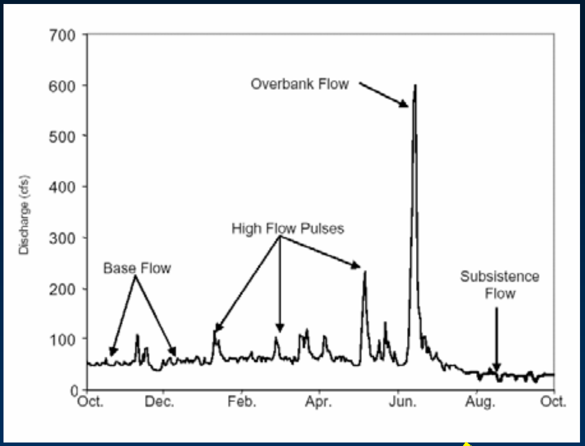
An Overview of the Hydrology-Based Environmental Flow Regime (HEFR) Method



Overbank Flows	Return Period (R) : 1 (years)	Volume (V) : 1743452 (ac-ft)	Duration (D) : 49 (days)	Peak Flow (Q) : 30000 (cfs)
High Flow Pulses	F: 0 D: 18	F: 0 D: 22	F: 0 D: 17	F: 0 D: 12
	Q: 14125 V: 352171	Q: 15550 V: 433473	Q: 11825 V: 278202	Q: 8570 V: 90605
	F: 1 D: 11	F: 1 D: 14	F: 0 D: 9	F: 0 D: 9
	Q: 10500 V: 148305	Q: 10500 V: 233782	Q: 8850 V: 89449	Q: 3700 V: 52621
	F: 1 D: 7	F: 1 D: 7	F: 0 D: 6	F: 0 D: 6
	Q: 4903 V: 57962	Q: 8735 V: 93710	Q: 3630 V: 36786	Q: 2373 V: 22191
Base Flows (cfs)	4910	5700	2110	1839
	2350	3670	1839	1839
	1839	2258	1839	1839
Subsistence Flows (cfs)	1839	1839	1839	1839
	Dec Jan Feb	Mar Apr May	Jun Jul Aug	Sep Oct Nov
	Winter	Spring	Summer	Fall

Hydrologic Conditions	
	Wet
	Average
	Dry
	Subsistence

High Flow Pulse Characteristics	
	F = Frequency (per season)
	D = Duration (days)
	Q = Peak Flows (cfs)
	V = Volume (ac-ft)

Dan Opdyke

Presentation to Trinity-San Jacinto BBEST

February 11, 2009

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Purpose

To develop a preliminary environmental flow regime recommendation for a

- Large river basin, with
- Few site-specific studies available, and
- Limited time and budget

SB3 Language:

"Environmental flow regime" means a schedule of flow quantities that reflects seasonal and yearly fluctuations that typically would vary geographically, by specific location in a watershed, and that are shown to be adequate to support a sound ecological environment and to maintain the productivity, extent, and persistence of key aquatic habitats in and along the affected water body.

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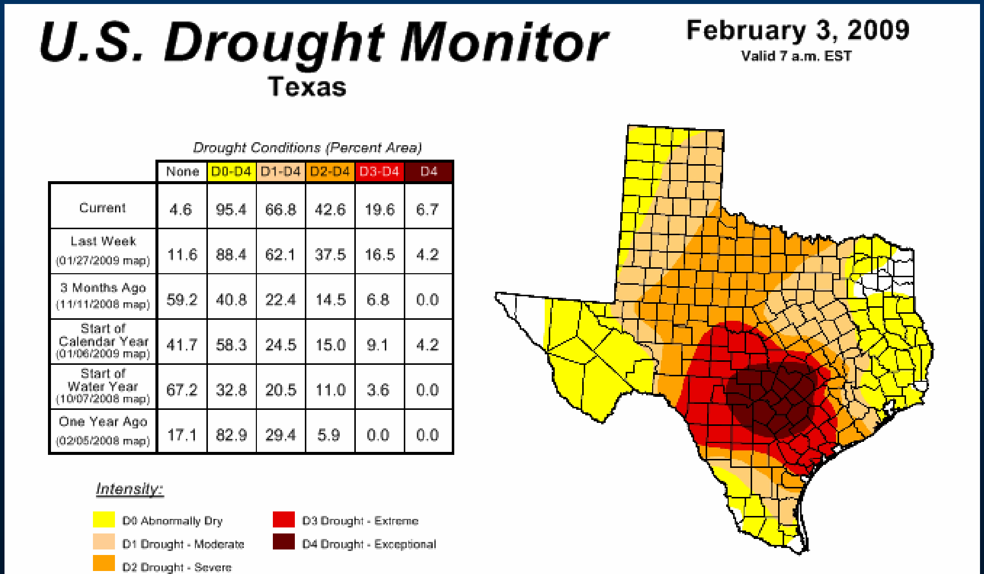
Generic Characteristics of a Flow Regime

Instream Flow Components

- Base flow, storms, etc.

Hydrologic Conditions

- Dry, average, wet, etc.



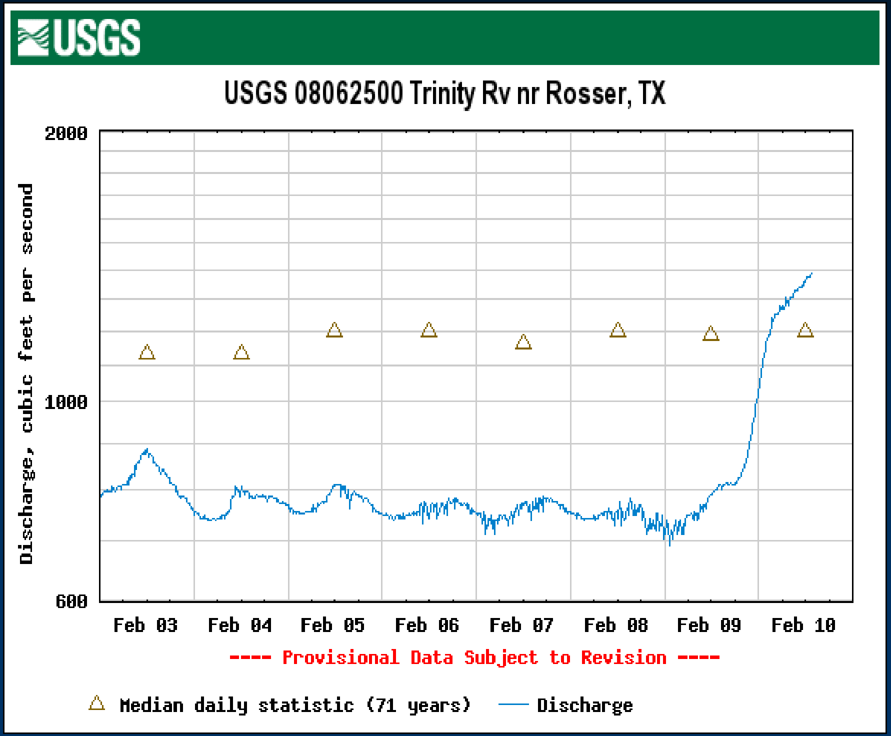
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	4.6	95.4	66.8	42.6	19.6	6.7
Last Week (01/27/2009 map)	11.6	88.4	62.1	37.5	16.5	4.2
3 Months Ago (11/11/2008 map)	59.2	40.8	22.4	14.5	6.8	0.0
Start of Calendar Year (01/06/2009 map)	41.7	58.3	24.5	15.0	9.1	4.2
Start of Water Year (10/07/2008 map)	67.2	32.8	20.5	11.0	3.6	0.0
One Year Ago (02/05/2008 map)	17.1	82.9	29.4	5.9	0.0	0.0

Ft. Worth 1949

Available Data

Hydrologic Data

- Available and consistent
- Long period of record (sometimes)
- Has been considered the "master variable“ (Poff et al., 1997 as cited in NRC, 2005)
- Relatively easy to work with



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HEFR Basics

- Uses hydrologic data
- Computations are rapid
- Populates a flow regime matrix

(1) Select Flow Gage

↓

(2) Select Period of Record

↓

(3) Separate (parse) Hydrograph using IHA EFC Algorithm

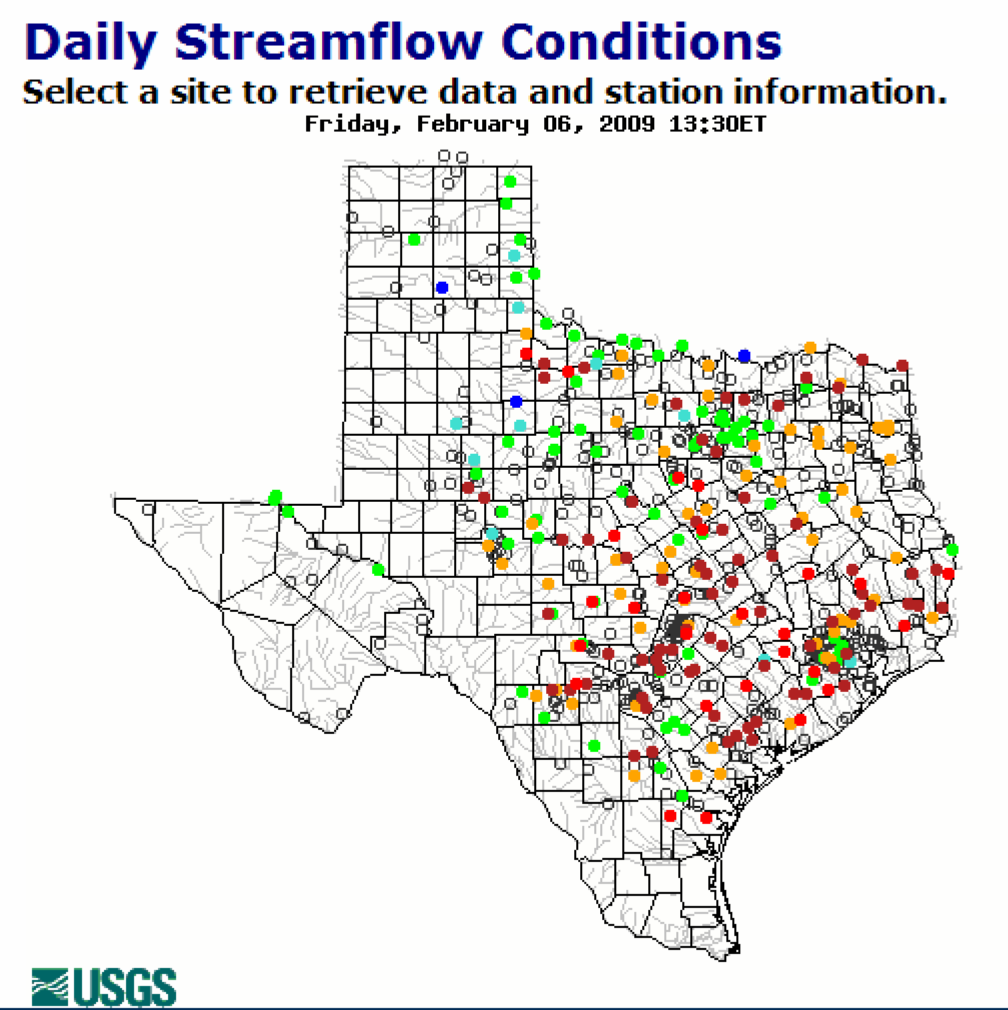
↓

(4) Generate Statistical Summaries in Excel

(1) Select Flow Gage

- Many to choose from
- SAC working on guidance
- USGS TX "Core" Network documented here:

http://pubs.usgs.gov/wri/wri014155/



http://waterdata.usgs.gov/tx/nwis/rt

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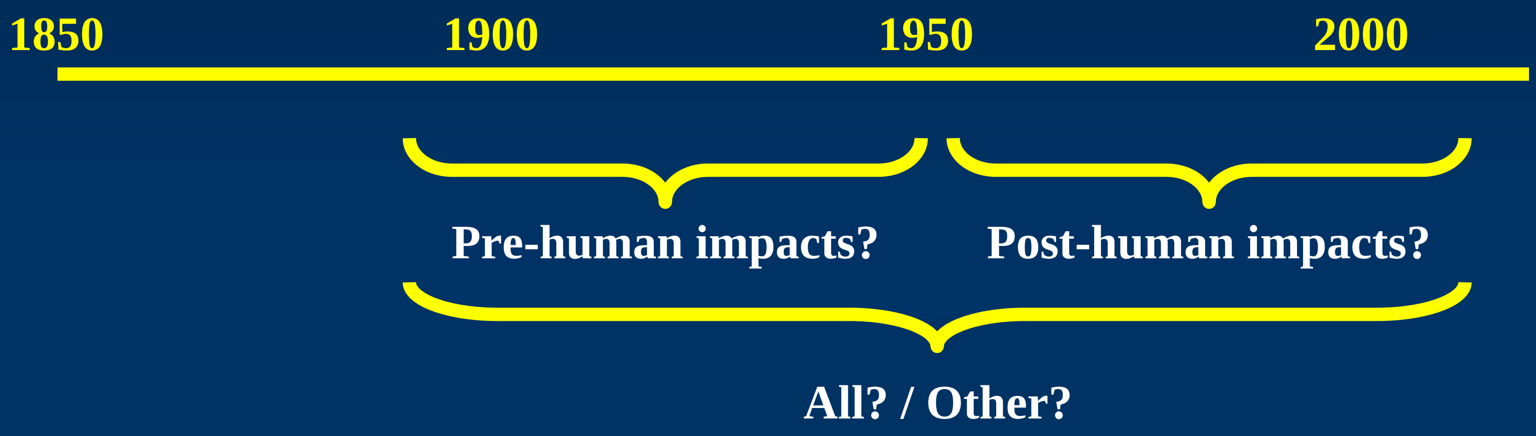
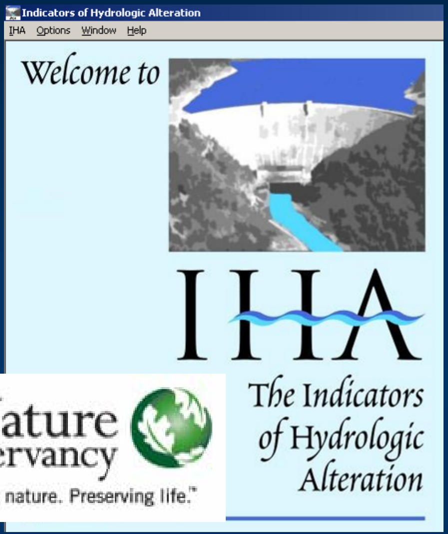
(2) Select Period of Record



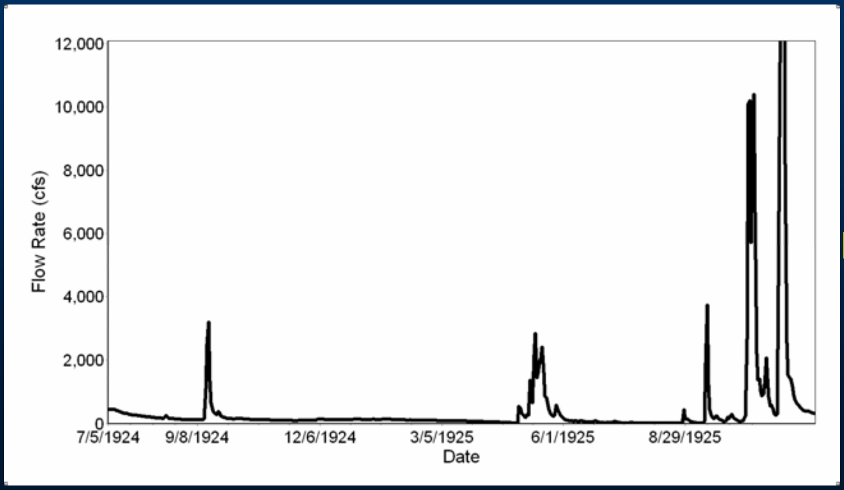
- Varies by gage
- Some discussion in Section 4 of Hydrologic Methods document

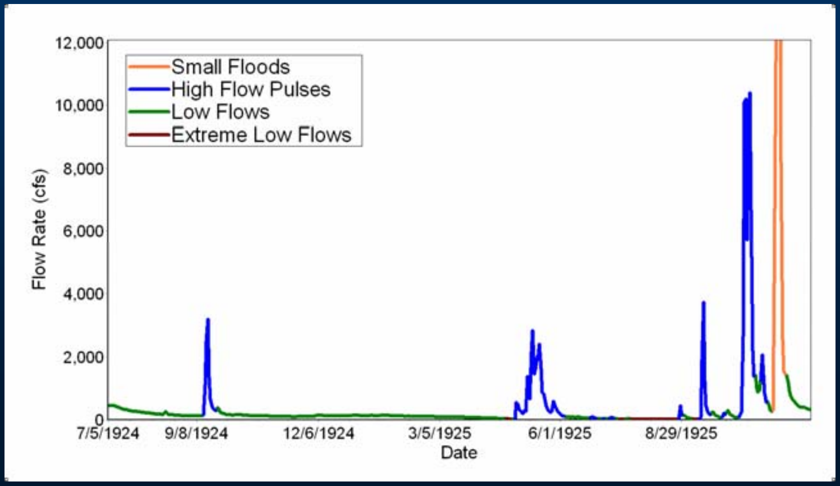
(3) Separate (parse) Hydrograph using IHA EFC Algorithm



IHA – Environmental Flow Components function

Splits hydrograph into IFCs





Terminology Translator

IHA ⇦ vs. ⇨ SB2/TIFP

	Environmental Flow Component	⇔	Instream Flow Component
flow components	Extreme low flow	⇔	Subsistence flow
	Low flow	⇔	Base flow
	High flow pulse	⇔	High flow pulse
	Small flood	⇔	Overbank flow
	Large flood	⇔	Overbank flow

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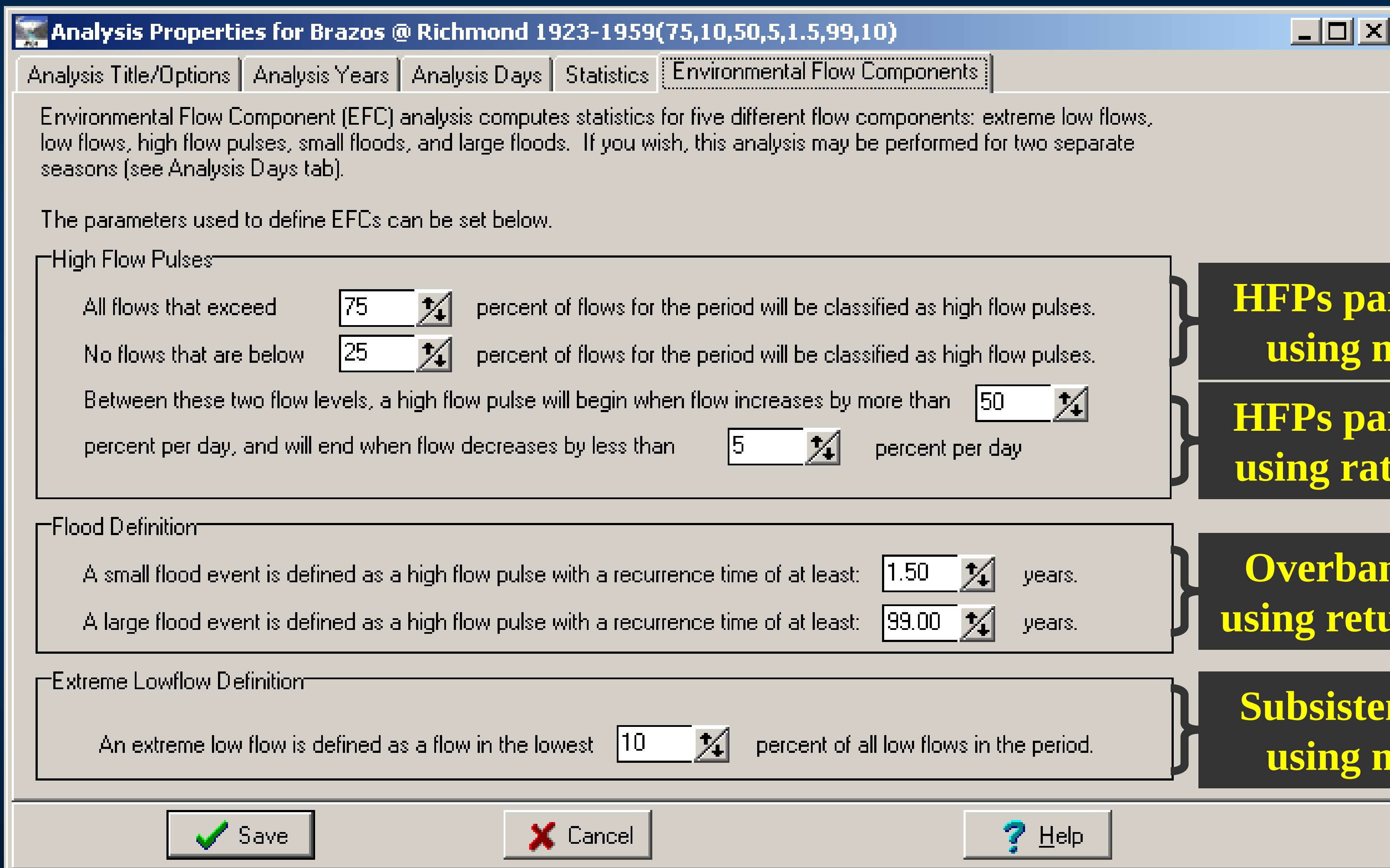
IHA EFC Algorithm



HFPs partly defined using magnitude

HFPs partly defined using rate of change

Overbanks defined using return intervals

Subsistence defined using magnitude

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(4) Generate Statistical Summaries in Excel

- **IHA generates many statistics**
  - Not used in HEFR
- **Instead, HEFR uses Excel to generate nonparametric statistics of IFCs for four hydrologic conditions**
  - Wet, Average, Dry, and Subsistence
- **Outputs may include: flow, volume, duration, frequency**

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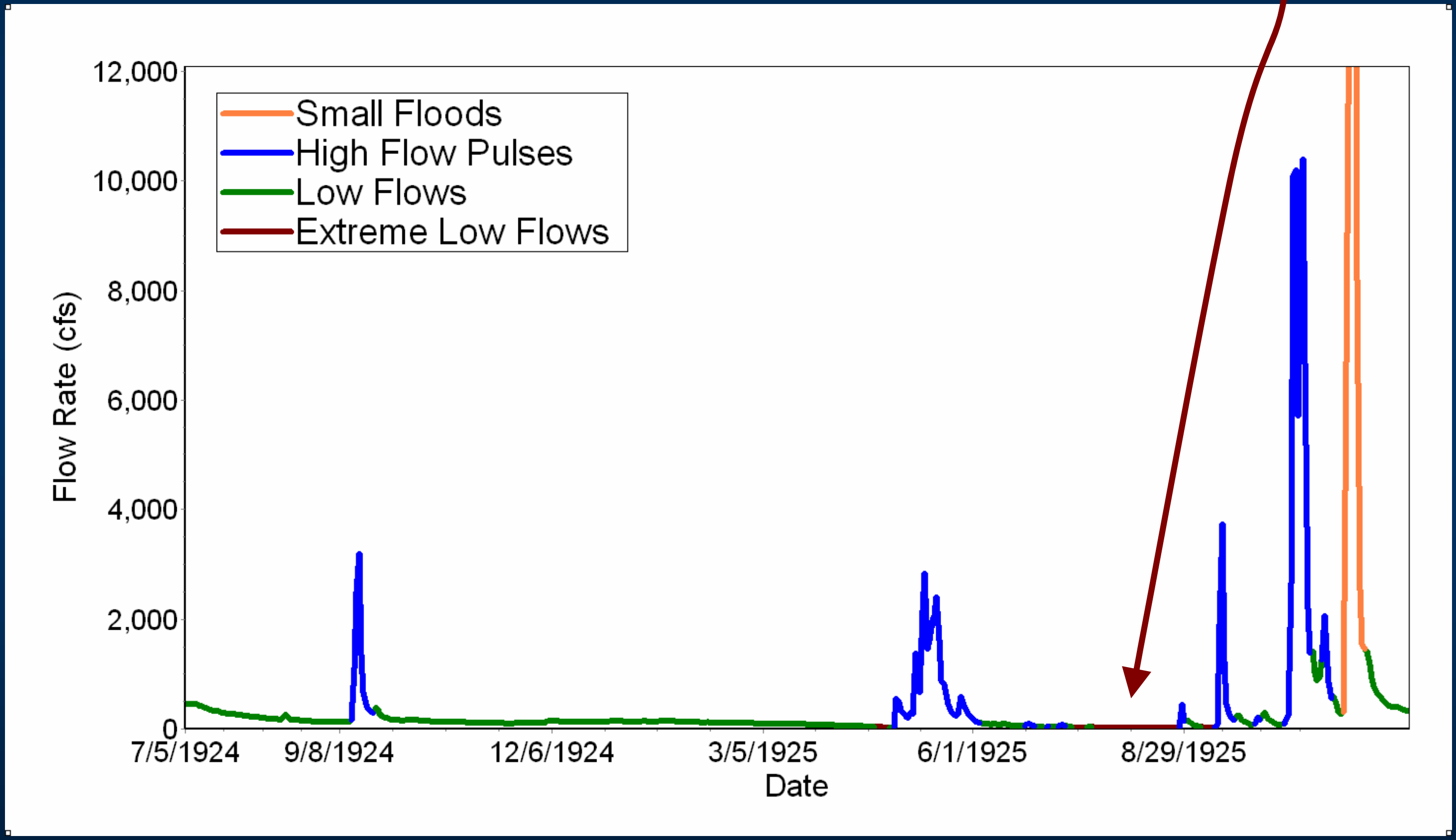
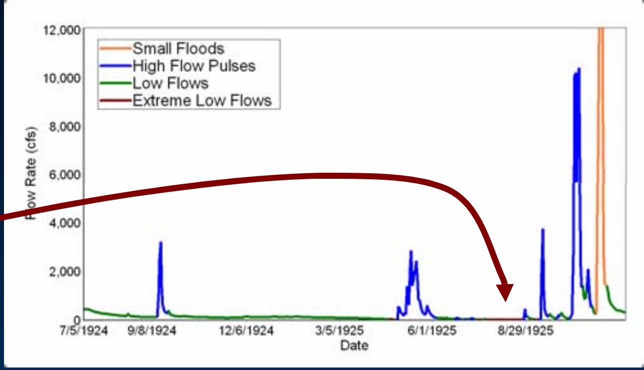
Subsistence Flows



Subsistence Flows

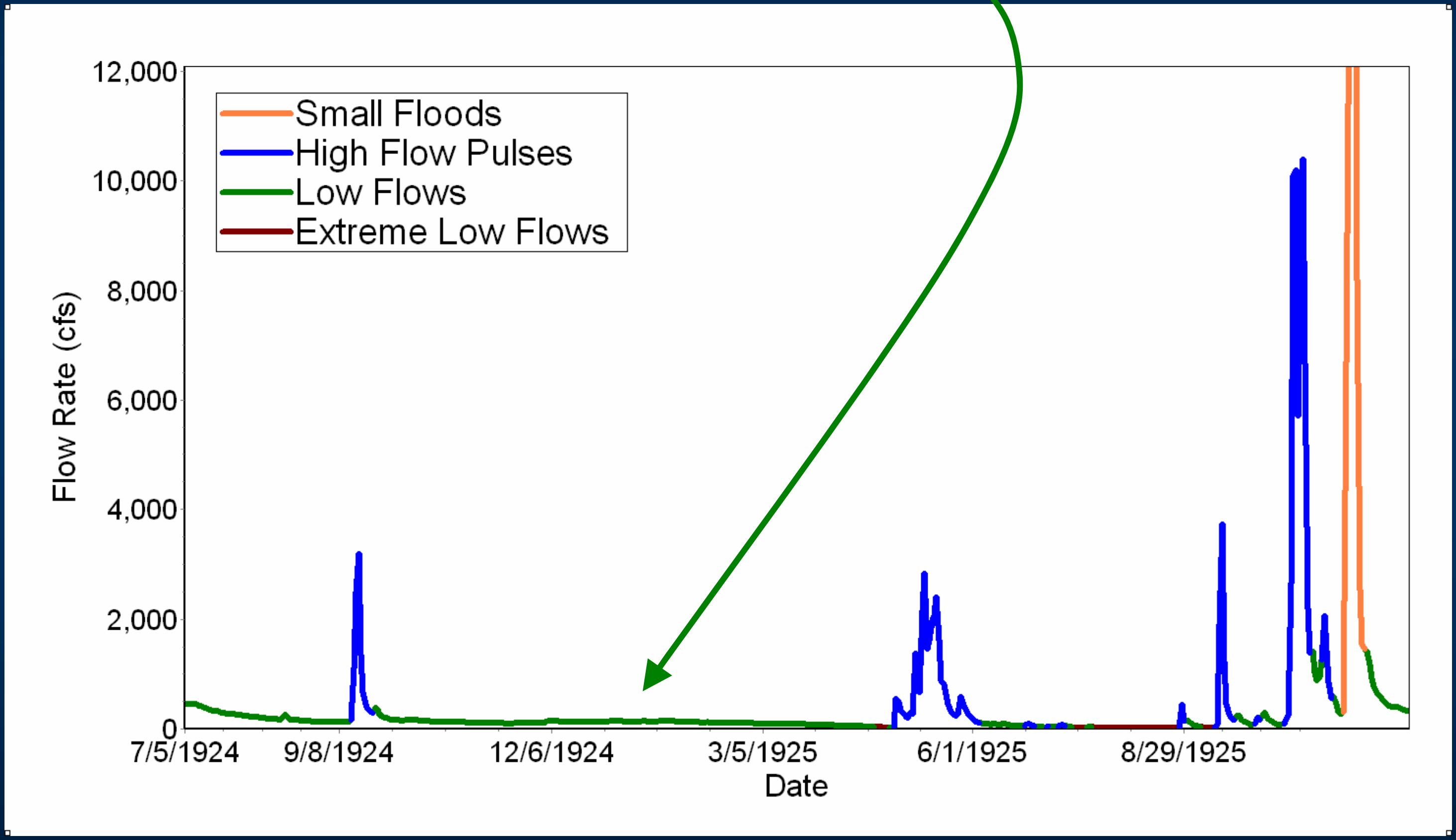


Default Recommendation:

MAX(50th percentile of extreme low flow, 7Q2)

- Calculated by month or season
- Percentile can be changed by user
- User enters 7Q2
- Assigned frequency of subsistence flows can be based on historical frequencies, e.g. 2.5% of the time.

Base Flows



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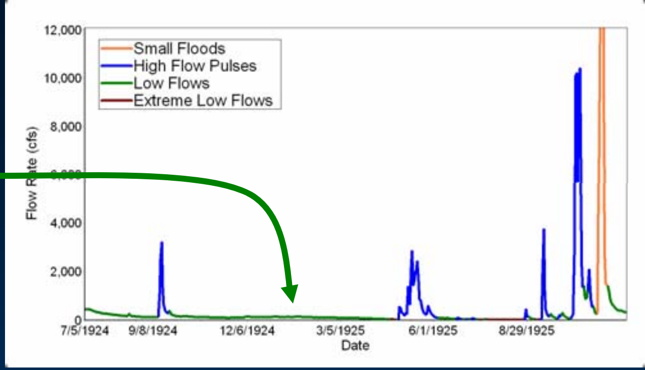

Base Flows

Default Recommendation:

Wet Hydrologic Condition	=	MAX(75th %-ile of base flows, 7Q2)
Average Hydrologic Condition	=	MAX(50th %-ile of base flows, 7Q2)
Dry Hydrologic Condition	=	MAX(25th %-ile of base flows, 7Q2)

- Calculated by month or season

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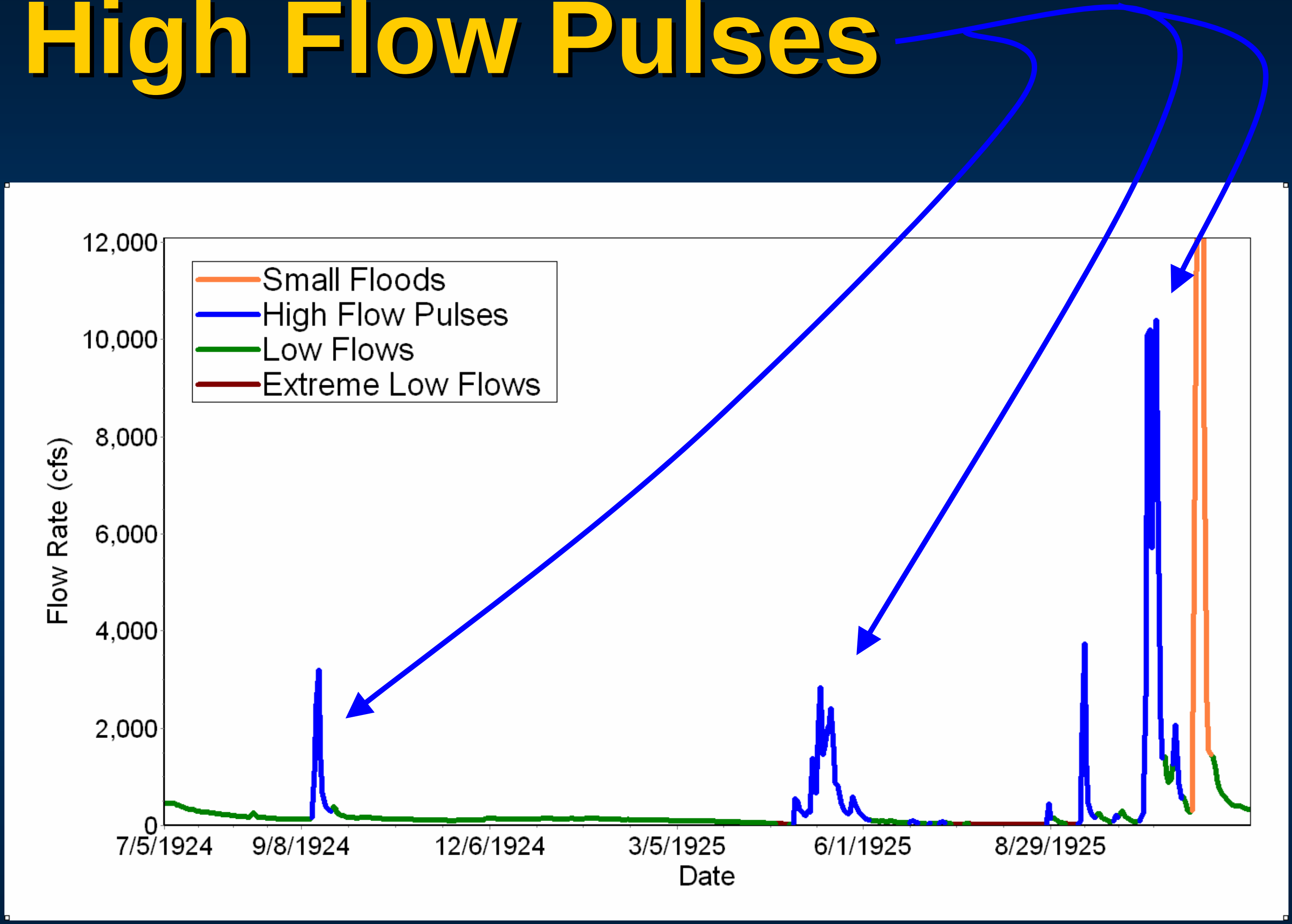
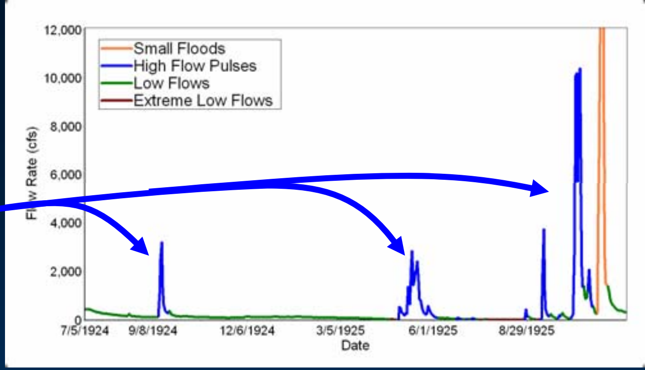
High Flow Pulses



High Flow Pulses



Default Recommendation:

Wet Hydrologic Condition	=	75th %-ile of peak, volume, and duration
Average Hydrologic Condition	=	50th %-ile of peak, volume, and duration
Dry Hydrologic Condition	=	25th %-ile of peak, volume, and duration

- "Qualifying" HFPs identified in period of record and frequency recommendations made accordingly
- Calculated by season

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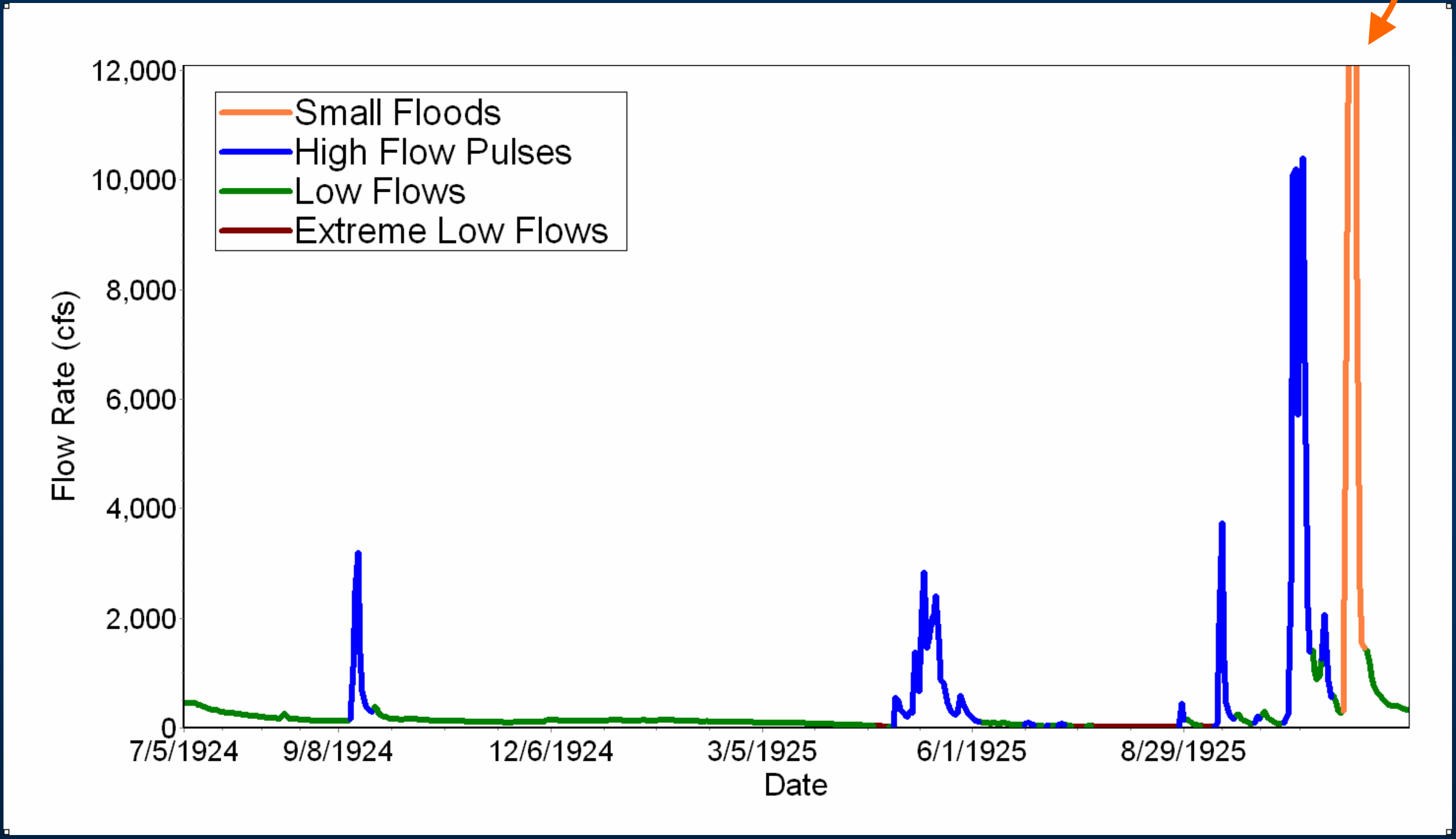
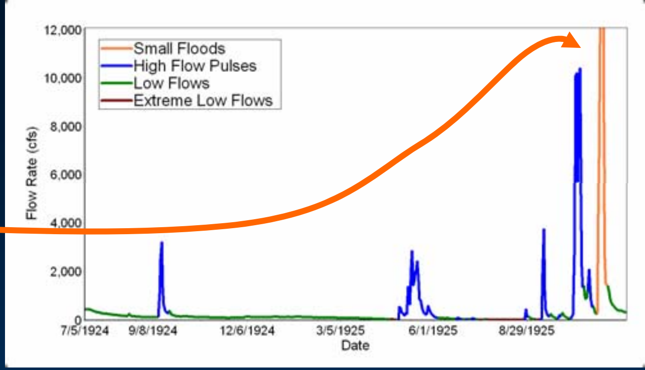
Overbank Flows



Overbank Flows



Default Recommendation:

Median of Peak, Duration, and Volume

- Frequency based on historical number of overbank events and expressed as a return interval
- No "hydrologic condition"

Hydrologic Condition

- Example frequencies as percent of time:

  2.5% for subsistence

  22.5% for dry

  50% for average

  25% for wet

$\Sigma = 100\%$

- Variety of trigger options

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Example Results Matrix

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The Fine Print

- All numerical values in this presentation are for example purposes only!
- Many decisions are required
- HEFR has some flexibility, but enhancements will probably be desired
- Results need to be examined from multiple perspectives
- Does not explicitly address freshwater inflows

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HEFR Advantages

- Can be directly applied anywhere a sufficient hydrologic period of record is available
- Can be indirectly applied at ungaged locations using a variety of methods
- Efficient
- Flexibility in both IFC assignments and final statistics
- Has the “look and feel” of SB2/SB3/flow regime concepts

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HEFR Disadvantages

- Only uses hydrologic data
- Flexibility means decisions and judgment are required
- No track record of applications in Texas
- Will likely require enhancements by BBEST/SAC and contractors to tailor algorithms

Bottom Line

- **HEFR can efficiently populate a flow matrix to generate a "first cut"**
- **Other disciplines are necessary before reaching a "final" recommendation**
  - Biology
  - Geomorphology
  - Water Quality
- **These disciplines can be used to guide HEFR parameter selection or as direct overlays that replace HEFR-generated flow recommendations**

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HEFR Workshop

- ***IF*** **BBEST wants to further consider HEFR:**
  - Looking for about 2 BBEST members plus interested consultants or other stakeholders
  - February 24, 10 AM
  - Espey Consultants offices in Austin
  - RSVP: dan.opdyke@tpwd.state.tx.us

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