Pembroke Abstraction Licence Renewal Supporting Information: Life Tables

Document no: JUKL/B2382602/LIC/R08
Revision: 1

RWE Generation UK Plc

Pembroke Marine Monitoring
25 October 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 to provide the relevant information and analysis requested by NRW.

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

Provision of updated EAVs for the entrapment data: This has not yet been provided. A review has been conducted by Jacobs which showed various differences in parameters from recently published literature that could influence the EAV values. Please provide this data.

The report presents a summary of the original literature review undertaken for the lifetable work as well as the findings of a further review and sensitivity. Despite the sensitivity only detecting a potential reason to update the plaice lifetable, all of those that had new data were updated and a review on the impact of the assessments made.

The updated lifetables have been used to look at the effect of the changes on the EAV calculations for both the entrainment and impingement data. The results indicate that despite updated life history data being available, there is little to no observable impact on the EAV calculations and therefore no change to the conclusions of the reports supporting the abstraction licence renewal.

Contents

Appendices

Tables

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 NRW in their letter dated 11th June 2024, reference PAN-025790.

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 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 February 2009, and reissued by National Resource Wales (NRW) on the 21st November 2014 to reflect the change in name of the Competent Authority. The licence allows for the following maximum quantities of water to be abstracted from Pennar Gut, Pembroke Dock (NGR SM9365402652):

- 144,000 cubic metres 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 their PAN-025790 letter, specifically:

Provision of updated EAVs for the entrapment data: This has not yet been provided. A review has been conducted by Jacobs which showed various differences in parameters from recently published literature that could influence the EAV values. Please provide this data.

This document provides the following elements to response to NRWs concerns:

- Summary of the information already provided to NRW.
- Output of the detailed sensitivity analysis undertaken on the lifetables.
- Influence of updates on lifetable data on entrainment data.

2. Initial Sensitivity Review

A review of recent literature published was conducted with respect to the Equivalent Adult Value (EAV) life table parameters. The primary focus of the review was to look at new data that is relevant to the Milford Haven/Irish Sea area and identify whether any are available that may be used to update the original 2013/2016 life tables created for the Pembroke Equivalent Adult Value (EAV) analysis.

2.1 Methods

Lifetables require data such as age-specific fecundity, survivorship and weight-at-age which is derived from published literature. The applicability of the EAV method is therefore limited to those species for which adequate life history data are available which are often the more studied commercial species. In Pembroke, EAV analysis has been performed for larval and juvenile stages of seven species. These are:

- Bass (*Dicentrarchus labrax*)
- Herring (*Clupea harengus*)
- Sprat (*Sprattus sprattus*)
- Sandeel (Ammodytes)
- Sand goby (*Pomatoschistus minutus*)
- Plaice (*Pleuronectes platessa*)
- Whiting (*Merlangius merlangus*)

Literature searches were undertaken on these seven species and any information relating to any of the following parameters were searched for according to each species or group, as applicable:

- Lifespan
- Spawning duration
- Lifestages - duration of
- Ageing - length at age/stage, growth rate
- Natural mortality
- Fishing mortality
- Fecundity
- Sex ratio
- Percent maturity

2.2 Outcome

The literature review undertaken indicated that much of the more recent data (where they are available) are within the range of those utilised within the original lifetables. However, some new data did differ and a high level sensitivity analysis was undertaken on the following species and parameters, to determine whether the associated EAVs may be subject to change:

- Bass (length at age, natural mortality, fishing mortality and percent maturity)
- Sprat (lifespan and fecundity)
- Herring (proportion mature, fishing mortality)
- Sandeel (duration of lifestages)

- Plaice (fishing mortality and maturity)
- Whiting (Lifespan duration, natural mortality and fishing mortality)

3. Detailed Sensitivity Analysis

Following on from the literature searches outlined in Section 2 above, a more detailed review was undertaken that also took into consideration any variations in EAV methodology used in the fish impact assessments undertaken during the consenting of the Hinkley Point C (HPC) New Nuclear Build by Cefas (2019[1]). The revised Cefas methods are set out in public documents presented to the HPC Public Inquiry. Appendix A presents the detailed findings of this review and are summarised below.

3.1 Methods

In undertaking the review, the standard EAV Method was used in the updates, along with the Cefas variation which relates to estimation of the natural mortality rate for both juvenile and adult age groups of the stock. Once the lifetables were updated, a sensitivity analysis was undertaken to compare the lifetime EAV trajectories. This would allow comparisons to be made of calculated EAVs for the different sets of input data against specific cases:

- Baseline 2013 Pembroke data
- Updated cases (following 2024 literature review)
- Cefas cases (estimates using Gislason methodology (2010[2])

3.2 Results

The study has highlighted the following:

- for some species, impact assessments based on the original Pembroke lifetables give more conservative results (i.e. a greater number of equivalent adults) than updated values, therefore updated lifetables would provide a lesser effect.
- Where the remaining species' updated figures are not conservative they actually fall below the Cefas adopted 95% lower limit EAVs, and it can be reasonably concluded that the updated changes are not significant.
- There is only one species where the updated figures fall outside of the 95% confidence limit, i.e., plaice.

[1] Cefas (2019). Revised Predictions of Impingement Effects at Hinkley Point c – 2018 Editions 2. BEEMS Technical Report No. 456. HPC-DEV024-XX-000-RET-100031, 165pp.

[2] Gislason, H., Daan, N., Rice, J.C., Pope, J.G. (2010). Size, growth, temperature and the natural mortality of marine fish. Fish. 11, 149-158.

4. Updated EAVs

Following on from the detailed sensitivity review an assessment has been made of the impact of the updated lifetables on the EAVs calculated for entrainment and impingement. Whilst EAVs are also calculated for the impinged fraction, it is the entrained fraction that is likely to be affected by changes in life table data owing to the life stages present. The impinged fraction are largely made up of adult fish where the EAV would equal one, therefore amendment of the life tables would not greatly affect the results presented.

Despite the above review only indicating a potential change for Plaice, a review of all updated tables was undertaken for data from 2020 and 2021.

The reporting of the monitoring programme has been amended to be a bi-annual interpretive report with summary reports provided in the interim. As such, the EAV data for 2022 has not been presented to date and will be part of the 2023 interpretive reporting where the updated lifetables will be used.

4.1 Entrainment EAVs

The effect of the updated lifetables is presented in the following table (Table 1) where the existing EAV numbers for entrainment are presented alongside the updated figures. It should be noted that not all lifetables were updated following literature review therefore updated EAVs are not presented for all species. Entrainment surveys are undertaken between mid-April and mid-August as per the agreed Pembroke environmental monitoring programme, as this captures the peak spawning period in the Haven. During 2020, restrictions imposed by the global pandemic resulted in a reduced survey programme between July and beginning of September for entrainment. Therefore only three sampling events allowing EAV analysis were undertaken.

Table 1: EAV data presented for entrainment data using original lifetables and updated lifetables as comparison. * sample taken in September owing to the pandemic.

Taxa	Extrapolated abundance	Original		Updated	
		Extrapolated EAV	Percentage (%) reduction	Extrapolated EAV	Percentage (%) reduction
2020 (July to early September* only due to restrictions imposed by Covid19)					
Gobiidae	10,346,373	10,346	99.9	No updates as lifetable not used for Gobiidae	
2021 (Mid April to Mid August)					
Herring	103,345	14	>99.9	14	>99.9
Sprat	79,632	42,432	46.7	41,863	47.4
Clupeidae - (assuming all individuals are sprat)	167,927	43,701	74.0	42,642	74.5
Clupeidae - (assuming all individuals are herring)	167,927	1,182	99.3	1,182	99.3
Whiting	958,001	46	>99.9	31	>99.9
Sea bass	81,615	1	>99.9	0.3	>99.9
Gobiidae	42,317,906	42,318	>99.9	No updates as lifetable not used for Gobiidae	

It is clear from the updates undertaken that there is no significant change in the data presented, and in all cases (in Table 1), the extrapolated EAV reduces with the updated life history data. This is largely a result of the updated literature affecting the larger size classes of fish. In the analysis undertaken, once a fish reaches a size where the EAV is equivalent to 1, then larger sizes are also classed as 1 (they equate to one adult lost from the population).

Plaice are only rarely entrained at the station (only recorded from 2015 and 2018) and therefore were not presented within Table 1. To provide an overview of the effect of the updated life table on Plaice EAV numbers, example data have been used and the original and updated life table parameters applied to show the effect on the EAV calculations (Table 2).

Table 2: Hypothetical Plaice EAV data presented using original lifetables and updated lifetables as comparison.

Taxa	Extrapolated abundance	Original		Updated	
		Extrapolated EAV	Percentage (%) reduction	Extrapolated EAV	Percentage (%) reduction
Plaice	103,345.22	227	99.8	409	99.6

For plaice the update lifetable would result in a higher EAV; however, the percentage change is minimal (0.2%).

4.2 Impingement EAVs

The effect of the updated lifetables is presented in the following table (Table 2) where the existing EAV numbers for impingement are presented alongside the updated figures. It should be noted that not all lifetables were updated following literature review therefore updated EAVs are not presented for all species.

Table 3: EAV data presented for impingement data using original lifetables and updated lifetables as comparison.

Taxa	Extrapolated abundance	Original		Updated	
		Extrapolated EAVs	Percentage (%) Reduction	Extrapolated EAVs	Percentage (%) Reduction
2020					
Herring	722	109	85%	103	86%
Clupeidae (as herring)	5,063	288	94%	271	95%
Sprat	19,635	14,685	25%	14,492	26%
Clupeidae (as sprat)	5,063	3,820	25%	3,773	25%
Sand goby	7,911	3,655	54%	No update	
Bass	2,710	36	99%	4	99.9%
Whiting	477	248	48%	256	46%
2021					
Herring	838	200	76%	181	78%
Clupeidae (as herring)	877	118	87%	104	88%
Sprat	19,200	14,879	23%	14,749	23%
Clupeidae (as sprat)	877	683	22%	674	23%
Sand goby	8,113	3, 687	55%	No update	

Taxa	Extrapolated abundance	Original		Updated	
		Extrapolated EAVs	Percentage (%) Reduction	Extrapolated EAVs	Percentage (%) Reduction
Bass	451	5	99%	2	99.9%
Whiting	148	81	45%	74	50%

In general the EAVs calculated (Table 3) using the updated lifetables are lower than those obtained using the original life tables. The only exception is for whiting in 2020 where the size classes present resulted in a larger EAV being calculated. The increase is not large with the percentage change reducing by only 2% which is considered insignificant in an ecological context.

5. Conclusions

The data outlined above clearly show that the data presented in the reports to support the abstraction licence renewal was, on the whole, precautionary in the context of EAVs. The updated lifetables yield lower results and were found to be in line with the Cefas approach used at HPC.

The purpose of EAV analysis is to put entrapment catches into the context of commercial fishing which exploits adult fish above the Minimum Landing Size. An assessment of juvenile fish catches by power stations in terms of raw numbers assumes that all fish would have survived to adulthood and entered the commercial fishery had they not been entrapped. In reality, natural mortality among early life stages is extremely high and of the many eggs spawned, few will survive to adulthood and become available to the commercial fishery. Comparing raw numbers of entrapped juvenile fish directly to numbers removed by commercial fishing would therefore overestimate entrapment pressure on commercial fish stocks.

The relationship between the extrapolated EAV number and the extrapolated raw abundance is used to show the proportion of the raw abundance entrapped that would survive to adulthood and essentially have been removed from the system. It is this proportion that has been used to look at the effect of the updated life tables on the EAV figures presented.

For those species shown in Table 1, all proportions either did not change or increased, therefore indicating that the original life tables used in the application yielded more conservative results for entrainment (i.e. a greater number of equivalent adults was predicted).

For plaice (Table 2) the updated EAV presented a smaller proportion, therefore indicating that a larger number of equivalent adults was predicted compared to the original. This change is however minimal, as the difference in the proportions was only 0.2%, which in the context of ecological populations is insignificant. As stated in this document, plaice are rare within the entrained fraction having only been identified during 2015 and 2018.

For the impingement data shown in Table 3, most proportions either did not change or increased, therefore indicating that the original life tables used in the application yielded more conservative results for impingement. The only exception being Whiting in 2020 where the EAV increased with the updated life table. This change was not considered significant from an ecological perspective as the change was only 2% and data were within the same order of magnitude, with an increase of eight fish.

Now that the updates have been made, it is considered appropriate to use the updated lifetables in future reporting for the ongoing Pembroke environmental monitoring programme. An explanation will be provided to guide the reader to the changes in the data and how these have been processed and presented within the interpretive reporting.

Appendix A: Technical Memorandum - EAV Sensitivity Analysis 2024

RWE Pembroke EAV Sensitivity Analysis 2024

Date:	03/09/24
Project name:	Pembroke Power Station
Attention:	
Company:	Jacobs UK Ltd
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Revision no:	1

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Introduction

Jacobs UK Ltd (Jacobs, 2024) has carried out a review of literature published in order to update the original 2013/2016 fish Life Tables created for the Pembroke Equivalent Adult Value (EAV) analysis. This forms part of the ongoing post-commissioning monitoring of impacts of the Station's cooling water abstraction from the Pembroke River/Milford Haven waterway.

The EAV concept puts losses of fish of any given age into the context of adult populations by estimating the biological value of a fish had it avoided the impact, relative to that of an adult that has just reached the median age of maturation, which is used as a reference age. The EAV can therefore be seen as a standardising procedure that allows the biological value of fish at different ages to be compared to a standardised 'reference' fish.

The literature review indicated that many of the more recent data found were within the ranges of the original Pembroke lifetables. However, some new data differed sufficiently to merit a high level sensitivity analysis to determine the likely change in EAV outcomes. In particular, the following species and associated parameters were identified:

- Bass (length at age, natural mortality, fishing mortality and percent maturity)
- Sprat (lifespan and fecundity)
- Herring (proportion mature, fishing mortality)
- Sandeel (duration of lifestages)
- Plaice (fishing mortality and maturity)
- Whiting (Lifespan duration, natural mortality and fishing mortality).

Sand goby (*Pomatoschistus minutus*) were also included in the review but no additional relevant data were found.

Jacobs UK Ltd commissioned the present small study to look for any further updates to the above but also take into consideration any novel variations in EAV methodology used in Cefas (2019) fish impact assessments undertaken for the Hinkley Point C (HPC) New Nuclear Build. The revised Cefas methods are set out in public documents presented to the HPC Public Inquiry in support of EDF Energy's application to relax the requirement for use of Acoustic Fish Deterrent.

Methods

The Standard EAV Method

The established method for calculating EAV derives from Goodyear (1978), who applied the method to power plant impact assessment in the USA. The method was subsequently adopted in the UK by the Central Electricity Research Laboratories (Turnpenny, 1988) and has been used routinely in thermal power station impact assessments.

In these formulations, EAV is derived using a variety of life-history parameters set out in the form known as 'lifetables' . Mathematically, the EAV value is derived using the following equations:

EAV = 1 / (St . Fa) ………………………………….(1),

where Fa is the average lifetime egg production of an adult and St is the probability of survival from birth to any future time t. Fa represents the lifetime reproductive effort and is defined as: Fa = ∑Pj.Sj.Ej.Rj for j=a to m ……………………(2),

where:

a is the age in years at which 50% of fish mature

j is the lifestage number

m is the number of lifestages

Pj is the fraction of females that are mature in lifestage j

Sj is the survival probability from the age at which >50% mature to lifestage j

Ej is the average fecundity of mature females in lifestage j

Rj is the proportion of females in lifestage j.

St represents the cumulative survivorship to lifestage j.

Survivorship is determined from Z, the total instantaneous mortality rate. This represents the sum of both natural mortality (M) and fishing (anthropogenic) mortality (F). This formulation differs from that of Goodyear (1978) only in the inclusion of the term Rj to take account of variable sex ratio (Turnpenny, 1989).

The Cefas Variation

Lifetables for several common UK commercial fish species (sole, plaice, dab, cod, whiting and herring) are given in Turnpenny (1988) and these have been used in a number of fish impact assessments. The lifetables were assembled from best available data at the time for UK waters but predominantly North Sea. Lifetables for other species such as sandeel, sprat and goby have later been added, as for the 2013 Pembroke EAV analysis. As a general principle lifetables have been refined for specific applications to reflect the most up-to-date and geographically relevant data, as per the Jacobs (2024) updates for Pembroke. The most difficult parameter to ascertain is natural mortality rate, M. Generally, accurate estimates of M are only obtained by years of detailed study and analysis, which is mostly devoted to the major commercial fish stocks under ICES, and even then to the mature, exploited age groups and not juvenile lifestages.

The Cefas variant relates purely to estimation of the natural mortality rate for both juvenile and adult age groups of the stock. A brief explanation is offered here but more details can be found in Appendix F of Cefas (2019). Simply put, the mortality rate of a fish is directly related to its size and hence vulnerability to predation. As a fish grows larger its vulnerability, and hence the value of M, decreases (this is shown to hold less true for small armoured or spiny species). Cefas (2019) reviews several methodologies for estimating M from length-at-age data but concludes that the formula presented by Gislason *et al*. (2010) is most appropriate for fish entrapment application:

$\ln(M) = 0.55 * 1.61\ln(L) + 1.44\ln(L_\infty) + \ln(K)$ …...(3)

where

L_∞ asymptotic length of the stock (cm),

K is a rate function which determines how fast the fish approaches L_∞ (year-1); and

L = total length (cm).

The values of L_∞ and K are derived from the standard Von Bertalanffy growth equation:

$L_t = L_\infty(1-e^{-K(t-t_0)})$………………………………………(4).

Von Bertalanffy estimates are published for many different species and stocks and even where not found they can usually be readily estimated using just length-at-age data. Using Equation 3, the Gislason M value can be estimated for individuals of any length/age, making it readily usable in EAV calculations.

Before using the Gislason method in the HPC case, Cefas first compared values of Gislason M with published ICES values of M for the same stock. Generally these showed a good relationship between the two but for some species the Gislason value was considerably higher and a correction factor (CF) of dividing by between 1 and 2 was necessary to achieve comparable results. Cefas also concluded that a rough estimate of the 95% confidence limits could be made by dividing and multiplying the Gislason M by 4 for lower and upper limits respectively. In developing their assessment procedure, Cefas state:

"Stock size estimates are much less sensitive to underestimates of M ….. and it is, therefore, common practice to set a conservative (low) value of M for stock assessment purposes."

and that:

"For impingement assessment purposes the concern is that M should not be overestimated; the higher the value of M, the lower the number of adult survivors and the lower the predicted effect of impingement. For sensitivity testing purposes it is low M values that are, therefore, of interest."

Cefas therefore propose that values M and M/4 are used for this purpose but not the upper value of 4*M.

Treatment of Jacobs EAV Spreadsheets

Baseline information for the earlier 2013 Pembroke analysis was supplied by Jacobs in the form of Excel Spreadsheets. These contain the full lifetable information used, as well as the formulae used to calculate EAVs. For the present investigation some adjustments to the supplied spreadsheets were necessary:

1. Some of the spreadsheets were supplied in numeric format without the underlying formulae; these were repopulated with the required formulae copied from the other spreadsheets to form a matching fully functional set.

2. It is a fundamental requirement that the EAV should have a value of unity at the age of 50% maturity (the latter is taken as the first age group in which a minimum of 50% are reported as mature). Final EAV values were standardised in all cases achieve this. This was done by dividing the age-specific EAVs by the calculated EAV at the age of 50% maturity.

Sensitivity Analysis

This was performed by running the spreadsheet EAV species models with alternative lifetable data to compare the lifetime EAV trajectories. These then allow comparisons to be made of calculated EAVs for the different sets of input data against specific cases, e.g. for modal year-class lengths shown in annual impingement records. The following cases were investigated:

1. **Baseline** cases (2013 Pembroke data).

2. **Updated** cases (substituting additional lifetable elements found in the Jacobs [2024] review plus any other relevant data found during the present task).

3. **Cefas** cases (estimates of M determined using the Gislason *et al.* [2010] methodology, also comparing EAVs for M and M/4 to bracket the range of interest); referred to as Gislason M and Gislason M/4. These cases also incorporate new values used in **Updated** cases for parameters other than M.

Size/age-specific values of Gislason M were calculated using Equation 3 above. Values of the Von Bertalanffy L_∞ and K from the most relevant/recent information were obtained from literature review.

Results

The results are presented by species below. Tables show the Original versus Updated and Cefas (Gislason, Gislason/4) method EAV estimates for different fish lengths (mm) and ages (days). Note that the Gislason/4 figures are used by Cefas as an approximation of lower 95% confidence limits. A colour-coding system has been used to highlight changes. Green indicates <=100% of Original EAV, indicating that original values are conservative. Amber is up to 20% above Original and probably should not be considered a significant change given the inherent variability in lifetable parameters. Red is >20% above, indicating Originals may be underestimated based on present lifetable criteria and that impact assessments for these cases may merit reassessment. Cases showing in green or amber indicate that impact assessments based on the 'Original' Pembroke 2013 lifetables will give more conservative results and hence that the new lifetable information does not worsen the outcome. However, where Updated EAV figures fall below the Gislason/4 (quasi-95% lower limit) EAVs, it may reasonably be concluded that the changes are not significant and merit no further investigation.

EAV relative to Original		
≤100%	100-120%	>120%

Plots show EAV versus fish age and length for each species, in each case transecting at EAV=1.

While lifetables must necessarily span the full life history of a stock to account for lifetime reproductive capacity and EAV projections are shown for ages above initial 50% maturity, it is predominantly for the ages of fish below this threshold that EAVs are useful, since once entering the fishery fish have a face-value based on actual rather than potential weight. Variations above the EAV=1 point are therefore of less interest. An exception to this would be where statutory minimum landing sizes are significantly above this point.

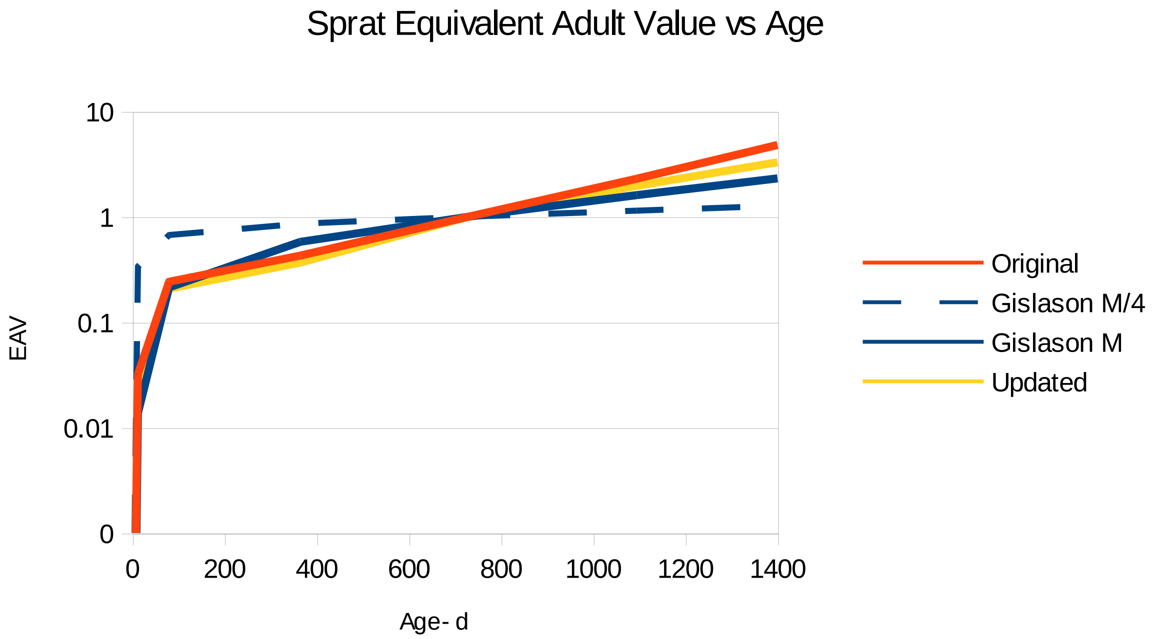
Original lifetables together with revised lifetables for the 3 cases (Updated, Cefas Gislason and Cefas Gislason/4) are presented in the Appendix. Revised lifetables include all amendments identified in Jacobs (2024) and other updates where shown. In the Cefas Gislason cases, size/age-specific values of M derived by the Gislason *et al.* (2010) equation override the other values where shown. All amended values are highlighted in orange.

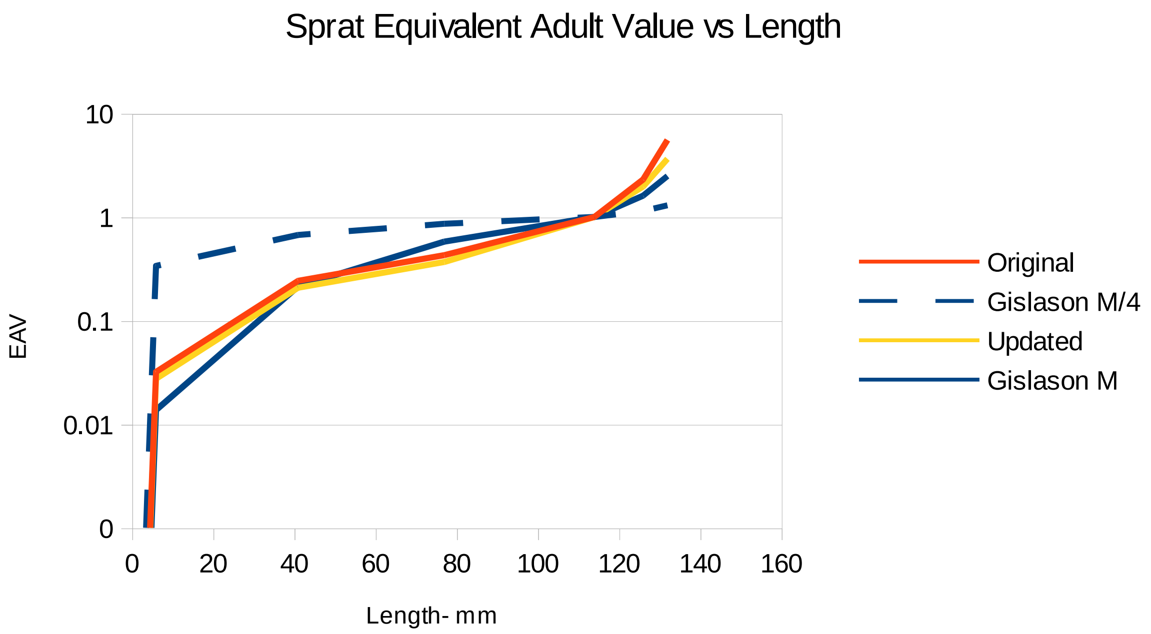
1. Sprat

The Jacobs (2024) review identified a maximum lifespan for sprat in the Bristol Channel/Bridgwater Bay of 3 y and lifetables were revised to reflect this. Lifetime fecundity estimates vary with M and 'Update' figure is in line with quoted total figure of ~14,800. 'Updated' figures show in green indicating that the 2013 assessment remains conservative. The EAV plots below show that all cases fall below M/4 line indicative of the 95% limits. Although the 77mm stage is in the red zone the overall picture suggests that existing assessments remain appropriate.

Von Bertalanffy growth coefficients used for the Gislason estimates of M for sprat were L∞=15.2cm, K=0.58 , which were mid-range values from Hunter *et al.* (2019) for North Sea and West of Scotland, and from Isles and Johnson (1962) for Western England. Cefas (2019) provide a Gislason Correction Factor (CF) of 1.9 for sprat.

Length (mm)	Age (d)	Standardised EAV				Sensitiivity	
		Original	Updated	Gislason M	Gislason M/4	Updated	Gislason M
3.0	3.5	2.60E-005	2.23E-005	1.11E-005	0.0002744	86%	43%
6.0	12.5	0.0319	0.0274	0.0137	0.3369	86%	43%
41	80	0.2417	0.2076	0.2133	0.6695	86%	88%
77	365	0.4274	0.3671	0.5773	0.8587	86%	135%
114	730	1	1	1	1	100%	100%
126	1095	2.2933	1.9621	1.6010	1.1419	86%	70%
132	1460	5.5290	3.6364	2.4811	1.2933	66%	45%
139	1825	13.3298					
145	2190	32.1367					




Sprat Equivalent Adult Value vs Length
10
1
0.1
0.01
0
EAV
0
20
40
60
80
100
120
140
160
Length- mm
Original
Gislason M/4
Updated
Gislason M

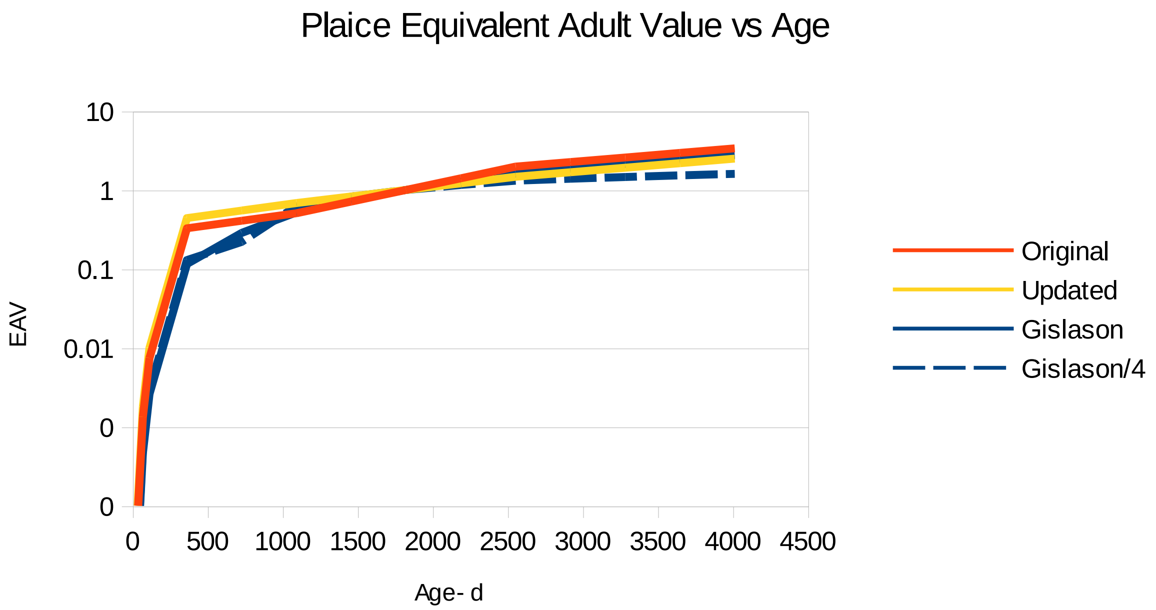
2. Plaice

In accordance with Jacobs (2024) review, revised cases adopt F=0.071 for ages 3 to 6, and size at 50% maturity of ~21cm. To achieve this also requires a commencement of egg production at a smaller size and to achieve this a fecundity of 25,000 has been added for fish of this size based on a plaice age-fecundity curve for plaice given in the 2016 lifetables for Welsh and West Coast waters.

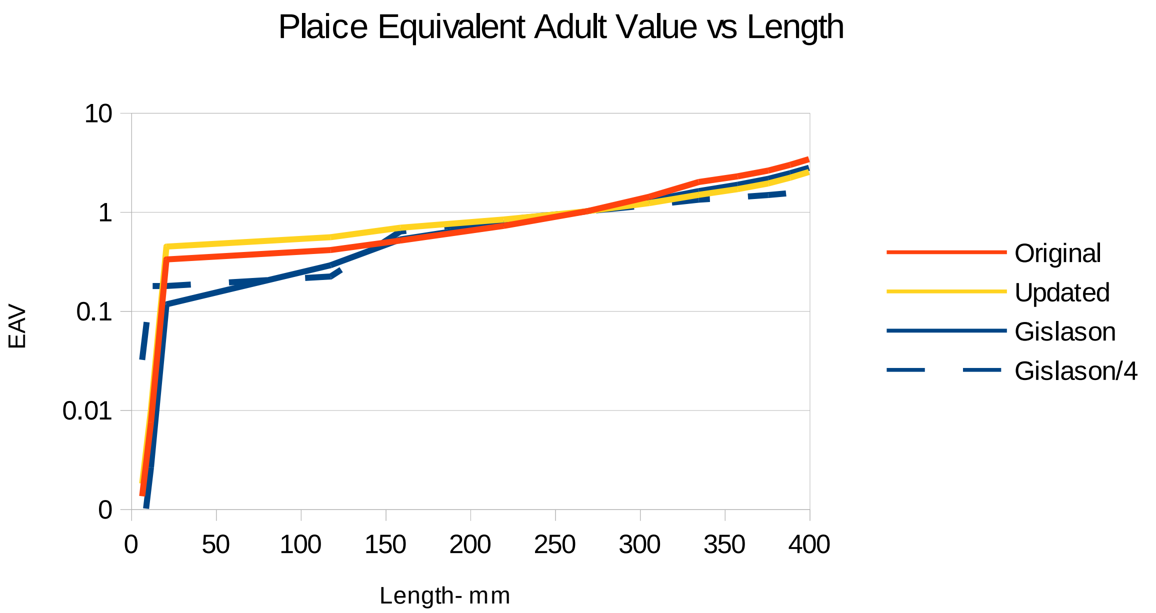
Von Bertalanffy growth coefficients used for the Gislason estimates of M for plaice were L∞=59.5cm, K=0.132, which were averaged values from Cefas (2019), who also provide a Gislason Correction Factor (CF) of 1.91 for plaice. These figures are within the range of values are similar to given by Doran (2011).

Results indicate 'Updated' figures in red/amber, exceeding Original 2013 Pembroke figures. However, using the Cefas Gislason procedure figures remain within the green/amber classification. Indicating that Original figures fall between the two. Plaice appear to be a case where both Original and Updated figures exceed the Gislason/4 figures.

Length (mm)	Age (d)	Standardised EAV				Sensitiivity	
		Original	Updated	Gislason	Gislason/4	Updated	Gislason M
	15	0.0000	0.00002	0.00000	0.00000	134%	35%
6.8	71	0.0013	0.002	0.000	0.001	134%	35%
12	115	0.0074	0.010	0.003	0.003	134%	35%
21.1	365	0.327	0.440	0.115	0.129	135%	35%
118	730	0.407	0.548	0.286	0.220	135%	70%
159	1095	0.507	0.682	0.520	0.625	135%	103%
220	1460	0.712	0.826	0.751	0.822	116%	106%
269	1825	1	1	1	1	100%	100%
306	2190	1.405	1.210	1.278	1.156	86%	91%
335	2555	1.974	1.465	1.596	1.310	74%	81%
358	2920	2.254	1.673	1.851	1.386	74%	82%
376	3285	2.574	1.911	2.125	1.458	74%	83%
389	3650	2.940	2.182	2.423	1.527	74%	82%
400	4015	3.358	2.492	2.749	1.596	74%	82%
409	4380	3.8344					
415	4745	4.3789					
420	5110	5.0008					
424	5475	5.7110					
430	5.8E+03	6.5221					



Plaice Equivalent Adult Value vs Age
10
1
0.1
0.01
0
0
EAV
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Age- d
Original
Updated
Gislason
Gislason/4



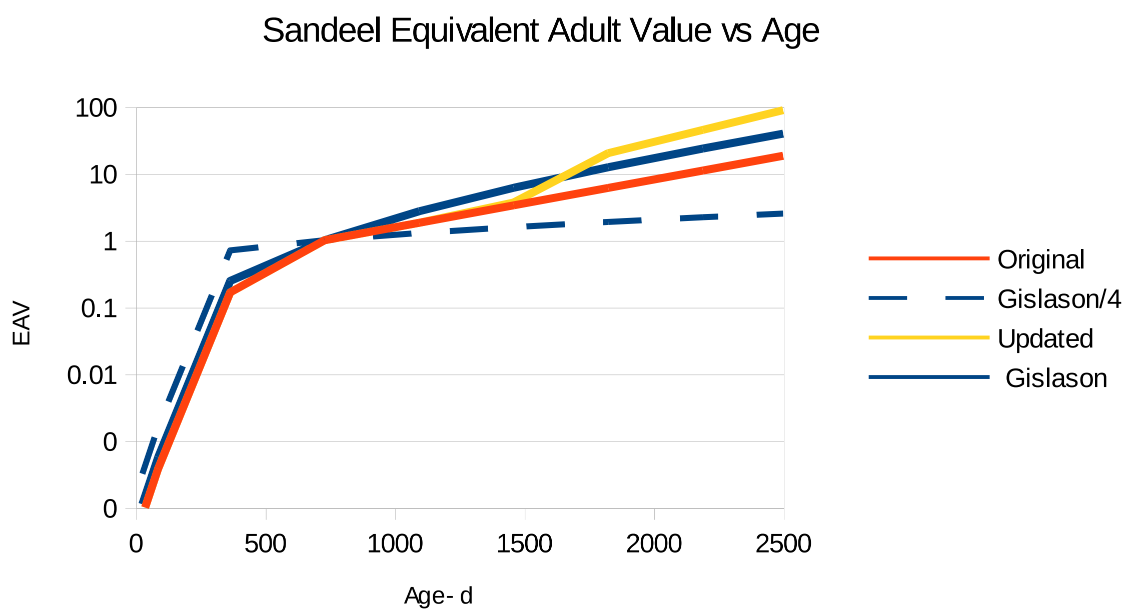
Plaice Equivalent Adult Value vs Length
10
1
0.1
0.01
0
EAV
0
50
100
150
200
250
300
350
400
Length- mm
Original
Updated
Gislason
Gislason/4

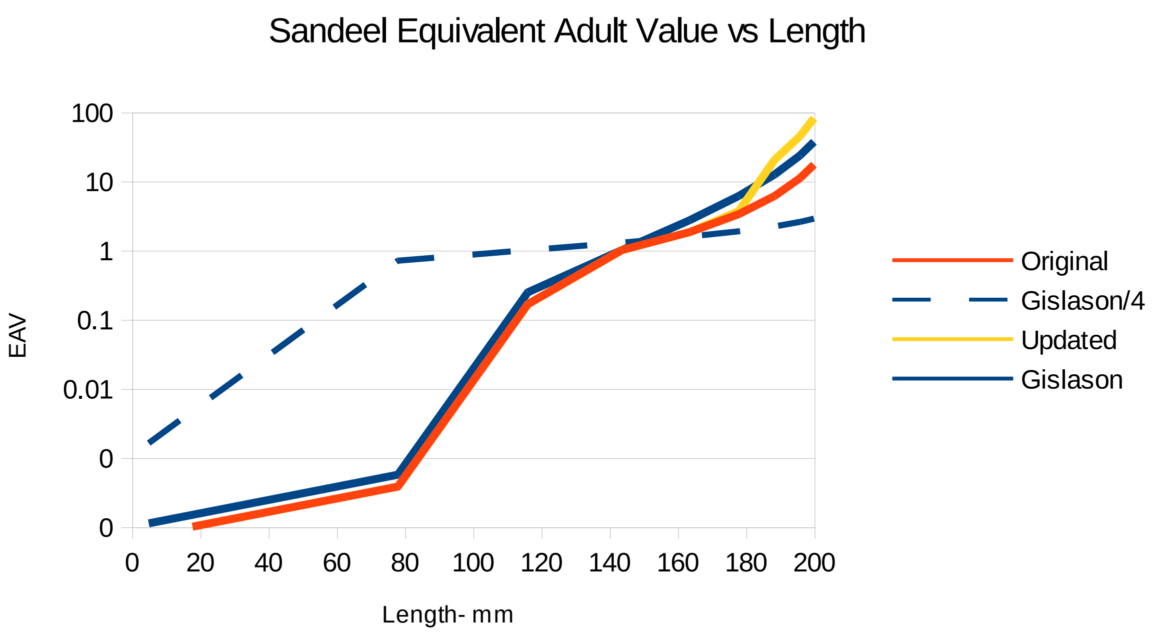
3. Sandeel

The sandeel lifetable has been updated in line with the 2016 lifetables, which updates juvenile lifestages, values of M and fecundity for west coast sandeels. Von Bertalanffy growth coefficients used for the Gislason estimates of M for sprat were L∞=22.0cm, K=0.49 based on Speirs *et al.,* (2019) for east coast of Scotland. A Correction Factor (CF) of 1.0 is used for sandeel as higher values appear to give unrealistically low estimates of M.

Resultant figures for EAV<1 remain the same, yielding green codes in in the table below. The Cefas Gislason method gives results around 50% or so higher across this age range, which may merit an updated impact assessment for sandeel. However, for Original, Updated and Cefas Gislason plots, all lifestages of EA<1 fall below the Gislason/4 line, implying that that there may be no significant increase in the EAVs at these ages.

Length (mm)	Age (d)	EAV				Sensitiivity	
		Original	Updated	Gislason	Gislason/4	Updated	Gislason M
-	26	7.5E-005	7.52E-005	0.000112	0.0003202	100%	148%
5	87	0.00038	0.00038	0.000564	0.001618	100%	148%
78	365	0.1653	0.1652989	0.2454	0.703823	100%	148%
116	730	1.0000	1	1	1	100%	100%
144	1095	1.822	1.822	2.711	1.283	100%	149%
164	1460	3.320	3.669	6.090	1.571	111%	183%
178	1825	6.050	20.086	12.342	1.874	332%	204%
188	2190	11.023	44.701	23.514	2.202	406%	213%
196	2555	20.086	99.484	43.066	2.562	495%	214%
201	2920	36.598	221.406	76.839	2.961	605%	210%


Sandeel Equivalent Adult Value vs Age
EAV
100
10
1
0.1
0.01
0
0
0
500
1000
1500
2000
2500
Age- d
Original
Gislason/4
Updated
Gislason


Sandeel Equivalent Adult Value vs Length
EAV
100
10
1
0.1
0.01
0
0
0
20
40
60
80
100
120
140
160
180
200
Length- mm
Original
Gislason/4
Updated
Gislason

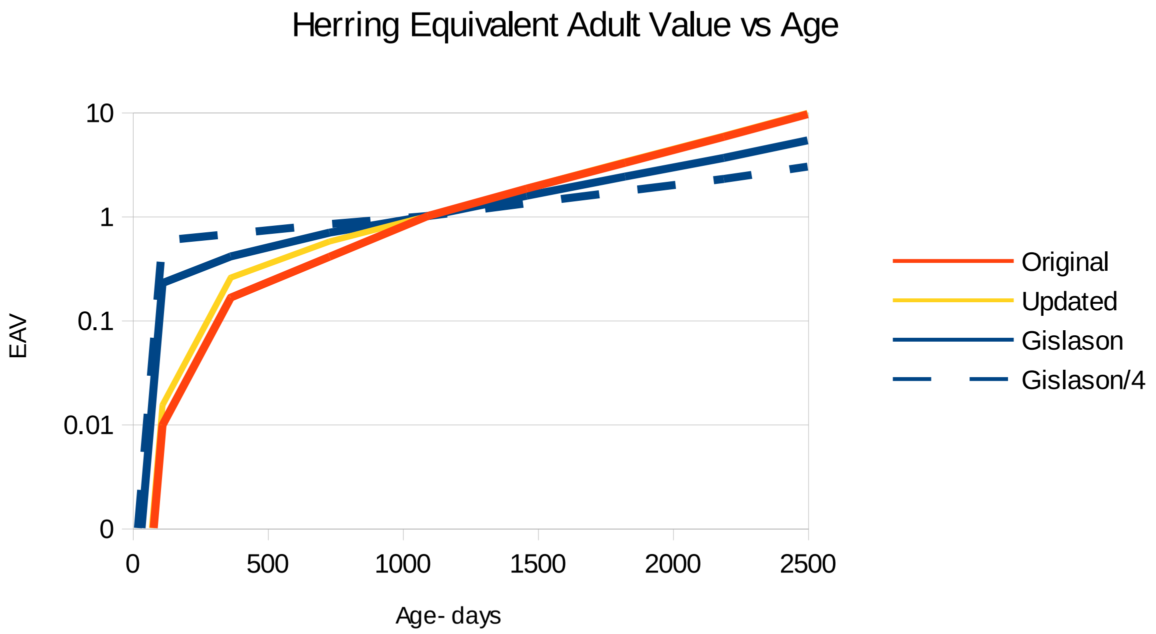
4. Herring

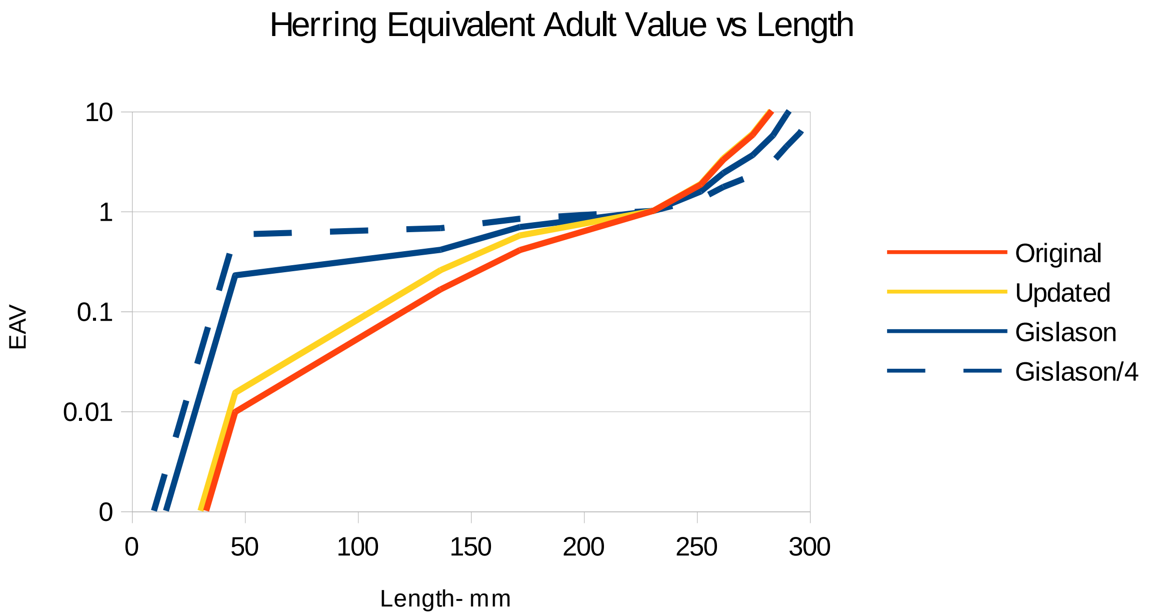
ICES fishing mortality (F) values as indicated by Jacobs (2024) for 2020 were used in revised herring lifetables; ICES natural mortality figures for age 1-5 groups herring were used in the Updated lifetable. No other changes were found to be necessary.

Von Bertalanffy growth coefficients used for the Gislason estimates of M for herring were L∞=31.5cm, K=0.315 , which were averaged values from Cefas (2019), who also provide a Gislason Correction Factor (CF) of 1.97 for herring.

Both Updated and Cefas Gislason method figures for EAV<1 fish were classified as red and could suggest a case for updating the impact assessment for herring. However, for Original, Updated and Cefas Gislason plots, all lifestages of EA<1 fall below the Gislason/4 line, implying that that there may be no significant increase in the EAVs at these ages.

Length (mm)	Age (d)	Standardised EAV				Sensitiivity	
		Original	Updated	Gislason	Gislason/4	Updated	Gislason M
5	11	8.28E-006	1.29E-005	0.0001926	0.00049249	156%	2325%
10	21	1.67E-005	2.60E-005	0.0003877	0.00099175	156%	2325%
46	112	0.0097	0.0152	0.2265	0.5792	156%	2325%
137	365	0.1641	0.2556	0.4084	0.6713	156%	249%
172	730	0.4051	0.5681	0.6904	0.8353	140%	170%
231	1095	1	1	1	1	100%	100%
252	1460	1.8323	1.8637	1.5626	1.3241	102%	85%
262	1825	3.2445	3.3500	2.3921	1.7350	103%	74%
275	2190	5.7622	5.9258	3.6160	2.2713	103%	63%
284	2555	10.3853	10.6802	5.7064	3.1266	103%	55%
290	2920	19.2060	19.7514	9.2216	4.4274	103%	48%
296	3285	34.3235	35.2981	14.4193	6.0922	103%	42%
300	3650	61.3404	63.0822	22.4646	8.3755	103%	37%
301	4015	109.6229	112.7358	34.9677	11.5120	103%	32%


Herring Equivalent Adult Value vs Age
10
1
0.1
0.01
0
EAV
0
500
1000
1500
2000
2500
Age- days
Original
Updated
Gislason
Gislason/4

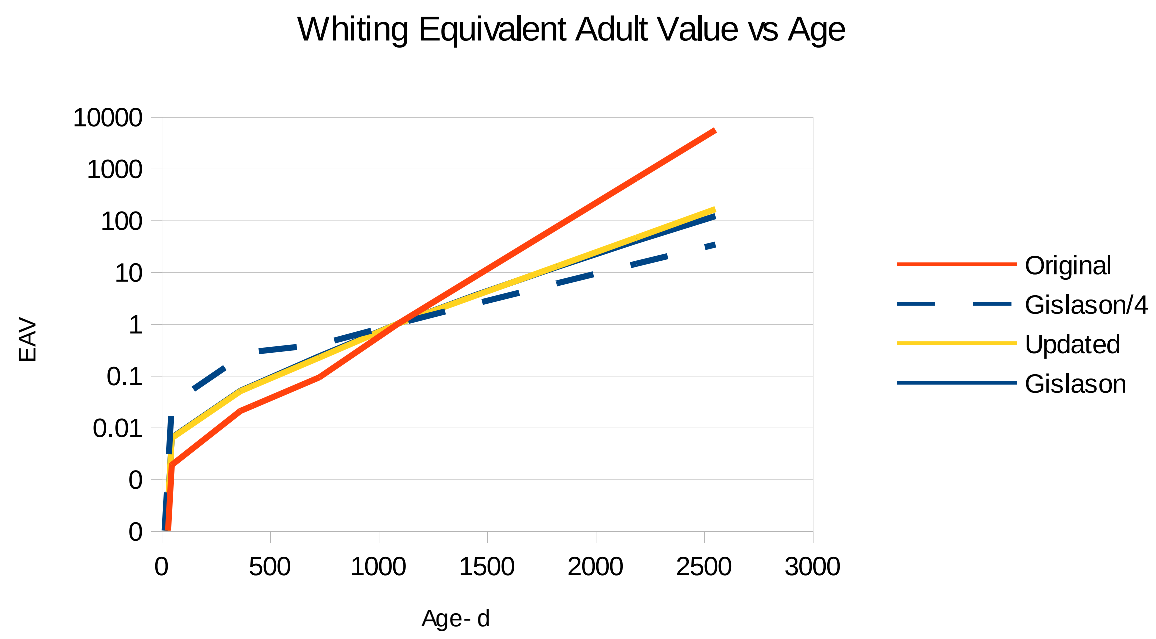

Herring Equivalent Adult Value vs Length
10
1
0.1
0.01
0
EAV
0
50
100
150
200
250
300
Length- mm
Original
Updated
Gislason
Gislason/4

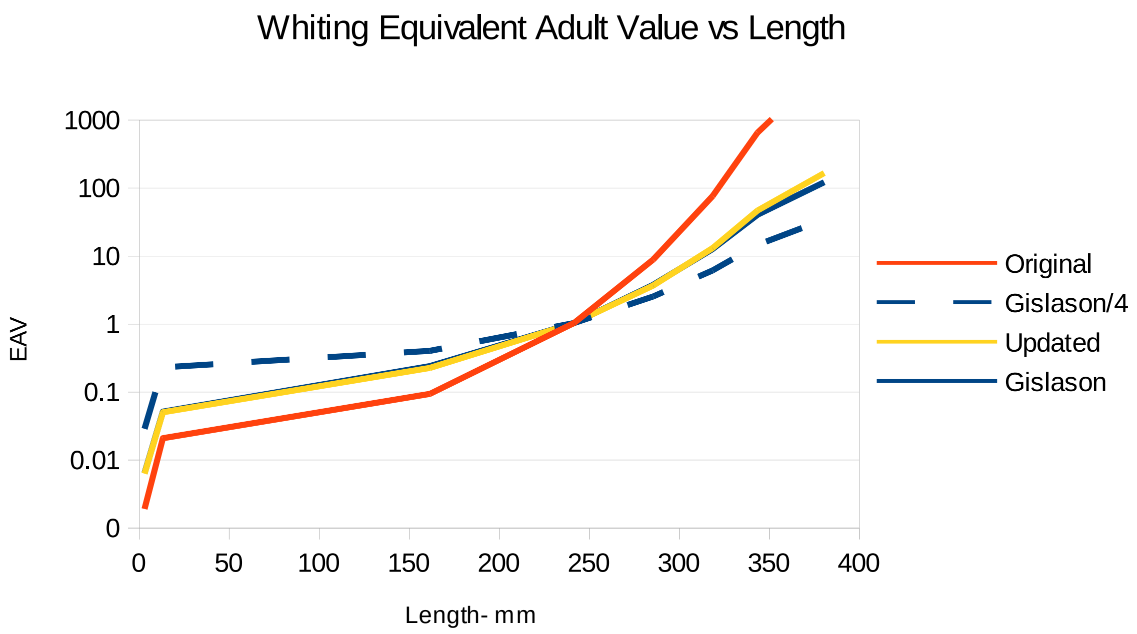
5. Whiting

As per Jacobs (2024), Updated life table is limited to 6 y of age, with amendments to both M and F values as indicated. Von Bertalanffy growth coefficients used for the Gislason estimates of M for whiting were L∞=50cm, K=0.24. Cefas (2019) provide a Gislason Correction Factor (CF) of 1.0 for whiting.

Both 'Updated' and 'Cefas Gislason' results are in the red zone, indicating a possible need for reassessment of impacts. However, for Original, Updated and Cefas Gislason plots, all lifestages of EA<1 fall below the Gislason/4 line, implying that that there may be no significant increase in the EAVs at these ages.

Length (mm)	Age (d)	Equivalent Adult Value				Sensitiivity	
		Original	Updated	Gislason	Gislason/4	Updated	Gislason M
-	7.9	1.45E-006	4.80E-006	4.90E-006	2.20E-005	330%	337%
3.5	49.9	0.0018	0.0061	0.0062	0.0279	330%	337%
13.7	365	0.0202	0.0488	0.0497	0.2231	241%	246%
-	419.9	0.0254	0.0612	0.0626	0.2808	241%	247%
162	730	0.0907	0.2187	0.2327	0.3898	241%	256%
242	1095	1	1	1	1	100%	100%
286	1460	8.5849	3.56	3.65	2.46	41%	43%
319	1825	73.6998	12.68	12.27	5.94	17%	17%
344	2190	632.70	45.15	39.15	14.15	7%	6%
381	2555	5432	160.77	117.78	33.19	3%	2%


Whiting Equivalent Adult Value vs Age
EAV
Age- d
10000
1000
100
10
1
0.1
0.01
0
0
0
500
1000
1500
2000
2500
3000
Original
Gislason/4
Updated
Gislason


Whiting Equivalent Adult Value vs Length
EAV
Length- mm
1000
100
10
1
0.1
0.01
0
0
50
100
150
200
250
300
350
400
Original
Gislason/4
Updated
Gislason

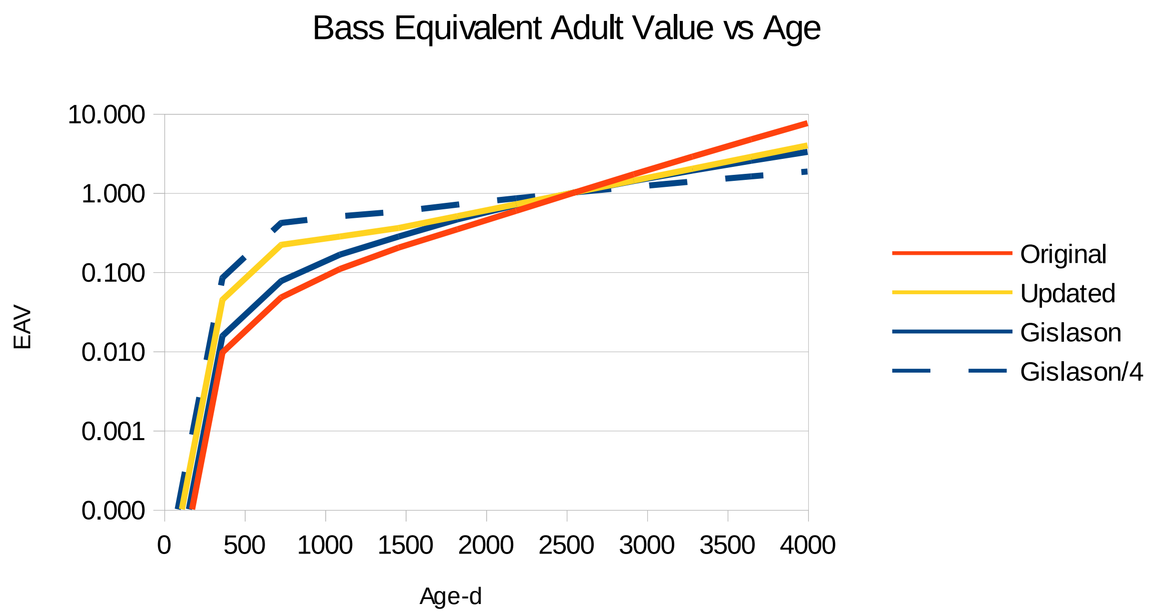
6. Bass

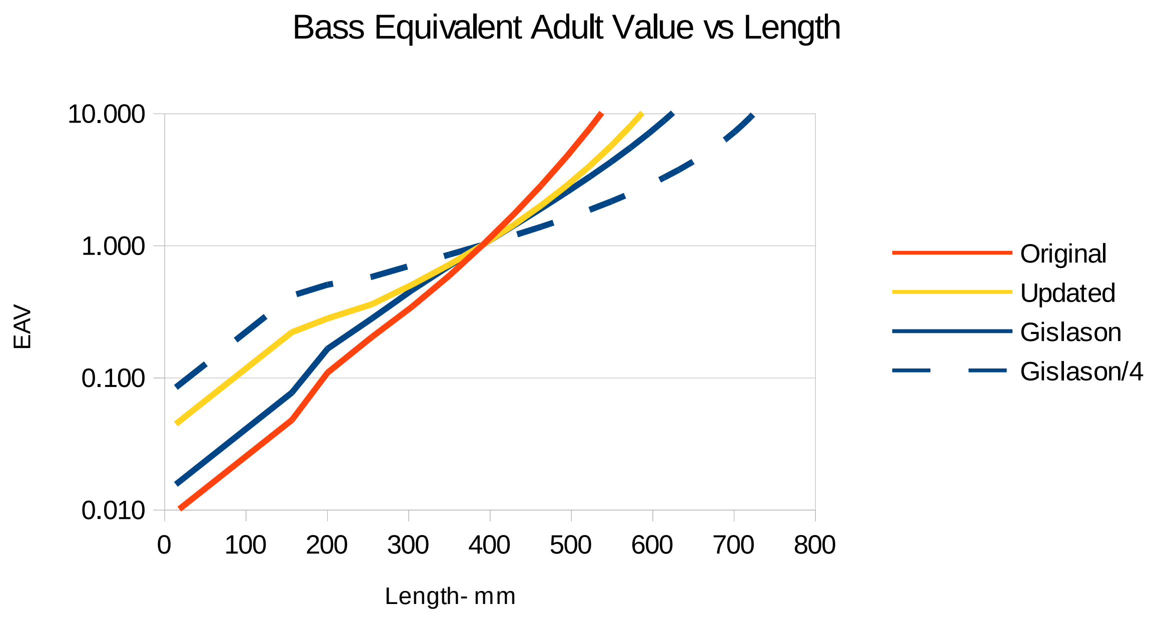
Following Jacobs (2024) advice from ICES, values of M=0.24 for all age groups >2 and F=0.105 for age groups >4 have been used in the revised Updated and Cefas Gislason lifetables.

Von Bertalanffy growth coefficients used for the Gislason estimates of M for bass were L∞=79cm, K=0.103 (Cambie *et al.* (2015), for Welsh waters. Cefas (2019) provide a Gislason Correction Factor (CF) of 1.0 for bass. The growth coefficients are in line with ICES figures for Irish and Celtic Seas in the 2016 lifetables.

This results in both cases in elevated EAVs for individuals of EAV<1, which may merit revised impact assessments. However, for Original, Updated and Cefas Gislason plots, all lifestages of EA<1 fall below the Gislason/4 line, implying that that there may be no significant increase in the EAVs at these ages. Jacobs (2024) refers to French data for bass length-at-age distribution in the English Channel from ICES, however this was not considered a necessary or more relevant update.

Length (mm)	Age (d)	Standardised EAV				Sensitiivity	
		Original	Updated	Gislason	Gislason/4	Updated	Gislason M
-	69	0.00001	0.00003	0.00001	0.00006	462%	161%
15	365	0.01	0.0441	0.0154	0.08331	462%	161%
158	730	0.05	0.218	0.076	0.412	462%	161%
202	1095	0.11	0.277	0.164	0.500	257%	152%
256	1460	0.20	0.355	0.278	0.573	177%	138%
306	1825	0.34	0.502	0.456	0.702	147%	133%
351	2190	0.58	0.708	0.693	0.843	121%	119%
392	2555	1	1	1	1	100%	100%
430	2920	1.70	1.41	1.39	1.18	83%	82%
464	3285	2.83	1.99	1.89	1.37	70%	67%
496	3650	4.68	2.82	2.51	1.59	60%	54%
524	4015	7.65	3.97	3.29	1.85	52%	43%
550	4380	12.40	5.61	4.25	2.13	45%	34%
574	4745	19.93	7.92	5.44	2.45	40%	27%
596	5110	31.80	11.19	6.91	2.81	35%	22%
615	5475	137	15.8	8.7	3.2	12%	6%
633	5840	587	22.3	10.9	3.7	4%	2%
650	6205	2506	31.5	13.6	4.2	1%	1%
665	6570	3920	44.5	16.9	4.8	1%	0%
678	6935	6106	62.8	21.0	5.5	1%	0%
691	7300	9482	88.7	25.9	6.3	1%	0%
702	7665	14697	125.2	31.9	7.2	1%	0%
712	8030	22779	176.8	39.1	8.2	1%	0%
722	8395	35306	249.6	48.0	9.3	1%	0%
730	8760	54721	352.5	58.7	10.6	1%	0%
738	9125	84813	497.7	71.7	12.0	1%	0%
745	9490	131452	702.7	12.3	13.7	1%	0%
752	9855	203740	992.3	15.0	15.5	0%	0%


Bass Equivalent Adult Value vs Age
EAV
10.000
1.000
0.100
0.010
0.001
0.000
0
500
1000
1500
2000
2500
3000
3500
4000
Age-d
Original
Updated
Gislason
Gislason/4


Bass Equivalent Adult Value vs Length
EAV
10.000
1.000
0.100
0.010
0
100
200
300
400
500
600
700
800
Length- mm
Original
Updated
Gislason
Gislason/4

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APPENDIX: LIFE TABLE REVISIONS

BASS

ORIGINAL

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name	Duration of Life stage (d)	Length (mm)	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)		Proportion mature (Pj)	Age-specific egg prodn.	1
0	1 & 2	Egg & Larvae	69	-	1.99	0.00	1.99	0.14						0.1372433
0	3	Juvenile & adolescent	296	15	7.16	0.00	7.16	0.00						0.0001068
1	3	Juvenile & adolescent	365	158	1.60	0.00	1.60	0.20						0.0000216
2	3	Juvenile & adolescent	365	202	0.83	0.00	0.83	0.44						0.0000094
3	3	Juvenile & adolescent	365	256	0.54	0.08	0.62	0.54						0.0000051
4	3	Juvenile & adolescent	365	306	0.40	0.14	0.53	0.59						0.0000030
5	3	Juvenile & adolescent	365	351	0.31	0.22	0.53	0.59						0.0000017
6	4	Adult	365	392	0.26	0.28	0.54	0.58	1.00	209,866	0.54	0.55	62,076	0.0000010
7	4	Adult	365	430	0.22	0.31	0.53	0.59	0.59	186,950	0.55	0.98	59,183	0.0000006
8	4	Adult	365	464	0.20	0.32	0.51	0.60	0.35	195,112	0.56	1.00	38,486	0.0000004
9	4	Adult	365	496	0.18	0.33	0.50	0.60	0.21	234,352	0.57	0.98	27,979	0.0000002
10	4	Adult	365	524	0.16	0.33	0.49	0.61	0.13	304,670	0.58	1.00	23,207	0.0000001
11	4	Adult	365	550	0.15	0.34	0.48	0.62	0.08	406,066	0.60	1.00	19,542	0.0000001
12	4	Adult	365	574	0.14	0.34	0.47	0.62	0.05	538,540	0.61	1.00	16,524	0.0000001
13	4	Adult	365	596	0.13	0.34	0.47	0.63	0.03	702,092	0.63	1.00	13,850	0.0000000
14	4	Adult	365	615	1.12	0.34	1.46	0.23	0.01	896,722	0.64	1.00	4,215	0.0000000
15	4	Adult	365	633	1.12	0.34	1.46	0.23	0.00	1,122,430	0.66	1.00	1,265	0.0000000
16	4	Adult	365	650	1.11	0.34	1.45	0.23	0.00	1,379,216	0.68	1.00	375	0.0000000
17	4	Adult	365	665	0.11	0.34	0.45	0.64	0.00	1,667,080	0.70	1.00	298	0.0000000
18	4	Adult	365	678	0.11	0.34	0.44	0.64	0.00	1,986,022	0.72	1.00	235	0.0000000
19	4	Adult	365	691	0.10	0.34	0.44	0.64	0.00	2,336,042	0.74	1.00	183	0.0000000
20	4	Adult	365	702	0.10	0.34	0.44	0.65	0.00	2,717,140	0.77	1.00	142	0.0000000
21	4	Adult	365	712	0.10	0.34	0.44	0.65	0.00	2,717,140	0.79	1.00	94	0.0000000
22	4	Adult	365	722	0.10	0.34	0.44	0.65	0.00	2,717,140	0.81	1.00	63	0.0000000
23	4	Adult	365	730	0.10	0.34	0.44	0.65	0.00	2,717,140	0.84	1.00	42	0.0000000
24	4	Adult	365	738	0.10	0.34	0.44	0.65	0.00	2,717,140	0.87	1.00	28	0.0000000
25	4	Adult	365	745	0.10	0.34	0.44	0.65	0.00	2,717,140	0.90	1.00	18	0.0000000
26	4	Adult	365	752	0.10	0.34	0.44	0.65	0.00	2,717,140	0.92	1.00	12	0.0000000
												Fa	267,816	

UPDATED

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name	Duration of Life stage (d)	Length (mm)	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)		Proportion mature (Pj)	Age-specific egg prodn.	1
0	1 & 2	Egg & Larvae	69	-	1.99	0.00	1.99	0.14						0.1372433
0	3	Juvenile & adolescent	296	15	7.16	0.00	7.16	0.00						0.0001068
1	3	Juvenile & adolescent	365	158	1.60	0.00	1.60	0.20						0.0000216
2	3	Juvenile & adolescent	365	202	0.24	0.001	0.24	0.79						0.0000170
3	3	Juvenile & adolescent	365	256	0.24	0.007	0.25	0.78						0.0000132
4	3	Juvenile & adolescent	365	306	0.24	0.105	0.35	0.71						0.0000094
5	3	Juvenile & adolescent	365	351	0.24	0.105	0.35	0.71						0.0000066
6	4	Adult	365	392	0.24	0.105	0.35	0.71	1.00	209,866	0.54	0.55	62,076	0.0000047
7	4	Adult	365	430	0.24	0.105	0.35	0.71	0.71	186,950	0.55	0.98	71,053	0.0000033
8	4	Adult	365	464	0.24	0.105	0.35	0.71	0.50	195,112	0.56	1.00	54,647	0.0000024
9	4	Adult	365	496	0.24	0.105	0.35	0.71	0.36	234,352	0.57	0.98	46,519	0.0000017
10	4	Adult	365	524	0.24	0.105	0.35	0.71	0.25	304,670	0.58	1.00	44,686	0.0000012
11	4	Adult	365	550	0.24	0.105	0.35	0.71	0.18	406,066	0.60	1.00	43,178	0.0000008
12	4	Adult	365	574	0.24	0.105	0.35	0.71	0.13	538,540	0.61	1.00	41,562	0.0000006
13	4	Adult	365	596	0.24	0.105	0.35	0.71	0.09	702,092	0.63	1.00	39,366	0.0000004
14	4	Adult	365	615	0.24	0.105	0.35	0.71	0.06	896,722	0.64	1.00	36,562	0.0000003
15	4	Adult	365	633	0.24	0.105	0.35	0.71	0.04	1,122,430	0.66	1.00	33,307	0.0000002
16	4	Adult	365	650	0.24	0.105	0.35	0.71	0.03	1,379,216	0.68	1.00	29,808	0.0000001
17	4	Adult	365	665	0.24	0.105	0.35	0.71	0.02	1,667,080	0.70	1.00	26,259	0.0000001
18	4	Adult	365	678	0.24	0.105	0.35	0.71	0.02	1,986,022	0.72	1.00	22,813	0.0000001
19	4	Adult	365	691	0.24	0.105	0.35	0.71	0.01	2,336,042	0.74	1.00	19,578	0.0000001
20	4	Adult	365	702	0.24	0.105	0.35	0.71	0.01	2,717,140	0.77	1.00	16,623	0.0000000
21	4	Adult	365	712	0.24	0.105	0.35	0.71	0.01	2,717,140	0.79	1.00	12,138	0.0000000
22	4	Adult	365	722	0.24	0.105	0.35	0.71	0.00	2,717,140	0.81	1.00	8,866	0.0000000
23	4	Adult	365	730	0.24	0.105	0.35	0.71	0.00	2,717,140	0.84	1.00	6,478	0.0000000
24	4	Adult	365	738	0.24	0.105	0.35	0.71	0.00	2,717,140	0.87	1.00	4,734	0.0000000
25	4	Adult	365	745	0.24	0.105	0.35	0.71	0.00	2,717,140	0.90	1.00	3,460	0.0000000
26	4	Adult	365	752	0.240	0.105	0.35	0.71	0.00	2,717,140	0.92	1.00	2,530	0.0000000
												Fa	626,244	

CEFAS GISLASON

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name	Duration of Life stage (d)	Length (mm)	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)		Proportion mature (Pj)	Age-specific egg prodn.	1
0	1 & 2	Egg & Larvae	69	-	1.99	0.00	1.99	0.14						0.1372433
0	3	Juvenile & adolescent	296	15	7.16	0.00	7.16	0.00						0.0001068
1	3	Juvenile & adolescent	365	158	1.60	0.00	1.60	0.20						0.0000216
2	3	Juvenile & adolescent	365	202	0.77	0.001	0.77	0.46						0.0000100
3	3	Juvenile & adolescent	365	256	0.52	0.007	0.53	0.59						0.0000059
4	3	Juvenile & adolescent	365	306	0.39	0.105	0.50	0.61						0.0000036
5	3	Juvenile & adolescent	365	351	0.31	0.105	0.42	0.66						0.0000024
6	4	Adult	365	392	0.26	0.105	0.37	0.69	1.00	209,866	0.54	0.55	62,076	0.0000016
7	4	Adult	365	430	0.23	0.105	0.33	0.72	0.72	186,950	0.55	0.98	72,048	0.0000012
8	4	Adult	365	464	0.20	0.105	0.30	0.74	0.53	195,112	0.56	1.00	57,685	0.0000009
9	4	Adult	365	496	0.18	0.105	0.28	0.75	0.40	234,352	0.57	0.98	52,146	0.0000007
10	4	Adult	365	524	0.16	0.105	0.27	0.76	0.30	304,670	0.58	1.00	54,026	0.0000005
11	4	Adult	365	550	0.15	0.105	0.26	0.77	0.24	406,066	0.60	1.00	57,002	0.0000004
12	4	Adult	365	574	0.14	0.105	0.25	0.78	0.18	538,540	0.61	1.00	60,512	0.0000003
13	4	Adult	365	596	0.13	0.105	0.24	0.79	0.14	702,092	0.63	1.00	63,732	0.0000002
14	4	Adult	365	615	0.13	0.105	0.23	0.79	0.11	896,722	0.64	1.00	66,272	0.0000002
15	4	Adult	365	633	0.12	0.105	0.23	0.80	0.09	1,122,430	0.66	1.00	67,982	0.0000002
16	4	Adult	365	650	0.12	0.105	0.22	0.80	0.07	1,379,216	0.68	1.00	68,846	0.0000001
17	4	Adult	365	665	0.11	0.105	0.22	0.80	0.06	1,667,080	0.70	1.00	68,916	0.0000001
18	4	Adult	365	678	0.11	0.105	0.21	0.81	0.05	1,986,022	0.72	1.00	68,279	0.0000001
19	4	Adult	365	691	0.11	0.105	0.21	0.81	0.04	2,336,042	0.74	1.00	67,036	0.0000001
20	4	Adult	365	702	0.10	0.105	0.21	0.81	0.03	2,717,140	0.77	1.00	65,288	0.0000001
21	4	Adult	365	712	0.10	0.105	0.21	0.81	0.03	2,717,140	0.79	1.00	54,819	0.0000000
22	4	Adult	365	722	0.10	0.105	0.20	0.82	0.02	2,717,140	0.81	1.00	46,140	0.0000000
23	4	Adult	365	730	0.10	0.105	0.20	0.82	0.02	2,717,140	0.84	1.00	38,917	0.0000000
24	4	Adult	365	738	0.09	0.105	0.20	0.82	0.01	2,717,140	0.87	1.00	32,886	0.0000000
25	4	Adult	365	745	0.09	0.105	0.20	0.82	0.01	2,717,140	0.90	1.00	27,835	0.0000000
26	4	Adult	365	752	0.09	0.105	0.20	0.82	0.01	2,717,140	0.92	1.00	23,592	0.0000000
												Fa	1,176,038	

CEFAS GISLASON/4

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name	Duration of Life stage (d)	Length (mm)	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)		Proportion mature (Pj)	Age-specific egg prodn.	1
0	1 & 2	Egg & Larvae	69	-	1.99	0.00	1.99	0.14						0.1372433
0	3	Juvenile & adolescent	296	15	7.16	0.00	7.16	0.00						0.0001068
1	3	Juvenile & adolescent	365	158	1.60	0.00	1.60	0.20						0.0000216
2	3	Juvenile & adolescent	365	202	0.19	0.001	0.19	0.83						0.0000178
3	3	Juvenile & adolescent	365	256	0.13	0.007	0.14	0.87						0.0000155
4	3	Juvenile & adolescent	365	306	0.10	0.105	0.20	0.82						0.0000127
5	3	Juvenile & adolescent	365	351	0.08	0.105	0.18	0.83						0.0000105
6	4	Adult	365	392	0.07	0.105	0.17	0.84	1.00	209,866	0.54	0.55	62,076	0.0000089
7	4	Adult	365	430	0.06	0.105	0.16	0.85	0.85	186,950	0.55	0.98	85,362	0.0000076
8	4	Adult	365	464	0.05	0.105	0.15	0.86	0.73	195,112	0.56	1.00	79,394	0.0000065
9	4	Adult	365	496	0.04	0.105	0.15	0.86	0.63	234,352	0.57	0.98	82,138	0.0000056
10	4	Adult	365	524	0.04	0.105	0.15	0.86	0.54	304,670	0.58	1.00	96,266	0.0000048
11	4	Adult	365	550	0.04	0.105	0.14	0.87	0.47	406,066	0.60	1.00	113,838	0.0000042
12	4	Adult	365	574	0.04	0.105	0.14	0.87	0.41	538,540	0.61	1.00	134,438	0.0000036
13	4	Adult	365	596	0.03	0.105	0.14	0.87	0.36	702,092	0.63	1.00	156,545	0.0000032
14	4	Adult	365	615	0.03	0.105	0.14	0.87	0.31	896,722	0.64	1.00	179,055	0.0000028
15	4	Adult	365	633	0.03	0.105	0.14	0.87	0.27	1,122,430	0.66	1.00	201,167	0.0000024
16	4	Adult	365	650	0.03	0.105	0.13	0.87	0.24	1,379,216	0.68	1.00	222,307	0.0000021
17	4	Adult	365	665	0.03	0.105	0.13	0.88	0.21	1,667,080	0.70	1.00	242,071	0.0000018
18	4	Adult	365	678	0.03	0.105	0.13	0.88	0.18	1,986,022	0.72	1.00	260,186	0.0000016
19	4	Adult	365	691	0.03	0.105	0.13	0.88	0.16	2,336,042	0.74	1.00	276,476	0.0000014
20	4	Adult	365	702	0.03	0.105	0.13	0.88	0.14	2,717,140	0.77	1.00	290,840	0.0000012
21	4	Adult	365	712	0.03	0.105	0.13	0.88	0.12	2,717,140	0.79	1.00	263,296	0.0000011
22	4	Adult	365	722	0.02	0.105	0.13	0.88	0.11	2,717,140	0.81	1.00	238,562	0.0000010
23	4	Adult	365	730	0.02	0.105	0.13	0.88	0.09	2,717,140	0.84	1.00	216,308	0.0000008
24	4	Adult	365	738	0.02	0.105	0.13	0.88	0.08	2,717,140	0.87	1.00	196,252	0.0000007
25	4	Adult	365	745	0.02	0.105	0.13	0.88	0.07	2,717,140	0.90	1.00	178,150	0.0000007
26	4	Adult	365	752	0.02	0.105	0.13	0.88	0.06	2,717,140	0.92	1.00	161,788	0.0000006
												Fa	3,736,514	

HERRING

ORIGINAL

Age (yrs)	Stage	Duration of Life stage (d)	Length (mm)	Mortality Function					Reproduction				
				Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	St
0	1	11	5	0.09	0.00	0.09	0.918						0.9182827
0	2	10	10	0.70	0.00	0.70	0.497						0.4560057
0	3	91	46	6.37	0.00	6.37	0.002						0.0007808
0	4	253	137	2.82	0.00	2.82	0.059						0.0000463
1	4 & 5	365	172	0.79	0.12	0.90	0.405						0.0000188
2	5	365	231	0.79	0.12	0.90	0.405	1.000	25,044	0.5	0.8	10,018	0.0000076
3	5	365	252	0.38	0.23	0.61	0.546	0.546	28,442	0.5	1.0	7,761	0.0000042
4	5	365	262	0.35	0.22	0.57	0.565	0.308	31,214	0.5	1.0	4,762	0.0000023
5	5	365	275	0.35	0.22	0.57	0.563	0.174	34,935	0.5	1.0	3,007	0.0000013
6	5	365	284	0.32	0.27	0.59	0.555	0.096	34,987	0.5	1.0	1,674	0.0000007
7	5	365	290	0.31	0.30	0.61	0.541	0.052	37,958	0.5	1.0	988	0.0000004
8	5	365	296	0.30	0.28	0.58	0.560	0.029	37,661	0.5	1.0	549	0.0000002
9	5	365	300	0.30	0.28	0.58	0.560	0.016	38,610	0.5	1.0	315	0.0000001
10	5	365	301	0.30	0.28	0.58	0.560	0.009	41,135	0.5	1.0	188	0.0000001
											Fa	29,262	

UPDATED

Age (yrs)	Stage	Duration of Life stage (d)	Length (mm)	Mortality Function					Reproduction				
				Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	St
0	1	11	5	0.09	0.00	0.09	0.918						0.9182827
0	2	10	10	0.70	0.00	0.70	0.497						0.4560057
0	3	91	46	6.37	0.00	6.37	0.002						0.0007808
0	4	253	137	2.82	0.00	2.82	0.059						0.0000463
1	4 & 5	365	172	0.68	0.03	0.71	0.491						0.0000228
2	5	365	231	0.45	0.20	0.65	0.525	1.000	25,044	0.5	0.8	10,018	0.0000119
3	5	365	252	0.40	0.21	0.60	0.548	0.548	28,442	0.5	1.0	7,789	0.0000065
4	5	365	262	0.37	0.22	0.59	0.557	0.305	31,214	0.5	1.0	4,710	0.0000036
5	5	365	275	0.35	0.19	0.54	0.583	0.178	34,935	0.5	1.0	3,081	0.0000021
6	5	365	284	0.32	0.20	0.52	0.598	0.106	34,987	0.5	1.0	1,847	0.0000013
7	5	365	290	0.31	0.10	0.41	0.664	0.071	37,958	0.5	1.0	1,338	0.0000008
8	5	365	296	0.30	0.10	0.40	0.668	0.047	37,661	0.5	1.0	887	0.0000006
9	5	365	300	0.30	0.10	0.40	0.668	0.031	38,610	0.5	1.0	608	0.0000004
10	5	365	301	0.30	0.10	0.40	0.668	0.021	41,135	0.5	1.0	433	0.0000003
											Fa	30,712	

CEFAS GISLASON

Age (yrs)	Stage	Duration of Life stage (d)	Length (mm)	Mortality Function					Reproduction				
				Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	St
0	1	11	5	0.09	0.00	0.09	0.918						0.9182827
0	2	10	10	0.70	0.00	0.70	0.497						0.4560057
0	3	91	46	6.37	0.00	6.37	0.002						0.0007808
0	4	253	137	0.59	0.00	0.59	0.554						0.0004329
1	4 & 5	365	172	0.41	0.03	0.44	0.646						0.0002795
2	5	365	231	0.25	0.20	0.45	0.638	1.000	25,044	0.5	0.8	10,018	0.0001782
3	5	365	252	0.22	0.21	0.43	0.653	0.653	28,442	0.5	1.0	9,290	0.0001164
4	5	365	262	0.21	0.22	0.43	0.654	0.427	31,214	0.5	1.0	6,596	0.0000761
5	5	365	275	0.19	0.19	0.38	0.683	0.291	34,935	0.5	1.0	5,049	0.0000519
6	5	365	284	0.18	0.20	0.38	0.682	0.199	34,987	0.5	1.0	3,458	0.0000354
7	5	365	290	0.18	0.10	0.28	0.759	0.151	37,958	0.5	1.0	2,866	0.0000269
8	5	365	296	0.17	0.10	0.27	0.764	0.115	37,661	0.5	1.0	2,172	0.0000206
9	5	365	300	0.17	0.10	0.27	0.767	0.088	38,610	0.5	1.0	1,707	0.0000158
10	5	365	301	0.17	0.10	0.26	0.767	0.068	41,135	0.5	1.0	1,396	0.0000121
											Fa	42,552	

CEFAS GISLASON/4

Age (yrs)	Stage	Duration of Life stage (d)	Length (mm)	Mortality Function					Reproduction				
				Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	St
0	1	11	5	0.09	0.00	0.09	0.918						0.9182827
0	2	10	10	0.70	0.00	0.70	0.497						0.4560057
0	3	91	46	6.37	0.00	6.37	0.002						0.0007808
0	4	253	137	0.15	0.00	0.15	0.863						0.0006737
1	4 & 5	365	172	0.10	0.03	0.13	0.877						0.0005909
2	5	365	231	0.06	0.20	0.26	0.771	1.000	25,044	0.5	0.8	10,018	0.0004559
3	5	365	252	0.06	0.21	0.26	0.771	0.771	28,442	0.5	1.0	10,963	0.0003514
4	5	365	262	0.05	0.22	0.27	0.763	0.589	31,214	0.5	1.0	9,094	0.0002683
5	5	365	275	0.05	0.19	0.24	0.788	0.464	34,935	0.5	1.0	8,039	0.0002115
6	5	365	284	0.05	0.20	0.25	0.782	0.363	34,987	0.5	1.0	6,311	0.0001655
7	5	365	290	0.04	0.10	0.14	0.867	0.315	37,958	0.5	1.0	5,970	0.0001434
8	5	365	296	0.04	0.10	0.14	0.868	0.273	37,661	0.5	1.0	5,141	0.0001245
9	5	365	300	0.04	0.10	0.14	0.869	0.237	38,610	0.5	1.0	4,579	0.0001081
10	5	365	301	0.04	0.10	0.14	0.869	0.206	41,135	0.5	1.0	4,239	0.0000940
											Fa	64,354	

SPRAT

ORIGINAL LIFETABLE

				Mortality Function					Reproduction				St	
Age (yrs)	Stage	Duration of Life stage (d)	Length (mm)	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1	EAV
0	1	3.5	3.0	0.014	0.000	0.014	0.986						0.9860975	0.0001
0	2	9	6.0	#NAME?	0.000	#NAME?	#NAME?						#NAME?	#NAME?
0	3	67.5	41	2.025	0.000	2.025	0.132						#NAME?	#NAME?
0	4 & 5	285	77	0.570	0.000	0.570	0.566						#NAME?	#NAME?
1	5	365	114	0.830	0.020	0.850	0.427	1.000	13,938	0.5	0.9	6,272	#NAME?	#NAME?
2	5	365	126	0.810	0.020	0.830	0.436	0.436	20,415	0.5	1	4,451	#NAME?	#NAME?
3	5	365	132	0.860	0.020	0.880	0.415	0.181	24,378	0.5	1	2,205	#NAME?	#NAME?
4	5	365	139	0.860	0.020	0.880	0.415	0.075	29,687	0.5	1	1,114	#NAME?	#NAME?
5	5	365	145	0.860	0.020	0.880	0.415	0.031	34,877	0.5	1	543	#NAME?	#NAME?
											Fa	14,584		

UPDATED LIFETABLE

				Mortality Function					Reproduction				St	
Age (yrs)	Stage	Duration of Life stage (d)	Length (mm)	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1	EAV
0	1	3.5	3.0	0.014	0.000	0.014	0.986						0.9860975	0.0001
0	2	9	6.0	7.113	0.000	7.113	0.001						0.000803	0.0840
0	3	67.5	41	2.025	0.000	2.025	0.132						0.000106	0.6363
0	4 & 5	285	77	0.570	0.000	0.570	0.566						5.99E-005	1.1252
1	5	365	114	0.982	0.020	1.002	0.367	1.000	13,938	0.5	0.9	6,272	2.20E-005	3.0646
2	5	365	126	0.654	0.020	0.674	0.510	0.510	20,415	0.5	1	5,202	1.12E-005	6.0130
3	5	365	132	0.597	0.020	0.617	0.540	0.275	24,378	0.5	1	3,352	6.05E-006	11.1443
4	5													
5	5													
											Fa	14,827		

CEFAS GISLASON M

				Mortality Function					Reproduction				St	
Age (yrs)	Stage	Duration of Life stage (d)	Length (mm)	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1	EAV
0	1	3.5	3.0	0.014	0.000	0.014	0.986						0.9860975	0.0001
0	2	9	6.0	7.113	0.000	7.113	0.001						0.000803	0.0709
0	3	67.5	41	2.75	0.000	2.747	0.064						5.15E-005	1.1056
0	4 & 5	285	77	1.00	0.000	0.996	0.369						1.90E-005	2.9924
1	5	365	114	0.53	0.020	0.549	0.577	1.000	13,938	0.5	0.9	6,272	1.10E-005	5.1835
2	5	365	126	0.45	0.020	0.471	0.625	0.625	20,415	0.5	1	6,376	6.86E-006	8.2986
3	5	365	132	0.42	0.020	0.438	0.645	0.403	24,378	0.5	1	4,913	4.43E-006	12.8606
4	5													
5	5													
											Fa	17,561		

K	CF	Cefas correction factor is 1.9
0.58	1.9	

CEFAS GISLASON M/4

				Mortality Function					Reproduction				St	
Age (yrs)	Stage	Duration of Life stage (d)	Length (mm)	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1	EAV
0	1	3.5	3.0	0.014	0.000	0.014	0.986						0.9860975	0.0000
0	2	9	6.0	7.113	0.000	7.113	0.001						0.000803	0.0505
0	3	67.5	41	0.69	0.000	0.687	0.503						0.0004041	0.1004
0	4 & 5	285	77	0.25	0.000	0.249	0.780						0.0003151	0.1288
1	5	365	114	0.13	0.020	0.152	0.859	1.000	13,938	0.5	0.9	6,272	0.0002705	0.1500
2	5	365	126	0.11	0.020	0.133	0.876	0.876	20,415	0.5	1	8,940	0.0002369	0.1713
3	5	365	132	0.10	0.020	0.125	0.883	0.773	24,378	0.5	1	9,425	0.0002092	0.1940
4	5													
5	5													
											Fa	24,637		

PLAICE

ORIGINAL

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name	Length (mm)	Duration of Life stage	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1
0	1	Egg		15	1.95	0.00	1.95	0.14						1.4E-01
0	2	Larvae	6.8	56	4.70	0.00	4.70	0.01						1.3E-03
0	3	Settling Juvenile	12	44	1.72	0.00	1.72	0.18						2.3E-04
0	4	Post-settling Juvenile	21.1	250	3.79	0.00	3.79	0.02						5.3E-06
1	4	Post-settling Juvenile	118	365	0.12	0.10	0.22	0.80						4.2E-06
2	5	Post-settling Juvenile	159	365	0.12	0.10	0.22	0.80						3.4E-06
3	5	Adult	220	365	0.12	0.22	0.34	0.71	1					2.4E-06
4	5	Adult	269	365	0.12	0.22	0.34	0.71	0.71177	39,718	0.67	0.5	9,874	1.7E-06
5	5	Adult	306	365	0.12	0.22	0.34	0.71	0.50662	51,466	0.68	0.9	16,213	1.2E-06
6	5	Adult	335	365	0.12	0.22	0.34	0.71	0.36059	75,093	0.70	1.0	18,819	8.7E-07
7	5	Adult	358	365	0.12	0.01	0.13	0.88	0.31575	85,134	0.71	1.0	18,996	7.6E-07
8	5	Adult	376	365	0.12	0.01	0.13	0.88	0.27648	96,619	0.72	1.0	19,189	6.7E-07
9	5	Adult	389	365	0.12	0.01	0.13	0.88	0.24210	136,851	0.73	1.0	24,186	5.8E-07
10	5	Adult	400	365	0.12	0.01	0.13	0.88	0.21199	144,989	0.74	1.0	22,796	5.1E-07
11	5	Adult	409	365	0.12	0.01	0.13	0.88	0.18563	164,612	0.75	1.0	23,020	4.5E-07
12	5	Adult	415	365	0.12	0.01	0.13	0.88	0.16255	155,227	0.77	1.0	19,302	3.9E-07
13	5	Adult	420	365	0.12	0.01	0.13	0.88	0.14233	216,394	0.78	1.0	23,921	3.4E-07
14	5	Adult	424	365	0.12	0.01	0.13	0.88	0.12463	304,076	0.79	1.0	29,876	3.0E-07
15	5	Adult	430	365	0.12	0.01	0.13	0.88	0.10913	192,177	0.80	1.0	16,778	2.6E-07
												Fa	242,971	

UPDATED

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name	Length (mm)	Duration of Life stage	Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1
0	1	Egg		15	1.95	0.00	1.95	0.14						0.142274
0	2	Larvae	6.8	56	4.70	0.00	4.70	0.01						0.001289
0	3	Settling Juvenile	12	44	1.72	0.00	1.72	0.18						0.000232
0	4	Post-settling Juvenile	21.1	250	3.79	0.00	3.79	0.02						5.2E-006
1	4	Post-settling Juvenile	118	365	0.12	0.10	0.22	0.80						4.2E-006
2	5	Post-settling Juvenile	159	365	0.12	0.10	0.22	0.80						3.4E-006
3	5	Adult	220	365	0.12	0.07	0.19	0.83	1	25,000	0.57	0.5	7,125	2.8E-006
4	5	Adult	269	365	0.12	0.07	0.19	0.83	0.82613	39,718	0.67	0.7	14,766	2.3E-006
5	5	Adult	306	365	0.12	0.07	0.19	0.83	0.68250	51,466	0.68	0.9	21,842	1.9E-006
6	5	Adult	335	365	0.12	0.07	0.19	0.83	0.56383	75,093	0.70	1.0	29,426	1.6E-006
7	5	Adult	358	365	0.12	0.01	0.13	0.88	0.49371	85,134	0.71	1.0	29,703	1.4E-006
8	5	Adult	376	365	0.12	0.01	0.13	0.88	0.43232	96,619	0.72	1.0	30,005	1.2E-006
9	5	Adult	389	365	0.12	0.01	0.13	0.88	0.37855	136,851	0.73	1.0	37,818	1.1E-006
10	5	Adult	400	365	0.12	0.01	0.13	0.88	0.33148	144,989	0.74	1.0	35,645	9.2E-007
												Fa	206,329	

CEFAS GISLASON

Age (yrs)	Stage No.	Stage Name	Length (mm)	Duration of Life stage	Mortality Function: Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	Reproduction: No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	St: 1
0	1	Egg		15	1.95	0.00	1.95	0.14						0.142274
0	2	Larvae	6.8	56	4.70	0.00	4.70	0.01						0.001289
0	3	Settling Juvenile	12	44	1.72	0.00	1.72	0.18						0.000232
0	4	Post-settling Juvenile	21.1	250	3.79	0.00	3.79	0.02						5.2E-006
1	4	Post-settling Juvenile	118	365	0.81	0.10	0.91	0.40						2.1E-006
2	5	Post-settling Juvenile	159	365	0.50	0.10	0.60	0.55						1.2E-006
3	5	Adult	220	365	0.30	0.07	0.37	0.69	1	25,000	0.57	0.5	7,125	8.0E-007
4	5	Adult	269	365	0.21	0.07	0.29	0.75	0.75150	39,718	0.67	0.7	13,432	6.0E-007
5	5	Adult	306	365	0.17	0.07	0.25	0.78	0.58793	51,466	0.68	0.9	18,816	4.7E-007
6	5	Adult	335	365	0.15	0.07	0.22	0.80	0.47098	75,093	0.70	1.0	24,580	3.8E-007
7	5	Adult	358	365	0.14	0.01	0.15	0.86	0.40606	85,134	0.71	1.0	24,429	3.3E-007
8	5	Adult	376	365	0.13	0.01	0.14	0.87	0.35372	96,619	0.72	1.0	24,550	2.8E-007
9	5	Adult	389	365	0.12	0.01	0.13	0.88	0.31018	136,851	0.73	1.0	30,987	2.5E-007
10	5	Adult	400	365	0.11	0.01	0.13	0.88	0.27342	144,989	0.74	1.0	29,402	2.2E-007
	Gislason factor											Fa	173,321	

CEFAS GISLASON/4

Age (yrs)	Stage No.	Stage Name	Length (mm)	Duration of Life stage	Mortality Function: Natural mortality (M)	Fishing mortality (F)	Total Instantaneous mortality (Z)	Survivorship (S)	Sj	Reproduction: No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	St: 1
0	1	Egg		15	1.95	0.00	1.95	0.14						0.142274
0	2	Larvae	6.8	56	4.70	0.00	4.70	0.01						0.001289
0	3	Settling Juvenile	12	44	1.72	0.00	1.72	0.18						0.000232
0	4	Post-settling Juvenile	21.1	250	3.79	0.00	3.79	0.02						5.2E-006
1	4	Post-settling Juvenile	118	365	0.43	0.10	0.53	0.59						3.1E-006
2	5	Post-settling Juvenile	159	365	0.95	0.10	1.05	0.35						1.1E-006
3	5	Adult	220	365	0.20	0.07	0.27	0.76	1	25,000	0.57	0.5	7,125	8.2E-007
4	5	Adult	269	365	0.13	0.07	0.20	0.82	0.82190	39,718	0.67	0.7	14,690	6.8E-007
5	5	Adult	306	365	0.07	0.07	0.15	0.86	0.71082	51,466	0.68	0.9	22,749	5.9E-007
6	5	Adult	335	365	0.05	0.07	0.12	0.88	0.62751	75,093	0.70	1.0	32,749	5.2E-007
7	5	Adult	358	365	0.04	0.01	0.06	0.95	0.59309	85,134	0.71	1.0	35,681	4.9E-007
8	5	Adult	376	365	0.04	0.01	0.05	0.95	0.56388	96,619	0.72	1.0	39,136	4.6E-007
9	5	Adult	389	365	0.03	0.01	0.05	0.95	0.53816	136,851	0.73	1.0	53,763	4.4E-007
10	5	Adult	400	365	0.03	0.01	0.04	0.96	0.51494	144,989	0.74	1.0	55,374	4.2E-007
												Fa	261,267	

WHITING

ORIGINAL

Age (yrs)	Stage	Duration of Life stage (d)	Length at beginning of stage (TL in mm)	Mortality Function					Reproduction				St
				Natural mortality (M) (yr-1)	Fishing mortality (F) (yr-1)	Total Instantaneous mortality (Z) (yr-1)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1
0	1	7.9	-	1.34	0	1.34	0.2610613						0.2610613
0	2	42	3.5	7.15	0	7.15	0.000788						0.0002057
0	3	315.1	13.7	2.39	0	2.39	0.0911946						1.88E-005
1	3	54.9	-	0.23	0	0.23	0.7980241						1.50E-005
1	4	310.1	162	1.27	0	1.27	0.2796033						4.19E-006
2	4	365	242	0.75	1.650	2.40	0.090718	1.00	201,313	0.62	0.90	112,171	3.80E-007
3	4	365	286	0.5	1.650	2.15	0.1164842	0.116	346,467	0.69	0.99	27,507	4.42E-008
4	4	365	319	0.5	1.650	2.15	0.1164842	0.014	494,073	0.65	0.99	4,341	5.15E-009
5	4	365	344	0.5	1.650	2.15	0.1164842	0.002	631,374	0.59	1.00	587	6.00E-010
6	4	365	381	0.5	1.650	2.15	0.1164842	0.000	879,990	0.51	1.00	82	6.99E-011
7	4	365	502	0.5	1.650	2.15	0.1164842	0.000	2,156,546	0.29	1.00	13	8.14E-012
8	4	365	-	0.5	1.650	2.15	0.1164842	0.000	2,156,546	0.29	1.00	2	9.49E-013
											Fa	144,703	

UPDATED

Age (yrs)	Stage	Duration of Life stage (d)	Length at beginning of stage (TL in mm)	Mortality Function					Reproduction				St	EAV	Updated
				Natural mortality (M) (yr-1)	Fishing mortality (F) (yr-1)	Total Instantaneous mortality (Z) (yr-1)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1		
0	1	7.9	-	1.34	0	1.34	0.2610613						0.2610613	0.00002	4.80394E-006
0	2	42	3.5	7.15	0	7.15	0.000788						0.0002057	0.02264	0.0060967466
0	3	315.1	13.7	2.08	0	2.08	0.1249302						2.57E-005	0.18123	0.0488012184
1	3	54.9	-	0.23	0	0.23	0.7980241						2.05E-005	0.22709	0.0611525595
1	4	310.1	162	1.27	0	1.27	0.2796033						5.73E-006	0.81220	0.218711887
2	4	365	242	0.75	0.770	1.52	0.2187119	1.00	201,313	0.62	0.90	112,171	1.25E-006	3.71355	1
3	4	365	286	0.5	0.770	1.27	0.2808316	0.281	346,467	0.69	0.99	66,317	3.52E-007	13.22339	3.5608525624
4	4	365	319	0.5	0.770	1.27	0.2808316	0.079	494,073	0.65	0.99	25,234	9.89E-008	47.08655	12.679670971
5	4	365	344	0.5	0.770	1.27	0.2808316	0.022	631,374	0.59	1.00	8,229	2.78E-008	167.66827	45.150438866
6	4	365	381	0.5	0.770	1.27	0.2808316	0.006	879,990	0.51	1.00	2,769	7.80E-009	597.04199	160.77405593
											Fa	214,719			

CEFAS GISLASON

Age (yrs)	Stage	Duration of Life stage (d)	Length at beginning of stage (TL in mm)	Mortality Function					Reproduction				St
				Natural mortality (M) (yr-1)	Fishing mortality (F) (yr-1)	Total Instantaneous mortality (Z) (yr-1)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1
0	1	7.9	-	1.34	0	1.34	0.2610613						0.2610613
0	2	42	3.5	7.15	0	7.15	0.000788						0.0002057
0	3	315.1	13.7	2.08	0	2.08	0.1249302						2.57E-005
1	3	54.9	-	0.23	0	0.23	0.7945336						2.04E-005
1	4	310.1	162	1.31	0	1.31	0.2690068				20.0		5.49E-006
2	4	365	242	0.69	0.770	1.46	0.2326795	1.00	201,313	0.62	0.95	118,403	1.28E-006
3	4	365	286	0.53	0.770	1.30	0.2736722	0.274	346,467	0.69	0.99	64,626	3.50E-007
4	4	365	319	0.44	0.770	1.21	0.2978846	0.082	494,073	0.65	0.99	26,084	1.04E-007
5	4	365	344	0.39	0.770	1.16	0.3132985	0.026	631,374	0.59	1.00	9,489	3.26E-008
6	4	365	381	0.33	0.770	1.10	0.3324185	0.008	879,990	0.51	1.00	3,780	1.09E-008
											Fa	222,382	

CEFAS GISLASON/4

Age (yrs)	Stage	Duration of Life stage (d)	Length at beginning of stage (TL in mm)	Mortality Function					Reproduction				St	EAV	Gaslason/4
				Natural mortality (M) (yr-1)	Fishing mortality (F) (yr-1)	Total Instantaneous mortality (Z) (yr-1)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1		
0	1	7.9	-	1.34	0	1.34	0.2610613						0.2610613	0.00001	2.19586E-005
0	2	42	3.5	7.15	0	7.15	0.000788						0.0002057	0.01579	0.027867952
0	3	315.1	13.7	2.08	0	2.08	0.1249302						2.57E-005	0.12642	0.2230681556
1	3	54.9	-	0.23	0	0.23	0.7945336						2.04E-005	0.15911	0.2807535828
1	4	310.1	162	0.33	0	0.33	0.7201796				20.0		1.47E-005	0.22093	0.3898382759
2	4	365	242	0.17	0.770	0.94	0.3898383	1.00	201,313	0.62	0.95	118,403	5.73E-006	0.56671	1
3	4	365	286	0.13	0.770	0.90	0.4059781	0.406	346,467	0.69	0.99	95,869	2.33E-006	1.39592	2.4631871217
4	4	365	319	0.11	0.770	0.88	0.4146741	0.168	494,073	0.65	0.99	53,865	9.65E-007	3.36630	5.9400549423
5	4	365	344	0.10	0.770	0.87	0.4199374	0.071	631,374	0.59	1.00	26,266	4.05E-007	8.01620	14.145097341
6	4	365	381	0.08	0.770	0.85	0.4262027	0.030	879,990	0.51	1.00	13,413	1.73E-007	18.80842	33.188659089
											Fa	307,816			

SANDEEL

ORIGINAL

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name.	Duration of Life stage (d)	Length at beginning of stage (TL in mm)	Natural mortality (M) (yr⁻¹)	Fishing mortality (F) (yr-1)	Total Instantaneous mortality (Z) (yr-1)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1
0	1	Egg	26	-	0.78	0	0.78	0.458406						0.45841
0	2	Larvae	61	5	1.62	0	1.62	0.197899						0.09072
0	3	Juvenile	278	78	6.08	0	6.08	0.002299						0.00021
1	4	Adult	365	116	1.8	0	1.80	0.165299	1.000	6,223	0.5	0.3	902	0.00003
2	4	Adult	365	144	0.6	0	0.60	0.548812	0.549	14,988	0.5	1.0	4,113	0.00002
3	4	Adult	365	164	0.6	0	0.60	0.548812	0.301	20,536	0.5	1.0	2,969	0.00001
4	4	Adult	365	178	0.6	0	0.60	0.548812	0.165	25,226	0.5	1.0	2,085	0.00001
5	4	Adult	365	188	0.6	0	0.60	0.548812	0.091	32,222	0.5	1.0	1,462	0.00000
6	4	Adult	365	196	0.6	0	0.60	0.548812	0.050	42,726	0.5	1.0	1,064	0.00000
7	4	Adult	365	201	0.6	0	0.60	0.548812	0.027	48,264	0.5	1.0	659	0.00000
												Fa	13,254	

UPDATED Wylfa lifetable)

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name.	Duration of Life stage (d)	Length at beginning of stage (TL in mm)	Natural mortality (M) (yr⁻¹)	Fishing mortality (F) (yr-1)	Total Instantaneous mortality (Z) (yr-1)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1
0	1	Egg	26	-	0.78	0	0.78	0.458406						0.45841
0	2	Larvae	54	5	1.62	0	1.62	0.197899						0.09072
0	3	Juvenile	285	78	6.08	0	6.08	0.002299						0.00021
1	4	Adult	365	116	1.8	0	1.80	0.165299	1.000	3,738	0.5	0.81	1,519	0.00003
2	4	Adult	365	144	0.6	0	0.60	0.548812	0.549	8,972	0.5	0.95	2,333	0.00002
3	4	Adult	365	164	0.7	0	0.70	0.496585	0.273	16,902	0.5	0.96	2,211	0.00001
4	4	Adult	365	178	1.7	0	1.70	0.182684	0.050	26,724	0.5	1.00	665	0.00000
5	4	Adult	365	188	0.8	0	0.80	0.449329	0.022	37,223	0.5	1.00	416	0.00000
6	4	Adult	365	196	0.8	0	0.80	0.449329	0.010	47,305	0.5	1.00	238	0.00000
7	4	Adult	365	201	0.8	0	0.80	0.449329	0.005	56,260	0.5	1.00	127	0.00000
												Fa	7,509	

CEFAS GISLASON

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name.	Duration of Life stage (d)	Length at beginning of stage (TL in mm)	Natural mortality (M) (yr⁻¹)	Fishing mortality (F) (yr-1)	Total Instantaneous mortality (Z) (yr-1)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1
0	1	Egg	26	-	0.78	0	0.78	0.458406						0.45841
0	2	Larvae	54	5	1.62	0	1.62	0.197899						0.09072
0	3	Juvenile	285	78	6.08	0	6.08	0.002299						0.00021
1	4	Adult	365	116	1.40	0	1.40	0.245388	1.000	3,738	0.5	0.8	1,519	0.00005
2	4	Adult	365	144	1.00	0	1.00	0.368843	0.369	8,972	0.5	0.9	1,568	0.00002
3	4	Adult	365	164	0.81	0	0.81	0.445196	0.164	16,902	0.5	1.0	1,332	0.00001
4	4	Adult	365	178	0.71	0	0.71	0.493411	0.081	26,724	0.5	1.0	1,083	0.00000
5	4	Adult	365	188	0.64	0	0.64	0.524885	0.043	37,223	0.5	1.0	791	0.00000
6	4	Adult	365	196	0.61	0	0.61	0.546006	0.023	47,305	0.5	1.0	549	0.00000
7	4	Adult	365	201	0.58	0	0.58	0.560475	0.013	56,260	0.5	1.0	366	0.00000
												Fa	7,208	

CEFAS GISLASON/4

					Mortality Function					Reproduction				St
Age (yrs)	Stage No.	Stage Name.	Duration of Life stage (d)	Length at beginning of stage (TL in mm)	Natural mortality (M) (yr⁻¹)	Fishing mortality (F) (yr-1)	Total Instantaneous mortality (Z) (yr-1)	Survivorship (S)	Sj	No. eggs per female (Ej)	Proportion of females (Rj)	Proportion mature (Pj)	Age-specific egg prodn.	1
0	1	Egg	26	-	0.78	0	0.78	0.458406						0.45841
0	2	Larvae	54	5	1.62	0	1.62	0.197899						0.09072
0	3	Juvenile	285	78	6.08	0	6.08	0.002299						0.00021
1	4	Adult	365	116	0.35	0	0.35	0.703823	1.000	3,738	0.5	0.8	1,519	0.00015
2	4	Adult	365	144	0.25	0	0.25	0.77931	0.779	8,972	0.5	0.9	3,312	0.00011
3	4	Adult	365	164	0.20	0	0.20	0.816841	0.637	16,902	0.5	1.0	5,164	0.00009
4	4	Adult	365	178	0.18	0	0.18	0.838112	0.534	26,724	0.5	1.0	7,129	0.00008
5	4	Adult	365	188	0.16	0	0.16	0.851169	0.454	37,223	0.5	1.0	8,452	0.00007
6	4	Adult	365	196	0.15	0	0.15	0.859606	0.390	47,305	0.5	1.0	9,233	0.00006
7	4	Adult	365	201	0.14	0	0.14	0.865245	0.338	56,260	0.5	1.0	9,501	0.00005