a network of Marine Protected Areas (DEFRA 2016);

however, they do not all prohibit bottom trawling activities. Although some efforts are in place to protect bottom habitats in this region, these efforts are not yet sufficient to meet the moderate mitigation threshold. Therefore, no mitigation points are awarded at this time.

Northeast Atlantic | Set gillnets | United Kingdom

Score: 0

The Cornwall Inshore Fisheries and Conservation Authority (CIFCA) does not currently have any specific modifications in place to mitigate the impact on the seafloor caused by the gillnet fishery; therefore, no mitigation points are awarded.

Factor 4.3 - Ecosystem-based Fisheries Management

Northeast Atlantic | Beam trawls | United Kingdom

Northeast Atlantic | Bottom trawls | United Kingdom

Northeast Atlantic | Set gillnets | United Kingdom

Moderate Concern

The UK is dedicated to working toward an ecosystem-based management approach through its Marine and Coastal Access Act, implemented in 2009 (House of Parliament 2010). The Marine Management Organization (MMO) is the main authority under this Act, with the main objectives focusing on strategic marine planning, streamlining marine licensing, marine nature conservation, fisheries management and enforcement, migratory and freshwater fishes, coastal access, and coastal and estuarine management (Joint Nature and Conservation Committee 2013). Under the auspices of the Marine and Coastal Access Act, the Cornwall Inshore Fisheries and Conservation Authority can create local bylaws for the conservation of Marine Conservation Zones (MCZ) (House of Parliament 2010).

Red mullet is a bottom feeder that feeds on benthic invertebrates and fish (Gosline 1984). Other larger finfish, sharks, and rays feed on red mullet in its juvenile and adult stages {FishBase 2008}. There is no indication that the removal of red mullet or most other main species caught in these fisheries would have negative effects on the food web in this region. Because some management is in place to protect species' ecological roles, and detrimental ecosystem impacts are unlikely, a score of moderate concern is awarded.

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