Draft Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives

Public Board Workshop
January 6-7, 2011

Focus of Workshop

- Focus: Discuss technical basis for developing alternative San Joaquin River flow and southern Delta salinity objectives
- Other Issues: including non-technical, environmental review, economics, policy and procedural issues focus of subsequent steps in process
- Additional comments: Due by noon, Feb. 8

Comments

- CA Farm Bureau Fed.
- CA Sportfishing Protection Al./CA Water Impact Net.
- Central Delta Wtr. Ag.
- Central Valley Clean Water Assoc.
- City of Stockton
- City of Tracy
- SF Pub. Util. Com.
- South Delta Water Ag.
- State Wtr. Contractors/San Luis Delta Mendota Wtr.
- Nat. Marine Fish. Serv.
- Coalition for a Sustainable Delta
- Contra Costa Wtr. Dist.
- Dept. Fish and Game
- Dept. Water Resources
- John Letty
- Stockton East Wtr. Dist.
- North. CA Water Assoc.
- San Joaquin R. Grp. Auth.
- Glenn-Colusa Ir. Dist.
- Bay Institute/Natural Res. Def. Council
- Dept. of Interior

Panel Participation Requests

- National Marine Fisheries Service
- Department of Fish and Game
- Bay Institute/Natural Resources Defense Council
- Department of Water Resources
- Department of Interior
- State & Federal Water Contractors
- California Sportfishing Protection Alliance/ California Water Impact Network
- South Delta Water Agency
- U.S. Environmental Protection Agency
- American Rivers
- San Joaquin River Group Authority

Proposed Questions

- National Marine Fisheries Service
- Department of Fish and Game
- Bay Institute/Natural Resources Defense Council
- Department of Interior
- SF Public Utilities Commission
- California Sportfishing Protection Alliance/ California Water Impact Network
- South Delta Water Agency
- U.S. Environmental Protection Agency
- SJR Group Authority
- SJR Exchange Contractors

Next Steps

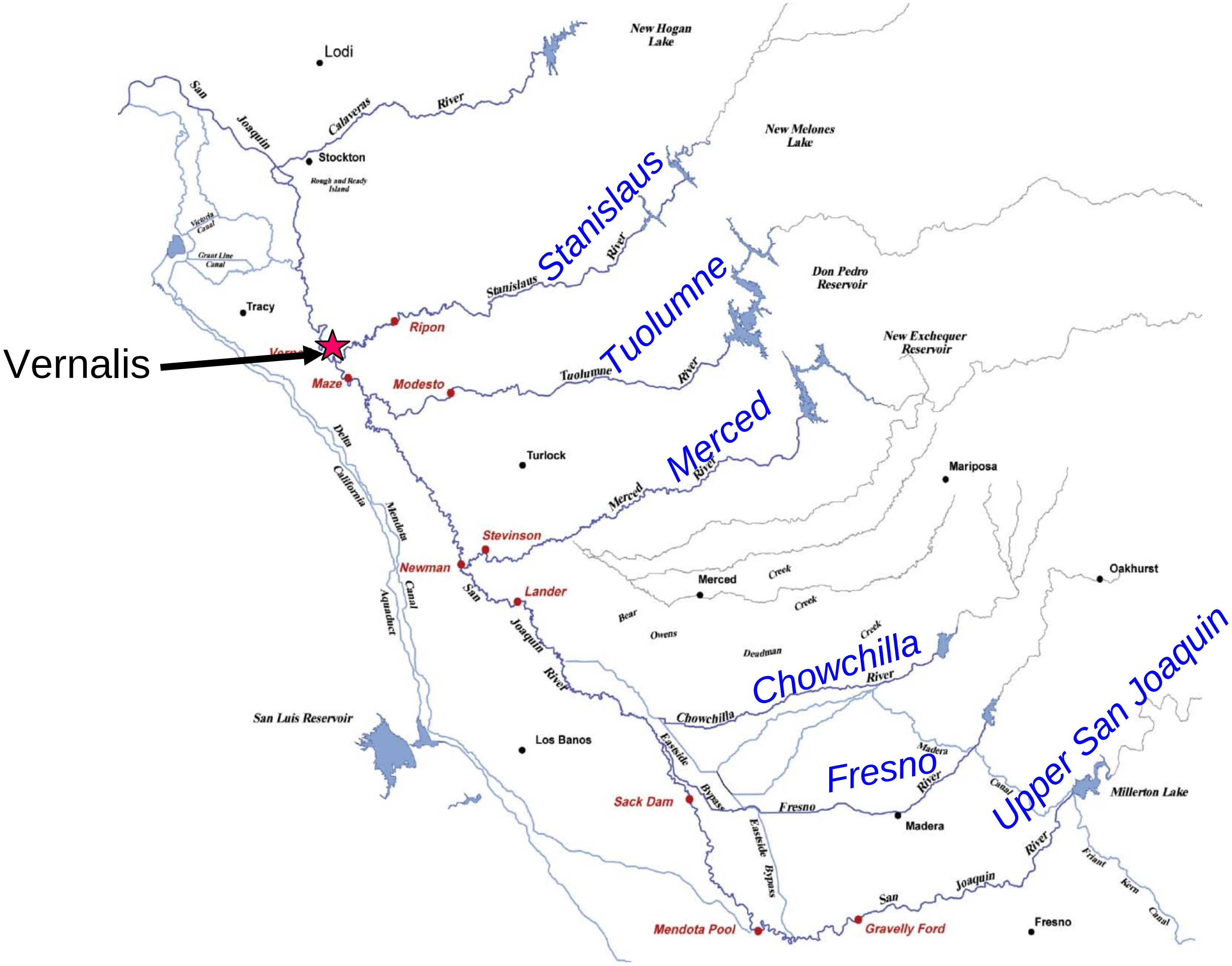
- Following workshop submit revised Technical Report for independent peer review
- Draft Substitute Environmental Document expected by end of 2011
- Consideration of approval of final Substitute Environmental Document and any changes to San Joaquin River flow and southern Delta salinity objectives by spring of 2012

Chapter 2: Hydrologic Analysis of San Joaquin River Basin

Outline

1. Project area and unimpaired flow
2. Typical hydrograph
3. Annual, monthly, and daily flows
4. Major tributary contributions to Vernalis
5. Flow downstream of Vernalis
6. Summary

Project Area



January 6 and 7, 2011 Workshop

California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

Unimpaired Flow

- "The flow that would occur absent the affects of dams and diversions"
- Not adjusted for changes in channel geometry, levees, valley flooding
- Data Source
  - DWR. 2007. "Central Valley Unimpaired Flow"
  - DWR, CDEC website "*Full Natural Flow*"

Unimpaired Flow

- Tributaries calculated using gage data downstream of the major dams
  - Adjusted for evaporation, storage, and diversions
- “Valley Floor” based on factors for west side streams and Fresno Slough, however does not incorporate groundwater interaction
- Vernalis = Sum of tributaries, valley floor, minor streams, and Tulare Basin outflow

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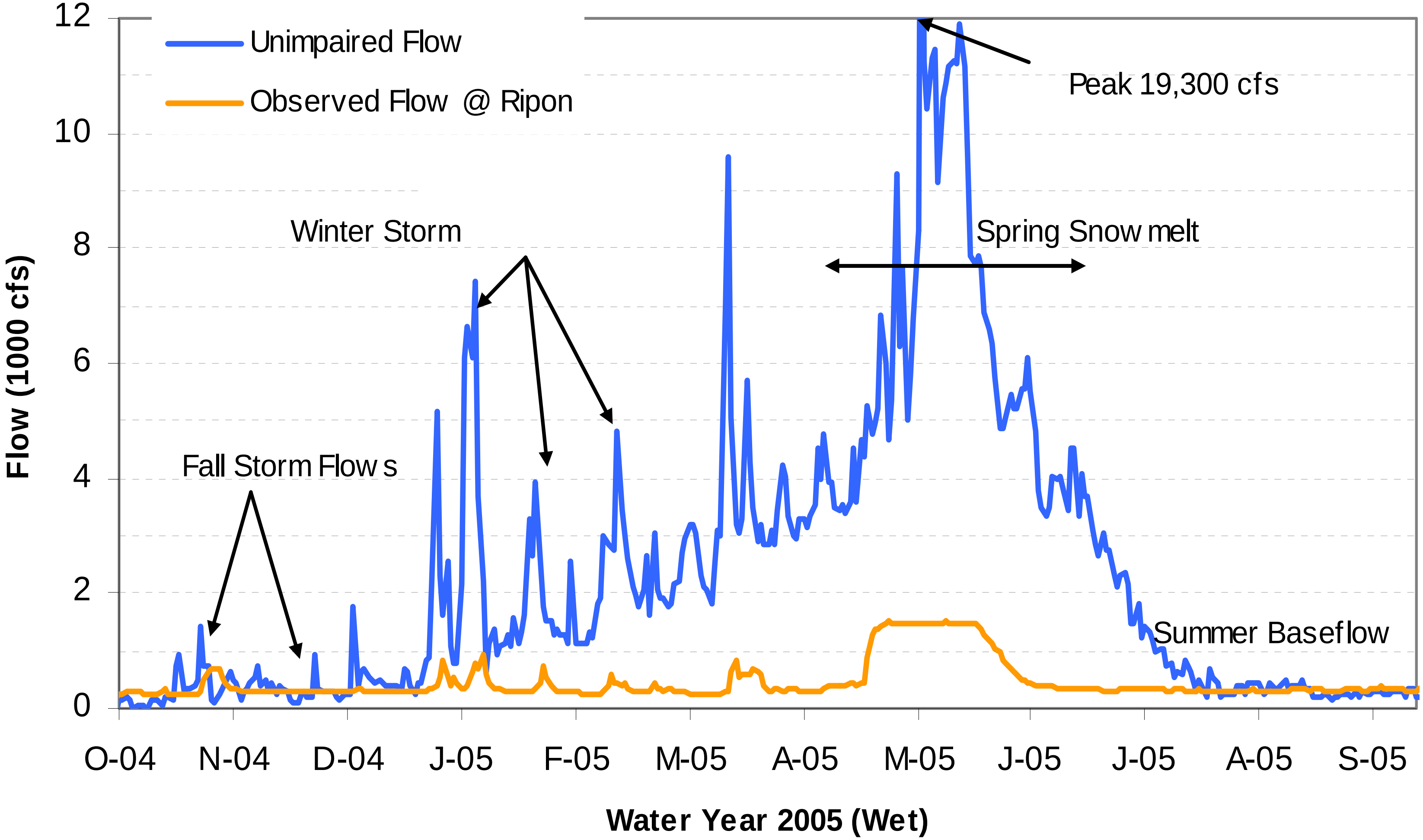
Typical Hydrograph – Stanislaus



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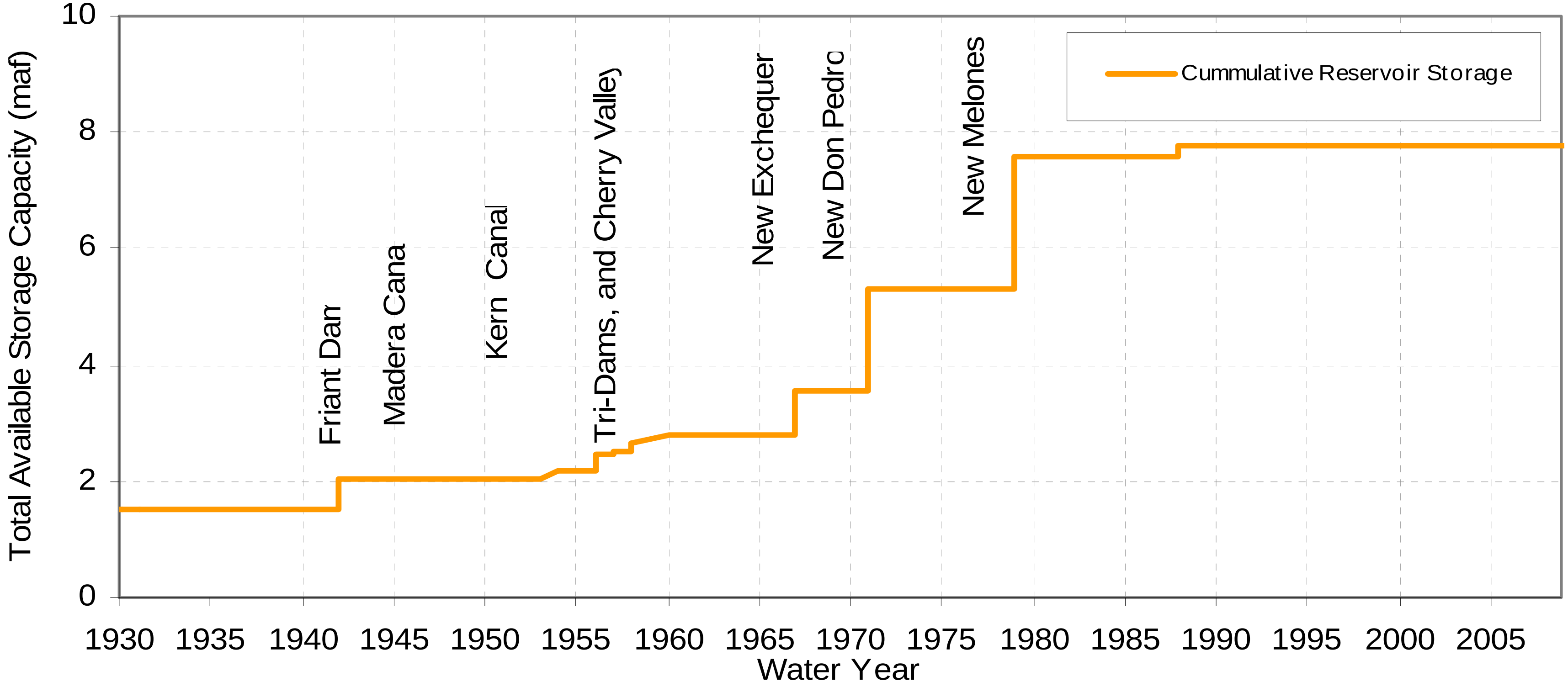
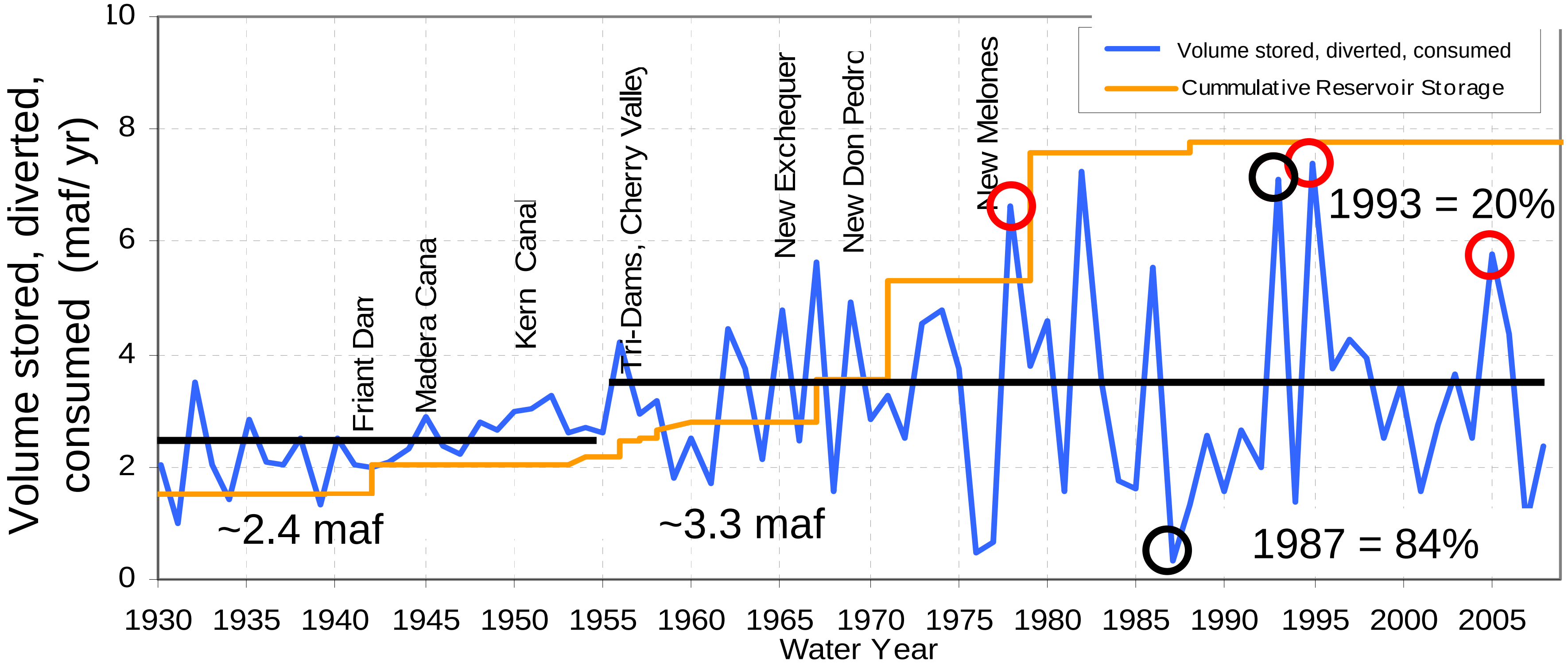
Annual Flows at Vernalis

Changes in Storage within SJR Basin

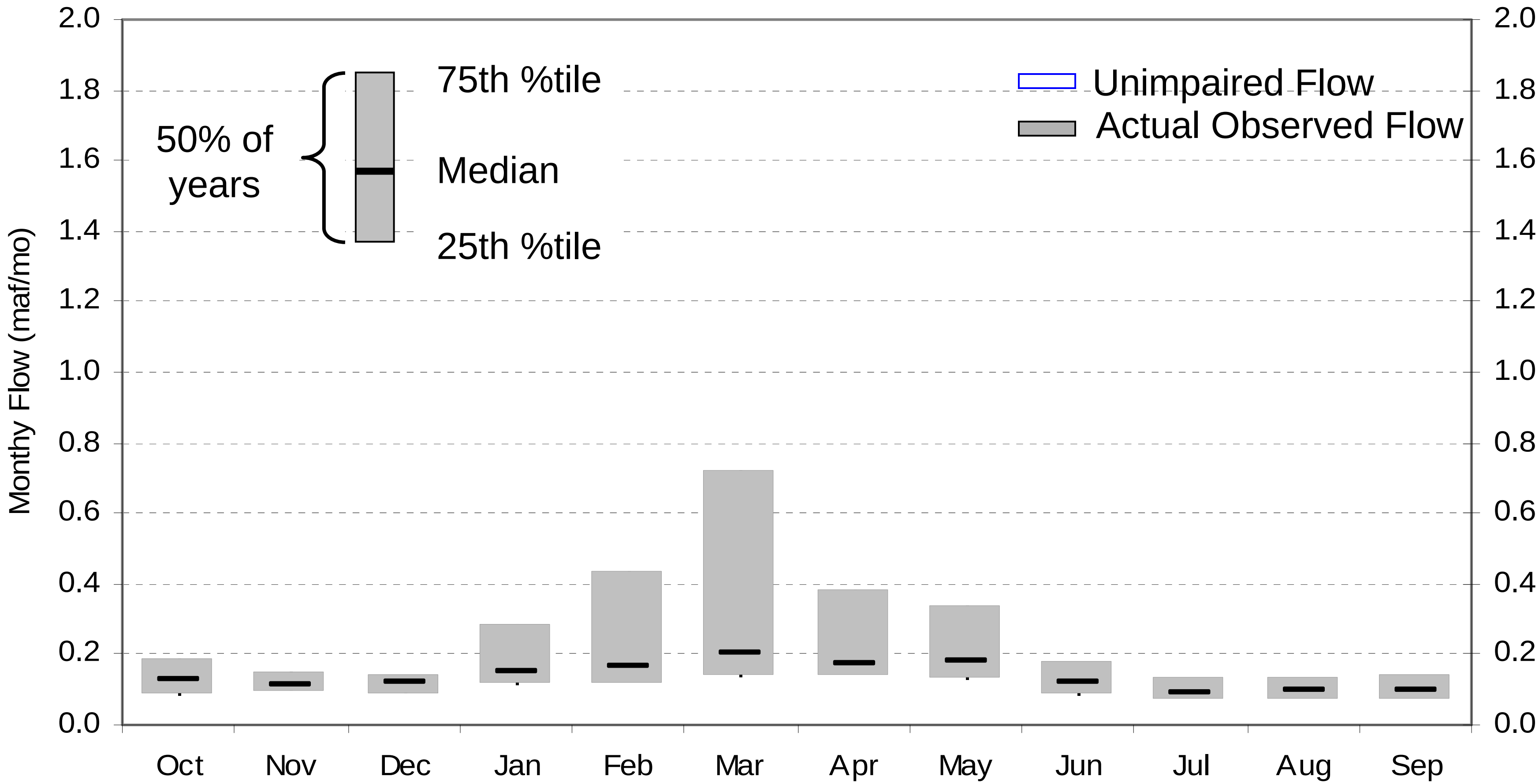


Annual Flows at Vernalis

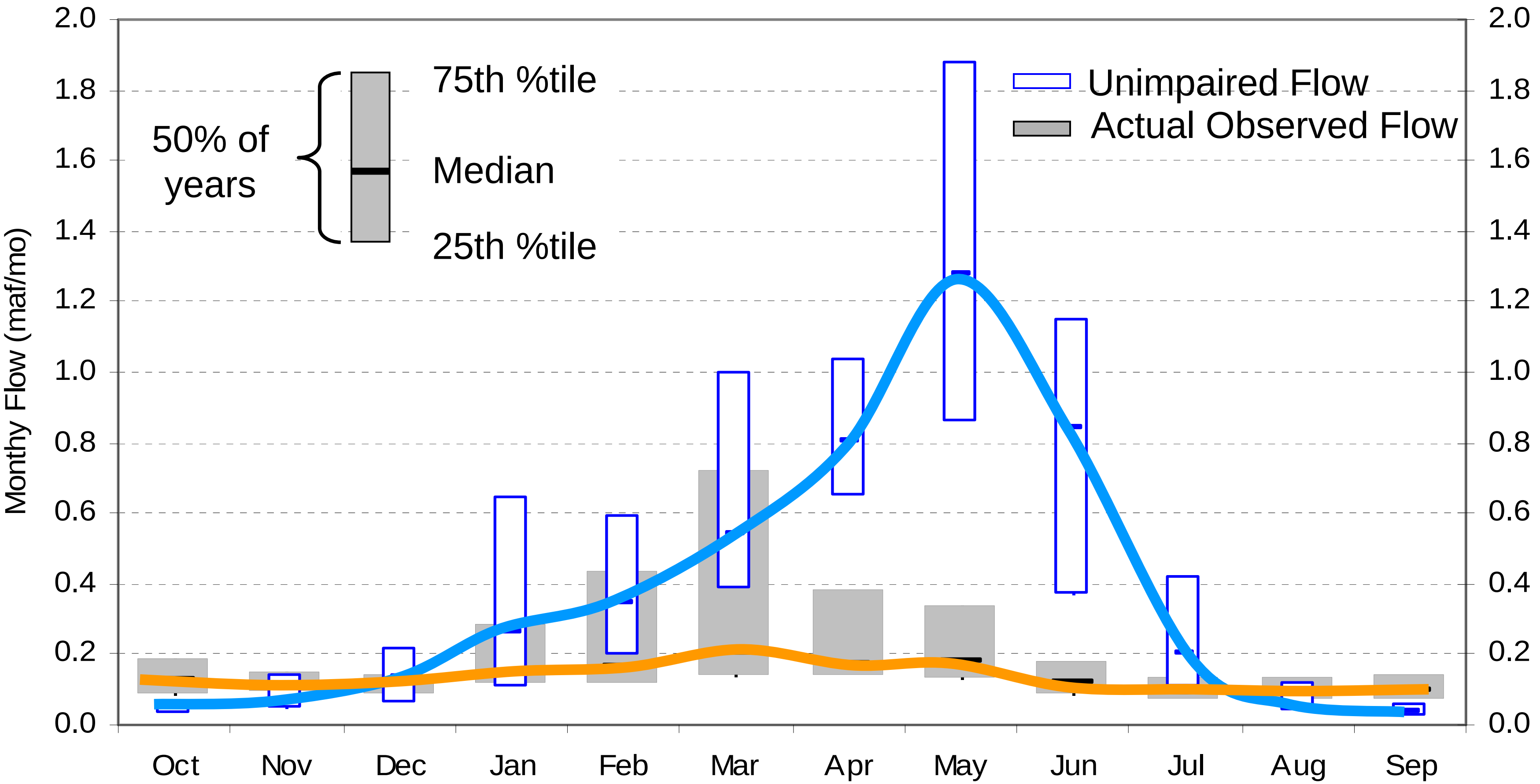
Changes in Storage within SJR Basin



Monthly Flows at Vernalis



Monthly Flows at Vernalis



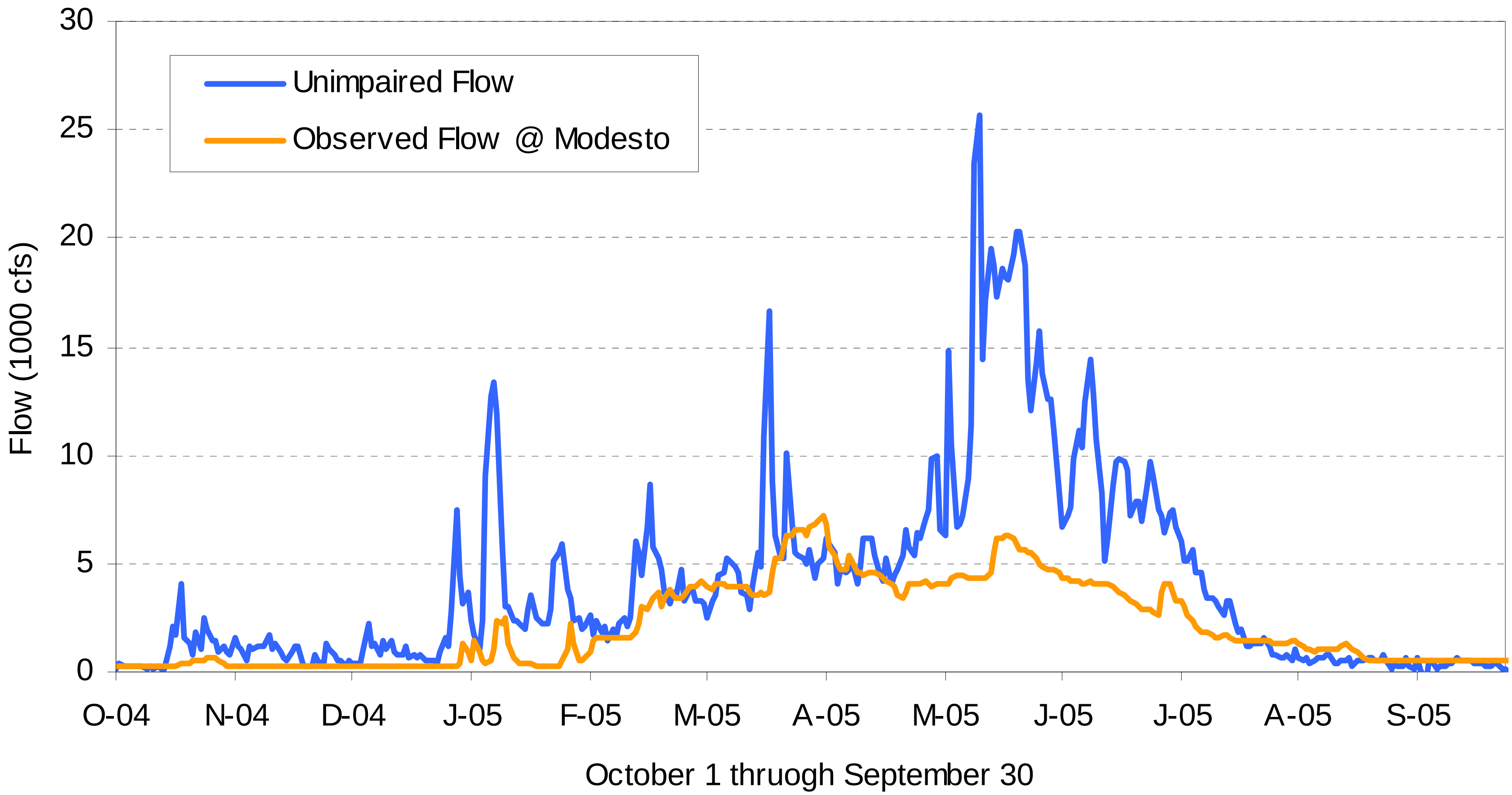
Monthly Flows at Vernalis

During 75% of years (~19 of past 25 yrs)

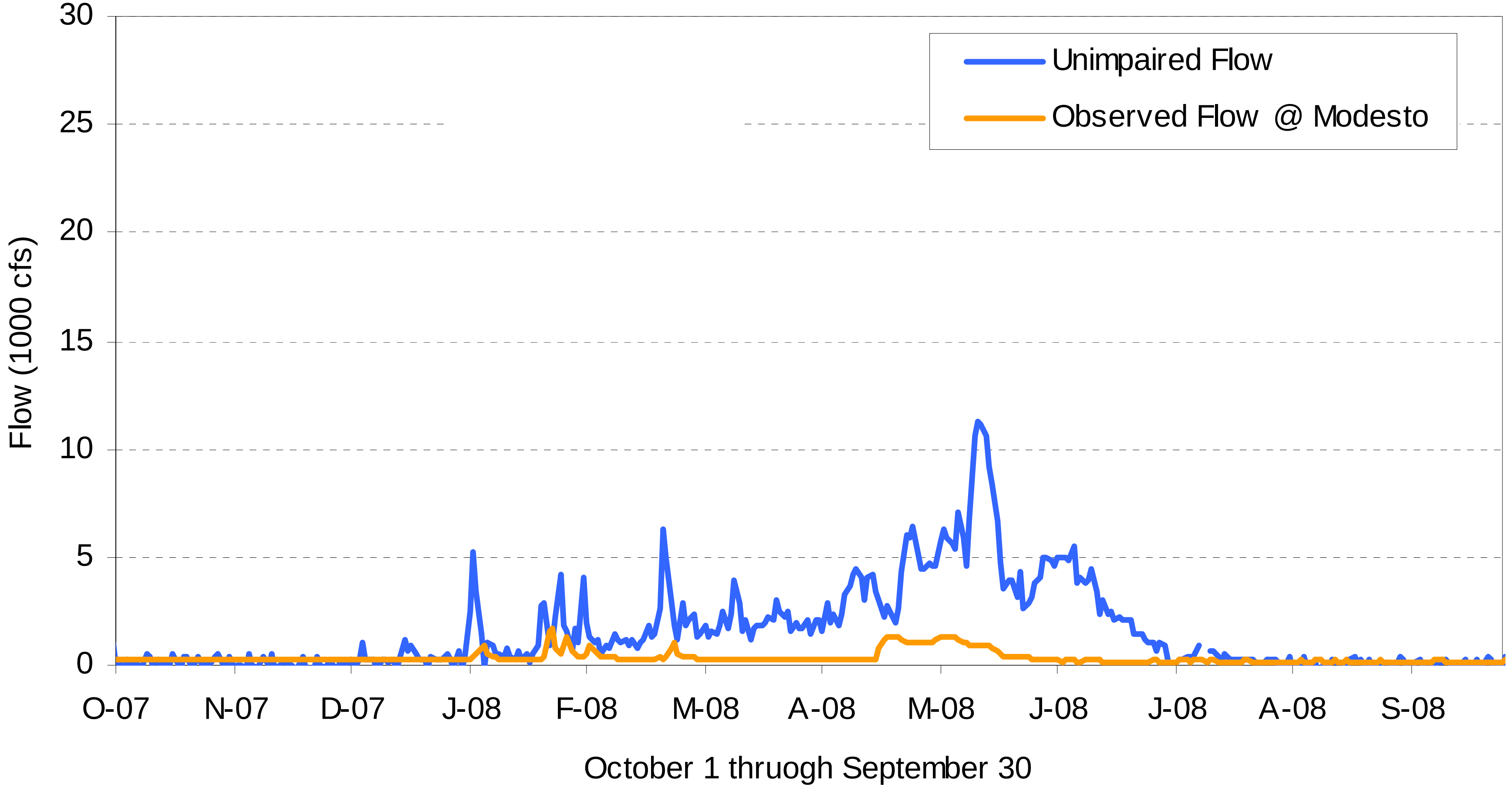
- April : < 40% of Unimpaired Flow
- May : < 25% of Unimpaired Flow
- June : < 30% of Unimpaired Flow

- May was never more than 60%
- June was never more than 55%

Daily Flows – Tuolumne
Wet Year (2005)



Daily Flows -Tuolumne Critically Dry Year (2008)



Annual Peak Daily Flows at Vernalis

Return Period	% Reduction from Unimpaired Flow (Annual 1-day Peak Flow)
1.5yr	70%
2yr	76%
5yr	53%
10yr	65%
Unimpaired peak flows from USACE, 2002. "Sacramento San Joaquin Comprehensive Study" compared to 1984-2008 gage data.	

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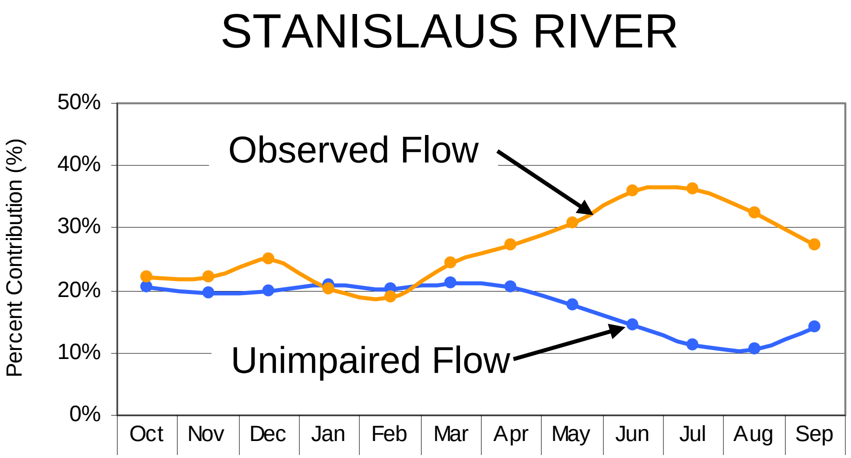
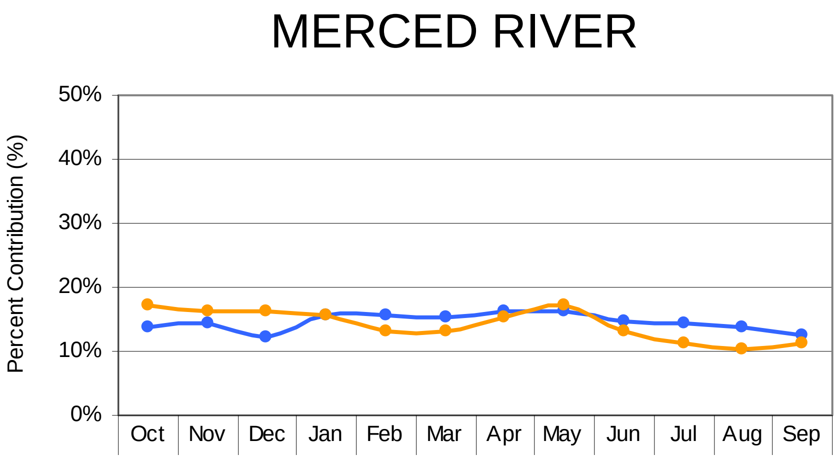
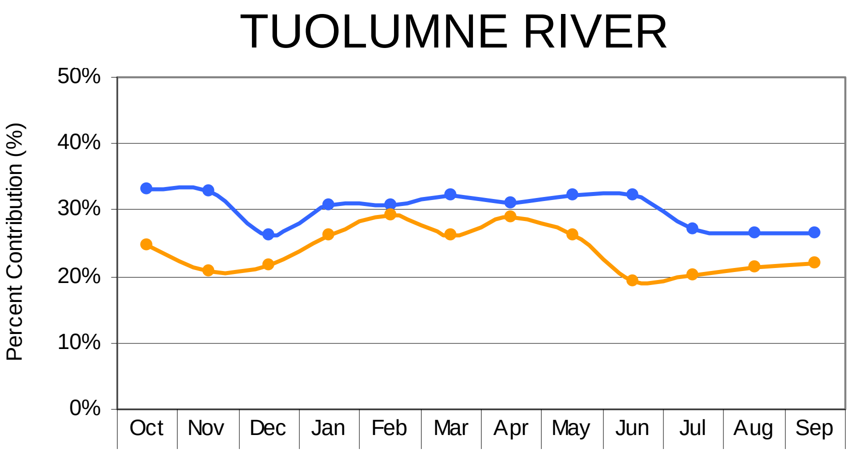
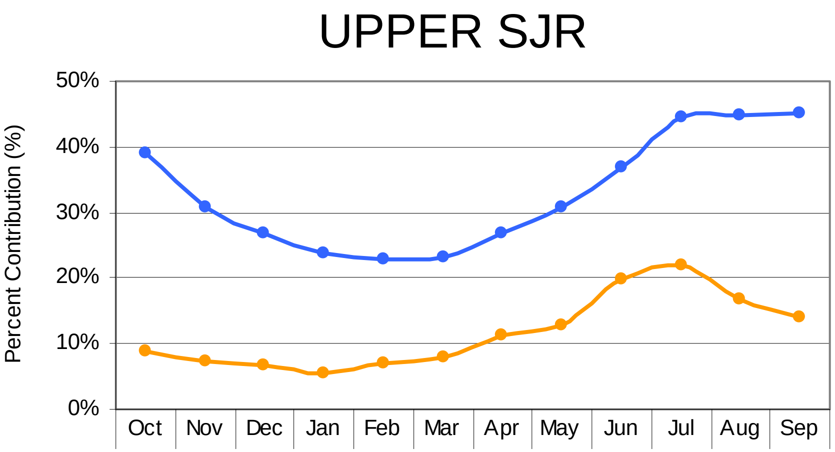
Tributary Contribution to Vernalis Flow









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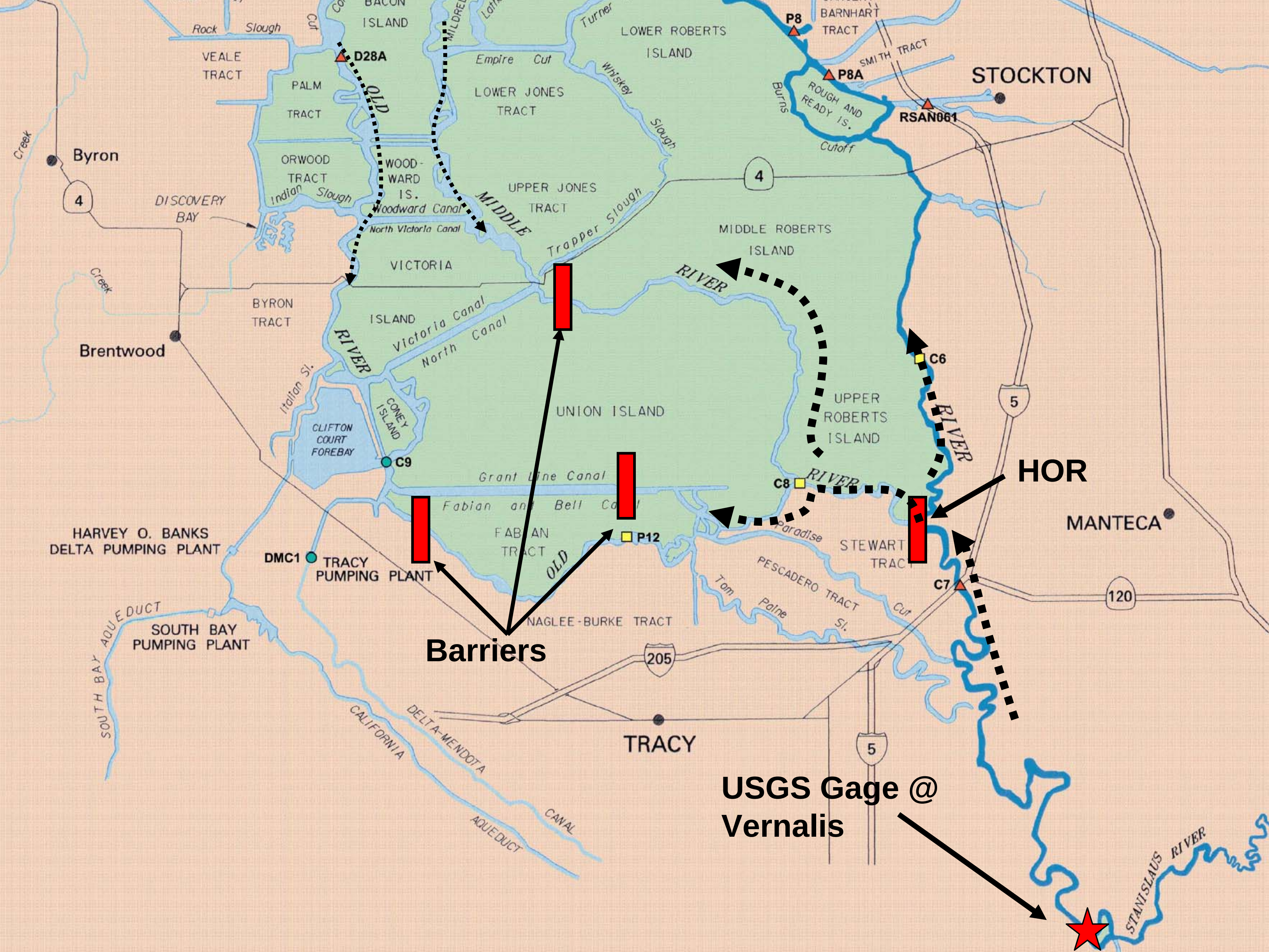

BACON ISLAND
Rock Slough
VEALE TRACT
D28A
OLD
PALM TRACT
LOWER JONES TRACT
Empire Cut
Turner
LOWER ROBERTS ISLAND
P8
BARNHART TRACT
SMITH TRACT
P8A
STOCKTON
ROUGH AND READY IS.
Burns Cutoff
RSAN061
Whiskey Slough
Byron
ORWOOD TRACT
WOODWARD IS.
Indian Slough
Woodward Canal
North Victoria Canal
MIDDLE
UPPER JONES TRACT
DISCOVERY BAY
4
Trapper Slough
MIDDLE ROBERTS ISLAND
VICTORIA ISLAND
RIVER
BYRON TRACT
Victoria Canal
North Canal
Brentwood
C6
UNION ISLAND
UPPER ROBERTS ISLAND
5
HOR
Italian Sl.
CONEY ISLAND
CLIFTON COURT FOREBAY
C9
Grant Line Canal
C8
Fabian and Bell Canal
FABIAN TRACT
P12
Paradise Cut
STEWART TRACT
MANTECA
HARVEY O. BANKS DELTA PUMPING PLANT
DMC1
TRACY PUMPING PLANT
Tom Paine Sl.
PESCADERO TRACT
C7
120
NAGLEE-BURKE TRACT
Barriers
SOUTH BAY AQUEDUCT
SOUTH BAY PUMPING PLANT
205
TRACY
CALIFORNIA AQUEDUCT
DELTA-MENDOTA CANAL
USGS Gage @ Vernalis
STANISLAUS RIVER

Summary

- Natural variability and magnitude reduced
- Seasonal peak flows shifted in time
- Tributary contributions altered
- Flows downstream of Vernalis altered

Chapter 3: Scientific Basis for Developing Alternate San Joaquin River Delta Inflow Objectives

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Outline

- Focus, Problem and Approach for Chap. 3
- Salmon and Steelhead Life History
- Salmon and Steelhead Population Trends
- San Joaquin River Basin Inflow Needs
- Importance of the Natural Hydrograph

Focus, Problem and Approach

- Focus: San Joaquin River flows at Vernalis for fall-run Chinook salmon & steelhead
- Problem: Reduced flows & changes in natural flow regime impairing fish and wildlife
- Approach: Evaluated existing scientific literature on inflows and protection of fish & wildlife and used to develop range of potential flow alternatives

Outline

- Focus, Problem and Approach for Chap. 3
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Generalized Life History

SJR basin Fall-Run Chinook Salmon and Central Valley Winter-Run Steelhead

Table 3-1. Generalized Life History Timing of Central Valley Fall-Run Chinook Salmon

	Upstream Migration Period	Spawning Period	Incubation	Juvenile Rearing and Outmigration	Rearing Duration
Overall	July to early January	October to December	October to March	December to July	3 to 12 Months
Peak	October to December	October to November	40 to 60 days	Late April to Late May	3 to 7 Months

Table 3-2. Life History Timing of Central Valley Winter-Run Steelhead

	Upstream Migration Period	Spawning Period	Incubation	Juvenile Outmigration	Rearing Duration
Overall	July to April	December to June	December to June	December to July	1 to 3 Years
Peak	October to February	January to March	30 days	March to April	1 to 2 Years

Outline

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Population Trends
SJR basin Fall-Run Chinook Salmon

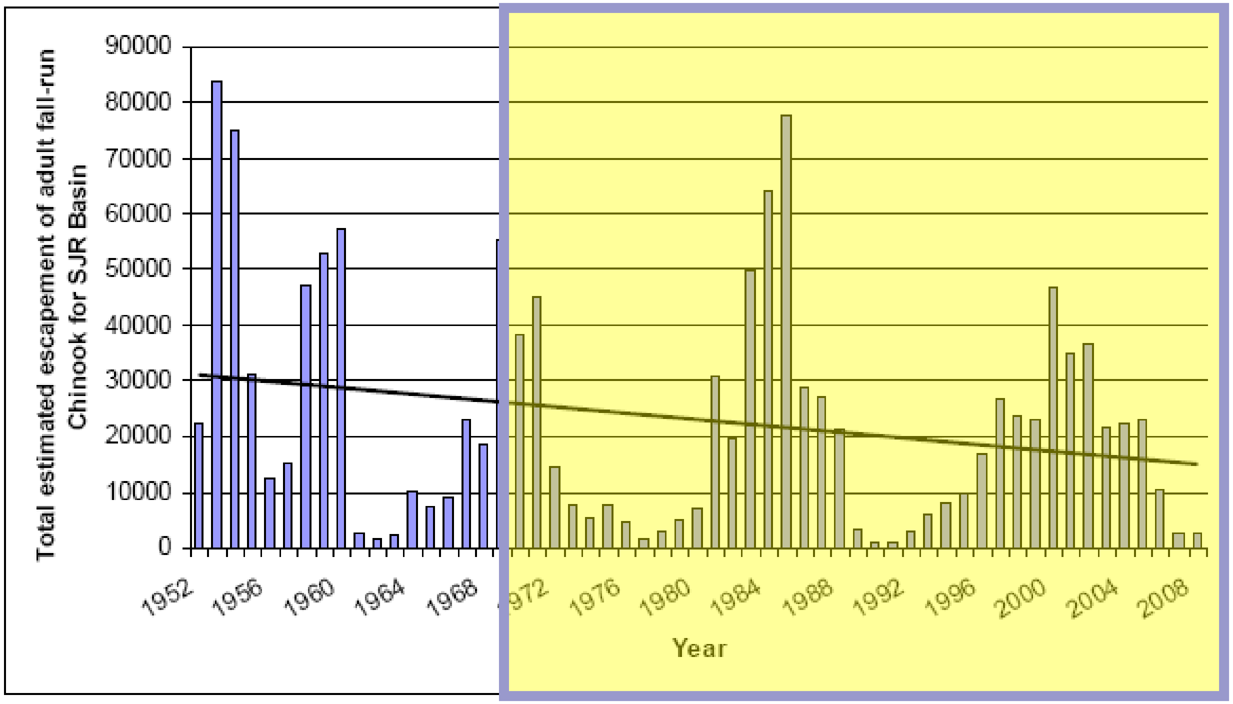


Figure 3-2. Total estimated escapement of adult fall-run Chinook for SJR basin from 1952 to 2008 (Source: DFG 2009b Grandtab)

Population Trends
SJR basin Fall-Run Chinook Salmon

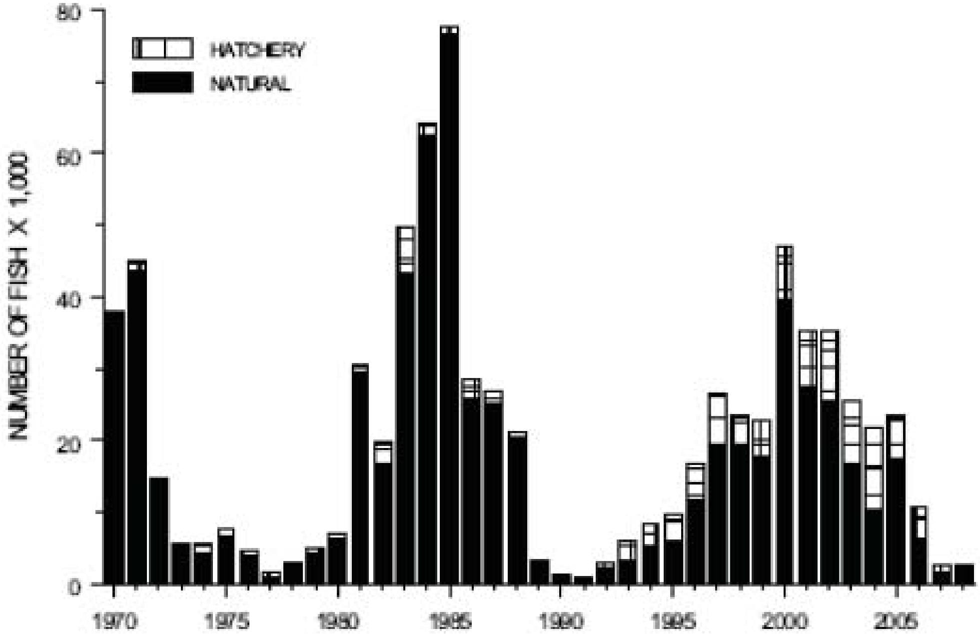
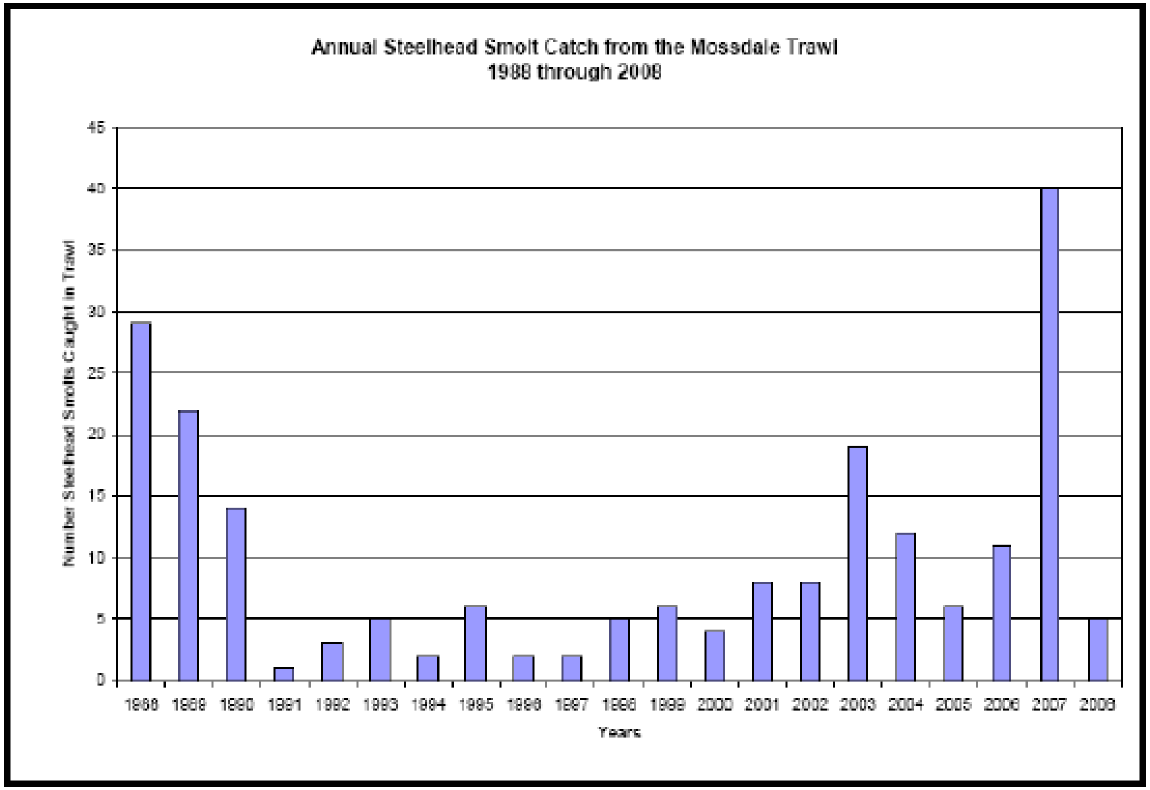


Figure 3-3. Annual natural and hatchery fall-run Chinook escapement to the SJR basin 1970 to 2008 (Source: Greene 2009)

Population Trends
SJR basin Central Valley Winter-Run Steelhead



Annual number of Central Valley steelhead smolts caught while Kodiak trawling at the Mossdale monitoring location on the SJR (Marston 2004, SJRGA 2007, Speegle 2008) (NMFS 2009a).

Figure 3-4. Annual number of Central Valley steelhead smolts

Outline

- Focus, Problem and Approach for Chap. 3
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Fall-Run Chinook Inflow Needs

- Primary limiting factor for San Joaquin River fall-run Chinook salmon survival and abundance is reduced flows during spring

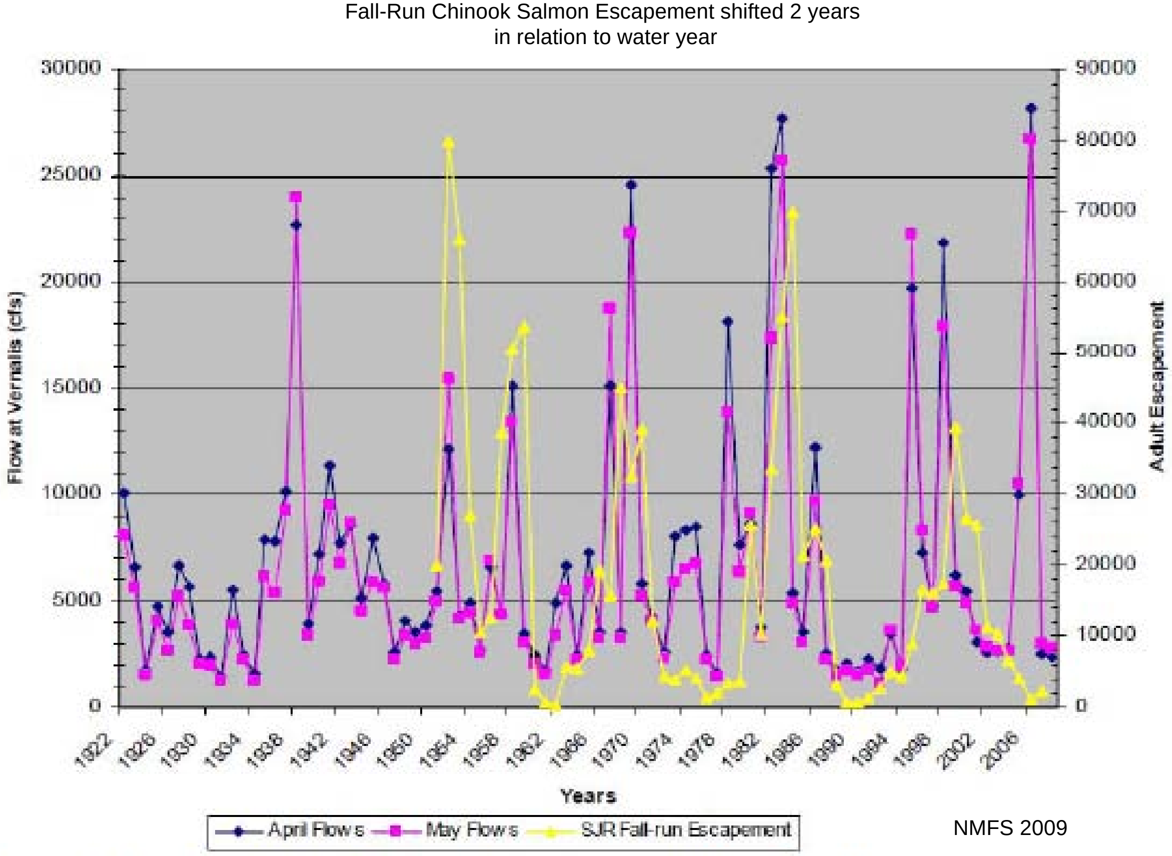
- State Water Board review focused on inflows to Delta from February through June

Functions Supported by Spring Flows

- Salmon have adapted to natural flows
- These flows provide several functions
  - Cues for outmigration
  - Improved transport downstream
  - Improved edge habitat and food production
  - Maintenance of channel habitat and transport of sediments, biota and nutrients
  - Increased turbidity and reduced predation
  - Improved water quality

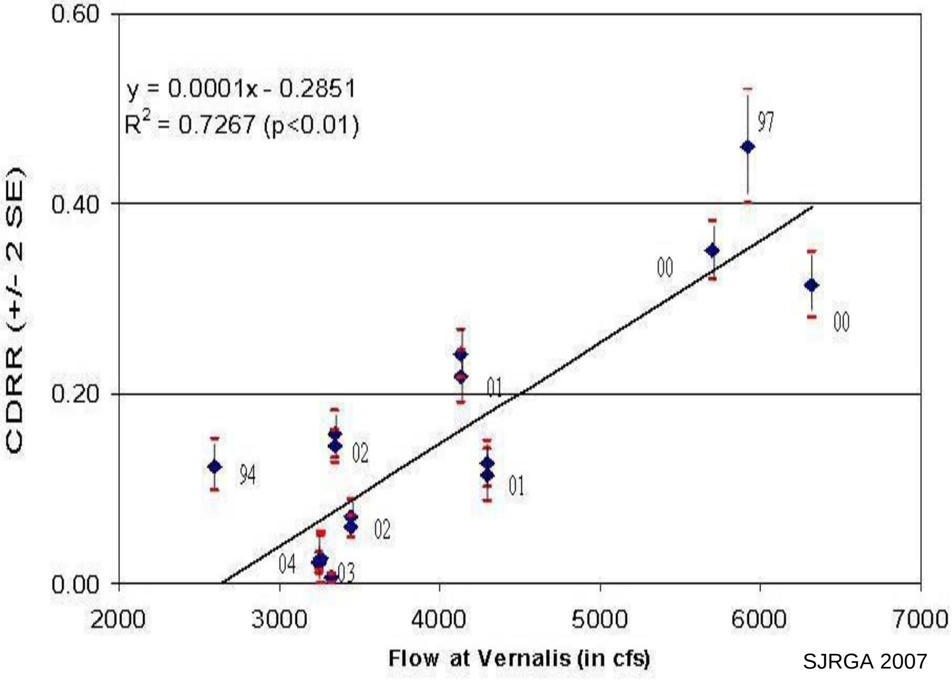
Salmon Abundance

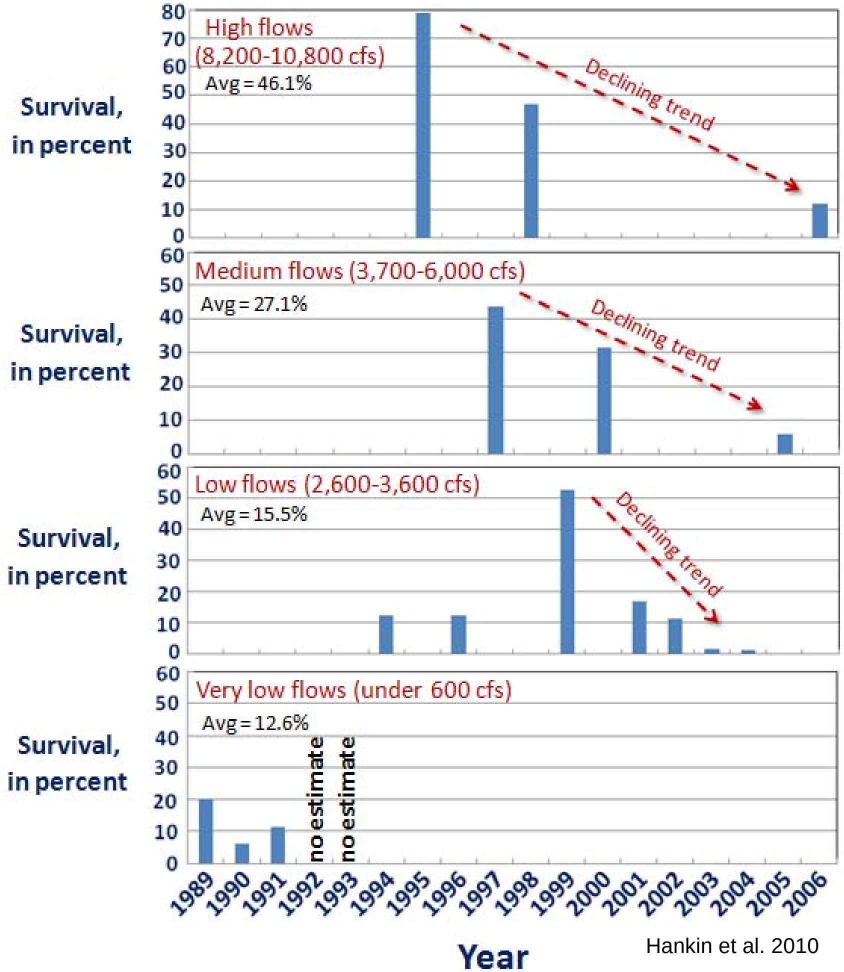
- Additional flow is needed
- The primary influence on adult escapement is flow two and a half years earlier



NMFS 2009

Salmon Survival





Combined Differential Recovery Rate (CDRR) are point estimates of survival

Supporting Studies

Study	Conclusion
Kjelson et al. 1981	Additional flow increased use of estuary and survival of juveniles
Kjelson and Brandes 1989	Salmon escapement and Vernalis flow correlated
Anadromous Fish Restoration Program 1995	Salmon declines attributed to inadequate streamflow – more flow needed
Brandes and McLain 2001	Relationship between survival and river flow statistically significant

Supporting Studies

Study	Conclusion
Mesick 2001	Recruitment correlated with springtime flows
Mesick et al. 2008; Mesick 2009	Winter and spring flows highly correlated with smolt production
Newman 2008	Positive association between flow and survival

Supporting Studies

- VAMP Peer Review
  - Increased flows have a positive effect on salmon survival
  - Higher flows through the Stockton Deep Water Ship Channel could benefit salmon
- VAMP Acoustic Evaluations
  - Survival of tagged fish has remained low
  - Dry conditions can lead to increased predation

Previous Flow Recommendations

- Increase flows at Vernalis to achieve salmon doubling goal
  - DFG: 7,000 to 15,000 cfs
  - AFRP: 1,744 to 17,369 cfs
  - TBI/NRDC: 5,000 cfs to an average of 10,000 cfs
- Increase flows at Vernalis to protect fish and wildlife beneficial uses
  - 60 percent of unimpaired

Outline

- Focus, Problem and Approach for Chap. 3
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- Salmon and Steelhead Population Trends
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- Natural Hydrograph Importance

Importance of the Natural Flow Regime

- A more natural flow regime would improve ecosystem functions
  - Fish communities
  - Food web
  - Habitat connectivity
  - Fluvial hydrogeomorphological processes
  - Temperature

Importance of the Natural Flow Regime

- Fish Communities
  - Native communities have adapted to flow variability
  - A natural flow regime protects genetic variability
- Food Web
  - High pulse flows benefit the lower trophic levels
  - Floodplain inundation provides organic matter

Importance of the Natural Flow Regime

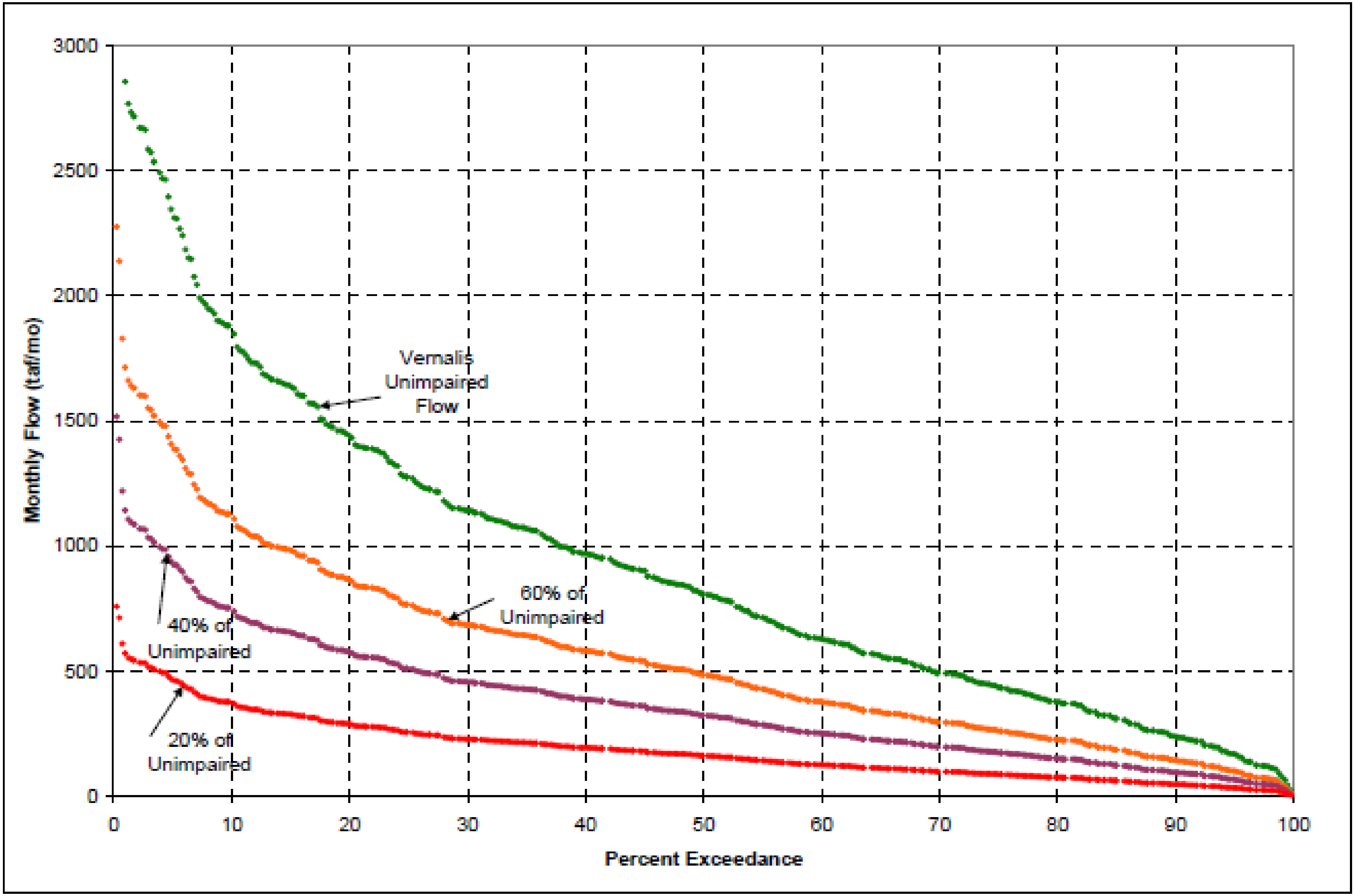
- Habitat connectivity (lateral and longitudinal)
  - Riparian and floodplain activation allows for energy flow
  - Improved juvenile fish survival
  - Beneficial migration transport
  - Less hostile rearing conditions
  - Greater net downstream flow

Importance of the Natural Flow Regime

- Fluvial hydrogeomorphological processes
  - Increased complexity
  - Mobilization of the streambed
  - Less homogenous channel
- Temperature
  - Decreased temperatures provide cold water refugia

Conclusions

- A higher and more naturally variable inflow regime from the SJR is needed
- Any flow objectives will incorporate adaptive management
- A range of alternative SJR flow objectives expressed as percentages of Unimpaired Flow will be analyzed

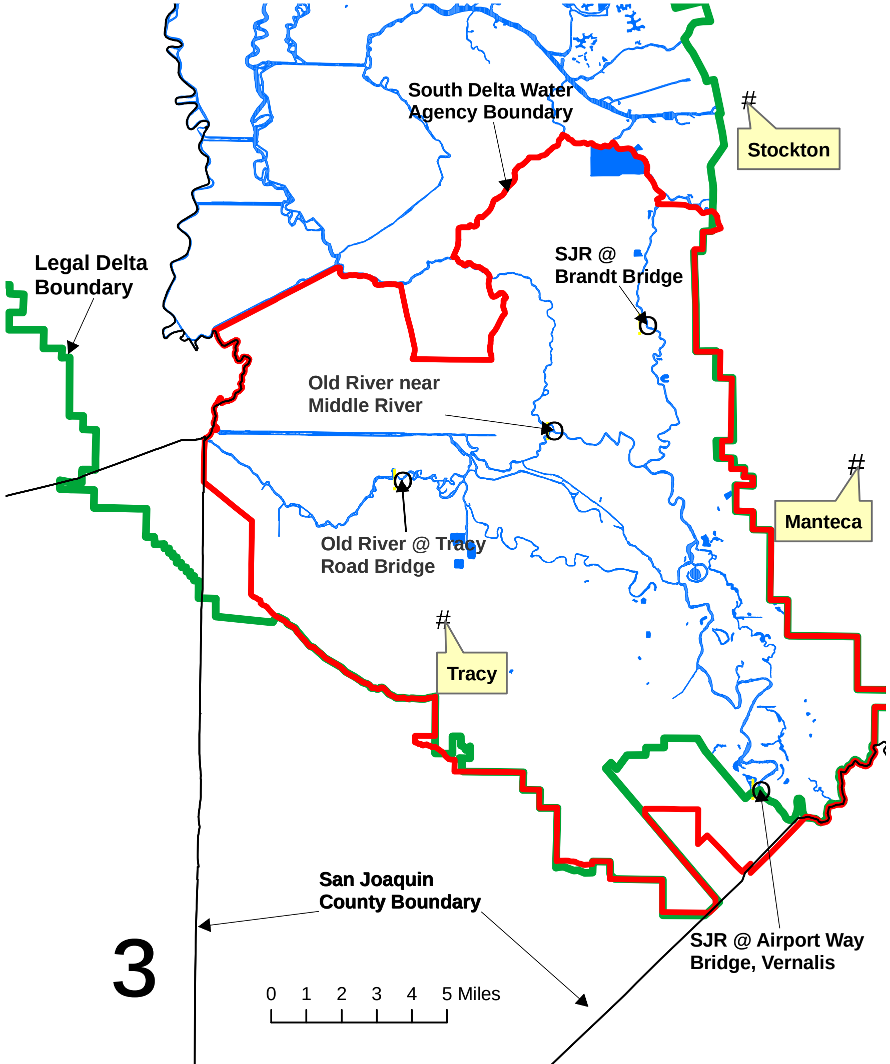


3000
2500
2000
1500
1000
500
0
Monthly Flow (taf/mo)
0
10
20
30
40
50
60
70
80
90
100
Percent Exceedance
Vernalis Unimpaired Flow
60% of Unimpaired
40% of Unimpaired
20% of Unimpaired

Chapter 4: Southern Delta Salinity

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Existing Salinity Objectives



3

Southern Delta (SD) Salinity

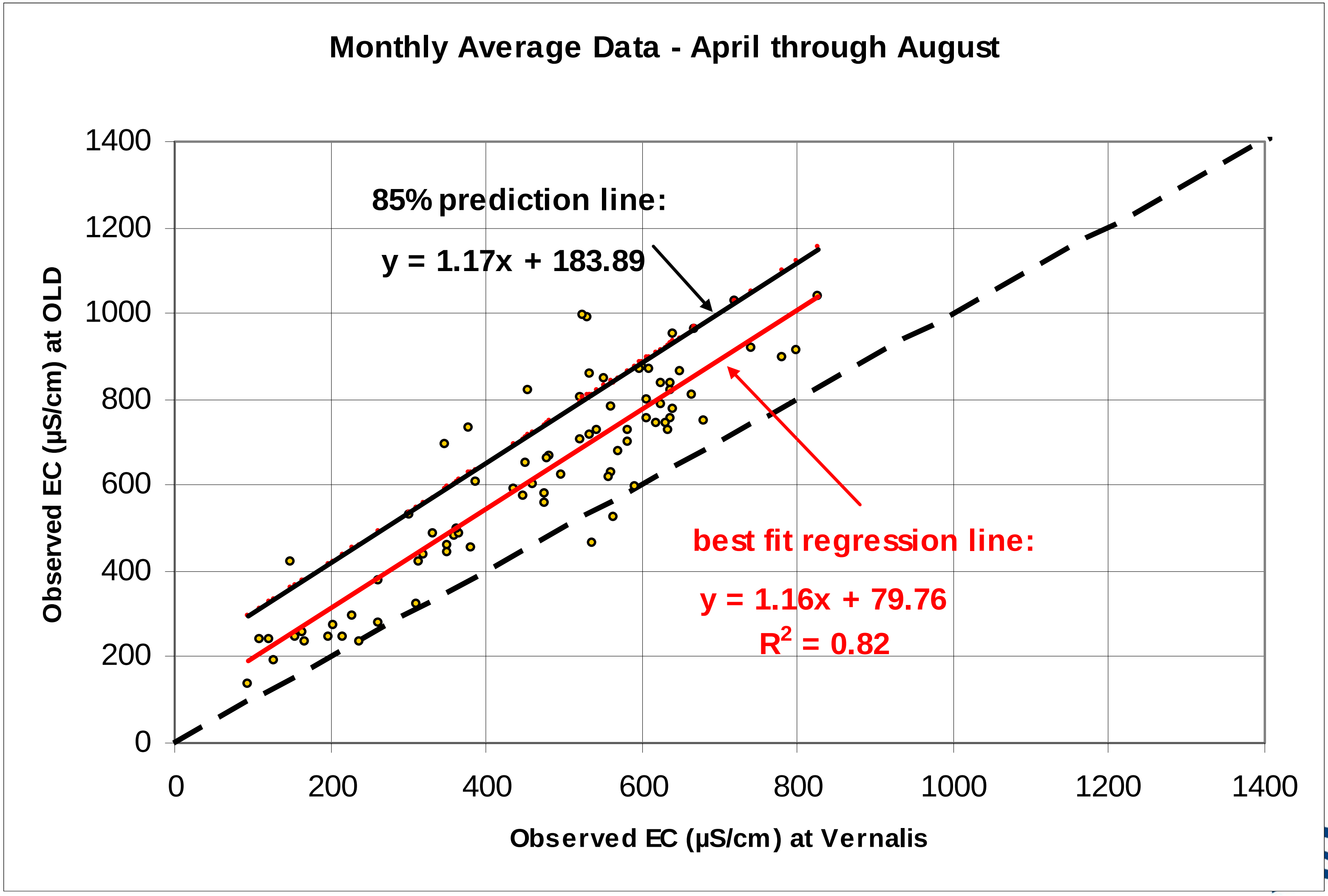
Outline:

- Characterizing SD salinity degradation
- Salt Loading from NPDES discharges
- Effects of salinity on agricultural uses
- Effects of salinity on municipal uses

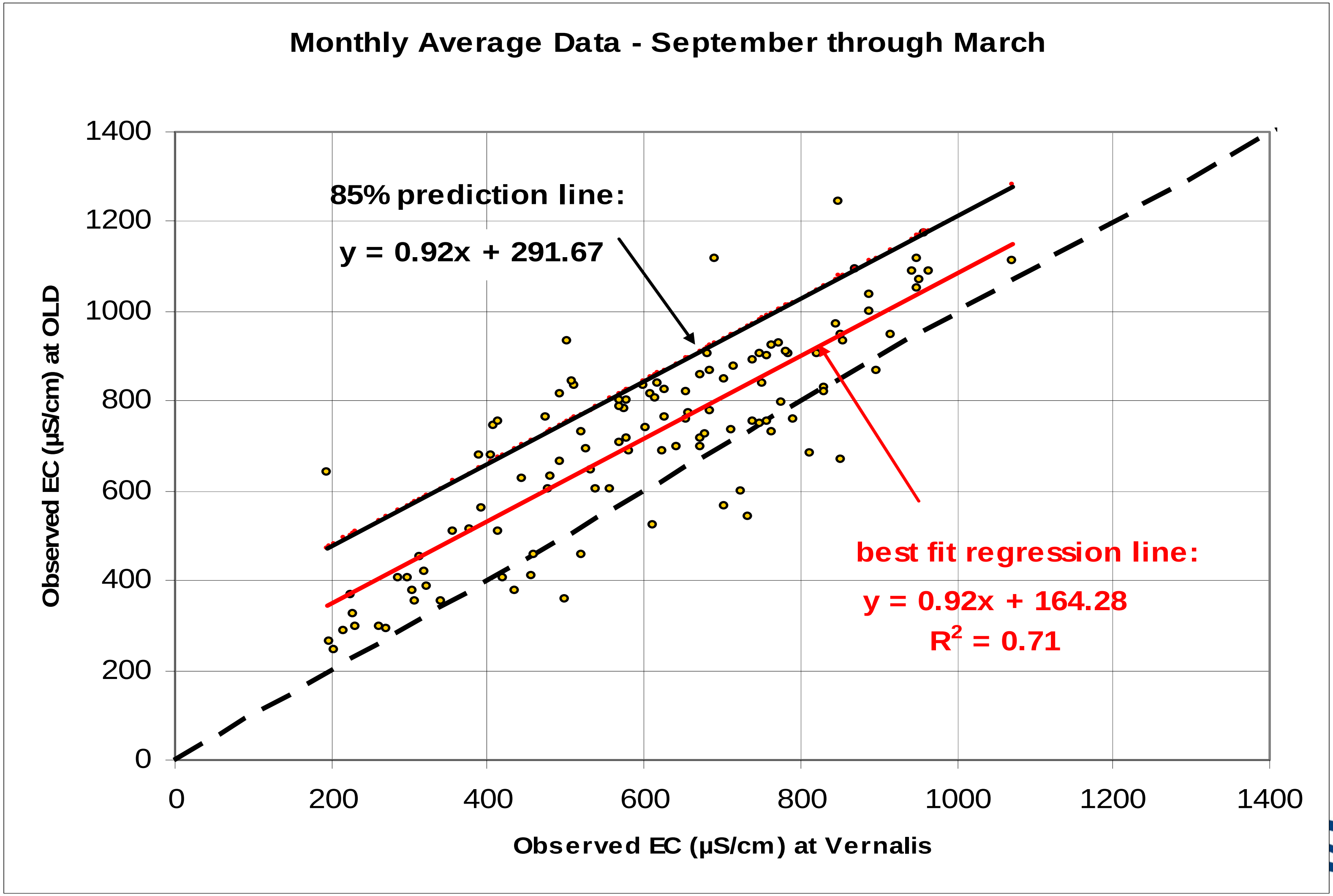
Factors Affecting SD Salinity

- Salinity of SJR at Vernalis
- Evapo-concentration from agricultural use
- Net flows in SD channels
  - Barrier operations
  - Project pumping
- NPDES point sources

Salinity Regression Analysis



Salinity Regression Analysis



Southern Delta (SD) Salinity

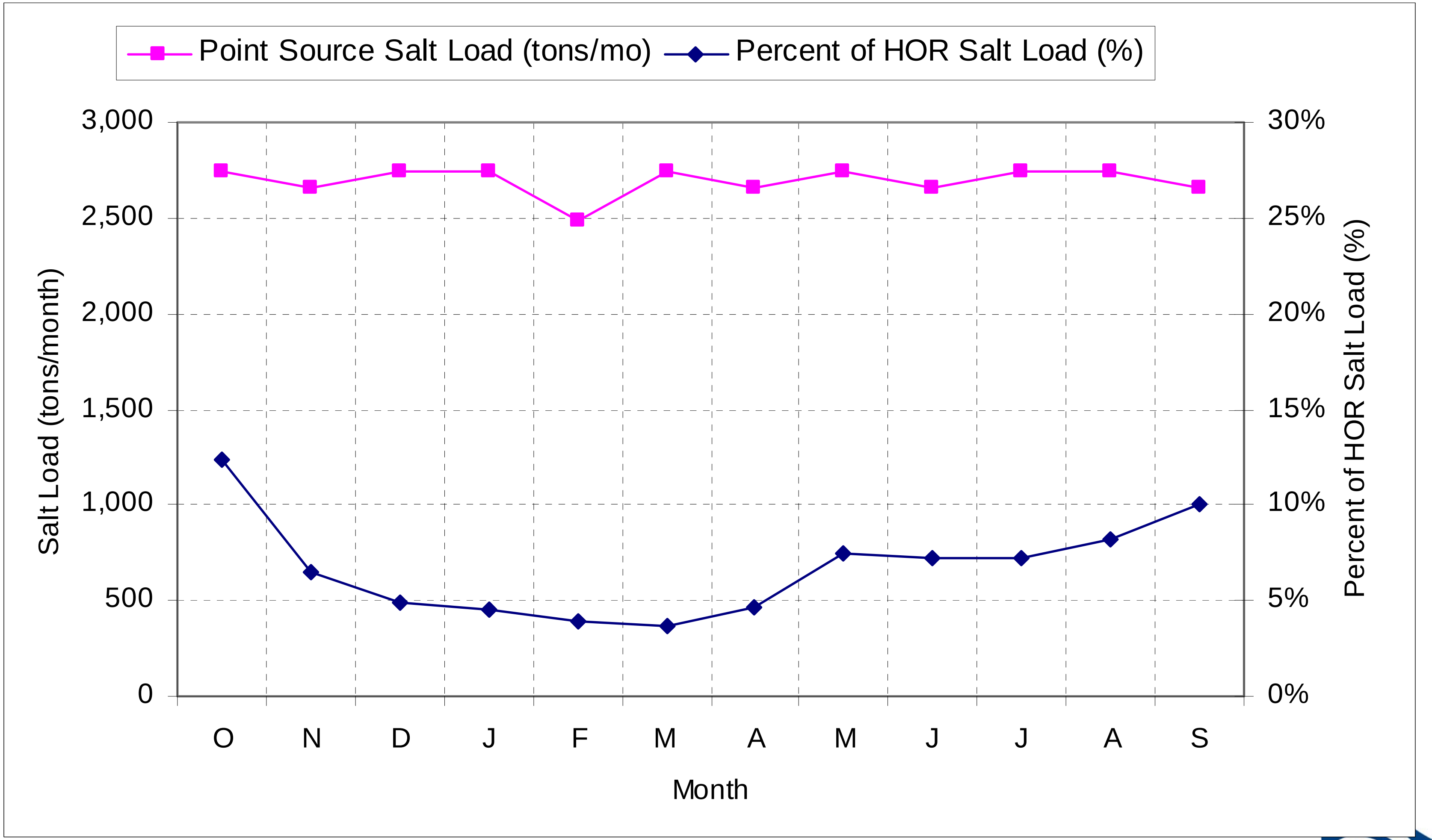
Outline:

- Estimating SD salinity degradation
- Salt Loading from NPDES discharges
- Effects of salinity on agricultural uses
- Effects of salinity on municipal uses

Loading from NPDES Discharges

- 2007 Regional Board led DWR study:
  - City of Tracy WWTP estimated to increase salinity 3 to 11 µS/cm at full capacity
- Mass balance analysis
  - Assumed permitted maximum salinity loads from Tracy, Deuel, and Mountain House
  - Compared to estimated of salt load entering SD at the head of Old River

Mass Balance Analysis Results



Southern Delta (SD) Salinity

Outline:

- Estimating SD salinity degradation
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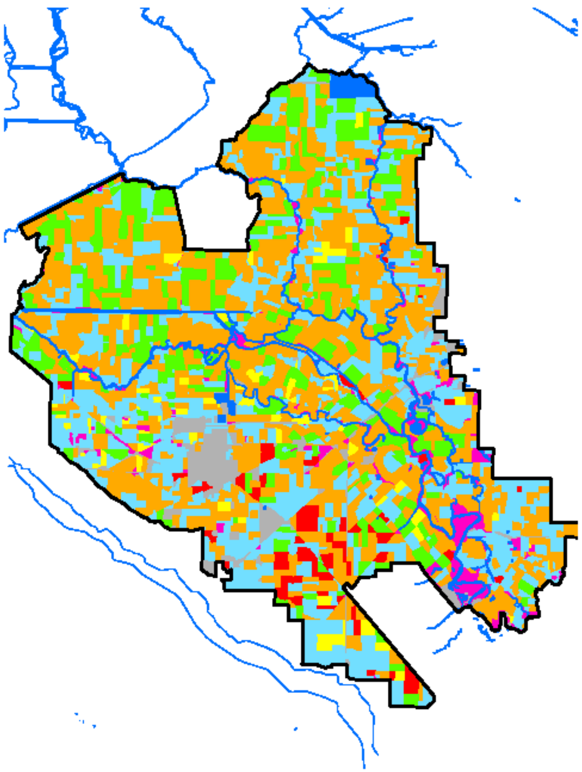
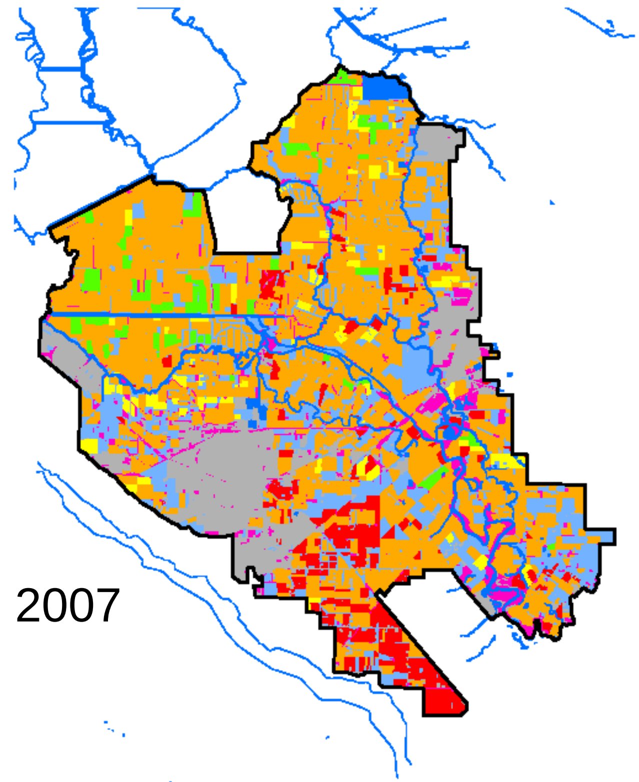
Salt Sensitivity of Crops in SD

From Figure 3.4, Hoffman (2010)



1976



2007

Most salt sensitive crops grown in SD:
- dry bean - almond, - walnut, - apricot

Findings from Hoffman, 2010

- No adverse effects from following factors:
  - Saline/sodic soils
  - Shrink/swell soils (bypass flows)
  - Chloride/sodium toxicity
  - Shallow groundwater
- Current salinity levels suitable for all crops
- Potential for boron toxicity

Findings from Hoffman, 2010 **con't**

- Drains in western part of SD averaged LF = 0.21 to 0.27; minimum = 0.11
- Relatively high leaching fractions (LF) associated with SD irrigation practices
- Studies of dry bean salt tolerance outdated
- No studies on early growth stages
- Studies recommended on bean tolerance, leaching fraction, and boron toxicity

Soil Water Salinity Modeling

- Recommends steady-state approach:
  - using “exponential” water uptake equation
  - including rainfall
- For dry bean, alfalfa, and almond in SD:
  - no loss yields at EC=1.0 dS/m and LF > 0.20
  - 5% yield loss with low rainfall at LF = 0.15
- Salt dissolution could increase soil water salinity by 5% over steady-state estimate

Southern Delta (SD) Salinity

Outline:

- Estimating SD salinity degradation
- Salt Loading from NPDES discharges
- Effects of salinity on agricultural uses
- Effects of salinity on municipal uses

Impacts on Municipal Uses

- Municipal and domestic supply beneficial use identified by Basin Plan for SD
- No municipal intakes in immediate area, but SWP and CCWD intakes are in vicinity
- USEPA maximum contaminant level (MCL):
  - Recommended MCL = 0.9 dS/m
  - Upper MCL = 1.6 dS/m

Chapter 5: Water Supply Impact Analysis

Water Supply Impact Analysis

Outline:

- Overview of Approach
- Estimating Additional Flows Required
- Estimating Reduction in Return Flow
- Total Water Supply Impact Analysis

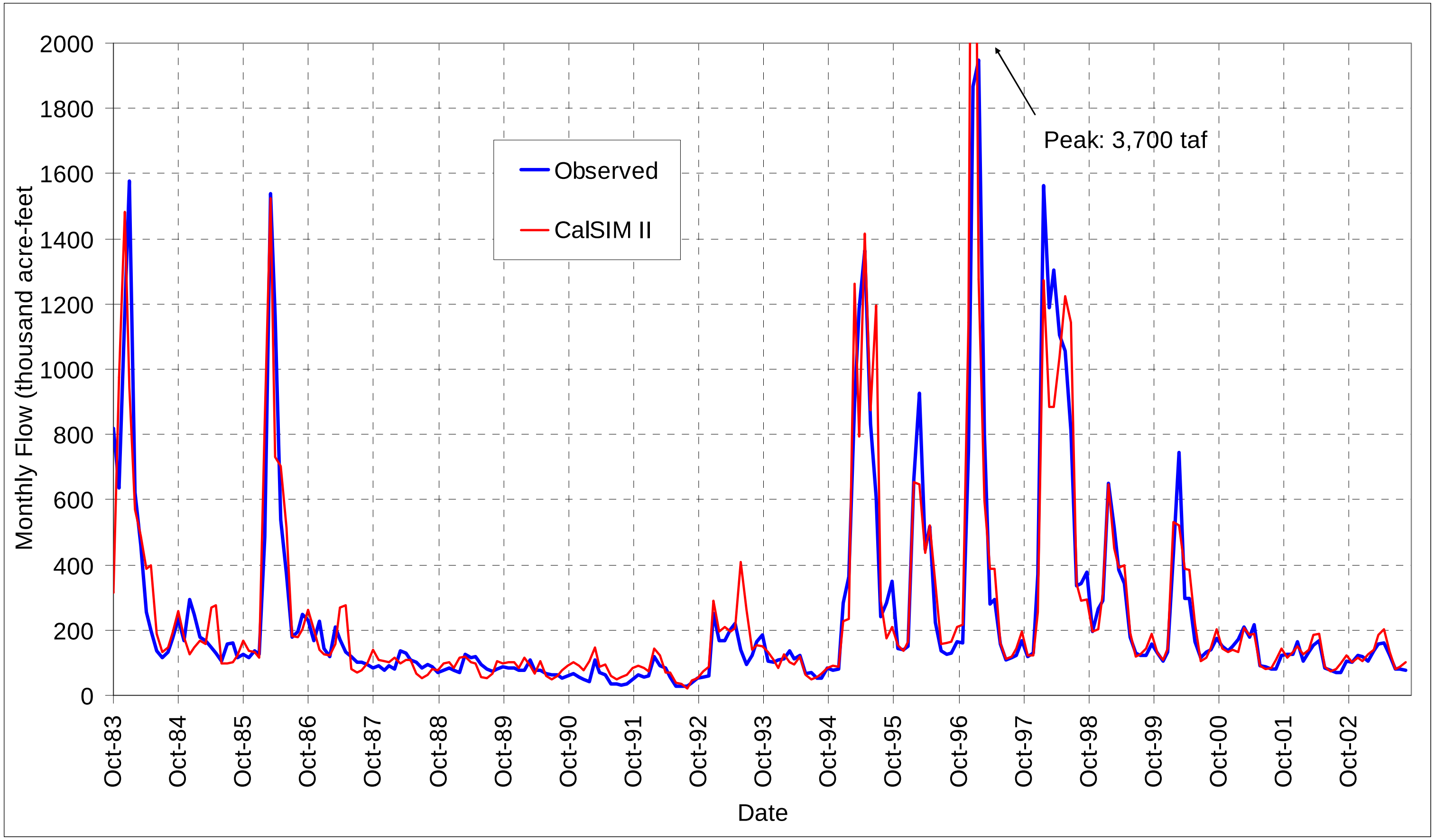
Water Supply Impact Analysis

- Conservative estimate of combined impact of flow and salinity objective alternatives.
- Additional flow above current conditions compared against diversions.
- Does not identify where or how additional flow will be obtained.
- Post-processing of CALSIM II model run representative of current conditions.

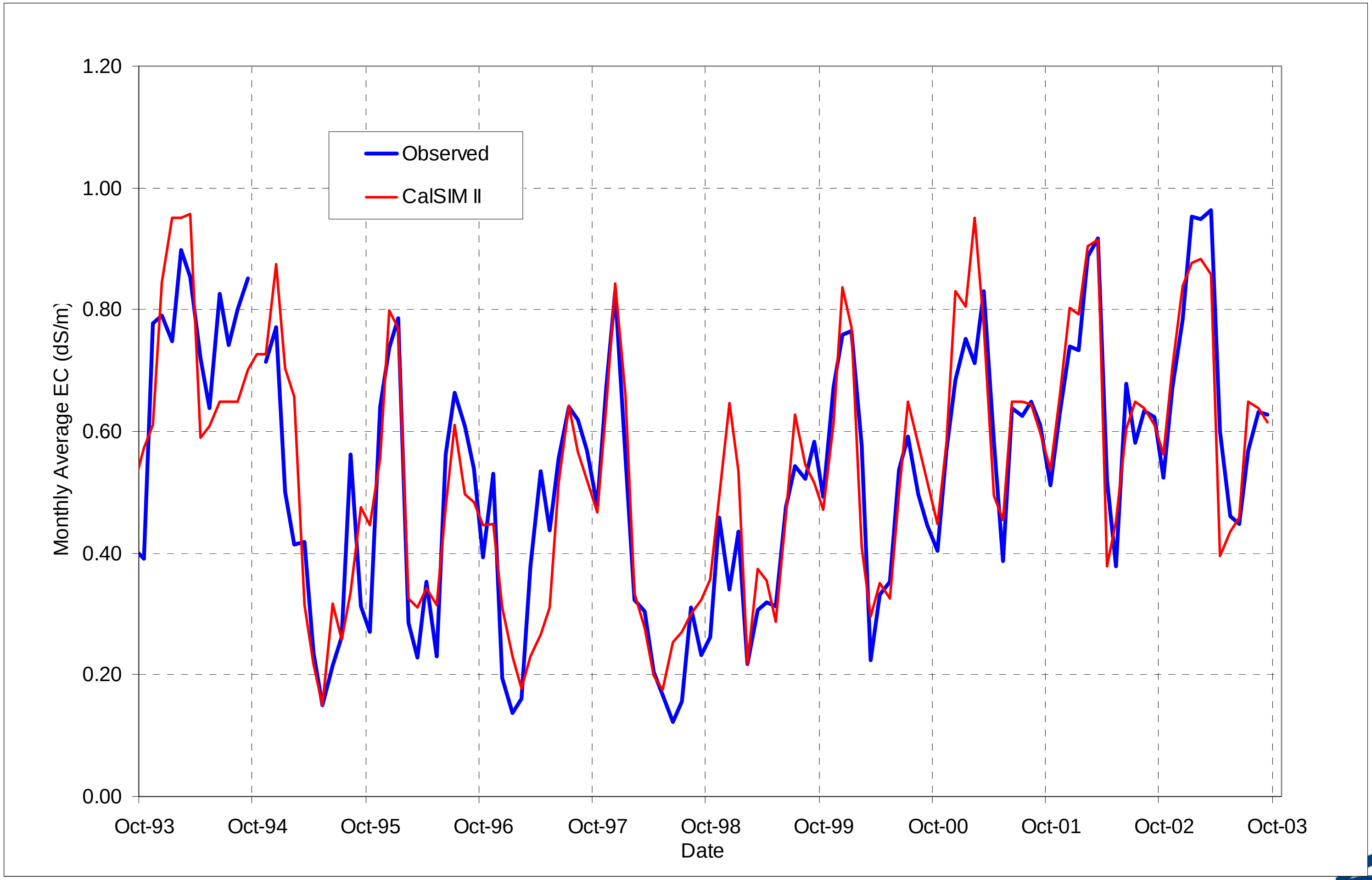
CALSIM II Operations Model

- SJR module of CALSIM II was developed by USBR as operations planning model
- Imposes current infrastructure, regulations, delivery constraints and estimates demand
- Assumes historical conditions from 1922 to 2003 representative of future
- Uses CALSIM II output from 2009 SWP Delivery Reliability Report

CALSIM vs. Observed - Vernalis Flow



CALSIM vs. Observed - Vernalis Salinity

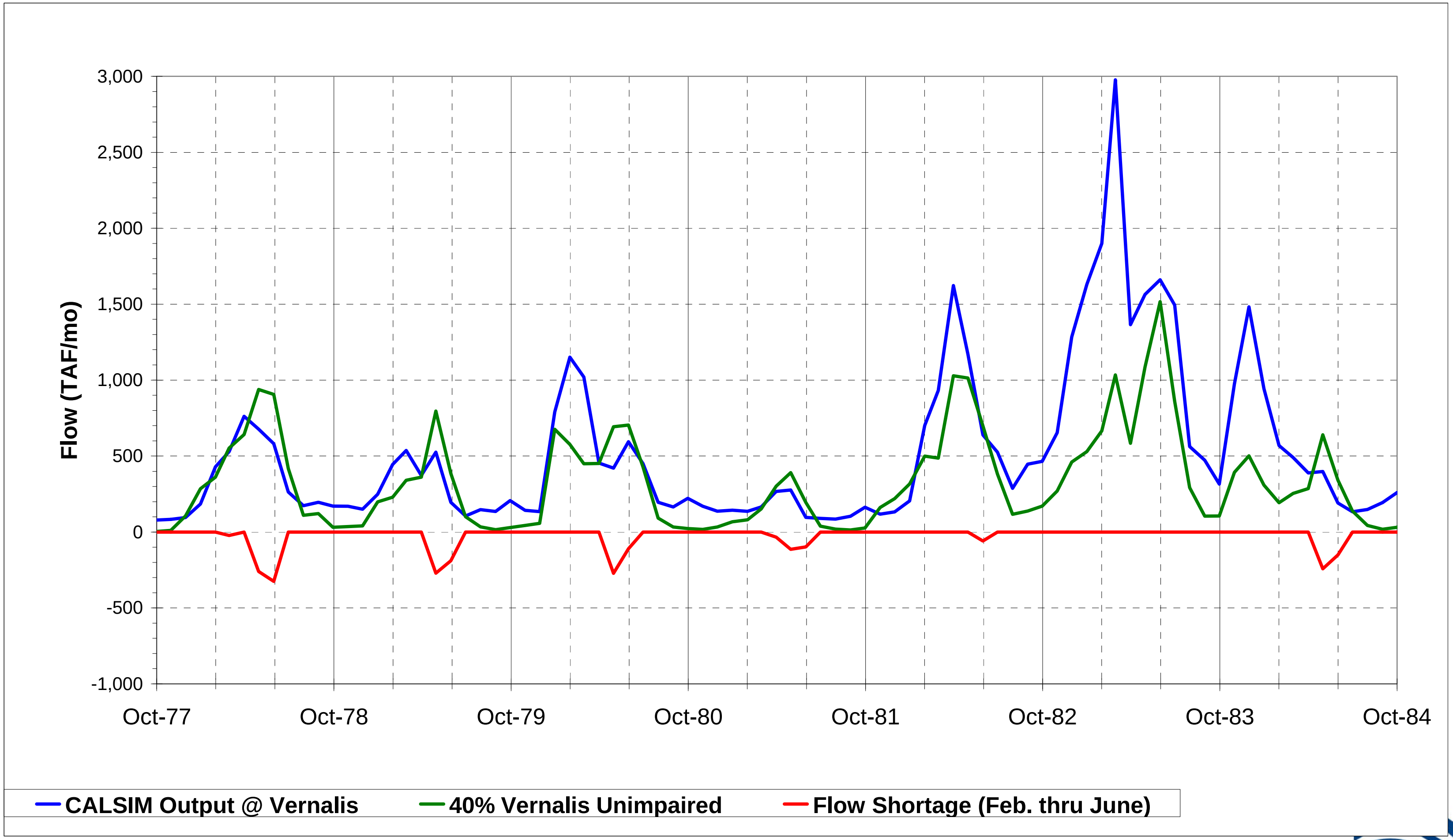


Water Supply Impact Analysis

Outline:

- Overview of Approach
- Estimating Additional Flows Required
- Estimating Reduction in Return Flow
- Total Water Supply Impact Analysis

Additional Flow for Meeting Flow Objective Alternatives



Additional Flow for Meeting Salinity Objective Alternatives

Three-step calculation on monthly time-step:

1. Use regression equations to determine required EC at Vernalis
2. Calculate low-salinity flows needed to achieve required EC at Vernalis
3. Subtract flows already being provided to meet flow objective alternative

Water Supply Impact Analysis

Outline:

- Overview of Approach
- Estimating Additional Flows Required
- Estimating Reduction in Return Flow
- Total Water Supply Impact Analysis

Return Flow Reductions

- Assumes required additional flows to come from reduced diversions
- Proportional reduction in return flows (requiring additional diversion reduction)
- Also assumes increase in irrigation efficiency in response to reductions
- Adds approximately 11% to the total water supply impact estimate

Water Supply Impact Analysis

Outline:

- Overview of Approach
- Estimating Additional Flows Required
- Estimating Reduction in Return Flow
- Total Water Supply Impact Analysis

Total Water Supply Impact

Sum of the following:

- Additional flow to meet flow objectives
- Additional flow to meet salinity objectives
  (not already being provided for flow objectives)
- Estimated reductions in return flows

Total Water Supply Impact

% Unimpaired Flow Alternative	Total Annual Volume by Water Year Type (average in thousand acre-feet) W	AN	BN	D	C
	for flow objectives only				
60%	1,531	1,723	1,496	981	793
50%	944	1,226	1,088	683	584
40%	462	766	709	409	389
30%	162	373	363	194	214
20%	23	83	101	49	69
	additional required for salinity objectives in combination				
60%	80	155	173	189	208
50%	80	155	181	203	223
40%	80	158	197	235	237
30%	81	158	221	271	265
20%	88	172	249	306	329

Total Water Supply Impact

% Unimpaired Flow Alternative	Percent of Diversions by Water Year Type (average in percent)				
	W	AN	BN	D	C
	for flow objectives only				
60%	76	83	71	45	49
50%	47	59	51	32	36
40%	23	37	33	19	24
30%	8	18	17	9	13
20%	1	4	5	2	4
	additional required for salinity objectives in combination				
60%	4	7	8	9	13
50%	4	7	8	9	14
40%	4	8	9	11	15
30%	4	8	10	12	16
20%	4	8	12	14	21

Questions?