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Status of non- assessed fish species in Irish waters

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ABSTRACT

This report gives the latest assessment results for abundance of several fish species not otherwise assessed by international bodies or national agencies within Ireland. The assessment was performed to support Ireland's obligations under the EU's Marine Strategy Framework Directive (MSFD) to assess the state of commercial and non-commercial fish stocks. The commercially important stocks included in this assessment are recorded as being caught in Irish MSFD waters, from ICES FISHSTAT database, and for which sufficient trawl survey data are available to assess them. The non-commercial fish species included in this assessment are those present in the Irish MSFD area, which are either listed as being of conservation concern under the EU's data collection programme for fisheries, those on the OSPAR list of threatened species, elasmobranch species prohibited from being caught in commercial fisheries under the EU CFP legislation and/or those listed as endangered with extinction on the EU fish red list. The evaluation of the status of commercial and non-commercial species in the subareas VI and VII of FAO fishing area 27 was carried out using data from research vessels surveys. Data since 1998 were used and results show that only 4 of 10 commercial stocks were above the Good Environmental Status (GES) threshold value. The results of this work were then used to populate an overall assessment of GES for MSFD Descriptors D1 and D3 by Ireland in 2019.

1. INTRODUCTION

The Celtic Seas region contains a varied coastline, from fjords and sea lochs, to sand dunes, bays, estuaries and numerous sandy beaches as well as a highly varied offshore topography. The large range of habitats in the region supports a diverse fish fauna. Many of species are taken in various fisheries, their populations being commercially important. Other species are not of commercial importance, but may be vulnerable to exploitation or are already depleted. The status of many of these species was assessed by the International Council for the Exploration of the Seas (ICES). Annual advice on the commercial stocks of interest to Ireland is given each year in the annual stock book (Anon., 2019).

Conservation of biological diversity has been recognized as a key responsibility of states to preserve or rebuild healthy ecosystems for the wellbeing of current and future generations (Froese et al., 2015). To achieve this goal, baseline evaluations of the status of these fish populations are required by the European Union’s (EU) Common Fisheries Policy (CFP) to manage European fisheries resources (European Union, 2008). Furthermore, the Marine Strategy Framework Directive (MSFD) established in 2008 by European nations with coastal borders (Prabath et al., 2017), complements the objectives of the EU Common Fisheries Policy, providing eleven descriptors of good marine environmental status (GES) (Probst et al., 2013).

The commercial stocks in this assessment are stocks which are fished in Irish MSFD waters. However, many of these stocks straddle the boundary between Ireland and other jurisdictions, while some are exploited in Irish waters, but not by Irish vessels.

The fish species of conservation concern included in this assessment are those listed in the Data Collection Framework (DCF) (EU) 2016/1251; the Convention to Protect the Marine Environment of the North East Atlantic (OSPAR) list of threatened species; elasmobranch species prohibited from being caught in commercial fisheries under the EU Common Fisheries Policy (CFP) legislation and those listed as endangered with extinction on the EU international Union for the Conservation Nature (IUCN) fish red list.

2. MATERIAL AND METHODS

2.1. Study area

The entire Celtic seas eco-region (Sub areas 6 and 7 of FAO fishing area 27) was the basic spatial unit for the present analysis (Figure 1). This is because it largely covers the Irish MSFD area, and contains within its boundaries the stocks/species of relevance to Ireland's reporting obligations. The surveys used in the analyses are shown in Fig 1 (right). It can be seen that the surveys cover the sub areas 6 and 7 of FAO fishing area 27, but cover some parts of sub area 8 also (EVHOE survey). Surveys covering areas outside to the MSFD were included where there was evidence exists for a continuous stock distribution.

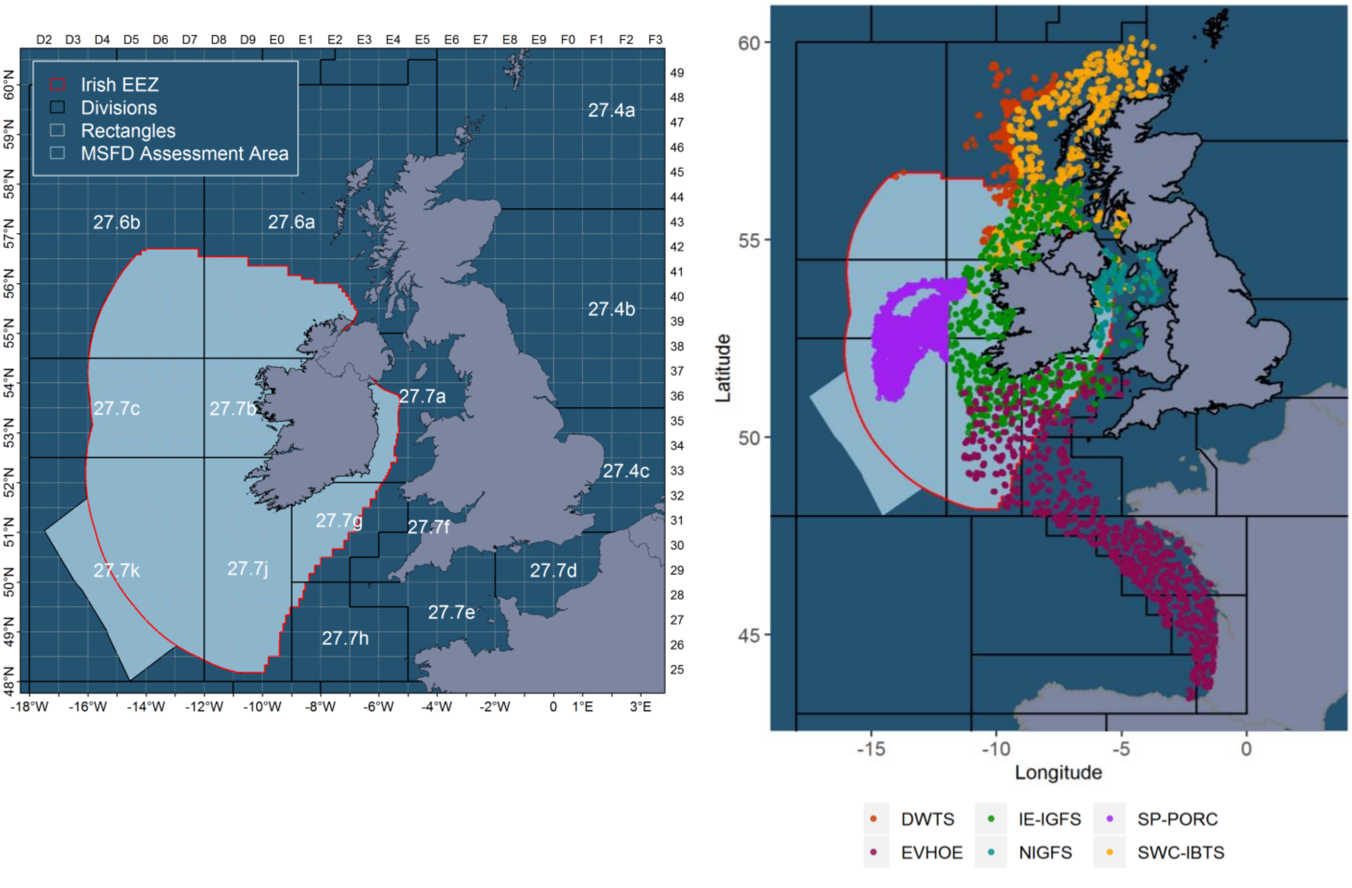


Fig 1. Map of the FAO 27 area showing the management subareas from which the different fish stocks were analysed (Left). Surveys used in the analyses shown (Right) as follows: DWTS **(**Scottish Deepwater Survey), EVHOE French Southern Atlantic Bottom Trawl Survey), IE-IGFS (Irish Ground Fish Survey), NIGFS (Northern Ireland Ground Fish Survey), SP-PORC (Spanish Porcupine Bottom Trawl Survey) and SWC-IBTS (Scottish West Coast Bottom Trawl Survey).

2.2. Data source and species selection

The most important data source for estimates of temporal and spatial variability in FAO fishing area 27 are Groundfish surveys which are conducted as part of the ICES International Bottom Trawl Survey programme (IBTS) in the Celtic Seas, North Sea, and Bay of Biscay. Abundance indices are in most cases relative and indicate relative changes in annual catch per unit of effort (CPUE) rather than providing estimates of actual population size. The efficiency with which a given survey will catch a particular species encountered on the seabed is usually unknown, but highly standardized monitoring programmes use relative differences in annual catch rate to infer changes in the underlying population. IBTS has provided regular biological and sampling data used for a wide range of stock assessment and ecosystems impact studies (Probst et al., 2013).

For each survey involved in the IBTS programme, careful consideration was given on a species-by-species basis to available data to ensure any assessment would be meaningful. Several commercial species that are heavily fished in Irish waters (e.g. striped red mullet, *Mullus surmuletus*) and non-commercial fish stocks (e.g. leaf gulper shark, *Centrophorus squamosus*) were left out of the analysis. The survey consistency was a key criteria to ensure a reasonably long unbroken time series of abundance covering the main distribution of the stock. Being a relative index it was important to have a trend over time as individual data points are only meaningful in relation to the points either side. If less than 5 years was available for the stock, or the surveys did not cover the area of interest the species was considered not suitably described by and therefore omitted from the analysis.

When two or more surveys were needed to assess a species, the length frequencies in areas of survey overlap were examined to ensure survey catchabilites were not wildly different between neighbouring surveys. This was particularly important where gears were significantly different, but the added assumption here was that the species in question were generally large and therefore fully selected. Residual plots were examined for evidence of significant departures from assumptions.

Information from the several groundfish surveys over 15 years (2003-2017) in quarters 3 and 4, were combined to determine annual mean abundance for commercial species. The raw sampling and biological data for demersal fish were downloaded from the ICES DATRAS database1.

However, for many non-commercial species included in this analysis, the data available from these surveys were too sparse to support quantitative assessment. The Scottish Deepwater survey from 1998 until 2017 appeared the most consistent over the longest time series to support an assessment of non-commercial species for a large portion of the study area.

Including additional data sets with low numbers and varying spatial and temporal extents was likely to add more noise than signal for these non-commercial species. In addition, the Scottish Deepwater Survey uses the IBTS protocols and takes place at the same time of year. Data were provided from the Centre of Fisheries Research Services, Aberdeen Marine Laboratory2.

The complete list of the 24 species involved in the assessment can be found in Table 1**,** which includes the surveys and time period used in their assessment.

The records of *Chimera monstrosa* and *Chimera opalescens* were combined as *Chimera spp* due to the difficulties in reliably separating these two species historically.

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

2 https://www.bodc.ac.uk/resources/inventories/edmed/org/38

Table 1. Surveys and time period used per species. Commercial species are coloured in green. Total hauls are the full set of valid hauls normally used for assessment purposes and indicate the total fishing effort for that survey. Total samples are the subset of valid hauls with a recorded catch for that species. Occurrence is the percentage of surveys where the species was caught over the specified time.

SPECIES	SURVEYS CODE						SUMMARY		
	EVHOE (French)	IE-IGFS (Irish)	SP-PORC (Spanish)	SWC-IBTS (Scottish)	NIGFS (Irish)	DWTS (Scottish)	Total Hauls	Total Samples	Occurrence
LEM (*Microstomus kitt*) (2003-2017)	X	X	X	X	X		6,102	2,570	42%
WIT (*Glyptocephslus cynoglossus*) (2003-2017)	X	X	X	X	X		7,002	2,089	29%
COE (*Conger conger*) (2003-2017)	X	X	X	X	X		7,028	1,936	27%
GUR (*Chelidonichthys cuculus*) (2003-2017)	X	X	X	X	X		6,102	3,402	55%
GUG (*Eutrigla gurnardus*) (2003-2017)	X	X	X	X	X		7,028	4,369	62%
TUB (*Chelidonichthys lucerna*) (2003-2017)	X	X		X	X		5,574	1,116	20%
JOD (*Zeus faber*) (2003-2017)	X	X		X	X		5,757	3,098	53%
TUR (*Scophthalmus maximus*) (2003-2017)		X					2,439	292	12%
FLE (*Platichthys flesus*) (2003-2017)		X					1,977	23	1%
SAR (*Leucoraja circularis*) (2003-2017)	X		X				3,156	190	6%
SGS (*Hexanchus griseus*) (2001-2017)			X				1,453	171	12%
BAN (*Antimora rostrata*) (1998-2017)						X	453	189	42%
BSD (*Alepocephalus bairdii*) (1998-2017)						X	453	298	66%
CMS (*Centroscyllium crepidater*) (1998-2017)						X	453	209	46%
CSF (*Centroscyllium fabricii*) (1998-2017)						X	453	127	28%

DAC *(Deania calcea)* (1998-2017)						X	453	177	39%
DBM *(Galeus melastomus)* (1998-2017)						X	453	123	27%
EGT *(Epigonus telescopus)* (1998-2017)						X	453	161	35%
ESP *(Etmopterus princeps)* (1998-2017)						X	453	147	32%
MOM *(CentMora mororoscyl-* (1998-2017)						X	453	108	24%
RBF *(Chimaera spp)* (1998-2017)						X	453	300	66%
RBM *(Helicolenus dactylopterus)* (1998-2017)						X	453	165	36%
RTF *(Hydrolagus mirabilis)* (1998-2017)						X	453	111	24%
VBY *(Etmopterus spinax)* (1998-2017)						X	453	106	23%

2.3. Data analysis

The approach carried out was based on the method used to construct OSPAR Common Indicator FC1 ("Recovery in the Population Abundance of Sensitive Fish Species) (OSPAR, 2018). This indicator was used in the OSPAR Intermediate Assessment 2017. In that instance, the indicator was used to provide an aggregated score for the overall fish community. However, for the needs of the present case the method was applied to provide status of individual species, rather than for a species assemblage. This is because Commission Decision 848/2017, seeks the status of each individual species in terms of GES.

The Catch per unit effort (CPUE) is used traditionally to estimate abundance indices derived from groundfish surveys. Effort can be measured in several ways, as catch per tow, catch per hour, or catch per unit of swept area. Hanchet et al., 2005 showed in their analysis that model results were similar for the different measures. CPUE has been estimated by two different units of effort, principally based on the data available. The Scottish Deepwater Survey did not provide values of tow distance or wingspread, therefore CPUE for non-commercial species was calculated as total number of individuals of a species caught per trawling hours (Kg/h).

However, the high variability in trawl speed, or other factors, suggests that such CPUE data might be noisy and affect the results of the abundance indices when several surveys are combined to carry out the assessment (Petrere et al., 2009). To avoid this bias, an alternative method was used to estimate abundances of the fish in Irish waters when various surveys were combined and/or the parameters were available for estimation.

For surveys other than the Scottish Deepwater Survey, CPUE was defined as total number of individuals of a species caught per square Kilometre of seabed swept by the trawl gear

(Km^2). To calculate the CPUE in this manner, data were required on the distance towed during each haul, which explicitly needs other values such as trawl depth or spread of the gear. All these surveys use a demersal otter trawl which is designed to herd shoaling fish in particular over a large area back into the mouth of the trawl. The area sampled between the wings of the trawl is often a third or less than that fished between the otter doors. However, for species not strongly associated with shoaling it is often considered their likelihood of capture is closer associated with encounter with the trawl rather than the doors and sweeps. Therefore wing spread is used here also as the more appropriate estimate of abundance.

In many instances a key parameter necessary to derive values for effort were either absent or ‘unlikely’ and these missing or erroneous values were replace by modelled estimates. However, a more rigorous approach to effort data standardisation and quality assurance would be beneficial going forward (Greenstreet et al., 2017).

Two primary data tables are provided from each survey, sampling and biological information. The details of the variables included in both tables and the parameters required for estimating the abundance index are listed in Table 2 and 3. Other explanatory variables were offered, but were not significant for the analysis.

Table 2. Definition and description of explanatory variables of the sampling data.

Field	**Description**
Haul ID[a]	Unique haul identifier (SurveyAcronym/Ship/Year/HaulNo/StNo/Gear)
Survey-Acronym	Unique survey identifier
Ship	Unique vessel identifier
Gear	Unique gear code
Year	Year that gear was shot
GroundSpeed[b]	Nautical miles per hour (over the ground SOG)
HaulDur (min)	Duration of fishing operation
Sweep length[e]	Lengths of the sweep
Lat	Latitude in decimal degrees of the haul shoot position
Long	Longitude in decimal degrees of the haul shoot position
StNo	Station number
ICESStSq	ICES statistical rectangle where gear was shot
SurvStratum	Stratum tag for stratified surveys
Depth (m)[d]	Depth tag assigned to the haul
Distance (km)[c]	Tow distance ($d_{H,TOW}$)
WingSpread (m)[f]	Mean distance between the wings during fishing operation ($d_{H,WINGS}$)
DoorSpread (m)	Mean distance between the doors during fishing operation ($d_{H,DOORS}$)
Net Open (m)	Mean head-line height above seabed during fishing operation ($d_{H,HEIGHT}$)
WingSwptArea (km^2)[g]	Area of seabed swept by the net ($A_{H,WINGS}=d_{H,TOW} \times (d_{H,WINGS}/1000)$)

The process to check incorrect values and fill-in missing data follow Moriarty et al. (2017) methodology unless stated otherwise.

a) **HaulID** – Unique tag assigned to each haul. This field is identical to the field with the same name in the Biological Information data table. This is the relational field used to link these two tables.

b) **GroundSpeed** – It was necessary to estimate the missing values of distance using *Distance = GroundSpeed x HaulDur.* SP-PORC and NIGFS surveys did not follow the Moriarty methodology, the IBTS Manual (ICES, 2019) was used to fill in missing values.

c) **Distance** – Information used to derive an estimate of the area of seabed swept by the gear when collecting the sampling. Ideally this should be a series of GPS positions to allow an accurate distance measure, especially in cases where the tow may not have been a completely straight line. Missing/incorrect values of distance covered was estimated for each haul using *GroundSpreed x HaulDur* and subsequently converted to kilometres*. A* haversine equation (distance between two points) was calculated to verify the estimate values.

d) **Depth** – Ocean bathymetry data provided by NOAA was used to estimate missing values, as well as to check the reliability of depth values existing.

e) **Sweep Length** – Is prescribed by the IBTS Manual (ICES, 2019), which recommends different lengths of sweep depending of the depth. Normally surveys present two different records for sweep length (short and long). Missing/incorrect values were calculated as estimation of the existing values of sweep length associated with a determined water depth.

f) **Wing-Spread** – Distance between the trawl wing-ends used to calculate swept area (Fig.2). Depth data was present (or estimated) for every record. Where a Wing-Spread value was not available the relationship between DoorSpread and Wing-Spread was determined. Different calculations were used to estimate the Wing-Spread according to the Sweep Length (short or long).

g) **WingSpwtArea** – It is the most important parameter necessary for deriving the required fish abundance per unit area (total number per square kilometre). We calculated the area of seabed swept by the net (wing swept area) as tow distance (Km) by mean distance between the trawl wing-ends (Km).

Table 3. Definition and description of explanatory variables of the biological data.

Field	Description
Haul ID	Unique haul identifier (SurveyAcronym/Ship/Year/HaulNo/StNo/Gear)
SpeciesSciName	Scientific species name
FishLength(cm)[i]	Integer number indicating fish length
IndivFishWght(g)[j]	Estimated weight of individual fish specified species and length ($W_{S,L}$)
Number[h]	Total number of fish of specified species and length in the catch ($N_{S,L,H}$)
DensAbund (N/km^2)[k]	Abundance density estimate ($D_{nos,S,L,D} = N_{S,L,H} / A_{H,WING}$)

h) **Number** – Number of fish of specified species and length obtained in the trawl sample. This field never shows missing values.

i) **FishLength** – Some values were missing from surveys included in the analysis. Scottish Deepwater surveys did not deliver values for this field so this lack of information did not allow estimating CPUE by length classes. In addition, other indicators such as size distribution within the population, proportion of fish larger than the size of first sexual maturity or mean maximum length could not be estimated either.

j) **IndivFishWght –** Many of these values were missing for surveys included in the analysis, for example, SWC-IBTS survey did not provide any values of weight. A relationship between the existing data of weight and length was used to fill in the missing values. However, LW regressions on the available data produced quite low values of R^2 for use as an estimator of missing weights, but were deemed the best available solution.

k) **DensAbund** – Abundance density estimate, total number of fish per square kilometre estimated at the spatial point location of that trawl sample. This is obtained by dividing the species total catch number by the area swept by the net.

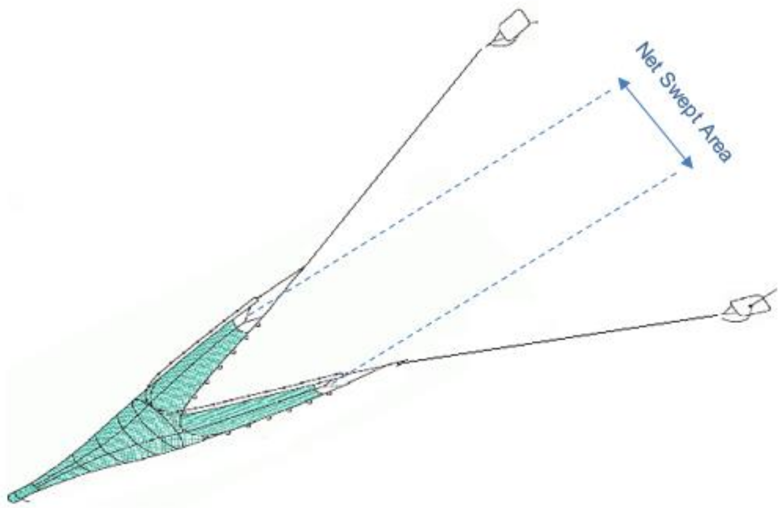


Fig.2. Area of seabed swept by the net.

2.4. Abundance-based indicators.

For each species included in this assessment, relative abundance density time-series were developed. Abundance indices (CPUE) calculated by trawling hours or Km^2 are shown transformed to natural logarithms to make all CPUE comparable.

The mean of the time series can tell us whether current abundance is above or below threshold, indicating a recovery or depletion of the species respectively.

For the species of conservation concern, abundance was measured against two thresholds or reference points, namely the 25th and 75th percentiles of annual abundance estimates over time. The 75th percentile is a reasonable metric of recovery for a depleted species (Greenstreet et al., 2012). The converse of this, is that if a species' abundance is below the 25th percentile it indicates that recovery has not occurred or the stock may be in decline (Greenstreet et al., 2012).

For the commercial species, the threshold was set as the 50th percentile of abundances over time. This is based on a recommendation in Commission Decision 848/2017 instructing that if quantitative assessments are not available survey abundance indices may be used and the current value can be compared against the long-term historic average (European Commission 2017).

3. RESULTS AND DISCUSSION

Abundance was assessed for 24 species, 10 commercial stocks and 14 non-commercial species or species of conservation concern. A summary of the results of each is shown in Table 4. Abundance trajectories over time for the commercial species are shown in Figures 3-12 and for the non-commercial species in Figures 13-26. Survey contribution plots are shown when more than one survey was used to carry out the analysis. The contribution was measured as weighting^2 × (standard deviation^2 × nº of hauls in which the species was caught)

Of the commercial stocks, 4 stocks showed abundance above the 50th percentile threshold. These were turbot, lemon sole, sandy ray and witch flounder. Sandy ray and witch flounder were also above the 75th percentile. The remaining 6 species were below the 50th percentile threshold. Of these, 3 were above the 25th percentile; flounder, tub gurnard and red gurnard. A further 3 stocks were below the 25th percentile, these were John dory, conger eel and red gurnard. According to the suggestion in Commission Decision 848/2017, the 50th percentile was used as the reference point to determine if hitherto un-assessed stocks were compatible with Good Environmental Status (GES) under the EU's Marine Strategy Framework Directive. Thus 4 out of the 10 commercial species analysed in this study conformed to GES.

Of the species of conservation concern, 10 species' abundance was above the 75th percentile threshold. These were antimora, longnose velvet dogfish, black dogfish, birdbeak dogfish, blackmouth dogfish, bigeye, lanternshark, mora, rabbitfish and velvetbelly lanternshark. One species (sixgill shark) showed abundance below the 25th percentile threshold, with 3 species between the 25th and 75th percentiles of abundance (large eyed rabbitfish, Baird's smoothhead and bluemouth). Following Greenstreet et al. (2012), the 75th percentile of abundance over time is taken as a reasonable metric for compatibility with GES. Thus 10 out of the 14 species of conservation concern conformed to GES.

The results of this study are the first estimates of abundance for many of these species. Some, such as sandy ray, have been assessed by ICES, but the results were inconclusive. The remaining commercial species have not been assessed in this area before. In all cases, these are the first assessment results for these species in this area which are reported in relation to a threshold or reference point.

The abundance trends presented are the first for many of the deep water species, particularly the rabbitfish. Deepwater shark abundance was examined before by Neat et al. (2015) and by ICES (2018). Results of those studies agree with the findings here for DAC. For the remaining deepwater sharks, neither Neat et al., (2015) nor ICES (2018) reported the upward trends found in this study, nor did ICES (2018) report a downward trend in SGS. None of these studies use time series stretching back to the early phase of deepwater fisheries, which began in 1989. As such they do not necessarily indicate stock development over time.

A particular weakness of the current study for the deep waters species is that no account was made in the analyses for depth effects. This is a key factor governing abundance, as each species has a particular depth range which it occupies. It is assumed that the survey design in the deepwater surveys did not change from year to year, and that the same depth range was sampled each year. Assuming that the same depth ranges were sampled each year, it is reasonable to accept that important trends in species abundance are not masked by artifacts due to changing depths being covered each year.

The current study is a first attempt at assessing abundance of these species, and of fulfilling Ireland's obligations under the Marine Strategy Framework Directive. Future work should focus on developing the OSPAR FC1 indicator approach to deep water survey data while accounting for depth effects. Future development work on this indicator for all species could also focus on dealing with year effects in the data. Sudden changes in abundance from year to year, which do not seem likely given the species' population dynamics. Finally, more work is required to understand the stock structure of the species in the Irish MSFD area, so that the appropriate assessment units are used.

Table 4. Results of assessments of abundance of fish species. Index value**;** Abundance value obtained for the last year assessed. Threshold value**;** Percentile used as the reference point to determine if fish species were compatible with Good Environmental Status (GES). Status**;** Red marks show those species which did not reach the GES, green marks show those species which reach the GES.

Species Code	Common Name	Scientific Name	Index value	Threshold value	Status
COE	European conger	*Conger conger*	2.025	50%	✗
FLE	European flounder	*Platichthys flesus*	0.124	50%	✗
GUG	Grey gurnard	*Eutrigla gurnardus*	6.457	50%	✗
GUR	Red gurnard	*Chelidonichthys cuculus*	4.749	50%	✗
JOD	John dory	*Zeus faber*	3.213	50%	✗
LEM	Lemon sole	*Microstomus kitt*	4.280	50%	✓
SAR	Sandy ray	*Leucoraja circularis*	1.113	50%	✓
TUB	Tub gurnard	*Chelidonichthys lucerna*	2.274	50%	✗
TUR	Turbot	*Scophthalmus maximus*	0.798	50%	✓
WIT	Witch flounder	*Glyptocephalus cynoglossus*	4.492	50%	✓
BAN	Antimora	*Antimora rostrata*	5.661	75%	✓
BSD	Baird's smoothhead	*Alepocephalus bairdii*	8.239	75%	✗
CMS	Longnose velvet dogfish	*Centroscymnus crepidater*	5.921	75%	✓
CSF	Black dogfish	*Centroscyllium fabricii*	5.743	75%	✓
DAC	Birdbeak dogfish	*Deania calcea*	5.884	75%	✓
DBM	Blackmouth catshark	*Galeus melastomus*	6.851	75%	✓
EGT	Bigeye	*Epigonus telescopus*	5.299	75%	✓
ESP	Lanternshark	*Etmopterus princeps*	5.385	75%	✓
MOM	Mora	*Mora moro*	5.402	75%	✓
RBF	Rabbitfish	*Chimaera spp.*	7.477	75%	✓
RBM	Bluemouth	*Helicolenus dactylopterus*	7.215	75%	✗
RTF	Large-eyed rabbitfish	*Hydrolagus mirabilis*	4.644	75%	✗
SGS	Sixgill shark	*Hexanchus griseus*	1.157	75%	✗
VBY	Velvet belly lanternshark	*Etmopterus spinax*	5.822	75%	✓

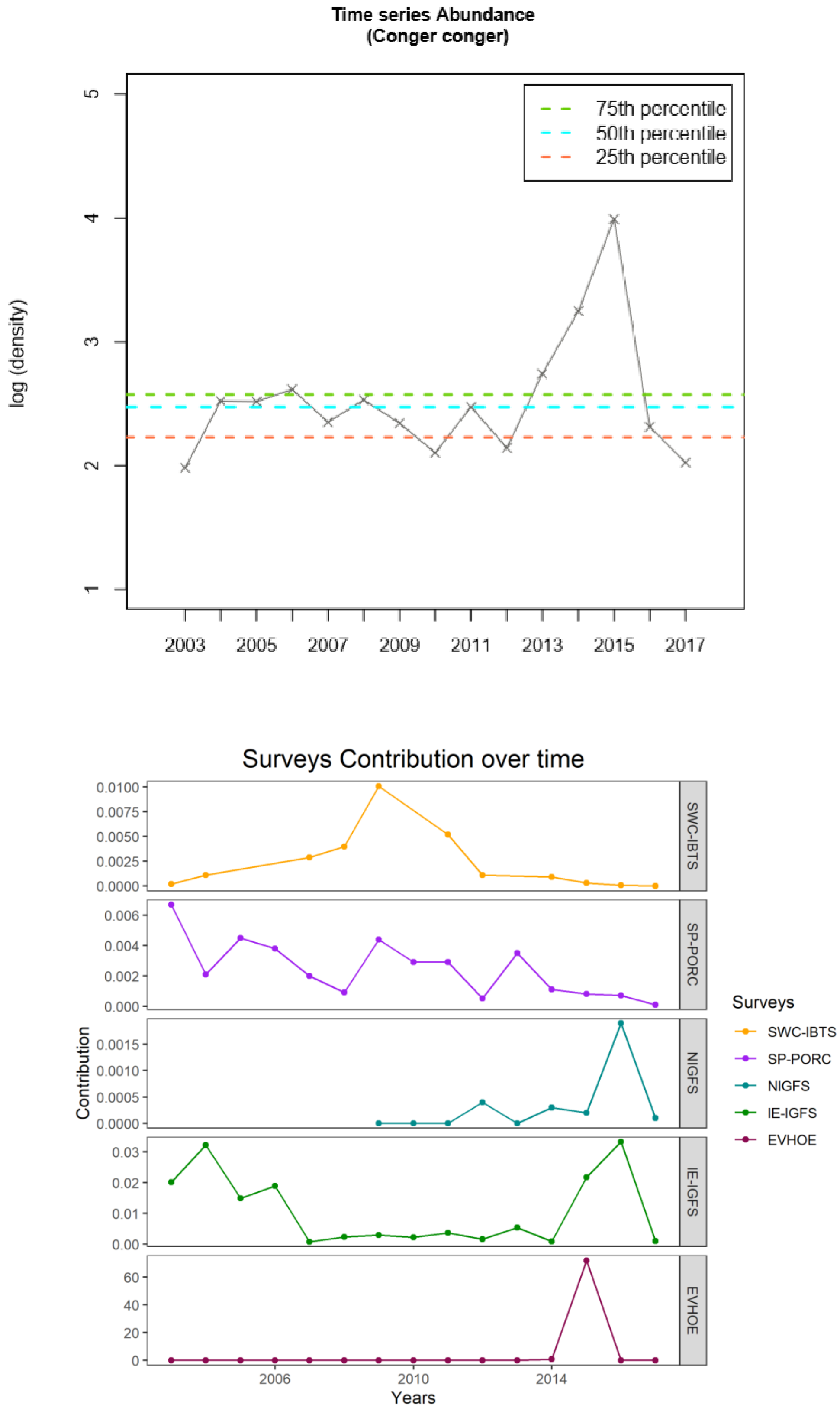


Fig 3. Abundance trends (upper panel) in number per km^2 for conger eel (*Conger conger*), showing 75th, 50th and 25th percentiles. Abundance is below the 50th percentile for this commercial species, so it is below the threshold for GES; and contribution over time (2003-2017) by individual survey (lower panel).

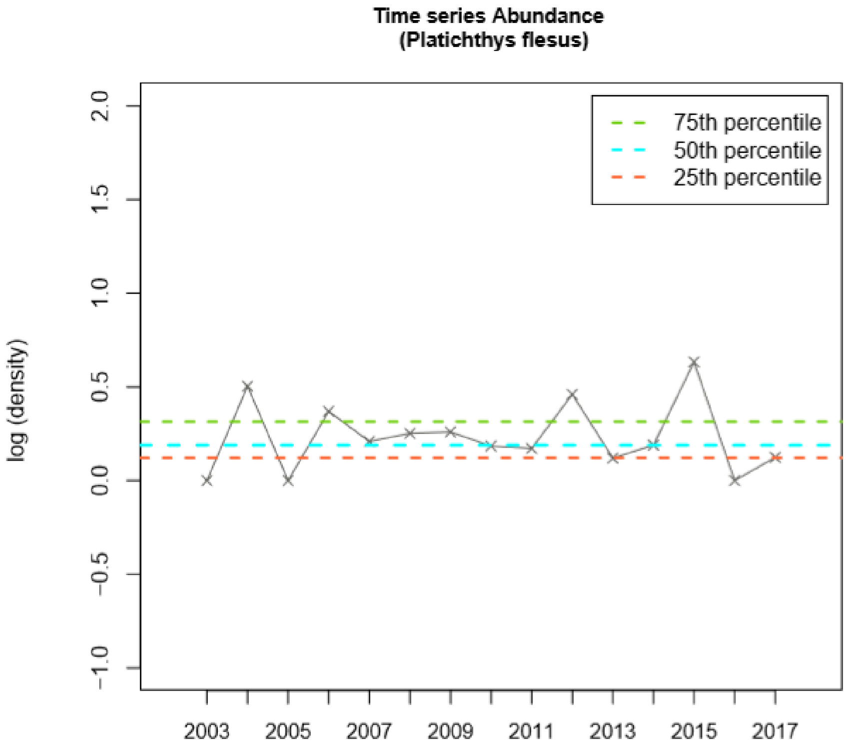


Fig 4. Abundance trends (upper panel) in number per km² for European flounder (*Platichthys flesus*), showing 75th, 50th and 25th percentiles. Abundance is below the 50th percentile for this commercial species, so it is below the threshold for GES.

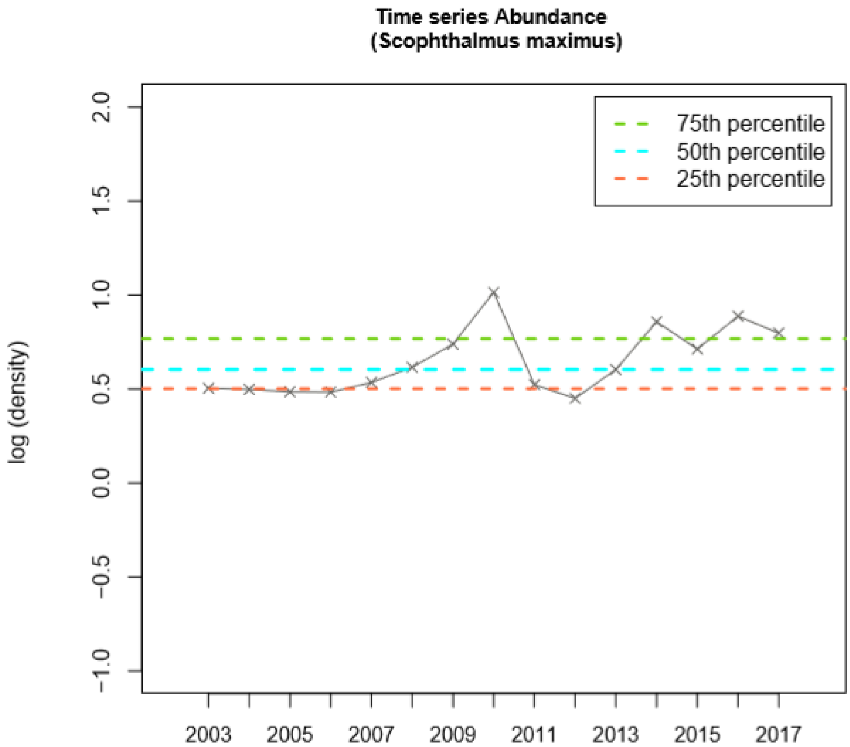
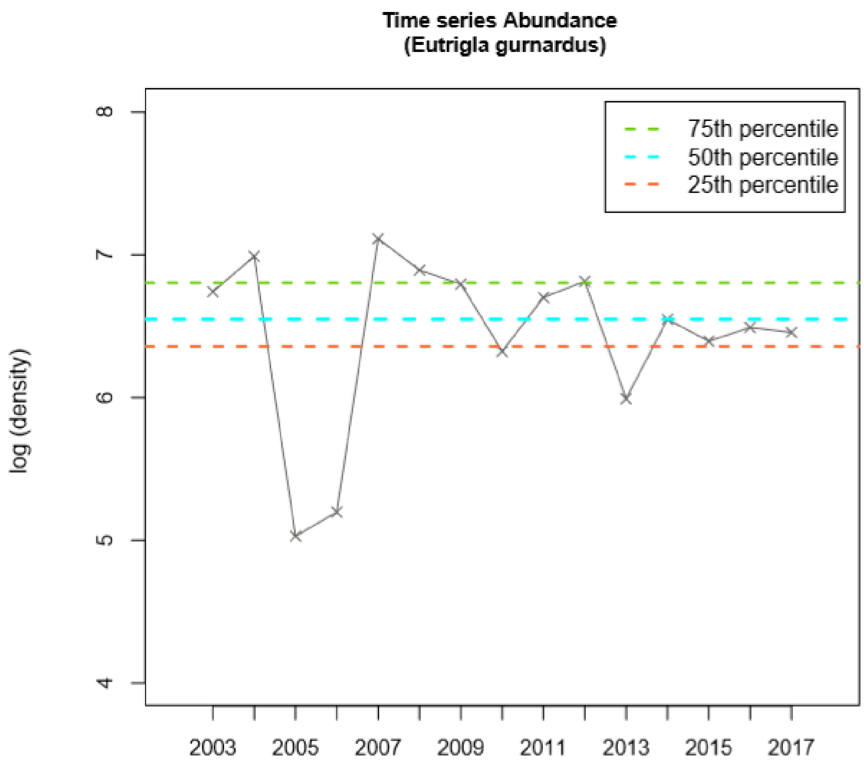


Fig 5. Abundance trends (upper panel) in number per km² for turbot (*Scophthalmus maximus*), showing 75th, 50th and 25th percentiles. Abundance is above the 50th percentile for this commercial species, so it is above the threshold for GES.



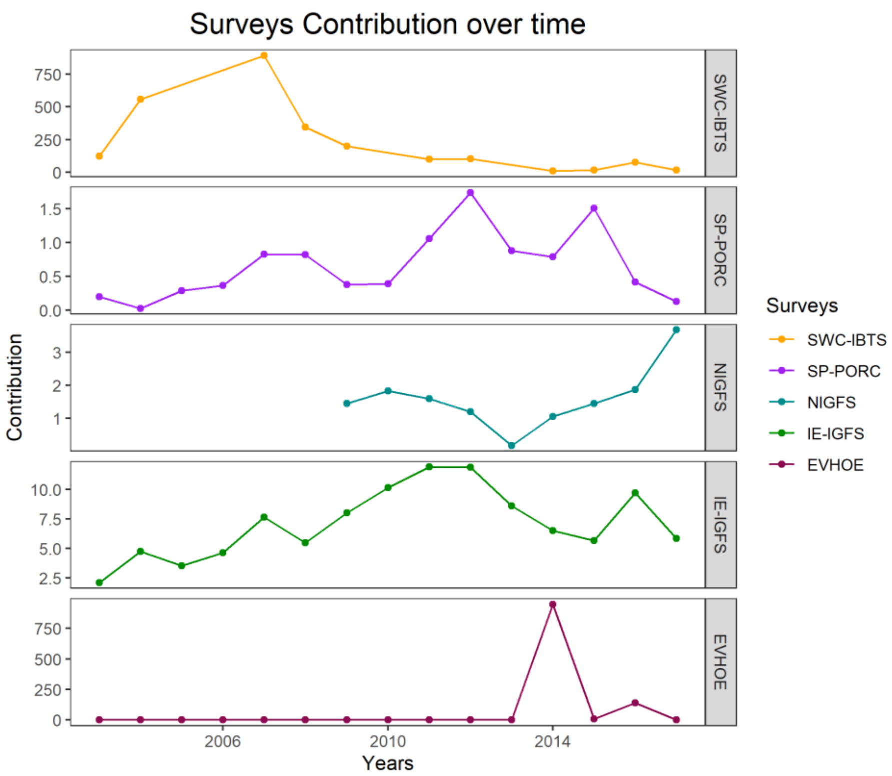


Fig 6. Abundance trends (upper panel) in number per km^2 for grey gurnard (*Eutrigla gurnardus*), showing 75th, 50th and 25th percentiles. Abundance is below the 50th percentile for this commercial species, so it is below the threshold for GES; and contribution over time (2003-2017) by individual survey (lower panel).

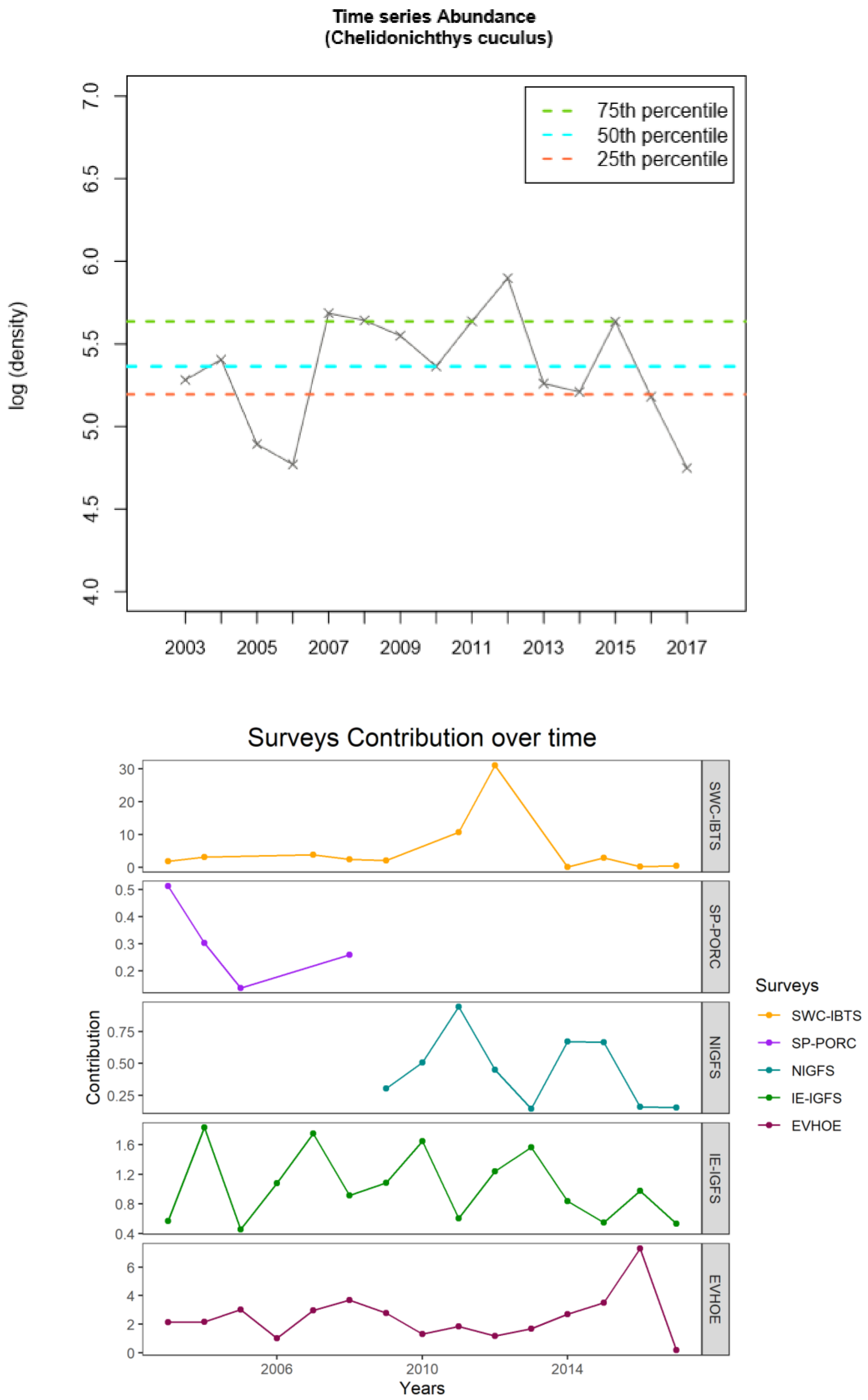


Fig 7. Abundance trends (upper panel) in number per km^2 for red gurnard (*Chelidonichthys cuculus*), showing 75th, 50th and 25th percentiles. Abundance is below the 50th percentile for this commercial species, so it is below the threshold for GES; and contribution over time (2003-2017) by individual survey (lower panel).

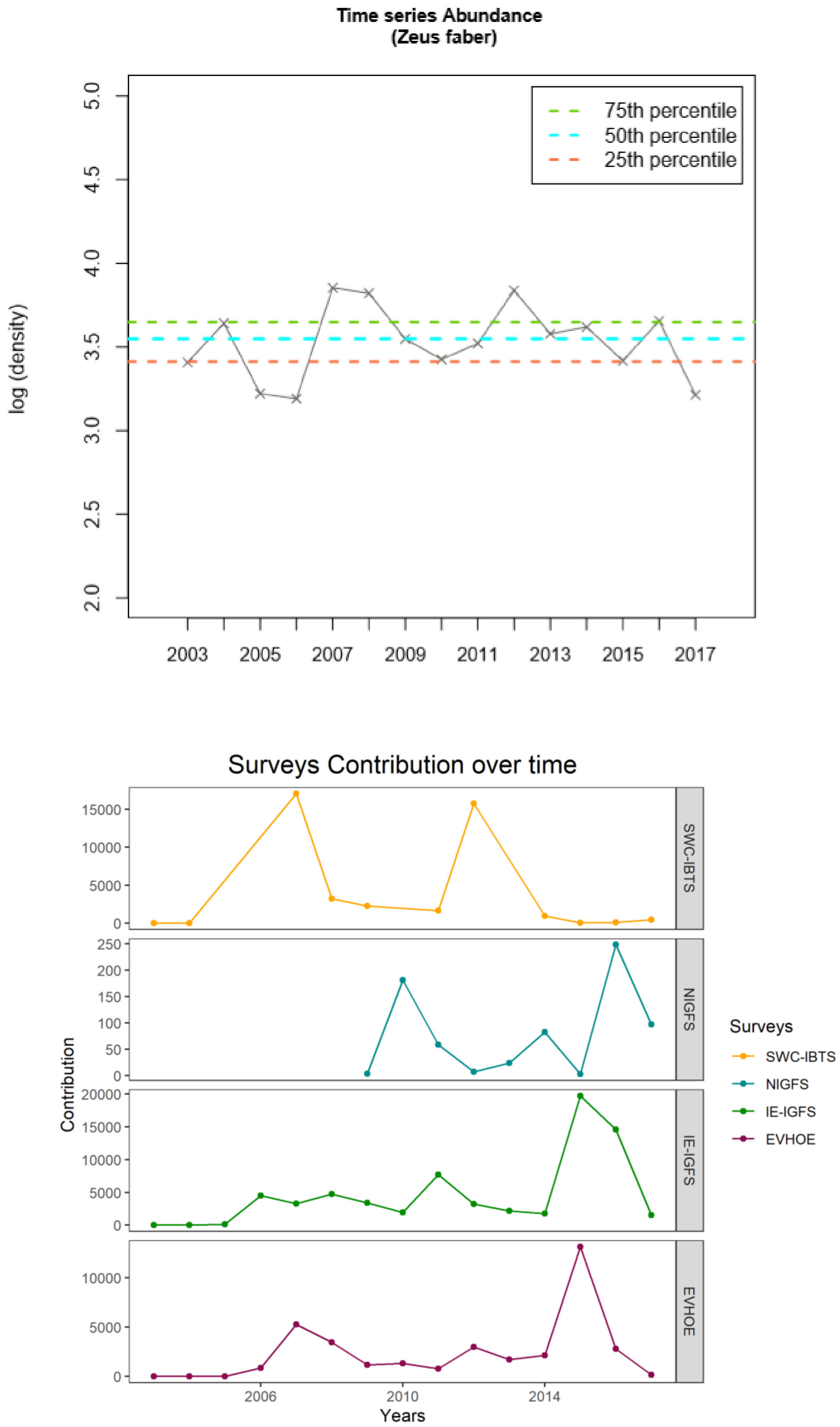
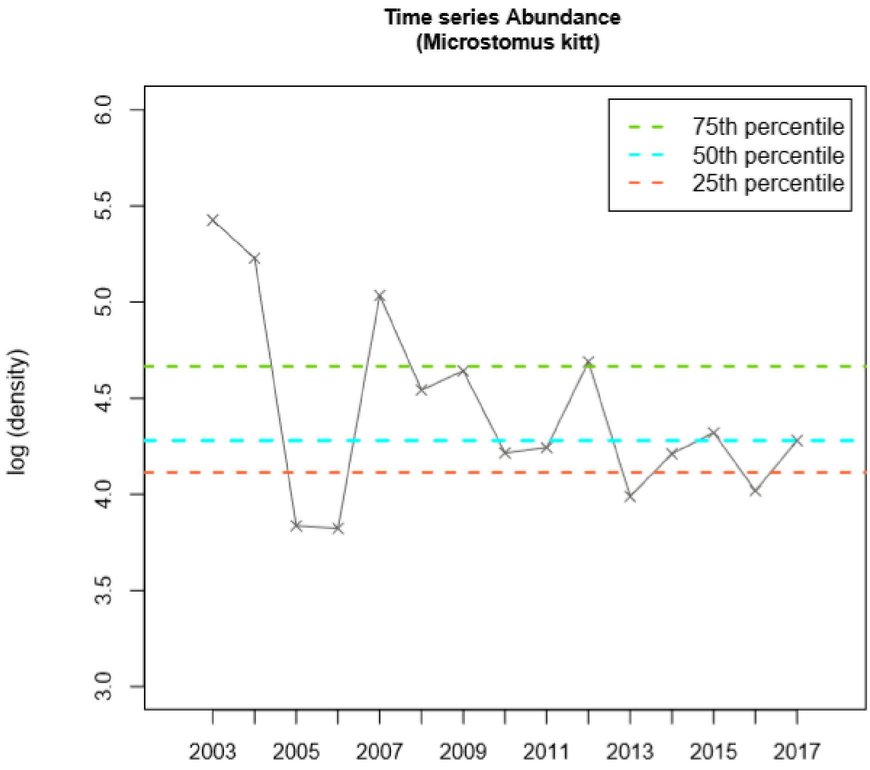


Fig 8. Abundance trends (upper panel) in number per km^2 for John dory (*Zeus faber*), showing 75th, 50th and 25th percentiles. Abundance is below the 50th percentile for this commercial species, so it is below the threshold for GES; and contribution over time (2003-2017) by individual survey (lower panel).



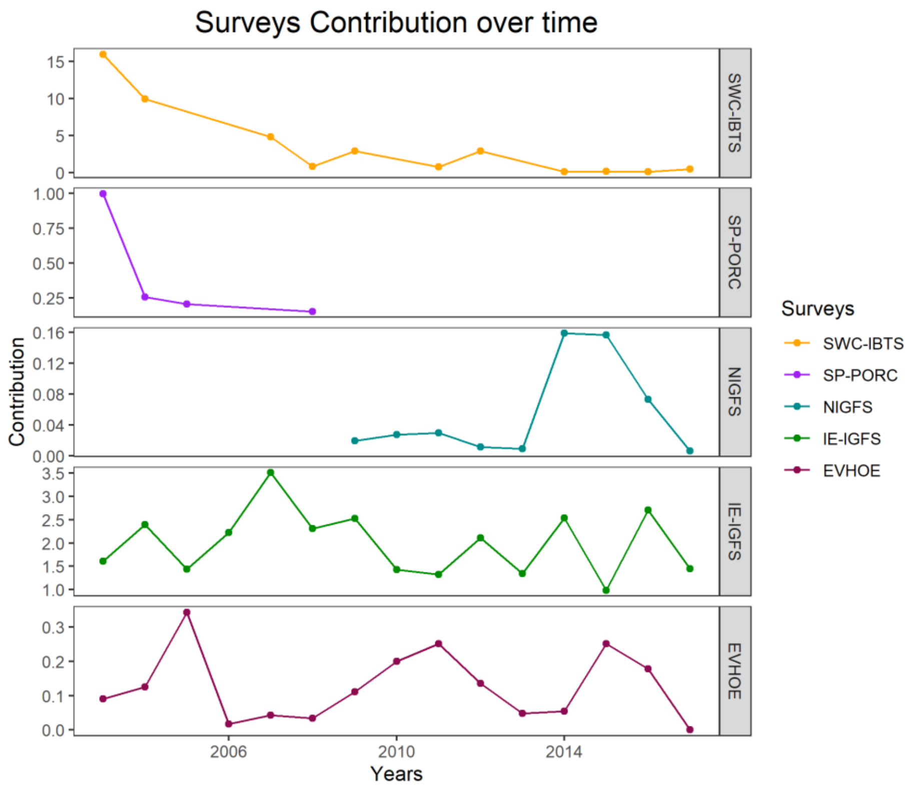
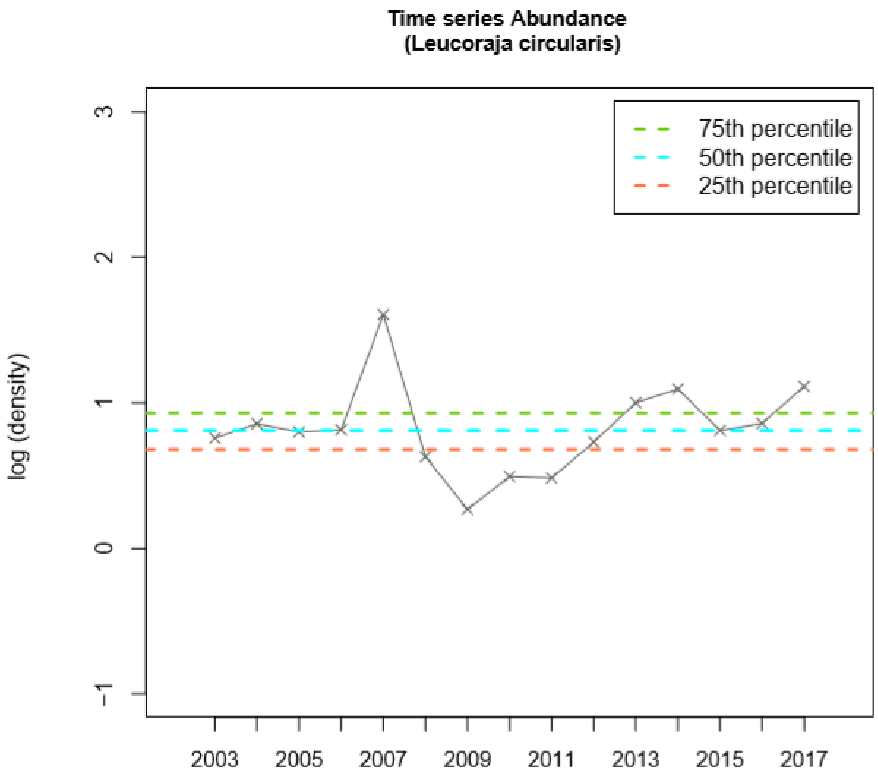


Fig 9. Abundance trends (upper panel) in number per km^2 for lemon sole (*Microstomus kitt*), showing 75th, 50th and 25th percentiles. Abundance is above the 50th percentile for this commercial species, so it is above the threshold for GES; and contribution over time (2003-2017) by individual survey (lower panel).



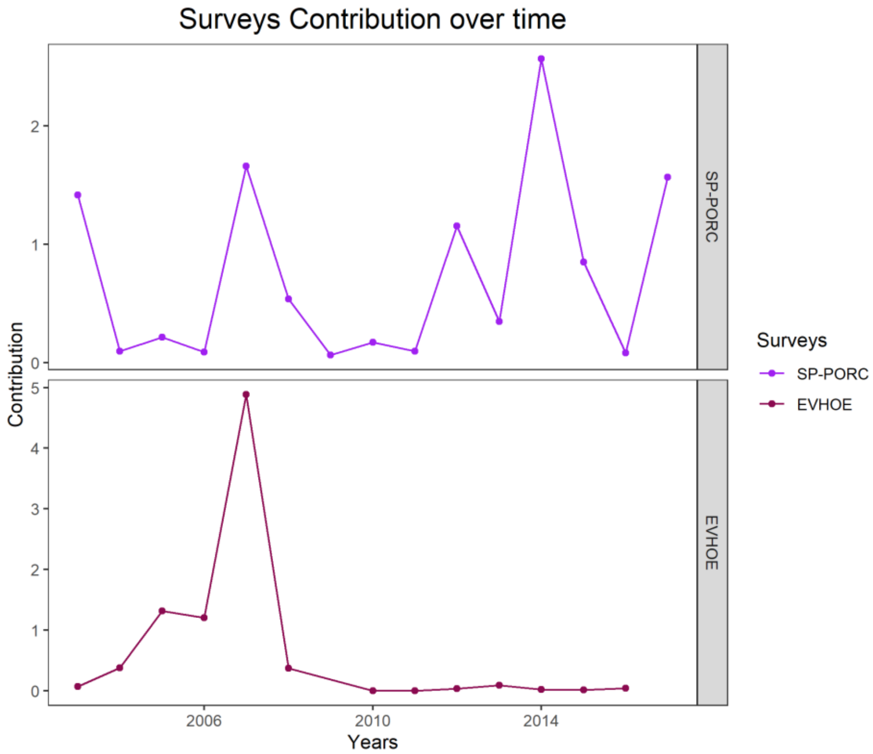


Fig 10. Abundance trends (upper panel) in number per km^2 for sandy ray (*Leucoraja circularis*), showing 75th, 50th and 25th percentiles. Abundance is above the 50th percentile for this commercial species, so it is above the threshold for GES; and contribution over time (2003-2017) by individual survey (lower panel).

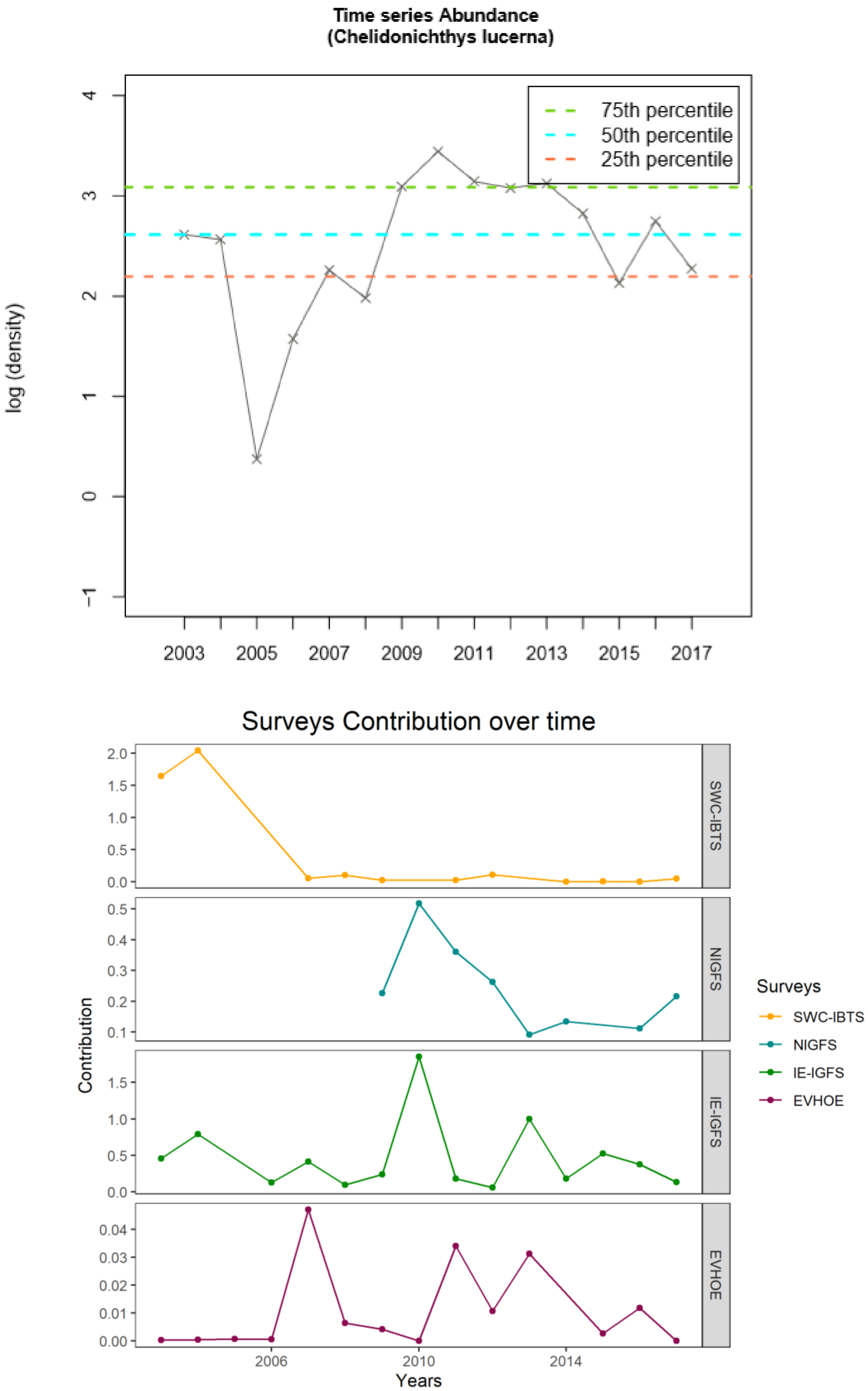
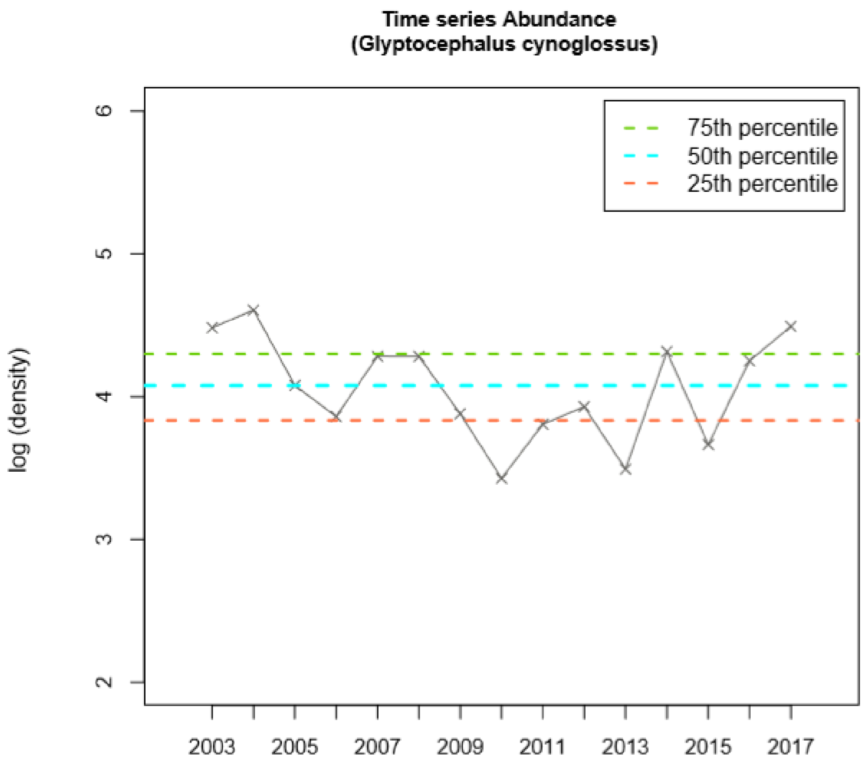


Fig 11. Abundance trends (upper panel) in number per km^2 for tub gurnard (*Chelidonichthys lucerna*), showing 75th, 50th and 25th percentiles. Abundance is below the 50th percentile for this commercial species, so it is below the threshold for GES; and contribution over time (2003-2017) by individual survey (lower panel).



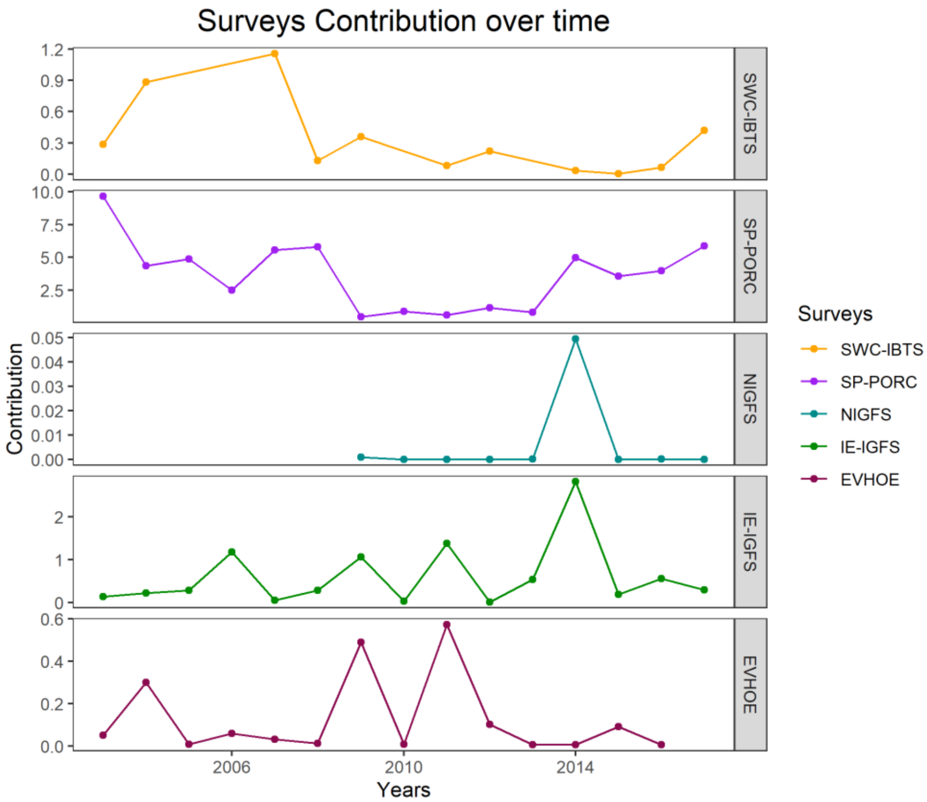


Fig 12. Abundance trends (upper panel) in number per km^2 for witch flounder (*Glyptocephalus cynoglossus*), showing 75th, 50th and 25th percentiles. Abundance is above the 50th percentile for this commercial species, so it is above the threshold for GES; and contribution over time (2003-2017) by individual survey (lower panel).

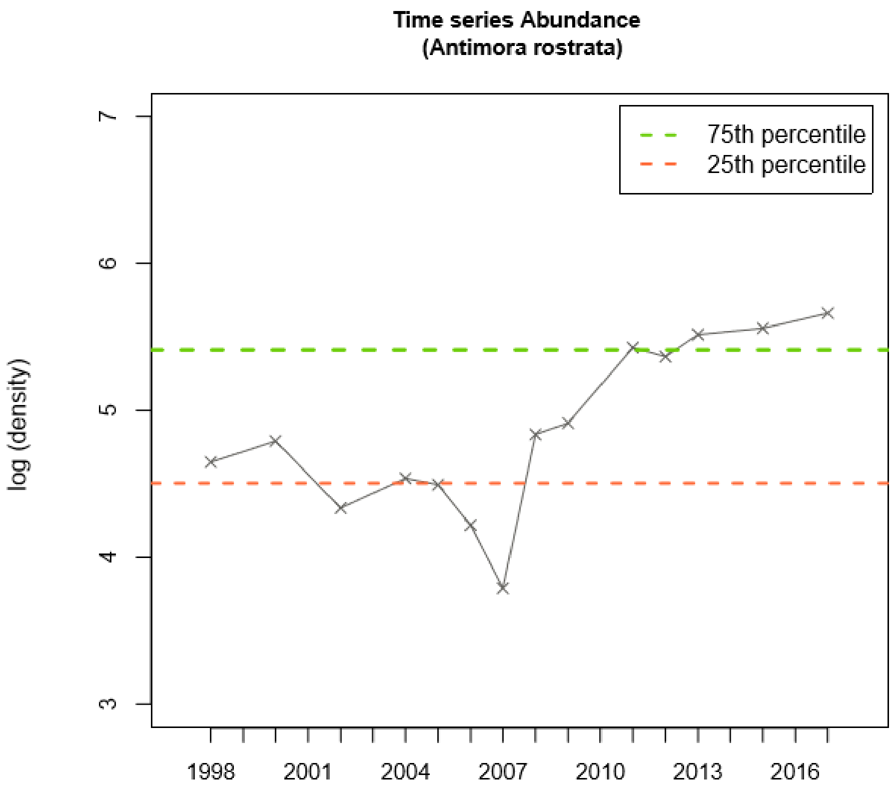


Fig 13. Abundance trends in number per km² for antimora (*Antimora rostrata*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

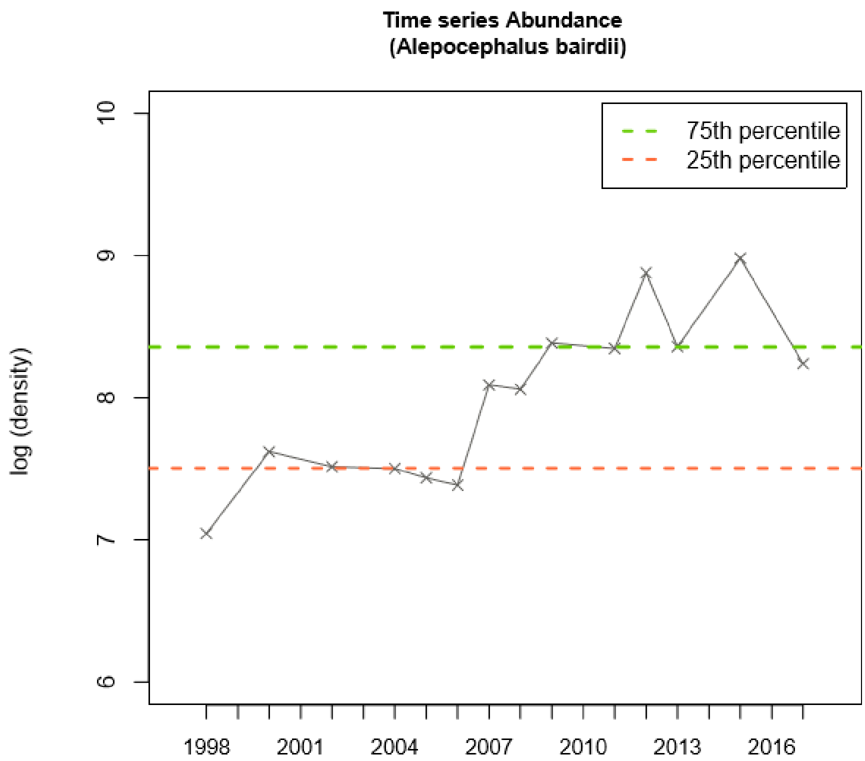


Fig 14. Abundance trends in number per km² for Baird's smoothhead (*Alepocephalus bairdii*), showing 75th and 25th percentiles. Abundance is below the 75th percentile for this non-commercial species, so it is below the threshold for GES.

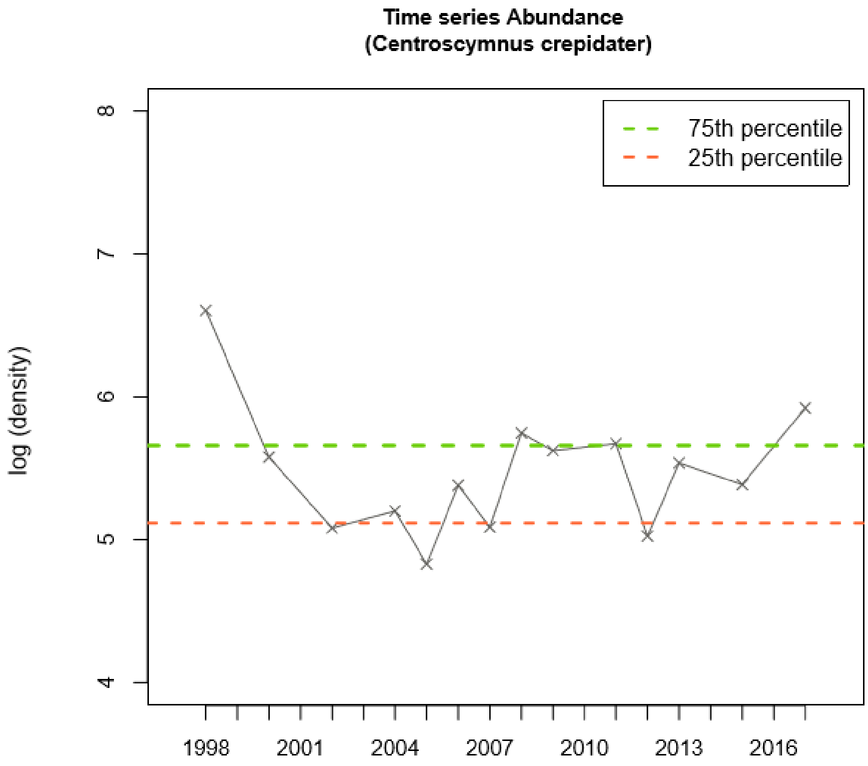


Fig 15. Abundance trends in number per km² for longnose velvet dogfish (*Centroscymnus crepidater*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

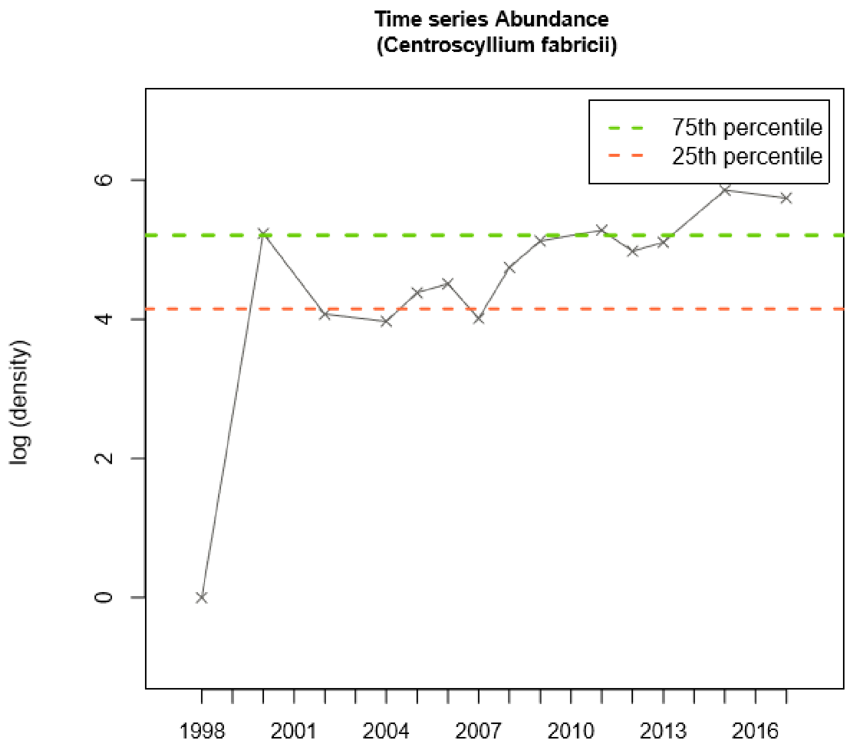


Fig 16. Abundance trends in number per km² for black dogfish (*Centroscyllium fabricii*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

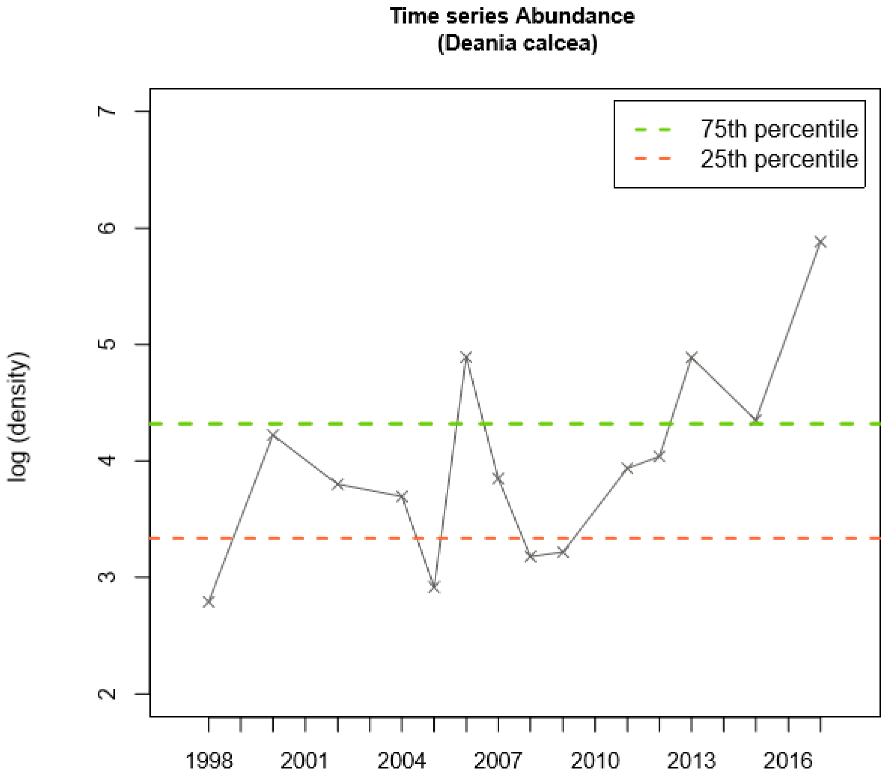


Fig 17. Abundance trends in number per km^2 for birdbeak dogfish (*Deania calcea*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

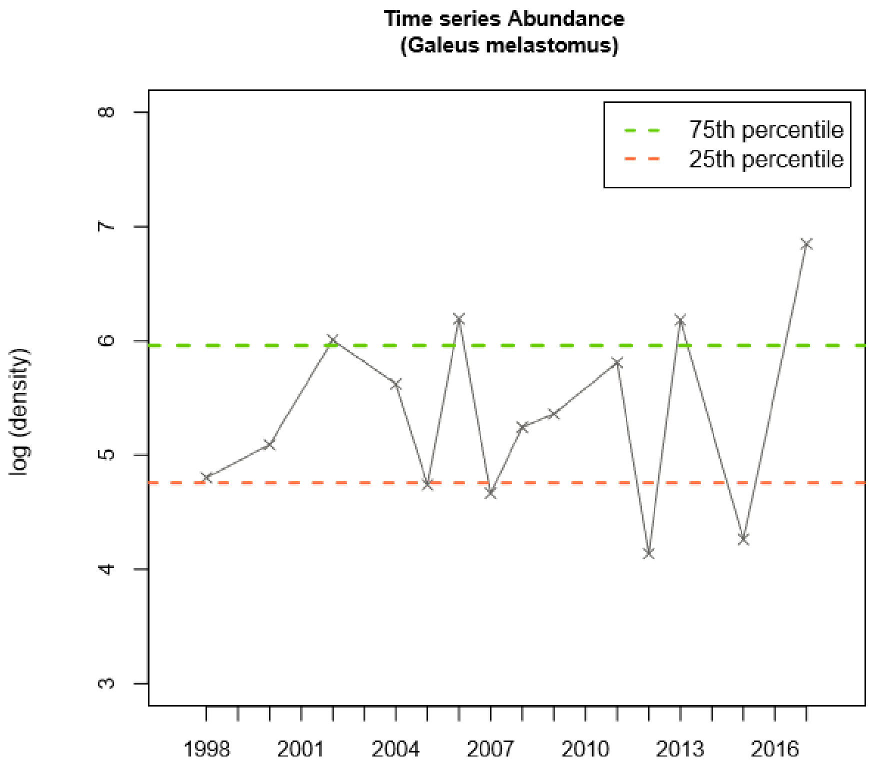


Fig 18. Abundance trends in number per km^2 for blackmouth catshark (*Galeus melastomus*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

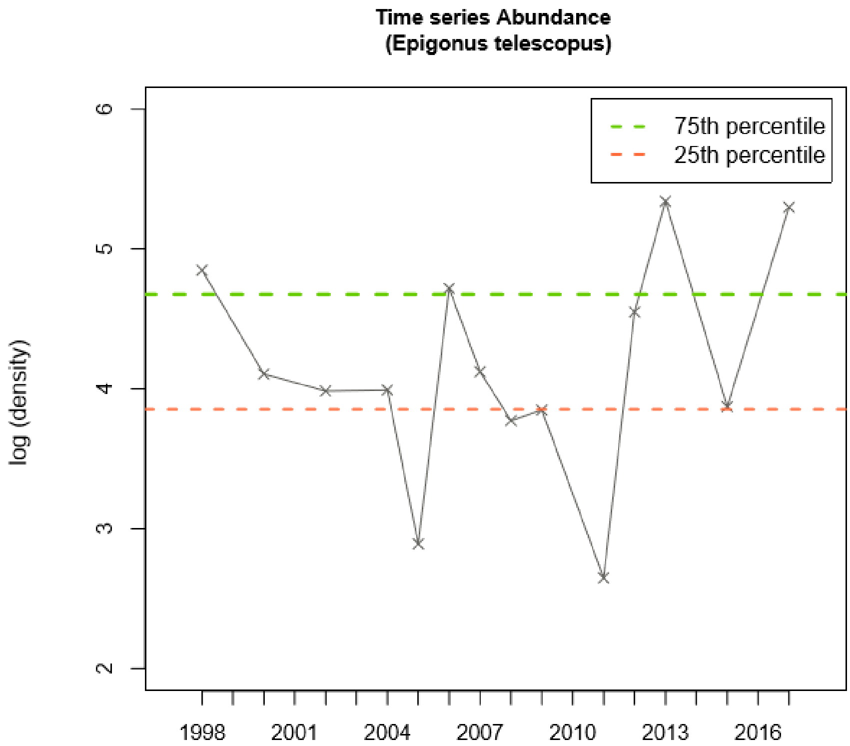


Fig 19. Abundance trends in number per km^2 for bigeye (*Epigonus telescopus*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

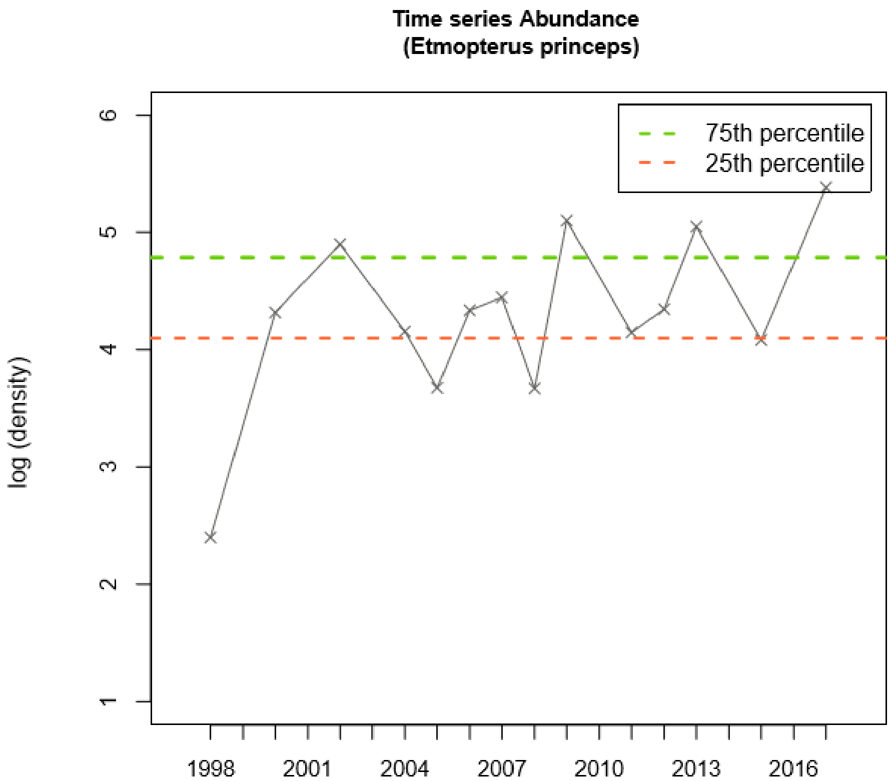


Fig 20. Abundance trends in number per km^2 for lanternshark (*Etmopterus princeps*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

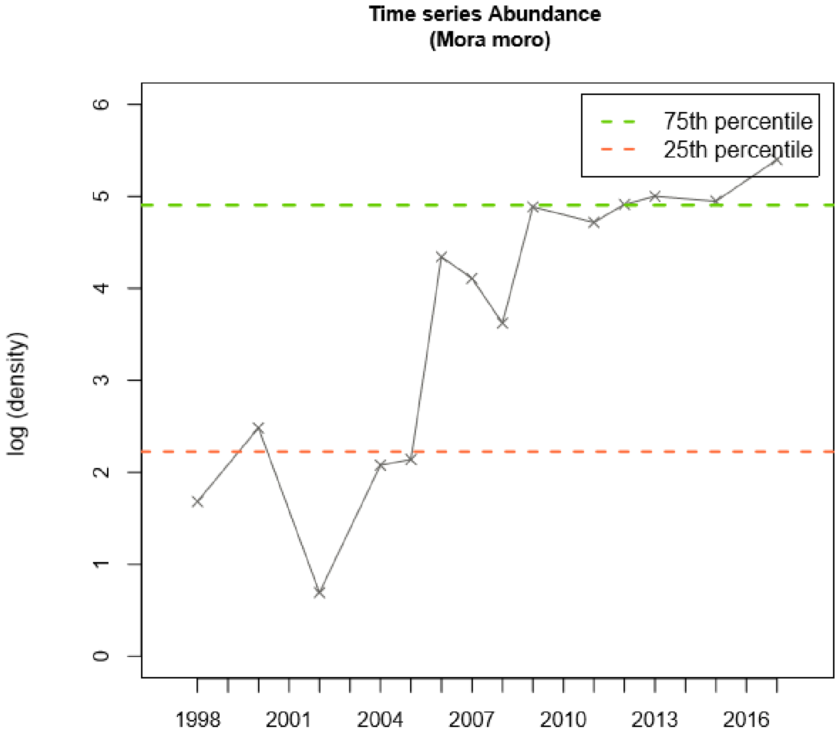


Fig 21. Abundance trends in number per km^2 for mora (*Mora moro*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

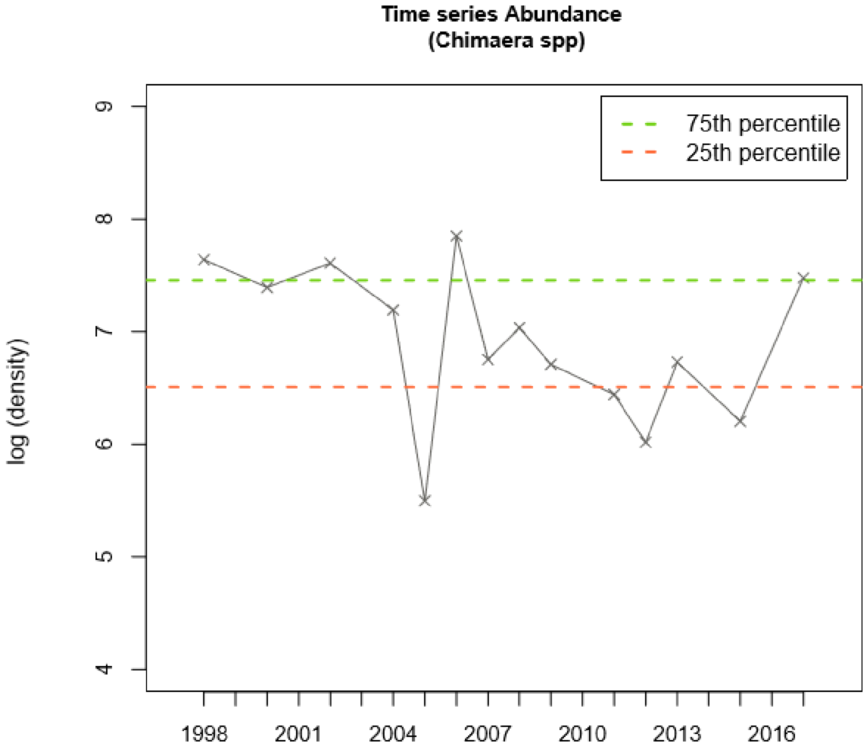


Fig 22. Abundance trends in number per km^2 for rabbitfish (*Chimaera spp.*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

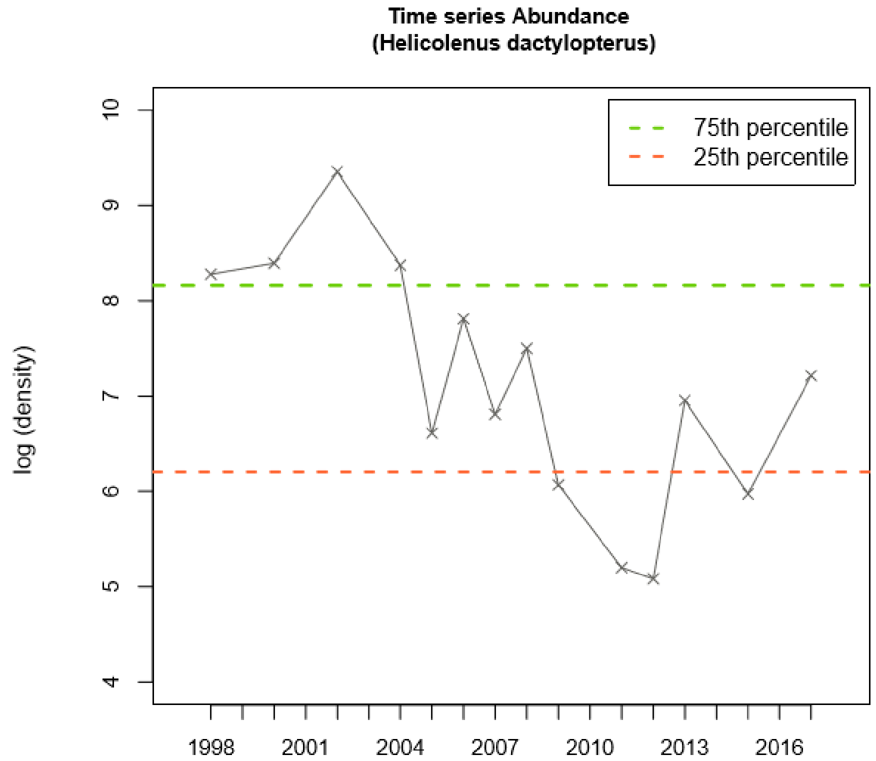


Fig 23. Abundance trends in number per km² for bluemouth (*Helicolenus dactylopterus.*), showing 75th and 25th percentiles. Abundance is below the 75th percentile for this non-commercial species, so it is below the threshold for GES.

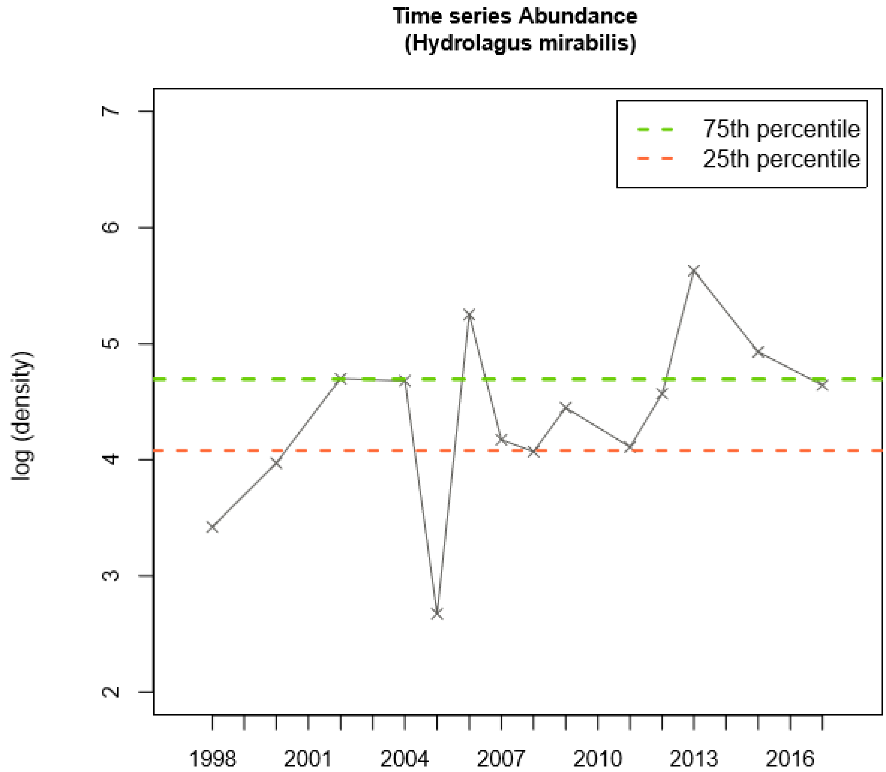


Fig 24. Abundance trends in number per km² for large-eyed rabbitfish (*Hydrolagus mirabilis*), showing 75th and 25th percentiles. Abundance is below the 75th percentile for this non-commercial species, so it is below the threshold for GES.

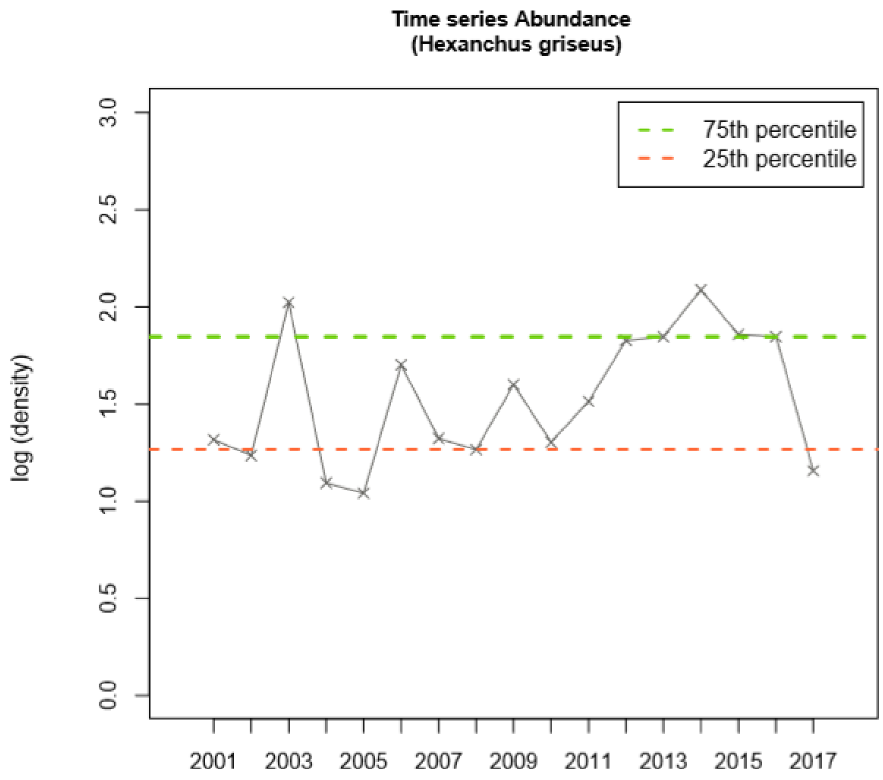


Fig 25. Abundance trends in number per km² for sixgill shark (*Hexanchus griseus*), showing 75th and 25th percentiles. Abundance is below the 75th percentile for this non-commercial species, so it is below the threshold for GES.

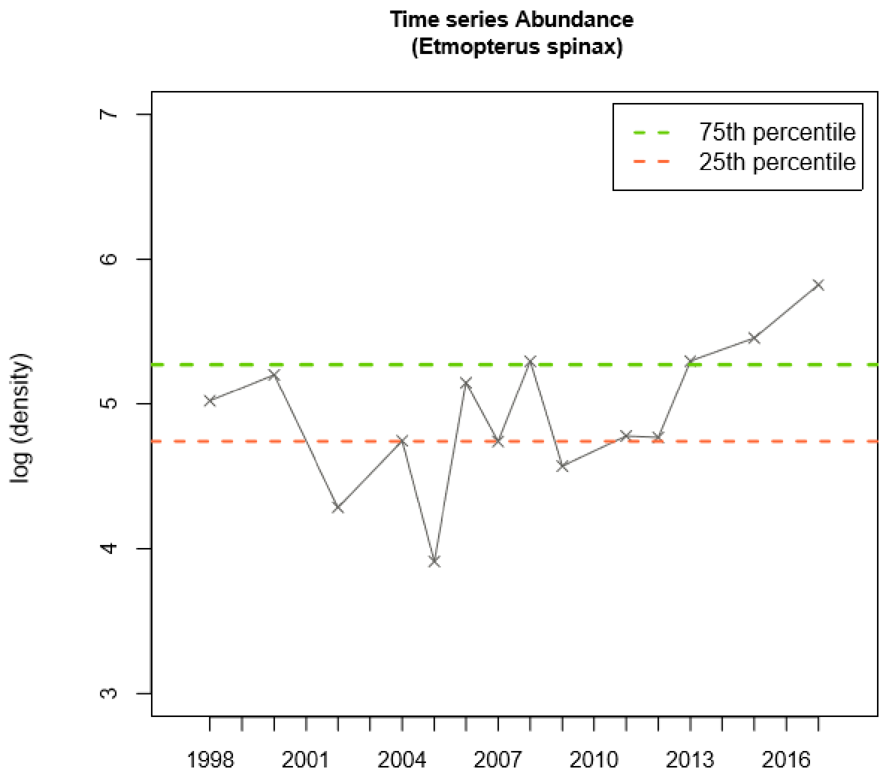


Fig 26. Abundance trends in number per km² for velvet belly lanternshark (*Etmopterus spinax*), showing 75th and 25th percentiles. Abundance is above the 75th percentile for this non-commercial species, so it is above the threshold for GES.

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