Rebuilder User Instructions for 2021

SS Forecast File

The first step in running the rebuilder is to set up the forecast.ss file from your base model to create the rebuild.dat file:

1 # Do West Coast gfish rebuilder output (0/1)

2023 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)

-1 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)

where this example requests SS to create a rebuild.dat file that sets up the rebuilding process to begin in 2023. After you have set-up the forecast file, rerun the model. A rebuild.dat file should now be created. The rebuild.dat file is the file that is passed to the rebuilder executable. Unfortunately, there are some minor modifications that are needed for the rebuild.dat file.

Rebuild Data File

The rebuilder manual can be located on the network and provides a definition for each line in the rebuild.dat file (\\nwcfile\FRAM\Assessments\Archives\2.Rebuilder\_Program\2021 Rebuilder\DOCUMENT.doc). There are some modifications that should be made to the rebuild.dat file prior to running the rebuilder executable. Walking down the rebuild.dat file here are the recommended changes in order:

1. Update the file name on line 2 to something meaningful (e.g., “quillback\_2021\_rebuild.dat”)
2. Maximum number of years – this value defines how low the rebuilder should forecast the population for rebuilding. The default value of 500 is higher than is needed for nearly all stocks. Reducing this number will speed up the running of the rebuilder. As example, yelloweye rockfish that have a maximum age of 100 years have set the maximum number of years to 200. There appears to be a minimum required value here (rebuilder failed to run when set to 100) – unsure what the lower bound is but know it runs with a value of 200.
3. Fecundity-at-age - The rebuilder requires that the value for age 0 be equal to 0. If your fecundity-at-age vector has a non-zero value for age 0, set to 0.
4. Year for Tmin Age-structure – This should be set to the current year (e.g., 2021) if current assessment initiates a rebuilding plan
   1. The entry above Tmin Age-structure (which is Age-structure at Ydec) may be from a different year (e.g. 2023). Match the age structure from the year entered for ‘Year for Tmin Age-structure’
5. Number of years with pre-specified catches – since management has already adopted harvest limits for the assessment year and the following year these total removals will need to be specified here. Change the 0 to a 2 to indicate two years with pre-specified catches.
6. Catches for years with pre-specified catches – a matrix of years and total removals (not removals by fleet) should be entered here where the rows should equal the number of years with pre-specified catches. These catches need to be in weight.
   * 1. Example:

2017 20

2018 20

1. Number of future recruitments to override – this should only be used if you are updating an existing rebuilding plan. The default value of -2 here should be changed to 0 for new rebuilding analyses.
2. Projection Type – this value should be set to 1 or 11. A value of 1 will produce results that correspond to a vector of probabilities and option 11 has the user specify a vector of SPR values to look at. I am unsure what the “right” approach is but the petrale sole and yelloweye rockfish rebuilding plans both used option 11.
3. Additional lines need to be added directly after the “Definition of the 40-10 rule” entries. The following lines should be added but modified to reflect the values associated with your model:

*As of SS3 version 3.30.19, these lines are* [*now included*](https://github.com/nmfs-stock-synthesis/stock-synthesis/issues/232) *within rebuild.dat and dont need to be added.*

#Definition of the control rule

10 40

**# Sigma Assessment Error (Base, Year1, Slope, MaxSigma)**

**0.5 2022 0.075 2.0**

**# Pstar**

**0.45**

**# Constrain catches by the ABC (1=yes; 2=no)**

**1**

**# Implementation Error (0=no; 1=lognormal; 2=uniform)**

**0**

**# Parameters of Implementation Error**

**1 0.3**

# Calculate coefficients of variation (1=yes)

0

1. Catches and Fs – if you have fixed catches set in this file above the Catches and Fs starting year needs to be set to the first year without fixed input removals.
2. There are additional input lines that need to be added:

*As of SS3 version 3.30.19, these lines are* [*now included*](https://github.com/nmfs-stock-synthesis/stock-synthesis/issues/232) *within rebuild.dat and dont need to be added.*

# Fixed catch project (1=Yes); Output replaced (1->9); Approach (-1=Read in else 1-9)

0 2 -1

**# (48a) Special catch options [switch (1 = Yes, 0 = No), Emsy, distribution, buffer, option to replace]**

**0 0.18 1.00 1.00 0 6**

**# (48b) B1Target**

**150000**

# Split of Fs (based on your model)

2021 0.310646

0.689354

-1 1 1 1

1. An additional line needs to be added for rebuild version 3.12j (December 2021) that controls the male/female sex ratio calculation for stock synthesis models with sex = -1. For models with sex = 1 or 2, set this to 1. Stock synthesis [currently doesn’t](https://github.com/nmfs-stock-synthesis/stock-synthesis/issues/512) automatically output this line to rebuild.dat

# Age specific selectivity and weight adjusted for discard and discard mortality

…..

**# Sex ratio correction**

**1**

# M and current age-structure in year Yinit: 2021

….

1. Yrs to define Ttarget for projection type – this vector should be set to correspond to the selected Projection Type. With a projection type of 1 this vector should be set to probabilities, example: 0.5 0.6 0.7 0.8 0.9. With a projection type of 11 this vector should be set to SPR values, example: 0.50 0.60 0.70 0.80 0.90.
2. Year of probability of recovery – this vector of 8 entries should be set to be based generally on the life history and the expected recovery time where values greater than Tmax should not be included (although when first running the rebuilder you do not know what Tmax will be). If you have an existing rebuilding analysis years of estimated rebuilding from the previous analysis should be included here. For a long-lived rockfish (e.g., ~maximum age of 100 years) the following vector provides a reasonable start for a rebuilding analysis starting in 2023 :
   1. 2030 2031 2041 2046 2051 2056 2061 2065

Running the Rebuilder

Move the modified rebuild.dat file to another folder that includes the rebuilder executable. In order to see error messages I suggest calling the executable using the command window (or the power shell) and running it from there. If there is an error reading the rebuild.dat file there will often be useful messages printed to the terminal window. Additionally, the echo.dat file will show you how the program reads your input file.

Reading RES.CSV

There are key places in the csv file where you will be able to find the key quantities of interest. The manual has information to assist users to find quantities within this file.

#Recovery\_Spec

* There are 10 unlabeled values in this section. The values in order are:

1. Zero catch rebuild time in numerical years (e.g., 11 years)

2. Allowable maximum time to rebuild in numerical years

3. Year the stock was declared overfished (true year)

4. First year of zero-catch projection (true year)

5. The first year of zero-catch projection minus year the stock was declared overfished minus

6. First year of the projection (true year)

7. First projection year (true year)

8. Number of years with pre-specified catches

9. Allowable maximum time to rebuild

10. First projection year plus the allowable maximum time to rebuild (true year) which should equal the year the stock is declared overfished plus the maximum time to rebuild

#Summary\_1

Multiple matrices of the probability of recovery by year, catch values by year, spawning biomass fraction relative to target, spawning biomass, ABC, SPR, probabilities of recovery, and catch by fleet corresponding to the probabilities.

#Summary\_2

* The second row of the matrix gives the SPR values that were used to correspond to the rebuilding probabilities.
* The rebuilding probability is provided in the fourth row.
* The years to rebuild for each probability is given on the sixth row. This value is given in total years (e.g. 24.6, not a specific year) and will need to be added to the first rebuilding year to determine the Ttarget. You can scroll back up to the summary 1 matrices to double check the number of years required to rebuild based on specific probabilities

#Summary\_3

Matrix of the probabilities (multiplied by 100) of recovery corresponding with the SPRs values from Summary 2 (row 2) for the input years requested in the rebuild.dat.

Incorporating Uncertainty

The rebuilder will incorporate future recruitment uncertainty if the input sigmaR value is greater than 0 in the rebuilder.dat file. However, one may want to incorporate additional uncertainty around a parameter/state of nature. This can be done by creating a binded rebuild\_uncertainty.sso file by pasting together the rebuild.sso file created from SS from each model run and depending upon how many times a state is included to the file reflects the weighting of that state of nature. For example, if one wants to incorporate uncertainty around steepness (or whatever decision table parameter) you would paste the model specific rebuild.sso into one single file. In this case typically one may want to assign the base model 50% weight with the low and high states being assigned 25% weight. To create the proper weighting you would paste the rebuild.sso from the base model twice into the combined file with the low and high state rebuild.sso files pasted once. This combined file can then be passed to the rebuild.dat file via the "# File with multiple parameter vectors " input. One may also want to consider the number of total simulation draws given the number of states. If a combined file is used, update lines in the rebuild.dat file “#Conduct projections with multiple starting values (0=No;else yes)” to be 1, and “# Number of parameter vectors” to reflect the number of times a rebuild.sso was pasted (e.g. 4 if the base model was pasted twice and the low and high states once).

Output Readers

There is a spreadsheet (SUMMARY.xls) with Macros that was intended to read and create output figures from the RES.CSV. Go to the main tab, and change the ‘directory’ and ‘file name’ to match your application. Hit the ‘clear output’ button (and save the data), and then the ‘basic graphs’ button. Another place for a useful example of interpreting and creating figures from the RES.CSV file can be found in the 2017 yelloweye rebuilding folders.

Additionally, I have a working function to pull quantities out of the RES.CSV file. This function is a work in progress (but worked for the 2021 and 2023 quillback applications) and can be found [here](https://github.com/chantelwetzel-noaa/copper_rockfish_2021/blob/master/code/get_values_rebuilder.R).

* Note however that this function uses the names “acl\_matrix” and “ofl\_matrix” for the Catch and ABC portions, respectively, of Summary\_1 from the RES.CSV file. Thus, if buffers are applied within the analysis, values from “ofl\_matrix” will need to be divided by these buffers to obtain the actual OFL values.

There is also a plotting code function available in [r4ss::DoProjectPlots](https://github.com/r4ss/r4ss/blob/main/R/RebuildPlot.R). This function has not been well maintained or developed across time and may not easily produce document ready figures without a bit of work. See the quillback rockfish [rebuilding script](https://github.com/brianlangseth-NOAA/quillback_rockfish_2021/blob/master/code/CA_rebuilding.R#L270) for document ready figures.

Random Tips

The calculation for mean generation time is provided in the Rebuilder Manual. Additionally, SS outputs the quantity in the GenTime column in the SPR\_series section where it is calculated as the fecundity weighted mean age.

If you use the SUMMARY.xls macros to generate rebuilder output, the excel sheet **cannot** be renamed. It must be named SUMMARY for it to work.

Depending on the application and the value for “Projection type”, some policies may not be attainable without setting “# Constrain catches by the ABC (1=yes; 2=no)” to 2. This was required to obtain some of the SPR = 0.5 and 0.55 policies for the 2021 and 2023 quillback rockfish analyses.

If buffers are to be applied, consider how they decay after many years. The values shown under step 9 above (“# Sigma Assessment Error (Base, Year1, Slope, MaxSigma”) cap the buffers at the category three buffer, which was the assumption for the 2021 and 2023 quillback rockfish analyses.