

# Tutorial for spictapp: The Shiny app for the Stochastic Production model in Continuous Time (SPiCT)

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This totutrial guides you through a SPiCT assessment using the click-based Shiny app “spictapp”.

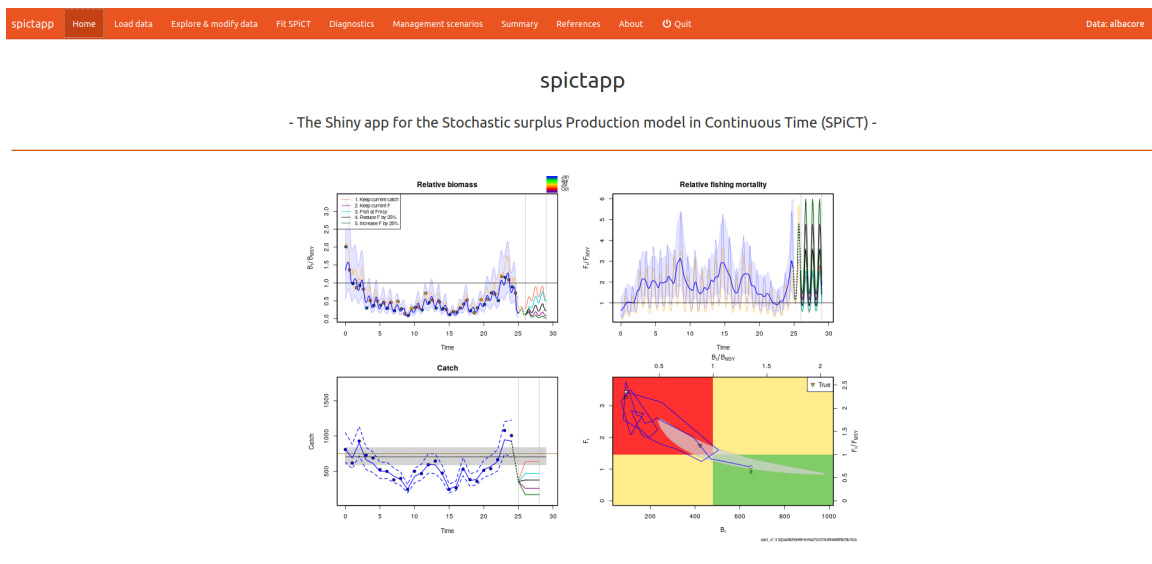


Figure 1: Home screen of spictapp.

## Download

The spictapp is hosted on [GitHub](#) and can be downloaded as a [zip archive](#). Unpack the archive to the destination of your choice.

## Start the App

Before the start of the app, **spictapp** checks if all required R packages are required and installs any missing packages. To assure windows compatibility without requiring Rtools (large software package), the binary version of the spict R package (version 1.3.0) is included in the zip archive and installed upon start of the app.

The app can be started by double-clicking the respective executable in the spictapp directory, i.e. 'spictapp' for linux and mac and 'spictapp\_win' for windows operating systems (the file endings are '.sh' and '.bat', respectively).

Alternatively the script **runapp.R** in the spictapp directory can be executed from within R or with **Rscript runapp.R** from the terminal or command line.

## Home

On start, the app shows the home screen of spictapp (Fig. 1), which shows four important plots of a simulated spict assessment (find more information to the plots below). At the top of the screen is the orange navigation bar of the app, which guides the user through the individual steps of a spict assessment (Fig. 2). The active tab is highlighted in darker tone (tab called 'Load data' in Fig. 2). The tab 'Quit' closes the app and browser window (in any browser other than firefox  $\geq 46.0.1$ ). This tutorial is structured following the steps of a common spict assessment and thus the tabs in the navigation bar.

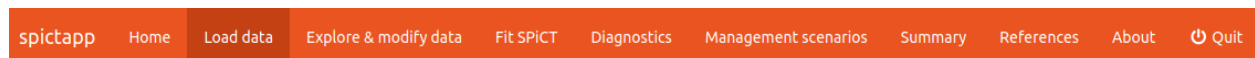


Figure 2: Tabs with assessment steps in the navigation bar.

At the far right of the navigation bar, the name of the uploaded data set is displayed (Fig. 3). In this example, the albacore example data set was selected. The data name is shown independent on the active tab and helps avoid confusion when dealing with different data sets.

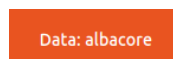


Figure 3: Data label in the navigation bar.

## Load data

Any assessment requires input data. SPiCT requires information about the catches from the commercial fleet with corresponding time intervals and an abundance index or effort data, alternatively. While the catches and effort refer to an interval and the times of the start of these intervals have to be provided, the abundance indices (multiple indices possible) correspond to a specific point in time, which can be specified as 2015.37 for mid May for example. Find more information about the data requirements of **SPiCT** in the two vignettes [SPiCT Guidelines](#) and [SPiCT Handbook](#).

The button 'Browse...' in the 'Load Data' tab allows you to browse through your directories and upload any data set to **spictapp** (Fig. 4). The only requirement for the data file is that it has either the '.txt' or '.csv' file extension. Both file types can be created from Excel or R. The specific properties of the file can be changed within the app with the options given for separators, quotes, and header. After uploading, the app displays the data in its raw format and will try to automatically match the column names with the names

expected by **SPiCT**. If successful in matching expected column names, the data set will also be displayed under ‘Data with assigned columns’.

**Load input data**

**Upload data file**

Choose a csv/txt file

Browse... hake.txt

Upload complete

Please use reset before uploading a new data set:

**Reset**

Your file must contain at least 3 columns: One vector with the times corresponding to the observations, one with the commercial catch observations, and one with either index or effort observations. The app tries to interpret the column names of your data automatically, but might not be successful in assigning all columns. If the 'Data with assigned columns' is empty or did not assign the columns correctly, please refer to the 'Assign columns' section below and press 'Update data' when done.

**File properties**

Separator: ☒ Comma, ☐ Semicolon, ☐ Tab, ☐ White space

Quote: ☐ None, ☒ Double Quote, ☐ Single Quote

Display: ☒ Head, ☐ All

☒ Header

**Uploaded file in raw format:**

Time	Catch.commercial.fleet	Survey.time	Catch.survey.fleet
1965	93.51	1965	1.78
1966	212.44	1966	1.31
1967	195.03	1967	0.91
1968	382.71	1968	0.96
1969	320.43	1969	0.88
1970	402.47	1970	0.90

**Data with assigned columns:**

Figure 4: Upload data to spictapp.

If not all columns expected by **SPiCT** could be matched, the user can select the columns corresponding to the commercial catch observations ('obsC'), with corresponding times ('timeC') and index ('obsI') or effort ('obsE') observations with corresponding times ('timeI') or ('timeE'), respectively, where the names in brackets reflect the corresponding standard **SPiCT** variable names (Fig. 5). Note, that the app allows to input several columns for the index observations and times, but only one column for the catch and effort observations and times.

With pressing 'Update data', the columns are assigned to the corresponding **SPiCT** variables and the resulting data is displayed under 'Data with assigned columns' (Fig. 6).

**SPiCT** also allows you to specify the uncertainty around input data as a factor to multiply estimated observation noise with. For example, the uncertainty of the catch observations might have changed over time due to an improved data monitoring system. The three input fields below the 'Update data' button, let you assign corresponding columns in your data to these variables (called 'stdevfacC', 'stdevfacI', and 'stdevfacE' in **SPiCT**, respectively).

One of the three original example data sets included in the spict package can be chosen by pressing 'Use example data set?' at the bottom of the page (Fig. 5). Note that many more example data sets are included in the data directory of the spictapp zip archive.

## Assign columns

Please assign the columns of your data to the required SPiCT input data. SPiCT requires a vector with catch observations and their times, as well as either index observations and their times or effort observations and their times. Press 'Update data' when all columns are assigned.

Commercial catch:

Times of catch observations

Time

Catch observations

Catch.commercial.fleet

Indices from scientific surveys:

Times of index observations

Survey.time

It is possible to select multiple columns representing different fleets and their times.

Index observations

Choose one

Time

Catch.commercial.fleet

Survey.time

Catch.survey.fleet

Effort information (optional):

Times of effort observations

Choose one

Effort observations

Choose one

Effort observations are optional if indices are available and required otherwise.

Update data

If information about the uncertainty of the observations is available, it can be provided as a factor scaling the uncertainty of the observations. This variable is called `stdevfac` for the different observations in SPiCT, e.g. `stdevfacC` for catches. Several columns can be selected if several indices are available.

Catch observations

Choose one

Index observations

Choose one

Effort observations

Choose one

## Use example data

☐ Use example data set?

Figure 5: Assign columns.

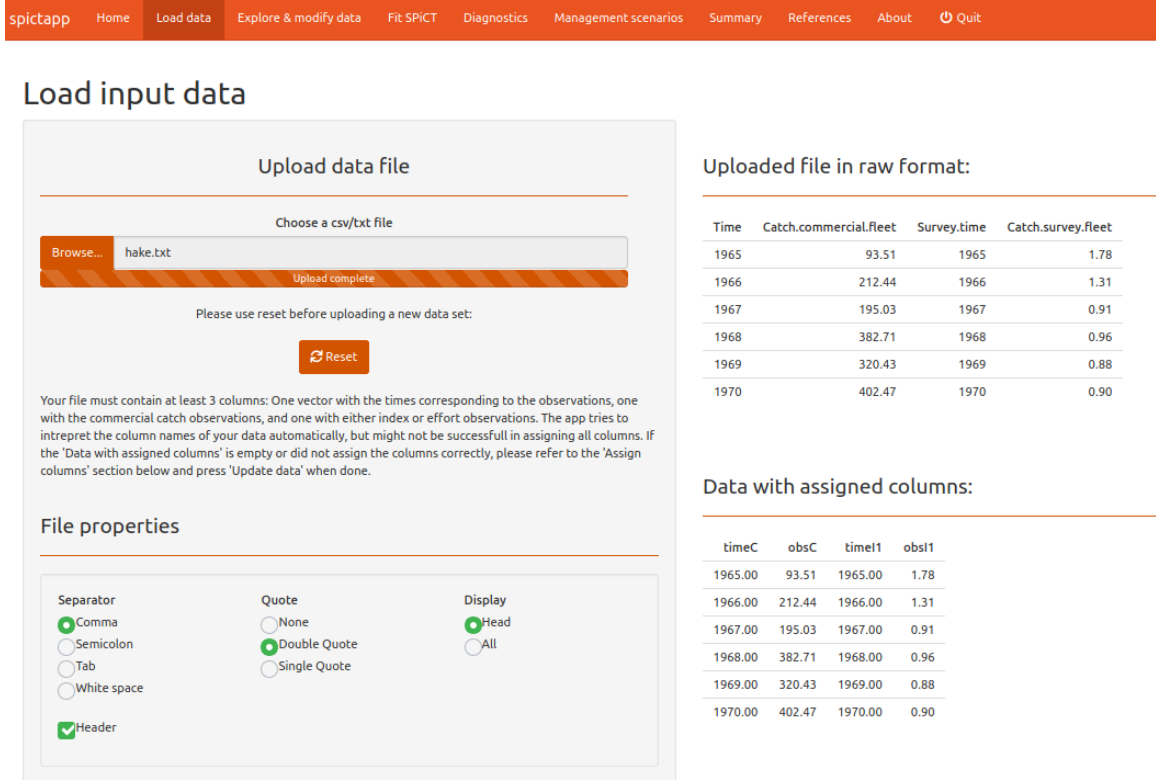


Figure 6: Uploaded data with assigned columns.

## Explore & modify data

This step of the analysis visualises the input data and allows to explore and modify the input data to the SPiCT assessment. The SPiCT timeline visualises the time period with observations (catch, indices, and/or effort), the forecast period which is used in all management related functions, and the potential intermediate period between observations and start of the management (Fig. 7). Furthermore, the observations are displayed as time series graphs (Fig. 7) and as text output (Fig. 8). Note that catches in SPiCT are generally labelled with a capital 'C', indices with a capital 'I', and effort with a capital 'E'. The number of plots can vary with the number of index time series (here 2).

Under 'General Settings', a range of options allows to modify the input data and model settings (Figures 7 and 8). The Euler discretisation time step defining the number of time steps within a year (default is 16) can be changed. The timing of the indices can be adjusted by entering a number(s) for each index, e.g. 0.25 to adjust the timing of the index to April. The time period of the observations can be shortened by changing the sliders. Be aware that this affects all time series (e.g. catches and all indices). For seasonal catch/effort observations, the number of seasonal, the season type and and spline order can be adjusted.

The 'Management settings' allow to specify the management interval (period for which to predict catches and in which to apply potential management strategies), as well as the management evaluation time (time at which to evaluate predicted states), and the management strategy by changing the fishing mortality, as a factor to multiply current  $F$  by or as an absolute  $F$  value. Note, that the management related settings can be re-adjusted in the 'Management scenarios' section.

SPiCT defines 3 uninformative priors by default: (i) on the shape of the production curve ( $\log(\mathbf{n})$ ); (ii) on the relation of the biomass process error to the index observation error ( $\log(\mathbf{\alpha})$ ); and on the fishing mortality process error to the catch observation error ( $\log(\mathbf{\beta})$ ). These priors can easily be switched off or modified (Fig. 9). In addition, SPiCT allows to specify prior distributions on a range of other model parameters and

Explore & modify input data

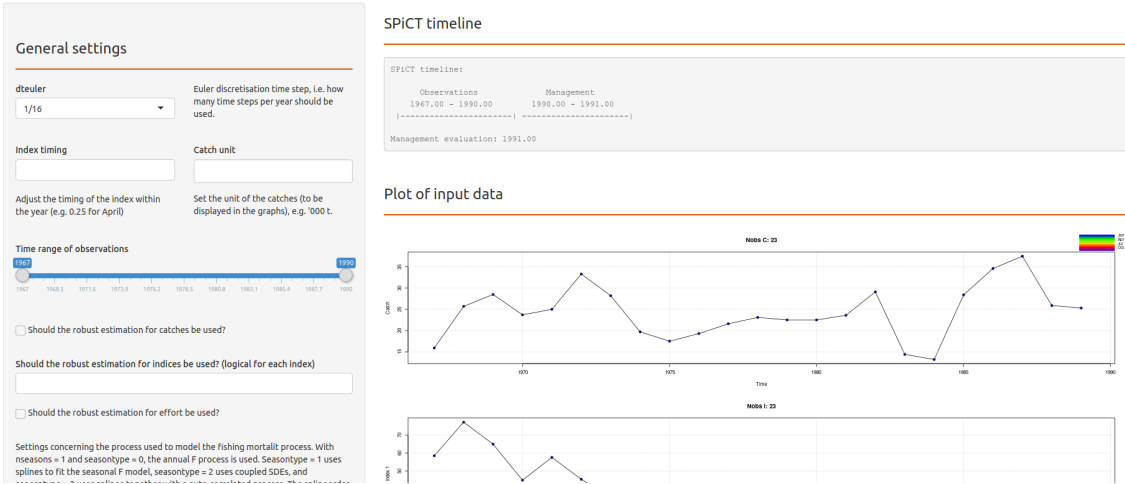


Figure 7: Explore and modify SPiCT input data, part I.

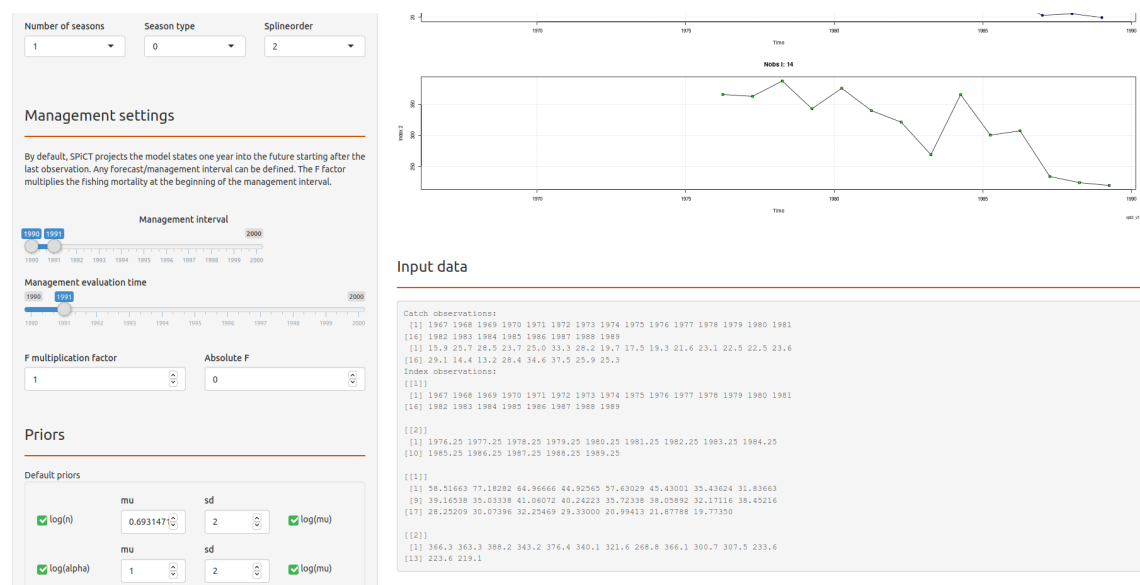


Figure 8: Explore and modify SPiCT input data, part II.

quantities, such as the carrying capacity ( $\log(K)$ ) or the stock productivity ( $\log(m)$ ). However, caution has to be applied when specifying additional priors as they affect model estimates and uncertainties and can greatly affect estimated stock status.

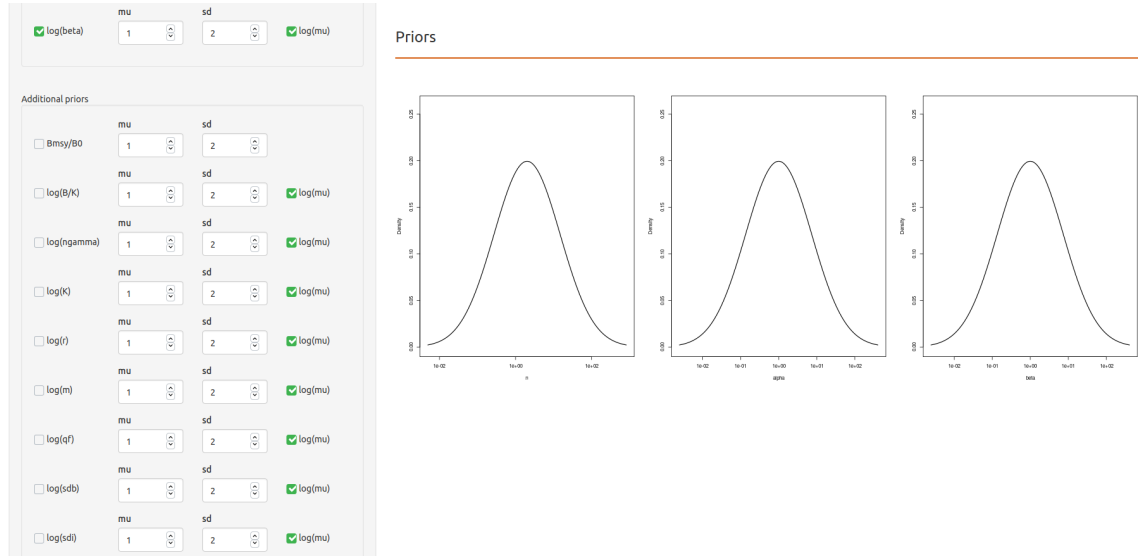


Figure 9: Explore and modify SPiCT input data, part III.

Instead of the standard SPiCT data plot, a more advanced version can be displayed with the option ‘Plot the advanced data plot?’ (at the bottom of the sidepanel on the lefthand side; not shown in the screenshots).

## Fit SPiCT

After data has been uploaded and was modified according to meet the assumptions of the model, SPiCT can be fitted to the input data by clicking on the ‘Fit SPiCT’ button (Fig. 10). A notification in the lower right corner of the browser informs you the model is being fitted, which can take some time dependent on the number of data points in the input data. After completion, a message will indicate if the model converged and the 4 main SPiCT graphs are shown (Fig. 10). Note, that the model results should not be used if the model did not reach convergence. There are a number potential reasons why the model did not reach convergence and steps that can be taken subsequently (see the [SPiCT Handbook](#)).

Additionally, the summary of the SPiCT fit is shown and the graphs with the absolute biomass and fishing mortality states as well as the production curve and either the seasonal F plot or a plot with time to recovery at the bottom of the page. The seed value allows to generate reproducible results. The optimiser settings do not need to be changed in the most cases.

## Diagnostics

Evaluating the diagnostics of a model fit is as important as the fit itself. The ‘Diagnostics’ tab allows to compare the posterior and prior distributions (if priors were specified; Fig. 12).

Furthermore, it shows a range of model diagnostics, such as normality of residuals (Fig. 13).

Fit SPiCT

For more information about SPiCT, please refer to the SPiCT handbook (link), the SPiCT guidelines (link) or the peer-reviewed SPiCT publications (link) and (link).

Fit SPiCT

Reset

Estimation settings

Seed value

1234

Set a seed value for reproducible results.

Optimiser

nlminb

optim method

BFGS

Optimiser control - iter.max

10000

Optimiser control - eval.max

10000

Model convergence

Model converged.

Main SPiCT plots

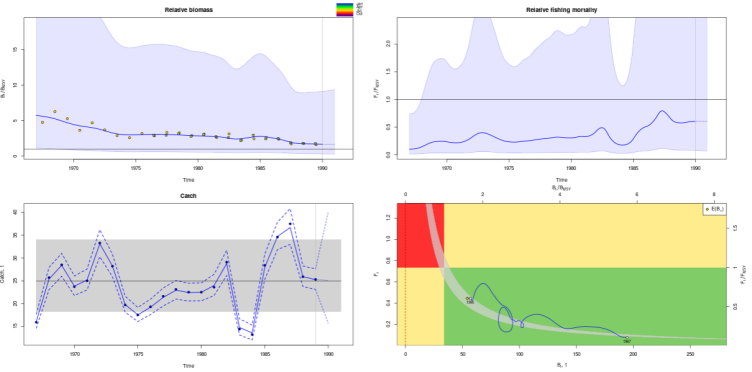


Figure 10: Fit SPiCT.

Priors

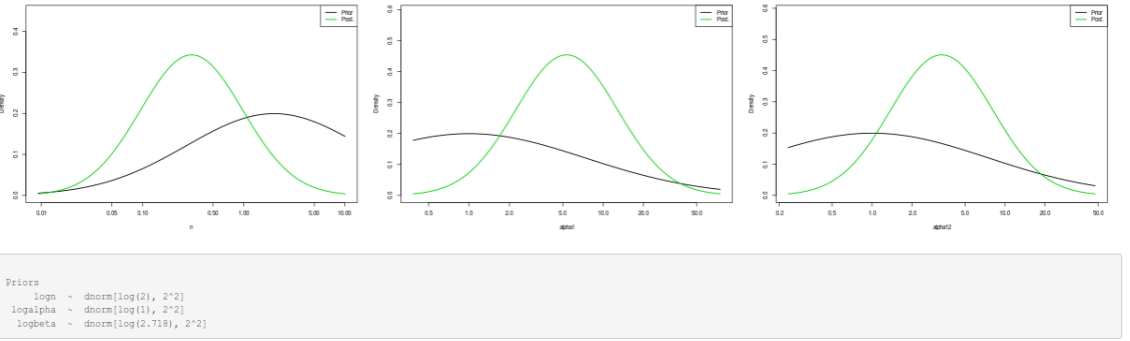


Figure 11: Priors.



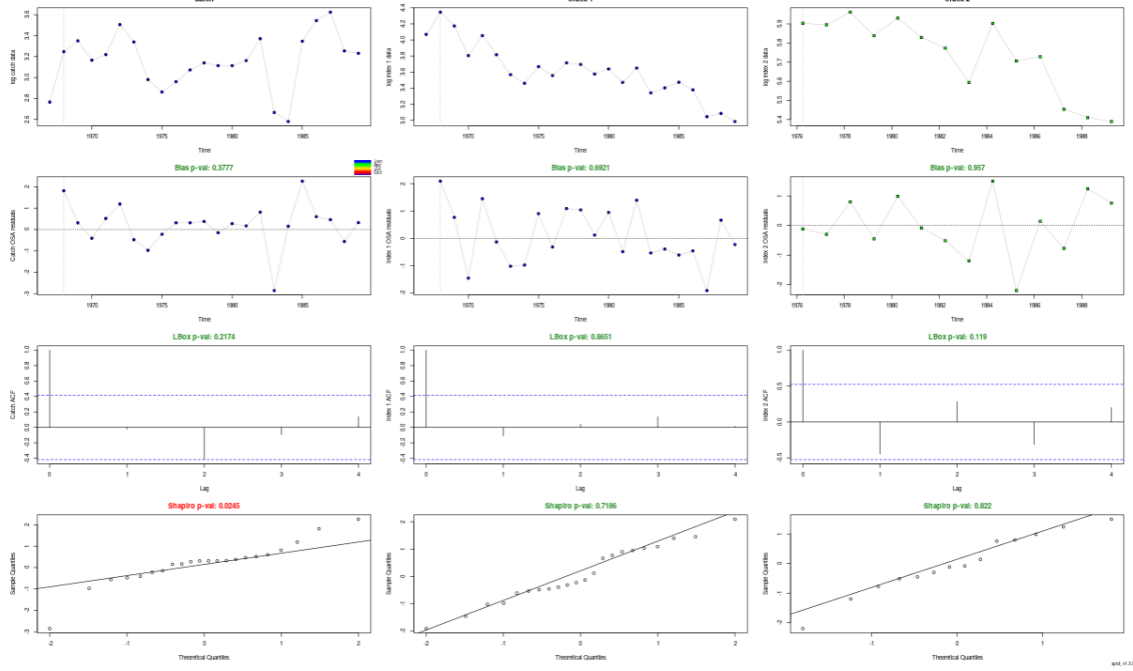


Figure 12: Diagnostics.

And allows to perform a retrospective and sensitivity analysis to initial values (Fig. 14).

The results of the retrospective and sensitivity analysis to initial values are shown under model diagnostics after completion (plot not shown here).

## Management scenarios

The implications of different management strategies on the predicted catch and states can be explored by applying different management scenarios. Any number of the 8 default management scenarios can be chosen:

1. **currentCatch**: Keep the catch of the current year (i.e. the last observed catch).
2. **currentF**: Keep the  $F$  of the current year.
3. **Fmsy**: Fish at  $F_{msy}$  i.e.  $F = F_{msy}$ .
4. **noF**: No fishing, reduce to 1% of current  $F$ .
5. **reduceF25**: Reduce  $F$  by 25%.
6. **increaseF25**: Increase  $F$  by 25%.
7. **msyHockeyStick**: Use ICES MSY hockey-stick advice rule [msycat34].
8. **ices**: Use ICES MSY 35th hockey-stick advice rule [wklifeix].

By default the scenarios 'currentCatch' and 'Fmsy' are chosen (Fig. 15). The management interval and management evaluation time can be adjusted. If an intermediate period is defined, the catch during the intermediate period can be defined. If undefined, the fishing mortality process is continued in the intermediate

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## Check model diagnostics

Checking the model diagnostics is one of the most important steps in fish stock assessment. Violated model assumptions can invalidate model results and conclusions.

### Retrospective analysis

Run retro

Reset

# years

5

Number of years to remove in the retrospective analysis. Make sure that enough years remain for the model fitting.

### Sensitivity analysis to initial values

Run check.ini

Reset

# trials

10

Number of trials for the sensitivity analysis.

Figure 13: Run retrospective and sensitivity analysis to initial values.

period. By default the median of the predicted catch distribution is used as the the total allowable catch (TAC), but any value can be chosen and the TAC will be re-calculated (Fig. 17).

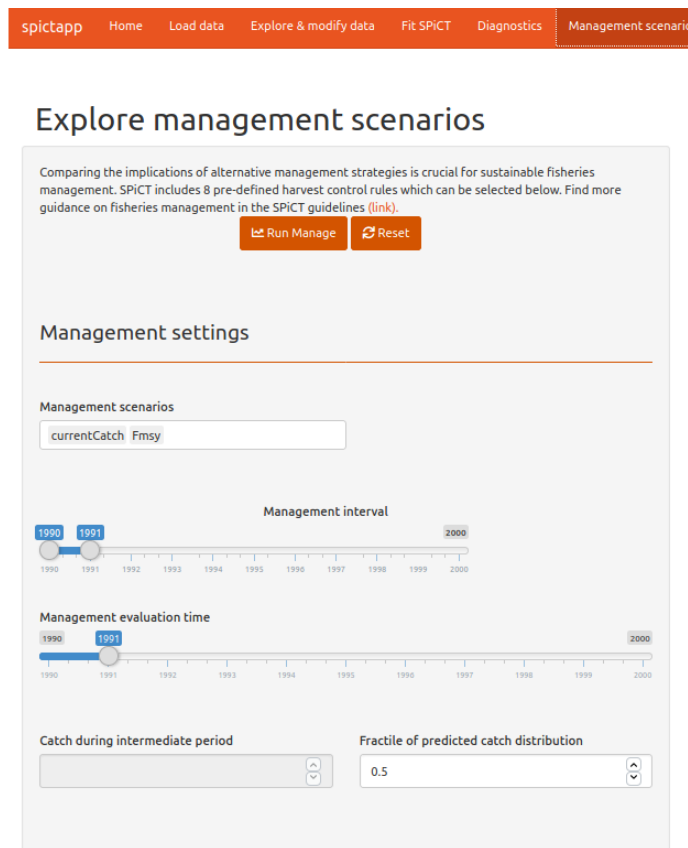


Figure 14: Run management scenarios.

The management plot shows the implications of the management scenarios on the relative biomass, fishing mortality, catches and kobe plot (Fig. 16). Note, that the lines corresponding to the different management strategies are only depicted in the kobe plot if the catch/effort data is not subannual.

Below the management plot the summary of the management scenarios as well as the TAC of each scenario is shown (Fig. 17).

## Summary

The ‘Summary’ tab summarises the results of all tabs and allows to download the results in form of a report (html file), a zip archive with the main results as tables, a zip archive with all figures, or the complete data used and produced in spictapp as a ‘RData’ file (Fig. 18). The RData file includes a list called ‘rv’ (for reactive values) that includes among others, the input data (`rv$inp`), the fitted object (`rv$fit`), as well as the retrospective and sensitivity analysis (`rv$retro` and `rv$sensi`, respectively) and the management results (`rv$mana`) if applied. It can be loaded in a R session by `load("spictapp_alldata_X_Y.RData")` where ‘X’ stands for the name of the data set and ‘Y’ for the date when it was downloaded. This data set allows to reproduce all steps of the spictapp in a plane R session using the spict package. The description of all individual elements of that list (`names(rv)`) would exceed the scope of this vignette.

## Management plot

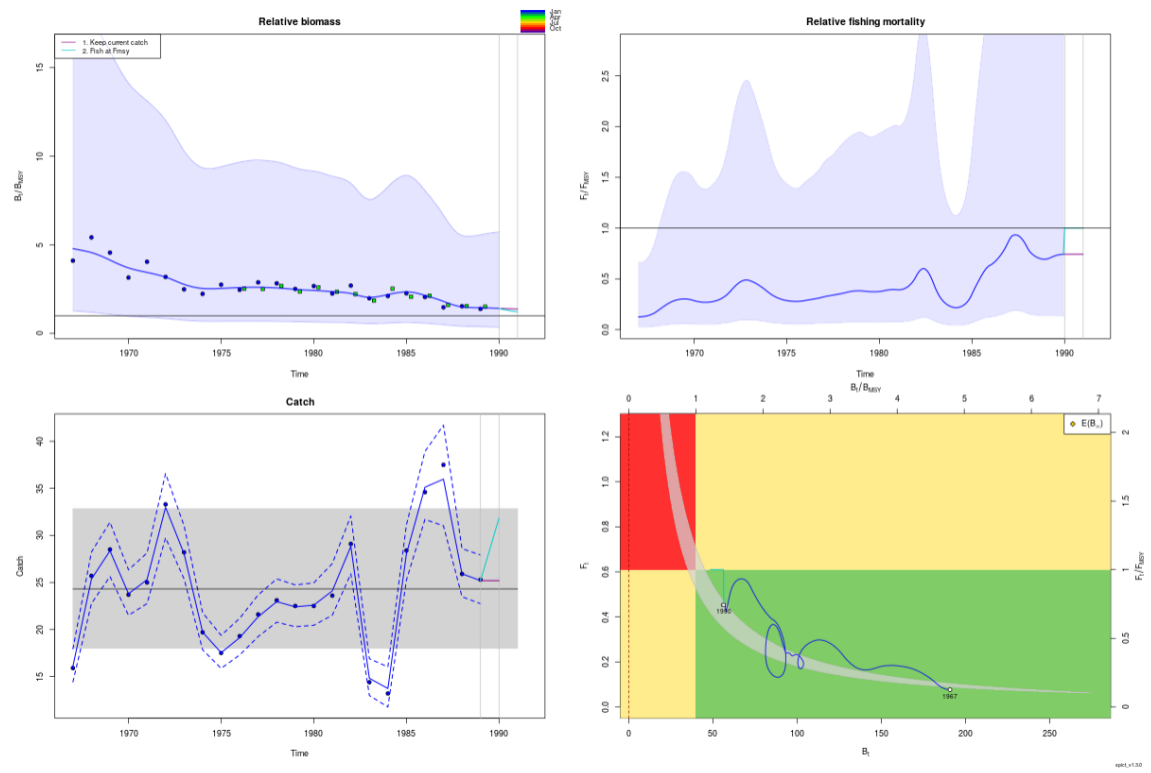


Figure 15: Plot of management scenarios.

Management summary

Selected scenario(s): currentCatch, Fmsy

No intermediate period to apply the intermediatePeriodCatch to. Change mantinerval if you want to specify a catch in the intermediate period.

SPiCT timeline:

Observations	Management
1967.00 - 1990.00	1990.00 - 1991.00

|-----|-----|

Management evaluation: 1991.00

Predictions

	C_1990.00	B_1991.00	F_1991.00	B_1991.00/Bmsy
1. Keep current catch	25.2	54.9	0.453	1.378
2. Fish at Fmsy	31.8	48.5	0.610	1.216
	F_1991.00/Fmsy	perc.dB	perc.dF	
1. Keep current catch	0.743	-2.4	0	
2. Fish at Fmsy	1.000	-13.9	0	

95% CIs of absolute predictions

	C_1990.00.lo	C_1990.00.hi	B_1991.00.lo	B_1991.00.hi
1. Keep current catch	22.8	27.9	34.9	86.3
2. Fish at Fmsy	20.5	49.4	27.4	85.9
	F_1991.00.lo	F_1991.00.hi		
1. Keep current catch	0.246	0.835		
2. Fish at Fmsy	0.237	1.566		

95% CIs of relative predictions

	B_1991.00/Bmsy.lo	B_1991.00/Bmsy.hi	F_1991.00/Fmsy.lo	
1. Keep current catch	0.318	5.969	0.126	
2. Fish at Fmsy	0.277	5.337	0.155	
	F_1991.00/Fmsy.hi			
1. Keep current catch	4.393			
2. Fish at Fmsy	6.452			

Total allowable catch (TAC)

\$currentCatch
[1] 25.197
\$Fmsy
[1] 31.835

Figure 16: Results of management scenarios.

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## Download assessment results

Generate an Rmarkdown-based assessment report summarising the results of the assessment of your data:

[Generate Assessment Report](#)

Download the assessment report:

Download all estimated parameters as a "csv" file:

[Download all tables](#)

Download all graphs as a pdf files in a "zip" archive:

[Download all graphs](#)

Download all data as a "RData" file:

[Download all data](#)

Figure 17: Download options.

## Other

The ‘References’ tab lists peer-reviewed articles about SPiCT and other documentation such as vignettes of the SPiCT package and this tutorial. The ‘About’ tab lists the version number of the app, instructions on how to download and start the app, information on how to report bugs or issues, ask questions or follow the development of the packages. ‘Quit’ closes the connection to the app and the browser window (except on firefox  $\geq 46.0.1$ ).

## References