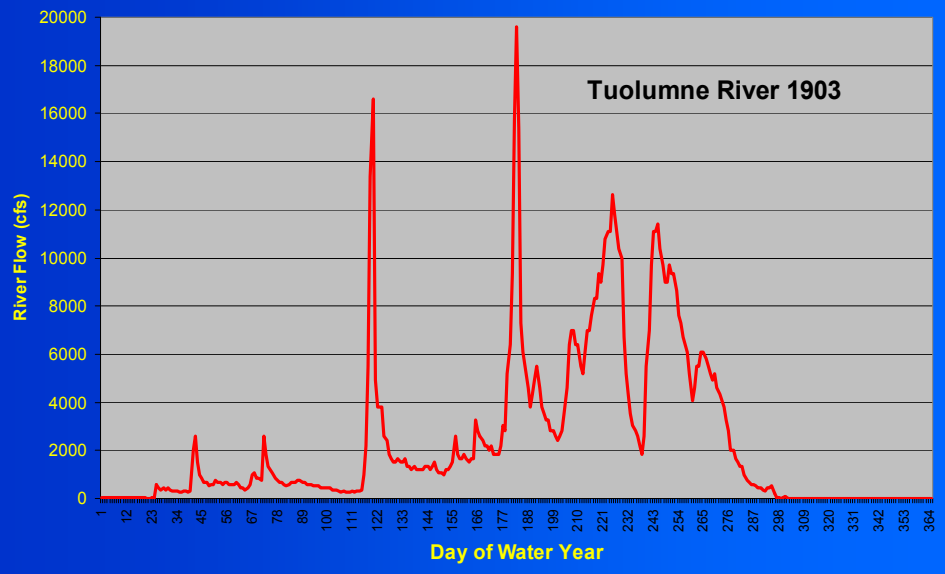
Characterizing Hydrologic Variability and Change:

The "NEW" Indicators of Hydrologic Alteration (IHA) Software

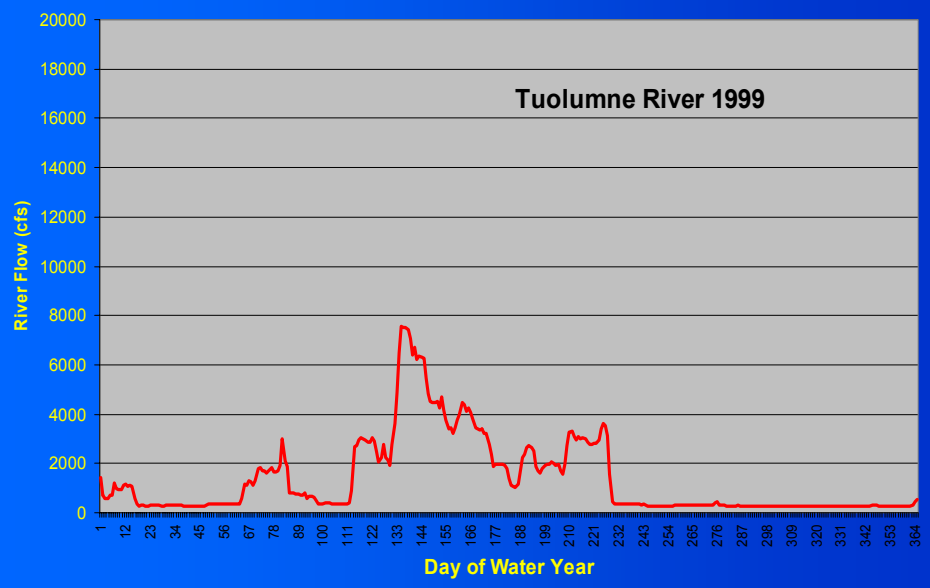
Brian Richter

The Nature Conservancy®

Comparing Hydrographs



Pre-Dam



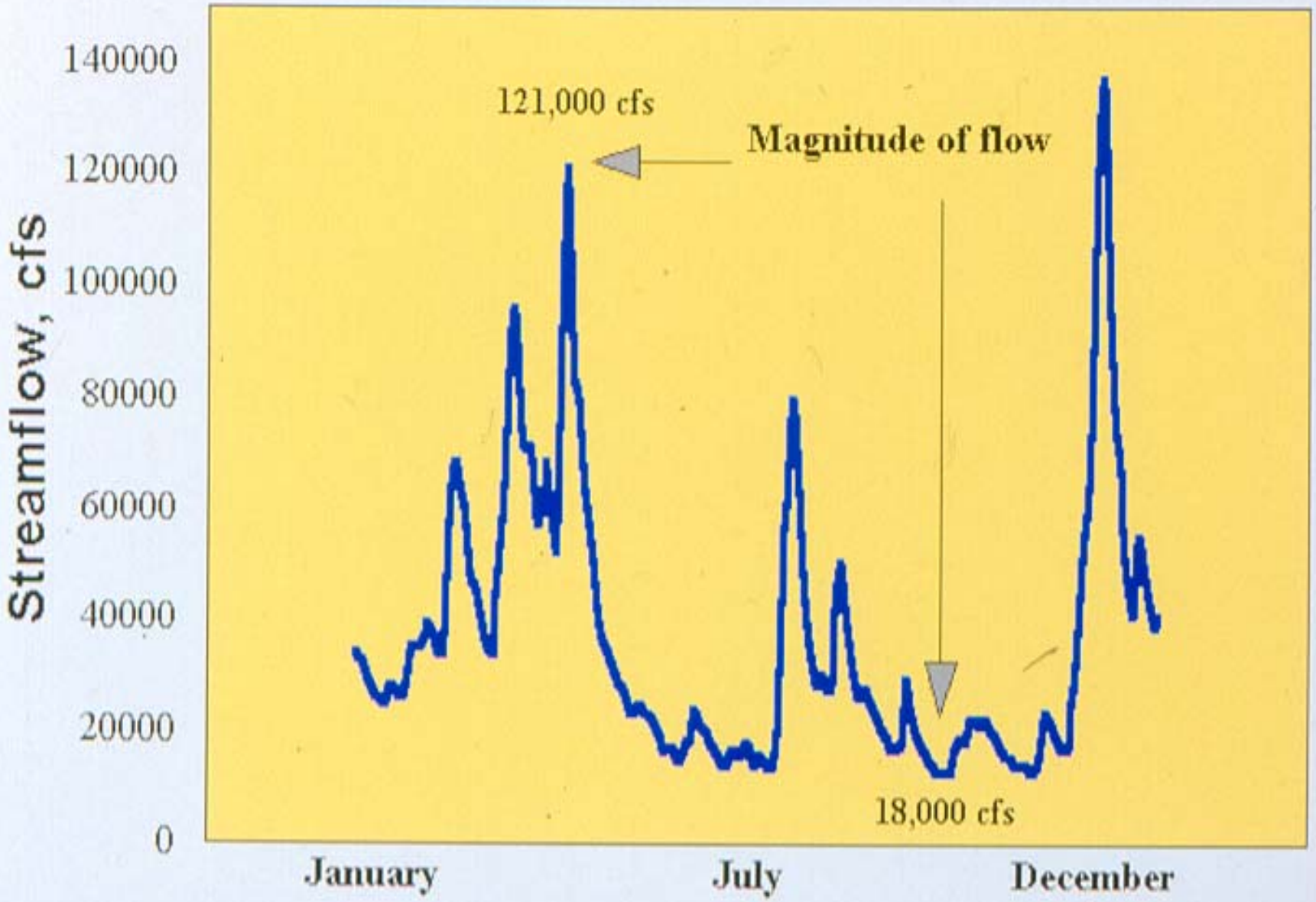
Post-Dam

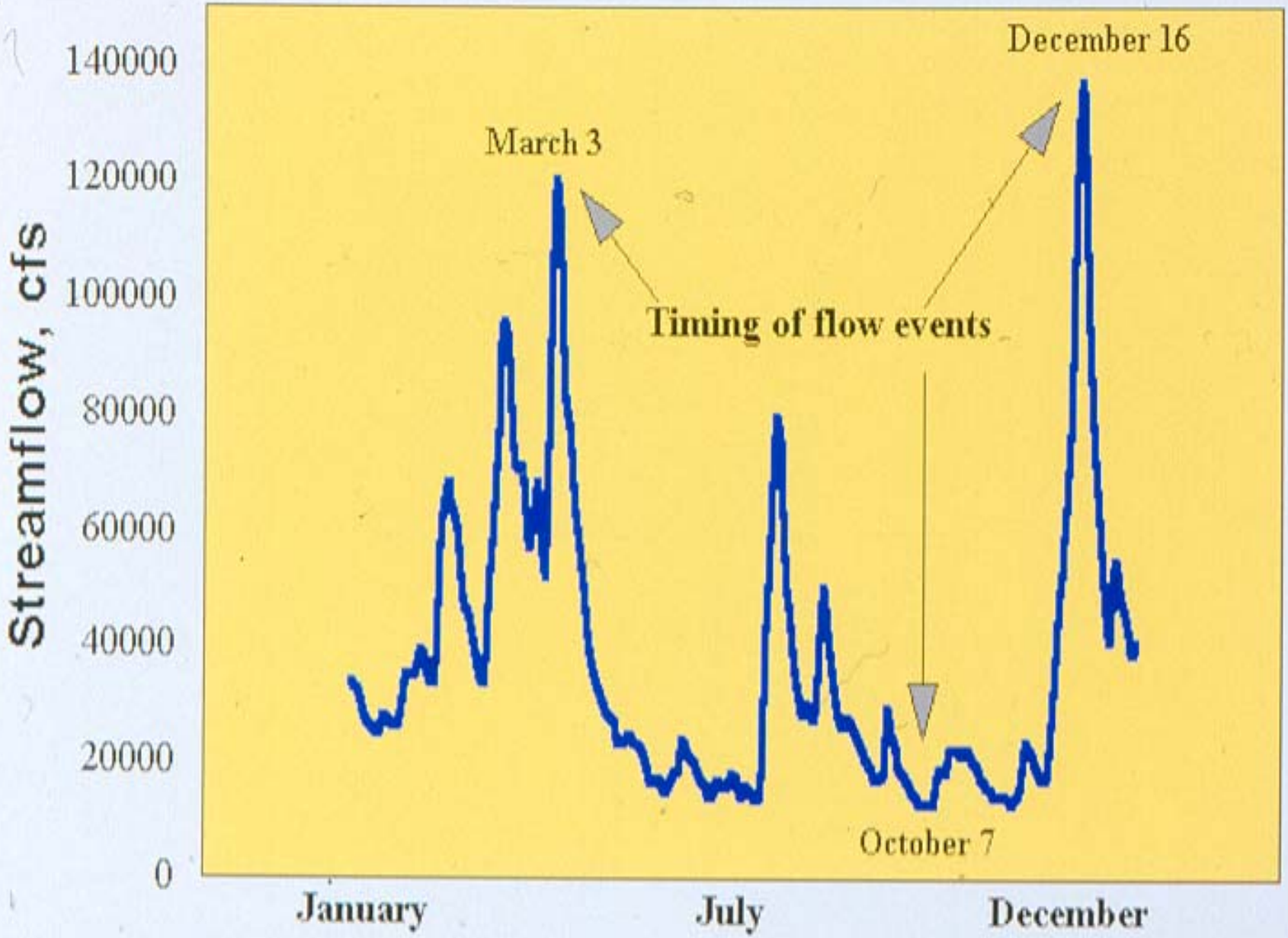
The IHA Software

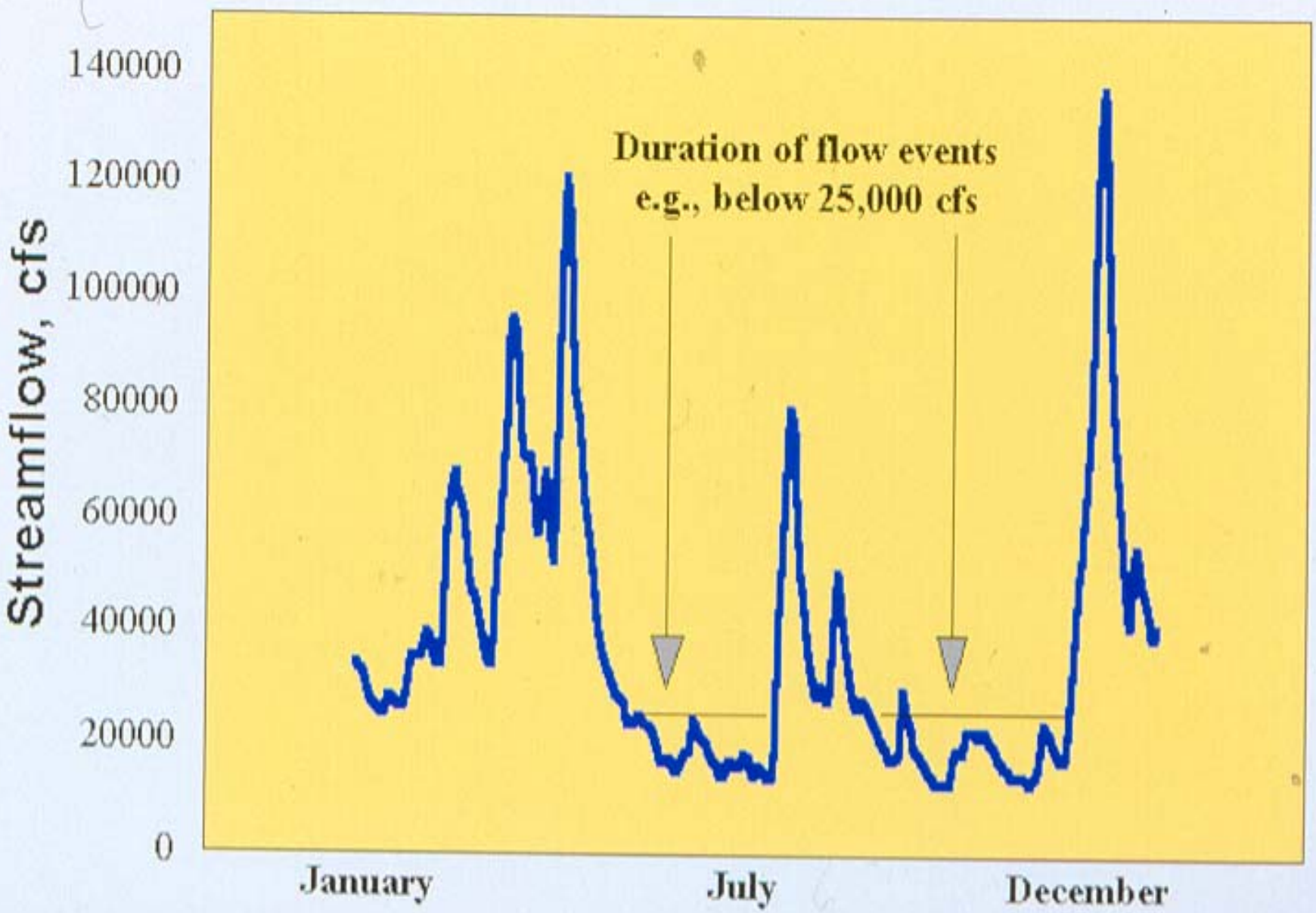
- Computes hydrologic statistics that are ecologically relevant -- for each year, and for selected periods of record
- These statistical parameters are sensitive to various forms of hydrologic alteration by human activities
- Enables comparison of statistics between two time periods, or assessment of gradual trends over time
- Can be used to explore flow-ecology relationships
- Can be used to test alternative water management scenarios

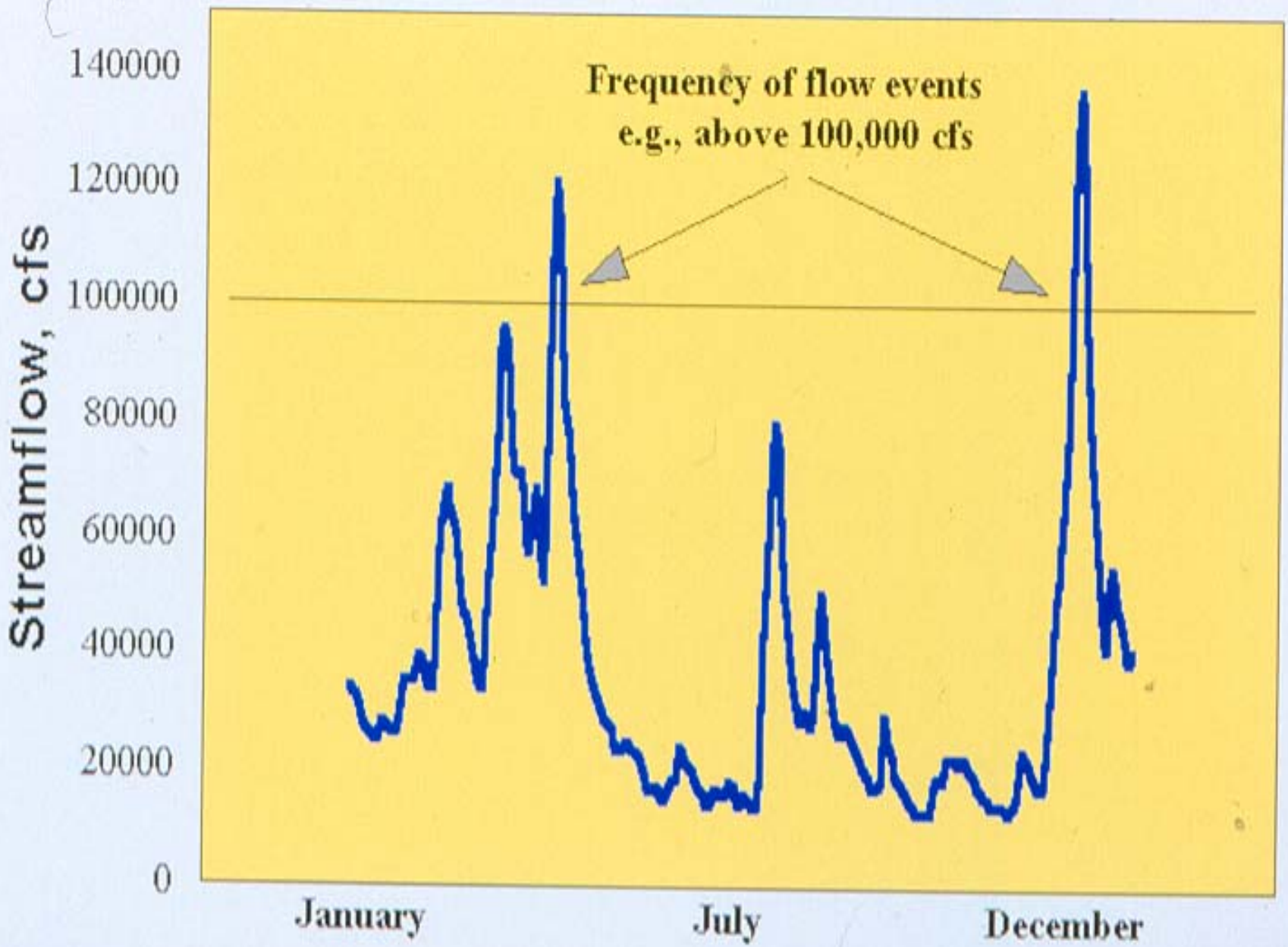
Five Characteristics of Flow Regimes

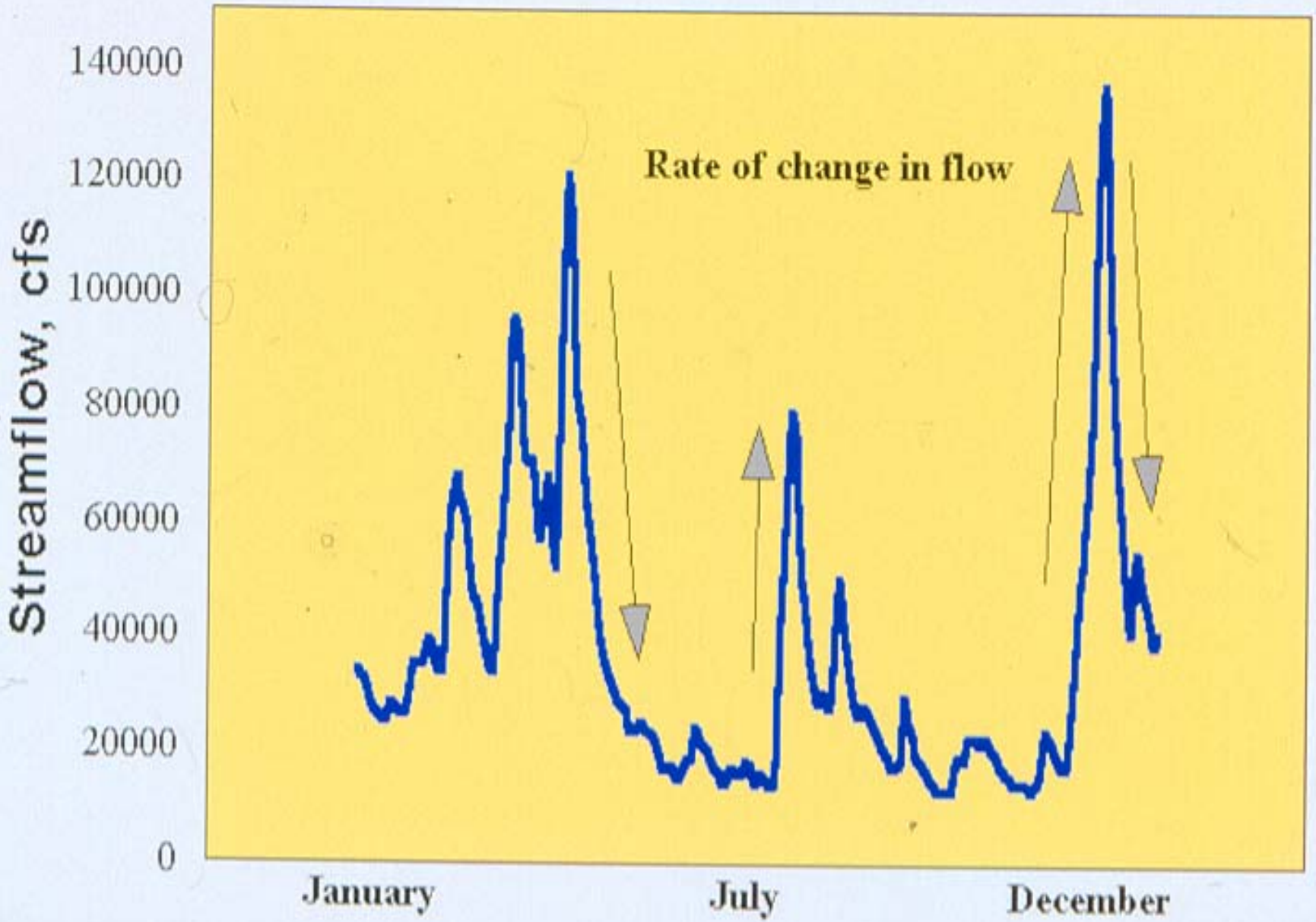
- Magnitude
- Duration
- Frequency
- Timing
- Rate of change


Streamflow, cfs
140000
120000
100000
80000
60000
40000
20000
0
121,000 cfs
Magnitude of flow
18,000 cfs
January
July
December


Streamflow, cfs
140000
120000
100000
80000
60000
40000
20000
0
March 3
December 16
Timing of flow events
October 7
January
July
December

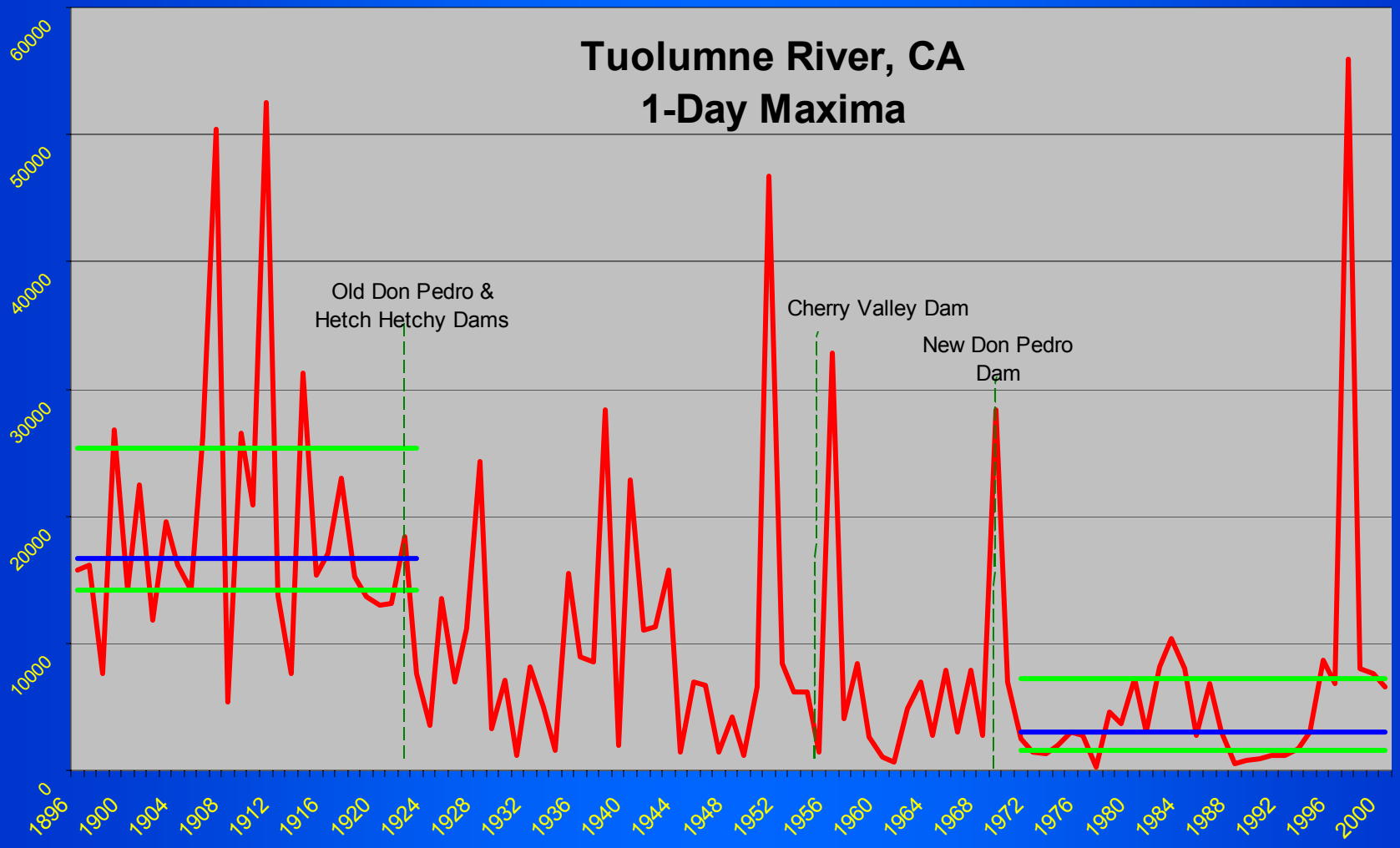

Streamflow, cfs
140000
120000
100000
80000
60000
40000
20000
0
Duration of flow events
e.g., below 25,000 cfs
January
July
December

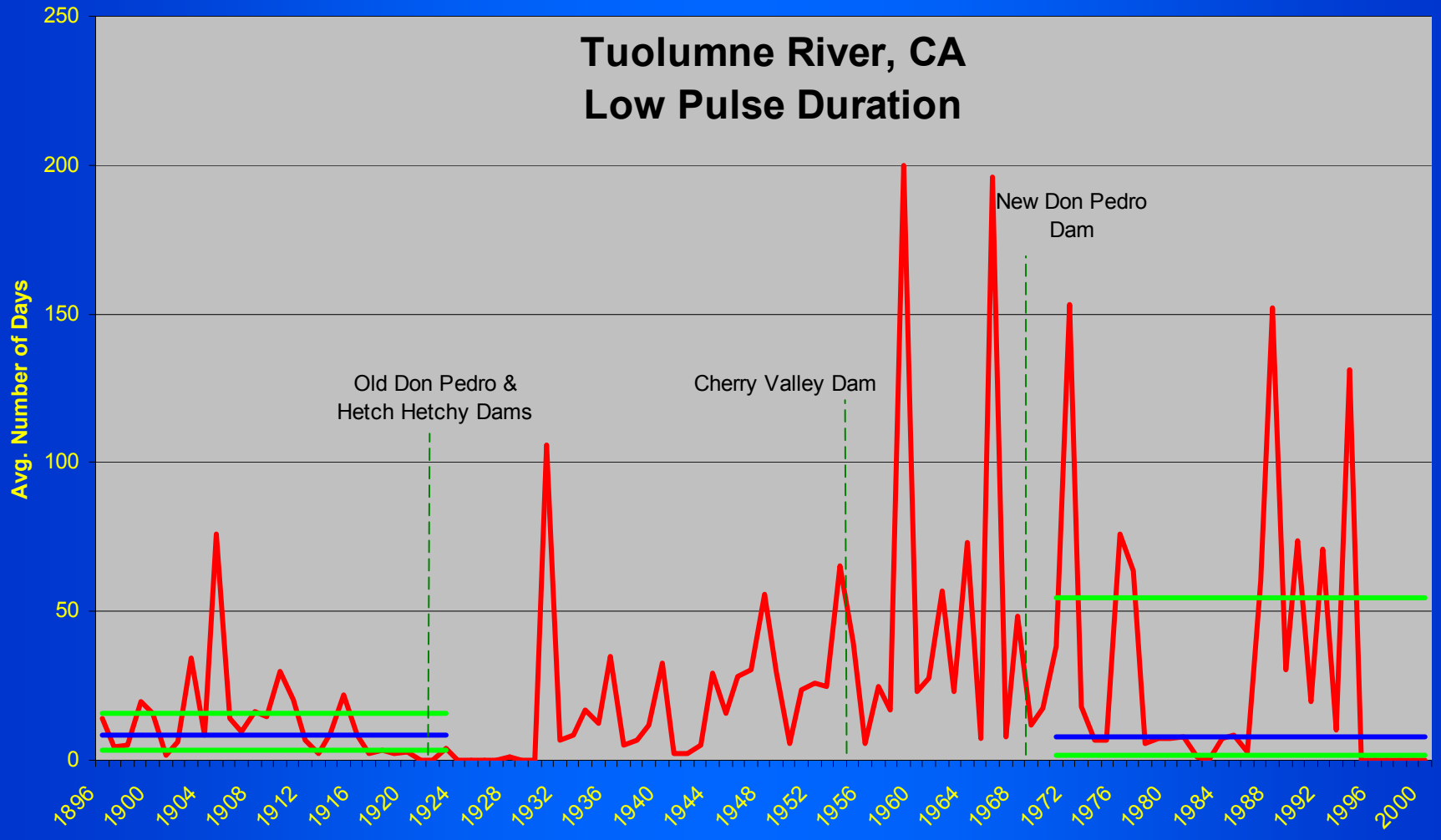

Frequency of flow events
e.g., above 100,000 cfs
Streamflow, cfs
140000
120000
100000
80000
60000
40000
20000
0
January
July
December


Streamflow, cfs
140000
120000
100000
80000
60000
40000
20000
0
Rate of change in flow
January
July
December

IHA Annual Statistics (33 different parameters)

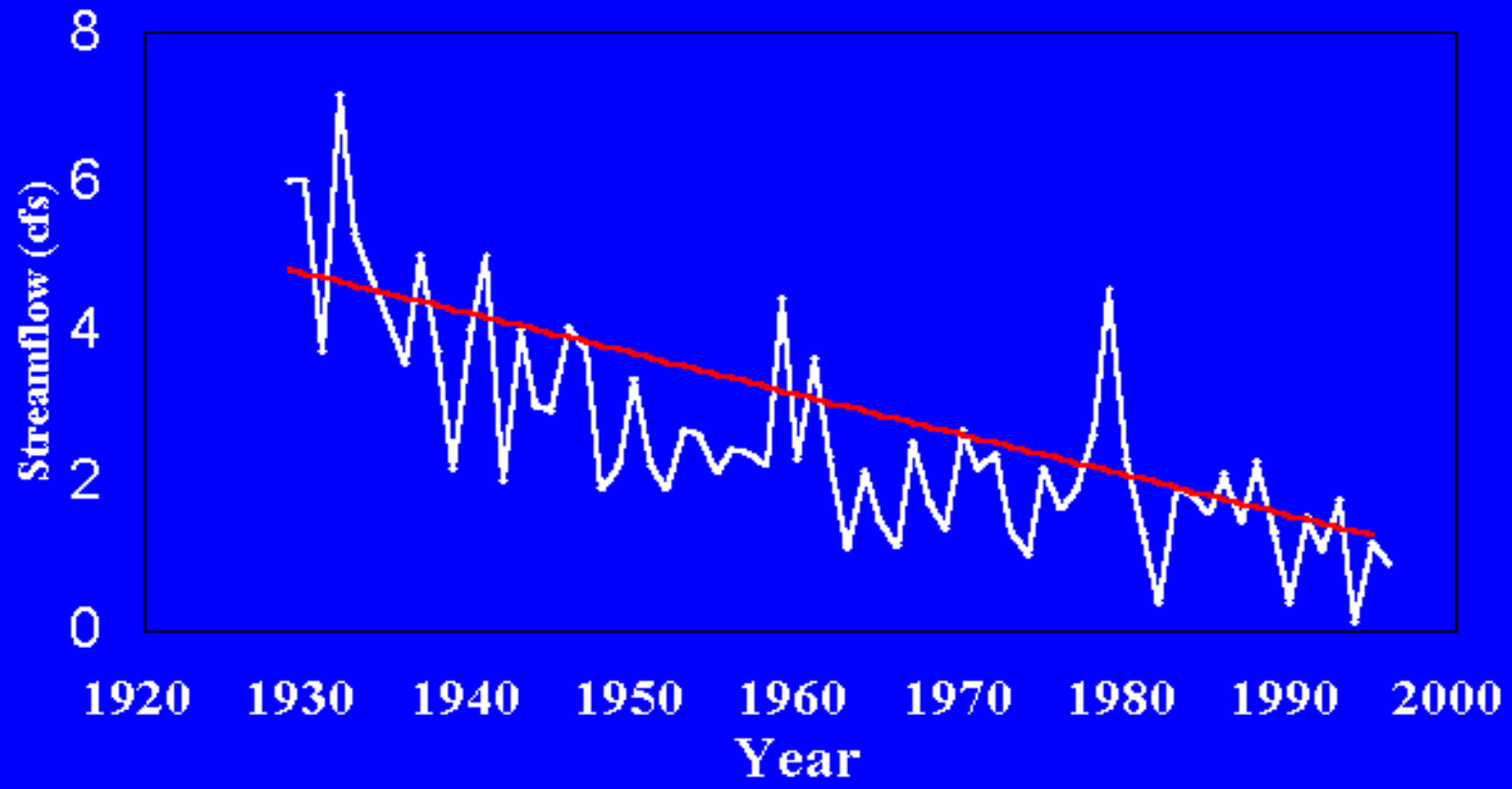
- Monthly averages
- Magnitude of annual extremes (1- to 90-day highs and lows)
- Timing of annual extremes
- Frequency & duration of high & low pulses
- Rates of flow changes
- Frequency of flow reversals
- Base flow index

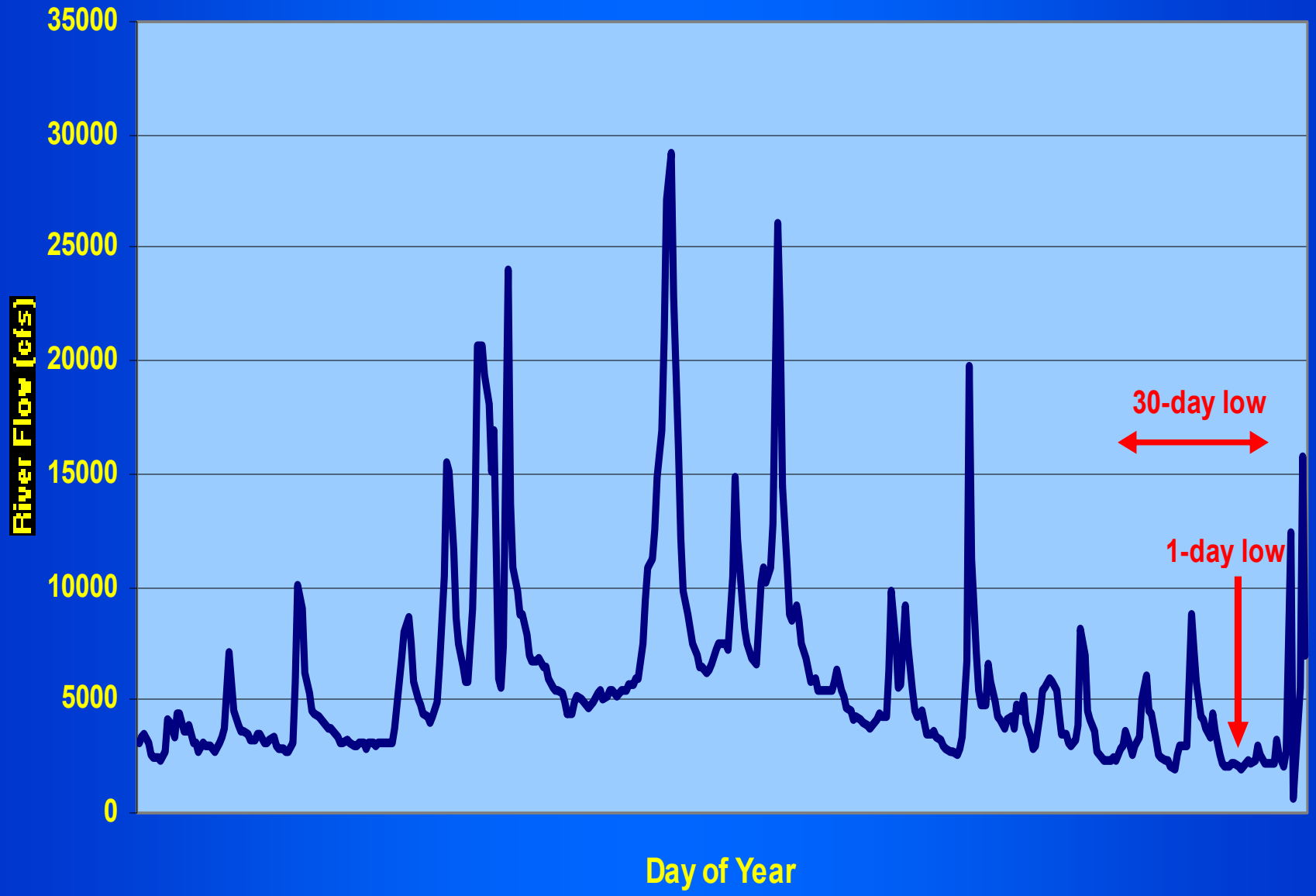

Tuolumne River, CA
1-Day Maxima
Old Don Pedro &
Hetch Hetchy Dams
Cherry Valley Dam
New Don Pedro
Dam
60000
50000
40000
30000
20000
10000
0
1896
1900
1904
1908
1912
1916
1920
1924
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000

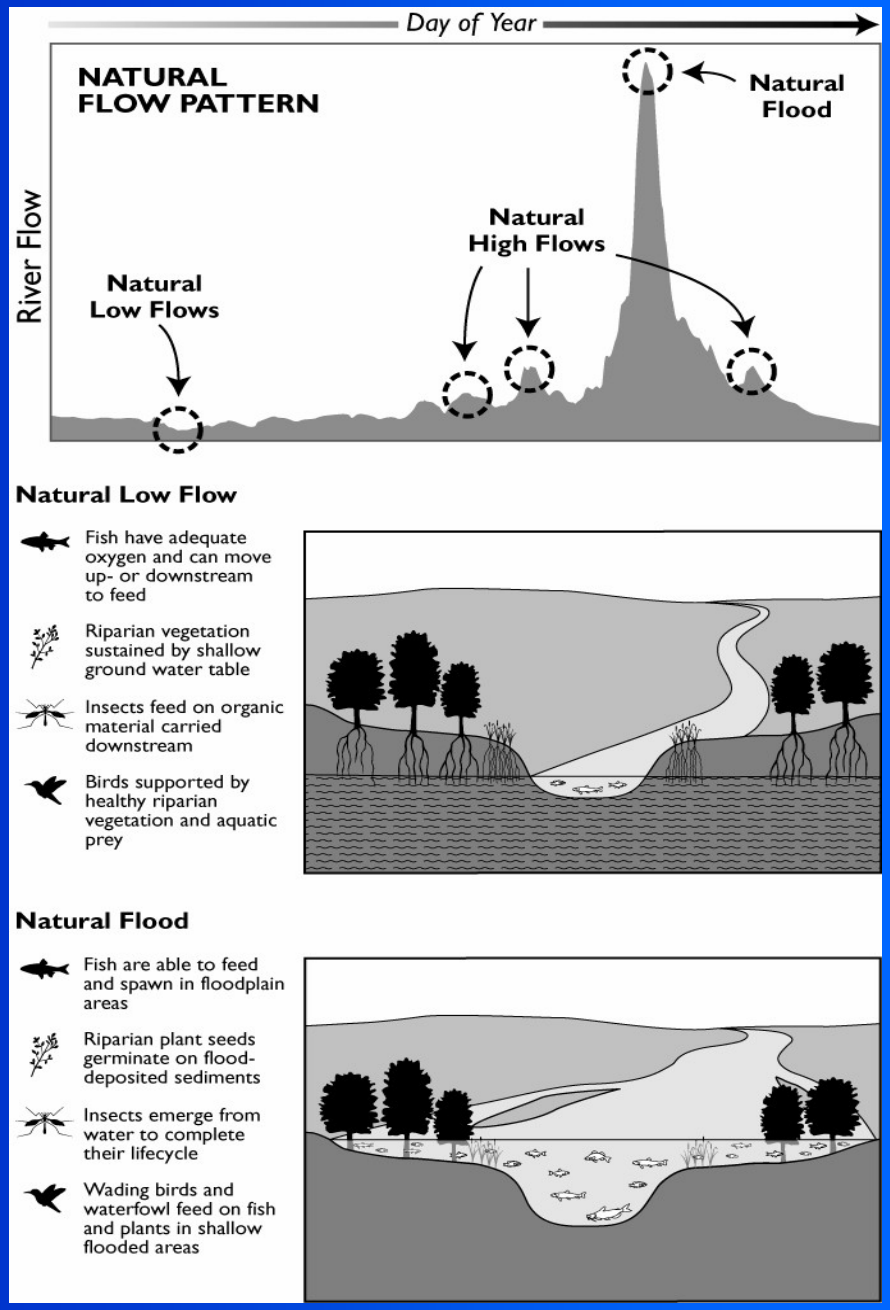

Tuolumne River, CA
Low Pulse Duration
Avg. Number of Days
250
200
150
100
50
0
Old Don Pedro &
Hetch Hetchy Dams
Cherry Valley Dam
New Don Pedro
Dam
1896
1900
1904
1908
1912
1916
1920
1924
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000

San Pedro River at Charleston, AZ

7-day low flow trends



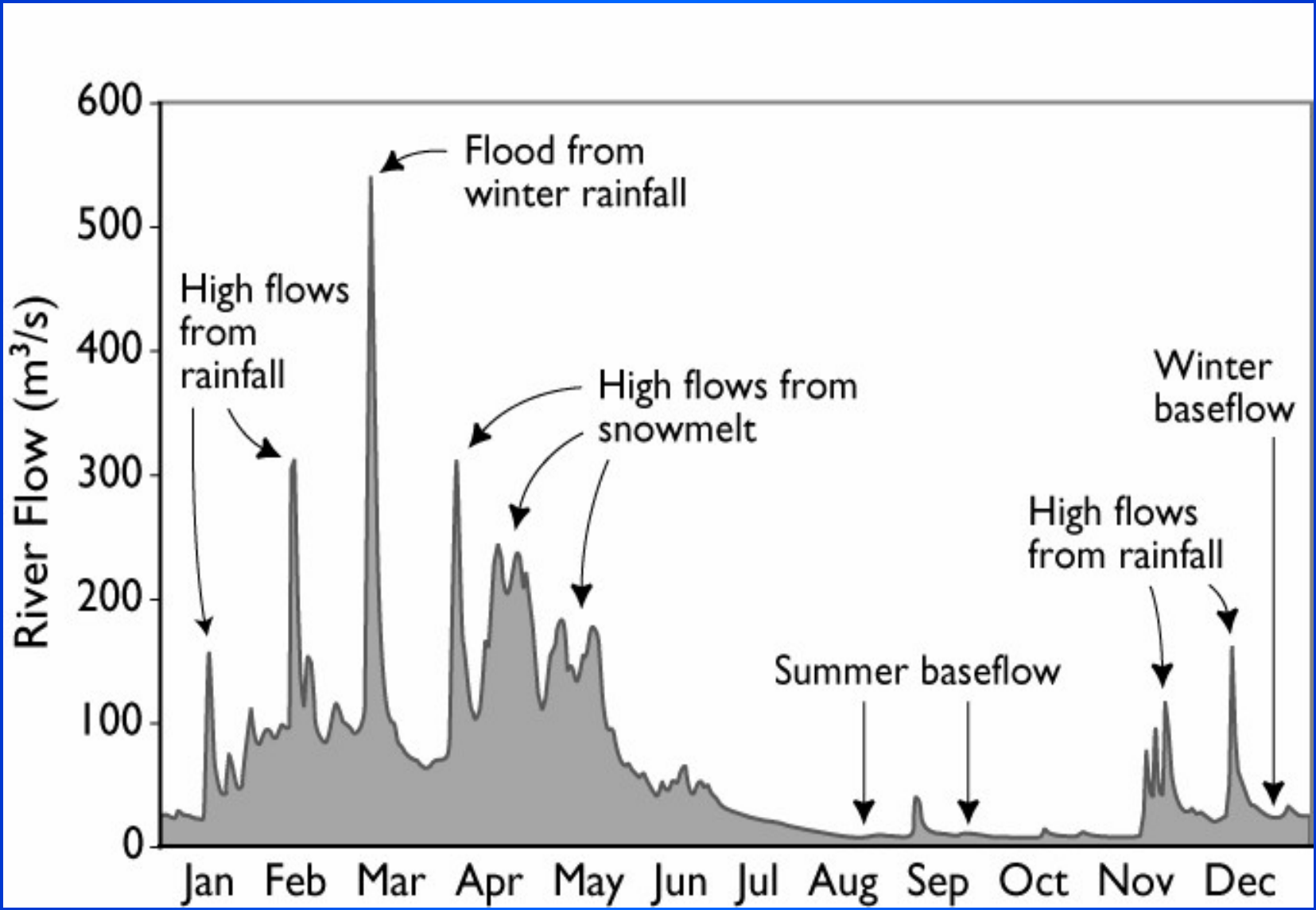

35000
30000
25000
20000
15000
10000
5000
0
River Flow [cfs]
30-day low
1-day low
Day of Year

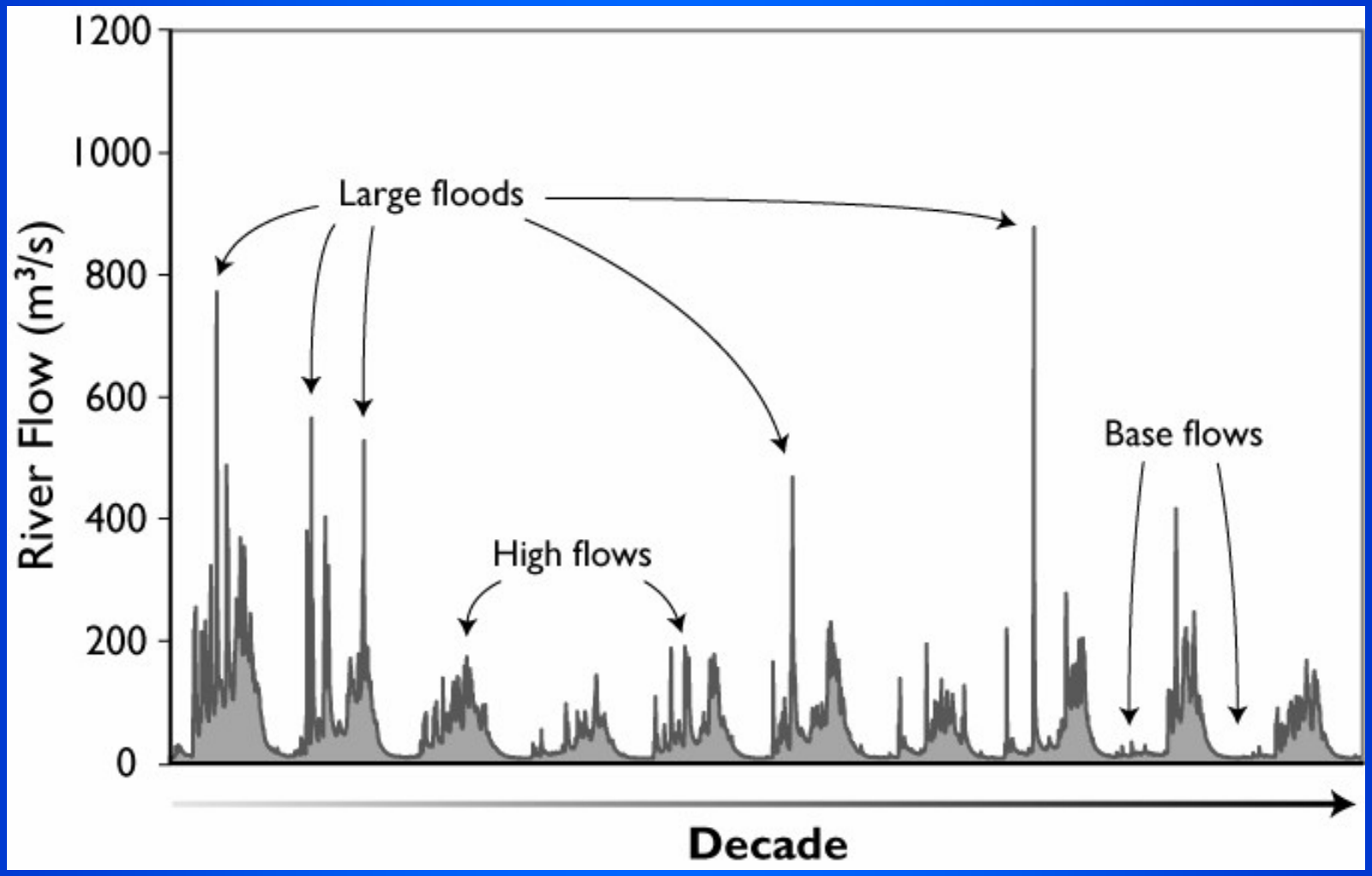


From "Rivers for Life: Managing Water for People and Nature" by Sandra Postel and Brian Richter, Island Press

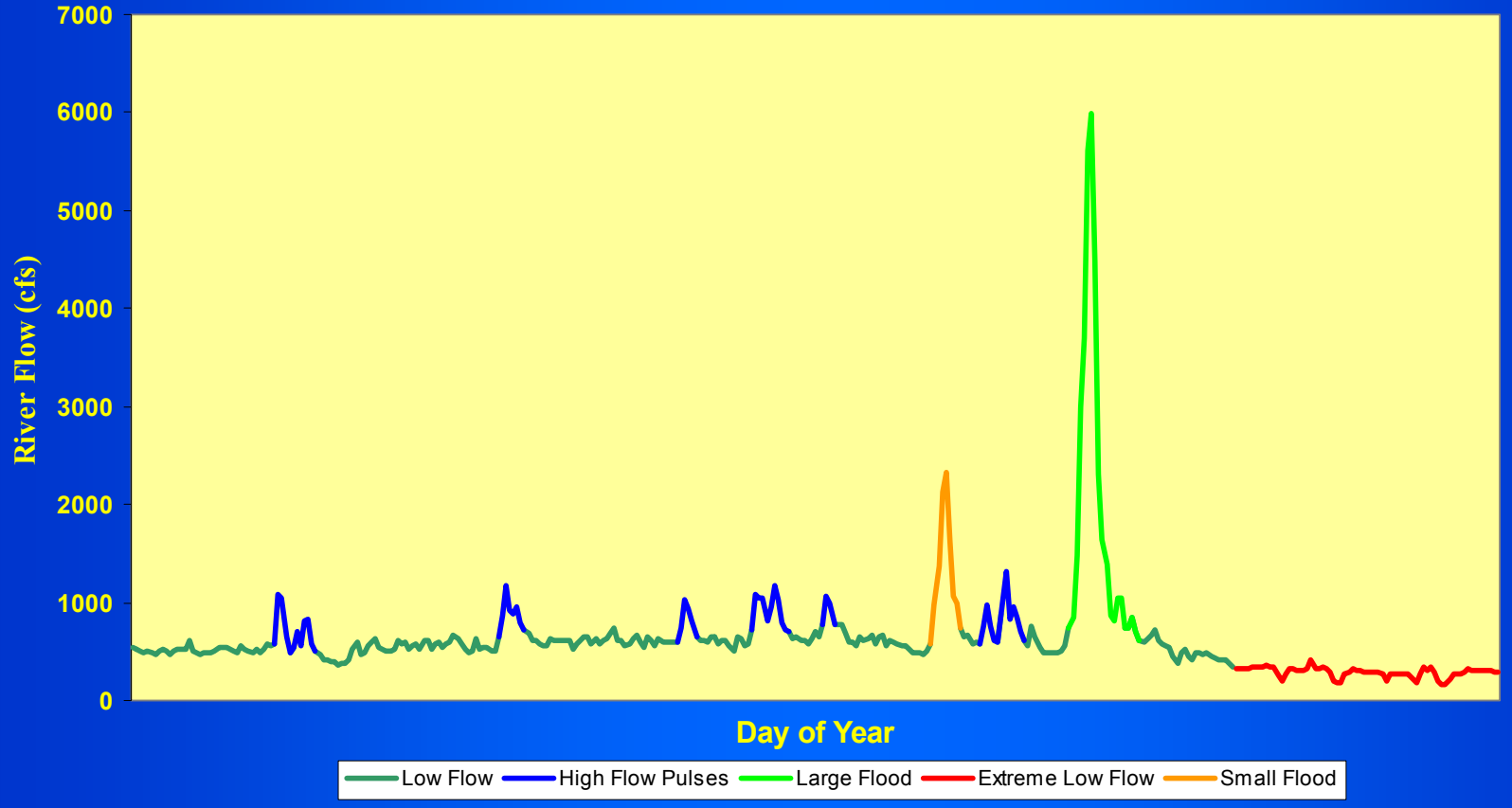
New Directions: Environmental Flow Components

- Extreme low flows
- Low flows
- High flow pulses
- Small floods
- Large floods


River Flow (m³/s)
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Flood from winter rainfall
High flows from rainfall
High flows from snowmelt
Winter baseflow
High flows from rainfall
Summer baseflow


1200
1000
800
600
400
200
0
River Flow (m³/s)
Large floods
High flows
Base flows
Decade

Environmental Flow Components



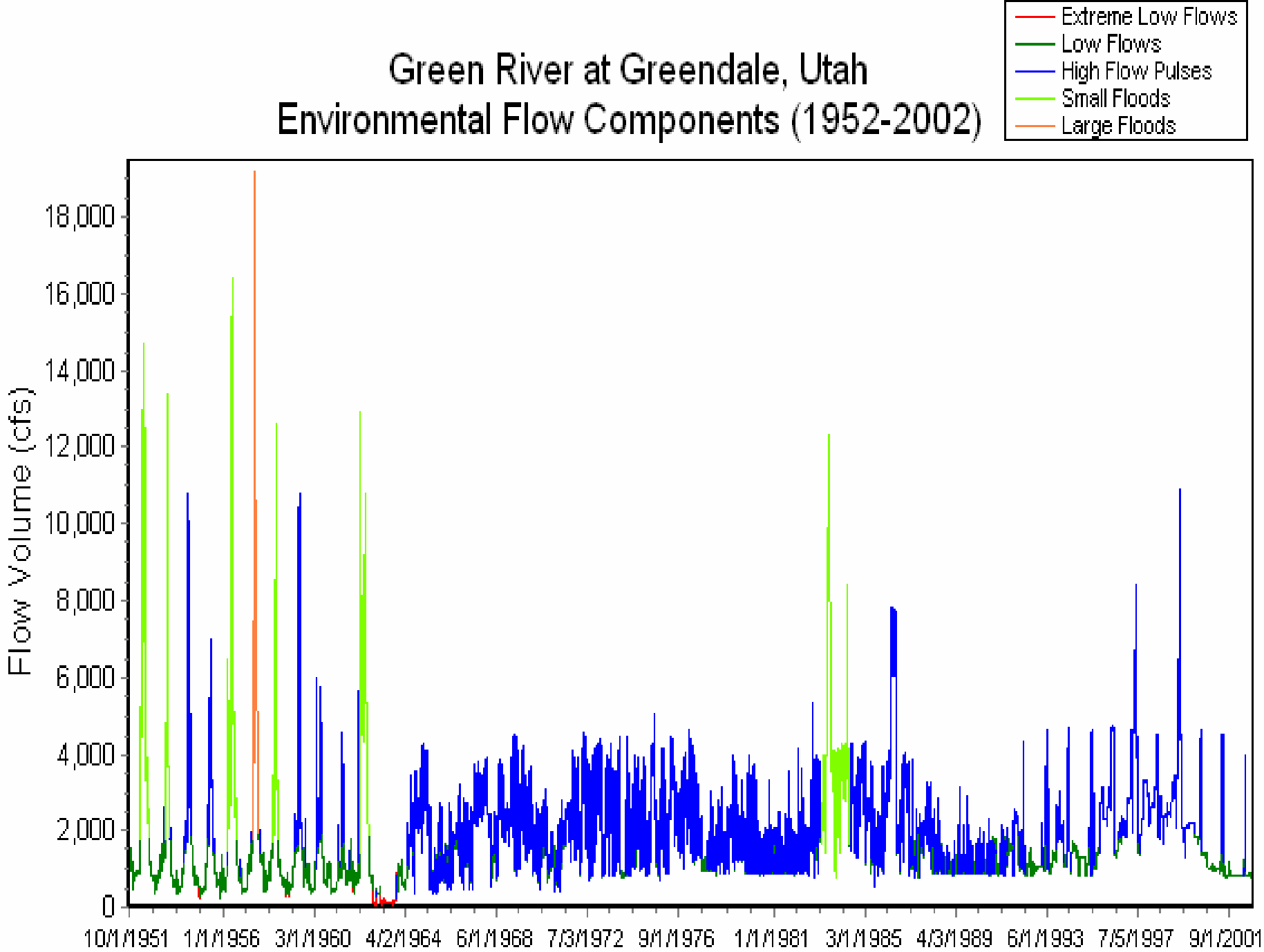
Environmental Flow Components (34 new parameters)

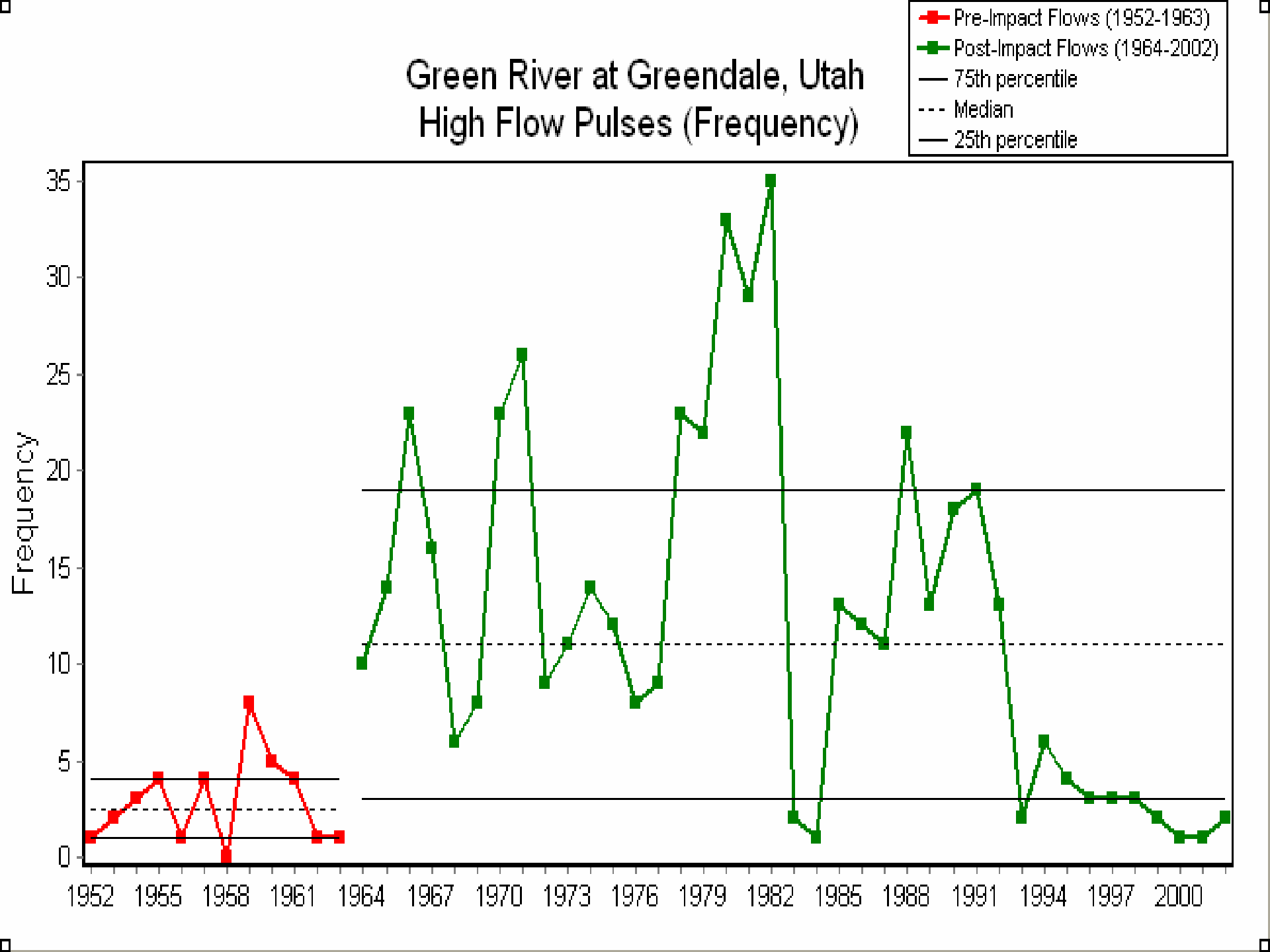
5 Event Types

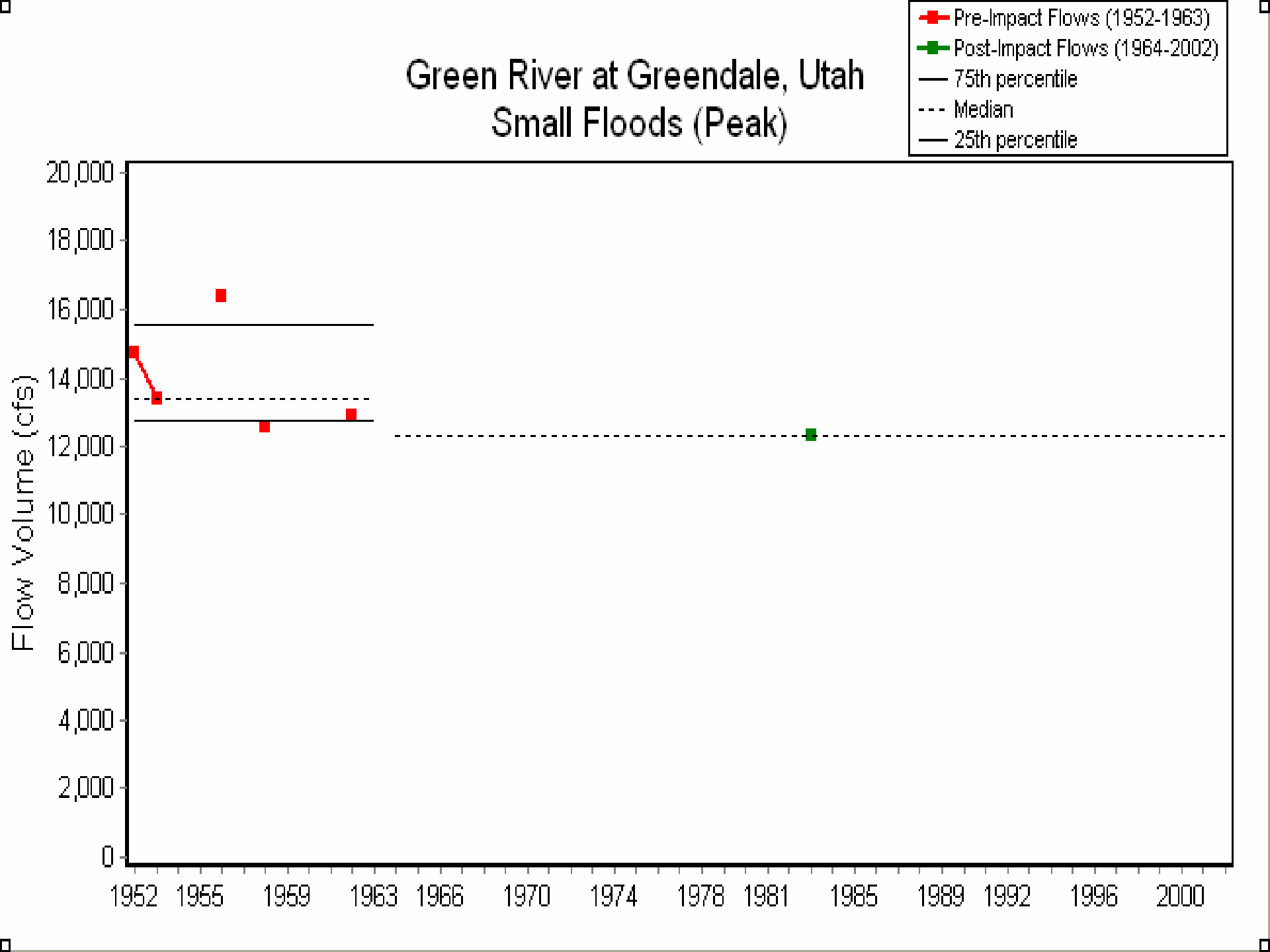
- Extreme low flows
- Low flows
- High flow pulses
- Small floods
- Large floods

5 Characteristics

- Magnitude
- Timing
- Duration
- Frequency
- Rate of change


Green River at Greendale, Utah
Environmental Flow Components (1952-2002)
Extreme Low Flows
Low Flows
High Flow Pulses
Small Floods
Large Floods
Flow Volume (cfs)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
10/1/1951
1/1/1956
3/1/1960
4/2/1964
6/1/1968
7/3/1972
9/1/1976
1/1/1981
3/1/1985
4/3/1989
6/1/1993
7/5/1997
9/1/2001


Green River at Greendale, Utah
High Flow Pulses (Frequency)
Pre-Impact Flows (1952-1963)
Post-Impact Flows (1964-2002)
75th percentile
Median
25th percentile
Frequency
0
5
10
15
20
25
30
35
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000


Green River at Greendale, Utah
Small Floods (Peak)
Pre-Impact Flows (1952-1963)
Post-Impact Flows (1964-2002)
75th percentile
Median
25th percentile
Flow Volume (cfs)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1952
1955
1959
1963
1966
1970
1974
1978
1981
1985
1989
1992
1996
2000

Limits of Hydrologic Alteration (LOHA) Method

River Health Category	Description of Biological Condition	Limits of Hydrologic Alteration in EFCs
A	*Natural or native condition*	Extreme lows: < 5% Low flows: <10% High-flow pulses:<10% Small floods: <10% Large floods: <15%
B	*Minimal changes in the structure of the biotic community and minimal changes in ecosystem function*	Extreme lows: < 5% Low flows: <10% High-flow pulses:<15% Small floods: <20% Large floods: <20%
C	*Evident changes in structure of the biotic community and minimal changes in ecosystem function*	Extreme lows: <10% Low flows: <15% High-flow pulses:<20% Small floods: <25% Large floods: <25%

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- brichter@tnc.org
- www.freshwaters.org