Developing Flow Prescriptions for the Sacramento-San Joaquin Delta

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Delta Solutions

Hydrologic and Ecosystem Links

- Flow Regime is a Major Determinant of Physical Habitat
- Species Life Histories Strategies Responded to Natural Flow Variations
- Habitat Connectivity is Essential to Many Species
- Invasive Species are Promoted by Flow Alterations
- Bunn and Arthington 2002

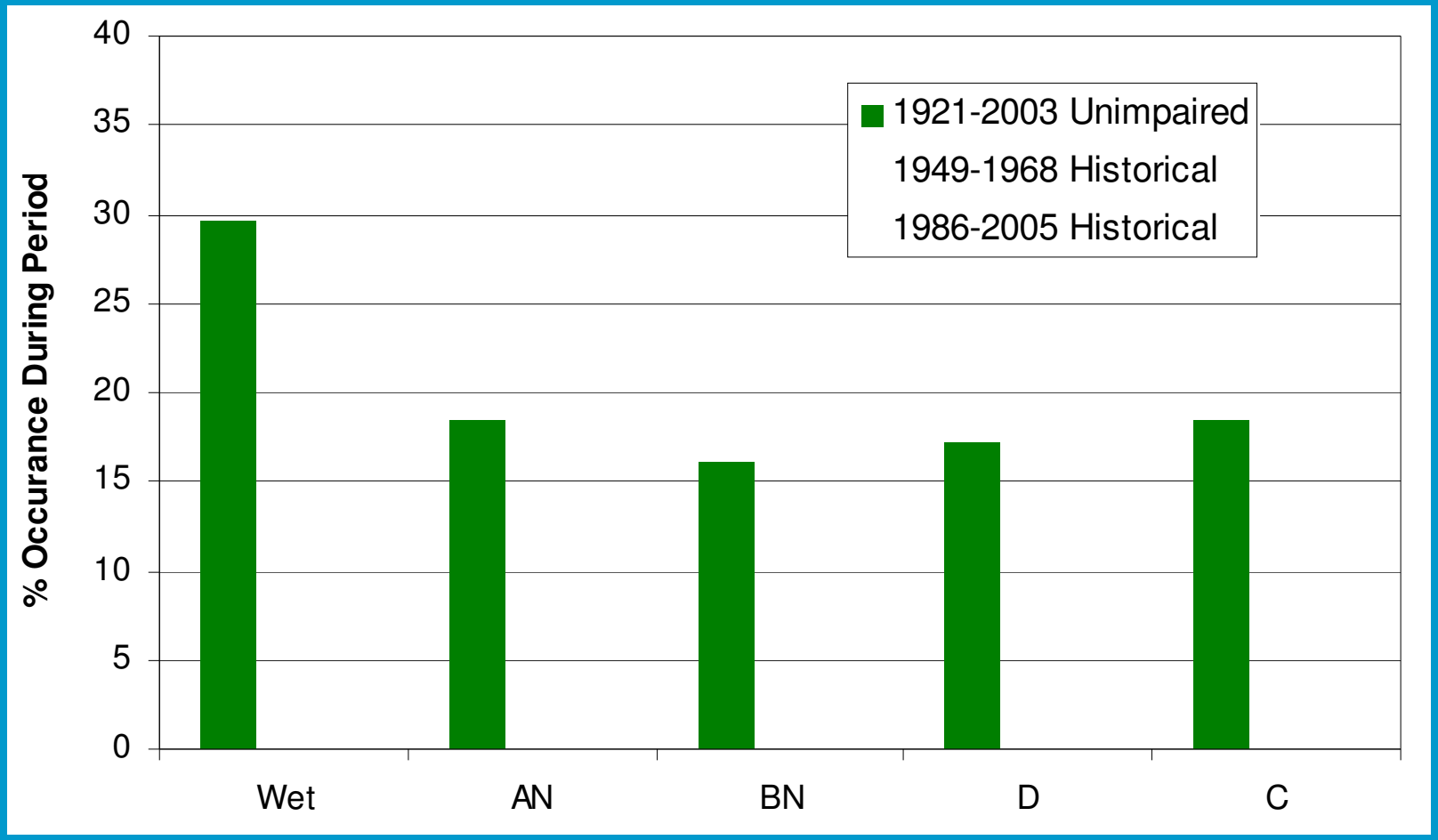
Approaches for Setting Flow Criteria in the Delta

- Unimpaired Flows (1921-2003)
- Historical Flows when fish were 'doing better' (1949-1968)
- Statistical relationships between flow and native species abundance
- Accumulated Functional Flows based on recent scientific literature

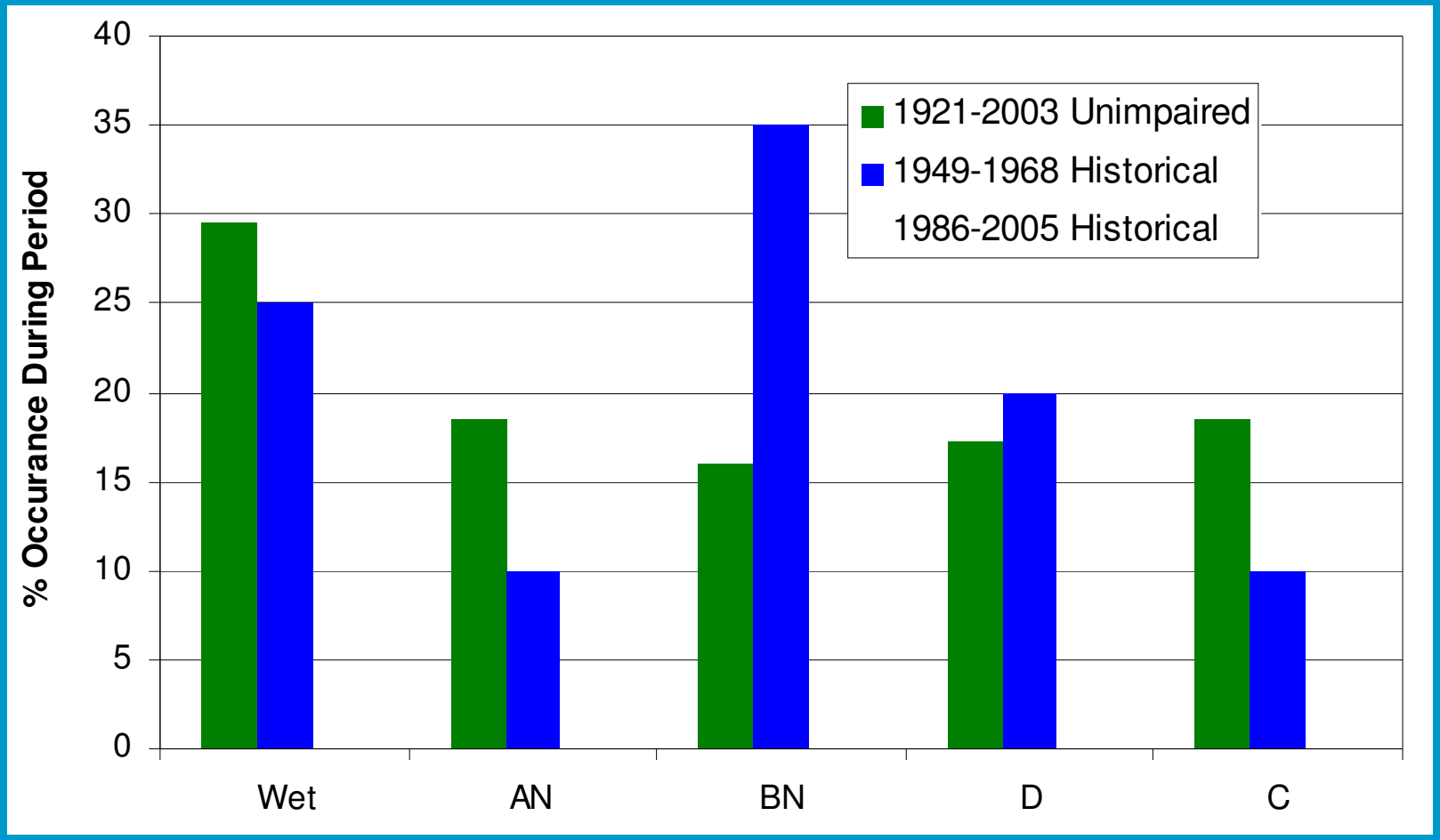
Unimpaired Flows (1921-2003)

- Not historical ‘natural’ flows into the Delta
  - More rain and less snow today, with earlier snow melt
  - Upstream floodplains no longer attenuate flows
  - Groundwater base-flow has changed
  - Delta is channelized with little marsh or floodplain

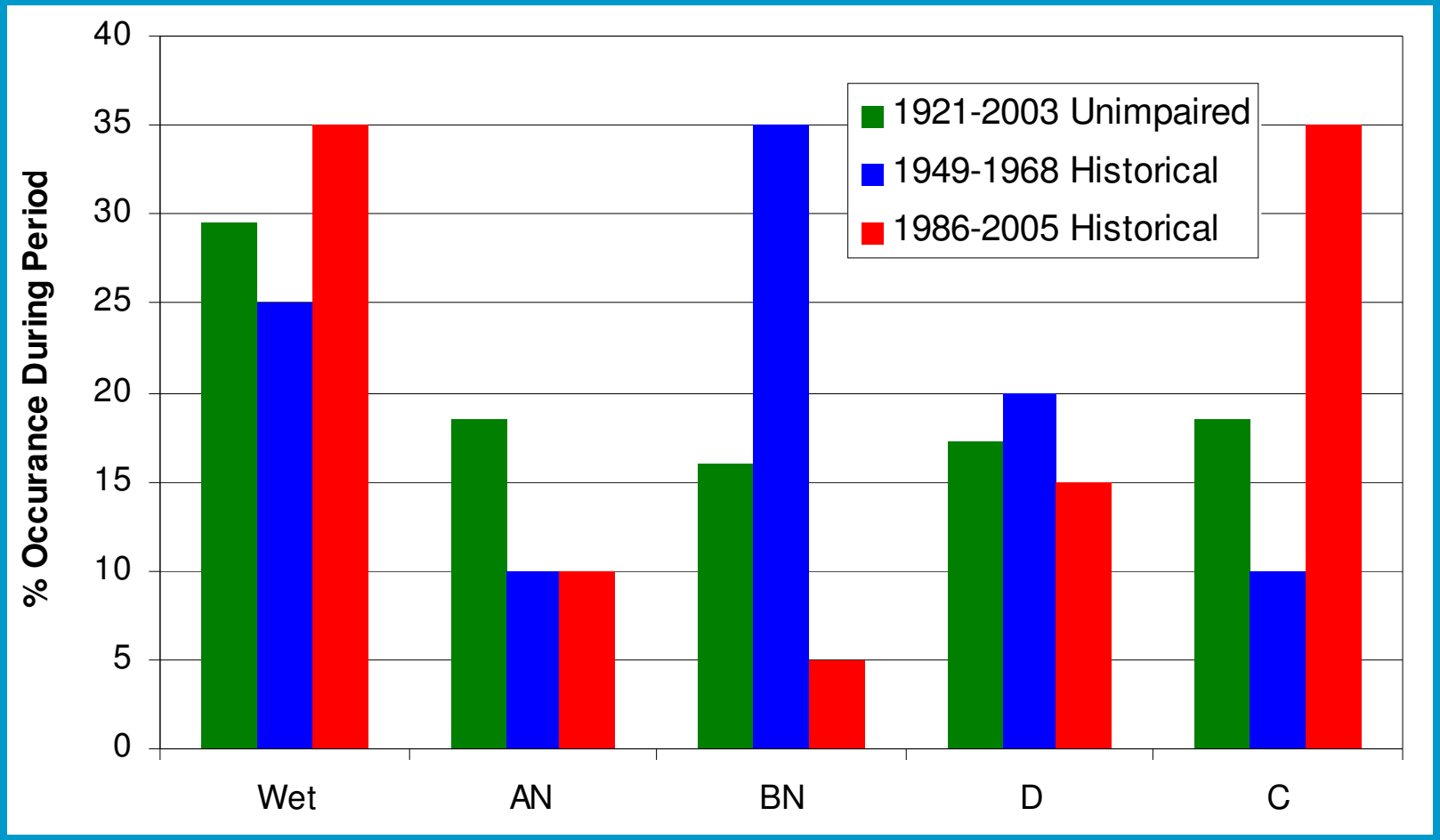
Water Year Comparison



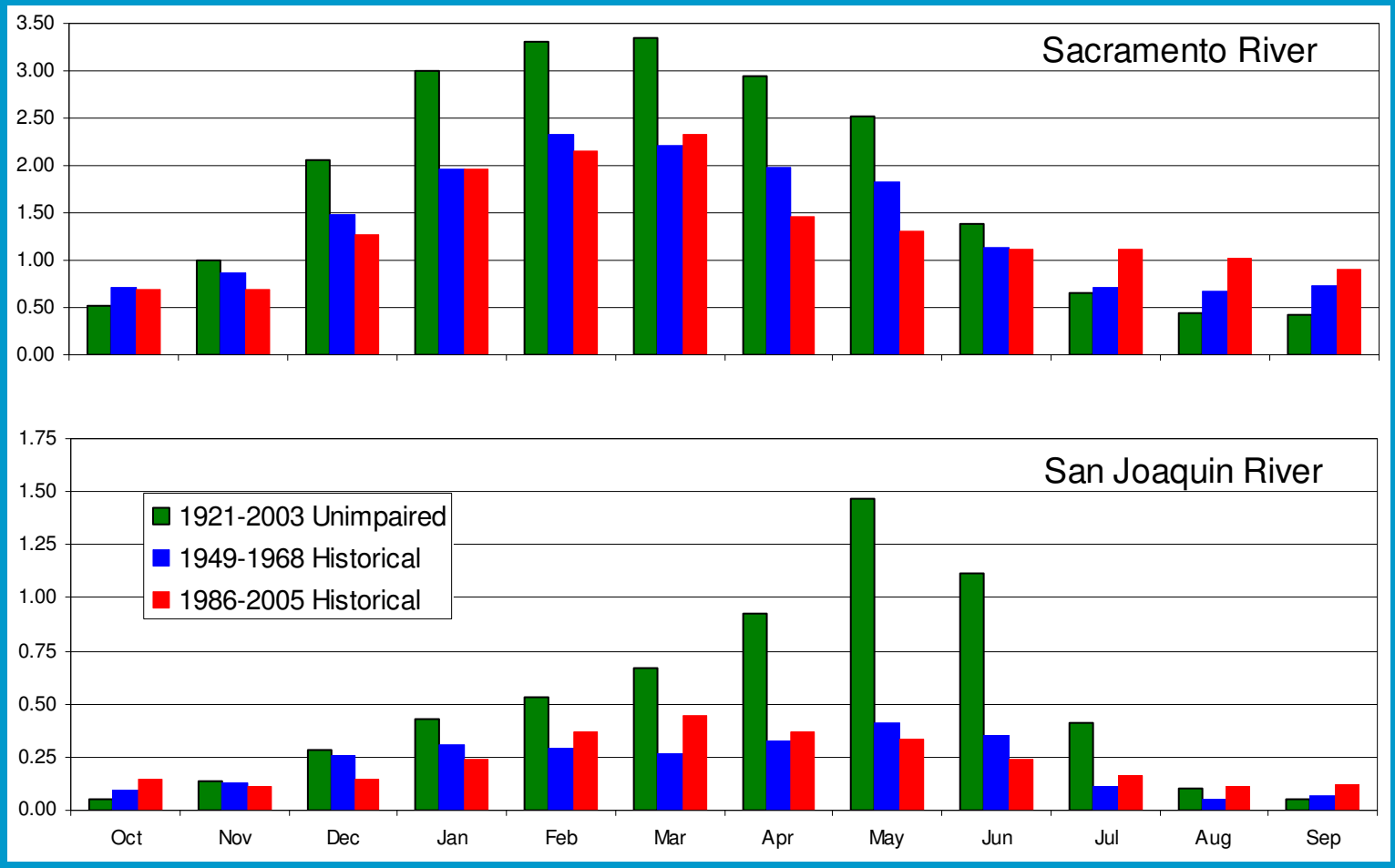
Water Year Comparison



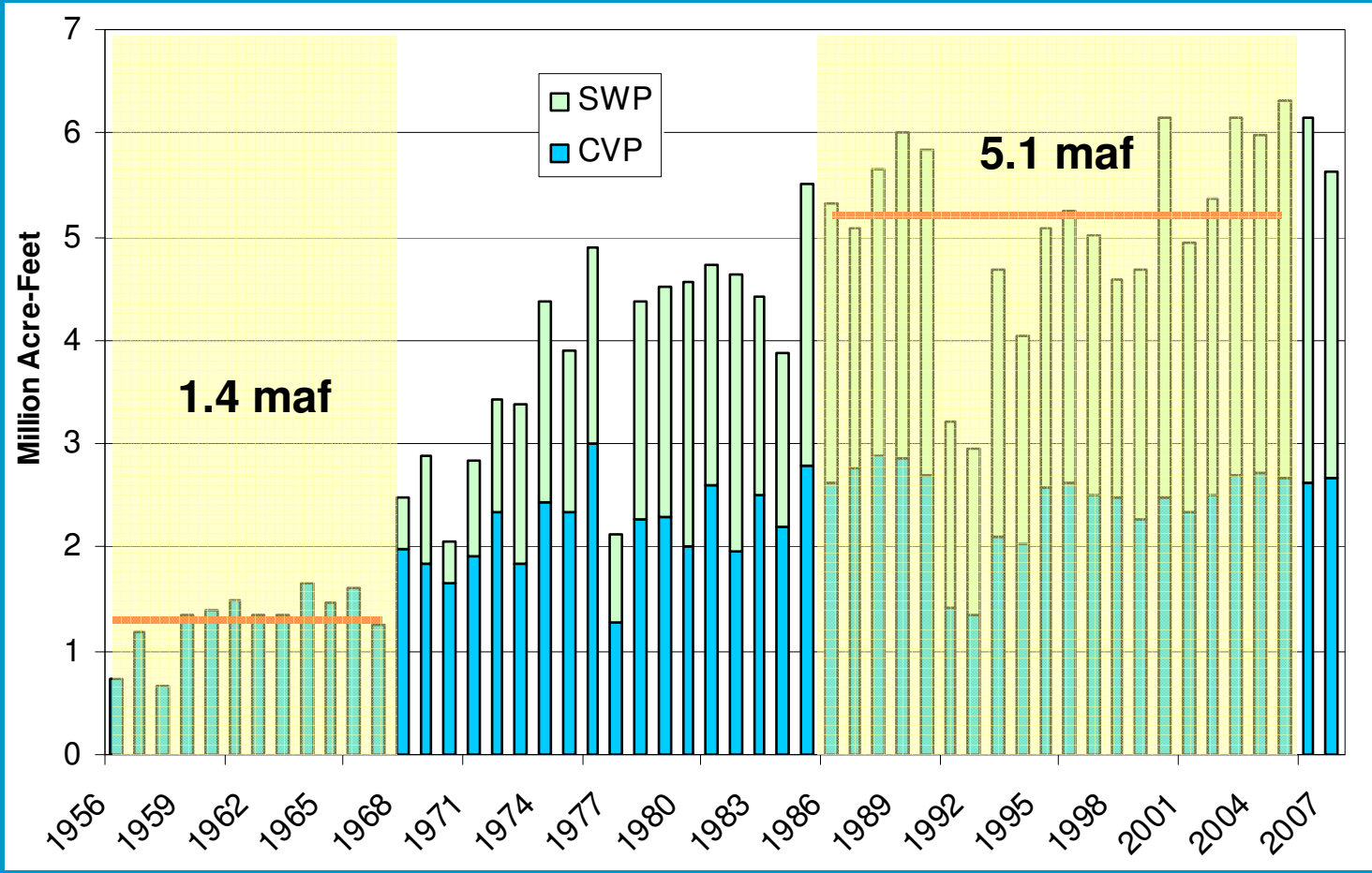
Water Year Comparison



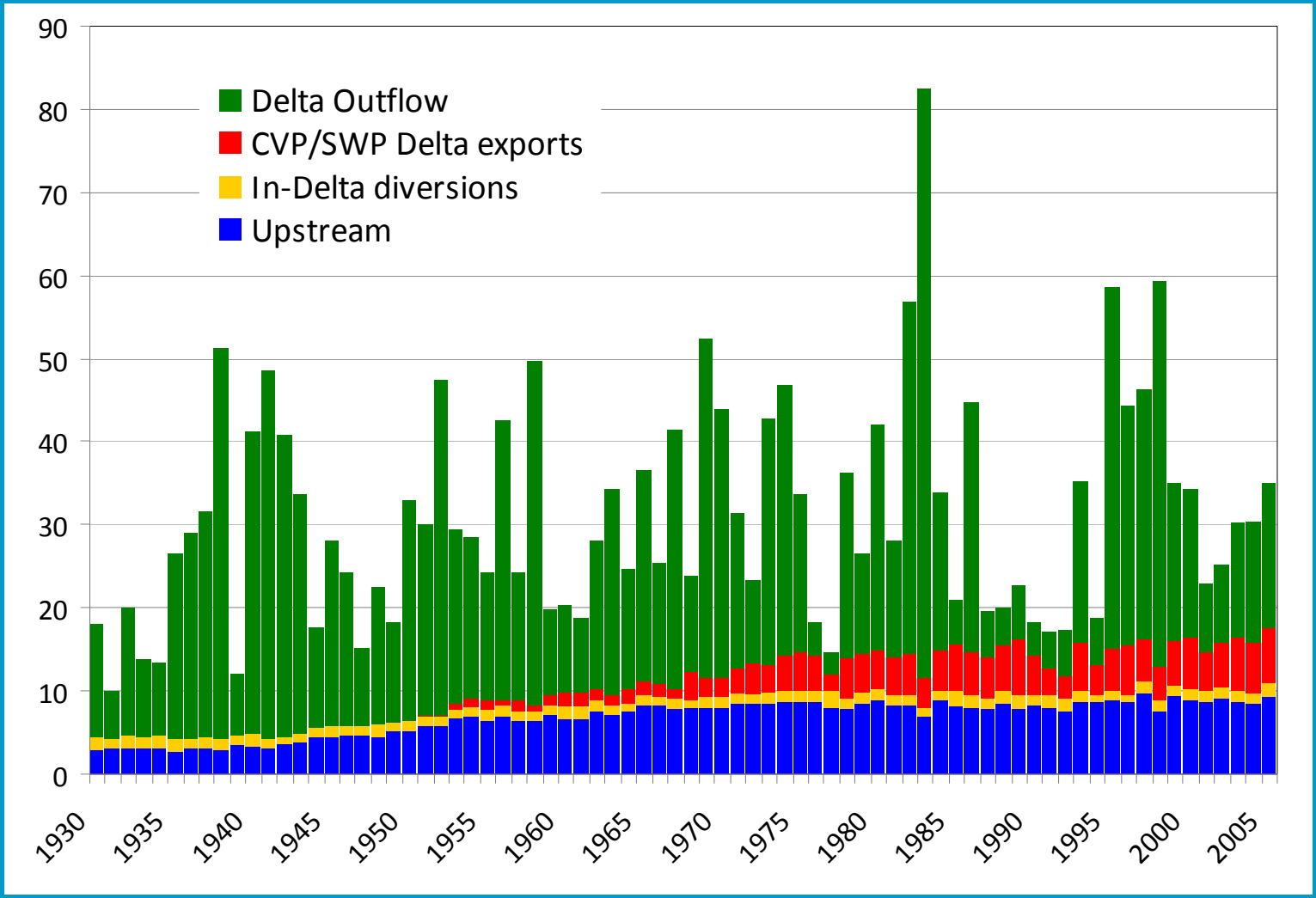
Major Inflows to Delta
(yearly average flows in maf/mo)



Exports from Delta (maf/yr)

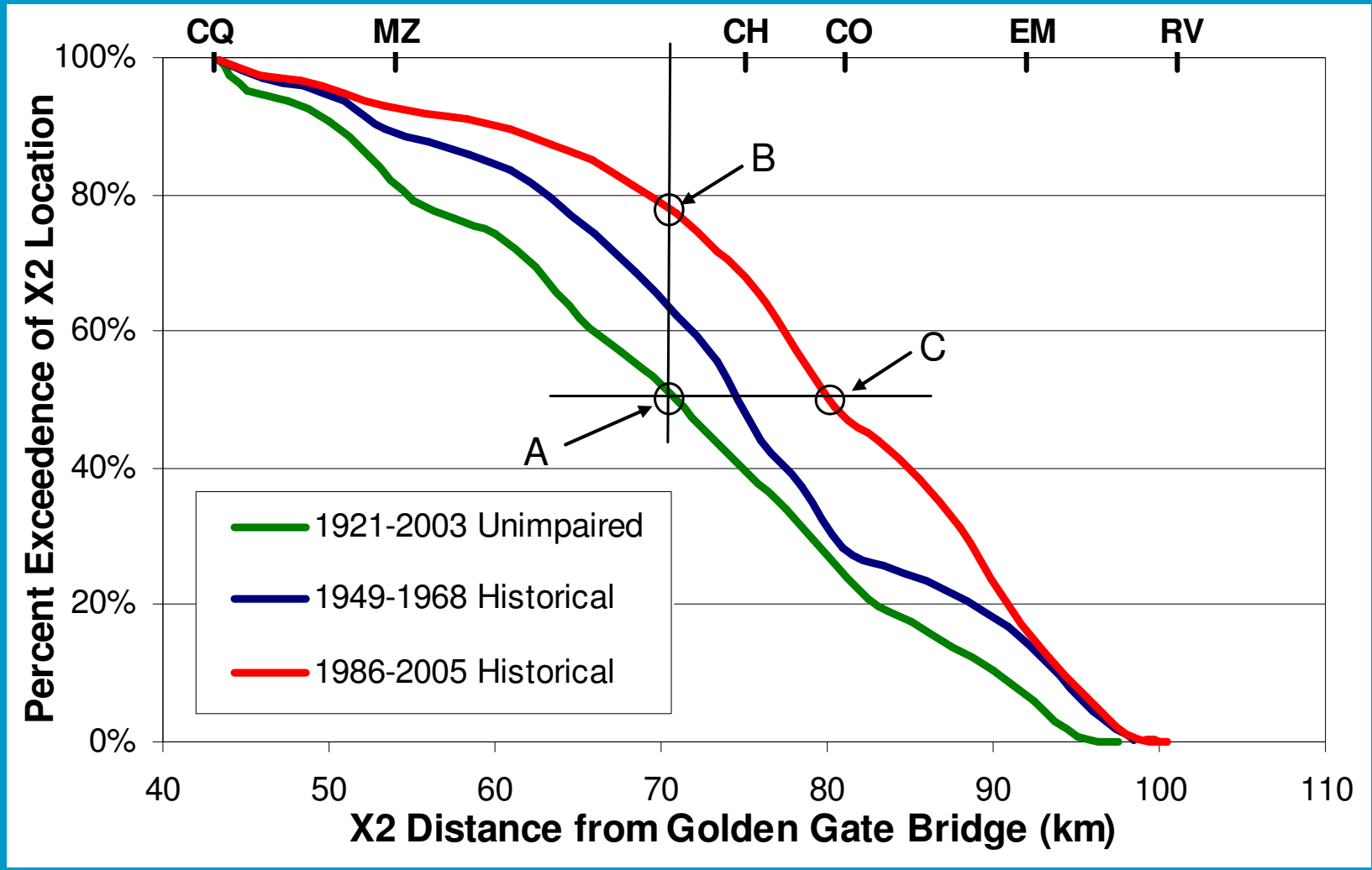


Available Water Use
(annual flows in maf/yr)



Data courtesy of TNC

Statistical Relationships



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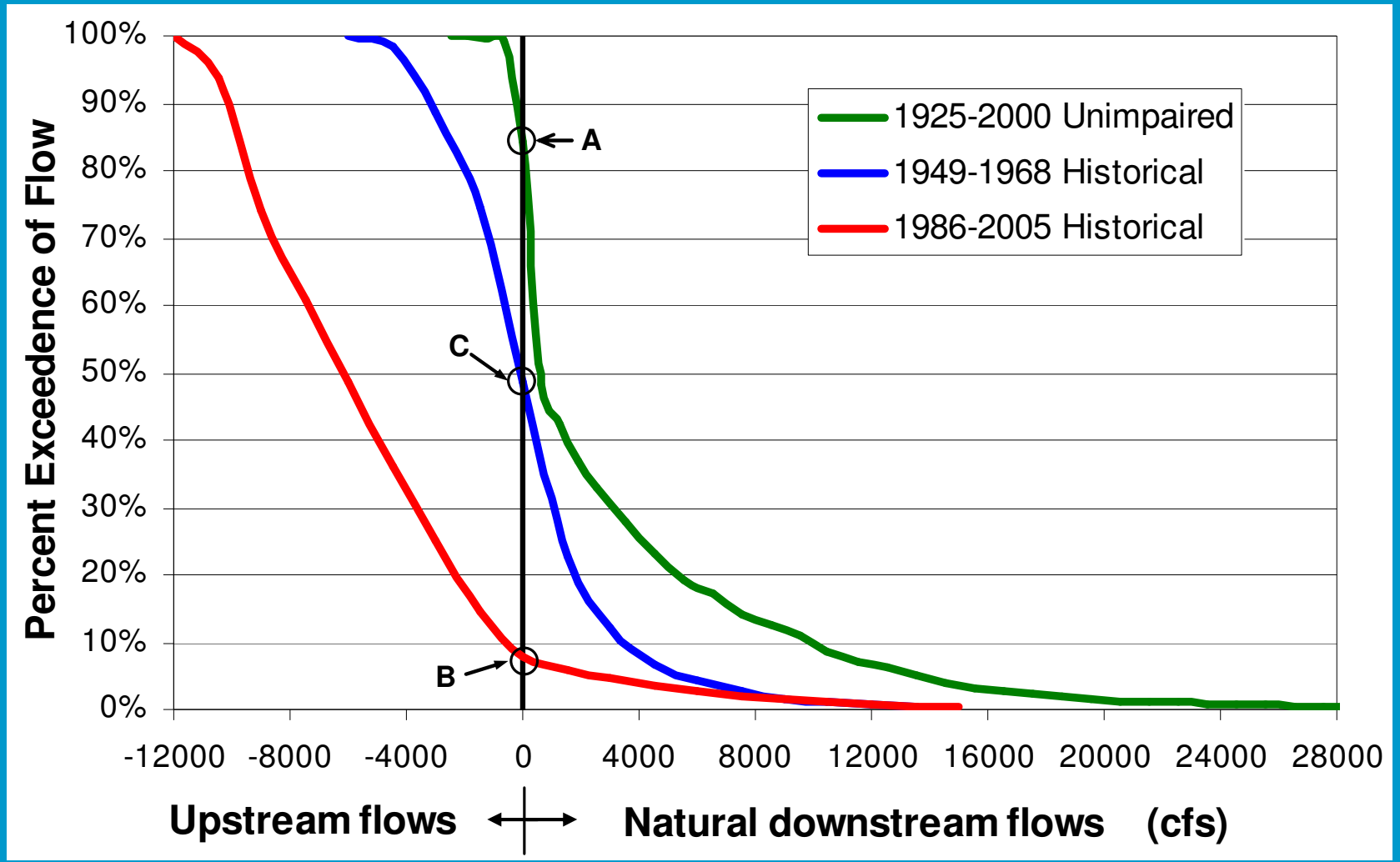


Sum of Old and Middle River Flows

Functional Flow Approach

(Fleenor *et al*. 2010 paper)

Steps:

1) Identify major ecosystem functions of flows
   - Identify flow locations
   - Fish passage and behavioral cues
   - Habitat support
   - *etc*.
2) Estimate flows needed for each function, by season and annual frequency
3) Accumulate flows (without double-counting)
4) Refine and finalize
5) Improve over time

Functional Flow Approach

Category	Item	Function	Flow (cfs)	Months Applied (10 = October)												# Years of 10
				10	11	12	1	2	3	4	5	6	7	8	9	
1. Yolo Bypass	1a	juvenile salmon, adult splittail most years	2,500*					1	1	1						8
	1b	juvenile salmon, adult splittail pulses	4,000**						1	1						6
2. Sac River	2a	SR adult salmon	10,000	1	1	1	1	1	1	1	1	1				6
	2b	Juvenile salmon migration – SR	25,000						1	1	1	1				6
	2c	Adult sturgeon	70,000				1	1	1	1	1					1
	2d	Min flow past PC intake	10,000	1	1	1	1	1	1	1	1	1	1	1	1	10
3. SJ Valley	3a	SJR juvenile salmon wet	20,000							1	1	1				2
		above normal	15,000							1	1	½				4
		below normal	10,000							1	1					6
		dry	7,000							1	½					8
		critical	5,000							1						10
	3b	Stockton Ship Channel DO	2,000	1									1	1	1	10
	3c	SJR adult salmon	2,000	1	1	1	1	1	1	1	1	1	1	1	1	10
4. Eastside Streams	4a	Mokelumne River flows	1,500						1	1						8
	4b	Eastside Stream minimum flows	1,060	1	1	1	1	1	1	1	1	1	1	1	1	9
5. Net Delta Outflows	5a	Delta smelt flows	48,000						1	1	1					5
	5b	Egeria suppression by reducing outflows (Experimental Flow)	8,000										1	1		3 ***
	5c	Overbite clam suppression by increasing flows (Experimental Flow)	120,000					1	1	1						3
Other	6a	Suisun Marsh Flows														
	6b	Close or Limit exports														
	7a	Safety Factor	20%													

*, ** Yolo Basin flows require flows of 45,750 and 50,100 cfs with current understanding of the weir

*** Flow is specified during driest of 10 years while all others are for wettest years

Functional Flow Approach

Scientific support for each flow:

1a. & 1b. BDCP draft report 2008 , Moyle *et al*. 2004; Sommer *et al*. 2004; Harrell and Sommer 2003; Harrell *et al*. 2009

1c. BDCP draft report 2008

2a. & 2b. Newman and Rice 2002, Williams 2006; Harrell *et al*. 2009, USFWS Exhibit 31 1987, Kjelson and Brandes 1989

2c. Harrell and Sommer 2003

2d. Newman and Rice 2002

3a. CDFG 2005, USFWS Exhibit 31 1987, Newman and Rice 2002, Williams 2006

3b. Lehman *et al*. 2004, Jassby and Van Nieuwenhuyse 2005, USFWS Exhibit 31 1987, Newman and Rice 2002, Williams 2006

3c. USFWS Exhibit 31 1987, Newman and Rice 2002, Williams 2006

4a. Henson *et al*. 2007

4b. Moyle *et al*. 2007

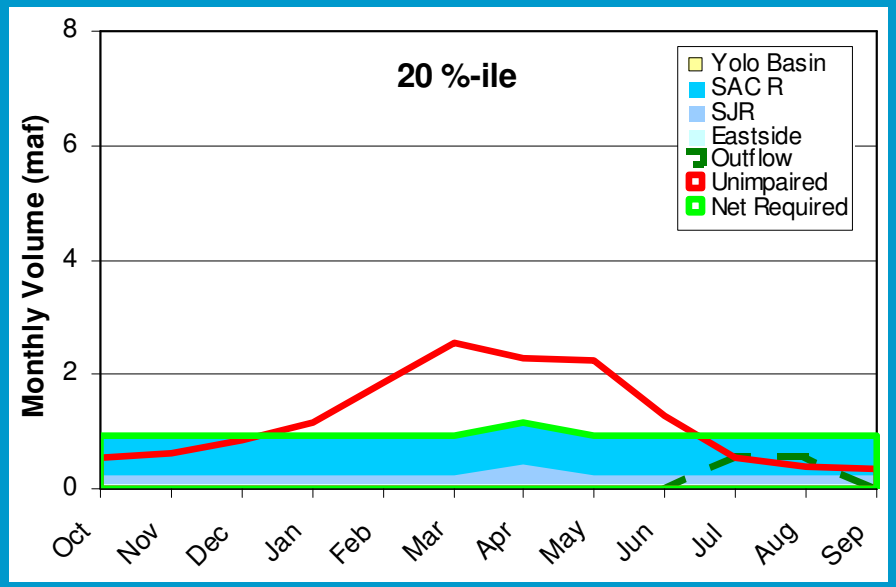
5a. Bennett 2005, Hobbs *et al*. 2005

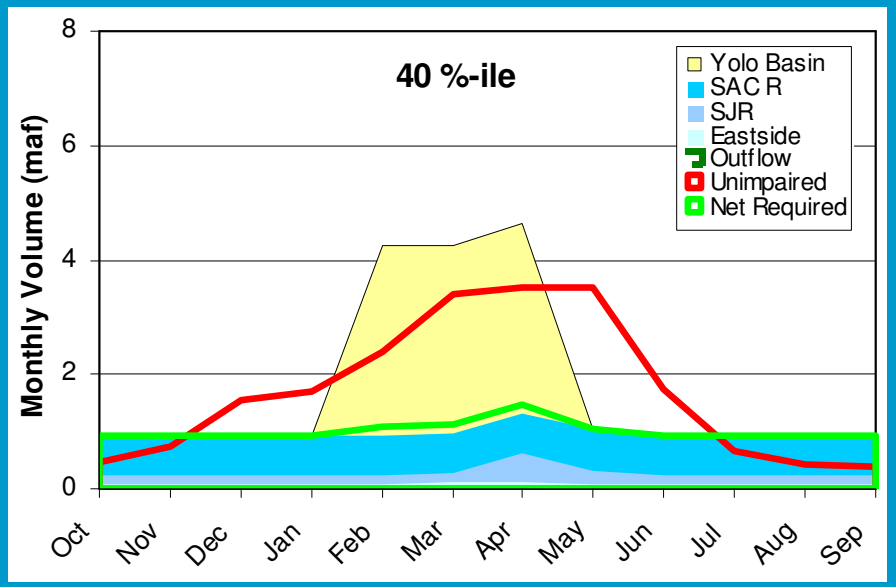
5b. Hauenstein and Ramirez 1986

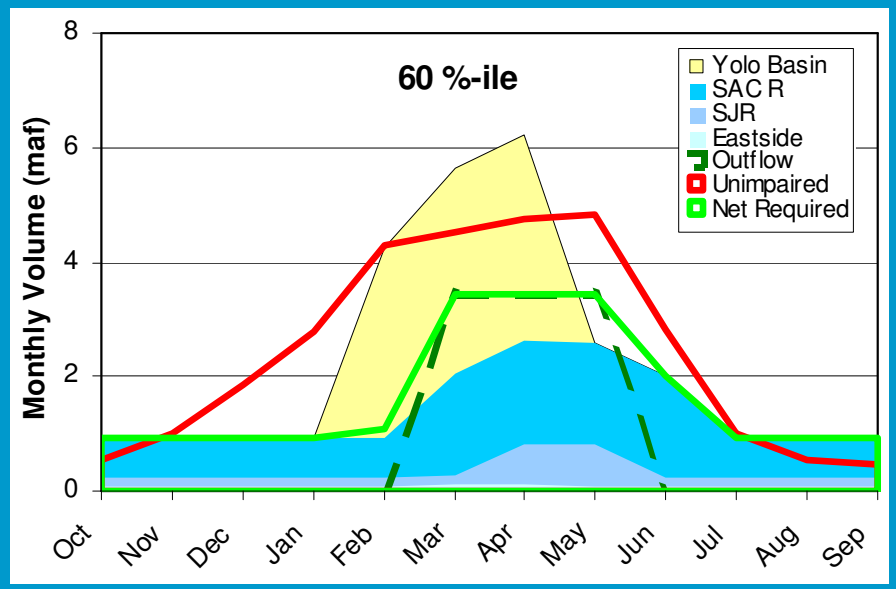
5c. Thompson 2005, Moyle personal comm.

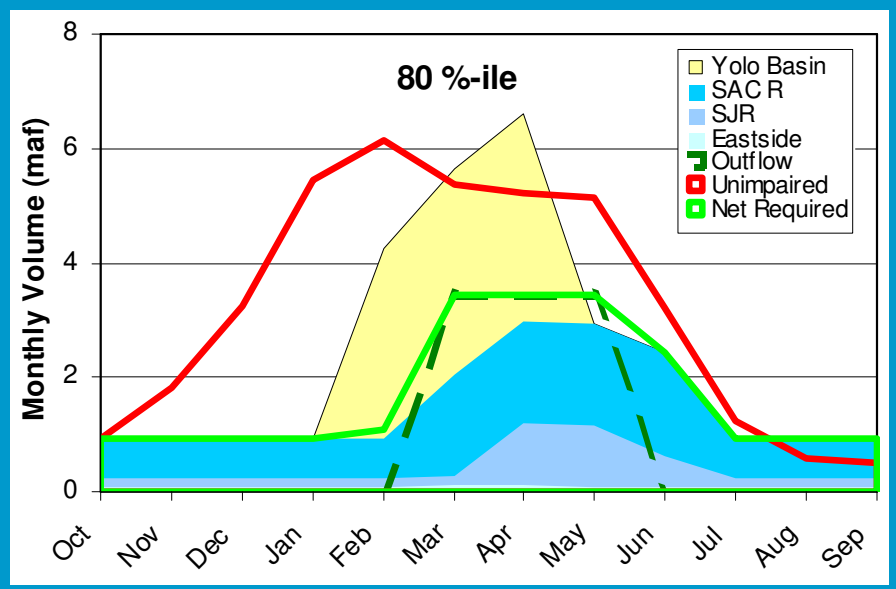
6a. Bennett personal comm.

Percentile Application of Functional Approach









Implementing Functional Flows

- Listed flows need further consideration
  - Guidance needed to set functional flow levels
  - Seasonal steps may miss smaller scale responses
  - Some flow functions might conflict
- Are some important functions missing?
- How to work with experimental flows?
- Refine to integrate upstream uses
- Monitoring response is required
- Management flexibility is crucial

Functional Flow Advantages

- Organizes flow prescription around ecosystem functions
- Ties flows to ecosystem functions
- Systematic approach to establishing and updating flow prescriptions
- Focuses scientific controversies
- Identifies weak areas of knowledge
- Allows for experimental/adaptive management flows

Fleenor *et al*. 2010

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