2D Hydrodynamic Modeling in the Yolo Bypass to Support Habitat Evaluation

Yolo Bypass Fisheries Enhancement Planning Team Meeting
April 11, 2012
Summary

- Key questions
- Recap typical flood conditions
- Habitat type mapping
- Conclusions
- Suggested next steps
Key Questions

• How does the Bypass function under typical flood conditions (i.e., Q2 and Q10)?

• How do characteristics of flooded habitat in the Bypass vary throughout a flood event, and what were they like in years fish are known to have thrived or done poorly?
2D Model Development

• Software
  – MIKE 21FM (DHI, 2011)

• Bypass Topography
  – DWR 2005 LiDAR
  – cbec 2009/2010 Tule Canal and Toe Drain bathy
  – No supplemental changes to guide flow on the landscape were modeled (i.e. existing conditions)

• Roughness
  – USACE 2007 RMA2 values
2D Model Development

• Hydrology
  – Yolo Bypass Management Strategy (JS/ICF, 2001)
  – cbec updated the dataset for 1999 – 2011

• Tidal boundary
  – Liberty Island – Yolo Bypass gage (LIY)

• Model limitations
  – Calibrated for low flows (1,000 – 3,000 cfs)
  – Depths < 2 inches not reported
  – Standing water not lost, affects drain time estimates
CVFPP 2004 / Q2 Preliminary Results

Snapshot from animation after 6 simulated days, pre-wetting before FRE spills

- Observed Flow at FRE = 78,500 cfs peak
- Modeled Flow at LIS = 89,000 cfs peak

Maximum inundation Extents

Modeled discharge extracted at Lisbon Weir

Q2 (2004) Animation
Maximum inundation Extents

- Observed Flow at FRE = 205,000 cfs peak
- Modeled Flow at LIS = 234,000 cfs peak

Modeled discharge extracted at Lisbon Weir

Q10 (2006) Animation
High ground near Putah Creek
Adapted from Table 3. Average flow conditions from December through March for water years 1968 to 1998 (BDCP Effects Analysis: 2D Hydrodynamic Modeling of the Fremont Weir Diversion Structure, cbec 2010).

<table>
<thead>
<tr>
<th>Sacramento River Flow at Verona Sampling Range</th>
<th>Restricted Notch Flow</th>
<th>KLRC</th>
<th>Cache Creek</th>
<th>Willow Slough</th>
<th>Putah Creek</th>
<th>West Side Tribs Only</th>
<th>West Side Tribs Plus Notch Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>(cfs)</td>
<td>(cfs)</td>
<td>(cfs)</td>
<td>(cfs)</td>
<td>(cfs)</td>
<td>(cfs)</td>
<td>Figure ID</td>
<td>(cfs)</td>
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<td>23100</td>
<td>28600</td>
<td>0</td>
<td>364</td>
<td>473</td>
<td>134</td>
<td>1E</td>
<td>1125</td>
</tr>
<tr>
<td>28600</td>
<td>32550</td>
<td>1000</td>
<td>735</td>
<td>965</td>
<td>179</td>
<td>2E</td>
<td>2170</td>
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<td>32550</td>
<td>35300</td>
<td>2000</td>
<td>971</td>
<td>1079</td>
<td>213</td>
<td>3E</td>
<td>2647</td>
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<tr>
<td>35300</td>
<td>37500</td>
<td>3000</td>
<td>1047</td>
<td>1344</td>
<td>243</td>
<td>4E</td>
<td>3073</td>
</tr>
<tr>
<td>37500</td>
<td>39200</td>
<td>4000</td>
<td>998</td>
<td>1235</td>
<td>329</td>
<td>5E</td>
<td>2976</td>
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<tr>
<td>39200</td>
<td>40750</td>
<td>5000</td>
<td>1359</td>
<td>2227</td>
<td>353</td>
<td>6E</td>
<td>4343</td>
</tr>
<tr>
<td>40750</td>
<td>42150</td>
<td>6000 (A)</td>
<td>1654</td>
<td>1891</td>
<td>218</td>
<td>7E</td>
<td>4037</td>
</tr>
<tr>
<td>54000</td>
<td>56000</td>
<td>6000 (B)</td>
<td>1911</td>
<td>3190</td>
<td>428</td>
<td>8E</td>
<td>6289</td>
</tr>
</tbody>
</table>

DRAFT – FOR DISCUSSION ONLY
BDCP Effects Analysis Modeling Re-Cap

Notch Flow (cfs) | Existing Legend | Existing Flow (cfs) | Proposed Legend | Proposed Flow (cfs)
---|---|---|---|---
0 | 1E | 1125 | 1E | 1125
1000 | 2E | 2170 | 2P | 3170
2000 | 3E | 2647 | 3P | 4647
3000 | 4E | 3073 | 4P | 6073
4000 | 5E | 2976 | 5P | 6976
5000 | 6E | 4343 | 6P | 9343
6000 (A) | 7E | 4037 | 7P | 10037
6000 (B) | 8E | 6289 | 8P | 12289
# Habitat Types Analysis

<table>
<thead>
<tr>
<th>Bin (animation code/color)</th>
<th>Current Speed (ft/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depth (ft)</strong></td>
<td></td>
</tr>
<tr>
<td>0.16a - 0.82 Very Shallow</td>
<td>Very Shallow/Slow (1)</td>
</tr>
<tr>
<td>0.82 - 6.6 Shallow</td>
<td>Shallow/Slow (2)</td>
</tr>
<tr>
<td>6.6 - 20 Deep</td>
<td>Deep/Slow (3)</td>
</tr>
<tr>
<td>1.96 - 3.28 Moderately Slow</td>
<td>All Depths/Slow/Moderately Slow (4)b</td>
</tr>
<tr>
<td>3.28 - 8.2 Fast</td>
<td>All Depths/Fast (5)c</td>
</tr>
<tr>
<td>&gt;8.2 Very Fast</td>
<td>All Depths/Very Fast (6)d</td>
</tr>
</tbody>
</table>

- a. Depths below 0.16 feet (5 cm) are below the model wetting threshold, and are thus ignored in this analysis.
- b. Good for fish, no appreciable field erosion potential.
- c. Significant potential to erode earthen berms and fields.
- d. Potential to erode established vegetation or riprap/cobbles.
2006 - Habitat Types Over Time
Habitat Types – “Bad” Year 2001

Modeled Flow at Lisbon

*Note: Fremont Weir did not spill
Habitat Types – “Bad” Year 2002

[Graph showing inundated area in acres from December 15, 2001, to June 13, 2002, with date and time markers and flow rates indicated by different colored lines.]

Flow (cfs) vs. Inundated Area (acres)

- Very Shallow/Slow
- Shallow/Slow
- Deep/Slow
- All Depths/Moderately Slow
- All Depths/Fast
- All Depths/Very Fast
- Observed Flow at FRE
- Modeled Flow at Lisbon

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Habitat Types – Q2 2004

- Very Shallow/Slow
- Shallow/Slow
- Deep/Slow
- All Depths/Moderately Slow
- All Depths/Fast
- All Depths/Very Fast
- Observed Flow at FRE
- Modeled Flow at Lisbon

Date/Time:
- 12/15/2003 0:00
- 1/14/2004 0:00
- 2/13/2004 0:00
- 3/14/2004 0:00
- 4/13/2004 0:00
- 5/13/2004 0:00
- 6/12/2004 0:00

Flow (cfs)

Inundated Area (acres)
Habitat Types – “Good” Year 2000

Inundated Area (acres)

Date/Time

Flow (cfs)

Very Shallow/Slow
Shallow/Slow
Deep/Slow
All Depths/Moderately Slow
All Depths/Fast
All Depths/Very Fast
Observed Flow at FRE
Modeled Flow at LIS

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Habitat Types – Q10 2006

- Very Shallow/Slow
- Shallow/Slow
- Deep/Slow
- All Depths/Moderately Slow
- All Depths/Fast
- All Depths/Very Fast
- Observed Flow at FRE
- Modeled Flow at Lisbon

Date/Time:
- 12/15/2005
- 1/14/2006
- 2/13/2006
- 3/15/2006
- 4/14/2006
- 5/14/2006
- 6/13/2006

Flow (cfs)
- Inundated Area (acres)
Habitat Types – “Good” Year 1998

Date/Time

Inundated Area (acres)

Flow (cfs)

- Very Shallow/Slow
- Shallow/Slow
- Deep/Slow
- All Depths/Moderately Slow
- All Depths/Fast
- All Depths/Very Fast

Observed Flow at FRE
Modeled Flow at Lisbon

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Conclusions

• Dry years dependent on westside tributaries
• Wet year dominated by Fremont Weir spills
• Fairly common high flows inundate a majority of the Yolo Bypass
• Hydraulic residence time ranges from 1 day during flood to 3 days for low flows
• Predominant habitat types are shallow/slow and deep/slow in the eastern Bypass as flows increase up to Q10
Suggested Next Steps

• Improve model detail in KLRC and Putah Creek

• Calibrate the model for Bypass flood flows and drainage conditions

• Update existing floodplain specific habitat criteria based on biological overlays

• Evaluate scenarios to inform CM2
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