About the SS3 VRE

The SS3 VRE is a tool that hosts codes necessary to run the Stock Synthesis version 3 (SS3) stock assessment model (a widely-used statistical catch-at-age model), parallelize, visualize and store the standardized data outputs, make projections, and automate the reporting. Stock assessment software are complex and advanced technical skills are required to develop the models. Producing output becomes time-intensive and even more complex as thousands of simulations must be run on supercomputers in order to include the multiple sources of uncertainty in assessment results. As few stock assessment participants have the specific technical skills required to reproduce these outputs, IRD, IFREMER, the IOTC and FAO have partnered with the H2020 BlueBridge project to develop a simple online tool in the form of a VRE to facilitate the use of SS3 to users with varying levels of expertise. The VRE enables any user to easily parameterize, execute and edit online various steps of the stock assessment work flow. It provides several collaborative web services, including: (i) a workspace to share documents or data, (ii) an RStudio server to process data online, and (iii) an automated reporting service to dynamically generate documents to package the results.

Currently, the SS3 VRE has replicated and made available the results of past stock assessments of swordfish (SWO, *Xiphias gladius*), bigeye tuna (BET; *Thunnus obesus*), and yellowfin tuna (YFT; *Thunnus albacares*), provided by the IOTC and their consultants. Theoretically, any species model can be similarly replicated.

Background :

Several different types of stock assessment models are used to provide scientific advice to managers about exploited populations. Stock Synthesis 3 (SS3) is a statistical catch-at-age model that is used widely (Methot and Wetzel, 2013), including assessments for several stocks under the management of the Indian Ocean Tuna Commission (IOTC). SS3 is flexible in terms of data inputs and complexity, making it possible to run with data-poor stocks. It can use a diverse array of fishery and survey data, including both age and size structure of the population.

SS3 is based on ADMB C++ software that maximizes the goodness-of-fit of a set of parameter values, and then calculates the variance of these parameters using inverse Hessian and MCMC methods. This software is complex and advanced technical skills are required to develop the models. As such, the developers of SS3 have provided a Graphical User Interface (GUI) to aid in the set up and parameterization of complex assessment models (Methot, 2017). However, the production of outputs can still be time-intensive and complex when thousands of simulations are needed to include the multiple sources of uncertainty in the assessment results. Interactions with the results also necessitate skilled language programming.

As few stock assessment participants have the specific technical skills required to reproduce these outputs, we developed this VRE to facilitate the parameterization, parallelization, and execution of various steps and the visualization of the results of SS3 to users with varying levels of expertise. We follow a similar approach as Imzilen et al. (2016), who developed a VRE based on Virtual Population Analysis of the eastern stock of Atlantic bluefin tuna (BFT-E; *Thunnus thynnus*) used in the stock assessment work flow of the International Commission for the Conservation of Atlantic Tunas.

Benefits :

A collaborative environment such as the VRE uses simple tools to enable the storage and access of the data and source codes necessary to replicate past results or to try new parameterizations of the model. Increasing access to this complex model will bring more transparency and collaboration within working groups by providing “non-modelers” with a possibility to test hypotheses for the stock assessment. This will also increase the number of users of various levels of expertise: from experts, to managers, to even wider audiences with the potential applications of these tools to serious games. Technical performance, document production, and harmonization of content will also be enhanced.

Target users and terms of use :

Target users are scientists / experts, NGOs, managers, and policy makers involved with stock assessment. Currently, SS3 is available to researchers with an NOAA VLab account. We have confirmed that it is acceptable to the developers and maintainers of SS3 that we make the software available to users in the format of the VRE. All users would require an account to access the VRE. The registration to the SS3 VRE is open to anybody but moderated by the VRE manager. Click on "Request Access". The VRE manager will receive your request and evaluate whether to grant you access.

Scenarios of use :

We tested the run times of several stock assessment models, provided by the IOTC and their consultants, including SWO, BET, and YFT. On the Bluebridge infrastructure Rstudio online, these models take between 1.5-20 minutes. Based on these run times, we identified various scenarios of use, and calculated the CPU resources they require (Table 1).

Table 1 : Scenarios of expected use of the VRE for the stock assessment, assuming ~20 minutes for one run.

ID	Summary	CPUs required:
Scenario 1	A consultant developing a model and running sensitivity analyses before the stock assessment (10,000 iterations). Results required within 1 day for a total of 3 days (i.e., allowing for 3 major modifications to the model).	(20*10000)/(3*24*60) = ~47 CPUs
Scenario 2	A consultant making modifications on the model during the stock assessment (1,000 iterations). Results required in 1 hour for 1 day of the meeting.	(20*1000)/60 = ~334 CPUs
Scenario 3	Meeting participants individually exploring parameters	
Scenario 3a	One simulation per user, approximately 30 users. Available for the full duration of the meeting, e.g. 5 days.	30 CPUs available throughout meeting
Scenario 3b	Each user allowed 10 iterations. Results required immediately (i.e., duration of single run). Schedule could be specified for a period of time within a single day.	30*10 = 300 CPUs

Work flow :

We tested the feasibility of reproducing past IOTC SS3 stock assessment models of tropical tunas and billfish on the BlueBridge infrastructure. We repackage the SS3 codes so that they can be parametrized, executed and edited online from a simple web page, with standardized data outputs. The codes are being adapted to follow a similar approach as that of BFT-E with ICCAT.

By doing so, we expect to manage the workflow in different steps (available in WPS):

1) model results/retrospective analysis
2) visualizations (shiny) and selection of runs,
3) projections,
4) automated reports (pdf or html from Sharelatex / knitr /Rmarkdown, e.g., http://vps282167.ovh.net/ocpudev/cmsy_reports/#)

We encourage suggestions from the group on the parameters that are tested and changed most frequently during working groups, and the specific outputs that the group would like to visualize to investigate the model.

Keywords :

Stock Synthesis, SS3, large pelagics, tuna, billfish, reproducible science, collaboration

Main services and functionality :

Related presentations and reports :

- IOTC Working Party on Billfish (September 2017, AZTI, San Sebastian, Spain), IOTC-2017-WPB15-26.

References :

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