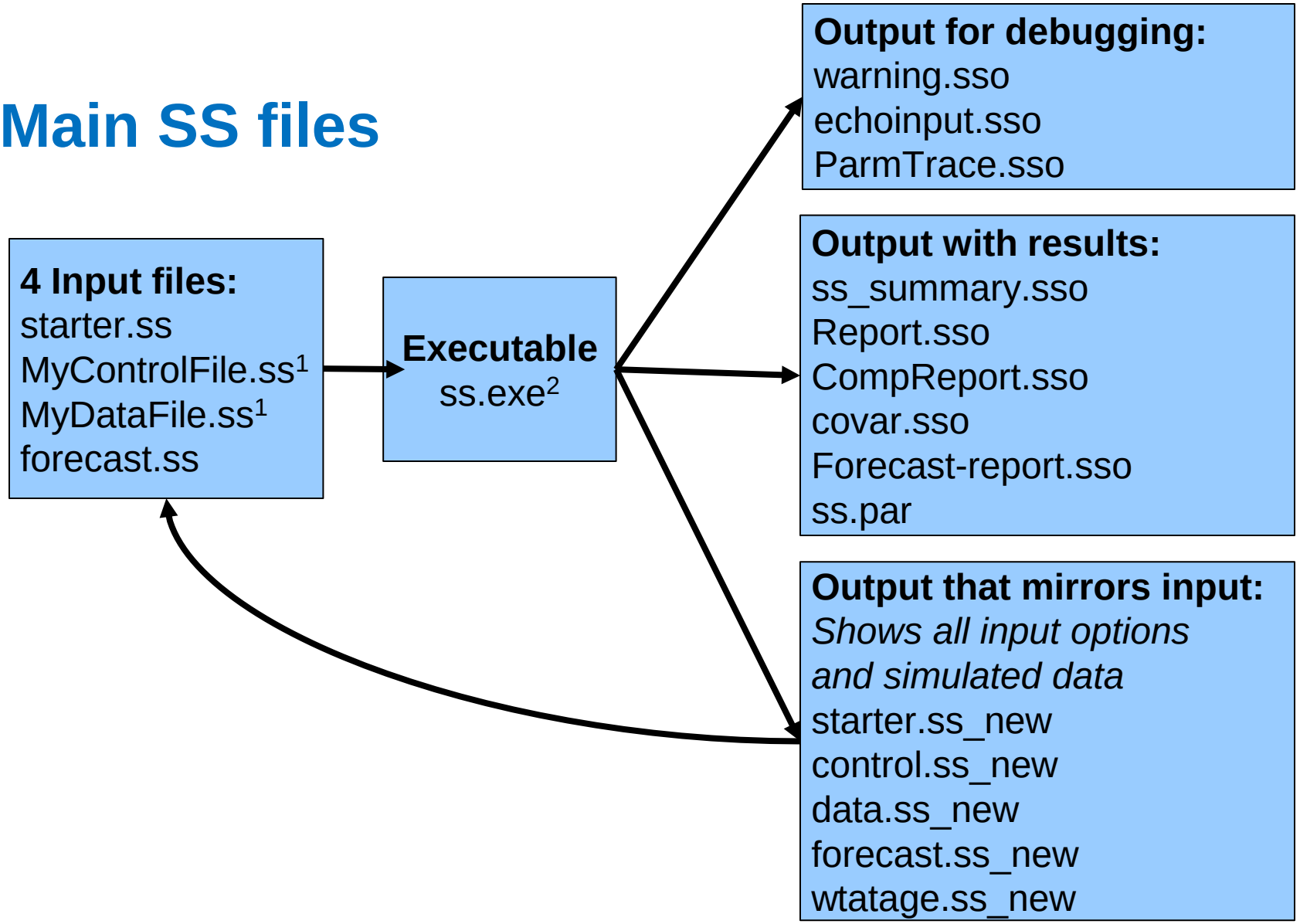
Getting Started with Stock Synthesis (SS)

How to use these slides

- This powerpoint is aimed at users who are new to SS and to running executables via the command line.
- This will cover several workflows for running existing SS models.
- A self-guided tutorial version of these slides is available from vlab: https://vlab.ncep.noaa.gov/web/stock-synthesis/document-library/-/document_library/0LmuycloZeIt/view_file/7137387

Background on SS

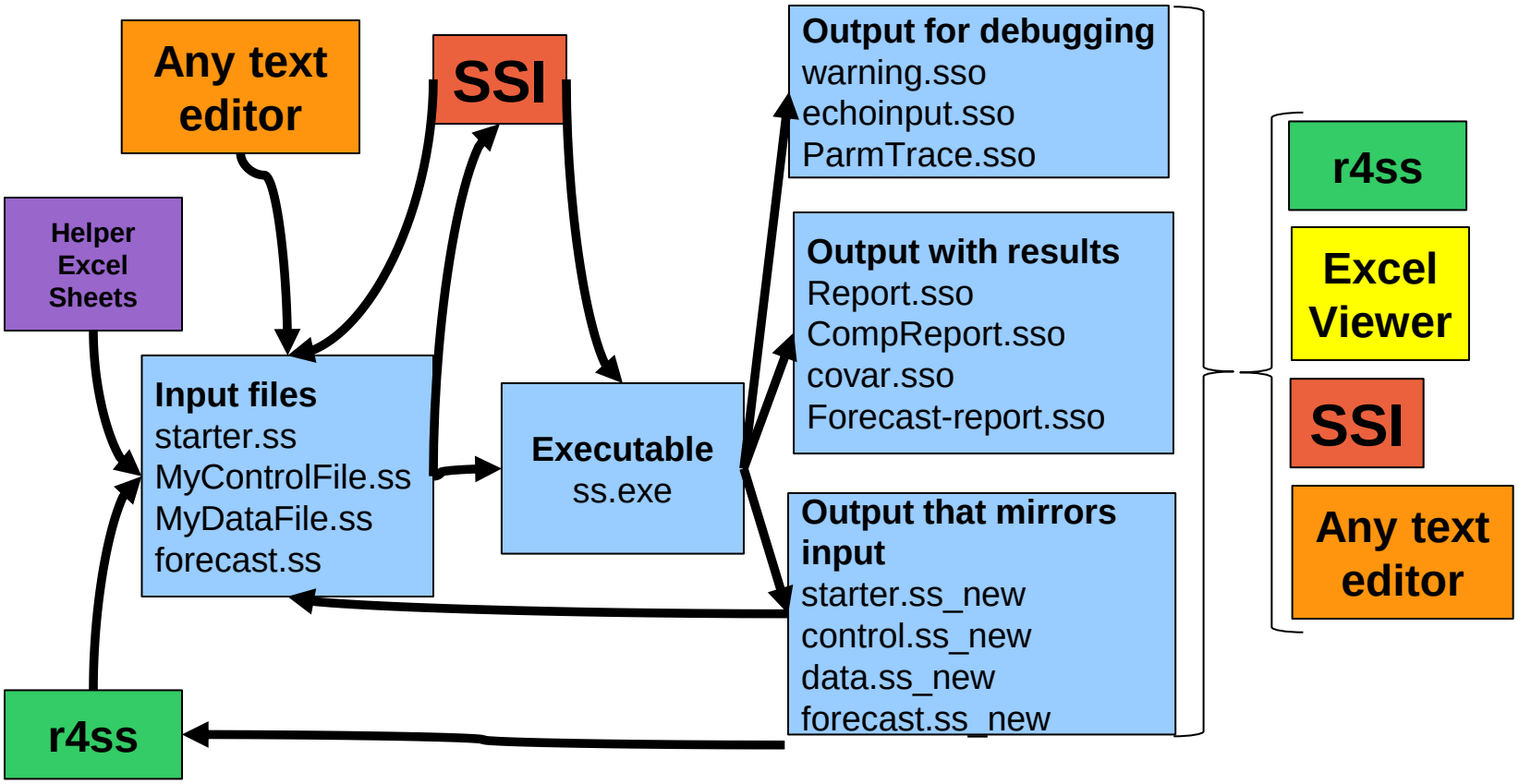
Main SS files



[1]*Can have any name, as long as specified in the starter file.*

[2]*The SS executable can have any name.*

Associated tools



Please see slide notes for definitions of some of these tools

The four input files read by ss.exe

1. **starter.ss:** Required file containing file names of the data file and the control file plus other run controls. Must be named starter.ss.
2. **Data file:** File containing model dimensions and the data. Can have any name, as specified in the starter file, but typically ends in .ss or .dat
3. **Control file:** File containing set-up for the parameters. Can have any name, as specified in the starter file, but typically ends in .ss or .ctl
4. **forecast.ss**: File containing specifications for reference points and forecasts. Must be named forecast.ss.

Two optional input files

1. **ss.par:** Text file with one line per parameter where order matters. Could be created from a previous model run. Read in ss.par to overwrite the initial parameter values in the control file (chose whether or not to read ss.par in starter.ss).
2. **wtatage.ss:** File containing empirical input of body weight by fleet and population and empirical fecundity-at-age (choose whether or not to read in a line of the control file)

Running SS

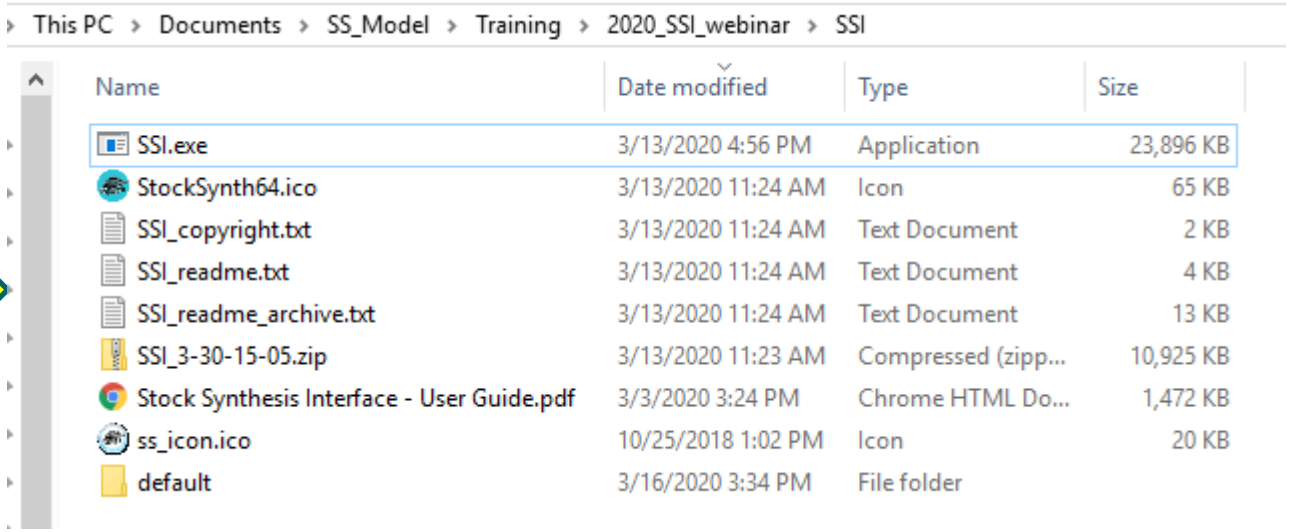
- Stock Synthesis Interface (SSI or the SS GUI) can be used to set up model files and run SS using the Stock Synthesis Interface. SSI and instructions for using it are available in the SS vlab document library's latest executables folder.
- SS typically runs in a command window
  - One folder approach
  - Two folder approach
  - PATH approach
- It is also possible to run SS via the command line from within R

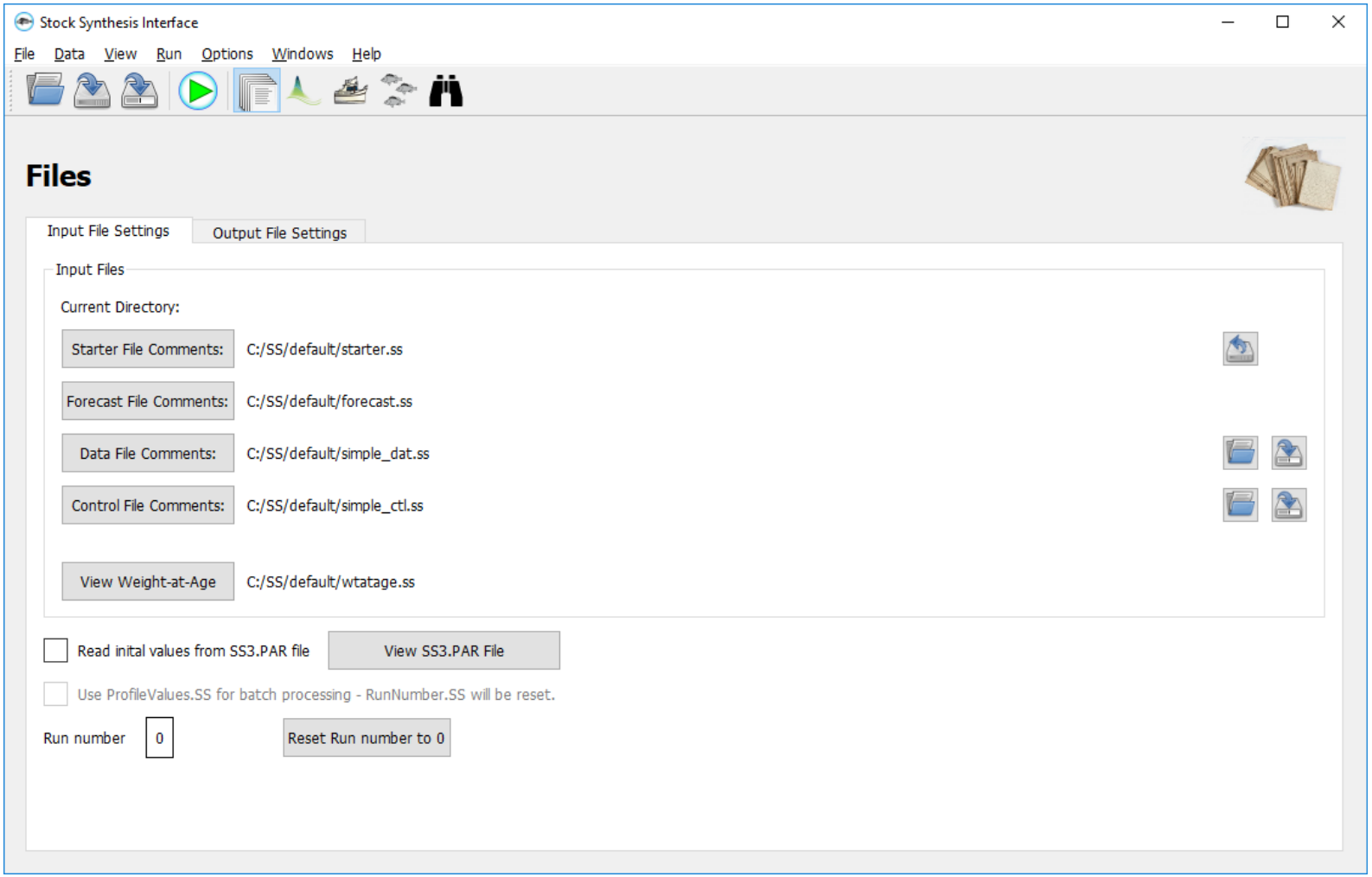
Using Stock Synthesis Interface (SSI) to load, modify, run, and plot SS3 models

Download and Unzip SSI

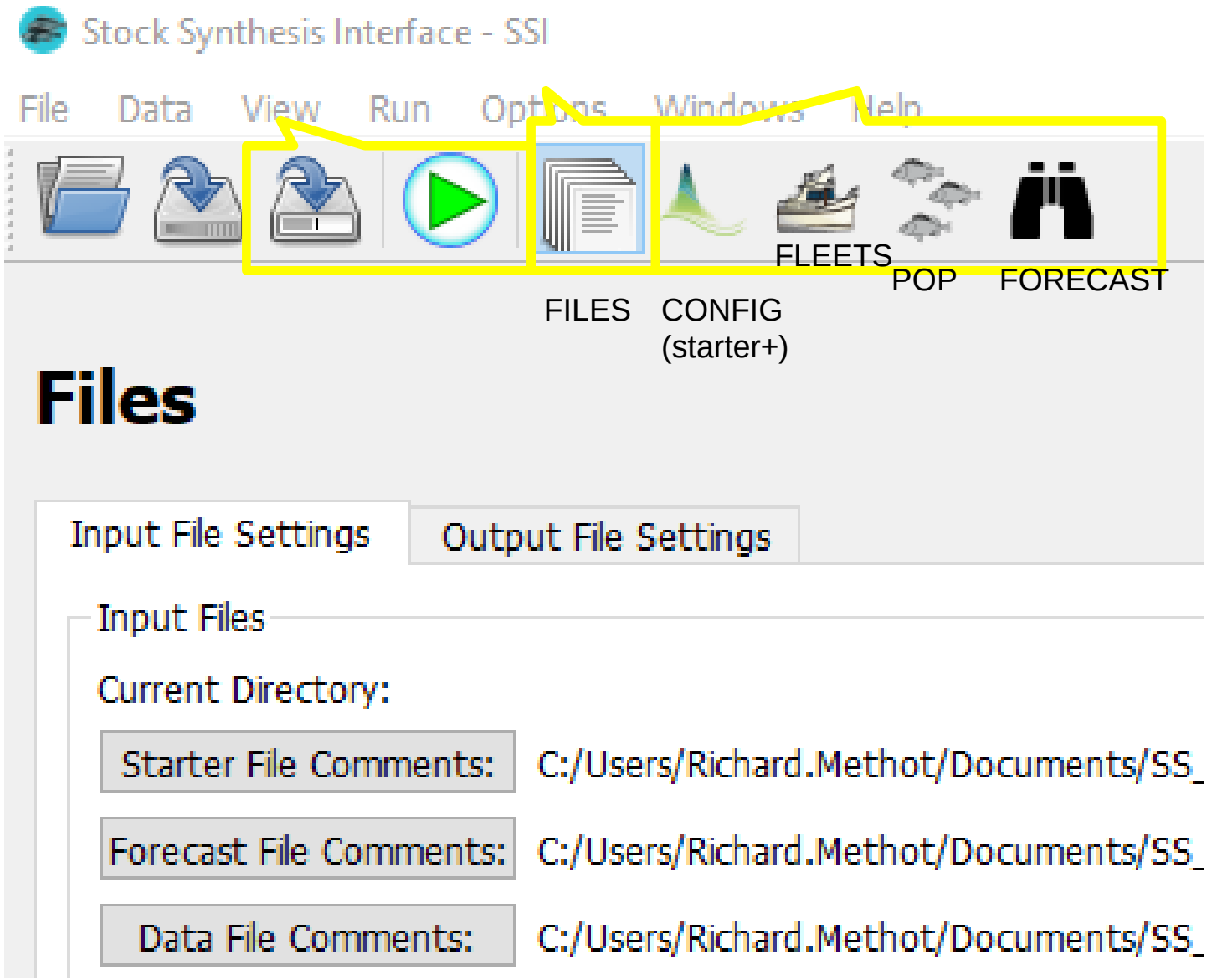
1. Single click on SSI.zip
2. Single click on download icon
3. Unzip to folder of your choice
4. File list shown here:

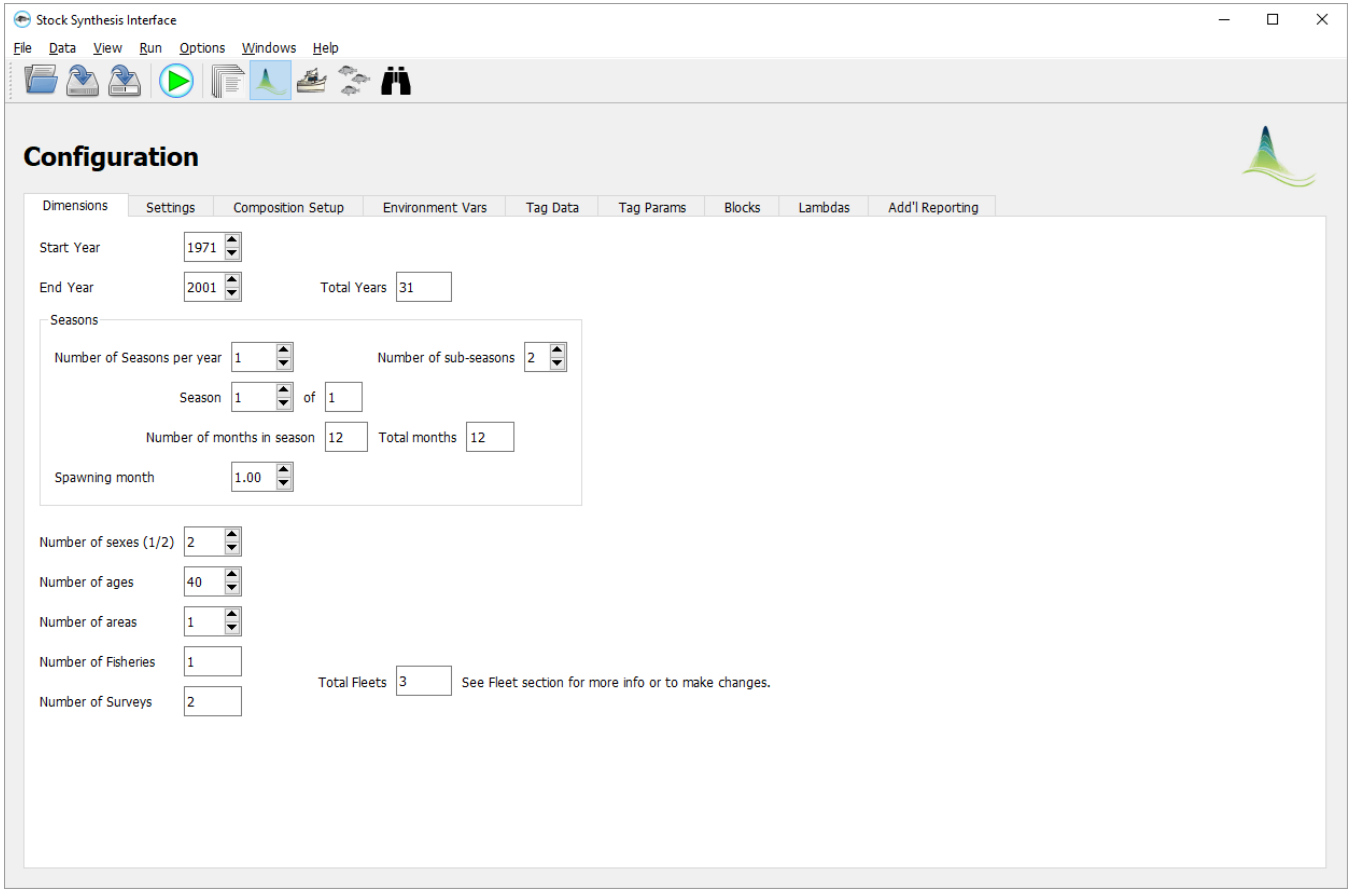
1. Then double-click on SSI.exe

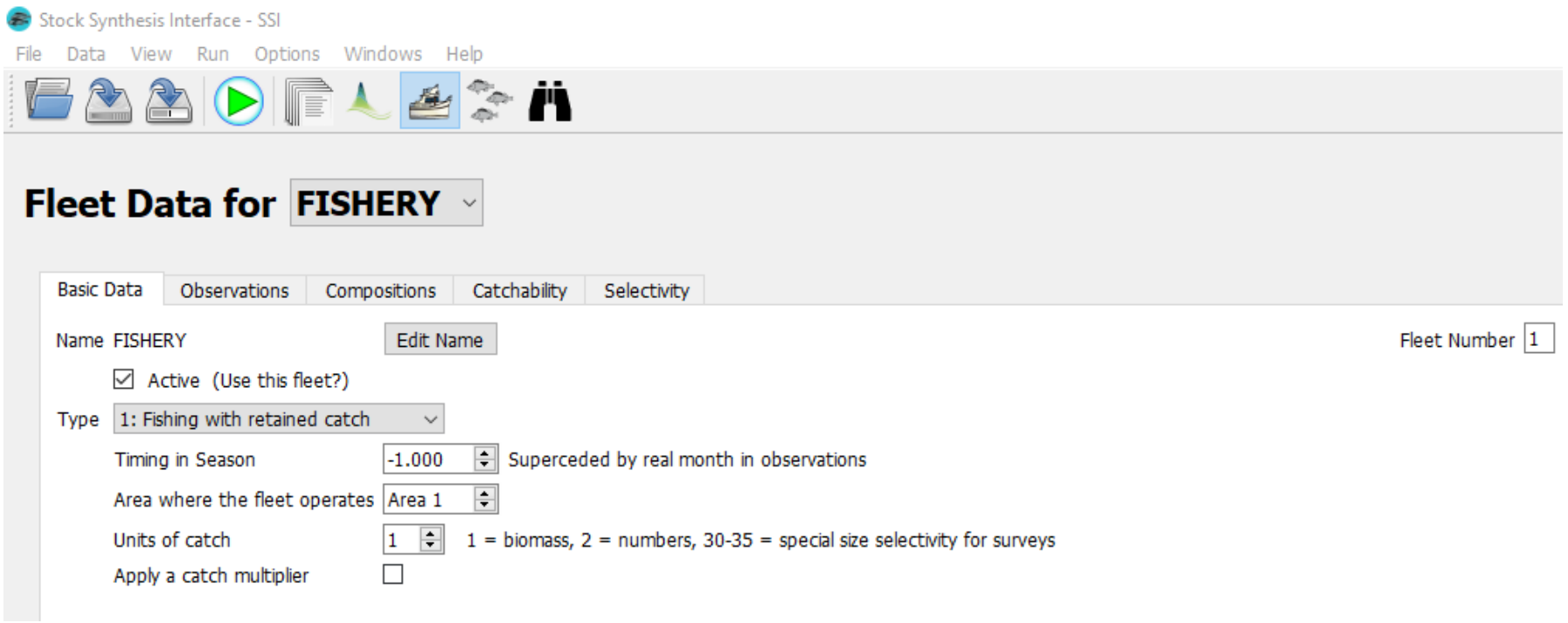


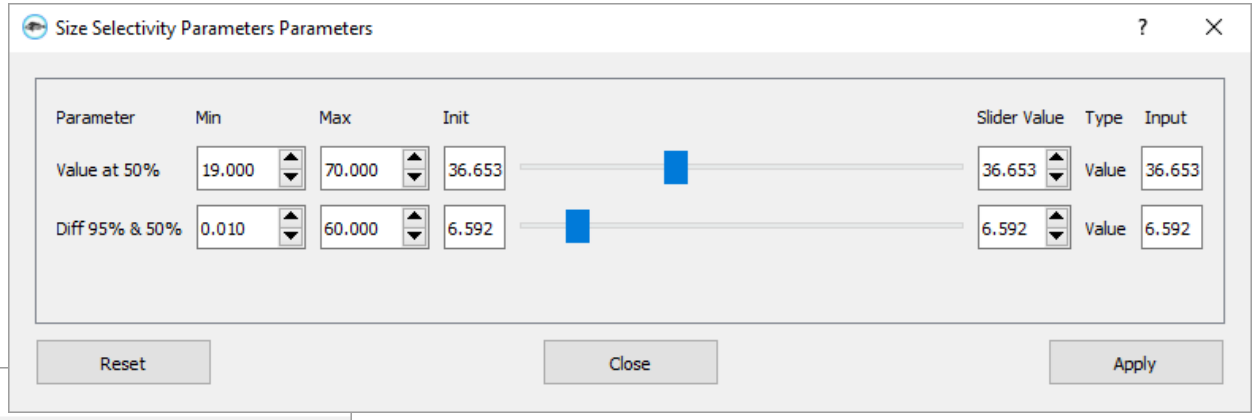

Stock Synthesis Interface
File Data View Run Options Windows Help
Files
Input File Settings
Output File Settings
Input Files
Current Directory:
Starter File Comments:
C:/SS/default/starter.ss
Forecast File Comments:
C:/SS/default/forecast.ss
Data File Comments:
C:/SS/default/simple_dat.ss
Control File Comments:
C:/SS/default/simple_ctl.ss
View Weight-at-Age
C:/SS/default/wtatage.ss
Read inital values from SS3.PAR file
View SS3.PAR File
Use ProfileValues.SS for batch processing - RunNumber.SS will be reset.
Run number
0
Reset Run number to 0

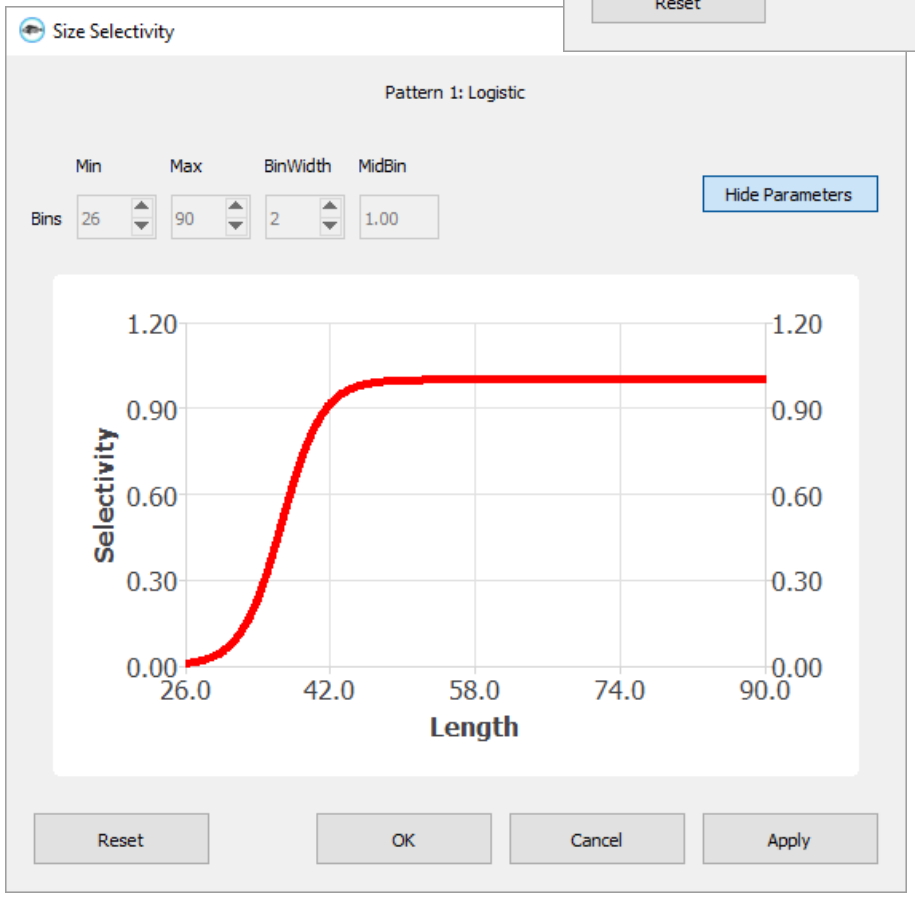
SSI Menu Bar

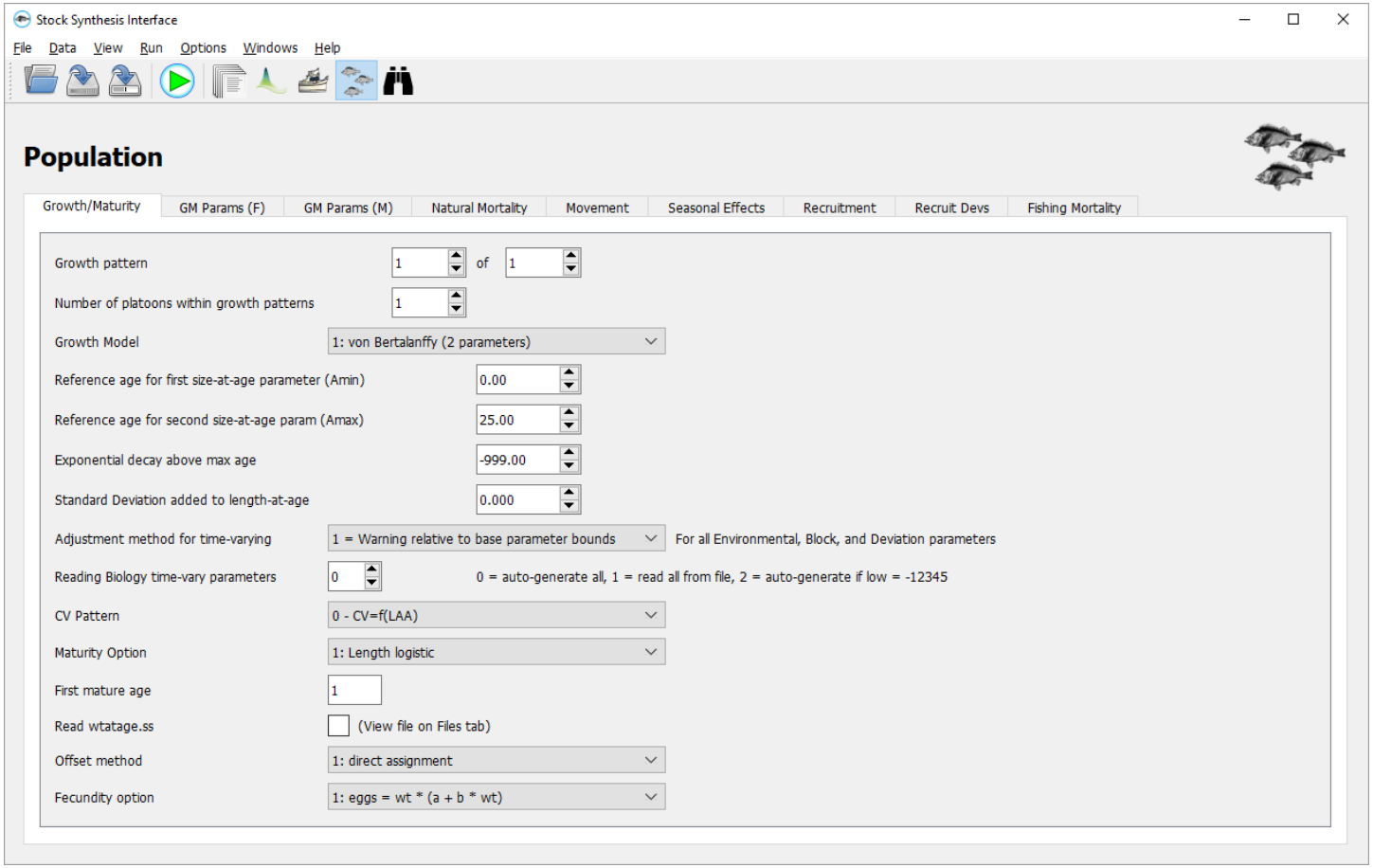

Stock Synthesis Interface - SSI
File
Data
View
Run
Options
Windows
Help
FLEETS
POP
FORECAST
FILES
CONFIG
(starter+)
Files
Input File Settings
Output File Settings
Input Files
Current Directory:
Starter File Comments:
C:/Users/Richard.Methot/Documents/SS_
Forecast File Comments:
C:/Users/Richard.Methot/Documents/SS_
Data File Comments:
C:/Users/Richard.Methot/Documents/SS_

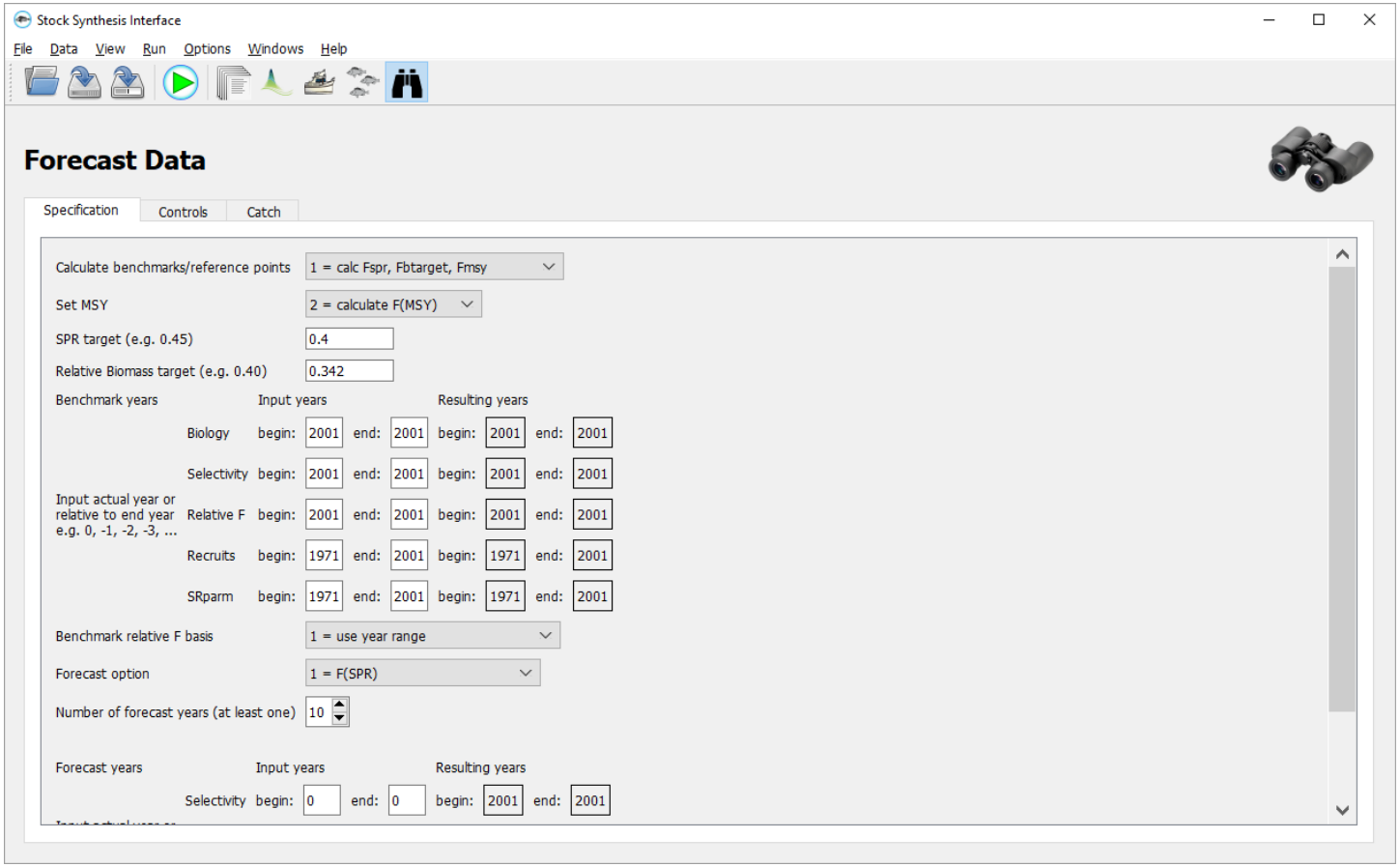

Stock Synthesis Interface
File Data View Run Options Windows Help
Configuration
Dimensions Settings Composition Setup Environment Vars Tag Data Tag Params Blocks Lambdas Add'l Reporting
Start Year 1971
End Year 2001
Total Years 31
Seasons
Number of Seasons per year 1
Number of sub-seasons 2
Season 1 of 1
Number of months in season 12
Total months 12
Spawning month 1.00
Number of sexes (1/2) 2
Number of ages 40
Number of areas 1
Number of Fisheries 1
Number of Surveys 2
Total Fleets 3
See Fleet section for more info or to make changes.

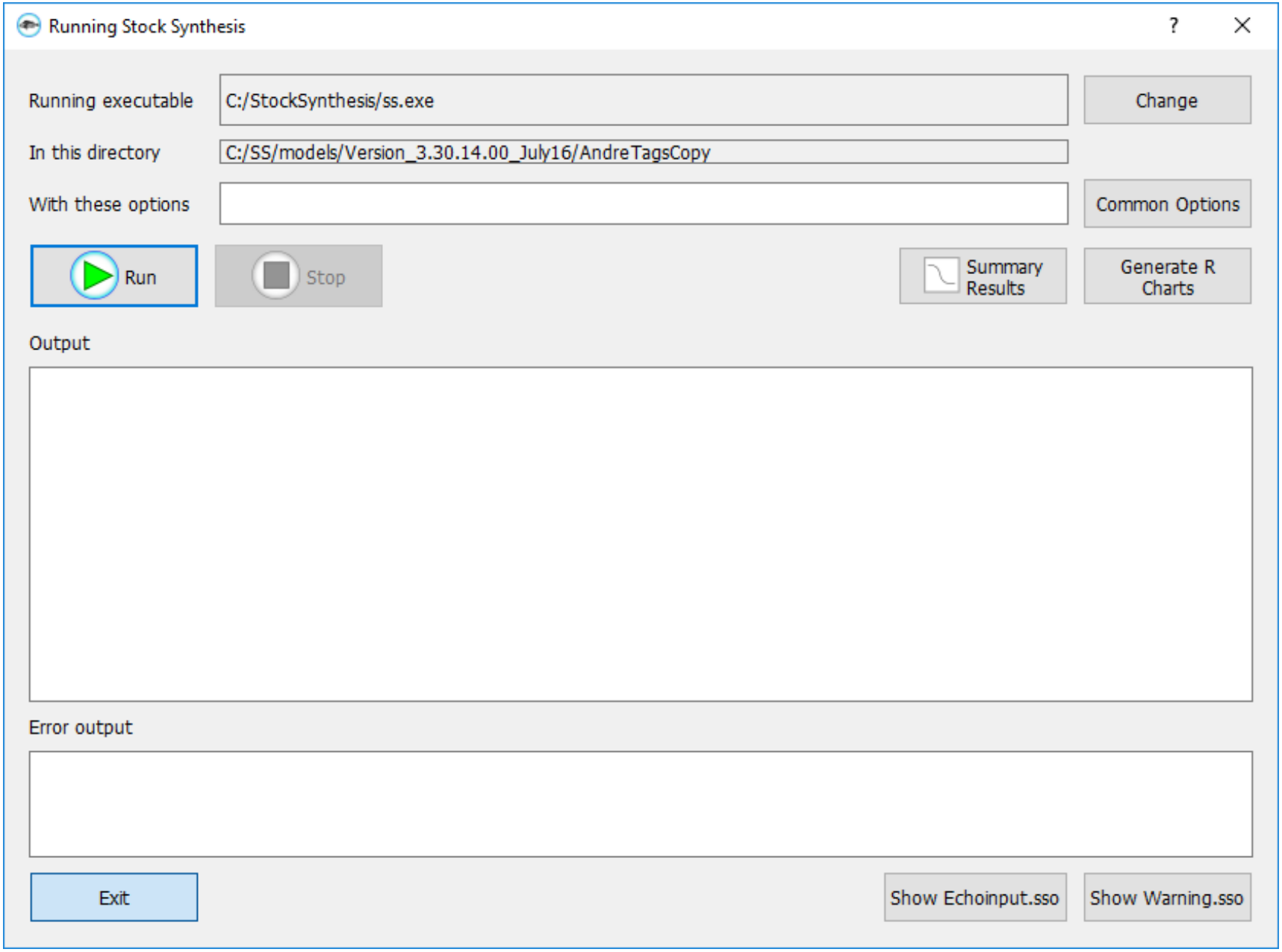

Stock Synthesis Interface - SSI
File Data View Run Options Windows Help
Fleet Data for FISHERY
Basic Data Observations Compositions Catchability Selectivity
Name FISHERY
Edit Name
Fleet Number 1
Active (Use this fleet?)
Type 1: Fishing with retained catch
Timing in Season -1.000 Superceded by real month in observations
Area where the fleet operates Area 1
Units of catch 1 1 = biomass, 2 = numbers, 30-35 = special size selectivity for surveys
Apply a catch multiplier


Size Selectivity Parameters Parameters
Parameter
Min
Max
Init
Slider Value
Type
Input
Value at 50%
19.000
70.000
36.653
36.653
Value
36.653
Diff 95% & 50%
0.010
60.000
6.592
6.592
Value
6.592
Reset
Close
Apply

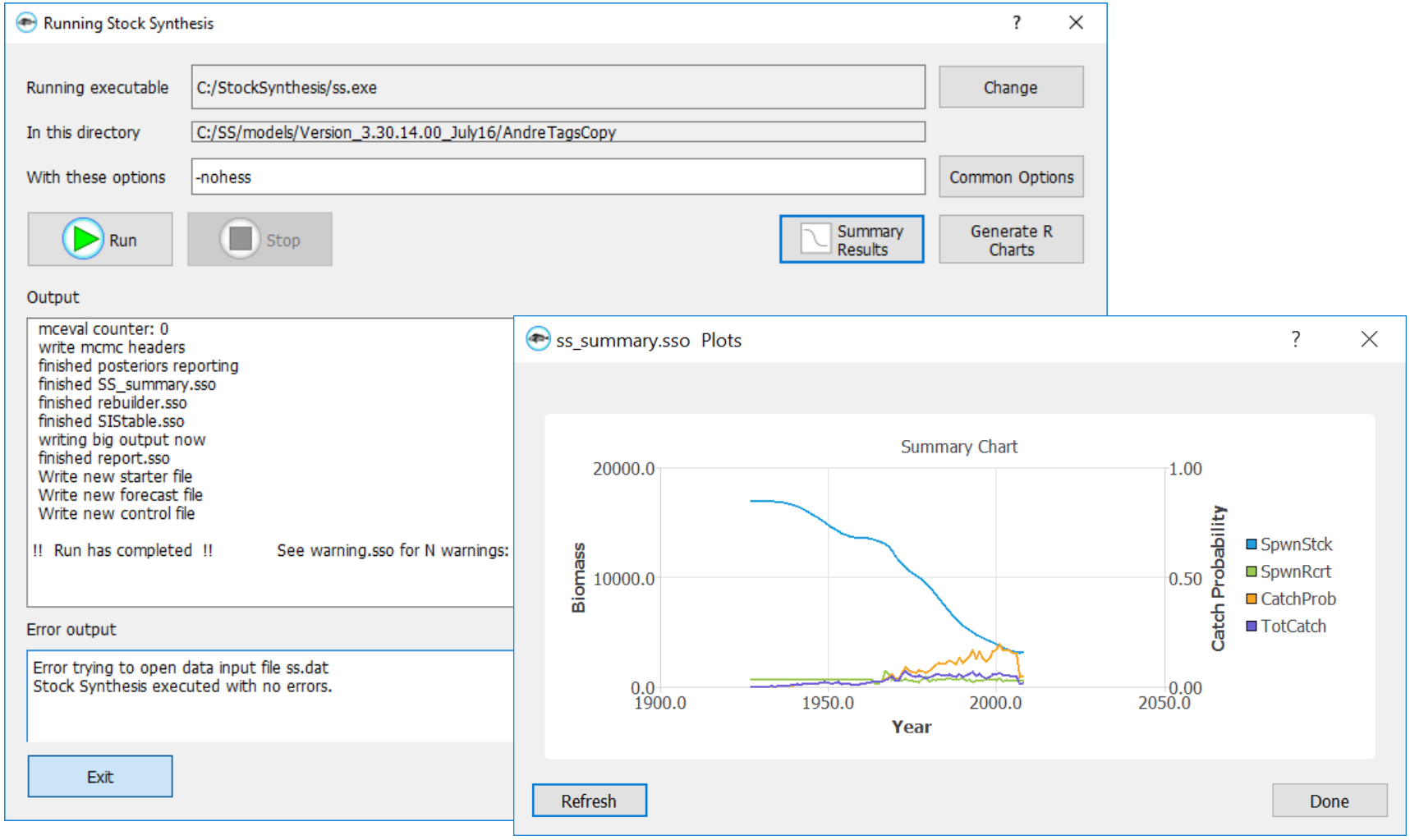

Size Selectivity
Pattern 1: Logistic
Min
Max
BinWidth
MidBin
Bins
26
90
2
1.00
Hide Parameters
1.20
0.90
0.60
0.30
0.00
Selectivity
26.0
42.0
58.0
74.0
90.0
Length
Reset
OK
Cancel
Apply


Stock Synthesis Interface
File Data View Run Options Windows Help
Population
Growth/Maturity
GM Params (F)
GM Params (M)
Natural Mortality
Movement
Seasonal Effects
Recruitment
Recruit Devs
Fishing Mortality
Growth pattern
1
of
1
Number of platoons within growth patterns
1
Growth Model
1: von Bertalanffy (2 parameters)
Reference age for first size-at-age parameter (Amin)
0.00
Reference age for second size-at-age param (Amax)
25.00
Exponential decay above max age
-999.00
Standard Deviation added to length-at-age
0.000
Adjustment method for time-varying
1 = Warning relative to base parameter bounds
For all Environmental, Block, and Deviation parameters
Reading Biology time-vary parameters
0
0 = auto-generate all, 1 = read all from file, 2 = auto-generate if low = -12345
CV Pattern
0 - CV=f(LAA)
Maturity Option
1: Length logistic
First mature age
1
Read wtatage.ss
(View file on Files tab)
Offset method
1: direct assignment
Fecundity option
1: eggs = wt * (a + b * wt)

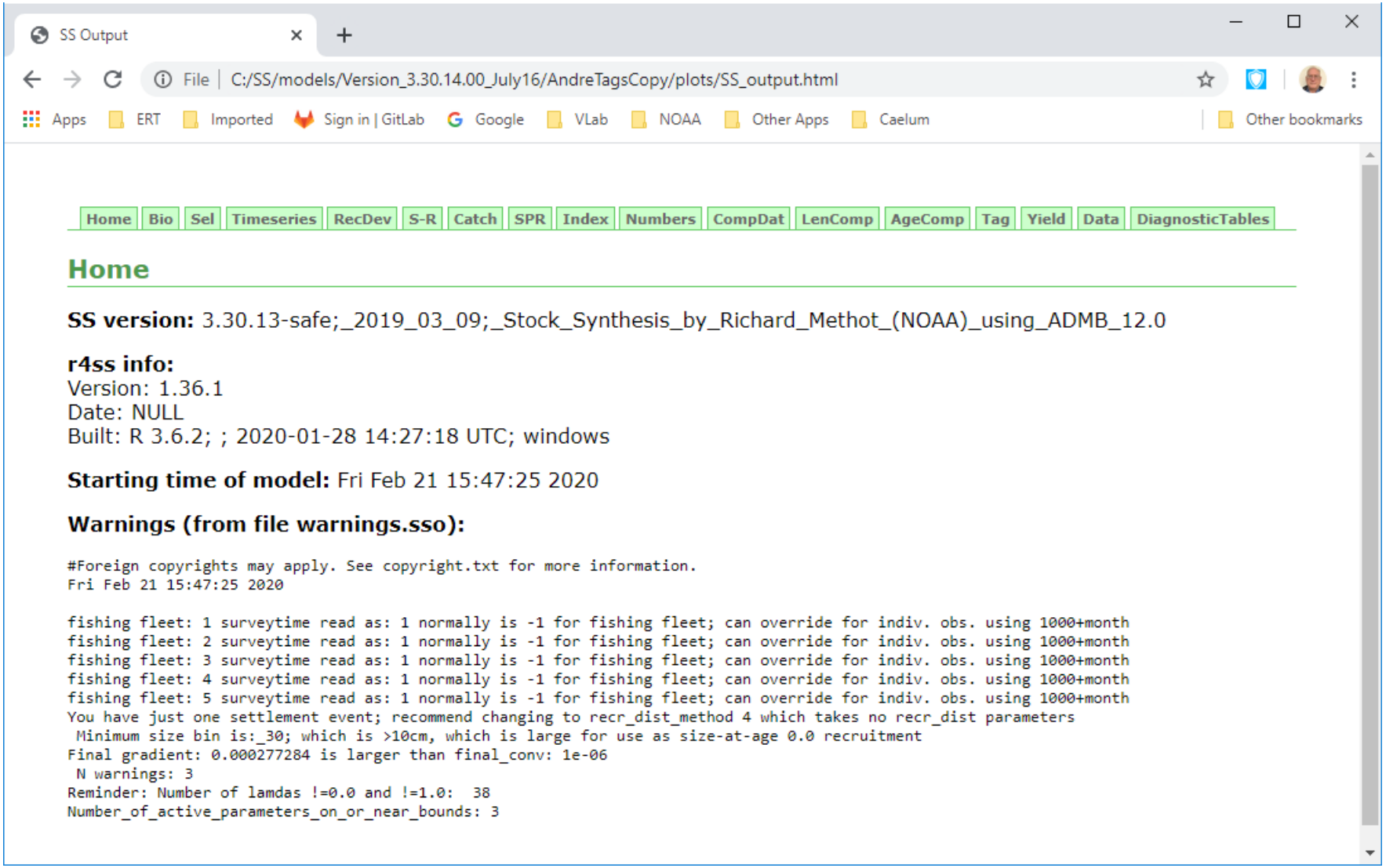

Stock Synthesis Interface
File Data View Run Options Windows Help
Forecast Data
Specification Controls Catch
Calculate benchmarks/reference points 1 = calc Fspr, Fbtarget, Fmsy
Set MSY 2 = calculate F(MSY)
SPR target (e.g. 0.45) 0.4
Relative Biomass target (e.g. 0.40) 0.342
Benchmark years Input years Resulting years
Biology begin: 2001 end: 2001 begin: 2001 end: 2001
Selectivity begin: 2001 end: 2001 begin: 2001 end: 2001
Input actual year or relative to end year e.g. 0, -1, -2, -3, ...
Relative F begin: 2001 end: 2001 begin: 2001 end: 2001
Recruits begin: 1971 end: 2001 begin: 1971 end: 2001
SRparm begin: 1971 end: 2001 begin: 1971 end: 2001
Benchmark relative F basis 1 = use year range
Forecast option 1 = F(SPR)
Number of forecast years (at least one) 10
Forecast years Input years Resulting years
Selectivity begin: 0 end: 0 begin: 2001 end: 2001


Running Stock Synthesis
?
Running executable
C:/StockSynthesis/ss.exe
Change
In this directory
C:/SS/models/Version_3.30.14.00_July16/AndreTagsCopy
With these options
Common Options
Run
Stop
Summary Results
Generate R Charts
Output
Error output
Exit
Show Echoinput.sso
Show Warning.sso

Running from the SSI

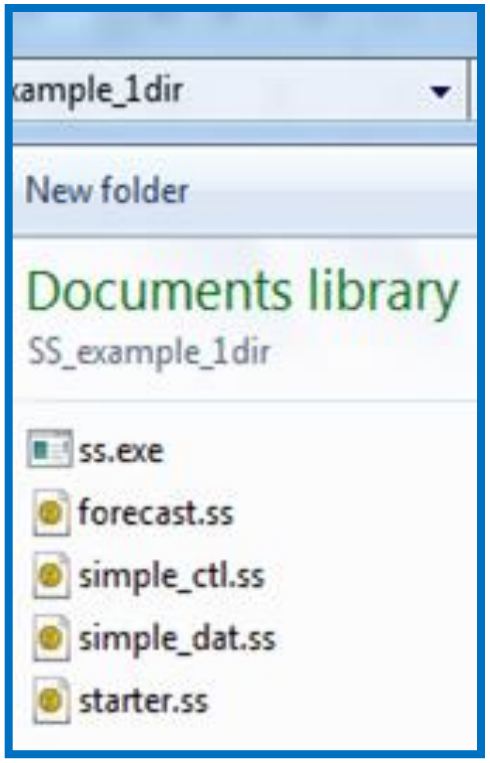


r4ss plots (available via “Generate R Charts” in SSI)



Running SS using the one folder approach

Running SS: The one folder approach. Model files and exe in same folder



Create a folder and add:

- ss.exe (or ss_opt.exe for running faster without internal checks)
- starter.ss
- Control File (Must match name in starter.ss)
- Data File (Must match name in starter.ss)
- forecast.ss
- Conditional files: wtatage.ss (if doing empirical wt-at-age approach) or ss.par (to continue from a previous run)

Pros and cons of the one folder approach

- **Pro:** Simple setup to run models
- **Con:** If you update your version of SS, then you may need to update it in many folders
- **Con:** Requires 1 copy of the executable per folder, which will take up a large amount of space when running many models

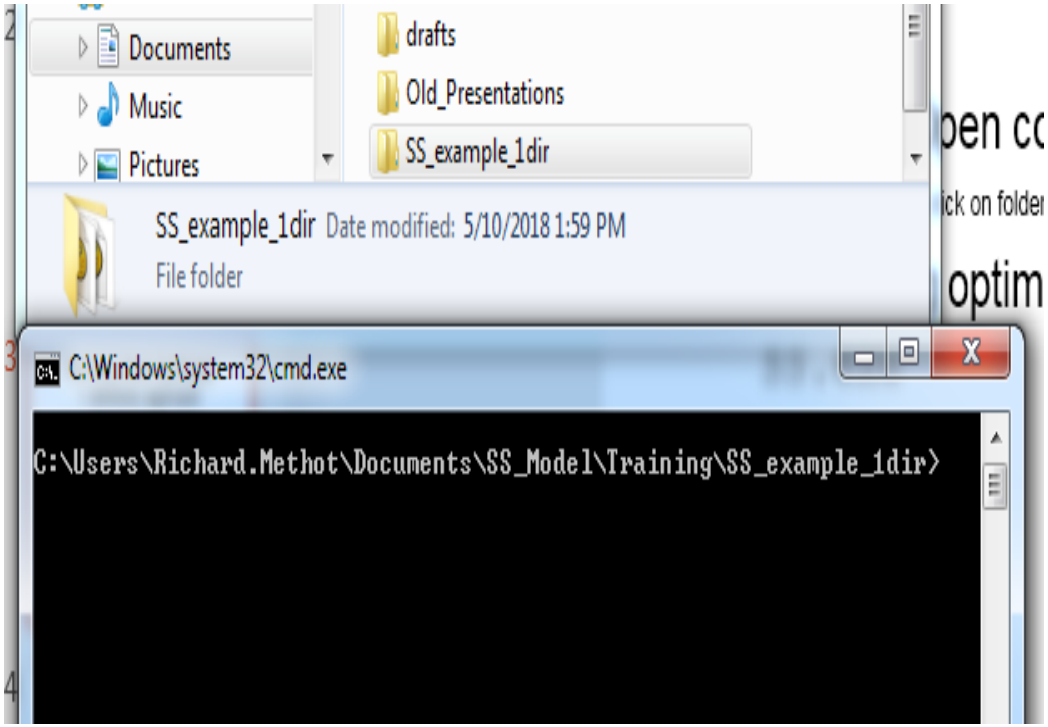
Starting SS from the command line

Click here to highlight.

Then shift right-click to get to “open command window here” option.

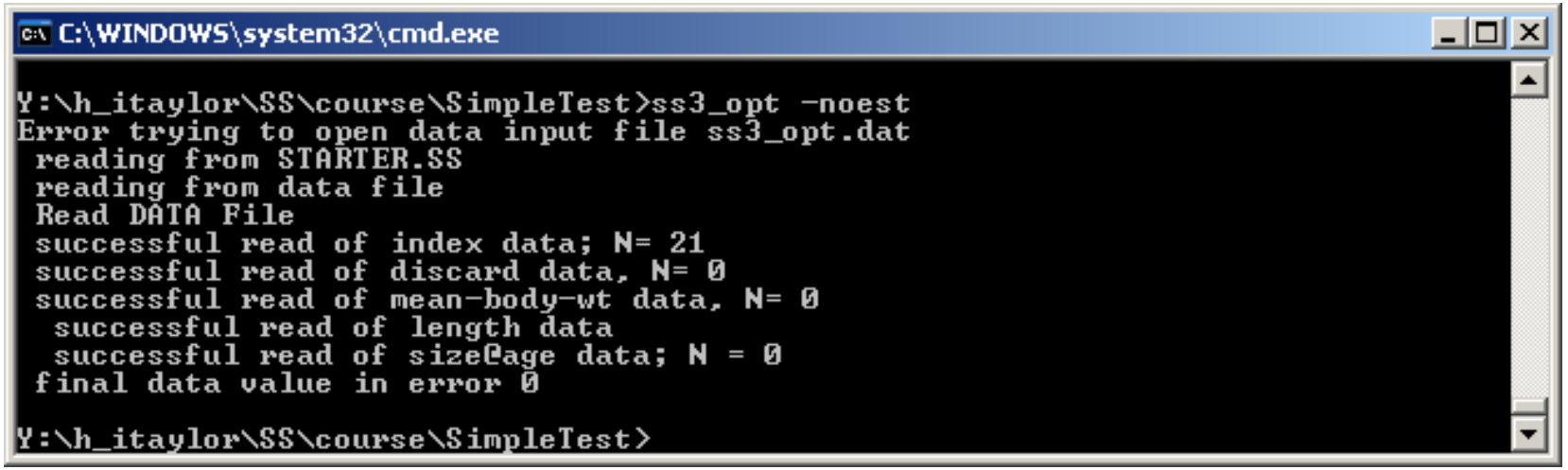
Which opens cmd.exe in that directory.

Then type ss (or other name of the ss exe) and hit <enter>



See notes for more tips on running an SS model from the command line.

Command line messages after starting an SS run



- Ignore message: `Error trying to open data input file ss.dat`
- If you get past `Estimating…please wait…` then the structure of the inputs is OK.
- Volume of information controlled in starter.ss file:
  `1 # run display detail (0,1,2)`
  Middle level (1) is usually best.

SS always opens and reads files in the same order, writing to echoinput.sso as it reads

- SS inputs are read in order by value, without reference to comments. Depending on the SS options selected, SS will expect a certain number of values in a certain order, so failing to provide them will result in errors or at least a different model specification than intended.
- Reading order of files: SS opens and reads starter.ss, then the data file, then forecast.ss, then the control file, then wtatage if using (optional), and finally ss.par if using (optional).

SS run order of operations

1. SS proceeds immediately to pre-processing of the data, creation of internal parameter labels, etc (order as described on the previous slide)
   - Some checks are written to echoinput.sso.
   - Problems written to warnings.sso.
2. Then, SS goes to the procedure section where iterative parameter changes are made by ADMB to minimize the negative log likelihood
3. When ADMB achieves convergence, control passes to the sd_phase for calculation of parameter variance (unless –nohess option). After the sd_phase, it then goes to the benchmark and forecast code section, and then to the final reporting.
4. Results are written to the same directory

Screen output at the end of a run

- If a run finishes, you will see something like:

```
!! Run has completed !! No warnings
```

(although it can complete with warnings also.)

- If a run does not finish, you will not see this line and likely will see some other error message output.

Examining the output

- Examine warnings.sso for issues and suggestions.
- Many output files are created: Report.sso, Forecast-report.sso, etc.
- Read the output and results into one of the these programs:
  - r4ss (https://github.com/r4ss/r4ss)
  - The excel viewer, SS_Output-330.xslm (on Vlab)
- The results will include the following:
  - Calculated selectivity, biomass, F time series, numbers-at-age, fit to data, etc.

Warning.sso File

- Always look at after running a model, regardless of whether the model run completed or not
- Contains a list of warnings generated during program execution.
- Note in command line if N warnings > 0

- N warnings include:
  - Notification of errors in input files.
  - Some advice on parameter settings.

Other SS run workflows and optional ways to run

Run SS – the two folder approach
Exe in different folder and use a batch file

- Folder 1 contains the SS executable, ss.exe
- Folder 2 is the model user folder. It contains the SS input files for a single model plus a batch file named SS330.bat (or *.bat)
- The first line of the batch file has the full path to SS.exe
  - `C:\MyDocuments\Assessments\SSmodel\SS.exe %1 %2`
  - Note that %1 … are how to pass command line options to the bat file. If you don't want to pass options (like `-noest` or `-nohess`), then there is no need to include `%1 %2` in your batch file - just put the file path to the executable.
- Open the command window in the model user folder
- Type name of the batch file (e.g., SS330 for SS330.bat) in the command window, which will start the batch file.
- Running the batch file will open SS.exe and run it with the model files in the directory.

Why the two folder approach?

- With this approach, you can have one (or more) folders with various versions of SS and many model user folders each with one (or more) batch files that point to various versions of SS.
- This eliminates the need to have multiple copies of the same ss executable on your computer, which is necessary with the one folder approach.

Run SS: Using an SS.exe in your PATH

- The PATH is where your computer will search for files be default. Therefore, if an ss executable called ss.exe is in your path, when you type ss into the command window, your computer will be able to find ss.exe and use it with the model files in the current directory.
- For more information, see the “Putting SS in your PATH” doc in the Getting Started folder within the SS vlab document library.
- After initial setup (once per computer), this makes using the same ss executable from many folders easy – you can run SS as if using the one folder approach, but there is no need to have the exe in the folder.

Running SS from within R

- When executable ss.exe in the same folder as model input files, use `system("ss")` from the R console to run.
- When using ss.exe that is in your path (in Windows), use:

```
get_bin <- Sys.which("ss.exe")[[1]]# get ss exe that is in your path
system(get_bin)#to run SS in current working directory
```

- Running SS from within R may be desirable for setting up simulations where many runs of SS models are required or if r4ss is being used to read SS model output

Using ss.par for initial values

- Typically, SS uses initial parameter values in the control file. However, initial values can be read from the ss.par file instead.
- To use ss.par instead, in starter.ss below the names of the data and control files, set the value to 1 rather than 0 on the line with comment

```
# 0=use init values in control file; 1=use ss.par
```

- Run model using one of the previously described workflows
- Using the ss.par file comes in handy when you want to use different initial values without modifying the control file. An ss.par file is created during each model run, so using an ss.par file from a previous model run will speed up run time if the initial values are closer to the MLE parameter estimates

Creating and modifying files

- Start from an existing data, control, forecast, and starter *.ss_new files (which will be heavily annotated by SS) as a template
- Use these with the Excel helper spreadsheets (available on vlab) and the SS user manual to determine model inputs.
- Replace the file content with your data/parameter setup and update the descriptors in the text file OR read the template ss_new files into SSI and modify the model from within SSI.
- Save each *.ss_new file as a *.ss and insert the new filenames for control and data files in the starter.ss file.
- Do the same for the parameter file starting from an SS annotated control.ss_new, forecast, and starter *.ss_new files.

Command line options

- ADMB options can be added to command line (ADMB).
  - Skip standard errors (for quicker results, or to get Report.sso if Hessian does not invert): `ss -nohess`
  - List all command line options: `SS -?` OR `ss -help`
- SS option to Run without estimating anything (as of 3.30.16): `ss -stopph 0`
- More info in ADMB Manual (Chapter 12: Command line options) http://www.admb-project.org/docs/manuals/

Going further: Plotting results and basic troubleshooting

Using r4ss to organize and plot SS output

- Two main functions: SS_output() and SS_plots()

```
library(r4ss) # use r4ss package on github
# create list of quantities for the model in mydir
replist <- SS_output(mydir)
SS_plots(replist)# create plots for SS run
```

- See https://github.com/r4ss/r4ss for installation instructions. The master branch is the most stable, but to use the version with the most recent fixes/developments, use the development branch.

What to do when SS doesn't run?

- Make sure all file names and directories / folders are named correctly (check that the starter file reference the correct names of control and data files). If file names and directories are named incorrectly, SS will not be able to find the file.
- If it starts to read files and then crashes:
  - Look at Warnings.sso.
  - Look at Echoinput.sso and work backwards from the bottom, looking for where it doesn't match your inputs.
  - Consult the Stock Synthesis User Manual.
    - For further information please refer to SS User Manual “Running SS” subsections, especially “Re-Starting a Run” and “Debugging Tips.”

If the input is OK and then crashes…

- If model crashes soon after starting the run, or if NAN messages appears on the screen, then:
  - Restart SS with the `-stopph 0` option. This will read files, produce report output, and produce *.ss_new files.
- Read Report.sso and Compreport.sso into R4SS or SS_Output-X.xlsm or the SSI to examine the details.
  - May show which likelihood component and which data have the NAN calculation.

How to get additional help?

- SS – VLAB website's resources:
  - https://vlab.ncep.noaa.gov/web/stock-synthesis
  - All can post on the forums: https://vlab.ncep.noaa.gov/web/stock-synthesis/public-forums
  - See resources including the SS user manual and the SSI user guide.
- Fisheries Research special issue on Stock Synthesis: https://www.sciencedirect.com/journal/fisheries-research/vol/142
- Emailing questions to nmfs.stock.synthesis@noaa.gov
- Other users and models
- http://www.capamresearch.org/