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NOAA FISHERIES
West Coast Region

Sacramento River
Ecological Flow Thresholds for Salmonids Workshop

Brycen Swart
September 29, 2016

Sacramento River

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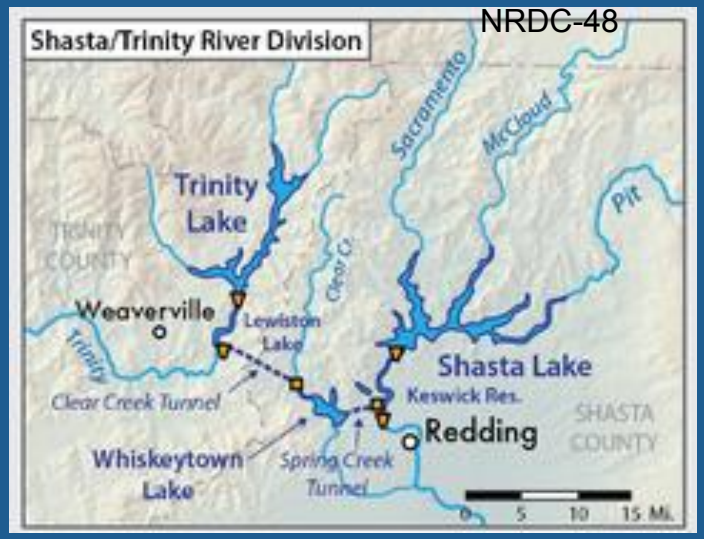
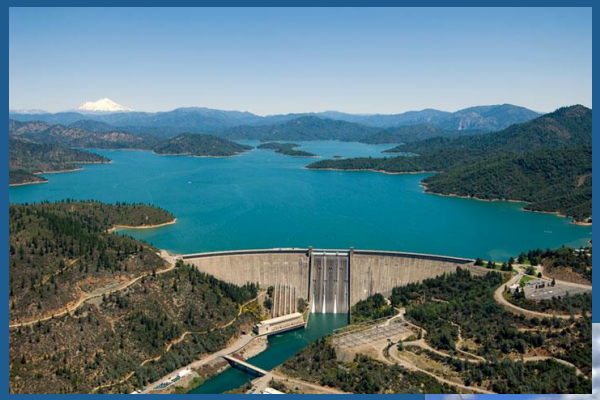
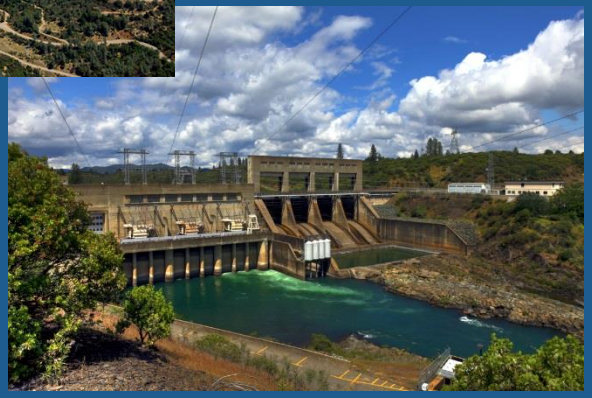
Shasta Division

Central Valley Project







Regulatory Context

- 2009
  - Biological Opinion on the CVP/SWP Long-term Water Operations (OCAP)
  - Jeopardy Determination
  - Shasta Division RPA actions address storage requirements, temperature compliance, drought contingencies, and re-introduction but not flows
- 2016
  - Shasta Division RPA Adjustment – RPA actions are not avoiding jeopardy
  - CVP/SWP Long-term Operations Re-initiation
- SWRCB – Bay-Delta Water Quality Control Plan

Current Flow Management

Minimum Flow Requirements

Period	Reclamation-CDFW MOA (1960)		Water Rights 90-5 (1990)	NMFS BiOp (1993)
Water Year Type	**Normal**	**Critically Dry**	**Normal**	**All**
January 1–February 28(29)	2,600	2,000	3,250	3,250
March 1–March 31	2,300	2,300	2,300	3,250
April 1–April 30	2,300	2,300	2,300	No Requirement
May 1–August 31	2,300	2,300	2,300	No Requirement
September 1–September 30	3,900	2,800	3,250	No Requirement
October 1–November 30	3,900	2,800	3,250	3,250
December 1–December 31	2,600	2,000	3,250	3,250

Flow Regime Approach

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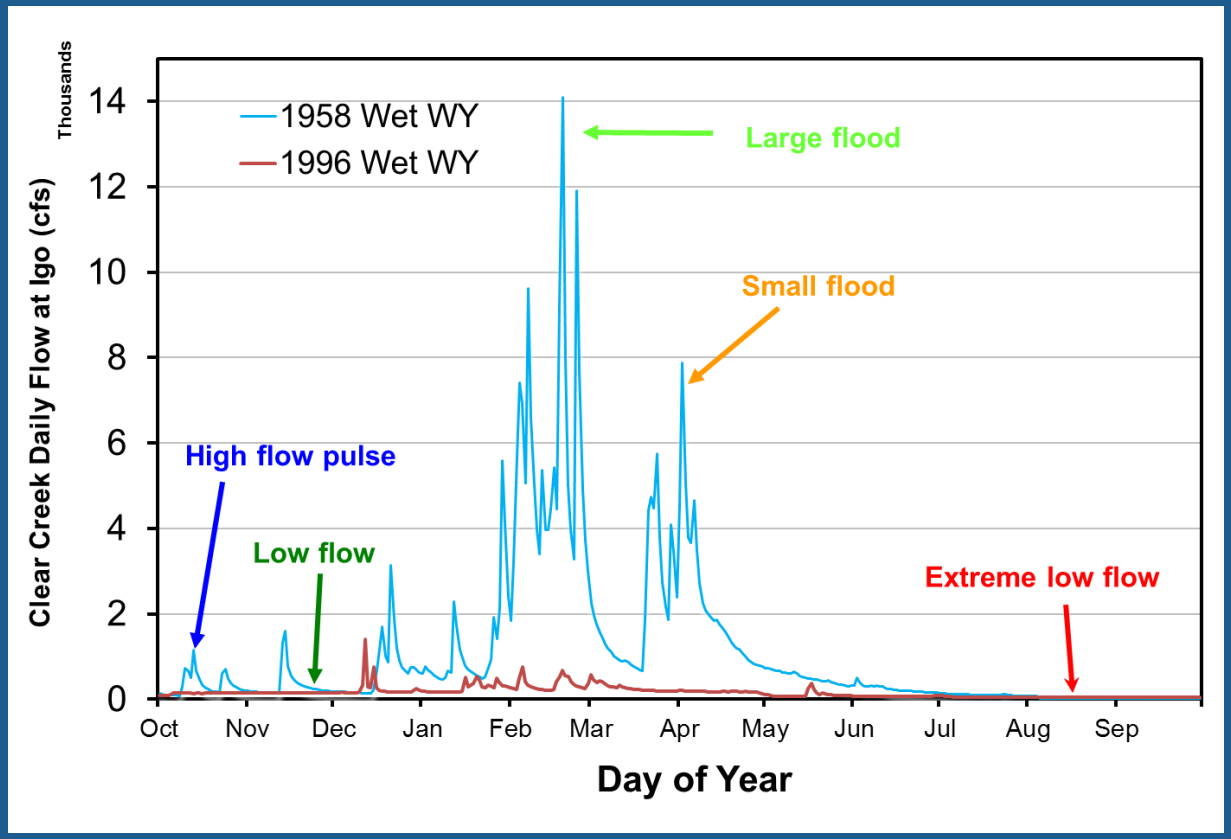
Mimic "natural", climatically-driven variability of flows from year to year and from season to season



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

Principles for Flow Regime Approach

- Flow determines the extent and type of physical habitat, which in turn determines the types of living organisms in that habitat.
- Aquatic species have evolved in such a way as to be well adapted to the natural flow regime to which they have been historically exposed.
- Maintenance of natural patterns of high flows, low flows and flow variation is essential to the viability of native riverine species.
- The alteration of flow regimes contributes to the invasion and success of exotic (non-native) species in rivers.

(Bunn and Arthington, 2002)

Implementing Flow Regime Approach

- Collect flow data and analyze them
- If there is a period of time when flows were measured before major human modifications occurred, that time period is used to set the baseline or natural, unmanaged flow conditions.
- If no such data exists, use other data (e.g., similar unimpacted rivers or unimpaired flow) to establish historic conditions.
- Set recommended flows throughout the year, providing flow recommendations for each hydrologic season (e.g. low flow, snowmelt, rainy season).

Pre-Dam Natural Flow

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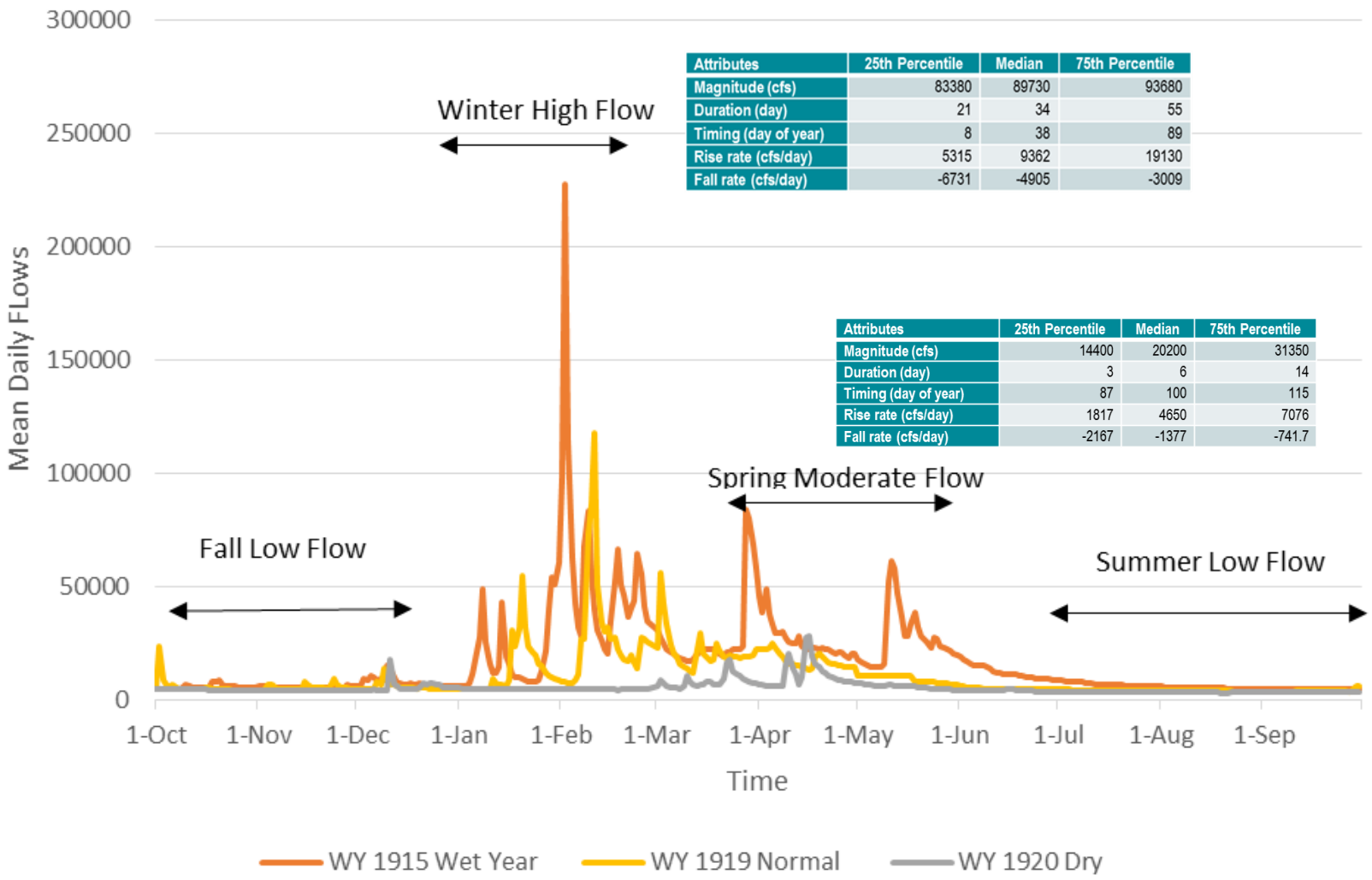

Attributes	25th Percentile	Median	75th Percentile
Magnitude (cfs)	83380	89730	93680
Duration (day)	21	34	55
Timing (day of year)	8	38	89
Rise rate (cfs/day)	5315	9362	19130
Fall rate (cfs/day)	-6731	-4905	-3009

Attributes	25th Percentile	Median	75th Percentile
Magnitude (cfs)	14400	20200	31350
Duration (day)	3	6	14
Timing (day of year)	87	100	115
Rise rate (cfs/day)	1817	4650	7076
Fall rate (cfs/day)	-2167	-1377	-741.7

Median Monthly Flows

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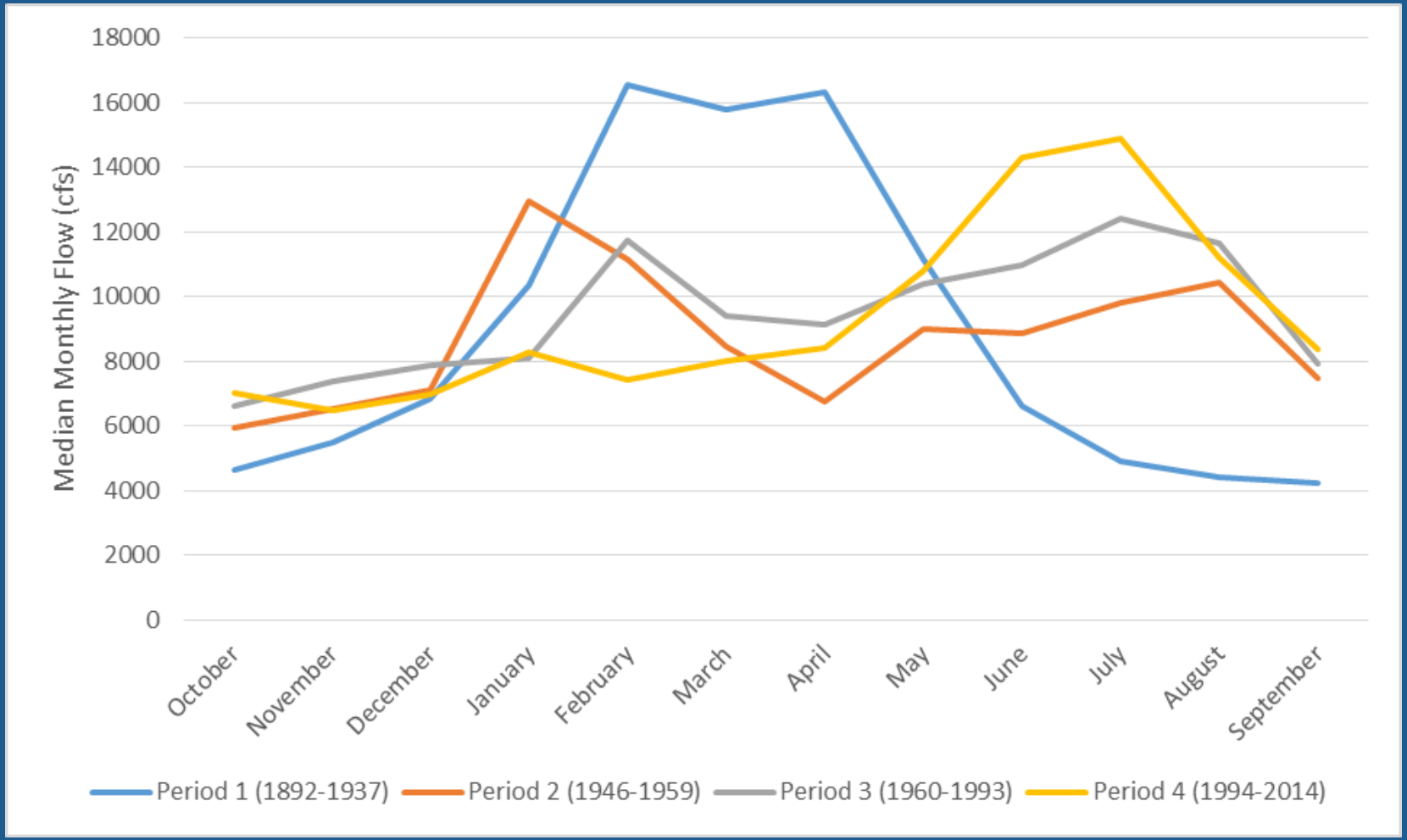


Changes in Flood Flows

Period	1.5-Year Flood	2-Year Flood	5-Year Flood	10-Year Flood
Period 1 (1892-1937)	89730	130000	153000	206000
Period 2 (1946-1959)	54600	85700	97400	125000
Period 3 (1960-1993)	50500	77500	101000	123000
Period 4 (1994-2014)	41400	73200	88800	105000
% Reduction (P1 and P2)	39%	34%	36%	39%
% Reduction (P1 and P3)	44%	40%	34%	40%
% Reduction (P1 and P4)	54%	44%	42%	49%

Changes in Spring Pulse Flows

Attributes	Period 1 (1892-1937)	Period 2 (1946-1959)	Period 3 (1960-1993)	Period 4 (1994-2014)
Magnitude (cfs)	20200	14800		
Duration (day)	6	2		
Timing (day of year)	100	112		
Frequency (per year)	1.5	1	0	0
Rise rate (cfs/day)	4650	2715		
Fall rate (cfs/day)	-1377	-2788		

Environmental Thresholds and Requirements

	Magnitude	Duration	Timing	Frequency	Source
Bed Mobilization	24,000 - 120,000	12 hour peak flow	Between Feb 20 - March 20	3 to 4 years	Cain 2008, DWR 2001, Kondolf 2000, Stillwater 2006
Bank Erosion and Channel Migration	15,000 - 60,000	?	Prior to late March	2 to 4 years	Stillwater 2007, Larsen 2007
Floodplain Inundation and Rearing Habitat Flows	>25,000	30 - 60 days	Feb 15 to April 30	Dry to Wet Water Year Types	Harrell 2008, DWR 2008
Riparian Flows	23,000 - 30,000	72 day recession period	April to May	Above Normal and Wet Years	Roberts 2003, Kondolf 2007, Cain 2008

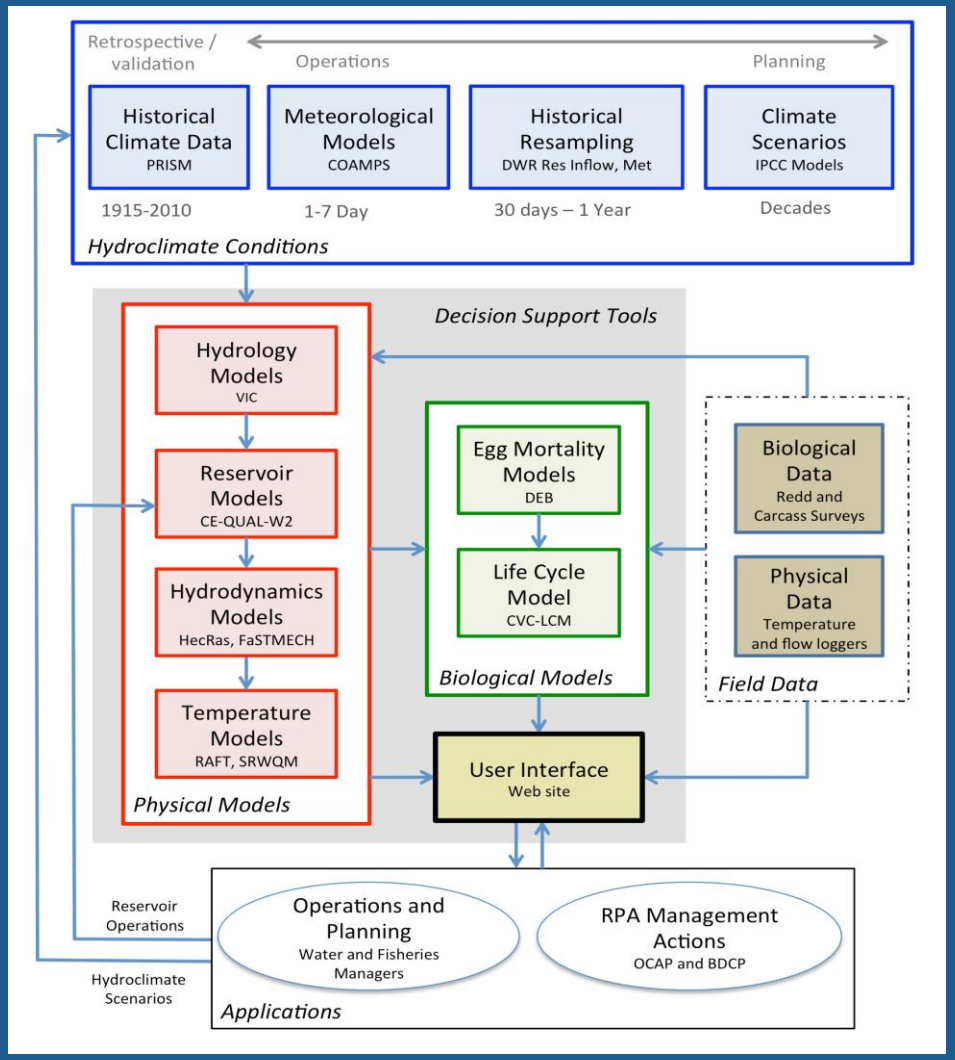
Potential Flow Recommendations

		Water Year Type				
	Timing	Critical	Dry	Below Normal	Above Normal	Wet
Bed Mobilization	Mid Feb – Mid Mar		35,000	65,000	85,000	105,000
Floodplain Inundation	Feb - Apr (45 days)			25,000	35,000	45,000
Riparian Establishment Flow	Apr				23,000	37,000
Fall Base Flow	Sep - Nov	5,250	5,250	5,250	5,250	5,250
Winter Base Flow	Dec - Feb	4,500	6,000	6,500	7,000	8,000
Spring Base Flow	Mar - May	10,000	12,000	12,500	14,000	14,000
Summer Base Flow	Jun - Aug	8,000	8,000	8,000	8,000	8,000

Next Steps

- Incorporate regression analysis of salmonid abundance with instream flow
- Refine flow recommendations
- CALSIM, SRWQM, and RAFT modeling

Validation


Retrospective / validation
Operations
Planning
Historical Climate Data
PRISM
Meteorological Models
COAMPS
Historical Resampling
DWR Res Inflow, Met
Climate Scenarios
IPCC Models
1915-2010
1-7 Day
30 days – 1 Year
Decades
Hydroclimate Conditions
Decision Support Tools
Hydrology Models
VIC
Reservoir Models
CE-QUAL-W2
Hydrodynamics Models
HecRas, FaSTMECH
Temperature Models
RAFT, SRWQM
Physical Models
Egg Mortality Models
DEB
Life Cycle Model
CVC-LCM
Biological Models
Biological Data
Redd and Carcass Surveys
Physical Data
Temperature and flow loggers
Field Data
User Interface
Web site
Reservoir Operations
Hydroclimate Scenarios
Operations and Planning
Water and Fisheries Managers
RPA Management Actions
OCAP and BDCP
Applications

Thanks! Any Questions?