# Workshop – Using EFM with 2D river hydraulics model output

EFM helps study teams determine ecological responses to changes in the flow regime of a river or connected wetland. EFM uses the same computational process whether flow regimes are defined at one or more gages, river cross sections, or spatial elements in a 2D computation mesh.

In this workshop, we will use output from a 2D river hydraulics model. Data are adapted from a restoration project on the Columbia River designed to improve floodplain habitats for fish by increasing connectivity between the river and floodplain and internally, within the floodplain area. Two scenarios are considered: existing conditions and increased connectivity.

The restoration area is approximately 800 acres. It is divided into 4 separate 2D flow areas in the river hydraulics model. We will analyze the 2D area named West Rook.



While the primary motivation for restoration is salmon habitat, stakeholders are also concerned about how increased connectivity will affect the area's diverse mix of wetland and riparian habitats whose vegetation provides habitat for an array of insects, birds, and mammals. Your task is to <u>define and test</u> <u>EFM relationships</u> to: 1) characterize vegetation and 2) show salmon habitat. Existing conditions and increased connectivity will be investigated and compared.

Resources provided:

- 1) Time series of depth for 2009 (ExistingConditions.hdf and IncreasedConnectivity.hdf)
- 2) A GIS project that includes geometry of the 2D elements for both scenarios
- 3) A spreadsheet with element areas for West Rook for both scenarios.

# Defining EFM Relationships: Vegetation

Insects, birds, and mammals use different plant communities as habitats for nesting, shelter, and forage. Distributions of floodplain vegetation are significantly affected by the timing and duration of inundation



during the formative growing season, **February through July** (for this project). An EFM analysis of field data collected near the restoration site produced the following summary of inundation and vegetation:

Inundation-driven vegetative communities in the study area include emergent wetlands, low woody shrubs, and floodplain riparian. Lands inundated for a greater **percentage of time** than emergent wetlands are open water. Lands inundated for a lesser **percentage of time** than riparian are upland terrestrial. Based on the image above, fill in the following modeling logic table:

Modeling Logic: Percent Time Inundated (early growing season) for Vegetation											
	Open Water Emergent Wetlands Low Woody Veg Floodplain Riparian Upland										
	Start	End	Start	End	Start	End	Start	End	Start	End	
Values											

1) Define an EFM relationship to compute percent inundation within the study area.

Season: Duration: 1-day % Exceedance Setting (frequency or duration, *pick one* - see hint 1): Reverse Lookup (see hint 2):

Hint 1: Flow <u>duration</u> considers percentage of time; flow <u>frequency</u> considers percentage of years.

*Hint 2: Consider the reverse lookup feature that allows users to compute the percentage of time a value is equaled or exceeded. What value of depth would separate inundated and non-inundated lands?* 

## **Salmon Rearing**

Juvenile salmonids use inundated floodplain areas as rearing habitat during their outmigration to the sea. In the Columbia River Basin, young chinook and steelhead utilize these areas as important forage sources and excellent cover from **February to June**.

Habitat suitability indices (HSI) relate quality of habitat to values of a variable. Typically, HSI are species and life stage specific. Suitabilities are expressed on a scale from 0 (unsuitable) to 1 (ideal). Depth, velocity, substrate, and cover are common HSI variables for aquatic species. A habitat suitability index for Salmon Rearing - Depth follows:



Whereas a single distribution of vegetation is shaped by conditions throughout the early growing season, consideration of fish habitat occurs intermittently **in time** and space.

2) Use the simplified HSI and a set of EFM relationships to calculate of salmon rearing habitat in terms of the **number of suitable habitat days** provided.

Modeling Logic: Suitabilities for Salmon Rearing											
	Suit =     Suit =     Suit =     Suit =										
	Start End Start End Start End Start End S						Start	End			
Depth	Depth O O										

EFM Relationships:

Season: Duration: 1-day % Exceedance Setting (frequency or duration, pick one - see hint 1): Reverse Lookup:

*Hint 1: Flow <u>duration</u> considers percentage of time; flow <u>frequency</u> considers percentage of years.* 

Hint 2: EFM can compute the percentage of time spent within a range of depths.

## Using EFM

 Now let's use EFM to test the relationships for vegetation and salmon rearing. Open EFM and use the "File – New" menu option to create a new application. Enter any model information on the Properties tab. Save application to a directory on your computer.

L EFM 2D Workshop.efm - HEC-EFM										
File E	idit P	lot H	lelp							
Model in	nformatio	n								
Title: Using EFM with 2D river hydraulics model output										
Autho	r:				-					
Locat	ion:					_				
Descr	ription:		Workshop analyz	ing vegetation and sa	lmon habitat wit	h the Ecosystem	Functions Mod	el 🔺		
								-		
EFM model pathname:C:\Workshops\EFM 2D\EFM 2D Workshop.efm										
Flow reg	gimes (pa	aired time	series of flow and	stage)						
Flow reg	gimes (pa Active	aired time	series of flow and Identifier	stage) Filename	Part A	Part B	Part F	Starting	_	
Flow reg Ref	gimes (pa Active	aired time Use edit	series of flow and Identifier menu to rename	stage) Filename	Part A	Part B	Part F	Starting		
Flow reg	gimes (pa Active	<b>ired time</b> Use edit	series of flow and Identifier menu to rename	stage) Filename	Part A	Part B	Part F	Starting		
Flow reg Ref Ø	gimes (pa Active V Relati	aired time Use edit onships	series of flow and Identifier menu to rename Tables Combo I	stage) Filename Relationships	Part A	Part B	Part F	Starting		

 The hydraulic data for this workshop are stored in files called "ExistingConditions.hdf" and "IncreasedConnectivity.hdf". HDF stands for Hierarchical Data Format. HDF files can include many different data tables.

Data for this exercise are:

- Period average values
- Daily time step
- Stage (in feet)
- Stored in columns in HDF
- 3) The next step is to add the flow regimes. Adding flow regimes from HDF is different than adding from text files or DSS. Use the "Edit Flow Regimes Batch add from HDF file..." menu option.



- Select HDF file	🖳 Batch Add Flow Regimes from HDF 🛛 🕹 🗙
Crowning * New folder	This feature automates creation of flow regimes. It works only with time series data archived in
Quarantine Name Date modified Type Size	HDF. Please use with caution. It can involve large datasets that are time consuming to compute.
ResSim Versions     ExistingConditions.hdf 3/24/20161:41 PM HDF4 File 16,028 KB     Temp     Temp     Prove d Converting to the file 3/26/2016 3/23 PM HDF4 File 18,028 KB	Flow regimes input file(s)
Users Users Windows	ExistingConditions.hdf Time link multiple HDF file
Workshops	Transitions: Skip first $\vee$ 1 time steps
EFM 2D	Dates and times (of data to be imported)
EFMSim 1. Select data file	○ Specify start and end
	From 04/03/2019 v 0000 Time Date StampHDF
File name: ExistingConditions.hdf	To 04/04/2019 v 0000 Start on column/row 0
Open V Cancel	Interval 1 day   End on column/row 0
Select HDF Dataset X	Time series table(s)
Select the dataset to be used for input date and time.	Use one-variable for both flow regime parts
HDFMetaData	1st Table WestRook-StageHDF 3 2nd TableHDF
Caterpillar-Stage	Data Stage feet Data
HartMcBride-Stage	Time series values
WestRook-Stage 2. Select time date table	
Dataset properties	Columns 4 (Use all (63/1) 5 Osc dairy incur of
Dataset name Time Date Stamp Data type String	C Rows C Selection Ficker (0)
Rows 181 Columns 1	O Instantaneous 7 Start on column/row 0
Select Cancel	Period average      Missing value screening      Values
Select LIDE Detect	Flow regime naming
Calculate detected for inset data and fine	Identifier WR_Existing 8 Limit arrays to:
Select the dataset to be used for input date and time.	Prefix (optional) Proker (0)
G G HDFMetaData	Suffix   HDF label 9  Integer 1
HartMcBride-Stage 3. Select data table and	Set period of record (optional)
WestRook-Stage enter Stage and feet	Starting 4/ 4/2019 v Ending 4/ 4/2019 v
Dataset remeaties	Activate added flow regimes (optional)
Dataset name WestRook-Stage Data type Single	Make "Active"
Rows 181 Columns 6371	10
Select Cancel	OK Apply Cancel

Follow the 10 steps in the image below to add the flow regime for Existing conditions:

4) Repeat this process for the Increased Connectivity flow regime (name this WR\_Restored). For now, only activate the Existing flow regime. The Flow Regimes table in EFM should look like:

F	Flow regimes (paired time series of flow and stage)											
	Ref	Active	Identifier	Filename	Part A	Part B	Part F	Starting	Ending			
			WR_Existing	ExistingConditions.	WR_Existing-H	(6371)		02/01/2009	07/31/2009			
			WR_Restored	IncreasedConnecti	WR_Restored-	(6393)		02/01/2009	07/31/2009			

The numbers in the Part B column correspond to the number of elements in the West Rook 2D area. Essentially, these are "compound flow regimes", each with over 6000 parts - one for each element.

5) Go to the Relationships tab. Use the "Edit - Relationships - Add..." menu option to add a new relationship named "Veg - Percent time inundated". Enter the statistical settings proposed in the "Vegetation" section of this workshop. Settings should be similar to:

Statistical Settings	Veg - Percent time inundated
Season	2/1 to 7/31
Duration	1 day
% Exceedance	Flow duration
Reverse lookup (stage, value)	0.041667 feet (0.5 inches)
Handle out of range with 0/100	On

Other queries (nonstandard)							
▼ Reverse lookup: ○ Flow ● Stage							
Value     0.041( feet							
Values per	O Values per Flow Regime						
Range	to feet						
Ranges per	Flow Regime						
Handle out of range with 0 or 100							
Count number of	of peaks between 🔓						

Note: This is a simple relationship. The value of 0.5 inches separates inundated and not inundated. This value is open to debate based on hydraulic model considerations (with no infiltration, water persists in elements at very small depths like a film of water) and ecological considerations (depths of water may influence dynamics like germination) contributing to the conversation.

- 6) Go to the "File Select Style Sheets Results" menu and select the "Basic, stage only, inverted" style sheet. Style sheets control the format of EFM results. In this case, "inverted" means that flow regimes will be tabulated in rows and relationships will be in columns.
- 7) When complete, save the EFM project and then click Recalculate.
- Copy results (use Ctrl A to select all) into the "EFM 2D Workshop.xlsx" spreadsheet provided in the workshop folder.
- Go to the Properties tab, deselect the "WR\_Existing" flow regime and select the "WR\_Restored" flow regime. Recalculate. Copy results and paste into the spreadsheet.

ow reg	w regimes (paired time series of flow and stage)									
Ref	Active	Identifier	Filename	Part A	Part B					
		WR_Existing	ExistingConditions.	WR_Existing-H	(6371)					
	□ WR_Restored IncreasedConnecti WR_Restored- (6393)									
			5							

10) Go to the Relationships tab. Deactivate the "Veg" relationship. Use the "Edit - Relationships - Add…" menu to add a relationship named "Salmon HSI - 0.1to1". Enter the statistical settings proposed in the "Salmon Rearing" part of this workshop. Settings should be similar to:

Statistical Settings	Salmon HSI - 0.1to1
Season	2/1 to 6/30
Duration	1 day
% Exceedance	Flow duration
Reverse lookup (stage, range)	0.1 to 1 feet
Handle out of range with 0/100	On



#### Reverse Look-ups - Flow Duration

	Veg - Percent time inundated
Flow Regime	% X, of time
WR_Existing-0	0
WR_Existing-1	0
WR_Existing-2	0
WR_Existing-3	0
WR_Existing-4	0
WR_Existing-5	0
WR_Existing-6	0
WR_Existing-7	0
WR_Existing-8	0
WR_Existing-9	0
WR_Existing-10	0
WR_Existing-11	0
WR_Existing-12	0
WR_Existing-13	0
WR_Existing-14	0
WR_Existing-15	0
WR_Existing-16	0
WR_Existing-17	0
WR_Existing-18	0
WR_Existing-19	0
WR_Existing-20	0
WR_Existing-21	0
WR_Existing-22	11.3
WR_Existing-23	10.8

- 11) Use the "Edit Relationships Duplicate..." menu to create relationships named "Salmon HSI 1to2" and "Salmon HSI 2to3". Remember to update the range values for each. Save your project.
- 12) Click recalculate. Copy results into the spreadsheet...remember you're likely on "WR\_Restored".
- 13) Go to the Properties tab. Deselect the "WR\_Restored" flow regime and select the "WR\_Existing" flow regime. Recalculate. Copy results into the spreadsheet.

## Analyzing EFM Results in Spreadsheet

All EFM calculations should now be complete. Over 8 million data values were used to generate the results you are about to analyze. Fill in the tables and respond to the questions below using the EFM results and the element areas to assess the restoration plan.

## Vegetation

Use your vegetation modeling logic to fill in the habitat area table. Logic should be similar to:

Modeling Logic: Percent Time Inundated (early growing season) for Vegetation											
	Open Water Emergent Wetlands Low Woody Veg Floodplain Riparian Upland										
Start End Start End Start End Start End						End	Start	End			
Values	Values 100 93 93 60 60 30 30 10 10 0										

Vegetation habitat area table.

Habitat Types	Existing (acres)	Restored (acres)	Change (acres)	Percent Change
Open Water				
Emergent Wetlands				
Low Woody Shrub				
Floodplain Riparian				
Upland Terrestrial				

- 1) Which habitat type gained the most area in West Rook?
- 2) Which habitat type lost the most area in West Rook?
- 3) Waterfowl are common in the restoration area. Emergent wetlands are their preferred habitat. Waterfowl predators (hawks and falcons) roost and nest in upland habitats. Based on the habitat responses detailed above, how will the restoration affect waterfowl within the West Rook area?
- 4) Describe the overall trend in habitat change from Existing to Restored.

#### Salmon Rearing

Fill in the tables and respond to the questions below using the EFM results and the element areas to assess the restoration plan. Modeling logic should be similar to:

	Modeling Logic: Suitabilities for Salmon Rearing										
	Suit = 0         Suit = 0.5         Suit = 1         Suit = 0.5							Suit = 0			
	Start	End	Start	End	Start	End	Start	End	Start	End	
Depth	Depth 0.0 0.1 0.1 1.0 1.0 2.0 2.0 3.0 3.0 >3.0										

Suitable habitat area provided for salmon rearing:

Habitat Type	Existing (acres)	Restored (acres)	Change (acres)	Percent Change
Salmon Rearing				

Hint: The progression of calculations used to obtain these values in the solution was: % time in each range (EFM results), number of days in each range, number of suitable habitat days in each range, total suitable habitat days, and total suitable habitat provided.

5) In West Rook, would the Restored alternative generate more salmon rearing suitable habitat?

## **Using GIS**

Let's investigate the EFM results in GIS. In the workshop folder, there is a map file called "EFM 2D - Workshop.mxd". Open it in ArcMap. Several layers are provided: 1) two copies of "Existing - Cells" and "Restored - Cells" shapefiles that have the cell layouts for their respective scenarios, West Rook area only, 2) "Mesh Cell Polygons" that has cells for all 2D areas in both scenarios (Alt 1 = Existing and Alt 2 = Restored), 3) a layer with the 2D areas, and 4) basemap imagery with labeling.

Right click on the "Existing - Cells" layer and open its attribute table. Note that the cells are labeled WestRook with a cell number, just like the EFM results.

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Tal	ble									
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Exi	sting -	Cells								
	FID	Shape *	Mesh Name	Cell Index	Area_ac	Vegetation	Salmon			
F	0	Polygon	WestRook	(	0.0549	0	0			
	1	Polygon	WestRook		0.050098	0	0			
	2	Polygon	WestRook		0.032623	0	0			



Fields named "Vegetation" and "Salmon" have already been added to the attributes tables for both scenarios. Let's add the EFM results to the Vegetation field.

1) Verify that the ArcMap Editor toolbar is activated on your computer by right clicking on empty space in the toolbar area of the ArcMap interface, perhaps next to the Help menu shown  $\rightarrow$ 

Help ] 💽 돈

2) Go to the Editor tool bar and select "Start Editing"...

-	Editor	-	- PA	17	1	4	Ŧ
	🦅 S	tart	Editing	9	R		ľ

...if asked which portion to edit, select the first "Existing - Cells" layer.

3) Go to the workshop spreadsheet. Navigate to the EFM results for Vegetation. Select the WR\_Existing statistical results. A handy key stroke in Excel is, with the top cell highlighted, press "Control - Shift - Down Arrow" to select the data column  $\rightarrow$ 

When selected, copy it.

4) Go to the attribute table. Paste the EFM Results into the Vegetation field.

Ta	ble									
0	- 1	a - I 🔓 🦉	3 🖸 🖓 🗙							
Exi	Existing - Cells									
	FID	Shape *	Mesh Name	Cell Index	Area_ac	Vegetation		Salmon		
Þ	0	Polygon	WestRook	0	0.0549	0,		0		
	1	Polygon	WestRook	1	0.050098	0	*	Cut		
	2	Polygon	WestRook	2	0.032623	0	ER)	Conv		
	3	Polygon	WestRook	3	0.042709	0		copy		
	4	Polygon	WestRook	4	0.058903	0	E.	Paste		
	5	Polygon	WestRook	5	0.050405	0	×	Delete 15		
	6	Polygon	WestRook	6	0.024473	0 <sup>L</sup>		Pacto		
	7	Polygon	WestRook	7	0.04559	0		raste		
	8	Polygon	WestRook	8	0.055519	0		Paste cell value.		
П	9	Polygon	WestRook	9	0.057392	0		1		

5) Verify that the EFM results pasted successfully. If so, go to the Editor menu and save edits.

4	Start Editing	
1	Stop Editing	
	Save Edits	2

<b>~</b>	3D Analyst
1	Advanced Editing
2	Animation
	ApUtilities
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	Data Driven Pages
	Data Frame Tools
	Distributed Geodatabase

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	•
	Veg – Percent time inundated
Flo <del>v</del> Regime	% X, of time
WR_Existing-0	0
WR_Existing-1	0
WR_Existing-2	0
WR_Existing-3	0
WR_Existing-4	0
WR_Existing-5	0
WR_Existing-6	0
WR_Existing-7	0
WR_Existing-8	0
WR_Existing-9	0
WR_Existing-10	0
WR_Existing-11	0
WR_Existing-12	0
WR_Existing-13	0
WR_Existing-14	0
WR_Existing-15	0
WR_Existing-16	0
WR_Existing-17	0
WR_Existing-18	0
WR_Existing-19	0
WR_Existing-20	0
WR_Existing-21	0
WR_Existing-22	11.3
WR_Existing-23	10.8

6) Repeat this process (steps 3-5) for Existing - Salmon.

For salmon, EFM results were computed for 3 ranges of depth because habitat value was a function of depth. Range values were then aggregated to compute a single value of suitable habitat provided by each scenario. For mapping purposes, a tally of habitat provided per cell is needed. Review your spreadsheet and identify a dataset to map.

*Hint: In the solution spreadsheet, range results were aggregated into values of "total suitable habitat days" per cell. These values are per cell (one column per scenario) and are useful for mapping.* 

7) After pasting salmon data into the attribute table and verifying that the paste was successful, use the Editor menu to save edits. Then stop the editing session.



- Right click on the "Restored Cells" and open its attribute table. Use the Editor menu to <u>start editing</u> (select the Restored layer if prompted) and repeat this process (steps 3-6) for the Restored scenario.
- 9) Save edits and stop the editing session when complete.
- 10) The last step in the mapping process is symbology. Right click on the "Existing Cells" layer. Select "Properties" from the bottom of the menu.

🚰 Properties 📐	
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Currently the Existing (and Restored) layers are set to the default, "Features - Single symbol".

Layer Properties	
General Source Select	tion Display Symbology Fields Definition Query Labels Joins & Relates Time HTML Popup
Show: Features Single symbol Categories Quantities	Draw all features using the same symbol.
Charts Multiple Attributes	Advanced

Switch this to "Quantities - Graduated colors" and display values from the Vegetation field.

General	Source	Select	tion	Displa	ay S	ymbology	Fields	Definition Q	uery	Labels	Joir	ns & R	elates	Time	HTML Popup
Show: Feature	es		Dr	aw qu	Janti	ties usin <u>c</u>	) color (	to show val	ues				lr	mport	]
Catego	nies		Fie	elds						Classifica	tion				
Quanti	ties		Va	alue:		Vegetatio	n	-		Nat	tural I	Breaks	(Jenk	s)	
Grad	Graduated colors     Graduated symbols     Normalization			ation:	none Cell Index	c			Classes:	5	•	Clas	ssify		
Prop Dot	Proportional symbols Dot density Color Ramp:			ip:	Area_ac Vegetation Salmon										
Multiple	e Attribu	tes	Sy	mbol	Ran	nge			Lab	oel					
					0.00	000 - 9.80	000		0.00	000 - 9.80	0000				
9.			9.80	80001 - 27.40000			9.80001 - 27.40000								
					27.4	0001 - 48.4	40000		27.4	40001 - 48	.4000	00			
					48.4	0001 - 66.	00000		48.4	40001 - 66	.0000	00			
	1 in	-			66.0	0001 - 94.	80000		66.0	00001 - 94	.8000	00			

The default ranges are editable by clicking on them and entering a new number. Enter numbers pertinent for the vegetation analysis.

There are two layers for Existing and two for Restored. Adjust their symbology to make vegetation and salmon rearing habitat maps for each scenario.



## Analyzing EFM Results in GIS

All EFM habitat mapping should now be complete. Each vegetation map entailed analysis of over one million data values. Roughly three million data values were processed for each salmon map. Visually compare the maps (Existing versus Restored for vegetation and salmon habitats). Respond to the following questions:

- 1) Describe the visual differences in vegetation between Existing and Restored conditions. Do these agree with the spreadsheet analysis?
- Describe the visual differences in salmon habitat between Existing and Restored conditions. Do
  these agree with the spreadsheet analysis? Note any areas of noticeable increase <u>and decrease</u>.
  Please explain your observations and connect your thinking with the spreadsheet analysis.

Part of the proposed restoration involves a learning objective about understanding the effects of the project in terms of vegetation and salmon responses. Roughly 40,000 square feet of space (~1 acre) is to be established as a test area to monitor changes that occur after implementation.

3) Based on the spatial model results, where would you establish a test plot or monitoring location (would require roughly 40,000 square feet) to measure change? What changes would be expected at that location following implementation?

#### New Feature...Ecovalue Summations!

EFM can now perform much of the math done earlier in this workshop via spreadsheet. Let's revisit salmon habitat to explore the new summations feature.

1) Go to the Properties tab. Click on the table row for the WR\_Existing flow regime and then click on the "Open Batch Add HDF..." button. Use the "Limit arrays to:" picker to select a few non-zero salmon elements (refer to your spreadsheet results) such as 41 and 42. Repeat for WR\_Restored.

52	WR_Existing-40	0	0	0	WR_Restored-40	6.7	0	0
53	WR_Existing-41	12.7	0	0	WR_Restored-41	8.9	5.6	0
54	WR_Existing-42	12.2	0.7	0	WR_Restored-42	9.7	6.4	0
55	WR_Existing-43	0	0	0	WR_Restored-43	3.1	0	0

		🖳 HDF Limit A	rray Output	$\times$
Batch Add Flow Reg	imes from HDF			
This feature automates of	creation of flow regimes	Column ID	Select Columns	^
HDF. Please use with c	aution. It can involve I	30		
Flow regimes input file(s)		31		
ExistingConditions.hdf		32		
		33		
Dates and times (of data	to be imported)	34		
	to be imported)	35		_
Specify start and e	na	36		_
From 04/03/2019	0000	37		_
To 04/04/2019		38		_
Interval 1 day	$\sim$	39		_
The sector table (s)		40		_
Time series table(s)		41		_
Use one variable for b	oth flow regime parts	42		_
1st Table WestRook-	StageHDF	43		_
Data Stage	feet	44		_
		45		_
Time series values		46		_
Columns	Use all (6371)	47		_
⊖ Rows				_
0.111		49		_
<ul> <li>Instantaneous</li> </ul>	Start on column	50		~
Period average	Missing value s	,		_
	1	ок 💦	Apply Cance	əl
Flow regime naming	E-define -	- 0		
	Identifier WR_Existing Limit arrays to:			
Prefix (optional) Picker (2)				
Suffix	IDF label	Integer 1		
Set period of record (opti	onal)			
Starting 4/ 4/2	2019 🗐 🔻 Ending	g 🗌 4/ 4/2019		
Activate added flow regin	mes (optional)			
Make "Active"				
		ОК	Apply Cancel	

## 2) Make both flow regimes active.

Flow regimes (paired time series of flow and stage)									
	Ref	Active	Identifier	Filename	Part A	Part B	Part F	Starting	Ending
		✓	WR_Existing	ExistingConditions	WR_Existing-H	(6371)		02/01/2009	07/31/2009
		✓	WR_Restored	IncreasedConnect	WR_Restored-	(6393)		02/01/2009	07/31/2009

- Go to the File Select Style Sheets Results and switch the style sheet to "Basic, summations only inverted".
- 4) Click on Relationships tab. Deactivate all relationships including "Veg".
- 5) Use the "Edit Relationships Add..." menu to add a relationship named "Salmon Summation". Use the following statistical settings:

Statistical Settings	Salmon Summation
Season	2/1 to 6/30
Duration	1 day
% Exceedance	50% - Flow duration

- 6) Turn on the "Write computation arrays" option.
- 7) Turn on the "Hypothesis tracking" option and switch its setting to Curve.
- 8) Enter the following Curve to represent the HSI for salmon.

Flow (even though it's stage)	Ecovalue
0	0
0.1	0
1	1
2	1
3	0
20	0

- 9) Turn on the "Ecovalue summation" option.
- 10) Turn on the "Apply paired data" option and copy in the element areas from the "WestRook Element Areas" worksheet for both WR\_Existing and WR\_Restored. Click ok.
- 11) Turn on the "Output total for the whole flow regime" option and decline the report parts option.
- 12) Save your project. Your relationship should now look like this:

				Ontions		
Relationship name: Salmon Summation			~	Write computation array	s 🔽 Active	
Description:			~	Hypothesis tracking - ind	creased flow will	
				0+0-0 Curv	eco-health	
				Confidence tracking:		
					амымы Поппп	_
			~			-
Statistical queries		Geographical queries		Other queries (nonsta	indard)	
Season				Reverse lookup:	Flow      St	tage
From: 02/01	(m/d)			Value	cfs	
To: 06/30	(m/d)			O Values per	Flow Regime	
Duration of 1 days				⊖ Range	to	cfs
For each duration	n, compute:			O Ranges per	Flow Regime	
	×			Handle out of	range with 0 or 1	100
From computed	values, select the:			Count number of	peaks between	
				and	cfs	
Rate of change:  Stage Flow						
feet pe	er days			Ecovalue summa	ation:	
○ Rising ● Falling ○ Absolute				Last computed time series $\sim$		
l ime series specific	cations			For compound flo	w regimes	_
50 × % exceedance (of time)				Apply paired of Apply paire	lata tables	
○ Flow frequency ● Flow duration				Output total for	r whole flow regi	ime
to	Water year range			Report parts:	🔾 yes 🔘 no	•
	ual water year			Flow duration: A	nalyze seasons	
Relationship-defined water year				Return % excee	dance of	
	~					

- 13) Click recalculate.
- 14) Detailed results can be viewed in EFM Plotter.
- 15) How do the ecovalue summation results agree with the salmon habitat areas computed in the spreadsheet?
- 16) Did you follow the computational process for the ecovalue summation?
- 17) Any thoughts on why they are different?