CEMP Guideline for the common indicator FC1 Sensitive Fish Species

(OSPAR Agreement 2022-04)[1]

This OSPAR biodiversity indicator is still in the early stages of implementation and as a result of iteration and learning, it is anticipated that there will be evolution of the methods and approaches documented in the CEMP guidelines. Version updates will be clearly indicated and be managed in a phased approach via ICG-COBAM through its expert groups and with the oversight and steer of BDC.

Contents

[1] This document is in English only

1 Introduction

The OSPAR indicator FC1 requires a standardised dataset derived from ICES co-ordinated surveys of fish, which are processed to create an Assessment Dataproduct. This guideline describes the origin of the data and links to the processing steps made to generate the Dataproduct.

2 Monitoring

2.1 Purpose

The objective of this indicator is to characterise change in populations of sensitive fish species (including demersal and pelagic species) in order to monitor change in fish biodiversity and complement assessments of commercially fished and assessed stocks made by other competent authorities (such as ICES and ICCAT).

2.2 Monitoring Strategy

Data come from scientific fisheries surveys that record all fish species caught during fishing. The indicator metric requires that surveys are conducted at regular intervals (typically annually) within a consistently sampled area with a standard gear and tow duration.

Currently, the most important data source is the ICES co-ordinated fisheries groundfish surveys (ICES 2021a,b) which are conducted as part of the international survey programme in the North Sea, Celtic Seas, Bay of Biscay, Iberian coast and the eastern margin of the Atlantic region (see Figure 1). Beam trawl data is more suitable in some locations that are difficult to sample with otter trawls (such as the Grand Overture Verticale, GOV) or where the community is dominated by benthic species.

The resources needed for this indicator is estimated to be high, but data collection costs are met primarily under the EU's Data Collection Framework (DCF) and the national programmes to support fisheries management.

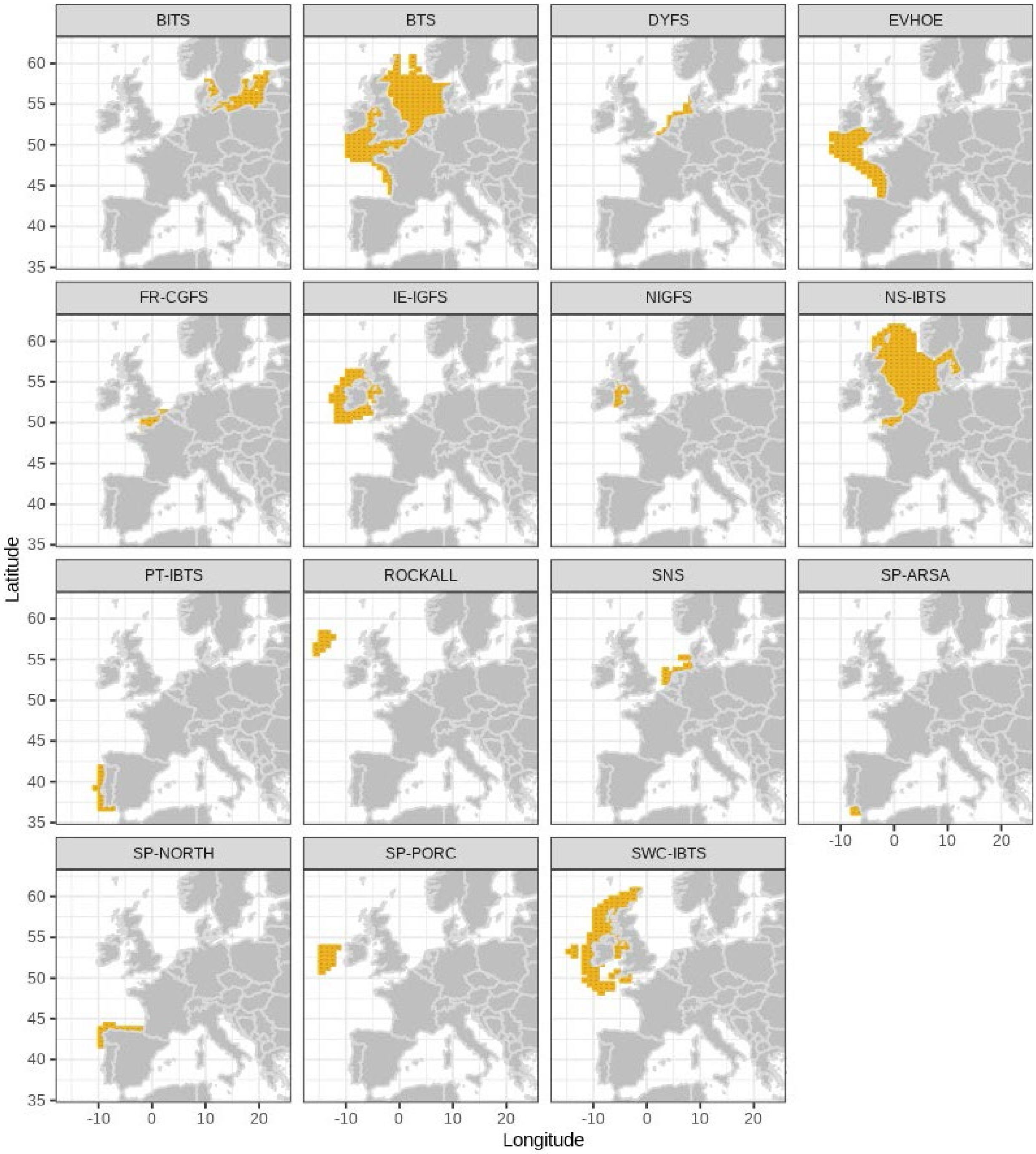

Figure 1. Spatial coverage of the surveys processed by ICES 2021b.

ICES. 2021a. Workshop on the production of swept-area estimates for all hauls in DATRAS for biodiversity assessments (WKSAE-DATRAS). ICES Scientific Reports. 3:74. 77 pp. https://doi.org/10.17895/ices.pub.8232

ICES. 2021b. Workshop on the production of abundance estimates for sensitive species (WKABSENS). ICES Scientific Reports. 3:96. 115 pp. https://doi.org/10.17895/ices.pub.8299

2.3 Sampling Strategy

Bottom trawls of various gears (including GOV and beam) sample the fish (including elasmobranch) and cephalopod community. Data recorded by the surveys include: species identification, numbers of individuals by size class (length). Infrequently encountered species may be recorded simply as present without length or weight measurements.

2.4 Quality assurance/ Quality Control

ICES Data Centre host the database of trawl surveys (DATRAS) for groundfish and beam trawl data. DATRAS has an integrated quality check utility. All data, before entering the database, have to pass an extensive quality check. Despite this errors and missing data arise, which are subsequently dealt with by the data submitters from the contributing countries as required. However, this screening process was implemented in 2009 for data from 2004 onwards. Since some survey time-series extend back to the 1960s, historic data (unless re-evaluated and re-submitted by contributing countries) may not have been subject to the same level of quality control as these more recent data. Furthermore, the type of information collected, the level of detail and resolution in the data, has gradually evolved over time. In order to derive a single format, quality assured monitoring programme data product covering the entire Northeast Atlantic region inconsistencies in the datasets required resolution. These corrections are detailed in ICES 2021a,b:

Biological data for trawl surveys are downloaded directly from DATRAS in raw exchange format (known as “HL data”). Ancillary data were processed by ICES 2021a,b to create the “SweptAreaAssessmentOuput” (which replaces the “HH data”) and these were downloaded from the same location:

https://datras.ices.dk/Data_products/Download/Download_Data_public.aspx

For FC1, the data are processed to create a standalone OSPAR dataproduct on species occurrence (presence and absence) and haul location. Initially, hauls are subset to determine the Standard Monitoring Programme (i.e. excluding hauls of duration shorter than 13 minutes or longer than 66 minutes) and these hauls are used to define the Standard Survey Area (excluding areas sampled infrequently over time) following the methods detailed in Greenstreet and Moriarty 2017). Additional QA/QC is made at this step to determine if species identification issues are present in the raw biological data. The standard survey area and hauls utilised in the assessment are shown in Figure 2.

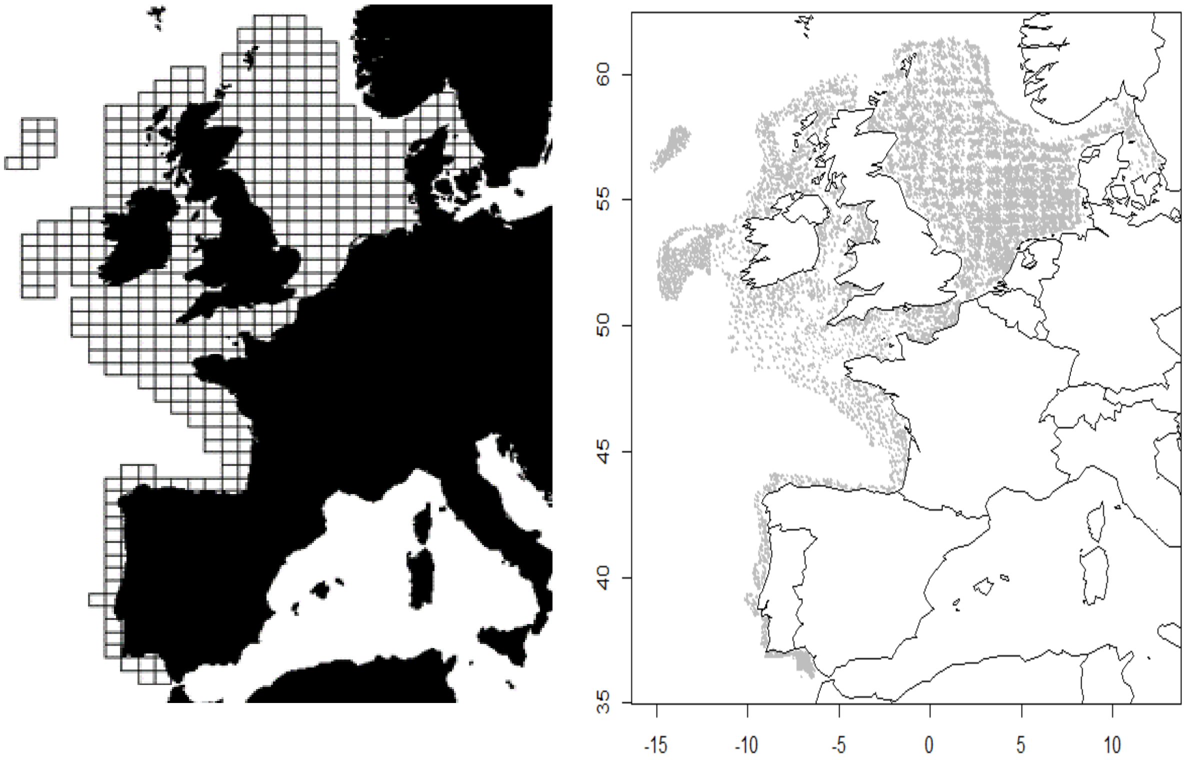

Figure 2a. The combined (all survey) standard survey area and hauls utilised (1983:2020)

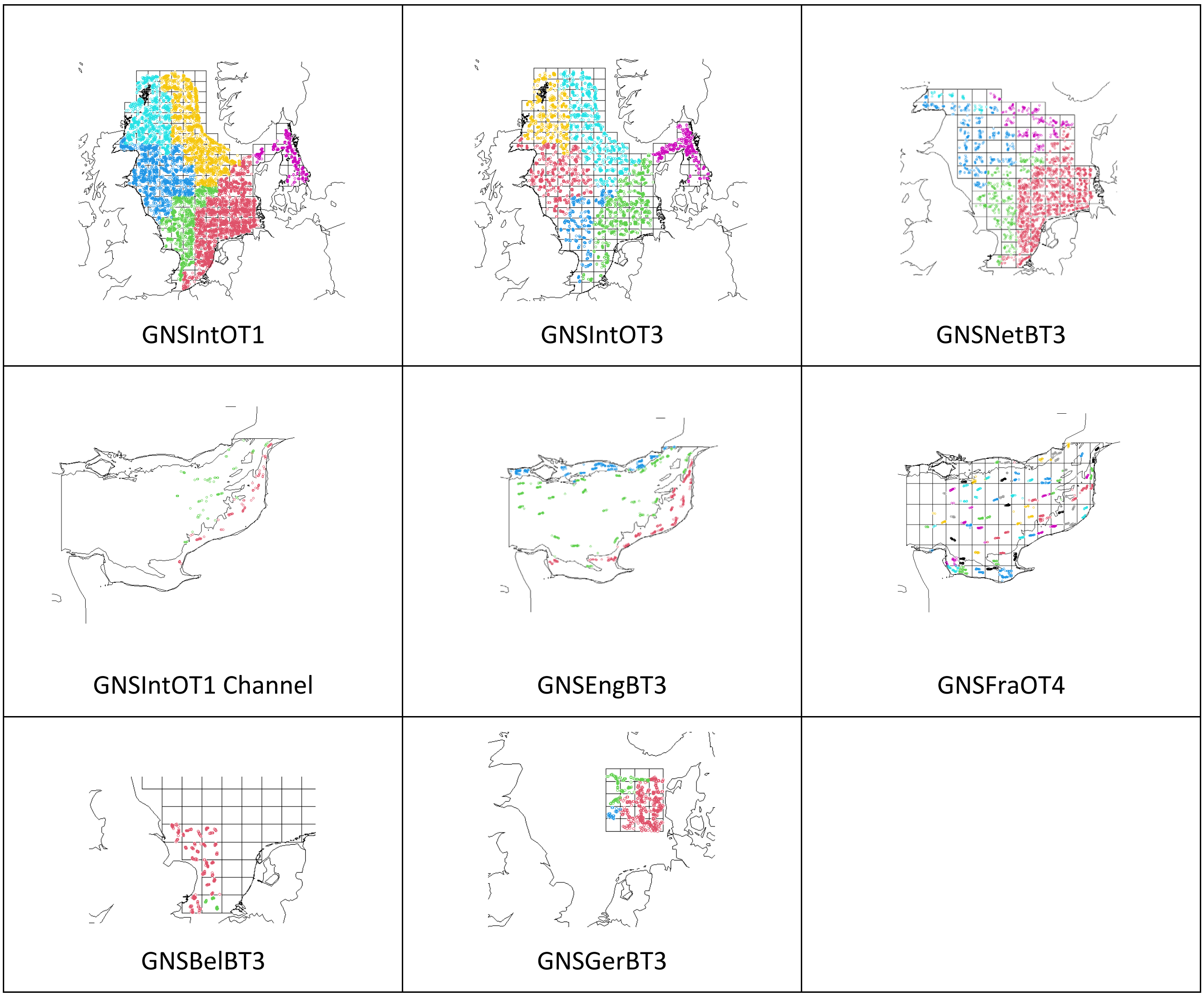

Figure 2b. Standard survey area for Greater North Sea surveys showing hauls utilised coloured by survey strata.

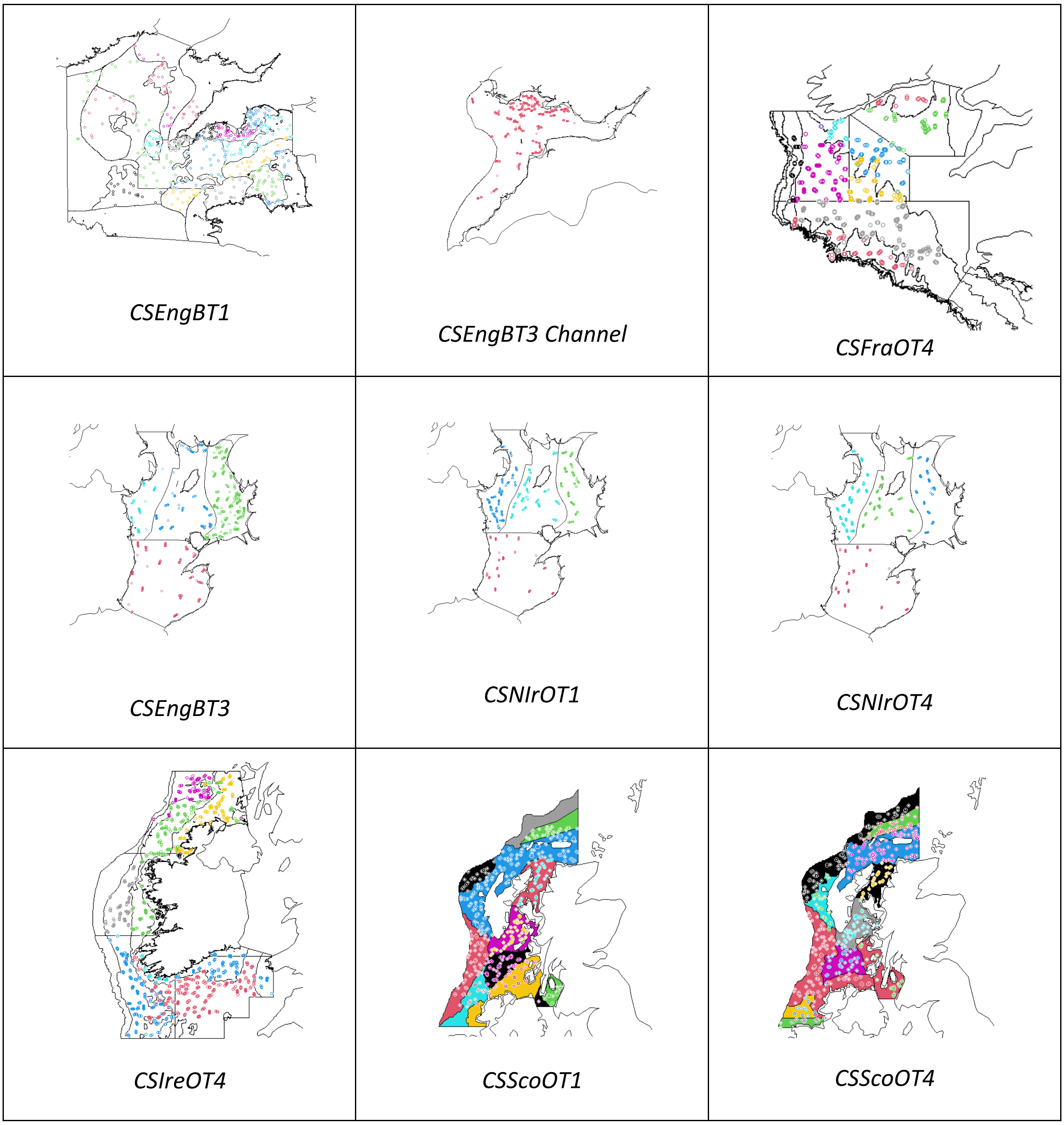

Figure 2c. Standard survey area for Celtic Seas surveys showing hauls utilised coloured by survey strata.

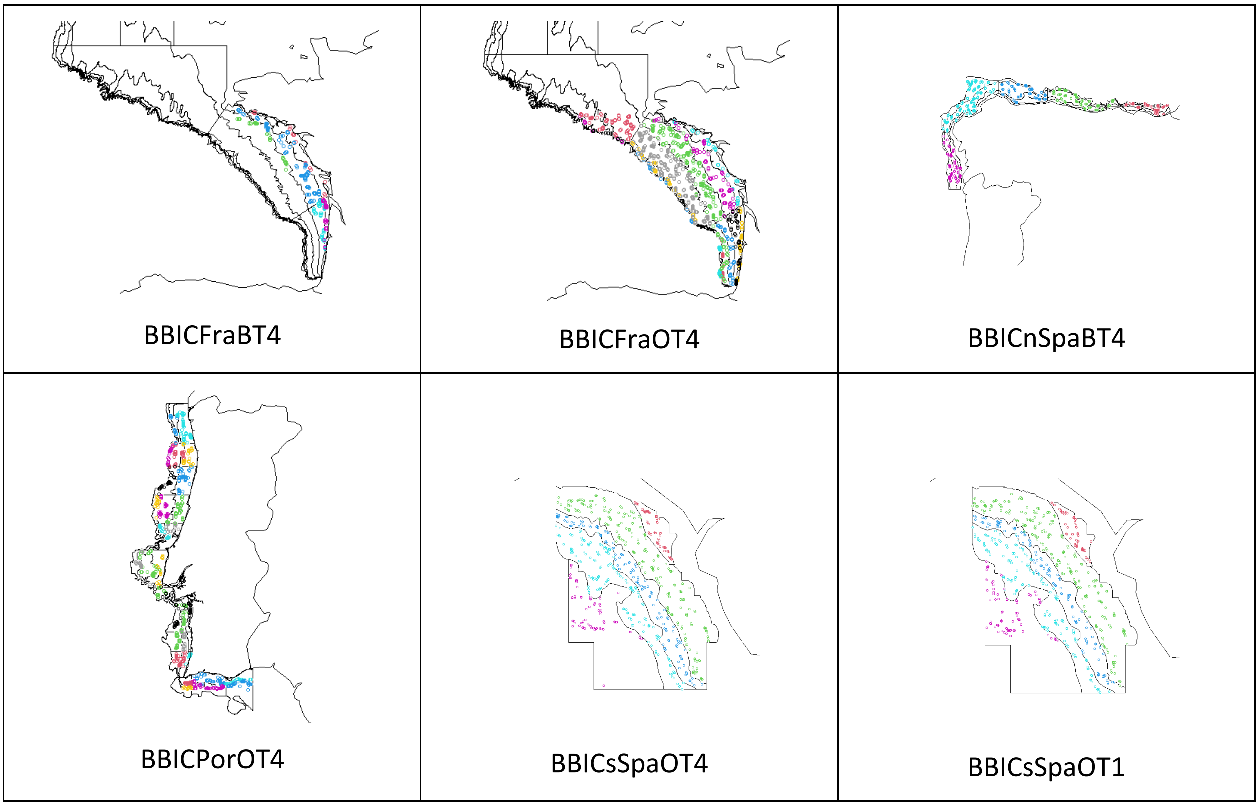

Figure 2d. Standard survey area for Bay of Biscay and Iberian coast surveys showing hauls utilised coloured by survey strata

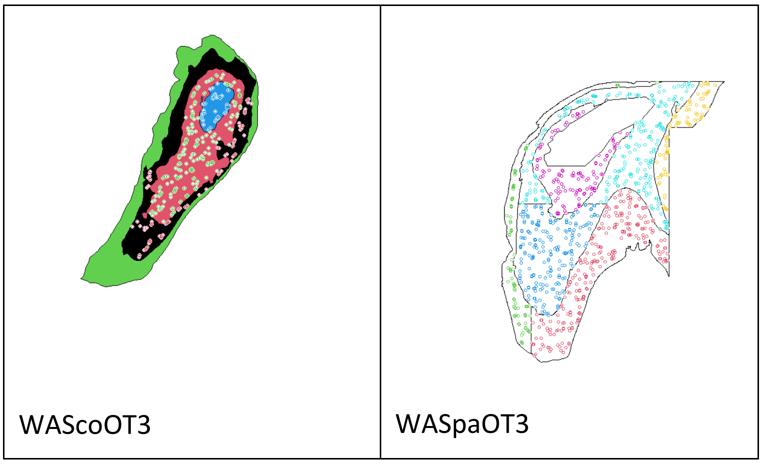

Figure 2e. Standard survey area for Wider Atlantic surveys showing hauls utilised coloured by survey strata

2.5 Data reporting, handling and management

Scientific trawl survey data are submitted to the ICES Database of Trawl Surveys (DATRAS):

http://www.ices.dk/marine-data/data-portals/Pages/DATRAS.aspx

The DATRAS reporting format is detailed online:

https://datras.ices.dk/Data_products/ReportingFormat.aspx

The metadata relating to the ICES co-ordinated surveys are available here:

http://www.ices.dk/marine-data/data-portals/Pages/DATRAS-Docs.aspx

3 Change Management

Responsibility for follow up of the assessments is with the Biodiversity Committee though the ICG-COBAM Fish expert group.

4 Indicator metric

4.1 Approach for sensitive species

The assessment procedure for sensitive species is based on the binomial model and derived from presence-absence (i.e. occurrence) information. The approach was developed in the ICES WKABSENS workshop (ICES, 2021b) and is applied here in a comprehensive assessment scheme. This assessment approach can distinguish between decreases, increases and stable frequency of occurrences even for data-poor species, for which other assessment methods based on abundance estimates are not appropriate.

The binomial model predicts the probability of *n* successful outcomes of a Bernoulli experiment that has two possible outcomes e.g. the toss of a coin or obtaining a six or not from a roll of a dice. The binomial distribution then gives the probability of *k* successes in *n* trials of the experiment with a fixed probability of the single success *p* (e.g. heads on a coin *p* = 0.5 or rolling a six on a die *p* = 0.167):

$$P(k|n,p) = \binom{n}{k} p^k\,(1-\mathrm{p})^{n-k} \qquad \text{(Eq.1)}$$

The cumulative distribution function of the binomial distribution determines the probability of *k* or fewer successes:

$$P(X \leq k|n,p) = \sum_{i=0}^{k} \binom{n}{i} p^i (1-p)^{n-i} \qquad \text{(Eq.2)}$$

Using the cumulative distribution function, it is possible to determine the values of *k* for which Eq.2 is below a predefined significance threshold, e.g. α < 0.05. These values of *k* represent the lower tail of the binomial distribution (Figure 3) and any observed *k* in this tail would indicate a significant deviation from an expected mean. Hence the largest *k* value for which Eq.2 is < α can be used as a threshold $k_{sig.}$ to identify the significant deviation from the expected mean. Thus, where the number of occurrences in *n* hauls within the assessment period is equal to or is fewer than the maximum *k* required to satisfy the condition $P(X \leq k|n,p) < \alpha$ we can say that there is a significant decrease in occurrences relative to the reference period for which *p* was set.

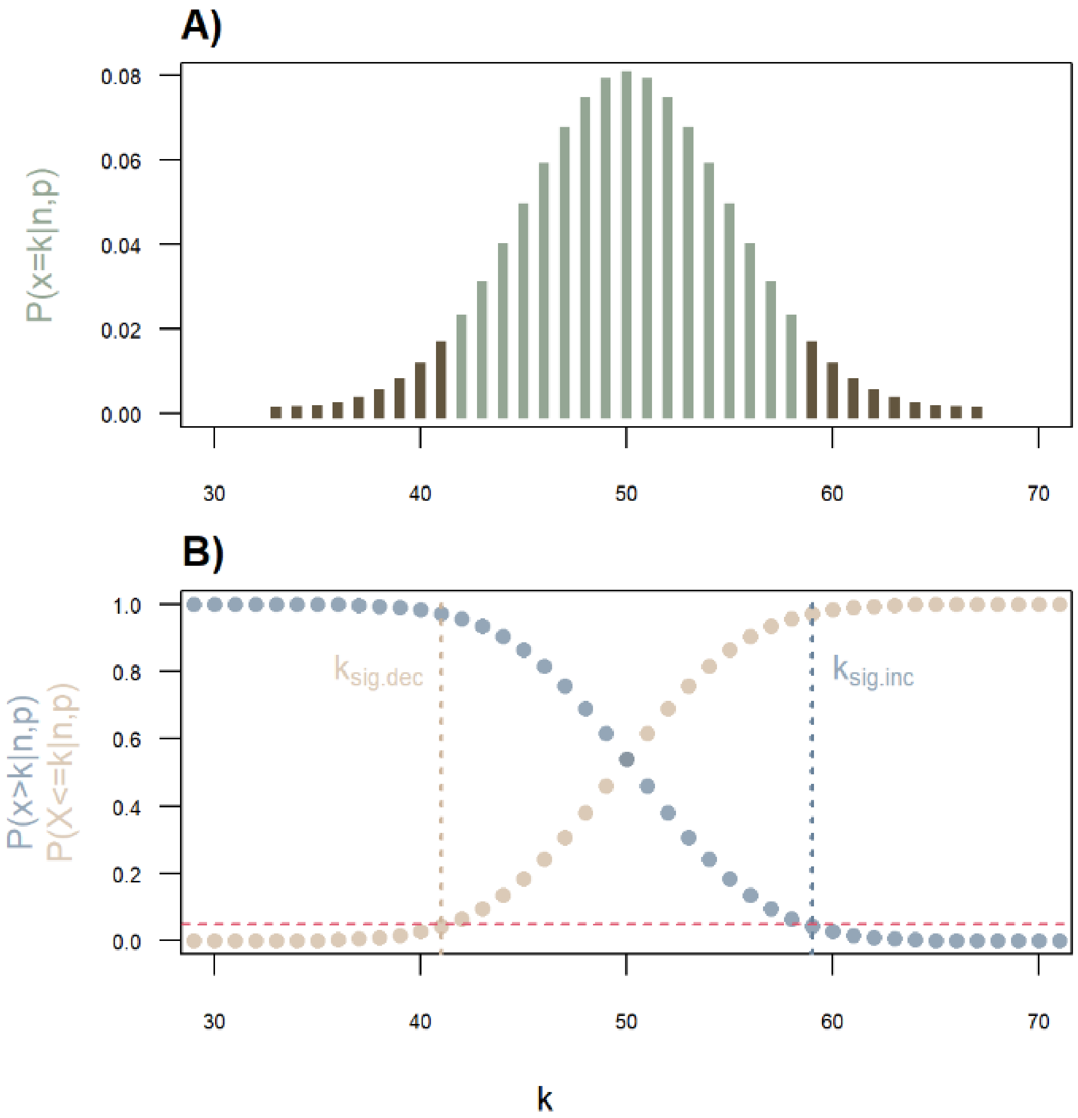

Figure 3. The concept of using the binomial distribution to identify significant deviations from the expected number of k successes (i.e. occurrences of species in a survey). In this example n = 100 (hauls) and p = 0.5 (probability of detection). A) The probability function as in Eq.1 indicates that k = 50 has the highest probability. B) Using the cumulative distribution function from Eq.2, one can calculate which numbers of k would be unlikely to observe (k_{sig}). Here, $k_{sig.dec}$ indicates the lower threshold (k = 41) and $k_{sig.inc}$ the upper threshold (k = 59). Hence observing fewer than 42 successful trials would be significantly unlikely, as would the observation of more than 58 successful trials.

The binomial distribution can be used to estimate the probability of observing *k* occurrences of a species in a survey in a particular assessment period (with *n* total hauls) once we have an estimate of the probability *p* of detecting the species in a single haul. The key assumptions here are that each haul in the survey data is considered an independent Bernoulli-experiment and the probability *p* of detecting the species is constant throughout the survey (spatially and temporally). If these conditions are met, *p* can be estimated from the frequency of occurrence of the species in the survey in a chosen reference period, where the frequency of occurrence is simply the number of hauls with occurrence divided by the total number of hauls. According to Eq.2, a threshold $k_{sig.}$ can be set, at which any observed *k* in the assessment period becomes significantly unlikely and thus indicates a statistically relevant decline in occurrence when compared to an expected occurrence derived from the reference period.

Accordingly, the counter-event for the upper tail of the binomial distribution can be used to set a threshold for indicating a statistically significant increase (where the probability is below the predefined significance threshold) in the species occurrence in the assessment period as follows:

$$P(X > k|n,p) = 1 - P(X \leq k|n,p) = 1 - \sum_{i=0}^{k} \binom{n}{i} p^i (1-p)^{n-i} \quad \text{(Eq.3)}$$

and

$$P(X \geq k|n,p) = P(X > (k-1)|n,p) = 1 - \sum_{i=0}^{k-1} \binom{n}{i} p^i (1-p)^{n-i} \quad \text{(Eq.4)}$$

We can say that there is a significant increase in occurrences, relative to the reference period for which *p* was set, if the number of occurrences in *n* hauls within the assessment period is equal to or greater than the minimum *k* required to satisfy the condition: $P(X \geq k|n,p) < \alpha$.

The assessment approach used occurrence data (presences and absences) from fishery-independent survey hauls to assess changes in occurrence for 102 sensitive fish species. Hauls were compiled from data collected by 25 groundfish surveys carried out between 1983 and 2020 across four separate OSPAR regions: the Greater North Sea (including the Kattegat, Skagerrak and the English Channel), the Celtic Seas, the Bay of Biscay and the Iberian Coast and the Wider Atlantic (Table 1). In Region II, two surveys were split to subset data for the eastern English Channel (CSEngBT1 and GNSIntOT1, with the latter only sampled since 2007) to maximise the data for analysis. Similarly, in Region III, the CSEngBT3 survey was split to give an assessment for the Irish Sea separate to the Bristol Channel. The CSBBFraOT4 survey was split between region III (CSFraOT4) and IV (BBICFraOT4) using the OSPAR region boundary. Between two and nine survey data sets were available for analysis in each OSPAR region (Table 1).

Two reference periods were compared to a six-year assessment period (ASP, 2015–2020, or the most recent six years available in the time series, Table 1). The two reference periods were from the starting year for each survey (earliest from 1983 onwards) until 2014 (long-term, RPL) and from 2009 until 2014 (short-term, RPS) comparing the occurrences during the fully available time-series and a six-year period previous to the assessment period. For three surveys, BBIC(n)SpaOT4, CSNirOT4 and BBICFraBT4, no long-term reference period was available due to the length of the time series (12 years or less). For BBIC(n)SpaOT4 and BBICFraBT4 (eight and ten years respectively) the assessment period and short-term reference period was set to four or five years respectively as opposed to six. No assessment could be made for survey CSEngBT1 due to the short length of the time series available (four years).

Table 1. Groundfish surveys by region and period over which they have been undertaken consistently, the long-term reference period (RPL), short-term reference period (RPS) and assessment period (ASP)							
OSPAR Region	**MSFD Region**	**Survey Acronym**	**Survey Period**	**RPL**	**RPS**	**ASP**	**Depth range (m)**
Celtic Seas	Celtic Seas	CSFraOT4	1997 – 2020 (no data 2017)	1997 – 2013	2008 – 2013	2014 - 2020	59 - 372
		CSEngBT1	2016 - 2019	NA	NA	NA	NA
		CSEngBT3	1993 - 2019	1993 – 2013	2008 – 2013	2014 - 2019	9 - 135
		CSEngBT3_ Bchannel	1993 - 2020	1993 – 2014	2009 – 2014	2015 - 2020	11 - 75
		CSIreOT4	2003 - 2020	2003 – 2014	2009 – 2014	2015 - 2020	13 - 260
		CSNIrOT1	2008 - 2020	2008 – 2014	2009 – 2014	2015 - 2020	12 - 120
		CSNIrOT4	2009 - 2020	NA	2009 – 2014	2015 - 2020	10 - 191
		CSScoOT1	1985 - 2020	1985 – 2014	2009 – 2014	2015 - 2020	44 - 470
		CSScoOT4	1997 - 2020	1997 - 2014	2008 – 2014	2015 - 2020	40 - 450
Wider Atlantic		WAScoOT3	1999 - 2020	1999 - 2014	2008 – 2014	2015 - 2020	122 - 255
		WASpaOT3	2006 - 2020	2006 - 2014	2009 – 2014	2015 - 2020	188 - 787
Greater North Sea	Greater North Sea	GNSEngBT3	1990 - 2020	1990 - 2014	2009 – 2014	2015 - 2020	8 - 81
		GNSFraOT4	1998 - 2020	1998 - 2014	2009 – 2014	2015 - 2020	8 - 82
		GNSGerBT3	1997 - 2020	1997 - 2014	2009 – 2014	2015 - 2020	14 - 125
		GNSIntOT1	1983 - 2020	1983 - 2014	2009 – 2014	2015 - 2020	10 - 245
		GNSIntOT1_ channel	2007 - 2020	2007 - 2014	2009 – 2014	2015 - 2020	20 - 98
		GNSIntOT3	1998 - 2020	1998 - 2014	2009 – 2014	2015 - 2020	13 - 280
		GNSNetBT3	1999 - 2020	1999 - 2014	2009 – 2014	2015 - 2020	11 - 204
		GNSBelBT3	2004 - 2020	2004 - 2014	2009 – 2014	2015 - 2020	12 - 70
Bay of Biscay and Iberian Coast	Bay of Biscay and Iberian Coast	BBIC(n)SpaOT4	2011 - 2018	NA	2011 - 2014	2015 - 2018	77 - 459
		BBIC(s)SpaOT1	1996 - 2020	1996 - 2014	2009 - 2014	2015 - 2020	19 - 752
		BBIC(s)SpaOT4	2002 - 2020	2002 - 2014	2009 - 2014	2015 - 2020	19 - 770
		BBICPorOT4	2005 – 2018 (no data 2012)	2005 - 2011	2006 - 2011	2013 - 2018	19 - 538
		BBICFraBT4	2011 - 2020	NA	2011 - 2015	2016 - 2020	9 - 250
		BBICFraOT4	1997 - 2020	1997 - 2014	2009 - 2014	2015 - 2020	10 - 587

Acronym convention: First 2–4 capitalised letters indicate the OSPAR region (CS: Celtic Seas; GNS: Greater North Sea; BBIC: Bay of Biscay and Iberian Coast; WA: Wider Atlantic). Next capitalised and lowercase letters indicate the country involved (Fra: France; Eng: England; Ire: Republic of Ireland; NIr: Northern Ireland; Sco: Scotland; Ger: Germany; Int: International; Net: Netherlands; Bel: Belgium; Por: Portugal; Spa: Spain). International refers to the two international bottom trawl surveys carried out in the North Sea and coordinated by the International Council for the Exploration of the Sea (ICES). Next two capitalised letters indicate the type of survey (OT: otter trawl; BT: beam trawl). Final number indicates the season in which the survey is primarily undertaken (1: January–March; 3: July–September; 4: October–December). Note: survey WAScoOT3 has been included in MSFD Celtic Seas region, but some of the survey area lies outside of the regional boundary.

4.2 Criteria for a species to be listed as sensitive

A list of sensitive fish species was developed to guide the work for the FC1 assessment. The list was created by first collating all sensitive fish species recorded on international and national hard law lists, Regional Seas Conventions lists, International Agreement Lists, relevant IUCN Red List species classified as EX, CR, VU or EN, and all ICES and academic work to identify sensitive fish species (Table 2).

Table 2 List of compiled data sources to determine list of sensitive species	
International and National Hard Law	• The EU Habitats Directive • The EU Common Fisheries Policy (CFP) Prohibited List • The CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora • The North East Atlantic Fisheries Commission (NEAFC) Prohibited Species List • UK Wildlife and Countryside Act • Fish protected in Icelandic waters
Regional Seas Conventions	• The OSPAR List of Threatened and Declining Species • The Helsinki Commission (HELCOM) Red List of Baltic Sea Species in danger of becoming extinct • The Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean
International Agreements	• CMS Convention on Migratory Species of Wild Animals (CMS) Appendix I and Appendix II species • The Bern Convention on the Conservation of European Wildlife and Natural habitats
Fish Red Lists	• European Red List of Fish • IUCN Global Red List
Academic Lists	• Fish Stock Advice (ICES, STECF, ICCAT, GFCM) • ICES Workshop on Fish of Conservation and Bycatch Relevance (WKCOFIBYC ICES 2021a) • ICES Workshop on the production of annual estimates of abundance of sensitive species (WKABSENS ICES 2021b) • Scientific Literature (Greenstreet et al., 2012b; Rindorf et al., 2020)

From this extensive list of species, species were removed if they did not occur in the OSPAR area. Remaining species were divided by region; Bay of Biscay and Iberian Coast, Celtic Seas, Greater North Sea, Norwegian Sea and parts of Macaronesia where data was available. Those species whose normal distribution was at the very edge of the OSPAR region were not assessed within the region.

Species where ICES or ICCAT quantitative assessments are conducted in all or part of their distribution were retained on the list but highlighted so as to avoid duplication of work. The list was then cross-referenced with the ICES WKABSENS (ICES, 2021b) and WKCOFIBYC (ICES, 2021a) sensitive species lists and reviewed by expert members of the OSPAR Fish working group to ensure all sensitive species were included.

To overcome the potential for species misidentification for those that are difficult to identify beyond the genus level, some species were grouped by genus for the assessment. These include *Hippocampus* spp. (combining *Hippocampus hippocampus* with *H. guttulatus*), *Alosa* spp. (combining *Alosa alosa* and *A. fallax*), *Dipturus* spp. (combining *Dipturus batis* complex, *D. batis*, *D. flossada* and *D. intermedia*), *Mustelus* spp. (combining *Mustelus mustelus* and *M. asterias*), *Sebastes* spp. (combining *Sebastes marinus*, *S. mentella* and *S. norvegicus*), *Dasyatis* spp. (combining *Dasyatis pastinaca* and *D. tortonesei*), *Galeus* spp. (combining *Galeus melastomus* and *G. atlanticus*), *Coregonus* spp. (combining *Coregonus maraena* and *Coregonus oxyrinchus*), *Raja brachyura* (including *Bathyraja brachyurops*) and *Deania calcea* (including *D. profundorum*). After grouping, a total of 102 unique taxonomic groups were retained on the OSPAR sensitive fish species list for the four OSPAR regions assessed in FC1 (Table 3).

All species captured during fishing on scientific surveys are recorded. For this assessment, that concerns sensitive and often rare species, only the occurrences (presence and absences) of a species were required. This simple methodology also means that the assessment can be expanded to include data from additional sources such as longline fishing gears or other quantitative sampling tools.

Table 3. List of 102 unique taxonomic groups retained on the OSPAR sensitive fish species list for the four OSPAR regions assessed in FC1

Scientific name	English name	Group	BBIC	CS	WA	GNS
Acipenser oxyrinchus	Gulf sturgeon	Coastal	no	yes	no	yes
Acipenser spp.	Sturgeons	Coastal	yes	yes	no	yes
Acipenser sturio	Atlantic sturgeon	Coastal	yes*	no	no	yes
Alopias spp.	Thresher sharks	Pelagic	yes	no	yes	no
Alopias superciliosus	Bigeye thresher	Pelagic	yes*	no	yes	no
Alopias vulpinus	Common thresher	Pelagic	no	yes	yes	no
Alosa	Allis and Twaite shad	Coastal	yes	yes	no	yes
Amblyraja radiata	Starry ray	Demersal	no	no	no	yes
Anarhichas denticulatus	Northern wolffish	Demersal	no	no	yes	no
Anarhichas lupus	Atlantic wolffish	Demersal	no	yes	yes	yes
Anarhichas minor	Spotted wolffish	Demersal	no	yes	yes	no
Anguilla anguilla	European Eel	Coastal	yes	yes	yes	yes
Argyrosomus regius	Meagre	Coastal	yes	no	no	no
Brama brama	Atlantic pomfret	Pelagic	yes	yes	yes	no
Brosme brosme	Tusk	Deep-sea	no	no	no	no
Carcharhinus falciformis	Silky shark	Pelagic	no	no	yes	no
Carcharhinus longimanus	Oceanic whitetip shark	Pelagic	no	no	yes	no
Carcharodon carcharias	White shark	Pelagic	no	no	yes	no
Cetorhinus maximus	Basking shark	Pelagic	yes	yes	yes	yes
Chelidonichthys lucerna	Tub gurnard	Demersal	yes	yes	no	yes
Chimaera monstrosa	Rabbitfish	Deep-sea	no	no	yes	no
Conger conger	Conger eel	Demersal	yes	yes	yes	yes
Coregonus spp.	*include Coregonus maraena and Coregonus oxyrinchus*	Coastal	no	yes	no	yes
Coryphaenoides rupestris	Roundnose grenadier	Deep-sea	no	no	no	no
Cyclopterus lumpus	Lumpfish	Demersal	yes	yes	yes	yes
Dalatias licha	Kitefin shark	Deep-sea	no	no	yes	no
Dasyatis pastinaca	Common stingray/ Tortonese's stingray	Demersal	yes	yes	no	yes
Deania calcea	Birdbeak dogfish (incl. *Deania profundorum*)	Deep-sea	no	no	yes	no
Dentex dentex	Common dentex	Coastal	yes	no	no	no
Dicentrarchus punctatus	Spotted seabass	Demersal	yes	no	no	no
Dipturus	*Dipturus*, *D. batis*, *D. flossada* and *D. intermedia*	Demersal	yes*	yes	yes	no
Dipturus nidarosiensis	Norwegian skate	Deep-sea	no	no	yes	no
Dipturus oxyrinchus	Long-nosed skate	Demersal	yes	yes	yes	yes
Ephippion guttifer	Prickly puffer	Demersal	yes	no	no	no

Epigonus telescopus	Cardinal fish	Deep-sea	no	no	yes	no
Epinephelus marginatus	Dusky grouper	Demersal	yes	no	no	no
Etmopterus spinax	Velvetbelly lanternshark	Deep-sea	no	no	yes	no
Gadus morhua	Atlantic cod	Demersal	no	no	yes	no
Galeorhinus galeus	Tope shark	Demersal	yes	yes	yes	yes
Galeus	Blackmouth catshark	Deep-sea	no	no	yes	no
Gymnura altavela	Spiny butterfly ray	Coastal	yes	no	no	no
Helicolenus dactylopterus	Bluemouth redfish	Demersal	yes	yes	yes	yes
Hexanchus griseus	Bluntnose sixgill shark	Deep-sea	no	no	yes	no
Hippocampus	*Hippocampus hippocampus* with *Hippocampus guttulatus*	Coastal	yes	yes	no	yes
Hippoglossus hippoglossus	Atlantic halibut	Demersal	no	yes	yes	yes
Hoplostethus atlanticus	Orange roughy	Deep-sea	no	no	no	no
Hydrolagus mirabilis	Large-eyed rabbitfish	Deep-sea	no	no	yes	no
Isurus paucus	Longfin mako	Pelagic	no	no	yes	no
Labrus bergylta	Ballan wrasse	Coastal	no	yes	no	no
Lamna nasus	Porbeagle	Pelagic	no	no	no	no
Lampetra fluviatilis	River lamprey	Coastal	yes*	yes	no	yes
Lepidorhombus whiffiagonis	Megrim	Demersal	no	no	no	yes
Leucoraja circularis	Sandy ray	Demersal	yes	yes	yes	yes
Leucoraja fullonica	Shagreen ray	Demersal	yes	yes	yes	yes
Leucoraja naevus	Cuckoo ray	Demersal	yes	yes	no	yes
Lophius budegassa	Blackbellied anglerfish	Demersal	no	yes	yes	yes
Lophius piscatorius	Anglerfish	Demersal	no	no	no	yes
Manta spp.	Manta rays	Pelagic	no	no	yes	no
Merluccius merluccius	European hake	Demersal	no	no	no	no
Mobula birostris	Giant manta	Pelagic	no	no	yes	no
Mobula mobular	Giant devilray	Pelagic	no	no	yes	no
Mobula spp.	Devilrays	Pelagic	no	no	yes	no
Mola mola	Ocean sunfish	Pelagic	no	yes	yes	yes
Molva dypterygia	Blue ling	Deep-sea	no	no	no	no
Molva macrophthalma	Spanish Ling	Demersal	yes	yes	yes	no
Molva molva	Common ling	Demersal	yes	yes	yes	no
Mora moro	Common mora	Deep-sea	no	no	yes	no
Mustelus	Mustelus spp. and *M. mustelus* and *M. asterias*.	Demersal	yes	yes	yes	yes
Myliobatis aquila	Common eagle ray	Coastal	no	no	no	yes
Petromyzon marinus	Sea lamprey	Coastal	yes	yes	no	yes
Phycis blennoides	Greater forkbeard	Demersal	yes	yes	yes	yes
Pollachius pollachius	Pollack	Coastal	yes	yes	no	yes
Pollachius virens	Saithe	Demersal	yes	no	no	no
Polyprion americanus	Wreckfish	Demersal	yes	no	yes	no
Pomatomus saltatrix	Bluefish	Pelagic	yes	no	no	no
Raja brachyura	Blonde ray (incl. *Bathyraja brachyurops*)	Demersal	yes	yes	no	yes

Raja clavata	Thornback ray	Demersal	yes	yes	yes	yes
Raja microocellata	Small-eyed ray	Demersal	yes	yes	no	yes
Raja montagui	Spotted ray	Demersal	yes	yes	no	yes
Raja undulata	Undulate ray	Coastal	yes	yes	no	yes
Rostroraja alba	White skate	Coastal	no	no	no	no
Salmo trutta trutta	Sea Trout	Coastal	yes	yes	no	yes
Sciaena umbra	Brown meagre	Demersal	yes	yes	no	no
Scophthalmus maximus	Turbot	Demersal	yes	yes	no	no
Scophthalmus rhombus	Brill	Demersal	yes	yes	no	yes
Scorpaena scrofa	Red scorpionfish	Coastal	yes	yes	yes	no
Scyliorhinus canicula	Lesser-spotted dogfish	Demersal	yes	yes	no	yes
Scyliorhinus stellaris	Greater-spotted dogfish	Demersal	yes*	yes	no	yes
Scymnodon ringens	Knifetooth dogfish	Deep-sea	no	no	yes	no
Sebastes	S. marinus, S. mentella, S. norvegicus	Pelagic / Demersal / Deep-sea	no	yes	yes	yes
Sebastes viviparus	Norway redfish	Demersal	no	yes	yes	yes
Sparus aurata	Gilt-head seabream	Pelagic	yes	yes	no	yes
Sphyrna zygaena	Smooth hammerhead	Pelagic	no	no	yes	no
Sphyrnidae	Hammerhead sharks	Pelagic	no	no	yes	no
Squalus acanthias	Spurdog	Demersal	no	no	no	no
Squatina squatina	Angelshark	Demersal	yes	yes	no	no
Synaphobranchus kaupii	Kaup's Aarrowtooth Eel	Deep-sea	no	no	yes	no
Tetronarce nobiliana	Atlantic torpedo ray	Demersal	yes	no	yes	no
Torpedo marmorata	Marbled electric ray	Demersal	yes	no	no	no
Trachyrincus scabrus	Roughsnout grenadier	Deep-sea	no	no	yes	no
Umbrina cirrosa	Shi drum	Coastal	yes	no	no	no
Zoarces viviparus	Eelpout	Coastal	no	yes	no	yes

**species not distributed across the whole BBIC Region*

BBIC = Bay of Biscay and Iberian Coast

CS = Celtic Seas

WA = Wider Atlantic

GNS = Greater North Sea

yes = present and assessed in the region

no = not present in the region or alternative third-party assessment available for the region and therefore not assessed in FC1 (see Table 3.5 in FC1 assessment for details of third-party assessments).

4.3 Spatial scope: assessment units

For each of the groundfish surveys in Table 1, occurrence data were determined for each sensitive species. Individual survey-based assessments were then performed. The individual survey-based assessments across each OSPAR region were then integrated to determine an overall assessment outcomes per species per assessment area. Deep-sea species should be assessed at the OSPAR area only (not by region). However, for the suite of surveys considered only one survey, WASpaOT3, adequately samples the deep-water fish community consistently over time (Table 1).

4.4 Baselines

None of the surveys extend sufficiently far back in time (prior to substantial anthropogenic impact) to provide an adequate reference period commensurate with acceptable status. Nevertheless, long-term recovery is the management objective, so this was considered the primary assessment outcome based on all available data, as in IA2017. However, each survey has a differing start year meaning that assessments of long-term change are not necessarily directly comparable between surveys or regions. A temporally coherent measure of change across the whole of the OSPAR area is captured by the assessment of short-term change, which can highlight where signs of recent recovery or ongoing depletion are evident.

4.5 Thresholds

Two quality flags were applied to the data for each species in each survey. First, to determine which species had five or more occurrences within a survey, and second, whether there was statistical power to detect a decrease with the binomial test (Table 4).

The assessment outcome for each species within a survey was considered ‘unknown’ where a species had less than five occurrences within a survey. Where there were five or more occurrences for a species and it was possible to detect a decrease, the assessment status was either ‘increase’, ‘stable’ or ‘decrease’ depending on the significance of the binomial distribution thresholds. Where it was not possible to detect a decrease the indicator assessment status was considered ‘unknown’, unless there was evidence for a significant increase.

For any species considered sensitive and present within a region but no data were available, the assessment status is ‘not assessed’.

Table 4. Details of indicator thresholds and quality flags applied to the data for each species in each survey to determine the assessment outcomes

Significant decrease	Significant increase	Quality flag: n>=5	Quality flag: power to detect decrease	Assessment outcome
n.s.	*	TRUE	TRUE	increase
n.s.	n.s.	TRUE	TRUE	stable
*****	n.s.	TRUE	TRUE	decrease
n.s.	*	FALSE	TRUE	unknown
n.s.	n.s.	FALSE	TRUE	unknown
*****	n.s.	FALSE	TRUE	unknown
not assessable	*	TRUE	FALSE	increase
not assessable	n.s.	TRUE	FALSE	unknown
not assessable	*	FALSE	FALSE	unknown
not assessable	n.s.	FALSE	FALSE	unknown

Assessment thresholds

By virtue of their sensitivity to additional human-related mortality, the population abundance and frequency of occurrence of each sensitive species sampled by each survey is assumed to have declined as a result of past human activities. There is good evidence that fishing mortality has indeed caused declines in the populations of sensitive species (e.g. Brander, 1981; Myers and Worm, 2005; Walker and Heessen, 1996).

Following IA2017, the primary threshold of the assessments is that sensitive species should be recovering over the long-term (i.e. demonstrating a statistically significant increase in occurrence).

A secondary assessment was also defined in IA2017 and this is performed to address an alternative question of whether further decline in the occurrence of sensitive species has been halted (i.e. species should be either stable or increasing in the long-term and must not be unknown).

These objectives are the same as IA2017, but the metric is now based on change in occurrence between period (and thus more suitable for rare species) as opposed to time-series of abundance data that require frequently sampled species.

4.6 Spatial integration within species

The results from multiple surveys were integrated using two different methods and to differing levels depending on species groups. Deep-sea species that were integrated across the whole OSPAR area, while all other species were integrated to the OSPAR region.

Two integration approaches were trialled, 'probabilistic' and 'weighted-averaging', for each species at the appropriate assessment scale. The choice of integration procedure had minimal effect on assessment outcomes, but as the weighted average approach is newly defined conclusions are drawn from the probabilistic integration method proposed for this indicator previously by IA2017.

Probabilistic integration (proposed by IA2017)

A significance level of 0.05 has been used to detect significant change in occurrence for each species in each available survey based on a departure from a binomial distribution. Therefore, it follows that the probability of observing a false positive in any one survey by chance is 5%. Hence, the binomial distribution can again be used to determine whether the resulting number of surveys with a specific indicator outcome (i.e. decrease or increase) is sufficient to say that the outcome is sufficiently unlikely to occur by chance (i.e. the outcome is significant overall). However, the fewer the number of surveys available to integrate the lower the reliability of the probabilistic integration approach.

Weighted average integration (the 'i-score')

The i-score intends to choose the "best" assessment results of multiple surveys based on the catchability of the surveys and the consistency in the assessment results. Therefore, the i-score is an averaged index of two metrics, mean relative occurrence and the proportional outcome. Before calculating each metric, the surveys are aggregated by their assessment outcomes so that evidence for either increase or decrease can be evaluated. The mean occurrences in the long-term reference period and the proportions of the according outcomes are averaged. For example, if for *Conger conger* in the Celtic Sea, four out of seven surveys indicate an increase and the mean relative occurrence in these surveys was 0.152, then the i-score would be calculated as:

$$\text{i-score} = (4/7 + 0.152) / 2 = 0.362$$

The i-score is calculated in also for the other assessment outcome categories (decrease, stable, unknown). The outcome-bin with the highest i-score is chosen to represent the assessment outcome for that species in the given region.

4.7 Spatial maps and survey ranking

As a number of surveys overlap spatially, surveys were ranked by their probability of being able to detect each species (probability of occurrence) to provide an indication as to which are the most appropriate for assessing each species (e.g. due to more appropriate gear type, season of survey or another unknown factor). This ranking order was then used to draw the outcomes as layered maps for each species, with the highest ranked survey (highest probability of occurrence) shown on the upper layer.