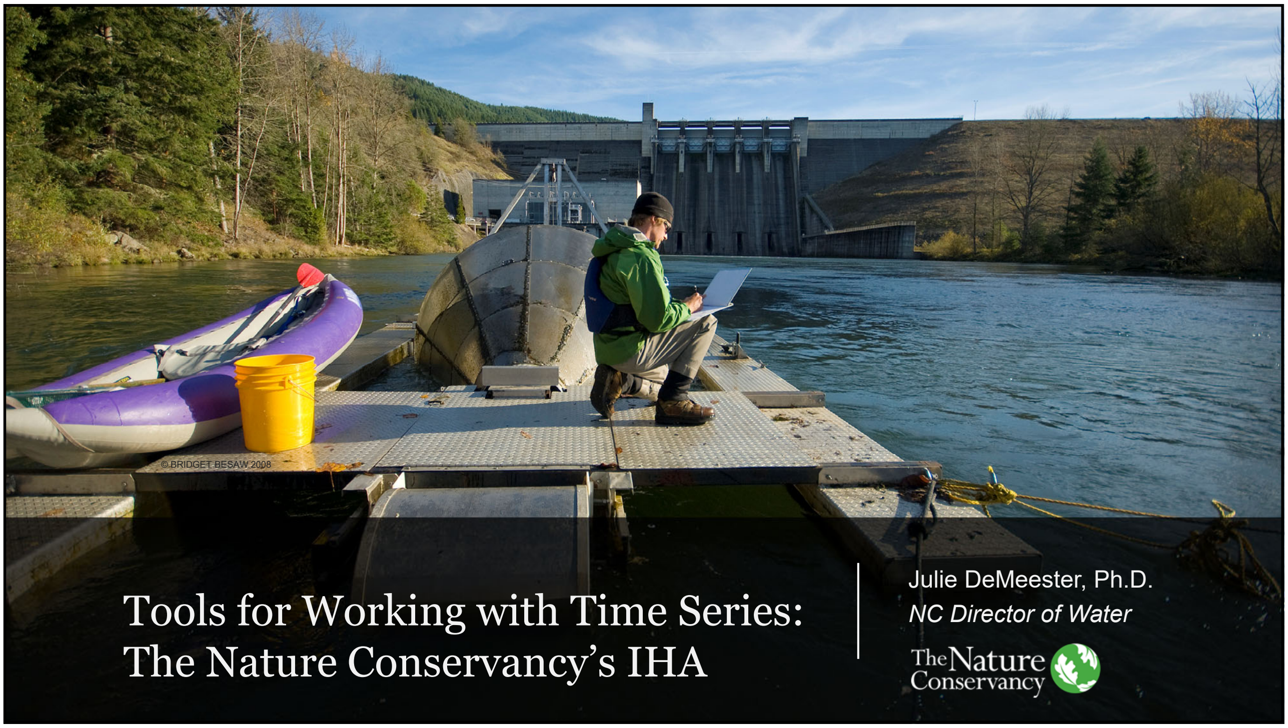

Tools for Working with Time Series: The Nature Conservancy's IHA

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NC Director of Water
The Nature Conservancy

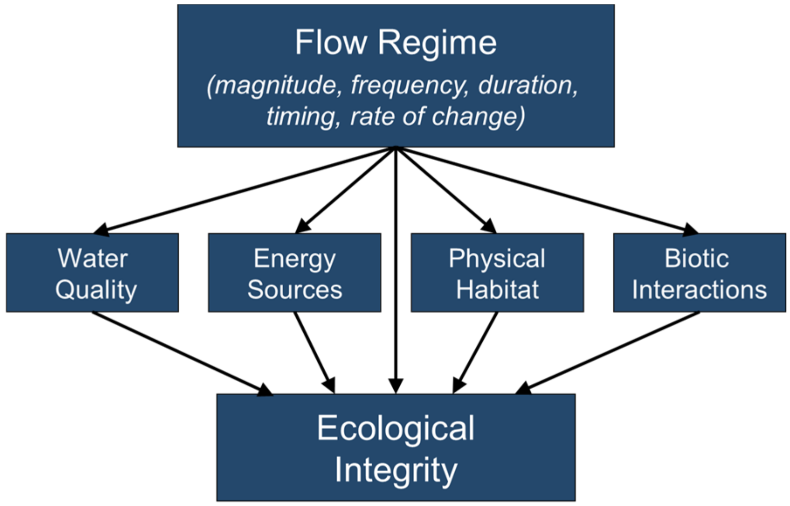
1

Lecture Overview

- The natural flow regime (*Poff et al. 1997*)
- Examples of important hydro-ecological flow regime components
- IHA Software (*Richter et al. 1996, 1997*)

2

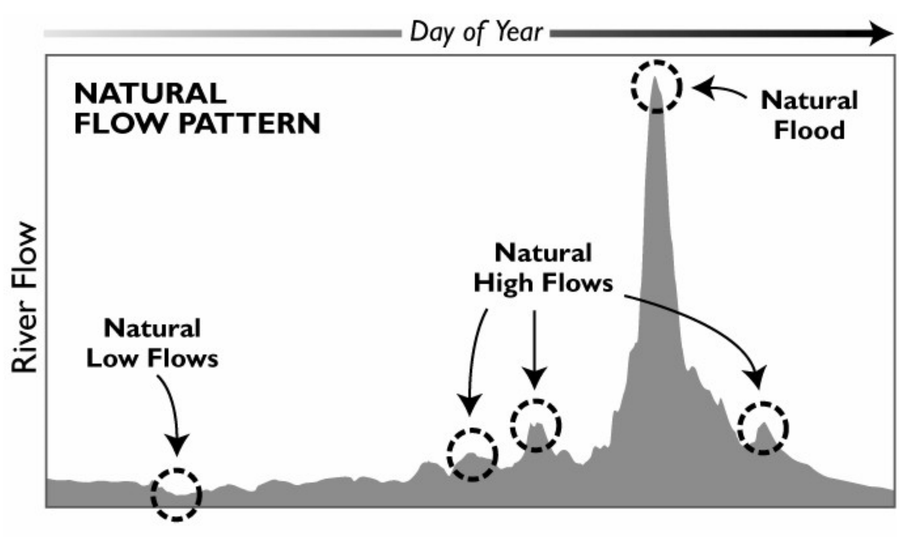
The Natural Flow Regime



(*Poff et al. 1997*)

3

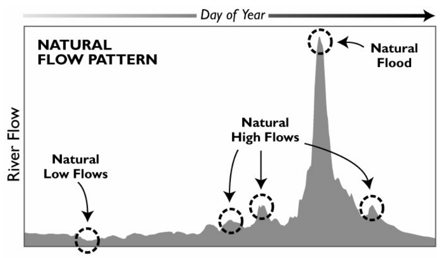
The Natural Flow Regime

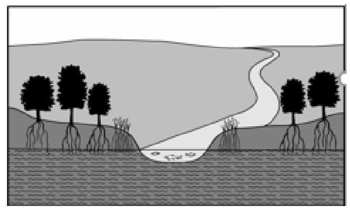


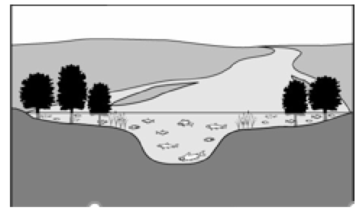
(*Postel and Richter 2003*)

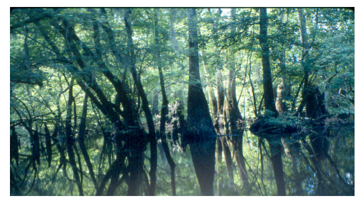
4

Ecological Functions of the Natural Flow Regime





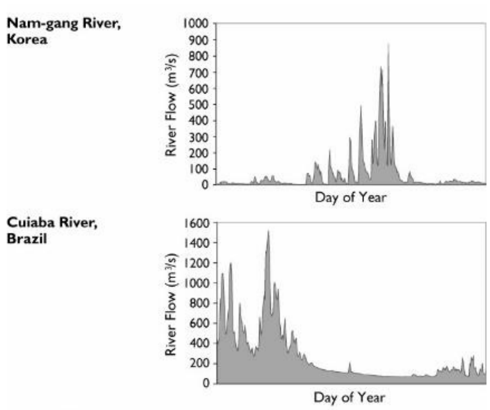


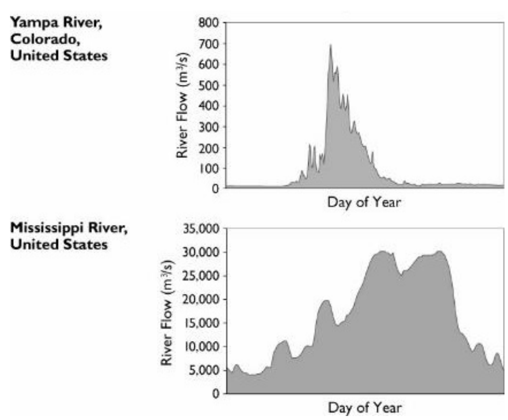


(*Postel and Richter 2003*)

5

Diversity of Natural Flow Regimes

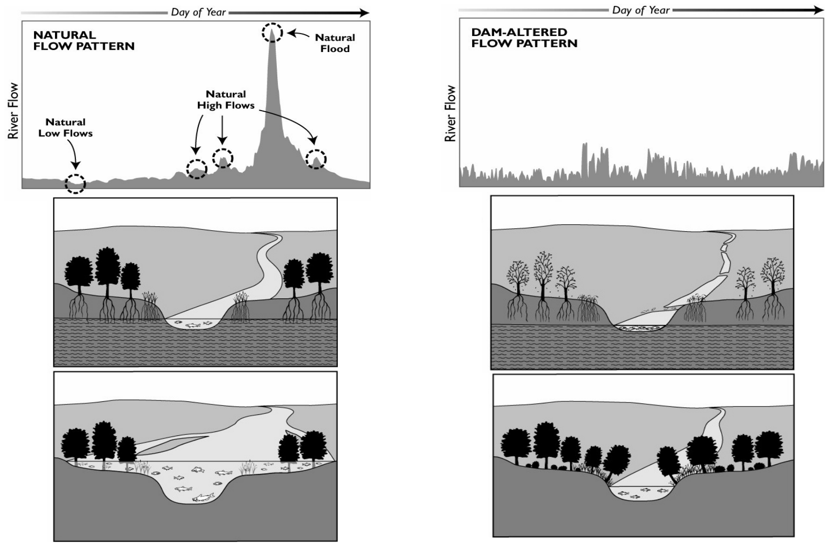




(*Postel and Richter 2003*)

6

Impacts of Altered Hydrologic Regimes



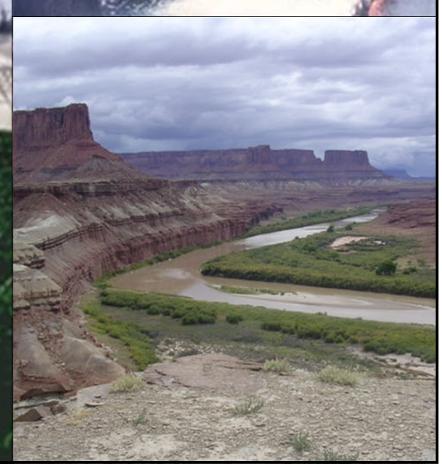
(*Postel and Richter 2003*)

7

IHA Software (*Richter et al. 1996, 1997*)

- Analyzes hydrologic characteristics and their changes over time.
- Computes 67 ecologically-relevant flow statistics using daily hydrologic data.
- Designed to be a user-friendly, flexible tool, applicable to a variety of hydrologic systems

The goal of IHA is to show changes to hydrology. The next step is to connect this to river functions and ecology.



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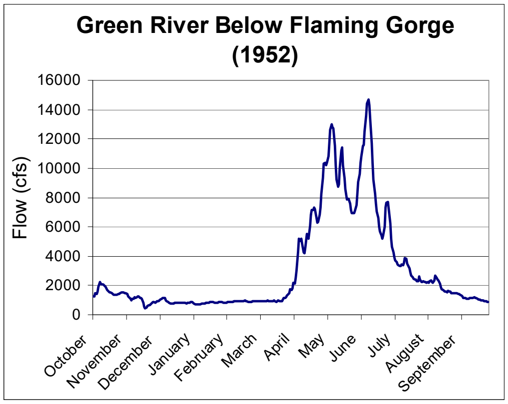
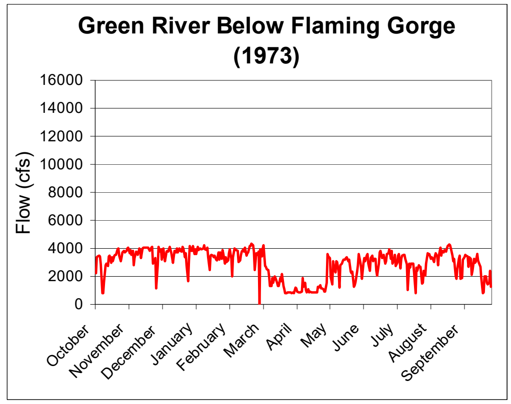
Comparing Time Series





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Analysis Options

<u>Type of analysis and statistics</u>:

- Two period (before and after) analysis or trend analysis
- Parametric or non-parametric statistics

<u>Time periods to analyze</u>:

- Can analyze a subset of water years in the period of record
- Can analyze seasonal periods (i.e. shorter than a 12-month water year).

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IHA Annual Statistics

(33 parameters; *Richter et al. 1996*)

- Monthly average flows
- Magnitude of annual extremes
  (1-, 3-, 7-, 30-, and 90-day highs and lows)
- Timing of annual extremes (1-day max and min)
- Zero flow days
- Frequency and duration of high and low pulses
- Rates of flow changes and reversals
- Base flow index

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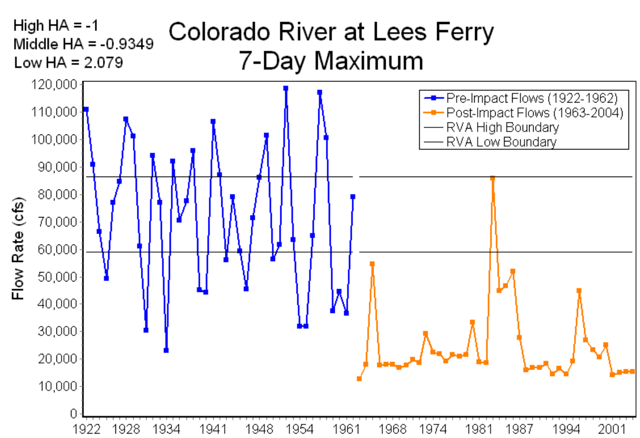
Range of Variability Analysis

- Measures the natural range of variability of each parameter
- Quantifies how this variability has been altered



(*Richter et al. 1997*)

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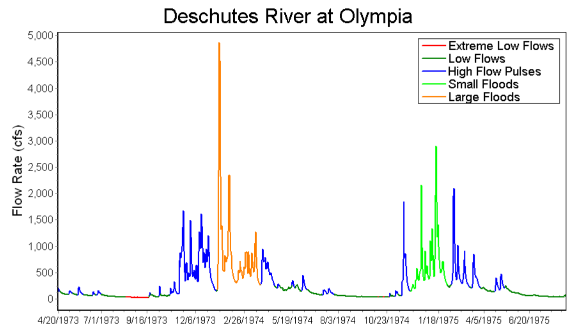
Environmental Flow Components (EFCs)

(34 parameters; *Richter and Thomas 2007*)

- Monthly low flows: mean/median
- Extreme low flows:
  magnitude (mean, median, minimum), frequency, duration, timing
- High flow pulses:
  magnitude (mean, median, maximum), frequency, duration, timing, rise/fall rates
- Small floods (i.e., 2-10 yr events)
  magnitude (mean, median, maximum), frequency, duration, timing, rise/fall rates
- Large floods (i.e., >10 yr events):
  magnitude (mean, median, maximum), frequency, duration, timing, rise/fall rates



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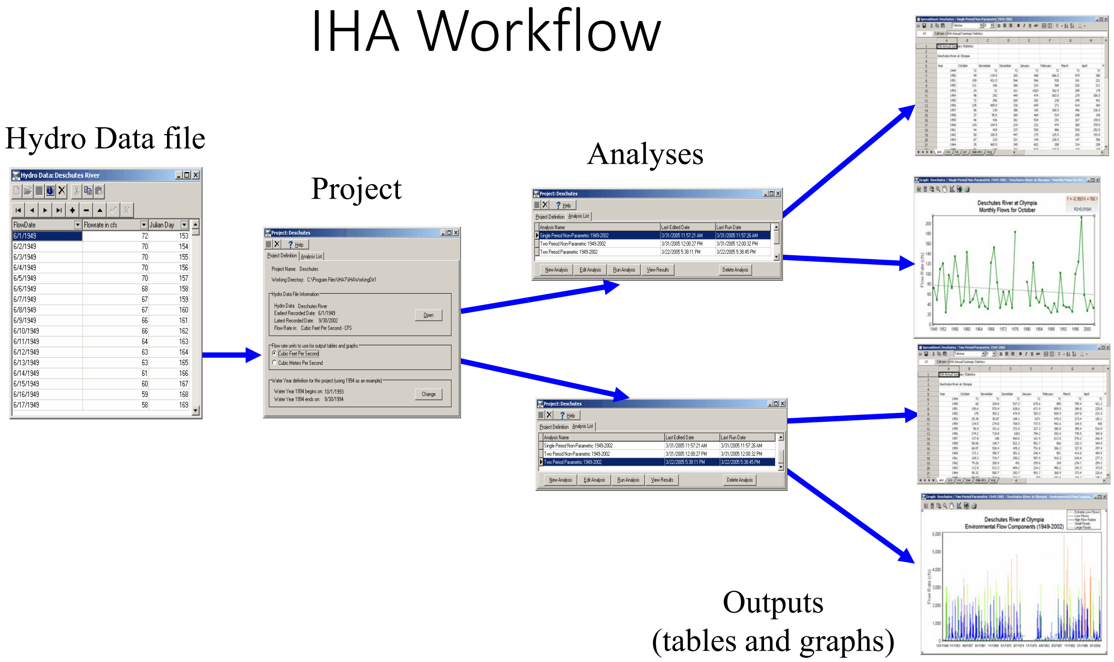
IHA Workflow



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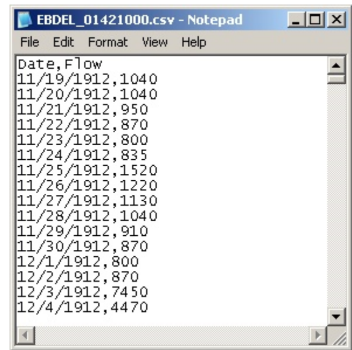
IHA Input Data

- Can import daily data from text files
  - From USGS: waterdata.usgs.gov
  - Two-column text format (calendar date, flow value)
- Batch imports also an option



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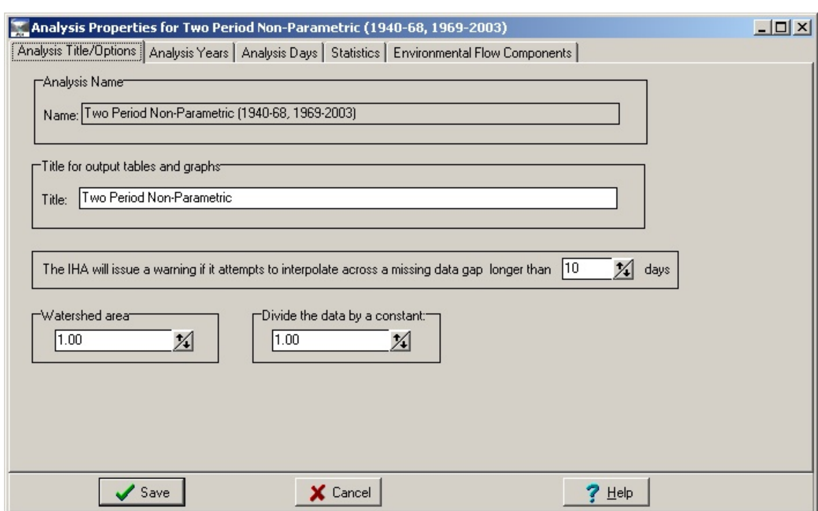
Analysis Set Up: General Options



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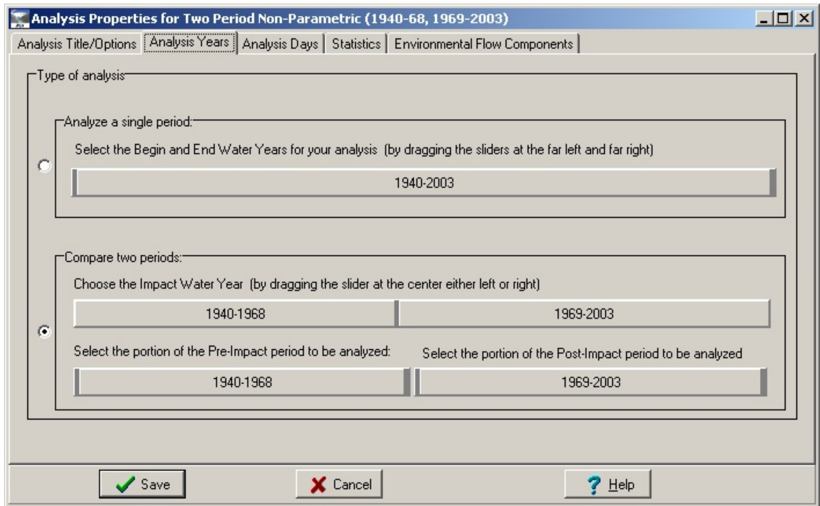
Analysis Set Up: One or Two Periods



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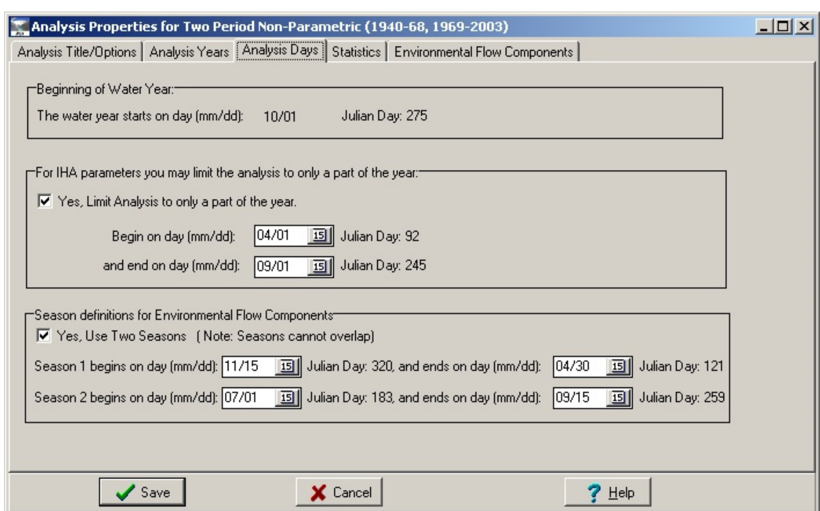
Analysis Set Up: Shortened Time Periods



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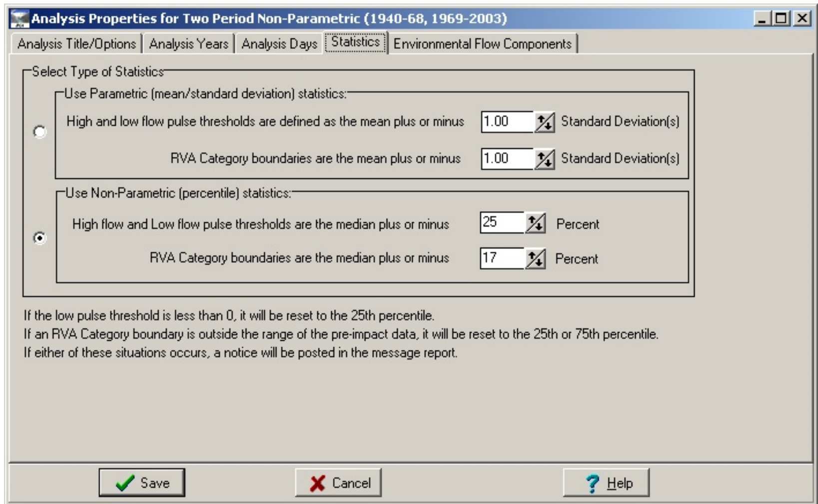
Analysis Set Up: Parametric or Non-Parametric



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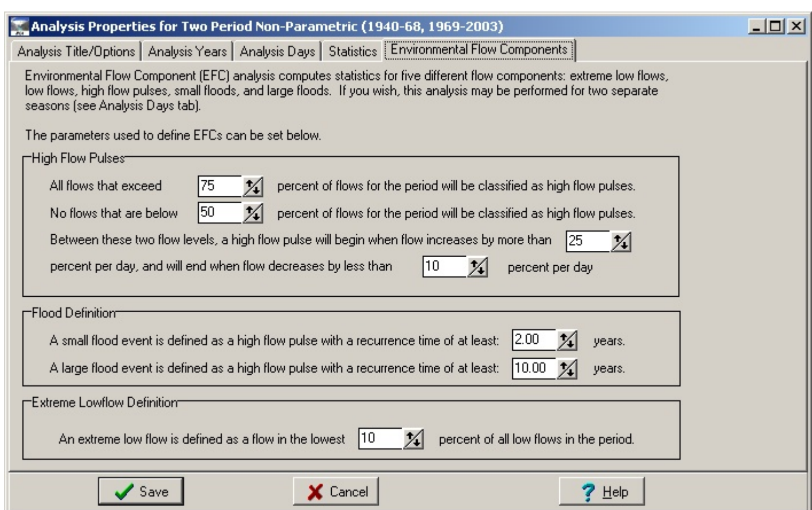
Analysis Set Up: EFC Definition



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IHA Outputs

<u>IHA output tables contain:</u>

- Annual values for each parameter (for each water year)
- Statistics calculated from these annual values
  - Will differ depending on whether parametric/non-parametric statistics or one- or two-period analysis were selected
- Daily flow values by EFC type
- List of warning messages

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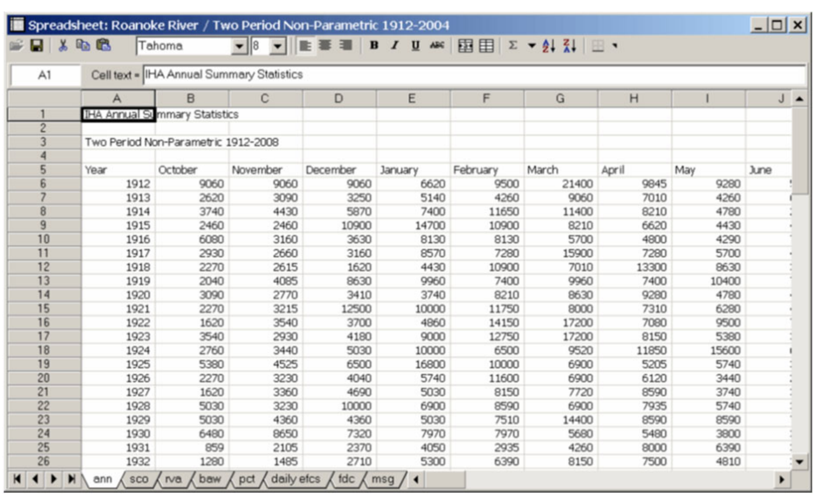
IHA Outputs


Spreadsheet: Roanoke River / Two Period Non-Parametric 1912-2004

A1 Cell text = IHA Annual Summary Statistics

	A	B	C	D	E	F	G	H	I	J
1	IHA Annual Summary Statistics									
2										
3	Two Period Non-Parametric 1912-2008									
4										
5	Year	October	November	December	January	February	March	April	May	June
6	1912	9060	9060	9060	6620	9500	21400	9845	9280	
7	1913	2620	3090	3250	5140	4260	9060	7010	4260	
8	1914	3740	4430	5870	7400	11650	11400	8210	4780	
9	1915	2460	2460	10900	14700	10900	8210	6620	4430	
10	1916	6080	3160	3630	8130	8130	5700	4800	4290	
11	1917	2930	2660	3160	8570	7280	15900	7280	5700	
12	1918	2270	2615	1620	4430	10900	7010	13300	8630	
13	1919	2040	4085	8630	9960	7400	9960	7400	10400	
14	1920	3090	2770	3410	3740	8210	8630	9280	4780	
15	1921	2270	3215	12500	10000	11750	8000	7310	6280	
16	1922	1620	3540	3700	4860	14150	17200	7080	9500	
17	1923	3540	2930	4180	9000	12750	17200	8150	5380	
18	1924	2760	3440	5030	10000	6500	9520	11850	15600	
19	1925	5380	4525	6500	16800	10000	6900	5205	5740	
20	1926	2270	3230	4040	5740	11600	6900	6120	3440	
21	1927	1620	3360	4690	5030	8150	7720	8590	3740	
22	1928	5030	3230	10000	6900	8590	6900	7935	5740	
23	1929	5030	4360	4360	5030	7510	14400	8590	8590	
24	1930	6480	8650	7320	7970	7970	5680	5480	3800	
25	1931	859	2105	2370	4050	2935	4260	8000	6390	
26	1932	1280	1485	2710	5300	6390	8150	7500	4810	

ann | sco | rva | baw | pct | daily efcs | fdc | msg

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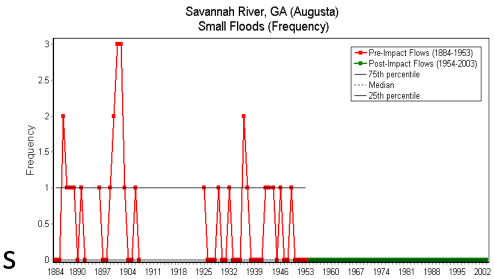
IHA Outputs

IHA graphs include:

- Annual data graphs
- Daily data graphs
- Range of Variability graphs
- Monthly mean/median graphs
- Flow duration curve graphs



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While Examining Hydrology, think about Ecology!

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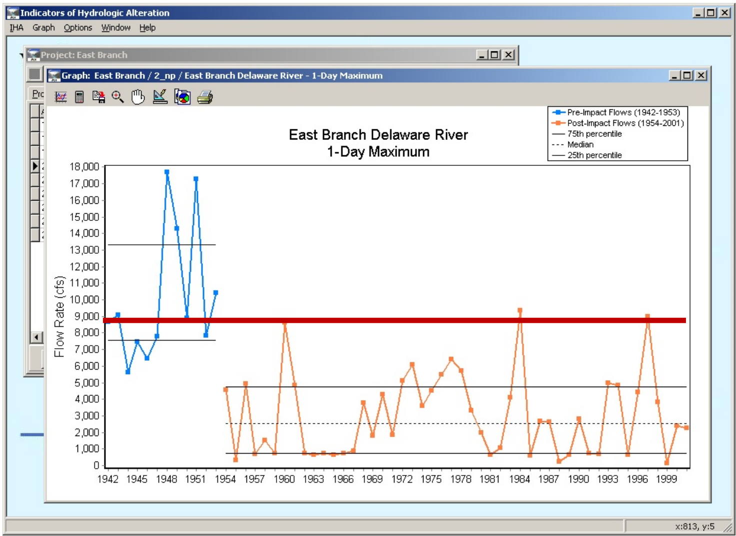
IHA Outputs



- The red line is an estimate of overbank flow. How might post-impact flows might affect ecology?
  - Limited overbank flow to interact with floodplains
  - Possible reduction in cues for fish to move upstream for spawning
  - Sediment dynamics might change without the higher flows

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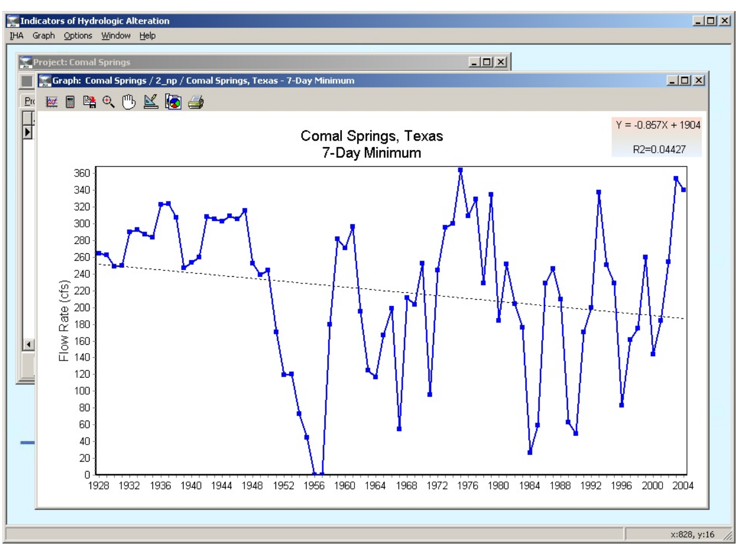
IHA Outputs



- Who or what might be impacted by this trend?
  - A declining trend of low flows might be costly to a water utility.
  - Declining low flows might affect species like mussels who need a minimum flow
  - In reverse, this dynamic could help some trees or aquatic species establish/outcompete others.

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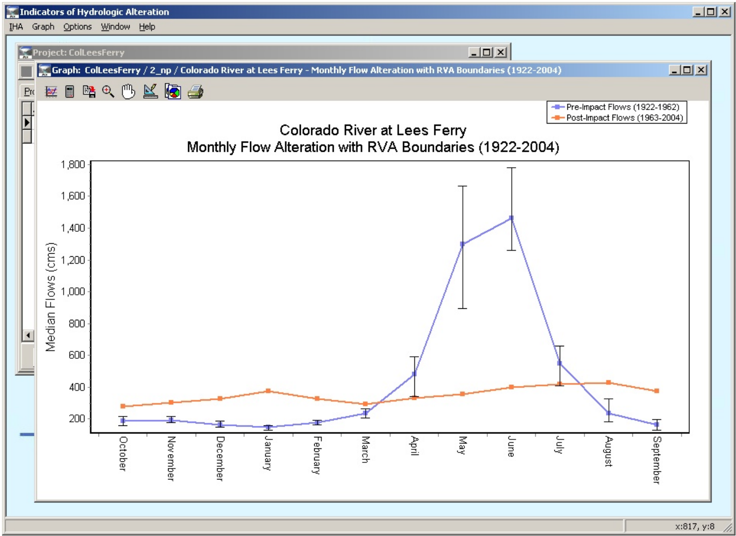
IHA Outputs



- How might post-impact flows might affect ecology?
  - The temperature of the water might change.
  - Likely a reduction in cues for fish to move upstream for spawning
  - Sediment dynamics might change without the higher flows

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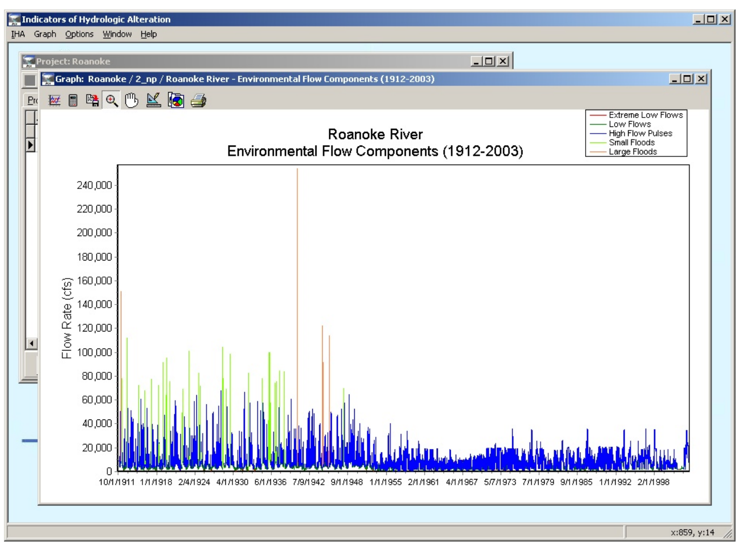
IHA Outputs



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For more information:
www.conservationgateway.org/ConservationPractices/Freshwater/
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