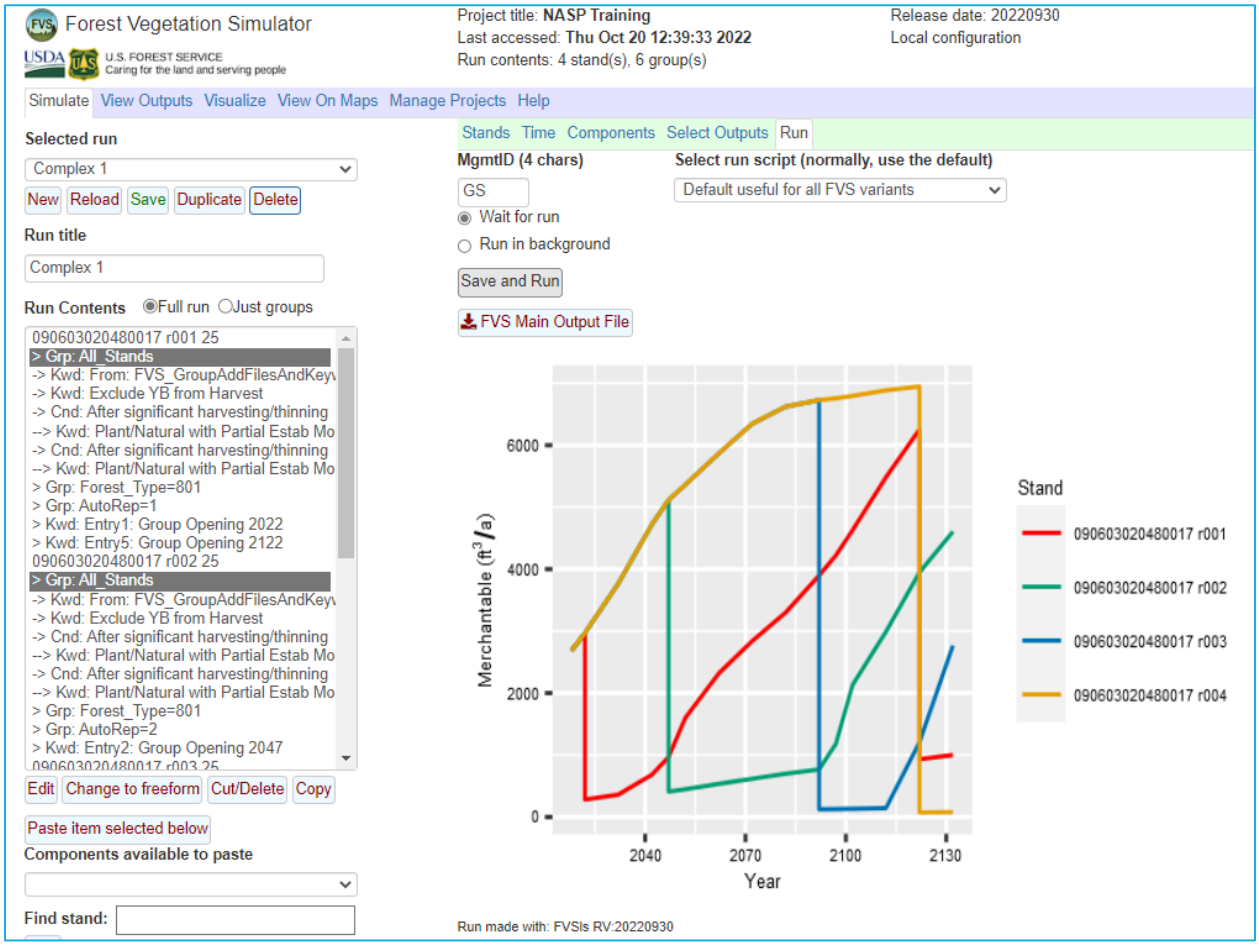
NASP Quick Start Training Guide
2024



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Installing FVS

The Forest Vegetation Simulator (FVS) is a browser-based forest modeling system utilizing the Shiny web application framework to interact with FVS geographic growth and yield models.

The installation package for FVS may be found in the download section on the FVS Software Complete Package webpage (https://www.fs.usda.gov/fvs/software/complete.php).

The installation package is a single executable that will install the standard suite of programs included with FVS. Installing all the components will require more than 250 MB of hard drive space and take about 10-15 minutes to install. Any program files from previous installations of the FVS Complete Package will be overwritten. All other project folders in the destination specified will not be overwritten. Depending on your security settings, you may need administrative privileges to install/unistall FVS.

To install the current FVS Software Complete Package, perform the following steps.

1. Click the link for the FVS Software Complete Package installation file to begin downloading it.
2. When prompted, Save the file to a location on your local computer (remember where you save it).
3. When the executable has finished downloading, choose to open the installation executable by clicking the **Open** button. If you do not have this option, navigate to the directory where you specified the file be saved and double-click on the executable.
4. Following the FVS splash screen, select a location to save your projects or accept the default location and click the **Install** button.
5. When the installation is finished, click the **Finish** button.

The installation package will install an FVS Icon 

on your desktop that is linked to the FVS program located in your selected folder. Within the folder, you will find the default project folder named, *Project_1*. When FVS is started, *Project_1* will be the active project.

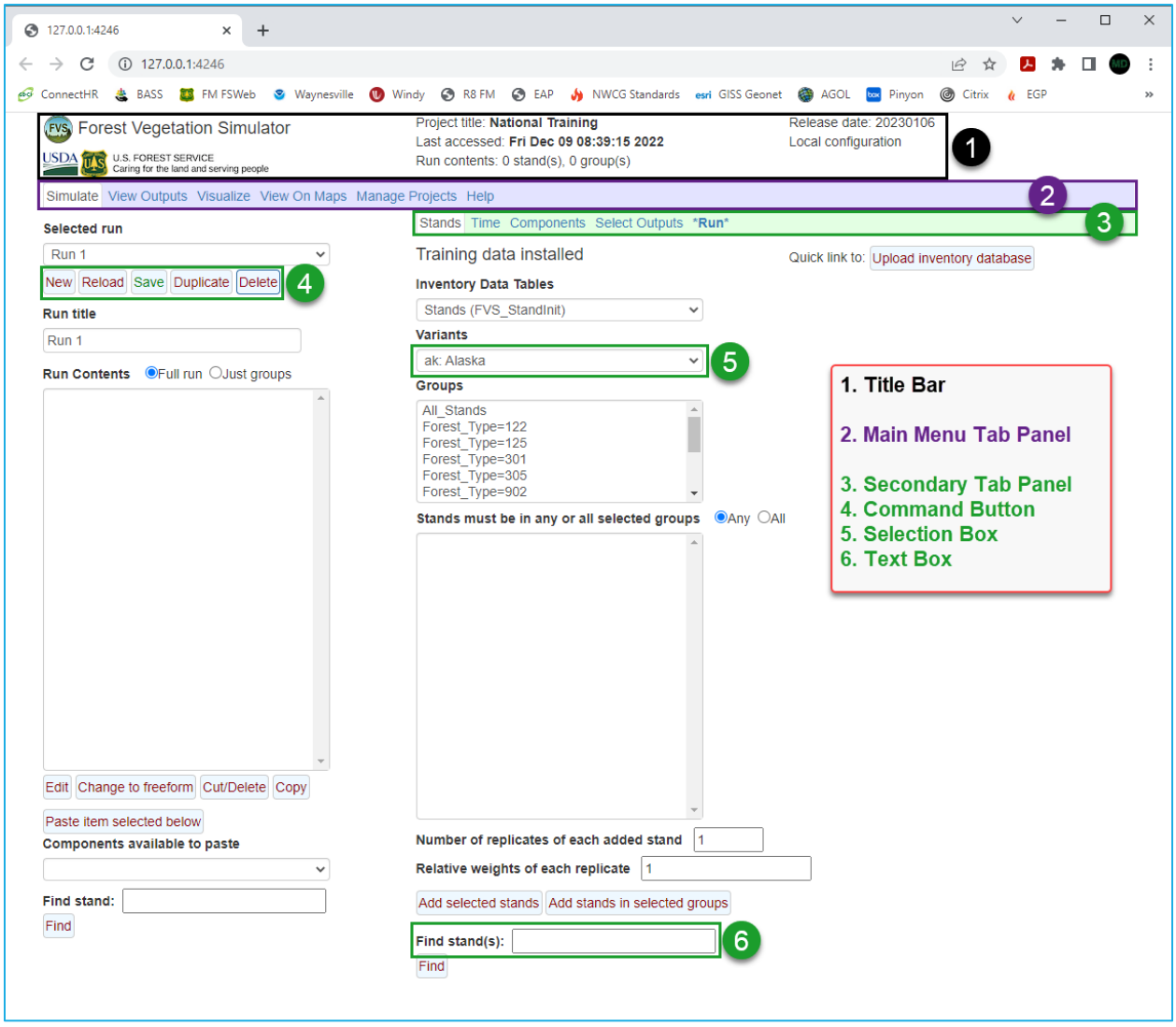
6. Double click the **FVS** icon on your desktop. FVS will open in your default browser.

Understanding the interface

At the top of the interface, you will see a title bar with information regarding the active project, the date and time you last accessed FVS, the release date, and the interface configuration.

Below the title bar you will see the main menu tab panel, consisting of six tabs: **Simulate**, **View Outputs**, **Visualize**, **View on Maps**, **Manage Projects**, and **Help**.

These tabs open pages that contain command items (buttons, selection and text boxes, and check boxes) as well as secondary menu tab panels that contain groups of command items.



Below is a brief description of each menu item.

Simulate

The **Simulate** tab is divided into two regions where on the left you have options to select or create runs and view/modify their contents. On the right, you have a secondary tab panel designed to help you parameterize runs. This tab panel is used to add stands to a run (**Stands**), set the time frame (**Time**), add instructions (**Components**), select output tables (**Select Outputs**), and run the simulation (**Run**).

View Outputs

The **View Outputs** tab contains a secondary menu tab panel on the left which allows you to load and explore FVS outputs (**Load** and **Explore)** that were selected on the **Simulate > Select Outputs** tab or create user-defined outputs using custom queries (**Custom Query)** of available output tables. A **Describe tables** selection box is found on the right which provides descriptions of all variables contained in any FVS output table.

Visualize

The **Visualize** tab contains check boxes and selection boxes that allow you to display two sets of images of stands in any FVS run, if the **SVS** check box was selected in the **Simulate > Select Outputs** menu prior to running the simulation. Each image set will contain three static images (perspective, profile, and overhead views) and one dynamic image (user may adjust view).

View on Maps

The **View on Maps** tab contains selection boxes that allow you to display FVS outputs from a selected run for stand polygons or points overlain on one of four Google base maps. The output may be viewed in tabular or graphical form by selecting the appropriate **Display** radio button.

Manage Projects

The **Manage Projects** tab contains a secondary menu tab panel which allows you to select, create and backup projects (**Manage Project);** import forest inventory input data and maps (**Import input data**); import runs, custom component files, graph settings, and queries from another project (**Import runs and other items);** and, download input/output databases and run components (**Downloads)**.

Help

The **Help** tab explains each of the aforementioned menu items in enough detail to guide you through making runs with FVS.

Creating an FVS project

FVS is installed with a default project, named *Project_1*, which contains a training dataset composed of inventory and map data from across the country. The modules associated with this training guide use this project for all exercises. If you wish to create a new project for your data, follow the steps below.

When it is time to run your data through FVS, we recommend creating a new FVS project using the **Manage Projects > Manage Project** tab. Once created, the new project will contain a copy of the training dataset mentioned above. You will be able to replace the training dataset with your own FVS-ready data using the **Manage Projects >Import input data > Upload inventory database** options. The following steps describe how to create a new project and replace the existing training dataset with your own dataset. Once your new project is created, you can toggle back and forth between projects using the **Select project** selection window on the **Manage Projects > Manage project** tab. When you open a selected project, you will be sent to the **Simulate** tab for that project.

1. Select the **Manage Projects > Manage project** tab.
2. In the **Create a new project** title text box, type in a name for your project such as, "*NASP Training*."
3. Click the **Make new project** button.
4. Once the project is created, use the **Select project** selection window to select *NASP Training* project and click the **Open selected project** button.

FVS will restart with the **Simulate** tab activated for your project. At the top of the page, you'll see the project title has been set to the name you entered.

Replacing the training database

There are two ways to navigate to the **Upload inventory database** tab: (1) you can click the **Upload inventory database** button on the quick link of the **Simulate > Stands** tab or you can navigate to the upload tab by clicking **Manage Projects > Import input data > Upload inventory database** tab. The **Upload inventory database** tab gives you the option to replace or add to the existing database with an FVS-ready database utilizing the FVS input database structure, as described in the User's Guide to the Database Extension. Acceptable database formats include SQLite databases (.db or .sqlite), Microsoft Access databases (.mdb or .accdb), or Microsoft Excel spreadsheets (.xlsx) where the table/sheet names are the same as the target table names. Variable names need to match FVS input database structure. Replacing the existing database is a two-step process where you first upload an FVS-ready database, then you install the uploaded database. The steps to do so are clearly spelled out in FVS.

5. Select the **Upload inventory database** tab.
6. Follow the directions in **Step 1** to upload your FVS-ready database.
7. Follow the directions in **Step 2** to install the uploaded database.

Once your database is installed, you may upload your map data using the **Upload map data** tab. Many map file formats are supported, refer to this list for a list of file formats. To upload a map, first create a .zip file that contains a single directory (folder) where the coverages are stored. Then upload the .zip file and let FVS try to load the appropriate files. If the .zip file contains more than one layer, you can select the layer that contains stand polygons (the system will attempt to make a valid selection). Note that the polygons must be identifiable by StandID but frequently the coverage data contains this information under a different variable name. FVS attempts to discover the correct variable to match to StandID. You can set the variable here if necessary.

If the geographic projection of your data is not stored with the data (usually it is part of the coverage data), then you can set the projection using the provided tools. You can select a projection from the list button or just type in the proj4 string into the text box. Note the projection is set or reset here but the spatial data are not re-projected. Any needed re-projection is done automatically.

Adding the map coverage is also a two-step process.

8. Select the **Manage Projects > Import input data > Upload map data** tab.
9. In Step 1, click the **Browse** button and select the zip file containing your spatial dataset. As the data is uploaded, FVS will attempt to attach your spatial data to the tabular data loaded in the previous steps. If successful, FVS will display the joining variable along with the percent match.
10. Click the **Install imported spatial data** button to finish installing your map data.

If you do not have map data for your project, you can still view FVS outputs on a map if you enter latitude and longitude in your input stand data (FVS_StandInit table). When viewing FVS outputs on maps using this method, the stands will appear as points on your map. The training data for Alaska only contains latitude/longitude point data while the rest of the training dataset contains polygon map data.

You are now ready to simulate forest development within your project.

Base 1: Single stand run

In this exercise, you will use FVS to describe stand development for the next thirty years using the **View Outputs**, **Visualize**, and **View On Maps** menu options.

Starting a new run

Starting an FVS run begins with naming and saving your run. Upon startup, FVS reads the inventory data and activates the **Simulate** menu. The default run title is set to *Run 1*. A new run can be initiated by clicking the **New** button and typing in a new title in the **Run Title** text box. The **Save** button saves the run.

1. Within the **Simulate** menu, begin a new simulation by clicking the **New** button.
2. Change the **Run title** to *Base 1*.
3. Click the **Save** button.

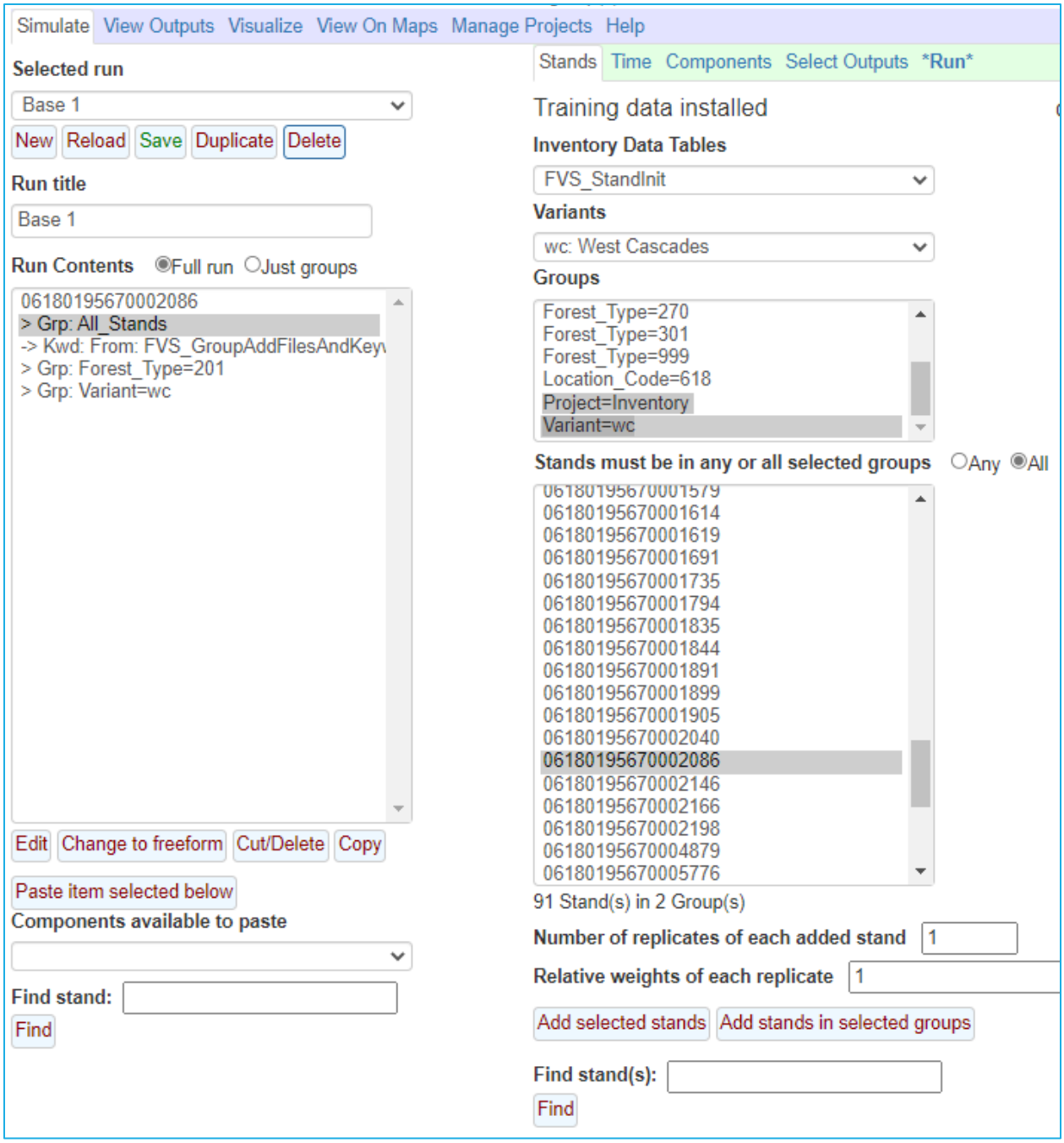
Adding a stand into a run

Specific stands may be added to the run by using the selection tools in the **Stands** menu. Your selection choices impact options in a top-down manner where your choice of **Inventory Data Tables** will dictate which **Variants** are available and subsequently which **Groups** are available. Selecting a grouping code will display stands that meet all the above criteria specified. If multiple group codes are selected, the default is to display any stands that have at least one of the grouping codes. This may be changed to display only those stands that meet all the grouping codes selected by changing the option associated with the **Stands must be in any or all selected groups** radio buttons to *All* from *Any*.

You can add a single stand by highlighting the stand and clicking the **Add selected stands** button. Once added to a run, the stand will be added to the **Contents** window.

Perform the following steps to add a stand into the run.

4. In the **Variants** selection box, select *wc : West Cascades*
5. In the **Groups** selection box, select *Forest_Type=201*.
6. In the **Stands** selection box, select stand *061801956700020 86*.
7. Click the **Add selected stands** button.



FVS keywords assigned to stands or grouping codes will be added into the simulation. In this dataset, keywords linking the FVS variant to the stand and tree data will be added from the *FVS_GroupAddfilesAndKeywords* table using the *All_Stands* grouping code. This can be seen in the **Contents** window with the indented line starting with *->Kwd:*.

Setting the time frame

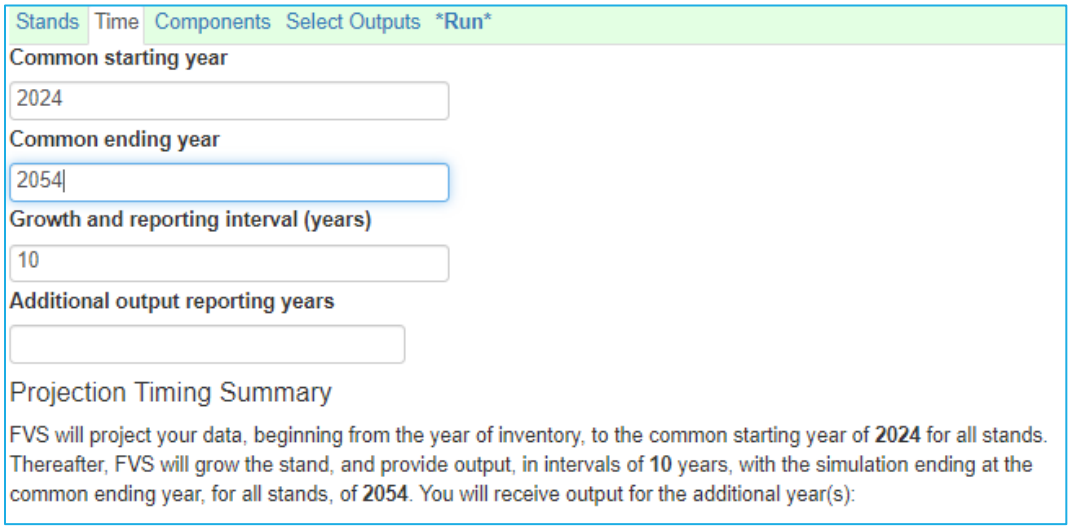
8. Select the **Time** menu.

Setting the time frame of the run is done using the **Time** menu. By default, the common starting year is set to the current year and the common ending year is set to ten growth cycles in the future. For

most variants, the default growth interval is ten years which results in a default simulation length of 100 years. The growth and reporting interval may be changed, and additional reporting years may be specified; however, care is needed as FVS can only simulate up to 40 total growth intervals.

Perform the following steps to set up a thirty-year simulation starting in 2024.

9. Change the **Common starting year** and **Common ending year** to *2024* and *2054*, respectively.
10. Read the **Projection Timing Summary** for a description of how your timing choices will affect the run.



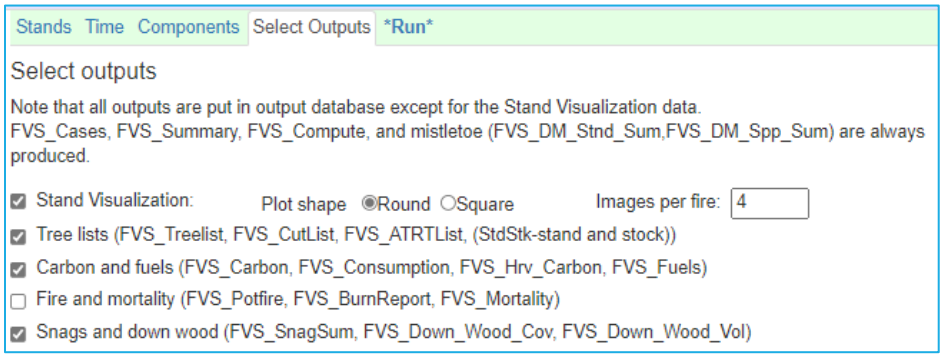
Selecting Outputs

11. Select the **Select Outputs** menu.

The **Select Outputs** menu allows you to request output tables for various output categories. Some tables are automatically produced, such as the *FVS_Summary* table which includes common stand level summary statistics describing stand density, size and volume. Other tables need to be selected using the check boxes provided.

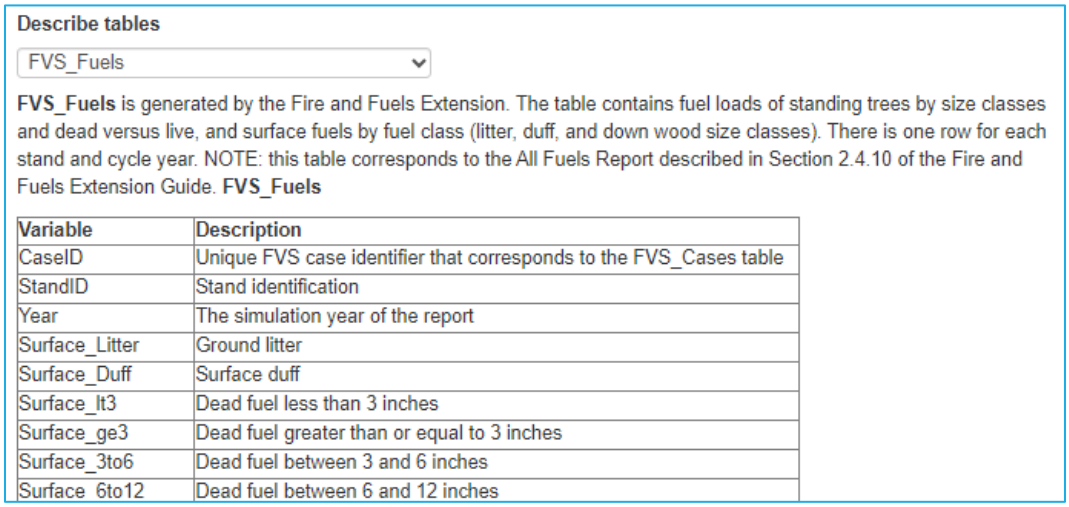
In this exercise, you will select outputs that will describe stand composition, surface material, and snags.

12. Check the **Stand Visualization** box to request image files
13. Check the **Tree lists** box to request output needed to create a stand and stock table.
14. Check the **Carbon and fuels** and **Snags and down wood** boxes to request output describing biomass in other stand components.



The **Describe tables** selection box at the bottom of the **Select Outputs** menu allows you to review table variables and their definitions. These definitions will provide most of the information you need to select the appropriate variables to describe your stand. Further information describing the variable calculation methods may be found in Essential FVS: A User's Guide to the Forest Vegetation Simulator (Dixon 2002), The Fire and Fuels Extension to the Forest Vegetation Simulator: Updated Model Documentation (Rebain 2010), and other FVS documents found on the FVS documents webpage. The **Describe tables** selection box also appears in the **View Outputs- Load** menu.

15. Use the **Describe tables** selection box to familiarize yourself with the outputs associated with the tables selected above.



Describe tables

FVS_Fuels

FVS_Fuels is generated by the Fire and Fuels Extension. The table contains fuel loads of standing trees by size classes and dead versus live, and surface fuels by fuel class (litter, duff, and down wood size classes). There is one row for each stand and cycle year. NOTE: this table corresponds to the All Fuels Report described in Section 2.4.10 of the Fire and Fuels Extension Guide. **FVS_Fuels**

Variable	Description
CaseID	Unique FVS case identifier that corresponds to the FVS_Cases table
StandID	Stand identification
Year	The simulation year of the report
Surface_Litter	Ground litter
Surface_Duff	Surface duff
Surface_lt3	Dead fuel less than 3 inches
Surface_ge3	Dead fuel greater than or equal to 3 inches
Surface_3to6	Dead fuel between 3 and 6 inches
Surface_6to12	Dead fuel between 6 and 12 inches

Running the simulation

16. Select the ***Run*** menu.

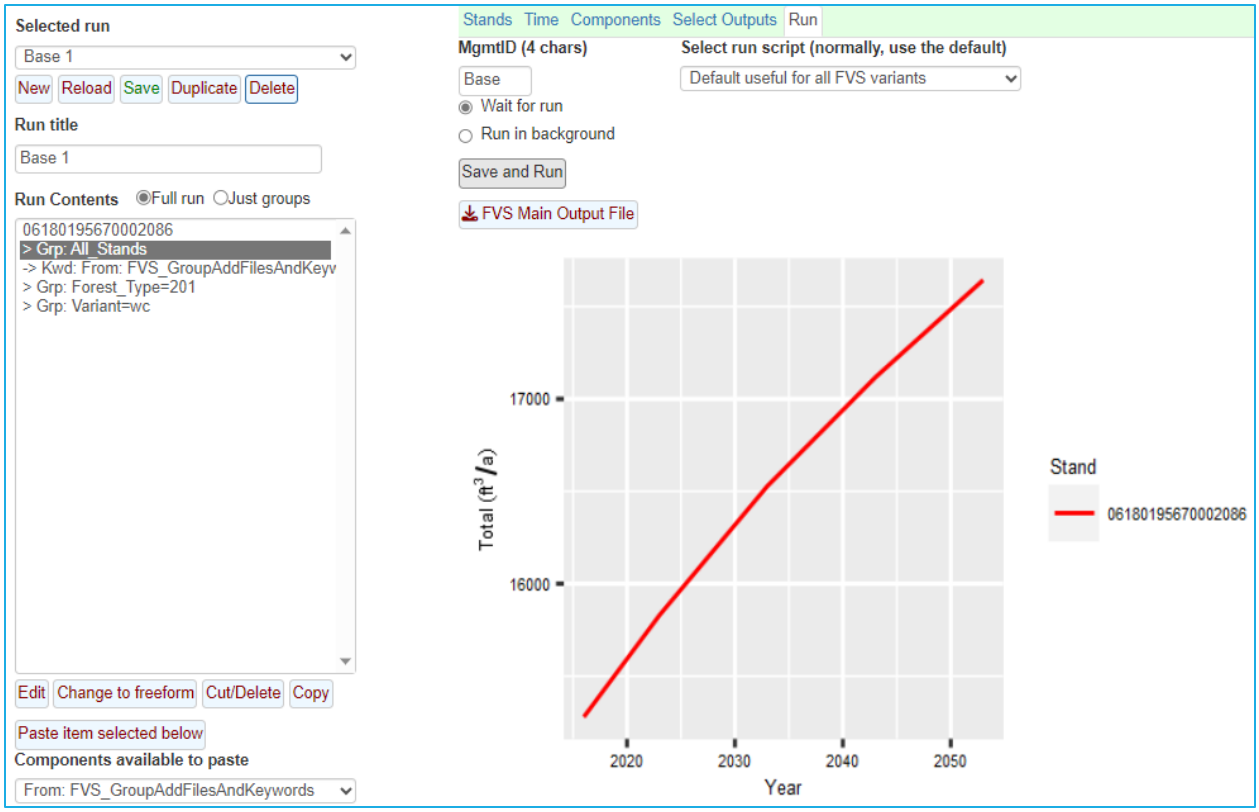
The final step of performing an FVS run is to save and run your simulation. This is accomplished through the **Run** menu. The **Run** menu title includes asterisks (***Run***)when there is a change from a previously saved version. Before clicking the **Save and Run** button on the **Run** menu, you can specify a specific management identification code for the run. This allows you to display outputs from various runs based on unique management identifications. Management identifications are also used to create subsets of averages across stands when creating/viewing average composite tables.

17. Change the management identification code (**MgmtID**) to *Base*.
18. Click the **Save and Run** button.

FVS will save the run as *Base 1* with a management identification code of *Base*.

(If you get a Windows Defender Firewall message regarding the R for Windows front-end, X out of the message and continue. If FVS closes, reopen the FVS program, all your work will be saved and re-do step 19 and the message should not appear again.)

If the run is successful, you will see a figure reporting the volume per acre in the stand for the run time frame. Any warnings or errors in the run will be reported below the figure.



Describing stand development using Maps

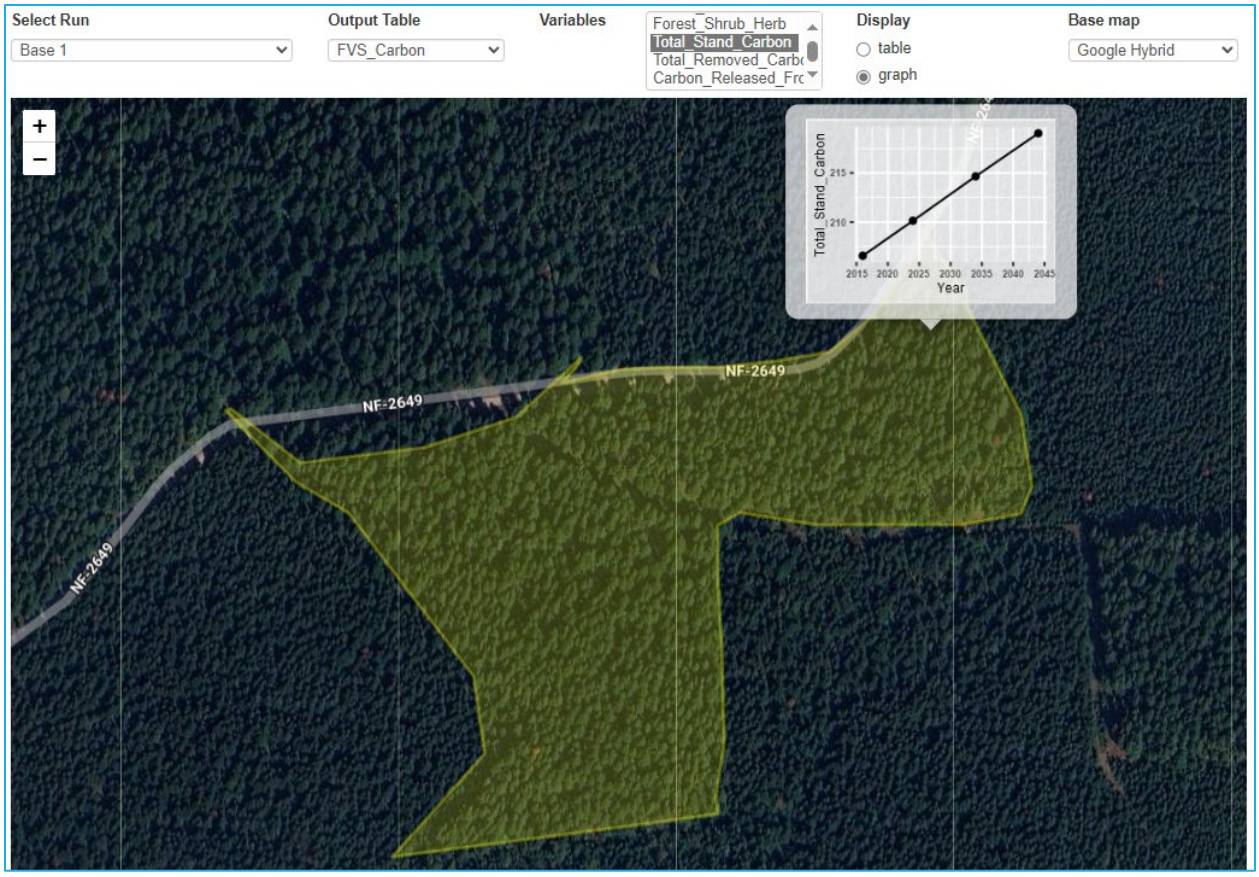
19. Select the **View on Maps** menu.

One of the easiest ways to explore stand development is to view your output using the **View on Maps** menu. **View on Maps** will display FVS outputs for your stand polygon projected on a base map.

20. Use the **Select Run** selection box to select *Base 1*.
21. Use the **Output Table** selection box to select *FVS_Summary2* table.
22. Use the **Variable** selection box to select *Tpa*.

Once trees per acre is selected, an image of your stand (yellow boundary) will display over a base map. You have four base map options in the **Base Map** selection box, with the default being *Google Hybrid* map. If you move your cursor over the image, FVS will display the trees per acre in the stand in a table over the projection period. By clicking the **graph** radio button in the **Display** area, you will see a figure of trees per acre over the projection period. You can make a table/graph stick to the map by simply clicking anywhere over the stand polygon. The table/graph will stick where you click and may be closed by clicking the X in the upper right corner of the table/figure.

Cycling through a few stand variables allows you to view how the stand is developing over the simulation time frame. Viewing trees per acre (*Tpa*) and basal area (*BA*) show you how density changes, while viewing the quadratic mean diameter (*QMD*) and top height (*TopHt*) show you how tree size changes. Similarly, you can get estimates of total production by viewing the merchantable cubic foot volume (TPrd*MCuFt*) in the stand or by switching tables to view total stand biomass (*FVS_Fuels – Total_Biomass*) or total stand carbon (*FVS_Carbon – Total_Stand_Carbon*).



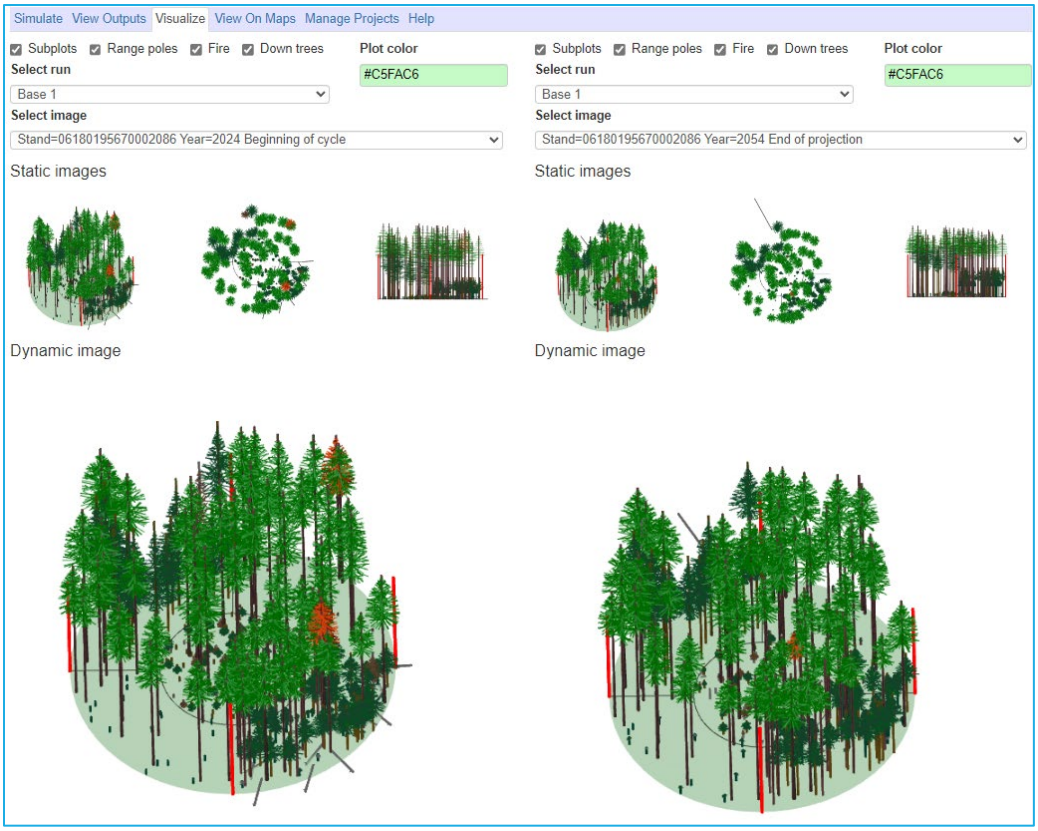
Describing stand development using Visualize

23. Select the **Visualize** menu.

The **Visualize** menu allows you to view and compare images of any stand in your run during your projection time frame. You may select up to two images at a time. Each selection pane allows you to select a run and an SVS image (case), as well as specify whether subplot boundaries, range poles, fire, and down trees will be included in the images. You also can specify the ground color. Once a run and image are selected, rendering of the image takes place. The speed of this process depends on the underlying SVS treelist and may take some time for large lists. It is important to wait patiently while the image is rendered before moving on to selecting a second image.

24. In the left **Select Run** selection box, select *Base 1*.
25. In the left **Select image** selection box, select year *2024*.
26. Wait for image to be drawn.
27. In the right **Select Run** selection box, select *Base 1*.
28. In the right **Select SVS image** selection box, select year *2054*.

Using your mouse, you can click on the Dynamic image and zoom in and out, and flip or rotate the images. Once you have an image set, you may be able to copy/paste or save each image by doing a right click over the image. If your browser does not give you these options, you can use a snipping tool or other screen capture programs to copy/paste or save your images.



Describing stand development using View Outputs

29. Select the **View Outputs** menu.

The **View Outputs** menu allows you to explore FVS output data through a two-step process using the **Load** and **Explore** menus or through custom SQL queries using the **Custom Query** menu. For most users, exploring data using the two-step **Load/Explore** process will accomplish most needs and is the focus of this training.

30. If it is not already selected, select the **Load** menu**.**

To view outputs, you begin by choosing the species codes to use in the tables, followed by loading the runs and FVS-generated output table(s) that interest you. When you select a table, all data columns are chosen by default; however, you can limit the database columns by selecting specific variables in the **Database variables to consider** selection box.

In addition to the traditional FVS-output tables, FVS generates a stand and stock table (StdStk) which reports trees per acre, basal area, and volumes by species and diameter class. By default, the stand and stock table is built with four-inch diameter classes (midpoint values reported in table); however, you have the ability to reset the diameter class width by changing the value in the **DBH class size** field and clicking the **Rebuild StdStk** button.

When selecting variables, you may review variable output definitions using the **Describe tables** selection box on the right side.

When selecting tables, you should only select tables of the same hierarchy (stand vs. diameter class vs. tree tables); otherwise, some non-sensical data may be provided.

31. In the **Runs to consider** selection box, select *Base 1*.
32. In the **Database tables to consider** selection box, make sure *FVS_Summary2* is selected.

Step two involves exploring the data you selected by selecting the **Explore** menu.

33. Select the **Explore** menu.

The selection tools on the left side of the **Explore** menu allow you to further refine your results by allowing you to select output for specific runs, stands, management identification codes, years, species, diameter classes, and variables. If some selection criteria are not available, that means the tables you selected do not have that information.

34. Select years *2024* through *2054*.
35. Using the check boxes in the lower left, select the following forest type, size class, and stocking class variables to include in the table to the right.
    a. *StandID*
    b. *Year*
    c. *Tpa*
    d. *BA*
    e. *ForType*

Output selected will be displayed in the **Table** menu on the right side, which is then downloadable in either MS Excel format (.xlsx) or comma delimited format (.csv) by setting the **File Type** and clicking the **Download table** button. Download the table into an excel file and format the table for sharing with others.

36. Click the **Download table** button.
37. Open the MS Excel file.
38. Change the variable names to be easier to understand.
39. Use the Essential FVS: A User's Guide to the Forest Vegetation Simulator (Dixon 2002), Appendix B, to translate the values into common terminology.

The resulting table should give viewers enough information so that they do not need to translate any of the output.

The data are also available to view in graphical form.

40. Select all the variables in the check boxes on the lower left side of the **Explore** window.
41. To view the selected outputs in graphical form, select the **Graphs** menu.

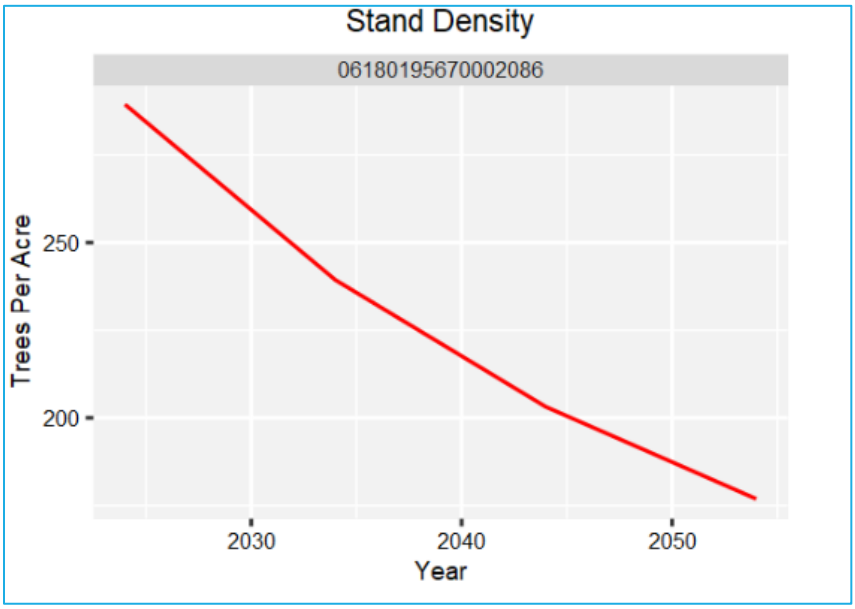
The **Graphs** menu provides access to graphing tools that operate on the data displayed in the table. The graphing options allow you to choose the type of the graph, the x and y axes, and labels. In addition, you have the ability to organize and label the output using horizontal and vertical facets and the plot-by code. While the facets allow you to organize multiple graphs side by side or top-down, the plot-by code allows you to display the outputs on one graph. Additional options are available when you choose to show more controls.

The best way to learn how the graphing tool works is to experiment. First display density over the time projection time frame.

42. Make the following changes to the graphing options:
    a. **Y-axis .....***Tpa*
    b. **Vertical facet.....***None*

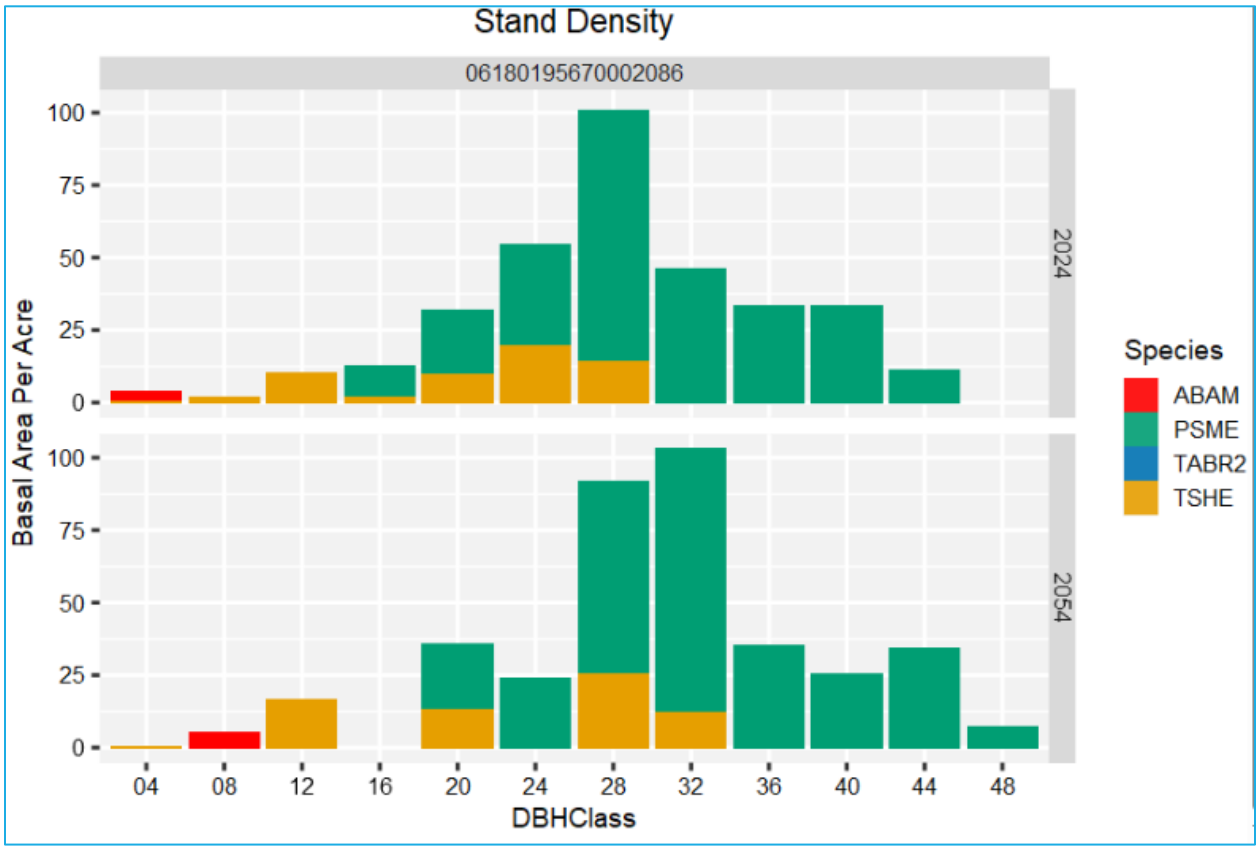
c. **X-axis** ..... *Year*
d. **Horizontal facet**..... StandID
e. **Title**..... Stand Density
f. **Y-label**..... Trees Per Acre

Once you finish the graph, depending on your browser, you may be able to do a right click and copy/paste or save the image. Another option to copy a graph is to use your operating system's snipping tool.



The graphing function is also useful in determining species composition within the stand. You will need to load the stand and stock table to explore species composition.

43. Select the **Load menu.**
44. In the **Runs to consider** selection box, select *Base 1*.
45. In the **Database tables to consider** selection box, select *StdStk*.
46. Select the **Explore** menu.
    a. **Years**..... *2024* and *2054*
    b. **DBHClasses**..... All except the *All* category
47. Make sure the **Graphs** menu is selected.
48. Make the following changes to the graphing options:
    a. **Type**..... *Bar*
    b. **Y-axis** ..... *LiveBA*
    c. **Vertical facet**..... *Year*
    d. **Width**..... *6*
    e. **X-axis** ..... *DBHClass*
    f. **Horizontal facet**..... *StandID*
    g. **Plot-by code** ..... *Species*
    h. **Height**..... *4*
    i. **Title**..... Stand Density
    j. **Y-label**..... Basal Area Per Acre



Using the outputs from this run, answer the following questions.

From the snag and fuels data (*FVS_SnagSum*, *FVS_Fuels,* and *FVS_Carbon*), describe snag, coarse woody debris dynamics, and carbon stocks over the time frame.

Base 2: Multi-stand run

In this exercise, you will use FVS to describe stand development for the next thirty years for groups of stands in the West Cascades.

Starting a new run

You can start a new simulation by going to the **Simulate** menu and clicking the **New** button.

1. Within the **Simulate** menu, begin a new simulation by clicking the **New** button.
2. Change the **Run title** to *Base 2*.
3. Click the **Save** button.

Adding stands into a run

Specific stands or groups of stands may be added to the run by using the selection tools on the **Stands** menu. You can add all stands in a grouping code by selecting a grouping code and clicking the **Add stands in the selected groups** button. Once added to a run, the stands will be added to the **Contents** window.

Perform the following steps to add all the Douglas-Fir stands (*Forest_Type=201*) into the simulation.

4. In the **Variants** selection box of the **Stands** menu, select *wc : West Cascades.*
5. In the **Groups** selection box, select *Forest_Type=201.*
6. Click the **Add stands in selected groups** button.

Setting the time frame

7. Select the **Time** menu.

If you want output on a specific year that doesn't land on a cycle boundary, you can add additional reporting years by specifying the years in the **Additional output reporting years** text box.

Perform the following steps to set up a forty-year simulation starting in 2024, while also including an additional reporting year fifteen years into the simulation (2039).

8. Change the **Common starting year** and **Common ending year** to *2024* and *2064*, respectively.
9. Add *2039* to the **Additional output reporting years** text box.
10. Read the **Projection Timing Summary** for a description of how your timing choices will affect the run.

Adding additional user-defined outputs

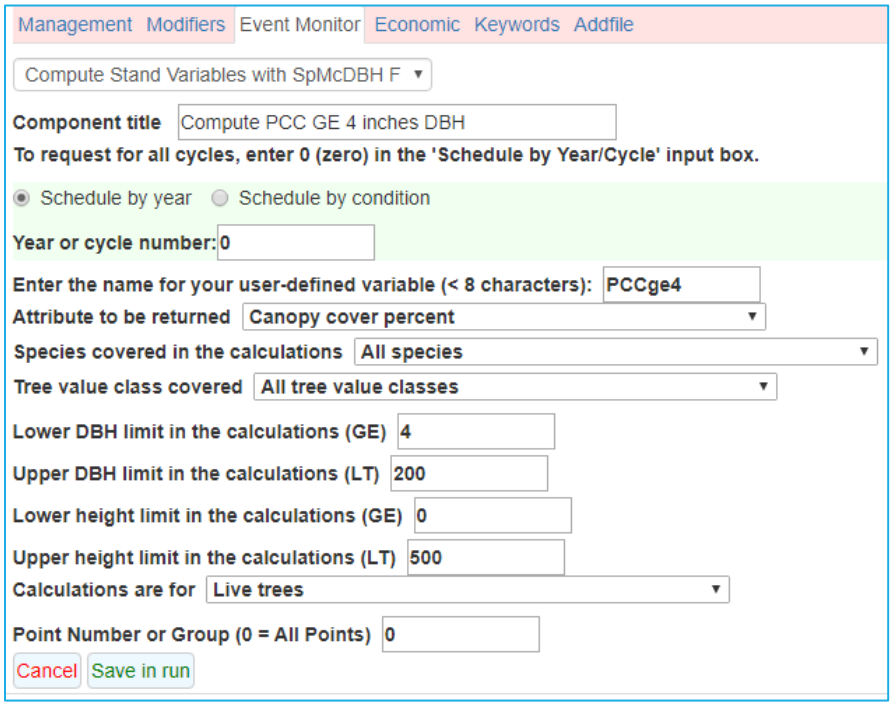
11. Select the **Components** menu.
12. Select the **Event Monitor** menu.

Most FVS output variables are also available through the calculation of user-defined variables using Event Monitor-Compute options. With the Event Monitor, users may use these variables along with additional FVS functions and operators to create new variables. The compute expressions you create need to conform to Event Monitor coding standards, as described in section 5.5.2 Event Monitor Rules of Essential FVS: A User's Guide to the Forest Vegetation Simulator (Dixon 2002).

Perform the following steps to compute the canopy cover of trees greater than or equal to four inches DBH.

13. Select *Compute Stand Variables with SpMcDBH Function* from selection box.
14. Change the **Component title** to *Compute PCC GE 4 inches DBH*

15. Enter the following parameters:
    a. **Year or cycle number:** *.0*
    b. **Enter the name ***PCCge4*
    c. **Attribute.....***Canopy cover percent*
    d. **Lower DBH limit ***4*
    e. Leave all other parameters set to the default values.



16. Click the **Save in Run** button.

Selecting Outputs

17. Select the **Select Outputs** menu.

In this exercise, you will ultimately be using SVS images and composite tables to describe the group simulation. Check the following boxes.

18. Check the **Stand Visualization**, **Tree lists**, **Carbon and fuels,** and **Snags and down wood** boxes.

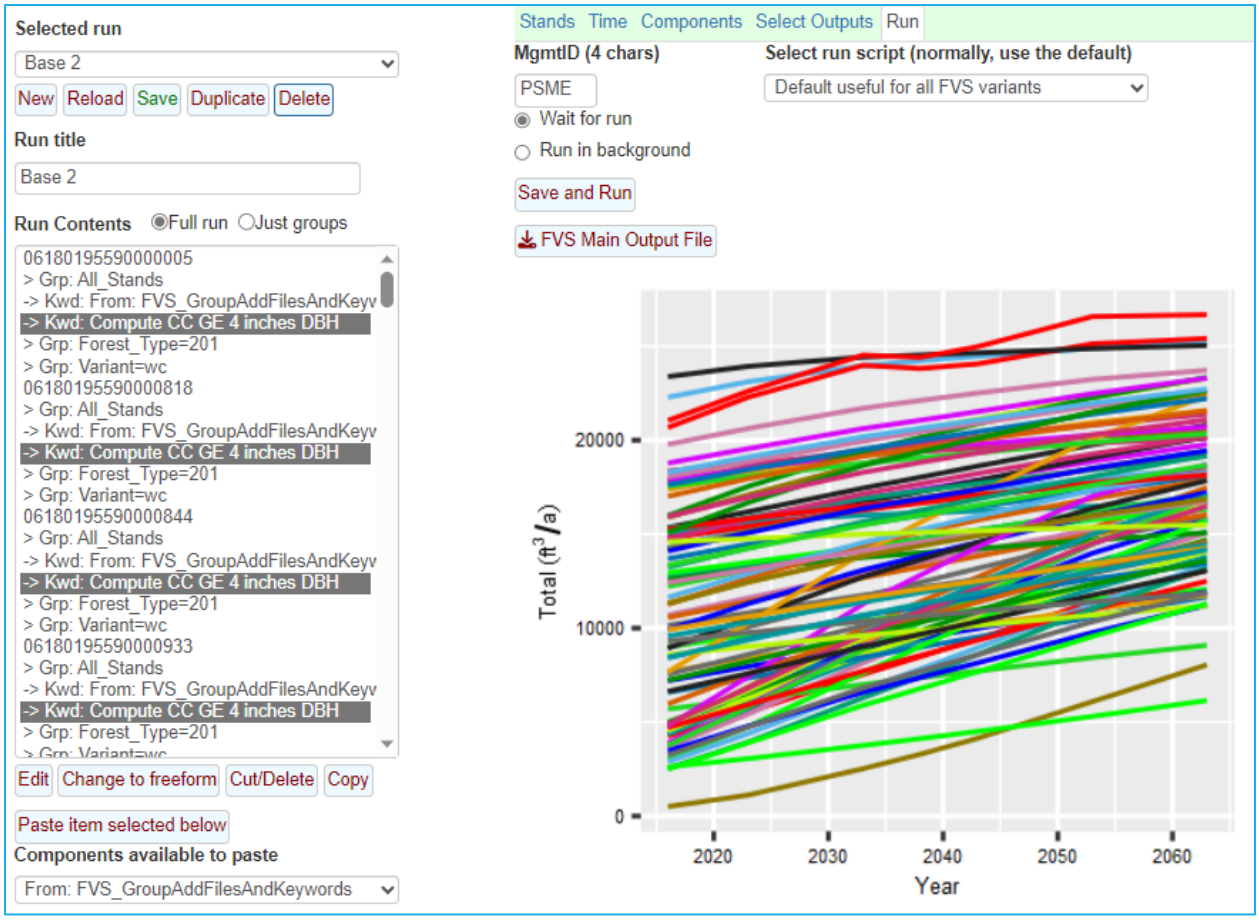
Running the simulation

19. Select the ***Run*** menu.

The final step of performing an FVS run is to perform the run.

20. Change the management identification code (**MgmtID**) to *PSME*.
21. Click the **Save and Run** button.

FVS will save the run as *Base 2* with a management identification code of *PSME*. If the run is successful, you will see a figure reporting the volume per acre for all stands during the projection time frame.



Describing stand development using Maps

22. Select the **View on Maps** menu.

View on Maps will allow you to display FVS outputs for any of the stands in the run on a map. Hovering over stand polygons will allow you to explore the diversity of values in a specific run.

Check the forest type and canopy cover estimates of each stand in the simulation.

23. Use the **Select Run** selection box to select *Base 2*.
24. Use the **Output Table** selection box to select *FVS_Summary2* table.
25. Use the **Variable** selection box to select *ForTyp*.

Write down the forest types for these stands.

26. Use the **Output Table** selection box to select *FVS_Compute* table.
27. Use the **Variable** selection box to select *PCCGE4*.

Write down the canopy cover range and stand ID for the stand adjacent to Belknap Hot Springs along NF2647 Road.

Describing stand development using Stand Visualization

28. Select the **Visualize** menu.

The **Visualize** menu allows you to view and compare images of any stand in your simulation during your simulation timeframe.

Use Stand Visualization to check the structure and composition of the stand written above.

29. In the left **Select Run** selection box select *Base 2*.
30. In the left **Select image** selection box, select *Stand=061801957500021 24* year=*2016*.
31. Continue viewing the rest of the stands in the simulation.

Do the inventory images match with the forest type and canopy cover you recorded above for this stand? Why or why not?

Describing stand development using View Outputs

32. Select the **View Outputs** menu.
33. If it is not already selected, Select the **Load** menu**.**

To view average outputs across a range of stands, you may select any of the runs and composite database tables. Composite tables are created when more than one stand is selected in the **Runs to consider** selection box, either through the selection of a single run with multiple stands or the selection of multiple runs. Composite tables are weighted averages (where values in the *Sam_Wt* column of the stand table are treated as weights) grouped by the management identification code associated with each stand. The composite tables are created for the summary table, the stand and stock table and the compute table. Composite tables are all prepended letters *Cmp*.

As with the other FVS tables, you should only select tables of the same hierarchy (stand vs. diameter class vs. tree tables); otherwise, some non-sensical data may be provided.

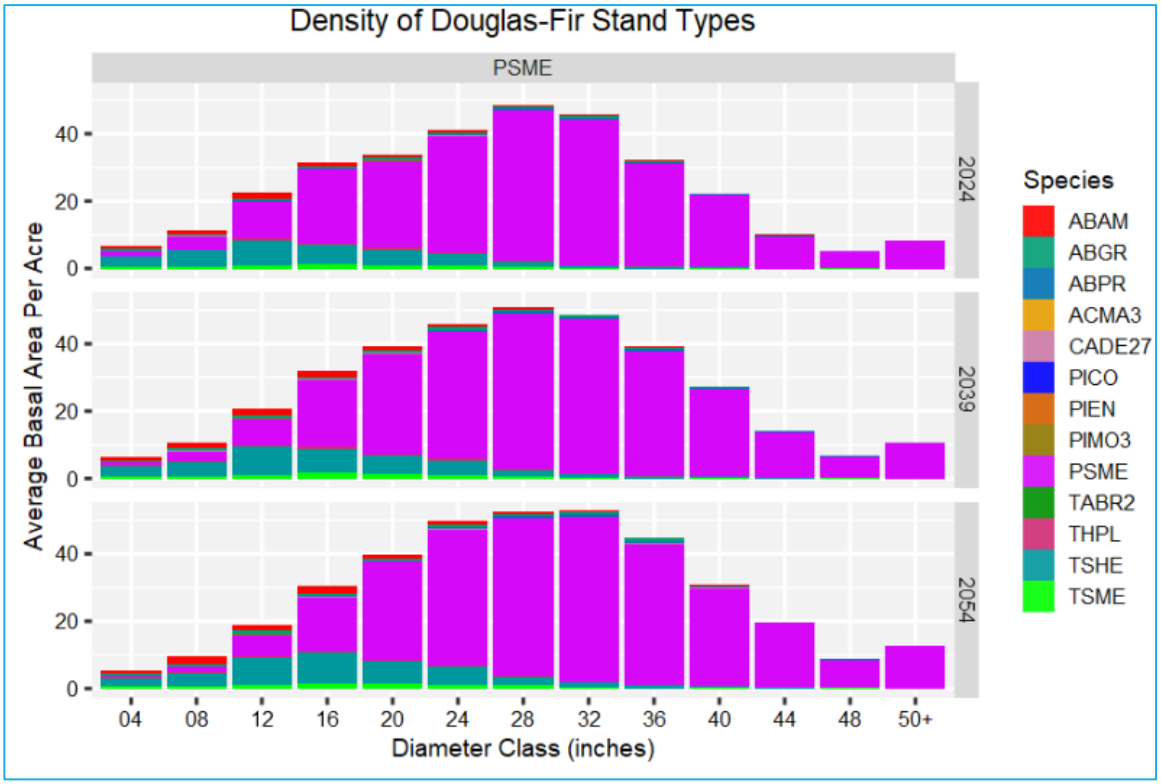
In this run, explore the average compute and summary tables first to describe stand density, size, volumes in 2023, 2038, and 2053.

34. In the **Runs to consider** selection box, select *Base 2.*
35. In the **Database tables to consider** selection box, select the *CmpCompute* and *CmpSummary2* tables.
36. Select the **Explore** menu.
    a. **Years**.....*2024, 2039,* and *2054*.
37. Using the check boxes in the lower left, select *MgmtID, Year, CmpPCCGE4, CmpTPA, CmpBA, CmpTopHt,* and *CmpQMD, CampTCuft, CmpMCuFt*.
38. Select the **Tables** menu.
39. Save this information to a table by clicking the **Download table** button.

Describe the change in density, size, and volume for this group of stands.

Explore the average stand and stock table to describe species composition and size structure in 2023, 2038, and 2053.

40. Select the **Load** menu.
41. In the **Runs to consider** selection box, select *Base 2*.
42. In the **Database tables to consider** selection box, select the *CmpStdStk* table.
43. Select the **Explore** menu.
    a. **Years**.....*2024, 2039 and 2054.*
44. Select all the **DBHClasses** except the *All* category.
45. To view the selected outputs in graphical form, select the **Graphs** menu.
46. Make the following changes to the graphing options:
    a. **Type**.....*Bar*
    b. **Y-axis**.....*CmpLiveBA*
    c. **Vertical facet**.....*Year*
    d. **Width**.....*6*
    e. **X-axis**.....*DBHClass*
    f. **Horizontal facet**.....*MgmtID*
    g. **Plot-by code**.....*Species*
    h. **Height**.....*4*
    i. **Title**.....Density of Douglas-Fir Stand Types
    j. **X-label**.....Diameter Class (inches)
    k. **Y-label**.....Average Basal Area Per Acre



Describe the change in species composition and structure for this group of stands.

Thin 1: Thinning to a basal area residual with species preferences

Thinning with species preferences is an option with all management actions. However, the method used to assign a species preference depends on the management action chosen.

If you choose a management action that contains a targeted species option, the residual densities apply only to the species selected within the DBH or height range specified. In this way, you can remove specific species from diameter and height ranges within a stand. The *Thin throughout a diameter range* action shown in the previous exercise works in this manner.

If you choose a management action that does not contain a targeted species option, such as T*hin from Below* and *Thin from Above*, the residual densities apply to all species within the DBH or height range specified; however, there are a couple of ways to have species influence these removal methods. First, you can allow a species to be excluded or re-included from scheduled harvest activities using the tree removal preference management action: *Exclude or include a species from harvest*. When excluded, FVS does not consider the excluded species density in the residual targets specified in the thinning. Second, for users looking to set a less rigid removal preference, there is the tree removal preference management action: *Removal pref by species*, which assigns a user-specified removal priority to each species.

When setting a species removal priority for these management actions, FVS uses a removal priority algorithm to decide which trees to cut first; see the equation below. The larger the tree record's calculated Removal Priority, the higher the probability that the tree record will get selected for removal. The removal priority is a function of tree DBH, species preference, tree value class, special tree status, dwarf mistletoe rating (western FVS variants) and plot density measures. By default, only the Fd variable and DBH of the tree records are considered; therefore, allowing FVS to thin from below or above.

$$\text{Removal Priority} = (Fd \cdot DBH) + SP + (Ft \cdot IMC) + Fm + (Fs \cdot STS) + (Fpba \cdot PBAi) + (Fpccf \cdot PCCFi) + (Fptpa \cdot PTPAi)$$

where:

Fd .....(–1) if thinning from below, (+1) if thinning from above

DBH .....Tree diameter at breast height

SP .....User-specified species preference

Ft.....User-specified multiplier for the tree value class code

IMC .....Tree value class code (see section 4.2.1)

Fm .....User-specified dwarf mistletoe preference

Fs.....User-specified multiplier for the tree special status code

STS .....Tree special status code (see Damage and Severity codes in section 4.2.1)

Fpba....User-specified multiplier for the point estimate of stand basal area

PBAi ....Stand basal area estimate for the inventory point (i) on which the tree is located

Fpccf ...User-specified multiplier for the point estimate of stand crown competition factor

PCCFi....Estimate of the stand crown competition factor for the inventory point (i) on which the tree is located

Fptpa...User-specified multiplier for the point estimate of stand trees per acre

PTPAi...Stand trees per acre estimate for the inventory point (i) on which the tree is located

Species removal preferences that are positive numbers increase the removal priority, and negative numbers decrease the removal priority. In this manner, you can either increase or decrease a tree record's removal priority by changing the value of the species variable.

In this exercise, you will be performing two runs. In the first run, you will use the *Thin from Below* management action to achieve a residual density of 60 square feet of basal area within a merchantable timber size range without targeting a specific species. In the second run, you will be thinning from below to the same residual density but will be favoring the removal of Douglas-fir and white fir. Both runs will project the stands for thirty years.

Starting the first run

1. Within the **Simulate** menu, begin a new simulation by clicking the **New** button.
2. Change the **Run title** to *Thin 1a*.
3. Click the **Save** button.

Adding a stand into a run

4. In the **Variants** selection box, select *ca : Inland CA, Southern Cascades.*
5. In the **Groups** selection box, select *Forest_Type=201.*
6. In the **Stands** selection box, select stand *06102460140600262.*
7. Click the **Add selected stands** button.

Setting the time frame

8. Select the **Time** menu.
9. Change the **Common starting year** and **Common ending year** to *2024* and *2054*, respectively.

Adding the thinning

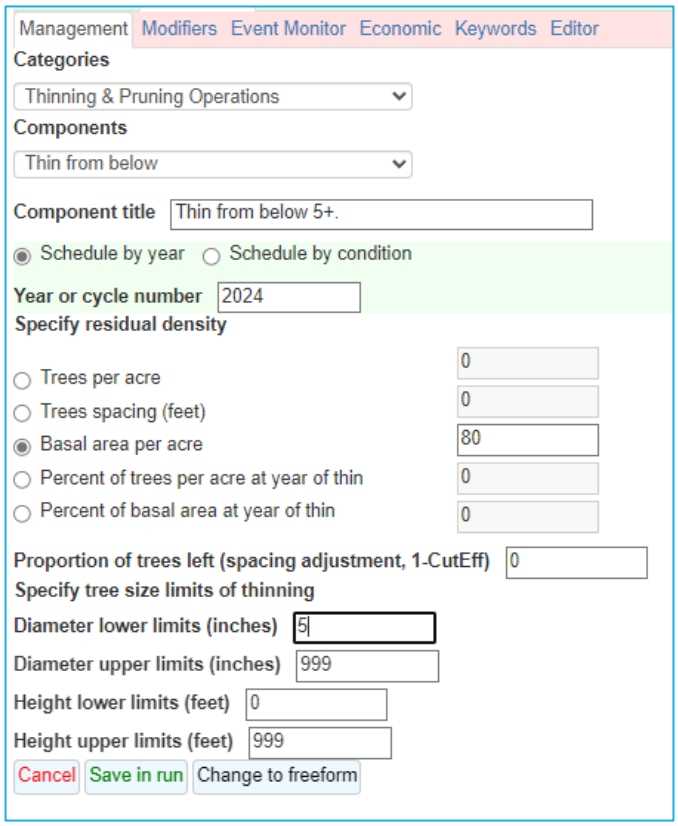
The *Thin from below* management action thins the stand from below to a residual trees per acre or basal area per acre density or to a residual percentage of those density statistics. The residual density may be set for a given diameter or height range. The tree record with the smallest diameter within the diameter and height range specified is cut first, then the next smallest tree record is cut and so on until the residual density is met. If the diameter and height ranges are left at the default values (minimum = 0 and maximum = 999) then the residual density is for the entire stand.

Another option in this management action is to reset the cutting efficiency through the **Proportion of trees left** field. This allows some smaller trees to be left in the stand. When FVS attempts to cut a tree record, the proportion of trees specified as left is used to determine how many trees per acre represented by the tree record are left standing. If left at the default proportion (0.0), FVS cuts all trees represented by the tree record; that is, the cutting efficiency is set to 1.0 - 0.0 = 1.

Reset the parameters of the thinning to thin from below to 80 square feet per acre of basal area in 2020 for all trees greater than or equal to 5" DBH. In this first run, species will not be preferentially removed from the stand during the thin from below.

10. Select the **Components – Management** menu.
11. From the **Categories** selection box, select *Thinnning and Pruning Operations.*
12. From the **Components** selection box, select *Thin from below.*

13. Change the **Component title** to *Thin from below 5+.*
14. Enter the following parameters:
    a. **Year or cycle number** *2024*
    b. **Specify residual density** ..... Basal area per acre
    c. **Residual Density** *80*
    d. **Proportion of trees left**..... *0*
    e. **Diameter lower limits** *5*
    f. **Diameter upper limits** *999*
    g. Leave all other parameters set to the default values.



15. Click the **Save in run** button.

Selecting Outputs

16. Select the **Select Outputs** menu.
17. Check the **Stand Visualization** box to request stand images
18. Check the **Tree lists** box to request output needed to create a stand and stock table.

Running the simulation

19. Select the ***Run*** menu.
20. Change the management identification code (**MgmtID**) to *T1a*.
21. Click the **Save and Run** button.

FVS will save the run as *Thin 1a* with a management identification code of *T1a*.

Examining the thinning effects

In this exercise you will be examining the outcomes of the runs using **Visualize** and the **View Outputs** menus.

Begin exploring the effects of this run by using **Visualize** menu to view pre- and post-harvest images. Rotate the images to a profile view and overhead view. Do the pre- and post-thinning images match your expectations? Why or why not?

Use the **View Outputs - Load/Explore** menus to check the thinning results with the stand and stock table (*StdStk*). Using 2" diameter classes will allow you to view the stand at the 5" DBH break. First create a diameter distribution graph of harvested basal area across species.

List the harvested basal area values for the 4 species that were targeted the most in the thin from below.

Species	Harvested Basal Area

Change the graph parameters to determine if the residual density is 80 BA. Did you hit 80 BA?

A second run will now be performed with the same thin from below action but, Douglas-fir and white fir will be preferentially removed during the thinning. You will use the previous run for the basis of this next run.

Starting the second run

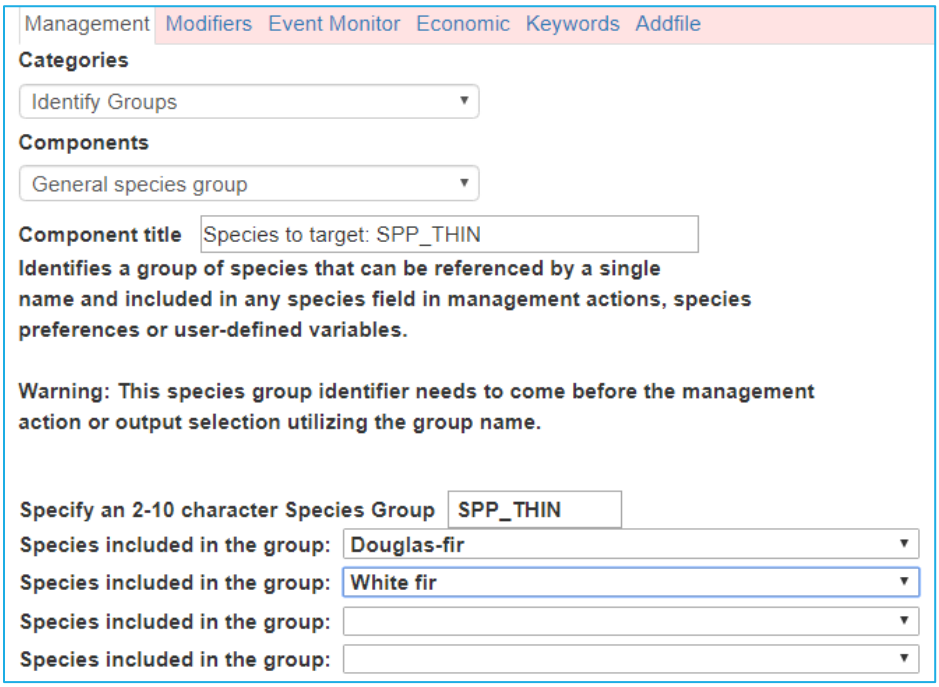
22. Within the **Simulate** menu, duplicate run *Thin 1a* by clicking the **Duplicate** button.
23. Change the **Run title** to *Thin 1b*.
24. Click the **Save** button.

You will now specify which species you want to preferentially remove in the thin form below that will occur in this simulation. Removal preferences can be specified for individual species or to groups of species. Since you are interested in targeting several species, a group of species will be defined.

Adding species preferences

25. Select the **Components – Management** menu.
26. From the **Categories** selection box, select *Identify Groups.*
27. From the **Components** selection box, select *General species group.*
28. Change the **Component title** to *Species to target: SPP_THIN.*

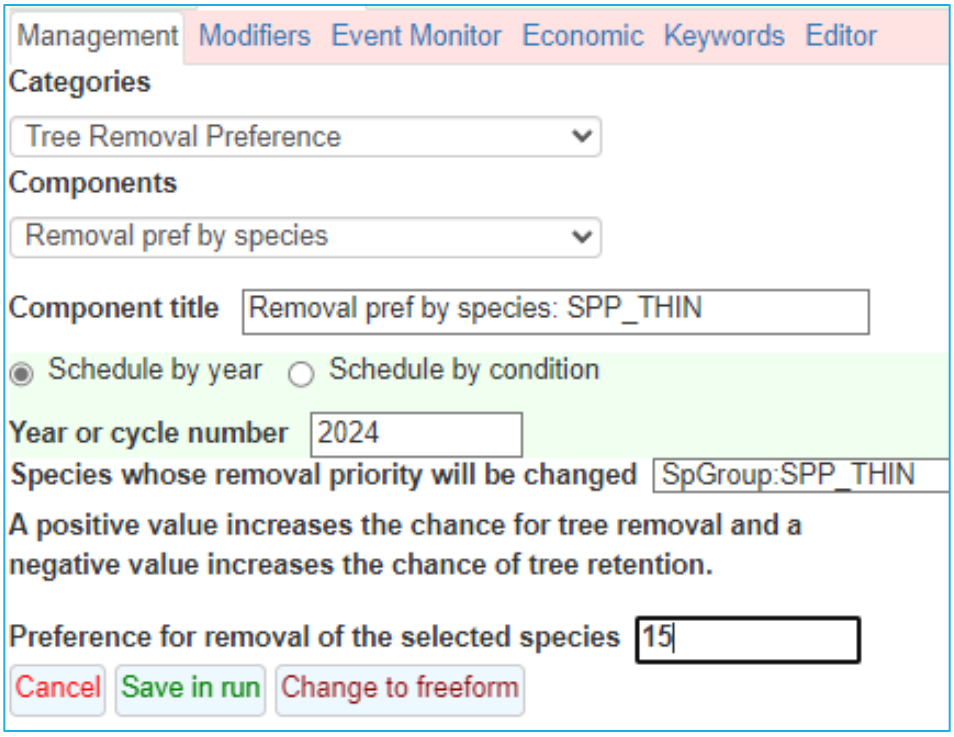
29. Enter the following parameters:
    a. **Specify a 2-10 character Species Group** ..... SPP_THIN
    b. **Species**..... Douglas-fir
    c. **Species**..... White fir



30. Click the **Save in run** button.

You will now specify that you want these species to be preferentially removed when a thinning occurs in your simulation. When using the species removal preference option, you must specify when this will take effect in a simulation. This option remains in effect until a second species removal preference option changes the removal priority of the species. In this simulation, you will have the removal preference take effect in 2023.

31. From the **Categories** selection box, select *Tree Removal Preference.*
32. From the **Components** selection box, select *Removal pref by species.*
33. Change the **Component title** to *Removal pref by species: SPP_THIN.*
34. Enter the following parameters:
    a. **Year of cycle number** *2024*
    b. **Species whose removal priority will be changed** ..... SpGroup:SPP_THIN
    c. **Preference for removal** *15*



35. Click the **Save in run** button.

Within FVS, there is an order preference for the *General species group* and *Removal pref by species* components within the **Contents** window. The *General species group* component must precede any other component which references the species group defined within the *General species group* component. In this case, *General species group* must precede the *Removal pref by species* component. If a *Removal pref by species* component is specified the same year that a thinning action is specified, the *Removal pref by species* component must precede the thinning component. In this case, the *Removal pref by species* component must precede the *Thin from below*. Given these rules, it will be necessary to relocate these components within the Contents window for this run.

36. Select the *Kwd: Thin from below 5+* component in the **Contents** window.
37. Click the **Cut/Delete** button.
38. Select the *Kwd:Removal pref by species: SPP_THIN.*
39. Click the **Paste item selected below** button.

You will now see the *Thin from below 5+* below the other keywords.

Running the simulation

40. Select the ***Run*** menu.
41. Change the management identification code (**MgmtID**) to T*1b*.
42. Click the **Save and Run** button.

Examining the species preference effects

Use the **View Outputs - Load/Explore** menus to check the thinning results with the stand and stock table (*StdStk*). Using 2" diameter classes will give allow you to view the stand at the 5" DBH break. Use the stand and stock table output to complete the following tasks/questions.

Using the diameter distribution graphs and the tabular stand and stock table, list the harvested basal area values for the 4 species that were targeted the most in the thin from below.

Species	Harvested Basal Area

How did the distribution of removed basal area change across species? Were you successful in removing less pine and targeting more Douglas-fir and white fir?

What could you modify in the run to not cut any Incense-cedar?

Thin 2: Thinning to a percent canopy cover

In FVS, thinning targets don't always have to be in terms of basal area per acre or trees per acre; more complex density metrics can be used as targets as well. The **Thin to a residual percent canopy cover** management action can be used to achieve a desired residual percent canopy cover. This management action has the user specify the target residual percent canopy cover, the species that will be removed in the thinning, and the desired diameter range from which trees will be harvested. In addition, users can select a type of cutting control which determines how the thinning will be conducted to achieve the residual percent canopy cover target. A thinning can be conducted in one of three ways for the diameter range specified in the management action; 1) thinned evenly throughout the diameter range, 2) thinned from below, or 3) thinned from above.

In this exercise, you will be managing a stand to stay between 40-60% canopy cover within the merchantable timber size class (DBH ≥ 5") by thinning evenly throughout this diameter range. You will first perform a natural growth run and explore output from the structural class table. Then you will perform a second run where you thin a stand down to a residual canopy cover of 40% in the merchantable size class range and explore management outcomes with user defined compute variables.

Starting the natural growth run

1. Within the **Simulate** menu, begin a new simulation by clicking the **New** button.
2. Change the **Run title** to *Thin 2a*.
3. Click the **Save** button.

Adding a stand into a run

4. In the **Variants** selection box, select *so: South Central OR N CA.*
5. In the **Groups** selection box, select *Forest_Type=221*.
6. In the **Stands** selection box, select stand *06010505210015501.*
7. Click the **Add selected stands** button.

Setting the time frame

8. Select the **Time** menu.
9. Set the timeframe for a 30-year projection starting in 2024.

Adding additional user-defined outputs

Add the additional output you need to explore the canopy cover of the stand based on specific size limits mentioned above.

10. Select the **Event Monitor** menu.
11. Select the *Compute Stand Variables with SpMcDBH function* from the selection box.
12. Change the **Component title** to *CC for DBH < 5 inches*
13. Enter the following parameters:
    a. **Year or cycle number** *0*
    b. **Enter the name** *CCIt5*
    c. **Attribute to be returned** ..... *Canopy cover percent*
    d. **Upper DBH limit** *5*
    e. **Calculations are for** ..... *Residual (after harvest) live trees*

f. Leave all other parameters set to the default values.

14. Click the **Save in run** button.
15. Select the *Compute Stand Variables with SpMcDBH function from the selection box.*
16. Change the **Component title** to *CC for DBH >= 5 inches*
17. Enter the following parameters:
    a. **Year or cycle number** *0*
    b. **Enter the name** CCge5
    c. **Attribute to be returned** ..... Canopy cover percent
    d. **Lower DBH limit** 5
    e. **Calculations are for** ..... *Residual (after harvest) live trees*
    f. Leave all other parameters set to the default values.
18. Click the **Save in run** button.
19. Select the *Compute Stand Variables with SpMcDBH function from the selection box.*
20. Change the **Component title** to *Stand Canopy Cover*
21. Enter the following parameters:
    a. **Year or cycle number** *0*
    b. **Enter the name** ..... CCStand
    c. **Attribute to be returned** ..... Canopy cover percent
    d. **Calculations are for** ..... *Residual (after harvest) live trees*
    e. Leave all other parameters set to the default values.
22. Click the **Save in run** button.

Running the simulation

23. Select the ***Run*** menu.
24. Change the management identification code (**MgmtID**) to *CCNA*.
25. Click the **Save and Run** button.

FVS will save the run as *Thin 2a* with a management identification code of *CCNA*.

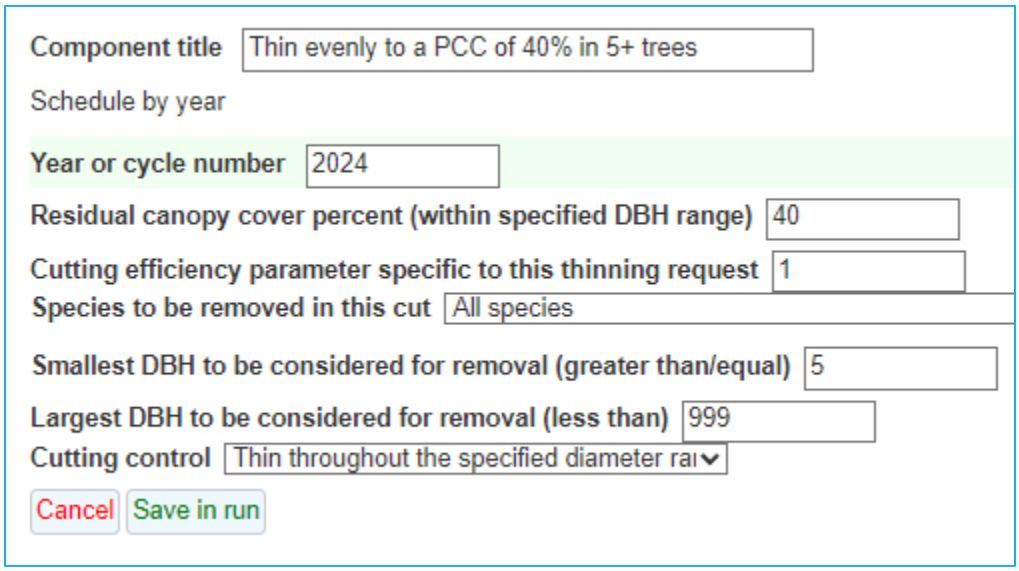
Starting the thinning run

You will now create a new run and perform a thinning to a residual percent canopy cover by evenly thinning all trees with DBH greater than 5".

26. Within the **Simulate** menu, begin a new simulation by clicking the **Duplicate** button.
27. Change the **Run title** to *Thin 2b.*
28. Click the **Save** button.

Adding the thinning

29. Select the **Components – Management** menu.
30. From the **Categories** selection box, select *Thinning and Pruning Operations.*
31. From the **Components** selection box, select *Thin to a residual percent canopy cover.*
32. Change the **Component title** to *Thin evenly to a PCC of 40% in 5+ trees*
33. Enter the following parameters:
    a. **Year or cycle number** *2024*
    b. **Residual canopy cover percent** *40*
    c. **Diameter lower limits** *5*
    d. Leave all other parameters set to the default values.



34. Click the **Save in run** button.

Running the simulation

35. Select the ***Run*** menu.
36. Change the management identification code (**MgmtID**) to *CCTH*.
37. Click the **Save and Run** button.

FVS will save the simulation as *Thin 2b* with a management identification code of *CCTH*.

Examining the thinning effects on canopy cover

Use the **View Outputs - Load/Explore** menus to check the canopy cover of the stand with the computed variables table (*FVS_Compute*).

Fill in the following information for 2024:

Variable	*CCNA* Canopy Cover	*CCTH* Canopy Cover
CCLT5		
CCGTE5		
CCStand		

Were you able to hit a target residual of 40% canopy cover in the merchantable timber size class with the thinning? Why doesn't the canopy cover add up to the stand canopy cover?

Fire 1: Prescribed burning

In this exercise, you will simulate a prescribed burn.

Starting a new run

1. Within the **Simulate** menu, begin a new simulation by clicking the **New** button.
2. Change the **Run title** to *Fire 1*.
3. Click the **Save** button.

Adding a stand into a run

4. In the **Variants** selection box, select *cr : Central Rockies GENGYM.*
5. In the **Groups** selection box, select *Forest_Type=221*.
6. In the **Stands** selection box, select stand *0302044019000010* and *0302044019000039.*
7. Click the **Add selected stands** button.

Setting the time frame

8. Select the **Time** menu.
9. Change the Common starting year and Common ending year to *2024* and *2054*, respectively.

Adding the prescribed burn

You will use the *Prescribed burn* management action to simulate the burn. This management action uses the *Simfire* keyword to simulate the burn; however, unlike its use in simulating the wildfire, you set the weather parameters to simulate a prescribed burn.

10. Select the **Components – Management** menu.
11. From the **Categories** selection box, select *Fuel Treatments.*
12. From the **Components** selection box, select *Prescribed burn.*
13. Change the **Component title** to *Prescribed burn in 2024*.
14. Enter the following parameters:
    a. **Year or cycle number** *2024*
    b. **Wind speed** *8*
    c. **Moisture level** ..... *2 = Dry*
    d. **Temperature** 70
    e. **Mortality code** ..... 1 = FFE estimates mortality
    f. **Percentage of stand area burned** 70
    g. **Season of this fire** ..... 4 = *Fall*
15. Click the **Save in run** button.

Selecting Outputs

16. Select the **Select Outputs** menu.
17. Check the **Stand Visualization, Carbon and fuels, Fire and mortality,** and **Snag and down wood** boxes.

Running the simulation

18. Select the ***Run*** menu.
19. Change the management identification code (**MgmtID**) to *RXBR*.
20. Click the **Save and Run** button.

FVS will save the run as *Fire 1* with a management identification code of *RXBR*.

Examining the prescribed burn effects

Begin exploring the effects of this run by using **Visualize** menu to view pre- and post-burn images. Do the pre- and post-burn images match your expectations. Why or why not?

Use the **View Outputs-Load/Explore** menus to describe the prescribed burn effects.

From the fire-caused mortality output, determine the percentage of fire-caused mortality by species. Did the percentages change by species?

From the snag output, were any large snags created by the prescribed burn? How long did they stay standing?

From the fire consumption output, how much litter, duff, material less than 3", and material greater than 3" were consumed by the prescribed burn?

From the fuels output, describe the surface and standing fuel loads over time.

Fire 2: Thinning followed by a pile burn

In this exercise, you will simulate a thinning followed by a pile and burn of the slash.

Starting a new run

1. Within the **Simulate** menu, begin a new simulation by clicking the **New** button.
2. Change the **Run title** to *Fire 2*.
3. Click the **Save** button.

Adding two stands into a run

4. In the **Variants** selection box, select *cr : Central Rockies GENGYM.*
5. In the **Groups** selection box, select *Forest_Type=221.*
6. In the **Stands** selection box, select stands *0302044019000010* and *0302044019000039.*
7. Click the **Add selected stands** button.

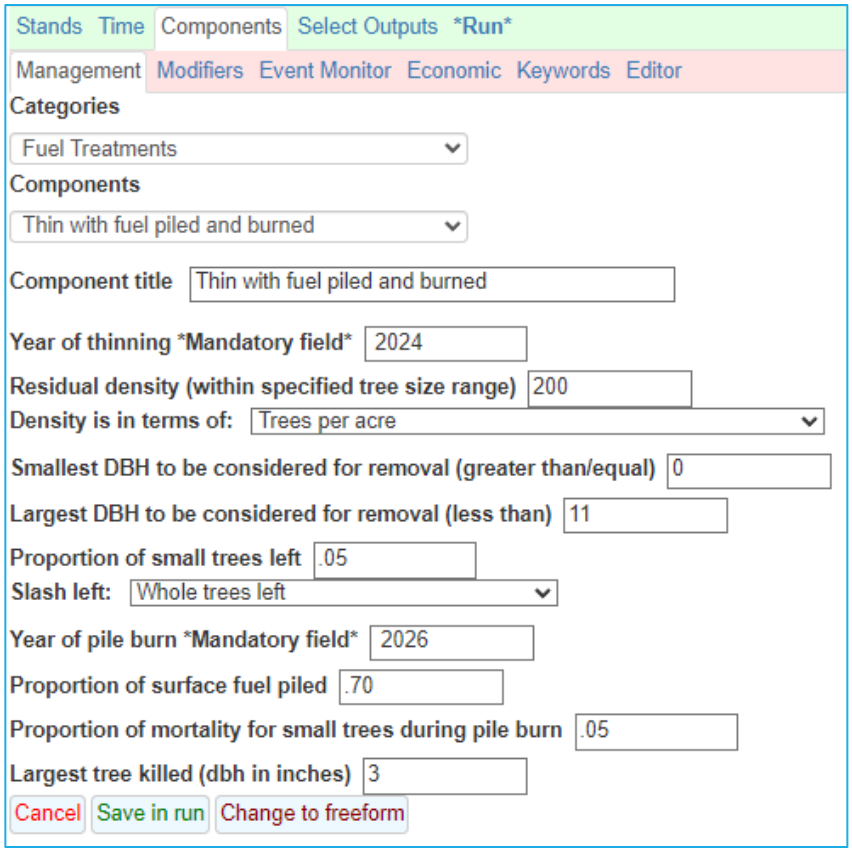
Setting the time frame

8. Select the **Time** menu.
9. Change the Common starting year and Common ending year to *2024* and *2054*, respectively.
10. Add the year *2026* to the **Additional output reporting years** text box.

Adding the fuels treatment

The *Thin with fuel piled and burned* management action allows you to thin a stand, manage logging slash and perform a subsequent pile and burn fuel treatment. Input parameters for the thinning include residual stand density (either trees per acre or basal area), diameter class interval, and the proportion of small trees left. Additional features control how much slash is left and how much surface fuel will be piled and burned. The proportion of surface fuel piled and burned applies to both the new activity fuels (slash) and any pre-existing surface fuel. Mortality from the pile burn can also be simulated.

11. Select the **Components – Management** menu.
12. From the **Categories** selection box, select *Fuel Treatments.*
13. From the **Components** selection box, select *Thin with fuel piled and burned.*
14. Enter the following parameters:
    a. **Year of thinning**..... *2024*
    b. **Residual density**..... *200*
    c. **Density in terms of** ..... *Trees per acre*
    d. **Largest DBH** *11*
    e. **Proportion of small trees left**..... *0.05*
    f. **Slash left:**..... *Whole trees left*
    g. **Year of pile burn**..... *2026*
    h. **Proportion of surface fuel piled**..... *0.70*
    i. **Proportion of mortality for small trees**..... *0.05*
    j. **Largest tree killed (dbh in inches)** *3*
    k. Leave all other parameters set to the default values.



15. Click the **Save in run** button.

Selecting Outputs

16. Select the **Select Outputs** menu.
17. Check the **Stand Visualization, Carbon and fuels, Fire and mortality, Snag and down wood**, and **Regeneration** boxes.

Running the simulation

18. Select the ***Run*** menu.
19. Change the management identification code (**MgmtID**) to *TwPB*.
20. Click the **Save and Run** button.

FVS will save the run as *Fire 2* with a management identification code of *TwPB*.

Examining the effects of the fuels treatment

Begin exploring the effects of this run by using **Visualize** menu to view pre- and post-treatment images for both stands. Adjust the images to determine the general effect on surface fuels and save the comparison. Did the treatment produce similar results? Why or why not?

Use the **View Outputs-Load/Explore** menus to compare the fuels treatment between the two stands. Note: you can use the facets and plot-by options in the **Graphs** menu to compare the two stands.

From the summary output that was created, compare the standing and removed trees per acre from the thinning.

Which stand removed more trees per acre?

Was post-thinning trees per acre greater than 200? Why or Why not?

Make a graph of QMD for the two stands. Explain the shape of the curves for the time frame?

From the down woody volume output, which tree diameter classes had the biggest increase from the thinning and the biggest decrease from the pile burn in the two stands?

From the fuels output, how did surface fuels respond to the treatment?

Overall, what output(s) would you use to quickly describe the treatment effects in these two stands to your management team?

Complex 1: Regenerating a stand via group selection

In this exercise, you will use FVS to explore regenerating a stand via group selection using the stand replication option. Replication can occur by adding the same stand more than once or by specifying the number of replicates and their relative weights prior to adding the stand to a run. Replicating a stand prior to running the simulation allows you to perform unique management to each stand replicate. The run results in replicate output as well as composite output for the stand as a whole. For instance, if you want to thin 30% of a stand, put openings in another 30% of the stand, and skip or leave the rest of the stand unmanaged (40%), you can add three replicates with relative weights of 30, 30 and 40 so that you can prescribe the unique management in each replicate and obtain outputs describing each of the three areas as well as a properly-weighted stand composite outputs for the run.

You will use the following information to regenerate stand *090603020480017* with group selection using the replication method.

> Establish group openings in 25% of the stand every 25 years where you select the size of openings to be conducive to maintaining mid-tolerant species such as basswood, ash, hickory, yellow birch, red oak, and black cherry. Retain all yellow birch in openings while cutting all other species greater than one inch in diameter.

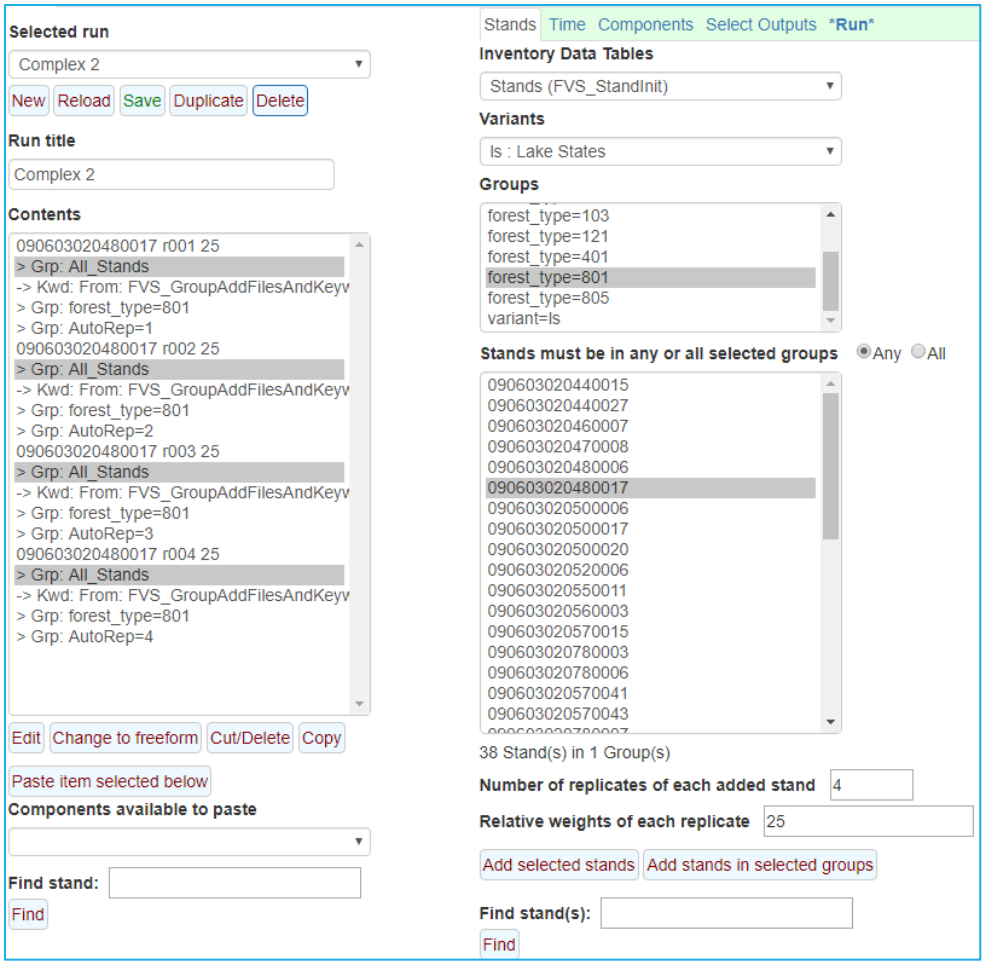
Starting a new run

1. Within the **Simulate** menu, begin a new simulation by clicking the **New** button.
2. Change the **Run title** to *Complex 1.*
3. Click the **Save** button.

Adding the stand replicates

4. In the **Variants** selection window of the **Stands** tab, select *ls : Lake States.*
5. In the **Groups** selection window, select *Forest_Type=801.*
6. In the **Stands** selection window, select stand *090603020480017.*
7. In the **Number of replicates of each added stand** text box, enter *4.*
8. In the **Relative weights of each replicate** text box, enter 25. This will give each replicate equal weighting of 25% (25/(4*25)).
9. Click the **Add selected stands** button.

The weights are used to modify the stand sampling weights specified in the input database. Often these sampling weights are stand sizes or the size of the land area represented by the stand. The set of replicate weights you enter is recycled, if necessary, so that each replicate gets a weight. For example, if you say you want 5 replications of each stand, and you enter 1,2 for the weights, the resulting set will be 1, 2, 1, 2, and 1. The weighting logic includes a normalization step such that each weight is divided by the sum of the weights for the stand, resulting in a proportional adjustment to the replicate sample weights; for example, the resulting normalized weights of the above example would be 0.14, 0.29, 0.14, 0.29, and 0.14. The normalized weights are then multiplied by the stand sampling weight entered in the database and the results are entered into the FVS run so that the sampling weights for each replicate are correctly reported in the FVS output.



Setting the time frame

10. Select the **Time** menu.
11. Change the **Common starting year** and **Common ending year** to *2024* and *2134*, respectively.
12. In the **Additional output reporting years** text box, add *2049 and 2099*.

Adding the group cuts

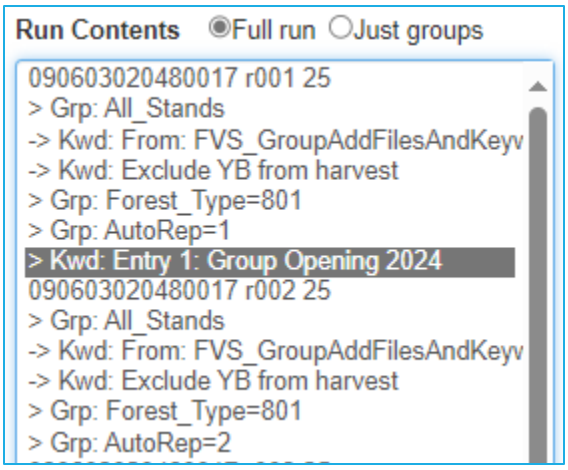
Each replicate will be modeled as separate group opening entries. You will start by omitting all yellow birch from cutting. The cutting steps are to cut all trees greater than 1.0 inch DBH in replicate *r001* in 2024 and 2124, replicate *r002* in 2049, replicate *r003* in 2074, and replicate *r004* in 2099.

13. Select the **Components – Management** menu.
14. From the **Categories** selection box, select *Tree Removal Preference*.
15. From the **Components** selection box, select *Exclude or include a species from harvest.*
16. Change the **Component title** to *Exclude YB from harvest.*
17. Enter the following parameters:
    a. **Year or cycle number** *2024*
    b. **Species**.....*yellow birch*
    c. *Exclude the species from harvest*
18. Click the **Save in Run** button.

To apply management to a single replicate, simply click the replicate identification in the **Contents** window, then select the management option.

19. In the **Contents** window, click *090603020480017 r001 25.*
20. From the **Categories** selection box, select *Thinning & Pruning Operations.*
21. From the **Components** selection box, select *Thin throughout a diameter range.*
22. Change the **Component title** to *Entry 1: Group Opening 2024.*
23. Enter the following parameters:
    a. **Year or cycle number** *2024*
    b. **Smallest DBH to be considered** *1*
    c. Leave all other parameters set to the default values.
24. Click the **Save in Run** button.

In the **Contents window**, you will notice that the management action has only been applied to the first replicate.



Use the **Copy/Paste/Edit** buttons below the **Contents** window with this management action to cut this replicate again in 2124.

25. In the contents window, select *kwd: Entry 1: Group Opening 2024.*
26. Click the **Copy** button.
27. Click the **Paste item selected below** button.
28. Select the second *kwd: Entry 1: Group Opening* action and click the **Edit** button.
    a. **Component title** ..... *Entry 5: Group Opening 2124*
    b. **Year or cycle number** *2124*
    c. Leave all other parameters set to their values.
29. Click the **Save in Run** button.

Use the **Paste/Edit** buttons below the **Contents** window to add the group cuts to the other replicates.

30. In the **Contents** window, select *090603020480017 r002 25.*
31. Click the **Paste item selected below** button.
32. Select the *kwd: Entry 1: Group Opening* 2024 action attached to replicate *r002* and click the **Edit** button.
    a. **Component title** ..... *Entry 2: Group Opening 2049*

b. **Year or cycle number** *2049*
c. Leave all other parameters set to their values.

33. Click the **Save in Run** button.
34. In the **Contents** window, select *090603020480017 r003 25.*
35. Click the **Paste item selected below** button.
36. Select the *kwd: Entry 1: Group Opening 2024* action attached to replicate *r003* and click the **Edit** button.
    a. **Component title** ..... *Entry 3: Group Opening 2074*
    b. **Year or cycle number** *2074*
    c. Leave all other parameters set to their values.
37. Click the **Save in Run** button.
38. In the contents window, select *090603020480017 r004 25.*
39. Click the **Paste item selected below** button.
40. Select the *kwd: Entry 1: Group Opening 2024* action attached to replicate *r004* and click the **Edit** button.
    a. **Component title** ..... *Entry 4: Group Opening 2099*
    b. **Year or cycle number** *2099*
    c. Leave all other parameters set to their values.
41. Click the **Save in Run** button.

Adding regeneration

Given the cuts, it is important to augment automatic sprouting following harvests with additional regeneration you expect to regenerate from seed or small seedlings that may not be in your data. To accomplish this, you will conditionally add natural regeneration following the harvest.

42. In the **Contents** window, click *Grp: All_stands.*
43. Select the **Components – Management** menu.
44. From the **Categories** selection box, select *Planting & Natural Regeneration.*
45. From the **Components** selection box, select *Plant/Natural with Partial Estab Model.*
46. Change the **Component title** to *Natural regeneration following harvests.*
47. Enter the following parameters:
48. Set the **Schedule the date of disturbance** radio button to *Schedule by condition.*
    a. **Create a condition** ..... *After "significant" harvesting/thinning*
    b. Leave all other parameters set to the default values.
49. In **Regen 1)**, specify the following:
    a. **Type of regeneration scheduled:** ..... *Natural*
    b. **Species**..... *red maple*
    c. **Trees/acre:**..... *100*
50. In **Regen 2)**, specify the following:
    a. **Type of regeneration scheduled:** ..... *Natural*
    b. **Species**..... *sugar maple*
    c. **Trees/acre:**..... *300*
51. Leave all other parameters set to their values.
52. Click the **Save in Run** button.

Since the Plant/Natural management action only allows for two species to be added, you'll need to add the other species by attaching additional plant/natural management actions to the condition.

53. From the **Categories** selection box, select *Planting & Natural Regeneration.*
54. From the **Components** selection box, select *Plant/Natural with Partial Estab Model.*
55. Change the **Component title** to *Natural regeneration following harvests.*
56. Set the **Schedule the date of disturbance** radio button to *Attach to existing condition.*
57. Enter the following parameters:
58. In **Regen 1)**, specify the following:
    a. **Type of regeneration scheduled:** .....*Natural*
    b. **Species**.....*black cherry*
    c. **Trees/acre:**.....*200*
59. In **Regen 2)**, specify the following:
    a. **Type of regeneration scheduled:** .....*Natural*
    b. **Species**.....*yellow birch*
    c. **Trees/acre:**.....*50*
60. Leave all other parameters set to their values.
61. Click the **Save in Run** button.

Regeneration now includes regeneration from sprouting and seed sources following all group entries. While you will not model it here, to maintain seedlings in the regeneration layer throughout the projection period, you need to consider whether or not to add periodic ingrowth into this run.

Selecting Outputs

62. Select the **Select Outputs** menu.
63. Check the **Stand Visualization, Tree lists**, and **Regeneration** boxes.

Running the simulation

64. Select the ***Run*** menu.
65. Change the management identification code (**MgmtID**) to *GS*.
66. Click the **Save and Run** button.

FVS will save the simulation as *Complex 1* with a management identification code of *GS*.

Examining the treatment effects

Begin exploring the effects of this run by using **Visualize** menu to view pre- and post-harvest images. The **Visualize** menu allows you to view and compare images of each replicate during the projection time frame; however, you do not get a combined image of all replicates. The naming of each image is also based on the stand as a whole.

In the prescription, only yellow birch should be left in the group openings. Use the images to describe the presence of yellow birch in the openings.

Use the **View Outputs-Load/Explore** menus to further explore the run output.

In this run, you have summary tables, treelist tables, stand and stock tables, and regeneration sprout and tally tables for each stand replicate. You have a composite summary statistics table and a composite stand and stock table averaged across the replicates.

Load/Explore the summary output to begin exploring the density in each replicate. Create a table that shows basal area by year (columns) for each replicate.

Scroll through the table and describe the density of each replicate.

Load/Explore the stand and stock table output to explore species composition of each replicate over the projection time frame. Create a graph of the live and harvested basal area by species for each replicate during the cutting years. Describe how species composition differs between the replicates.

Load/Explore the regeneration output. What is the average size of the sprouts and natural regeneration by replicate?

How did the number of small trees in the stand change following harvests?

Load/Explore the composite summary output. Describe volume production in the stand over the projection time frame using the **Graphs** menu. Total production is the standing + harvested volume in the stand. Describe how sawlog production is trending over the projection time frame.

Change the y-axis to total merchantable volumes. Does the trend change?

Load/Explore the composite stand and stock table to describe species composition at the start and end of the projection time frame. Describe the change in species composition for the stand.

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