Restoration Goal Technical Feedback

San Joaquin River Restoration Program

November 17, 2009

CSU Stanislaus, Turlock, CA

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Agenda

- Introductions
- NMFS Public draft Recovery Plan for Central Valley Salmon and Steelhead
- Background
- Models and Analytic Tools
  - Hydrology
  - Temperature
  - Flood Hydraulics
  - Sediment
  - Vegetation
  - Groundwater
  - 2D Hydraulics
  - Fisheries
- Comments and Questions
- Next Meeting

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Settlement Background

- 1988 – Lawsuit challenging renewal of the long-term Friant Division contracts
- 2004 – Federal Judge rules Reclamation violated Section 5937 of the Fish and Game Code
- 2005 – Settlement negotiations reinitiated to avoid remedy phase
- 2006 – Settlement Agreement signed and implementation begins
- 2009 – Federal legislation enacted

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Settlement Goals

- Restoration Goal
  - To restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.
- Water Management Goal
  - To reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

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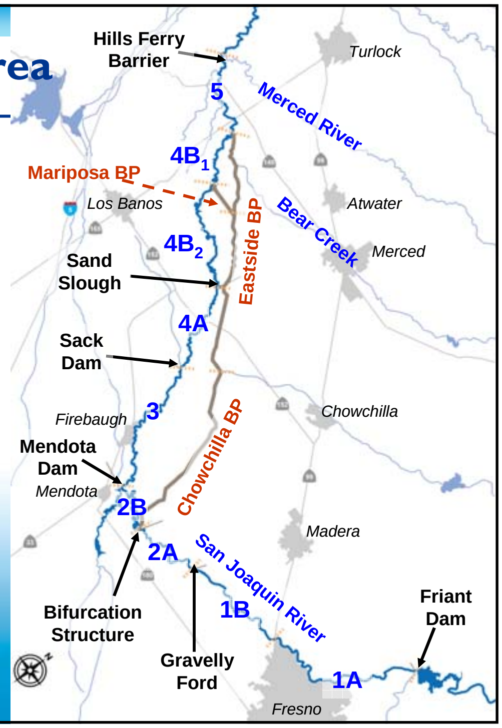
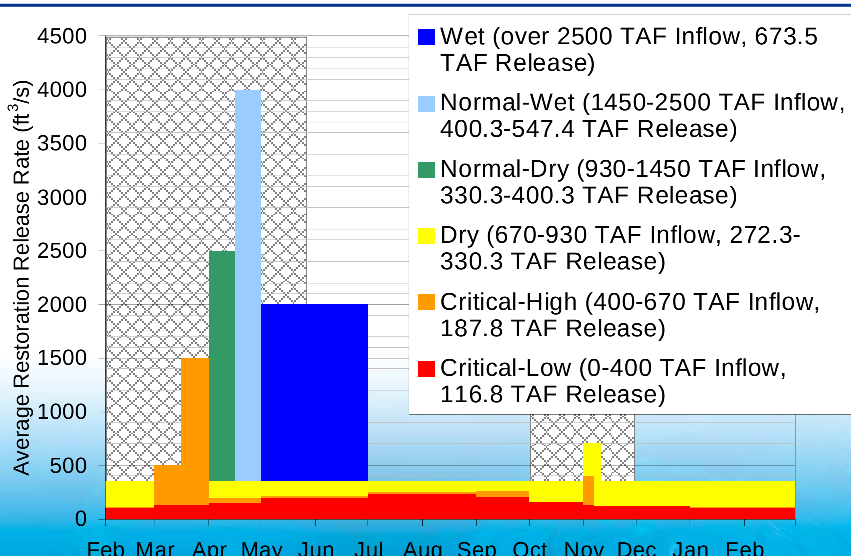
Restoration Area

- 150 miles of River
- Historically Different Reaches
- Water Supply Infrastructure
- Flood Control Bypasses
- Urban Areas
- Historically Disconnected Reaches



Restoration Releases at Friant Dam



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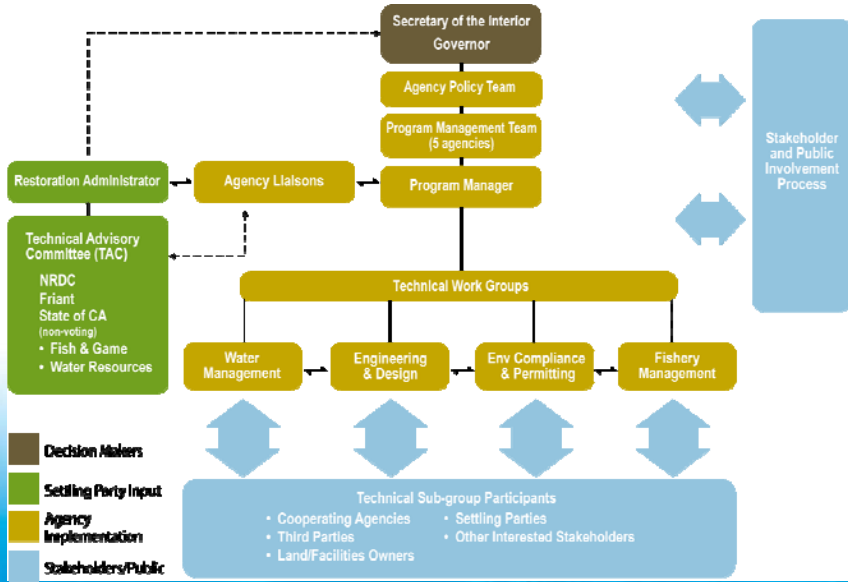
Program Roles



Context for Today

- SJRRP Components
  - WY2010 Interim Flows EA/IS
  - Operations
  - Program EIS/EIR
  - Fish Management Plan
  - Restoration Flow Guidelines
  - Site-Specific Projects
  - Water Management Actions
- Today
  - Modeling and Analysis Tools for the SJRRP

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Introduction to Modeling Subgroup

- Model Selection
- Common Sources
- Information Exchange
- Consistent Assumptions

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Water Supply: CalSim

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Water Supply Model Overview

- Water Supply for the California Central Valley (CVP and SWP) under alternative:
  - Land Uses (e.g. 2030 Level of Development)
  - Infrastructure Developments (e.g. Temperance Flats)
  - New Water Supply Policies (e.g. SJRRP)
- Mass-Balance Accounting
  - Monthly Volumes
  - Historic Hydrologic Conditions (Oct 1921 – Sep 2003)
  - Simplifications of Water Quality and Delta Conditions

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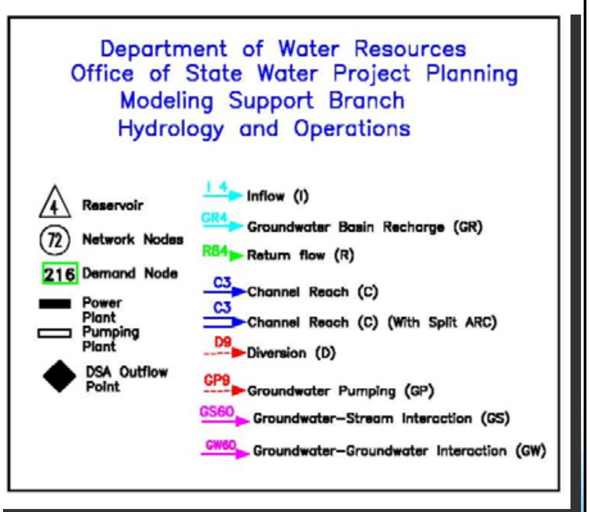
Water Supply Model Overview (cont'd)



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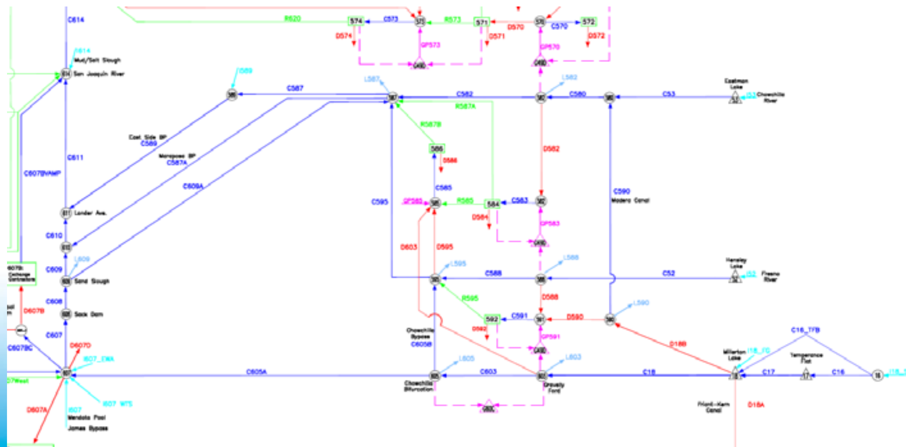
Water Supply Model: Starting Point for SJRRP



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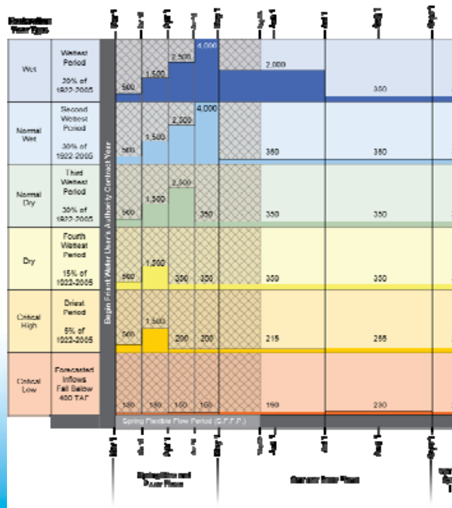
Water Supply Model: Infrastructure Updates to CalSim for SJRRP

Infrastructure

- Inclusion of Mendota Pool Bypass
- Inclusion of Friant-Kern Canal reaches
- Inclusion of groundwater facilities to receive Paragraph 16(b) water
- Inclusion of Pumping Station on Lower San Joaquin River

Water Supply Model: Operational Updates to CalSim for SJRRP



Operational Rules

- Operation of SJRRP releases by year type
- Operation of SJRRP recapture:
  - Along the San Joaquin River
  - In the Delta
- Operation of Paragraph 16(b) Water

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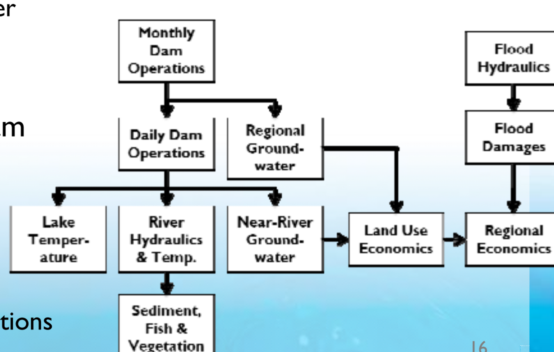
Use of Water Supply Model Results

- Diversions at Friant Dam
  - Basis for Deliveries to Friant Long-Term Contractors (Class 1 & 2) and Others
  - Basis for evaluating Paragraph 16(a) & (b) water
  - Basis for Groundwater Pumping in Friant and Other Districts
- Releases at Friant Dam
  - Frame Overall Operations within Restoration Area
  - Used in assessing Delta Pumping Conditions



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Alternatives Formulation: CalSim Evaluations

Purpose of CalSim runs

- Understand range of operations for Friant Dam
- Understand implications to CVP and SWP supplies
- Understand range of recapture for potential recirculation to Friant

Evaluations Exist for:

1. Baseline
2. 1 SJRRP Alternative: *Friant Dam Operations are identical for Alternatives A, B & C*
3. Supplemental analyses to bracket range of operations

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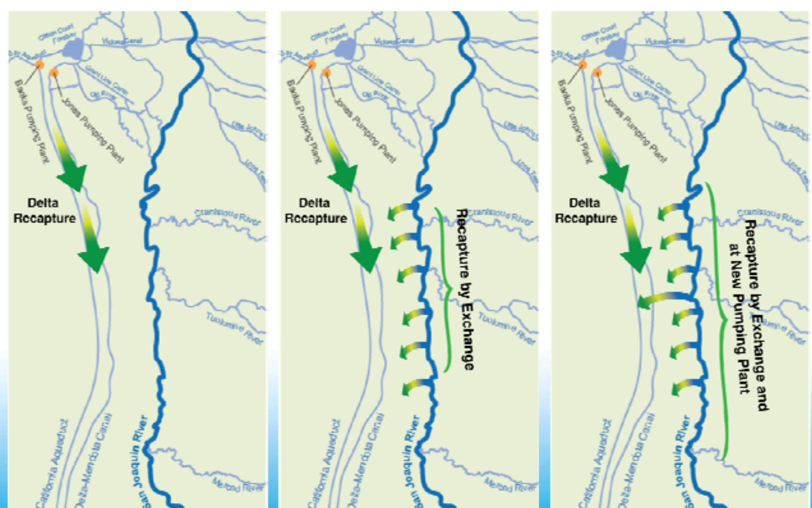
CalSim Baseline & SJRRP Alternative



Alternatives A1 and A2 | Alternatives B1 and B2 | Alternatives C1 and C2

CalSim Supplemental Analyses

1. "Stair-step" Release Requirement
2. SJRRP without Paragraph 16 water
3. Flexible Flow shifts (forward & backward)
4. Full 10% Buffer Flows
5. Capacity limitations in Restoration Area, no Mendota Bypass
6. Restored Friant-Kern Canal capacity
7. Wanger Bookend on OMR Requirement in Delta (-750 cfs)

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Hydrology and Temperature

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Monthly to Daily Conversion

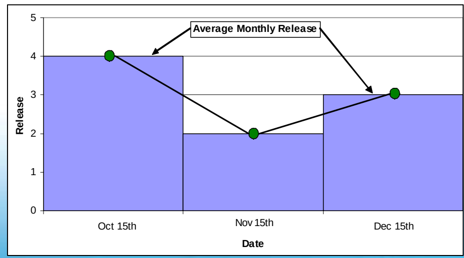
Purpose: Develop a set of daily Millerton Reservoir operations suitable for use in San Joaquin River routing and temperature modeling.

Uses the Daily Millerton Reservoir Model

Developed for USJRBSI

Monthly boundary conditions from CalSim interpolated to convert to daily

Perform a simplified daily routing



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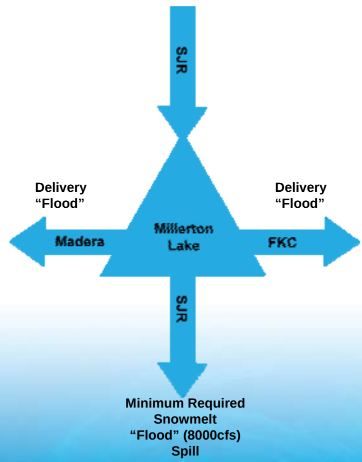
Water Operations – Daily Millerton Reservoir Model

How it works

- Start with initial storage plus SJR Inflow
- Madera and FKC diversion (CalSim)
- SJR Minimum Release (CalSim)
- SJR Snowmelt Pre-release (CalSim)
- Fill Conservation Storage
- "Flood" release to Madera, FKC up to capacity limits
- "Flood" release to SJR up to 8,000 CFS channel capacity
- Fill Flood Control Storage
- "Flood" spill to SJR



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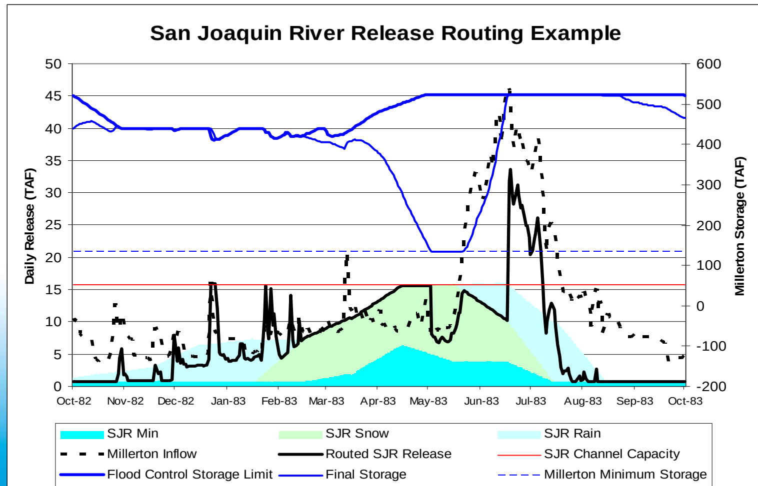
Water Operations – Daily Millerton Reservoir Model Results

Final results are a set of daily Millerton Reservoir operations



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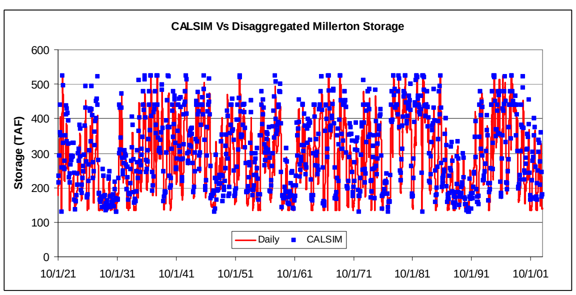
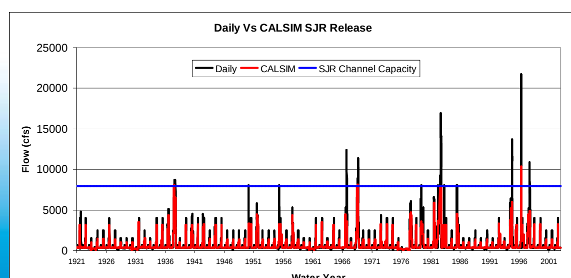
Daily – CalSim Millerton Reservoir Release Comparison



Annual operations match well

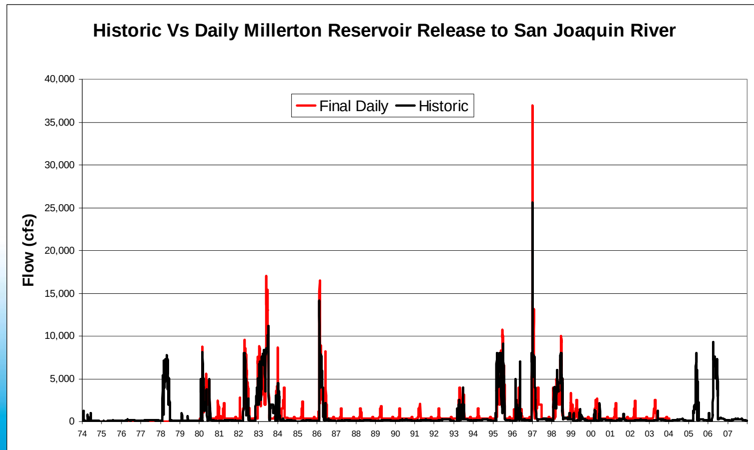
Magnitude different from monthly to daily boundary condition process. Higher peaks in daily release is expected.



Daily – Historical Millerton Reservoir Release Comparison

Not expected to match exactly.

Timing of peaks matches very well.



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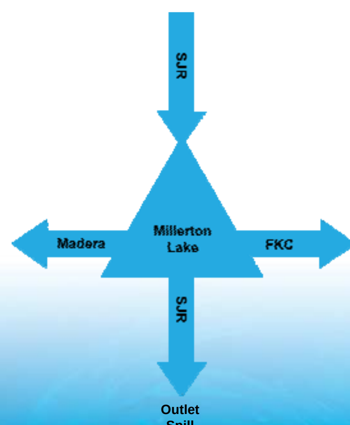
Temperature – Millerton Reservoir

Purpose: Simulate San Joaquin River Release Temperature

- 2-D Reservoir Temperature Model based on CE-QUAL-W2
- Developed in support of USJRBSI
- Hourly time step from 1980 through 2003



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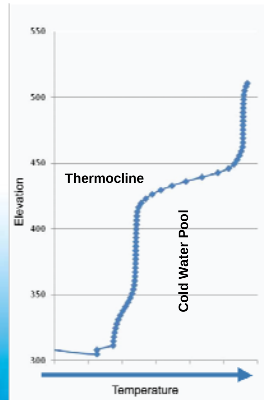
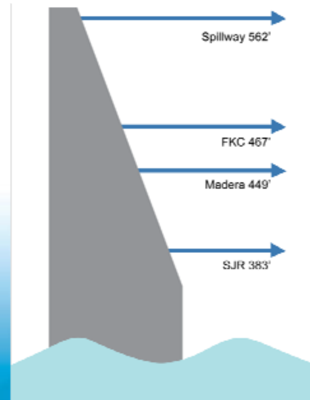
Temperature – Millerton Reservoir

- How it works
  - Computes temperature profile at dam
  - Use profile to compute release temperatures





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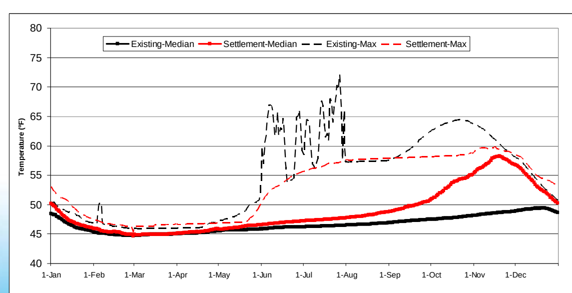
Temperature – Millerton Reservoir Release Temperatures

- High, short spikes in maximum temperatures due to spills
- Seasonal increase in Oct-Dec due to reduction in Cold Water Pool



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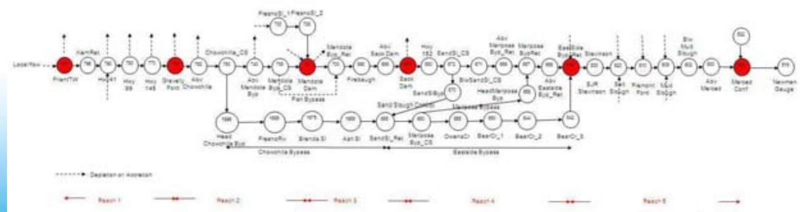
Temperature – San Joaquin River Millerton Reservoir to Merced River

- Purpose –Route daily flows and simulate San Joaquin River water temperatures
  - 1-D River Temperature Model based on HEC5Q
  - Hourly time step
  - 1980 through 2003



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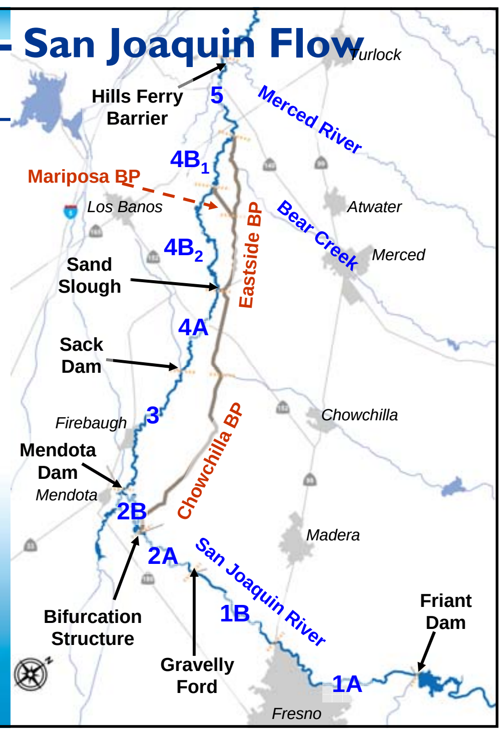
Temperature – San Joaquin Flow Routing

How it works

HEC-5 routes flow through the system

- Flow splits at
  - Chowchilla Bypass
  - Mendota Bypass (With Project Only)
  - Sand Slough
  - Mariposa Bypass
- HEC-5Q simulates temperatures of the flows

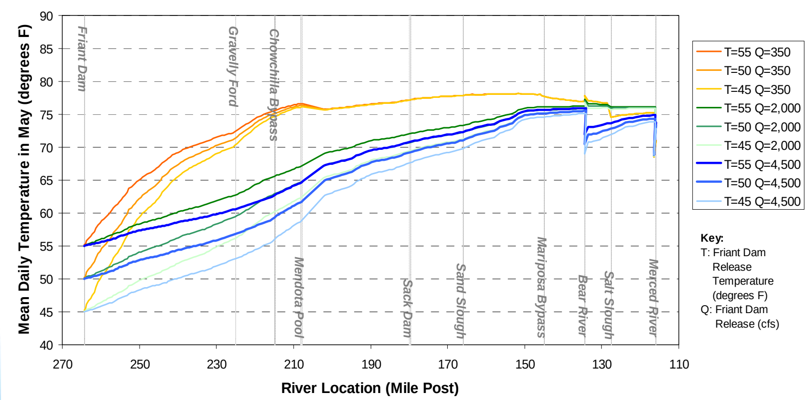


Temperature – Sensitivity Studies

- Several sets of sensitivity studies were performed to frame the system temperature response.
  - Millerton release temperature w/wo restoration
  - SJR temperatures at different flow rates
  - Potential effects of increased riparian vegetation and channel modification on SJR temperatures

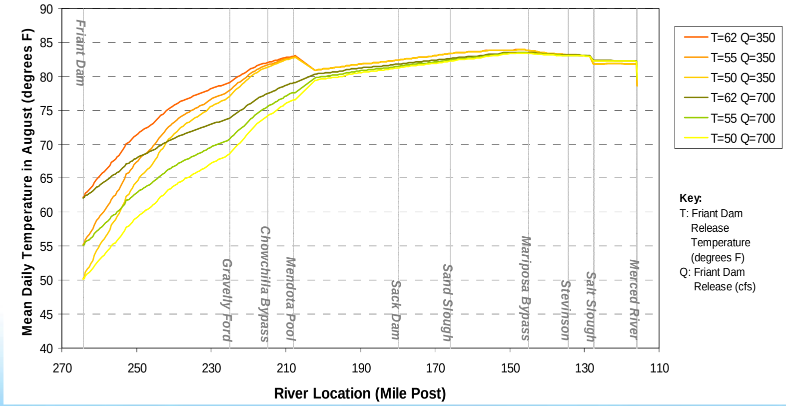
  * No Mendota Bypass in sensitivity modeling

Temperature – Sensitivity Studies _Flow Rate Impact on Temperature



Median of simulated temperatures in San Joaquin River (May)

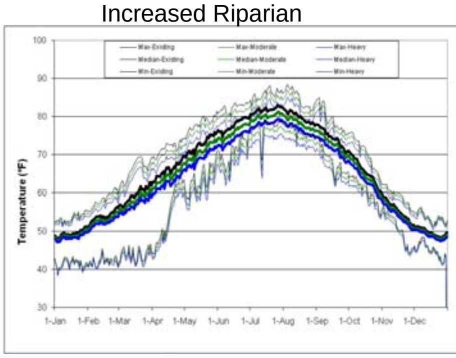
Temperature – Sensitivity Studies _Flow Rate Impact on Temperature



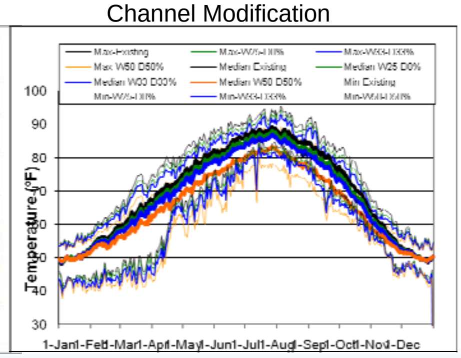
Median of simulated temperatures in San Joaquin River (August)

Temperature – Riparian and Channel Modification Impacts

Increased Riparian



Channel Modification



Reduces peak summer temperatures 3 -5 degrees but still at or over 80 F

Maintains biologically better temperatures 2-5 weeks later in the year.

Plots at Gravelly Ford, approximately 40 miles downstream of Millerton Lake

Temperature – Major Conclusions

- Ambient conditions are a very important factor in water temperatures. (It gets hot there!)
- Flow is more effective in maintaining cooler water temperatures than release temperature
- Equilibrium temperature is relatively independent from the flow.
- Equilibrium temperature is usually attained in Reach 5 in winter/spring, reach 2B in summer and Reach 2A in the fall.
- Riparian shading and channel modifications have limited potential for significant cooling in the Restoration Area

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Unsteady Flow (UNET) Modeling for Flood Damage Analysis

California Department of Water Resources and Tetra Tech, Inc.

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General Description of UNET Model

- UNET: One-Dimensional Unsteady Flow Through a Full Network of Open Channels (USACE, 2001a).
- Model Capabilities:
  - Routes flood hydrographs through network of channels and storage areas.
  - Flow diversions.
  - Hydraulic structures (bridges, weirs, etc.).
  - Levee overtopping and failures.
- Original UNET model developed for Sacramento and San Joaquin River Basins Comprehensive Study (Comp Study, USACE, 2001b).
- Comp Study Model geometry based on 1998 (in-channel) and 2000 (overbank) topography.

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Model Input

- Model geometry and network connectivity.
- Upstream and tributary inflow hydrographs for various storm events (6) and storm centerings (5).
- Downstream and internal boundary conditions.
- Hydraulic roughness (Manning's n-value).
- Diversion structure operating criteria.
- Levee information (alignment, top of levee elevation, likely failure point, breach elevation).

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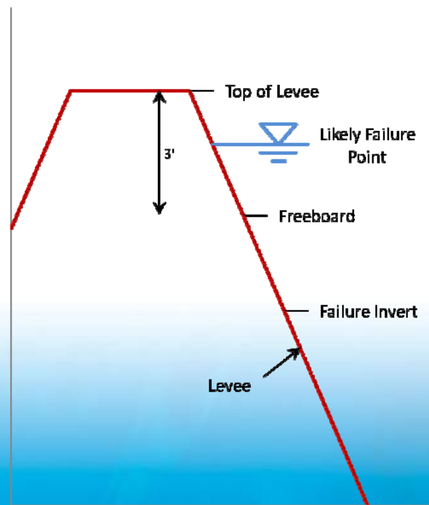
Levees: Likely Failure Points (LFPs)



Subreach	Number of LFPs	U/S LFP RM	D/S LFP RM	Average LFPs Spacing (miles)
Subreach 2A	14	224.0	216.9	0.5
Subreach 2B	0	NA	NA	NA
Subreach 3	23	202.0	182.4	0.9
Subreach 4A	19	182.3	169.0	0.7
Subreach 4B1	2	149.4	149.1	0.3
Subreach 4B2	9	147.1	136.4	1.2

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Modifications to Comp Study Model

- Revised operating criteria at Chowchilla Bifurcation Structure and San Joaquin River Control Structure.
- Phase I Settlement Agreement.
  - Setback levees in Reach 2B (above Bypass Channel).
  - 475 cfs main-channel capacity in Reach 4B.
  - No levee strengthening required.
- Phase II Settlement Agreement.
  - Same as Phase I plus setback levees in Reach 4B.
  - Strengthened levees at two locations in Reach 4B.

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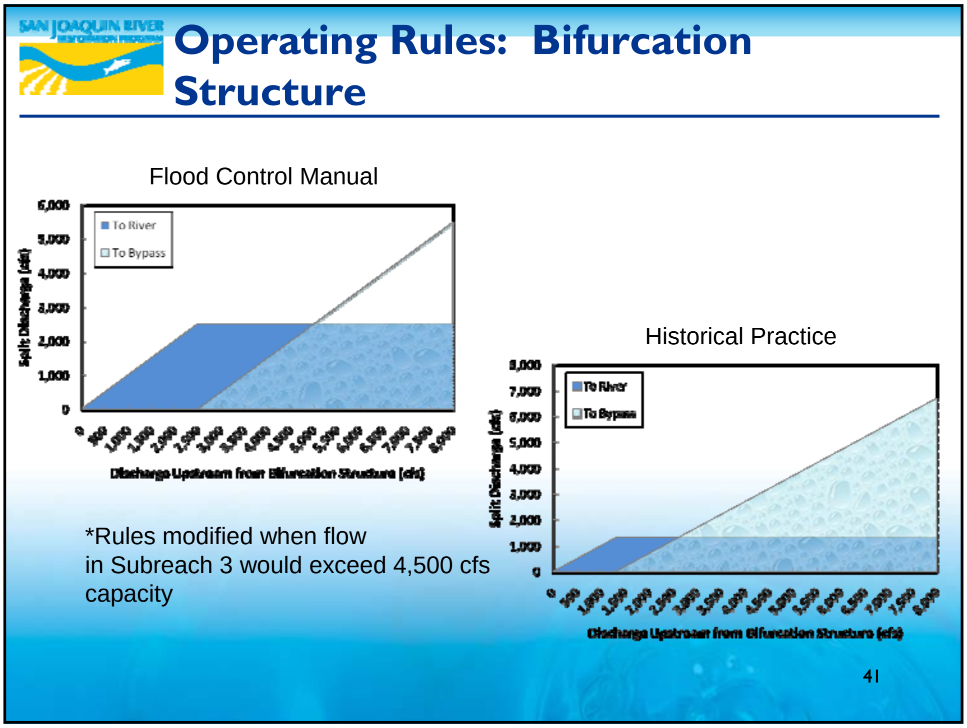
SAN JOAQUIN RIVER
Operating Rules: Bifurcation Structure
Flood Control Manual
To River
To Bypass
Split Discharge (cfs)
Discharge Upstream from Bifurcation Structure (cfs)
Historical Practice
To River
To Bypass
Split Discharge (cfs)
Discharge Upstream from Bifurcation Structure (cfs)
*Rules modified when flow
in Subreach 3 would exceed 4,500 cfs
capacity
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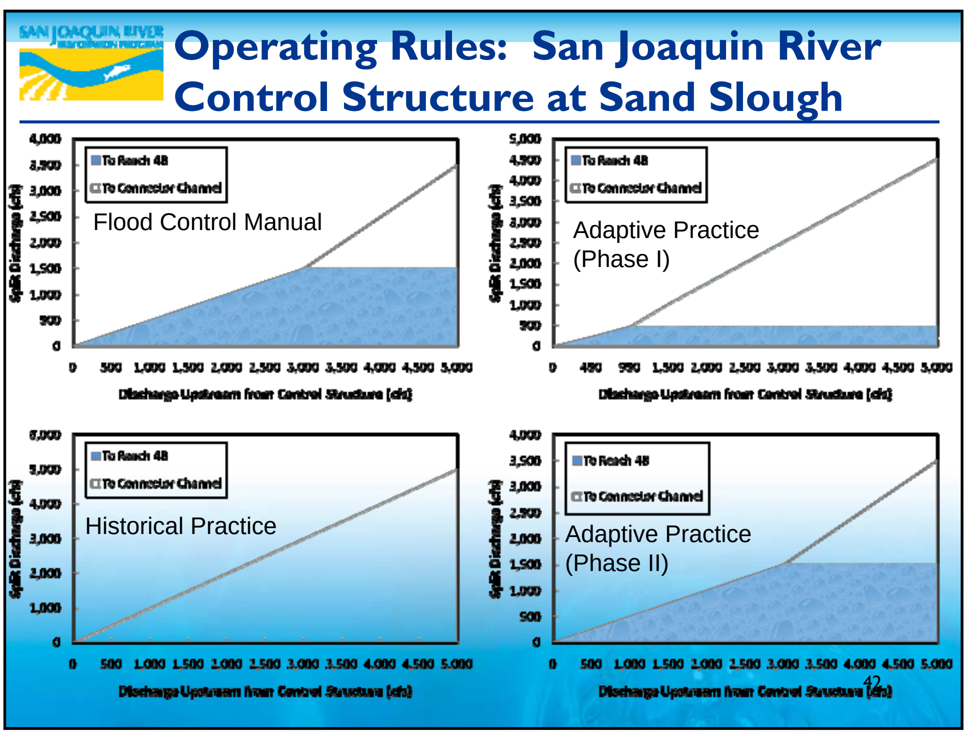
SAN JOAQUIN RIVER
Operating Rules: San Joaquin River Control Structure at Sand Slough
To Reach 4B
To Connector Channel
Flood Control Manual
Split Discharge (cfs)
Discharge Upstream from Control Structure (cfs)
To Reach 4B
To Connector Channel
Adaptive Practice
(Phase I)
Split Discharge (cfs)
Discharge Upstream from Control Structure (cfs)
To Reach 4B
To Connector Channel
Historical Practice
Split Discharge (cfs)
Discharge Upstream from Control Structure (cfs)
To Reach 4B
To Connector Channel
Adaptive Practice
(Phase II)
Split Discharge (cfs)
Discharge Upstream from Control Structure (cfs)
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SAN JOAQUIN RIVER RESTORATION PROGRAM

Model Scenarios

Scenario	Geometry	Operating Rules
1	Without-Project Conditions	Flood Control Manual
2	Without-Project Conditions	Historical Practice
3	Phase I Settlement Agreement Conditions	Flood Control Manual
4	Phase I Settlement Agreement Conditions	Adaptive Practice (Phase I)
5	Phase II Settlement Agreement Conditions	Flood Control Manual
6	Phase II Settlement Agreement Conditions	Adaptive Practice (Phase II)

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SAN JOAQUIN RIVER RESTORATION PROGRAM

Model Runs

Scenario	Event	Storm Centering				
		El Nido	Friant	Kings	Newman	Vernalis
Scenario 1	10-yr					
	25-yr					
	50-yr					
	100-yr					
	200-yr					
	500-yr					
Scenario 2	10-yr					
	25-yr					
	50-yr					
	100-yr					
	200-yr					
	500-yr					
Scenario 3	10-yr					
	25-yr					
	50-yr					
	100-yr					
	200-yr					
	500-yr					
Scenario 4	10-yr					
	25-yr					
	50-yr					
	100-yr					
	200-yr					
	500-yr					
Scenario 5	10-yr					
	25-yr					
	50-yr					
	100-yr					
	200-yr					
	500-yr					
Scenario 6	10-yr					
	25-yr					
	50-yr					
	100-yr					
	200-yr					
	500-yr					

- 6 scenarios, 6 storm events, 5 storm centerings = 180 finite channel runs.
- Additional 180 infinite channel runs.
- Approximately 20-day long simulations.
- 15-minute computer run time for each simulation.

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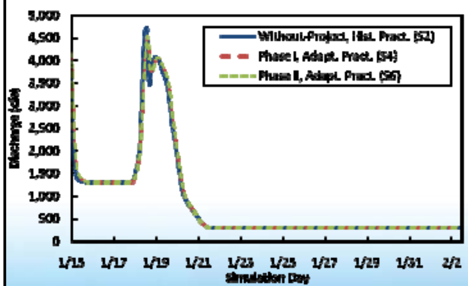
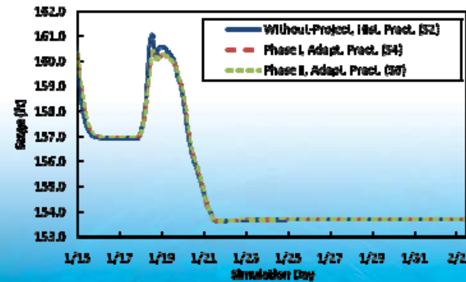
Model Results

Effects of project in Reach 2B: Historical/Adaptive Practice Operating Rules (100-year Event, Friant Storm Centering)





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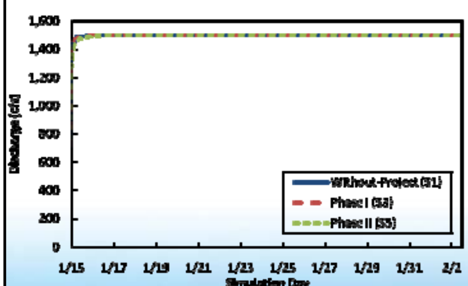
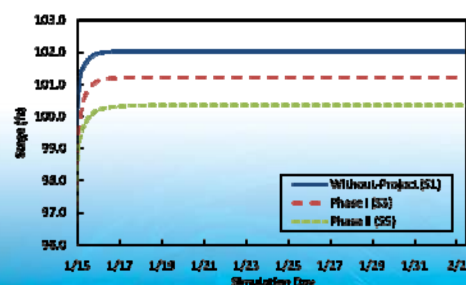
Model Results

Effects of project in Reach 4B1: Flood Control Manual Operating Rules (100-year Event, Friant Storm Centering)





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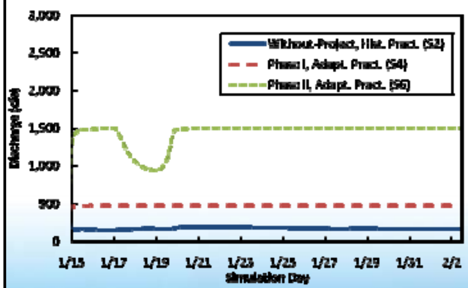
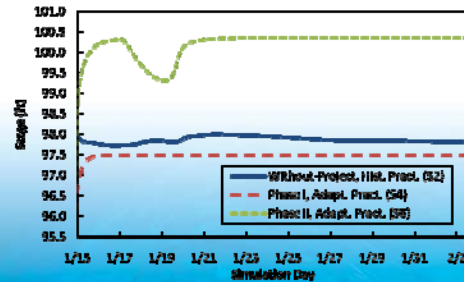
Model Results

Effects of project in Reach 4B1: Historical/Adaptive Practice Operating Rules (100-year Event, Friant Storm Centering)





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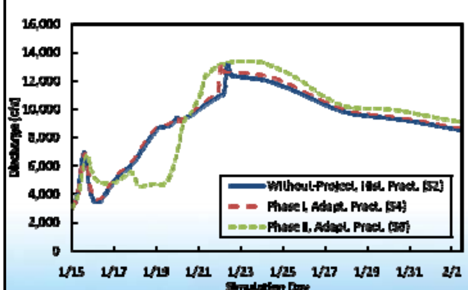
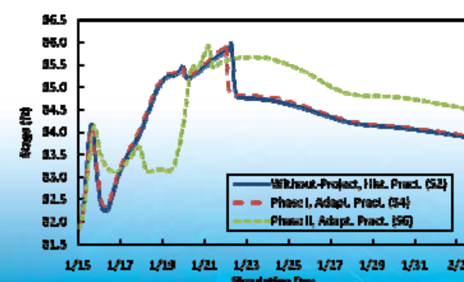
Model Results

Effects of project in Reach 4B2: Historical/Adaptive Practice Operating Rules (100-year Event, Friant Storm Centering)





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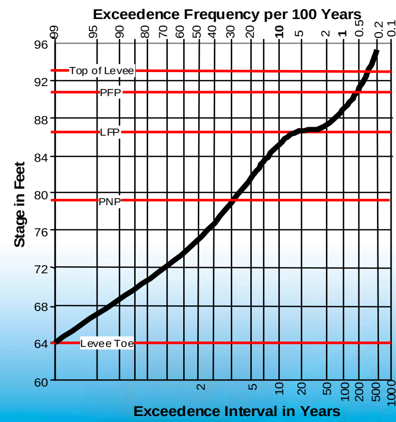
SAN JOAQUIN RIVER

Stage-Frequency Curves for FDA

Model results used to develop maximum stage - frequency curves for input to Flood Damage Analysis.



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SAN JOAQUIN RIVER

Sediment Transport Modeling

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Sediment Monitoring

- Bed Material Size
  - Pebble Counts
  - Volumetric Samples
  - Photographic techniques

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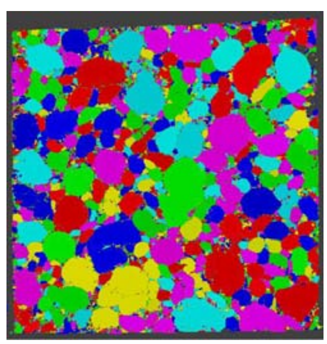
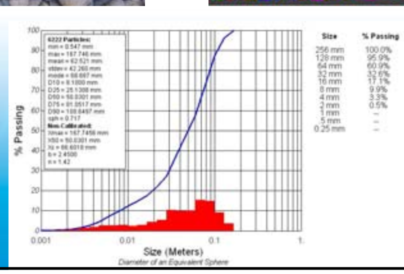
Photographic Techniques





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Sediment Monitoring

- Suspended and Bedload Transport
  - 5 locations for main stem sampling from bridge, cableway, boat or wading
    - HW 41, Skaggs Bridge, Gravelly Ford, below Chowchilla, below Mendota Dam

DH- 38, Photo from http://www.wiu.edu/geology/StudentResearch

Photo from USGS water image library

TR2- Photo from vulcan.wr.usgs.gov

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Sediment Transport Modeling

- Model Objectives
  - Assess impact of Project alternatives on the sediment transport in San Joaquin River from Friant Dam to Merced River
    - Changes to river bed material
    - Changes to bed elevation
    - Changes to river planform
    - Assess gravel mobilization
    - Input to vegetation/fish habitat analysis
  - Support channel and floodplain design

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Sediment Transport Modeling

- Methods
  - Geomorphic studies
    - Analysis of aerial photographs
    - Analysis of historical accounts and data
  - Mobilization studies in Reach 1
    - Compute flows at which sediment is mobilized in Reach 1
    - Use 1D and 2D hydraulic models (HEC-RAS and SRH-2D)
  - One-Dimensional Sediment transport modeling
    - Compute changes to bed elevation and bed material throughout project reach
    - Use SRH-1D

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Application to San Joaquin

- Data Used
  - Aerial photographs, site visits
  - Daily average flow predictions – generated using CALSIM II and a daily submodel
  - Cross section geometry – 1998 survey of the COE. HEC-RAS model from Mussetter Enginnering
  - Bed material – bulk surface and subsurface samples collected in all reaches where access was possible
  - Sediment loads – none available

Modeling is not done independent of other analyses

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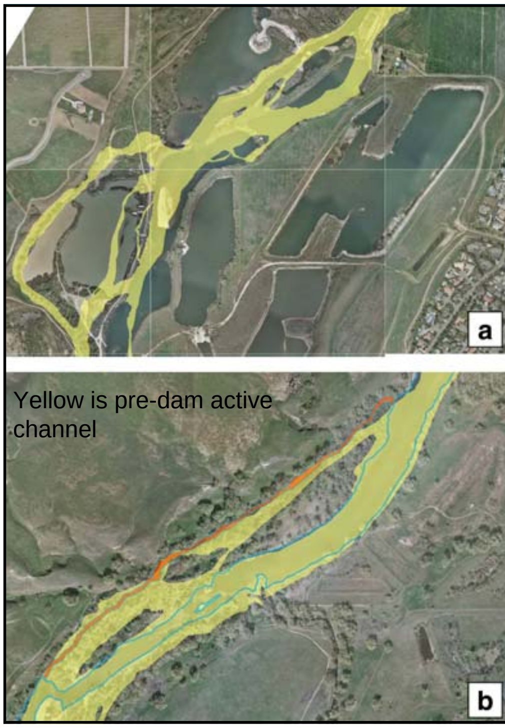

Geomorphology: Changes since Friant Dam in Reach 1

- Analyzed 1938 and 2007 photos
- Width reduction and channel narrowing due to reduced flows, channel incision, and vegetation encroachment
- Reduction in channel complexity – fewer side channels, less variability

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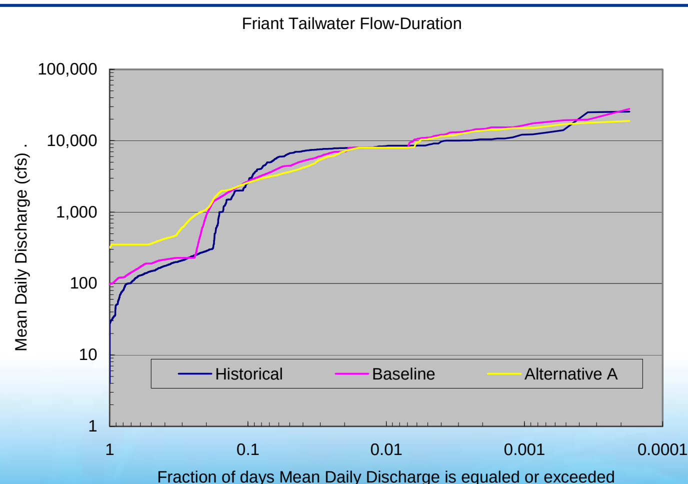
Hydrology: Changes Due to SJRRP



- Initial flow estimate show that, on average, the frequency of flows greater than 8,000 cfs are decreased because Friant spills less often under the SJRRP than under Baseline Conditions

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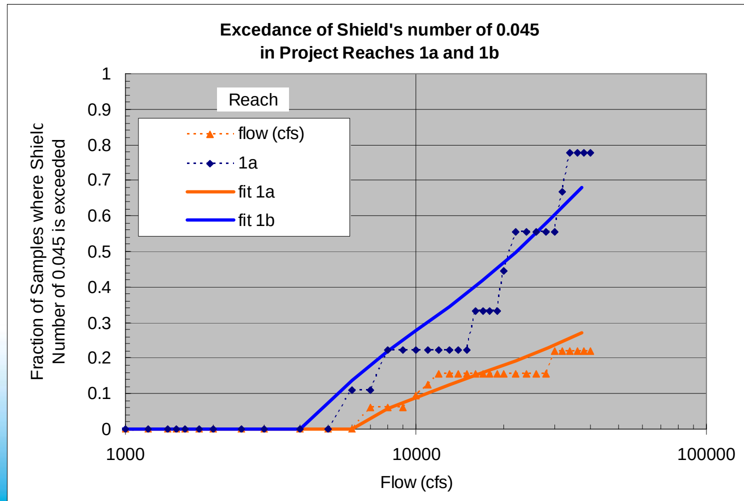
Incipient Motion and Mobilization



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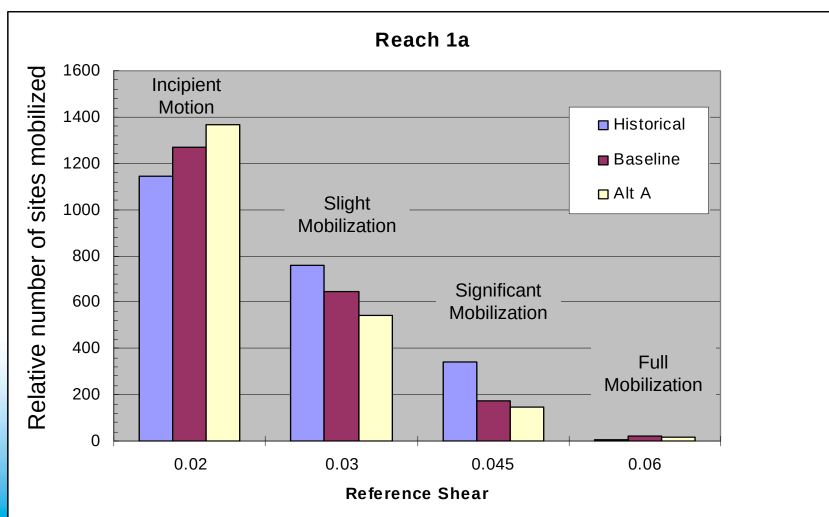
Incipient Motion and Mobilization of Riffles

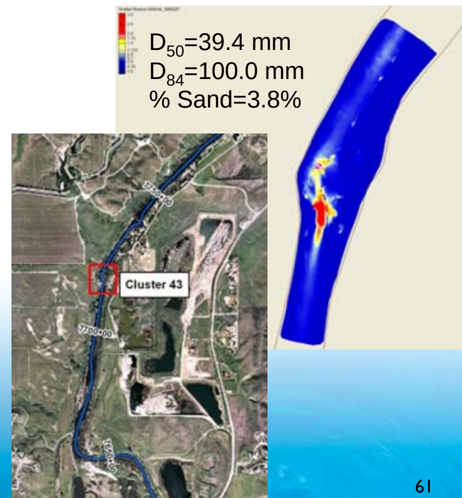


60

2D Incipient Motion Analysis

- Work by Tt-MEI
- Grain Shear Stress Computed from SRH-2D Results
- Riffle gradations from field sampling

Riffle 43 4500 cfs



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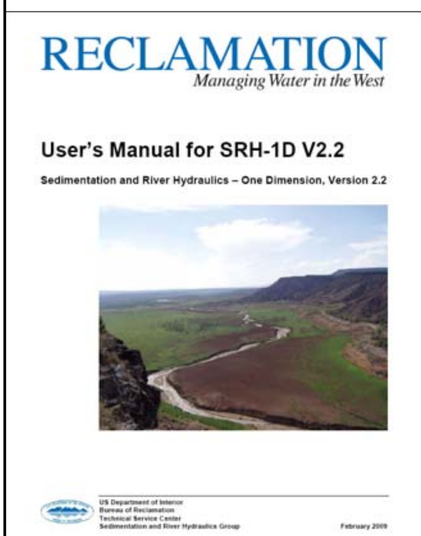
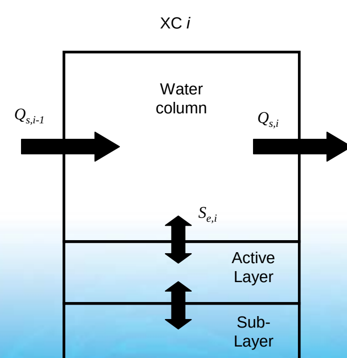
Sediment Transport Modeling

- SRH-1D: numerical model to predict erosion and deposition





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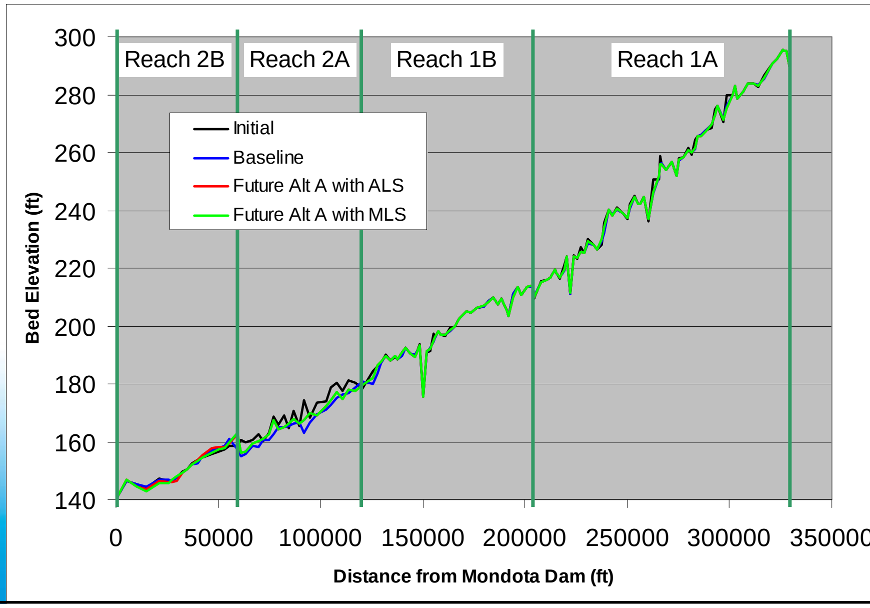
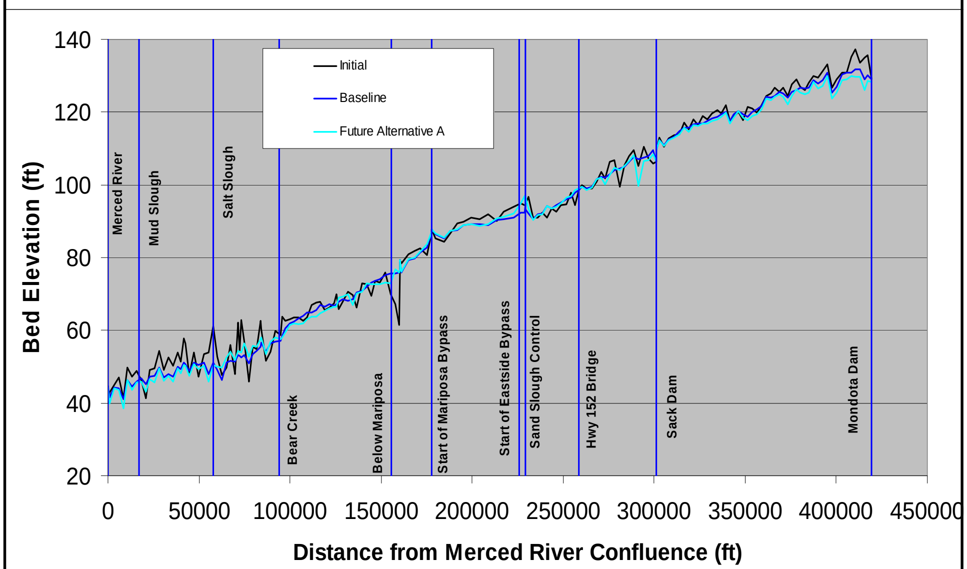
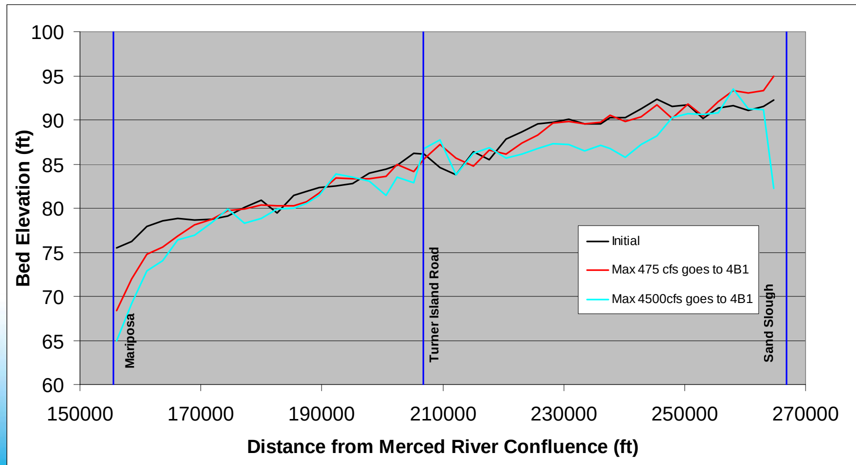
Erosion and Deposition: Friant to Mendota



Erosion and Deposition: Mendota to Merced



Application to Reach 4B



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Current Erosion in lower Eastside Bypass and Reach 5

Degradation in San Joaquin – Reach 5

Degradation in Eastside Bypass

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Summary

- Reach 1
  - project is likely to reduce the period of time the flows are above 2000 cfs, and therefore reduce the sediment transport in Reach 1
  - bed will remain stable with or without project
- Reach 2
  - slightly more erosion is predicted in Reach 2a with project
  - deposition possible in reach 2b with or without project, potentially slightly more under with project
- Reach 3 and 4a
  - relatively stable with some increase erosion possible under project conditions
- Reach 4b1
  - some slight deposition in upstream portion if max flow is 475 cfs
  - erosion is likely throughout reach if max flow is 4500 cfs
- Reach 4b2 and 5
  - continue to degrade with or without project
- Eastside bypass
  - Overall, will to continue to degrade with or without project

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SRH-1DV 1D Flow-Sediment-Vegetation Model

Modeling Vegetation Response to Management Actions

Sedimentation & River Hydraulics Group
Technical Service Center, Denver Colorado

November 2009
Turlock, CA

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San Joaquin River Vegetation Studies

- Predict Hydraulic Capacity
- Regenerate native cottonwood-willow communities
- Restrain the spread of invasive riparian vegetation
- Vegetation to aid fisheries

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To predict changes in vegetation for estimating future hydraulic capacity with HECRAS,

MEI-Tt and EDAW based future vegetation conditions on modeled 350 cfs and 1500 cfs inundation maps.

Slide provided by MEI/Tt

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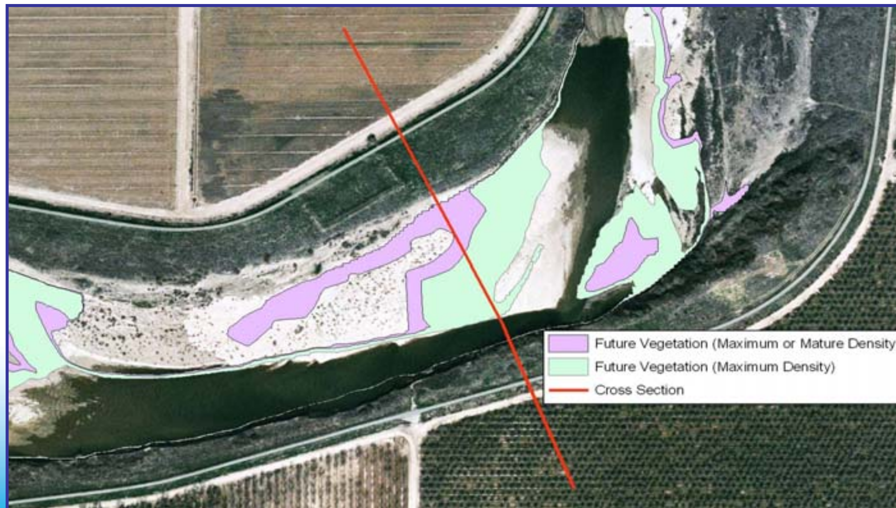
Vegetation zones designated by Maximum and Mature density



Slide provided by MEI/Tt

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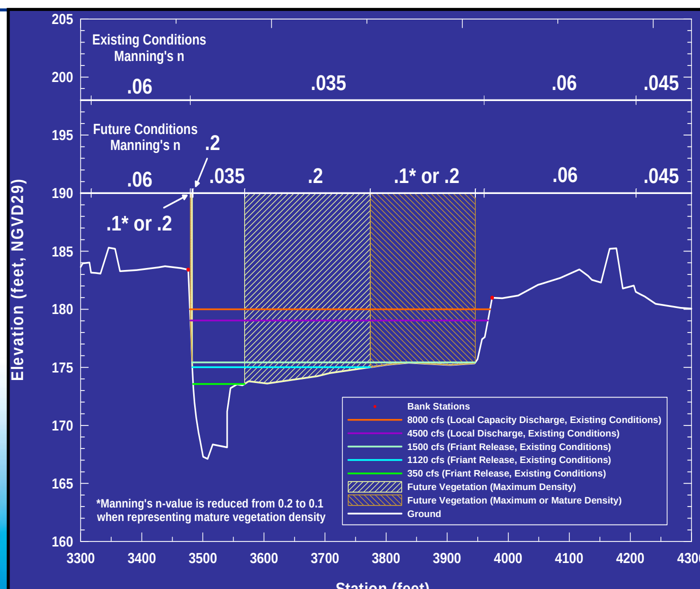
Roughness applied across vegetation zones



Slide provided by MEI/Tt

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SRH-1DV

SRH-1D is the base model for SRH-1DV

- Hydraulics: Step-backwater model with steady or unsteady flow capability, computes water surface elevation and hydraulic parameters at specified time steps
- Sediment transport: is computed at the specified time step for 10 grain sizes at each cross-section providing erosion and deposition, and substrate predictions

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Since 1999, the Sedimentation and River Hydraulics Group (SRHG) at Reclamation's Technical Service Center has used 1D models to study linkages between management actions, flow regime, sediment transport, riparian vegetation and species habitat in river environments.

Platte River- SedVeg-Gen3 for avian habitat, forage fish habitat, native vegetation and river morphology studies (fully braided river)

Sacramento River- SRH-1DV for native vegetation studies

San Joaquin River- SRH-1DV for native vegetation, invasive vegetation and hydraulic capacity studies.

Dr. Blair Greimann is the author of SRH-1DV vegetation code with Dr. Victor Huang also supporting code development.

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SRH-1DV -Linking Physical and Ecological Processes to Management Actions

Physical Processes

In addition to hydraulic and sediment transport computations,
estimates groundwater elevation based on river water surface elevation, and specified soil permeability

Ecological Processes

Germination, growth and mortality of native vegetation
Germination, growth and mortality of invasive vegetation

Vegetation Types

Selected as: species of interest, representative of a community, or geomorphically significant.

-Natives:

- Fremont cottonwood
- Gooding's black willow
- Narrow-leaf willow

-Invasives:

- Red sesbania
- Giant reed (Arundo)

-For computations:

- dry land grass
- no-grow areas

Red sesbania

Giant reed

1D models represent ground surface with cross sections and flow in one direction- downstream.

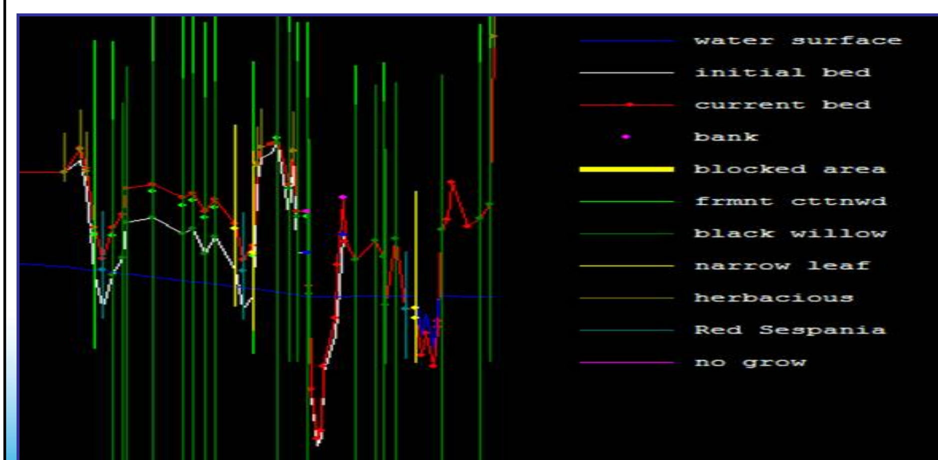
San Joaquin River studies uses 300 cross sections with approximately 80 points per cross section.

Every point can potentially support all six plant types or a no-grow designation.

In addition to flow and sediment transport computations, SRH-1DV can track: age, root growth, stem growth, canopy growth, growth seasons, germination periods, seed viability, distance to groundwater, capillary fringe, and mortality (removal) due to scour, desiccation, inundation, competition, shading, and senescence.

for:
- each plant type,
- at every point,
- at every cross section,
- on every flow day,
- in modeled reach for the period of study.

Model cross section with water table, vegetation stems and vegetation roots



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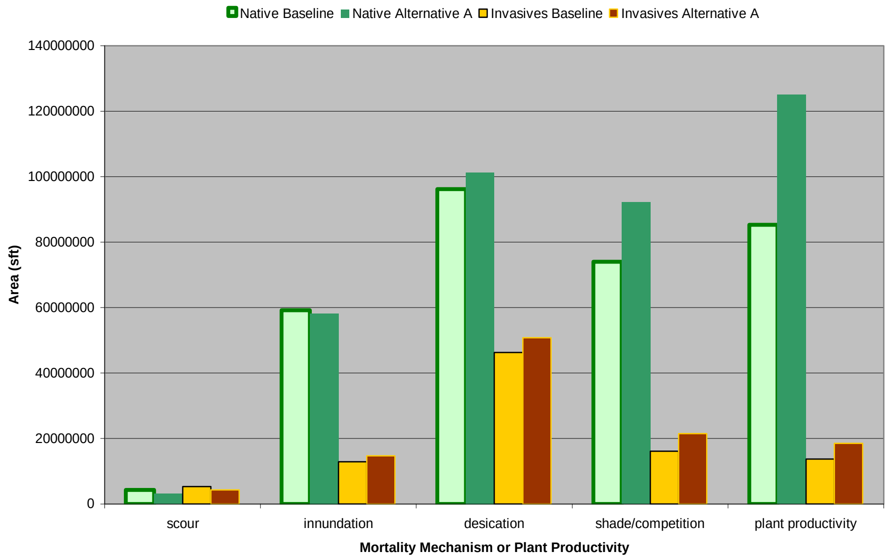
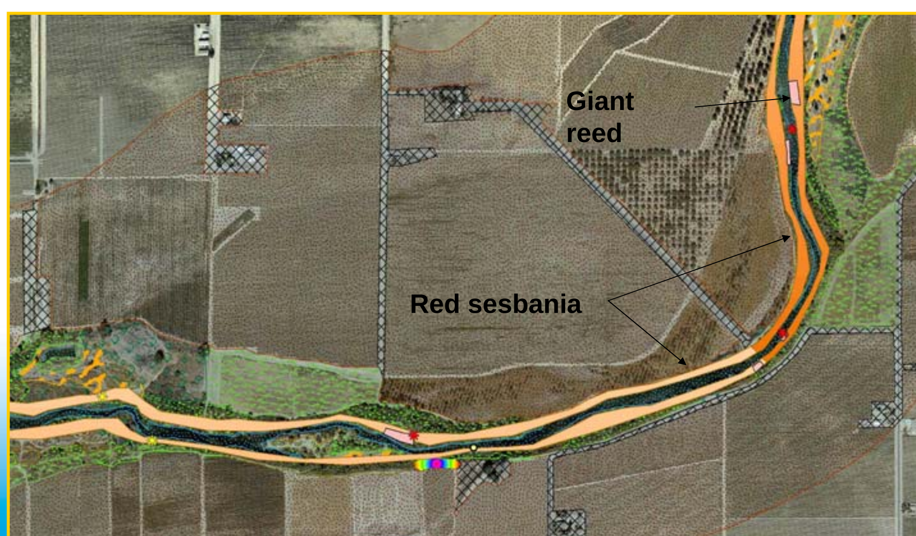
Systemwide General Results

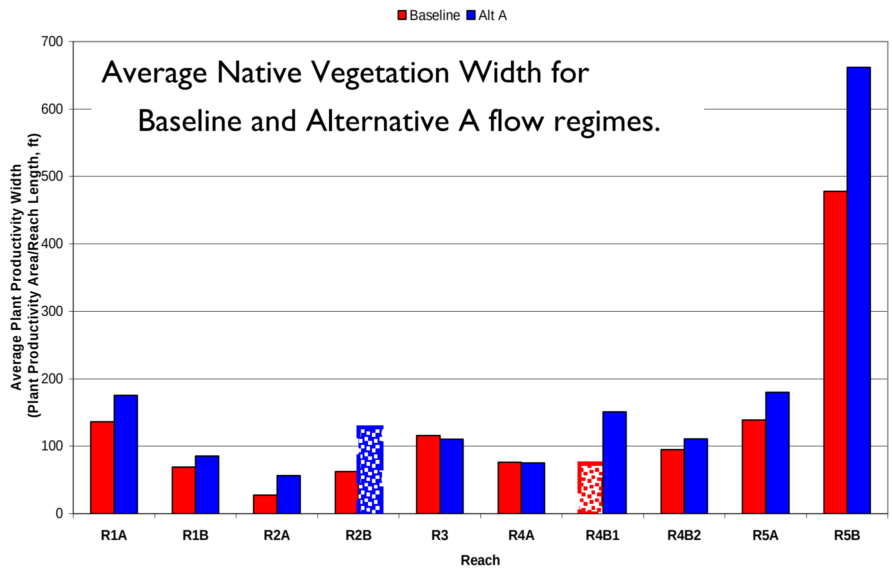
Relative comparison of alternatives
Total Area of Vegetation and Mortalities



Once established, invasive vegetation persists as a thin ribbon of coverage along the river bank



Systemwide Reach Results-
Relative Comparison of Alternatives

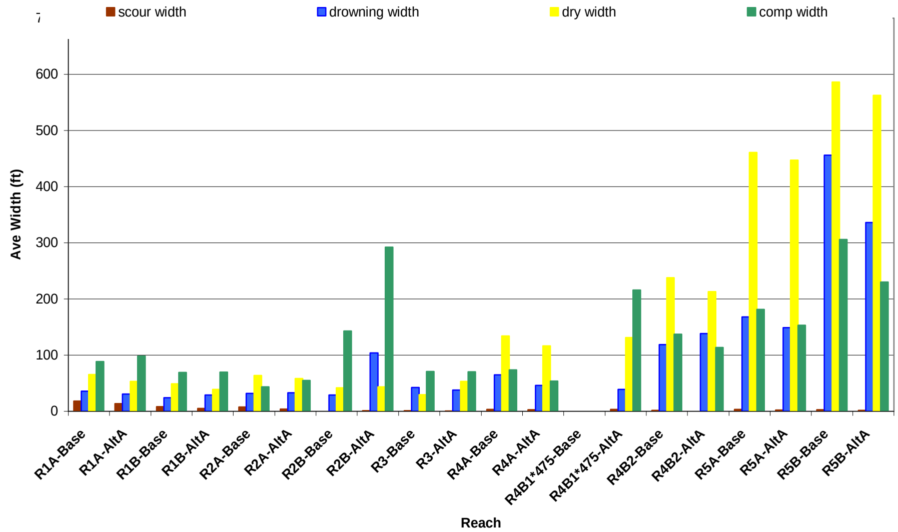


-Confirmed relation between Mendota Pool water surface, groundwater elevation, root depth, and persistent vegetation in Reach 2B

-Detected sensitive threshold in Reach 4A between vegetation establishment in overbank areas, Program flows and typical root growth depths.

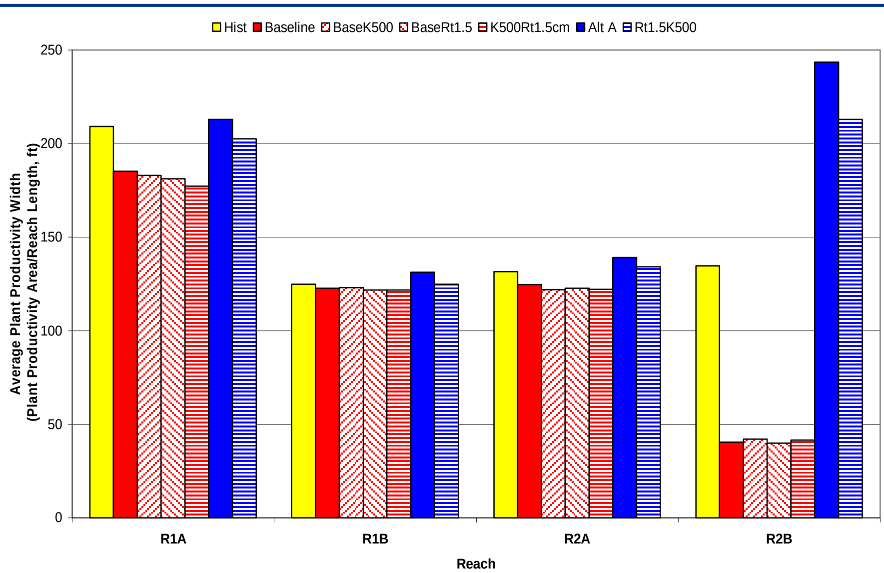
SAN JOAQUIN RIVER RESTORATION PROGRAM

Systemwide Reach Results – Native Vegetation Mortality

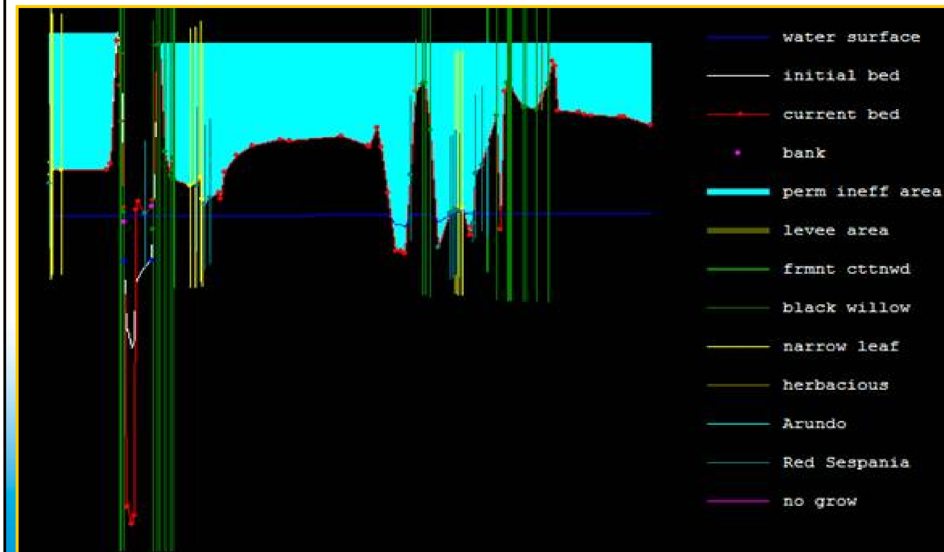


SAN JOAQUIN RIVER RESTORATION PROGRAM

Series of sensitivity studies- examples: root growth rates, groundwater conductivity, historical flows



General analysis of Levee Setbacks in Reach 2B



Results to date available in PEIS/R

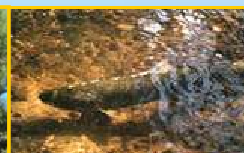
- Appendix N- Summary of Geomorphology, Sediment Transport and Vegetation
- Appendix N, Attachment 6- SRH-1DV vegetation modeling

Future Directions- Analysis

- Aid Design of Reach 4B1
- Automated predictions of channel resistance for computations of future hydraulic capacity
- Continue alternatives analysis for:
    - expansion of native vegetation
    - restraint of invasive vegetation

Potential Applications:

- test vegetation removal strategies for conveyance and control of invasive vegetation
- provide support to fisheries habitat studies


Associated Model Development

Model verification

- Groundwater model predictions using 2000-2002 Vegetation Studies (SAIC, 2002 and 2003)
- Spread of invasives using 2000 mapping, 2008 invasive mapping, 2010 spring flows field review
- Elevation establishment and mortality (dessication, scour, innundation) using vegetation monitoring cross sections, SAIC reports (2002, 2003) and 2010 field reviews

Expand model capabilities

- link vegetation growth or removal to channel resistance (hydraulic capacity)
- add large-scale vegetation density capabilities
- add function relating Fremont cottonwood and Gooding's black willow seed release to temperature (Stillwater Science, 2006)

Groundwater

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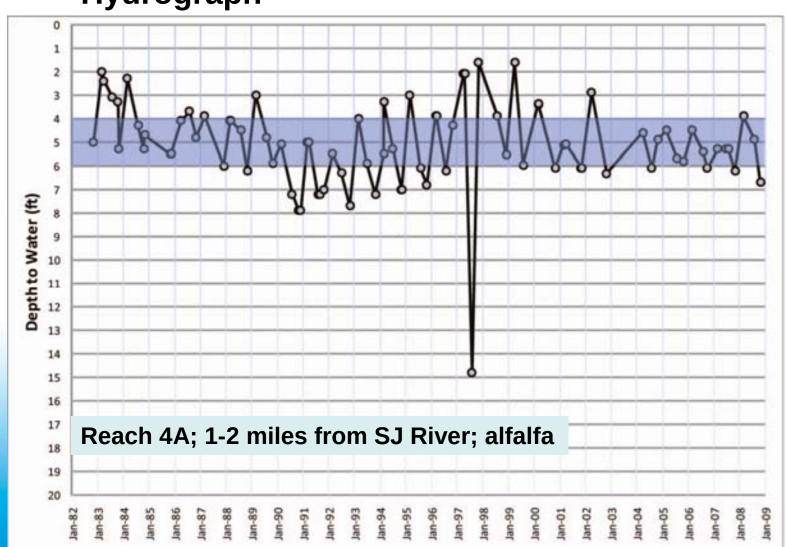
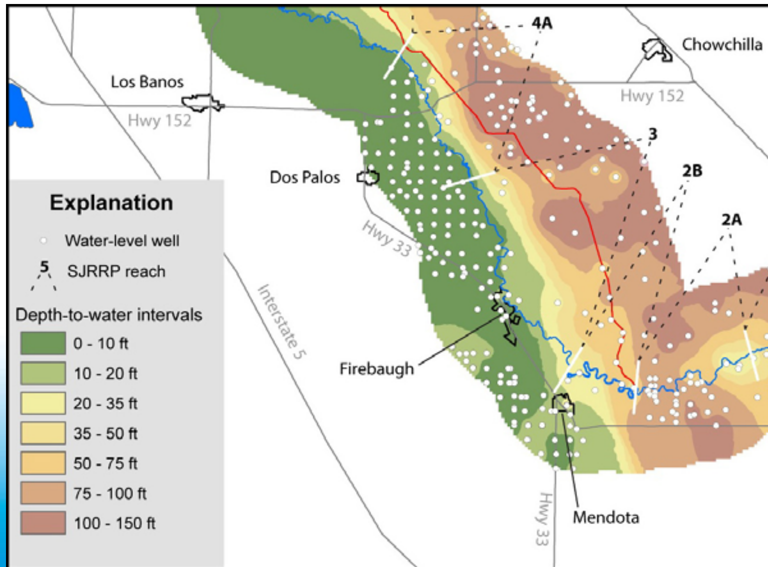
Groundwater

Hydrograph



Groundwater



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Groundwater

The hydrographs & water-table maps are being used for:

- Development of monitoring thresholds
- Identification of areas likely susceptible to seepage impacts
- Analysis of water-table response to local precipitation
- Model calibration

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Groundwater

Texture of aquifer sediments is important:

- Shallow silt & clay = drainage problem
- More sand = more connected to river and to local pumping
- Texture distribution greatly influences groundwater flow

→ The more we know about texture, the better

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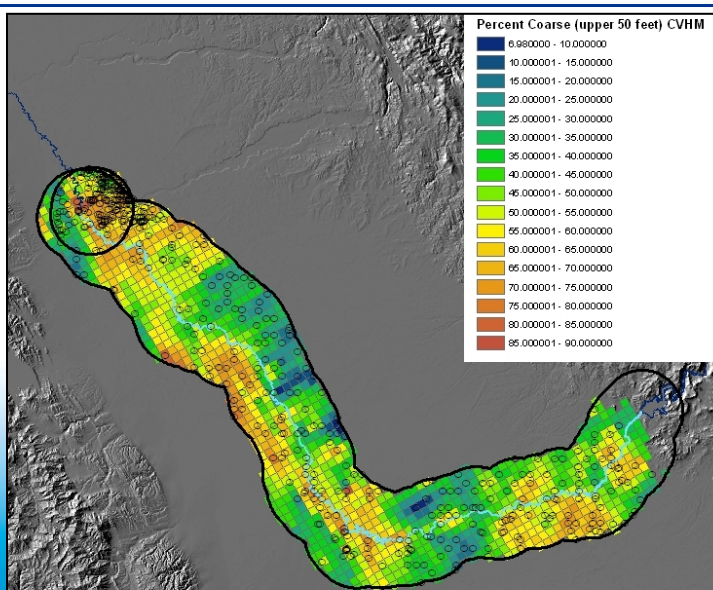
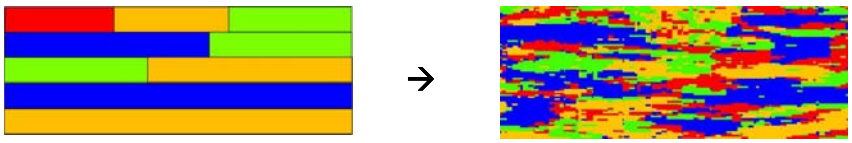
Groundwater

We know a little bit about texture now, but need better resolution



Groundwater



Incorporation of more (and better) texture data:

- Improved texture distribution
- Improved simulation models
- Improved prediction of impacts

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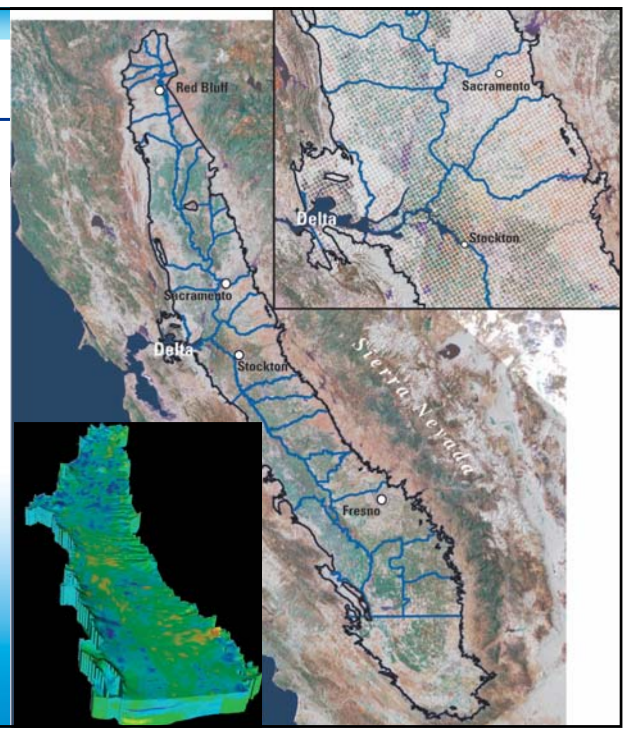
USGS Central Valley Hydrologic Model

- Published, public domain
- Water budget built in
- Simulates
  - Surface water
  - Agriculture
  - Subsidence
  - Etc.



Groundwater

USGS Central Valley model, spatially refined, will be used to:

- Help guide groundwater monitoring
- Predict impacts under various conditions
- Test the effectiveness of potential actions for avoiding impacts
- Quantify seepage losses and distribution

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2D Hydraulics

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2D Hydraulics

Purpose

- **Provides input for habitat evaluation**
- **Provides input for analysis of potential morphology responses**

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2D Hydraulics

- **Why 2D?**
  - **Lateral and longitudinal flow patterns**
  - **Helps in the analysis of floodplain processes**
  - **More dependable local velocities and shear stresses for designs**
- **Model Objectives**
  - **Provide high-resolution hydraulic information to help assess aquatic and riparian habitat conditions**
  - **increase understanding of the levee capacities and potential improvements to design**

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2D Hydraulics

- **Reclamation's SRH-2D model (Lai, 2006)**
  - **Two-dimensional, depth-averaged model that simulates hydraulics**
- **Model Progress**
  - **Reach 1A & 2B: preliminary model developed and calibrated**
  - **Reach 1B, 2A, & 4B: mesh developed; models require calibration**

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2D Hydraulics

Input:

- **Topography & bathymetry obtained from hydrographic and photogrammetric surveys**
- **Channel roughness polygons – (7 Zones)**
- **Development of a computational mesh**
- **Flow boundary conditions – Steady State**

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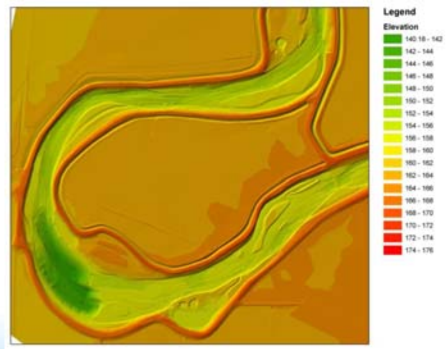
2D Hydraulics

- **Surface Development**
  - **Hydrographic and photogrammetric surveys**
  - **Final models will incorporate new LiDAR**



Example from Reach 2B

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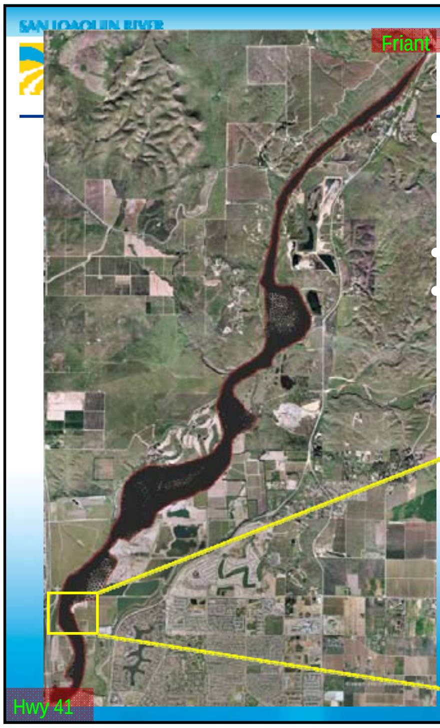
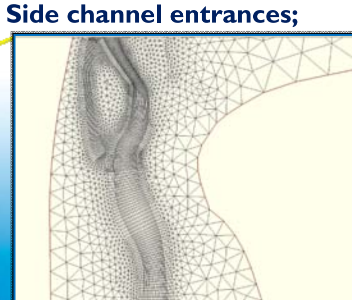
Computational Mesh (1A)



- **-> Structured main channel mesh**
  - **10-20 ft laterally**
  - **20-50 ft longitudinally**
- **-> Unstructured floodplain**
- **-> Control lines along major breaks:**
  - **Overbank points;**
  - **Drop structures;**
  - **Side channel entrances;**



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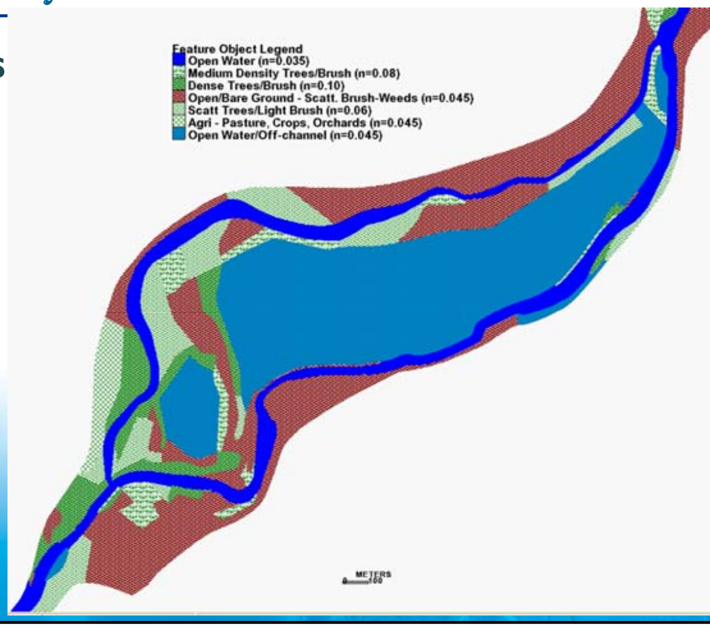
2D Hydraulics

Roughness Zones



2D Hydraulics

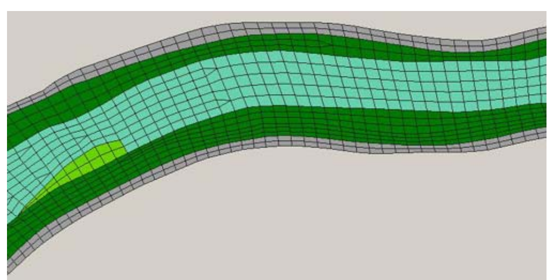
Sample Mesh (2B)

25–30 ft laterally

40–45 ft longitudinally

Roughness Zones

- Light blue = main channel
- light green = light vegetation
- dark green = heavy vegetation
- gray = levee.



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2D Hydraulics

- **Model Output:**
  - Water Surface Elevation
  - Water Depth
  - Velocity (Vector & Magnitude)
  - Froude Number
  - Bed Shear – For sediment incipient motion analysis

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Sample Results 1A-01

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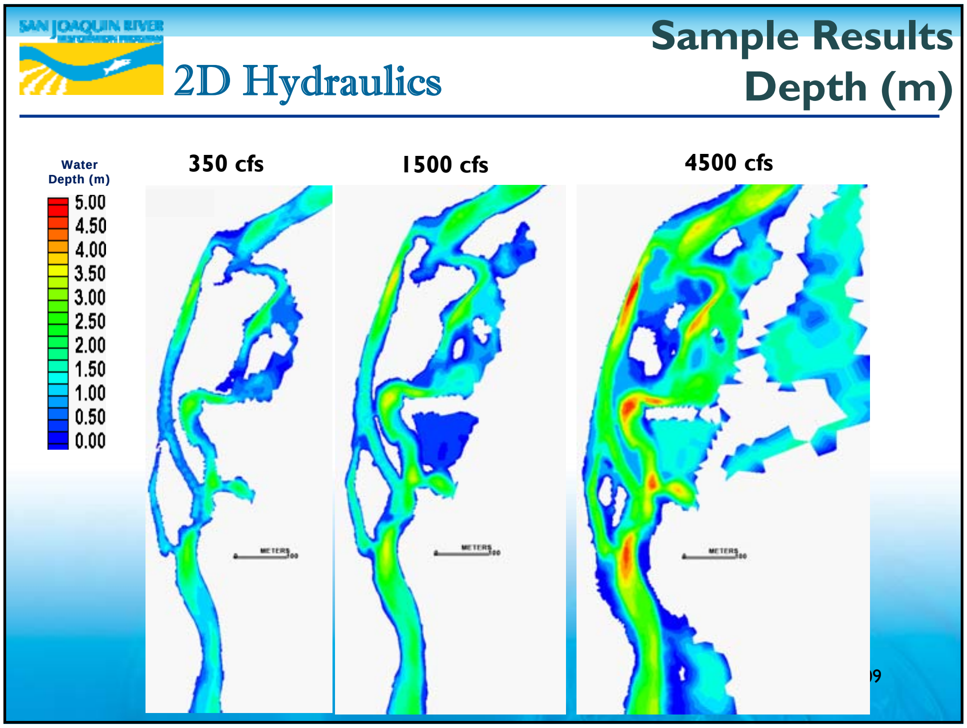
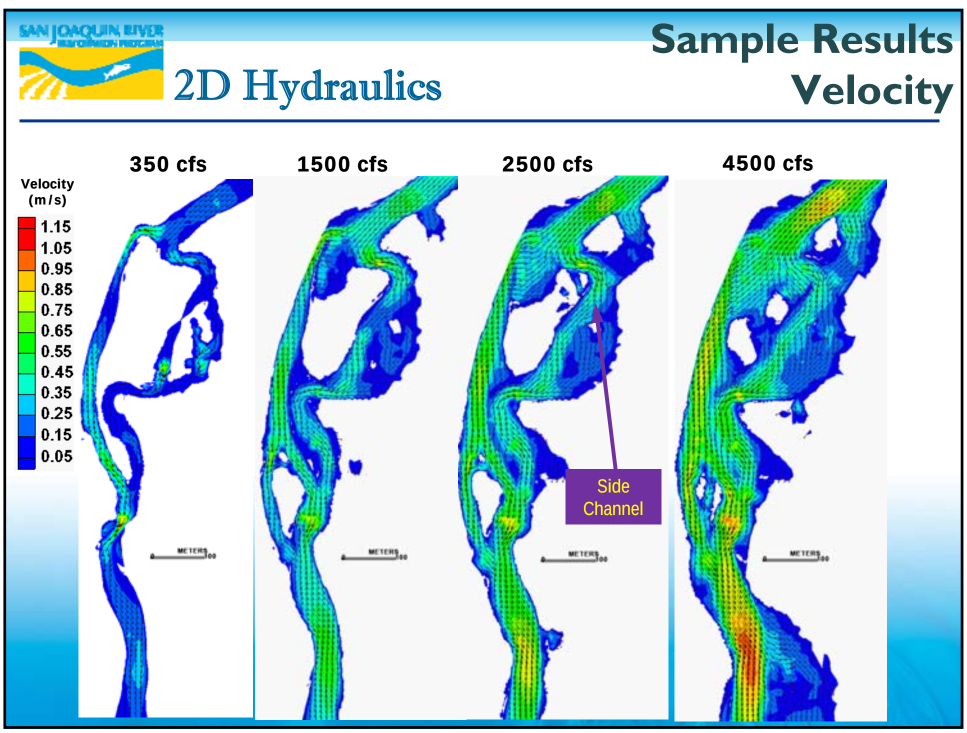


SAN JOAQUIN RIVER
2D Hydraulics
Sample Results
Depth (m)
Water Depth (m)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
350 cfs
1500 cfs
4500 cfs



SAN JOAQUIN RIVER
2D Hydraulics
Sample Results
Velocity
Velocity (m/s)
1.15
1.05
0.95
0.85
0.75
0.65
0.55
0.45
0.35
0.25
0.15
0.05
350 cfs
1500 cfs
2500 cfs
4500 cfs
Side Channel

2D Hydraulics — Example analysis Habitat

- **Example Habitat Distribution using Froude Number Criteria:**
  - **Pools:** 0.0 < Fr < 0.09
  - **Glides:** 0.09 < Fr < 0.42
  - **Riffles:** Fr > 0.42

Based on (Hilldale & Mooney, 2007. Identifying Stream Habitat Features With a Two- Dimensional Hydraulic Model, USBR, Tech Series No. TS-YSS-12) where they found good correspondence between the Froude No. and the different habitat on the Yakima River in Washington.

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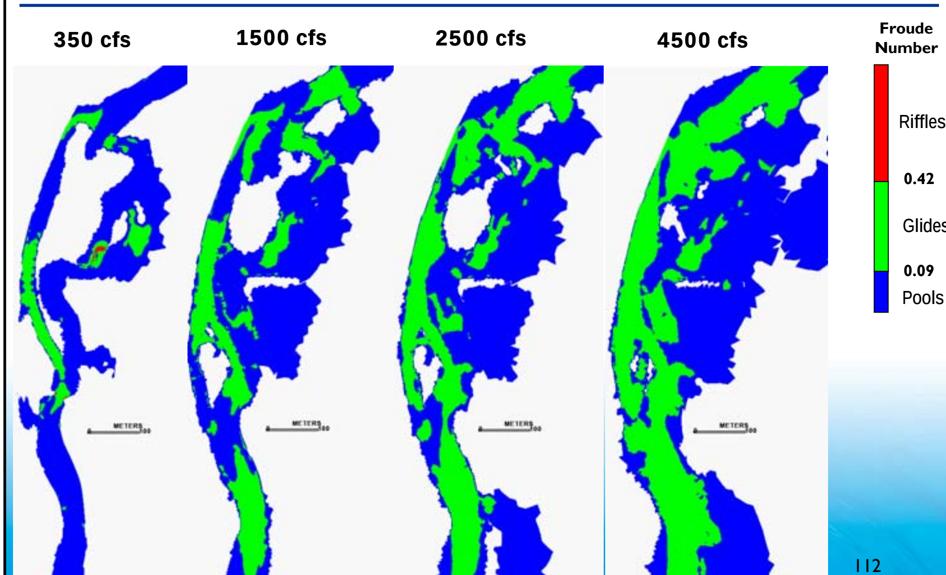
2D Hydraulics — Example Distribution of Pools, Glides, & Riffles



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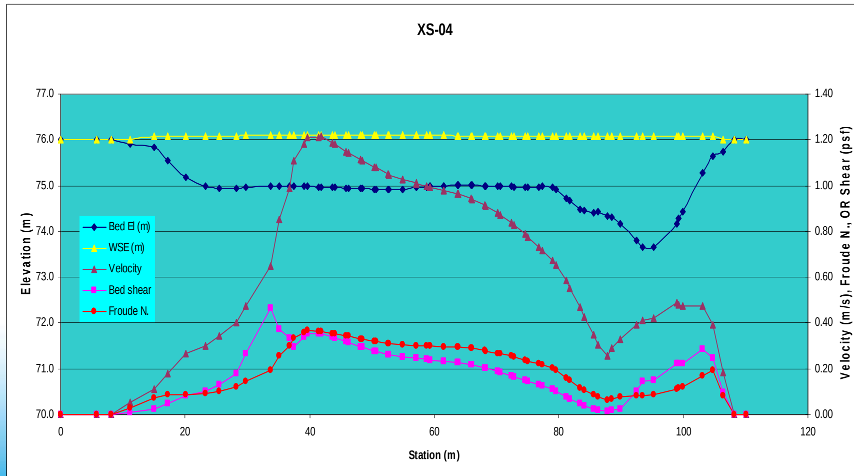
2D Hydraulics

Lateral Variability Across Channel



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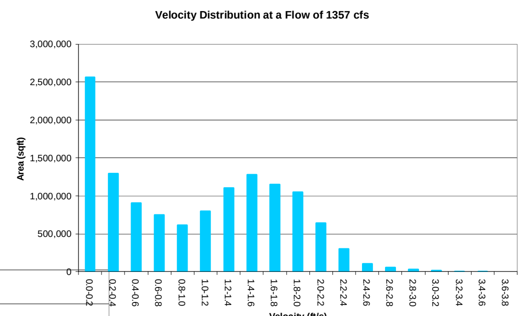
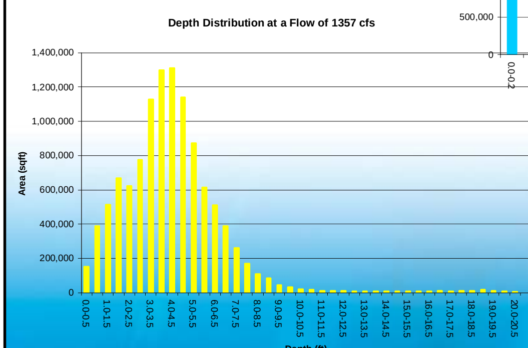
2D Hydraulics

Example Results Reach 2B

- **Depth and Velocity Distribution Plots**
  - **Quantify total areas within specified ranges**
  - **Useful for habitat suitability analyses**





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2D Hydraulics

Additional 2D Applications

- Vegetation: input for simulating establishment and mortality of riparian species
- Provides input for analysis of sediment dynamics; bar formation and riffle erosion
- Roughness: variability in lateral roughness based on vegetation and sediment dynamics
- Levee Design: sensitivity studies for impacts of changing height or location, or both

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Fisheries

Using the Ecosystem Diagnosis & Treatment Model to help guide fish restoration actions

Shannon Brewer, FMWG

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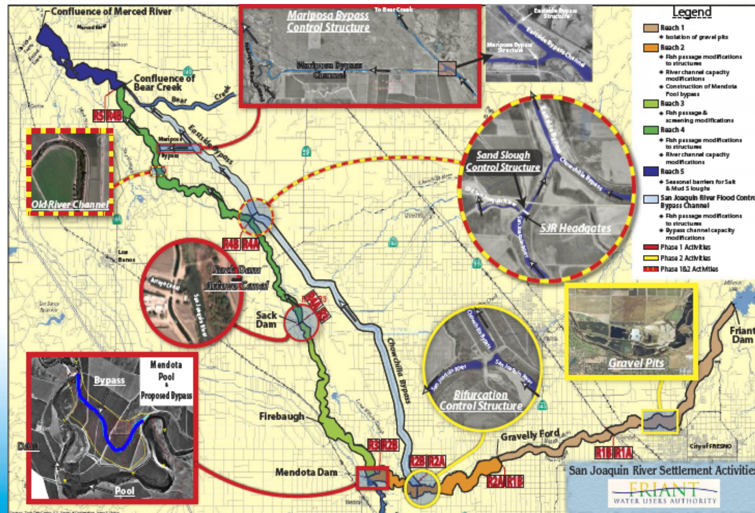
Fisheries – Unique Challenges



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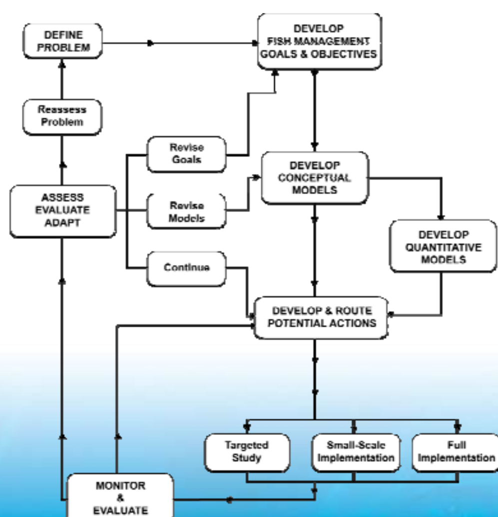
Fisheries – Adaptive Management



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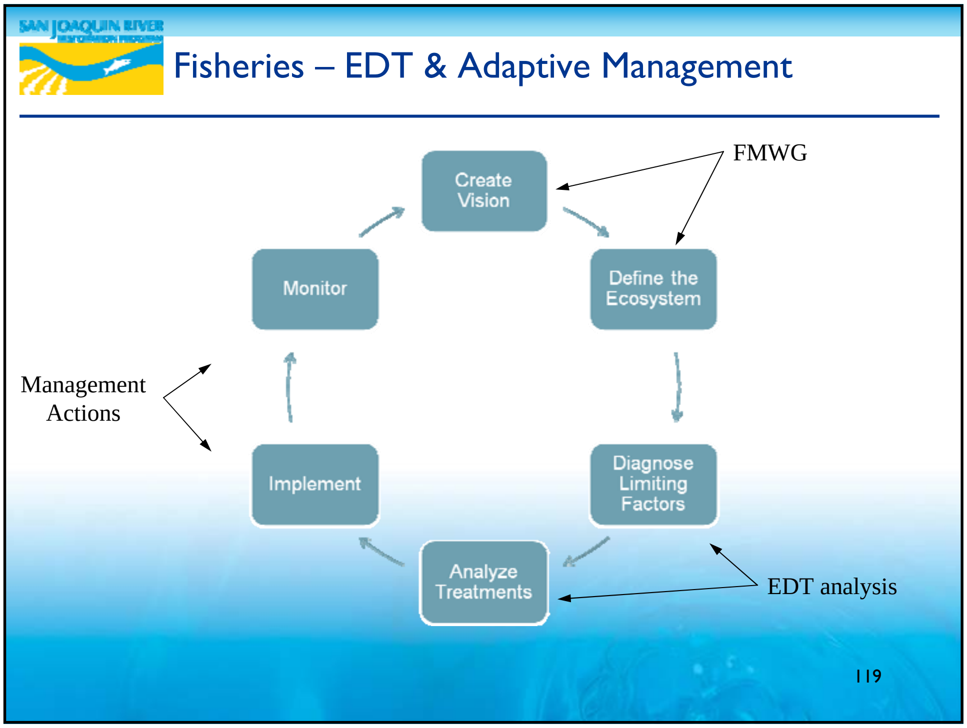
SAN JOAQUIN RIVER
Fisheries – EDT & Adaptive Management
Create Vision
Define the Ecosystem
Diagnose Limiting Factors
Analyze Treatments
Implement
Monitor
FMWG
Management Actions
EDT analysis
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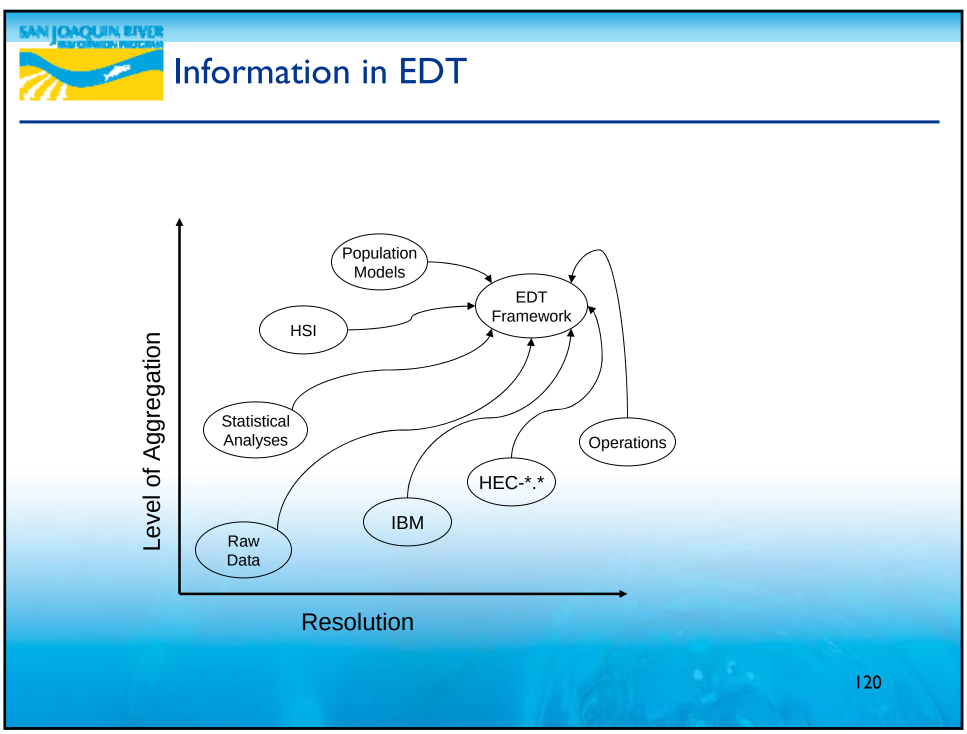
SAN JOAQUIN RIVER
Information in EDT
Population Models
EDT Framework
HSI
Statistical Analyses
Operations
HEC-*.*
IBM
Raw Data
Level of Aggregation
Resolution
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EDT overview

- Rule-based model
- multiple-stage Beverton-Holt production model
- First, life stage performance benchmarks are defined (and adjusted for existing conditions)
- A rules set is created - describes the habitat needs of the species of interest (declining from benchmark performance)
- Life-history trajectories - how environmental conditions are experienced by the fish
- Performance is compared under “template” and “patient” conditions and is the basis of a “diagnosis” of factors limiting the population

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EDT overview

- Provides a process for moving forward with restoration actions, even when faced with uncertainty
- Analytical model- links actions to desired outcomes

“Template”

“Patient”

Provides a basis for conclusions about the limitations of the system (or a particular action)

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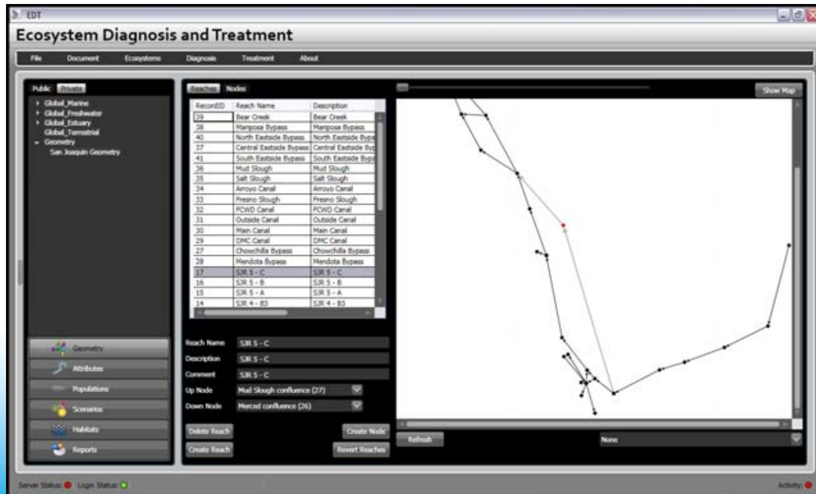
SAN JOAQUIN RIVER

EDT- geometry



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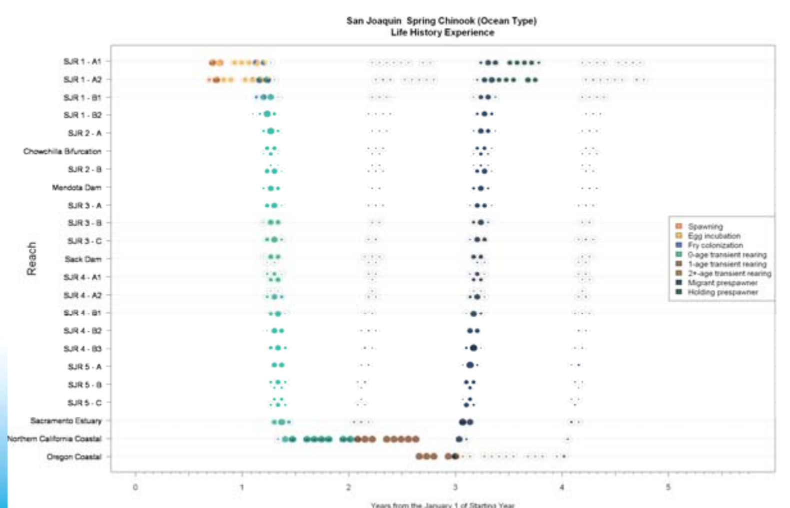
Focal species life-history experience



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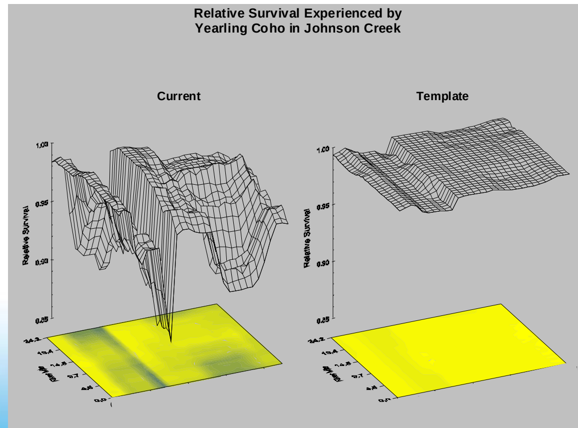
EDT Diagnostic Landscape



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How will FMWG use EDT

Assist with the assessment of restoration alternatives

Identify key uncertainties, data needs, and testable hypotheses

Evaluate & refine our conceptual model

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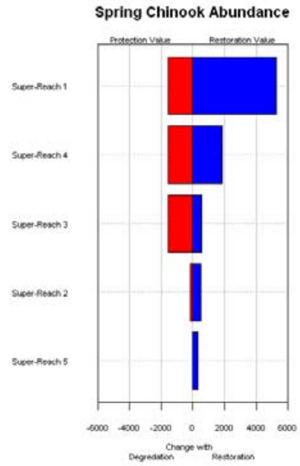
Geographic area report – one strategy for prioritization



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EDT summary

San Joaquin Spring Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Super-Reach 1	◯	◯	•		•				•	•		•	•	●		⬤		●
Super-Reach 2	○	∘							•		•	•	•	●		●		●
Super-Reach 3	◯	○		•					•		•	•	•	●		●		●
Super-Reach 4	◯	○		•					•			•	●	●		⬤		
Super-Reach 5	∘	∘		●								●	●	●		⬤		

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A	◯ / ⬤	High
B	○ / ●	Medium
C	∘ / •	Low
D & E	(blank)	Indirect or General

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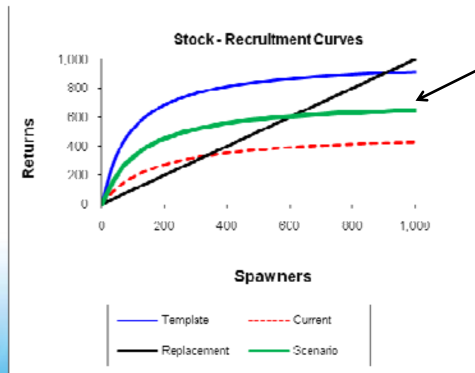
Restoration possibilities



Possible restoration alternative

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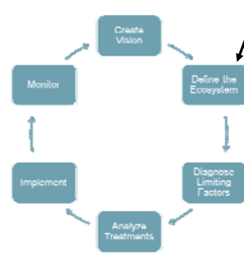
Next steps

- Complete baseline model (current versus template)
- Identify list of alternatives and data necessary to evaluate those alternatives
- Implement
- Monitor

Currently here



Adapt Plans, Goals, & Objectives

Revisit EDT

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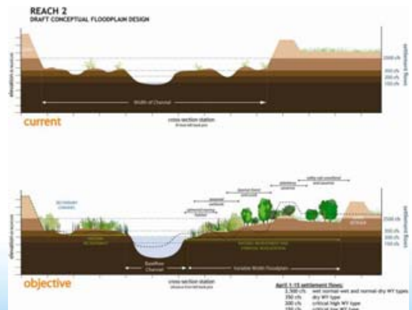
Possible evaluations using EDT

- Spatial extent of floodplain (2B, 4B, 5)
- 4B flows (how much Q in bypass versus channel)
- Compare to our conceptual model- Is one factor really more important than another?



Credit: Stillwater science

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Next Meeting

- January
- Potential Future Meeting Topics
  – Program EIS/R

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