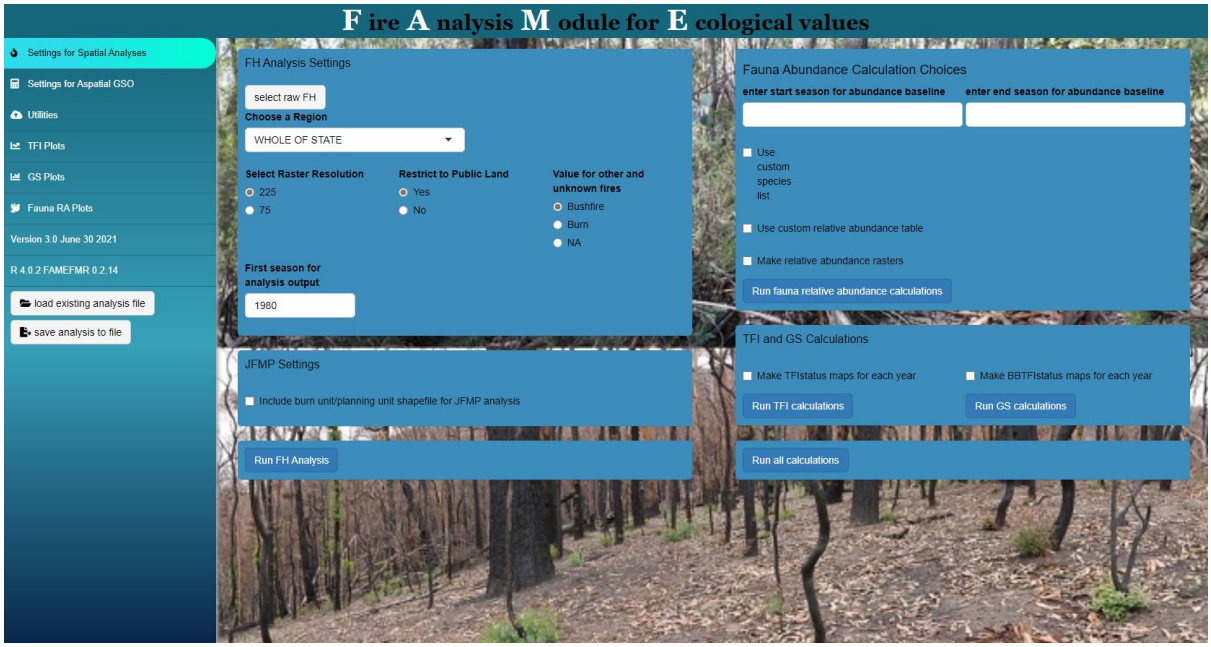
Fire Analysis Module for Ecological values (FAME)
User Manual Version 3.0



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 FAME v2 functions and shinyapp	30/03/2021
V3.0	N. Amos	Major update to FAME v3 functions including JFMP analysis	3/8/2021

Glossary

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

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.

FAME performs 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 relative 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).

FAME V3 includes all of the functions from version 1.1 and 2. In addition it allows for calculation of burned below TFI and Fauna abundance metrics at the level of individual planning or burn units for the purposes of generating an automated draft JFMP and comparing draft JFMP scenarios with defined trade-offs between life and property metrics and ecological resilience metrics. As of version 2 the module and pre-processing tool allows the output tables required for the Statewide Fuel Management Report to be produced.

All settings for spatial analysis in v3.0 are now included on a single tab, and it is now possible to save an analysis file at any stage and reload it (and all its settings) for later use.

The underlying R code for V2 has been rewritten and is much faster than previous versions. The code is now on GitHub with the main functions in an R package “FAMEFMR”.

FAME 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.

The preferred standard method for use of FAME is to launch a pre-configured image on Amazon Web Services (AWS). This will ensure that you are using the current standard version of all the necessary installed R packages, it also allows to choose a virtual machine with appropriate RAM for the size of the problem that is being processed in R

Users with experience in using and installing R and R-Studio packages may choose to clone the FAME shiny GitHub repository to their local workstation. This approach is detailed in the Appendix 2

Changes to input table formatting in FAME v2 and v3 compared to FAME v1.1.

There are Changes in the custom input tables for fauna abundance analysis compared to the tables in version1. The format of each input and output table is detailed in Appendix 1. Custom input tables prepared for v1 will not work in V2 and v3. In brief the changes are as follow. The format of the species list tables generated by and used as inputs to FAME 2 and 3 updated – including updating the TAXON_ID from 2016 VBA to current VBA (2021), and also updated the threat status categories, and corresponding thresholds. The new species csv file table has the following columns only: TAXON_ID, COMMON_NAME, SCIENTIFIC_NAME, DIVNAME, FFG_ACT_STATUS, EPBC_ACT_STATUS, VIC_ADVISORY_STATUS, Include, WriteSpeciesRaster, CombThreshold, HDMPath.

To update your custom species lists it is easier to use an ad hoc shape file of your DELWP Region to create a Spplist.csv from on the utilities tab in FAME and then search/filter to recreate the exact species list you require which will now be compatible with the format FAME recognises.

The custom abundance table format has also changed. There are two changes. The column previously called VBA_CODE is now called TAXON_ID This is for consistency with the same values in other tables. The EFG_GS has changed format (for consistency between the aspatial GSO and the rest of the app) so that instead of being EFGXX_1,_2,_3,_4 it is now EFGXX_J,_A,_M,_O.

Initial setup and launching FAME on AWS server.

The process for starting and running FAME on AWS for DELWP staff (and others with suitable credentials) is detailed in a separate document on DELWP ECM . This is the preferred method for most users. The document can be found at:https://delwpvicgovau.sharepoint.com/:w:/s/ecm_732/EYWEC7xW1NpHtvAFwwH_roQBHlnBPRBeNxmkDFYU1pxh4Q?e=KZjCSj

If you wish to make your own local installation of FAME, then refer to appendix 2. No support is available for locally installed FAME.

Workflow

The workflow consists of multiple processing steps. The preparatory step occurs on a local desktop computer in ARCGIS the remaining analysis all take place within the R shiny app – usually on a remote AWS server. 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) or ARCGIS pro.
    - Upload this dataset to the FAME server.
    - Upload any other input datasets (custom species lists, ad-hoc study areas, species response files or JFMP input files required to FAME server.
2. Fire sequence analysis in FAME
    - Carry out fire history analysis on the server. At this stage you chose whether or not you are undertaking a JFMP analysis. If so after this step proceed directly to step 7. **NOTE fire sequence analysis process for JFMP should not be used for the processes in steps 3-5, this may cause errors in the shiny app.**
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. This analysis is independent of the spatial analysis.

7. JFMP analysis – the JFMP analysis must be undertaken separately to the other analysis.
8. Download results of FAME analyses.

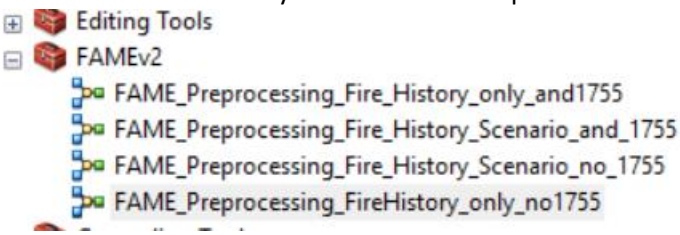
Stage one: Data preparation

Setting up files on your local desktop PC

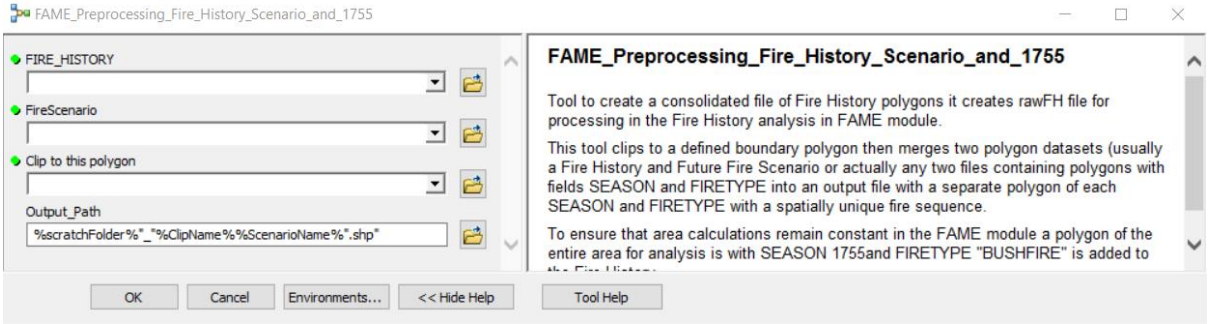
a. Generate a folder for input files on your local desktop PC
b. Save and prepare Fire Scenario which is the fire scenario shapefile formatted as described in the Appendix 1.
c. Decide on the area of analysis. You should select a polygon that is as small as possible given your area of interest for the 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 included in the ArcMap project in the downloaded FAME_Preprocessing.zip 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 in VICGRID_94 projection.
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 e.g. 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.



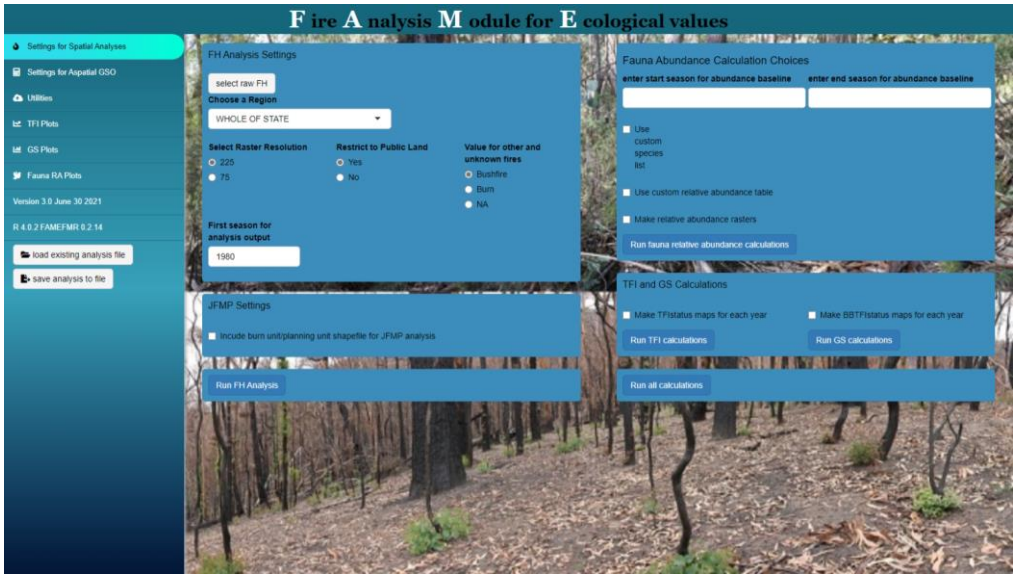
- FIRE_HISTORY: this will generally be the current corporate fire history layer, it can be selected from your normal access point for the corporate library, however if you are doing many iterations of pre-processing step, you may wish to make a local copy to speed the pre-processing read time.
- FireScenario, 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

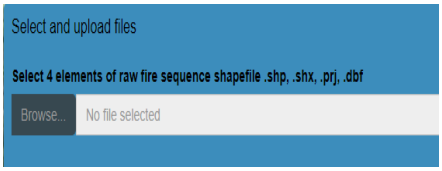
Stage two: Fire sequence analysis in FAME

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.

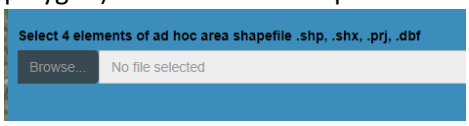
a. Launch the FAME module home page in your web browser (Chrome or Microsoft Edge have been tested other modern browsers should also work). The version of FAME and the associated FAME_FMR R package are displayed at the bottom of the sidebar on the left of the screen. This will generally be done by running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



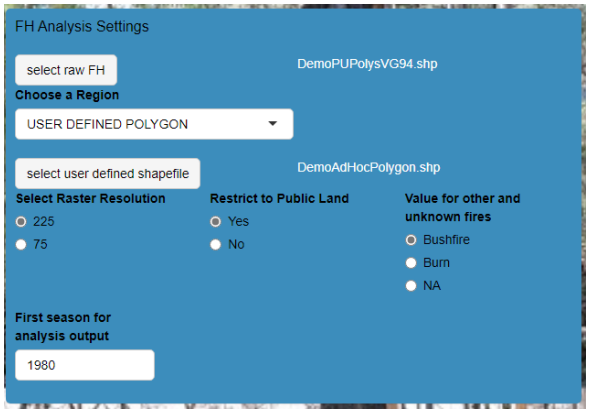
b. Select the utilities tab in the bar on the left of the screen
the Utilities tab provides for upload and download of files from the server, as well as creation of draft species lists and area specific data input files for the aspatial GSO analysis (see below).



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 “Settings for Spatial 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
select raw FH	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	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,

Setting name	Purpose	Values
	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.	"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

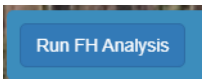
Table 1 Fire Sequence analysis choices.

e. If you are undertaking a JFMP analysis further selections and input shapefiles are required .

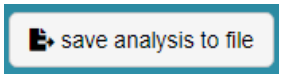
Setting name	Purpose	Values
Include burn unit/planning unit shapefile for JFMP analysis	To allow selection of additional shapefile for burn units required for JFMP analysis	Check box yes/no (default unchecked)
Select Planning unit shapefile	Shapefile defining the FMZ code, Fire District unique integer ID Each	Shapefile uploaded using the “Select 4 elements of PU/BU

Setting name	Purpose	Values
	PU and associated metadata about the planning unit/burn unit.	shapefile" (third option) on utilities tab
JFMP SEASON 0	Defines the last fire season before the JFMP being analysed (e.g. for a JFMP covering 2019-2021 the value would be 2018. For a JFMP for 2029-2031 the value would be 2028.	Four digit integer for Fire Season. Default value is the current fire season.

Table 2 JFMP Fire Sequence analysis choices

f. 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 shapefiles will be created at the conclusion of the process. The content of the files is described in the outputs document.

g. If you wish to at this point you may save the FHAnalysis session to a file on the server for later reloading. This allows the FH analysis (and all its settings) to be reloaded. To do this use the 

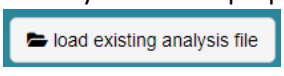
on the sidebar menu at the left of the page. Use a file name that clearly defines the stage of the analysis completed and the input files (e.g. FH_Analysis_FRAU_FH_2020_DemoAdHocPolygon" as you may later want to reload this file for further work.

h. Note if your selections included burn unit/planning unit for JFMP then the output FHAnalysis file can only be used for JFMP analysis, and not for charting of other outputs.

i. 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.

Stages three and four and five : Spatial TFI, Growth Stage and Fauna Relative Abundance Calculations

These three separate calculations may be run independently in any order.

a. 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 using the 

button in the FH analysis

loaded is displayed in the second row of the second column of the “Settings for Spatial Analysis Tab.

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 chosen a button will appear to select the relevant .csv file (which has previously been uploaded to the server).
Relative abundance table by growth stage	Where you provide custom relative abundance tables these inputs may either give relative abundance classed for each of the four vegetation growth stages (this is currently the default) or you may provide a table that give a relative abundance value for each species	Default checkbox checked (input data is abundance by growth stage. Alternative (checkbox unchecked) abundance by years since fire.

Setting name	Purpose	Values
	for each year since fire for YSF from 0-400.	
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

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 "Add Custom input CSV" the fourth option on the "Utilities" tab Select and upload files box.

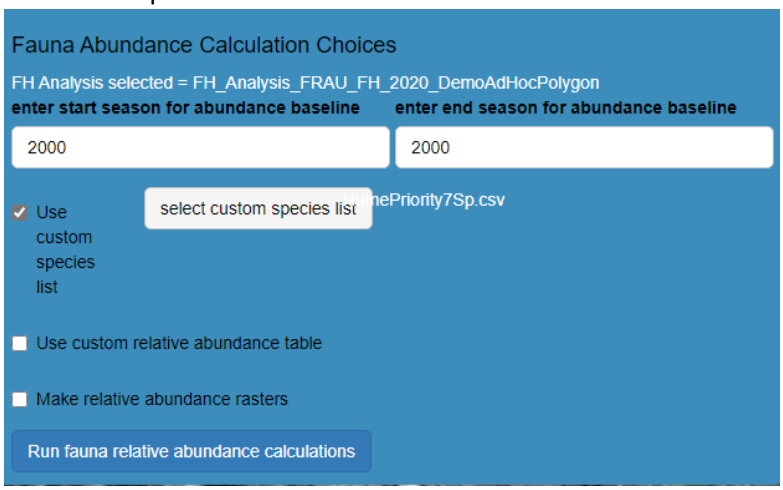
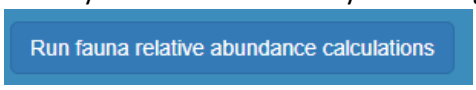


Table 3 Species relative abundance input choices

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



Button 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.

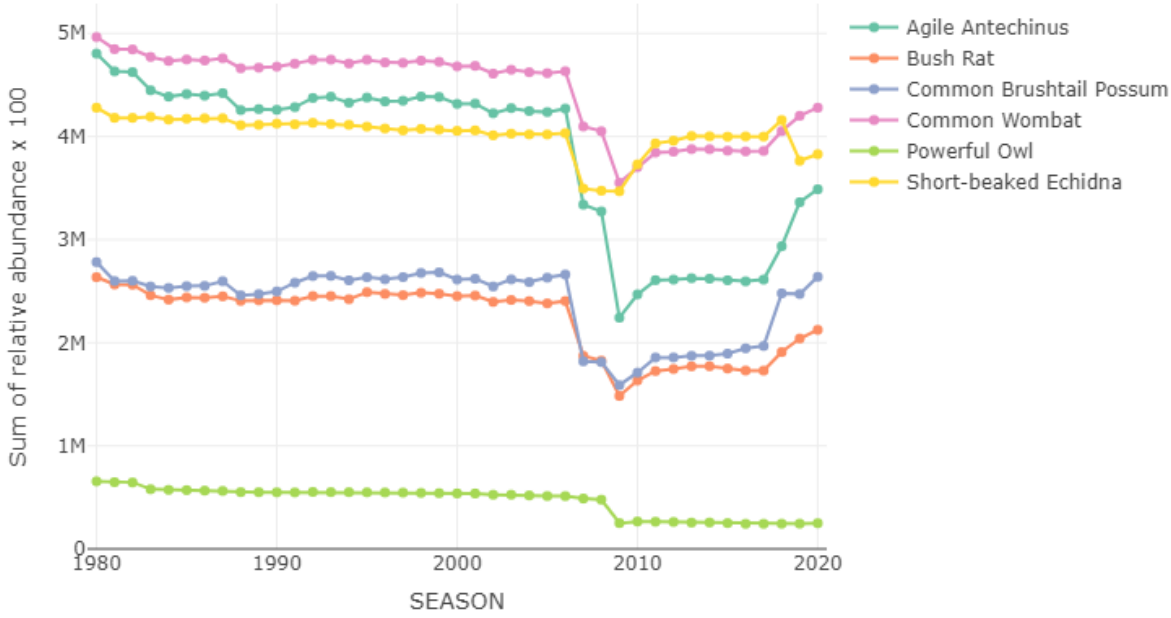
d. The outputs will be saved to the results directory for download

e. 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

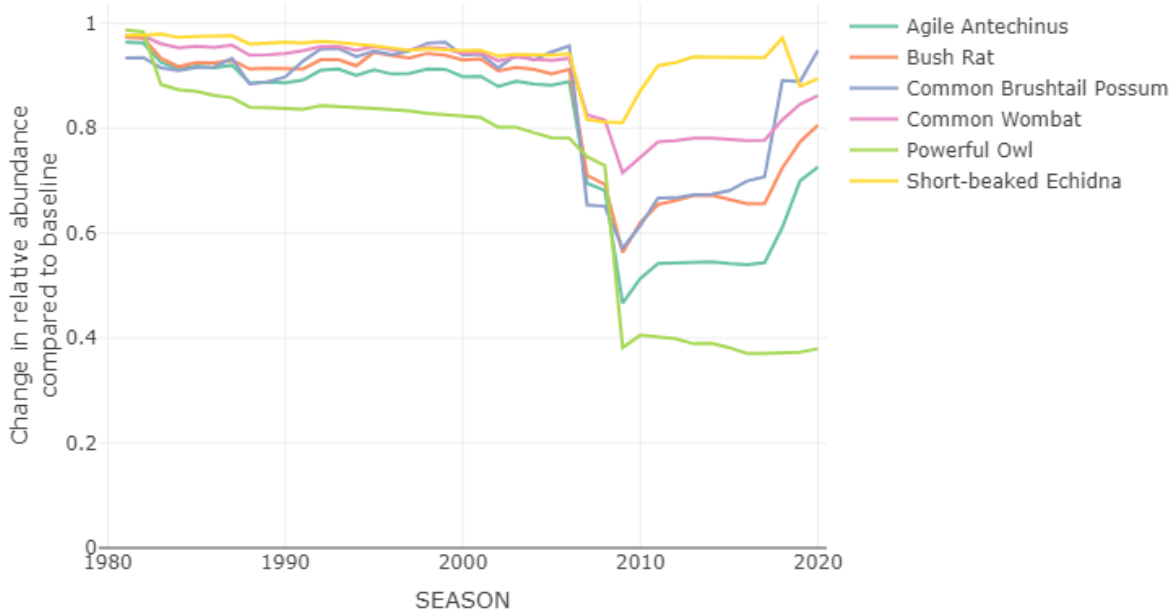
Fauna RA plots

f. When the Fauna relative abundance calculations are complete you can select the Fauna RA plots tab on the left sidebar menu. This provides two plots on which the user can chose to display results 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.

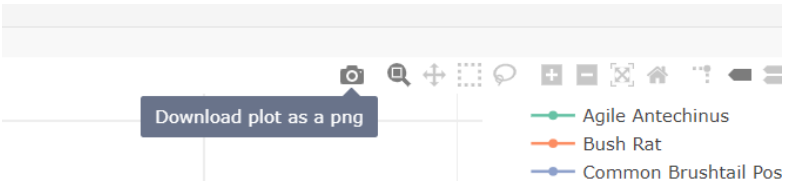
The upper plot displays the summed relative abundance multiplied by 100 of the species selected for each SEASON



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



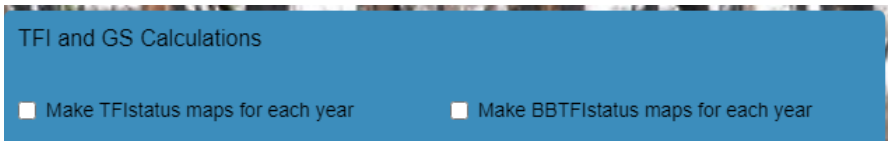
g. The charts can be copied and downloaded as a .png graphic – if you hover the mouse over the top of the chart a menu to do this will appear:



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 or BBTFI rasters for each SEASON – to do so incurs a small extra computation time.



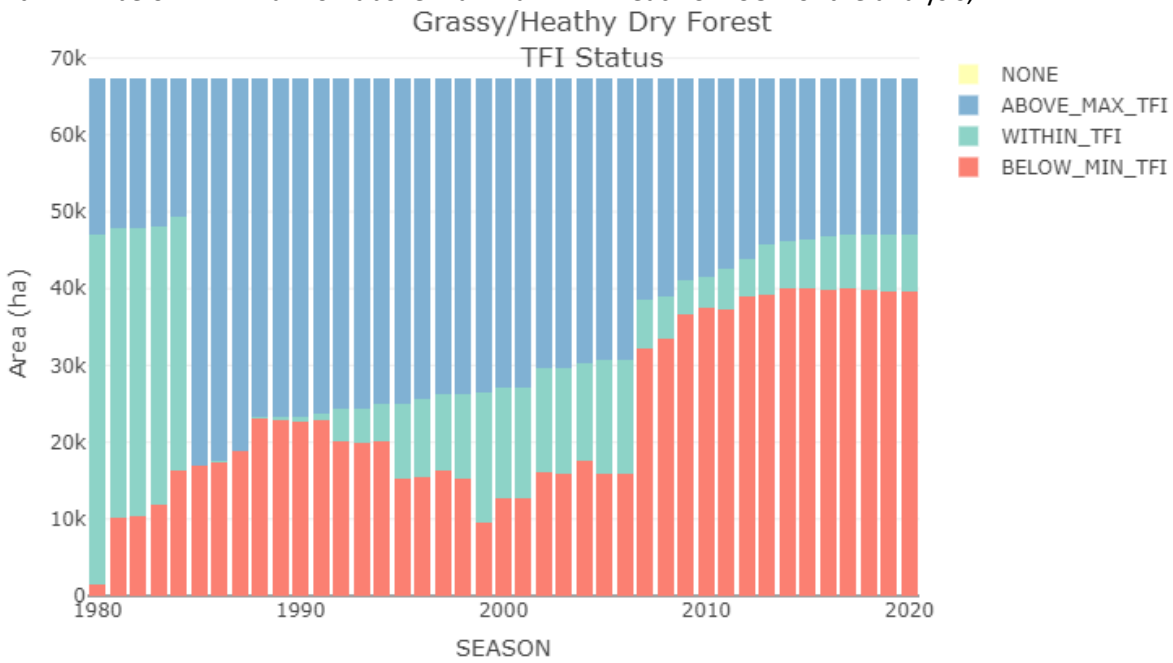
b. To run the calculations, press the bottom centre button 

. 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.

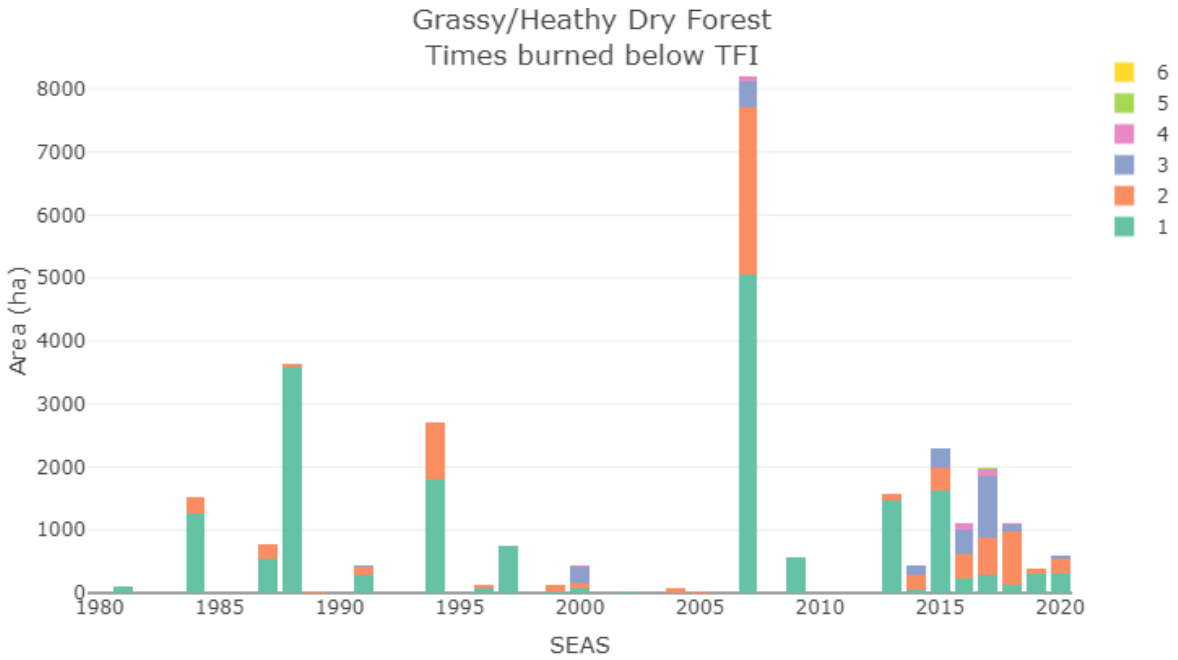
c. The outputs will be saved to the results directory for download

TFI plots

d. 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,



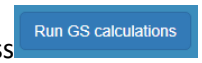
the lower plot displays the area and number of times burned below TFI in each SEASON.



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

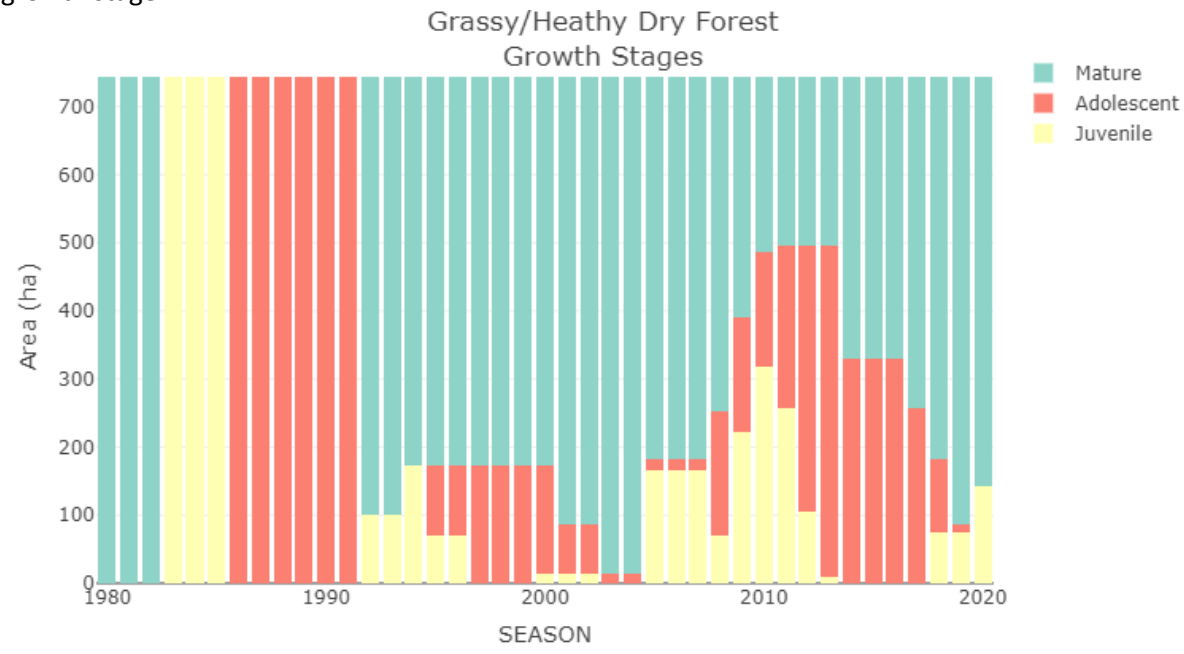
a. There are no choices to be made before running Growth stage calculations

b. Press  button to run the calculations.

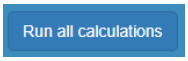
c. The outputs will be saved to the results directory for download

GS plots

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



Run All Calculations at once

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.**

Save Analysis results.

All the spatial analysis results can be saved to file using the save analysis to file button on the left sidebar menu – as before the file should be given a name (no spaces) that will records the inputs and processing that has occurred so that you can reload it in future.

When you reload a stored previous analysis you can continue where you left off -either reusing the data that has already been processed to display outputs and save charts for different EFGs or Species on the two chart tabs, or to run a new analysis using a stored FH analysis with a new set of species (via selection of a new custom species list and or custom species responses).

Stage six: JFMP calculations.

JFMP objective

The purpose of the JFMP component of FAME is to allow generation of an automated selection of burn units to be burned in a 3 year JFMP cycle. This autoJFMP has the objective of minimising

The JFMP calculations allow scoring of the contribution of each burn unit in a defined area to four metrics. The scores for all four measures are the difference between the scores in the fourth year (JFMP_SEASON0 +4)after the start of a JFMP(JFMP_SEASON0) resulting from burning, or not burning the burn unit in the second year of the JFMP (JFMP_SEASON0+2. The Flora and Fauna scores are calculated by FAME, the “Life and Property” metrics (LP1 and LP2) are calculated outside of FAME and provided to FAME as four columns in the attribute table for the burn unit shapefile used in the analysis (Two columns for each giving the score at JFMP_SEASON0+4 when the burn unit was burned in JFMP_SEASON0+2 and when it was not burned.

The Fauna metric is the sum for all species of the change in relative abundance of each species in each burn unit divided by the total number of 225M pixels of the binary HDM of that species in the area of interest. It is calculated by subtracting the score for the burn unit if burned in in JFMP_SEASON0+2 for the score if the burn unit is not burned during the JFMP _

The Flora Metric is the area burned below TFI if the burn unit were burned in JFMP_SEASON0+2 that have never previously been burned below TFI in the recorded fire history.

LP1 and LP2 are views of the contribution of the burn unit to residual risk given the fire history of each burn unit, and as such need to be recalculated exterior to FAME when the fire history of the area of interest has changed.

The weightings afforded to each metric relative to the others, and differences in the weighing of Life and property vs environmental resilience scores according to Fire Management Zone (FMZ) in choosing which burn units it is preferable to burn are made by small input csv files, the content of these files is provided in appendix 1.

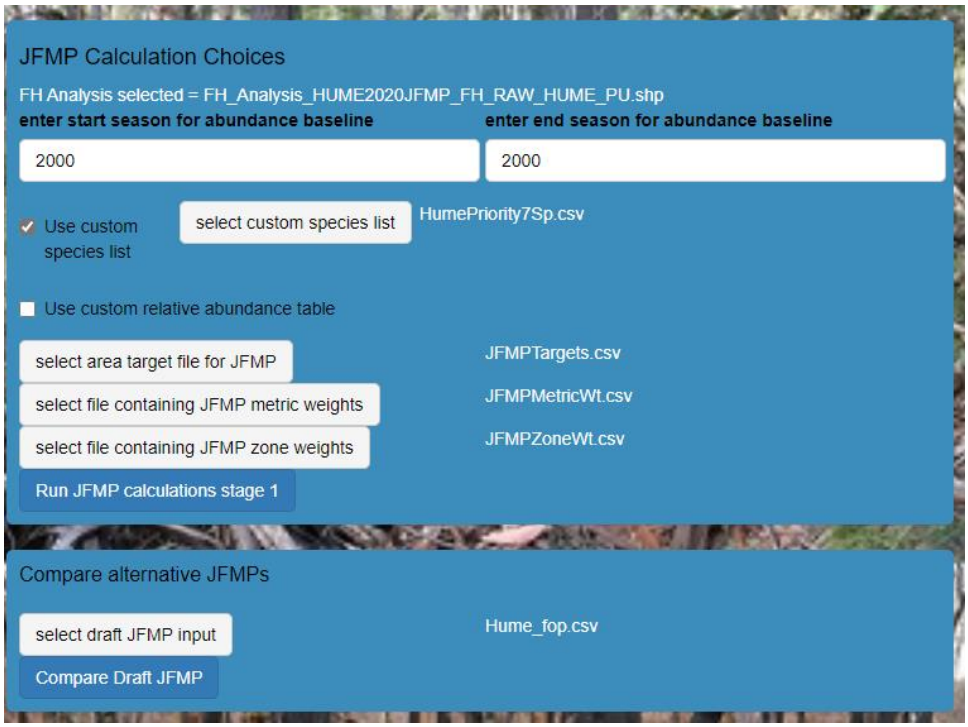
The autoJFMP selects the burn units that minimise the sum of the weighted scores given a target area for burning in the JFMP for each Fire District and FMZ – these targets are also supplied as an input csv file.

The user can also provide any alternative selection of burn units to be burned and compare the aggregate scores, remaining area never burned below TFI, and changes in each species relative abundance given the units burned with each other and the auto JFMP.

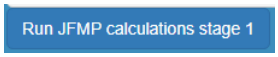
Initial JFMP calculations and auto JFMP

The processing for JFMP calculations uses some of the same files and scripts as the standard fauna relative abundance and BBTFI calculations. It requires an additional step in its input FH analysis file – to add individual burn units to the calculation

a. When the option to "Include burn unit/planning unit shapefile for JFMP analysis" is selected on the left-hand column of the Settings for spatial analysis tab the right-hand column options will change to reflect this. The second column will be headed "JFMP Calculation choices and the FH Analysis selected will be displayed on the next line.



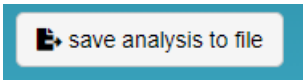
b. The choices to be made for the Fauna relative abundance metric calculations are the same as for the normal Fauna relative abundance calculations (Table 3 Species relative abundance input choices). Generally, for the JFMP analysis you will be using a species list restricted to the species occurring in the Region and/or species of particular interest in fire management planning. The first draft of this list should be generated using the " Run draft species list" button the utilities tab (see additional utilities section below for further details.
c. Choose the area target file which gives the target area in hectares to be burned for each FMZ in each Fire District.
d. Choose the .csv file weightings for the four JFMP metrics (Fauna, Area never BBTFI, and the two Life and Property metrics (LP1 and LP2). Lastly a zone weighting file give the relative weight to be given to Life and property metrics vs Ecological Resilience metrics in each FMZ. The structure required for each of these files is given in the appendix, for inputs for FAME.

e. Once you have made these settings press the 

button at the bottom of the bottom of the JFMP Calculation choices box. This process involves running abundance estimates for all the species chosen and reporting them at the level of the individual planning units. On completion a tick will appear alongside the button for a few seconds.

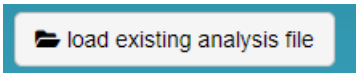
f. Note : This is the most time consuming, and memory requiring part of any of the FAME processes. If the app "greys out" during these calculations, then it is likely that RAM has been exhausted. Unfortunately, this means that you will need to rerun the process on a server with more RAM. If you are running FAME on the AWS server then a larger amount of RAM (up to 256 Gb) can be chosen in the launch script.

g. The outputs will be saved to the results directory for download

h. If you wish to compare alternate JFMP scenarios at a future time you will need to save your analysis at this point using the 

button on the left hand menu.

Comparison of alternative JFMP scenarios

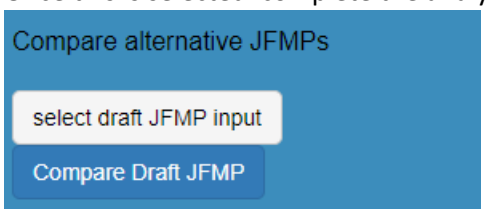
a. If you are returning to FAME to do these comparisons in a separate session to running the corresponding JFMP1 calculations(section immediately above) you will first need to reload your saved JFMP scores and analysis using the 

button on the left hand menu and selecting the relevant file. This will reload the JFMP analysis and all other FAME settings from that previous session.

b. Alternative JFMP scenarios – for instance feedback from district fire planners on which combination of burn units are practical to be burned given the autoJFMP and other considerations are provided to FAME as a CSV file the first column gives the PU (burn unit numeric ID) the second column is the autoJFMP burn status (these two columns can be copied from the autoJFMP.csv output file) each subsequent column (as many as there are alternative scenarios) gives a unique name for the scenario (the names may only have alphanumeric characters or underscore with no spaces) and each row states BURN or NO_BURN according to the status of the PU in that scenario.

c. This file must be uploaded using "Add Custom input CSV" option on the utilities tab. It can then be selected using the "select draft JFMP input" button

d. Once this is selected complete the analysis using the "compare draft JFMP button.



e. The outputs will be saved to the results directory for download.

Stage seven: Aspatial Growth stage optimisation

The aspatial Growth Stage optimisation analysis runs separate to the other FAME analyses, so may be run at any time with or without the spatial analysis.

File formatting

There are several input files that you need to edit in Excel or elsewhere to run the GSO in FAME. The files should also be saved as .csv format.

Draft files for editing can be produced for your area of interest using the 

button on the utilities tab to generate correctly formatted files, and then download them to your PC for editing. You will need to select the area for the analysis using the selection under "Choose and area for species List" on the utilities tab and select whether you wish to restrict the area to public land.

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 using the . gsofiles to upload option on the Settings for Aspatial GSO tab.

The first .csv file details the area of each species HDM in each EFG in the study area 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. You may wish to remove some EFGs from this file if you do not want them to be considered in the analysis, otherwise do not change this file.

	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. 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%). You may wish to edit this file to remove marginal EFGs that you do not wish to be considered in the analysis. Otherwise, all EFGs must have the sum of PercLandscpe for the four growth stages as positive values with a sum of 1. In the draft example file you download there is a single Scenario – Scenario_0 with equal areas allocated to each Growth stage, you will need to edit these values to the proportions required. You can add multiple Scenarios to the table by copying and pasting all the rows for Scenario_0 at the end of the file and rename the scenario (the name may only have alphanumeric characters or underscore and should be kept to about 10-12 characters with no spaces.).

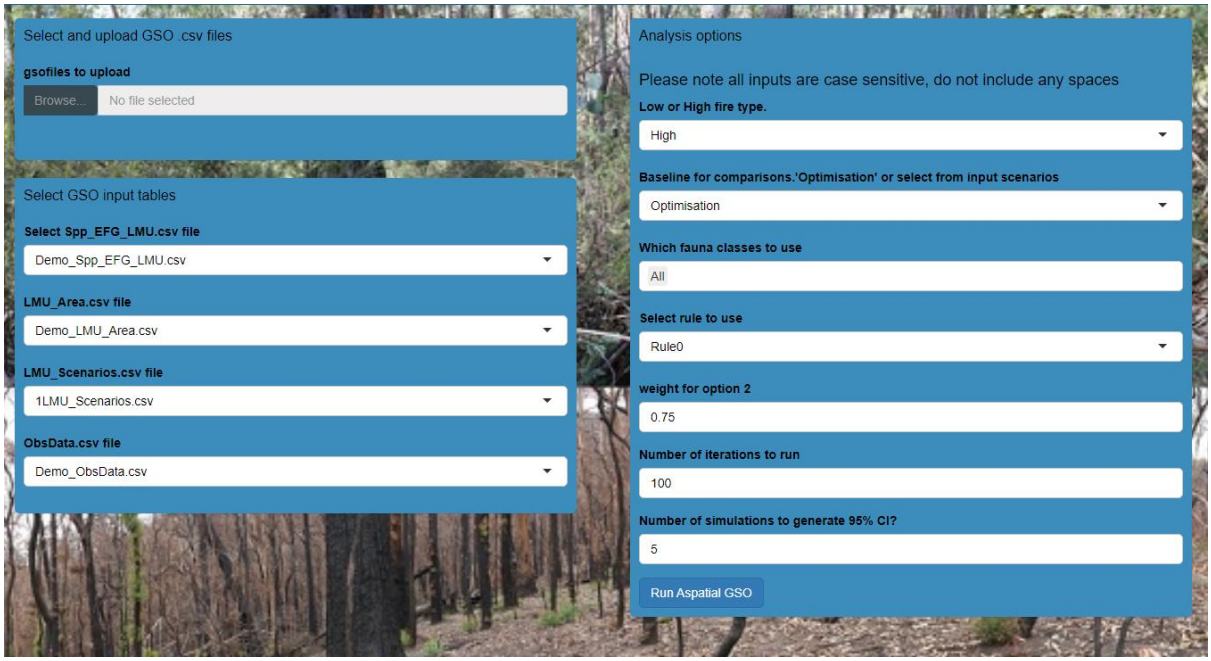
	A	B	C	D	E	F
1	EFG_NO	EFG_NAME	BGS_NAME	BGS_ID	Scenario	PercLandscape
2	6	Heathland (sands)-General	Juvenile	1	2006	0.075204844
3	6	Heathland (sands)-General	Adolescent	2	2006	0.180491625
4	6	Heathland (sands)-General	Mature	3	2006	0.744303531
5	6	Heathland (sands)-General	Old	4	2006	0
6	6	Heathland (sands)-General	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

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.



GSO Options

Option	Name in *R*	Options
Low or High fire type.	FireType	"Low" or "High" Default "High".
Baseline for comparisons. 'Optimisation' or select from input scenarios	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".
Select rule to use 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	Default("Rule0"), or "Rule1", "Rule1a", "Rule1b", "Rule1c", "Rule2", "Rule2a", "Rule2b", "Rule2c", "Rule3", "Rule3a", "Rule3b" or "Rule3c"
weight for option 2 The weight to use when combining expert opinion and observational data if using "Rule2".	data	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").

Number of iterations to run.	nrep	Number greater than 0. Default is 100.
Number of simulations 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 were 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 enough 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

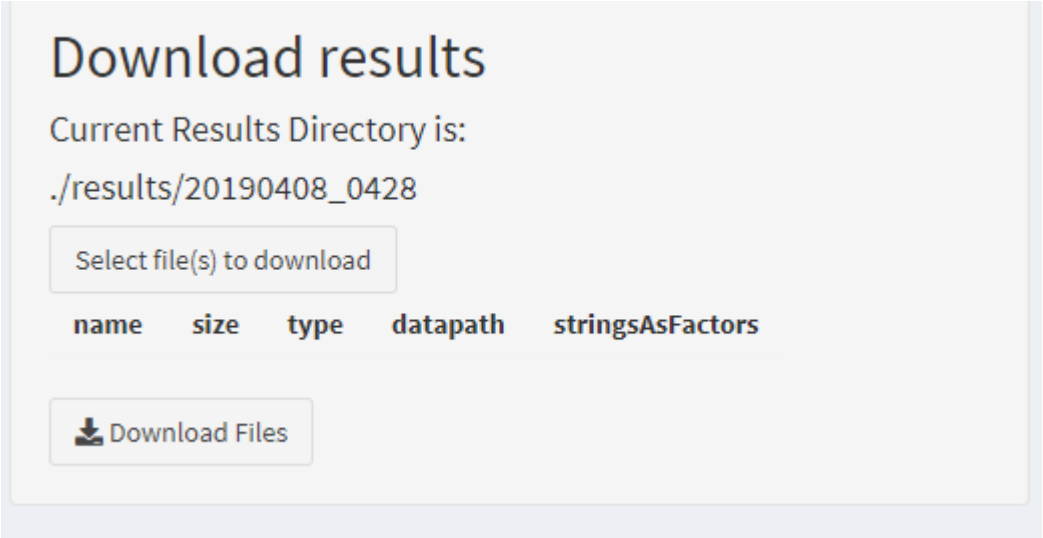
Once the data files are saved in the folder "./GSOInputs" and the model options are selected in the second coloured box the GSO is ready to run. To run the model, you just need to click the "Run GSO button at the bottom left of the GDSO shiny app window.

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

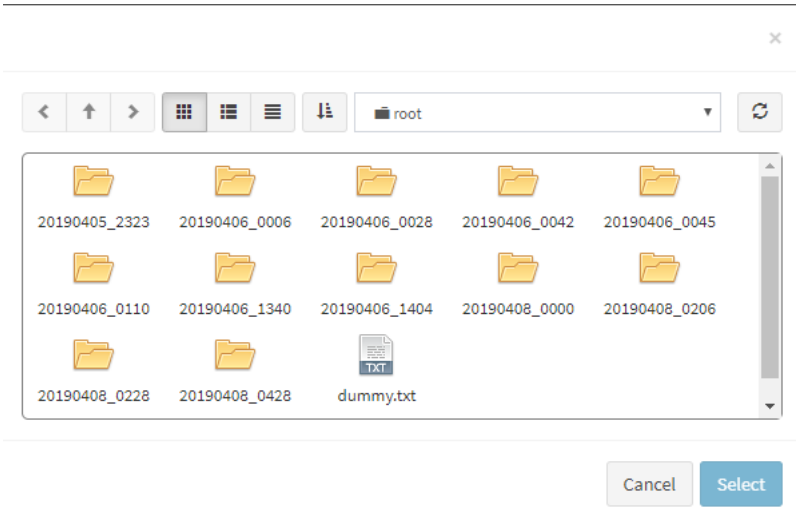
Once the analysis has run two files will be created. "GSO_Analysis_Output.docx which can be used as the basis of a report. It documents the options used, including model choices, EFGs and species used and produces some tables, plots, and comparisons. A file "GSO Species Changes.csv" is also created to 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.

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.

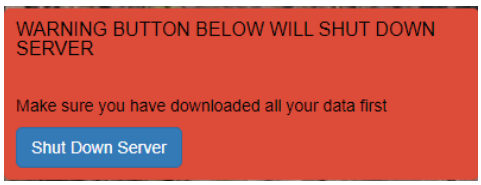
When finished selecting, press the select button at the bottom right of the file browser window.

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 download's 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

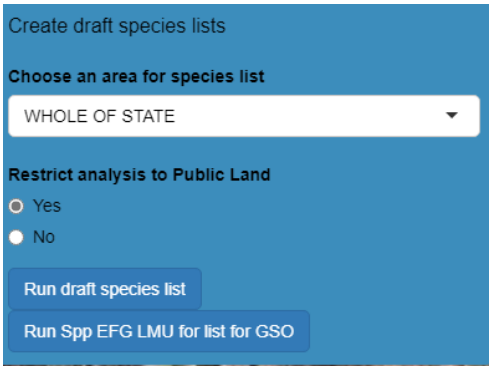
Shut Down Server

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.



Custom 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 utility should be used to generate a draft species list for editing and use in JFMP calculations. The JFMP calculation require the number of cells for each species in the area of interest (region or AdHoc polygon) to be provided – the output of this tool contains that information.



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.

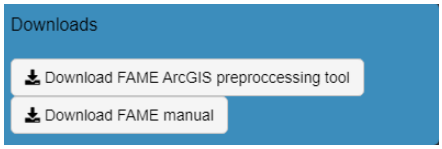
To run this tool, select a previously uploaded polygon for the area of interest, or one of the foregoing, chose whether or not to calculate only the proportion occurring on public land, and press the Run draft species list Button. This file can be downloaded using the download procedure described above. 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

Three further files required to run the aspatial GSO calculations the EFG_AREAS and spp_EFG_LMU and LMU_Scenario 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 ArcMap project file (.mxd) with a demo dataset loaded.



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

References

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.

MacHunter, J., P. Menkhorst, and R. Loyn. 2009. Towards a Process for Integrating Vertebrate Fauna into Fire Management Planning. Arthur Rylah Institute for Environmental Research

Department of Sustainability and Environment, Heidelberg, 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 10 PC with ARCGIS 10.5 +, 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 (i.e., 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 (i.e., 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 Fire History and Fire Scenario 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

./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. This is handled automatically by the upload raw FH button on the utilities page of the app.

JFMP Burn Unit/Planning Unit shapefile

If a JFMP analysis is being done then a shapefile, in VicGrid94 projection of all the Burn Units/Planning units in the Fire Region or other area of interest is required. These must cover the whole of the Fire Region or area of interest. If an AdHoc boundary is used, then they should be clipped to the same Ad-Hoc polygon as used for the Fire History shapefile. The shapefile must contain a single polygon for each Burn Unit/Planning unit. The extent of the planning units. Where there are areas of the Region/ AdHoc shapefile that do not have “real” burn units, dummy burn units to cover these areas should be included in the file and assigned PU, DISTRICT_N, Hectares and FMZ_CODE values. Usually, these dummy burn units would be assigned to an FMZ_CODE of “NONE” with a single polygon for each DISTRICT_N. You will also need to add FMZ_CODE of “NONE” and target area of Zero to each district in the corresponding the JFMP Area Target and ZoneWt files (see below)

The shapefile must have the following attributes in its table all these fields must be present with value of zero for numeric fields if there is no data (i.e., for LP2 fields).

Field Name	Details
OBJECTID	ESRI required Object ID field do not edit.
DISTRICT_N	Name of the DELWP Fire District that the burn unit is in
FMZ_CODE	A short code for the Fire Management Zone– no spaces or special characters. having separate area targets. If the standard 4 FMZs are used it is suggested that the codes APZ,BMZ,LMZ and PBEZ are used, but any codes may be used, assign value of “NONE” to dummy burn unit files. Alle codes used must be the same in the JFMP Area Target and ZoneWt files (see below).
PU	Unique integer key for each planning unit
PuHectares	Area of the Planning Unit in Hectares

LP1_NoBurn	Value for Life and property score 1 at JFMP year 4 (i.e., the year after the completion of the JFMP assuming no fires within the burn unit during the JFMP
LP1_Burn	Value for Life and property score 1 at JFMP year 4 (i.e., the year after the completion of the JFMP assuming that the Burn unit is burned once by a controlled burn (in year 2 of the JFMP)
LP2_Burn	Value for Life and property score 2 at JFMP year 4 (i.e., the year after the completion of the JFMP assuming no fires within the burn unit during the JFMP or zero if only one life and property score is used
LP2_NoBurn	Value for Life and property score 2 at JFMP year 4 (i.e., the year after the completion of the JFMP assuming that the Burn unit is burned once by a controlled burn (in year 2 of the JFMP) or zero if only one Life and property score is used

The shapefile may contain other fields as you wish (e.g., Burn unit name or other id, etc). These will be ignored by FAME but retained through to the output JFMP tables.

R script files.

There are seven R script files in the application root directory required to start the and 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 following three files are the core of the shiny app. In RStudio the app can be started by pressing the “run app” button at the top of the script window for any of these three

./global.r

./server.r

./ui.r

Two files check whether the app has already been installed and run on the server. If not, they will download and install the necessary files and R packages to enable the app to run. They are called automatically when the app is first started.

./download_FAME_inputs_from_S3.R

./installationCheck.R

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.

./disableWhenRunning.js

./ButtonDisableHelpers.r

The root directory also contains an R script that only needs to be run (and possibly edited) when new or changed HDMs are added to FAME. It extracts values from the rasters of the HDMS and stores them to the sparse matrix .qs file used by FAME for species abundance calculations.

./compileHDMVals.R

Reference / Lookup Tables

These reference and default input files are stored in the ./ReferenceTables directory.

Default FAME taxon list

FAME_TAXON_LIST.csv

List of terrestrial fauna with HDM rasters (577) includes VBA TAXON_ID, threat status, taxonomic divisions, threshold values of significant decline for each species (based on their threat status) and the path of the HDM raster for the species.

Field Name	Details
TAXON_ID	VBA 2021 Taxon ID for the species
COMMON_NAME	VBA common name for the species
SCIENTIFIC_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.
Include	Whether or not the species should be included in the analysis This field in contains information on which species have corresponding data in the default relative abundance table (OrdinalExperLong.csv see below). If they do then the value here is Yes.
MakeRasters	Whether or not abundance rasters should be made if the option is selected in the UI
CombThreshold	Combination default threshold of significant change based on Regan (XXXX)
HDMPath	The Path to the 225m version of the HDM for the species

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)

OrdinalExpertLong.csv

Long table format of species abundance responses based on expert opinion per growth stage.

Field Name	Details
COMMON_NAME	Common Name of Fauna Taxon (same as VBA 2021)
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 (April 2021)

EFG_TSF_4GScorrectedAllEFGto400yrsv2.csv

This Growth stage to TSF lookup file is used to “inflate” expert abundance opinions recorded in the per growth stage format to years since fire.

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 /*ExpertEstimate.csv*

Expert opinion data as a number 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 2021 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

Input tables for JFMP analysis

There are three small additional tables that are always required as inputs to the JFMP analysis. One additional -the alternative draft JFMP input file is required to compare JFMP burn proposals derived outside of FAME to the fame autoJFMP result. These tables are all specific for particular JFMP regions and districts, so they are not provided as part of the reference file package, but examples are present in the ./CustomCSV/Hume directory.

These files should all be stored in the Custom CSV directory. They should be given unique names and . uploaded using the "add custom CSV" button on the utilities.

JFMP area target file

First of these is the JFMP target file. This file links via the FMZ_CODE field to the planning/burn unit shapefile provided to the JFMP FH analysis process. It allows for Regions that have more than the standard four Fire Management Zones to allocate target areas to each of their zone units, using whatever names (with no spaces or special characters) they prefer, as long as the names are identical between this file and the planning/burn unit shapefile.

Target file for JFMP format:

Field Name	Details
DISTRICT_N	Fire district name (text) corresponding to the values in the PU input shapefile.
FMZ_CODE	Short alphanumeric code(no gaps) with corresponding field in the PU input shapefile. All FMZ must be included even if the burn target for the FMZ is nil (e.g., Planned Burning Exclusion Zone).
targetHa	The target area to be burned during the 3 years of the JFMP (in hectares) for each DISTRICT_N and FMZ_CODE. Where the area target for the FMZ code is Nil the target ha must be set to -1

JFMP metric weight file

The JFMP metric weight file allows for different weighting within the two pairs of scores (Ecological Resilience and Life and Property used in the JFMP. The total weight for each pair must equal two.

Field Name	Details

FaunaWt	Weighting given to the fauna component of the Ecological resilience FaunaWt + FloraWt must always equal 2. If the weightings are to be equal, then both FloraWt and FaunaWt = 1.
FloraWt	Weighting given to the flora component of the Ecological resilience FaunaWt + FloraWt must always equal 2. If the weightings are to be equal, then both FloraWt and FaunaWt = 1.
LP1Wt	Weighting given to the LP1 component of the life and property metric(defined by column LP1 in the PU Inputs shapefile). . LP1Wt + LP2Wt must always equal 2. If the weightings are to be equal, then both = 1.
LP2Wt	Weighting given to the LP2 component of the life and property metric(defined by column LP1 in the PU shapefile). LP1Wt + LP2Wt must always equal 2. If the weightings are to be equal, then both == 1. Where only a single LP value is used then LP2Wt should be set to 0.

JFMP zone weight file

The JFMP zone weight file allows different weighting of life and property versus ecological resilience (flora and fauna) scores in the autoJFMP. For example, if you wish to only consider Life and property scores in selecting areas for burning in the Asset protection zone then LPwt would receive a value of 100 while BDwt is assigned 0. If you wish a zone to weight the Life and Property and Eco resilience scores equally (for instance in the BMZ) then each of LPwt and BDwt would be assigned a value of 50. Weightings must be given for all zones and "dummy" Zones in the FMZ_CODE field of the planning unit input shapefile.

Field Name	Details
FMZ_CODE	Short alphanumeric code(no gaps) with corresponding field in the PU input shapefile.
LPwt	The weighting given to the life and property metric relative to the ecological resilience metric. LPwt+BDwt must equal 100, except where the zone is to be excluded from calculations in which case LPwt = 0 and DBWt= 0
BDwt	The weighting given to the ecological resilience relative to the life and property metric. LPwt+BDwt must equal 100, except where the zone is to be excluded from calculations in which case LPwt = 0 and DBWt= 0

Alternative JFMP scenario input file

Alternative JFMP scenarios – for instance feedback from district fire planners on which combination of burn units are practical to be burned given the autoJFMP and other considerations are provided to FAME as a CSV file the first column gives the PU (burn unit numeric ID) the second column is the autoJFMP burn status (these two columns can be copied from the autoJFMP.csv output file) each

subsequent column (as many as there are alternative scenarios) gives a unique name for the scenario (the names may only have alphanumeric characters or underscore with no spaces) and each row states BURN or NO_BURN according to the status of the PU in that scenario.

Field Name	Details
PU	The burn unit unique ID for each burn unit in the autoJFMP. Note, this column should be identical in content (though it can be sorted in a different order) to the PU column in the autoJFMP
JFMP scenario name (one column for each scenario)	BURN or NO BURN according to the scenario. Other values are not permitted.

Optional Custom CSV files for species relative abundance calculations.

These files should all be stored in the Custom CSV directory. They are uploaded using the "add custom CSV button on the utilities tab.

Custom Species List.

The custom species list follows the same formatting as the default taxon list with two additional field at the end (cellsInState, cellsInArea, areaProp). The starting point for a custom species list should be made by creating and downloading it using the "Create draft species lists" option on the utilities tab.

The areaProp column value is the proportion of HDM cells for that species that are in your area of interest. Only species where this value is >0 should be included in the analysis and where there is abundance data for the species in at least one EFGs overlapping with the species HDM in the area of interest

Only the following edits may be made to the file:

Exclude species that you do not wish to include in the analysis, or where they have zero cells , or no abundance data for your area of interest.

You can exclude species from your analysis by changing a value of "Yes" to "No" in the "include" field. Alternatively, you may exclude species simply by deleting the row for that species from your table.

You can include additional species in the analysis that have a value of "No Post Fire Abundance Data" in the "include column only when you use the custom species list in conjunction with a custom species abundance table that contains abundance data for the species.

Field Name	Details
TAXON_ID	VBA 2020 Taxon ID for the species
COMMON_NAME	VBA common name for the species
SCIENTIFIC_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.
Include	Whether or not the species should be included in the analysis This field in contains information on which species have corresponding data in the default relative abundance table (OrdinalExperLong.csv see below). If they do then the value here is Yes.
MakeRasters	Whether or not abundance rasters should be made if the option is selected in the UI
CombThreshold	Combination default threshold of significant change based on Regan (XXXX)
HDMPath	The Path to the 225m version of the HDM for the species
cellsInState	The number of 225m cells in the state identified as habitat in the HDM
cellsInArea	The number of 225m cells of the HDM identified as habitat in the area of interest. This figure is used to weight change in species abundance JFMP in calculations.
areaProp	The proportion of the statewide HDM cells in the area of interest.

Custom post fire relative abundance tables.

You can provide custom relative abundance data to replace the limited default expert opinion data These data can be provided in either of two formats. And the relevant choices made accordingly when doing species relative abundance calculations. Like all the tables all the content is Case sensitive and should not contain spaces or other characters.

Custom abundance by Growth stage.

This file follows the format of the default abundance table OrdinalExpertLong.csv

It is a Long table format of species responses saved as a csv. To populate this table correctly there should be 8 rows per species and EFG combination, one row for each growth stage 1: for each FireType You are most likely to use a table in this format if you want to amend growth stage base abundance expert opinion.

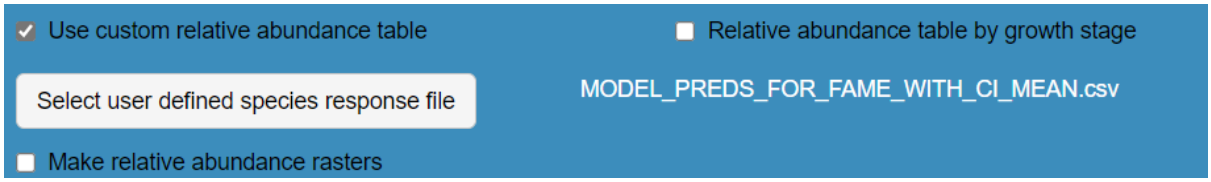
Field Name	Details
COMMON_NAME	Common Name of Fauna Taxon (same as VBA 2021)
FireType	Low or High (intensity) Both fire types must be included even where all fires are considered “high intensity” – for instance some heath EFGS. In this case the values for a growth stage will be identical for both FireTypes. You are most likely to use a table in this format if you want to amend growth stage base abundance expert opinion.
EFG_GS	Composite String of EFG number and growth stage in the format EFGxx_y where xx is the two-digit EFG number (i.e., 02 for EFG 2) and y is the letter corresponding to the growth stage (J,A,M,0)

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 (corresponding to Juvenile, Adolescent Mature and Old)
TAXON_ID	VBA TAXON_ID (APRIL 2021)

Custom abundance by Time Since Fire.

This file has a simple format requiring only five fields. You are most likely to use this custom input where you have more detailed data on species abundance with time since fire, or do not consider that abundance should be related to growth stages. If you have models of species response to time since fire from field data, this in the input you are most likely to use.

When you chose this file type as an input you need to un-check the "Relative abundance table by growth stage" box.



The file must contain 802 lines for each species/EFG combination 802 lines (years since fire of 0 -400 for each FireType). Given that you are unlikely to have empirical data for the upper end of the range of Yeas since fire you will need to decide about how to populate the cells. Where the method has been used so far, the usual technique has been to use the same abundance estimate as for the longest YSF for which data is available. Alternatively, you may decide to exclude all such areas from your analysis.

Field Name	Details
EFG_NO	EFG Number
FireTypeNo	1 for Low intensity or 2 for High intensity. Both fire types must be included even where all fires are considered "high intensity" – for instance some heath EFGS. In this case the values for a growth stage will be identical for both FireTypes. You are most likely to use a table in this format if you want to amend growth stage base abundance expert opinion.
TAXON_ID	VBA TAXON_ID (APRIL 2021)
YSF	0:400 -400 rows per EFG/TAXON_ID/Firetype
Abund	Relative abundance Relative abundances for all species included in the file must be in the same scale. All YSF must be populated NA values are not permitted

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.

R script to update HDM values from individual rasters of HDMs

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/08732250_before_after_2014_fire.jpg

Background image collected as part of DELWP project HawkEye.

./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.

Files for aspatial GSO

Input CSV files

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 seven of workflow above.

R and Rmarkdown files.

These files are in the ./GSO subdirectory

/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

An R file (which can be opened and read as text) giving the settings and inputs for the GSO analysis.

Input settings

In addition to the input files there are several 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.	Bushfire (Default) Burn NA

	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.	
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 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 custom relative abundance table	The default relative abundance provides expert opinion of the relative abundance by growth stage for a subset of species identified as key fire response species for particular (treatable) EFGs. As a result, there is neither uniform coverage of EFGs , and some species are only covered for some of the EFGs where they have an appreciable occurrence. The default data are based on MacHunter et al. (2009) and revised in an access database the Future Fauna Occupancy Database (2012-2015).	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 for each species of interest with time since fire. The required format for the custom input file is in the custom species list section above.

	Users may wish to use an alternative "custom" dataset where either sufficient field data is available the expert opinion data may be replaced or supplemented with models based on this field data, or they wish to use alternative expert opinion data in their calculations When the user choses a custom relative abundance input dataset they must also indicated what format, the input is in (either abundance by growth stage or abundance by years since fire.	
Relative abundance table by growth stage	Checkbox to determine type of custom species abundance input	Checked box – the input custom relative abundance data is in the "by growth stage" format Unchecked box – the input custom relative abundance data is in "by years since fire" format.
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
JFMP calculations		
Include burn/unit planning unit shapefile for JFMP	Choose whether FH analysis is a for a JFMP. **Note once this option is chosen and run a new FAME session should be started to run non JFMP analysis**	
Enter start and end of abundance baseline period	Set the seasons to be used to calculate the baseline relative abundance used to calculate %	1980,1980(default) Any single year, or range of years after 1979 contained in the fire sequence

	change from baseline. It can be a single year or a range of years.	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

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 GS and TFI related calculations in FAME. This is the "rawFH" file for analysis. The file is output in VicGrid94 projection.

The file contains a series of completely overlapping polygons. The polygons overlapping each have the attributes of a single fire SEASON and Type at that location. The overlapping polygons represent the spatial extent of a unique fire history sequence.

Field Name(s)	Details
OBJECTID	System generated ID for the unique polygon
FIRETYPE	The FireType for the fire represented by the polygon (either "BURN" or "BUSHFIRE"
SEASON	The four-digit SEASON for the fire
Shape_Leng	System generated length for the polygon boundary (not used in FAME)
Shape_Area	System generated area for the polygon boundary (not used in FAME)

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_Analysis". An R data file can also optionally be saved this contains the same data, plus metadata of all analysis settings and input file names.).

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 e.g., 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)

A binary serial file (.qs) can be saved to save a FAME process run for further use and/or reference. The file contains a list of named elements each being a named variable or data input or output for the FAME process. Some of these elements (e.g., the FHAnalysis object are lists in themselves). Depending on when in the process this .qs file is saved it will contain some or all of the following elements.

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 analysis(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 indices of U_AllCombs_TFI rows

TFI status and burned below TFI

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

In subdirectory :./TFI_Rasters/

TFI_BY_YEAR.tif

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

of TFI status with associated attributes table giving status for each year.

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

TFI_STATUS_LUT.csv

A lookup table giving the TFI status values and names.

BBTFI_BY_YEAR.tif

In subdirectory ./BBTFI_Rasters/ 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.

BBTFI_BY_YEAR.tif

BBTFI_BY_YEAR.tif.aux.xml

BBTFI_BY_YEAR.tif.vat.dbf

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.

Species relative abundance 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 estimated relative abundance x100 expressed as the rounded integer value.

Filenames are:

./RA_Rasters/Sp_XXXXX_YR_YYYY.tif

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

JFMP Outputs.

Initial JFMP and autoJFMP outputs.

These outputs are produced when the "Run JFMP calculations stage 1" button is pressed.

grpSpYearSummLong.csv

A long format table – usually only used internally in FAME but may be useful if users wish to look at non-standard reporting from the JFMP. Generally, it is too long (> 1M lines) to open in excel. The file has one line giving the estimated relative abundance for each combination of TAXON_ID x PU x EFGZ_NAME x SEASON

.Field Name	Details
TAXON_ID	2021 VBA TAXON_ID for the species
PU	Unique ID for each burn unit/planning unit in JFMP
EFG_NAME	The Name of the EFG
SEASON	Four-digit fire SEASON
sumRA	The calculated sum or relative abundance for that species

PU_Rankings_<PU_Shapefile Name>.csv

This file contains the results of all the burn unit (PU) level calculations used in the JFMP analysis. It also contains all the input and joined table used in these calculations for reference. It ranks the Planning units on the basis of the four individual scores used in the JFMP selection process. These ranks are "dense ranks" so that there is no gap in the numeric rank following equally ranked cases (i.e. if three cases ranked as equal first position, the next highest ranked case would be ranked as second not fourth).

Field Name	Details
Rows from planning unit input shapefile	
DISTRICT_N	Name of the DELWP Fire District that the burn unit is in
FMZ_CODE	A short code for the Fire Management Zone– no spaces or special characters. having separate area targets. If the standard 4 FMZs are used it is suggested that the codes APZ,BMZ,LMZ and PBEZ are used, but any codes may be used, assign value of "NONE" to dummy burn unit files. Alle codes used must be the same in the JFMP Area Target and ZoneWt files (see below).
PU	Unique integer key for each planning unit
PuHectares	Area of the Planning Unit in Hectares

LP1_NoBurn	Value for Life and property score 1 at JFMP year 4 (ie the year after the completion of the JFMP assuming no fires within the burn unit during the JFMP
LP1_Burn	Value for Life and property score 1 at JFMP year 4 (ie the year after the completion of the JFMP assuming that the Burn unit is burned once by a controlled burn (in year 2 of the JFMP)
LP2_Burn	Value for Life and property score 2 at JFMP year 4 (ie the year after the completion of the JFMP assuming no fires within the burn unit during the JFMP or zero if only one life and property score is used
LP2_NoBurn	Value for Life and property score 2 at JFMP year 4 (ie the year after the completion of the JFMP assuming that the Burn unit is burned once by a controlled burn (in year 2 of the JFMP) or zero if only one Life and property score is used
Other fields calculated or joined for JFMP calculations	
Burn_BBTFI	The area (Ha) of the PU that would be burned below TFI for the first time if the PU is burned in JFMP_SEASON0 +2
NoBurn_BBTFI	The area (Ha) of the PU that would have been burned below TFI for the first time if the PU is not burned in the JFMP (this is the same as the area BBTFI by the Fire History up to year JFMP_SEASON_0)
BBTFI_Diff	BBTFI. "the effect on BBTFI for the PU should it be burned in the JFMP" equal to Burn_BBTFI or zero if Burn_BBTFI is NA.
WtSumRA_Burn	The sum of the weighted sum or relative abundance for all species included in the analysis and occurring in the PU calculated at JFMP_SEASON0 +4 following a burn of the PU in JFMP_SEASON0 +2. (The weighted sum of relative abundance for each species is the rum of relative abundance divided by the number of 225m pixels of that species HDM occurring in the JFMP area of interest).
WtSumRA_NoBurn	The sum of the weighted sum or relative abundance for all species included in the analysis and occurring in the PU calculated at JFMP_SEASON0 +4 with no burn during the JFMP (The weighted sum of relative abundance for each species is the sum of relative abundance divided by the number of 225m pixels of that species HDM occurring in the JFMP area of interest).
WtSumRA_Diff	The sum of the weighted sum or relative abundance for all species included in the analysis and occurring in the PU calculated at JFMP_SEASON0 +4 following a burn of the PU in JFMP_SEASON0 +2. (The weighted sum of relative abundance for each species is the sum of relative abundance divided by the number of 225m pixels of that species HDM occurring in the JFMP area of interest).
WtSumRA_DiffStd	WtSumRA_Diff value scaled from 0-1 so that it can be added to other scores in AutoJFMP
BBTFI_DiffStd	BBTFI_Diff value scaled from 0-1 so that it can be added to other scores in AutoJFMP
LP1_Diff	LP1_Burn - LP1_NoBurn
LP2_Diff	LP2_Burn - LP2_NoBurn
LP1Std	LP1_Diff value scaled from 0-1 so that it can be added to other scores in AutoJFMP

LP2Std	LP2_Diff value scaled from 0-1 so that it can be added to other scores in AutoJFMP
WtSumRA_RankREGION	Dense Rank all PU according to their WtSumRA_Diff (small to large)
BBTFI_RankREGION	Dense Rank all PU according to their BBTFI_Diff (small to large)
LP1_RankREGION	Dense Rank all PU according to their LP1_Diff (small to large)
LP2_RankREGION	Dense Rank all PU according to their LP2_Diff (small to large)
WtSumRA_RankDISTRICT	Dense Rank of PU in each DISTRICT_N according to their WtSumRA_Diff (small to large)
BBTFI_RankDISTRICT	Dense Rank of PU in each DISTRICT_N according to their BBTFI_Diff (small to large)
LP1_RankDISTRICT	Dense Rank of PU in each DISTRICT_N according to their LP1_Diff (small to large)
LP2_RankDISTRICT	Dense Rank of PU in each DISTRICT_N according to their LP2_Diff (small to large)
WtSumRA_RankDISTRICT_FMZ	Dense Rank of PU in each DISTRICT_N by FMZ_CODE combination according to their WtSumRA_Diff (small to large)
BBTFI_RankDISTRICT_FMZ	Dense Rank of PU in each DISTRICT_N by FMZ_CODE combination according to their BBTFI_Diff (small to large)
LP1_RankDISTRICT_FMZ	Dense Rank of PU in each DISTRICT_N by FMZ_CODE combination according to their LP1_Diff (small to large)
LP2_RankDISTRICT_FMZ	Dense Rank of PU in each DISTRICT_N by FMZ_CODE combination according to their LP2_Diff (small to large)
LPwt	Value joined from JFMP zone weight file for the corresponding FMZ_CODE
BDwt	Value joined from JFMP zone weight file for the corresponding FMZ_CODE
FaunaWt	Value joined from JFMP metric weight format file.
FloraWt	Value joined from JFMP metric weight format file.
LP1Wt	Value joined from JFMP metric weight format file.2
LP2Wt	Value joined from JFMP metric weight format file.0
DiffSum	Aggregated weighted sums of JFMP scores. Weighted according to the tow JFMP weightings input files. This value is used to select the PU to burn in the autoJFMP It is calculated as follows: DiffSum = (LP1Std * LP1Wt + LP2Std * LP2Wt) * LPwt + (WtSumRA_DiffStd * FaunaWt + BBTFI_DiffStd *FloraWt) * BDwt
<any other filed value>	This file retains all the fields in the input PU shapefile – there can be as many of these as the user chooses. Usually, the most important of these is the burn unit / planning unit ID used “outside” of fame – this can be used to link the FAME output back to other planning processes that do not have the PU field in them.

autoJFMP<PU_shapefile_name>.csv

This file identifies which PU are selected to be burned by the automated JFMP algorithm. The rows are sorted by DISTRICT_N, FMZ_CODE and DiffSum, then the cumulative area of the PU in that order is calculated for each DISTRICT_N by FMZ_CODE combination. If the cumulative sum up to the

previous row is less than the target area for burning, then the PU is identified for burning in the autoJFMP

The autoJFMP output file contains all the rows and columns of the PU_Rankings file plus the following columns:

Field Name	Details
targetHa	The target in hectares to be burned in the FMZ in the Fire district, joined from the JFMP targets input file.
Dist_FMZ_cum_ha	The cumulative area in Ha of in the District and FMZ
cumbefore	The preceding cumulative area
AutoJFMP_State	Whether or not the PU should be burned in the automated JFMP. Value BURN or NO BURN

autoJFMP_summary<PU_shapefile_name>.csv

This file summarises the outcome of the autoJFMP – ie the aggregates of scores for the whole area should the burns in the autoJFMP occur. It provides a similar summary of the scores should there be no burning in the JFMP period (No_JFMP). It summarises the scores for each DISTRICT_N and the areas burned in the JFMP in each district and FMZ_CODE. The number of columns(fields) in the table will vary according to the number of FMZ_CODEs.

JFMP_Name	Name of the scenario either AutoJFMP or No_JFMP
DISTRICT_N	Fire District Name
Burned_ha	Hectares burned in the scenario
NoBurn_Ha	Hectares not Burned in the scenario
AreaHa	Total Area of Fire District in the JFMP
SumFaunaRA	The summed weighted fauna relative abundance for all species for the Fire District
SumNeverBBTFI	The area of each district in analysis that fire history (and JFMP) scenario) indicates has never been burned below TFI. This figure (rather than the area burned below TFI for the first time is shown as it is a better figure for comparing scenarios. If the area BBTFI for the first time is 0 this could be either because no area was burned below TFI at all or because the entire PU had already been burned below TFI at some
SumLP1	Summed LP1 for the scenario
SumLP2	Summed LP2 for the scenario
Burned_ha <FMZ_CODE>	Area (Ha) of the FMZ burned in the JFMP scenario (one column for each FMZ_CODE

JFMP comparison outputs

These outputs are produced when the “Compare Draft JFMP” button is pushed

allJFMP_Summary_< Alternative JFMP scenario input name>.csv

This file allows comparison of alternative burn proposals “ draft JFMPs” the autoJFMP and No_JFMP scenarios. As such it contains the same fields as the autoJFMP _summary file (directly above) and has the aggregate scores for the additional draft scenarios provided as inputs in the alternative JFMP scenario input file.

jfmpSppRaSumm.csv

This file gives the estimated summed relative abundance across the whole JFMP area for each selected species for each JFMP scenario, along with the estimated baseline relative abundance and the change in relative abundance resulting from the JFMP scenario

Field Name	Details
TAXON_ID	2021 VBA TAXON_ID for the species
COMMON_NAME	2021 VBA Common Name for the species
CombThreshold	Threshold value used to determine whether the threshold for decline has been breached
JFMP_Name	Name of the JFMP scenario
totalRA	The sum total or relative abundance estimated at JFMP_SEASON0+4 for the species for all cells in the JFMP area
BaselineVal	The baseline sum total or relative abundance estimated for the species for all cells in the JFMP area
Delta	The proportionate change in relative abundance compared to the baseline (totalRA/BaselineVal)
BelowThreshold	Whether Dealt breaches the change in relative abundance threshold (CombThreshold) for the species at JFMP_SEASON0+4

jfmpCountSpeciesBelowThreshHold.csv

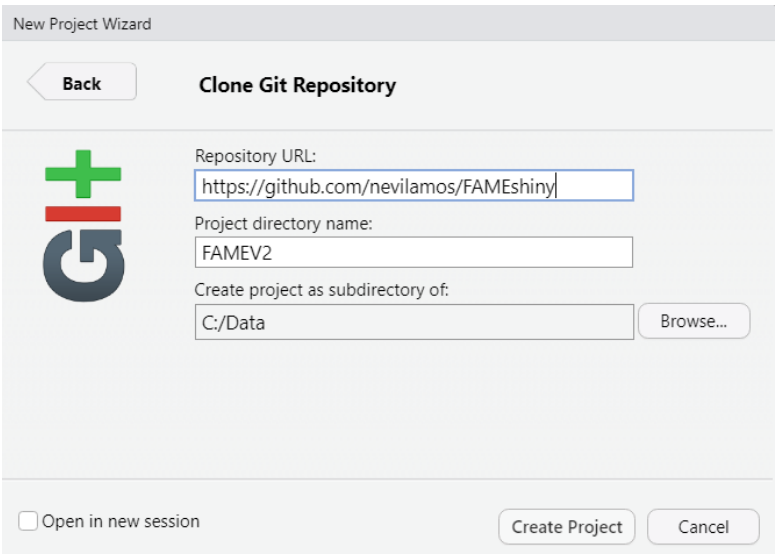
This file gives the count of the selected species breaching their threshold value in each JFMP scenario

Field Name	Details
JFMP_Name	Name of the JFMP scenario
n_BelowThreshold	The number of species breaching their change in abundance threshold value at JFMP_SEASON0+4 in each scenario

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

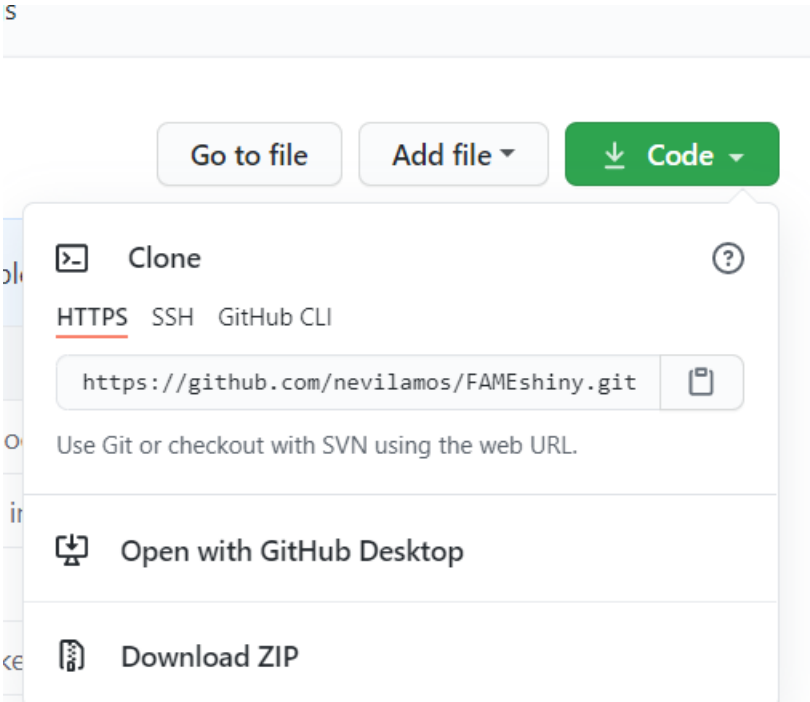


Enter URL for FAMEshiny (https://github.com/nevilamos/FAMEshiny) and Project directory name of your choice (on DELWP SOE computers this should in C:/Data).

Click create project.

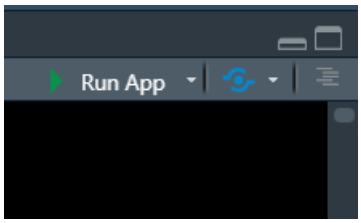
The project files should download form GitHub and the project open.

Alternatively you can go to the github URL (https://github.com/nevilamos/FAMEshiny) in your 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 your Local machine simply open ui.r and click again on run app.