Fire Analysis Module for Ecological values (FAME)
User Manual Version 2
March 2021

Contents

Version control

Version	Author	Changes	Date
V0.5	N. Amos	First draft	8/4/2019
V0.9	J. MacHunter	Review and minor edits	10/4/2019
V0.99	J. MacHunter	Added GSO documentation from inputs doc	17/4/2019
V1.0	N. Amos	Appendix added with inputs and outputs and revision from previous comments addressed	23/04/2019
V1.01	N. Amos	Minor update to reflect changes to TFI outputs following training workshop and addition of shutdown utility	9/05/2019
V2.0	N. Amos	Major update to ne FAME v2 functions and shinyapp	30/03/2021

Glossary

TFI – Tolerable Fire Interval
BBTFI – Burnt Below Tolerable Fire Interval
EFG – Ecological Fire Group
HDM – Habitat Distribution Model
GSO – Growth Stage Optimisation
GUI – Graphical User Interface
GS -Vegetation post fire growth stage

Introduction

This software provides a Fire Analysis Module for Ecological values (henceforth FAME). The body of this manual should be read in conjunction Appendix 1 which provides details on the structure of the input and output files required by the module, and the values calculated in the outputs.

The module allows for the spatial analysis of fire sequence information from an input file of individually dated fire footprints. This data is analysed in conjunction with fauna habitat distribution models (HDM) and vegetation maps of Ecological Fire Groups (EFG sensu Cheal 2010) of vegetation (and associated lookup tables) to allow calculation of the metrics to evaluate the impacts of fire on ecological values (Table 2, ERP 1 Final Report, p12). At this stage FAME is scripted to provide Tolerable Fire Interval status of vegetation, and changes in modelled abundance of vertebrate fauna species. The conceptual basis and method for evaluating flora species requires further investigation before it will be possible to incorporate into FAME (ERP 1 Final Report, p16).

As of version 2 the module and pre-processing tool allows the output tables required for the Statewide Fuel Management Report to be produced.

The underlying R code for V2 has been rewritten and is much faster than previous versions. The code is now

The module also incorporates the aspatial vegetation growth stage optimisation (GSO) tool, written in R, that extended scripts developed by Sitters et al. (2018) and then subsequently revised by Paul Moloney at ARI which enabled greater flexibility in decision rules regarding input data for species responses to fire (Porigneaux et al. 2017).

FAME provides a Graphical User Interface (GUI) via a web browser which connects to a server where the analysis occurs. FAME facilitates exploration of fire scenario options for users with minimal experience with command line or script-based analyses.

Initial Setup.

Installation of the utilities to launch a FAME server on Amazon web services.

To launch FAME on a web server you need to have python v3.7 or later and the package boto3 installed on your PC. This will allow you to run a script that will automatically start a FAME sever for you on AWS and open int in your default web browser.

a. Contact FFRAU to obtain AWS credentials to allow you to launch FAME servers. The will provide you with credentials and a python script “launch_fame.py” that you will run to start and access a FAME server.
b. Install python 3.7: download the installer from https://www.python.org/ftp/python/3.7.3/python-3.7.3-amd64.exe, create a new folder called C:\Python37, then run the install as administrator and tick the box “add Python to PATH” and install python in folder C:\Python37
c. Go into this folder and change the name of the python.exe to python3.exe (this prevents any clashes with python 2.7 used by ArcGIS)
d. Press the windows key and type “environment variables” in the search bar, “Edit environment variables” should appear as option, click it and then click “Environment Variables”, under system variables double click “Path” and then “New” and add “C:\Python37\” and “C:\Python37\Scripts”. Click “Ok” to exit.

e. Check that python 3.7 is installed correctly by opening the windows command prompt (windows key then type CMD) as an administrator (right click and click "Run an administrator") and typing: *python3 --version*
f. Still in the command prompt, install the AWS python package by typing *pip3 install boto3* and then press enter
g. In some cases the command in f. does not work if so try *python3 -m pip install boto3*
h. Install the AWS CLI tools (https://s3.amazonaws.com/aws-cli/AWSCLI64PY3.msi)
i. Once this has finished, type *aws configure* and press enter, this will prompt to you to enter your *Access key ID* and *Secret access key* in the spreadsheet, for the "Default region name" type *ap-southeast-2* and for "Default output type" type *json*
j. Check that credentials are recognised by typing *aws s3 ls* and then press enter, if you see multiple lines with date time and names then it is set up correctly.

To launch FAME server

a. Run command prompt as an administrator then type :
    a. python3 C:\PATHTOSCRIPT\launch_fame.py (replacing PATHTOSCRIPT with where you saved the python script)
b. Enter your region
c. The script will print the "instance id", this is used to terminate the server in case Shiny crashes and doesn't recover, to terminate the server in the command prompt type *aws ec2 terminate-instances --instance-ids* SERVERINSTNACEID (replacing SERVERINSTNACEID with the real instance ID returned by the script)
d. Once the server has been started FAME be opened in your default web browser
e. The software does take a bit of time to install and the web browser might launch before this happens, if you see an error this is because the software is still installing, click refresh a few time and it should load

Download the pre processing tool files

a. Download the pre-processing tool and associated files from:https://ecological-risk-analysis.s3-ap-southeast-2.amazonaws.com/FAME_FMR/FAMEPreProcessing/FAMEPreProcessing.zip or the utilities page of the FAME shiny app.
b. Unzip the downloaded FAMEPreProcessing.zip into your preferred location (suggest c:\data on DELWP SOE computer.

Workflow

The workflow consists of seven stages. The preparatory stage occurs on a local desktop computer and next five stages on the remote server. The final stage occurs involves both the remote server and a local desktop computer. A brief overview of each stage is provided below followed by more detailed instructions in the following sections.

1. Data preparation
    - Collate input files and save to desktop computer
    - Combine the future fire scenario with past fire history and clip the data to the region of interest. This process is undertaken on a local desktop computer in ArcMap v10.5 (or later version).
    - Upload this dataset to the FAME server.
2. Fire sequence analysis in FAME
    - Carry out fire history analysis on the server

3. Fauna relative abundance (RA) following fire: and.
    - Combine the fire scenario outputs from stage one, vegetation mapping (EFG), species' habitat distribution models (HDMs) for vertebrate fauna and lookup tables of the predicted effect time since fire and EFG on the relative abundance of each species (within the area identified as its potential range by the HDM).
4. Tolerable fire interval (TFI) analysis.
    - Combine the fire scenario outputs from stage two with vegetation mapping and TFI values for the EFGs (Cheal 2010) to output summaries, and if desired raster maps of the annual status of vegetation age relative to TFI.
    - Identify those areas where there are inter-fire intervals that have and /or will result in an area being Burned Below TFI (BBTFI) one or more times.
5. Growth Stage Analysis
    - Combine the fire scenario outputs from stage two with vegetation mapping with four step growth stage classes to determine area of vegetation in each growth stage. Summary tables of growth stage by EFG.
6. Aspatial Growth Stage Optimisation for Fauna Species.
    - A separate process provides for aspatial optimisation for determining the ideal distribution of growth stages for EFGs in a defined area that will maximise the Geometric Mean Abundance (GMA) of species. This is determined by the lookup of species' relative abundance with growth stage and EFG, and a list of species occurring in the area of interest.
7. Down results of FAME analyses.

Stage one: Data preparation

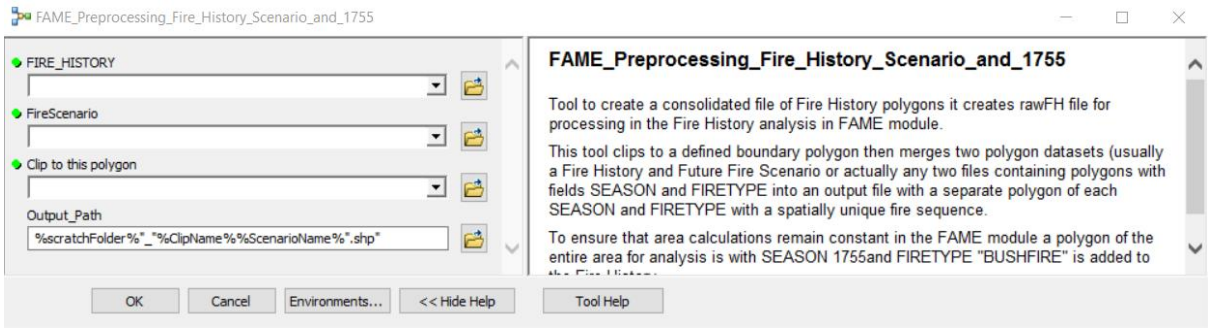
Setting up files on your local desktop PC

a. Generate a folder for input files on your local desktop PC
b. Save and prepare FireScenario which is the fire scenario shapefile formatted as described in the Appendix 1.
c. Decide on the area of analysis. You should select a polygon that is as small as possible given your area of interest for the analysis as this will speed all further processing steps. The default options are the FFR regions in the LF_DISTRICT layer in the CGDL database. A local copy of this is made for use in the tool and called LF_REGIONS.shp. The polygon(s) for the FFR regions should be selected from this file. If you wish to select a different area of interest, then an ad-hoc polygon shapefile must be generated and saved locally.
d. Fire History should be accessed via most recent version on CDSL or document alternative fire history data including relevant metadata (if that is used).
e. Save relevant files on PC according to formats specified in the document Appendix 1

Pre-processing fire history data

a. Open the FAME_preprocess.mxd select the FAMEv2 toolbox from the toolboxes window. There are four tools in this toolbox, depending whether or not the analysis is of a single fire history file or a fire history file and a separate future fire scenario, and whether or not a notional fire across the study area in 1755 is required:

b. The usual option for FAME analyses is “FAME_Preprocessing_Fire_History_Scenario_and_1755” The other options may be used in special cases eg where you are interested only in a fire history , not future scenarios. Or for preparation of Fuel Management Report.
c. Double click on the required tool to open its dialog box.
d. The resulting dialog box requires 3 or 4 inputs depending on your choice of tool, the inputs are explained in the right of the box.



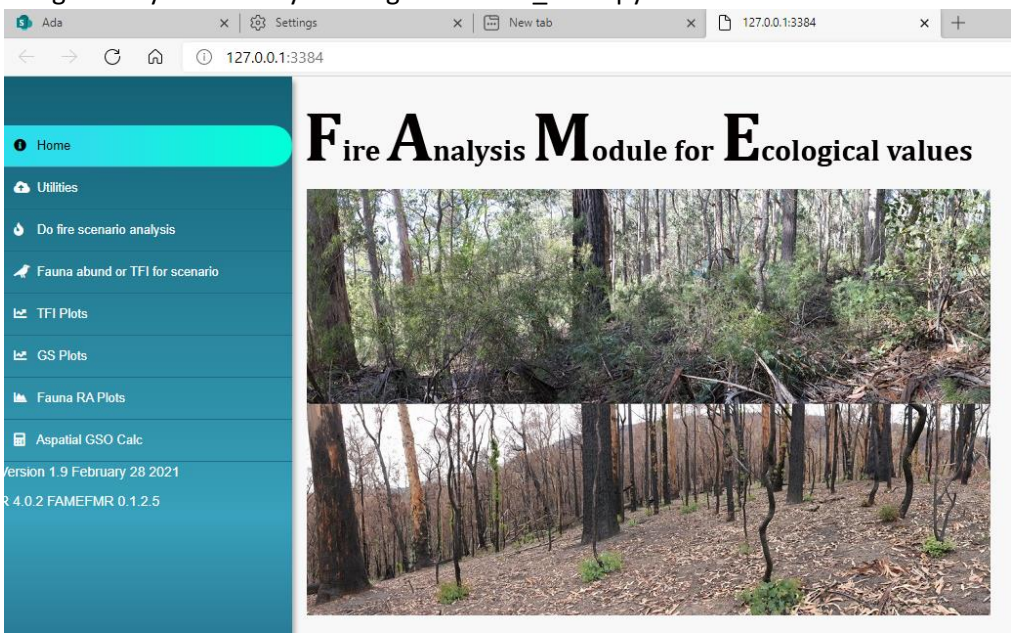
- FIRE_HISTORY: this will generally be the current corporate fire history layer, it can be selected from your normal access point for the corporate library, however if you are doing many iterations of pre-processing step, you may wish to make a local copy to speed the pre-processing read time.
- FireScenario, the fire scenario shapefile formatted as described in the Appendix 1.
- A polygon to clip the output file to. You should select a polygon that is as small as possible given your area of interest for the analysis as this will speed all further processing steps. The default options are the LF_REGIONS, which can be selected from LF_REGIONS.shp, which is saved in the same directory as the FAME toolbox. If you wish to select a different area of interest, then an ad-hoc polygon shapefile must be selected.
- The name and location for the output fire scenario file. Make this filename unique and meaningful to you as this name is used to provide the base name for outputs of the FAME analysis. By default the output file will be given the name of the clip polygon (or just “LF_REGION” if the default regions are used) concatenated with the Fire Scenario Name. It is suggested that you enter a file name following using the following convention Region(name)_LMU(name)_Scenario(number)_version(number).shp

e. Click the OK button in the dialog box to run the tool, the output”rawFH” file will be accessible for upload to FAME module

Stage two: Fire sequence analysis in FAME

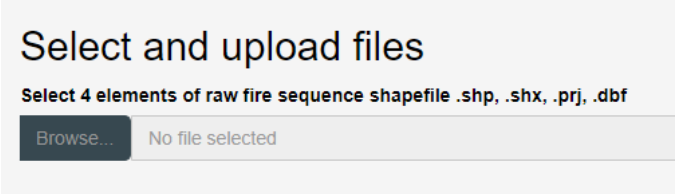
This analysis provides the unique sequence of fires at any location. It results in a polygon dataset where each polygon has a unique fire sequence which comprises all preceding inter fire intervals and associated fire types (bushfire / planned burn). The analysis also maps time since fire for every year of the analysis into the same polygon dataset. These analyses have consolidated and improved previous approaches using the DELWP tool known as FireHAT.

a. Launch the FAME module home page in your web browser (Chrome is or Microsoft Edge have been tested other modern browsers should also work). The version of FAME and the associated FAME_FMR R package are displayed at the bottom of the sidebar on the left of the screen. This will generally be done by running the launch_fame.py

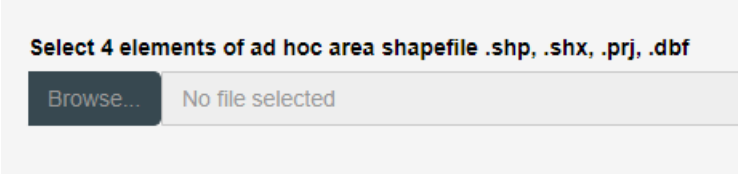


b. Select the utilities tab in the bar on the left of the screen
the Utilities tab provides for upload and download of files from the server, as well as creation of draft species lists and area specific data input files for the aspatial GSO analysis (see below).

c. Click the Browse… button under “Select 4 elements of raw fire sequence

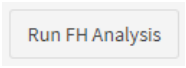


select the four files that comprise the shapefile for the scenario that you created in stage one. If you used an AdHoc shapefile to clip you need to use the second item on this tab to upload that as well. If you are doing an analysis based on LF_Regions, or statewide (or have previously uploaded the AdHoc polygon) then this second upload is not required.



d. Switch to the “Do fire scenario analysis” tab. Here you need to make several selections before running the Fire Scenario Analysis For all except “Fire scenario shapefile” and “Choose a Region” default values are set. You must therefore select these first two settings and decide whether the default values for the remaining three options are appropriate for your analysis. Purpose of each setting is tabulated below.

Setting name	Purpose	Values
Fire scenario shapefile	The fire sequence (combination of fire history and future fire scenario) to be analysed.	Shapefile produced in the preparatory ARCGIS tool and uploaded to module
Choose a Region	Sets the boundary of the analysis. Analysis should be restricted to only the area of interest to minimise computation time. Usually this boundary should correspond to the clipping boundary used in the ArcGIS preparatory to create the fire sequence for analysis, however the analysis will still run if these boundaries differ (if they overlap each other). Areas outside the clipping of the Fire Scenario will be set to “NA”. If the region chosen is within the Fire Scenario area clipped, the analysis will be restricted to the region chosen.	Whole of State (Default) Ad Hoc polygon (user-provided shapefile in VG94 projection of the boundary of the region of interest) or One of the DELWP Forest and Fire Regions (FFR) "BARWON SOUTH WEST"=1, "GIPPSLAND"=2, "GRAMPIANS"=3, "HUME"=4, "LODDON MALLEE"=5, "PORT PHILLIP"=6,
Raster Resolution	Sets the resolution used for analysis, this is important in determining memory requirements and processing speed. Use of 75m raster increases processing and memory requirements ~10x	225 m (default) 75 m
Restrict Analysis to Public Land	The analysis can be carried out across both public and private land, however fire history is much less complete for private land.	Yes (Default) No
Other and Unknown fire value	Fire history may contain fires of unknown type, you need to decide how to treat these in the analysis. They may be treated as either a bushfire or a burn, or alternatively areas with an unknow fire type may be treated as “NA” values. If the latter is chosen then TFI status, and relative abundance for the cell cannot be calculated based on that fire.	Bushfire (Default) Burn NA
First season for analysis output	Start the analysis at the first season which may be of interest, this reduces processing time, particularly in the Relative abundance calculations (that loop year by year). Calculations occur for each season from the first chosen to the maximum season value in the fire sequence.	1980 (default) Any season after the first season in the fire sequence file provided

e. When you are happy with the settings press the 

button. A spinner will be displayed while the analysis is undertaken, and an animation of a burning fire will appear to the left of the screen while the server is busy processing your data. Depending on the size of the area, and complexity of the fire scenarios you have chosen this process may take from a few seconds (for a few thousand hectares and a few hundred fires) to an hour or more (for a statewide analysis with ~100,000 fires) to run. A green tick will appear to the right of the button and disappear again after 5 seconds when the processing has completed. FH analysis rdata and shapefiles will be created at the conclusion of the process. The content of the files is described in the outputs document.

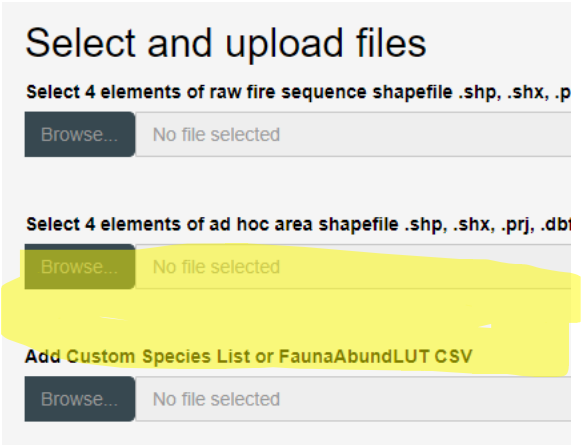
f. Note::where fire boundaries are particularly complex (e.g where the boundaries are identified by fine scale burnability layers, or there are many fires bounded by a linear feature – such as a road, but the boundaries do not coincide perfectly) there is a chance that the resulting rawFH file will contain topology errors. Unfortunately, the topology engines used by ARCGIS and the FAME process in R are different, so errors may occur in FAME due to topology errors that are not identified in ARCGIS. It is suggested that you try changing the XY tolerance environment values in the ARCGIS FAMEv2 tool if topology errors are occurred during stage 2. If the problem is not resolved, then consult a GIS analyst for other potential solutions.

g.

Stages three and four: Spatial TFI and Fauna Abundance Calculations

a. Select the “Fauna abund or TFI for scenario” tab. To run these analyses, you need to use a previously calculated FH analysis, if you are doing this immediately following stage 2 (above), then the FH analysis you have just created will be loaded automatically. If you wish to select a different FH analysis or have prepared the FH analysis previously you will need to select this in the “FH analysis to use” dropdown at the top of the screen. The FH analysis loaded is displayed below this box.

b. If you wish to use a custom species list or custom relative abundance lookup table the .csv files for these (given unique and identifiable names) must be uploaded before proceeding to the analysis. This is done using the upload custom Species option on the “Utilities” tab upload box.

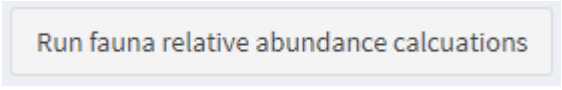


Fauna abundance calculations

a. There are four options to select, all have a default value.

Setting name	Purpose	Values
Enter start and end of abundance baseline period	Set the seasons to be used to calculate the baseline relative abundance used to calculate % change from baseline. It can be a single year or a range of years.	Defaults "First season for analysis output". Any value between this and the maximum season in the analysis can be chosen Note the start season for the baseline must be equal to or greater than the default "First season for analysis output". For a single year chose the same value for start and end, for a range select a higher value for the end
Use default or custom species list	The default is to calculate species responses for all species that have relative abundance data, and to plot relative abundances Rasters for all the species that have RA calculated (as an option). Reducing either of these lists to the species of interest in the region only will significantly reduce calculation times and make outputs easier to handle.	Default: Standard species list (all species that have RA data available are calculated whether or not they occur in the region of interest). Alternative values: Uploaded manually edited draft species list produced using the "create draft species" list utility in the app
Use default or custom relative abundance	Where sufficient field data is available the expert opinion data may be replaced with models based on this field data. In other cases, there may be regional variations in responses that are not addressed in the statewide data. Further the current FFO data only addresses treatable EFGs. Ideally as the available curated response data improves the default dataset would be updated to these values	Default relative abundance uses statewide expert opinion data of relative abundance for each growth stage and EFG and firetype available (previously known as the FFO dataset). If custom values are choosing a dropdown box will appear to select the relevant .csv file (which has previously been uploaded to the server).
Make relative abundance rasters	Whether to output individual Species x Season relative abundance rasters. These provide the spatial view of changes in abundance for each taxon through the fire sequence, however they increase the computation time.	No (default for more rapid computation). Yes (if spatial output is desired). You can then select whether you wish to create rasters for all years or only some. If you chose some, then a further dropdown appears where you select the year(s) to create.

b. When you are satisfied with your settings you can run the calculations by pressing the:

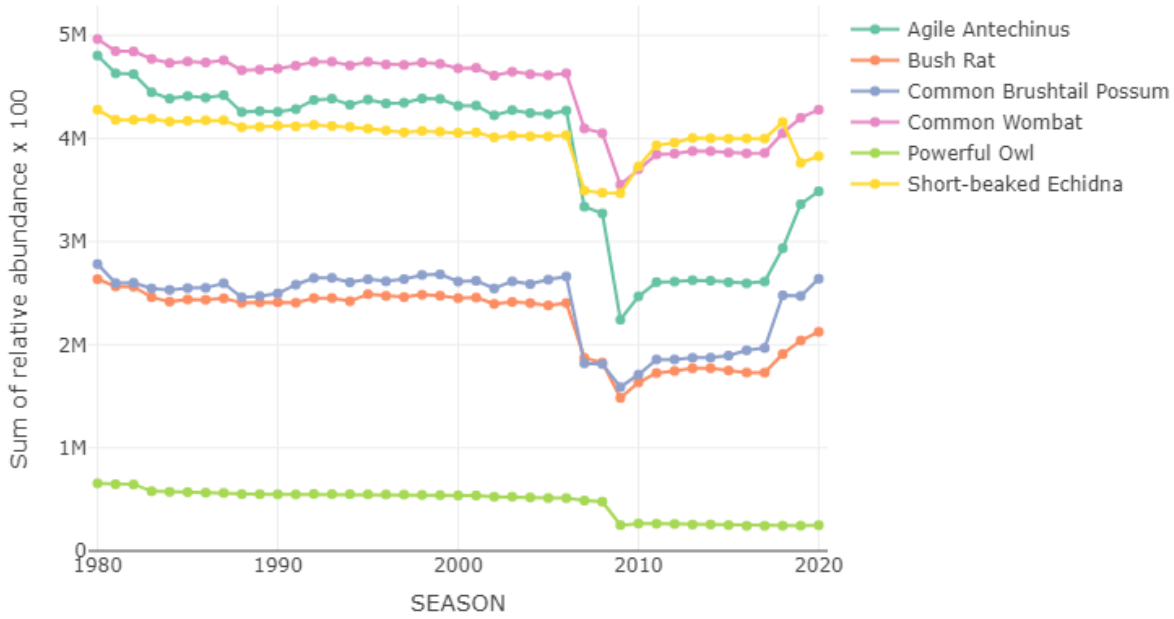


at the bottom left of the tab. **The browser window must be left open while the calculations occur.** When the calculations have completed the app will automatically switch to the "Fauna RA plots" tab.

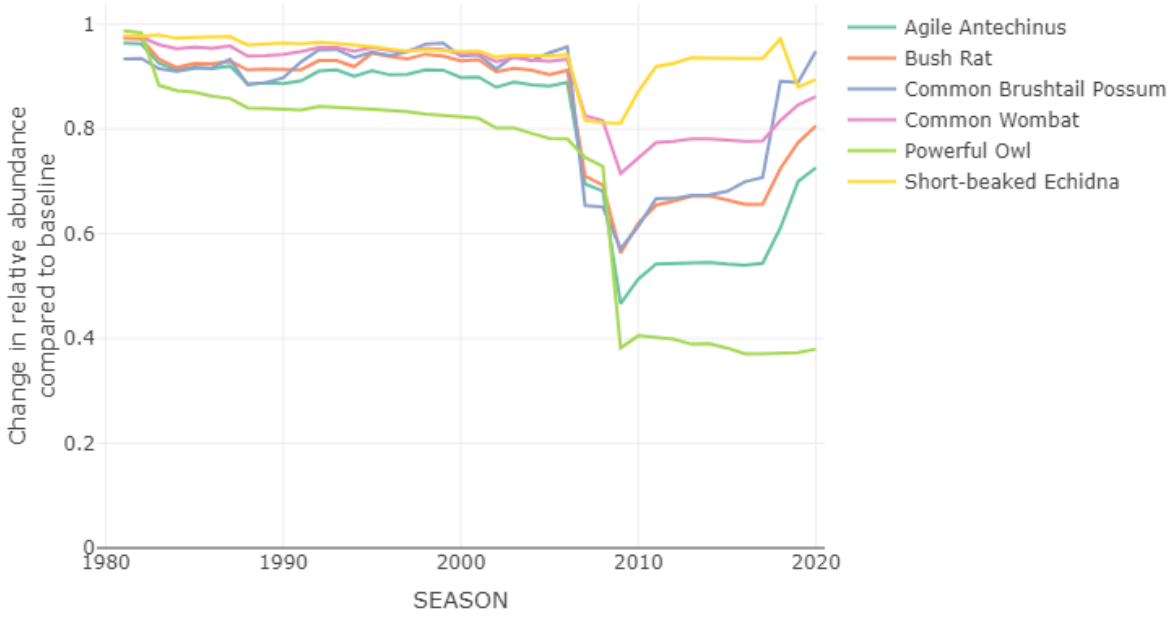
Note: This is the lengthiest calculation, it will increase in duration with: number of species selected in your list; number of years in the scenario; whether or not rasters are output; and increasing size of the area of interest. A run for a few species, for a small region (e.g. Port Philip) with no raster output may take a few seconds to run at 225m resolution. A run for all available species for the whole state outputting all rasters at 225m resolution will take an hour or more. At 75m the speed is approximately 10x longer and is constrained to only a portion of the state by available RAM. To run the 75m analysis for the whole state would require the AWS instance to be changed to one with more RAM in the launch_fame.py script.

Fauna RA plots

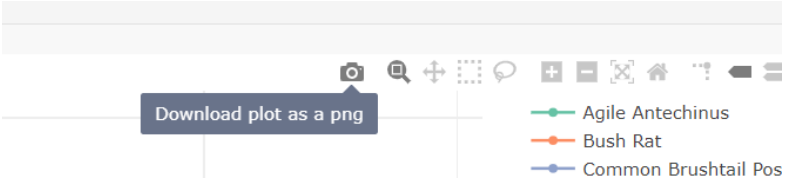
c. The RA plots widow displays two plots on which the user can chose results for for 1-7 species. Initially no taxa are shown. The user must select them from the top left drop down box. Once species have been selected, they are displayed with the legend indicating the name of each selected. To remove a species, use the arrow cursors and backspace in the dropdown box. The user can also use the slider on the right to change the time period that the graph covers.
The upper plot displays the summed relative abundance multiplied by 100 of the species selected for each SEASON



The lower chart shows change in relative abundance compared to the baseline season(s) chosen



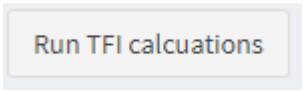
d. The charts can be copied and downloaded as a .png graphic – if you hover the mouse over the top of the chart a menu to do this will appear:



simply click to download the chart. If you want to change the aspect ratio of the plot change the width of your browser window before downloading

TFI calculations

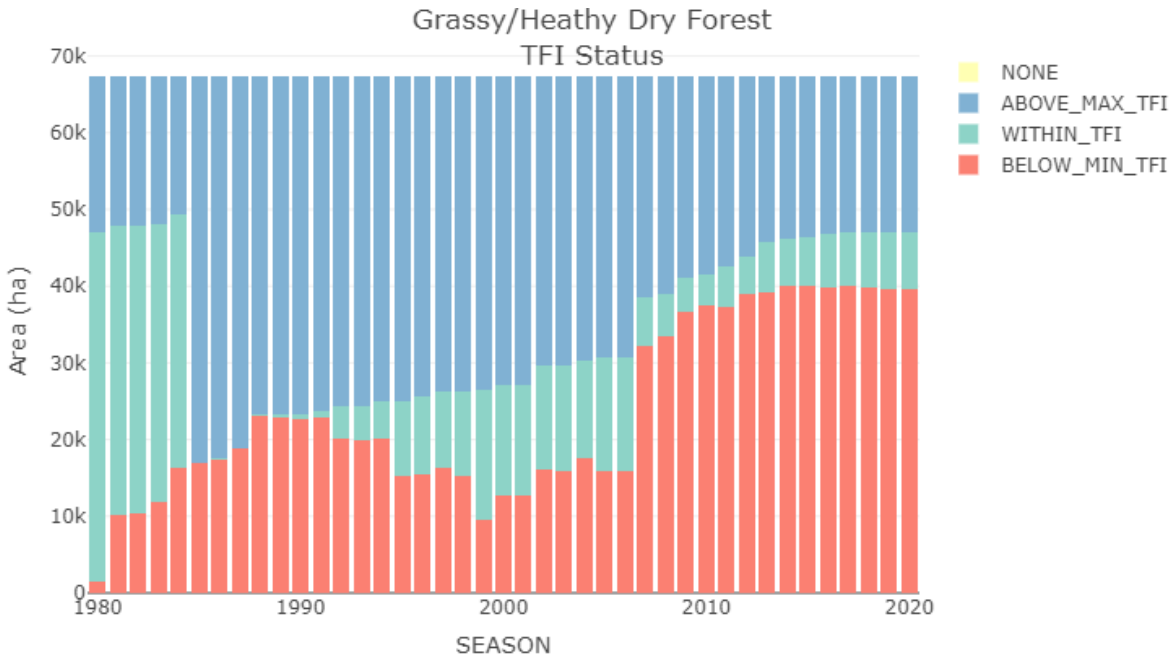
a. A single choice is required before calculating TFI status and BBTFI results. Whether or not to output individual TFI rasters for each SEASON – to do so incurs a small extra computation time. The Two BBTFI raster maps are output automatically.

b. To run the calculations, press the bottom centre button 

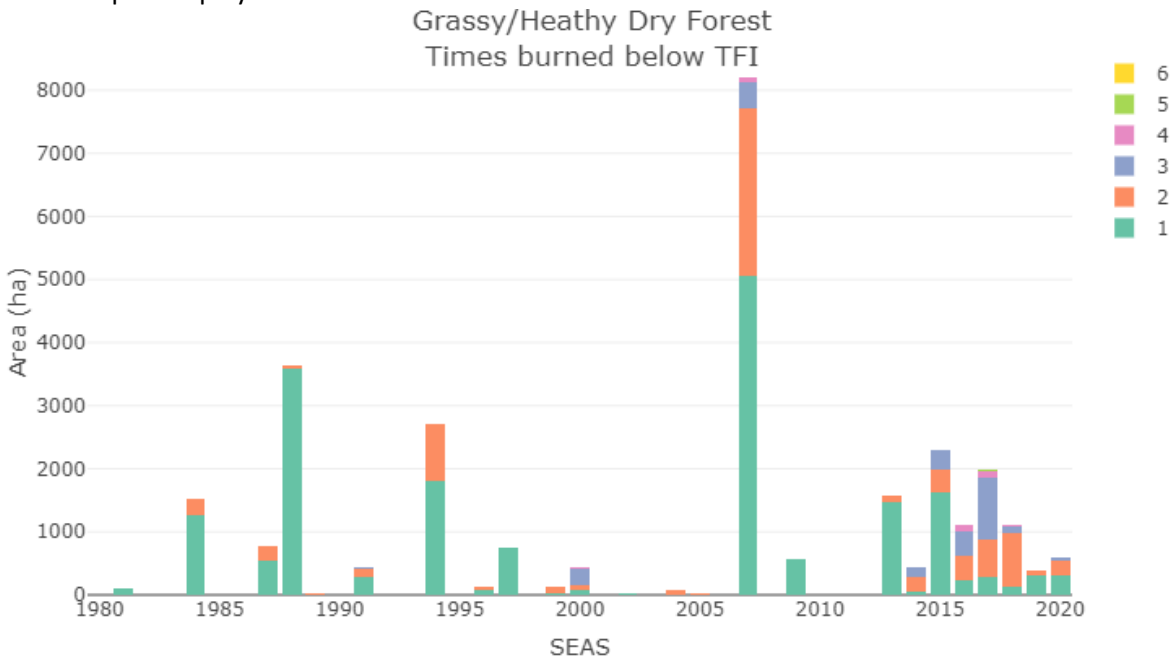
. This calcuation may take c considerable time (half an hour or more if a large areas is being calcuated – but considerably less time than the corresponding fauna RA calcuations. **The browser window must be left open while the calculations occur.** On completion of the calculations the app will automatically switch to the "TFI plots" tab.

TFI plots

c. The TFI Plots tab contains two interactive plots, the upper plot displays the area of an EFG within TFI below minimum or above maximum TFI in each SEASON of the analysis,



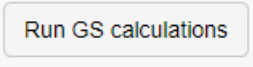
the lower plot displays the area and number of times burned below TFI in each SEASON.



The EFG and the time period to display are selected using the dropdown and slider at the top of the tab. Only a single EFG may be displayed at a time. The charts can be downloaded as .png in the same way as the relative abundance plots (see above).

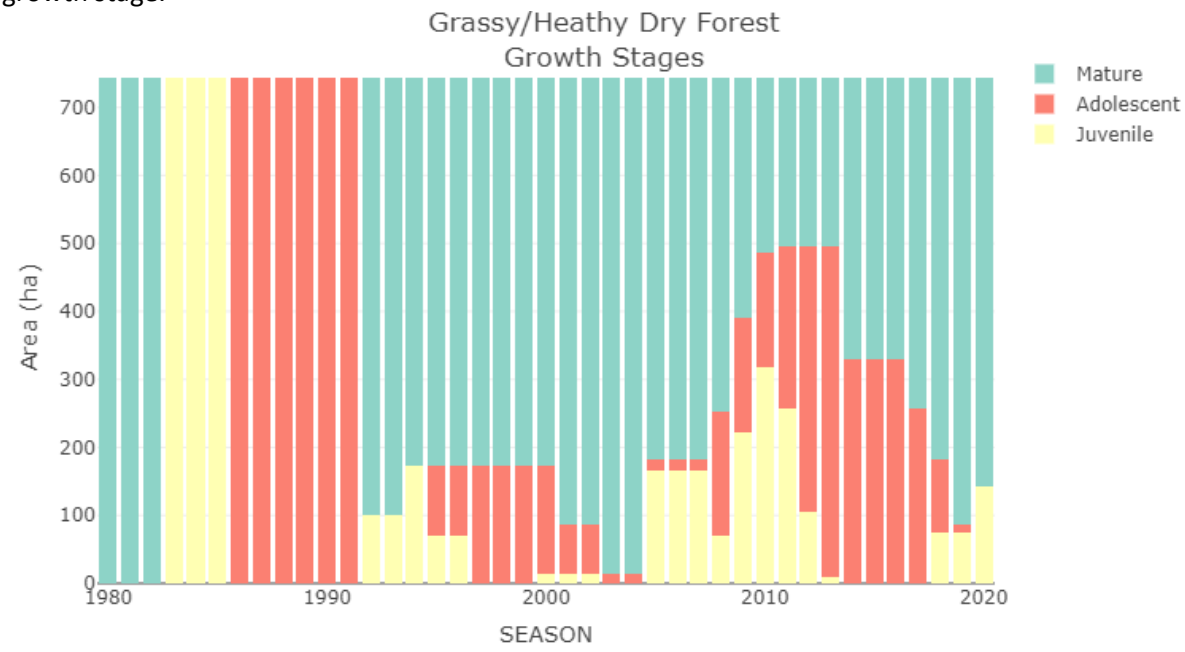
GS Calculations

a. There are no choices to be made before running Growth stage calculations

b. Press 

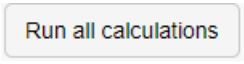
button to run the calculations. **The browser window must be left open while the calculations occur.**

c. The GS Plots tab contains a single plot showing the proportion and area of vegetation in each growth stage.



Run All Calculations at once

All of Relative abundance, Growth Stage and TFI calculations can be run together – once the revenant settings described above for each have been selected by pressing the



button on bottom right of the tab. **The browser window must be left open while the calculations occur.**

Stage six: Growth stage optimisation in Shiny

This document is a guide to using the growth stage optimisation (GSO) tool from the FAME v1.0 shiny app.

File formatting

There are several input files that you need to create in Excel or elsewhere to run the GSO in *R The files should also be saved as .csv (somma separate value) format*.

They require that you use the same headers and file name endings otherwise errors in the code may occur. (the name can be prefixed with individual details of the file, for instance the LMU name), Please note that ***R* is case sensitive**. The files should be stored in **./GSOinputs"**. This is taken care of by uploading them to the shiny server from the app interface.

The first .csv file required is ends with"Spp_EFG_LMU.csv" which can be generated using the utility in the FAME module on the utilities tab. The file includes the species that might be expected to be found in each EFG within the LMU (and will need manual validation of the species included) it has the form:

	A	B	C	D	E	F
1	COMMON	EFG_NO	EFG_NAM	TAXON_ID	CellCount	ha
2	Agile Ante	1	Coastal-Gr	11028	240	1215
3	Agile Ante	2	Coastal-W	11028	2470	12504.38
4	Agile Ante	3	Coastal-Sc	11028	3212	16260.75
5	Agile Ante	6	Heathlanc	11028	38933	197098.3
6	Agile Ante	7	Grassy/He	11028	232342	1176231

The second file required “LMU Area.csv” has the total area of each EFG within the LMU, with its EFG name and number.

	A	B	C
1	EFG_NO	EFG_NAME	ha
2	1	Coastal-Grassland	2490.75
3	2	Coastal-Woodland	23322.9375
4	3	Coastal-Scrub	29306.8125
5	5	Heathland (sands)-Little and Big Deserts	191387.8125
6	6	Heathland (sands)-General	376867.6875

The file ending “LMU_Scenarios.csv” has the information about the scenarios to be compared. The “PercLandscape” column is the proportion of that EFG in that GS. Therefore, they need to sum to 1 for an EFG within each scenario. For instance, in EFG 6 in the 2017 (current) scenario the proportions are 0.04, 0.06, 0.42 and 0.48, which add up to 1 (or 100%).

	A	B	C	D	E	F
1	EFG_NO	EFG_NAME	BGS_NAME	BGS_ID	Scenario	PercLandscape
2	6	Heathland (sands)-General	Juvenile	1	2006	0.075204844
3	6	Heathland (sands)-General	Adolescent	2	2006	0.180491625
4	6	Heathland (sands)-General	Mature	3	2006	0.744303531
5	6	Heathland (sands)-General	Old	4	2006	0
6	6	Heathland (sands)-General	Juvenile	1	2017 (current)	0.04
7	6	Heathland (sands)-General	Adolescent	2	2017 (current)	0.06
8	6	Heathland (sands)-General	Mature	3	2017 (current)	0.42
9	6	Heathland (sands)-General	Old	4	2017 (current)	0.48
10	6	Heathland (sands)-General	Juvenile	1	Strategy 1	0.13
11	6	Heathland (sands)-General	Adolescent	2	Strategy 1	0.11
12	6	Heathland (sands)-General	Mature	3	Strategy 1	0.34
13	6	Heathland (sands)-General	Old	4	Strategy 1	0.41
14	6	Heathland (sands)-General	Juvenile	1	Strategy 2	0.17
15	6	Heathland (sands)-General	Adolescent	2	Strategy 2	0.32
16	6	Heathland (sands)-General	Mature	3	Strategy 2	0.21
17	6	Heathland (sands)-General	Old	4	Strategy 2	0.3
18	7	Grassy/Heathy Dry Forest	Juvenile	1	2006	0

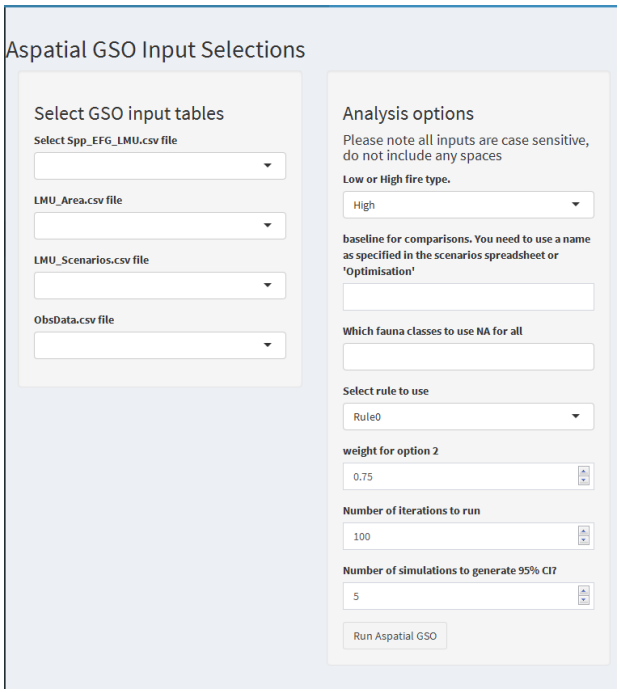
The next required is “ObsData.csv”. This contains the observational data, with each row containing the observations for one species at one survey site.

	A	B	C	D	E	F	G	H	I
1	SurvID	SurveyMethod	VBA_CODE	COMMON_NAME	EFG_NO	TSF	FireType	Response	DIVNAME
2	FBB_0984	Bird1	10235	Australian Hobby	7	4.58	Low	0	Birds
3	FBB_0985	Bird1	10235	Australian Hobby	7	20	Low	0	Birds
4	FBB_0986	Bird1	10235	Australian Hobby	7	30	Low	0	Birds
5	FBB_0987	Bird1	10235	Australian Hobby	7	NA	NA	0	Birds
6	FBB_0988	Bird1	10235	Australian Hobby	7	4.67	Low	0	Birds
7	FBB_0989	Bird1	10235	Australian Hobby	7	27	Low	0	Birds
8	FBB_0994	Bird1	10235	Australian Hobby	7	20	Low	0	Birds
9	FBB_0995	Bird1	10235	Australian Hobby	7	26	High	0	Birds
10	FBB_0996	Bird1	10235	Australian Hobby	7	1.75	Low	0	Birds
11	FBB_0997	Bird1	10235	Australian Hobby	7	8	High	0	Birds
12	FBB_0998	Bird1	10235	Australian Hobby	7	4	High	0	Birds
13	FBB_0999	Bird1	10235	Australian Hobby	7	72	High	0	Birds
14	FBB_1004	Bird1	10235	Australian Hobby	7	39	Low	0	Birds
15	FBB_1005	Bird1	10235	Australian Hobby	7	25	Low	0	Birds
16	FBB_1006	Bird1	10235	Australian Hobby	7	16	High	0	Birds
17	FBB_1007	Bird1	10235	Australian Hobby	7	NA	NA	0	Birds
18	FBB_1008	Bird1	10235	Australian Hobby	7	39	Low	0	Birds
19	FBB_1009	Bird1	10235	Australian Hobby	7	13	Low	0	Birds
20	FBB_1010	Bird1	10235	Australian Hobby	7	5	Low	0	Birds
21	FBB_1011	Bird1	10235	Australian Hobby	7	31	Low	0	Birds
22	FBB_1016	Bird1	10235	Australian Hobby	7	29	High	0	Birds
23	FBB_1017	Bird1	10235	Australian Hobby	7	29	High	0	Birds
24	FBB_1018	Bird1	10235	Australian Hobby	7	29	High	0	Birds

Options for GSO in Selected in shiny app

The shiny app provides a single screen GUI to select the four.csv file required and select all the settings required for t GSO to be run (these were previously handled by editing the text in the R file). All four must be selected even if one, the ObsData.csv file, is not used under Rule 0 (see below). The options are given in the table below.

Shiny GSO GUI



GSO Options

Option	Name in *R*	Options
Most recent fire type	FireType	"Low" or "High"
The scenario to use for comparisons	Comparison	This will depend on which scenario you want to set for comparisons, and what you called your scenarios. If you want to use the optimised solution, then type "Optimisation".
Which combination of data to use. Options range from exclusive use of expert opinion or observational data to various combinations of both. See below for what each option means.	Rule	"Rule0", "Rule1", "Rule1a", "Rule1b", "Rule1c", "Rule2", "Rule2a", "Rule2b", "Rule2c", "Rule3", "Rule3a", "Rule3b" or "Rule3c"
The weight to use when combining expert opinion and observational data if using "Rule2".	dWt	A number between 0 and 1, with 0 meaning no weight goes to the survey data (effectively "Rule0") and 1 meaning all weight goes to survey data (where available, effectively "Rule1").
The number of times we resample from the data to estimate the abundance index.	nrep	Number greater than 0. Default is 100.
The number of times we simulate the process, used to generate 95% confidence intervals.	nsim	Number greater than 0.

Background to decision rules in aspatial GSO

A workshop in July 2017 with researchers, policy and PBBOs concluded that the best way to use observational data and expert opinion in combination is not yet settled, and potentially different for different objectives and scenarios. Hence, some decisions still need to be made as to how the expert opinion and observational data should be combined. Currently there are 9 options:

- Rule 0 uses only the expert opinion;
- Rule 1 uses the mean of the observational data where available, and the expert opinion otherwise;
  - Rule 1a is similar to Rule 1, but uses the maximum instead of the mean;
  - Rule 1b is similar to Rule 1, but uses the median instead of the mean;

  - Rule 1c is similar to Rule 1, but uses the upper quartile instead of the mean;
- Rule 2 uses a weighted average of the mean of the observational data and the expert opinion where available, and the expert opinion otherwise.
  - Rule 2a is similar to Rule 2, but uses the maximum instead of the mean;
  - Rule 2b is similar to Rule 2, uses the median instead of the mean;
  - Rule 2c is similar to Rule 2, uses the upper quartile instead of the mean
- Rule 3 uses the mean of the observational data does not use the expert opinion. Please note this will restrict the model to EFG GS with observational data, and may therefore have a vastly reduced number of species considered.
  - Rule 3a is similar to Rule 3, but uses the maximum instead of the mean;
  - Rule 3b is similar to Rule 3, uses the median instead of the mean;
  - Rule 3c is similar to Rule 3, uses the upper quartile instead of the mean

Where expert data is used together with observational data the former needs to be recast into a scale that is comparable to observational data, e.g. with birds a commonly used method is a 20 minute / 2ha count. Currently, this recasting has been done for birds only (as part of testing these new methods). Further work is needed to check if the recast values are sensible as well as recasting data for other taxonomic groups e.g. mammals and reptiles. In the interim the expert estimations in the ordinal scale have been assumed to satisfy numerical scale characteristics but biometric advice suggests this is highly problematic. The main issue is that one of the assumptions of GMA is that the data on species' relative abundances are linearly related but this may not be satisfied with ordinal data as it could be any non-linear shape.

Considerations and decision points

- Are there sufficient numbers of species to provide a robust GSO if just using observational data?
- What analysis rule will be applied, including any weighting of observational data versus expert opinion. In general, the mean will be an appropriate choice to summarise the observational data. However, when the species of interest are rare in the environment, but are abundant when they are present, the maximum or upper quartile may give a better indication of the value of each GSO. When the species of interest have non-zero observations for at least half the observations, the median could be used, to be more robust to large outliers than the mean.

Running the GSO

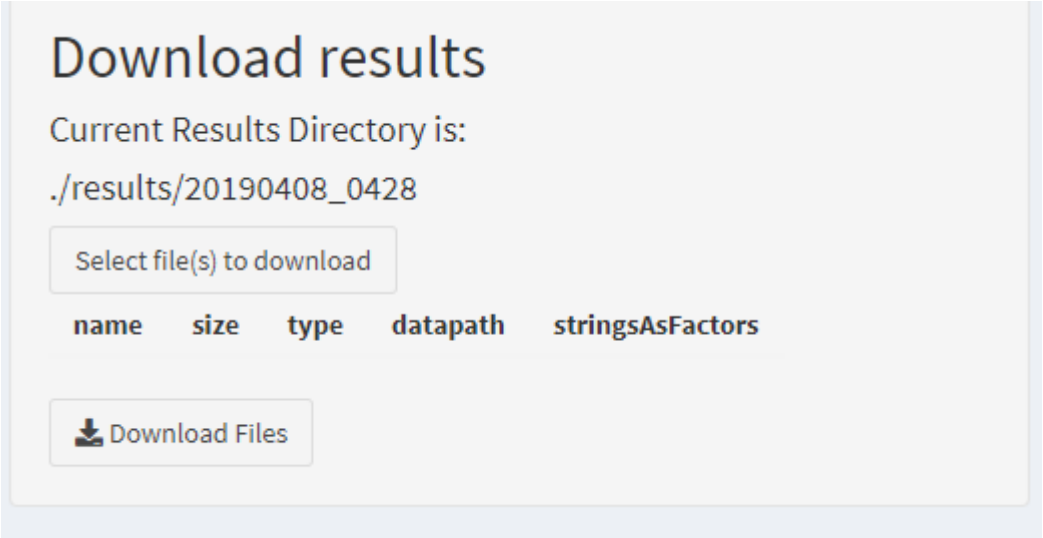
Once the data files are saved in the folder "./GSOInputs" and the model options are selected in the second coloured box the GSO is ready to run. To run the model, you just need to click the "Run GSO button at the bottom left of the GDSO shiny app window.

Note: this process may take some time depending on the amount of observational data, number of simulations required and the speed of the computer.

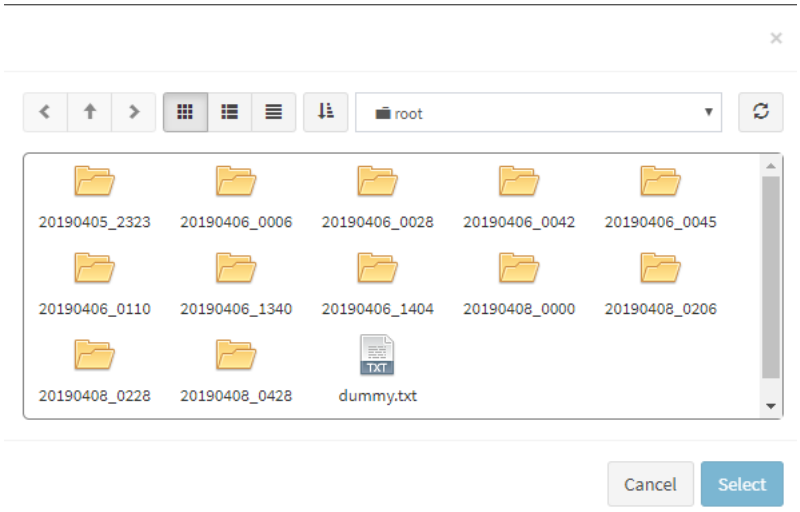
Once the analysis has run two files will be created. "GSO_Analysis_Output.docx which can be used as the basis of a report. It documents the options used, including model choices, EFGs and species used and produces some tables, plots and comparisons. A file "GSO Species Changes.csv" is also created to store the change in abundance index for each species and scenario. Note these files will be overwritten if the "Run GSO" button is pushed again.

Stage six: Downloading results from the module

a. Downloading results in handled from the "Download results" box at the bottom right of the Utilities tab:



Click on the Select (files) to download button to open a download dialog box:



this opens a file browser window, which will display all the directories of results data on the server, plus a file called dummy.txt. Each session of FAME creates a results directory named <YYYYMMDD_HHMM> (numerical date time to the nearest minute) when the session is opened. All results are housed in this directory.

The "Download Results" box provides the results directory name for the current session for easy identification.
If you wish to download all results from the current session select this directory in the file browser window along with the "dummy.txt" file (this last step is necessary because the browser will only download a directory when a file is also identified for download – you will simply ignore the dummy .txt file after download).

Alternatively you can browse the contents of the individual download directories and select files and directories therein for download.

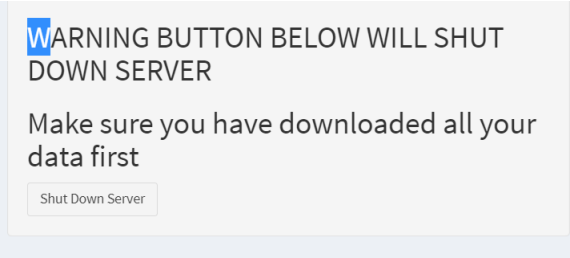
When finished selecting, press the select button at the bottom right of the file browser window.

b. The Download results box will then display the list of files (or directories containing files) that you have selected for download. To complete the process, click the "Download files" button at the bottom of the box. This will zip your selection and download to a file named output.zip in your local downloads directory. From here it can be unzipped, and the contents examined. Details of the structure and content of each of the files in the downloads directory is given in FAMEv1.0_Inputs_Outputs.doc

Additional utilities

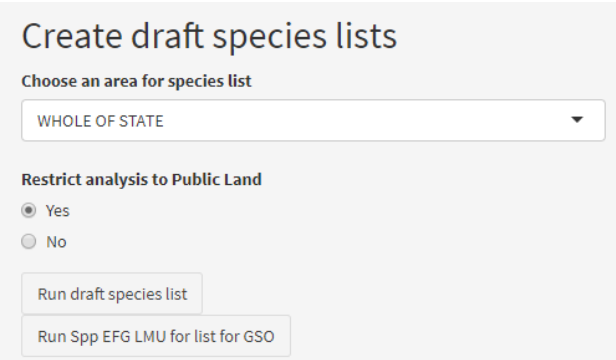
Shut Down Server

You can shut down the server when running on AWS the utilities page has a button on the bottom left of the utilities tab. This will shut down the server, **any data that has not been downloaded will be lost**. This button is provided to save running costs when the server is not in use.



Draft species list

The Utilities page includes an option to create a draft species list – this also estimates the proportion of the species range within the area of interest.



This is useful if you are unsure which species it may be appropriate to include in your analysis**. It should only however be considered as a starting point for a custom list, the list will need expert input to determine which species are present and relevant to the study area**. The proportion of the species range is calculated on the number of cells of the 225m binary HDM for the species in the area of interest, and may be further restricted to those on public land only.

To run this tool select a previously uploaded polygon for the area of interest, or one of the LF_Regions, chose whether or not to calculate only the proportion occurring on public land, and press the Run draft species list Button. This file can be downloaded using the download procedure described above. You can then edit the "Include" and Make Raster columns as required to finalise your custom species list. This should be renamed and uploaded to the module for further processing.

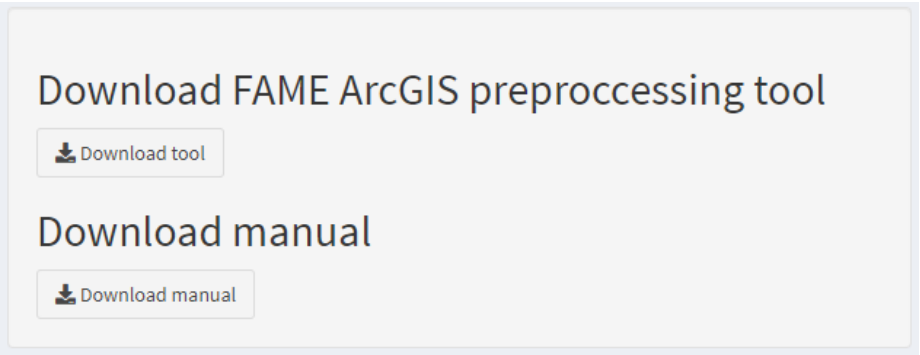
EFG_AREAS and spp_EFG_LMU files

Two further files required to run the aspatial GSO calculations the EFG_AREAS and spp_EFG_LMU files are also calculated by this Utility , press the "Run Spp EFG LMU for region to create these files. These files will need manual editing to remove "noise", e.g. those EFGs with a marginal occurrence in the area interest.

Download of manual and ArcGIS Pre-processing tool.

The utilities page incudes buttons to download and view the Manual for the app, and the pre-processing tool and associated files, including an AcrMAP project file (.mxd) with a demo dataset loaded.

Simply push the button s on the bottom left of the utilities tab to download these files.



Cheal, D. 2010. Growth stages and tolerable fire intervals for Victoria's native vegetation data sets. Fire and Adaptive Management Report 84, Department of Sustainability and Environment, East Melbourne, Victoria.

Porigneaux, J.-M., M. Baker, J. MacHunter, and P. Moloney. 2017. Guide to Geometric Mean of Abundance (GMA) Analyses and Vegetation Growth Stage Structure (GSS) Optimisation, version *

Appendix 1 Inputs/Outputs of FAME.

ARCGIS/ Windows pre-processing:

Pre-processing of the input fire history polygons is required in ArcGIS, this creates a file that is then loaded to the server for processing.

Hardware and software requirements:

Windows 7 or 10 PC with ARCGIS 10.3.1, 8GB ram.

Inputs

Code.

ArcMap v10.5 or later toolbox “FAMEv2.0.tbx”

Data Files

Two fire sequence polygon datasets (either shapefiles or file geodatabase) in VICGRID94 projection, one giving the fire history (ie past fire events) and the other giving a future fire scenario. The Template is based on the required fields from the corporate FIRE_HISTORY dataset. In each dataset the polygons must have at least the attributes SEASON and FIRETYPE (Table1). Other attributes can be present in the attribute table, they will be deleted from the output.

Each combination of fire SEASON and FIRETYPE must be represented by a separate polygon (ie each polygon may only have one SEASON and FIRETYPE).

Field Name	Permissible values	Datatype	Length
SEASON	4 digit year value for the SEASON of the fire event >=1755	SHORT INTEGER	
FIRETYPE	“BURN”,“BUSHFIRE”,”OTHER”,”UNKNOWN”	STRING	50

Table 1. Required attribute fields for Fire History and Fire Future input feature classes.

A polygon shapefile containing polygon(s) to be selected as the boundary of the analysis area to be clipped from FireHistory and FireScenario above. Either an Adhoc polygon created by the user or polygon(s) selected from the supplied LF_REGIONS.shp which is a local copy of the LF_DISTRICT layer in the CGDL database.

Outputs

Shapefile with same fields (SEASON, FIRETYPE) as the input file, combining all the fire events into a single file clipped to the boundary selected.

Inputs

Directory structure.

All files (inputs and outputs) should be located in a single main (root)directory, and subdirectories thereof. Files are shown below with their unix “dot notation” to indicate their location in this root directory The subdirectories contained in this main directory (./) are :

./AdHocPolygons

./CustomCSV

./FH_Outputs

./GSO

./GSOInputs

./HDMS

./HDMS/225m/BinaryThresholded

./HDMS/225m/BinaryThresholded

./InputGeneralRasters

./rawFH

./ReferenceShapefiles

./ReferenceTables

./results/<YYYYMMDDHHMM>

> Subdirectories of the results directory are created each time the application is started, these are given the name of the numeric datetime string at their creation. Note that on AWS these times will be UTC not local time.

./www

Files for spatial relative abundance TFI an BBTFI calculations

Fire History Shapefile

Output File shapefile from Stage 1. Shapefile of selected polygons defining boundary for Ad Hoc study area boundary, if required. This file should be placed in the directory ./rawFH

R script files.

./TFI_functionsShiny.r

./EcoResFunctionsShiny.r

> These two files contain all the r functions used in calculations. The purpose individual functions are briefly described in the file themselves.

./global.r

./server.r

./ui.r

./disableWhenRunning.js

./ButtonDisableHelpers.r

> These five files are the constituent files required to run the shiny app – the global file provides setup and loads the functions and required r packages. The ui provides the user interface for shiny and the server serves data and outputs to the UI and saves results to disk. The last two files provide javascript and a number of functions which disable buttons in the interface while processing is running, and provide basic return of error messages to the ui if a process fails to complete. These last two files were sourced and adapted from examples found in web help groups.

./makeHDMVals.r

This file is provided for reference it is used to convert the HDM rasters into sparse matrices for use in the module

Reference / Lookup Tables

./ReferenceTables/DraftTaxonListStatewidev2.csv

List of fauna HDM rasters (577) includes VBA species #, threat status, taxonomic divisions

Field Name	Details
TAXON_ID	VBA 2016 Taxon ID for the species
HDMPath	The Path to the 225m version of the HDM for the species
ShortName	for internal use only
Include	Whether or not the species should be included in the analysis
MakeRasters	Whether or not abundance rasters should be made if the option is selected in the UI
COMMON_NAME	VBA common name for the species
NAME	VBA systematic name for the species
DIVNAME	The broad taxonomic division (class) that the species is in
FFG_ACT_STATUS	Conservation status under *the Flora and Fauna Guarantee Act 1988*
EPBC_ACT_STATUS	Conservation status under the Commonwealth *Environmental Protection and Biodiversity Conservation Act*
VIC_ADVISORY_STATUS	Conservation status in the DELWP advisory list of threatened Fauna.
SigThreshold.x	significant threshold for impact based on Vic Advisory conservation status
SigThreshold.y	significant threshold for impact based on EPBC conservation status
CombThreshold	Combination of the above two fields to give threshold used in calculations of charges in relative abundance tables

./ReferenceTables/VBA_FAUNA.csv

Common names and codes for fauna used for aspatila GSO calcuations
(Untimately this file would be replaced with the similar .\ReferenceTables\DraftTaxonListStatewidev2.csv used in the spatial relative abundance part of the module, Reconciliation of fieldnames in the GSO will be required before this can occur).

Field Name	
SPEC_NO	Old Atlas of Victorian Wildlife Number for the species
COMMON_NAME	VBA common name for the species
NAME	VBA systematic name for the species
DIVNAME	The broad taxonomic division (class) that the species is in
TAXON_ID	VBA 2016 Taxon ID for the species

./ReferenceTables/EFG_EVD_TFI.csv

Look up of TFI parameters for EFGs csv copy of Lookup in CGDL “EFG_EVD_TFI”

Field Name	Details
OBJECTID	Object _ID for ArcGIS table (not used)
EFG_NUM	EFG Number,99 for no EFG
EFG_NAME	EFG Name
EVD_NUM	EVD Number (Not Used)
EVD_NAME	EVD Name (Not Used)
MIN_LO_TFI	Minimum TFI(Tolerable Fire Interval) (integer years) for low intensity fire
MIN_HI_TFI	Minimum TFI (integer years) for high intensity fire
MAX_TFI	Maximum TFI (integer years)

./ReferenceTables/OrdinalExpertLong.csv

Long table format of species responses based on expert opinion

Field Name	Details
COMMON_NAME	Common Name of Fauna Taxon (same as VBA 2016)
FireType	Low or High (intensity)
EFG_GS	Composite String of EFG number and growth stage (not used)
Abund	Relative abundance for the EFG and growth stage Numeric 0-1 or NA for absent or no-data
EFG_NO	EFG Number
GS4_NO	Growth stage (4 classes) 1:4
TAXON_ID	VBA TAXON_ID

./ReferenceTables/EFG_TSF_4GScorrectedAllEFGto400yrs.csv

Growth stage to TSF lookup

Field Name	Details
EFG_NO	EFG Number
EFG_NAME	EFG Name
GS4_NO	Growth stage (4 classes) 1:4
Start	Start of growth stage (from source data, not used) age in years
End	End of growth stage (from source data, not used) age in years, end age is equal to start age of next GS
startInt	Integer values for GS4_NO 2:4 startInt=Start+1 to create exclusive ranges
endInt	endInt= integer version of End
YSF	Age of vegetation in Years (0-400) “Years Since Fire

./ReferenceTables /TBL_VegetationGrowthStages.xlsx

Source of lookup for EFG full names used in aspatail GSO. (Ideally this file would be replaced with the similar .\ReferenceTables\EFG_EVD_TFI.csv.csv used in the spatial relative

abundance part of the module. Reconciliation of fieldnames in the GSO will be required before this can occur).

Field Name	Details
EFG_NO	EFG Number
EFG_NAME	EFG Name
GS_NAME	Original (Cheal 2010) growth stage name
BGS_START	Start (in years from fire) of Broad Growth Stage
BGS_ID	Integer ID for broad growth stage **1** Juvenility **2** Adolescence **3** Mature **4** Old **5** Unassigned EVC **6** Invalid vegetation
BGS_NAME	Juvenility Adolescence Mature Old Unassigned EVC Invalid vegetation

./ReferenceTables /ExpertEstimate.csv

Expert opinion data as an amount of birds, used in recalibration of expert opinion data for use in conjunction with observation data in aspatial GSO.

Field Name	
COMMON_NAME	VBA common name for the species
TAXON_ID	VBA 2016 Taxon ID for the species
None	Amount (always zero) considered to occur when original FFO abundance value ==0
Few	Amount considered to occur when original FFO abundance value ==1
Some	Amount considered to occur when original FFO abundance value ==2
Lots	Amount considered to occur when original FFO abundance value ==3

./ReferenceTables/HDMSums225.csv

Total # of thresholded cells of each HDM

Raster files used in calculations

./InputGeneralRasters/EFG_NUM_225.tif

./InputGeneralRasters/EFG_NUM_75.tif

Rasters of EFG number for the state.

./InputGeneralRasters/IndexVals225.tif

./InputGeneralRasters/IndexVals75.tif

Rasters providing a sequential index number for each cell in the state.

./InputGeneralRasters/LF_REGION_225.tif

./InputGeneralRasters/LF_REGION_75.tif

Rasters providing numbered cells (1:6) for the six DELWP fire regions in the state.

Cell Values of Rasters of HDMs at 75m and 225m pixel size

The values stored as lists of sparse ngCmatrices within list each are the values for a single species raster named by the species TAXON_ID. name for each column is the VBA TAXON_ID for the species. the rows of these matrices are indexed to ./InputGeneralRasters/IndexVals225.tif and ./InputGeneralRasters/IndexVals75.tif.

./HDMS/HDMVals225list.qs

./HDMS/HDMVals75list.qs

./HDMS/ HDMVals225.qs (this file has the list of matrices in ./HDMS/HDMVals225list.qs combined as columns into a single larger matrix.

These files allow the compact storage of the presence/absence values form the Binary HDMS (Otherwise about 6Gb as compressed tiffs. The R script to generate these sparse matrices is ./makeHDMVals.r. These sparse arrays provide faster loading and look-up of the HDM footprints and are used instead of the HDM rasters themselves in the module.

Graphics files used in the UI

./www/ajax-loader.gif

Loader animation – open source

./www/FAME.png

./www/08732250_before_after_2014_fire.jpg

Header text and image on the home screen

./www/Fire-animation.gif

./www/LinktoCreativeCommonsWikiFor Fire Animation.gif.txt

Gif animation displayed when processing is occurring, and text file giving details of creative commons licence location.

Input settings

In addition to the input files there are a number of settings that must be, or can optionally be, chosen before running the Spatial Relative Abundance, and TFI calculations.

Setting name	Purpose	Values
Fire Scenario Analysis		

Fire scenario shapefile	The fire sequence (combination of fire history and future fire scenario) to be analysed.	Shapefile produced in the preparatory ARCGIS tool and uploaded to module
Region for analysis	Sets the boundary of the analysis. Analysis should be restricted to only the area of interest to minimise computation time. Usually this boundary should correspond to the clipping boundary used in the ARCGIS preparatory too to create the fire sequence for analysis, however the analysis will still run if these boundaries differ (as long as they overlap each other. Areas outside the clipping of the Fire scenario will be set to NA. If the region chosen is within the Fire Scenario area clipped, the analysis will be restricted to the region chosen.	Whole of State (Default) Ad Hoc polygon (user-provided shapefile in VG94 projection of the boundary of the region of interest) or One of the DELWP Fire regions "BARWON SOUTH WEST"=1, "GIPPSLAND"=2 , "GRAMPIANS"=3, "HUME"=4, "LODDON MALLEE"=5, "PORT PHILLIP"=6,
Raster Resolution	Sets the resolution used for analysis, this is important in determining memory requirements and processing speed. Use of 75m raster increases processing and memory requirements ~10x	225 m (default) 75 m
Public Land Only	The analysis can be carried out across both public and private land, however fire history is much less complete for private land.	Yes(Default) No
Other and Unknown fire value	Fire history may contain fires of unknown type, you need to decide how to treat these in the analysis. They may be treated as either a bushfire or a burn, or alternatively areas with an unknow fire type may be treated as “NA” values. If the latter is chosen then TFI status, and relative abundance for the cell cannot be calculated based on that fire.	Bushfire (Default) Burn NA
First season for analysis output	Start the analysis at the first season which may be of interest, this reduces processing time, particularly in the Relative abundance calculations (that loop year by year). Calculations occur for each season from the first chosen to the maximum season value in the fire sequence.	1980 (default) Any season after the first season in the fire sequence file provided
Spatial TFI and Relative abundance calculations		

Enter start and end of abundance baseline period	Set the seasons to be used to calculate the baseline relative abundance used to calculate % change from baseline. It can be a single year or a range of years.	1980,1980(default) Any single year, or range of years after 1979 contained in the fire sequence For a single year chose the same value for start and end
Use default or custom species list	The default is to calculate species responses for all species that have relative abundance data, and to plot relative abundances Rasters for all the species that have RA calculated (as an option). Reducing either of these lists to the species of interest in the region only will significantly reduce calculation times and make outputs easier to handle.	Default: Standard species list (all species that have RA data available are calculated whether or not they occur in the region of interest). Alternative values: Uploaded manually edited draft species list produced using the "create draft species" list utility in the app
Use default or custom relative abundance	Where sufficient field data is available the expert opinion data may be replaced with models based on this field data. In other cases, there may be regional variations in responses that are not addressed in the statewide data. Further the current FFO data only addresses treatable EFGs. Ideally as the available curated response data improves the default dataset would be updated to these values	Default relative abundance uses statewide expert opinion data of relative abundance for each growth stage and EFG and firetype available (previously known as the FFO dataset). Custom uses a user uploaded and created dataset of relative abundance (range 0-1), for each species and EFG growth stage. This must be formatted in exactly the same format as the default .csv file
Make relative abundance rasters	Whether to output individual Species x Season relative abundance rasters. These provide the spatial view of changes in abundance for each taxon through the fire sequence, however they increase the computation time.	No (default for more rapid computation Yes (if spatial output is desired). Note if yes is chosen the default is to do this for each species for each year from the first year for analysis- This can result in a very large number of files being created and require increased download and storage space.
Make TFI status/BBTFI rasters	Whether to output individual season TFI status rasters. Has slight increase in computation time. And data storage/ download requirements	No (default) Yes

Outputs

Preparatory ARGIS tool – separate process on windows PC.

Shapefile (four component files .shp,.dbf, .shx, .prj) in Vicgrid94 projection. Required as precursor to all subsequent spatial RA and TFI related calculations in the module.

Outputs created by FAME.

All outputs created by the module are saved in ./Results/YYMMDDHHMM/ directory or subdirectories thereof.

Fire scenario analysis.

The initial fire scenario analysis replaces the previous corporate "FireHAT" processing. It creates a shapefile that contains on polygon for each unique spatial sequence of fire events. The file (actually four files .shp,.shx,.prj.and .dbf. Collectively these are referred to as the "FH anaylsis". An R data file is also saved this contains the same data, plus metadata about the analysis and a raster with the polygon ID values (to allow linking of the FH analysis vector data to further analysis in a raster environment.

The file names and locations:

./FH_analysis_<name_of_input_rawFH file>.shp

The polygon attributes are:

Field Name(s)	Description of values contained	Example/ or possible values
SEAS01 … SEASxx	The date of sequential fire seasons for fires in the area of the polygon, SEAS01 gives the date of the first (oldest recorded) fire at each location. SEASON02 the next fire for SEASxx, xx= greatest number of sequential fires occurring in the study area.	Four-digit integer fire SEASON eg 1980 or 2055. 0= No fire NA= No fire R Sf_DataFrame
FireType01 … FiretypeXX	The Fire type corresponding to the SEAS01 … SEASON xx value	Single digit integer 1=Burn 2=Bushfire 3=Other 4=Unknown 0=NULL NA=NULL in R Sf_DataFrame
INT01 … INTyy where yy=xx-1	The inter-fire interval between sequential fires at a location. INT01 is the interval (in years) SEAS02-SEAS01	Integer value >=1 0= No interval NA=No interval in R Sf_DataFrame
YSFXXXX … one field for each year including and after the First season for analysis output	The number of years (fire seasons) since the last fire at the location prior to season date XXXX	Integer

LBYXXXX one field for each year including and after the First season for analysis output	The last SEASON (up to XXXX) when the pixel was burned	Integer (SEASON)
LFTXXXX one field for each year including and after the First season for analysis output	The type of the last fire (up to (XXXX)	Fire type 1,2
ID	1 based index unique id for each polygon Present in shapefile and R SFDF	1: number of polygons
FID	Zero based index unique ID for each feature in shapefile, not present in SFDF	0:(number of polygons-1)

An Rdata file named “FH_analysis_”<name_of_input_rawFH file>.Rdata stored in the ./FH_Outputs directory s0 they can be reloaded contains three R objects, each of these is a list containing further objects

R - Object	Objects listed within it	Details
FHanalysis	TimeSpan	Time span of fire seasons contained in the input fire scenario Min (SEASON):max(SEASON)
	YSFNames	Names of the YSF fields in the FHanalysis
	LBYNames	Names of the YSF fields in the FHanalysis
	LFTNames	Names of the YSF fields in the FHanalysis
	FireScenario	The input fire scenario shapefile analysed
	RasterRes	The raster resolution output from the anaysis(75 or 225)
	ClipPolygonFile	The polygon used to clip the analysis extent if one of the standard options is used then this will be "LF_REGIONS.shp", if an Ad hoc polygon was selected it will be the name of the ad hoc polygons shapefile.
	Region_No	Integer value corresponding to the Region selected for the clipping polygon (see Inputs: Region for analysis)
	PUBLIC_ONLY	Whether the analysis was restricted to public land only (TRUE or FALSE)
	name	The name of the output FHanalysis . Rdata file
	FH_IDr	R raster object with the extent of the clip polygon. Cell values are the values of the FHanalysis polygon ID values (Note not the FID values from the shapefile)
	OutDF	The R Simple Features Dataframe containing the results of the vector FHanalysis.

CropRasters	Raster	R raster with extent equal to the Clippolygon, positive integer value for cells within the Clippolygon (value = FHanalysis$ Region_No) NA for all other cells.
	Extent	Extent object for Raster above
	clipIDX	Index values for all cells within the clip polygon from ./InputGeneralRasters/IndexVals225.tif or ./InputGeneralRasters/IndexVals75.tif Corresponding to RasterRes, Used for fast extraction of HDM values etc from corresponding rasters and arrays
	IDX	Indices of cells of ./InputGeneralRasters/IndexVals225.tif or ./InputGeneralRasters/IndexVals75.tif Corresponding to RasterRes, For each cell of cropRasters$Raster
	EFG	Cell wise EFG_NO values for cells in the rectangular extent of cropRasters$Raster
	RGN	Cell wise FIRE Region_No values for cells in the rectangular extent of cropRasters$Raster
	DELWP	Cell wise DELWP Region_No values for cells in the rectangular extent of cropRasters$Raster
	FIREFMZ	Cell wise Fire Management Zone values for cells in the rectangular extent of cropRasters$Raster
	PLM	Cell wise 1 for public land 0 for not public land
	HDM_RASTER_PATH	The path to the HDM raster files corresponding to the RasterRes
allCombs	U_AllCombs_TFI	Data table containing all unique combinations of FH_ID(ie unique fire history), EFG, FIRE_RGN, DELWP, FIRE_FMZ, and PLM for the area of interest. Indexed to Index_AllCombs
	Index_AllCombs	the per cell indces of U_AllCombs_TFI rows

TFI status and Burned below TFI

An .Rdata file containing the results and intermediate steps of the analysis is saved : with the name

./“FH_analysis_”<name_of_input_rawFH file>_TFI.Rdata

Tabular outputs

./TFI_EFG_SUMMARY.csv

Summary of the area of each EFG under TFI in each SEASON

Column	Value
EFG_NAME	EFG Name
TFI_STATUS	NONE = no TFI Status (either no EFG, no fire history or not included in analysis) BELOW_MIN_TFI

	WITHIN TFI ABOVE_MAX_TFI
SEASON (4-digit year)	SEASONS from the first season selected for analysis outputs to the maximum season value in the fire scenario
	Cell value : Area in hectares

./TFI_LONG.csv

Long format table of area in each TFI Status grouped on EFG_NAME, FIRE_FMZ_NAME, FIRE_REGION_NAME, DELWP_REGION, PLM, and SEASON. Used for Statewide Fuel management reporting.

Column	Value
EFG_NAME	EFG Name
FIRE_FMZ_NAME	Fire FMZ name
FIRE_FMZ_SHORT_NAME	
FIRE_REGION_NAME	Fire Region Name
DELWP_REGION	DELWP REGION Name
EFG	EFG Number
FIRE_REG	Fire Region Number from CGDL LF_REGION
FIREFMZ	Fire management Zone Number
PLM	Public land (according to PLM_GEN in CGDL 0= Not public land, 1= Public land
DELWP	DELWP REGION number
SEASON	SEASONS from the first season selected for analysis outputs to the maximum season value in the fire scenario
TFI_VAL	-99 NONE 0 WITHIN_TFI 1 BELOW_MIN_TFI 5 ABOVE_MAX_TFI 6 ABOVE_MAX_BELOW_MIN_HI_TFI
nCells	Count of number of raster cells in category
Hectares	Area in hectares
TFI_STATUS	NONE = no TFI Status (either no EFG, no fire history or not included in analysis) BELOW_MIN_TFI WITHIN TFI ABOVE_MAX_TFI ABOVE_MAX_BELOW_MIN_HI_TFI

./TimesBBTFI_SUMMARY.csv

Cross-tabulated summary of the areas burnt below TFI by EFG

Column	Value
EFG_NAME	EFG Name
NA ,1-x	Number of times burned below TFI (these are exclusive not additive, ie an area burned 6 times below TFI will not also be included in the areas burned 1-5 times below TFI, so the sum of the row gives the total area burned below TFI. NA= not ever BBTFI
	Cell value : Area in hectares

./BBTFI_LONG.csv

The long- format version of TimesBBTFI_Summary.csv. Can be formatted for reporting as required. Used for Statewide fuel management report.

Column	Value
EFG_NAME	EFG Name
FIRE_FMZ_NAME	Fire FMZ name
FIRE_REGION_NAME	Fire Region Name
DELWP_REGION	DELWP REGION Name
PLM	Public land (according to PLM_GEN in CGDL 0= Not public land, 1= Public land
SEAS	SEASONS from the first season selected for analysis outputs to the maximum season value in the fire scenario
FireType	The Fire Type leading to the BBTFI event 1= BURN 2 =BUSHFIRE
TBTFI	Number of Times the area has been burned below TFI
Hectares	Area in hectares

Raster outputs

./TFI_Rasters/ TFI_BY_YEAR.tif

TFI_BY_YEAR.tif.vat.dbf

TFI_BY_YEAR.tfw

TFI_BY_YEAR.tif.aux.xml

Columns	Value
TFI_xxxx	TFI status in SEASON xxxx.
	Cell TFI value for SEASON -99 NONE 0 WITHIN_TFI 1 BELOW_MIN_TFI 5 ABOVE_MAX_TFI 6 ABOVE_MAX_BELOW_MIN_HI_TFI

TIF raster file readable in ARGGIS with Raster attribute table (RAT)

./TFI_Rasters/TFI_STATUS_LUT.csv

A lookup table giving the TFI status values and names.

./BBTFI_Rasters/BBTFI_BY_YEAR.tfw

BBTFI_BY_YEAR.tif

BBTFI_BY_YEAR.tif.aux.xml

BBTFI_BY_YEAR.tif.vat.dbf

TIF raster file readable in ARGGIS with Raster attribute table (RAT) giving values for times burned below TFI for each year. The SEASON when first BBTFI and the total number of times BBTFI to date. Grouped by same values as BBTFI_LONG.csv (Above). Also give values for min and max TFI for each group.

Additional columns in RAT are

Columns	Value
TBTFI_xxxx	If burned below TFI in SEASON xxxx, the number of times BBTFI by that SEASON otherwise empty
FireTYPE_xxxx	FireType for resulting in BBTFI event for season otherwise empty
FIRSTBBTFI	The SEASON when first burned below TFI if never Burned below TFI then empty.
totalTimes	Total number of times burned below TFI

Spatial Relative Abundance of Fauna.

Tabular Outputs.

./SpYearSummSpreadbyYearLong.csv

Summary of the proportionate species relative abundance for each season after the current year in the dataset, compared to the baseline years set.

Column	Value
1:8	Details are the same as./ReferenceTables/DraftTaxonListStatewidev2.csv.
SEASON	SEASON
SUM_RAx100	Sum of calculated relative abundance x100 (to convert decimal to integer) for that species.

./SpYearSummWide.csv

Wide format of above data ./SpYearSummSpreadbyYear.csv provided for further analysis if required

./SppSummChangeRelativetoBaseline.csv

Comparison of the calculated summed relative abundance in each season to benchmark and threshold value. Used to determine number of species , and which species decline to below a threshold level in reporting.

COLUMN	Value
1:7	Details are the same as./ReferenceTables/DraftTaxonListStatewidev2.csv.
XXXX-YYYY(4 digit SEASON)	Proportion of benchmark value in that season
NoLessthanThreshhold	Number of times (in the seasons in preceding columns, that the summed relative abundance was below the threshold).
LastLessThanThreshold	TRUE/FALSE. Whether the species relative abundance was below the threshold in the final year of the scenario.

./SppConsideredInAnalysis.csv

Table including only those species that were considered in the analysis – ie those selected for inclusion in the input species list, that had HDMS intersecting with the analysis area. Details are the same as./ReferenceTables/DraftTaxonListStatewidev2.csv.

Raster outputs

Optional output is output of species rasters is "Yes" in UI. (Potentially many thousand rasters. One raster will be produced for each Species selected in MakeRasters field of input species table, and for each year selected in the UI. The cell value is the relative abundance x100.

Filenames are:

./RA_Rasters/Sp_XXXXX_YR_YYYY.tif

Where XXXXX is the VBA TAXON_ID and YYYY is the SEASON.

Files for aspatial GSO calculator chosen in inputs

The process for running the GSO calculator from R studio was documented previously. A revised version of this file describing the process for running GSO from the shiny app is included in stage six of workflow above (page 11).

R and Rmarkdown files.

./GSO/ GSO_Functions.R

R file contains all the functions for the GSO analysis

./GSO/GSOAnalysisCodeShiny.R

R file that runs the GSO analysis

./GSO/GSOAnalysisOutput.Rmd

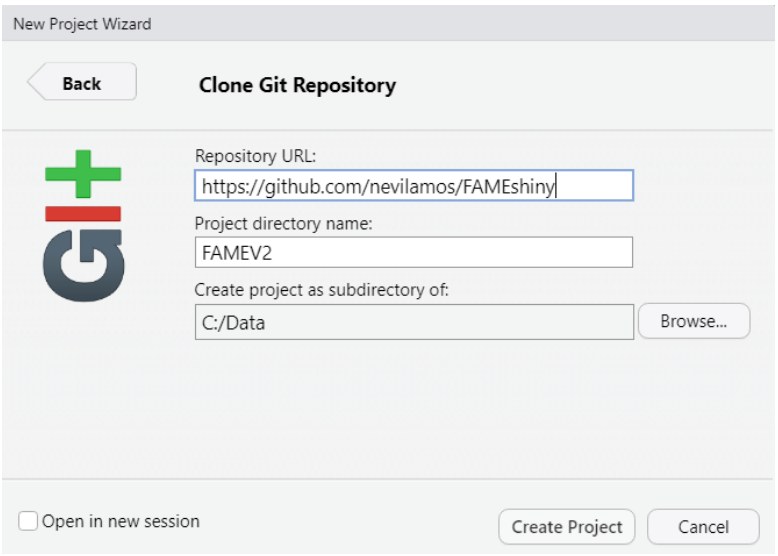
An R markdown file that when run calls GSOAnalysisCodeShiny.R and writes the results of the analysis and accompanying explanatory text to an MS word .docx file.

./GSO/ GSOSettings.r

Appendix 2 Local Installation of FAME from Github.

Install R v4.02 or later and R- Studio v1.4 or later.

Open R studio and chose File >> New Project >> Version Control >> Git

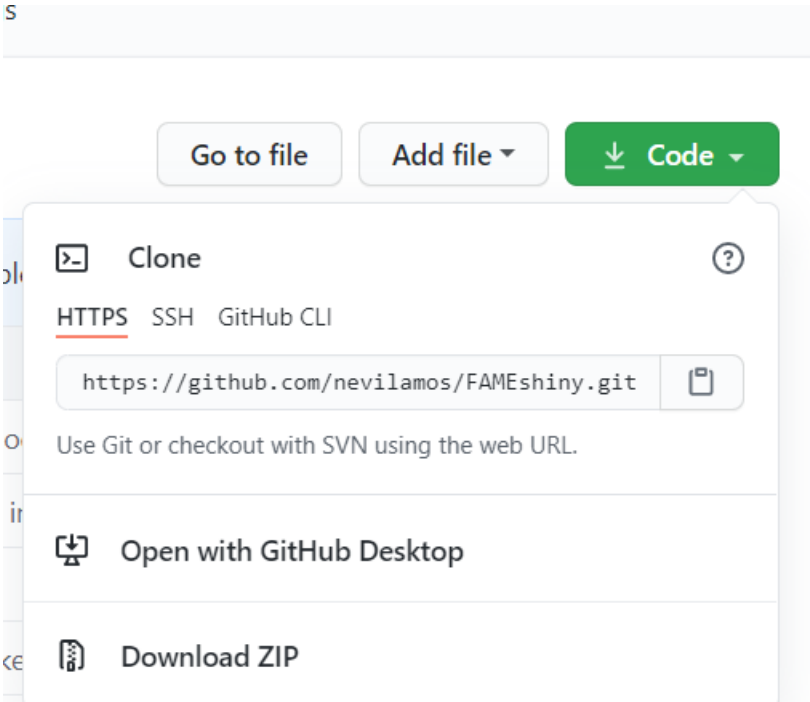


Enter URL for FAMEshiny (https://github.com/nevilamos/FAMEshiny) and Project directory name of your choice (on DELWP SOE computers this should in C:/Data).

Click create project.

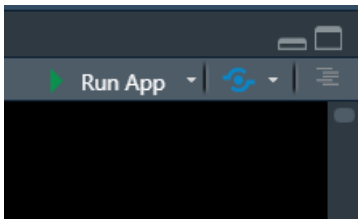
The project files should download form GitHub and the project open.

Alternatively you can go to the github URL (https://github.com/nevilamos/FAMEshiny) in you browser and click the green button “Code” and select Download ZIP



If you download the Zip unzip it into a new directory on C:\Data. Then click on the file "FameShiny.Rproj" to start the project in R.

Open file ui.r and click RunApp at the top of the source window in r-Studio



The first time you do this R will attempt to download and install all required files from AWS and install all the required R packages, this involves download of approximately 1.1GB of files so may take some time.

When all files have downloaded the FAME shiny app will start.

Subsequently to run the app in R-Studio on you Local machine simply open ui.r and click again on run app.