Kobe Plotting

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Contents

1 Introduction

Scientific Advice within the tuna Regional Fisheries Management Organisations (tRFMOs) is based on a common framework (ref). The advice requires estimation of the probabilities of $F < F_{MSY}$ and $B > B_{MSY}$ for a range of management options, generally a range of total allowable catchs (TAC). Advice is presented as

- a phase plot showing fishng mortality and stock status relevant to management reference points

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[*] ICCAT

- a pie chart summarising current stock status; and
- a Kobe strategy matrix which summarises the probability of achieving management targets for different management options over time.

This requires, a stock assessment, estimates of reference points and projections In this document we show how R can be used to summarise stock assessment results in the Kobe II format using the R package kobe.

The package can be loaded with the command:

2 Input Data

The package requires a data.frame with columns for stock and fishing mortality relative and columns describing any scenarios. Data can be read in from different stock assessment outputs using methods in other FLR packages; see the section on Stock Assessment Packages for examples.

The basic data needed are time series of F/F_{MSY} and SSB/B_{MSY} (or some other benchmark such as $F_{0.1}$) for historic and projections. These need to include estimates of uncertainty, e.g. produced by bootstrapping an assessment or running Monte Carlo Markov Chain simulations. An example data set is

3 Stock Trends

4 Phase plot

5 Probabilities

6 K2SM

7 Assessment Packages

```
> library(kobe)
> library(ggplot2)
> library(plyr)
> library(reshape)
> ## example data sets
> data(sims)
> ggplot(assmt)   +
+   geom_hline(aes(yintercept=1),col="red",size=2)  +
+   geom_line( aes(year,stock,group=iter,col=iter))
```
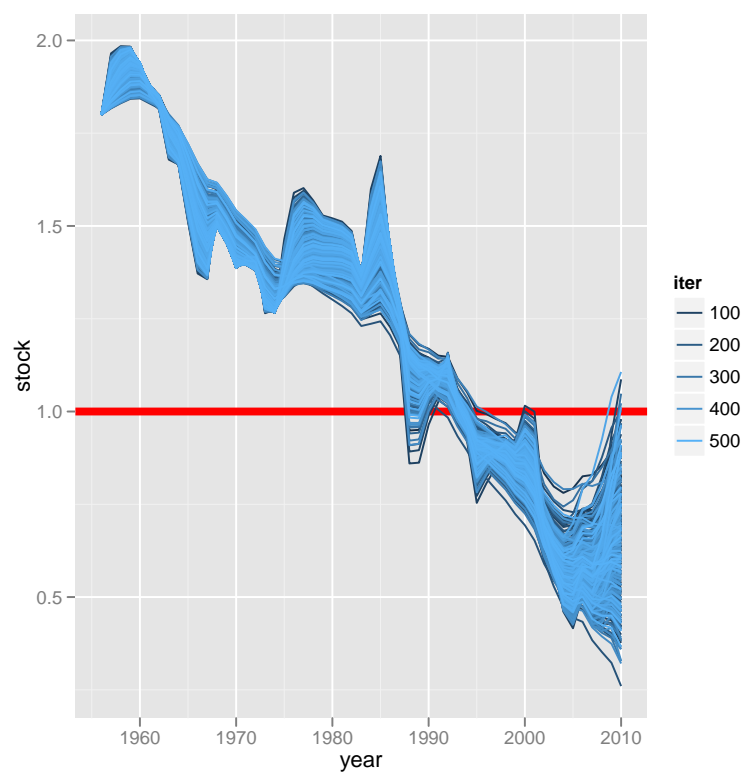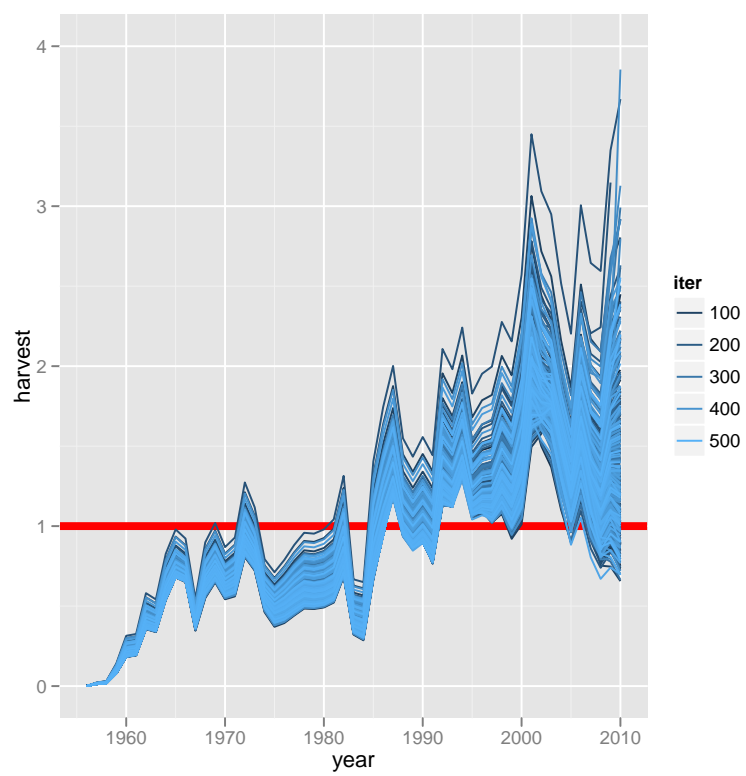
Figure 1: Time series of SSB
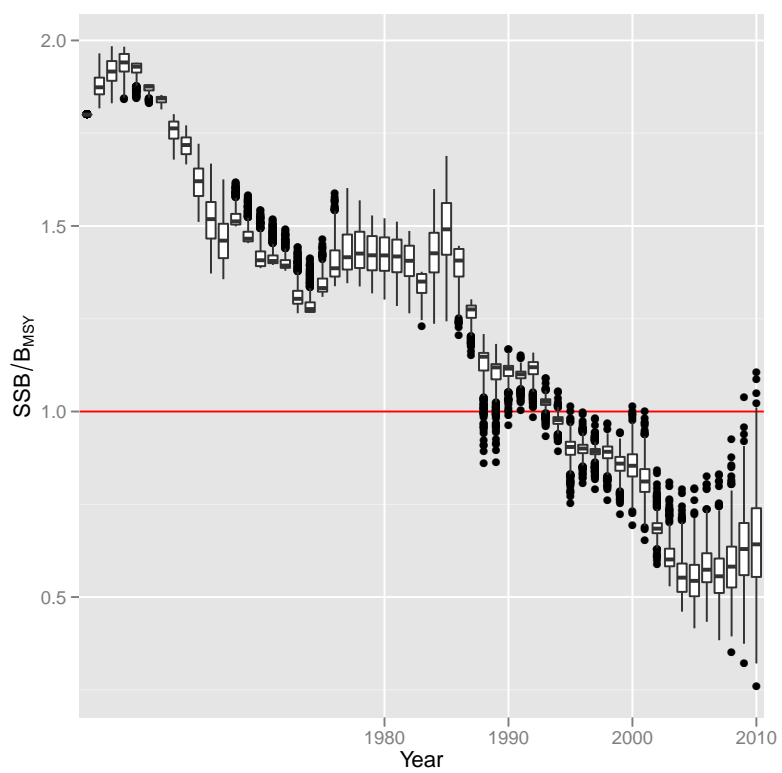
Figure 2: Time series of SSB

Figure 3: Time series of SSB

8   Implementation

The plots are implement using three methods,

The data and code used in this document is in the package `kobe` , which first need to be loaded e.g.

kobe.ts contains a time series of ssb relatuve to B_{MSY} and F relative to F_{MSY} for a historical time series and a projected time series for a range of TACs by iteration. There is a method kobe that produces the kobe phase, a function that generates the K2SM and a utility function kobeP.

To summarise these data the medians of ssb and havest are calculated, since the data are by iteration

as seen by plotting the data

The trends in SSB and fishing mortality can also be plotted

Kobe Advice Framework

The Kobe Advice Framework is based on the Kobe Phase Plot and the Kobe II Strategy Matrix (K2SM). The phase plot plots F relative to F_{MSY} against SSB relative to B_{MSY}

The four quadrants correspond to

The management objective is to recover the stock and reduce fishing mortality so that the stock is in the green quadrant. Therefore projections are performed to evaluate the consequences of different TACs e.g. by plotting the median trajectories

This plot does not include the full uncertainty, i.e. the probability of being in the green quadrant for a given TAC in any year. The function kobeP caculates the various probabilities e.g.

In addition

or a matrix

The probabilities can also be plotted as pie charts e.g. if the Commission have a agreed a TAC of x then the expected probabilities over time are given by

Extended Examples

In this section show how the basic plots can be enhanced and further analyses conducted.

Mariginal Densities

Contouring

Combined Plots

Alternative K2SMs

FLR

In this section we show the flexibility when assessment methods are implemented as R packages and provide examples of how to using existing assessment packages to provide Kobe advice and

If an assessment model is implemented in R then the inputs and results can easily be processed by R packages, functions and scripts. However most stock assessment software relies upon text files for data input therefore many packages now provide R packages to help read these text files into R. Once a data.frame is available then the examples in the previous section can be used. We then provide some examples of how the code can be extended.

Executables

ASPIC

ASPIC

VPA2Box

SS3

Multifan-CL

Further Examples

References

Appendix

1. In support of the SCRS scientific advice, the Executive Summaries within the SCRS annual report which present the results of the stock assessment

results should include, when possible:

i) A statement characterizing the robustness of methods applied to assess stock status and to develop the scientific advice. This statement should focus on modeling approaches and on assumptions.

ii) Three Kobe matrices, in accordance with the format set out in Annex Table 2:

    (a) A Kobe II strategy matrix indicating the probability of B>B_{MSY} for different levels of catch across multiple years.

    (b) A Kobe II strategy matrix indicating the probability of F<F_{MSY} for different levels of catch across multiple years.

    (c) A Kobe II strategy matrix indicating the probability of B>B_{MSY} and F<F_{MSY} for different levels of catch across multiple years.

    (d) Kobe II strategy matrices to be prepared by the SCRS should highlight in a similar format as shown in Annex Table 2 a progression of probabilities over 50 % and in the range of 50-59 %, 60-69 %, 70-79 %, 80-89 % and ??? 90 %.

    (e) When the Commission agrees on acceptable probability levels on a stock by stock basis and communicates them to the SCRS, the SCRS should prepare and include, in the annual report, the Kobe II strategy matrices using color coding corresponding to these thresholds.

iii) A statement concerning the reliability of long term projections period.

iv) A Kobe plot chart showing

    (a) management reference points expressed as FCURRENT on F_{MSY} (or a proxy) and as BCURRENT on B_{MSY} (or a proxy);

    (b) the estimated uncertainty around current stock status estimates;

    (c) the stock status trajectory. in accordance with the format set out in Annex Figure 1.

v) A pie chart summarizing the stock status showing the proportion of model outputs that are within the green quadrant of the Kobe plot chart (not overfished, no overfishing), the yellow quadrant (overfished or overfishing), and the red quadrant (overfished and overfishing), in accordance with the format set out in Annex Figure 2.

vi) An indication of the modeling approaches used by the SCRS to conduct the stock assessment shall be included in the caption and in the

corresponding text accompanying the introduction of the matrices and the charts.

vii) Statements, where needed, reflecting the different opinions expressed regarding the SCRS scientific advice during the endorsement process.

2. The Kobe plot chart described in paragraph 1 should reflect the uncertainties on the estimates of the relative Biomass (BCURRENT on B_{MSY}??or its proxy) and of the relative fishing mortality (FCURRENT on F_{MSY} or its proxy), provided that statistical methods to do so have been agreed upon by SCRS and that sufficient data exist to do so.

3. The SCRS should review recommendations and templates for the Kobe II strategy matrices, plot and pie charts as laid down in this resolution and should advise the Commission on possible improvements.

4. If the Commission adopts alternative reference points, such as limit reference points associated to the precautionary approach, the SCRS should also provide in its annual report versions of the elements described in paragraphs 1 and 2 calculated with respect to these alternative reference points and following the format specified in the same paragraphs.

5. The SCRS should indicate in its annual report those cases where the modeling approaches used during the assessment and/or data limitation did not allow for the preparation of the elements mentioned above.

6. The Kobe II strategy matrices are intended to reflect the scientists understanding of the uncertainties associated with their model estimates. Therefore, where models and/or data are insufficient to quantify those uncertainties, the SCRS should consider alternative means of representing them in ways that are useful to the Commission.

7. When, due to data limitations, the SCRS is unable to develop Kobe II strategy matrices and associated charts or other estimates of current status relative to benchmarks, the SCRS should develop its scientific advice on fisheries indicators in the context of Harvest Control Rules, if previously agreed upon by the Commission.

8. The SCRS should also include in its annual report any other tables and/or graphics that it considers useful to provide advice to the Commission.

9. The Commission encourages the SCRS to also include in the detailed reports, where possible, the following additional elements:

   i) a scoring table addressing data completeness and quality with the format set out in Annex Table 1;

ii) information on the by-catches of the different fleet segments and fisheries, as well as other ecosystems considerations.