October 11, 2018
Update of the applied research project:
Merced River Restoration
in Yosemite Valley

A cooperative agreement between
UC Santa Barbara and the National Park Service:
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Update of the applied research project:
Merced River Restoration in Yosemite Valley

• PROJECT OVERVIEW
  – Project scope and scope phases
  – Study area and project reach

• PROJECT ACTIVITIES
  – Findings
  – Restoration work to date
  – Implications for restoration
Scope of the research project

Three phases:

Phase 1: BACKGROUND AND INITIAL GUIDANCE. Summary of existing data and reports, initial field work, guidance on site-scale riparian restoration projects, stakeholder meetings.

Phase 2: REACH- AND WATERSHED-SCALE DATA COLLECTION AND ANALYSIS. Complete field mapping and modeling; implement updates to 2D modeling (as needed); cooperative development of criteria for success/failure of mitigation techniques; stakeholder meetings.

Phase 3: ALTERNATIVE MEASURES FOR SUGAR PINE BRIDGE. Project designs and alternatives in the Sugar Pine Bridge reach to arrest channel widening, narrow channel, restore riparian zone vegetation, & restore in-channel complexity; evaluation of alternatives; 50% project design of preferred design option; stakeholder meeting.
Study Area and Project Reach
1. Study Area
2. Project Reach (Phase 3)
FINDINGS

Floodplain vs. terrace (age? origin?)
10-yr flood, existing topography

Dark blue, 0–1 m depth; light blue, 1–2 m; green, 2–4 m

5-yr flood, 1919 topography

(10-yr Q ≈ 125% of 5-yr Q)

From Minear and Wright 2013
20-yr flood, existing topography

Dark blue, 0–1 m depth; light blue, 1–2 m; green, 2–4 m

10-yr flood, 1919 topography

(20-yr Q ≈ 125% of 10-yr Q)

From Minear and Wright 2013
Above Happy Isles Bridge
RM 3.0 ($D_{50} = 300$ mm)

Above Sugar Pine Bridge
RM 1.9 ($D_{50} = 104$ mm)

Above Housekeeping Camp
RM 1.0 ($D_{50} = 48$ mm)

Below Sentinel Bridge
RM -0.3 ($D_{50} = 13$ mm)

Bed sediment sizes and longitudinal changes
Declining gradient = declining ability to transport sediment
- Limited sediment supply relative to water discharge
- Active deposition of coarsest gravel (i.e., declining *competence*)
- Tendency for channel shifting
- Active transport of finer gravel (i.e., ample *capacity*)
Meander migration modeling

Sentinel Bridge

FINAL POSITION (CONSTRAINED)

FINAL POSITION (UNCONSTRAINED)

Single-bend close-up (next slide)
Meander migration modeling (50-year simulation)

INITIAL POSITION

FINAL POSITION (UNCONSTRAINED)

FINAL POSITION (CONSTRAINED)

Ahwahnee Bridge

FLOW
Meander migration modeling—zones of greatest potential opportunity:

Sentinel Bridge
Geologic mapping (NPS, USGS, UC Santa Barbara, in progress)
Origin and age of terrace surface?
Merced River longitudinal profile and elevations for adjacent surfaces

- Qcti₁—Tioga outwash, older
- Qcti₂—Tioga outwash, younger
- Qf—alluvium (Qf)
- Qtm—Merced River terraces
- *—north bank
- ●—south bank
- ♦—Merced River active channel

Key points:
- Taft toe
- Qfa & Qtm₁
- Eagle Creek fan
- Sentinel Toe
- Confluence with Tenaya Creek
- Moran Toe & HKPG01
- "Medial" moraine
- Confluence with Yosemite Creek
- Confluence with Indian Creek
- Confluence with Bridalveil Creek

Distance upstream from Pohono Bridge (km): 0 to 10

Elevation (m): 1174 to 1222
Terrace ages and the recent history of the Merced River
Terrace ages and the recent history of the Merced River

- Hillslope deposits (i.e., not relevant for river history)
- Terrace-building (river incision?) at 80 & ~400 years
- Less discrete period 600-1700+ yr (valley-wide migration?)
Association of the age and type of vegetation with geologic substrate

<table>
<thead>
<tr>
<th>Geologic Map Unit</th>
<th>Proportion of Reach (Happy Isles to Sentinel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial outwash, up to 5 m (Qotil2)</td>
<td>25</td>
</tr>
<tr>
<td>Glacial outwash, up to 7 m (Qotil1)</td>
<td>20</td>
</tr>
<tr>
<td>Glacial till, reworked (Qtti)</td>
<td>10</td>
</tr>
<tr>
<td>Glacial till, poorly sorted (Qtti)</td>
<td>5</td>
</tr>
<tr>
<td>Merced River Terrace, about 2.5 m (Qtmr3)</td>
<td>40</td>
</tr>
<tr>
<td>Merced River Terrace, about 3.5 m (Qtmr2)</td>
<td>15</td>
</tr>
<tr>
<td>Alluvium, youngest (Qyal)</td>
<td>15</td>
</tr>
<tr>
<td>Alluvium, &lt; 2m (Qoal)</td>
<td>5</td>
</tr>
<tr>
<td>Quat, debris fan/talus slope (Qfa)</td>
<td>5</td>
</tr>
<tr>
<td>Quat, rock avalanche (Qra)</td>
<td>5</td>
</tr>
<tr>
<td>Quat talus (Qt)</td>
<td>5</td>
</tr>
</tbody>
</table>

Quaternary Glacial Units
Quaternary Terraces - Merced River
Geomorphic Map Units

Geologic Map Unit
- Young Vegetation
- Mixed Age Structure
- Mature Vegetation
Findings and implications for river restoration (1)

• The Merced River is largely disconnected from its historical floodplain, a likely consequence of past gravel extraction, desnagging, blasting of El Capitan moraine, and floodplain filling → reconnection where feasible is critical.

• The river has substantially widened, a consequence of riparian degradation from human traffic → reducing physical access and “rebuilding” riparian zone (geomorphic and vegetative) is necessary.

• The river’s sediment load is limited → restoration that depends on sediment deposition will be slow.
Findings and implications for river restoration (2)

• Migration potential varies spatially → trade-offs between infrastructure protection and unimpeded riverine functioning need site-by-site evaluation.

• The riparian zone is broadly degraded, but spatial variability in geology and bank conditions create differing restoration needs and varying probabilities of successful restoration outcomes.

• Although the bridges restrict flow and limit migration potential, the severity of these effects are variable and have less influence on overall riverine processes than other, historical and ongoing, systemic impacts.
Restoration Projects

- Ahwahnee Bridge
- Sugar Pine Bridge

Legend:
- Restoration Treatments
- Buildings
- Trails
- Rivers

Roads:
- Major Roads
- Other Paved Roads
- Unpaved Roads

- 2018 Riprap removal
- 2017 Bank rebuilding
- 2016 Bank rebuilding
- Future riprap removal
- Future bank repair
- 2015 Bank revegetation
Restoration Projects

Treatment area 5.5

- 4.3: 2018 Riprap removal
- 5.4: 2017 Bank rebuilding

Future riprap removal
Future bank repair

Ahwahnee Bridge
Sugar Pine Bridge
Treatment Area 5-5
(before project)
Completed 2016 right-bank riparian restoration project, October 2016
2016 right-bank project, one year later (October 2017)
Treatment Area 5-5

2016 right-bank project, two years later (October 2018)
Treatment Area 5-4
(before project)
Completed 2017 left-bank riparian restoration project, October 2017
Treatment Area 4-3 (before project)
Treatment Area 4-3

2018 left-bank riparian restoration project in progress (October 2018)
With special thanks to
Jim Roche, Greg Stock,
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