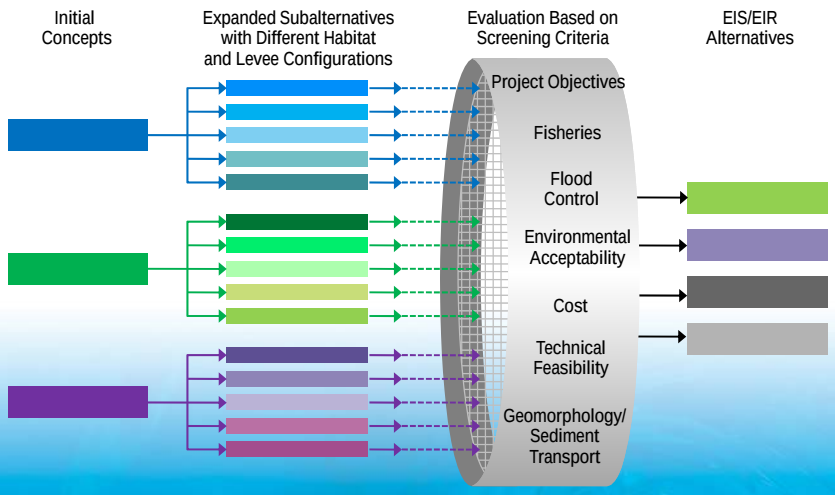
San Joaquin River Restoration Program

Reach 4B, Eastside Bypass, and Mariposa Bypass Channel and Structural Improvements Project

Restoration Goal Technical Feedback Group Meeting
May 17, 2012

Alternative Evaluation



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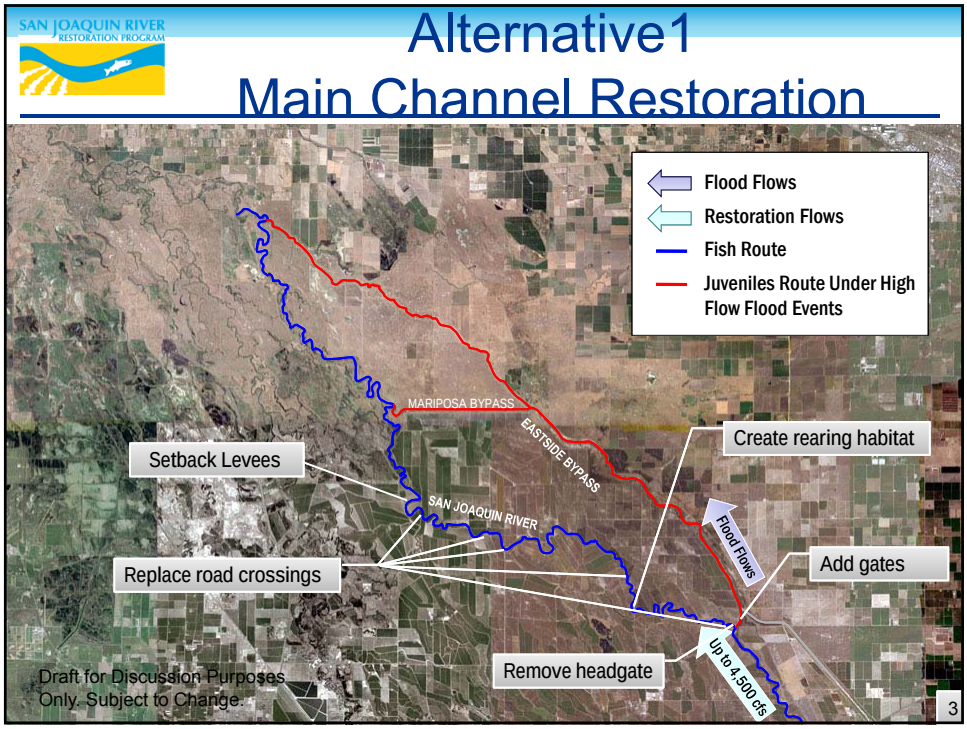
SAN JOAQUIN RIVER RESTORATION PROGRAM
Alternative1
Main Channel Restoration
Flood Flows
Restoration Flows
Fish Route
Juveniles Route Under High Flow Flood Events
MARIPOSA BYPASS
EASTSIDE BYPASS
SAN JOAQUIN RIVER
Setback Levees
Replace road crossings
Create rearing habitat
Flood Flows
Add gates
Remove headgate
Up to 4,500 cfs
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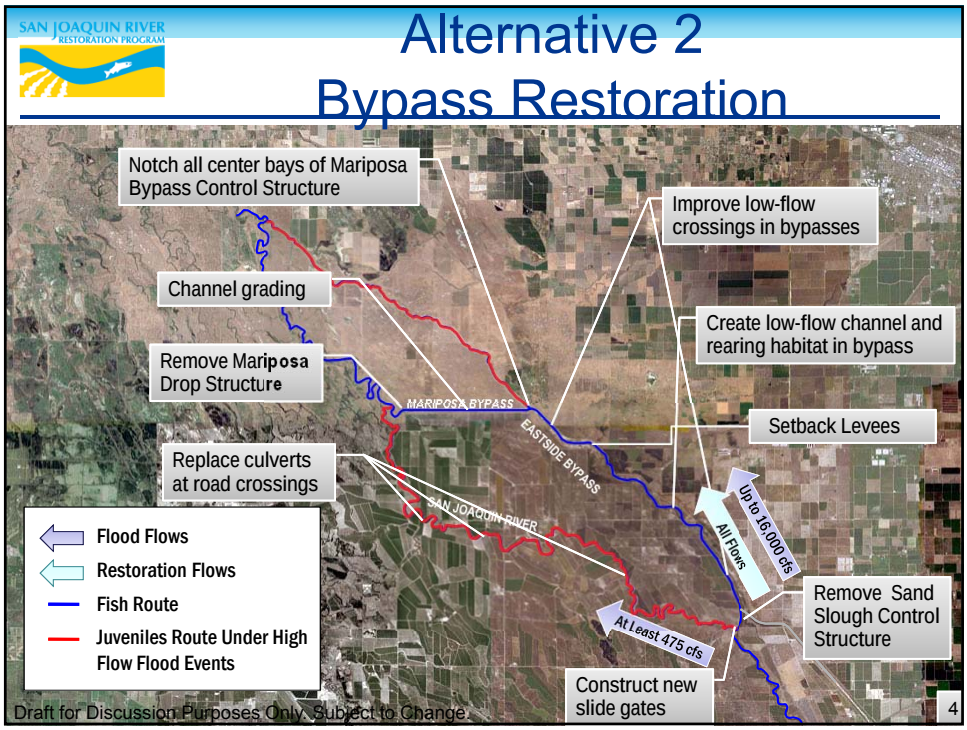
SAN JOAQUIN RIVER RESTORATION PROGRAM
Alternative 2
Bypass Restoration
Notch all center bays of Mariposa Bypass Control Structure
Improve low-flow crossings in bypasses
Channel grading
Create low-flow channel and rearing habitat in bypass
Remove Mariposa Drop Structure
MARIPOSA BYPASS
EASTSIDE BYPASS
Setback Levees
Replace culverts at road crossings
SAN JOAQUIN RIVER
Up to 16,000 cfs
All Flows
Flood Flows
Restoration Flows
Fish Route
Juveniles Route Under High Flow Flood Events
Remove Sand Slough Control Structure
At Least 475 cfs
Construct new slide gates
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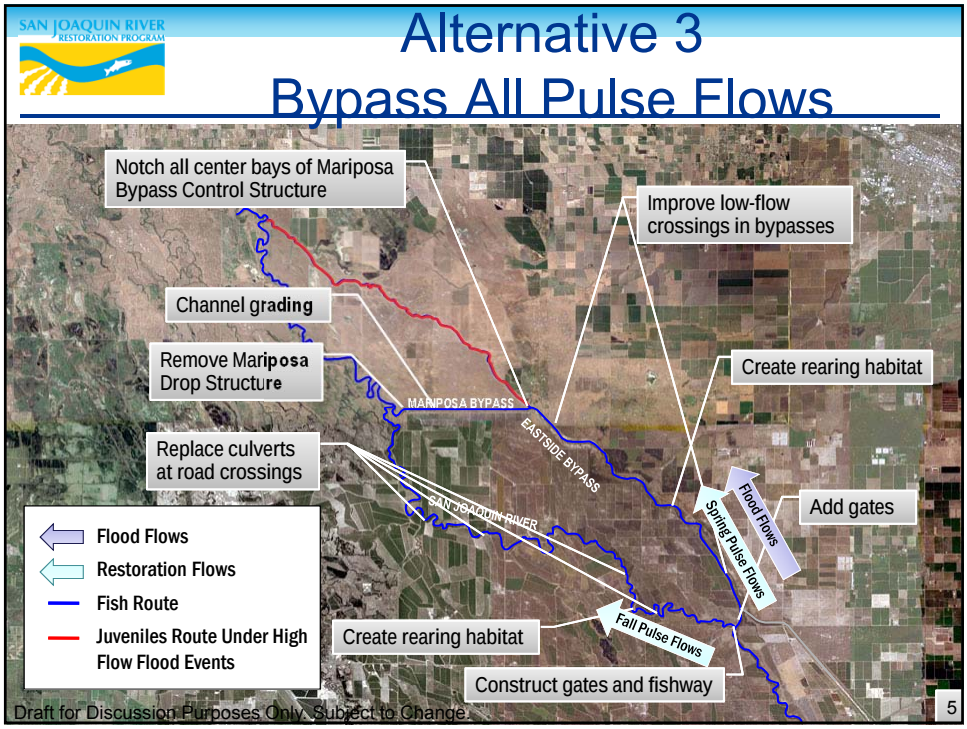
SAN JOAQUIN RIVER RESTORATION PROGRAM
Alternative 3
Bypass All Pulse Flows
Notch all center bays of Mariposa Bypass Control Structure
Improve low-flow crossings in bypasses
Channel grading
Remove Mariposa Drop Structure
Create rearing habitat
MARIPOSA BYPASS
EASTSIDE BYPASS
Replace culverts at road crossings
SAN JOAQUIN RIVER
Flood Flows
Spring Pulse Flows
Add gates
Flood Flows
Restoration Flows
Fish Route
Juveniles Route Under High Flow Flood Events
Create rearing habitat
Fall Pulse Flows
Construct gates and fishway
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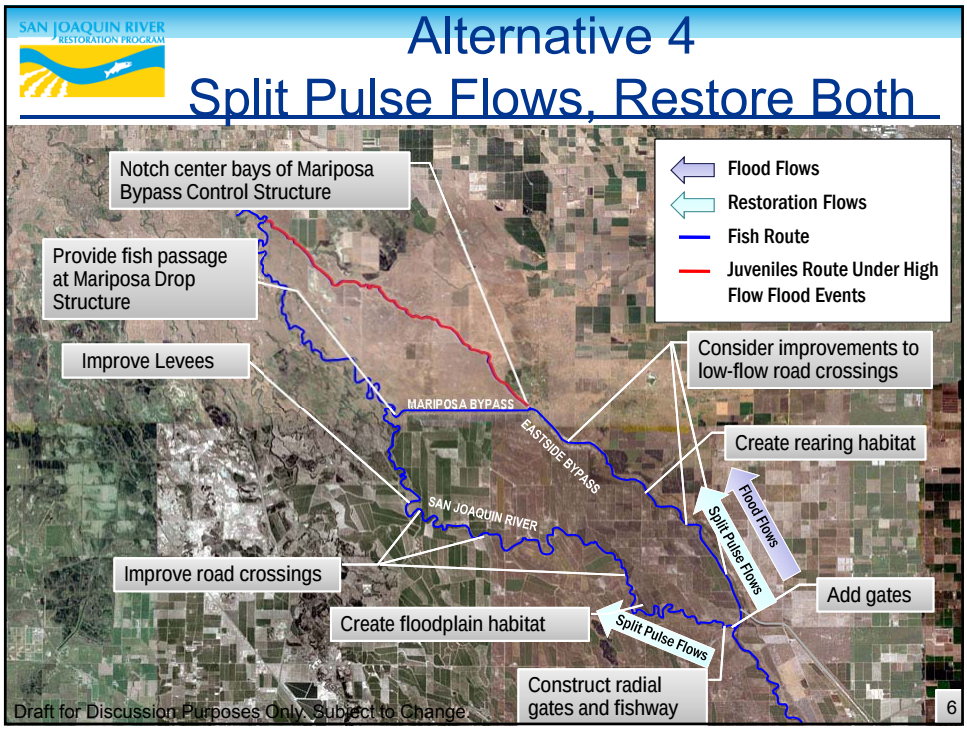
5


SAN JOAQUIN RIVER RESTORATION PROGRAM
Alternative 4
Split Pulse Flows, Restore Both
Notch center bays of Mariposa Bypass Control Structure
Flood Flows
Restoration Flows
Fish Route
Juveniles Route Under High Flow Flood Events
Provide fish passage at Mariposa Drop Structure
Improve Levees
Consider improvements to low-flow road crossings
MARIPOSA BYPASS
EASTSIDE BYPASS
Create rearing habitat
SAN JOAQUIN RIVER
Split Pulse Flows
Flood Flows
Improve road crossings
Add gates
Create floodplain habitat
Split Pulse Flows
Construct radial gates and fishway
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6

SAN JOAQUIN RIVER RESTORATION PROGRAM

Reach 4B Initial Alternatives

Channel/ Structure	Initial Alternative 1 Main Channel Restoration	Initial Alternative 2 Bypass Restoration	Initial Alternative 3 Bypass All Pulse Flows	Initial Alternative 4 Split Pulse Flows and Restore Both
San Joaquin River Flows	Up to 4,500 cfs (all Restoration Flows)	At least 475 cfs of Flood Flows	Restoration Flows of at least 475 cfs	Base and fall pulse flows; some spring pulse flows
Bypass System Flows	Flood flows greater than 4,500 cfs	All flows up to capacity	Flow greater than 475 cfs	Flow greater than Reach 4B capacity
Fish Routing	SJR	Eastside Bypass Reach 2, Mariposa Bypass	SJR, Eastside Bypass Reach 2 and Mariposa Bypass	SJR, Eastside Bypass Reach 2, Mariposa Bypass
Habitat	SJR	Bypass	SJR and Bypass	SJR and Bypass
Reach 4B Headgates	Remove Headgate	Simple Gate	Construct gates and roughened channel fishway	Construct gates and roughened channel fishway
Eastside Bypass Control Structure	No Change	No Change	Fish Passage	No Change
Mariposa Bypass Control Structure	No Change	Notch Center Bays	Notch Center Bays	Notch Center Bays
Mariposa Drop Structure	No Change	Remove Drop Structure	Remove Drop Structure	Fish Passage
Reach 4B1 Levee Alignment Options	B, C, D	A	A	A
Eastside Bypass Levee Alignment Options	None	NE, NW, or Combination	None	None

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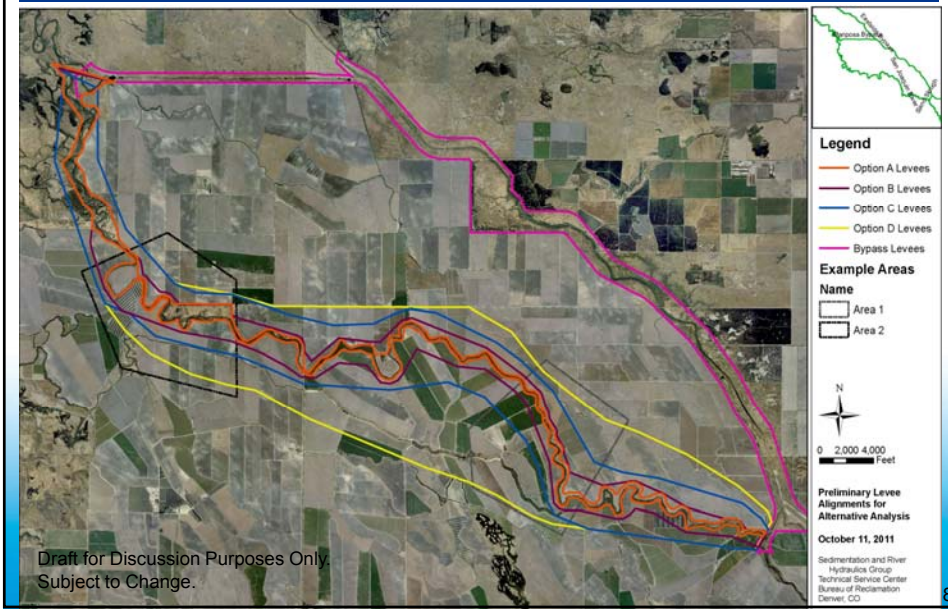
SAN JOAQUIN RIVER RESTORATION PROGRAM

Reach 4B1 Levee Alignments



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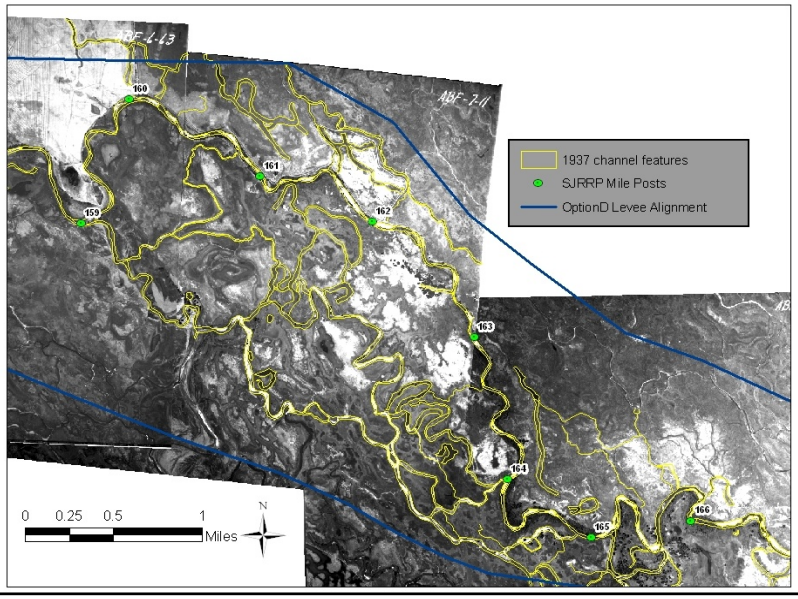
8

Reach 4B1 Historical Morphology



9

Reach 4B1 Alignments

Levee Alignment Options	Initial Alternatives				Levee Length		Capacity	Approx. Width Between Levees
	1	2	3	4	Left Side	Right Side		
Option A		✓	✓	✓	102,000 ft	90,200 ft	1,500 cfs	250-400 ft
Option B	✓				77,800 ft	76,400 ft	4,500 cfs	1,300 to 2,000 ft
Option C	✓				72,800 ft	66,300 ft	4,500 cfs	3,500 to 5,500 ft
Option D	✓				70,200 ft	65,100 ft	4,500 cfs	1-2 miles wide at widest part

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10

Photo Credit: Carson Jeffres

Modeling Floodplain Productivity on The San Joaquin, Reach 4B

Andy Collison & Betty Andrews – ESA PWA
Blair Greimann – Reclamation
Joe Merz – Cramer Fish Sciences

11

Background

San Joaquin River 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 the Friant Division long-term contractors
- Meeting the Restoration Goal requires more than just a restored channel – fish need rearing opportunities along the river as they migrate out

12

Floodplain Inundation Provides Significant Rearing Opportunities

Fish reared in-channel

Fish reared on floodplain

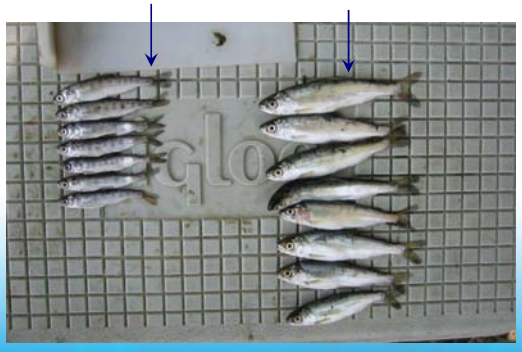
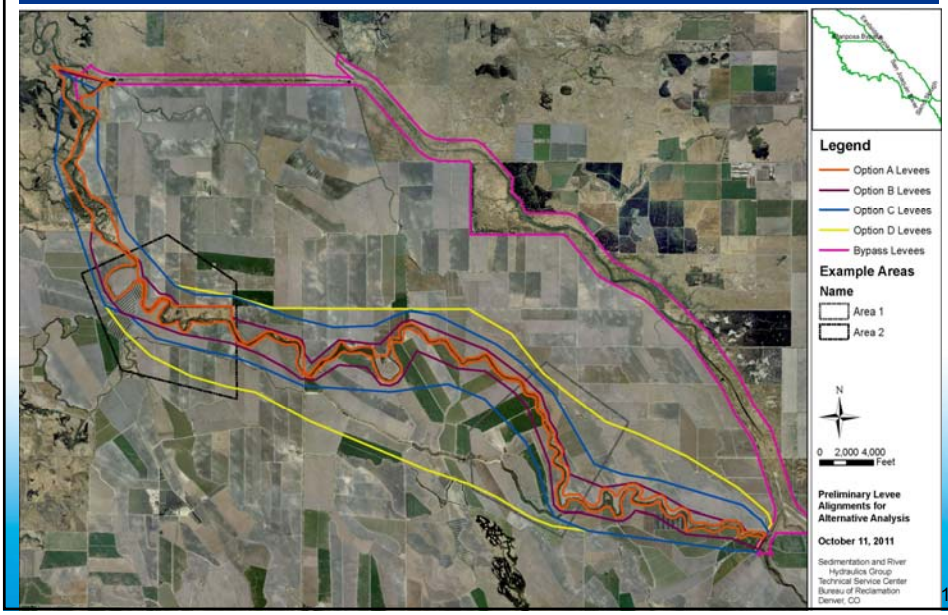


Photo by Jeff Opperman, Cosumnes Preserve

Larger fish have increased chance of survival

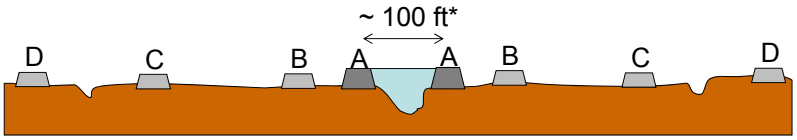
13

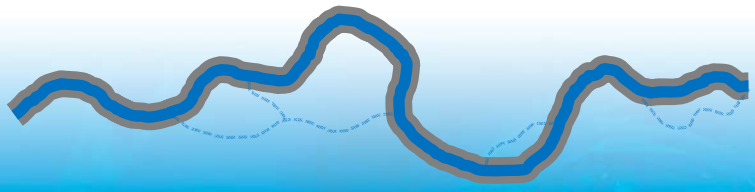
Different Levee Alignments Result in Varying Floodplain Inundation Patterns



14

Levee Alignment A

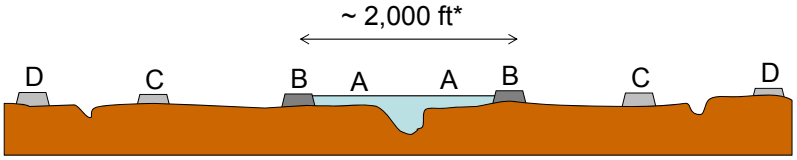


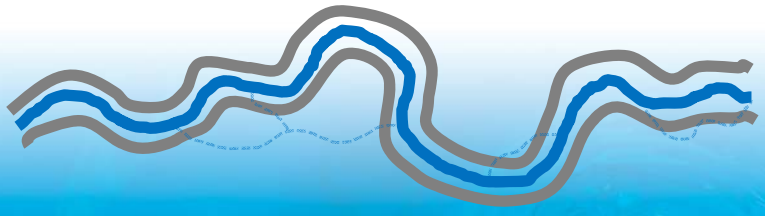


* levee setback distances vary along channel

15

Levee Alignment B

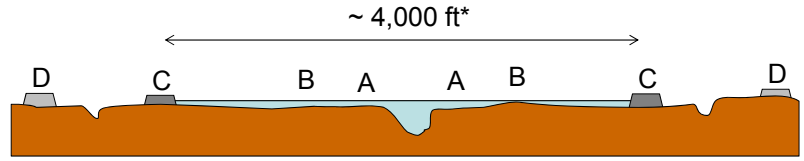




* levee setback distances vary along channel

16

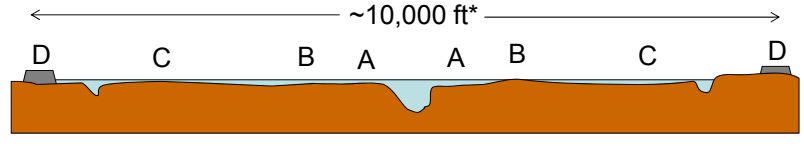
Levee Alignment C

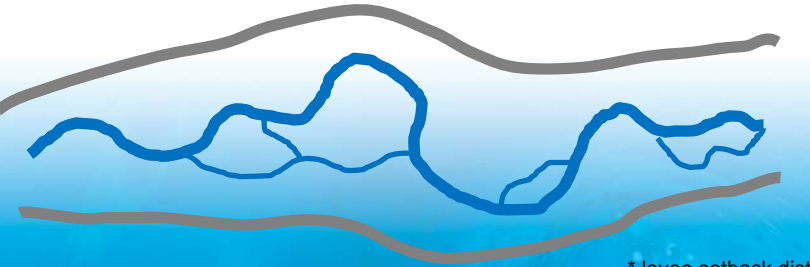


* levee setback distances vary along channel

17

Levee Alignment D





* levee setback distances vary along channel

18

Questions We Need to Answer

Sources: UCSB (above), DWR (below)

- How much floodplain inundation do we need (area, duration, frequency) to support the fish population goals?
- How can we estimate floodplain function to screen initial alternatives and to evaluate final alternatives in more detail?
- Can we make better use of the available water and floodplain to optimize fish survival and productivity?

19

Initial Approach – Modified Habitat Suitability Index Assessment

Velocity **Depth**

20

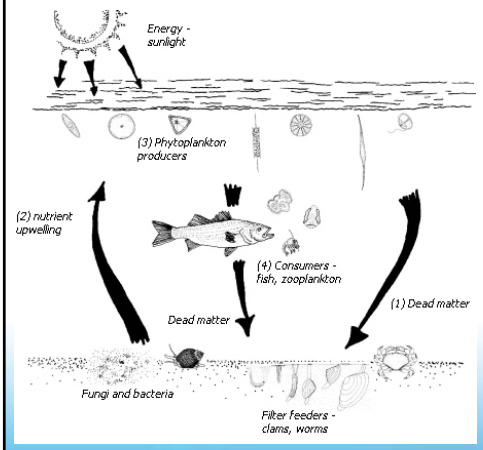
Limitations with Modified HSI Approach

Sources: UCSB (above), DWR (below)

- Designed primarily for channel not floodplain habitats
- Quantifies value of areas where fish can be physically present, but ignores floodplain contributions to river (e.g. nutrient productivity)
- Doesn't quantify biological productivity or fish population
- We need additional tools to get to this information

21

Alternative – Floodplain Productivity Model

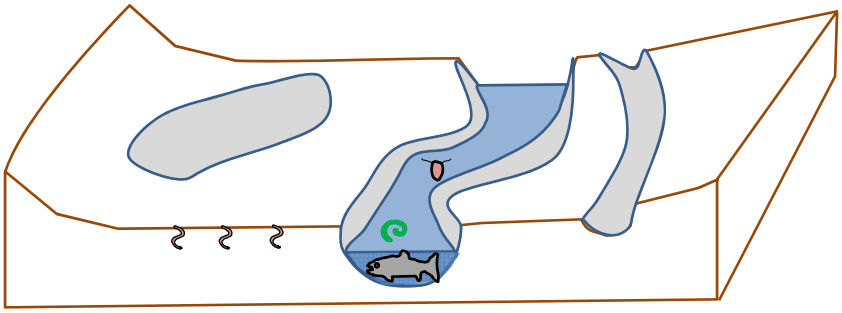


- Simple model of primary floodplain productivity
- Assumes two modes of production:
  - Connected floodplain production
    - Channel and floodplain are connected
  - Disconnected production
    - Floodplain is wetted, disconnected and subsequently reconnected

22

Case 1: Channel Inflow

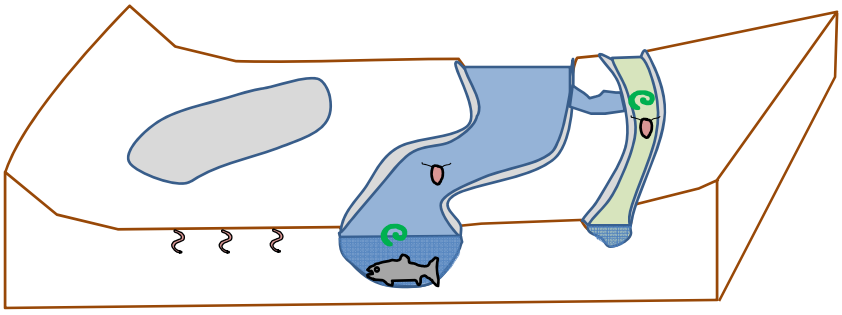
- Exposure to light in the water column is low
- Phytoplankton densities (and those of higher trophic levels: zooplankton, benthic invertebrates, macroinvertebrates) are low



23

Case 2: Channel and Side Channel Inflow

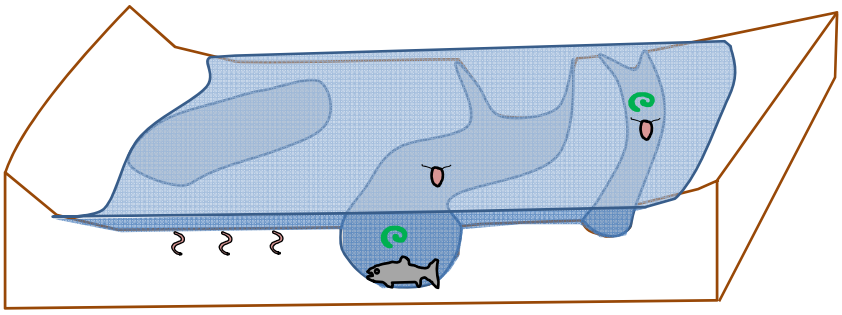
- More of the water column in the side channel is exposed to light
- Velocities are lower in the side channel (higher friction, lower flows), so residence times are higher
- Temperatures increase more quickly in the side channel
- Phytoplankton densities (and those of higher trophic levels) increase more rapidly in the side channel



24

Case 3: Shallow Inundating Floodplain

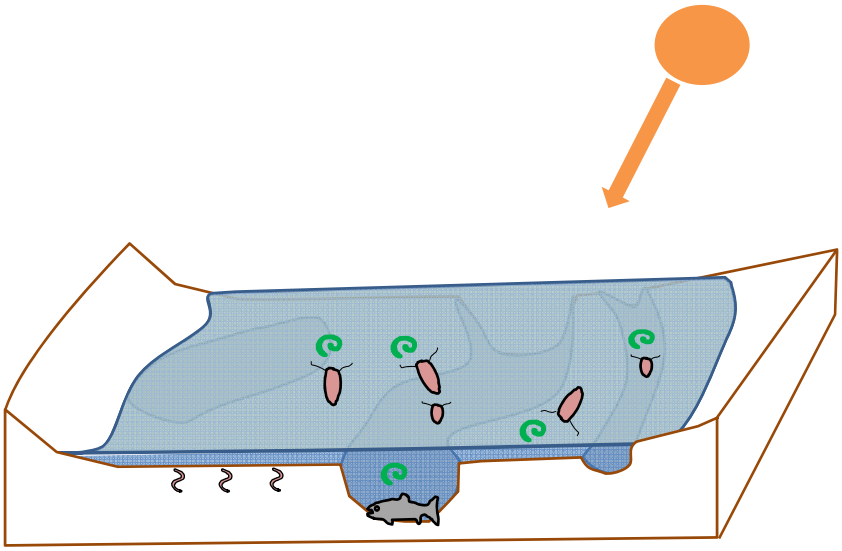
- Velocities are lower on the floodplain (more roughness, more wetted edge), so residence times are higher
- Exposure to light is high on the floodplain, due to shallow flows and the opportunity for sediment to drop out at slower velocities
- Temperature increases more quickly on the floodplain
- Phytoplankton densities (and those of higher trophic levels) increase more rapidly on the floodplain



25

Case 3: Shallow Inundating Floodplain

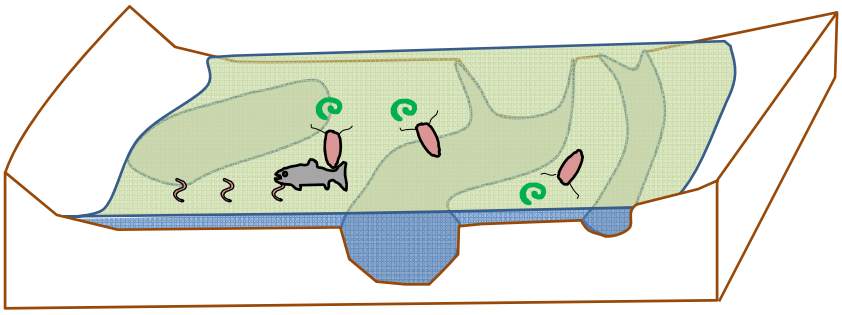
3: Shallow inundating floodplain



26

Case 3: Shallow Inundating Floodplain

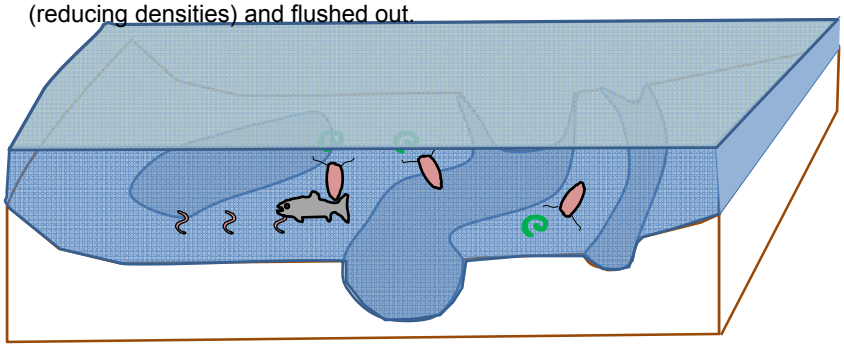
- For Cases 2 or 3, if prior flooding has occurred, residual phytoplankton (and higher trophic levels) on the floodplain or in the side channel will "prime" the productivity pump



27

Case 4: Deep Inundating Floodplain

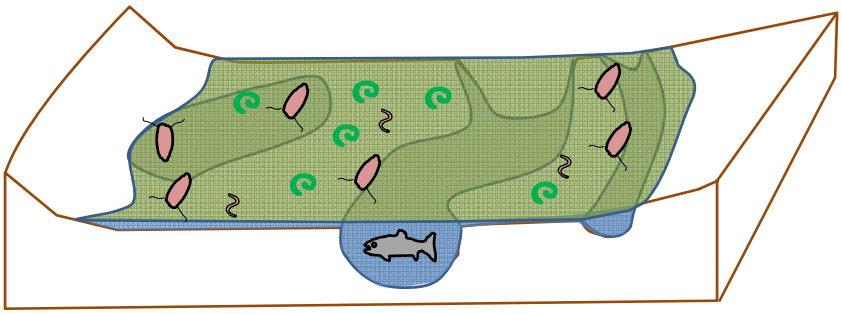
- Differences between the river and floodplain conditions drop: water column exposure to light, temperature, velocities and phytoplankton densities (and those of higher trophic levels) on the floodplain trend toward that of the river as flows deepen
- Degree of difference between the river and floodplain conditions will depend primarily on floodplain flow depth, residence time, and amount of mixing
- For Case 4, if prior flooding has occurred, residual phytoplankton (and higher trophic levels) on the floodplain or in the side channel will be diluted (reducing densities) and flushed out.



28

Case 5: Draining Floodplain

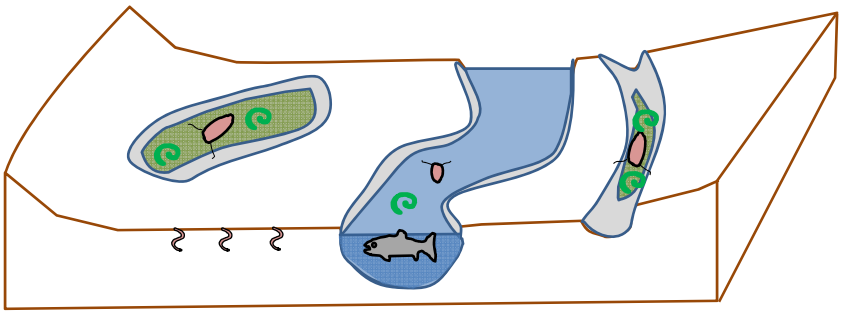
- Water is draining from the floodplain back to the channel, concentrating phytoplankton (and higher trophic levels) on the floodplain and sending an influx of food sources back into the river



29

Case 5: Draining Floodplain
Case 6: Ponded floodplain

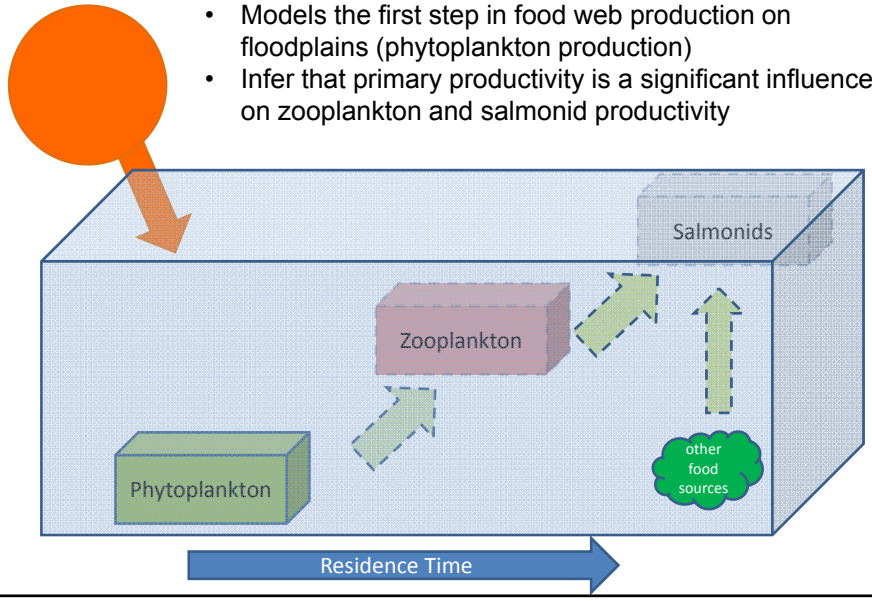
- Water is retained on the floodplain from prior flooding. It is seeping back to the channel, concentrating phytoplankton (and higher trophic levels) on the floodplain.
- With sufficient ponding (disconnection) time, the oxygen demands of biomass on the floodplain lead to eutrophication.



30

A Simple Primary Productivity Model

- Models the first step in food web production on floodplains (phytoplankton production)
- Infer that primary productivity is a significant influence on zooplankton and salmonid productivity



31

Simplified Connected Model

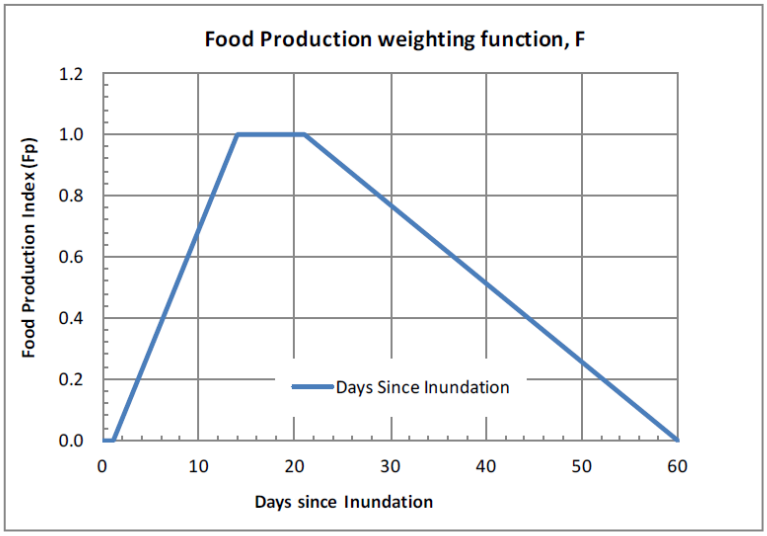


Figure 9-1. Food production index as a function of days since inundation.

32

Simplified Connected Model

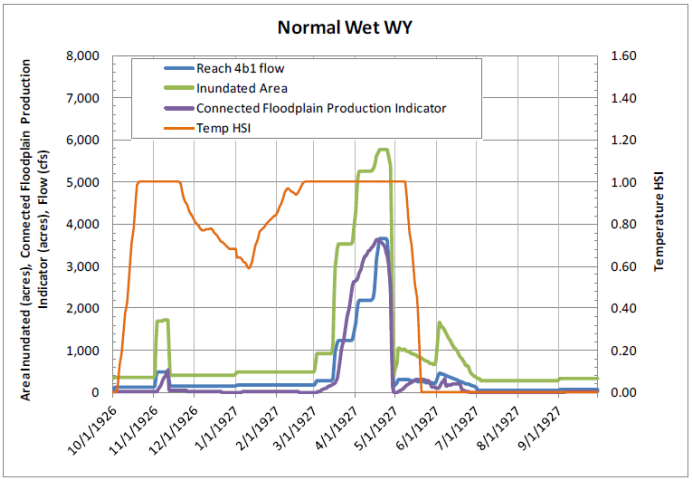


Figure 9-3. Flow, flooded area, connected food production indicator, and temperature HSI for a typical Normal Wet WY for Alternative 1, Levee Option C for Reach 4b1.

33

Simplified Disconnected Model

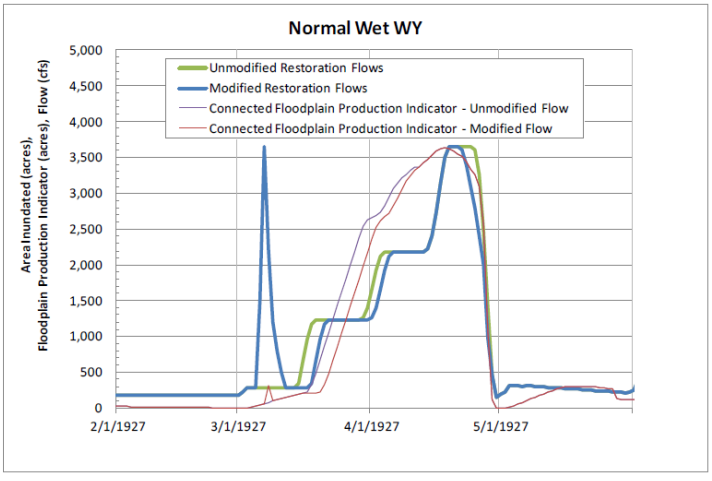


Figure 9-5. Connected food production indicator for a typical Dry WY for Alternative 1, Levee Option C for Reach 4b1, assuming that there is a flow pulse

34

Draft Preliminary Results

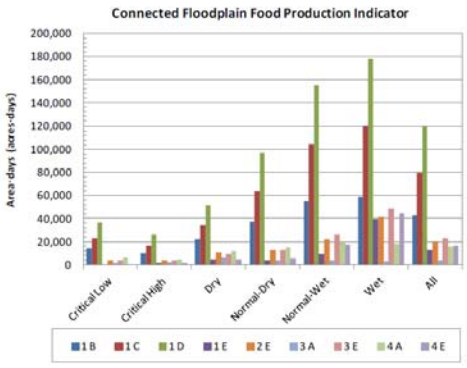


Figure 9-7. Connected Floodplain Food Production Indicator for each Alternative and Levee Option.

- Wider floodplain alignments (B-D) much more productive than 'A' alignment
- Connnected productivity is very dependent on type of water year – big fall off in productivity for dry years

35

Draft Preliminary Results

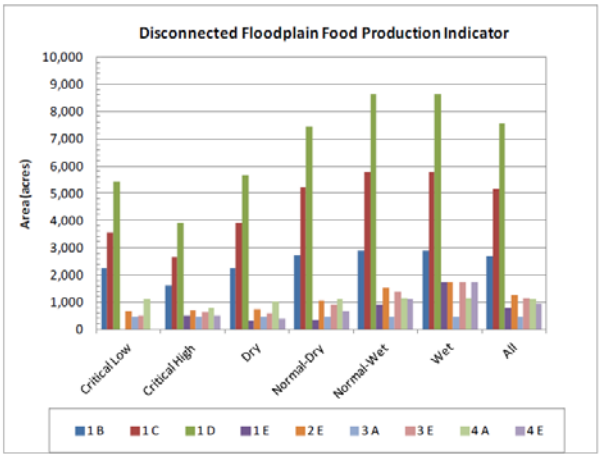


Figure 9-6. Disconnected Floodplain Food Production Indicator for each Alternative and Levee Option.

- Wider floodplain alignments (B-D) much more productive than 'A' alignment
- Disconnnected productivity can be relatively consistent and high even during dryer years for wider sub alternatives

36

Conclusions and Next Steps

- Floodplain productivity model provides a tool for screening and assessing alternatives that better captures floodplain productivity (as opposed to suitability of habitat for fish occupancy)
- Provides a tool for water managers to increase floodplain productivity by timing water pulses – e.g. support more fish with same amount of water
- Could be extended to potentially allow modeling of secondary productivity:
  phytoplankton → zooplankton → fish population
- Potential next steps:
  - Monitor primary and secondary productivity during connected and disconnected flow events to gather input data for model
  - Refine model to reflect secondary productivity

37