Pembroke Abstraction Licence Renewal Supporting Information: Trend Analysis

Document no: JUKL/B2386202/LIC/R09
Revision: 0

RWE Generation UK Plc

Pembroke Marine Monitoring
1 December 2024

Executive summary

This report has been prepared in support of the Abstraction Licence Renewal for Pembroke Power Station. It is part of a suite of documents that provide the relevant information and analysis requested by Natural Resources Wales.

This report is provided to respond to the following request from NRW to RWE:

Provision of species-specific trend analysis: this has not been provided. Charts showing monthly impingement of three species (sprat, sand smelt, poor cod) over the monitoring period is provided but nor [sic] *formal trend analysis has been applied to test for the presence of trends in these species or any other species.*

The report presents a summary of the trend analysis for the species impinged at Pembroke Power Station. As part of the request to examine individual species trends in the impingement dataset, NRW proposed an example method that had been undertaken as part of the Hinkley C assessment work, referred to as the 'Hinkley method'. Additional analyses have been completed as part of this report due to variation in normality of the distribution of the impingement data.

The results of this report indicate that there are no unexpected trends within the fish communities present in the Haven; species showing decreasing trends in the impingement data show increasing trends within the wider community, concluding that abstraction is not having an impact on populations. There is no change in the conclusions of the wider Pembroke Environmental Monitoring Programme, or in the Habitats Regulations Assessment (HRA) document in support of the Abstraction Licence Renewal.

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1. Introduction

This report has been prepared as part of the series of documents to support the Abstraction Licence Renewal for Pembroke Power Station. The suite of documents provides the relevant information requested by Natural Resources Wales (NRW) in their letter dated 11th June 2024, reference PAN-025790 and subsequent explanatory emails.

1.1 Abstraction

Water is abstracted year-round from Pennar Gut for non-evaporative cooling of RWE Generation UK plc's (RWE) Pembroke Power Station. Cooling water is drawn from Pennar Gut, at the mouth of the Pembroke River, and discharged back into the Milford Haven. The current licence (see below) is due to expire on the 31st March 2025.

The existing licence (22/61/06/0156) was originally granted by Environment Agency Wales (EAW) on the 3rd of February 2009, and reissued by NRW on the 21st November 2014 to reflect the change in name of the Competent Authority. The licence allows the following maximum quantities of water to be abstracted from Pennar Gut, Pembroke Dock (NGR SM9365402652):

- 144,000 cubic meters per hour
- 3,456,000 cubic metres per day
- 1,200,000,000 cubic metres per year
- at an instantaneous rate not exceeding 40 cubic metres per second.

1.2 Document Aim

The aim of this report is to provide the additional information requested by NRW in email correspondence and their PAN-025790 letter around the trend analysis work. RWE have responded to specific requests for further work which has prompted additional requests which have included the following elements:

Provision of species-specific trend analysis (Email from NRW permit officer dated 6th February 2024)

Provision of species-specific trend analysis: this has not been provided. Charts showing monthly impingement of three species (sprat, sand smelt, poor cod) over the monitoring period is provided but nor [sic] *formal trend analysis has been applied to test for the presence of trends in these species or any other species.* (PAN-025790 letter dated 11th June 2024)

Point 5 (Provision of species-specific trend analysis) - Again, we consider further work than proposed is necessary. To clarify, we consider that trend analysis for impingement/entrainment data of individual species is what is needed, rather than trend analysis of the overall impingement data. This could be used to identify any species whose trend is reducing in the monitoring data and therefore merit further assessment to understand the influence of Pembroke Power Station or other factors in the reducing trend. An example would be Appendix E of the attached report for Hinkley Point C. (Email from Senior marine advisor dated 5th July 2024)

Point 5 – If no negative trend is observed for a species then this will help to add strength to the argument for the operation of the power station not affecting that species, and so it can act as a screening exercise to identify species of potential concern for the assessment. (Email from NRW senior permitting officer, dated 28th August 2024).

This document has been prepared to respond to this comment and provide trend analysis for the species impinged at Pembroke Power Station. Several methods have been presented to provide NRW with the specific analysis that they have requested, but also other methods have been used for a more complete view of the data.

1.3 Context

The data set held for Pembroke is extensive with an ongoing large-scale environmental monitoring programme looking at all aspects of the marine ecology of the Haven. No single element of this programme is looked at in isolation as there are links and influences from each component of the community and a holistic interpretation provides a more accurate view. The fisheries component of the monitoring focuses on four main aspects:

- Entrapment surveys (impingement and entrainment);
- Ichthyoplankton surveys in the Haven;
- Subtidal fish surveys; and
- Intertidal fish surveys.

The data from each of these surveys is analysed and reviewed to provide an assessment of any patterns present within the data. Change in fish communities is to be expected as they respond to a range of varying biotic and abiotic influences. The purpose of the fish monitoring since operation of the power station commenced was to monitor changes observed in the communities and to inform an assessment of whether any change could be attributed to operation of the power station, alongside its significance in the context of the SAC. The overall aim of the assessments undertaken for the Pembroke Environmental Monitoring Reports are:

- Assess changes in the fish community assemblages over the full monitoring period. This is achieved through investigating the changes in the following data as a time series throughout the monitoring period:
  - Community abundance and composition of all data sets, including statistical analysis;
  - Community diversity;
  - Functional guilds of juvenile and adult fish; and,
  - Fish community age structure.
- If a change is detected, an assessment is made as to whether it is significant from an ecological and conservational perspective. The ecological significance of a detectable change is based on expert judgement which takes into consideration, among others: the magnitude of the change compared to natural variability, potential gaps in individual datasets and sensitivity of any features. This is achieved through:
  a. Statistical analysis of community abundance and composition;
  b. Persistence analysis of the taxa recorded during the monitoring programme, to investigate their presence at different life stages and in different areas of the estuary;
  c. Trend analysis of the intertidal and subtidal fish data;
  d. Specific records of species of conservation interest; and,
  - Comparison with historic datasets and data from NRW's own monitoring programme.
  2) If a significant change is detected, the cause is investigated to assess whether it is attributable to power station operation. This is achieved through a detailed discussion of all results as a whole for the fish community of Milford Haven.

This context is important as trends observed in the impingement data need to be reviewed in the context of what is happening in the wider communities of the Haven, rather than in isolation. This report provides an overview of the trend analysis completed on the impingement data and also pulls information through from the wider data sets as appropriate.

2. Methods

2.1 Statistical overview

In the request to examine individual species trends within the impingement dataset, NRW provided an example method that had been undertaken as part of the Hinkley C assessment work[1], referred to here as the 'Hinkley method'. The Hinkley method used the Mann-Kendall Statistic to look at the different distribution of fish populations in different months of the year; specifically, the Seasonal Kendall Test was used which is insensitive to seasonality and tests each month.

To accompany the seasonal Mann-Kendall results, the Hinkley method also presents plots of the data so that patterns of change can be observed (such as a fluctuating population that increases and decreases with time). Where statistically significant trends were found, plots of the data were presented with a LOESS[2] smoothing curve to visually show the trends. The use of LOESS is a method of regression analysis that is relevant to data that are not normally distributed (non-parametric) so tests for distribution should be applied to ensure accurate use of the method; the distribution of data is not stated in the Hinkley method therefore it is assumed that the use of a non-parametric test it is relevant to all species.

It is acknowledged that the Hinkley method was the proposed example by NRW in their information request, however additional analysis has been completed for the Pembroke data set to thoroughly examine the trends in the data. Analysis of the data has been explored on a monthly and yearly basis for both geometric mean and arithmetic mean scaling methods. As a result of this, a series of statistical tests is required as some of the data show a normal distribution and therefore a parametric method is more appropriate for the trend analysis in that instance.

The following assessment has been completed:

- Initially the data were assessed for the normality (or otherwise) of its distribution using the Shapiro-Wilk test to determine if a parametric or non-parametric approach was to be used for the remaining analysis.
- To identify trends within the data either a linear regression (parametric) or Mann-Kendall (non-parametric) was used.
- LOESS plots were created for all species showing a significant trend (following the 'Hinkley Method').
- To supplement the trend analysis a further analysis of variance (either ANOVA or Kruskall-Wallis) was used to determine the statistical significance of any variation observed within the data. Post-hoc testing (Tukey or Dunne tests) was used to determine the sources of variation within the data set. Overall, this allows for the identification of any trends within the data and analysis of the significance and ultimate source of identifiable trends.

2.2 Data used

The above approach has been applied to all species within the Pembroke impingement data where there are more than three records of a species across the data set. It is not considered appropriate to apply a trend to smaller data sets as little can be concluded.

Owing to the way that the impingement data at Pembroke is calculated, the analysis has been carried out on both geometric and arithmetic data sets using monthly and yearly data for completeness. The above methods have also been applied to the intertidal and subtidal data sets to identify if trends observed within

[1] Robinson,B., Walmsley, S., & Maxwell, D. (2018). Revised Predictions of Impingement Effects at Hinkley Point C – 2018. Technical report HPC-DEV024-XX-000-RET-100031.

[2] A LOESS (Locally estimated scatterplot smoothing) smoothing curve is a trendline applied to a scatterplot that creates a smooth line through the data.

the impingement data were also seen across the wider data set. Impingement data have been analysed for trends between 2012 and 2022[3] and wider communities have been assessed between 2009 and 2022 for completeness.

[3] 2012 data have been used in this reporting as they are appropriate for the examination of trends.

3. Results and Discussion

The full results of the statistical tests undertaken are provided in Appendices A, B and C and present the findings of the trend analysis. Table 1 below provides a visual summary of the results of trend analysis across the full fish programme. The table shows all significant trends found within the impingement data for both the arithmetic and geometric mean scaling methods.

Of the 88 species identified within the impingement programme, 73 had more than three observations across the monitoring period. Of these, 28 showed significant trends with the seasonal Mann-Kendall or regression (method dependant on normality of data); two were increasing trends (corkwing wrasse and wrasse indet), with the remainder showing statistically significant decreasing trends. As outlined in Section 2.2 interpretation of impingement data in isolation could result in misleading conclusions therefore trends within the intertidal and subtidal data sets were reviewed for the same species (where available) to look at trends in the wider communities; these are also presented in Table 1. All species within the intertidal data set showed increasing trends (nine of which were significant). The subtidal data showed a mix of increasing and decreasing trends with some being significant (Table 1).

Table 1: Summary table showing the results of the trend analysis for those 28 species where a significant trend was reported. Results across all data sets is provided. Cells highlighted orange with ↓ show a decreasing trend and cells highlighted green with ↑ show an increasing trend. Both ** and * in the cells denote a statistically significant trend.

Common name	Functional Guild	Number of observations	Impingement (2012 – 2022)		Intertidal (2009 to 2022)	Subtidal (2009 – 2022)
			Arithmetic	Geometric		
15-spined stickleback	Estuarine resident	237	** ↓	** ↓		↑
Bib	Marine juvenile	124	** ↓	** ↓	↑	** ↓
Black goby	Estuarine resident	156	** ↓	** ↓	↑	↓
Cod	Marine juvenile	28	** ↓	** ↓	↑	** ↓
Common goby	Estuarine resident	272	** ↓	** ↓	* ↑	
Corkwing wrasse	Estuarine resident	87	* ↑	* ↑	* ↑	↓
Dab	Marine juvenile	47	** ↓	** ↓		** ↓
Dover sole	Marine Juvenile	15	** ↓	** ↓		↓
European eel	Migratory	104	** ↓	** ↓	↑	↑
Flounder	Estuarine resident	121	** ↓	** ↓	* ↑	** ↓
Garfish	Marine seasonal	16	** ↓	** ↓	* ↑	
Gobiidae	Estuarine resident	33	** ↓	** ↓	* ↑	
Grey gurnard	Marine seasonal	134	** ↓	** ↓		** ↓
Herring	Marine juvenile	165	** ↓	** ↓	* ↑	** ↓
Lesser sandeel	Estuarine resident	24	** ↓	** ↓	↑	
Lesser weever	Marine adventitious	7	** ↓	** ↓		

Common name	Functional Guild	Number of observations	Impingement (2012 – 2022)		Intertidal (2009 to 2022)	Subtidal (2009 – 2022)
			Arithmetic	Geometric		
Lesser-spotted dogfish	Marine adventitious	211	** ↓	** ↓		** ↓
Mackerel	Marine adventitious	13	** ↓	** ↓		↑
Mullet indet.[4]		85	** ↓	** ↓	↑	
Painted goby	Marine adventitious	159	** ↓	** ↓	↑	
Plaice	Marine juvenile	77	** ↓	** ↓	* ↑	** ↓
Pogge	Estuarine resident	28	** ↓	** ↓		↓
Poor cod	Marine adventitious	199	** ↓	** ↓		** ↓
Sand goby	Estuarine resident	266	** ↓	** ↓	* ↑	
Sandeel indet.		9	** ↓	** ↓		
Short-spined sea scorpion	Estuarine resident	21		** ↓		
Sprat	Marine seasonal	216	** ↓	** ↓	* ↑	** ↓
Wrasse indet.		5	* ↑	* ↑		

3.1 SAC species

Milford Haven is a component of the Pembrokeshire Marine Special Area of Conservation (SAC) owing to the diverse habitats for marine flora and fauna created by the presence of rocky, sandy and muddy substrata. In terms of fish species there are four listed as 'Annex II' species and are:

- sea lamprey (*Petromyzon marinus*);
- river lamprey (*Lampetra fluviatilis*);
- Allis shad (*Alosa alosa*); and
- Twaite shad (*Alosa fallax*).

These species are known to migrate through Milford Haven to the Pembroke and Cleddau Rivers but only sea lamprey have occasionally been recorded from the impingement programme. The results of the trend analysis did not identify a significant trend in the sea lamprey numbers with the Mann-Kendall statistic identifying a very slight decreasing trend (tau=0.05, p=0.21, Table A-1 and Table A-2). The results of the analysis show that operation of the power station is having no discernible effect on these qualifying species of the SAC.

[4] Indet. is used when further identification was not possible (often a result of damage)

3.2 Other species of conservation concern

3.2.1 Section 7 species

Species listed under Section 7 of the Environment (Wales) Act 2016, represent those of principal importance in Wales. This list is a key reference for all statutory and non-statutory bodies involved in operations that affect biodiversity in Wales. Several species listed in Section 7 have been recorded from the impingement monitoring programme and are summarised along with the trend analysis results in Table 2 below.

Table 2: Trend analysis results for Section 7 species (Bold text in the interpretation column denote a significant result)

Common Name	Tau	P value	Interpretation
Plaice	-0.146	0.014	**Decreasing trend**
Thornback ray	0.019	0.673	Increasing trend
Cod	-0.096	0.047	**Decreasing trend**
Whiting	-0.107	0.106	Decreasing trend
Dover sole	-0.076	0.048	**Decreasing trend**
Mackerel	-0.076	0.018	**Decreasing trend**
Scad/horse mackerel	-0.057	0.217	Decreasing trend
European eel	-0.207	0.001	**Decreasing trend**
Raitt's sand eel	-0.057	0.060	Decreasing trend
Sea trout	-0.026	0.401	Decreasing trend
Long-snouted seahorse	0.007	0.812	Increasing trend

Only five of the trends identified above were found to be significant. The corresponding trends in the wider fish data show increasing trends (Table 1) with the exception of Dover sole which also has a negative trend in the subtidal data (result is not significant and the species is not caught in the intertidal data). This is showing that negative trends in the impingement data are not being seen in the wider community (Table 1).

The result for Dover sole, whilst showing a negative trend, needs to be treated with caution as it is based on only 15 observations which were primarily early in the monitoring programme (pre 2017), although the species was recorded again in 2022 (Appendix B and C). Dover sole is a marine juvenile species spending time in estuaries as young fish before moving out to deeper water, therefore is not present throughout the year and is subject to wider anthropogenic influences, such as being targeted as a commercial fishery. Results of the ANOVA highlight that differences relate to the abundance in 2014 being greater than those in 2013, and 2017-2021 and 2015 being greater than those in 2012, 2013, and 2016-2021 (Appendix D). Examining the trend in annual abundance for Dover sole shows a decreasing trend that is not significant (Table A-3 and Table A-4).

3.3 Other species

With reference to Table 1 above the only species where a decreasing trend is observed in the impingement data as well as the wider fish data are Dab, Dover sole (discussed in Section 3.2.1), grey gurnard, lesser weever, lesser spotted dogfish, pogge, poor cod, sandeel indet, and short-spined sea scorpion.

Of importance to the analysis is the functional guild of the species. This shows the behaviour of the fish and their use of estuarine and marine habitats. The community composition of the Haven is a mixed assemblage with species utilising the estuary for certain life stages (marine juvenile and marine adventitious), those that move through during migratory passage (migratory) and those that remain in the estuary permanently (estuarine resident). The vast majority of marine species spend a proportion of their life outside of estuaries where they are subject to environmental and predation pressures.

Downward trends in those species that are not permanently within the estuary are reflective of shifts in wider stocks and are subject to varying anthropogenic influences, therefore attribution to a specific cause is not possible. Examination of the LOESS plots for these species (Appendix B and Appendix C) show a fluctuating population with increases and decreases in abundance over the programme highlighting the natural fluctuations in the species. Trends within the estuarine residents reflect what is happening within the estuary system and are more relevant to assessment of effect from station operations.

3.3.1 Estuarine residents

Of the species identified in Section 3.3 as having a decreasing trend within the impingement, 10 were identified as estuarine residents. From these estuarine residents only two species also showed decreasing trends within the wider fish data sets, these being pogge, and short-spined sea scorpion. The results of the trend analysis for these species is shown in Table 3.

Table 3: Trend analysis results for Estuarine resident species (Bold text in the interpretation column denote a significant result * denotes that a significant trend was only observed within the geometric mean data)

Common Name	Tau	P value	Interpretation
Pogge	-0.126	0.004	**Decreasing trend**
Short-spined sea scorpion	-0.085	0.046	**Decreasing trend***

Pogge have been identified in the impingement data set throughout the monitoring period but in low numbers with only 28 observations between 2012 and 2021 and a maximum of four individuals on any one occasion. They have been absent from the intertidal monitoring programme and have only been identified twice within subtidal monitoring, therefore are rare within the data. Pogge tend to stay inshore with a preference for sandy bottoms where they feed on crustaceans and polychaetes. The results of the ANOVA (Appendix D) show the trend is driven by differences between 2012 and 2014, 2013 and 2014 as well as 2014 and 2015, 2018-2021. The LOESS plot for pogge shows the distribution throughout the period and that they are present within more recent monitoring at levels similar to previous years. With a species that is so rare within the data, it is not appropriate to draw conclusions for any trends observed. The fact that the species is still within the data set (having been present in recent years) shows that it is still present within the wider fish community and part of the functioning of the estuary. It is not considered that the station operation is a key driver in the patterns observed within the data; the species is rare in the whole monitoring dataset.

Short-spined sea scorpions are also rare within the data set with records across only 21 occasions and a maximum of two individuals on any one occasion. They have only been present in the intertidal data sets during 2009 and 2010 and are absent from the subtidal monitoring. A decreasing trend was only identified from the geometric mean data set, with the trend in arithmetic showing as not significant (p=0.057). No significant trends were observed within the yearly analysis. Short-spined sea scorpions tend to prefer rocky bottoms with sand or mud and to reside amongst seaweed. This is likely the reason why they are not caught during the wider monitoring programmes and are rarely identified within the impingement data. The LOESS plot for the short spined sea scorpion shows an absence during 2018 and 2019, however data from more recent years (2020/2021) is comparable to earlier in the environmental monitoring programme and there is no evidence of a continual decline with the trend being influenced by the small and intermittent data set.

Based on the increasing trends of the more common estuarine resident species within the wider intertidal and subtidal data sets (Table 1) and continual presence of the rarer species showing a decreasing trend (Appendix B and Appendix C), there is no evidence of the power station having an effect on the community as a whole.

3.3.2 Increasing trends

Two species within the impingement data reported significant increasing trends; corkwing wrasse and wrasse indet (Table 1). No conclusions can be drawn from an increasing trend in an unidentified species and just reflects either damaged species that could not be speciated or a size class that was too small for confident identification. Corkwing wrasse are showing an increasing trend in the impingement data as well as a significant increasing trend in the intertidal data set therefore impingement is not affecting numbers within the Haven.

4. Conclusions

- 73 species had trend analysis undertaken, of which 28 showed significant trends with the seasonal Mann-Kendall or regression (method dependant on normality of data).
- Corkwing wrasse and wrasse indet. showed increasing trends with the remainder showing statistically significant decreasing trends.
- All species within the intertidal data set showed increasing trends (nine of which were significant). The subtidal data showed a mix of increasing and decreasing trends with some being significant.
- Sea lamprey is the only SAC species to have been found in the impingement data. A decreasing trend was observed but it was not statistically significant.
- Of Section 7 species of principle importance only five showed significant decreasing trends. The corresponding trends in the wider fish data show increasing trends with the exception of Dover sole.
- Dover sole showed a significant negative trend on the impingement with a non-significant decreasing trend in the subtidal data. This is however, based on only 15 observations which were primarily early in the Pembroke Environmental Monitoring programme on a species that is marine juvenile therefore affected by anthropogenic influences outside of the Haven.
- The only species where a decreasing trend is observed in the impingement data as well as the wider fish data are dab, Dover sole, grey gurnard, lesser weever, lesser spotted dogfish, pogge, poor cod, sandeel indet, and short-spined sea scorpion. Of these only pogge, and short-spined sea scorpion are estuarine residents. Both species are rare within the data set and it cannot be concluded that abstraction is causing the decreasing trends.
- Two species had increasing trends but one was an unidentified species that cannot be used for trends and the other is corkwing wrasse which is also increasing in the intertidal data.

The results of the trend analysis presented in this report and the appendices do not highlight anything that is unexpected within the fish communities present in the Haven. Species that show decreasing trends within the impingement data show increasing trends in the wider community therefore it can be concluded that abstraction is not having an impact on populations. There has been considerable work at Pembroke Power Station to improve the efficiency of the mitigation measures installed, and these improvements are likely leading to reduced abundances on station.

The analysis presented does not change any of the conclusions of the wider Pembroke Environmental Monitoring Programme as reported annually to NRW. This monitoring has shown that seasonal fluctuations and patterns observed in the abundance and species composition of fish communities have not changed since the power station became operational with the population structure of the most common species remaining the same since pre-commissioning. Detailed technical assessments to date have shown only small differences in the overall fish community structure within Milford Haven over the period of construction, commissioning and operation of the power station. These differences reflect the complex life histories of the most numerous species present in the study area both within and outside the Haven, rather than a shift in community structure or fish abundance. Isolated high catches of some common species have been recorded over the years; however, these species spawn outside the Haven and therefore are not solely affected by conditions within the estuary. A decreasing trend in annual subtidal fish catches was first observed in 2007, prior to station operations; as such it is considered that it is likely part of a longer-term trend or cyclical pattern and not associated with power station operation.

The work presented in this document on species specific trend analysis does not change the conclusions made within the Habitats Regulations Assessment written in support of the current Abstraction Licence Renewal.

Appendix A. Additional information

Table A-1. Trends in Monthly geometric mean impingement data. MK statistic was applied to all species as non-parametric test was appropriate.

Common name	No. of observations	Test for normal distribution			Seasonal MK statistic		Interpretation
		Shapiro-Wilk	P		tau	P	
15-spined stickleback	237	0.503	<0.001		-0.174	**0.014**	Significant
2-spotted goby	20	0.345	<0.001		-0.044	0.258	
3-spined stickleback	57	0.253	<0.001		-0.037	0.494	
5-bearded rockling	163	0.583	<0.001		-0.057	0.362	
Ballan wrasse	28	0.545	<0.001		-0.024	0.655	
Bass	159	0.397	<0.001		0.094	0.149	
Bib	124	0.465	<0.001		-0.130	**0.042**	Significant
Black goby	156	0.601	<0.001		-0.417	**1.69E-09**	Significant
Brill	7	0.22	<0.001		-0.022	0.477	
Butterfish	73	0.727	<0.001		-0.052	0.388	
Clupeid indet.	156	0.158	<0.001		-0.074	0.295	
Cod	28	0.48	<0.001		-0.096	**0.047**	Significant
Common goby	272	0.267	<0.001		-0.335	**3.22E-06**	Significant
Corkwing wrasse	87	0.652	<0.001		0.133	**0.034**	Significant
Dab	47	0.565	<0.001		-0.148	**0.003**	Significant
Dover sole	15	0.391	<0.001		-0.076	**0.048**	Significant
Dragonet (common)	74	0.715	<0.001		-0.085	0.130	
Dragonet (Indet)	7	0.231	<0.001		0.028	0.312	
Dragonet (reticulated)	6	0.231	<0.001		0.004	0.941	
European eel	104	0.603	<0.001		-0.193	**0.003**	Significant
Flounder	121	0.67	<0.001		-0.413	**2.41E-10**	Significant
Gadoid indet.	16	0.352	<0.001		0.017	0.671	
Garfish	16	0.34	<0.001		-0.085	**0.017**	Significant
Gilthead sea bream	23	0.451	<0.001		0.011	0.819	
Gobiidae	33	0.395	<0.001		-0.204	**1.54E-04**	Significant
Golden grey mullet	128	0.541	<0.001		-0.037	0.558	
Goldsinny wrasse	8	0.231	<0.001		-0.017	0.563	
Greater pipefish	225	0.737	<0.001		-0.124	0.086	
Grey gurnard	134	0.494	<0.001		-0.200	**0.001**	Significant
Gurnard	14	0.297	<0.001		0.028	0.396	
Herring	165	0.511	<0.001		-0.280	**1.65E-05**	Significant
John dory	22	0.412	<0.001		-0.052	0.202	
Lesser sandeel	24	0.437	<0.001		-0.074	**0.049**	Significant
Lesser weever	7	0.229	<0.001		-0.069	**0.007**	Significant

Common name	No. of observations	Test for normal distribution			Seasonal MK statistic		Interpretation
		Shapiro-Wilk	P		tau	P	
Lesser-spotted dogfish	211	0.734	<0.001		-0.281	**3.48E-05**	**Significant**
Long-snouted seahorse	5	0.202	<0.001		0.007	0.812	
Long-spined sea scorpion	114	0.769	<0.001		0.039	0.562	
Lozano's goby	6	0.203	<0.001		0.019	0.475	
Lumpsucker	8	0.274	<0.001		-0.048	0.106	
Mackerel	13	0.31	<0.001		-0.076	**0.018**	**Significant**
Montagu's sea snail	10	0.278	<0.001		-0.007	0.846	
Mullet indet.	85	0.491	<0.001		-0.230	**6.06E-05**	**Significant**
Nilsson's pipefish	57	0.692	<0.001		0.013	0.844	
Painted goby	159	0.614	<0.001		-0.365	**1.09E-07**	**Significant**
Pilchard	52	0.49	<0.001		-0.076	0.123	
Pipefish indet	11	0.337	<0.001		-0.006	0.912	
Plaice	77	0.708	<0.001		-0.146	**0.014**	**Significant**
Pogge	28	0.482	<0.001		-0.126	**0.004**	**Significant**
Pollack	147	0.719	<0.001		0.083	0.225	
Poor cod	199	0.493	<0.001		-0.344	**5.47E-07**	**Significant**
Raitt's sandeel	14	0.272	<0.001		-0.057	0.060	
Rock goby	304	0.415	<0.001		-0.057	0.438	
Sand goby	266	0.196	<0.001		-0.230	**0.001**	**Significant**
Sand smelt	312	0.158	<0.001		-0.070	0.334	
Sandeel indet.	9	0.313	<0.001		-0.072	**0.028**	**Significant**
Scad/Horse Mackerel	30	0.221	<0.001		-0.050	0.285	
Sea lamprey	19	0.358	<0.001		-0.050	0.121	
Sea trout	9	0.275	<0.001		-0.026	0.401	
Shanny	18	0.423	<0.001		0.050	0.210	
Short-spined sea scorpion	21	0.446	<0.001		-0.085	**0.046**	**Significant**
Snake pipefish	163	0.627	<0.001		-0.094	0.170	
Solenette	5	0.176	<0.001		-0.031	0.153	
Sprat	216	0.244	<0.001		-0.220	**0.001**	**Significant**
Striped red mullet	21	0.343	<0.001		-0.061	0.108	
Thicked-lip grey mullet	10	0.279	<0.001		0.039	0.201	
Thin-lipped grey mullet	33	0.425	<0.001		0.050	0.283	
Thornback ray	17	0.437	<0.001		0.019	0.673	
Tompot blenny	24	0.506	<0.001		0.009	0.864	
Transparent goby	112	0.574	<0.001		0.065	0.321	
Tub gurnard	43	0.356	<0.001		-0.085	0.052	
Whiting	121	0.706	<0.001		-0.111	0.094	
Worm pipefish	24	0.501	<0.001		0.002	1.000	

Common name	No. of observations	Test for normal distribution			Seasonal MK statistic		Interpretation
		Shapiro-Wilk	P		tau	P	
Wrasse indet	5	0.204	<0.001		0.054	**0.029**	**Significant**

Table A-2. Trends in Monthly arithmetic mean impingement data. MK statistic was applied to all species as non-parametric test was appropriate.

Common name	No. of observations	Test for normal distribution			Seasonal MK statistic		Interpretation
		Shapiro-Wilk	P		tau	P	
15-spined stickleback	237	0.392	<0.001		-0.178	**0.012**	**Significant**
2-spotted goby	20	0.222	<0.001		-0.044	0.258	
3-spined stickleback	57	0.253	<0.001		-0.037	0.494	
5-bearded rockling	163	0.552	<0.001		-0.028	0.671	
Ballan wrasse	28	0.422	<0.001		-0.028	0.602	
Bass	159	0.312	<0.001		0.102	0.119	
Bib	124	0.465	<0.001		-0.126	**0.049**	**Significant**
Black goby	156	0.439	<0.001		-0.407	**3.58E-09**	**Significant**
Brill	7	0.22	<0.001		-0.178	0.436	
Butterfish	73	0.664	<0.001		-0.059	0.322	
Clupeid indet.	156	0.175	<0.001		-0.074	0.295	
Cod	28	0.305	<0.001		-0.096	**0.047**	**Significant**
Common goby	272	0.384	<0.001		-0.331	**4.13E-06**	**Significant**
Corkwing wrasse	87	0.312	<0.001		0.130	**0.040**	**Significant**
Dab	47	0.418	<0.001		-0.152	**0.002**	**Significant**
Dover sole	15	0.344	<0.001		-0.076	**0.048**	**Significant**
Dragonet (common)	74	0.591	<0.001		-0.074	0.189	
Dragonet (Indet)	7	0.217	<0.001		0.028	0.312	
Dragonet (reticulated)	6	0.195	<0.001		0.004	0.941	
European eel	104	0.394	<0.001		-0.207	**0.001**	**Significant**
Flounder	121	0.58	<0.001		-0.424	**7.84E-11**	**Significant**
Gadoid indet.	16	0.269	<0.001		0.009	0.832	
Garfish	16	0.233	<0.001		-0.089	**0.013**	**Significant**
Gilthead sea bream	23	0.252	<0.001		0.015	0.749	
Gobiidae	33	0.303	<0.001		-0.204	**1.54E-04**	**Significant**
Golden grey mullet	128	0.435	<0.001		-0.030	0.644	
Goldsinny wrasse	8	0.209	<0.001		-0.017	0.563	
Greater pipefish	225	0.566	<0.001		-0.054	0.467	
Grey gurnard	134	0.37	<0.001		-0.174	**0.005**	**Significant**
Gurnard	14	0.235	<0.001		0.031	0.332	
Herring	165	0.383	<0.001		-0.224	**0.001**	**Significant**
John dory	22	0.288	<0.001		-0.056	0.170	
Lesser sandeel	24	0.321	<0.001		-0.081	**0.030**	**Significant**
Lesser weever	7	0.205	<0.001		-0.069	**0.007**	**Significant**
Lesser-spotted dogfish	211	0.718	<0.001		-0.259	**1.39E-04**	**Significant**
Long-snouted seahorse	5	0.205	<0.001		0.007	0.812	

Common name	No. of observations	Test for normal distribution			Seasonal MK statistic		Interpretation
		Shapiro-Wilk	P		tau	P	
Long-spined sea scorpion	114	0.607	<0.001		0.039	0.562	
Lozano's goby	6	0.194	<0.001		0.019	0.475	
Lumpsucker	8	0.276	<0.001		-0.048	0.106	
Mackerel	13	0.238	<0.001		-0.076	**0.018**	**Significant**
Montagu's sea snail	10	0.26	<0.001		-0.007	0.846	
Mullet indet.	85	0.335	<0.001		-0.219	**1.36E-04**	**Significant**
Nilsson's pipefish	57	0.531	<0.001		0.006	0.948	
Painted goby	159	0.433	<0.001		-0.361	**1.47E-07**	**Significant**
Pilchard	52	0.166	<0.001		-0.069	0.165	
Pipefish indet	11	0.208	<0.001		-0.006	0.912	
Plaice	77	0.604	<0.001		-0.146	**0.014**	**Significant**
Pogge	28	0.401	<0.001		-0.126	**0.004**	**Significant**
Pollack	147	0.49	<0.001		0.080	0.246	
Poor cod	199	0.505	<0.001		-0.307	**7.91E-06**	**Significant**
Raitt's sandeel	14	0.112	<0.001		-0.057	0.060	
Rock goby	304	0.387	<0.001		-0.087	0.235	
Sand goby	266	0.345	<0.001		-0.215	**0.003**	**Significant**
Sand smelt	312	0.27	<0.001		-0.041	0.583	
Sandeel indet.	9	0.226	<0.001		-0.072	**0.028**	**Significant**
Scad/Horse Mackerel	30	0.168	<0.001		-0.057	0.217	
Sea lamprey	19	0.322	<0.001		-0.050	0.121	
Sea trout	9	0.277	<0.001		-0.026	0.401	
Shanny	18	0.409	<0.001		0.050	0.210	
Short-spined sea scorpion	21	0.443	<0.001		-0.081	0.057	
Snake pipefish	163	0.542	<0.001		-0.091	0.188	
Solenette	5	0.157	<0.001		-0.031	0.153	
Sprat	216	0.323	<0.001		-0.220	**1.35E-03**	**Significant**
Striped red mullet	21	0.241	<0.001		-0.057	0.132	
Thicked-lip grey mullet	10	0.228	<0.001		0.039	0.201	
Thin-lipped grey mullet	33	0.2	<0.001		0.043	0.364	
Thornback ray	17	0.393	<0.001		0.019	0.673	
Tompot blenny	24	0.422	<0.001		0.006	0.932	
Transparent goby	112	0.424	<0.001		0.057	0.381	
Tub gurnard	43	0.19	<0.001		-0.067	0.130	
Whiting	121	0.429	<0.001		-0.107	0.106	
Worm pipefish	24	0.473	<0.001		0.002	1.000	
Wrasse indet	5	0.177	<0.001		0.054	**0.029**	**Significant**

Table A-3. Trends in yearly geometric mean impingement data. A combination of MK statistic and Regression was used owing to data distribution.

Common name	No. of observations	Test for normal distribution		Trend method and output			Interpretation
		Shapiro-Wilk	p value	MK / Regression	p value	tau	
15-spined stickleback	237	0.699	**<0.001**	MK	0.152	-0.378	
2-spotted goby	20	0.878	0.123	R	0.075		
3-spined stickleback	57	0.74	0.003	MK	0.152	-0.378	
5-bearded rockling	163	0.866	0.091	R	0.687		
Ballan wrasse	28	0.928	0.429	R	0.822		
Bass	159	0.884	0.145	R	0.792		
Bib	124	0.904	0.244	R	**0.016**		**Significant**
Black goby	156	0.855	0.174	R	0.051		
Brill	7	0.839	0.043	MK	0.281	-0.289	
Butterfish	73	0.88	0.13	R	0.320	-9.042	
Clupeid indet.	156	0.38	**<0.001**	MK	0.371	-0.244	
Cod	28	0.832	0.035	MK	0.243	-0.311	
Common goby	272	0.765	0.005	MK	**0.049**	-0.511	**Significant**
Corkwing wrasse	87	0.848	0.055	R	0.087		
Dab	47	0.833	0.037	MK	0.088	-0.444	
Dover sole	15	0.748	0.003	MK	0.204	-0.333	
Dragonet (common)	74	0.982	0.976	R	0.094		
Dragonet (Indet)	7	0.772	0.007	MK	0.249	0.289	
Dragonet (reticulated)	6	0.732	0.002	MK	0.917	0.044	
European eel	104	0.908	0.264	R	0.285		
Flounder	121	0.871	0.104	R	**0.005**		**Significant**
Gadoid indet.	16	0.724	0.002	MK	0.564	0.156	
Garfish	16	0.797	0.013	MK	**0.041**	-0.511	**Significant**
Gilthead sea bream	23	0.824	0.029	MK	0.928	0.044	
Gobiidae	33	0.432	**<0.001**	MK	**0.012**	-0.644	**Significant**
Golden grey mullet	128	0.804	0.016	MK	1.000	-0.022	
Goldsinny wrasse	8	0.783	0.009	MK	0.564	-0.156	
Greater pipefish	225	0.843	0.048	MK	0.474	-0.200	
Grey gurnard	134	0.909	0.275	R	0.093		
Gurnard	14	0.6916	**<.001**	MK	0.655	0.133	
Herring	165	0.826	0.03	MK	**0.002**	-0.778	**Significant**
John dory	22	0.762	0.005	MK	0.283	-0.289	
Lesser sandeel	24	0.827	0.031	MK	0.178	-0.356	
Lesser weever	7	0.645	**<.001**	MK	**0.027**	-0.533	**Significant**
Lesser-spotted dogfish	211	0.892	0.177	R	**0.002**		**Significant**
Long-snouted seahorse	5	0.611	**<.001**	MK	0.911	0.044	

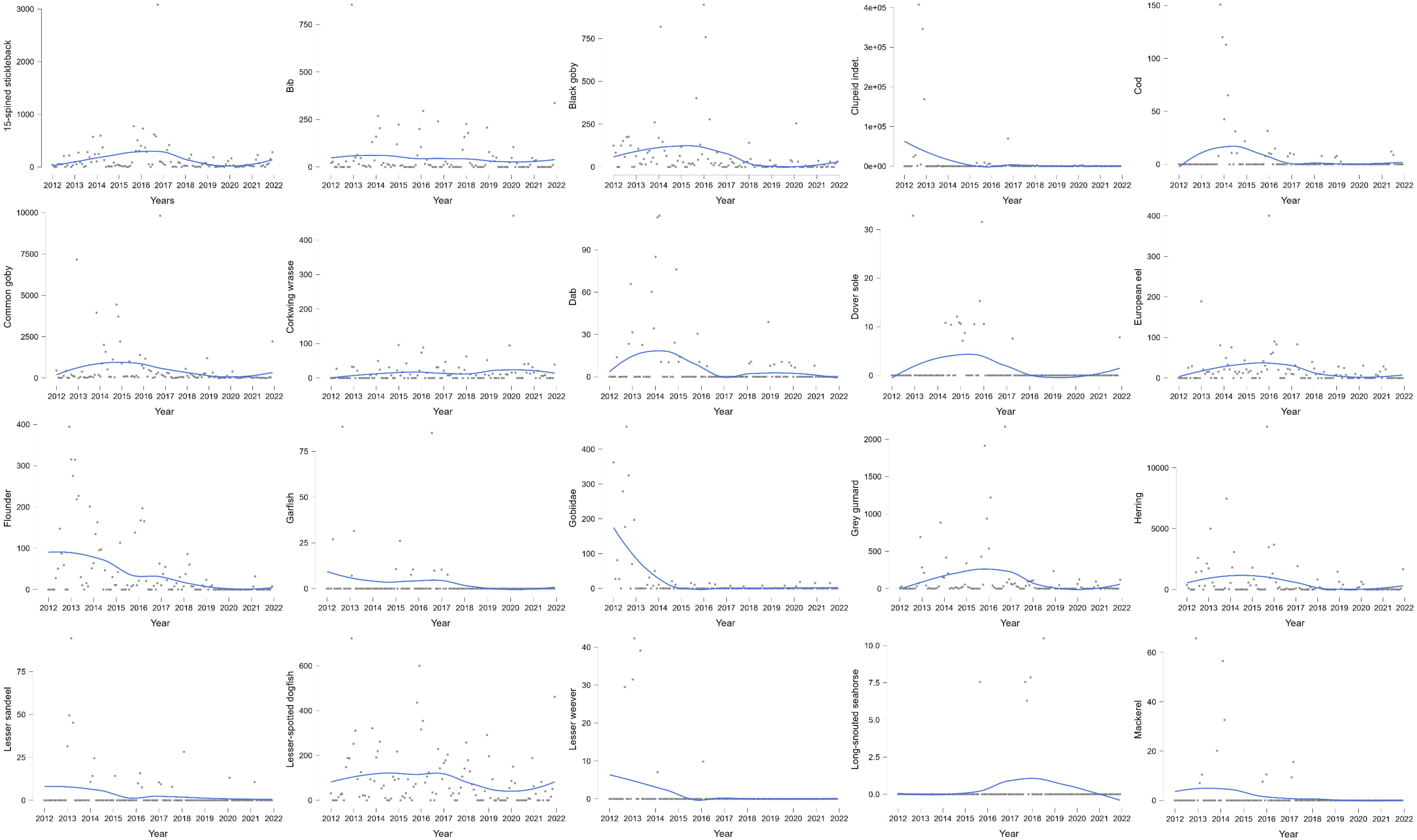
Common name	No. of observations	Test for normal distribution			Trend method and output			Interpretation
		Shapiro-Wilk	p value		MK / Regression	p value	tau	
Long-spined sea scorpion	114	0.927	0.417		R	0.898		
Lozano's goby	6	0.744	0.003		MK	0.476	0.178	
Lumpsucker	8	0.74	0.003		MK	0.146	-0.311	
Mackerel	13	0.836	0.04		MK	**0.009**	-0.644	**Significant**
Montagu's sea snail	10	0.791	0.011		MK	1.000	0.022	
Mullet indet.	85	0.883	0.14		R	**0.002**		**Significant**
Nilsson's pipefish	57	0.911	0.287		R	0.984		
Painted goby	159	0.921	0.361		R	**0.038**		**Significant**
Pilchard	52	0.848	0.055		R	0.436		
Pipefish indet	11	0.889	0.164		R	0.711		
Plaice	77	0.903	0.239		R	**0.034**		**Significant**
Pogge	28	0.853	0.064		R	0.095		
Pollack	147	0.961	0.797		R	0.562		
Poor cod	199	0.909	0.277		R	0.065		
Raitt's sandeel	14	0.779	0.008		MK	0.249	-0.289	
Rock goby	304	0.78	0.008		MK	0.107	-0.422	
Sand goby	266	0.726	0.002		MK	0.074	-0.467	
Sand smelt	312	0.478	**<.001**		MK	0.721	-0.111	
Sandeel indet.	9	0.789	0.01		MK	**0.046**	-0.511	**Significant**
Scad/Horse Mackerel	30	0.569	**<.001**		MK	0.210	-0.333	
Sea lamprey	19	0.84	0.044		MK	0.316	-0.267	
Sea trout	9	0.855	0.067		R	0.312		
Shanny	18	0.946	0.616		R	0.130		
Short-spined sea scorpion	21	0.895	0.191		R	0.220		
Snake pipefish	163	0.859	0.074		R	0.189		
Solenette	5	0.659	**<.001**		MK	0.169	-0.267	
Sprat	216	0.774	0.007		MK	0.210	-0.333	
Striped red mullet	21	0.872	0.106		R	0.202		
Thicked-lip grey mullet	10	0.78	0.008		MK	0.249	0.289	
Thin-lipped grey mullet	33	0.661	**<.001**		MK	0.325	0.267	
Thornback ray	17	0.799	0.014		MK	1.000	0.022	
Tompot blenny	24	0.923	0.386		R	0.836		
Transparent goby	112	0.971	0.9		R	0.153		
Tub gurnard	43	0.682	**<.001**		MK	**0.032**	-0.556	**Significant**
Whiting	121	0.925	0.403		R	0.212		
Worm pipefish	24	0.958	0.759		R	0.853		
Wrasse indet	5	0.631	**<.001**		MK	0.221	0.267	

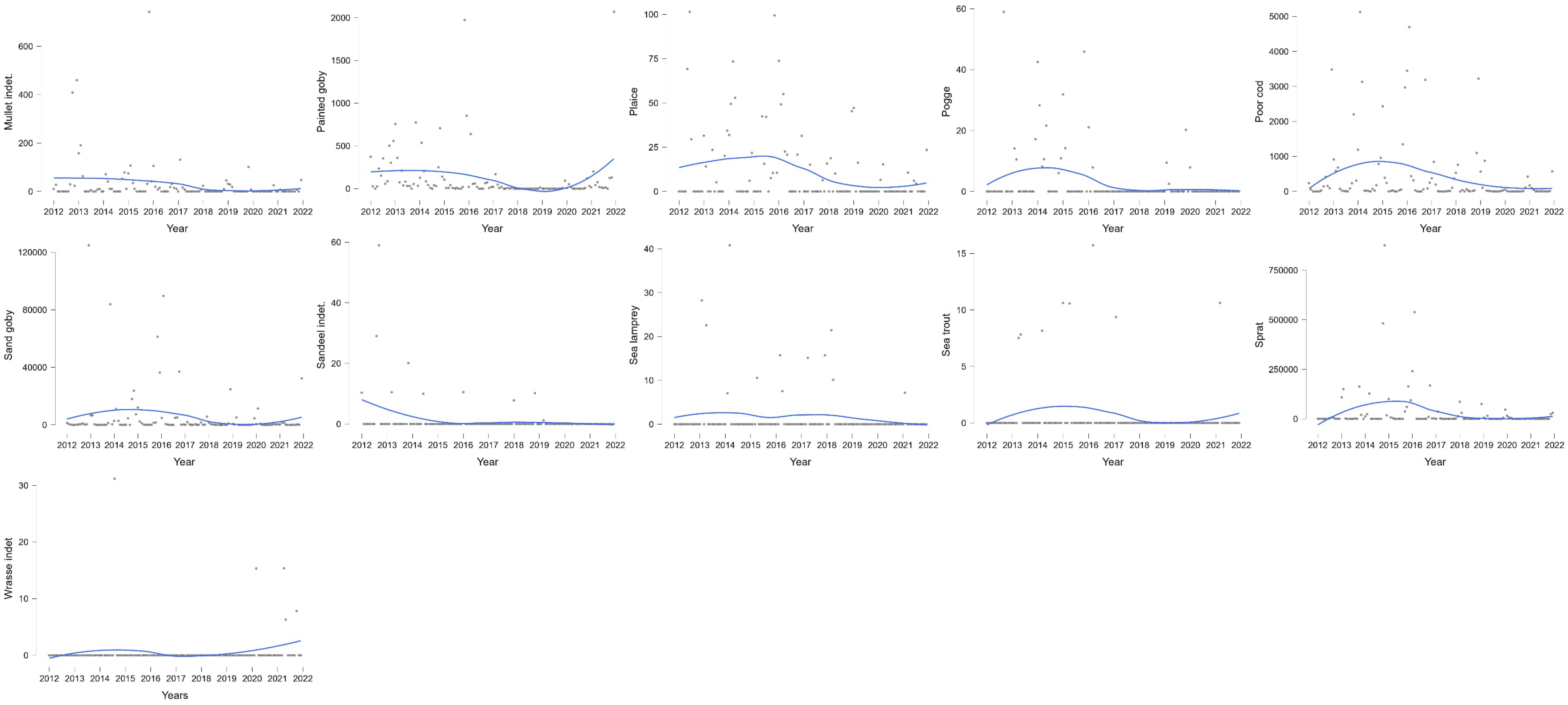
Table A-4. Trends in yearly arithmetic mean impingement data. A combination of MK statistic and Regression was used owing to data distribution.

Common name	No. of observations	Test for normal distribution		Trend method and output			Interpretation
		Shapiro-Wilk	p value	MK / Regression	p value	tau	
15-spined stickleback	237	0.681	**<0.001**	MK	0.152	-0.378	
2-spotted goby	20	0.816	0.023	MK	0.180	-0.356	
3-spined stickleback	57	0.655	**<0.001**	MK	0.074	-0.467	
5-bearded rockling	163	0.875	0.113	R	0.725		
Ballan wrasse	28	0.773	0.007	MK	0.928	-0.044	
Bass	159	0.908	0.27	R	0.801		
Bib	124	0.934	0.489	R	**0.045**		**Significant**
Black goby	156	0.793	0.035	MK	**0.032**	-0.556	**Significant**
Brill	7	0.809	0.018	MK	0.151	-0.378	
Butterfish	73	0.743	0.003	MK	0.152	-0.378	
Clupeid indet.	156	0.416	**<0.001**	MK	0.721	-0.111	
Cod	28	0.638	**<0.001**	MK	0.323	-0.267	
Common goby	272	0.837	0.04	MK	**0.032**	-0.556	**Significant**
Corkwing wrasse	87	0.68	**<0.001**	MK	0.283	0.289	
Dab	47	0.686	**<0.001**	MK	**0.025**	-0.578	**Significant**
Dover sole	15	0.741	0.003	MK	0.204	-0.333	
Dragonet (common)	74	0.852	0.062	R	**0.034**		**Significant**
Dragonet (Indet)	7	0.664	**<0.001**	MK	0.337	0.244	
Dragonet (reticulated)	6	0.742	0.003	MK	0.917	0.044	
European eel	104	0.752	0.004	MK	0.152	-0.378	
Flounder	121	0.827	0.031	MK	**0.004**	-0.733	**Significant**
Gadoid indet.	16	0.671	**<0.001**	MK	0.442	0.200	
Garfish	16	0.782	0.009	MK	**0.041**	-0.511	**Significant**
Gilthead sea bream	23	0.669	**<0.001**	MK	0.928	0.044	
Gobiidae indet.	33	0.399	**<0.001**	MK	**0.032**	-0.556	**Significant**
Golden grey mullet	128	0.741	0.003	MK	1.000	-0.022	
Goldsinny wrasse	8	0.637	**<.001**	MK	0.564	-0.156	
Greater pipefish	225	0.781	0.009	MK	0.592	-0.156	
Grey gurnard	134	0.764	0.005	MK	**0.049**	-0.511	**Significant**
Gurnard indet.	14	0.508	**<.001**	MK	0.655	0.133	
Herring	165	0.797	0.013	MK	**0.007**	-0.689	**Significant**
John dory	22	0.572	**<.001**	MK	0.283	-0.289	
Lesser sandeel	24	0.584	**<.001**	MK	0.178	-0.356	
Lesser weever	7	0.534	**<.001**	MK	**0.027**	-0.533	**Significant**
Lesser-spotted dogfish	211	0.916	0.321	R	**0.005**		**Significant**
Long-snouted seahorse	5	0.639	**<.001**	MK	0.911	0.044	

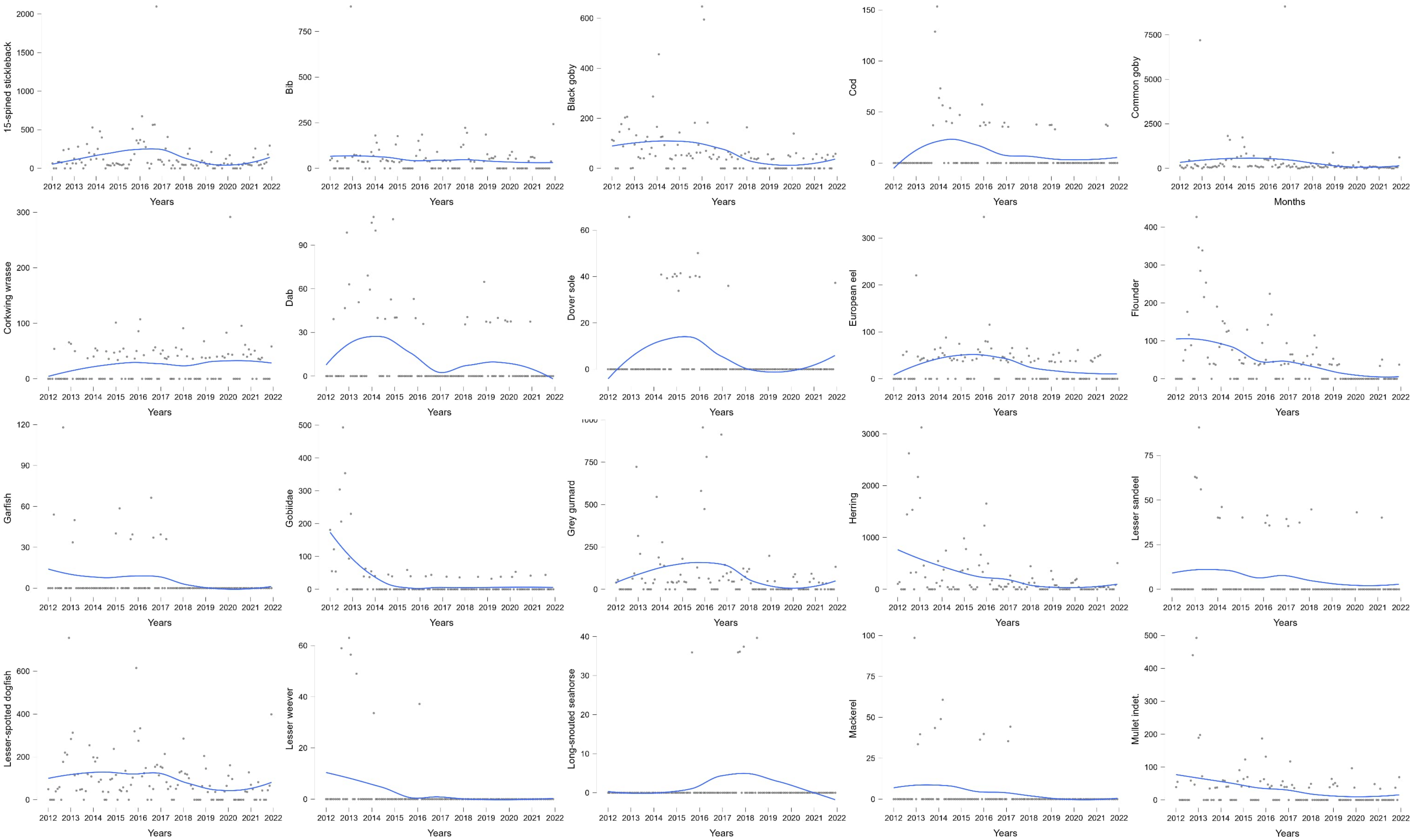
Common name	No. of observations	Test for normal distribution			Trend method and output			Interpretation
		Shapiro-Wilk	p value		MK / Regression	p value	tau	
Long-spined sea scorpion	114	0.774	0.007		MK	0.858	-0.067	
Lozano's goby	6	0.72	0.002		MK	0.760	0.089	
Lumpsucker	8	0.726	0.002		MK	0.146	-0.311	
Mackerel	13	0.791	0.011		MK	**0.009**	-0.644	**Significant**
Montagu's sea snail	10	0.778	0.008		MK	1.000	-0.022	
Mullet indet.	85	0.782	0.009		MK	**0.004**	-0.733	**Significant**
Nilsson's pipefish	57	0.893	0.182		R	0.979		
Painted goby	159	0.835	0.039		MK	0.152	-0.378	
Pilchard	52	0.703	**<.001**		MK	0.171	-0.356	
Pipefish indet.	11	0.749	0.003		MK	0.421	-0.222	
Plaice	77	0.882	0.137		R	**0.020**		**Significant**
Pogge	28	0.865	0.088		R	**0.038**		**Significant**
Pollack	147	0.913	0.302		R	0.821		
Poor cod	199	0.898	0.206		R	0.090		
Raitt's sandeel	14	0.52	**<.001**		MK	0.249	-0.289	
Rock goby	304	0.781	0.008		MK	0.474	-0.200	
Sand goby	266	0.872	0.107		R	**0.013**		**Significant**
Sand smelt	312	0.589	**<.001**		MK	1.000	0.022	
Sandeel indet.	9	0.625	**<.001**		MK	**0.046**	-0.511	**Significant**
Scad/Horse Mackerel	30	0.49	**<.001**		MK	0.107	-0.422	
Sea lamprey	19	0.882	0.137		R	0.213		
Sea trout	9	0.874	0.111		R	0.422		
Shanny	18	0.908	0.266		R	0.362		
Short-spined sea scorpion	21	0.845	0.051		R	0.210		
Snake pipefish	163	0.868	0.094		R	0.145		
Solenette	5	0.66	**<.001**		MK	0.261	-0.222	
Sprat	216	0.762	0.005		8	0.283	-0.289	
Striped red mullet	21	0.761	0.005		MK	0.088	-0.444	
Thicked-lip grey mullet	10	0.768	0.006		MK	0.337	0.244	
Thin-lipped grey mullet	33	0.554	**<.001**		MK	0.421	0.222	
Thornback ray	17	0.691	**<.001**		MK	0.721	-0.111	
Tompot blenny	24	0.876	0.116		R	0.780		
Transparent goby	112	0.975	0.935		R	0.467		
Tub gurnard	43	0.501	**<.001**		MK	0.074	-0.467	
Whiting	121	0.836	0.04		MK	0.283	-0.289	
Worm pipefish	24	0.95	0.663		R	0.755		
Wrasse indet	5	0.636	**<.001**		MK	0.316	0.222	

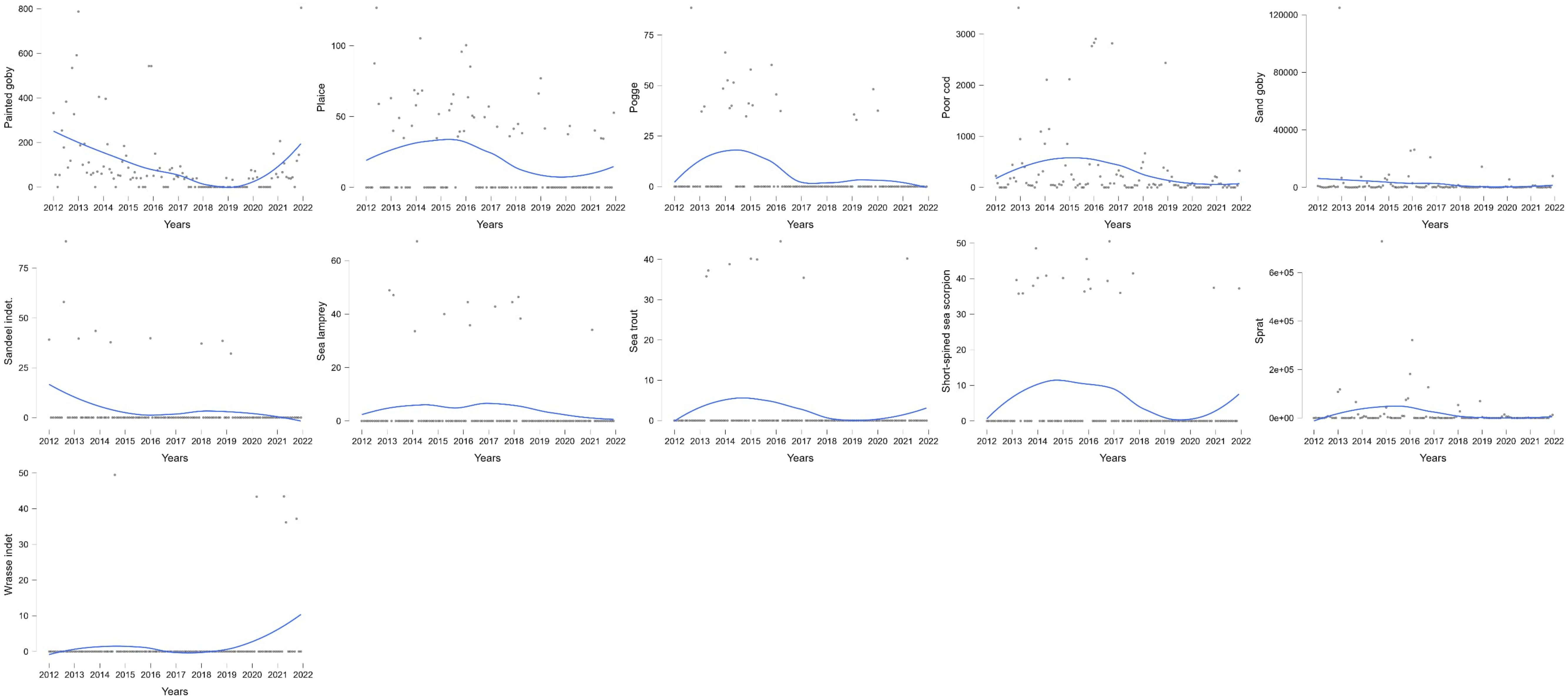
Appendix B. LOESS plots for arithmetic monthly significant trends




Mullet indet.
Year
Painted goby
Year
Plaice
Year
Pogge
Year
Poor cod
Year
Sand goby
Year
Sandeel indet.
Year
Sea lamprey
Year
Sea trout
Year
Sprat
Year
Wrasse indet
Years

Appendix C. LOESS plots for geometric monthly significant trends




Painted goby
Plaice
Pogge
Poor cod
Sand goby
Sandeel indet.
Sea lamprey
Sea trout
Short-spined sea scorpion
Sprat
Wrasse indet
Years
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

Appendix D. ANOVA Results

Table D-1. ANOVA results for geometric mean and arithmetic mean impingement data. A non-parametric Kruskal-Wallis test was applied to assign a P-Value as all data was not normally distributed. Results highlighted in BOLD show significance (p < 0.05). Differences column shows any differences between the data for geometric and arithmetic mean values.

Common name	No. of observations	Geometric Mean		Arithmetic Mean		Differences
		P Value	Post-hoc	P Value	Post-hoc	
15-spined stickleback	237	**0.01**	**2012<2016 2013>2018-2020 2014-15<2016 2016>2017-2021**	**0.006**	**2012<2016 2013>2019-2020 2015<2016 2016>2017-2021**	Different P Value Geometric Post-hoc 2013 > 2018 2014<2016
2-spotted goby	20	0.254		0.261		
3-spined stickleback	57	0.649	2015-2016, 2015-2019	0.649		
5-bearded rockling	163	0.79		0.779		
Ballan wrasse	28	0.053		**0.044**	**2012<2016-2017 2013<2017 2016>2021 2017>2020_2021**	Geometric not significant
Bass	159	**0.005**	**2012<2015-2018+2020 2013<2016-2017 2014<2016 2016>2019+2021 2017>2021**	**0.004**	**2012<2015-2018+2020 2013<2016-2017 2014<2016 2016>2019+2021 2017>2021**	Different P Values
Bib	124	0.0501		0.0525		
Black goby	156	**<0.001**	**2012>2017-2021 2013>2017-2021 2014>2019-2020 2015&2016>2019-2020**	**<0.001**	**2012>2017-2021 2013>2017-2021 2014>2019-2021 2015&2016>2019-2021**	Arithmetic Post-hoc 2014>2021 2015&2016>2021
Brill	7	0.582		0.575		
Butterfish	73	0.669		0.66		
Clupeid indet.	156	**<0.001**	**2012>2013,2014, 2017-2019 & 2021 2013<2015,2016 & 2020 2014<2015-2016 &2020 2015>2018-2019**	**0.001**	**2012>2013, 2014, 2017-2019 & 2021 2013<2015-2016 &2020 2014<2015-2016 &2020 2015>2018-2019**	
Cod	28	**0.003**	**2012<2014&2016 2013<2014 2014>2015&2017-2021 2016>2017&2020**	**0.003**	**2012<14&2016 2013<2014 2014>2015&2017-2021 2016>2017&2020**	
Common goby	272	**<0.001**	**2012>2021 2013>2021 2014>2012-2013 & 2017-2021 2015>2017 & 2019-2021 2016>2019-2021 2018>2021**	**<0.001**	**2012>2021 2013>2021 2014>2012-2013 & 2017-2021 2015>2017 & 2019-2021 2016>2019-2021 2018>2021**	
Corkwing wrasse	87	0.377		0.327		
Dab	47	**0.007**	**2013>2017&2021 2014>2016-2017&2019-2021 2019>2017&2021**	**0.007**	**2013>2017&2021 2014>2016-2017&2019-2021 2019>2017&2021**	
Dover sole	15	**<0.001**	**2014>2013&2017-2021 2015>2012-2013&2016-2021**	**<0.001**	**2014>2013&2017-2021 2015>2012-2013&2016-2021**	
Dragonet (common)	74	0.678		0.675		
Dragonet (Indet)	7	0.545		0.545		
Dragonet (reticulated)	6	0.267		0.27		

Common name	No. of observations	Geometric Mean		Arithmetic Mean		Differences
		P Value	Post-hoc	P Value	Post-hoc	
European eel	104	**0.002**	**2012<2013-2016 2013>2021 2014>2018-2021 2015>2021 2016>2018-2021**	**0.002**	**2012<2013-2016 2013>2021 2014>2018-2021 2015>2021 2016>2018-2021**	
Flounder	121	**<0.001**	**2012>2020 2013>2012&2015&2017-2021 2014>2019-2021 2015>2020 2016>2019-2021 2017&2018>2020**	**<0.001**	**2012>2020 2013>2012&2015&2017-2021 2014>2019-2021 2015>2020 2016>2019-2021 2017-2018>2020**	
Gadoid indet.	16	**0.005**	**2012<2020 2013>2012&2014-2019&2021 2020>2015-2017&2019**	**0.005**	**2012<2020 2013>2012&2014-2019&2021 2020>2015-2017&2019**	
Garfish	16	0.065		0.068		
Gilthead sea bream	23	**0.041**	**2017>2012-2014&2019-2021 2018>2012&2021**	**0.043**	**2017>2012-2014&2019-2021 2018>2012&2021**	Different P Value
Gobiidae indet	33	**<0.001**	**2012>2013-2021**	**<0.001**	**2012>2013-2021**	
Golden grey mullet	128	**0.008**	**2012>2013-2014 2012>2016-2018 2013>2019-2020 2015>2016 2016>2019-2020**	**0.009**	**2012>2013-2014 2012>2016-2018 2013>2019-2020 2015>2016 2016>2019-2020**	
Goldsinny wrasse	8	0.551		0.545		
Greater pipefish	225	**0.025**	**2012>2016 2013>2016 2014>2019 2016>2018-2021**	**0.011**	**2012>2016 2013>2016 2014>2019-2020 2016>2018-2021**	Different P Value Arithmetic Post-hoc 2014>2020
Grey gurnard	134	**0.011**	**2013&2014>2019&2021 2015>2019 2016>2018 2016&2017>2019&2021**	**0.013**	**2013&2014>2019&2021 2015>2019 2016>2018 2016&2017>2019&2021**	Different P Value
Gurnard indet	14	**<0.001**	**2012-2018>2019 2019>2020 2019>2021**	**<.001**	**2012-2018>2019 2019>2020 2019>2021**	
Herring	165	0.083	2012>2020, 2013>2020, 2015>2019-2021,	0.174	2012>2020, 2013>2020, 2015>2019-2021,	
John dory	22	0.716		0.713		
Lesser sandeel	24	0.169	2012>2013, 2013>2015, 2013>2018-2021,	0.165	2012>2013, 2013>2015, 2013>2019-2021,	
Lesser weever	7	0.094	2013>2015, 2013>2017-2021,	0.087	2013>2014-2015, 2013>2017-2021	
Lesser-spotted dogfish	211	**0.05**	**2013>2019 2013>2020 2014>2019 2015>2019 2016>2019-2021 2017>2019**	0.101	2013>2019 2013>2020 2014>2019 2016>2019-2021 2017>2019	Arithmetic not significant
Long-snouted seahorse	5	**0.04**	**2012>2017 2013>2017 2014>2017 2015>2017**	**0.042**	**2012>2017 2013>2017 2014>2017 2015>2017**	Different P Value

Common name	No. of observations	Geometric Mean		Arithmetic Mean		Differences
		P Value	Post-hoc	P Value	Post-hoc	
			2016>2017 2017>2018-2021		**2016>2017 2017>2018-2021**	
Long-spined sea scorpion	114	**0.033**	**2012>2013&2016&2017&2021 2013>2019 2015-2017>2019 2019>2021**	**0.036**	**2012>2013 2012>2016-2017 2012>2021 2013>2019 2016>2019 2017>2019 2019>2021**	Different P Value Geometric Post-hoc 2015>2019
Lozano's goby	6	0.415	2012>2019, 2013>2019, 2015>2019, 2016>2019, 2019>2020, 2019>2021	0.415	2012>2019, 2013>2019, 2015>2019, 2016>2019, 2019>2020-2021	
Lumpsucker	8	0.074	2012>2015, 2015>2017-2021	0.074	2012>2015, 2015>2017-2021	
Mackerel	13	0.306	2013>2018-2021,	0.301	2013>2018-2021	
Montagu's sea snail	10	0.343		0.339		
Mullet indet.	85	0.062	2012>2020, 2014>2020, 2015>2018, 2015>2020, 2015>2021, 2016>2020,	0.06	2012>2020, 2014>2020, 2015>2018, 2015>2020, 2015>2021, 2016>2020,	
Nilsson's pipefish	57	**0.021**	**2012>2014 2012>2017-2018 2013>2014 2013>2017-2018 2014>2019 2014>2021 2017>2021 2018>2021**	**0.019**	**2012>2014 2012>2017-2018 2013>2014 2013>2018 2014>2019-2021 2017>2021 2018>2021**	Different P Value Geometric Post-hoc 2013>2017 Arithmetic Post-hoc 2014>2020
Painted goby	159	**<.001**	**2012>2015-2020 2013>2017-2020 2014>2017-2020 2015>2018-2019 2016>2018-2019 2017- 2020>2021**	**<.001**	**2012>2015-2020 2013>2017-2020 2014>2017-2020 2015&2016>2018-2019 2016>2018-2019 2018-2020>2021**	Geometric Post-hoc 2017>2021 Arithmetic Post-hoc 2016>2018-2019
Pilchard	52	**0.006**	**2012>2015 2012>2016 2012>2018 2015>2019-2021 2016>2019-2021 2018>2019-2021**	**0.007**	**2012>2015 2012>2016 2012>2018 2015>2019-2021 2016>2019-2021 2018>2019-2021**	Different P Value
Pipefish indet	11	0.679		0.673		
Plaice	77	0.091	2014>2020, 2015>2019, 2015>2020, 2016>2017-2020,	0.082	2014>2020, 2015>2020, 2016>2017, 2017-2020	
Pogge	28	**0.003**	2012>2014 2013>2014 2014>2015-2021	**0.003**	2012>2014 2013>2014 2014>2015-2021	
Pollack	147	**0.047**	**2012>2014-2018 2012>2020-2021 2013>2015 2015>2019**	**0.048**	**2012>2014-2018 2012>2020-2021 2015>2019 2019>2021**	Different P Value Geometric Post-hoc 2013>2015 Arithmetic Post-hoc 2019>2021
Poor cod	199	0.051	2013>2020 2013>2021 2014>2020 2014>2021	0.059	2013>2020 2013>2021 2014>2020 2014>2021	

Common name	No. of observations	Geometric Mean		Arithmetic Mean		Differences
		P Value	Post-hoc	P Value	Post-hoc	
			2015>2020 2016>2020 2016>2021		2015>2020 2016>2020 2016>2021	
Raitt's sandeel	14	0.167	2012>2013 2013>2016 2013>2018 2013>2020 2013>2021	0.167	2012>2013 2013>2016 2013>2018 2013>2020-2021	
Rock goby	304	**0.031**	**2012>2014-2015** **2014>2021** **2015>2021** **2017>2021** **2020>2021**	**0.03**	**2012>2014-2015** **2014>2021** **2015>2019** **2015>2021** **2016>2021** **2017>2021** **2020>2021**	Different P Value Arithmetic Post-hoc 2015>2019 2016>2021
Sand goby	266	0.236	2012>2019, 2014>2019, 2015>2019, 2016>2019,	0.3	2014>2019, 2015>2019, 2016>2019,	
Sand smelt	312	0.746		0.827		
Sandeel indet.	9	0.256	2012>2015, 2012>2017, 2012>2020-2021,	0.256	2012>2015, 2012>2017, 2012>2020-2021,	
Scad/Horse Mackerel	30	0.356	2015>2020, 2016>2020, 2018>2020,	0.358	2015>2020, 2016>2020	
Sea lamprey	19	0.621		0.621		
Sea trout	9	0.6		0.609		
Shanny	18	0.351	2012>2021, 2018>2021	0.37	2012>2021, 2018>2021	
Short-spined sea scorpion	21	**0.04**	**2012>2013** **2012>2016** **2013>2018-2021** **2016>2018-2019**	**0.039**	**2012>2013** **2012>2016** **2013>2018-2021** **2016>2018-2019**	Different P Value
Snake pipefish	163	0.142	2012>2016, 2013>2018, 2014>2018, 2016>2018,	0.111	2012>2014, 2012>2016,2013>2018, 2014>2018, 2016>2018,	
Solenette	5	0.268	2012>2013, 2013>2014, 2013>2017-2021,	0.268	2012>2013, 2013>2014, 2013>2017-2021	
Sprat	216	0.578		0.584		
Striped red mullet	21	0.313	2014>2015, 2014>2020, 2014>2021, 2015>2016, 2016>2020, 2016>2021	0.309	2014>2015, 2014>2021-2021, 2015>2016, 2016>2020-2021,	
Thicked-lip grey mullet	10	0.177	2012>2018, 2013>2018, 2014>2018, 2015>2018, 2018>2020	0.177	2012-2015>2018, 2018>2020,	
Thin-lipped grey mullet	33	0.055	2012-2015>2016, 2016>2019-2021	0.053	2012-2015>2016, 2016>2020, 2016>2021	
Thornback ray	17	0.55	2012>2015, 2015>2017,	0.558	2012>2015, 2015>2017,	
Tompot blenny	24	0.088	2012>2016 2013>2014 2013>2016 2013>2021 2016>2017-2019	0.084	2012>2016, 2013>2014, 2013>2016, 2013>2021, 2016>2017-2019,	
Transparent goby	112	0.407	2013>2016-2017	0.331	2013>2016-2017	
Tub gurnard	43	0.933		0.936		
Whiting	121	**0.015**	**2012>2013-2014** **2012>2016-2018**	**0.018**	**2012>2013-2014** **2012>2016-2018**	Different P Value

Common name	No. of observations	Geometric Mean		Arithmetic Mean		Differences
		P Value	Post-hoc	P Value	Post-hoc	
			2013>2019&2021 2014>2019&2021 2016>2019&2021 2017>2019&2021		**2013>2019&2021 2016>2019&2021 2017>2019&2021**	Geometric Post-hoc 2014>2019&2021
Worm pipefish	24	0.211	2013>2014, 2014>2015, 2014>2015, 2014>2017	0.212	2013>2014, 2014>2015, 2014>2017	
Wrasse indet	5	**0.044**	**2012-2020>2021**	**0.044**	**2012-2020>2021**	