

# HEC-EFM 4.0

## March 2017

### Release Notes

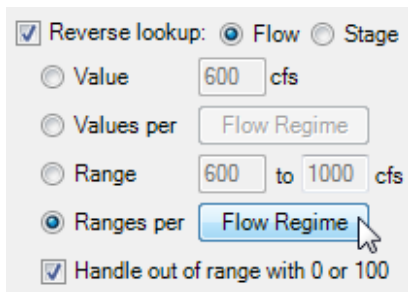
Version 4.0 supersedes versions 3.0 and 3.0.NET, which were released in January 2013. Installing version 4.0 will not overwrite any previous software versions. Also, the new version is backward compatible, which means that any HEC-EFM project files created with previous versions are fine and ready for use with version 4.0.

During numerical testing performed at HEC, version 4.0 exactly reproduced quantitative results generated with versions 3.0, 3.0.NET, and 2.0, but users are encouraged to verify their existing applications.

Version 4.0 is programmed in Visual Basic .NET. It includes several new features, improved software behaviors, and bug fixes for issues that were not detected prior to release of version 3.0.NET. The Quick Start Guide has also been updated and is currently the most complete and comprehensive source of information about the software. Changes incorporated in the new versions follow:

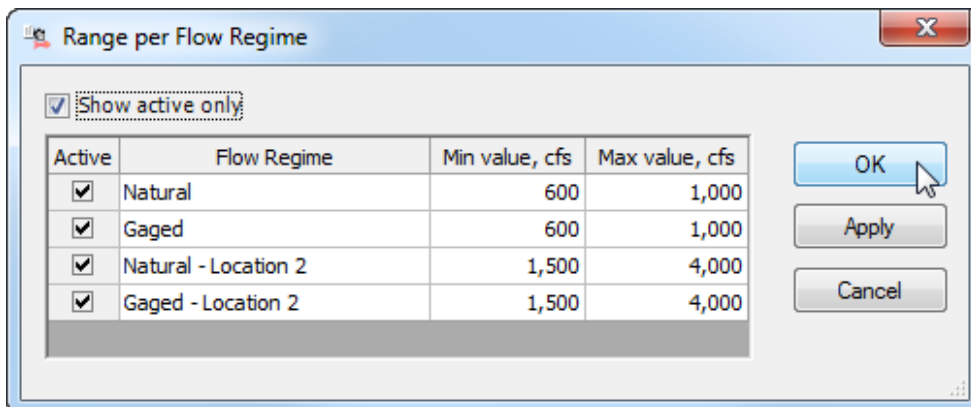
### New Features

- *Reverse Lookups.* Reverse lookup capabilities were greatly expanded to allow users to specify the flow or stage of interest and have the software compute the percentage of time or of years that flow or stage is equaled or exceeded.



Annotations for the Reverse Lookup configuration panel:

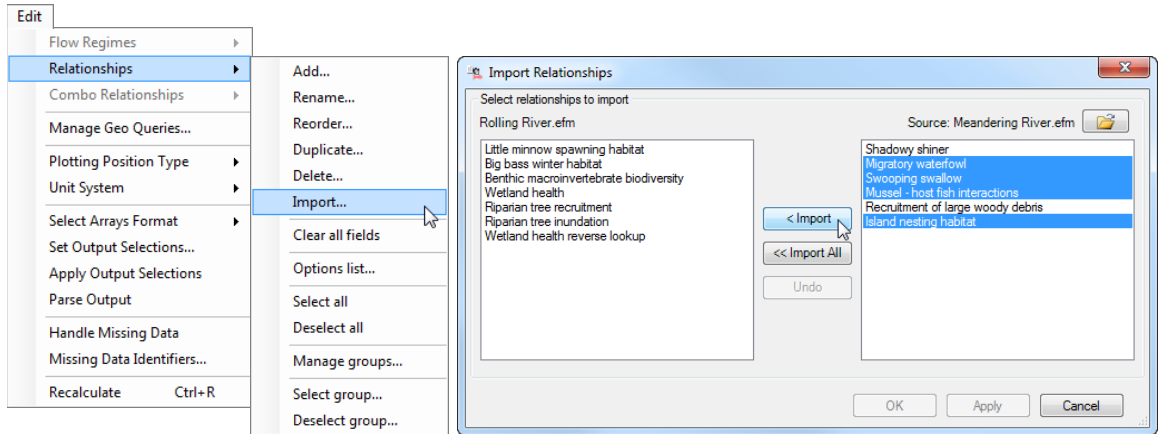
- ← Select which flow regime data to analyze, flow or stage.
- ← Specify the value or range to analyze (options: one value/range for all flow regimes or different values/ranges for each flow regime).
- ← Option to return a numeric result, 0 or 100 (in lieu of an "out of range" text message).



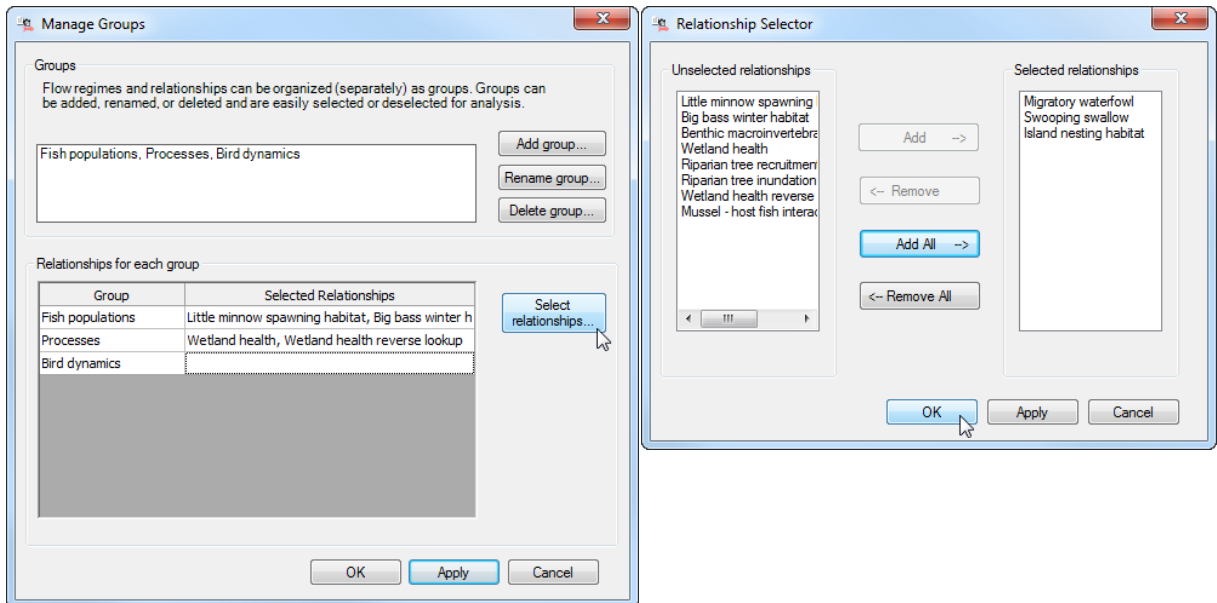
Range per Flow Regime dialog box showing a table of active flow regimes and their value ranges.

Active	Flow Regime	Min value, cfs	Max value, cfs
<input checked="" type="checkbox"/>	Natural	600	1,000
<input checked="" type="checkbox"/>	Gaged	600	1,000
<input checked="" type="checkbox"/>	Natural - Location 2	1,500	4,000
<input checked="" type="checkbox"/>	Gaged - Location 2	1,500	4,000

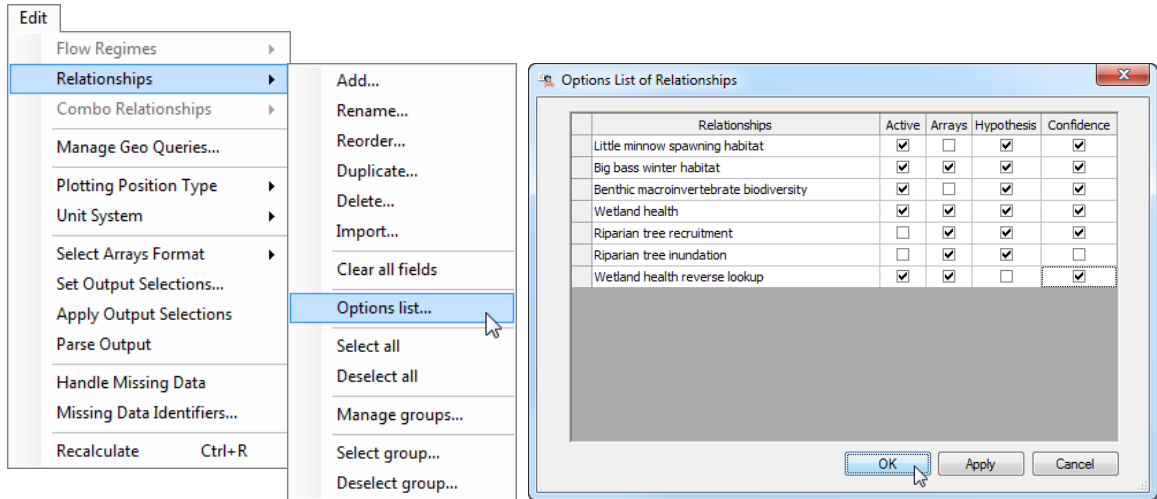
- *Importers to connect multiple EFM applications.* Users can now import flow regimes and relationships from existing applications of EFM via the “Edit – Relationships (or Flow Regimes) – Import...” menu option.



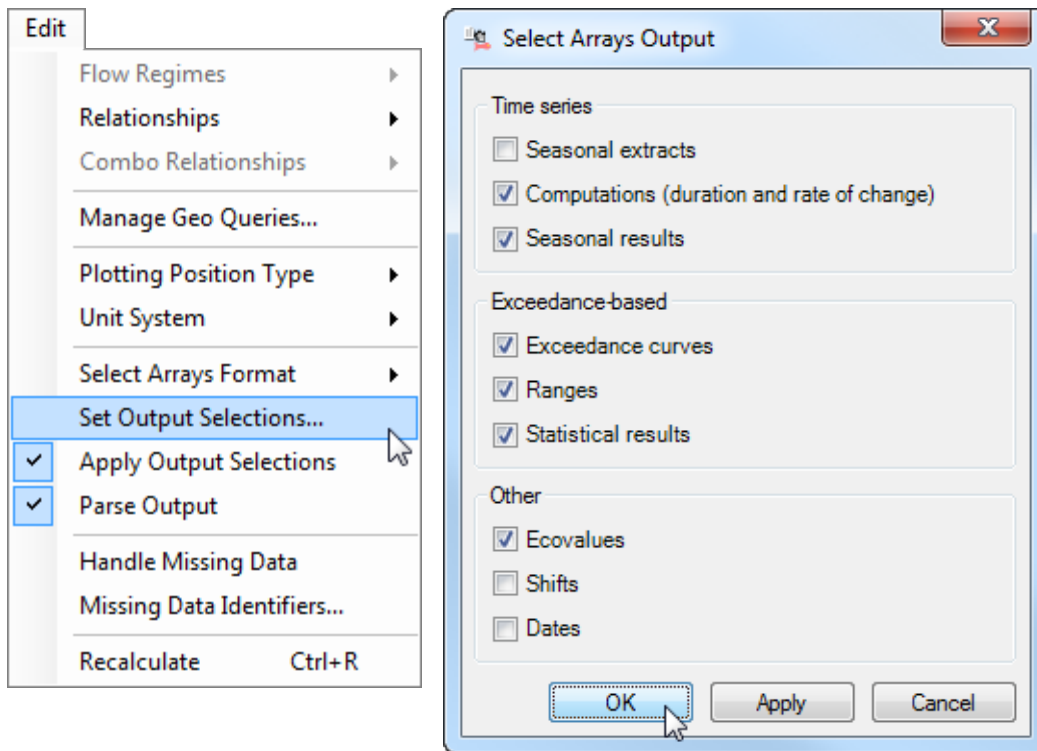
- *Groups.* “Groups” are collections of flow regimes and relationships. Groups are defined separately for flow regimes and relationships and then can be selected and deselected for simulation via the “Edit – Flow Regimes – Groups” and “Edit – Relationships – Groups” menus. Relationship groups tend to be structured around ecological similarities. Flow regime groups tend to reflect a shared theme or are organized per location-based flow regimes. Groups are most useful in applications with numerous flow regimes and relationships.



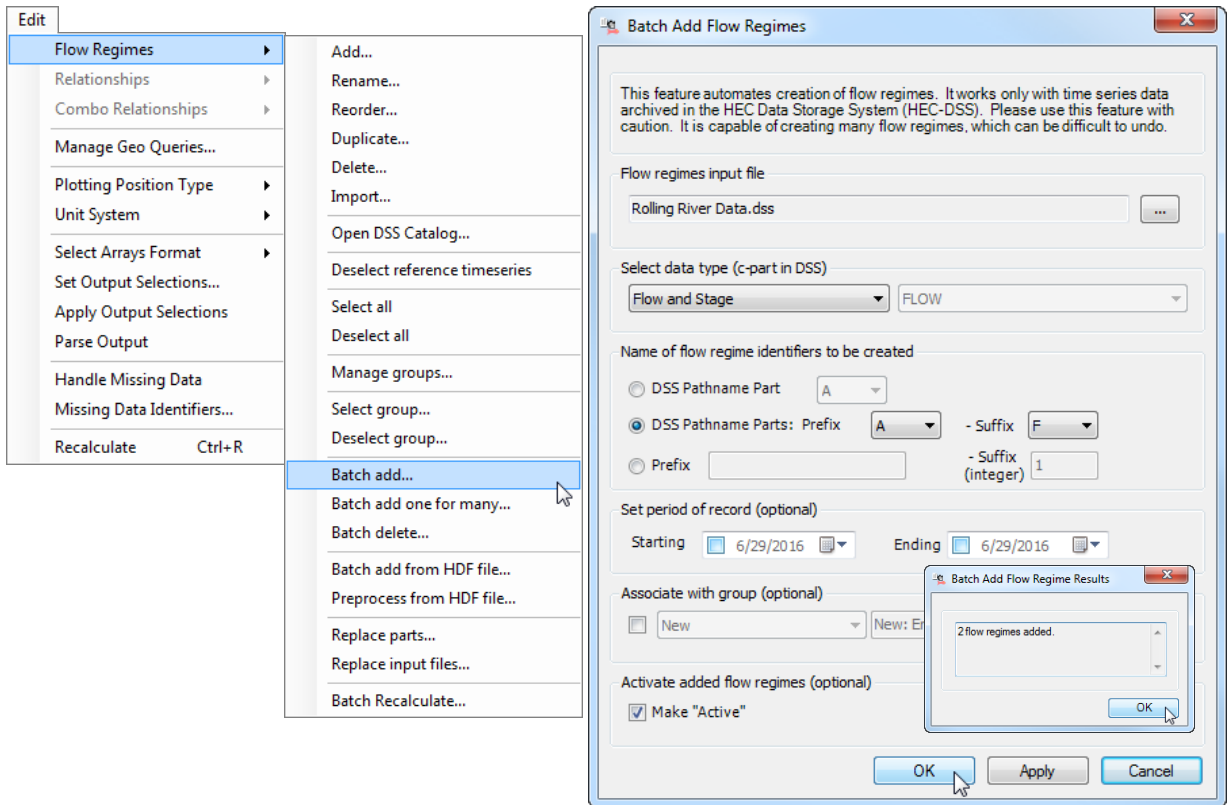
- *Options list for relationships.* To improve the management of EFM relationships, an interface was added that allows the user to more easily view and manage option settings for relationships.



- *Output settings.* Several output options were provided to allow users to select which output to write to memory. Deselecting undesired outputs reduces the computer memory needed to store output files, reduces compute times, and makes use of HEC-EFM Plotter faster because there are fewer data records to track and display.



- *Batch creating flow regimes.* To expedite addition of multiple flow regimes, HEC-EFM added two features that automate creation of new flow regimes. Both are available through the “*Edit – Flow Regimes*” menu. “*Batch add...*” works only with data stored in HEC-DSS. Users specify input data file, types of data to associate with the flow regimes, and naming convention for flow regime identifiers. This feature is useful when analyzing many alternatives or many locations. “*Batch add one for many...*” creates many flow regimes, each with the same data sets, which can be advantageous when investigating multiple sites around the same water body (e.g., separate habitat areas that respond differently to the same fluctuations in stage).



- *Output data formatting.* Format options for tables generated by the software that report model results and parameters were added. Through the “File – Select Style Sheets – Results” menu, several pre-packaged options are available for the main results table. Users are also able to add and remove custom style sheets for Results, Report, Data Summary, and Arrays tables. Modifications of style sheets is best done through XML editors, which are available online. Pre-packaged options are currently available only for the Results table.

Evaluated on: 06/29/2016 09:26 **Style sheet = Standard, flow and stage**

**Summary**

Relationship	Conf.	Natural		Chg.	Gaged	
		Stage, ft	Flow, cfs		Stage, ft	Flow, cfs
Little minnow spawning habitat	*	4275.2	1,226	Pos	4275.7	1,703
Big bass winter habitat	*	4274.1	525	Pos	4274.3	609
Benthic macroinvertebrate biodiversity	*	4279.4	6,620	Neg	4277.2	3,190
Wetland health	*	4274.3	636	Pos	4274.5	771
Riparian tree recruitment	*	4274.9	1,017	Pos	4275.1	1,129
Riparian tree inundation	*	4273.7	373	Neg	4274.3	609

**Index Values**

Index	Gaged
A - All	-4.7
B - Fish	27.4

No reverse lookup flow frequency data sets were analyzed.

**Reverse Look-ups - Flow Duration**

Relationship	Conf.	Natural	Chg.	Gaged
		% X, of time		% X, of time
Wetland health reverse lookup	*	34.1	Pos	67.1

Evaluated on: 06/29/2016 09:32 **Style sheet = Basic, flow only, inverted**

**Summary**

	Little minnow spawning habitat	Big bass winter habitat	Benthic macroinvertebrate biodiversity	Wetland health	Riparian tree recruitment	Riparian tree inundation
Flow Regime	Flow, cfs	Flow, cfs	Flow, cfs	Flow, cfs	Flow, cfs	Flow, cfs
Natural	1,226	525	6,620	636	1,017	373
Gaged	1,703	609	3,190	771	1,129	609

**Index Values**

Index	A - All	B - Fish
Gaged	-4.7	27.4

No reverse lookup flow frequency data sets were analyzed.

**Reverse Look-ups - Flow Duration**

Flow Regime	Wetland health reverse lookup
	% X, of time
Natural	34.1
Gaged	67.1

- *Using 2D information.* EFM can import time series data that are stored in the Hierarchical Data Format (HDF) for use as flow regimes. HDF is a frequently used database format (<http://www.hdfgroup.org/>) and is employed by at least two HEC software to store model simulation outputs (HEC-RAS for two-dimensional unsteady flow output and HEC-EFMSim for two-dimensional ecological simulation output). Through the “*Edit – Flow Regimes – Batch add from HDF...*” menu, users specify input files, dates and times of data, data tables and key aspects of their structure, and a naming convention for the flow regime. Resulting flow regimes are compound in the sense that a single flow regime identifier contains multiple sets of concurrent time series. Each part is computed independently.

The screenshot displays the HEC-EFMSim interface. On the left is a project tree for 'RollingRiver\_2D.hdf'. The main window shows a table of time series data for 'Depth' at a specific location. A dialog box titled 'Batch Add Flow Regimes from HDF' is open, showing configuration options for importing data from the HDF file. Below the dialog is a table listing the resulting flow regimes.

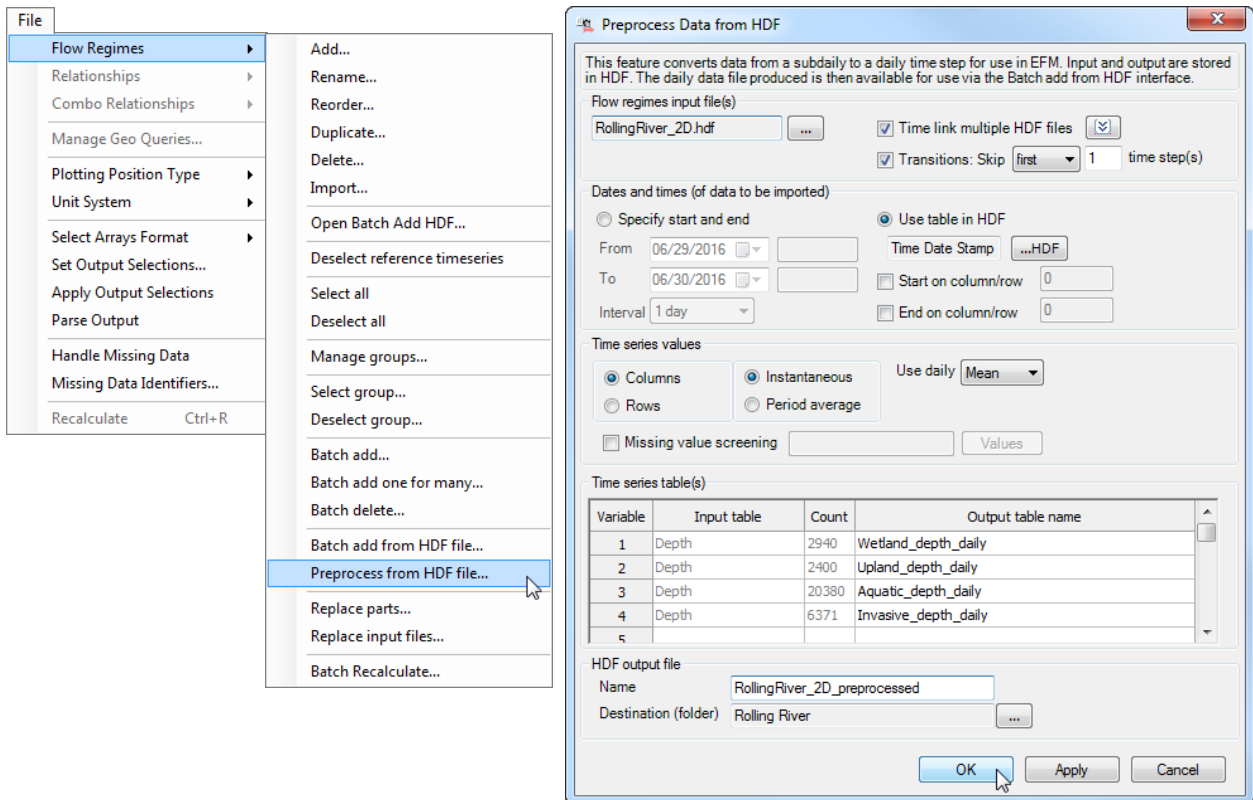
**Batch Add Flow Regimes from HDF Dialog Configuration:**

- Flow regimes input file(s): RollingRiver\_2D.hdf
- Time link multiple HDF file:
- Transitions: Skip **first** 1 time steps
- Use table in HDF:
- From: 10/01/2014 0000
- To: 09/30/2016 0000
- Interval: 1 hour
- 1st Table: Depth
- Data: Depth, feet
- Flow regime naming: Identifier: Wetland Restoration Zone
- Set period of record (optional): Starting: 6/29/2016, Ending: 6/29/2016
- Activate added flow regimes (optional):  Make "Active"

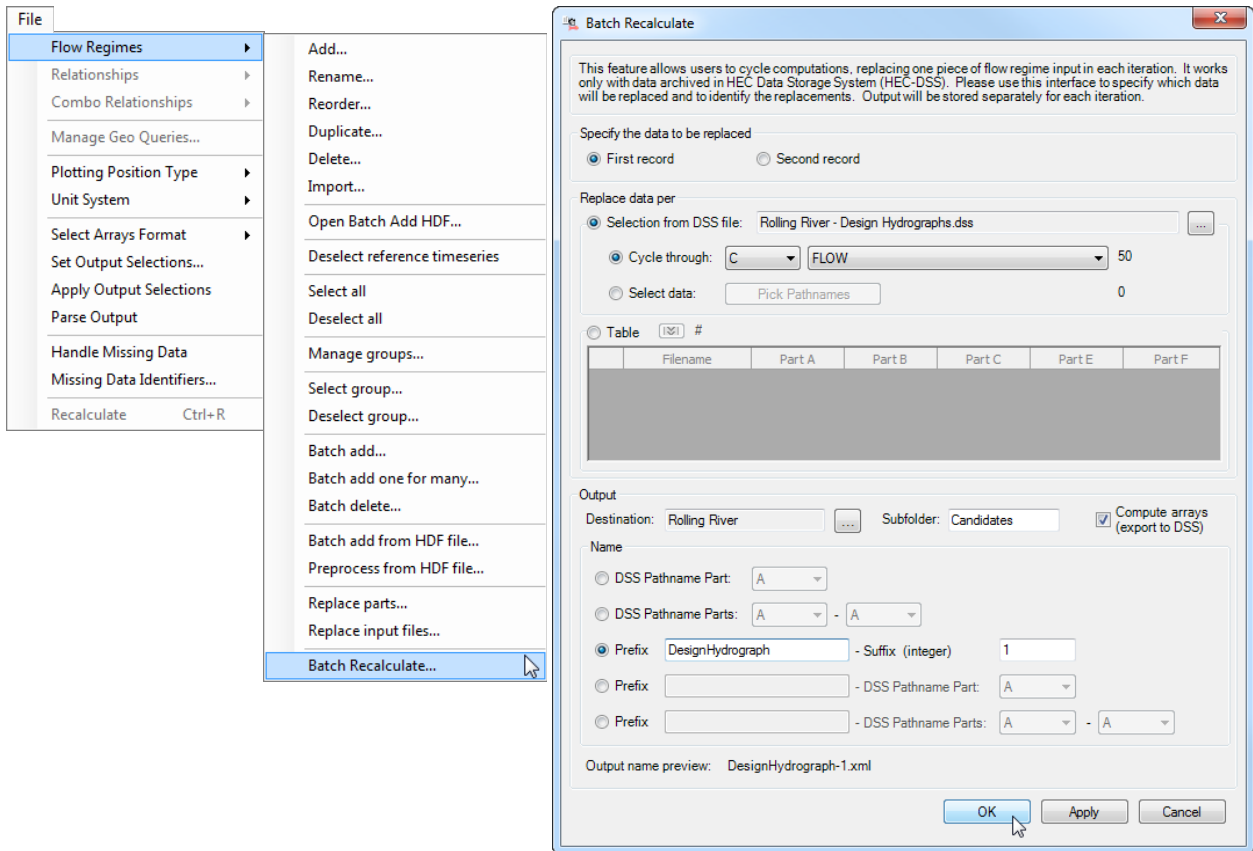
**Flow Regimes (paired time series of flow and stage) Table:**

Ref	Active	Identifier	Filename	Part A	Part B	Part F	Starting
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Wetland Restoration Zone	RollingRiver_2D.hdf	Wetland Resto (2940)			02/01/2009
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Upland Management Area	RollingRiver_2D.hdf	Upland Managi (2400)			02/01/2009
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Aquatic Structures	RollingRiver_2D.hdf	Aquatic Structi (20380)			02/01/2009
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Invasive Species Suppression	RollingRiver_2D.hdf	Invasive Speci (6371)			02/01/2009

- *Preprocess 2D data.* EFM offers a menu option “*Preprocess from HDF file...*” that converts subdaily data to daily and saves the daily results in a new HDF table. An associated time/date table is also generated. The number of time series is unchanged; all time series are processed. The resulting HDF file can then be used via the *Batch Add Flow Regimes from HDF* interface. Preprocessing avoids repetitious conversions from subdaily to daily data and has been shown to reduce overall compute times by approximately one third.

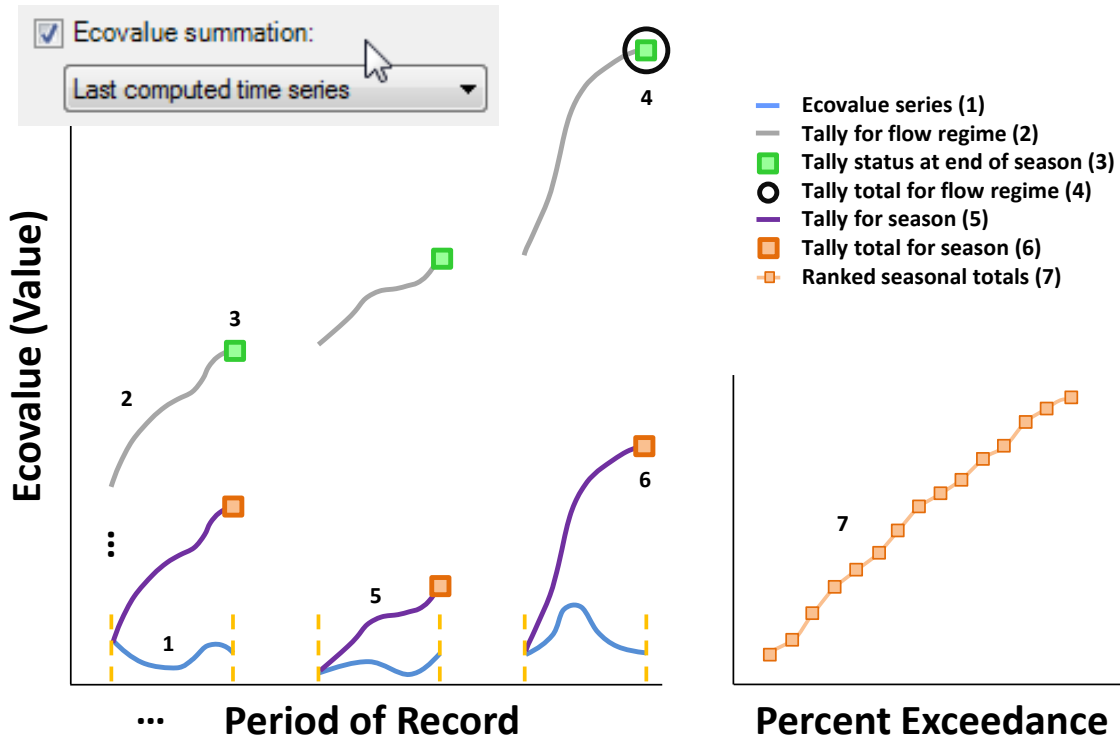


- *Batch Recalculate.* EFM offers an option to cycle computations, replacing one piece of flow regime input in each iteration. This option is useful when designing hydrographs or designing topography – that is, considering many hydrograph options with a single topography (reservoir reoperations) or considering many topographic options for a single flow hydrograph (earthwork). This cyclic application of HEC-EFM is initiated through the “File – Flow Regimes – Batch Recalculate...” menu.





- *Ecovalue summations.* A new option was added that allows the ecovalues provided by different flow regimes to be tallied over the course of whole seasons and flow regimes. This feature also tallies differences in the ecovalues provided by active non-reference and reference flow regimes.



### Improved Behaviors

- **Output management.** Deficiencies in the output capabilities of EFM 3.0.NET were revealed during an EFM application that investigated climate. This application involved roughly 100 flow regimes (down-scaled hydrology based on different climate models and emission scenarios), each with roughly 150 years of record, for a total of 5.5M data values. EFM was capable of importing the data and computing results, but was not able to write the optional DSS output to disk. This limitation was remedied in EFM version 4.0 by offering the user the option to parse output, which allows big output requests to be split into manageable pieces.
- **Input management.** Using subdaily 2D time series as flow regimes challenged the input capabilities of EFM 3.0.NET. A set of EFM applications that investigated floodplain reconnection effects for fish, plants, and waterfowl had flow regimes with more than 2.5B input data values. Input processes used in EFM 3.0.NET read in all input data at one time, which led to memory errors during simulations. This process was changed in EFM 4.0 to process flow regimes in chunks, store results, and clear memory as needed.

## Documentation

- The Quick Start Guide was updated to include descriptions of new features (3.5, 4.4.1, 5, and 6).
- A journal article was published describing EFM's use for habitat mapping:  
Hickey, J.T., R. Huff, and C.N. Dunn. 2015. *Using habitat to quantify ecological effects of restoration and water management alternatives*. Environmental Modelling & Software 70:16-31. <http://dx.doi.org/10.1016/j.envsoft.2015.03.012>.
- A project report was published describing EFM's use for environmental hydrograph design and climate considerations:  
Hickey, J., W. Fields, A. Hautzinger, S. Sesnie, P. Shafroth, and D. Gilbert. 2016. *Managing water and riparian habitats on the Bill Williams River with scientific benefit for other desert river systems*. USACE Hydrologic Engineering Center. PR-97. <http://www.hec.usace.army.mil/publications/ProjectReports/PR-97.pdf>