River Corridor Design Considerations to Facilitate Salmon Reintroduction to the San Joaquin River

Scott McBain
McBain & Trush, Inc.

2009 NCER Conference
July 21, 2009
Why are floodplain design criteria important to salmon?

- Velocity refugia during high flows
- Providing floodplain rearing habitat at various locations along the 150 mile reach provides opportunities for diverse life history tactics
- Timing, frequency, and duration of inundation for overbank juvenile rearing, which improves growth rates and increases survival to adults (floodplains, high flow scour channels, alcoves)
Floodplain design should consider wide range of objectives

- Regulatory issues
- Policy issues
- Flood conveyance/management
- Ecological considerations
  - Geomorphic stability (vertical scour and lateral migration)
  - Riparian vegetation
- Salmon habitat
- Infrastructure/Cost
The TAC shall advise the RA on “modifications in San Joaquin River channel capacity (incorporating new floodplain and related riparian habitat) to ensure conveyance of up to 4,500 cfs through Reach 4B…”
Reach 4B channel rehabilitation needs
Flood Management Considerations

Existing: many reaches with less than 50-yr protection and project design capacity

Flood Safe Goal: 200-yr protection in urban areas, project design capacity in rural areas
Ecological considerations
Potential hydraulic/geomorphic criteria for floodplain width:

- Patch hole in levee
- Flood conveyance (no floodplains, maximum velocity)
- Flood conveyance (small floodplains, moderate velocity)
- Flood conveyance (moderate floodplains, low floodplain velocity)
- Meander belt (moderate floodplains, allow some lateral channel adjustment)
- Migration zone (larger floodplains, allow lateral channel migration and avulsion)
- Continuous floodplain inundation for duration > X days for nutrient exchange, primary production

SCALE

Triage

Enhancement

Restoration
Potential riparian habitat criteria for floodplain width

- One continuous canopy width (hey, its green!)
- Two continuous canopy width (begin to affect understory microclimate)
- <2.5 acre willow patches (willow flycatcher, yellow warbler)
- <12 acre willow patches (yellow-breasted chat)
- Larger patch site, less edge (reduce cowbird parasitism)
- >100 ft wide, >25 acres (yellow-billed cuckoo)
- Wide enough for oxbow formation (western pond turtle, yellow-billed cuckoo)
Fry and juvenile salmon rearing habitat considerations for Reach 4B

- Floodplain velocities < 1 ft/sec
- Floodplain depths < 1.5 ft
- Rearing Timing: January 1-May 31 (need to get out after that)
- Absolute minimum continuous duration target: greater than 5 days
- Preferred minimum continuous duration target: greater than 18 days
Management Variables (knobs)

- Flow release magnitude, timing, and duration (within Settlement flow volumes and infrastructure constraints)
- Floodplain width (inundation area)
- Floodplain elevation (inundation frequency, duration, area, and timing)
- Floodplain topography (depth and velocity diversity, stranding)
Design tasks/procedures

- Reconstruct future hydrology at design site based on combination of controlled releases, flood control releases, and tributary accretion during juvenile salmon rearing timing (often requires operations and hydrodynamic models)
- Gaming of floodplain width options (planform)
- Gaming of floodplain elevation options (cross section)
- Develop hydraulic model to predict water surface elevation as a function of local streamflow magnitude
- Analyze ecological benefits (thresholds, inundation duration, areas with suitable depths and velocities) with hydraulic model using predicted future hydrology
- Estimate earthworks, costs, logistics, constraints, and policies for design options
- Iterate for different flow releases, floodplain width, and floodplain elevation options
Timing and magnitude of inundation: Settlement hydrographs at Friant (controlled) + flood control and tributary accretion down to Reach 4B

SETTLEMENT RELEASES

ACCRETION AND FLOOD CONTROL RELEASES

PREDICTED FUTURE FLOWS AT REACH 4B
Hypothetical 5-day and 18-day flow duration curve at Reach 4B during fry & juvenile rearing period (January-May)

- Predicted 5-day flow duration at Reach 4B during January-May period
- Predicted 18-day flow duration at Reach 4B during January-May period

Inflections in Flow Duration curves

INUNDATION THRESHOLD OF EXISTING GROUND SURFACE BEHIND LEVEES
Floodplain Width Options
Cross section design iterations

- Hypothetical existing ground surface
- Low flow water surface (300 cfs)
- Design Alternative #1
- Design Alternative #2
- Design Alternative #3

CONSIDERATIONS:
- Ecological scale thresholds
- Inundation frequency & duration
- Mass balance
- Earthworks and cost
- Access
- Land use (agriculture, wetland, riparian)
Considering ecological and flood management benefits with economic and policy costs

Top of ecological benefit inflections, base of cost inflections

- Ecological Benefit Threshold B
- Ecological Benefit Threshold A
- Cost Threshold #2
- Cost Threshold

<table>
<thead>
<tr>
<th>Floodway Width (ft)</th>
<th>Cost for land, fill, easements, etc.</th>
<th>Ecological Benefit Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>200</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>300</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>400</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>500</td>
<td>450</td>
<td>450</td>
</tr>
</tbody>
</table>

- Ecological Benefit Threshold B: 3,500,000
- Ecological Benefit Threshold A: 3,000,000
- Cost Threshold #2: 2,500,000
- Cost Threshold: 2,000,000

Graph showing the relationship between floodway width and ecological and cost benefits.
Summary

♦ Need to coordinate and compile various objectives to quantify and help justify design parameters

♦ Need to integrate various hydrology sources, life-history timing of target species, and habitat scale thresholds into floodplain design widths and elevations to inform managers of ecological needs.

♦ Then need to integrate policy, regulatory, and cost aspects for managers to decide floodplain designs