Sound Watershed Consulting

Creating Functional Water Environments

Assessing the Ecological Integrity of the Walker River: How "Natural" is the Walker River Hydrograph

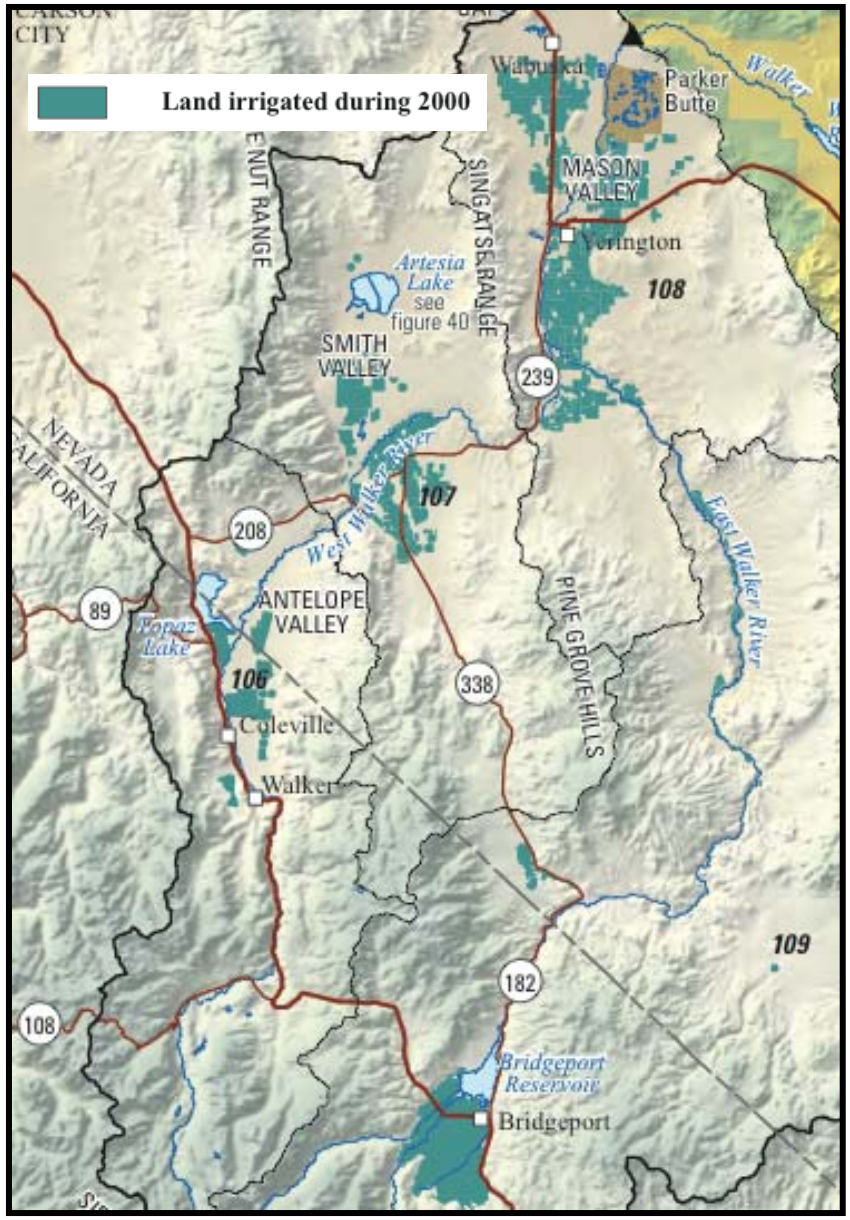
Mike Liquori

Jeff Prancevic

History

150+ years of diversions

55%-131% of natural inflows diverted (2000-2007)

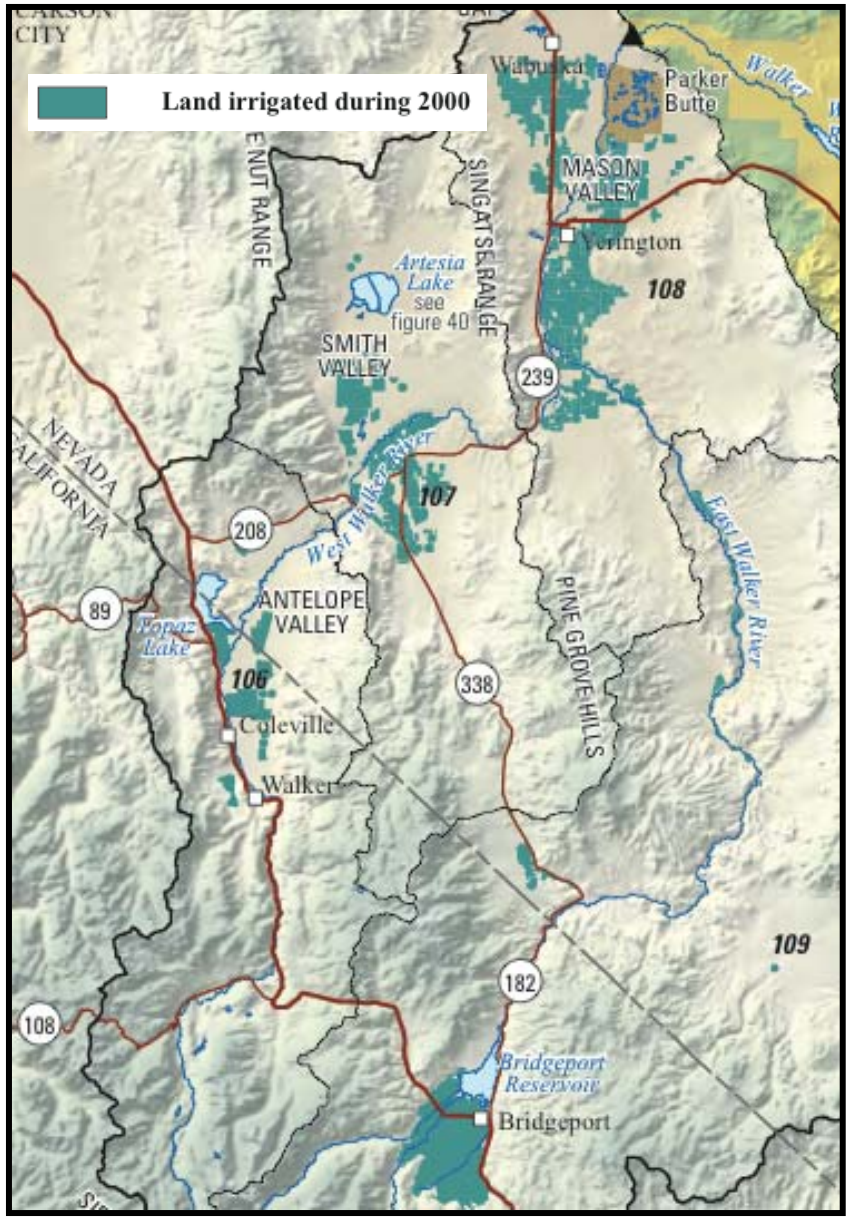


History

150+ years of diversions

55%-131% of natural inflows diverted (2000-2007)

How do these diversions affect ecosystem processes?



Poff et al 1997

The Natural Flow Regime

A paradigm for river conservation and restoration

N. LeRoy Poff, J. David Allan, Mark B. Bain, James R. Karr, Karen L. Prestegaard, Brian D. Richter, Richard E. Sparks, and Julie C. Stromberg

Humans have long been fascinated by the dynamism of free-flowing waters. Yet we have expended great effort to tame rivers for transportation, water supply, flood control, agriculture, and power generation. It is now recognized that harnessing of streams and rivers comes at great cost: Many rivers no longer support socially valuing. However, current management approaches often fail to recognize the fundamental scientific principle that the integrity of flowing water systems depends largely on their natural dynamic character; as a result, these methods frequently prevent successful river conservation or restoration. Streamflow quantity and timing are critical components of water

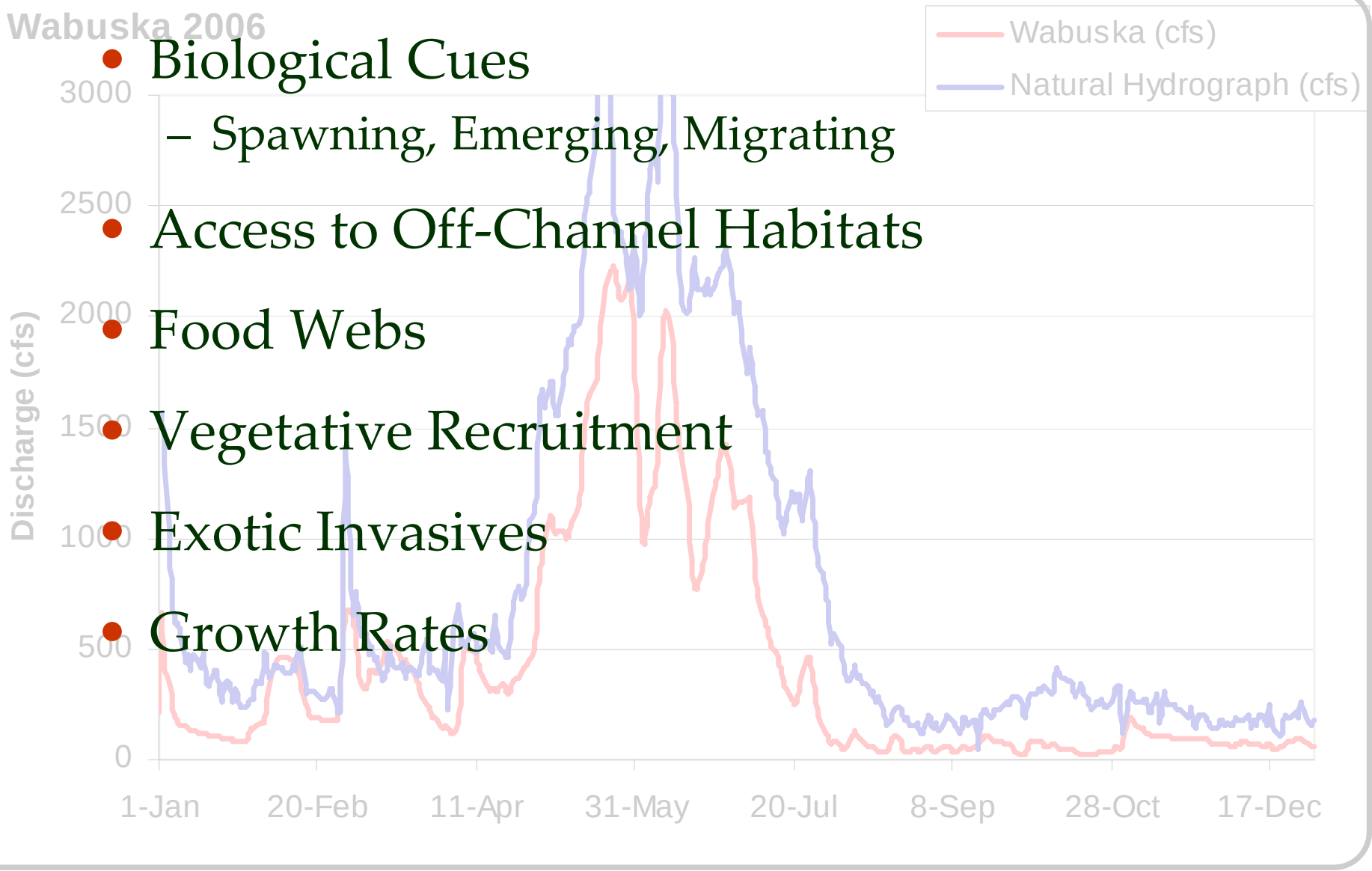
The ecological integrity of river ecosystems depends on their natural dynamic character

Poff Natural Flow Regime

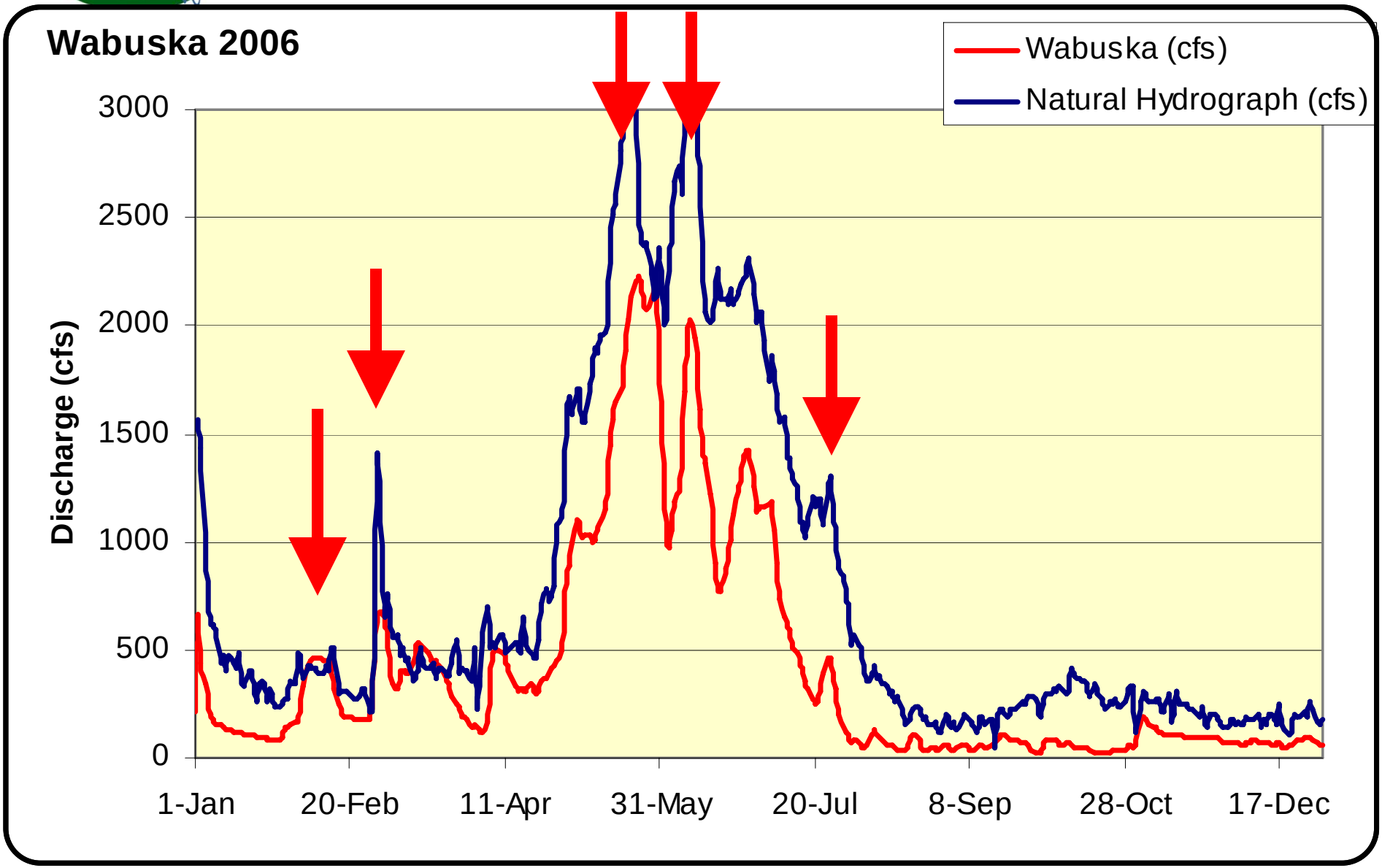
- **Timing**
  - Seasonal Peaks
  - Prolonged Low Flows
  - Prolonged Inundation
- **Peak Frequency & Magnitude**
  - Variation
  - Stabilization
- **Rate of Change**
  - Stage Rate of Change
  - Accelerated Flood Recession
- **Duration**
  - Peak Duration
  - Baseflow Duration
  - Baseflow Spikes

Ecological Impacts from Timing

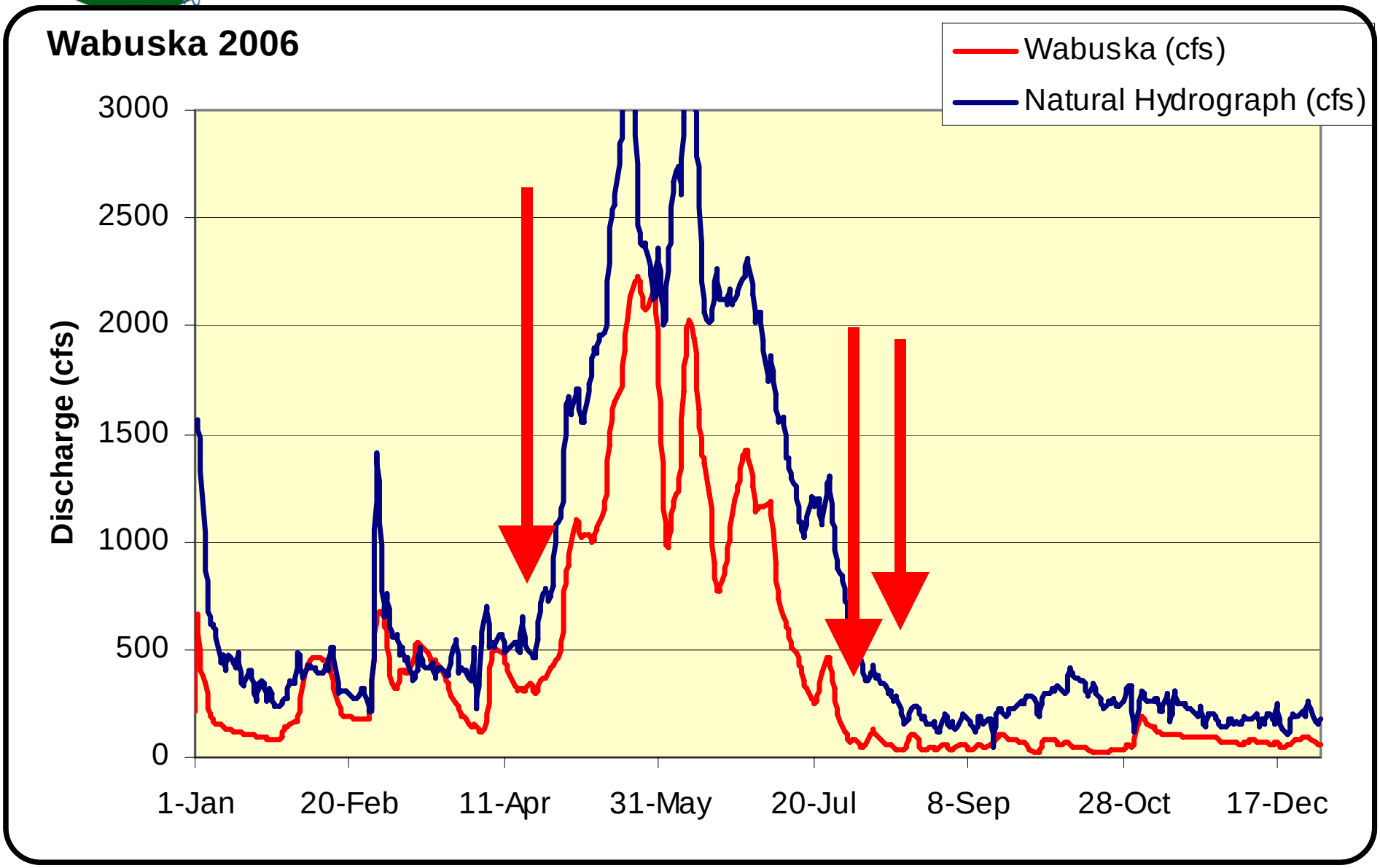
- Biological Cues
  - Spawning, Emerging, Migrating
- Access to Off-Channel Habitats
- Food Webs
- Vegetative Recruitment
- Exotic Invasives
- Growth Rates



Timing


Wabuska 2006
Wabuska (cfs)
Natural Hydrograph (cfs)
Discharge (cfs)
3000
2500
2000
1500
1000
500
0
1-Jan
20-Feb
11-Apr
31-May
20-Jul
8-Sep
28-Oct
17-Dec

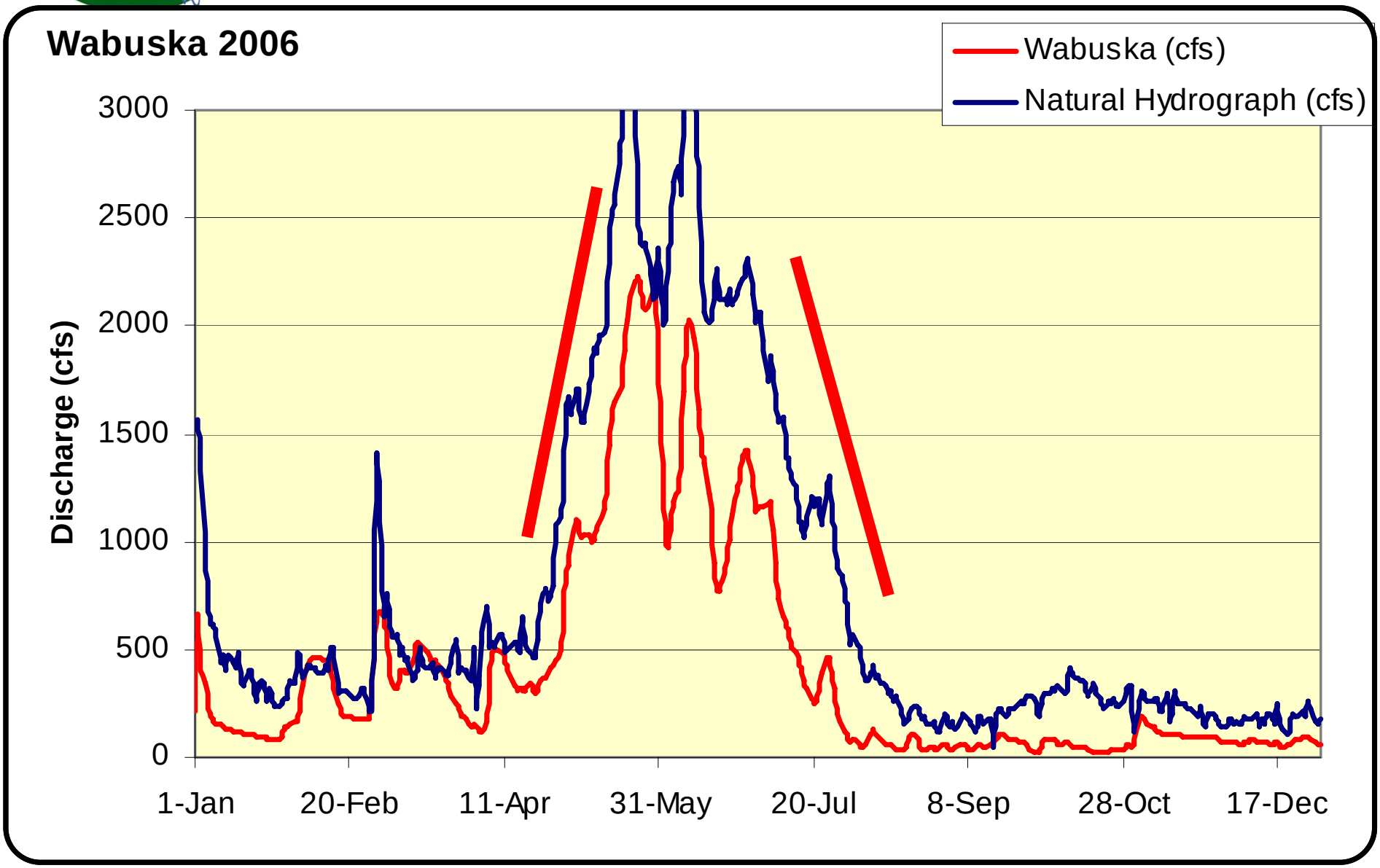
Timing


Wabuska 2006
Wabuska (cfs)
Natural Hydrograph (cfs)
Discharge (cfs)
3000
2500
2000
1500
1000
500
0
1-Jan
20-Feb
11-Apr
31-May
20-Jul
8-Sep
28-Oct
17-Dec

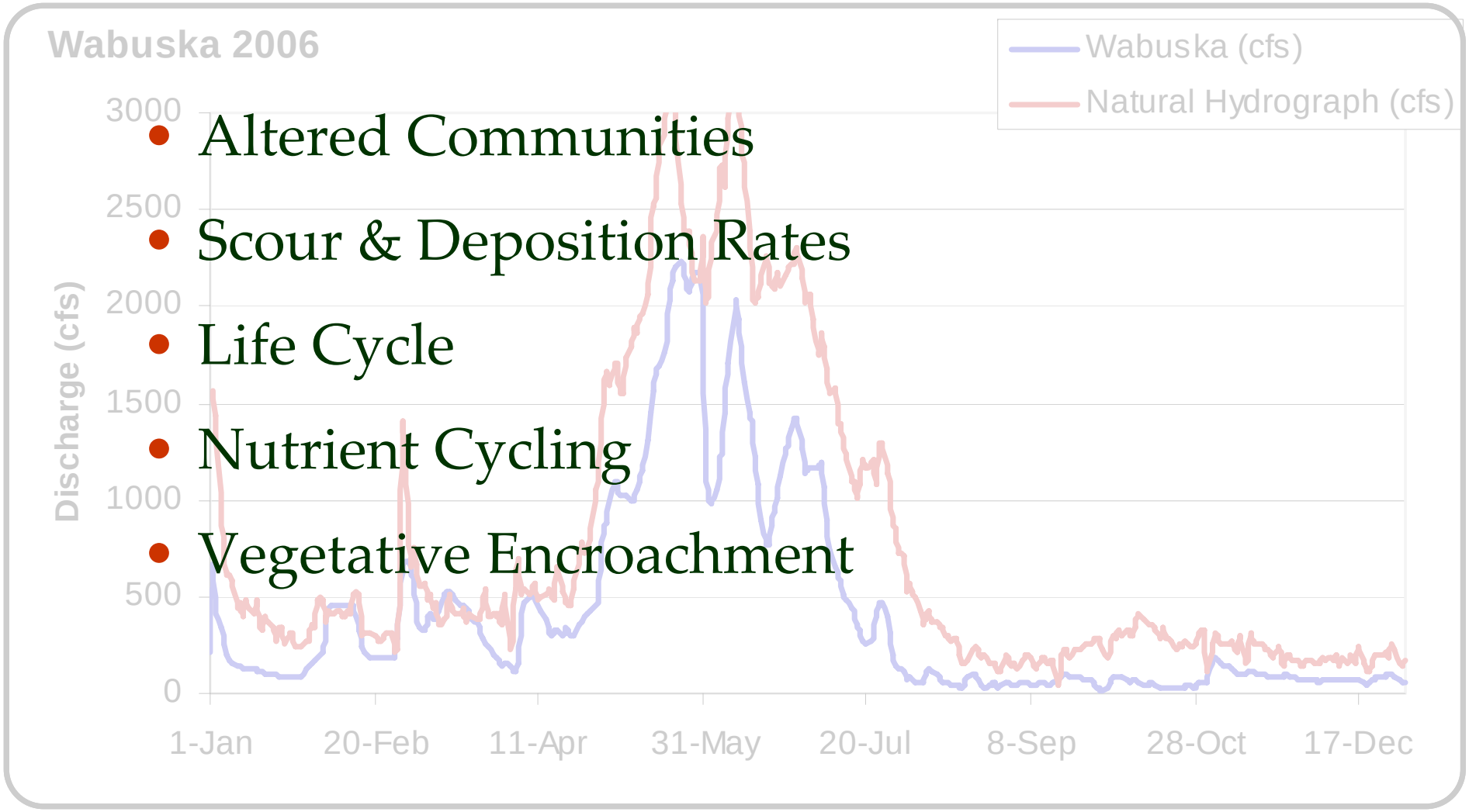
Ecological Impacts from Rate of Change

- Wash-out and Stranding of Species
- Failure of Seedling Establishment
  - Cottonwood Recruitment Box

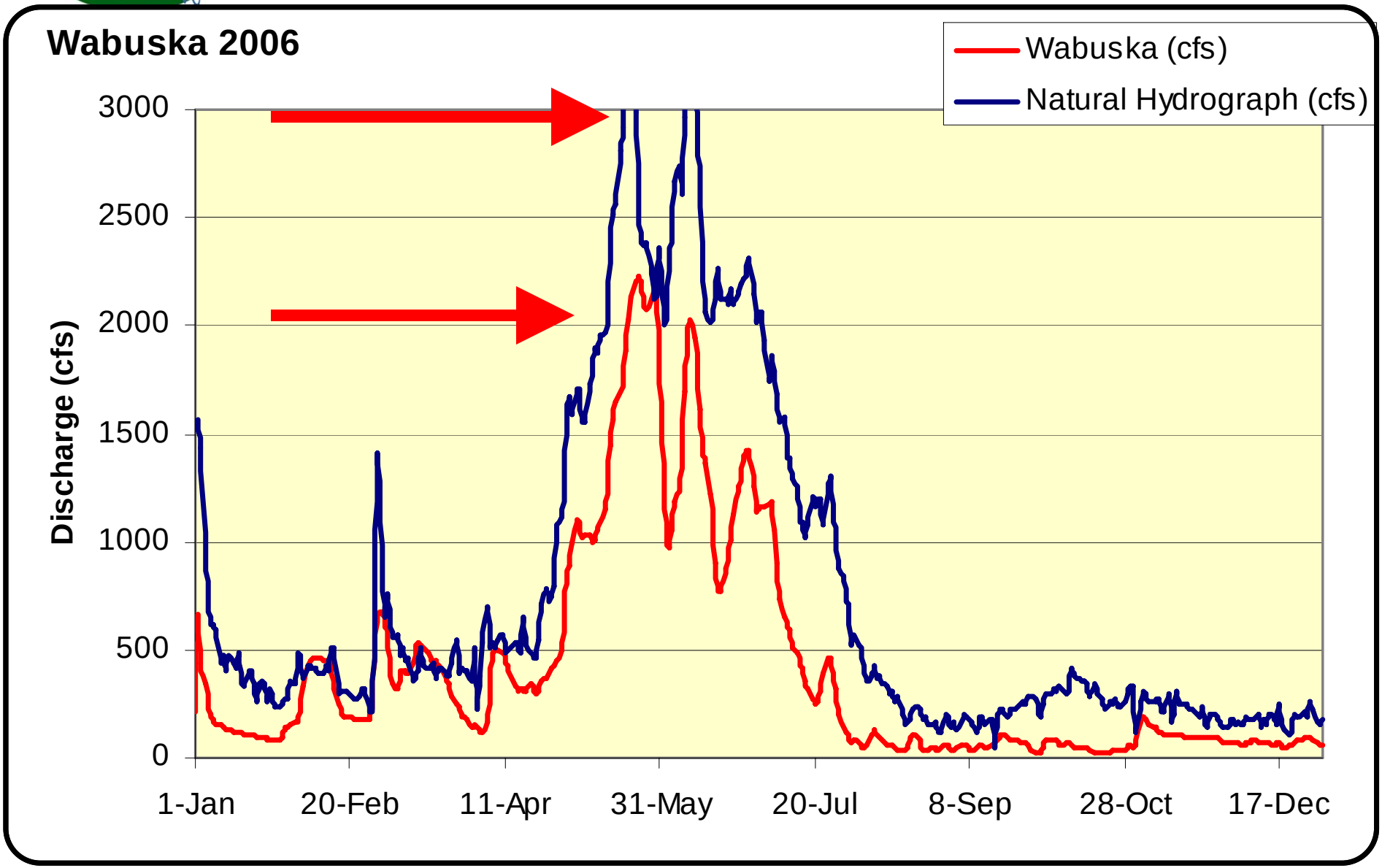
Rate of Change



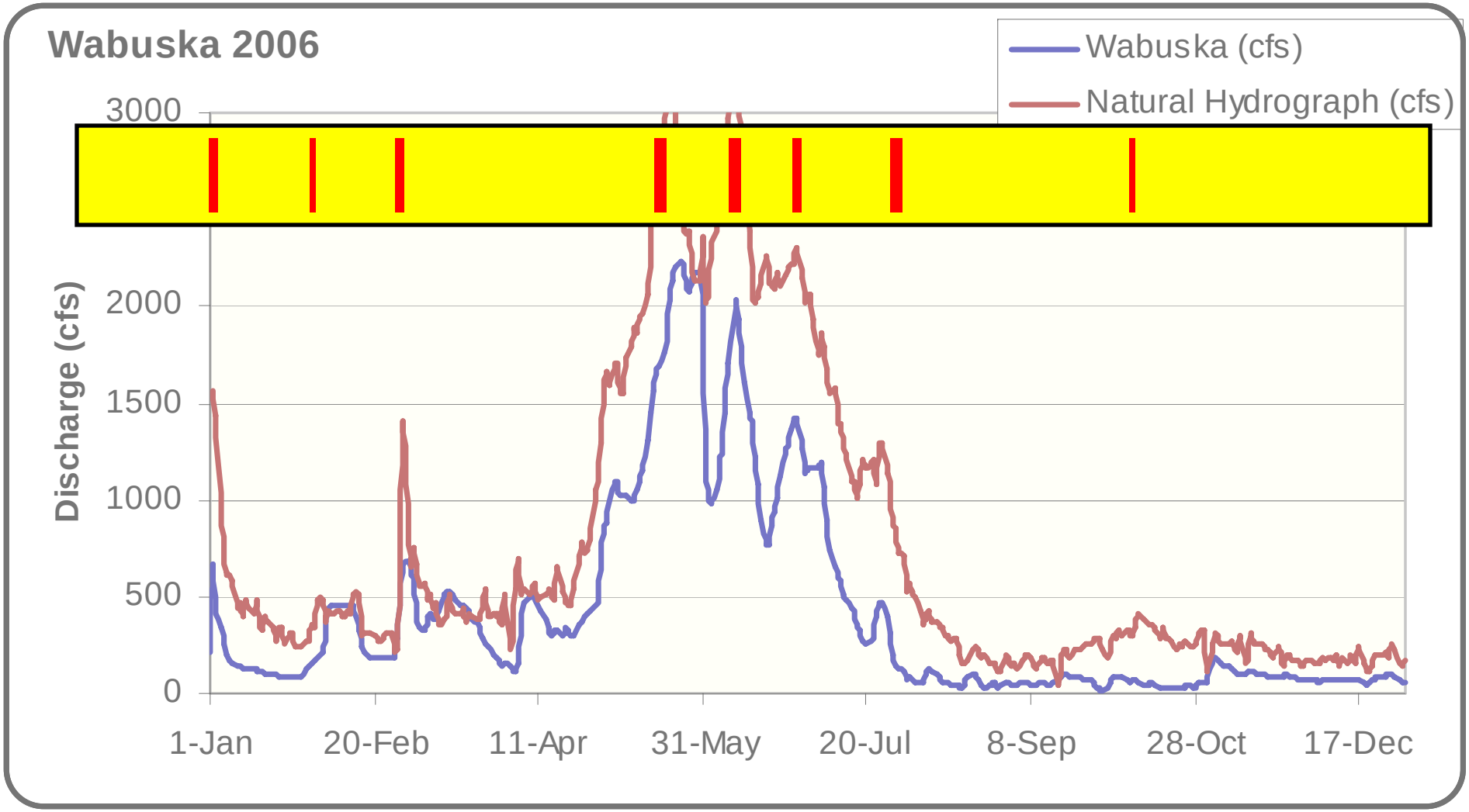
Ecological Impacts from Magnitude & Frequency



Magnitude

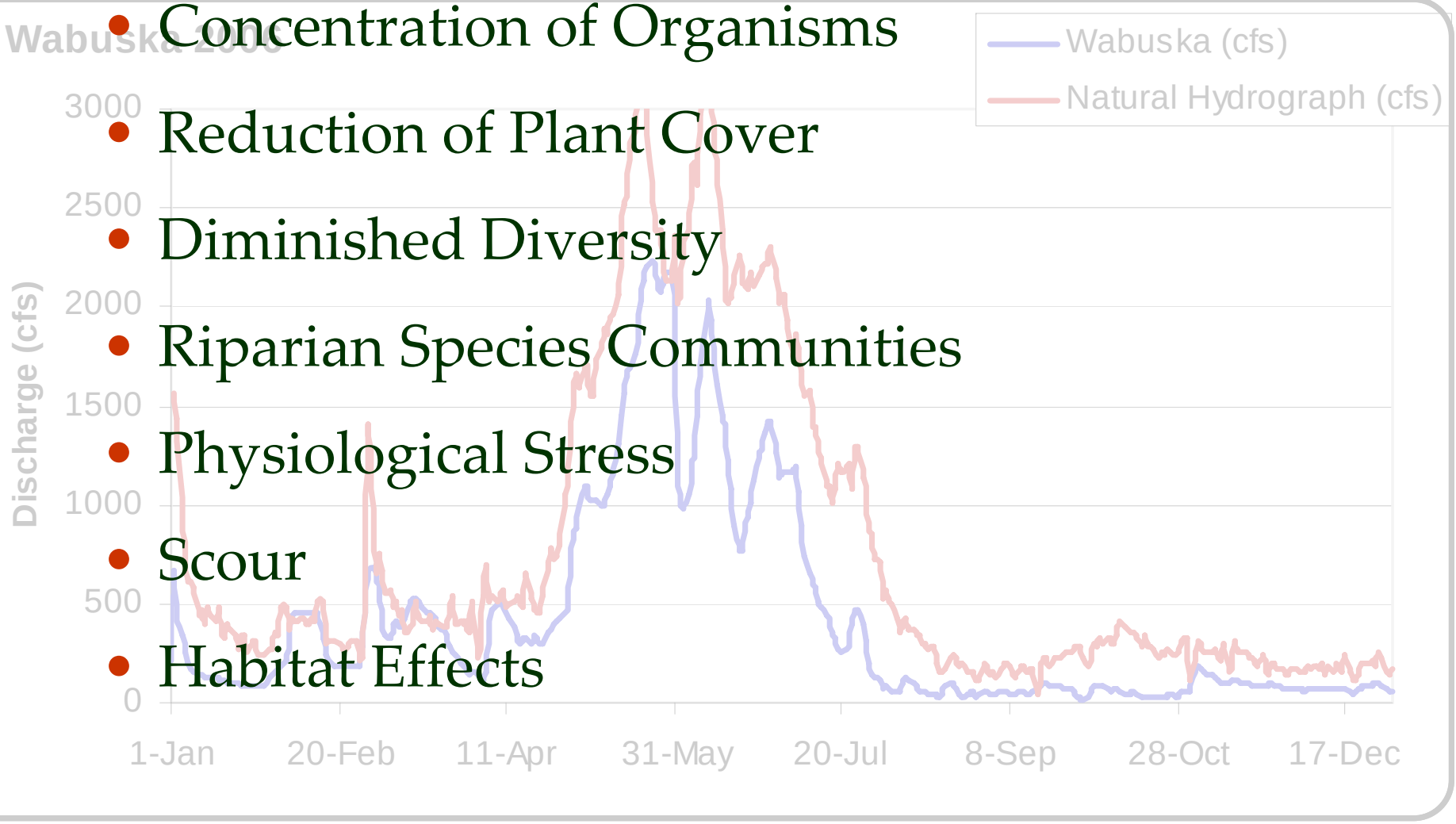

Wabuska 2006
Wabuska (cfs)
Natural Hydrograph (cfs)
Discharge (cfs)
3000
2500
2000
1500
1000
500
0
1-Jan
20-Feb
11-Apr
31-May
20-Jul
8-Sep
28-Oct
17-Dec

Frequency

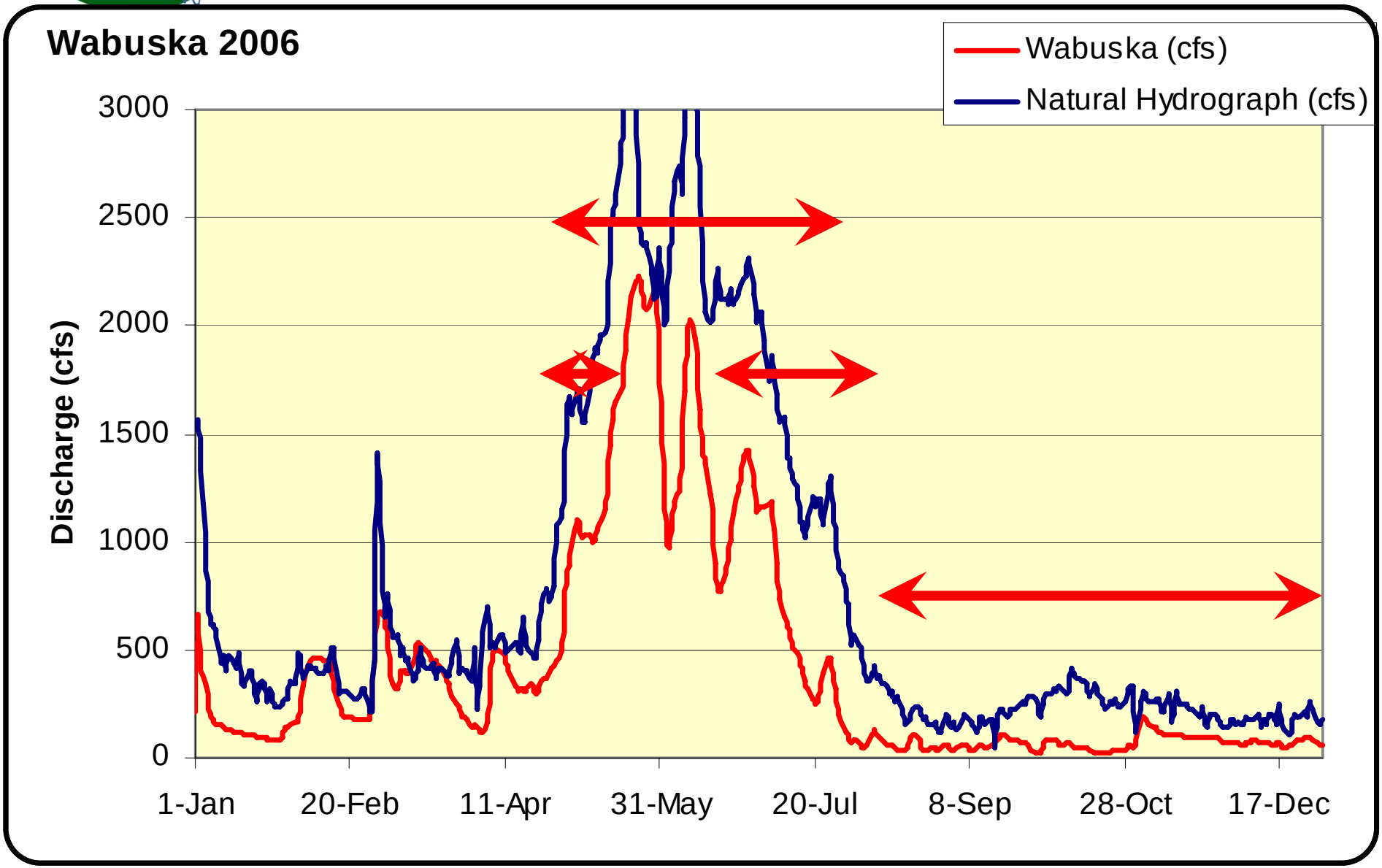

Wabuska 2006
Wabuska (cfs)
Natural Hydrograph (cfs)
Discharge (cfs)
3000
2000
1500
1000
500
0
1-Jan
20-Feb
11-Apr
31-May
20-Jul
8-Sep
28-Oct
17-Dec

Ecological Impacts from Duration

- Concentration of Organisms
- Reduction of Plant Cover
- Diminished Diversity
- Riparian Species Communities
- Physiological Stress
- Scour
- Habitat Effects



Duration


Wabuska 2006
Wabuska (cfs)
Natural Hydrograph (cfs)
Discharge (cfs)
3000
2500
2000
1500
1000
500
0
1-Jan
20-Feb
11-Apr
31-May
20-Jul
8-Sep
28-Oct
17-Dec

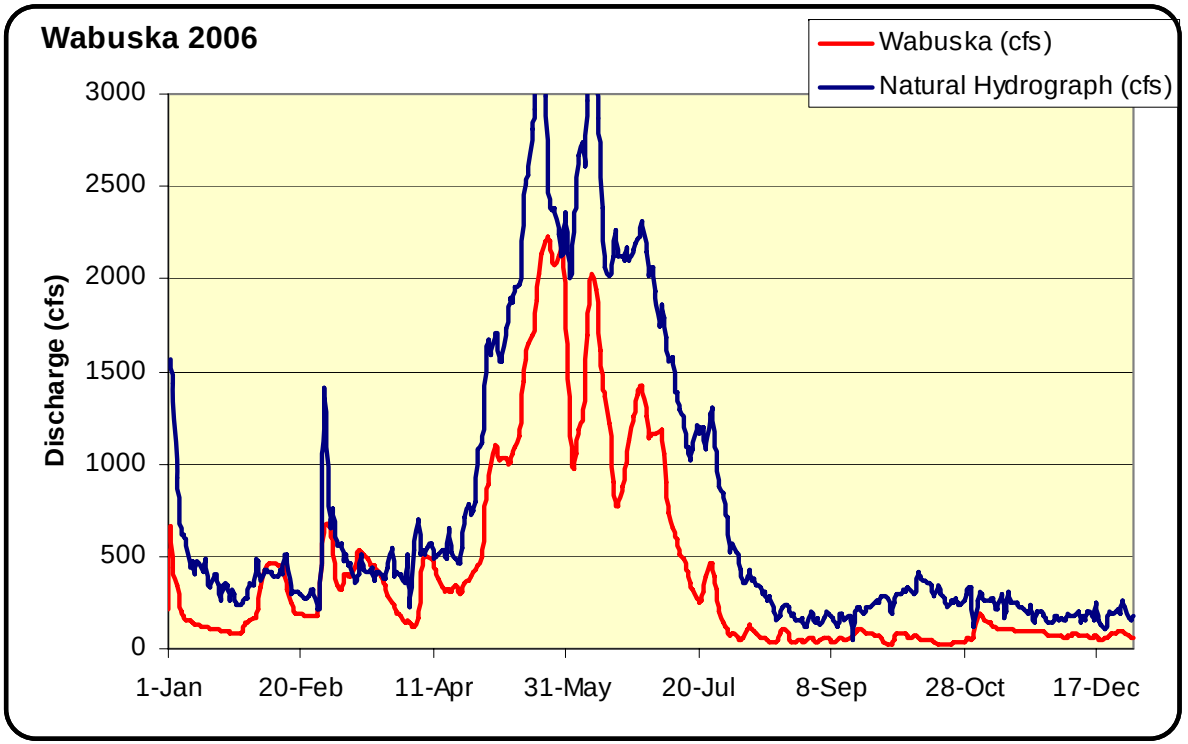
Sound Watershed Consulting

Creating Functional Water Environments

Application to West Walker River

Methodology

- Natural Hydrograph Estimates
  - Losses
  - Time Lag – 1 Day
- Flow Below Diversions



Sources of River Losses

- **Evapotranspiration**
  - **Riparian**
  - **Reservoir**
- **Net SW/GW Exchange**
  - Ditch Leakage
  - River Losses
- **Net Storage Balance**
- **Flow Attenuation**

Sources of River Losses

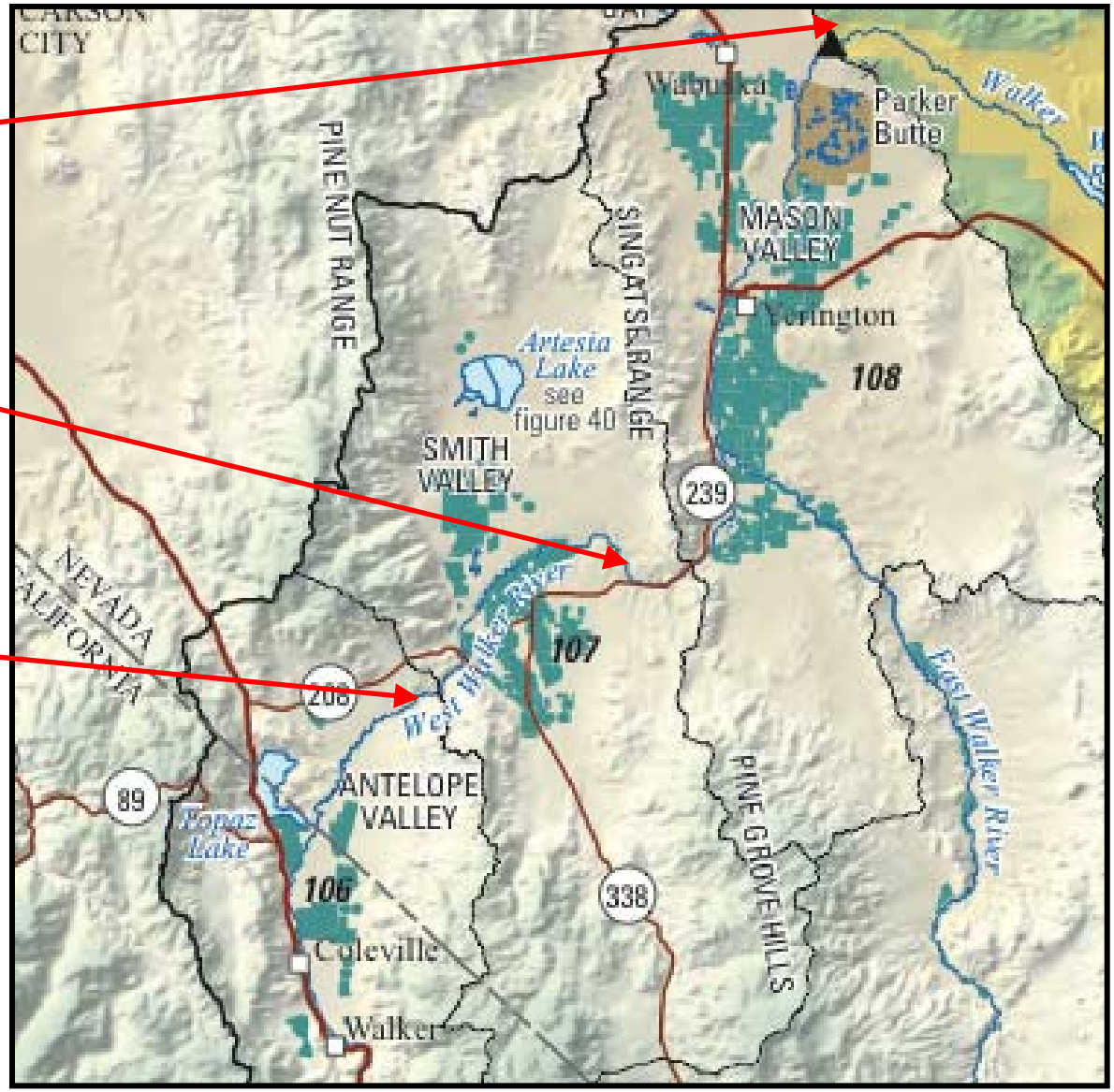
- **Evapotranspiration**
  - **Riparian**
  - **Reservoir**
- **Net SW/GW Exchange**
  - Ditch Leakage
  - River Losses
- **Net Storage Balance**
- **Flow Attenuation**

Data Sources:

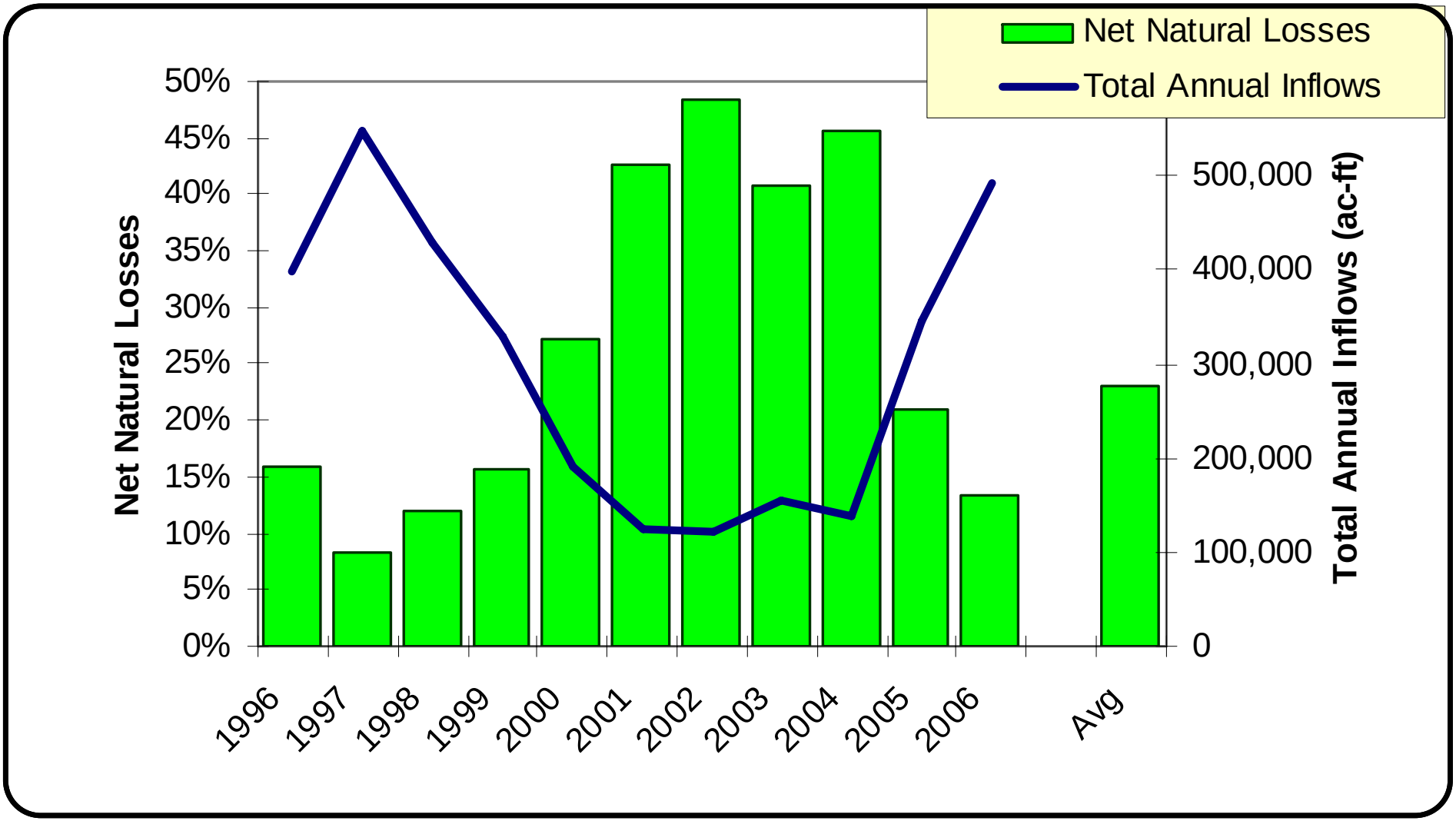
USGS River Gages
Water Budgets
Diversion Data
Empirical Analysis

Sites Evaluated

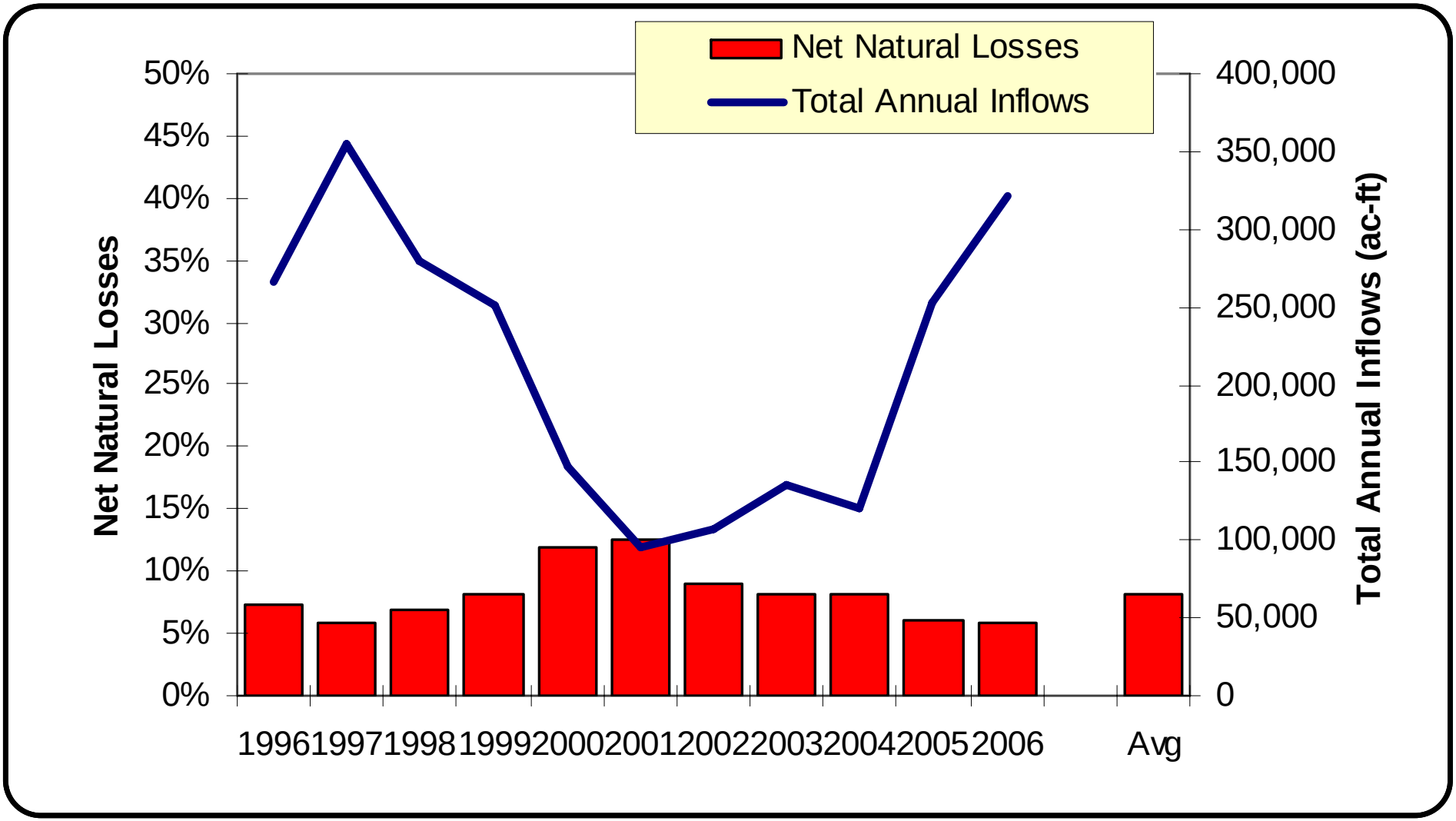
- **Wabuska**
- **Hudson**
- **Hoye**



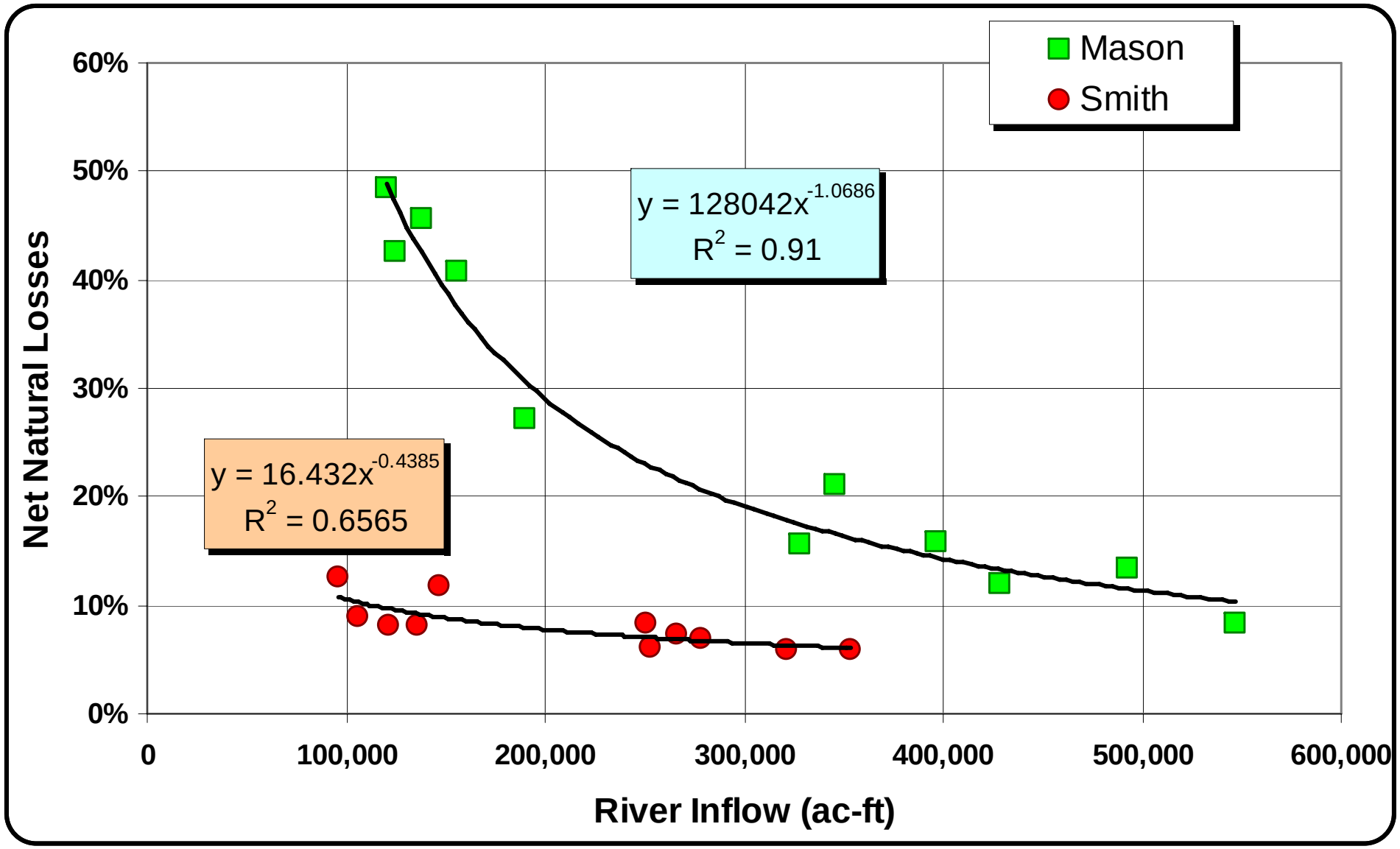
River Loss Functions - Mason



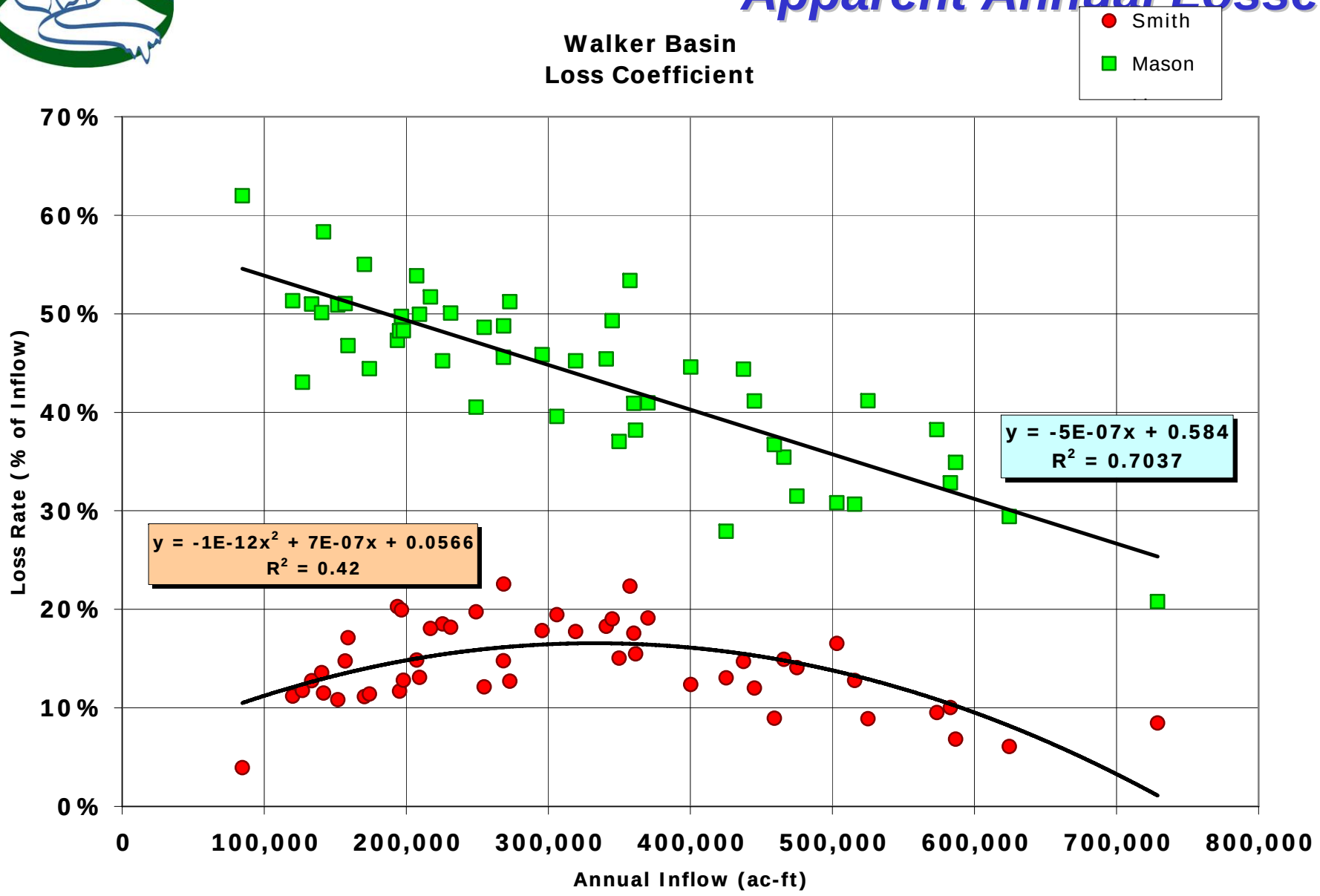
River Loss Functions - Smith



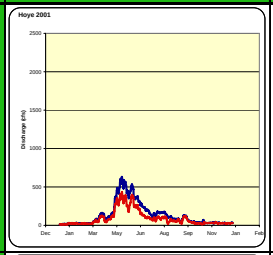
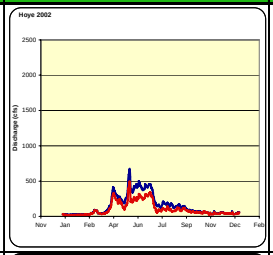
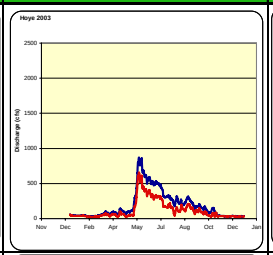
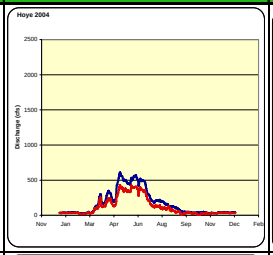
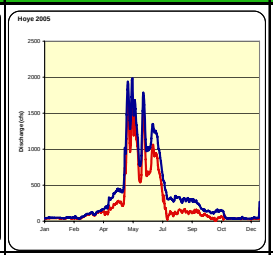
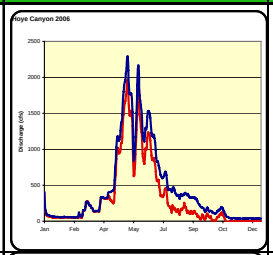
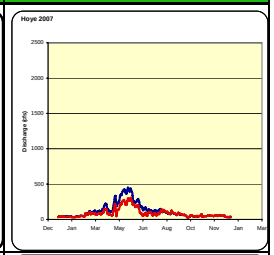
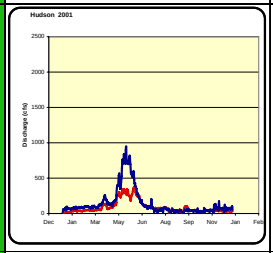
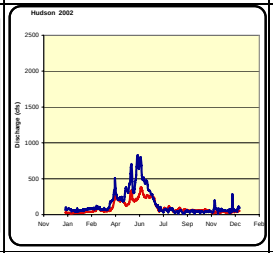
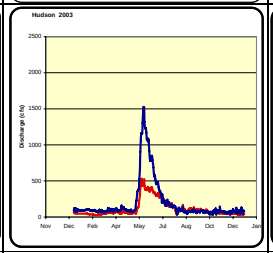
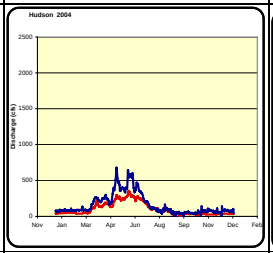
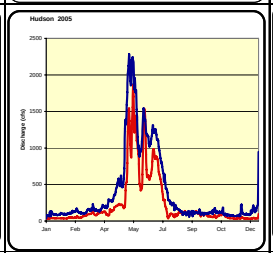
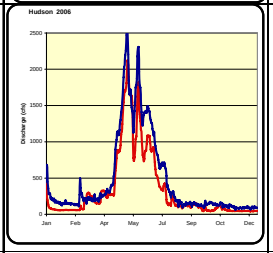
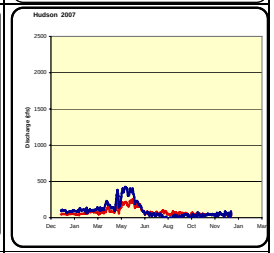
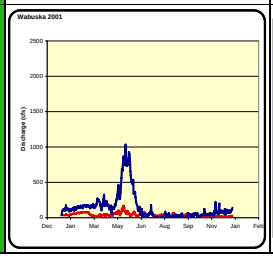
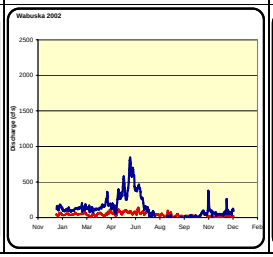
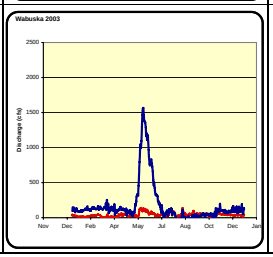
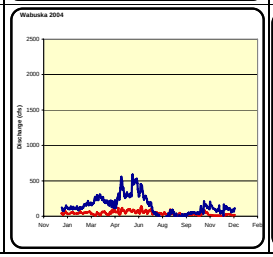
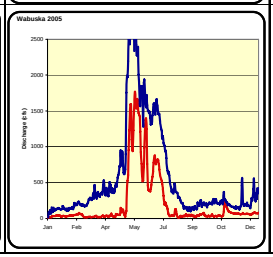
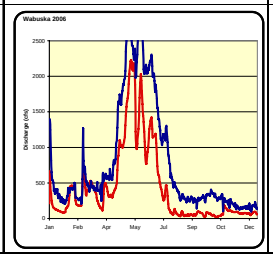
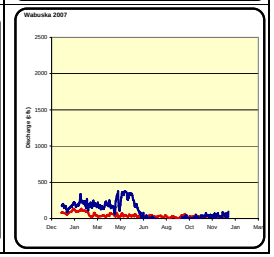
River Loss Functions



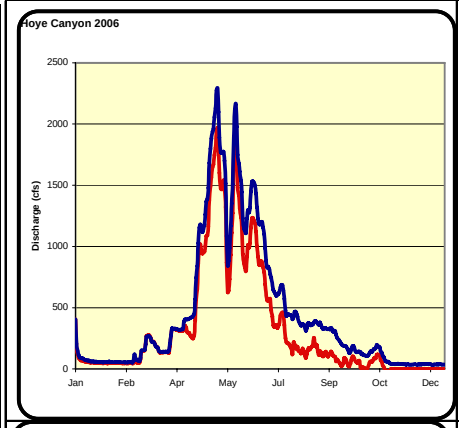
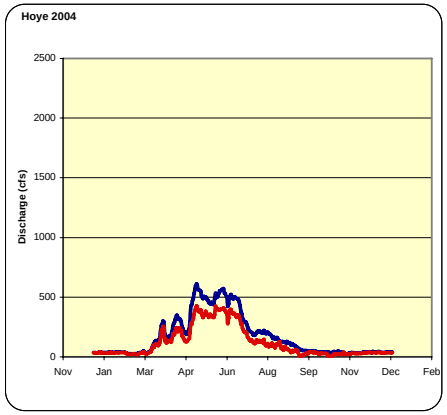
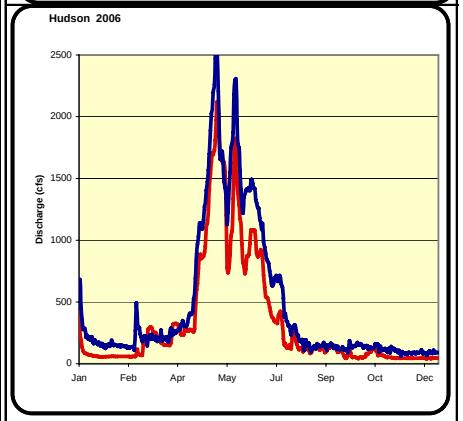
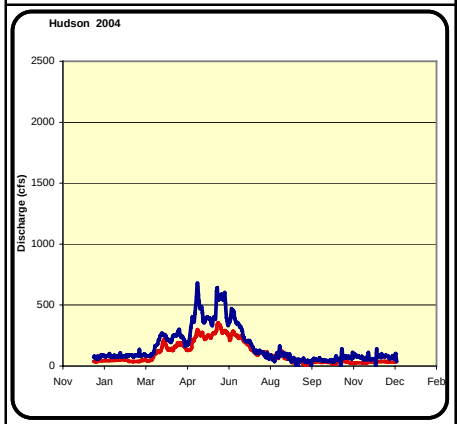
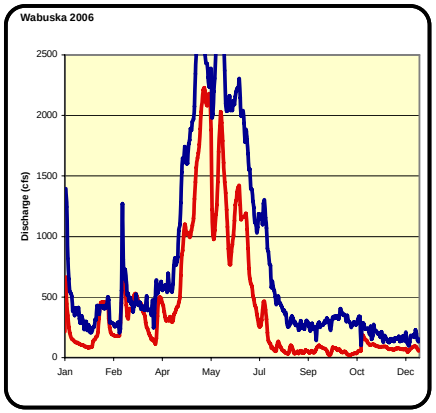
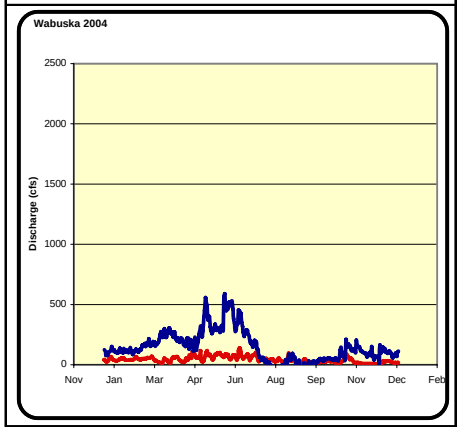
Apparent Annual Losses



Results

	2001	2002	2003	2004	2005	2006	2007
HOYE							
HUDSON							
WABUSKA							

Wet v. Dry Years

	2006	2004
HOYE		
HUDSON		
WABUSKA		

Natural

Observed

Criteria for Impacts

Timing

- Change in micro-peak timing

Rate of Change

- Change in rising & falling limbs

Magnitude

- Difference in peak magnitude

Frequency

- Reduction in peak frequencies

Duration

- Change in baseflow, snowmelt & storm peaks

LOW
MODERATE
HIGH

Summary Table of Impacts

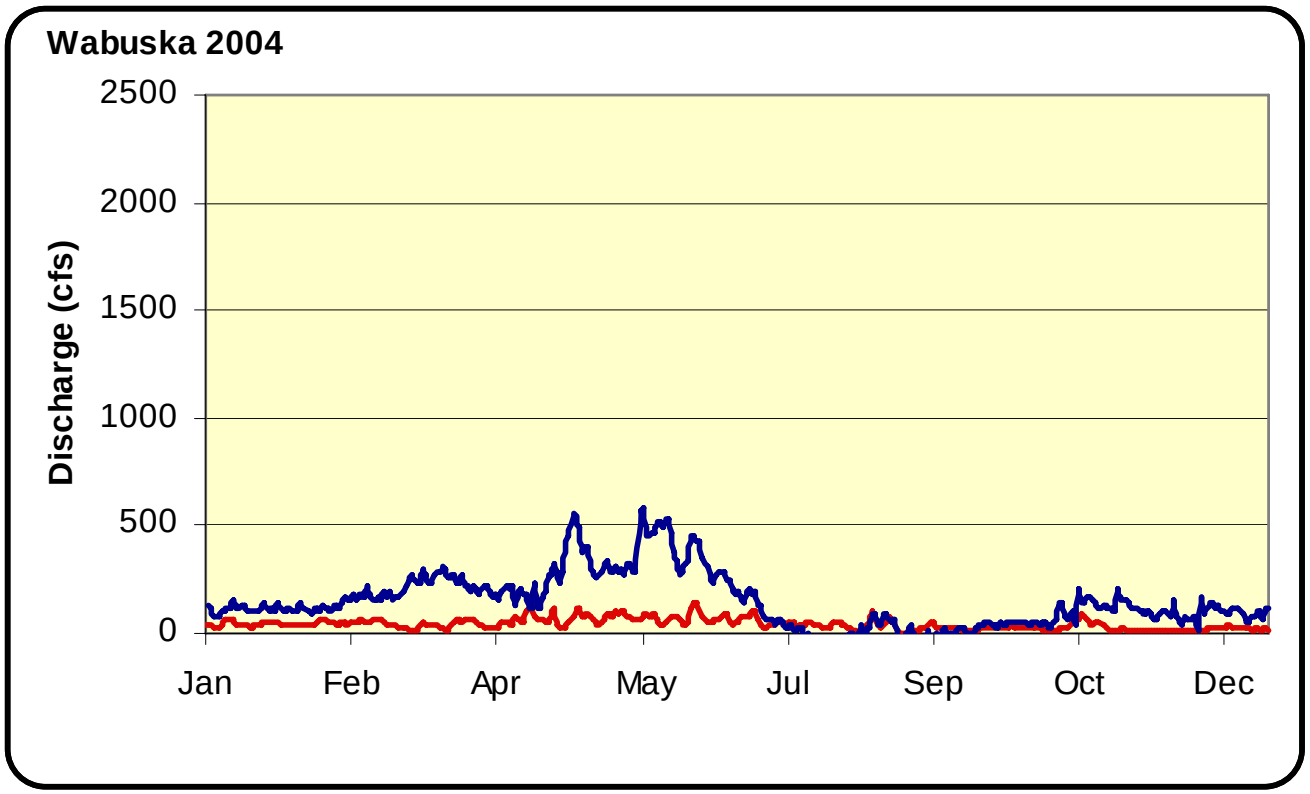
	2001	2002	2003	2004	2005	2006	2007
	DRY	DRY	NORMAL	DRY	WET	WET	DRY
	Timing						
Hoye	Low	Low	Low	Low	Low	Low	Low
Hudson	Low	Low	Low	Low	Low	Low	Low
Wabuska	High	High	High	High	Low	Low	High
	Rate of Change						
Hoye	Low	Low	Low	Low	Low	Low	Low
Hudson	Low	Low	Low	Low	Low	Low	Low
Wabuska	Low	Low	Low	Low	Low	Low	Low
	Magnitude						
Hoye	Low	Low	Low	Low	Low	Low	Low
Hudson	Mod	Mod	High	Low	Low	Low	Low
Wabuska	High	High	High	High	Mod	Low	High
	Frequency						
Hoye	Low	Low	Low	Low	Low	Low	Low
Hudson	Low	Low	Low	Low	Low	Low	Low
Wabuska	High	High	High	High	Low	Low	High
	Duration						
Hoye	Low	Low	Low	Low	Low	Low	Low
Hudson	Low	Low	Low	Low	Low	Low	Low
Wabuska	High	High	High	High	Mod	Mod	High

Summary of Impacts

	Low	Mod	High
Hoye	100%	0%	0%
Hudson	91%	6%	3%
Wabuska	34%	9%	57%

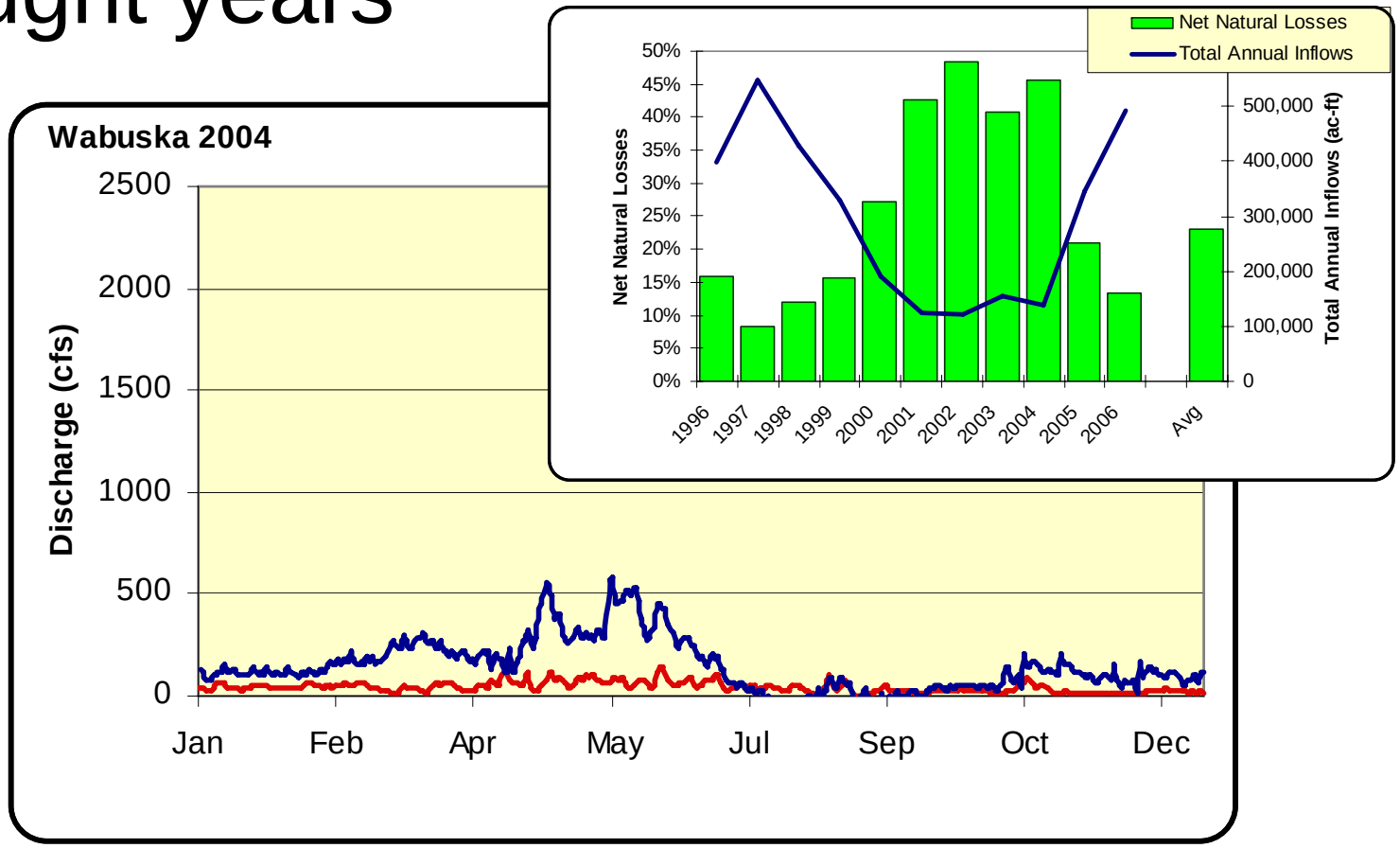
Summary of Key Observed Impacts

A loss of peaks at Wabuska during drought years

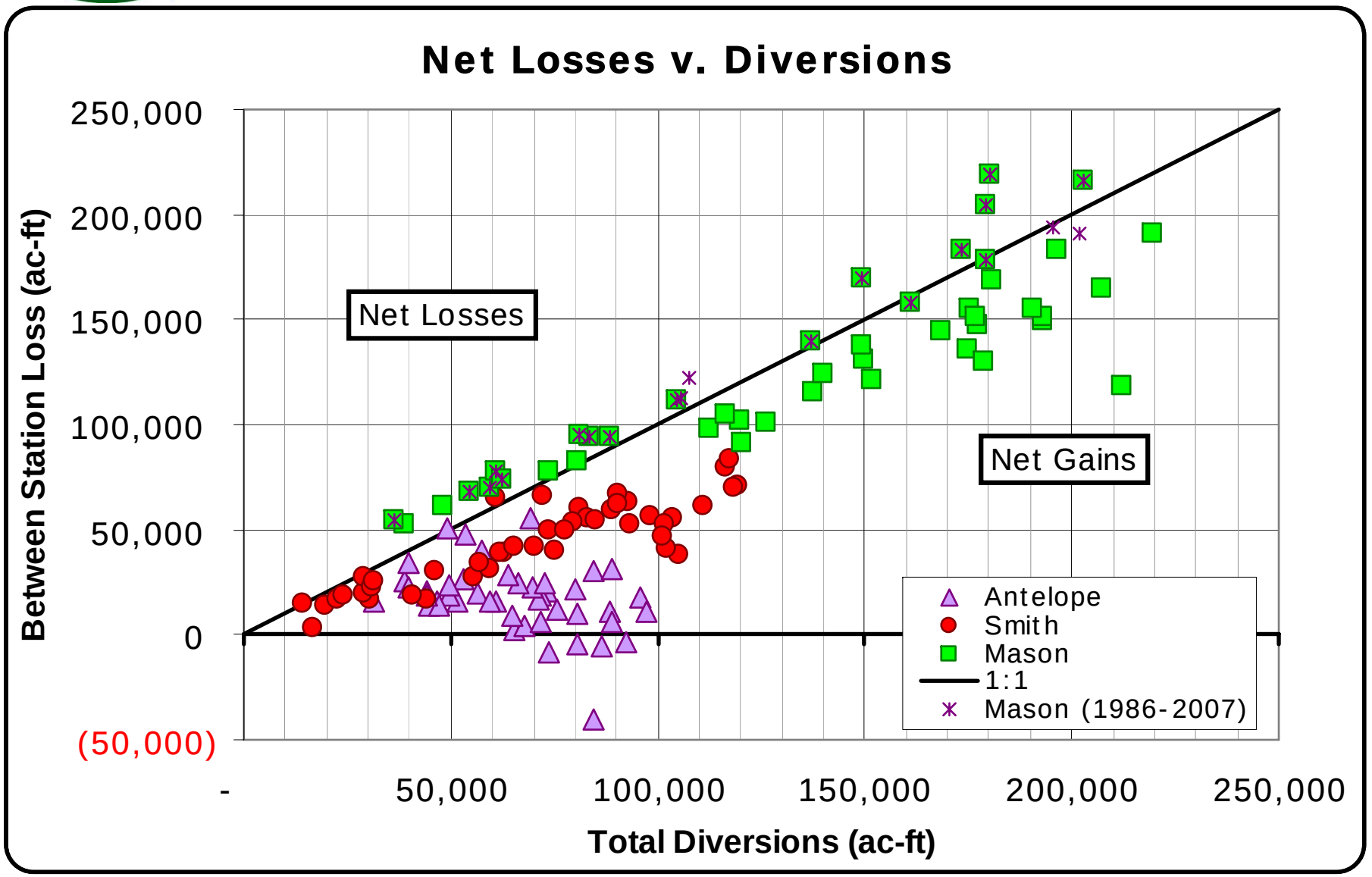


Summary of Key Observed Impacts

A loss of peaks at Wabuska during drought years

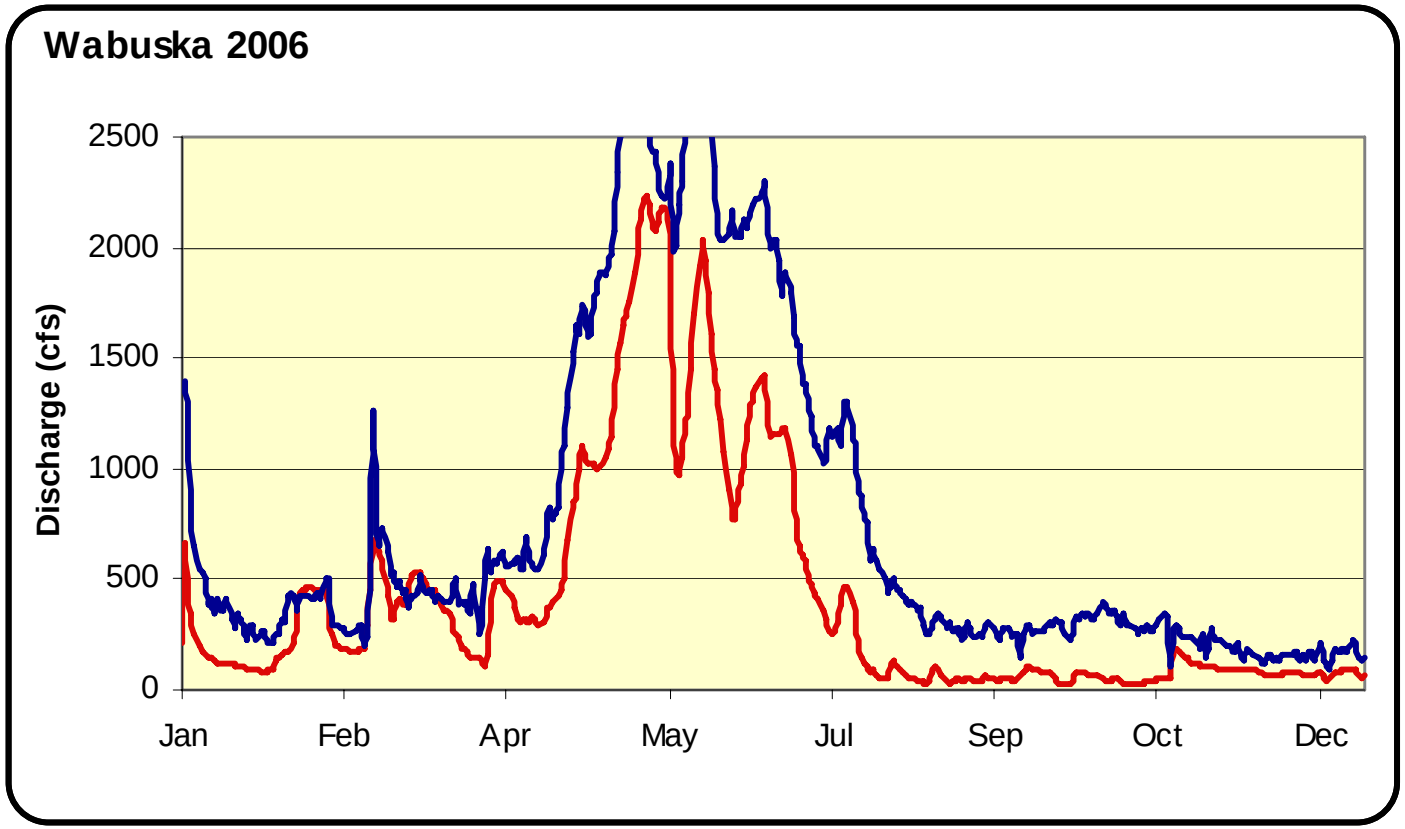


Net Annual Valley Losses

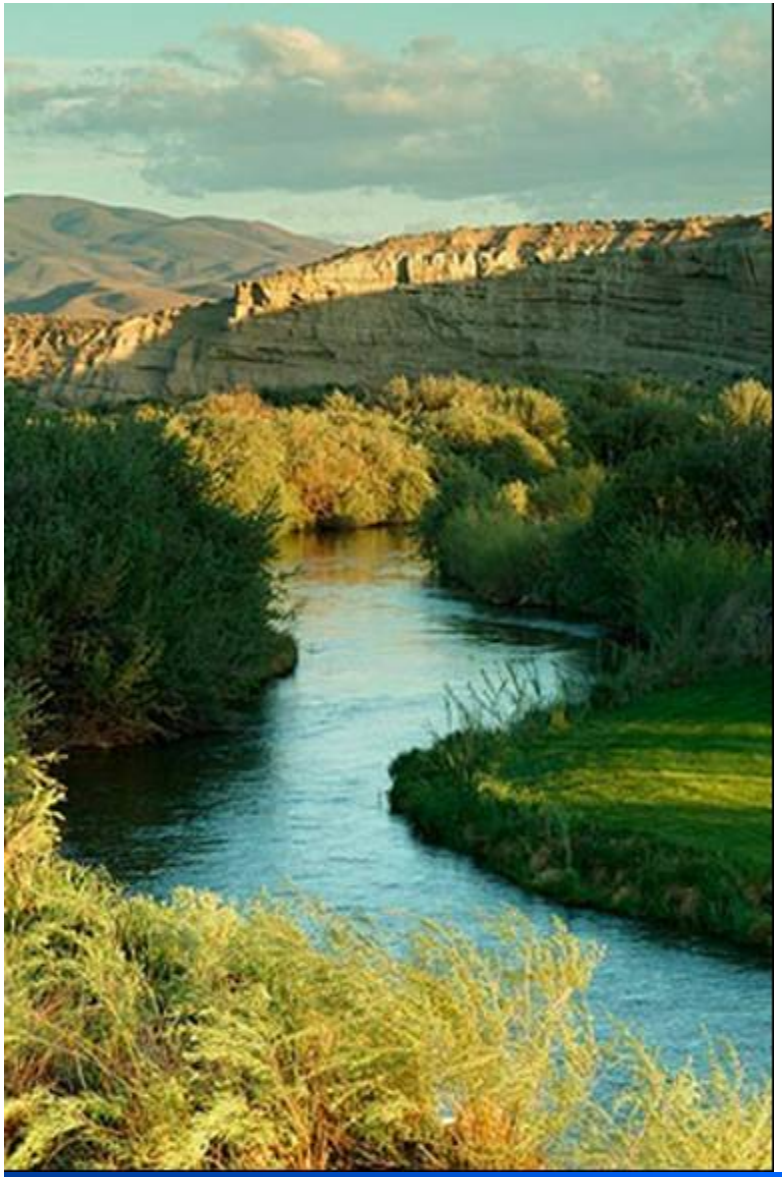


Summary of Key Observed Impacts

Occasional reductions in duration of the snowmelt peak



Take Home Message



Overall, the river appears to have retained much of the integrity of the natural flow regime according to these factors.