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Hydrologic Engineering Center

Regime Prescription Tool
HEC-RPT

User's Manual

Version 3.0

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14. ABSTRACT

The Regime Prescription Tool (HEC-RPT) is a software tool designed to facilitate entry, viewing, and documentation of flow recommendations in real-time, public settings.

HEC-RPT is primarily a visualization tool and is not intended to perform the detailed quantitative analyses (e.g., statistical analyses or reservoir and river routing) already performed by other software packages. Instead, HEC-RPT seeks to complement other software by making it easier to create flow times series that other software packages can import and use in their analyses.

HEC-RPT is used as a “stand alone” or independent software capable of accessing hydrologic data for reading, writing, and plotting data. Management recommendations formulated in HEC-RPT can be exported to HEC-DSS (Data Storage System) and are thereby available for immediate analysis in other software, including reservoir system simulation, river hydraulics, and ecosystem functions.

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HEC-RPT, User's Manual

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Foreword

The Regime Prescription Tool (HEC-RPT) is designed to help groups of scientists, engineers, and water managers access hydrologic data and draft flow recommendations while they formulate different ways to manage rivers.

HEC-RPT is the first joint software development by the U.S. Army Corps of Engineers (USACE) and The Nature Conservancy (TNC). Development costs (through the first release version) were shared between the Hydrologic Engineering Center of the Corps, the Portland District of the Corps, and The Nature Conservancy. Development was undertaken in support of the Sustainable Rivers Program, which is an ongoing nation-wide partnership between the Corps and The Nature Conservancy to improve the health and life of rivers by changing the operations of Corps water resources infrastructure.

Development was performed at the Hydrologic Engineering Center (HEC), which is a division of the Institute for Water Resources, U.S. Army Corps of Engineers. John Hickey, HEC, Water Resource Systems Division, designed the software and managed its development. Shannon Newbold, Resource Management Associates (RMA), contributed to design and performed the programming. Andy Warner, formerly with The Nature Conservancy, contributed to design and led the Conservancy's participation during initial development. Mary Karen Scullion, Brad Bird, and Bruce Duffe, formerly with Portland District of the Corps, were instrumental in project initiation. Mary Karen led the District's participation during initial development.

Versions 1.0 and 1.1 were released when Chris Dunn was Chief of the Water Resource Systems Division and Darryl Davis was Director of HEC. Version 2.0 was released when Matt McPherson was Chief of the Water Resource Systems Division and Chris Dunn was Director of HEC. Version 3.0 was released when Richard Nugent was Acting Chief of the Water Resource Systems Division and Lea Adams was Director of HEC.

This manual introduces HEC-RPT and details its functionality and supporting resources such as its demonstration project. There are also several publications that include information related to HEC-RPT applications. Hickey et al. (2015) provides an overview of software and highlights commonalities between HEC-RPT and other collaborative decision support tools. Esselman and Opperman (2010) describes use of HEC-RPT to help define environmental flows below a proposed hydroelectric dam for Patuca River in Honduras. Methods and results of HEC-RPT applications for environmental flows are detailed in reports for the Yangtze River in China (CTGPC and TNC 2009) and the Willamette (Gregory et al. 2007), McKenzie (Risley et al. 2010), Santiam (Bach et al. 2013), Des Moines (Blann 2016), Cape Fear (DeMeester et al. 2019), Kansas (TNC and USACE 2021), Iowa (USACE and TNC 2023), Cossatot (Hart et al. 2023), and Pecos (USACE 2023) rivers in the United States. HEC-RPT was also used to formulate pool management alternatives for reservoirs in the Kansas River basin (TNC and USACE 2023).

CHAPTER 1

Introduction

1.1 Purpose

The Regime Prescription Tool (HEC-RPT) is a software tool designed to facilitate entry, viewing, and documentation of flow recommendations in real-time, public settings. HEC-RPT seeks to improve 1) communications in group settings by allowing real-time recording and plotting of the recommendations as they are developed and 2) the recommendations produced by making hydrologic information more immediately accessible to scientists, engineers, and water managers during the formulation process.

HEC-RPT is primarily a visualization tool and is not intended to perform the detailed quantitative analyses (e.g., statistical analyses or reservoir and river routing) already performed by other software packages. Instead, HEC-RPT seeks to complement other software by making it easier to create flow time series that other software packages can import and use in their analyses.

HEC-RPT is used as a “stand alone” or independent software capable of accessing hydrologic data for reading, writing, and plotting data. Management recommendations formulated in HEC-RPT can be exported to HEC-DSS (Data Storage System) and are thereby available for immediate analysis in other software, including reservoir system simulation, river hydraulics, and ecosystem functions.

1.2 Motivation

The idea for this software was conceived during a Sustainable Rivers Program workshop for the Savannah River, where nearly 50 scientists worked together to formulate a set of flow recommendations designed to sustain the integrity of Savannah River ecosystems. The Sustainable Rivers Program partners the U.S. Army Corps of Engineers (Corps) and The Nature Conservancy in an ongoing effort to re-operate Corps water resources infrastructure to achieve more ecologically sustainable flows, while maintaining or enhancing project benefits. During the two-day workshop, sets of flow recommendations were created for three ecotypes of particular importance in the Savannah Basin (shoals, floodplain forest, and estuary). Each set was comprised of specified pulse, flood, and low flows for wet, average, or dry hydrologic conditions. After recommendations were prepared for the individual ecotypes, those three sets were unified into a single set of recommendations through the merging of features specified for each of the ecotypes.

Throughout this formulation and unification process, many hydrographs were created, discarded, and morphed. Facilitators were pressed to track all of the recommendations and lacked an easy way to present results electronically. It was noted that a tool capable of rapidly displaying, adjusting, and documenting hydrographs would make the formulation process easier and, if it were also capable of accessing and plotting historical hydrologic data to guide the scientists upon their request, then the product as well as the process would be improved.

1.3 Programming done by utilization of other code

HEC-RPT progressed from an idea to a functional software tool in less than 8 months. This rapid development was made possible in part by the integration of several components already developed for other HEC software, including plotting windows and a database interface from HEC-DSSVue (USACE 2023) and an interface for scripting with time series from HEC-ResSim (USACE 2021). Without these components, HEC-RPT development would have been a more difficult process.

1.4 Software details

HEC-RPT is programmed in Java and is compatible with Windows operating systems. Using HEC-RPT requires use of HEC-DSSVue, but a copy of that software has been embedded in the HEC-RPT code and is part of the install package. Therefore, HEC-RPT does not require installation of any other software to be functional. The installation file and documentation are available for download at www.hec.usace.army.mil/software/. The executable and supporting files are installed to the default directory: C:\Program Files (x86)\HEC\HEC-RPT\. The demonstration project and supporting files are installed to a user specified directory via the software's "Help – Install Demonstration Project…" menu option.

CHAPTER 2

Using HEC-RPT

HEC-RPT is designed to be as simple as possible, while providing users with a tool for creating water management alternatives and viewing historical data that is flexible enough to accommodate a range of formulation approaches used in group settings. In HEC-RPT, the basic framework for formulating alternatives is that recommendations are 1) created for different subjects of interest known as systems, 2) related to hydrologic condition or seasonal conditions known as states, and 3) expressed as a series of desired conditions known as components. Figure 1 shows key features of the main interface.

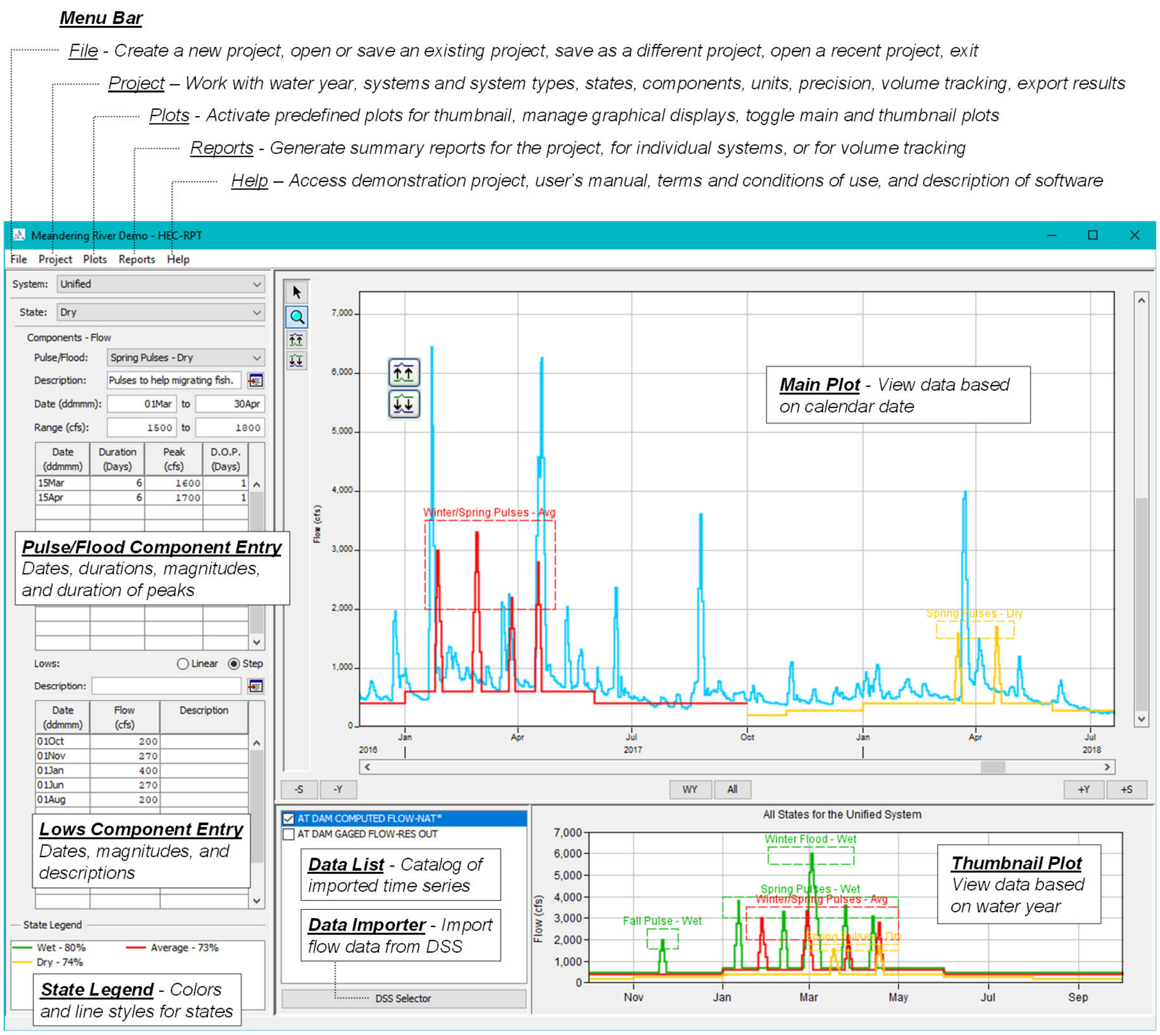


Figure 1. Key features of the main interface.

2.1 Hierarchy of terms

Information related to an RPT application is stored in a structure that allows it to be easily accessed during application, imported to other RPT applications, and exported for use in other software. The basic construct follows: Project, systems (and associated system types), states, and components.

2.1.1 Project

"Project" refers to the whole RPT application, including its systems, system types, states, and components and associated hydrologic data (Figure 2). A project is typically defined in terms one or more water bodies that have an independent (or nearly so) set of management strategies and infrastructure. For example, where a single set of reservoirs is used to manage waters of a basin, a single RPT project is often used to help formulate water management alternatives for that basin. Scale of application is a user decision.

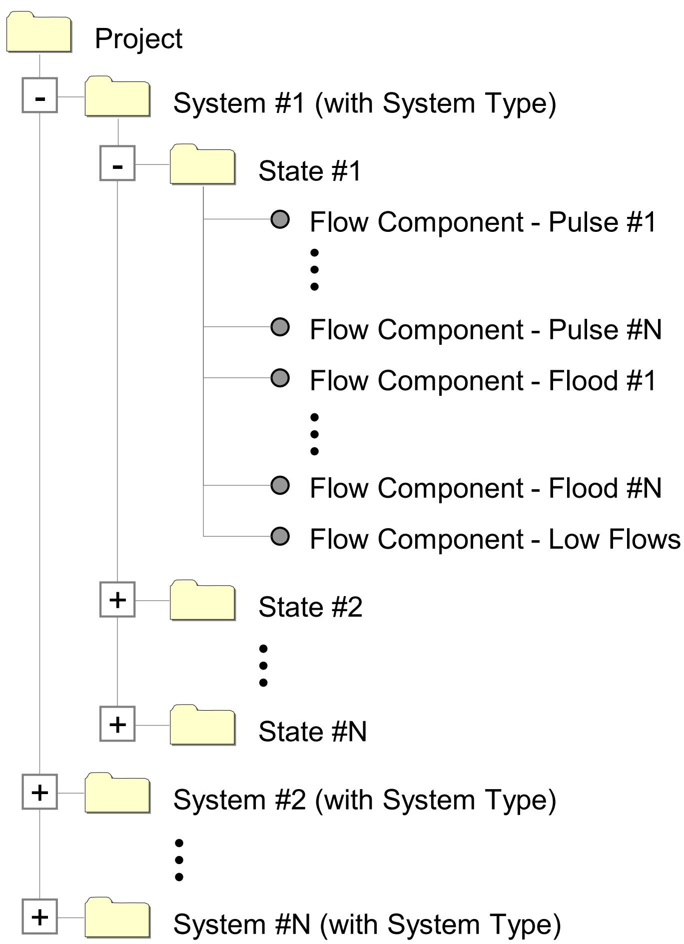


Figure 2. Project, system, state and flow component structure.

2.1.2 Systems and system types

"System" is the term used to describe a subject of interest for which management alternatives will be formulated. There tends to be multiple systems within one project and there is no limit to the number of systems per project. A system may refer to a location - such as an important river reach, or to an aspect of an ecosystem associated with a water body - such as a floodplain forest community, or to a guild of creatures - such as fishes, or to different points of view for water management - such as water supply, hydropower operations, or recreation.

Each system has a “system type”. System types for “Flow” and “Elevation” are included automatically for RPT applications and cannot be edited by users. System types are comprised of a name, English and metric units, and units conversions. For example, the flow system type is named “Flow”, has English units of “cfs” (cubic feet per second), metric units of “cms” (cubic meters per second), and equations that guide conversions between units systems (e.g., metric = English * 0.028316847…). Users can create other system types for their RPT application such as water temperature (Figure 3).

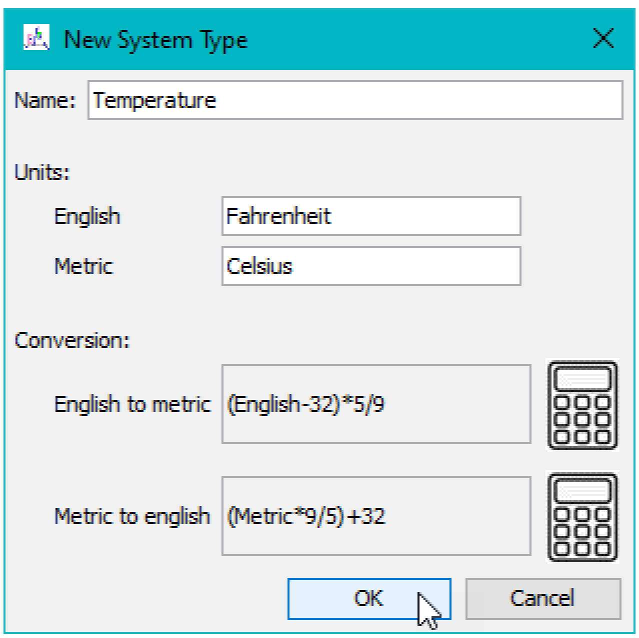


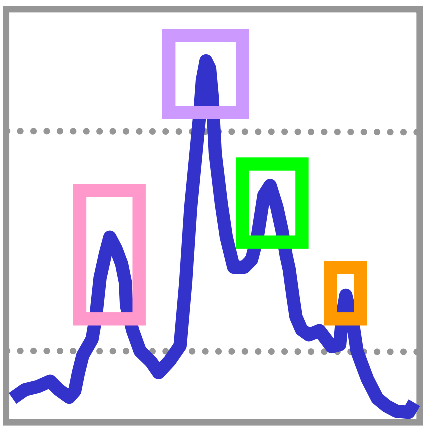
Figure 3. Adding a new system type.

2.1.3 State

"State" refers to a prevailing condition (e.g., hydrological or seasonal) that is associated with a set of water management alternative. There tends to be multiple states within one project and there is no limit to the number of states per project. The same set of states is used for all systems in a project. A sample set of three states is: wet, average, and dry. Management recommendations, in the form of a series of components, are prepared for each state in each system.

2.1.4 Components

"Components" are the building blocks of a recommended alternative. There are three types of components - lows, pulses, and floods. The lows component creates the foundation of the recommended time series. Lows are defined for each day in a water year (for each state in each system). Pulses and floods deviate from this base of lows. A recommendation (for one state in a system) can have many pulses and floods, but only one series of lows. Both pulses and floods are defined by timing, duration, magnitude, and duration of peak. This approach was developed by The Nature Conservancy (Richter et al. 2006) and was adapted in part from the "Building Block Methodology" (King et al. 2000) and the "Holistic Approach" (Arthington et al. 1992) methods for defining environmental flows (Figure 4), which were formalized and first used in South Africa and Australia in the 1990's.



Flood Flows - High flows usually associated with intense runoff events and resulting in geomorphic change. Ecologically important for resetting ecological communities, reducing non-native species, and creating new riparian habitats.

Pulse Flows - Moderate or small increases from low flow conditions. Pulses provide a diverse range of ecological services, including migratory cues, seasonal habitat for fish spawning and migratory birds, and riparian plant recruitment.

Low Flows - Low flows occur at times when runoff from rainfall is small. Ecologically, these provide services such as fish and plant survival, connectivity of aquatic habitat, and relatively stable conditions for spawning and rearing of some fish species.

Figure 4. Low, pulse, and flood components creating a time series of recommendations in terms of flow.

2.2 Starting or accessing projects

Project creation and use in HEC-RPT follows the same procedures as common windows-based software. HEC-RPT can be activated from the Start menu ("Start – All Programs – HEC – HEC-RPT") or by double-clicking on the executable (.exe) file, on any shortcuts that target that executable, or on an existing project file (if the extension ".eco" has been associated with the program). Once the software is activated, project files can be saved, saved as, or new files can be created.

Each project has a user-defined water year. The default water year for HEC-RPT begins October 1 and ends September 30. To change this setting, go to the "Project – Define Water Year…" menu and enter a different start and end date (Figure 5).

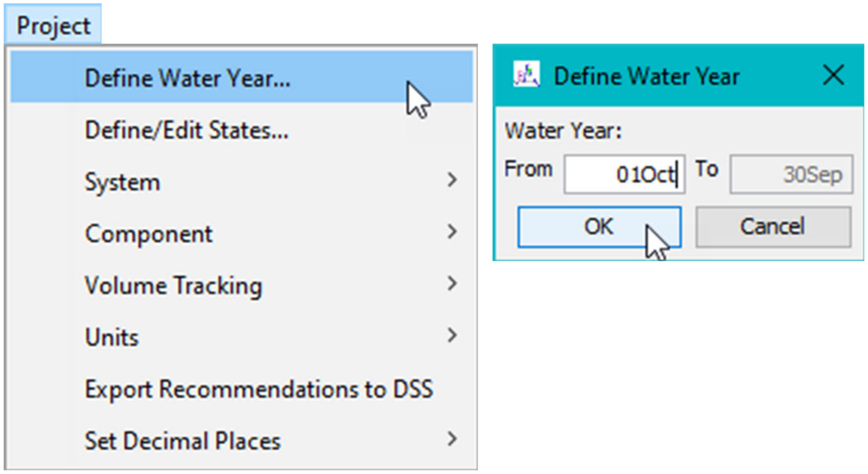


Figure 5. Menu option and interface for changing water year.

The basic sequence when making a new project follows: 1) create the systems, 2) define the states, and 3) populate the management recommendations. Historical data can be added to the project to serve in the formulation process at any time. Choice of unit system (English or metric) and numeric precision are set via the "Project – Units" and "Project – Set Decimal Places" menus, respectively (Figure 5). Application messages are accessible via the “Reports – Console Output" menu option.

2.3 Creating systems (and system types)

Systems are managed via the "Project – System" menu. This menu offers options to create new systems, rename, duplicate, or delete existing systems, and import systems from other projects (Figure 6).

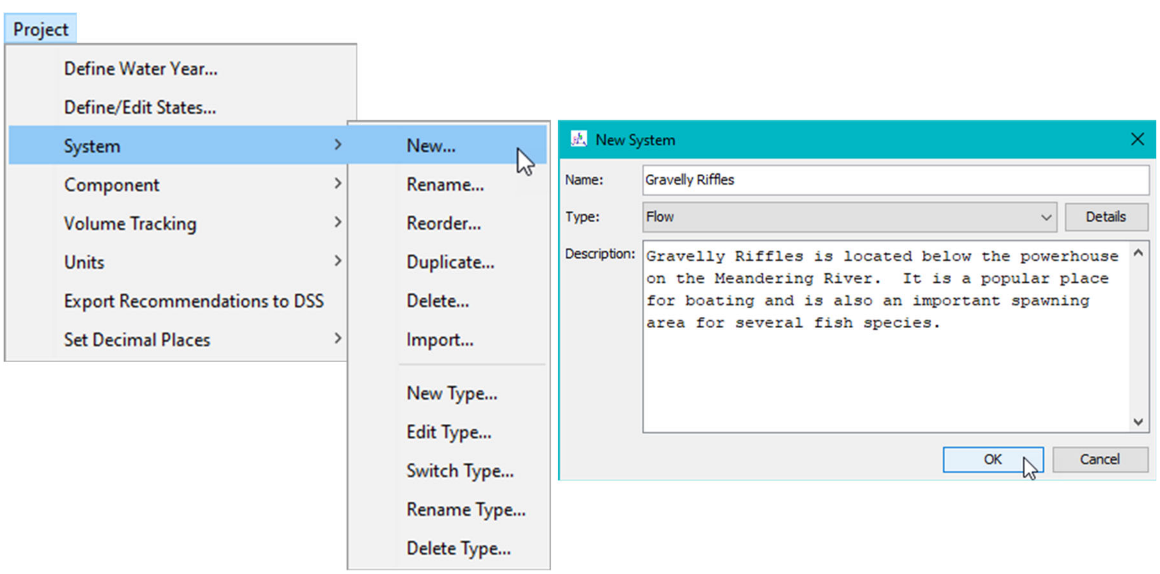


Figure 6. Menu option and interface for creating a new system.

All projects start with a system called "<Default>" that allows users to define states and even populate recommendations before creating a new system. The default system is provided only as a starting point and has limited utility in HEC-RPT. Users are encouraged to create new systems for their projects. If recommendations are created for the default system, users can import those recommendations to a system of their choosing to enable the full suite of RPT features.

Details on importing systems and components are provided in the "Importers for systems and components" section of this manual.

2.4 Defining states

There are two methods for defining states: 1) Define by name and year and 2) Define by scripting with time series. Selection of method is controlled by the radio buttons located to the left of the method titles (Figure 7). Only one method may be active; however information entered by the user for either option is stored to allow users to test or alternate between methods. The Define/Edit States editor is accessed via the "Project – Define/Edit States…" menu selection.

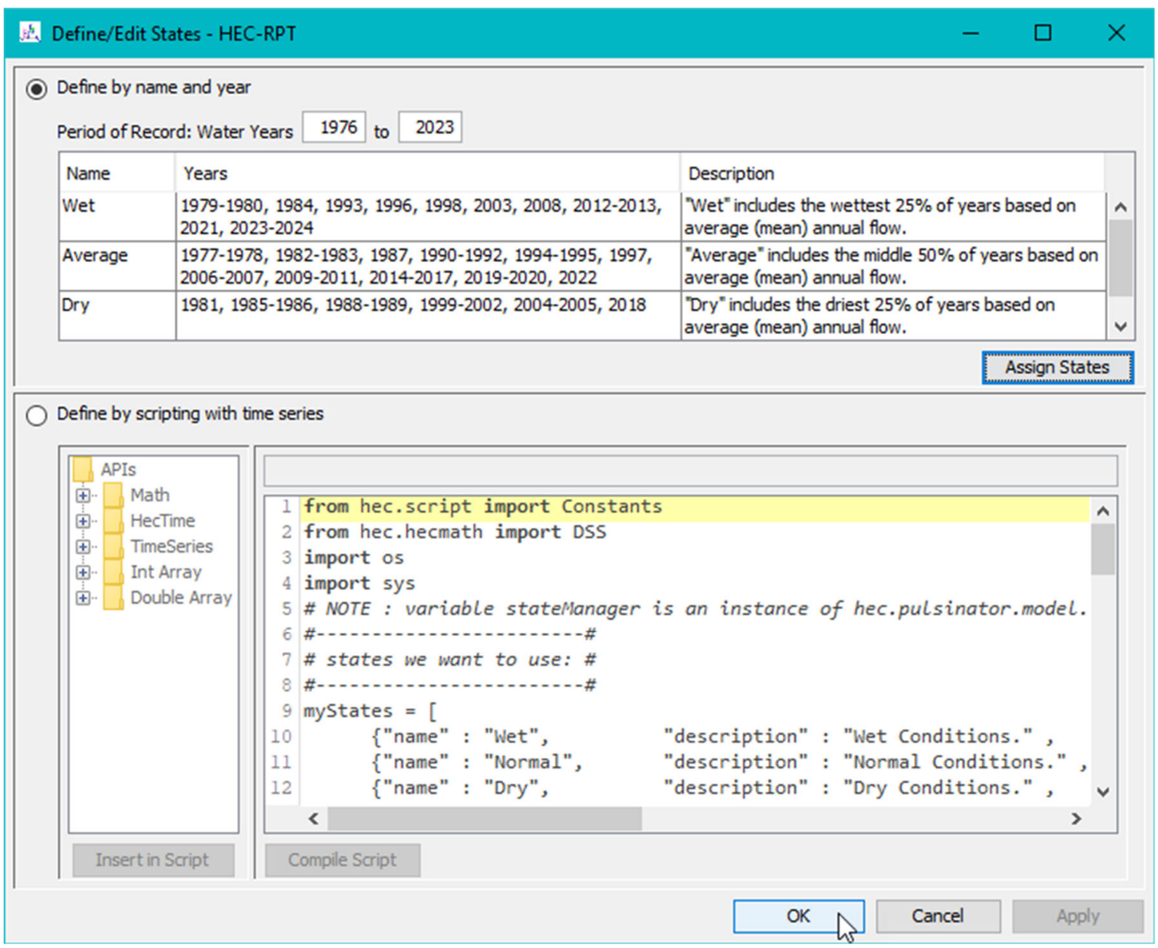


Figure 7. Interface for "Define/Edit States".

As settings are entered for defining states, that information can be applied to the Project by clicking the Apply button or the OK button, which applies the changes and closes the editor.

The demonstration project included as part of the HEC-RPT installation package contains information for both methods of defining state.

2.4.1 Define state by name and year

The "Define by name and year" method allows users to create states and then associate different water years with those states. In this method, each water year is represented by a single state. After states are entered into the "Name" column in the table, water years can be assigned to a state by either typing them into the "Years" column in the table or by clicking on the "Assign Year States" button, which offers drop down lists of states for each water year within the user-defined period of record (Figure 8). Recommendations are plotted per this period of record. Water years outside of the period of record can be removed from the "Years" column via manual editing or by clicking the "Trim to Period of Record" button (Figure 8, see water year 2024 as example of a year that would be trimmed). In the demonstration project, three states (Wet, Average, and Dry) were used and water years within the period of record were assigned to a state based on annual average flow (i.e., the wettest fourth (25%) of years in the period of record was classified as "Wet", the middle half (50%) as "Average", and the driest fourth (25%) as "Dry").

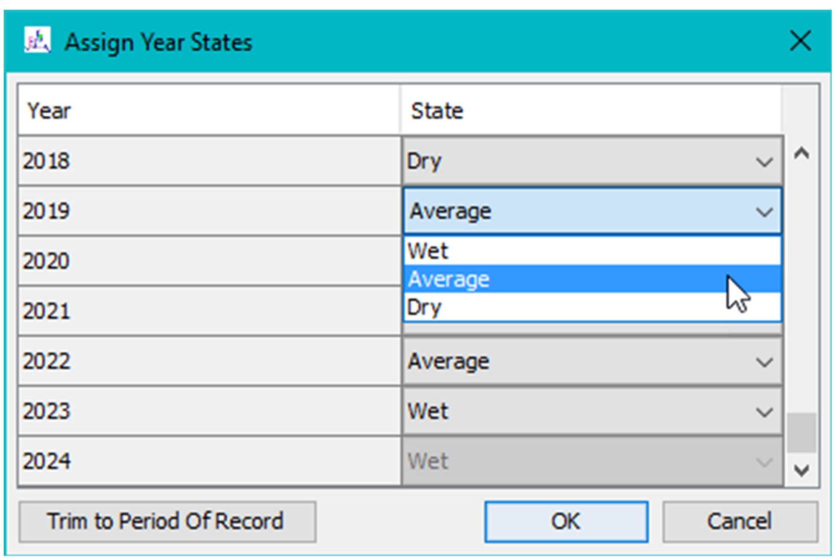


Figure 8. Interface for "Assign Year States".

2.4.2 Define state by scripting with time series

The "Define by scripting with time series" method involves scripting Jython code to set a period of record, import time series of data, perform calculations with those time series, and, ultimately, to use a logic statement to determine state (e.g., if X is less than

2, then state equals "Dry"). As many types of time series and computations can be used in scripting, this method opens up an unlimited number of ways to define state and allows HEC-RPT to assess scenarios from a perspective more akin to water management operations where hydrologic conditions can change many times over the course of a water year.

While this method offers a great deal of flexibility and power in defining states, it can also be complicated. Jython is an implementation of the computer language Python that has been adapted for use with Java. In other words, using Jython is essentially the same as writing computer code.

The demonstration project assigns a state to each day in the period of record by comparing that day's recent unimpaired flows (computed as a 90-day backward looking average) to the historical distribution of unimpaired flows for that calendar day (90-day averages for that calendar day were computed for many historical water years, which were then used to define a distribution). In this case, unimpaired is a term used to describe flow conditions without man-made effects.

For more information about creating and using scripts, please refer to the HEC-DSSVue User's Manual (USACE 2023).

2.5 Populating recommendations

As states are defined (and applied) a line along the X-axis of the main plot will appear. The colors of this line represent the different states and times within the period of record when a given state is in effect (Figure 9). Details about assignment and changing of colors are provided in the "Color management" section of this manual.
When all time within the period of record has been assigned to a state, the colored line will appear continuous and represents a set of unpopulated flow recommendations.

2.5.1 Adding lows

Lows are assigned to each day of the water year for each state in each system. Low points (combinations of date and value) are entered into the "Lows" table. HEC-RPT interpolates between these known points using either a linear method, which connects known points with a straight line of average daily values, or a step method, which holds lows at the value of the last known point until the date of the next point is reached and then lows step up or down to the value of that next point. Description fields are provided for the whole lows category, where general approaches can be documented, as well as for the individual low points, where strategies for different points can be detailed. Choice of method is controlled by the radio buttons in the "Lows" area of the user interface (Figure 10).

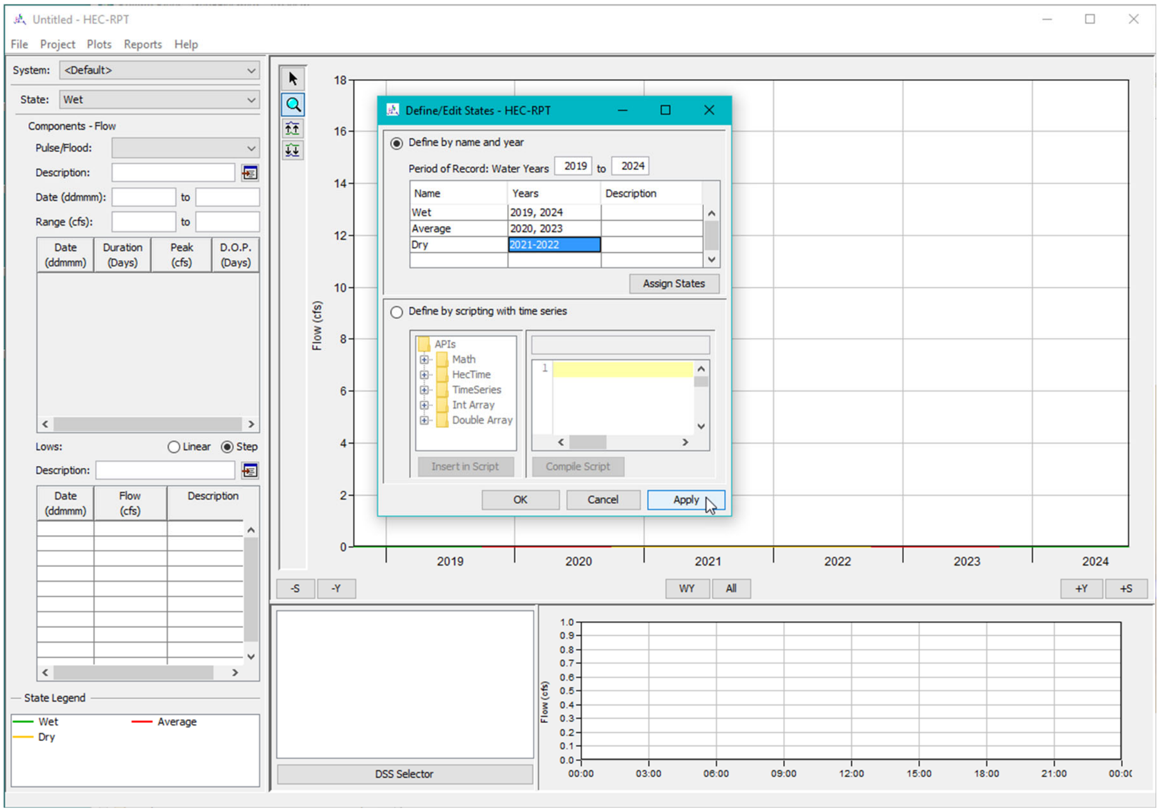


Figure 9. New states appear as colored lines along the X-axis of the main plot.

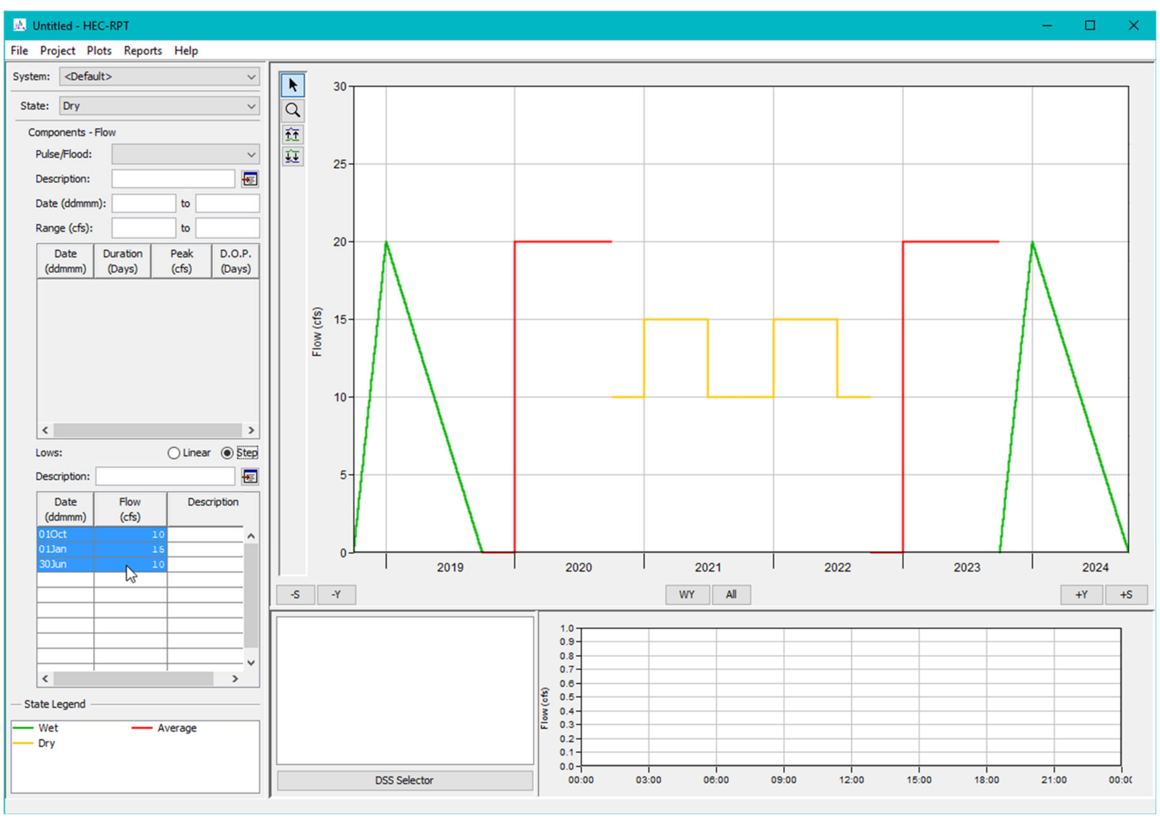


Figure 10. Lows are displayed for each state.

Dry year values are highlighted in the figure and plotted in orange. Wet years (in green) and average years (in red) each have only two data points, 0-cfs on 01Oct and 20-cfs on 01Jan. The difference between the two is that wet is using the linear interpolation method and average is using the step interpolation method.

To support plotting of lows, zero flow points are used at the end of each water year for the linear method. To avoid seeing that zero point in plots, a low value for that date needs to be specified in the table.

2.5.2 Adding pulses and floods

Pulses and floods are managed via the "Project – Component" menu option. This menu offers options to create new pulses and floods, rename, duplicate, or delete existing pulses and floods, and import flow components from other systems and states.

When "New…" is selected, a window opens that has a text entry field for name of new component and a set of radio buttons to specify whether the new component is a pulse or a flood (Figure 11). From a software perspective, there is no difference in the parameters that characterize pulses and floods – both are defined by name, range of possible dates and magnitudes (a.k.a., graphical window), and a trace of the recommendations defined by date of start, duration, peak, and duration of peak. However, pulses and floods are catalogued and reported as separate components in HEC-RPT because of their different physical and ecological effects.

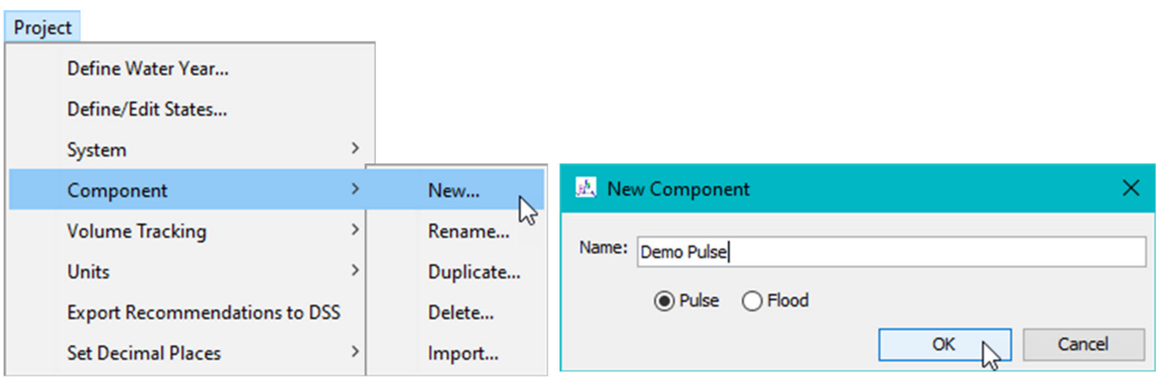


Figure 11. Menu option and interface for creating a new pulse or flood component.

Settings for the pulse-flood parameters are entered into the components area of the HEC-RPT interface. Most parameters are for specifying the pulse-flood window and the pulse-flood trace (Figure 12). The window defines the date and flow ranges for a given pulse-flood (e.g., this pulse can occur anytime between 15Jan and 30Apr and be between 30- and 35-cfs). The trace is a single realization of that pulse event (as defined by date of start, duration, peak, and duration of peak).

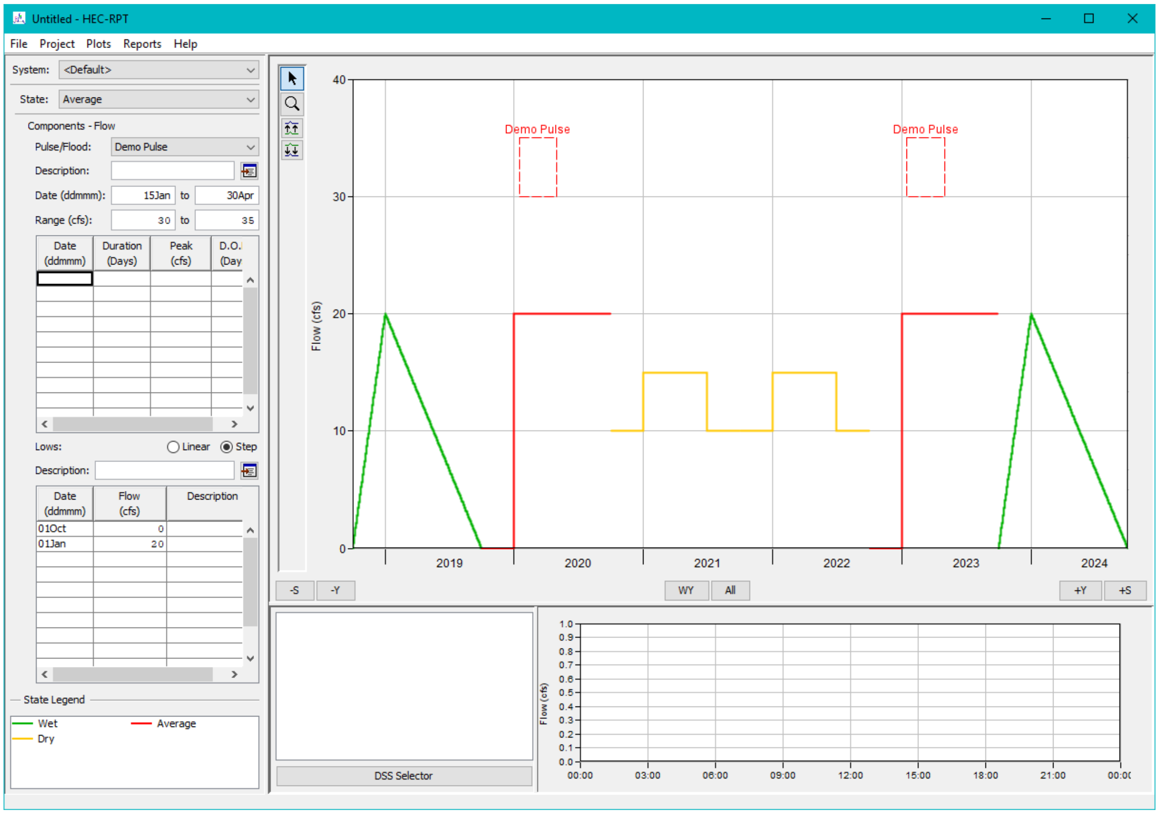


Figure 12. Date and flow ranges define an operation window for a recommended pulse/flood component.

Traced pulse-floods deviate from the low flow called for at the beginning of the rise and return to the low flow called for at the end. Between these points, the peak is as triangular as possible; when the duration and duration of peak do not allow a symmetric triangular peak, the extra day is added to the receding limb (Figure 13).

Traces can have multiple peaks for a single pulse-flood window. Overlapping departures from lows will create oddities in the plotting of the traces and the export of traced time series. Users are encouraged not to overlap multiple peaks within the same window. In the case of overlapping peaks in different windows, the trace will reflect the highest value required for each day being plotted.

Pulses and floods can also deviate from lows towards zero, which might be useful in states that call for episodic conditions below the lows. However, downward pulses and floods that fall to exactly zero will create errant data points in the output. Users are cautioned to have positive non-zero values as minima for inverted peaks (0.1 or any small value would suffice).

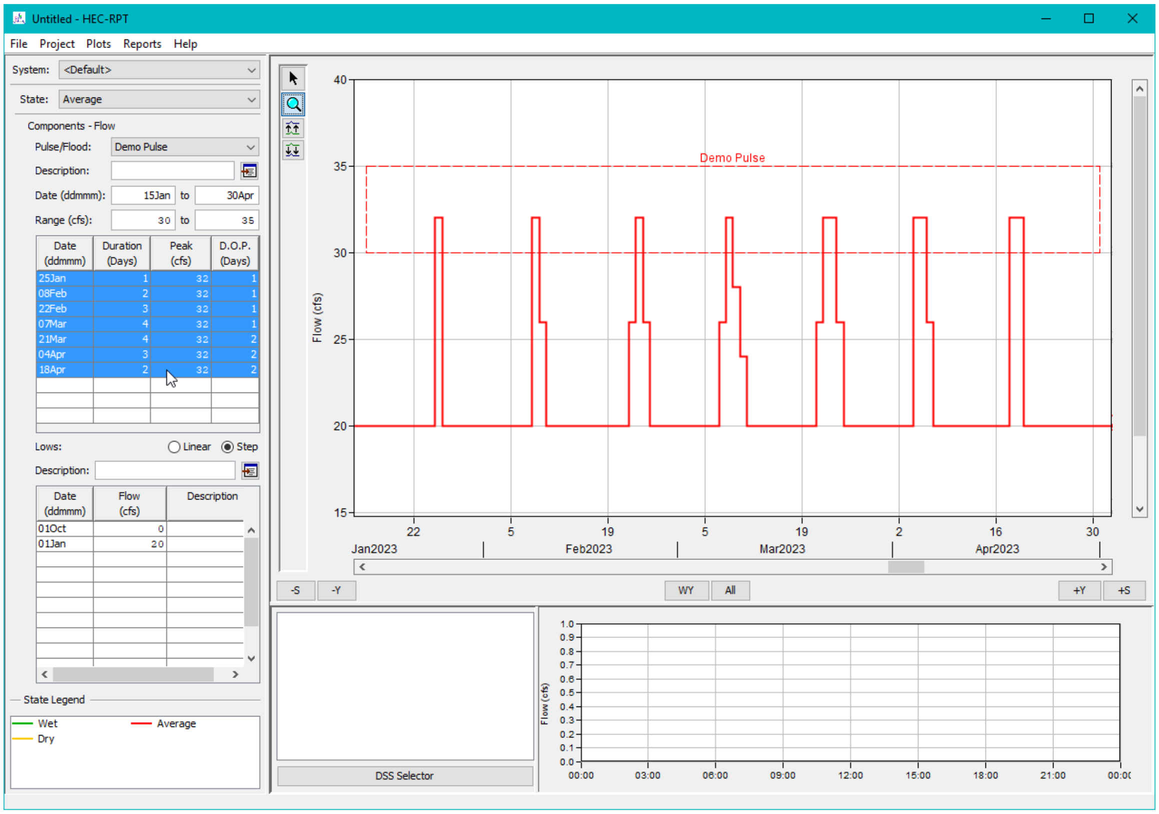


Figure 13. Sample trace for the Demo Pulse. This trace has 7 peaks, each with the same magnitude and different combinations of timing, duration, and duration of peak.

2.6 Banding

Banding is used to draw a range of acceptable values around the trace. This can be useful in situations where the objectives of a recommendation can be achieved through varied conditions, as long as conditions stay within a minimum and maximum. In this sense, bands are a helpful way to visualize the seasonal flexibilities (wide band) and rigidities (narrow band) associated with recommendations.

Bands are set equal to the trace until adjusted by the user. Subsequently, bands are always bounded by the trace such that an upper band can never be drawn below the trace and a lower band can never be drawn above the trace. Upper and lower bands are drawn individually for each combination of System and State.

Drawing is initiated by clicking either the upper or lower band buttons associated with the main plot (Figure 14). When the cursor is moved to the main plot window it will appear as intersecting vertical and horizontal lines with an orange circle in the middle. Bands are drawn through a series of left clicks. A left double click will save the new band. Alternatively, left clicks followed by a right click will open a menu with options for saving or discarding the drawn, but unapplied, points (Figure 15).

Figure 14. Upper and lower banding buttons.

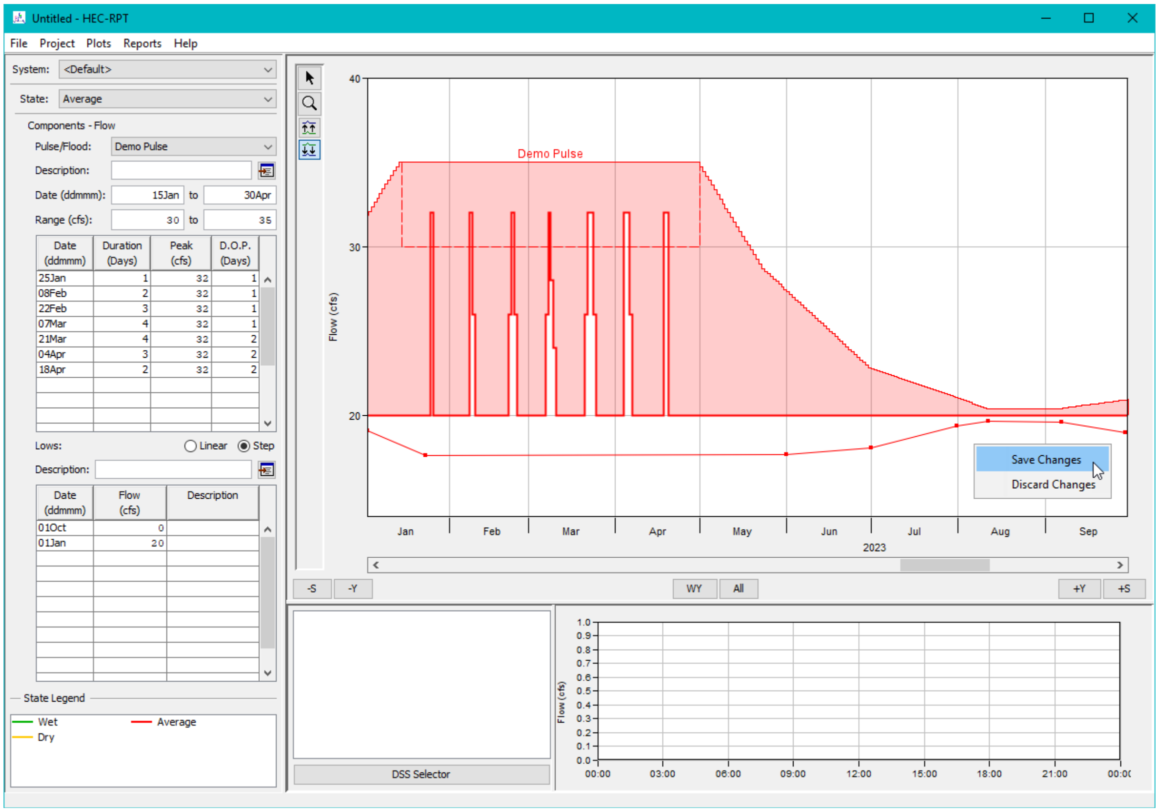


Figure 15. Use of banding to show acceptable ranges. Upper band is above the trace. Lower band is being drawn below the trace. Points entered can be saved or discarded via right click menu options.

Bands are overwritten when redrawn. Bands, like traces, are repeated seasonally based on state and can therefore be drawn for a maximum of one year (to allow for that entire annual pattern to be repeated without overlap). When drawing, a vertical line is displayed one year after the earliest point. The orange circle in the middle of the cursor will not pass beyond that line, which is a visual indication that any points drawn to the right of the line will not be accepted as part of the band. Existing bands are displayed or hidden in accordance with the "Plots – …Display Options – Display Banding" menu option settings. Existing bands can be removed by entering band points that fall wholly below the trace for upper bands or wholly above the trace for lower bands.

2.7 Importing and viewing data

Data are imported to HEC-RPT projects from DSS files. Data in DSS are stored according to pathnames. These pathnames have six parts (a/b/c/d/e/f). Each pathname part represents a different characteristic of the data. Typically, a-part names the river, b-part names the location, c-part names the type of data (e.g., flow), d-part lists the start date of the data (or its period of record when viewing a condensed catalog as shown below), e-part notes the time step interval, and f-part is reserved for a user-defined tag.

The browser that accesses DSS files and allows users to select data to import is activated by clicking on the DSS Selector button. DSS files can be opened through this interface by clicking on the open folder icon in the upper left or via the "File – Open" menu. Data in the DSS file can be imported by highlighting the pathname of the data and clicking the Set Pathname button at the bottom of the browser (Figure 16).

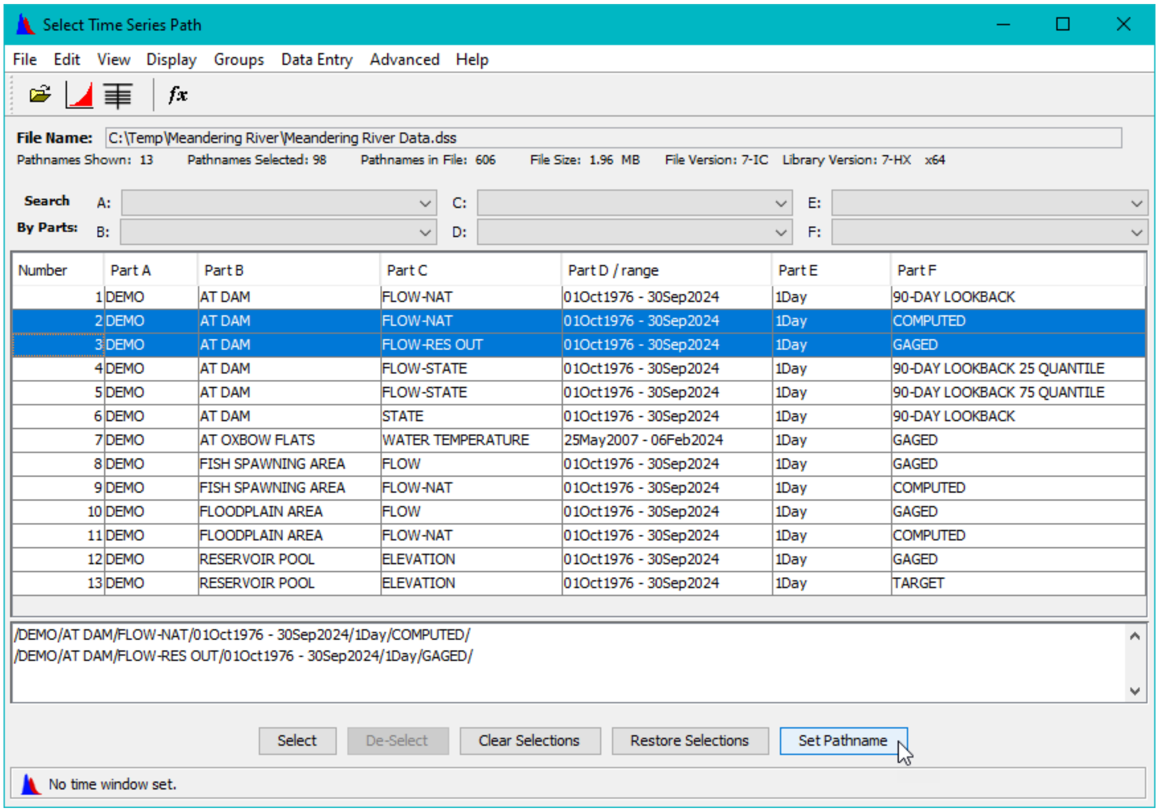


Figure 16. Interface for importing DSS time series data.

When imported, the time series will be plotted in the Main Plot window and shown as active in the window (b-, f-, and c-parts are listed) above the DSS Selector button. To hide the data while leaving it in the project, deactivate the pathname by un-checking its check box. To remove data from the project, right click on the pathname and select "Remove". Data may also be reordered, relabeled, and identified for use in volume tracking (Figure 17). Data (regular and irregular series) for a wide range of time steps (1-min to yearly) may be imported.

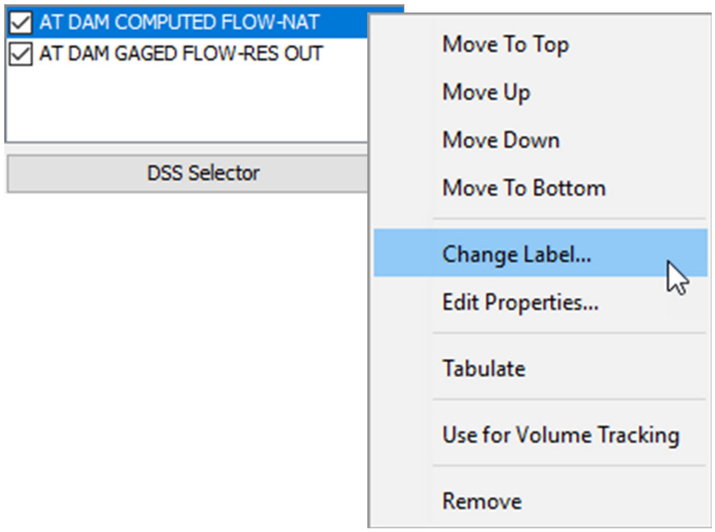


Figure 17. Data list, DSS Selector button, and data menu options.

Imported data are associated with systems. Each system has a separate list of imported data. Data are displayed in the main plot when data units match system units (Figure 3) or an alias thereof (a list of aliases is included with the HEC-RPT software). For example, if three time series were imported to a system that used the "Flow" system type (English units of "cfs" and metric units of "cms") and the three time series had units of "cfs", "m3/s", and "feet", then the first time series would display because its units match the English units of the current system type, the second time series would display because "m3/sec" is an alias for the metric system type unit of "cms", and the third time series would not display because units of "feet" is not compatible with "cfs" or "cms". However, if the system type were then changed from "Flow" to "Elevation", the first two time series would not be displayed and the third would because "feet" is also the English units of the "Elevation" system type.

The ability to plot and navigate hydrologic data is a strength of HEC-RPT. The software has two plot windows. Within these windows reside the main plot and the thumbnail plot. The main plot is inherently viewed in the upper right hand plot window and the thumbnail in the lower right, but their positions can be toggled via the "Plots – Toggle" menu option or by pressing the CTRL-T keys.

2.7.1 Main plot

The main plot displays time series based on *calendar date*. Imported time series are attached to a system. The range of time plotted for a system is bracketed with the earliest start and latest end dates of all imported time series and the period of record specified in the Define/Edit States editor. Flow recommendations entered for a system and state will populate this plot automatically.

2.7.2 Thumbnail plot

The thumbnail plot displays time series based on a 12-month *water year*, independent of calendar date. Several plot types are available via the "Plots – Predefined Plots" menu option, each focusing on a different perspective of the flow recommendations and historical data. As in the main plot, when a flow recommendation is entered, the selected thumbnail plot will display the change automatically (if the affected recommendation is part of the predefined plot option being displayed).

Predefined plots

Five types of predefined plots are available via the "Plots – Predefined Plots" menu, including 1) all states for one system, 2) one state for all systems, 3) choose systems and states, 4) multi-year traces, and 5) percentile plots (Figure 18). The selected plot will remain in view until replaced by the user with a different predefined plot.

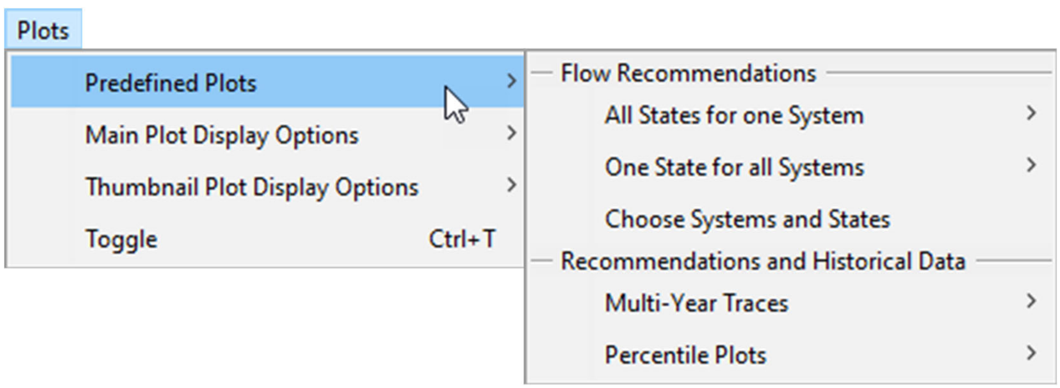


Figure 18. Menu options for the predefined plots.

All states for one system

This plot option displays recommendations for all states in a single system (Figure 19). This allows users to compare recommendations for the full range of states, which is typically a reflection of the spectrum of hydrologic conditions.

One state for all systems

This plot option displays recommendations for a single state for all systems in the project (Figure 20). This allows users to compare state-based recommendations for different locations or guilds of creatures, which could be useful when merging or unifying different river management perspectives into a single set of recommendations.

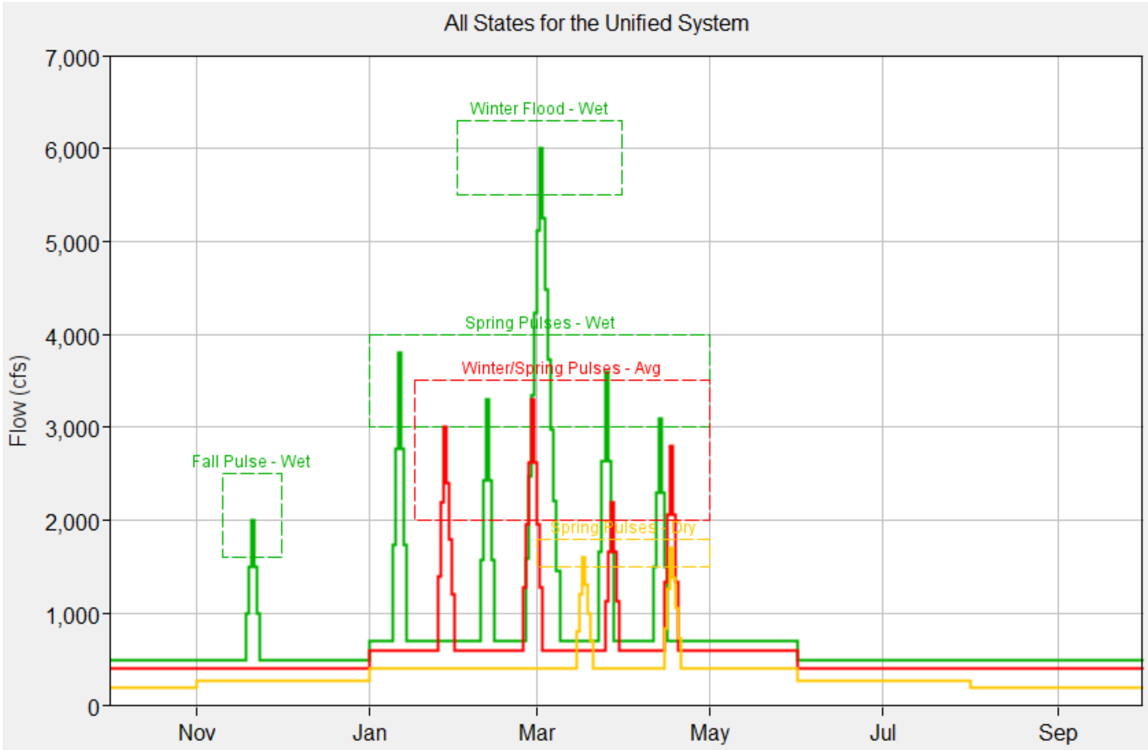


Figure 19. Display for an "All States for one System" plot.

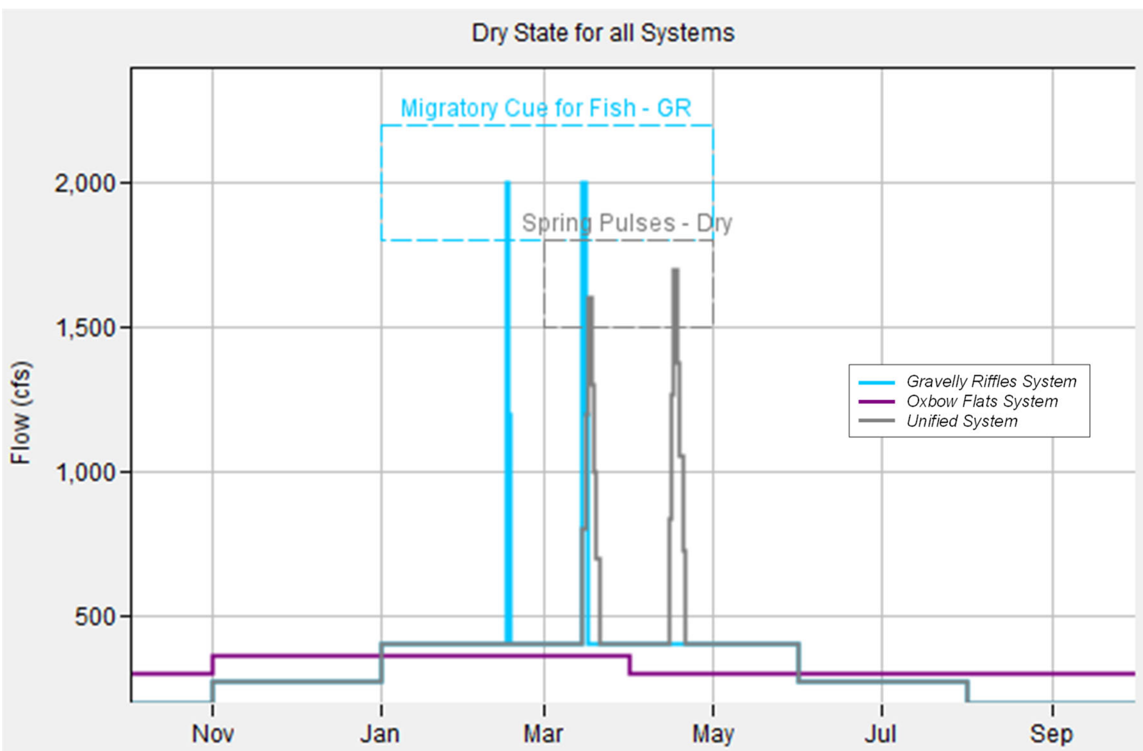


Figure 20. Display for a "One State for all Systems" plot. Wet state recommendations are plotted for three systems, Gravelly Riffles, Oxbow Flats, and Unified.

Choose systems and states

This plot option displays recommendations for user-selected pairings of systems and states (Figure 21). This allows users to create custom plots of recommendations for particular comparisons. The list of available pairings is filtered per the selected system type to assure that all selections can be plotted with the same units.

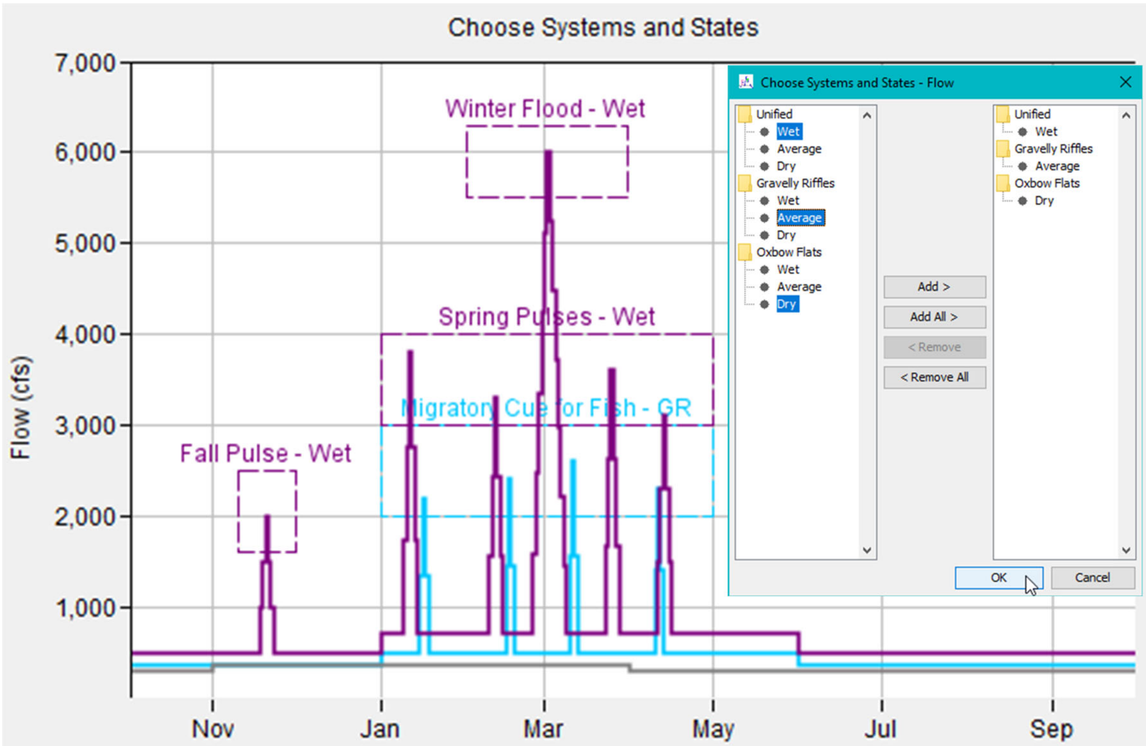


Figure 21. Display for a "Choose Systems and States" plot.

Multi-year traces

Multi-year traces display historical years of the same state over the same generic water year period. This allows users to investigate similarities and differences between years of the same state while formulating flow recommendations for that state.

The multi-year option is available only when state is defined by name and year. Plots are selected according to system and state. When selected, the user sets the time series to be plotted using the dropdown list of pathnames at the top of the options editor and has two options for displaying the plot. The first option is to plot a fixed number of historical years. The second is to plot specific historical years that are listed for the already selected state. If a fixed number of years are selected, the user will have the option to scroll through different years of that state by right clicking on the thumbnail and selecting the +1 and -1 year menu options.

Figure 22 shows the Multi-Year Options editor that appears when the user selects a multi-year trace through the “Plots - Predefined Plots” menu. Based on the settings in the figure, a multi-year trace with two historical years (fixed number of years option) of the AT DAM/FLOW-NAT time series would be plotted. The two historical years would be 1977 and 1978, which are the first two years classified as “Average” (Figure 7). Selecting +1 would change the years displayed to 1978 and 1982.

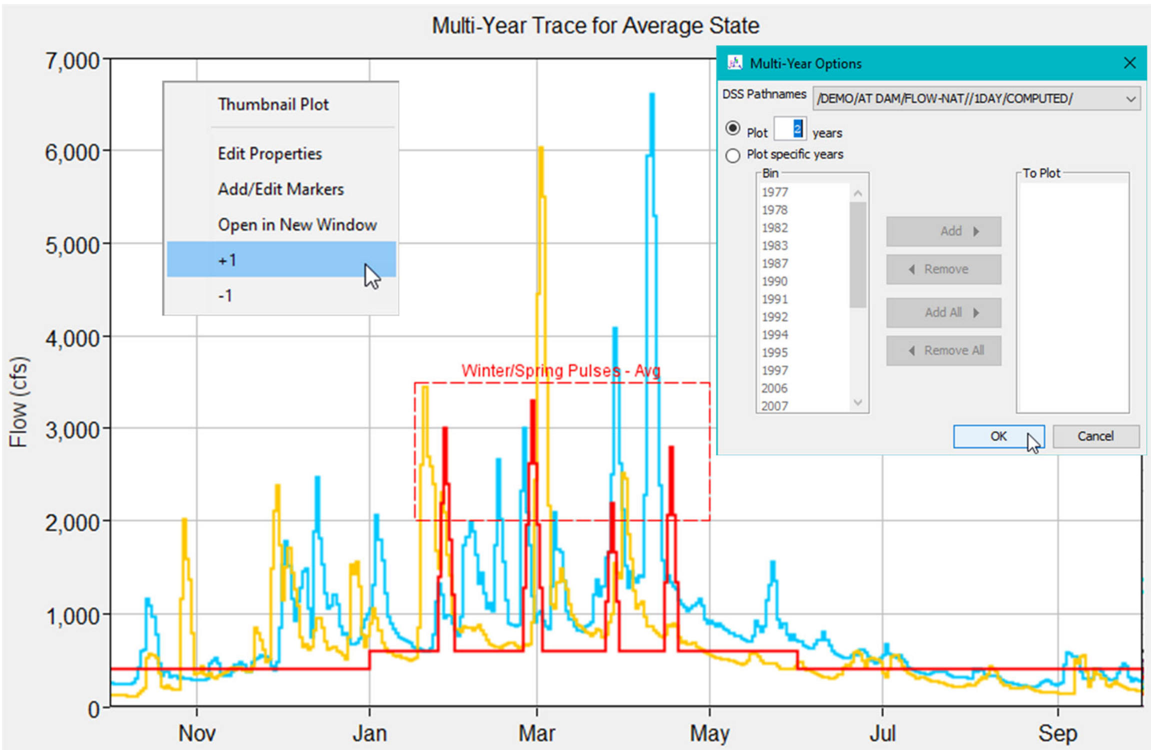


Figure 22. Options editor and plot display for a multi-year trace of two "average" years.

Percentile plots

Percentile plots show how values on any given date (day/month) are distributed. For instance, these plots can show the river flows on 01Jan that are above a certain flow rate in half of the historical years (50%). Plotting this percentile with other percentile lines helps to clarify seasonal flow patterns and show the commonality of different magnitude flows.

Plots are selected according to system and state. When selected, the user picks the time series to be analyzed using the dropdown list of pathnames at the top of the options editor and presses the Compute button located below the dropdown list. Eleven different data sets are computed. The user selects all or a subset of these data sets for viewing. Clicking OK causes the selected data sets to be plotted (Figure 23).

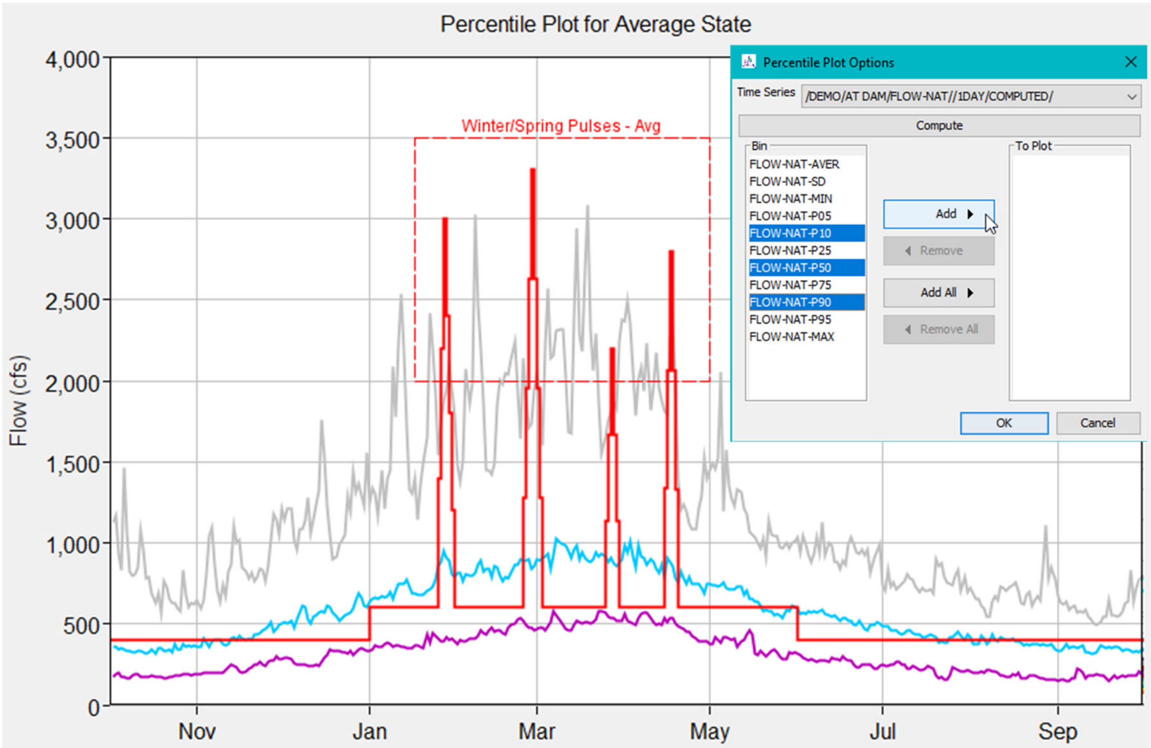


Figure 23. Options editor and display for a percentile plot. Percent non-exceedance lines are plotted for the 10, 50, and 90 percentiles.

2.7.3 Controls for the plots

A variety of controls are provided to facilitate use of the plot windows. Menu controls are available via the "Plots – Main Plot Display Options" and the "Plots – Thumbnail Plot Display Options" menus. These menus allow users to show or hide graphical windows, window labels, and flow recommendations in the plots and to prevent labels from overwriting. Tool buttons include pointer and zoom, located to the left of the upper plot window, and All, WY, +/- Y, and +/- S, which are located below the upper plot window (Figure 24). The main interface of HEC-RPT (Figure 1) has an upper and lower plot window. The user determines which of these windows displays the Main Plot and which displays the Thumbnail Plot by toggling via the "Plots – Toggle" menu option or by pressing the CTRL-T keys.

The pointer tool (identified as an arrow) is used to access right click menus associated with the upper and lower plots and to simply serve as a mouse controlled pointer. The zoom tool (identified as a magnifying glass) is used to zoom in and out of the plot in the upper plot window. To zoom in, click on the plot and hold down the left mouse button.

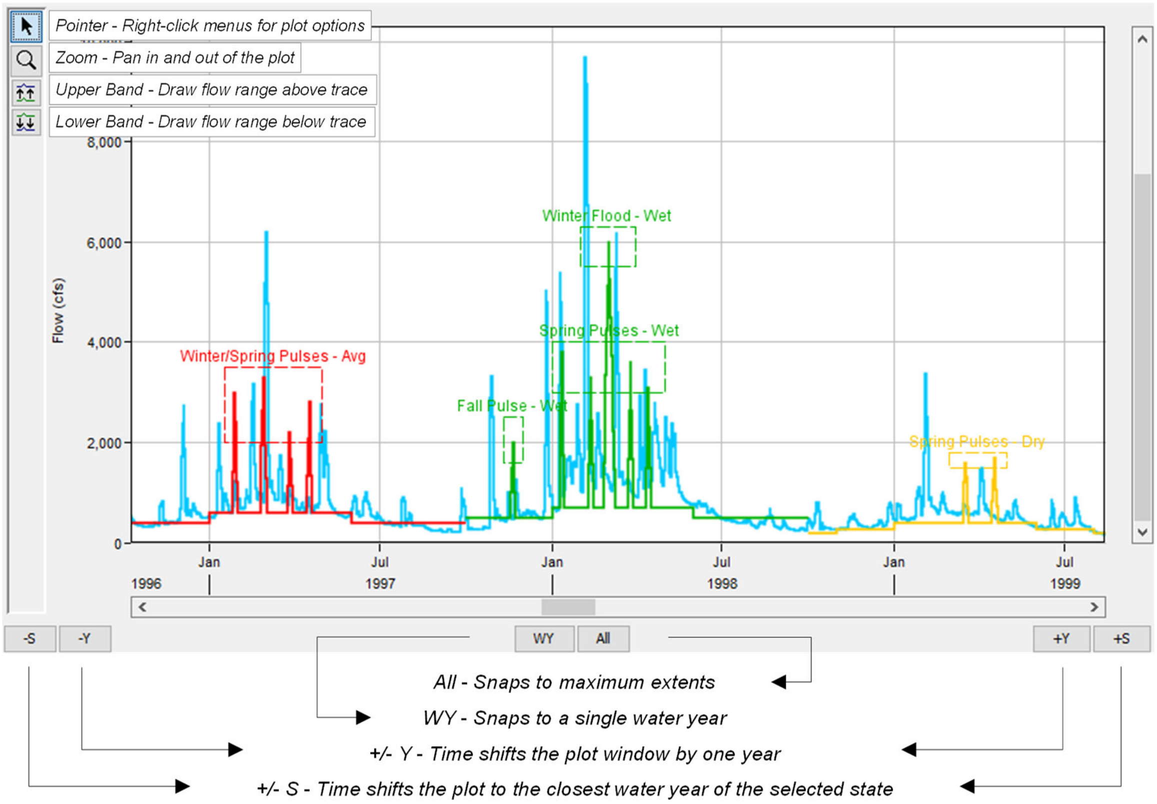


Figure 24. Button controls for navigating plots.

Move the mouse to draw a box. When the box covers the plot area of interest, release the mouse button. The plot window will change to show the area of interest. To zoom out, right click on the plot. Behaviors for the upper and lower banding buttons are described in the “Banding” Section of this manual.

The All, WY, +/-Y, and +/-S buttons are controls for the Main Plot regardless of which plot window (upper or lower) it is in. If All is pressed, the main plot zooms out to its maximum extents. If WY is pressed, the main plot snaps to a view for a single water year. If more than one year is being viewed, when WY is pressed, then the plot snaps to the first water year of that view. If less than a full year is being viewed, then the plot snaps to the full water year. The +/-Y buttons advance/reverse the plot window by one water year. The +/-S buttons plot the next/previous water year of the state that is active in the state dropdown list in the upper left of the interface (this button is functional only when state is defined by name and year).

2.7.4 Spin-off plots

There is an option to "spin-off" copies of plots into separate, stand-alone windows. This option was added to enable different hydrologic plots to be maintained while the user creates new views using the plot windows embedded in the HEC-RPT interface. To spin-off a plot, use the pointer tool, right click on a plot, and select the "Open in

New Window" menu option. Plots that are spun-off may be saved in a number of formats (e.g., .jpg and .ps) for easy import to presentations and documents.

2.7.5 Color management

Colors are assigned to new time series on a first come - first serve basis using a standard set of eight colors. When all eight colors are used, the color sequence simply begins again and repeats indefinitely. Each state is assigned a color, which applies to its flow recommendations, graphical windows, and window labels for all systems in the project. If the color of a state is changed by the user, then that change is applied to all instances of that state throughout the project.

The only exceptions to this rule is for the “One State for all Systems” and the “Choose Systems and States” thumbnail plots. In these plot, visual differences between the systems are enhanced by assigning different colors to each system-state series. Color changes in these plots will not affect other plots and, conversely, color changes in other plots will not affect these thumbnails.

To change colors, use the pointer tool and move the pointer over the target time series in the plot. Right click and select "Edit Properties". Color, as well as line style, fill, and line symbols, can be changed. Symbology for imported time series can also be changed via right clicking on the target time series in the data list and selecting “Edit Properties”.

Symbology for time series is initially set per the color sequence at time of first import. Symbology can then be modified by the user, including changing labels (Figure 17). Subsequent imports of already imported time series always use the latest symbology. Symbology for existing instances of time series is not affected by symbology changes.

2.7.6 Markers

Markers can be added to the main and thumbnail plots by right clicking on the plot window and selecting "Add/Edit Markers". An editor will appear that offers menu options to add new, duplicate, or delete a marker. For the main plot, markers are associated with a system and a state (or all states – as shown in Figure 25). For the thumbnail, markers are associated with individual predefined plot types (or all plots).

Markers can be applied to the plots iteratively by clicking on the Apply button or by clicking the OK button to apply the marker and close the editor. Markers can be used to delineate key times of the year, flow thresholds, or any other aspect of the plot window that might be of importance. Markers consist of lines, shading, and labels, all of which are controlled through the Add/Edit Markers editor. In Figure 25, the main plot shows three separate markers (Max Hydropower, Max Channel Capacity, and Peak Hurricane Season).

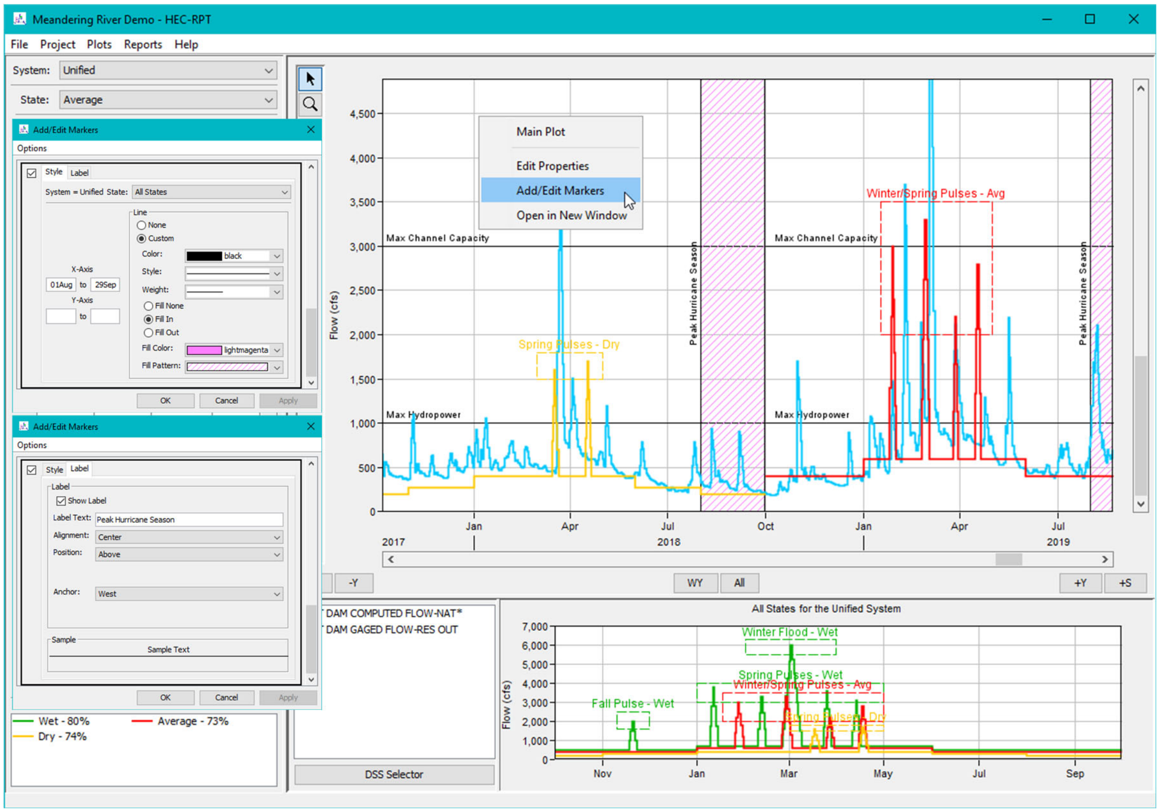


Figure 25. Marker editor and use.

2.8 Volume tracking

Volume tracking allows users to compare the volumes of water that would be required to meet a set of flow recommendations with the corresponding volumes of water associated with an imported time series. Only one imported time series can be selected for use in volume tracking per system and volume tracking can be used only for systems with a “Flow” system type. Flows are summed day-by-day and state-by-state for the period of record specified in the “Define/Edit State” interface (Figure 7). Total flows for the state-based recommendations are then divided by the corresponding total flows of the imported time series and multiplied by 100 to compute a percent volume for each state, which is then reported in the state legend (Figure 26). Missing values in the imported time series are treated as zeros.

Those percent volumes are computed based on the trace of each flow recommendation. Additional percent volumes based on the upper and lower bands of each flow recommendation are tabulated in the volume report accessed through the “Reports – Volume” menu option and as described in the “Reporting” section of this manual.

Volume tracking can be activated by selecting the “Project – Volume Tracking – Active” menu option. A time series can be designated for use in volume tracking through the “Project – Volume Tracking – Settings” menu option or by right clicking on that time series in the Data List and selecting the “Use for Volume Tracking” menu option. Time series designated for use are identified with an asterisk in the Data List.

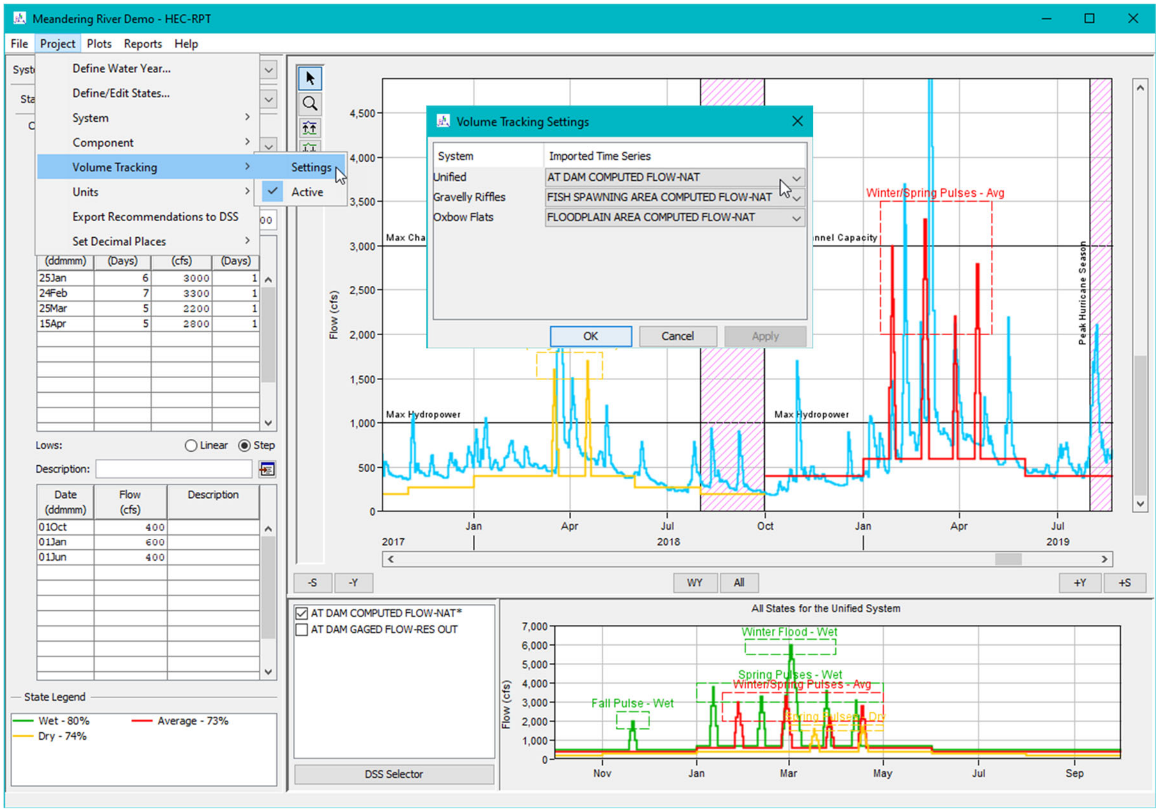


Figure 26. Volume tracking for Unified System. Percent volumes are reported in the State Legend. “Flow-Nat” selected as imported time series to be used in computations.

2.9 Reporting

HEC-RPT generates summaries of systems, states, and flow components that can be saved as text files. Reports can be generated for individual systems or for the whole project via the "Reports" menu (Figure 27). Volume tracking reports are also offered.

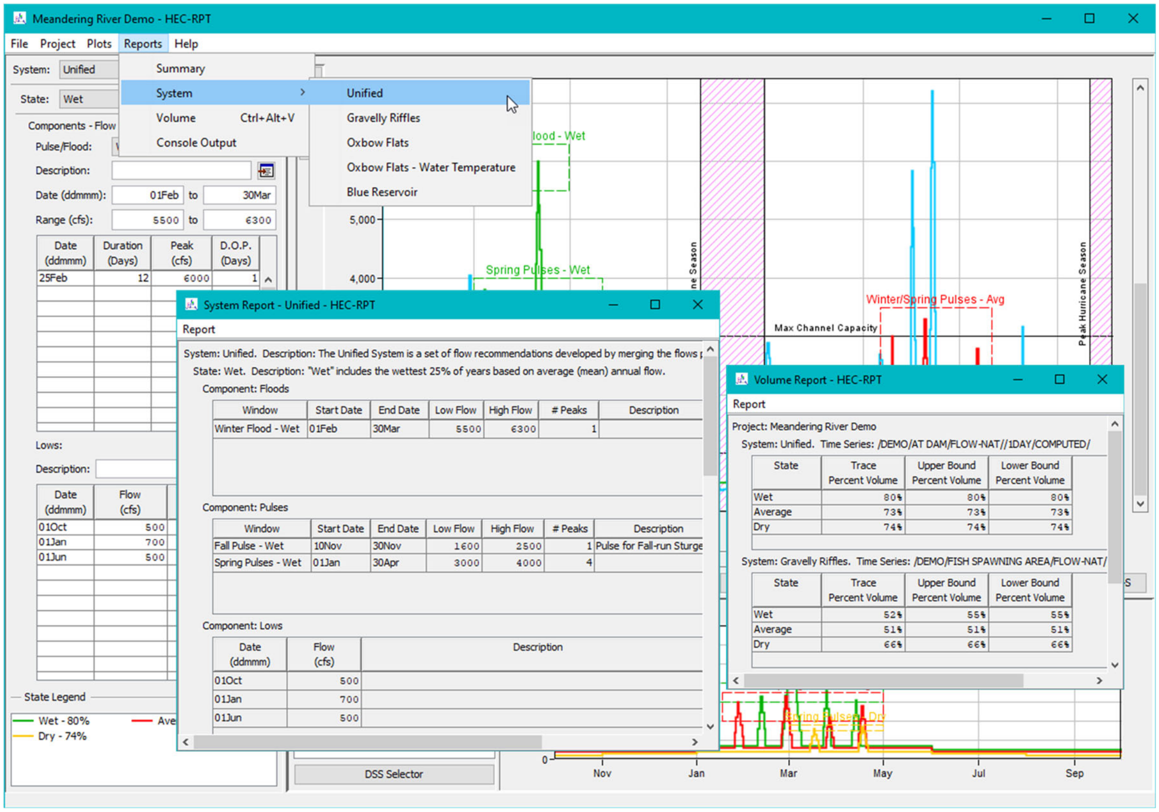


Figure 27. Excerpt of the System report for the Unified System. Text versions of report are available via the "Report – Save As" menus.

2.10 Data management

Each project (.eco) has a companion DSS file named "Project (name) – ECO.dss" that is created by the software. Time series imported to the project are copied into this project DSS file and the location identifiers for that data are redirected from the source DSS files to the project DSS file. Creation of this project DSS file makes projects portable because all information for a project is thereby contained in "Project.eco" and its companion "Project – ECO.dss". To relocate or package a copy of the HEC-RPT project, simply move or duplicate those two files.

Flow recommendations can be exported to DSS (as time series of average daily flows) via the "Project – Export Recommendations to DSS" menu option. Recommendations are exported for the following combinations:

/system/state/flow//1day/flow component/
/system/all states/flow//1day/flow component/
/system/state/flow//1day/all flow components/
/system/all states/flow//1day/all flow components/

By exporting the whole recommendation (all states – all components) and each of the parts, HEC-RPT stages future modeling and trade-off analyses that investigate the feasibility of implementing all or part of the flow recommendations (Figures 28 and 29).

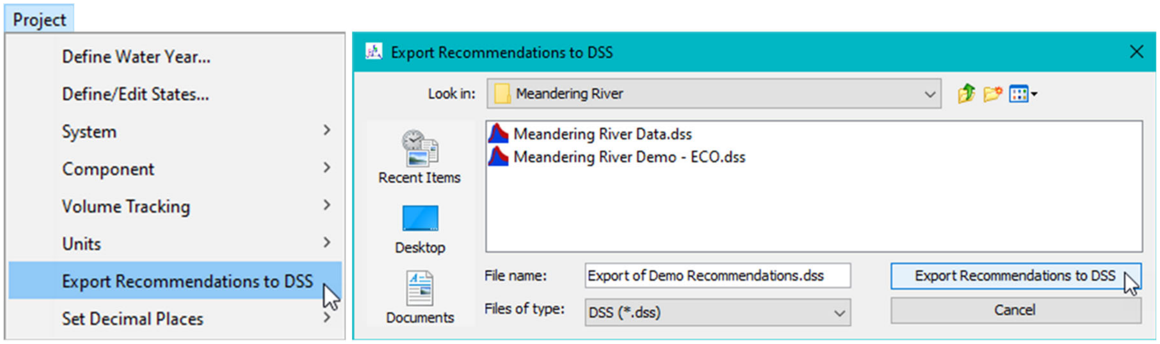


Figure 28. Menu option and interface for exporting flow recommendations to DSS.

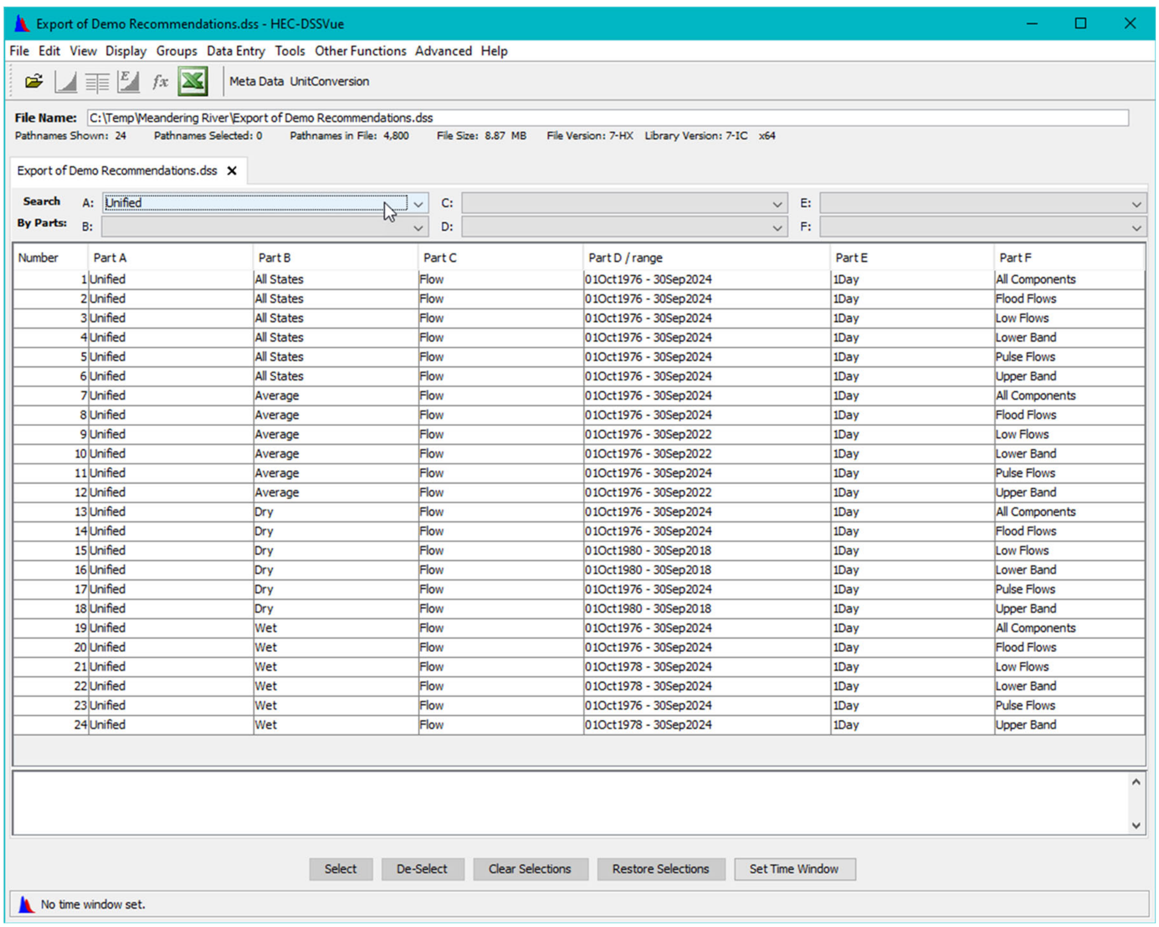


Figure 29. Catalog of data exported for the Unified System.

2.11 Importers for systems and components

Importers are provided which allow 1) systems to be imported to an open project from a source project and 2) components to be shared among the different systems and states of a single project.

2.11.1 Importing systems

The system importer is accessed via the "Project – System – Import" menu (Figure 30). When activated, the user can specify the source project by clicking on the open button in the upper right corner of the Import System window. When a source project is opened, all systems in that project will appear in the right hand data panel. To import, highlight the system(s) to transfer, click the Import button, and then click the Apply or OK button. The Undo button will reverse any unapplied transfers. If a system is imported that uses a system type not in the destination project, then that system type will also be imported.

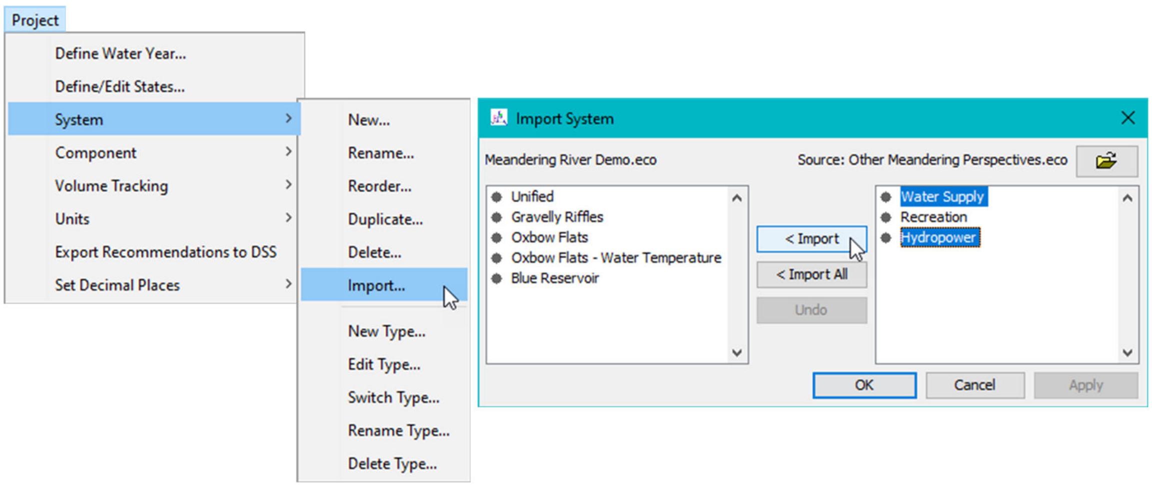


Figure 30. Menu option and interface for importing systems.

2.11.2 Sharing components

The component importer is accessed via the "Project – Component – Import" menu (Figure 31). When activated, the user can transfer components between different systems and states. Individual components or sets of components defined for a system and state can be transferred. Transfers are made by highlighting the destination in the left-hand data window and the source (or component to be transferred) in the right-hand data window, clicking the Add button, and then by clicking the Apply or OK button. Transfers can be made from state to state or from component to state. The Undo button will reverse any unapplied transfers.

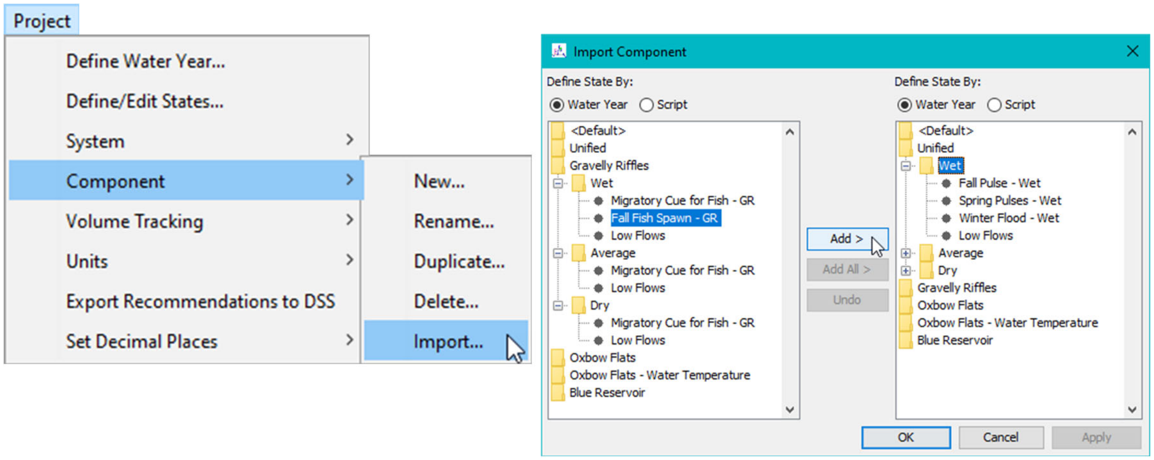


Figure 31. Menu option and interface for importing components.

CHAPTER 3

Details about the Demonstration Project

The demonstration project contains recommendations and hydrologic data for the fictional Meandering River. The project has five systems (Unified, Gravelly Riffles, Oxbow Flats, Oxbow Flats – Water Temperature, and Blue Reservoir) and three states for each method of defining state (wet, average, and dry for "define state by name and year" and wet, normal, and dry for "define state by scripting with time series"). "Normal" was used to reflect use of the different “define state” methods and is analogous to average. Components are identical for the parallel system-states.

The demonstration project and three supporting files (Table 1; Figure 32) are installed to a user specified directory via the software’s “Help – Install Demonstration Project…” menu option. To use the “define by scripting with time series” method for defining states, users will need to update a DSS file location in the script from "C:\HEC Data\HEC-RPT\" to the install location chosen for the demonstration project (see script line 16 in the project file “Meandering River Demo.eco”). The DSS file referenced should remain “Meandering River Data.dss”.

Table 1. File names and descriptions for the demonstration project.

File	Description
Meandering River Demo.eco	Project file. Contains all interface settings and information entered for the demonstration project.
Meandering River Demo – ECO.dss	Project companion DSS file. This file was automatically created by the software when the demo project was saved. DSS data referenced in the project are copied from their source DSS file into this project archive.
Meandering River Data.dss	DSS data file for the Meandering River. Contains time series data for the damsite and downstream points of interest. This file also contains data required to run the script used in the project’s “define by scripting with time series” method for defining states.
Export of Demo Recommendations.dss	Export of project recommendations. File contains recommendation time series for all systems in the project based on the “define state by name and year method”. This file was generated by the export to DSS software function described in the Data Management portion of this manual.

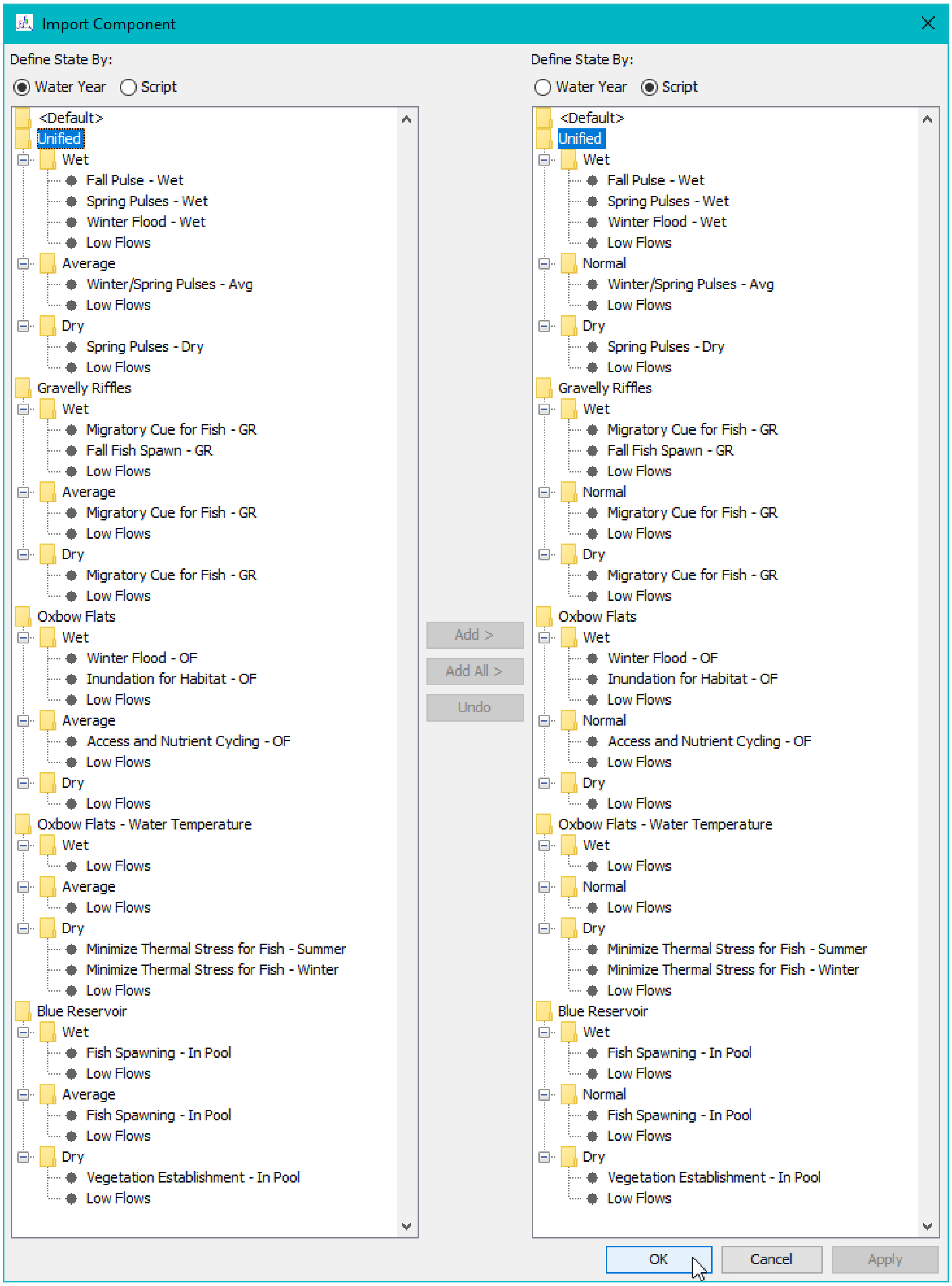


Figure 32. Project architecture for "Meandering River Demo.eco".

After installing HEC-RPT, please open "Meandering River Demo.eco" and test some of the features described in this manual. This may seem like an overly short introduction to a demonstration project, but HEC-RPT is primarily a visualization tool. It is not intended to perform detailed quantitative analyses. Users should see plots automatically respond to changes to flow components, markers, predefined plot selections, etc., which makes HEC-RPT easy to experiment with and to learn. Enjoy!

CHAPTER 4

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CHAPTER 5

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