IHA V 7.1 Tutorial

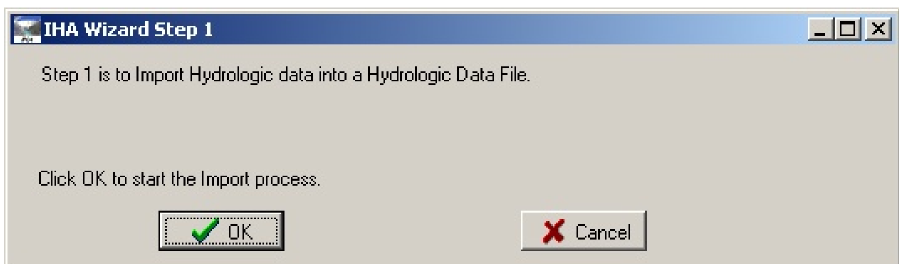
Part 1 of this tutorial will take you through the IHA Wizard, which explains some basic features of the software, and allows you to set up a basic analysis. Part 2 will take you through some more advanced features of the software.

Hitting F1 at any time during this tutorial will bring up the Help System. The IHA User's Manual is also available on your program menu.

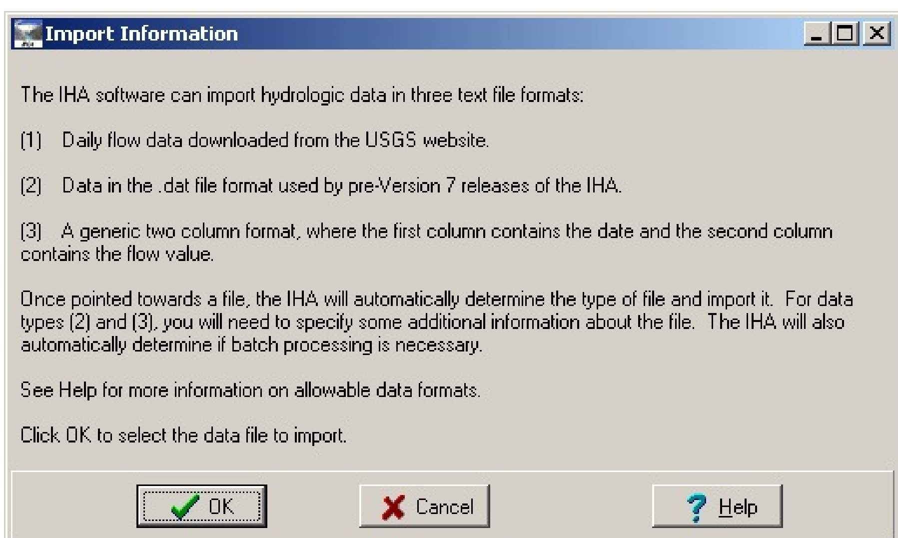
Part 1: IHA Wizard

To start the IHA Wizard, click OK on the welcome screen that appears when you first start the software, or select menu option **IHA | Wizard**. Each of the steps in this section of the tutorial corresponds to an individual Wizard window. The tutorial will describe the function of each of these windows, and also some of the other windows which appear in the background.

1. IHA Wizard Step 1. Import Hydrologic Data.



A. Click OK on this window to bring up the following window:



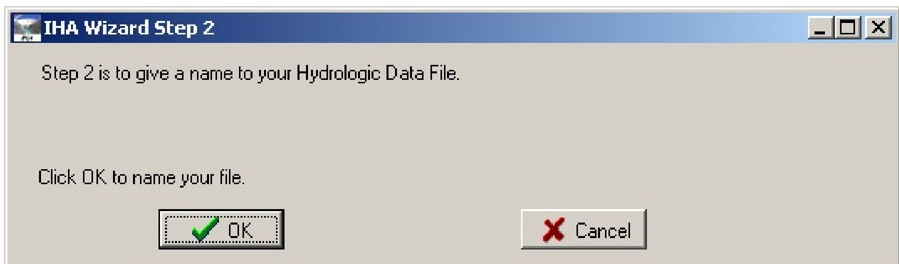
As described in this window, the IHA can import daily hydrologic data in three different formats.

B. Click Help if you wish to read more about these formats (or see section 3.2.1 in the IHA User's Manual).

C. Clicking OK will allow to you select a text file to import. Import the file named Roanoke_River_NC_02080500.usgs. This file is available on the IHA Software CD in the directory IHA Software\Data for Tutorial.

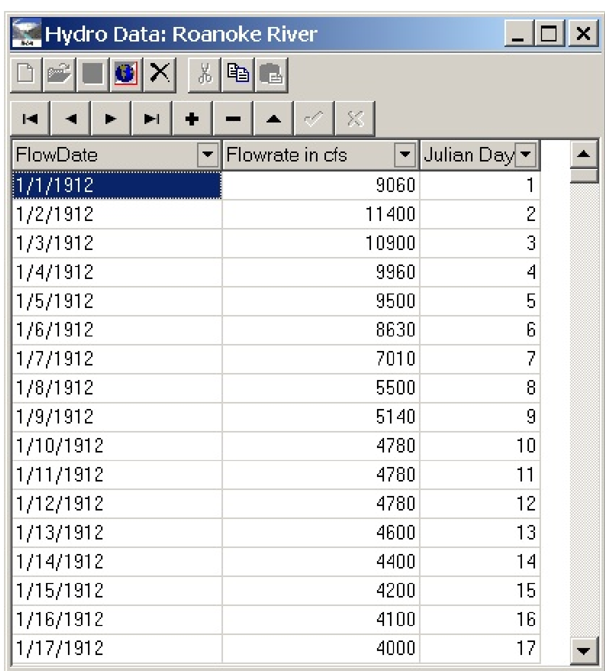
This file contains data from a USGS stream-gauging station on the Roanoke River in Virginia, downloaded from the USGS website. This gage is about 40 miles downstream from the John H. Kerr Dam, operated by the Army Corps of Engineers.

2. <u>IHA Wizard Step 2. Name your Hydrologic Data File.</u>



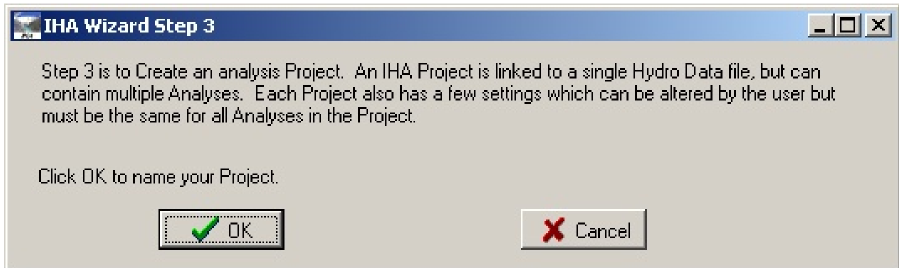
A. Click OK on this window to enter a name for your imported file.

After naming your Hydro Data file, in the background you will see the Hydrologic Data Editor (shown below), which shows your flow data, along with the calendar date and Julian day. The data in the Editor can be sorted by clicking on any of the three columns. The Editor can be also be used to add, delete, or edit records from the Hydro Data file.



FlowDate	Flowrate in cfs	Julian Day
1/1/1912	9060	1
1/2/1912	11400	2
1/3/1912	10900	3
1/4/1912	9960	4
1/5/1912	9500	5
1/6/1912	8630	6
1/7/1912	7010	7
1/8/1912	5500	8
1/9/1912	5140	9
1/10/1912	4780	10
1/11/1912	4780	11
1/12/1912	4780	12
1/13/1912	4600	13
1/14/1912	4400	14
1/15/1912	4200	15
1/16/1912	4100	16
1/17/1912	4000	17

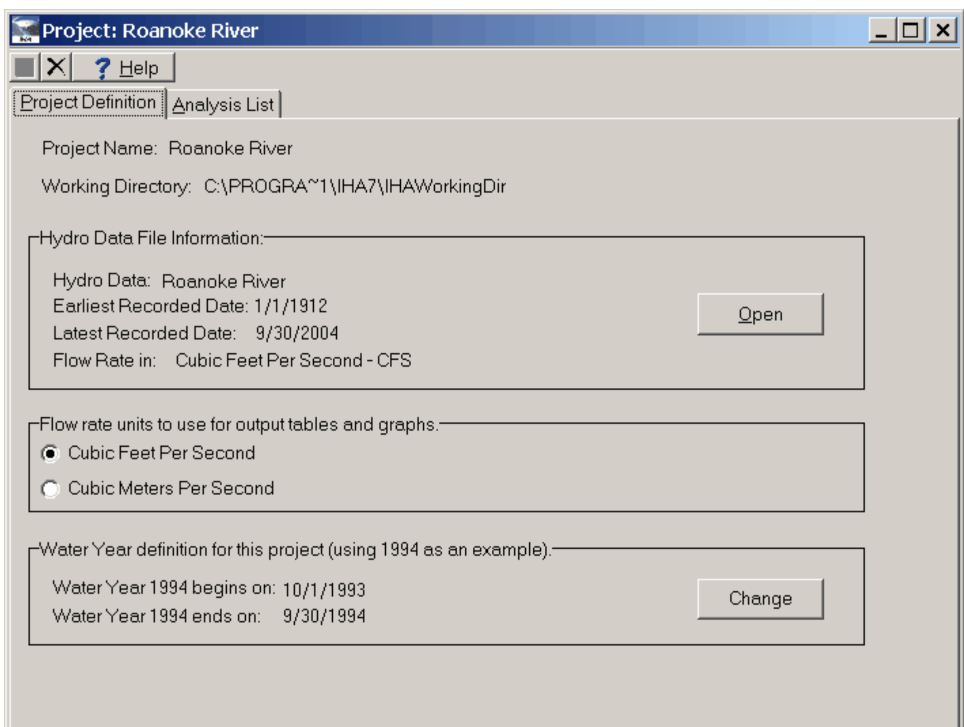
3. IHA Wizard Step 3. Create an Analysis Project.



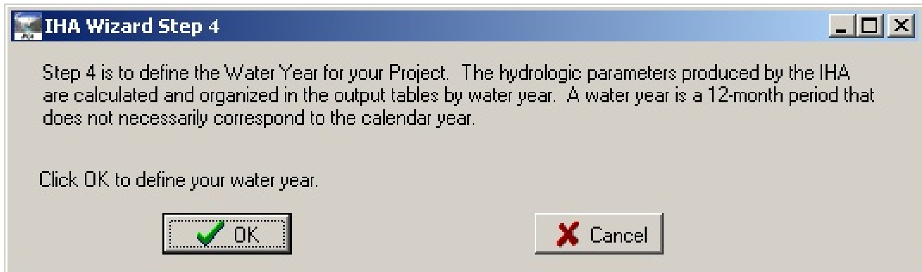
Analyses in the IHA are organized in separate Projects. Each Project is linked to a single Hydro Data file, but can contain multiple Analyses. Each Project also has a few settings which can be altered by the user but which will be the same for all Analyses in the Project.

A. Click OK on this window to name your new Project.

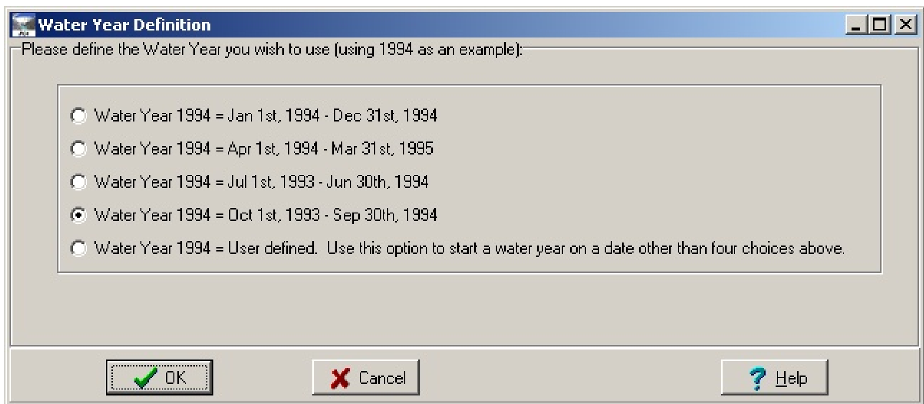
After naming your Project, in the background you will see the Project window, with the first tab showing (see below). The Project window lists the project name, working directory (the directory on your computer where the IHA stores its files), some information about the Hydro Data file, the flow rate units that will be used for output tables and graphs, and the water year definition.



4. IHA Wizard Step 4. Define your water year.



A. Click OK on this window to bring up the following screen:

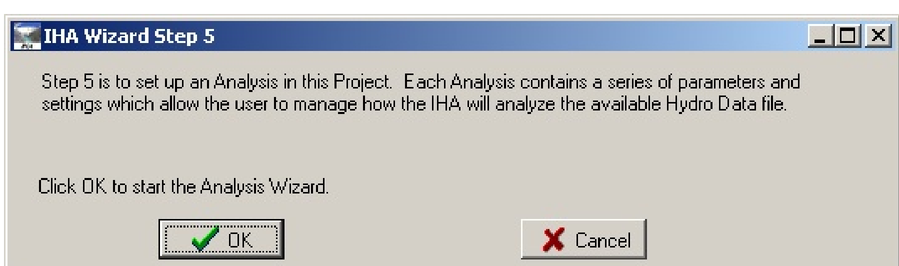


The hydrologic statistics produced by the IHA are calculated and organized in the output tables by water year. A water year is a 12-month period that does not necessarily correspond to the calendar year. Each Project has specified water year which will be used for all of its Analyses. The default water year in the IHA is Oct. 1 - Sept. 30, but the water year can also be reset to any other day of the year on this screen if desired.

B. Leave the water year as the default (Oct. 1 – Sept. 30).

C. Click OK to proceed to the next screen.

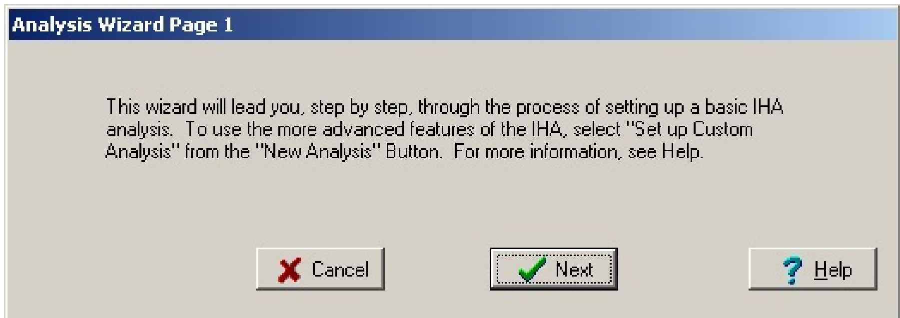
5. IHA Wizard Step 5. Create an Analysis in this Project.



Each Analysis contains a series of parameters and settings which allow the user to manage how the IHA will analyze the available Hydro Data file.

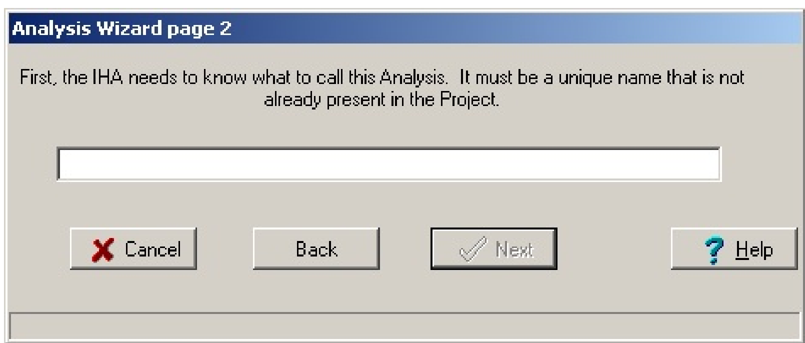
A. Click OK on this window to start the Analysis Wizard.

6. <u>Analysis Wizard Page 1. Introductory screen.</u>



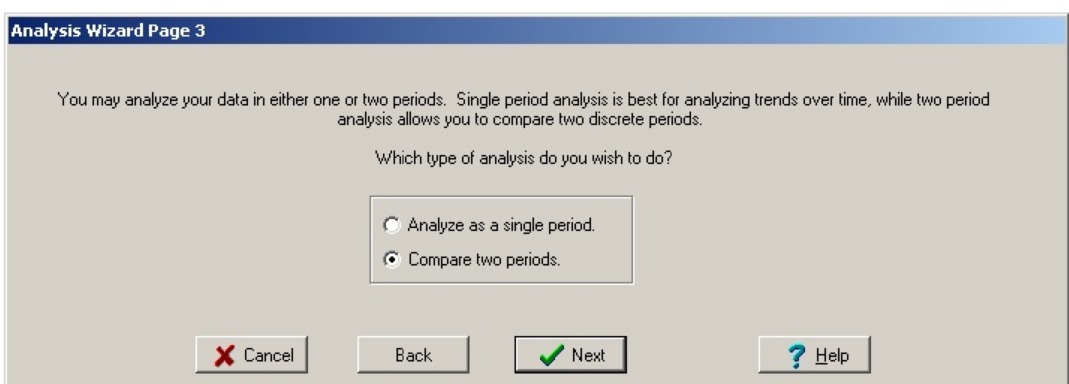
A. Click Next on this window to proceed to the next screen.

7. <u>Analysis Wizard Page 2. Name your Analysis.</u>



A. Enter a name for your Analysis and click Next.

8. <u>Analysis Wizard Page 3. Select One Period or Two Period Analysis.</u>

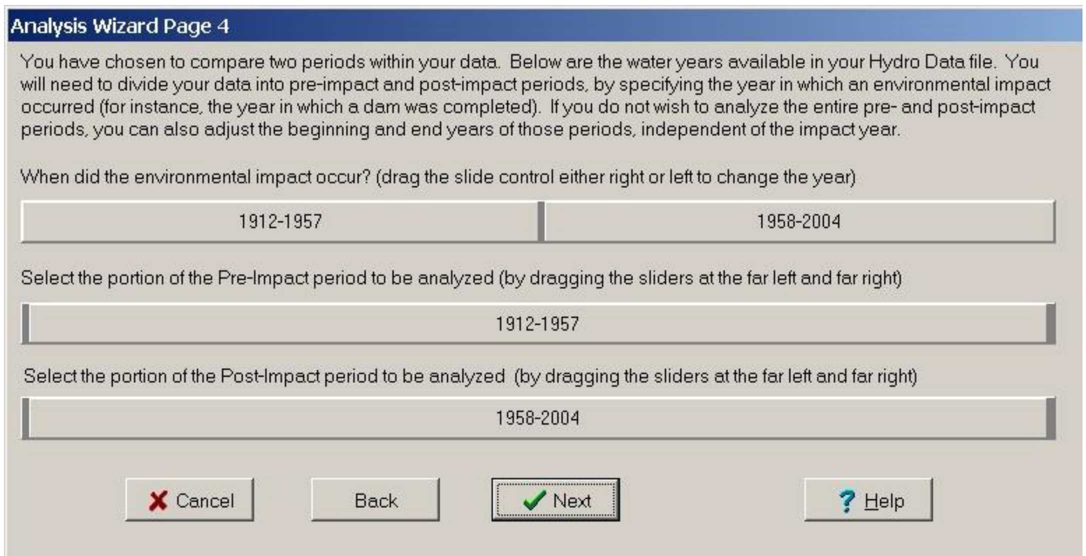


The IHA can compare two distinct time periods in your hydrologic record, or analyze trends over a single time period. Two period analysis should be used when the hydrologic system you wish to study has experienced an abrupt change such as construction of a dam. Single period analysis should be used for hydrologic systems that have experienced a long-term accumulation of human modifications.

A. Select two period analysis, and click Next.

Two period analysis is used here because there is dam on the Roanoke River.

9. <u>Analysis Wizard Page 4. Select which Years to Analyze.</u>



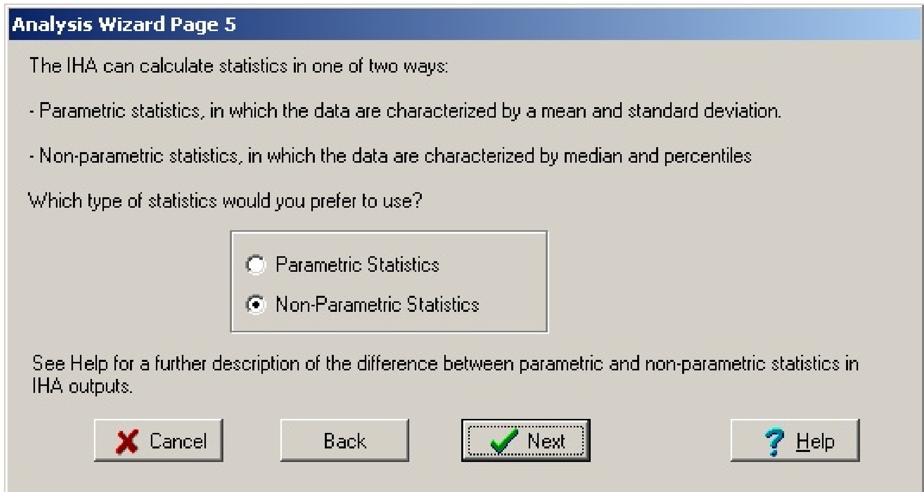
This screen shows the years available in your Hydro Data file, with slider bars to select the years to be analyzed. The top slider bar is used to divide the data into pre-impact and post-impact periods. The bottom two slider bars can be used to adjust the beginning and ending years of these two periods, independent of the impact year. In case there are missing years in your data, the Wizard will check to make sure that the years you have selected are present in your Hydro Data file before letting you proceed.

A. Select 1953 as the impact year (the first year of the post-impact period). This is the year the John H. Kerr Dam was constructed.

B. Set the analysis to cover the entire pre- and post-impact periods (1912-52, 1953-2004).

C. Click Next.

10. Analysis Wizard Page 5. Select Parametric or Non-Parametric Statistics.

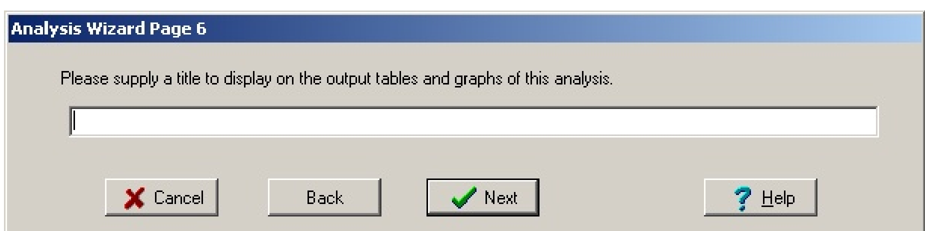


IHA parameters can be calculated as parametric (mean/standard deviation) or non-parametric (percentile) statistics. A key assumption of parametric statistics is that the data are normally distributed. Non-parametric statistics are often useful because of the skewed (non-normal) nature of many hydrologic datasets.

A. Click the Help button if you wish to read more about these two options.

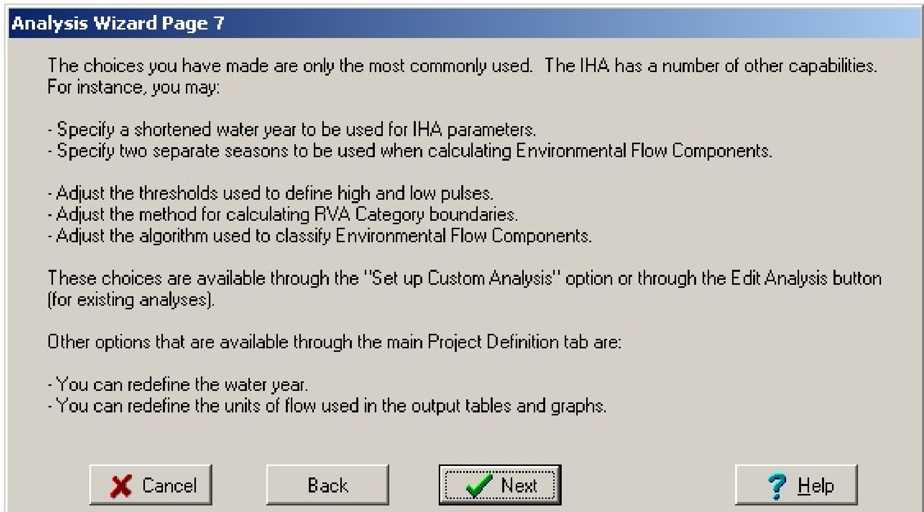
B. Select the option to use non-parametric statistics, and click Next.

11. Analysis Wizard Page 6. Provide a Default Title to be Used for Tables and Graphs.



A. Enter a title and click Next.

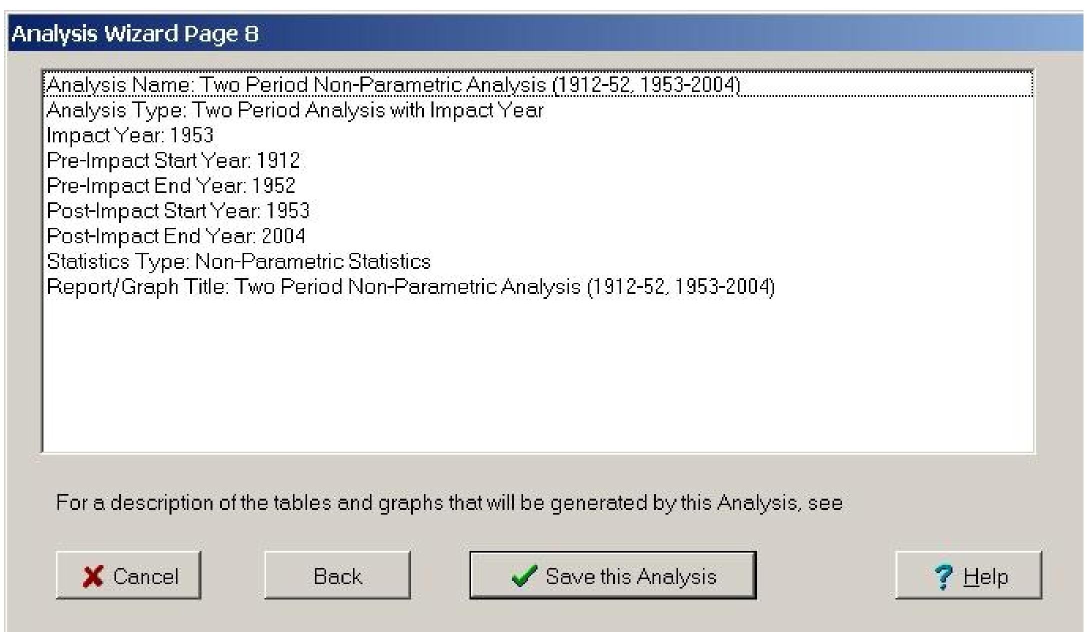
12. Analysis Wizard Page 7. List of Capabilities.



This explanatory screen explains some of the other options that are available in the IHA.

A. After reading this screen, click Next.

13. Analysis Wizard Page 8. Save your Analysis.

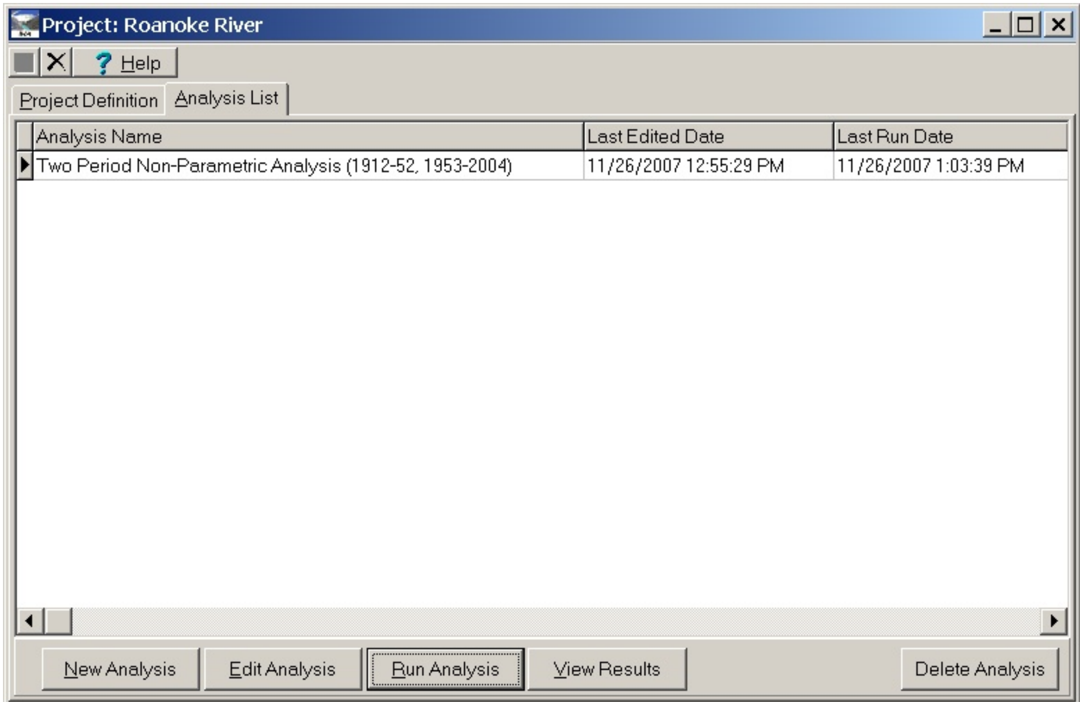


This window shows the options you have selected for this Analysis.

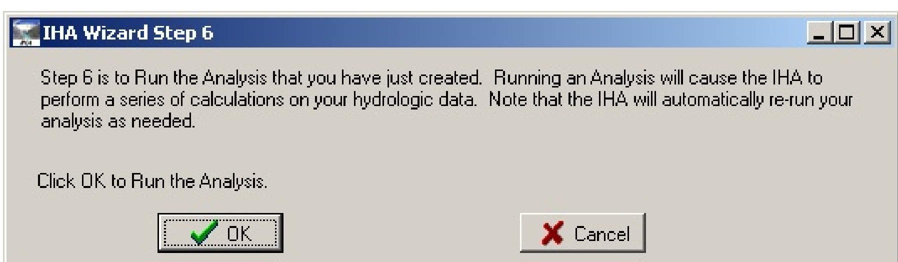
A. Click Save to save your Analysis.

This will return you to the IHA Wizard.

This will also cause the Project window in the background to switch to the second tab, which shows the list of Analyses contained in this project. Buttons on this tab can be used to create a new analysis, edit an analysis, run an analysis, view the results of an analysis, and delete an analysis. These options will be explained in detail later in the tutorial.



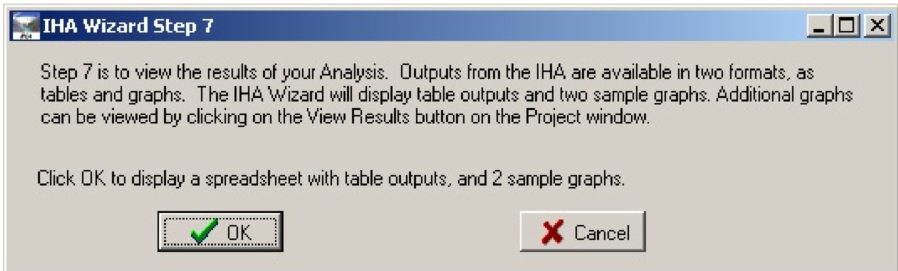
14. IHA Wizard Step 6. Run your Analysis.



Running an Analysis will cause the IHA to perform a series of calculations on your hydrologic data.

A. Click OK on this window to run this Analysis.

15. <u>IHA Wizard Step 7. View IHA outputs.</u>



IHA outputs are contained in a series of tables and graphs.

A. Click OK on this window to bring up a spreadsheet with output tables from this analysis, and two of the many available graphs.

B. Activate the window entitled Spreadsheet.

This spreadsheet contains all of the IHA's output tables. The visible tab (the msg tab) is the message report, which contains a series of messages and warnings about how the calculations were conducted.

C. Click on the ann tab of the spreadsheet.

This table is the Annual Summaries Table, which contains the output of the IHA by water year.

D. Hit F1 to bring up the help system, which further describes these and other tables, and also describes all of the statistics generated by the IHA (or see section 4.2 of the IHA User's Manual).

This spreadsheet has basic spreadsheet functionality (formulas, built-in operators and functions), and it can also be saved in Microsoft Excel format and reopened later either in the IHA or in Excel.

E. Activate the graph window titled Monthly Flows for October.

This graph shows the median monthly flows during October at the Roanoke River gage from 1912-2004. This parameter is one of 67 statistical parameters produced by the IHA.

F. See the help system for more information on this and other IHA outputs (or see section 2.2 of the IHA User's Manual).

G. Activate the graph window titled Environmental Flow Components.

This graph shows a daily hydrograph, with each day grouped into one of five types of Environmental Flow Components (EFCs) (extreme low flows, low flows, high flow pulses, small floods, large floods).

H. See the help system for more information about EFCs (or see section 2.3 of the IHA User's Manual).

Part 2 of this tutorial contains more information on working with graphs in the IHA.

Part 2: More Advanced Features

Part 2 will further describe various features of the IHA, using the data generated in Part 1 as an example.

1. Hydro Data File Editor.

A. Click on the Hydrologic Data Editor window (this should be in the background behind your other windows).

If it is necessary to change the flow rate units used in the file, this can be done by selecting menu option **Hydro Data | Flow Rate Units**. Options are also available on the **Hydro Data** menu to view the recorded and missing date ranges in the file, and export the file to a comma-delimited text format. Note that if there are days in your hydrologic record with no data, these dates will not be shown in the Editor, but values for those dates will be interpolated when an analysis is run.

2. Creating a New Analysis and Editing Analysis Properties.

A. Activate the Project Window (described earlier in Steps 3 and 13 of Part 1), and then click on the Analysis List tab.

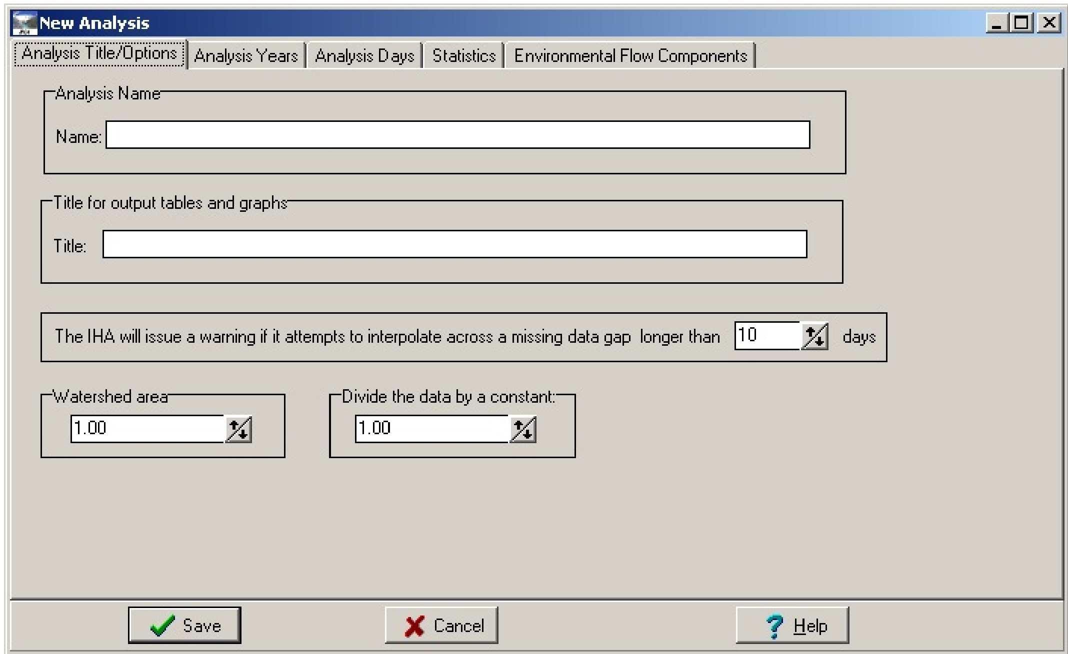
B. Click on the New Analysis button.

Three options are available here, to start the Analysis Wizard (this was described earlier in Steps 6-13 of Part 1), to copy an existing analysis, or to set up a custom analysis.

C. Select the option to Set up Custom Analysis.

This will bring up the Analysis Properties window, which has five tabs. Each tab is described below.

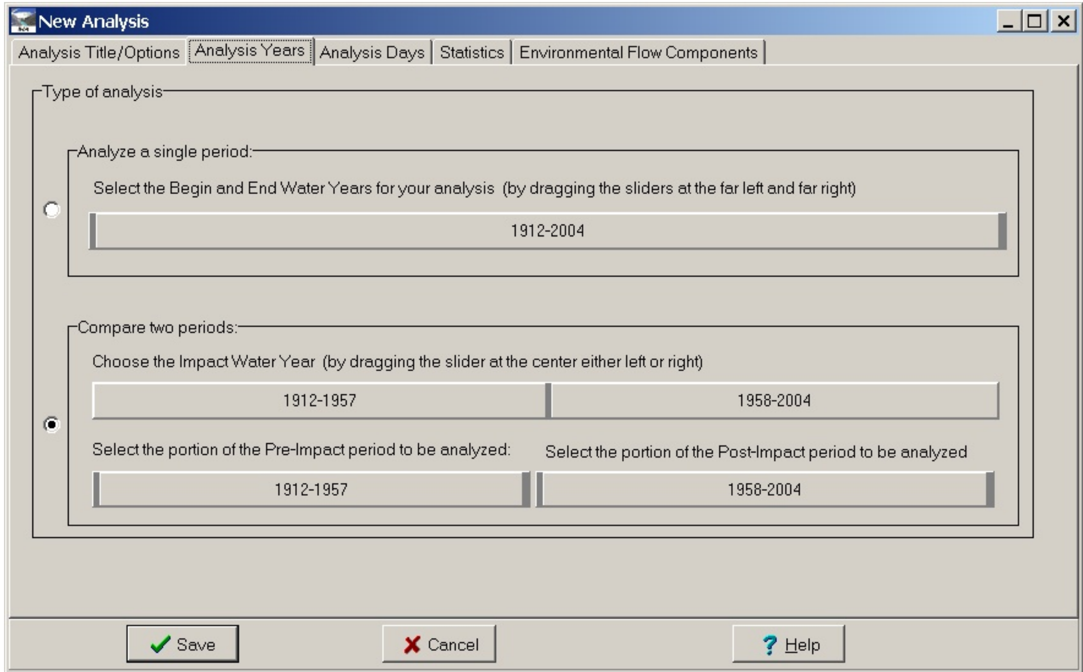
D. Click on the tab entitled Analysis Title/Options.



This tab allows the user to set the following:

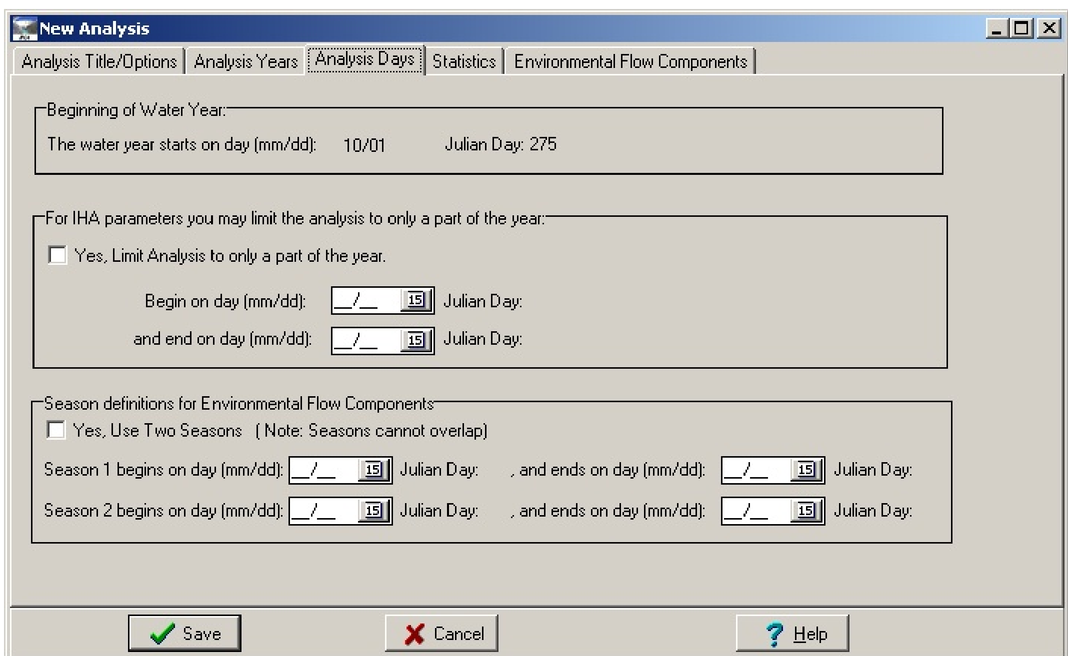
- Name of the Analysis.
- Default title to use for output tables and graphs.
- The minimum number of consecutive days of interpolated data that will trigger a warning message. This message will appear in the message report to warn the user if there is a large amount of interpolated data in certain years.
- Watershed area. This number is not used in any calculations, but is displayed at the top of one of the Scorecard output table.
- A constant to divide the output flow data values by. This can be used to "normalize" flow values in the output tables. For example, if data from two watersheds with different sizes are being compared, the data could be divided by watershed area. This normalization affects only the outputs expressed in units of flow rate (e.g. cubic feet per second) and also the rise and fall rates.

E. Click on the tab entitled Analysis Years.



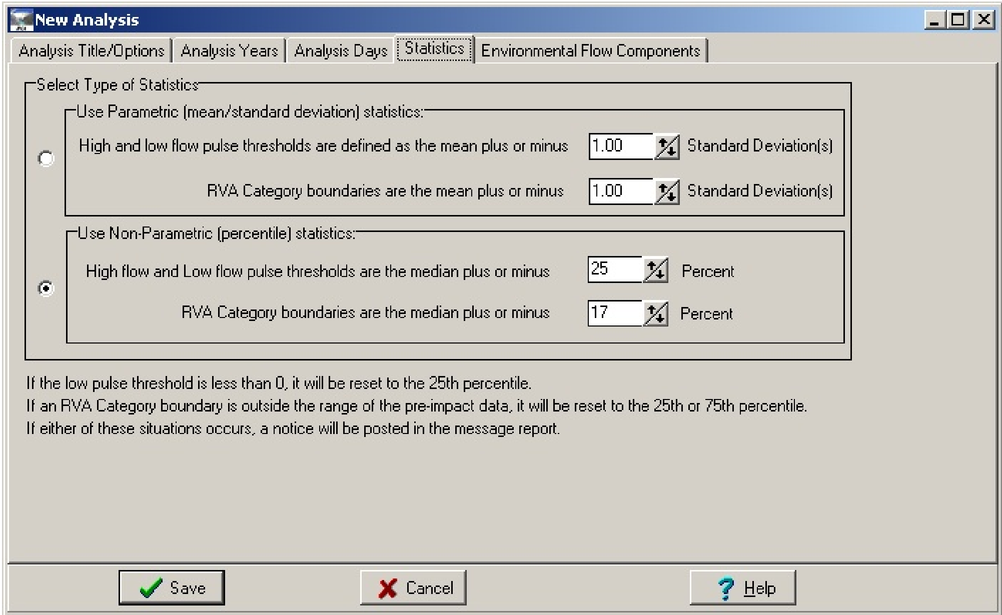
This tab allows the user to choose between single period and two period analysis, and to set the water years to be used.

F. Click on the tab entitled Analysis Days.



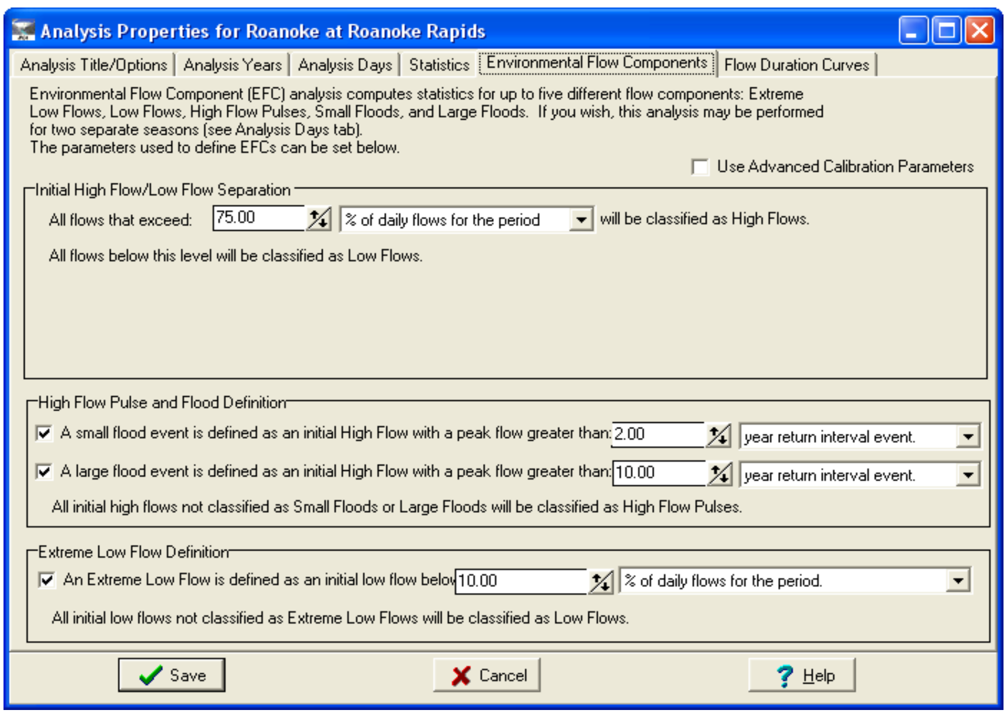
This tab displays the current water year. It also allows the user to limit the time period being used to generate the IHA parameters and define two seasons to be used for non-monthly EFC parameters. Hit F1 to read more about the shortened water year capabilities of the IHA (or see section 5.5 of the IHA User's Manual).

G. Click on the Statistics tab.



This tab allows the user to specify whether parametric (mean/standard deviation) or non-parametric (median/percentile) statistics are used for analysis. The thresholds used to define high and low pulses and the RVA category boundaries can also be set here.

H. Click on the Environmental Flow Components tab.



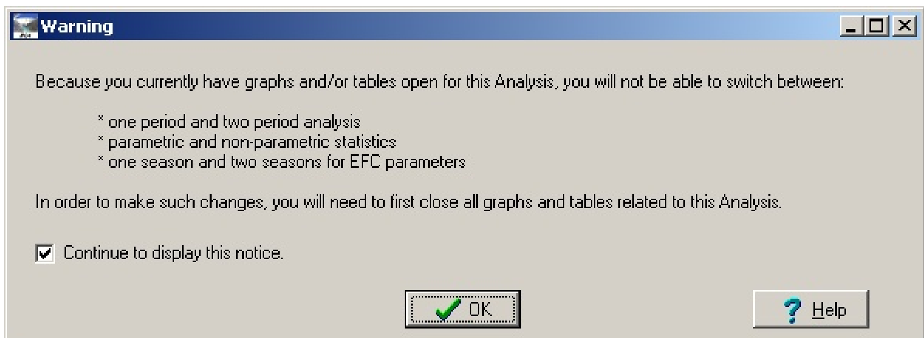
This tab allows the user to reset the parameters used in the algorithm that defines the Environmental Flow Components, in order to calibrate the algorithm. Calibration of the EFC algorithm will be covered later in this tutorial.

I. Close the Analysis Properties window (by either canceling or saving this analysis).

3. <u>Editing Analysis Properties while Tables and/or Graphs are Open.</u>

A. After closing down the Analysis Properties window, click on the Edit Analysis button.

This will bring up the Analysis Properties window for the currently selected Analysis, which allows you to alter the properties of that analysis. Assuming that the graphs and tables from the Part 1 of the tutorial are still open, the following message will appear:



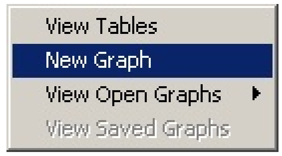
This message is to warn you that it will not be possible to switch between one period and two period analysis, parametric and non-parametric statistics, and one season and two seasons for EFC parameters in the Analysis Properties window. This is done so that drastic changes in how the Analysis is conducted cannot be made, since this would affect the accuracy of the data in the open graph or table windows. The relevant sections of the Analysis Properties window will be grayed out. Other more minor changes in Analysis settings can be made, and after these changes are saved, the the values in the graphs and the tables will automatically be recalculated when the user returns to those windows.

B. Review the tabs in the Analysis Properties window to see which options are grayed out.

4. <u>Working with IHA Graphs.</u>

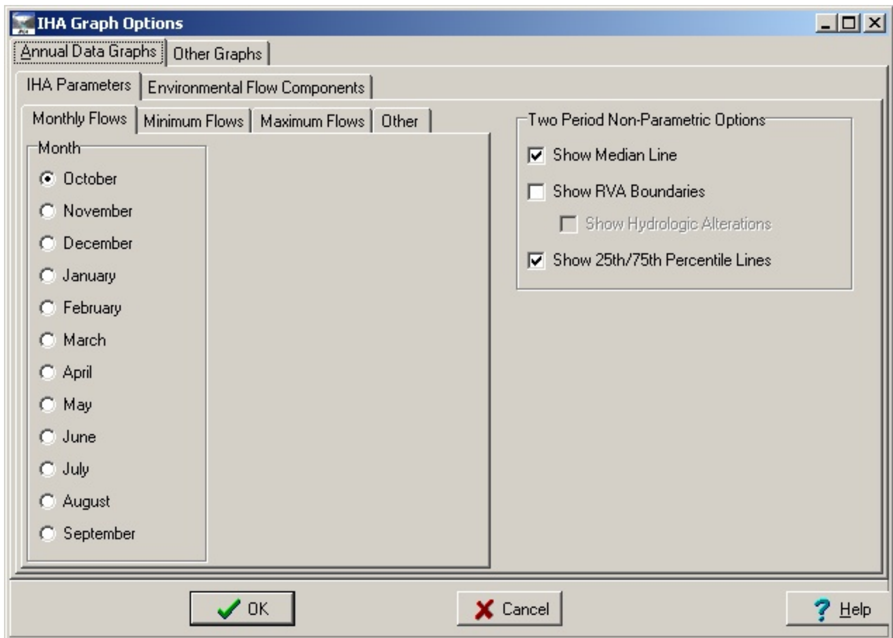
A. Return to the list of Analyses (on the second tab of the Project window), select the Analysis that you created using the Wizard in Part 1 of this tutorial, and click on the View Results Button.

Four options are available here, to view the table spreadsheet, to view a new graph, to view any open graphs, and to view saved graphs.



B. Select the option to view a New Graph.

This will bring up the IHA Graph Options window, which allows you to select between 70 different graphs, and also to select different features to place on these graphs.

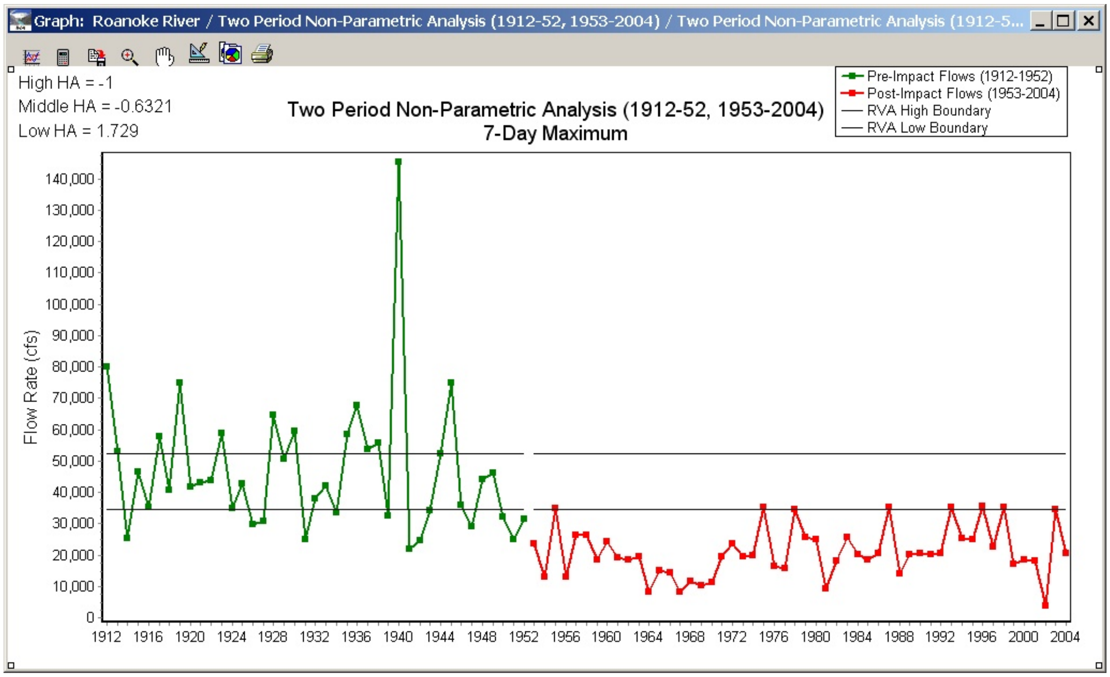


C. Hit F1 to read about all the available graphs in the help system (or see section 4.3 of the IHA User's Manual).

D. After reviewing the different types of available graphs, go to the tab for Annual Data Graphs, IHA Parameters, Maximum Flows, and select the 7-day maximum flow graph.

E. Select the options to Show RVA Boundaries and Show Hydrologic Alterations. Turn off the median line.

F. Hit OK to display the following graph:



There is a series of buttons on the upper left of the graph window, which can be used to work with this graph.

G. Hit F1 to read about what each of the buttons does (or see section 4.3.3 of the IHA User's Manual).

5. <u>Explanation of Hydrologic Alteration factors</u>

When analyzing the change between two time periods, the IHA software enables users to implement the Range of Variability Approach (RVA) described in Richter et. al. (1997). The RVA uses the pre-development natural variation of IHA parameter values as a reference for defining the extent to which natural flow regimes have been altered, and quantifies this alteration in a series of Hydrologic Alteration factors.

The graph of 7-day maximum flows displayed in Step 4 is an example of an annual data graph that shows the results of an RVA analysis. In an RVA analysis, the full range of pre-impact data for each parameter is divided into three different categories. The default method for non-parametric analysis is to divide the data into three equal categories (0-33rd percentile, 34th-67th percentile, and 68th-100th percentile). The boundaries between these categories are shown on the graph as straight black lines.

The program next computes the expected frequency with which the "post-impact" values of the IHA parameter should fall within each category, based on the pre-impact frequencies (in the non-parametric default, this would be 33% of the annual values in each of the three categories). Then it computes the frequency with which the "post-impact" annual values of IHA parameters actually fell within each of the three categories. A Hydrologic Alteration factor is then calculated for each of the three categories as follows:

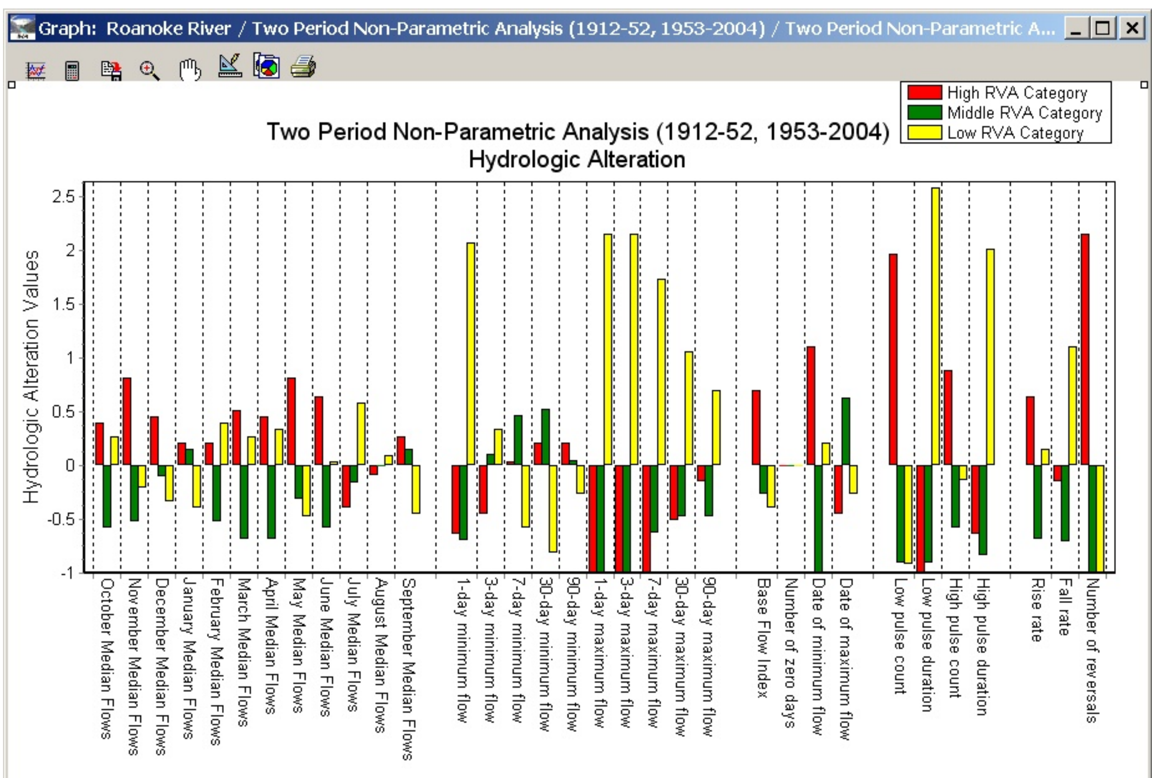
(observed frequency – expected frequency) / expected frequency

A positive HA factor means that the frequency of values in the category has increased from the pre-impact to the post-impact period, while a negative value means that the frequency of values has decreased. The HA factors are displayed in the upper left corner of the 7-day maximum flows graph. In this example, the frequency of values in the low category has increased, while the frequency of values in the middle and high categories has decreased.

A. Examine the graph of 7-day maximum flows to ensure that you understand how the HA factors have been calculated and what they indicate about how this IHA parameter has been altered.

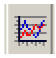
B. Click on the button on the 7-day maximum flow graph, to bring up the Graph options screen.

C. Switch to the Other Graphs tab. The first tab displayed will be for the Hydrologic Alteration graph (showing all Hydrologic Alteration factors). Hit OK to display this graph:

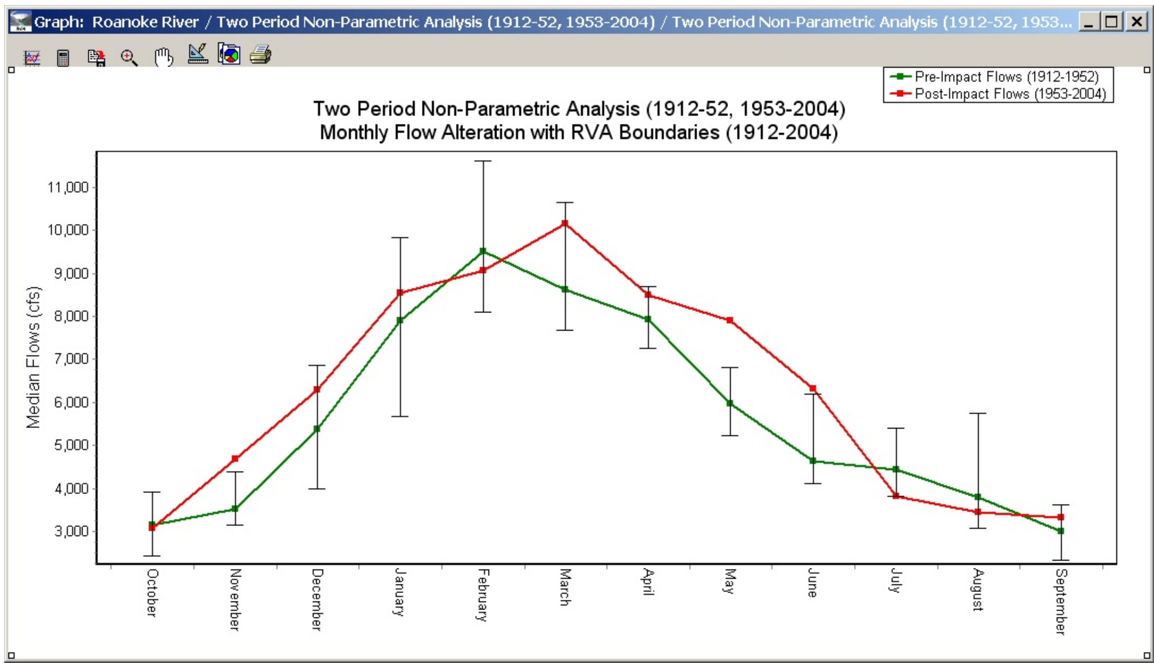


This graph shows HA factors for all parameters (except for Environmental Flow Components). RVA analysis is not available for Environmental Flow

Components. This graph can be used to compare the degree of hydrologic alteration in these different IHA parameters.

D. Click on the  button on the HA graph to bring up the Graph options screen.

E. Under the Other Graphs tab, switch to the Monthly Flows tab (leave the Show RVA Boundaries checkbox checked), and hit OK to display the following graph:



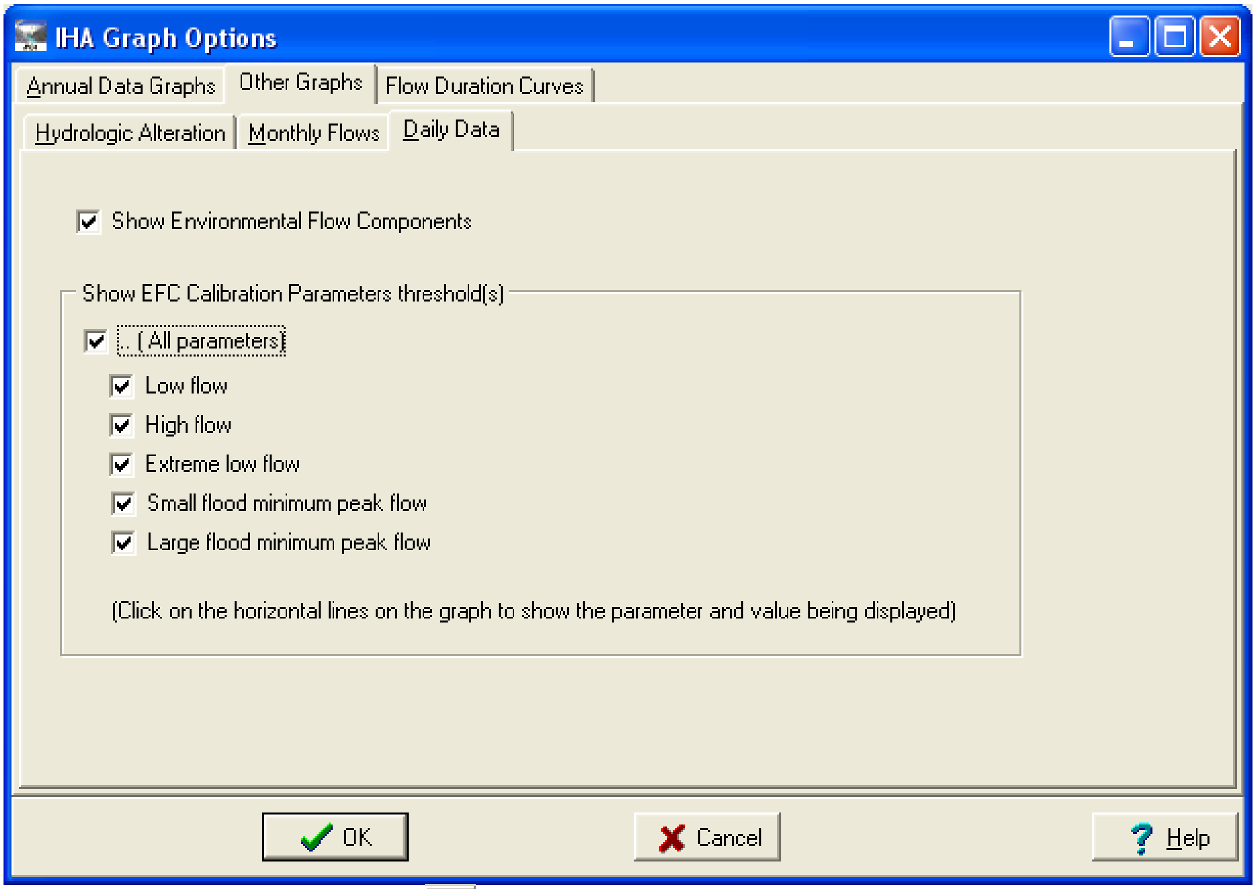
This graph shows the median monthly flows before and after the John H. Kerr Dam began operation. The upper and lower boundaries of the RVA middle category are also shown. This graph can be used to assess how seasonal patterns of flow have been altered.

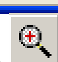
F. To read more about RVA Analysis, search in the help system index for “RVA Analysis”, or see section 2.4 of the IHA User’s Manual.

Part 3- Advanced Functions and New Features to IHA 7.1

1. Environmental Flow Components and their Calibration

A. Activate the graph window titled Environmental Flow Components. This graph should be already open since it was previously used at the end of Part1 of this tutorial. If you cannot find it, then go to the Graph options screen, switch to the Other Graphs tab, and activate the Daily Data tab. Check the checkbox for Show Environmental Flow Components on. Hit OK to display this graph.



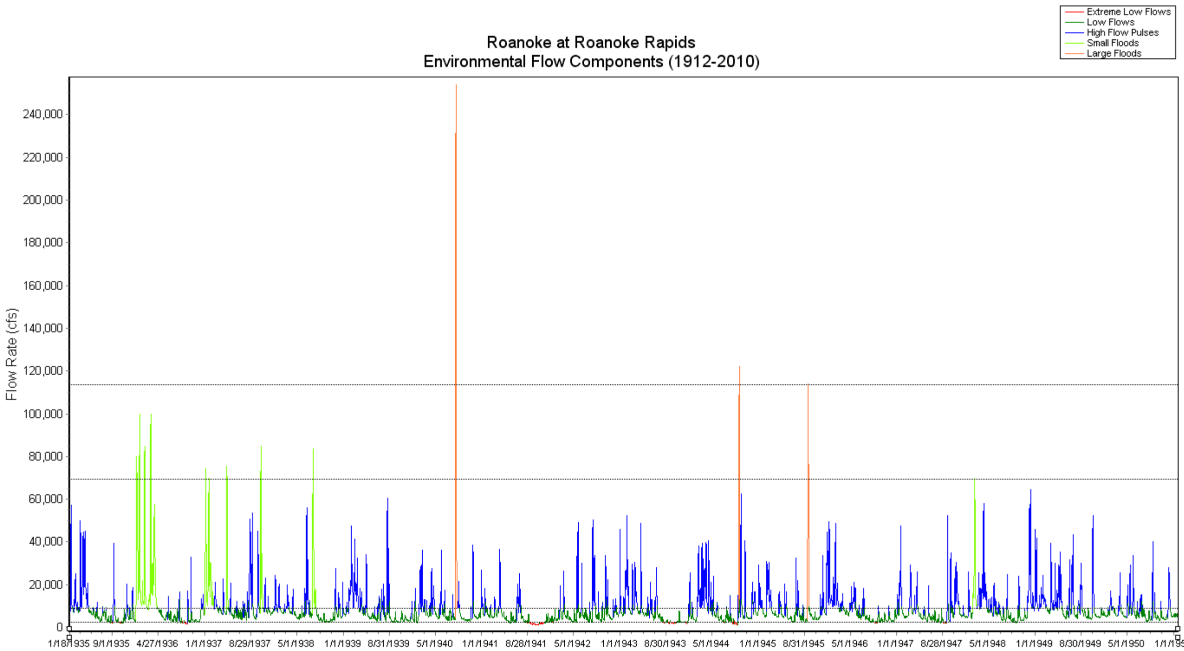
B. Select the zoom button  on the graph window, and practice zooming in and out of this graph.

After enabling the zoom capability by clicking on this button, clicking and holding the mouse button and drawing a box over any area of the graph will zoom into that section of the graph. To zoom back out to the full extent of the graph, click directly on the zoom button again.

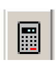
C. Select the scroll button , and practice scrolling around on this graph.

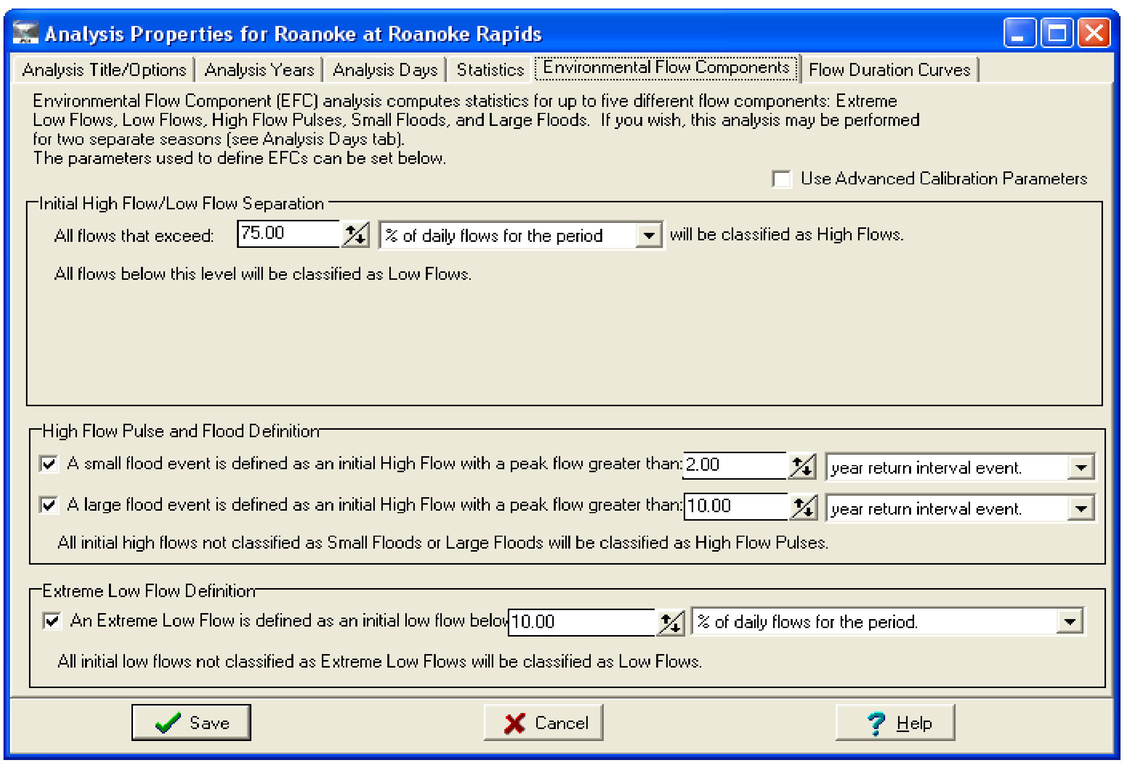
To scroll in any direction, click and hold the mouse button and then move the hand in the desired direction.

D. Zoom into the graph, centering it between approximately 1935 and 1951. This should display the part of the hydrograph shown below. The different EFC types can be distinguished by color (Small Floods are light green, High Flow Pulses are dark blue, Low Flows are dark green, and Extreme Low Flows are red).



E. Examine the default EFC thresholds in the graph and understand how they lead to the definition and color-coding of the EFCs.

F. Click on the  button to bring up the Analysis Properties window.



G. The Environmental Flow Components tab of the Analysis Properties window is always displayed when that window is accessed from the daily EFC graph. The next steps will describe how the algorithm is calibrated. The parameters on this tab can be adjusted to calibrate the algorithm, after which the daily EFC graph is automatically updated to display the results.

H. The upper box on the EFC tab (entitled Initial High Flow/Low Flow Separation) describes how the algorithm distinguishes between an initial set of high flows and low flows.

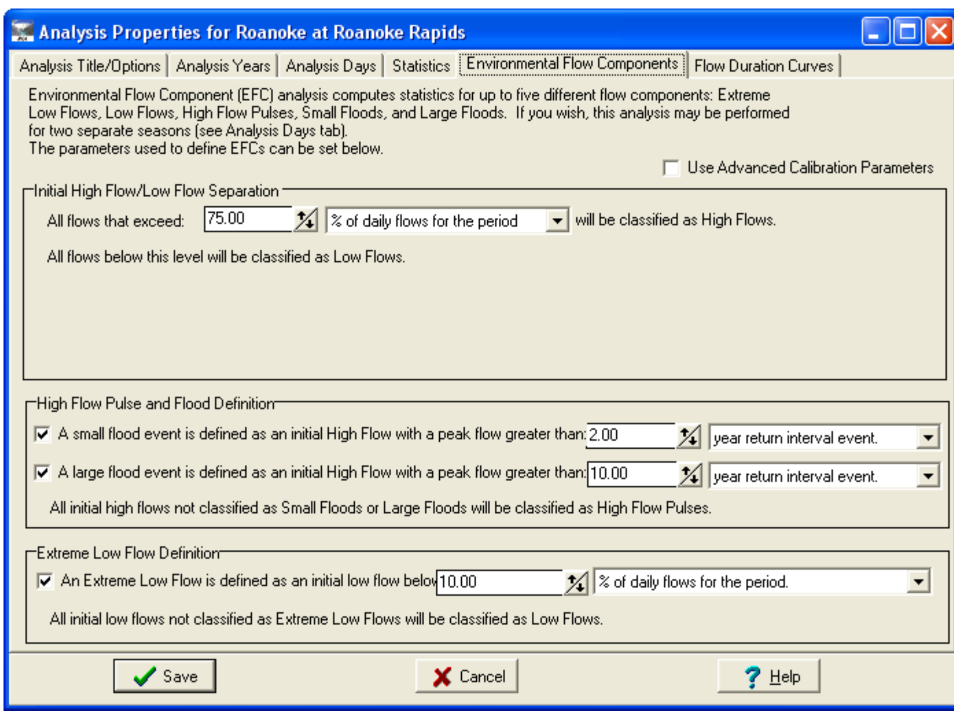
Options for splitting initial high flows from initial low flows are:

a. exceedence flow value (75% exceedence or Q25 is default)

b. volumetric flow in cfs (useful when a habitat/biological threshold is known)

These initial high flows are later split into high flow pulses, small floods, and large floods, and the initial low flows are later split into low flows and extreme low flows.

Adjust the default threshold and hit save, and watch to see if any changes are evident in the graph. The threshold will probably have to be changed drastically before any changes are visible.



F.

Bring up the Analysis Properties window again by clicking on the  button. This time look at the second box on this tab, entitled High Flow Pulse and Flood Definition. The two parameters in this box define how the initial high flows are separated out into 3 different high flow classes.

Options for defining the three high flow classes are:

a. year return interval event (the default)

b. exceedence flow value
c. volumetric flow in cfs (useful when a habitat/biological threshold is known)

The default calibration is that all high flows with less than a 2 year return interval are classified as high flow pulses, those with between a 2 and 10 year return interval are classified as small floods, and those with greater than a 10 year return interval are classified as large floods.

Reset the value that is set to 10 (the minimum return interval for large floods, highlighted in the graphic below) to 5, and hit save, which will return you to the EFC daily graph.

Look at the EFC daily graph. You should see that the two floods during 1936 have been changed from small floods to large floods (they are now colored orange), due to reduction of this return interval setting.

I. Bring up the Analysis Properties window again. This time look at the third box, entitled Extreme Low Flow Definition. This defines those initial low flows that will be classified as extreme low flows.

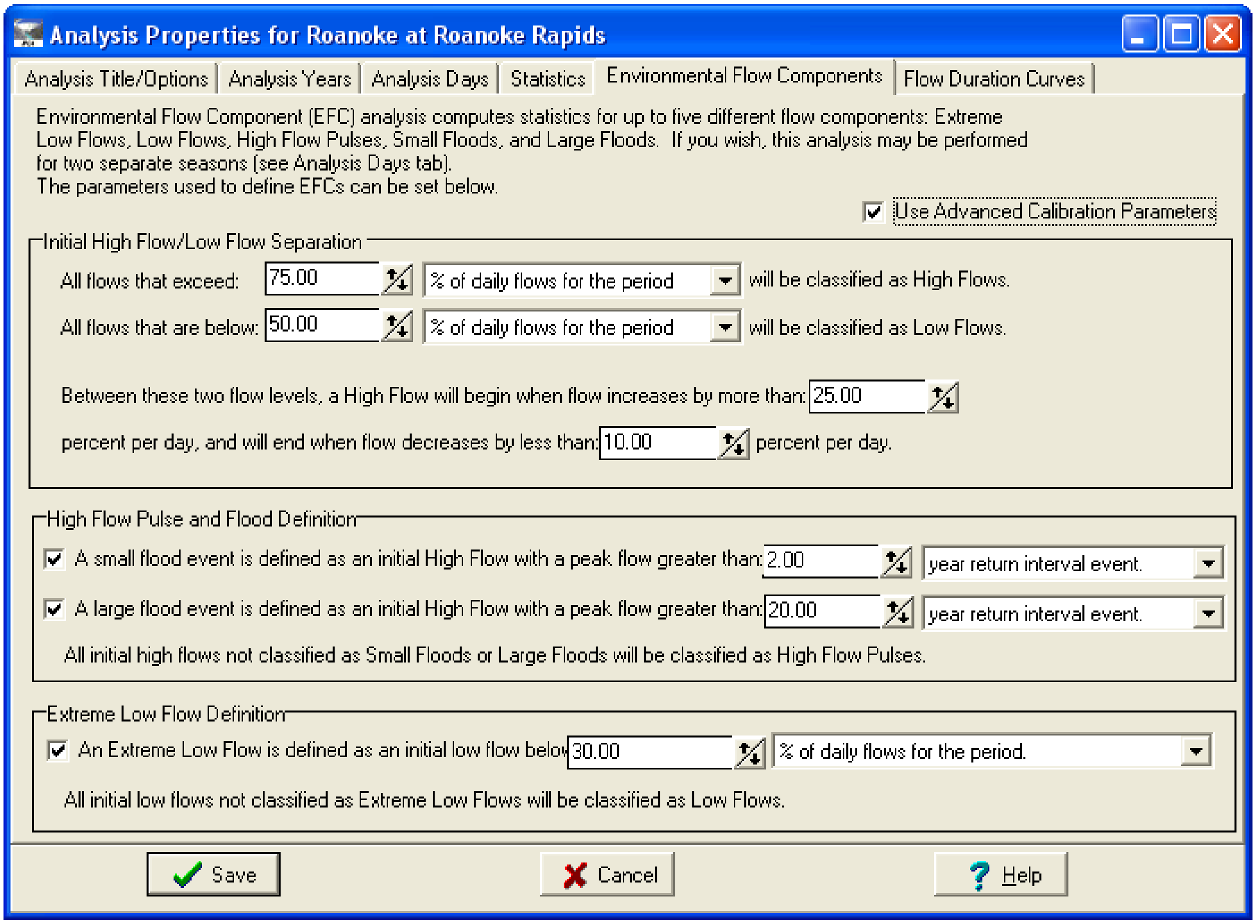
Options for defining extreme low flows are:

a. % of daily flows for the period
b. % of low flows for the period
c. Volumetric flow in cfs

Zoom into one year of the record that includes extreme low flow (in red) and change the extreme low flow default to 30% of daily flows for the period and hit save. Examine how the extreme low flow distribution changes.

Note that all initial low flow not classified as Extreme Low Flows will be classified as Low Flows

J. Return to the Analysis Properties window once more. Click “Use Advanced Calibration Parameters” to bring up additional options:



This high flow/low flow separation approach consists of:

(1) Initialization: The first day of the dataset needs to be initialized as either a high flow or low flow. If it is greater than the low flow threshold, then it is classified as a high flow; otherwise, it is a low flow. If it is a high flow, then if it is greater than the high flow threshold, it is coded as being on the ascending limb; otherwise it is coded as being on the descending limb.

(2) Proceeding sequentially through the rest of the daily values, the following rules are used to differentiate between low flows and high flows, and between ascending and descending limbs of high flow events:

1. Following a low flow day, the next day is assigned to the ascending limb of a high flow event if the daily flow is greater than the high flow threshold, or if flow is greater than the low flow threshold and the increase from the previous day is more than the high flow start rate threshold. Otherwise, it continues as a low flow.

2. The ascending limb of a high flow event continues until daily flow decreases by more than the high flow end rate threshold, at which time the descending limb of the event starts.

3. During the descending limb of a high flow event, the ascending limb restarts if daily flow increases by more than the high flow start rate threshold.

4. During the descending limb of a high flow event, the event ends if the rate of decrease of flow drops below the high flow end rate threshold (meaning that the change in flow is between -1 x high flow end rate threshold and high flow start rate threshold), unless the flow is still greater than or equal to the high flow threshold, in which case the descending limb continues.

5. The event always ends if flow decreases to equal to or less than the low flow threshold, regardless of whether the event is on the ascending or descending limb.

6. After the high flow event ends, a low flow condition resumes.

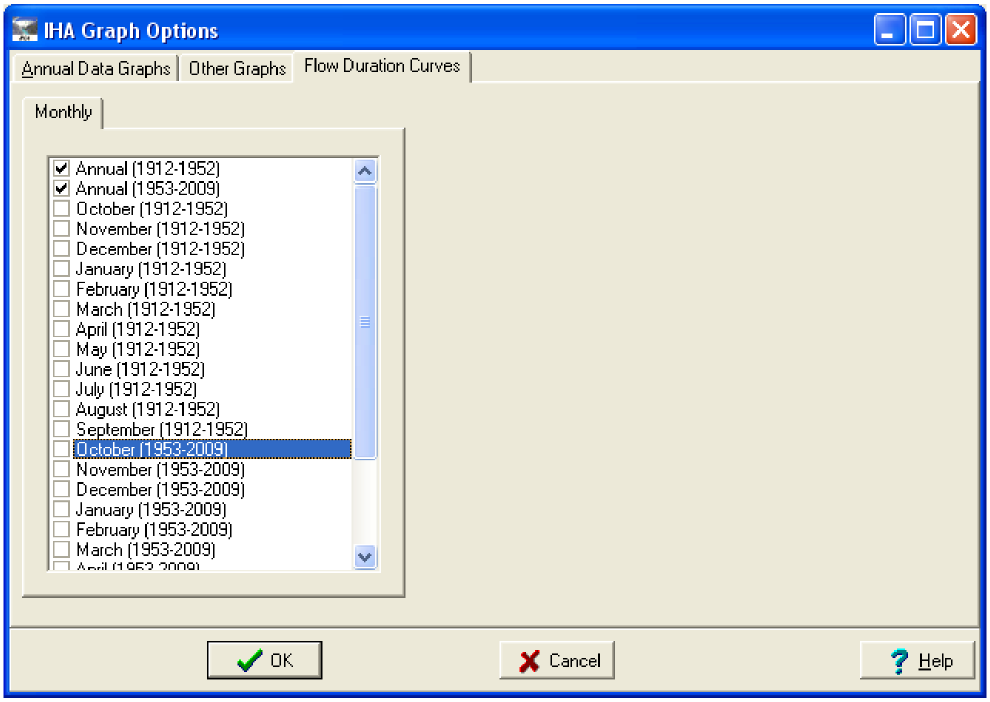
If desired, experiment with this calibration approach and examine the results.

K. These examples have been presented to show the basic mechanics of calibrating the EFC algorithm. Fully calibrating the algorithm would involve iteratively adjusting all of the parameters on the Environmental Flow Components tab until desired results have been achieved for the entire hydrograph.

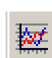
Further information about calibrating the EFC algorithm is available in the help system if you look in the index under "EFC Algorithm," or in section 2.3 of the IHA V 7.1 User's Manual.

2. Flow Duration Curves

A. Open the Flow Duration Curve tab under IHA Graph Options and select Annual flow duration curves for the pre and post-impact period by clicking the appropriate boxes, as shown below:



B. Examine the difference between the annual flow duration curves, including significant deviations and similarities.

C. Click on the  button to go back to the IHA Graph Options Tab and experiment with comparison of monthly flow duration curves by selecting pre and post-impact months. Note that multiple months of FDCs can be shown on one graph.

Conclusion

This concludes the IHA Tutorial. For more information about the IHA, please see the help system or the IHA V 7.1 User's Manual.