Deliverable No. 6.8

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[1] Document will be a draft until it was approved by the coordinator
[2] PU: Public, PP: Restricted to other programme participants (including the Commission Services), RE: Restricted to a group specified by the consortium (including the Commission Services), CO: Confidential, only for members of the consortium (including the Commission Services)
[3] The initials of the revising individual in capital letters

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Deliverable D6.8

Interactive Platform to integrate codes, visualization and data interaction tools for the Case Studies

29/06/2020

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Executive Summary

The overall objective of WP6 within the FarFish project is to develop tools that provide added value, relevance and usefulness in support of management and decision making for the actors involved in each of the case studies in the project. To achieve this, the project has developed a suite of R-based tools that let users upload and analyse their own data purely through a web browser, so they can be used on any computer without installation or knowledge of the R programming language. The source code for the tools is also public and hosted on GitHub, allowing institutions to manage their own installation if required in the future.

The FarFish-DLMtool is an interactive tool where the users can incorporate their data and obtain pertinent information in return. The user guide provided in this report allows anyone to use the tool after the project ends. In addition, all parts of the project are open source, which means the code behind the tool and the tool itself will remain available for anyone to use and adapt, and thus remaining useful beyond the life of the project.

This report is structured in three parts, the first part corresponds to a technical user manual of the FarFish-DLMtool for people inside and outside FarFish, the second is an impact evaluation of the tool and the third describes its implementation for four bycatch species in FarFish case studies.

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1 Introduction

The overall objective of WP6 within the FarFish project is to develop tools that provide added value, relevance and usefulness in support of management and decision making for the actors involved in each of the case studies in the project. As described in deliverables 6.4 and 6.7, the relevance and added value was ensured through a consultation process. The tool presented in this document has been receiving feedback mainly by the partners involved in the implementation of the case studies but also from external actors: the WKDLSSLS ICES group, some participants in the ICES Annual Scientific Conference, the members of the IMPRESS (Improving scientific advice to fishery management for resources of interest for Spain in Atlantic waters) project and university students. This constant feedback ensures the relevance and added value while ensuring technical characteristics that make it useful within the context of the Responsive Fisheries Management System implemented in FarFish. As an active component of this system, according to the DoA, the tool should accomplish a set of operative characteristics such as:

1) Facilitating an equal footing for the technical dialogue of all actors involved.
2) Guaranteeing all-actors accessibility by working under open-access schemes.
3) Interaction with data, simulation and visualization based on free platforms.
4) Tools remaining once the project has ended.

To achieve this, we have developed a suite of R-based tools that let users upload and analyse their own data purely through a web browser, so they can be used on any computer without installation or knowledge of the R programming language. The source code for the tools is also public and hosted on GitHub, allowing institutions to manage their own installation if required in the future.

The FarFish-DLMtool is an interactive tool where the users can incorporate their data and obtain pertinent information in return. The user guide provided in this deliverable will allow anyone to use the tool after the project ends. In addition, all parts of the project are open source and are accessible on the GitHub. This means the code behind the tool and the tool itself will remain available for anyone to use and adapt, and thus remaining useful beyond the life of the project. This effort has also benefited from WP1 work that allows us to directly explain the tool functionalities to operators and scientists, as well as get their feedback (see D6.7 for a detailed explanation). Data gathered by WP2 has been also used to provide examples of the tool performance on the assessment of data-limited important bycatch species identified by Management Recommendations (WP4).

The deliverable is structured in three parts, the first part corresponds to a technical user manual of the FarFish-DLMtool for people inside and outside FarFish, the second is an impact evaluation of the tool and the third describes its implementation for four bycatch species.

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2 User guide for the FarFish-DLMTool for Data Limited stocks

The FarFish-DLMTool was initially thought as a tool available for all people but we had to develop a private version, available only for registered users on the FarFish website, due to some confidentiality data issues on the information provided by the different CSs. Nevertheless, after observing the success that the tool had among the CSs, it was decided that it was important to improve it and expand it into a version available for all the community. As observed in Figure 1, the main menu for the tool available at https://ffdb.farfish.eu/, provides access to the FarFish-DLMtool (requiring registration), to the FarFish-DLMGui (no registration required) and to the source code that is behind both versions. By understanding the functioning of FarFish DLMGui, you can understand straightforwardly how to use the FarFish-DLMtool, then this document is focused on explaining in detail how to use the FarFish DLMGui.

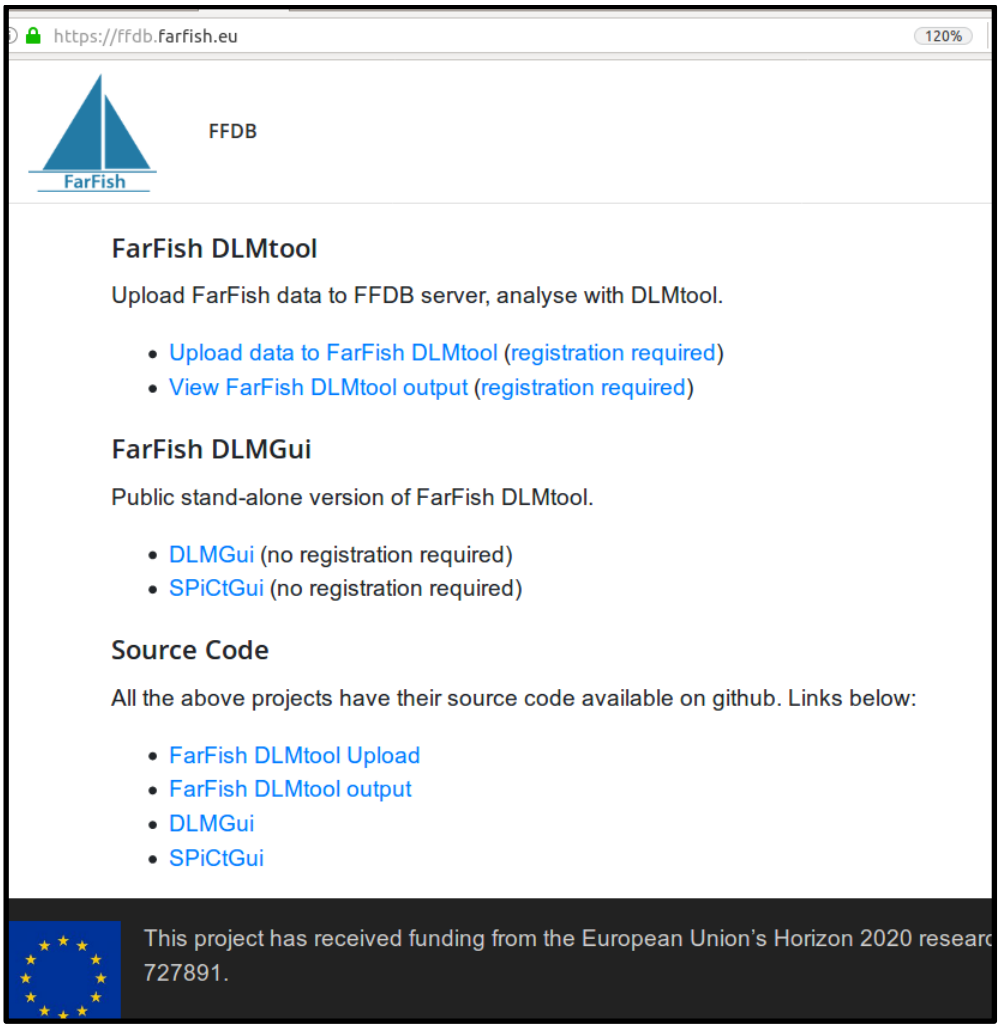

Figure 1: FarFish-DLMtool main menu screenshot

FarFish DLMGui consists in two parts, the DLMGui (Data Limited methods graphical user interface) based on the DLMtool R package to implement the methods described in Carruthers et al. (2014), and the SPiCTGui (Stochastic surplus model in continuous time graphical user interface) which is based on the SPiCT R package to implement a continuous-time state-space model (Pedersen et al, 2014). The SPiCT was the last method included in the tool and it was selected because of its ability for dealing with data limited stocks, grasping stock and fishery dynamics with only catches and abundance indexes as inputs. The use of the method is increasing worldwide and it is also recommended for assessment of category 3 and 4 stocks in ICES areas (ICES, 2018, 2019).

2.1 FarFish-DLMGui (No registration required)

It is possible to access to this component of the tool from the main menu (https://ffdb.farfish.eu/) by clicking on "DLMgui" as shown in Figure 2.

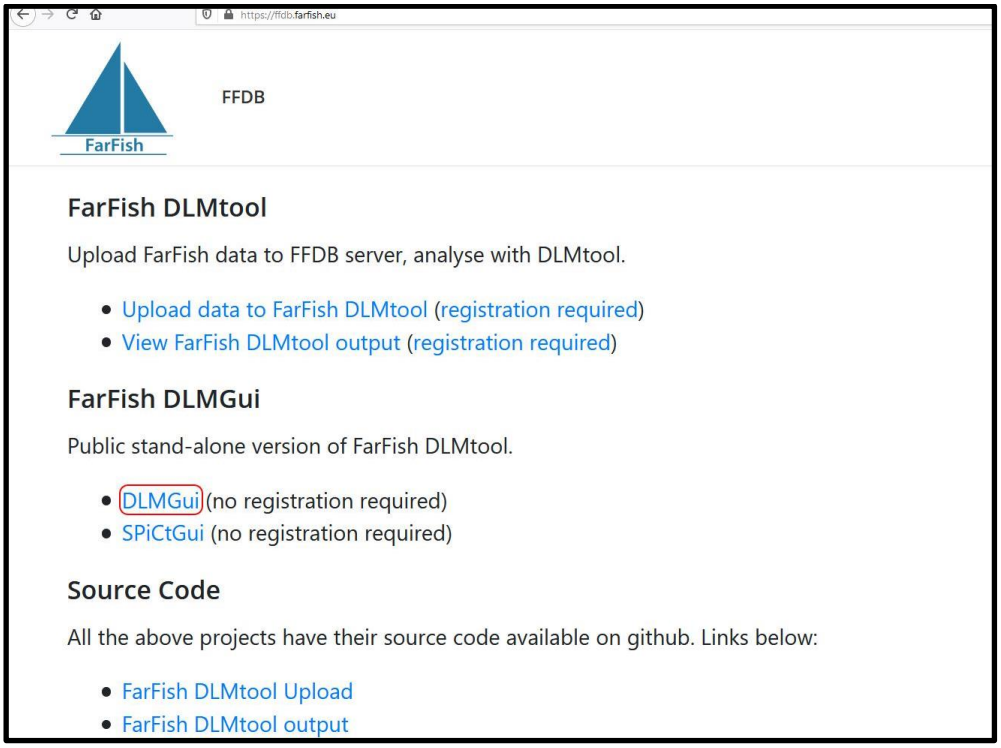

Figure 2: FarFish-DLMtool main menu screenshot highlighting the link to the DLMGui component

This link will redirect you to a screen like the one displayed in Figure 3, with different tab options for data input, visualization, diagnostics and summary results.

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Figure 3: Farfish-DLMGui screenshot highlighting the different tab options for data input, visualization, diagnostics and summary results

2.1.1 Data input

The data input is performed in the "Edit data" tab. In this tab the user has two options: To upload a CSV document with the data or to enter the information available by hand. Uploading data can be done by clicking the "Browse" button highlighted in red in Figure 4. A CSV document suitable to be uploaded can be obtained after filling the excel template that is available here and saving that document with a .csv extension in her/his machine.

Figure 4: FarFish-DLMGui main menu screenshot. Click on 'Browse' to load a DLMtool CSV file (red square). The "Edit data" progress can be saved at any time in a CSV format file by giving name to that file in the "Filename to save as" box (blue square) and then clicking on the "Save data to CSV" button

Users can enter their data by filling the tables that appear when scrolling down and can save their progress at any time in a CSV format file by giving name to that file in the "Filename to save as" box (blue square in Figure 4) and clicking on the "Save data to CSV" button next to it. To guide this process, it is recommended to click on the blue link "Load demo data" (Figure 5) that will fill the tables automatically, then the user can remove this data and replace it with her/his own. It is important to remark that if there is any missing information the corresponding field can be filled with "NA" or can be left empty.

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Figure 5: Click on 'Load demo data' to load example data

As you scroll down the page, the first table to fill corresponds to data description as shown in Figure 6, where you can write the name of the species, the region and also to specify the units of your data.

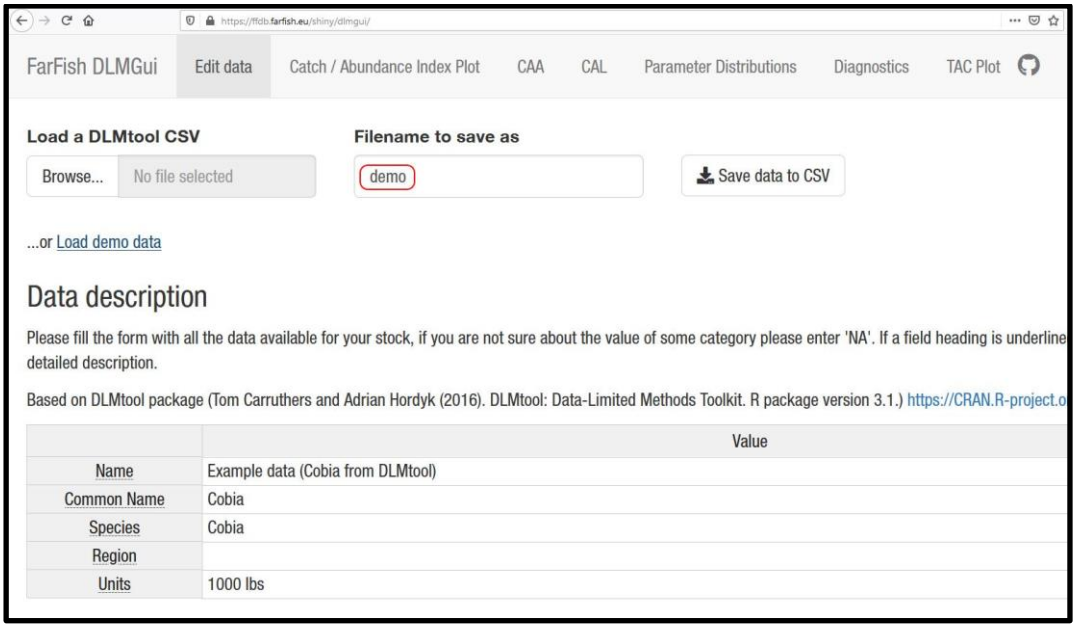

Figure 6: Data description table filled with demo data

The second table corresponds to annual catch data time series (Figure 7). The first and last year of the time series can be modified by clicking the up and down arrows in the two fields next to "Years:". The data to fill the cells corresponding to catch can be copied and pasted from an excel file. In a similar way the user can fill the "Abundance index" (Figure 8) and "Annual fishing effort" (Figure 9) tables.

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Catch data

Enter the unit for catch data in the field above, e.g. "Tonnes".

Years: 1950 ... 2011

	1950	1951	1952	1953	1954	1955	1956
Catch	104.7041	112.2076	111.3035	128.2866	149.8358	137.8407	162.6785

Figure 7: **Catch data input from demo file ("Edit data" tab)**

Abundance Index

Enter the unit for abundance index data in the field above, e.g. "Tonnes".

Years: 1981 ... 2011

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Abundance Index	0.72	0.71	0.81	0.36	0.36	0.71	1.18	0.88	0.81	0.55

Figure 8: **Abundance index input from demo file ("Edit data" tab)**

Annual fishing effort

Years: 1950 ... 2011

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1
Effort	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Figure 9: **Annual fishing effort input from demo file ("Edit data" tab)**

For catch at age and catch and length data input (Figures 10 and 11) it is also necessary to specify the maximum age and the number of length bins found in the user's data, in the respective "Bin total" field. All length bins should be the same length. The data to fill the data cells can also be copied and pasted from an excel file.

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Catch at age

Catch should be in individuals.

Bin Total: 16 **Years:** 1984 ... 2011

	1	2	3	4	5	6	7	8	9	10	11	1
1984	0.9999	0	2.0001	0	0	0	0	0	0	0	0	0
1985	0	1	0	0	0	0	1	0	0	0	0	0
1986	0	3.0008	7.0004	1.001	5.9994	3.9996	0	0	1.001	0	0	0
1987	1.9998	9	0	1.9998	0	3.0006	1.9998	0	0	0	0	0
1988	0	4.9997	0.9996	1.9992	4.0001	0.9996	0.9996	1.9992	0.9996	0	0	0
1989	0	9.9996	19.0008	18.0024	4.9998	6.9966	4.9998	5.9982	5.9982	0	0.9984	0.99
1990	0	0	49.0254	16.665	11.7665	3.9188	3.9188	3.9188	2.9391	5.8883	0.9797	1.95

Figure 10: Catch at age input table from demo file ("Edit data" tab)

Catch at length

Length should be in mm, catch should be in individuals. All bins should have a number in, apart from the final column which is th
the final column all years should be NA.

Bin Total: 45 **Years:** 1981 ... 2011

	1	2	3	4	5	6	7	8	9	10	11	
Min Length	170	200	230	260	290	320	350	380	410	440	470	50
1981	0	0	0	0	0	0	0	1	0	0	1	0
1982	0	0	0	1.2	0	0	0	1.2	0	1.2	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	2.5556	0	0	0

Figure 11: Catch at length input table from demo file ("Edit data" tab)

There is also a place to enter some biological information or life history traits by filling the "Constants" table. As remarked before if there is any missing information, the corresponding field can be filled with "NA" or can be left blank as shown in Figure 12. For more information about the field, the user can put the mouse pointer on the dotted line below the "Constant" name and some additional information will appear (Figure 13).

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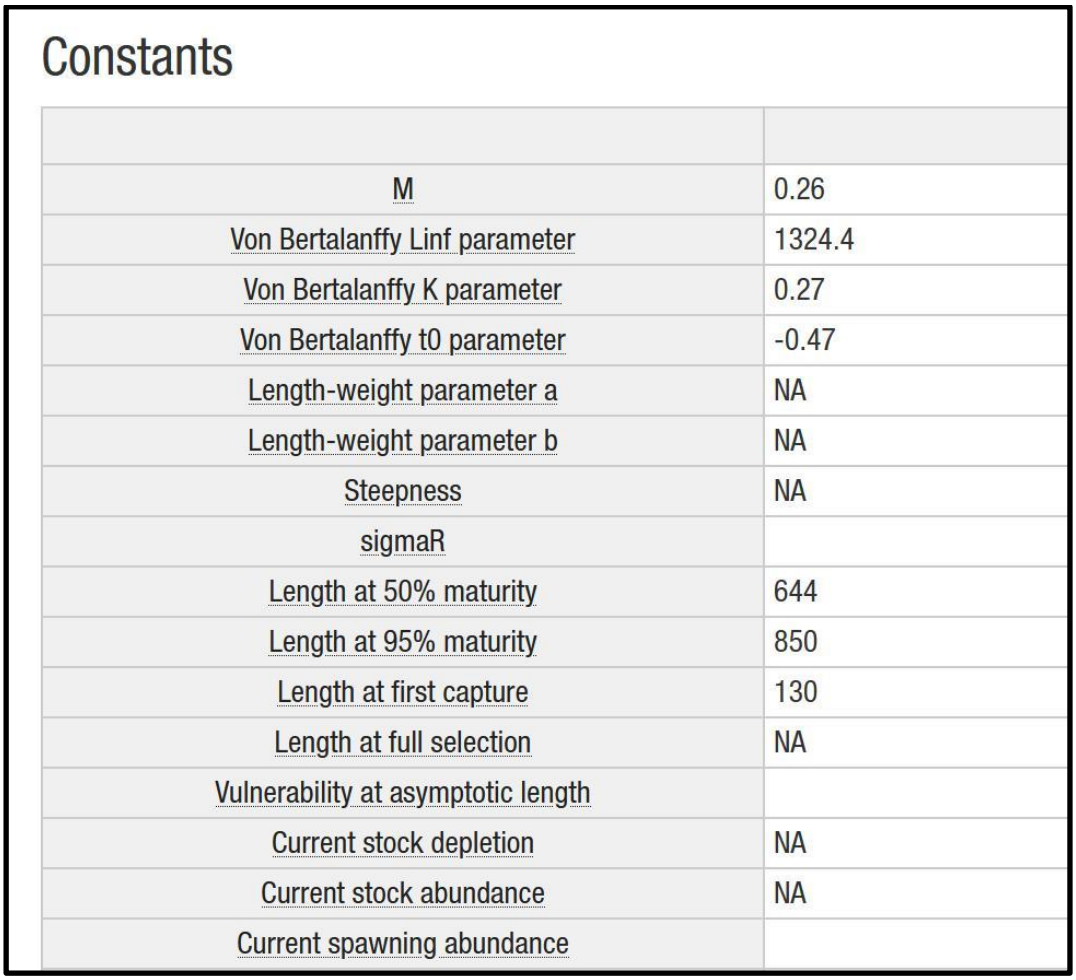

Constants

M	0.26
Von Bertalanffy Linf parameter	1324.4
Von Bertalanffy K parameter	0.27
Von Bertalanffy t0 parameter	-0.47
Length-weight parameter a	NA
Length-weight parameter b	NA
Steepness	NA
sigmaR	
Length at 50% maturity	644
Length at 95% maturity	850
Length at first capture	130
Length at full selection	NA
Vulnerability at asymptotic length	
Current stock depletion	NA
Current stock abundance	NA
Current spawning abundance	

Figure 12: Constants table from demo file ("Edit data" tab). Note that when there is missing information the corresponding fields can be filled with "NA" or left blank

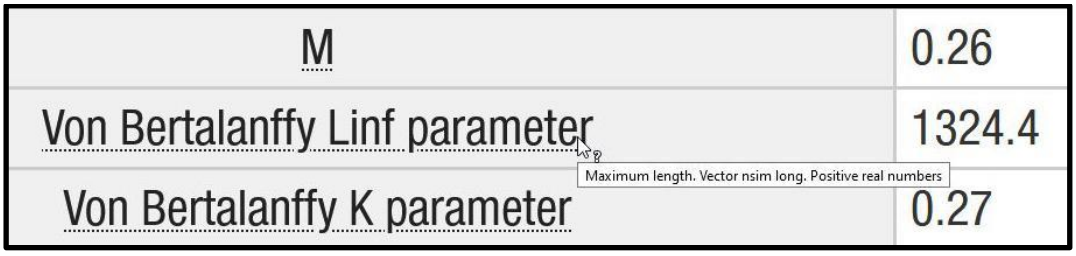

Figure 13: : Zoom in for the "Constants" table to illustrate how the user can put its mouse pointer in the dotted line below the "Von Bertalanffy Linf parameter" to get more information about the field

If the user has a measure of impresicion for the "Constants" that could be transformed into a coefficient of variation (the ratio between the standard deviation and the mean), it can be registered in the "Coefficient of variation" table (Figure 14). A field can be left blank if there is no information available in this regard.

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Coefficient of variation

CV is a measure of imprecision, i.e. how imprecise you think this value could be

CV M	0.54
CV von B. Linf parameter	0.23
CV von B. K parameter	0.07
CV von B. t0 parameter	0.05
CV Length-weight parameter a	0.1
CV Length-weight parameter b	0.1
CV Steepness	0.2
CV sigmaR	
CV Length at 50% maturity	0.1
CV of length-at-age	0.1
CV Length at first capture	0.2
CV Length at full selection	0.2
CV Catch	0.2
CV Abundance index	0.21
CV Effort	0.2
CV Recruitment index	0.2

Figure 14: Coefficient of variation table from demo file ("Edit data" tab)

2.1.2 Data visualization

The DLMGui allows the user to visualize catches and abundance indices time series (by clicking on the "Catch/ Abundance Index plot" tab, Figure 15), catch at age and length by years (by clicking the "CAA" and the "CAL" tabs, Figures 16 and 17, respectively) and the constants with their coefficients of variation as statistical distributions (by clicking on "Parameters Distributions" tab, Figure 18). Please note that all visualization plots can be downloaded by clicking on the "Download plot" button in the bottom left corner of each of the visualization tabs.

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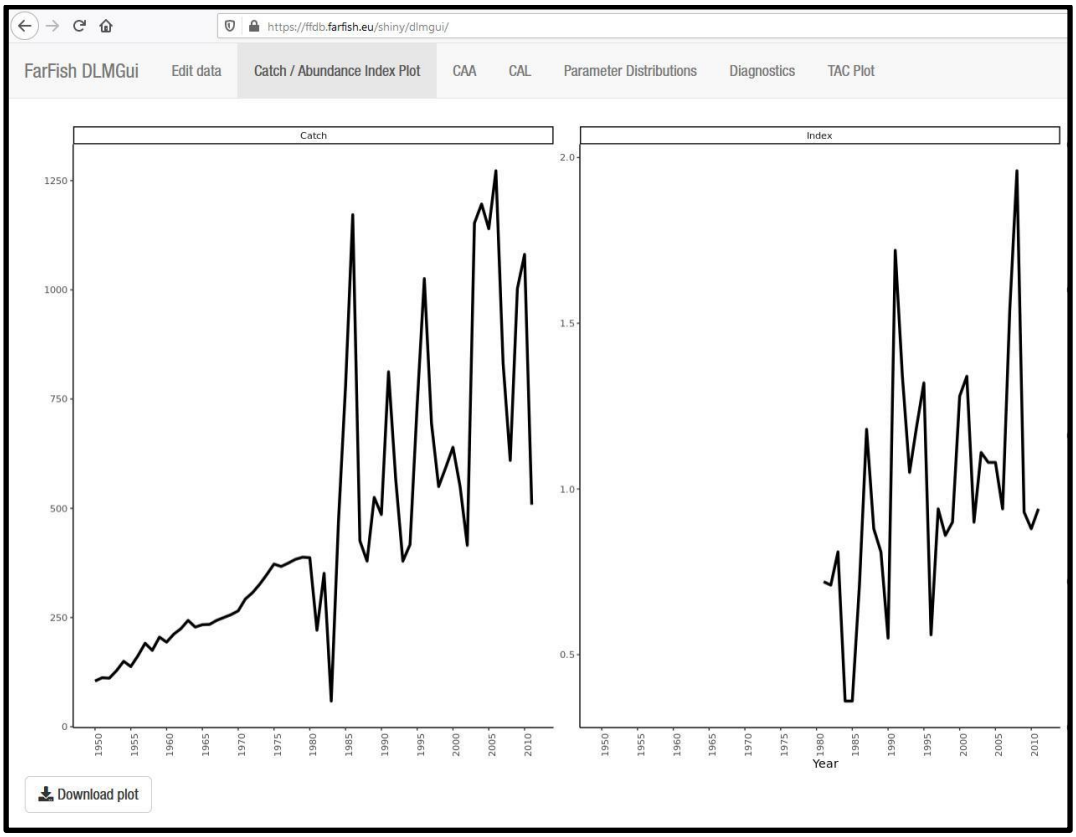

Figure 15: Catch / Abundance index plot visualization from demo file ("Catch/ Abundance Index plot" tab)

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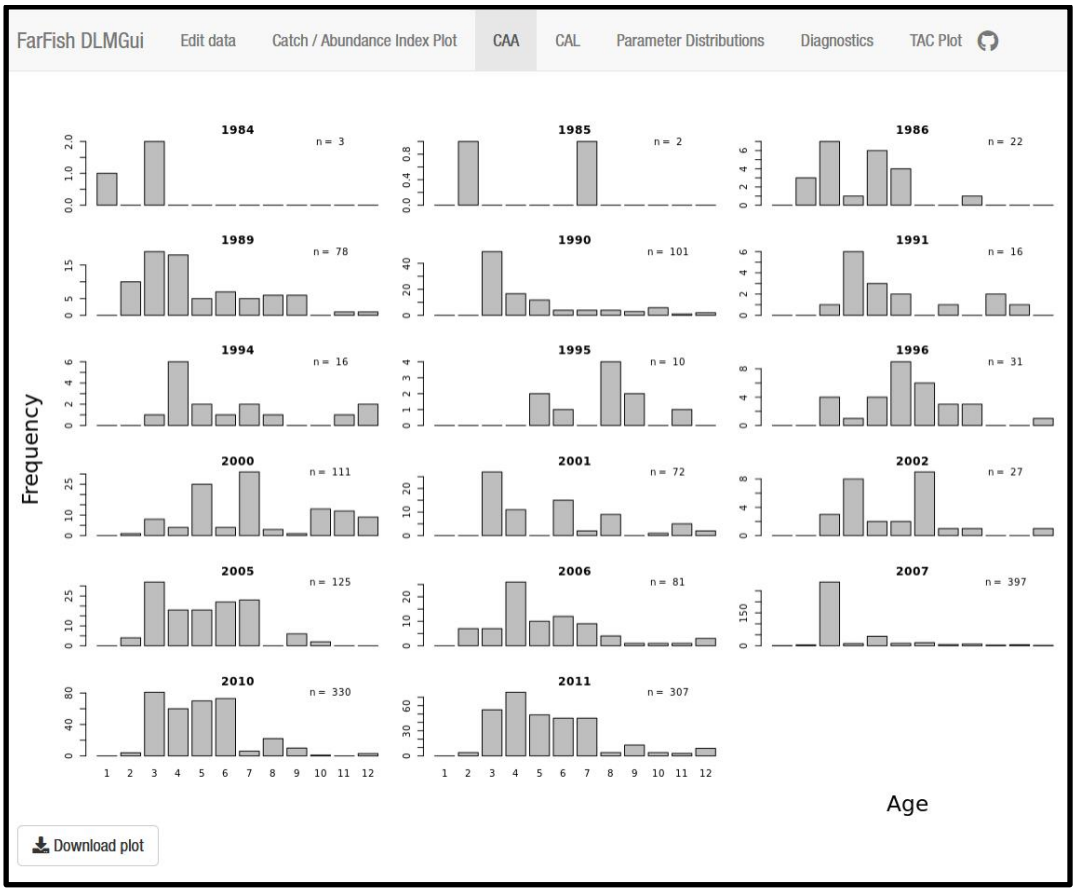

Figure 16: Plots for catch at age by year from demo file ('CAA' tab

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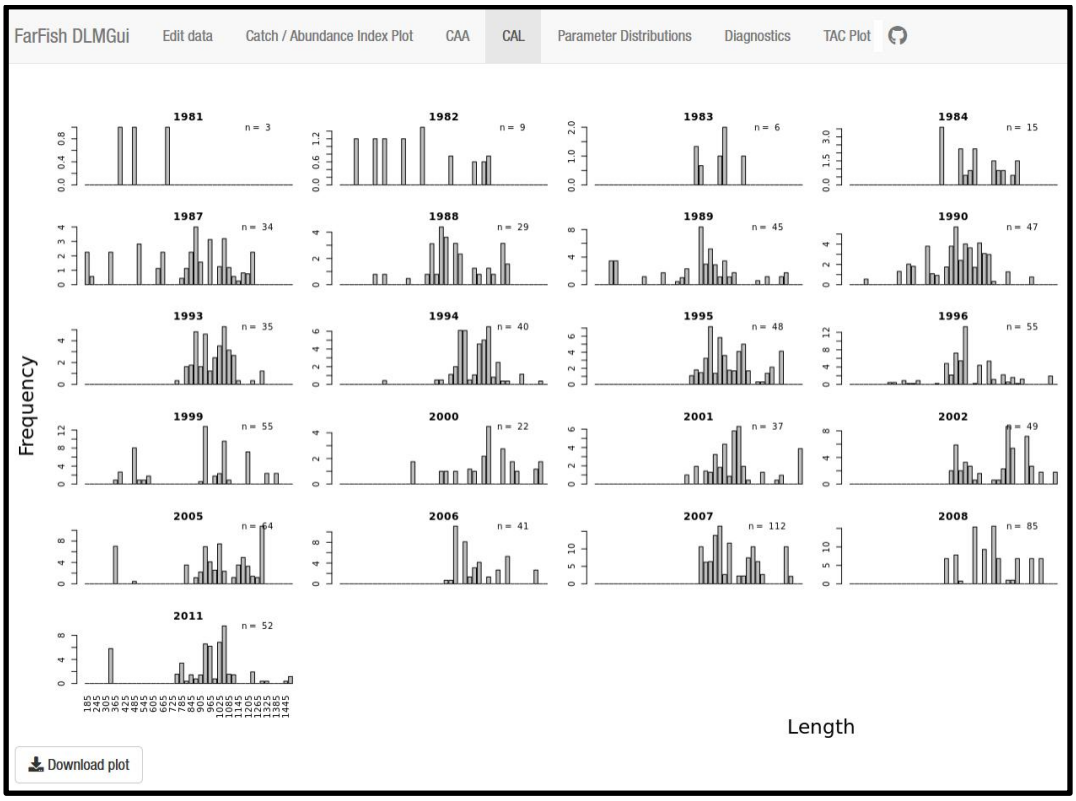

Figure 17: Catch at length input visualization from demo file ('CAL' tab)

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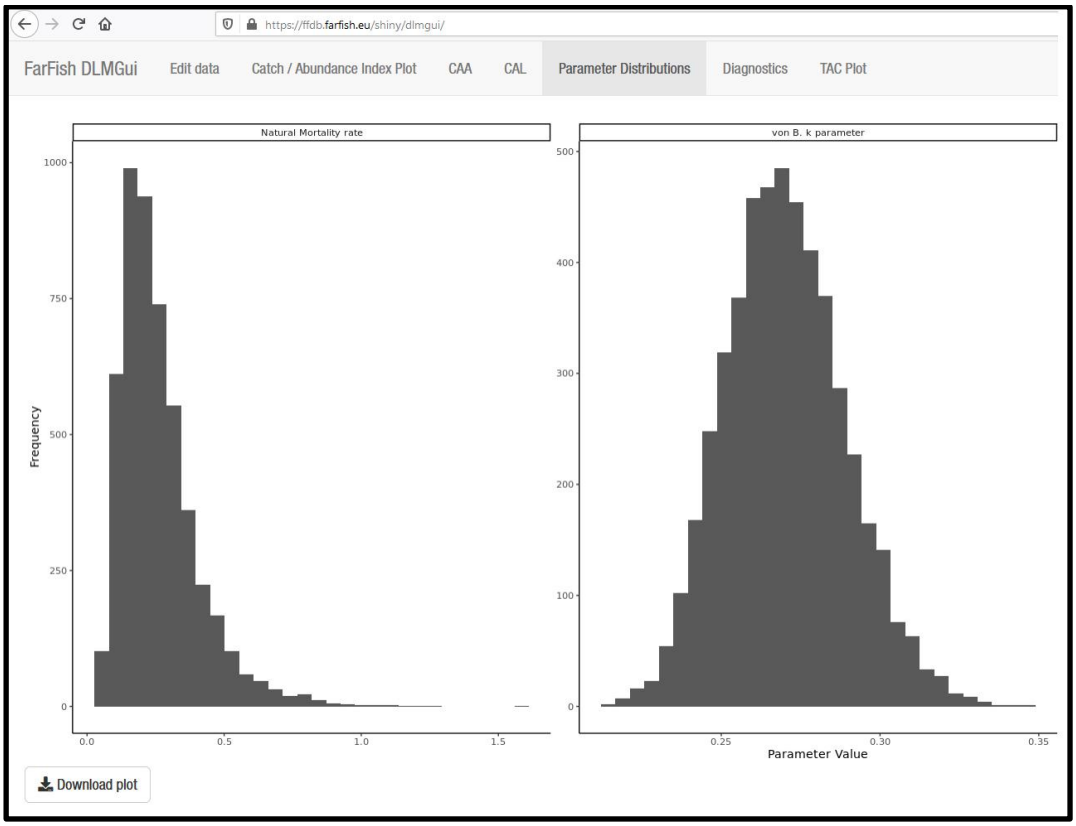

Figure 18: Visualization of constants with coefficient of variation as statistical distributions ("Parameter Distributions" tab).

2.1.3 *Diagnostics of what management procedures and methods can be implemented with your data*

The DLMGui provides a diagnostic on what management procedures (MP) and methods can and cannot be applied with the data available. There are two different tables displayed when clicking on the "Diagnostics" tab: "Enough data to produce" (Figure 19) and "Cannot produce" (Figure 20). In the first table, the user can find the MP that can be applied, the first and fourth columns, "Direction" and "type", indicate the type of control of the MP. The control type can be input, output or mixed: Output controls return a total allowable catch, input controls allow regulation of fishing effort, size selectivity, or spatial area (Carruthers and Hordyk, 2020). When the MP is a mixture of both the "Direction" field appears blank. The second and fifth columns, "Code" and "Description" present the short name of the MP and a short description, but by clicking on the "Code" MP the user will be redirected to a complete description on DLMtool documentation. In the "Cannot produce" table there is also a column named "Reason" that specifies what data is missing to perform the MP.

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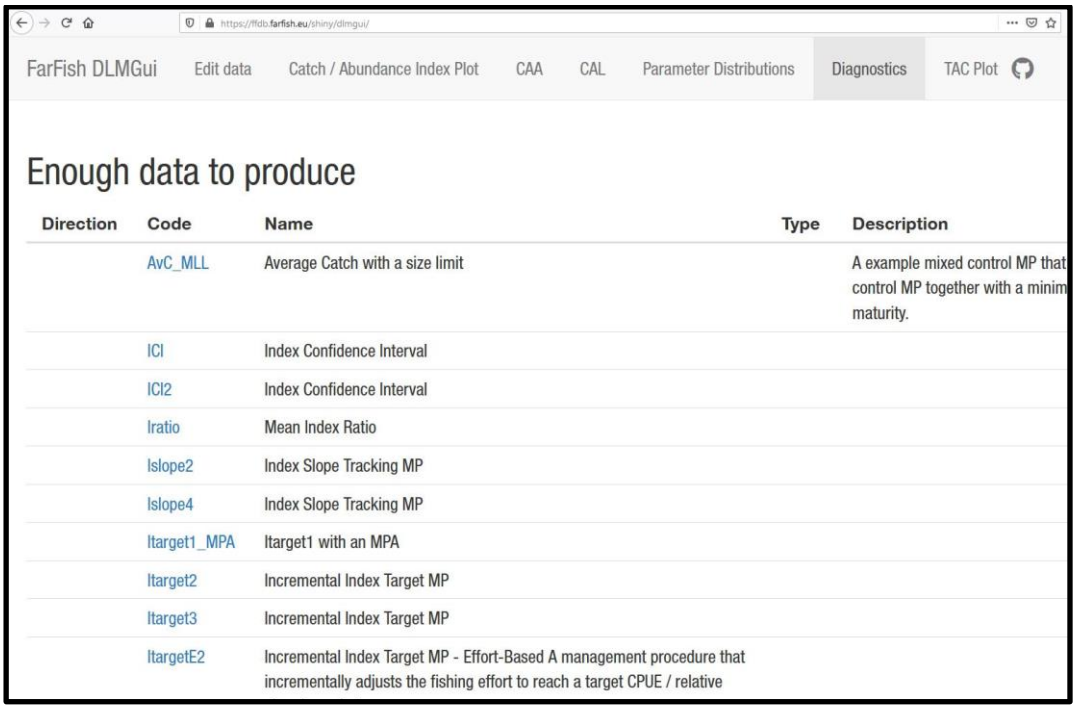
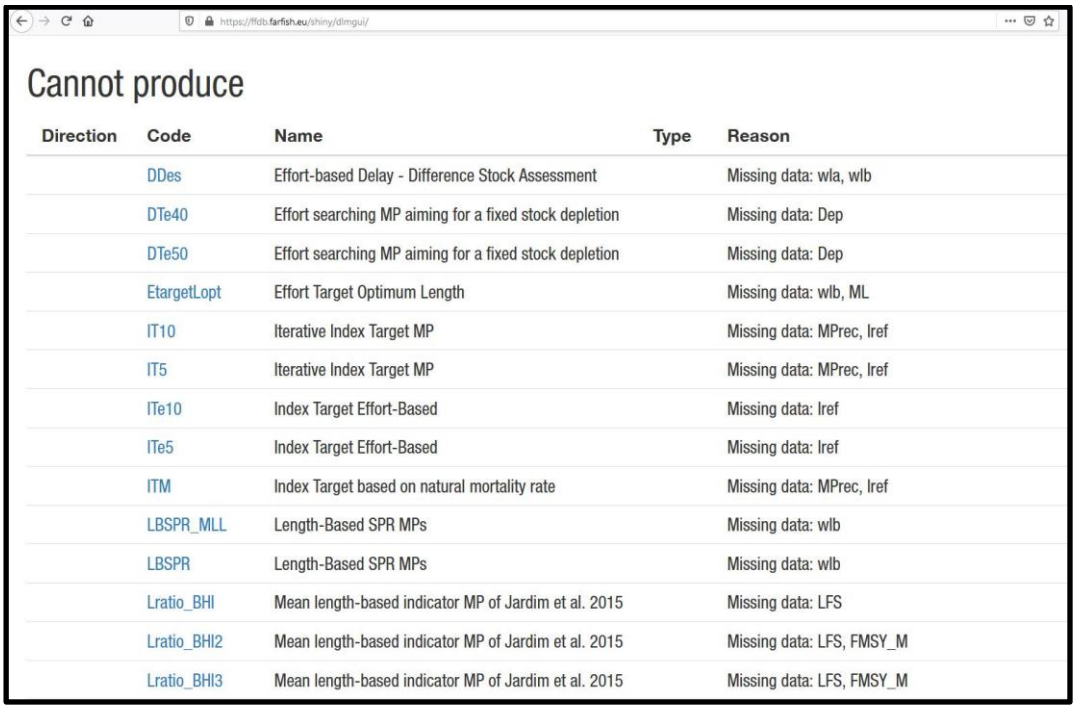


Enough data to produce

Direction	Code	Name	Type	Description
	AvC_MLL	Average Catch with a size limit		A example mixed control MP that control MP together with a minim maturity.
	ICI	Index Confidence Interval		
	ICI2	Index Confidence Interval		
	Iratio	Mean Index Ratio		
	Islope2	Index Slope Tracking MP		
	Islope4	Index Slope Tracking MP		
	Itarget1_MPA	Itarget1 with an MPA		
	Itarget2	Incremental Index Target MP		
	Itarget3	Incremental Index Target MP		
	ItargetE2	Incremental Index Target MP - Effort-Based A management procedure that incrementally adjusts the fishing effort to reach a target CPUE / relative		

Figure 19: 'Enough data to produce' section from demo file ('Diagnostics' tab)



Cannot produce

Direction	Code	Name	Type	Reason
	DDes	Effort-based Delay - Difference Stock Assessment		Missing data: wla, wlb
	DTe40	Effort searching MP aiming for a fixed stock depletion		Missing data: Dep
	DTe50	Effort searching MP aiming for a fixed stock depletion		Missing data: Dep
	EtargetLopt	Effort Target Optimum Length		Missing data: wlb, ML
	IT10	Iterative Index Target MP		Missing data: MPrec, Iref
	IT5	Iterative Index Target MP		Missing data: MPrec, Iref
	ITe10	Index Target Effort-Based		Missing data: Iref
	ITe5	Index Target Effort-Based		Missing data: Iref
	ITM	Index Target based on natural mortality rate		Missing data: MPrec, Iref
	LBSPR_MLL	Length-Based SPR MPs		Missing data: wlb
	LBSPR	Length-Based SPR MPs		Missing data: wlb
	Lratio_BHI	Mean length-based indicator MP of Jardim et al. 2015		Missing data: LFS
	Lratio_BHI2	Mean length-based indicator MP of Jardim et al. 2015		Missing data: LFS, FMSY_M
	Lratio_BHI3	Mean length-based indicator MP of Jardim et al. 2015		Missing data: LFS, FMSY_M

Figure 20: 'Cannot produce' section from demo file on ('Diagnostics' tab)

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2.1.4 Summary result

A boxplot of a recommended TAC for each output MP is presented in the "TAC plot" tab (Figure 21). This plot can be customized by the user displaying only specific MPs by clicking on the checkbox next to the MP in the "MPs to show" list as shown in Figure 22. This plot and the data used to produce it, can be downloaded with the "Download plot" and "Download result table" buttons. There is also a warning about the use of these results without previous knowledge on stock assessment. This warning was included following stakeholder's suggestions after testing the tool.

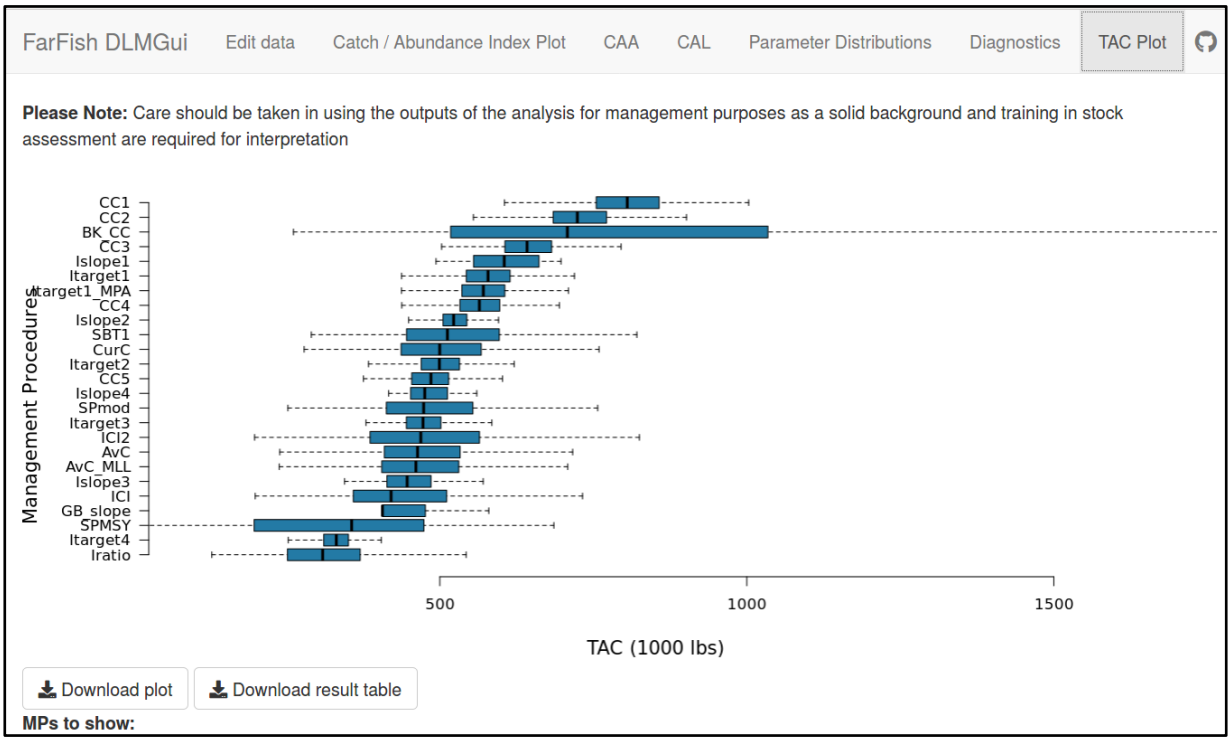

Figure 21: Boxplot of the recommended TAC for each output MP from demo file ('TAC Plot' tab)

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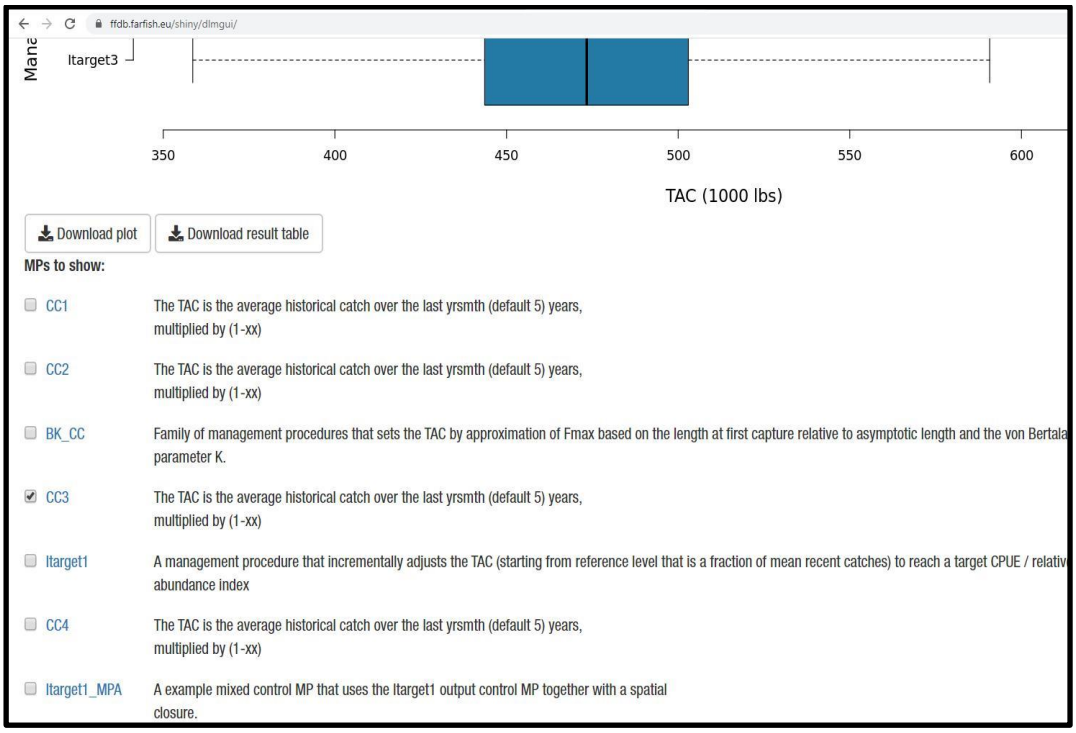

Figure 22: List of MPs with a checkbox for the user to choose what MP's to show on the TAC plot ('TAC Plot' tab)

2.2 FarFish-SPiCTGui (No registration required)

This component of the tool was developed to implement a SPiCT model (Stochastic surplus model in continuous time) which is based on a continuous-time state-space model described in Pedersen et al, 2014. The version used here has one of the latest advances in this model, which is to allow productivity and growth varying over time (Mildenberger et al, 2019). The use of this model is increasing in the fishery scientific community because of its few data requirements (it can be implemented only with catches and one or more abundance indices) and because of the possibility to have smaller data time scales (quarterly or bi-annual data).

It is possible to access this component of the tool from the main menu (https://ffdb.farfish.eu/) by clicking on "SPiCTGui" as shown in Figure 23.

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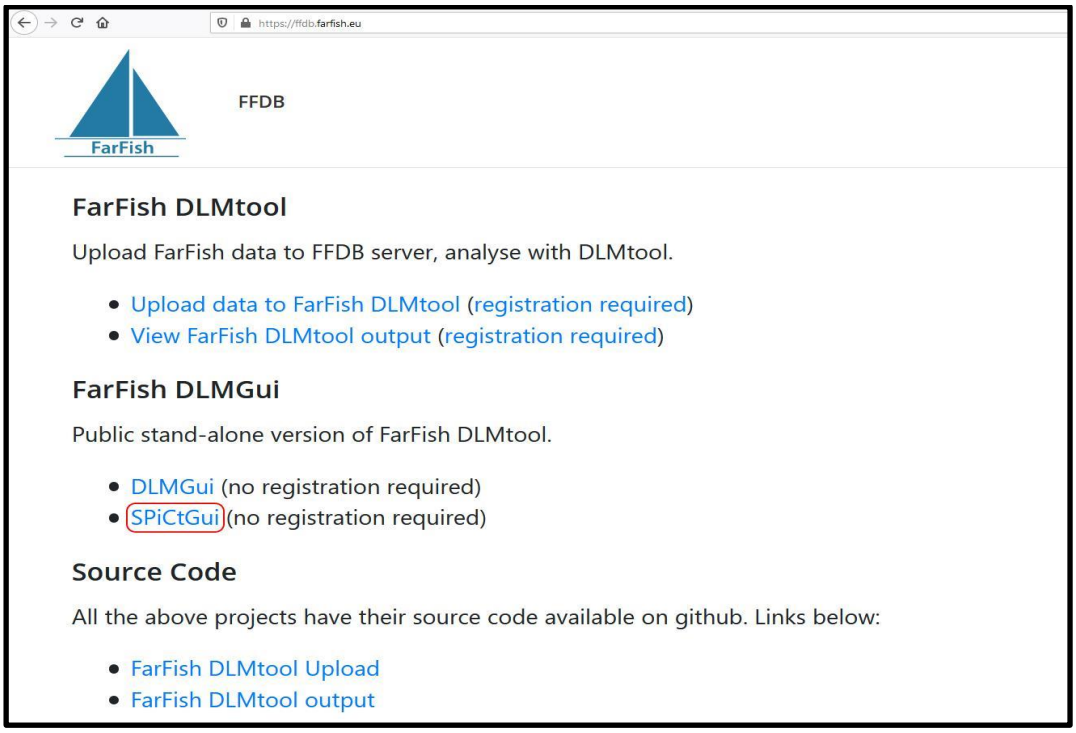

Figure 23: FarFish-DLMtool main menu screenshot highlighting the link to the SPiCtGui component

This link will redirect you to a screen like the one displayed in Figure 24, with different tab options for data input, visualization, and results.

Figure 24: FarFish-SPiCtGui screenshot highlighting the different tab options for data input, visualization and results.

2.2.1 Data input

The data input is performed in the "Edit data" tab. In this tab the user has two options: To upload the data or to enter the information available by hand. Uploading data can be done by clicking the "Browse" button highlighted in red in Figure 25. SPiCT data format suitable to be uploaded can be obtained after filling the excel template that is available here and saving that document in her/his machine.

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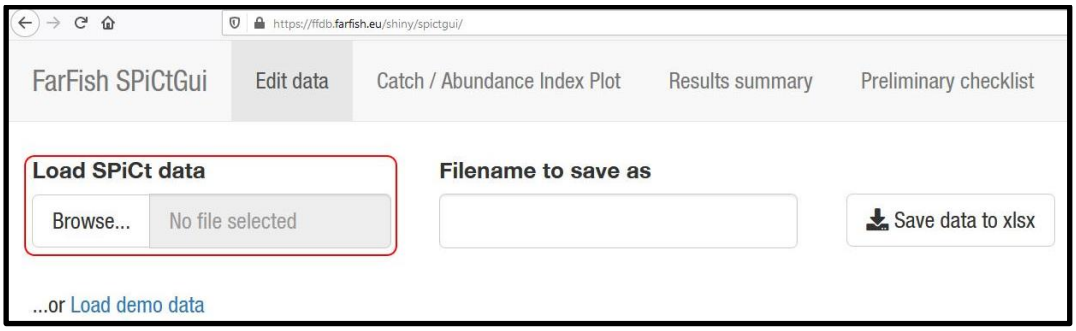

Figure 25: FarFish-SPiCtGui main menu screenshot. Click on 'Browse' to load SPiCt data file

The user can enter her/his data by filling the tables that appear when scrolling down and can save her/his progress at any time in a xlsx format file by giving a name to that file in the "Filename to save as" box (red square in Figure 26) and clicking on the "Save data to xlsx" button next to it. To guide this process, it is recommended to click on the blue link "Load demo data" (Figure 27) that will fill the tables automatically, then the user can remove this data and replace it with their own. It is important to note that if there is any missing information the corresponding field can be filled with "NA" or can be left empty.

Figure 26: The "Edit data" progress can be saved at any time in a xlsx format file by giving a name to that file in the "Filename to save as" box (red square) and then clicking on the "Save data to xlsx" button

Figure 27: Click on 'Load demo data' to load example data

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When scrolling down the first choice to make corresponds to “Model configuration”, the user can decide a seasonal productivity or time varying growth SPiCT implementation by clicking the corresponding checkbox. For the demo data none of the checkboxes was ticked as shown in Figure 28, this corresponds to the usual SPiCT implementation described in Pedersen et al.

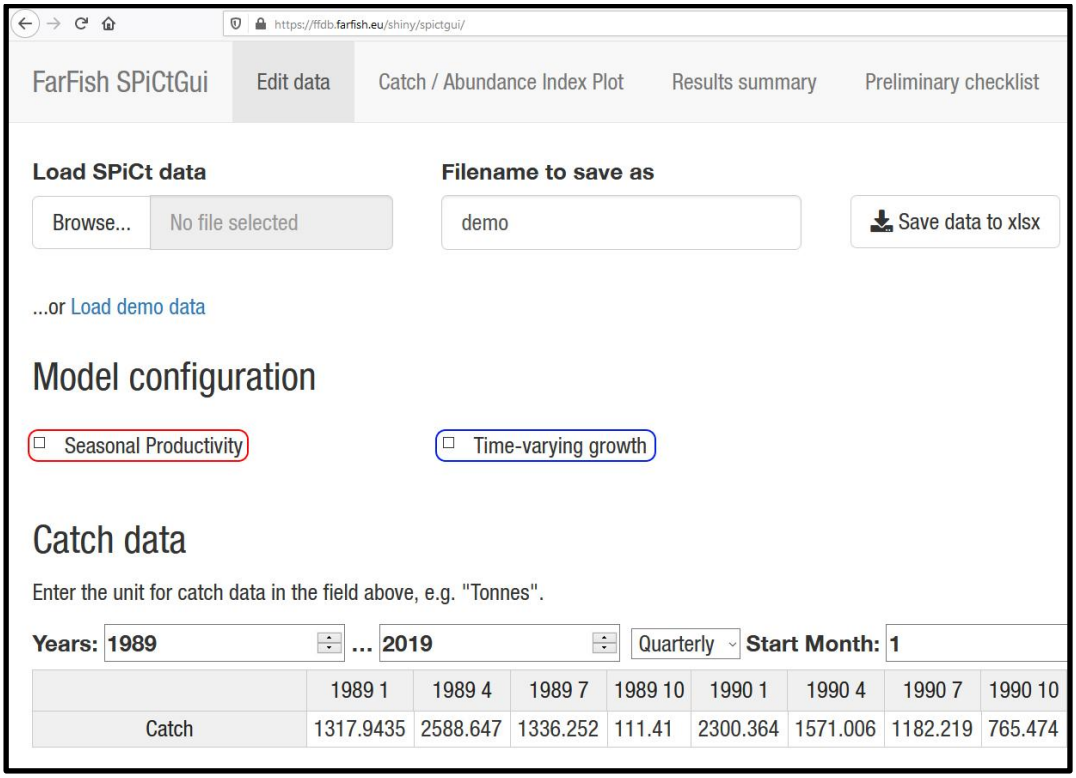

Figure 28: Model configuration selection and catch data for demo data. Tick on the checkbox for model configuration according to your preferences. If none of the options is ticked, a usual SPiCT (Pedersen) will be implemented

The second heading corresponds to catch data time series (Figure 28). The first and last year of the time series can be modified by clicking the up and down arrows in the two boxes next to “Years:”. The time scale of the data should be modified using the options of the dropdown menu next to the last year box. The data to fill the cells corresponding to catch can be copied and pasted from an excel file. In a similar way the user can fill the “Abundance index” information (Figure 29), but in this case the user can specify the exact month of the year when the index was collected. A maximum of four indices can be incorporated for the implementation. Please take into account that the indices should account only for the exploitable biomass. A link for the SPiCT manual, as well as useful references can be found at the end of all the tabs.

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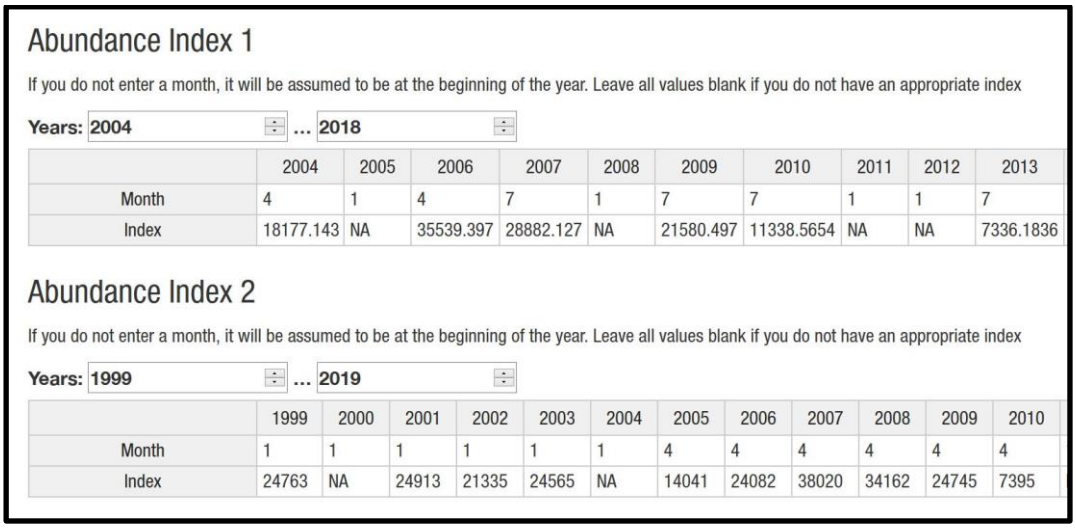

Abundance Index 1

If you do not enter a month, it will be assumed to be at the beginning of the year. Leave all values blank if you do not have an appropriate index

Years: 2004 ... 2018

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Month	4	1	4	7	1	7	7	1	1	7
Index	18177.143	NA	35539.397	28882.127	NA	21580.497	11338.5654	NA	NA	7336.1836

Abundance Index 2

If you do not enter a month, it will be assumed to be at the beginning of the year. Leave all values blank if you do not have an appropriate index

Years: 1999 ... 2019

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Month	1	1	1	1	1	1	4	4	4	4	4	4
Index	24763	NA	24913	21335	24565	NA	14041	24082	38020	34162	24745	7395

Figure 29: **Abundance index 1 & 2 filled with demo data ("Edit tab")**

2.2.2 *Data visualization*

The SPiCTGui allows the user to visualize catches and abundance indices time series (by clicking on the "Catch/ Abundance Index plot" tab, Figure 30). Please note that these plots can be downloaded by clicking on the "Download plot" button.

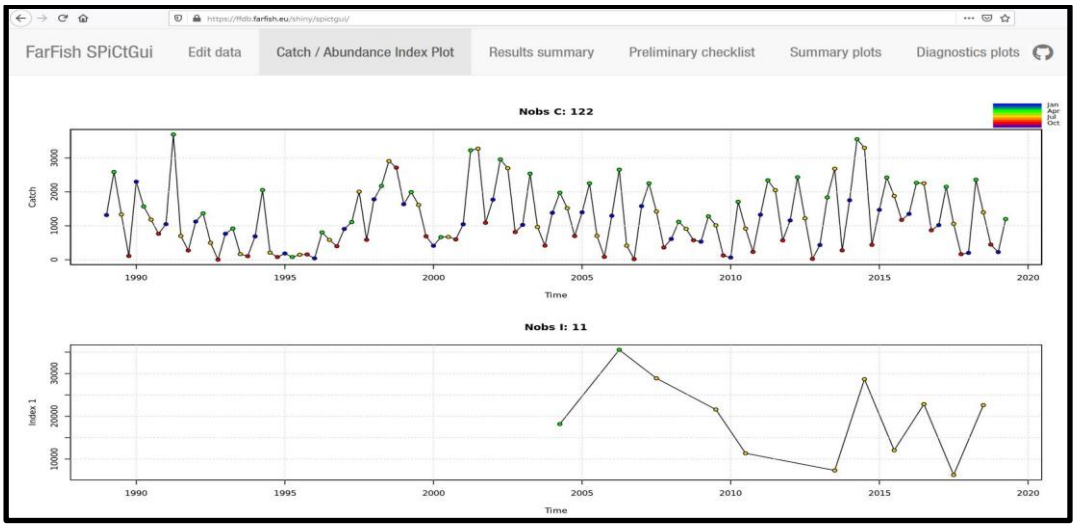

Figure 30: **Catch / Abundance index plot visualization from demo file ("Catch/ Abundance Index plot" tab).**

2.2.3 *Result*

Results of SPiCT implementation are divided into four tabs: "Result summary", "Summary plots", "Preliminary checklist" and "Diagnostics plots". The first two present model results in raw and graphical formats, the third is a preliminary checking to see if the model implementation can be used

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for stock assessment purposes and the fourth is to check if there have been violations of model assumptions.

2.2.3.1 *Model results*

Information about convergence and assumptions of the model, as well as estimated parameters are presented in the "Summary results" tab (Figure 31). To have a detailed description on how to interpret these results it is recommended to read the SPiCT manual (there is also a link to the manual at the end of all the tabs, under the "References" heading). These results can be also downloaded in a format that can be read in R by clicking on the "Download spict.fit Rdata" button (Figure 31).

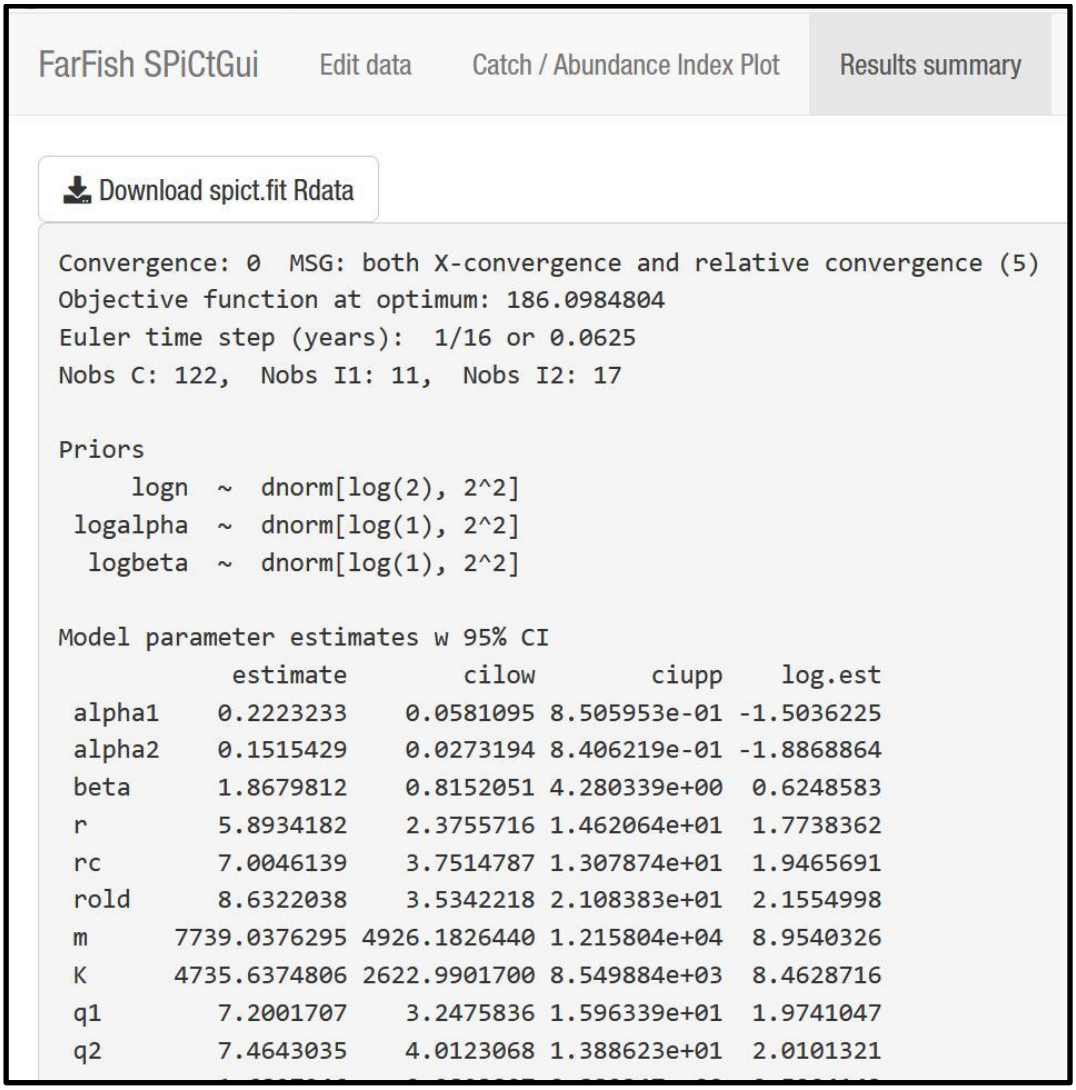

Figure 31: Information about convergence and assumptions of the model, as well as estimated parameters for demo file ("Results summary" tab).

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The “summary plots” tab shows estimated biomass, fishing mortality, catch and production time series (blue lines) with their confidence intervals (shaded blue areas), as well as estimated reference points (horizontal black lines) as can be observed in Figure 32. A detailed explanation for plots interpretation can be found in the SPiCT manual.

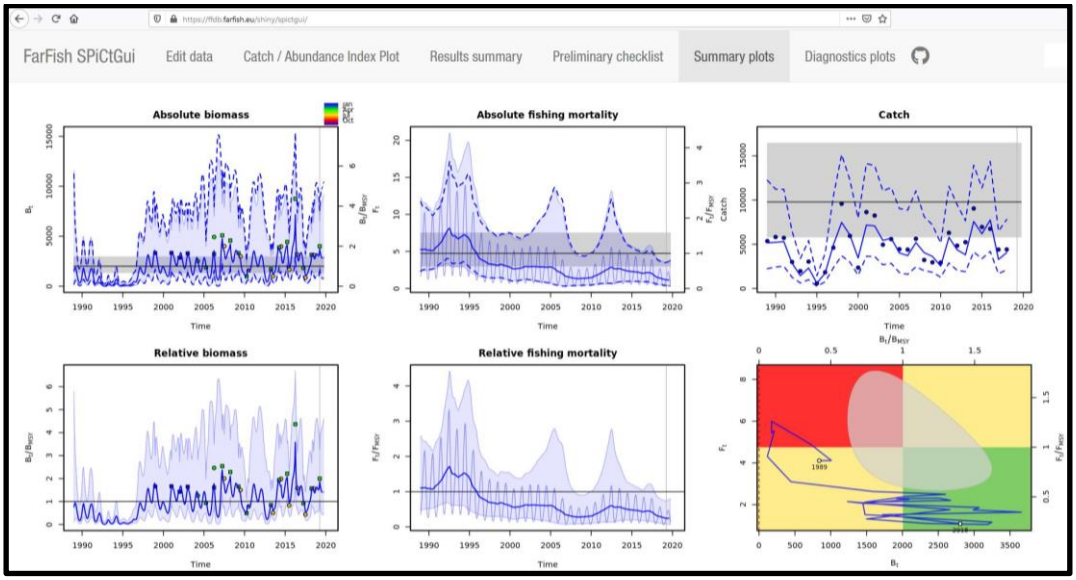

Figure 32: Summary plots for demo file (“Summary plots” tab)

2.2.3.2 Suitability of SPiCT for assessment purposes

The “Preliminary checklist” allow the user to check if the main conditions for the use of the SPiCT implementation in stock assessment are met (Figure 33). There are more conditions that should be checked but they are still not included in the tool. In case the user wants to use the SPiCT model for stock assessment, she/he must check the whole list that is available on the SPiCT guidelines documentation (There is also a link to these guidelines at the beginning of the tab).

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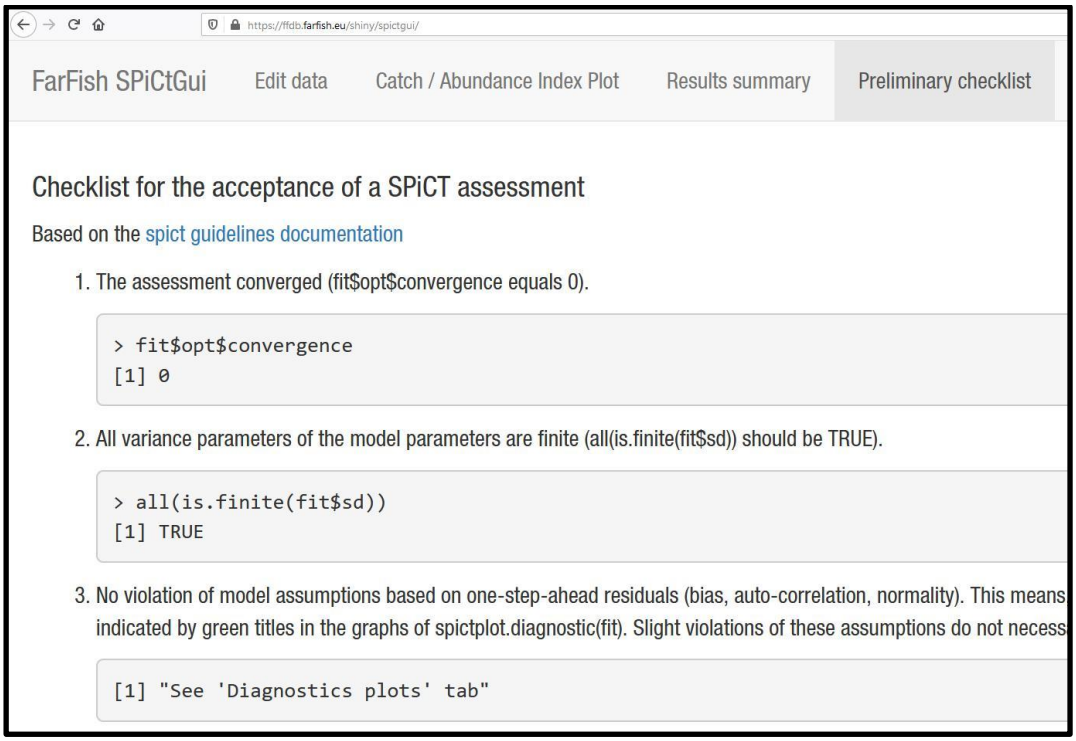

Figure 33: Checklist for the acceptance of a SPiCT assessment ("Preliminary checklist" tab)

2.2.3.3 Checking violation of model assumption

The "Diagnostics plot" tab helps to see if there are violations of model assumptions (Figure 34). This can be checked by visual inspection of the color of the titles of the plots, if they are green, no violation has been found, they will be red otherwise. Slight violations of model assumptions do not necessarily invalidate model results.

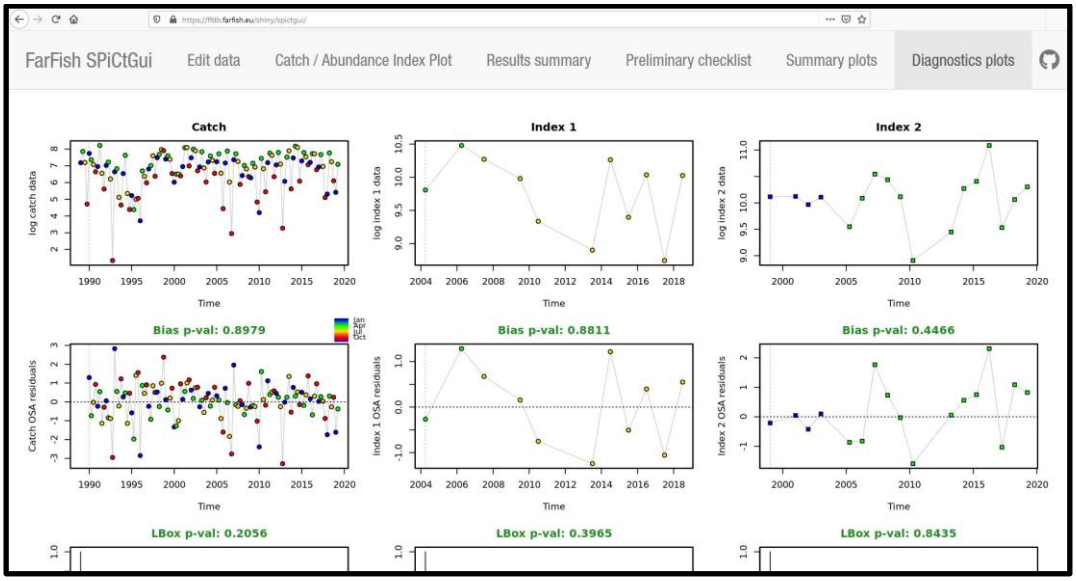

Figure 34: Plots for diagnostics on model assumption violations from demo file ("Diagnostics plots" tab)

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3 Impact evaluation

Using Google Analytics engine, we have been tracking the users of the FarFish DLMTool (requiring registration). Since the creation of the tool, it has been used by 45 people from 13 different countries, including people from outside the EU, from countries like Senegal, Namibia, Seychelles, Morocco and Colombia, as can be observed in Figure 35.

The statistics for the webpage use can be consulted by anyone at this link.

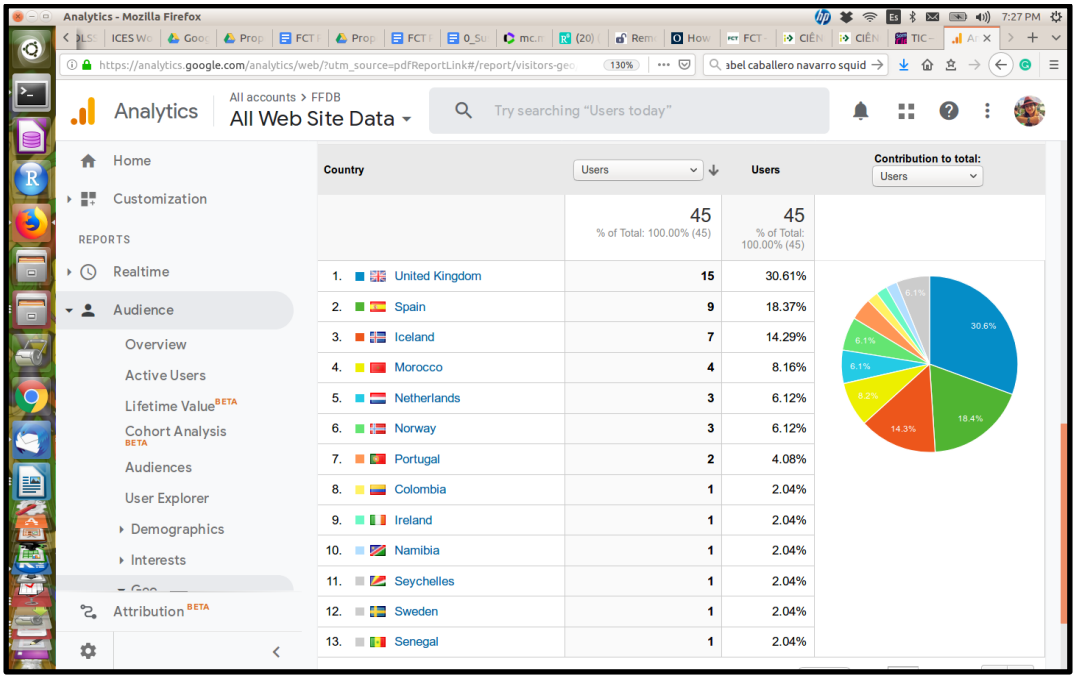

Figure 35:Screenshot of Google Analytics account for the page associated to the FarFish DLMtool webpage

Some additional impact stats can be found here.

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4 FarFish-DLMtool used for Cape Verde and Seychelles case studies

Some key bycatch species were chosen according to their relevance and data availability. These species were the Common dolphinfish (*Coryphaena hippurus*) and Wahoo (*Acanthocybium solandri*) in the Indian Ocean and Frigate tuna (*Auxis thazard*) and Wahoo in the Atlantic Ocean. It was decided to implement the tool for the whole Indian and the whole Atlantic Ocean based on the oceanic nature of these species and the lack of structure for these stocks. Data has been gathered by WP2 using IOTC and ICCAT data sources (IOTC database 2018, ICCAT database 2018).

This approach can be further scaled to Cape Verde and Seychelles by using the catch proportion of these species. Nevertheless, it was found that for Common dolphinfish, it was possible to obtain abundance and mortality estimates when using scaled catches together with the CPUE of a nearby region.

4.1 Cape Verde

4.1.1 Frigate Tuna

4.1.1.1 Data input

Catches for the whole Atlantic Ocean from 1950 to 2017 and one abundance index (Spain CPUE) from 1991 to 2017 were available for this species, as well as some biological parameters. These data were obtained from ICCAT database files from 2018 edition statistics (ICCAT database 2018, please consider that these statistics are being continually revised).

4.1.1.2 DLMGui results

4.1.1.2.1 Management procedures that can be applied with the data available

A list of the MPs that can be applied for this species management is presented in Figure 36. The list was obtained from tab “Diagnostics” after filling the data template in the “Edit data” tab.

Direction	Code	Name	Type	Description
	AvC_MLL	Average Catch with a size limit		An example mixed control MP that uses the average catch output control MP together with a minimum size limit set at the size of maturity.
	ICI	Index Confidence Interval		
	ICI2	Index Confidence Interval		

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	Iratio	Mean Index Ratio		
	Islope2	Index Slope Tracking MP		
	Islope4	Index Slope Tracking MP		
	Itarget1_MPA	Itarget1 with an MPA		
	Itarget2	Incremental Index Target MP		
	Itarget3	Incremental Index Target MP		
	ItargetE2	Incremental Index Target MP - Effort-Based A management procedure that incrementally adjusts the fishing effort to reach a target CPUE / relative abundance index		
	ItargetE3	Incremental Index Target MP - Effort-Based A management procedure that incrementally adjusts the fishing effort to reach a target CPUE / relative abundance index		
	minlenLopt1	Size limit management procedures		
input	curE	Current effort	Effort	A reference input control that maintains current effort (subject to fishing efficiency changes)
input	curE75	75% of Current effort	Effort	A reference input control that maintains 75% of current effort
input	ItargetE1	Effort adjusted target CPUE	Effort	Management procedure incrementally adjusts the effort to reach a target CPUE / relative abundance index.
input	ItargetE4	Effort adjusted target CPUE	Effort	Management procedure incrementally adjusts the effort to reach a target CPUE / relative abundance index.

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input	matlenlim	Length selectivity equal to maturity	Sel.	Fishing selectivity is set according to the maturity curve
input	matlenlim2	Length selectivity higher than maturity	Sel.	fishing selectivity is set slightly higher than the maturity curve
input	slotlim	Slot limit	Sel.	Sets a slot limit to control effort.
input	MRnoreal	Area 1 Marine Reserve with no reallocation	MPA	Sets a marine reserve in Area 1 with no reallocation of fishing effort to area 2
input	MRreal	Area 1 Marine Reserve with reallocation	MPA	Sets a marine reserve in Area 1 and reallocates fishing effort to area 2
output	AvC	Average Catch	Catch	Sets TAC as average historical catch
output	CC1	Constant catch linked to average catches	Catch	TAC is a average historical catches
output	CC2	Constant catch linked to average catches	Catch	TAC is 90% of average historical catches
output	CC3	Constant catch linked to average catches	Catch	TAC is 80% of average historical catches
output	CC4	Constant catch linked to average catches	Catch	TAC is 70% of average historical catches
output	CC5	Constant catch linked to average catches	Catch	TAC is 60% of average historical catches
output	NFref	No reference point	Catch	A reference MP that sets annual catch to almost zero (0.01)
output	GB_slope	Geromont and Butterworth CPUE slope	EmInd	TAC recommendations to stabilize CPUE
output	Islope1	CPUE slope MP	EmInd	TAC is adjusted to maintain constant CPUE
output	Itarget1	CPUE target MP	EmInd	TAC is adjusted to achieve a target CPUE

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output	Itarget4	CPUE target MP (more biologically precautionary)	EmInd	TAC is adjusted to achieve a target CPUE
output	SBT1	Southern Bluefin Tuna 1	EmInd	An MP that adjusts TACs according to apparent trend in CPUE
output	SPmod	Surplus production-based TAC modifier	PopDy	Inferred derivative of surplus production with biomass is used to adjust the TAC
output	SPMSY	Catch-trend MSY MP	Catch	Catch trends reflect depletion and combined with catches can be used to find viable r-K pairs. The OFL is dep x (1-dep) x 2 x r x K
NA	CurC	NA	NA	NA
NA	Islope3	NA	NA	NA

Figure 36: List of management procedures (MPs) that can be applied with the data available for Frigate tuna in the Atlantic Ocean. It was obtained from 'Enough data to produce' section on FarFish DMLGui 'Diagnostics' tab.

4.1.1.2.2 Quota estimates

The estimated recommended TAC provided by output-type MP's is shown in Figures 37 and 38. The SBT1 recommended TAC it is not displayed in Figure 37 because the recommended TAC by this method is comparatively higher than the others and this does not allow appreciating the variability in TACs for the other methods.

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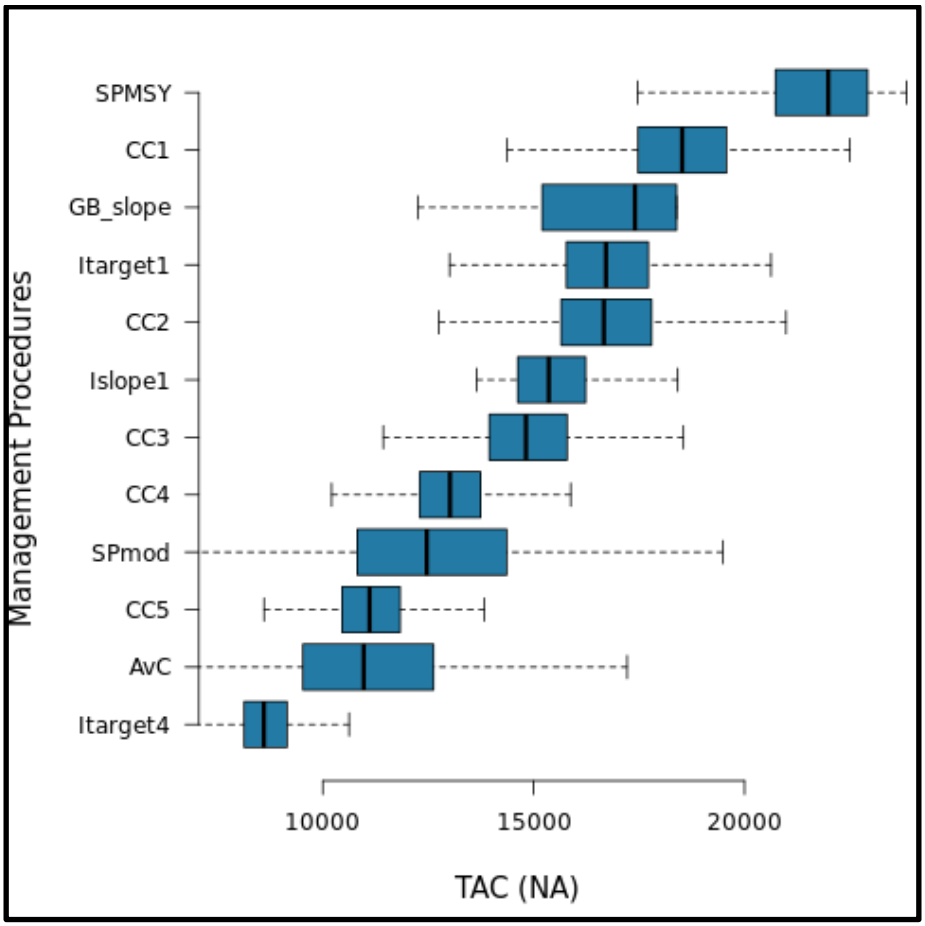

Figure 37: Recommended TAC plot for Frigate tuna in the Atlantic Ocean. It was obtained from 'TAC Plot' tab on FarFish DLMGui. It does not include SBT1 recommended TAC.

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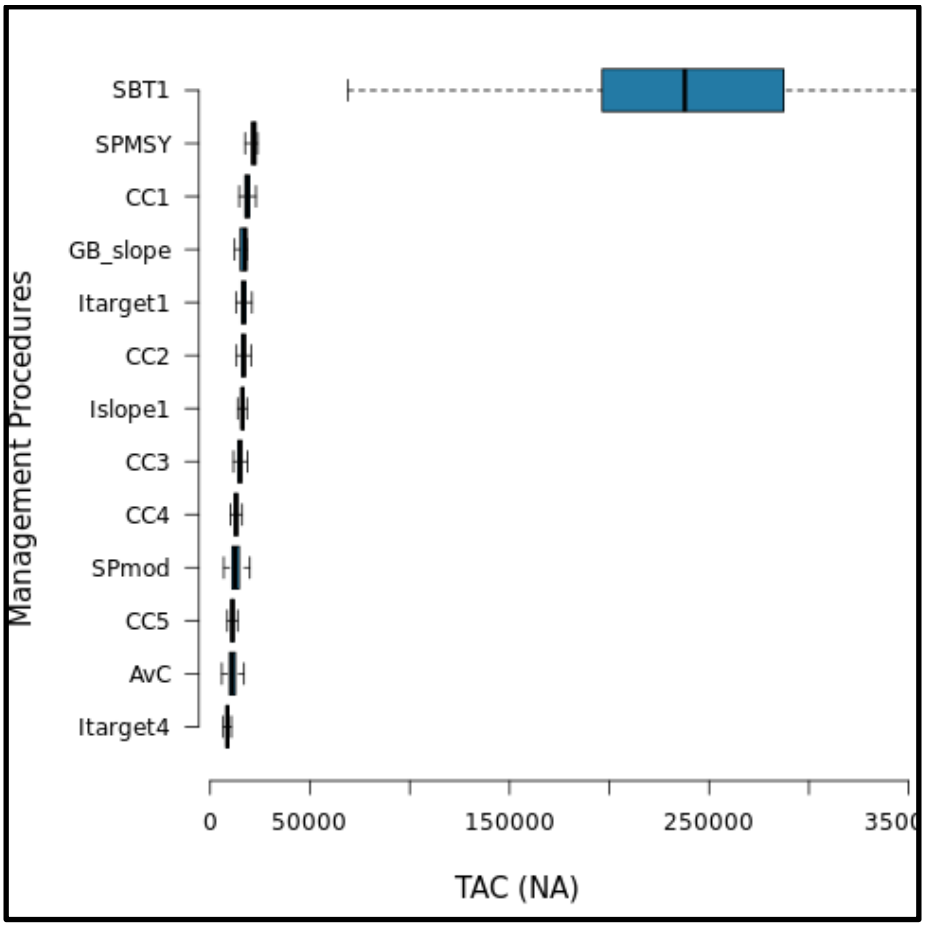

Figure 38: Recommended TAC plot for Frigate tuna in the Atlantic Ocean including SBT1 MPs estimate. It was obtained from 'TAC Plot' tab on FarFish DLMGui.

4.1.1.3 SPiCTGui results

4.1.1.3.1 Summary results

No SPiCt model could be loaded because the model does not achieve proper convergence. This lack of convergence can be observed in the "Results summary" tab where the corresponding value to convergence is 1 (Figure 39). This is also displayed with a message warning against the use of the results for management purposes.

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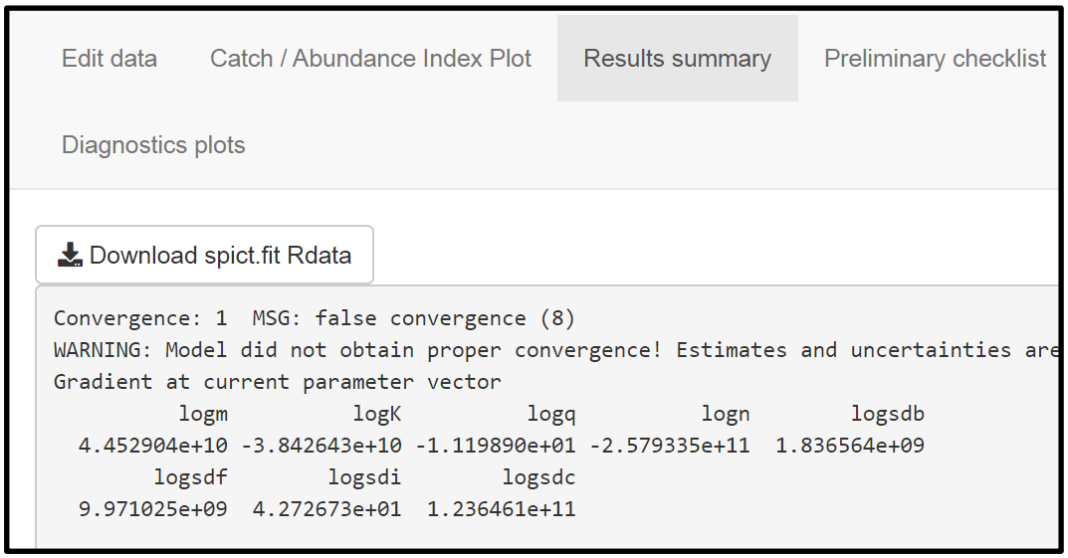

Figure 39: SPiCT summary results for Frigate tuna in the Atlantic. It was obtained from "Results summary" tab on FarFish SPiCtGui.

4.1.1.3.2 Suitability of SPiCT for assessment purposes

Because of the lack of convergence, SPiCt is not suitable for assessment purposes. This can be confirmed by the "Preliminary checklist" tab as can be observed in Figure 40.

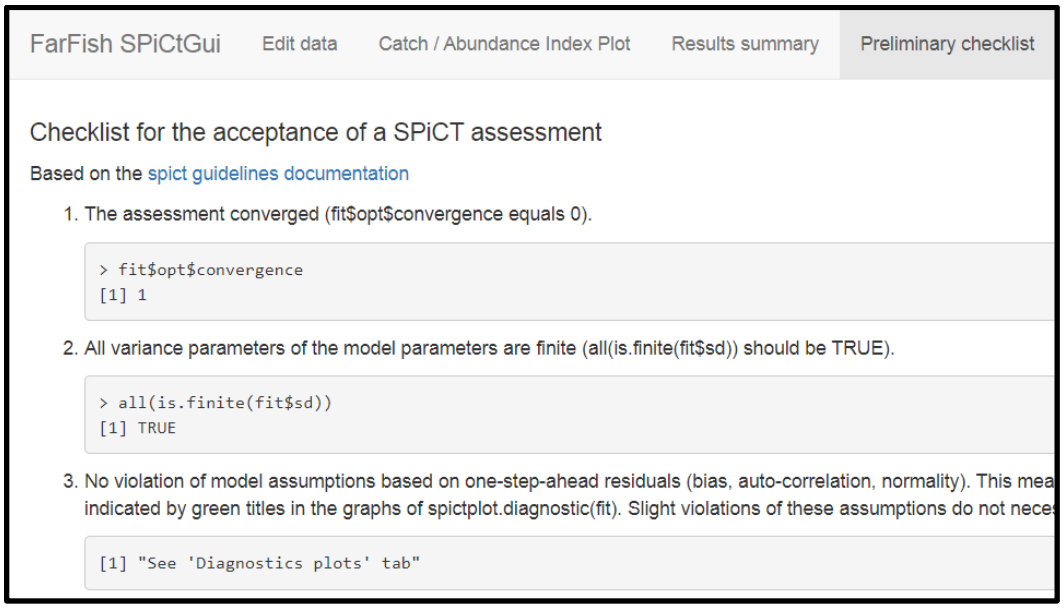

Figure 40: Checklist for the acceptance of a SPiCT assessment for Frigate tuna in the Atlantic Ocean. It was obtained from "Preliminary checklist" tab on FarFish SPiCtGui.

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4.1.1.3.3 Checking violation of model assumptions

Violation of assumptions cannot be checked because the model did not converge. In this case the tool displays an error message about this situation and residuals for the estimation cannot be calculated (Figure 41).

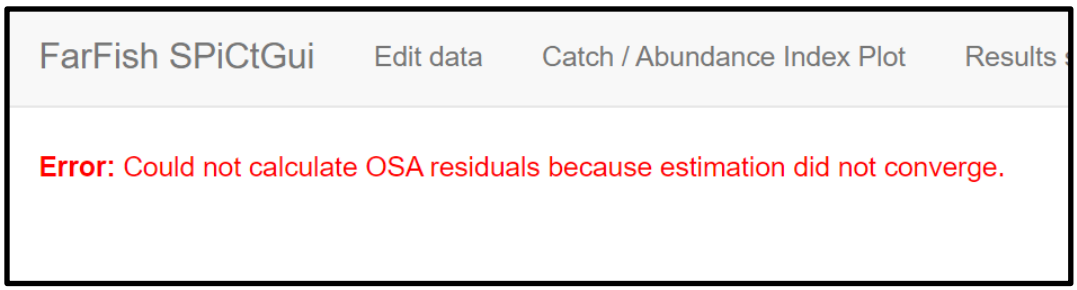

Figure 41: Error message from "Diagnostics plots" tab for Frigate tuna in the Atlantic Ocean, due to lack of convergence.

4.1.2 Wahoo

4.1.2.1 Data input

Catches for the whole Atlantic Ocean from 1968 to 2017 were available for this species, as well as some biological parameters. These data were obtained from ICCAT database files from 2018 edition statistics (ICCAT database 2018, please consider that these statistics are being continually revised).

4.1.2.2 DLMGui results

4.1.2.2.1 Management procedures that can be applied with the data available

A list of the MPs that can be applied for this species management is presented in Figure 42. The list was obtained from tab "Diagnostics" after filling the data template in the "Edit data" tab.

Direction	Code	Name	Type	Description
	AvC_MLL	Average Catch with a size limit		An example mixed control MP that uses the average catch output control MP together with a minimul size limit set at the size of maturity.
	minlenLopt1	Size limit management procedures		
input	curE	Current effort	Effort	A reference input control that maintains current effort (subject to fishing efficiency changes)
input	curE75	75% of Current	Effort	A reference input control that

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		effort		maintains 75% of current effort
input	matlenlim	Length selectivity equal to maturity	Sel.	Fishing selectivity is set according to the maturity curve
input	matlenlim2	Length selectivity higher than maturity	Sel.	fishing selectivity is set slightly higher than the maturity curve
input	slotlim	Slot limit	Sel.	Sets a slot limit to control effort.
input	MRnoreal	Area 1 Marine Reserve with no reallocation	MPA	Sets a marine reserve in Area 1 with no reallocation of fishing effort to area 2
input	MRreal	Area 1 Marine Reserve with reallocation	MPA	Sets a marine reserve in Area 1 and reallocates fishing effort to area 2
output	AvC	Average Catch	Catch	Sets TAC as average historical catch
output	CC1	Constant catch linked to average catches	Catch	TAC is a average historical catches
output	CC2	Constant catch linked to average catches	Catch	TAC is 90% of average historical catches
output	CC3	Constant catch linked to average catches	Catch	TAC is 80% of average historical catches
output	CC4	Constant catch linked to average catches	Catch	TAC is 70% of average historical catches
output	CC5	Constant catch linked to average catches	Catch	TAC is 60% of average historical catches
output	NFref	No reference point	Catch	A reference MP that sets annual catch to almost zero (0.01)
NA	CurC	NA	NA	NA

Figure 40: List of management procedures (MPs) that can be applied with the data available for Wahoo in the Atlantic Ocean. It was obtained from 'Enough data to produce' section on FarFish DMLGui 'Diagnostics' tab.

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4.1.2.2.2 Quota estimates

The estimated recommended TAC provided by output-type MP's is shown in Figure 43.

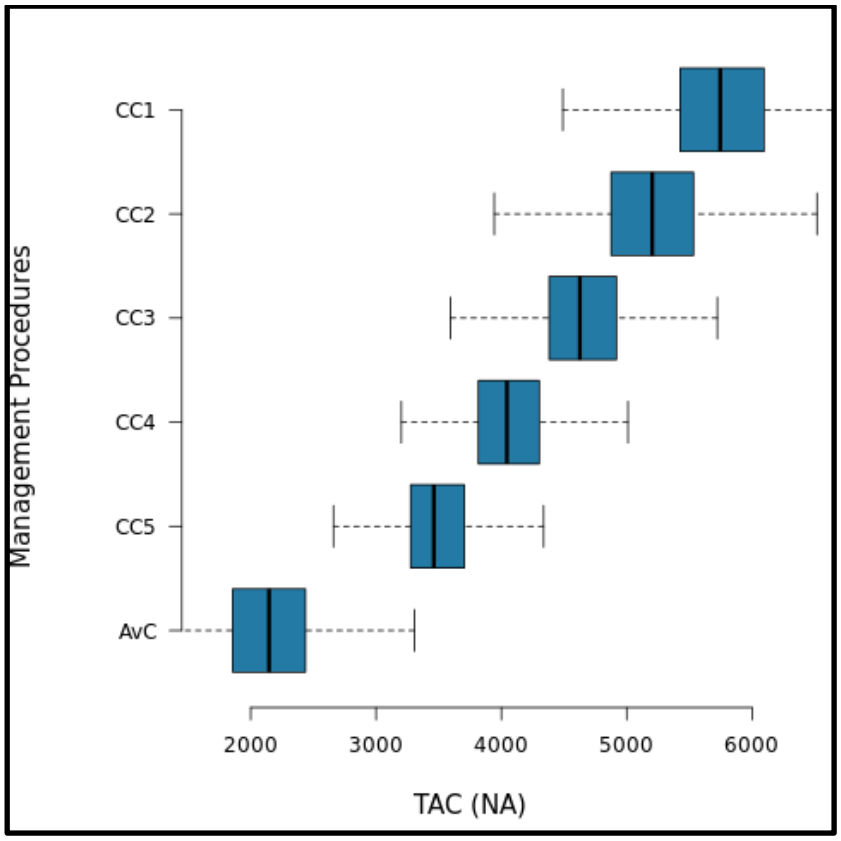

Figure 41: Recommended TAC plot for Wahoo in the Atlantic Ocean. It was obtained from 'TAC Plot' tab on FarFish DLMGui.

4.1.2.3 SPiCTGui results

4.1.2.3.1 Summary results

Minimum data requirements cannot be filled owing to the lack of at least one abundance index. No SPiCt model could be loaded and FarFish SPiCtGui displays a warning message to inform about this situation (Figure 44).

Figure 42: Error displayed in the 'Results summary' tab on Farfish SPiCTGui because minimum data requirements cannot be filled for Wahoo in the Atlantic Ocean.

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4.1.2.3.2 Suitability of SPiCT for assessment purposes

Because of the lack of enough data to run the SPiCt model, it is not suitable to be used for assessment purposes. This can be confirmed by the "Preliminary checklist" tab where error messages are displayed (Figure 45).

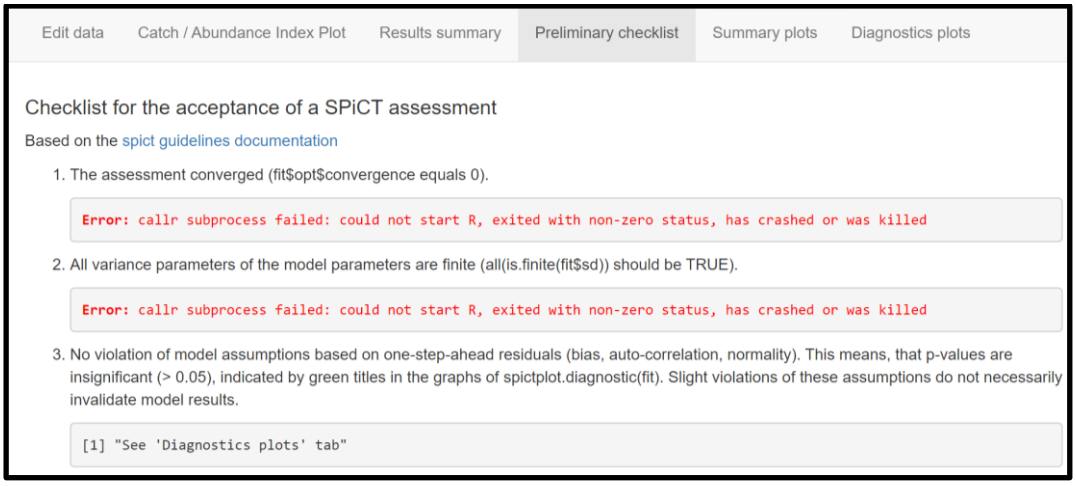

Figure 43: Checklist for the acceptance of a SPiCT assessment for Wahoo in the Atlantic Ocean. It was obtained from "Preliminary checklist" tab on FarFish SPiCtGui.

4.1.2.3.3 Checking violation of model assumptions

Violation of assumptions cannot be checked because minimum data requirements could not be filled and no SPiCt model could be loaded. In this case the tool displays an error message warning that the process that runs the model could not start, as observed in Figure 46.

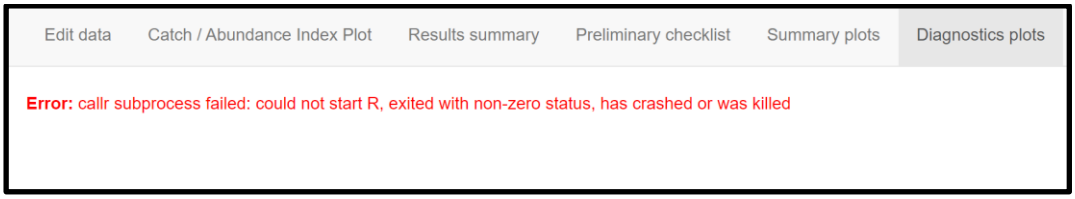

Figure 44: No diagnostics plots could be loaded from Wahoo in the Atlantic Ocean available data in SPiCtGui component

4.2 Seychelles

4.2.1 Common Dolphinfish

4.2.1.1 Data input

Catches of this species for Seychelles were calculated by scaling the catches time series available for the whole Indian Ocean from 1998 to 2017 using the Seychelles catch proportion. This scaled catches time series was considered more suitable to be used together with CPUE data (1994-2017) from

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Reunion islands (a nearby region), than the whole Indian Ocean catches. These data were obtained from IOTC database files from 2018 edition statistics (IOTC database 2018, please consider that these statistics are being continually revised). Some biological parameters obtained from Fishbase were also used.

4.2.1.2 DLMGui results

4.2.1.2.1 Management procedures that can be applied with the data available

A list of the MPs that can be applied for this species management is presented in Figure 47. The list was obtained from tab "Diagnostics" after filling the data template in the "Edit data" tab.

Direction	Code	Name	Type	Description
	AvC_MLL	Average Catch with a size limit		An example mixed control MP that uses the average catch output control MP together with a minimul size limit set at the size of maturity.
	ICI	Index Confidence Interval		
	ICI2	Index Confidence Interval		
	Iratio	Mean Index Ratio		
	Islope2	Index Slope Tracking MP		
	Islope4	Index Slope Tracking MP		
	Itarget1_MPA	Itarget1 with an MPA		
	Itarget2	Incremental Index Target MP		
	Itarget3	Incremental Index Target MP		
	ItargetE2	Incremental Index Target MP - Effort-Based A management procedure that incrementally adjusts the fishing effort to reach a target CPUE / relative abundance index		
	ItargetE3	Incremental Index Target MP - Effort-Based A management procedure that incrementally adjusts the fishing effort to reach		

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		a target CPUE / relative abundance index		
	minlenLopt1	Size limit management procedures		
input	curE	Current effort	Effort	A reference input control that maintains current effort (subject to fishing efficiency changes)
input	curE75	75% of Current effort	Effort	A reference input control that maintains 75% of current effort
input	ItargetE1	Effort adjusted target CPUE	Effort	Management procedure incrementally adjusts the effort to reach a target CPUE / relative abundance index.
input	ItargetE4	Effort adjusted target CPUE	Effort	Management procedure incrementally adjusts the effort to reach a target CPUE / relative abundance index.
input	matlenlim	Length selectivity equal to maturity	Sel.	Fishing selectivity is set according to the maturity curve
input	matlenlim2	Length selectivity higher than maturity	Sel.	fishing selectivity is set slightly higher than the maturity curve
input	slotlim	Slot limit	Sel.	Sets a slot limit to control effort.
input	MRnoreal	Area 1 Marine Reserve with no reallocation	MPA	Sets a marine reserve in Area 1 with no reallocation of fishing effort to area 2
input	MRreal	Area 1 Marine Reserve with reallocation	MPA	Sets a marine reserve in Area 1 and reallocates fishing effort to area 2
output	AvC	Average Catch	Catch	Sets TAC as average historical catch

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output	CC1	Constant catch linked to average catches	Catch	TAC is a average historical catches
output	CC2	Constant catch linked to average catches	Catch	TAC is 90% of average historical catches
output	CC3	Constant catch linked to average catches	Catch	TAC is 80% of average historical catches
output	CC4	Constant catch linked to average catches	Catch	TAC is 70% of average historical catches
output	CC5	Constant catch linked to average catches	Catch	TAC is 60% of average historical catches
output	NFref	No reference point	Catch	A reference MP that sets annual catch to almost zero (0.01)
output	GB_slope	Geromont and Butterworth CPUE slope	EmInd	TAC recommendations to stabilize CPUE
output	Islope1	CPUE slope MP	EmInd	TAC is adjusted to maintain constant CPUE
output	Itarget1	CPUE target MP	EmInd	TAC is adjusted to achieve a target CPUE
output	Itarget4	CPUE target MP (more biologically precautionary)	EmInd	TAC is adjusted to achieve a target CPUE
output	SBT1	Southern Bluefin Tuna 1	EmInd	An MP that adjusts TACs according to apparent trend in CPUE
output	SPmod	Surplus production based TAC modifier	PopDy	Inferred derivative of surplus production with biomass is used to adjust the TAC
NA	CurC	NA	NA	NA
NA	Islope3	NA		

Figure 45: List of management procedures (MPs) that can be applied with the data available for Common Dolphinfish in Seychelles. It was obtained from 'Enough data to produce' section on FarFish DMLGui 'Diagnostics' tab.

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4.2.1.2.2 Quota estimates

The estimated recommended TAC provided by output-type MP's is shown in Figure 48.

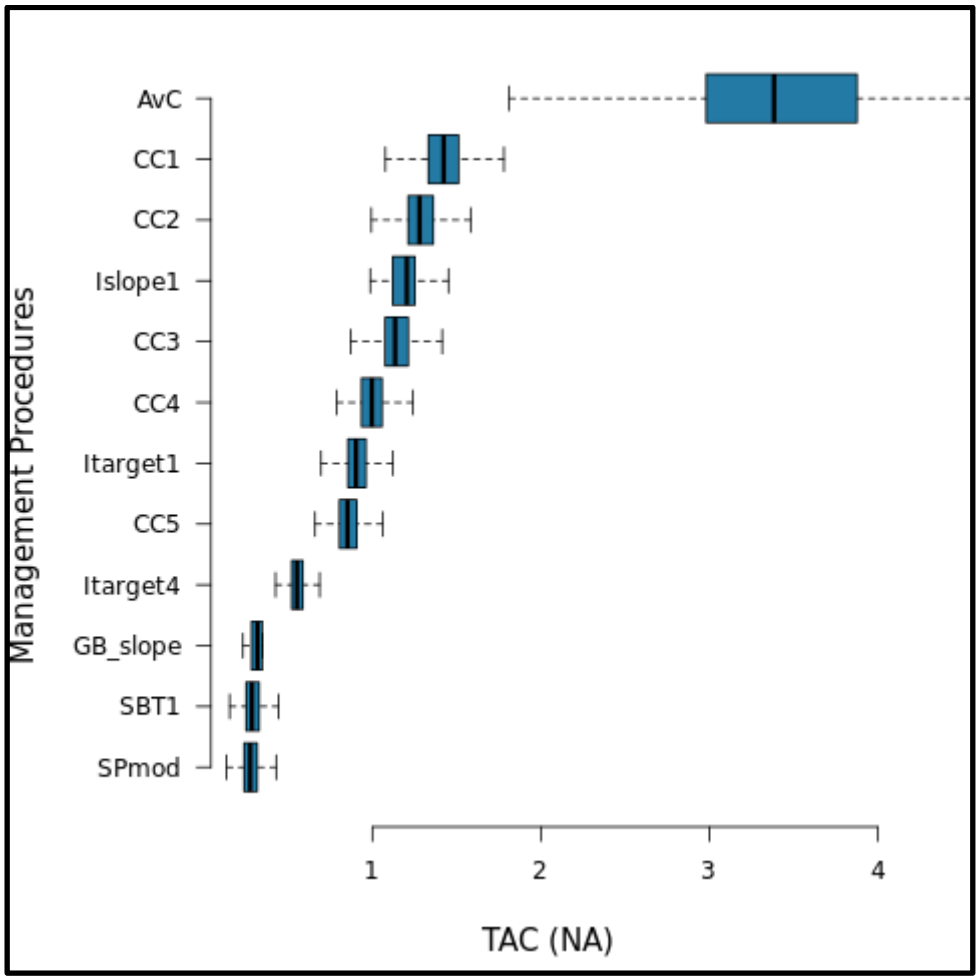

Figure 46: Recommended TAC plot for common Dolphinfish in Seychelles. It was obtained from 'TAC Plot' tab on FarFish DLMGui.

4.2.1.3 SPiCTGui results

4.2.1.3.1 Summary results

The SPiCt model achieves proper convergence. This convergence can be observed in the "Results summary" tab where the corresponding value to convergence is 0 (Figure 49). The estimated deterministic MSY is around 6.6 tons, B_{MSY} is close to 9.45 tonnes and F_{MSY} is equal to 0.7. The estimated biomass in the last year of the time series is around 22 tonnes and predicted biomass for the next year is approximately 22.3 tonnes.

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```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 31.0280295
Euler time step (years):  1/16 or 0.0625
Nobs C: 20,  Nobs I1: 24

Priors
     logn  ~  dnorm[log(2), 2^2]
 logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]

Model parameter estimates w 95% CI
          estimate     cilow        ciupp    log.est
 alpha   3.4801667 0.3719798 3.255973e+01  1.2470802
 beta    0.1922869 0.0287032 1.288158e+00 -1.6487669
 r       0.8869635 0.2272505 3.461837e+00 -0.1199514
 rc      1.4008197 0.1529444 1.283013e+01  0.3370576
 rold    3.3300768 0.0001008 1.100558e+05  1.2029954
 m       6.6209841 3.3908211 1.292826e+01  1.8902440
 K      22.9405704 5.7680340 9.123902e+01  3.1329070
 q       0.0030625 0.0007248 1.294020e-02 -5.7885235
 n       1.2663493 0.1309280 1.224826e+01  0.2361382
 sdb     0.0681785 0.0077500 5.997823e-01 -2.6856256
 sdf     0.6607764 0.4508059 9.685442e-01 -0.4143398
 sdi     0.2372726 0.1733731 3.247234e-01 -1.4385454

Deterministic reference points (Drp)
        estimate     cilow     ciupp    log.est
 Bmsyd 9.4530137 1.4818205 60.303843  2.2463336
 Fmsyd 0.7004099 0.0764722  6.415065 -0.3560896
 MSYd  6.6209841 3.3908211 12.928264  1.8902440
Stochastic reference points (Srp)
        estimate     cilow    ciupp    log.est rel.diff.Drp
 Bmsys 9.4254123 1.4786755 60.07971  2.2434095 -0.002928405
 Fmsys 0.7001903 0.0761456  6.43854 -0.3564032 -0.000313580
 MSYs  6.5995757 3.3575157 12.97221  1.8870054 -0.003243901

States w 95% CI (inp$msytype: s)
                  estimate     cilow      ciupp    log.est
 B_2017.00      22.0939022 5.6954554 85.7070209  3.0953017
 F_2017.00       0.0122700 0.0028308  0.0531837 -4.4005940
 B_2017.00/Bmsy  2.3440781 0.8497541  6.4662261  0.8518922
 F_2017.00/Fmsy  0.0175239 0.0031616  0.0971299 -4.0441908

Predictions w 95% CI (inp$msytype: s)
                prediction     cilow      ciupp    log.est
 B_2018.00      22.3712874 5.7083372 87.6743052  3.1077783
 F_2018.00       0.0133343 0.0027501  0.0646523 -4.3174185
 B_2018.00/Bmsy  2.3735076 0.8529009  6.6051498  0.8643688
 F_2018.00/Fmsy  0.0190438 0.0030968  0.1171097 -3.9610153
 Catch_2018.00   0.2990255 0.1029119  0.8688622 -1.2072263
 E(B_inf)       22.5221673        NA         NA  3.1145000
```

Figure 47: SPiCT summary results for common Dolphinfish in Seychelles. It was obtained from "Results summary" tab on FarFish SPiCtGui.

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Estimated absolute biomass time series is always over the B_{MSY} value and F always below F_{MSY}, as can be observed in the absolute biomass plot from "summary plots" tab displayed in Figure 50. Note that all values are over or below the horizontal black lines that represents B_{MSY} and F_{MSY}, respectively. These estimates are compared in the Kobe plot of relative fishing mortality over biomass estimates in Figure 50. The comparison suggests that the fishery has been exploited sustainably because all the estimates are in the green zone.

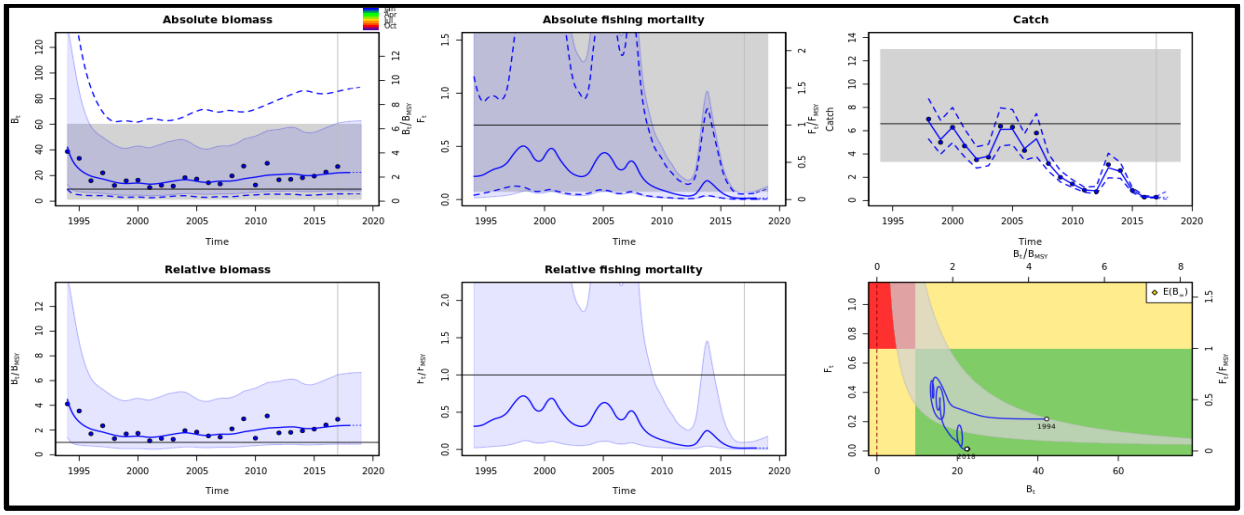

Figure 50: **Summary plots for Common Dolphinfish in Seychelles. It was obtained from 'Summary plots' tab on FarFish SPiCTGui.**

4.2.1.3.2 Suitability of SPiCT for assessment purposes

The SPiCT model for this species converged and also the variance was finite for all the parameters. Those are the first two requirements for a SPiCt model to be considered for assessment purposes as shown in the "Preliminary checklist" tab (Figure 51).

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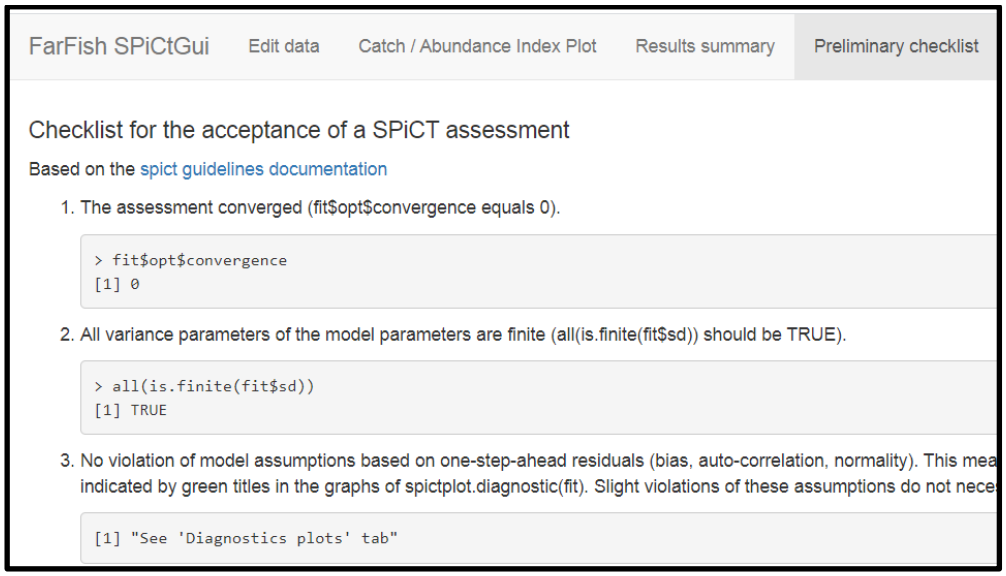

Figure 51: Checklist for the acceptance of a SPiCT assessment for common Dolphinfish in Seychelles. It was obtained from "Preliminary checklist" tab on FarFish SPiCtGui.

4.2.1.3.3 Checking violations of model assumptions

The third requirement for the SPiCT to be used for assessment purposes is to check that there have not been violations of model assumptions (number 3 in Figure 51). There was no violation of any assumption in the SPiCT model for this species as observed in the "Diagnostics plots" tab (Figure 52), where all plot tittles were in green (otherwise titles would be red).

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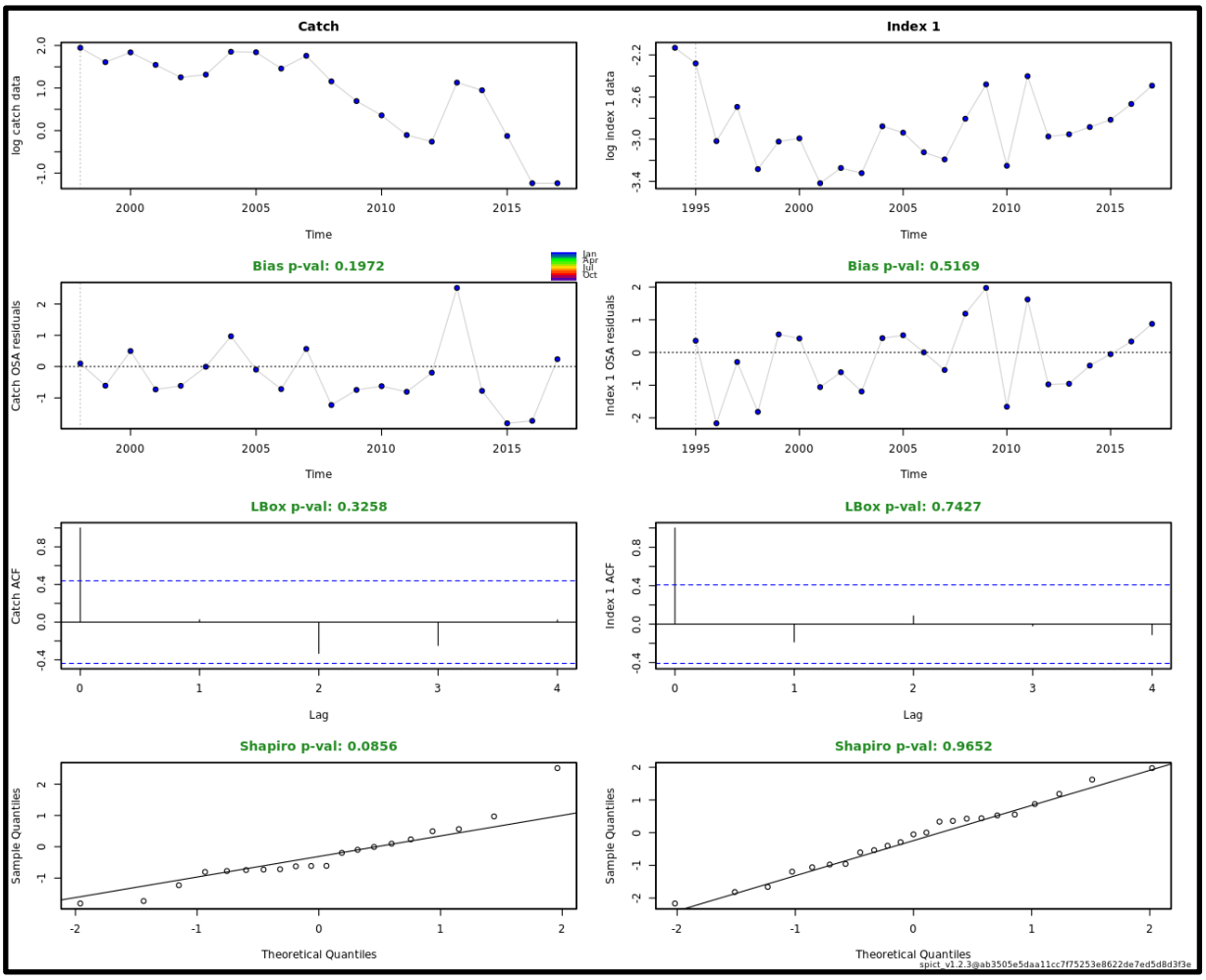

Figure 52: Check of model assumptions violation for common Dolphinfish in Seychelles. No violations found for this model (green titles). It was obtained from "Diagnostics plots" tab on FarFish SPiCtGui.

4.2.2 Wahoo

4.2.2.1 Data input

Catches for the whole Indian Ocean from 1950 to 2017 and one abundance index (Reunion Islands CPUE) from 1994 to 2017 were available for this species, as well as some biological parameters. These data were obtained from IOTC database files from 2018 edition statistics (IOTC database 2018, please consider that these statistics are being continually revised).

4.2.2.2 DLMGui results

4.2.2.2.1 Management procedures that can be applied with the data available

A list of the MPs that can be applied for this species management is presented in Figure 53. The list was obtained from tab "Diagnostics" after filling the data template in the "Edit data" tab.

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Direction	Code	Name	Type	Description
	AvC_MLL	Average Catch with a size limit		An example mixed control MP that uses the average catch output control MP together with a minimum size limit set at the size of maturity.
	ICI	Index Confidence Interval		
	ICI2	Index Confidence Interval		
	Iratio	Mean Index Ratio		
	Islope2	Index Slope Tracking MP		
	Islope4	Index Slope Tracking MP		
	Itarget1_MPA	Itarget1 with an MPA		
	Itarget2	Incremental Index Target MP		
	Itarget3	Incremental Index Target MP		
	ItargetE2	Incremental Index Target MP - Effort-Based A management procedure that incrementally adjusts the fishing effort to reach a target CPUE / relative abundance index		
	ItargetE3	Incremental Index Target MP - Effort-Based A management procedure that incrementally adjusts the fishing effort to reach a target CPUE / relative abundance index		
	minlenLopt1	Size limit management procedures		
input	curE	Current effort	Effort	A reference input control that maintains current effort (subject to fishing efficiency changes)

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input	curE75	75% of Current effort	Effort	A reference input control that maintains 75% of current effort
input	ItargetE1	Effort adjusted target CPUE	Effort	Management procedure incrementally adjusts the effort to reach a target CPUE / relative abundance index.
input	ItargetE4	Effort adjusted target CPUE	Effort	Management procedure incrementally adjusts the effort to reach a target CPUE / relative abundance index.
input	matlenlim	Length selectivity equal to maturity	Sel.	Fishing selectivity is set according to the maturity curve
input	matlenlim2	Length selectivity higher than maturity	Sel.	fishing selectivity is set slightly higher than the maturity curve
input	slotlim	Slot limit	Sel.	Sets a slot limit to control effort.
input	MRnoreal	Area 1 Marine Reserve with no reallocation	MPA	Sets a marine reserve in Area 1 with no reallocation of fishing effort to area 2
input	MRreal	Area 1 Marine Reserve with reallocation	MPA	Sets a marine reserve in Area 1 and reallocates fishing effort to area 2
output	AvC	Average Catch	Catch	Sets TAC as average historical catch
output	CC1	Constant catch linked to average	Catch	TAC is a average

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		catches		historical catches
output	CC2	Constant catch linked to average catches	Catch	TAC is 90% of average historical catches
output	CC3	Constant catch linked to average catches	Catch	TAC is 80% of average historical catches
output	CC4	Constant catch linked to average catches	Catch	TAC is 70% of average historical catches
output	CC5	Constant catch linked to average catches	Catch	TAC is 60% of average historical catches
output	NFref	No reference point	Catch	A reference MP that sets annual catch to almost zero (0.01)
output	GB_slope	Geromont and Butterworth CPUE slope	EmInd	TAC recommendations to stabilize CPUE
output	Islope1	CPUE slope MP	EmInd	TAC is adjusted to maintain constant CPUE
output	Itarget1	CPUE target MP	EmInd	TAC is adjusted to achieve a target CPUE
output	Itarget4	CPUE target MP (more biologically precautionary)	EmInd	TAC is adjusted to achieve a target CPUE
output	SBT1	Southern Bluefin Tuna 1	EmInd	An MP that adjusts TACs according to apparent trend in CPUE
output	SPmod	Surplus production-based TAC modifier	PopDy	Inferred derivative of surplus production with biomass is used to adjust the TAC
output	SPMSY	Catch-trend MSY MP	Catch	Catch trends reflect

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				depletion and combined with catches can be used to find viable r-K pairs. The OFL is dep x (1-dep) x 2 x r x K
NA	CurC	NA	NA	NA
NA	Islope3	NA	NA	NA

Figure 53: List of management procedures (MPs) that can be applied with the data available for Wahoo in the Indian Ocean. It was obtained from 'Enough data to produce' section on FarFish DMLGui 'Diagnostics' tab.

4.2.2.2.2 Quota estimates

The estimated recommended TAC provided by output-type MP's is shown in Figure 54.

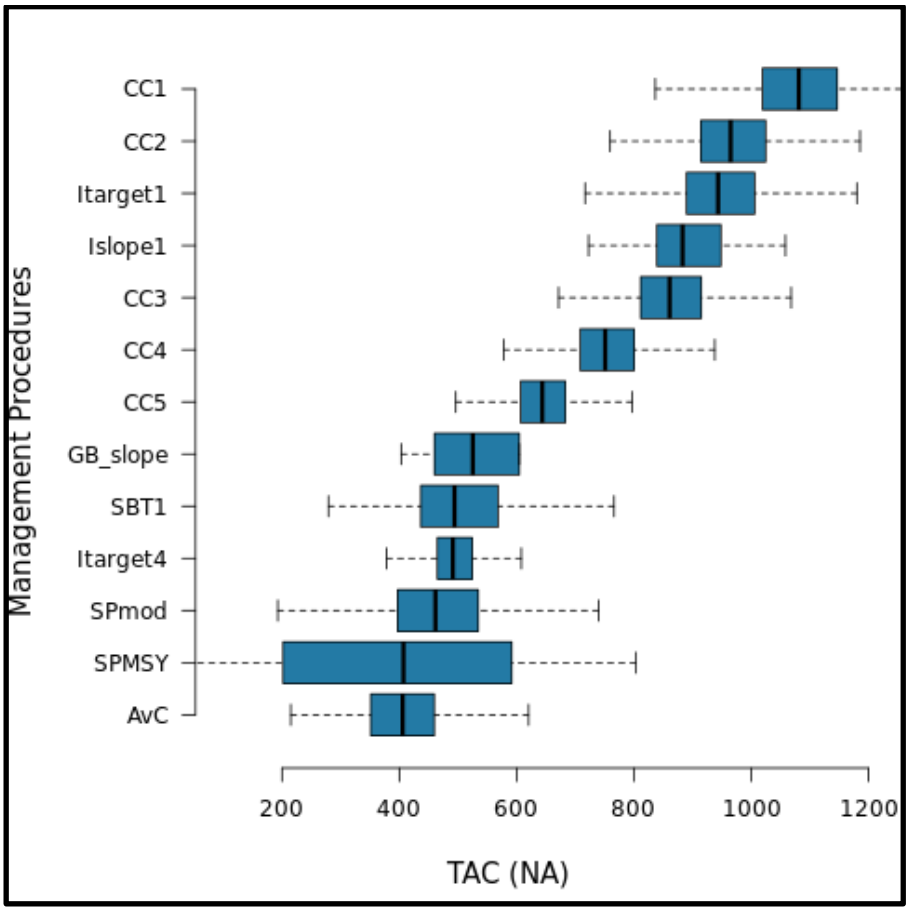

Figure 54: Recommended TAC plot for Wahoo in the Indian Ocean. It was obtained from 'TAC Plot' tab on FarFish DLMGui.

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4.2.2.3 SPiCTGui results

4.2.2.3.1 Summary results

No SPiCt model could be loaded because the model does not achieve proper convergence. This lack of convergence can be observed in the "Results summary" tab where the corresponding value to convergence is 1 (Figure 55). This is also displayed with a message warning against the use of the results for management purposes.

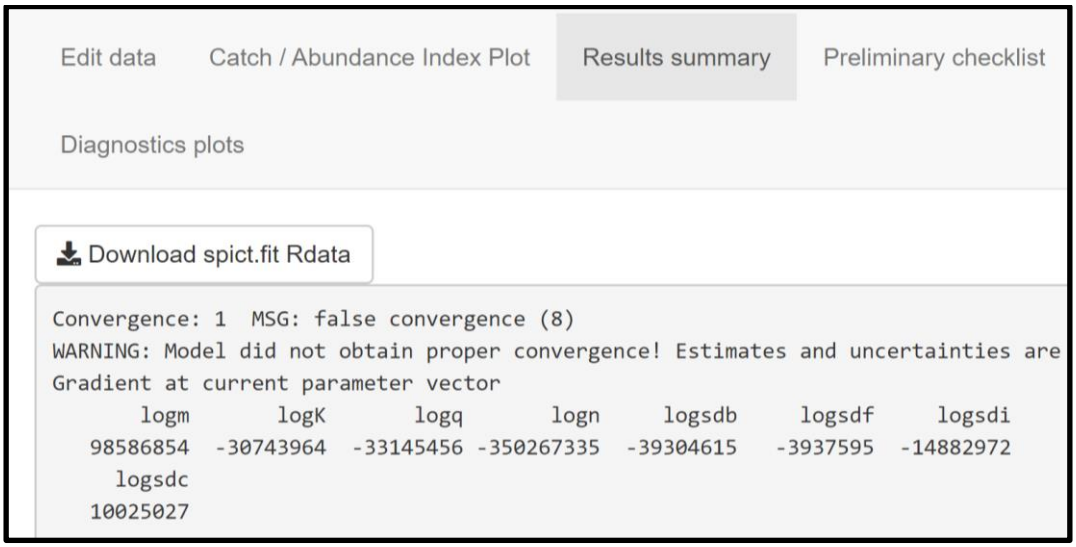

Figure 55: SPiCT summary results for Wahoo in the Indian Ocean. It was obtained from "Results summary" tab on FarFish SPiCtGui.

4.2.2.3.2 Suitability of SPiCT for assessment purposes

Because of the lack of convergence, SPiCt is not suitable for assessment purposes. This can be confirmed by the "Preliminary checklist" tab as can be observed in Figure 56.

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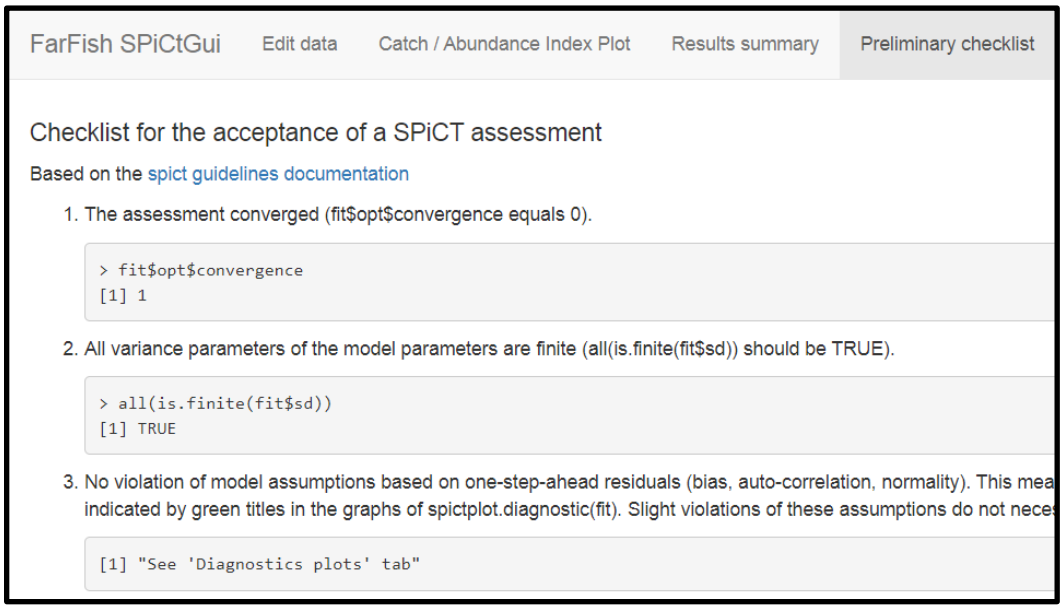

Figure 56: Checklist for the acceptance of a SPiCT assessment for Wahoo in the Indian Ocean. It was obtained from "Preliminary checklist" tab on FarFish SPiCtGui.

4.2.2.3.3 Checking violation of model assumptions

Violation of assumptions cannot be checked because the model did not converge. In this case the tool displays an error message about this situation and residuals for the estimation cannot be calculated (Figure 57).

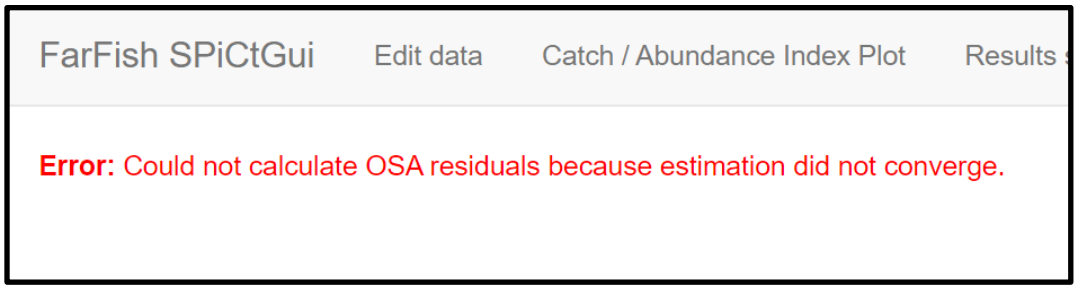

Figure 57: Error message from "Diagnostics plots" tab for Wahoo in the Indian Ocean, due to lack of convergence.

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5 References

Carruthers, T. R., Punt, A. E., Walters, C. J., MacCall, A., McAllister, M. K., Dick, E. J., & Cope, J. (2014). Evaluating methods for setting catch limits in data-limited fisheries. Fisheries Research, 153, 48–68. https://doi.org/10.1016/j.fishres.2013.12.014

Carruthers, T and Hordyk, A. (2020). Data-Limited Methods Toolkit (DLMtool 5.4.2) User Guide. https://dlmtool.github.io/DLMtool/userguide/introduction.html

ICCAT database. 2018. ICCAT Nominal Catches and Catch and Effort Data - Reference file. t1nc-ALL_20181205 and t2ce_20181205web (https://www.iccat.int/es/accesingdb.html for updated edition).

ICES. 2018. ICES reference points for stocks in categories 3 and 4. In Report of the ICES Advisory Committee, 2018. ICES Advice 2018, ICES Technical Guidelines, Section 16.4.3.2. 50 pp. https://doi.org/10.17895/ices.pub.3977

ICES.2019. Ninth Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks(WKLIFE IX). ICES Scientific Reports. 1:77. 131 pp. http://doi.org/10.17895/ices.pub.5550

IOTC database 2018. IOTC Catch and Effort Data - Reference File. IOTC-2018-DATASETS-NCDBrev2 and IOTC-2018-WPEB14-DATA04 - CELongline (https://ww2.iotc.org/WPTT/22DP/Data/08-CEref for updated edition).

Mildenberger, Tobias K, Casper W Berg, Martin W Pedersen, Alexandros Kokkalis, and J Rasmus Nielsen. 2019. "Time-variant productivity in biomass dynamic models on seasonal and long-term scales." ICES Journal of Marine Science, September. https://doi.org/10.1093/icesjms/fsz154

Pedersen, Martin W., and Casper W. Berg. 2017. "A stochastic surplus production model in continuous time." Fish and Fisheries 18 (2): 226–43. https://doi.org/10.1111/faf.12174

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