Understanding the Sacramento River Valley
Before Levees and Dams

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Introduction

3 Main Topics

- Natural Geomorphic Function of the Sacramento River Valley in early 1800s
- Historical and Geomorphic Context of the 1862 Flood
- Integration of Geomorphic Function into the Sacramento River Flood Control Project Design
Topic 1: Natural Geomorphic Function of the Sacramento River Valley in early 1800s

1800 - Natural River System

….but first a brief stop in the mid-Oligocene (30 million years ago)
The Sacramento River Valley is an Inland Sea... 
...30 million years ago (mid-Oligocene)

Sacramento River Valley Timeline

Topic 1: Natural Geomorphic Function of the Sacramento River Valley in early 1800s

1800 - Natural River System

…..now back to the early 1800s
30 million years later, the Sacramento Valley is still an aggrading system.

Sacramento and Feather Rivers are sediment delivery system of modern era.

Sacramento and Feather Rivers lack capacity to convey seasonal floods and regularly overtop.
Sacramento Valley cross-section shows natural river levees and near-bank deposits at higher elevation than adjacent flood basins.

- Preferential sediment deposition next to river (coarser material)
- Fine material deposits in flood basins (fertile agricultural soils)

Source: (National Elevation Dataset)
1800 – Natural River System

1895 surveys show low water elevations in rivers above the basin floor.

Location is 3.5 miles north of Knights Landing in an east – west alignment.

Source: (California Commissioner of Public Works, 1895)
Sacramento River Flood Basins

- 2,131 square miles of flood basins defined by G.K. Gilbert in 1917.
1800 – Natural River System

Reasons for downstream decline in Sacramento River flow capacity include:

- Loss of flow to adjacent flood basins
- Geologic controls
- Decline in slope

Slope = 0.0003

Stony Creek

Source: USACE (1957)
1800 – Natural River System

Conceptual Diagram of Geomorphic Units along the Sacramento River
Meandering River Model

Modified from Miall (1996)

Photo by H.J.A. Berendsen (Columbia River)
The Surficial Expression of Sacramento Valley Sedimentation Processes in 1800 – Rivers and Flood Basins

Note preferential sediment deposition (higher elevation) along rivers and sloughs

Source: NED and Google Earth

water resource specialists
Sloughs are a primary conveyor of flow and sediment from rivers to flood basins.

Larger sloughs were named by early settlers.

Slough = a stagnant swamp or backwater

Source: NED and Google Earth

water resource specialists
Sloughs and lakes are readily seen on the early USGS central valley topo maps.

- Butte Slough
- Gilsizer Slough
- More sloughs and lakes

Source: USGS (1887)
1800 - Natural River System

- Larger and more famous flood basin lakes of the Sacramento Valley

Bush Lake in American Basin

- 1907

Plumas Lake on Feather River

- 1911

Sacramento

Source: USGS (1907)

Star bend

Source: USGS (1911)
Very large floods such as the Great Flood of 1907 turned the Sacramento Valley into an “inland sea”.

Maximum extent of the Great 1907 Flood

USGS estimated 1907 Sacramento River peak flow into Suisun Bay to be 600,000 cfs. (Source: Taylor, 1913)

For comparison, the 1986 estimate was 650,000 cfs. (Source: DWR Bulletin 69-86)
Sacramento River Valley Timeline

Topic 2: Historical and Geomorphic Context of 1862 Flood

1848 Gold Discovered

1849 – 1861 What didn’t early settlers know before the 1862 flood?
Historical Context for Early Settlers Before 1862 Flood – Gold Rush Era

- 1847 San Francisco Population = 500
- 1850 San Francisco Population = 21,000
- 1870 San Francisco Population = 150,000

Port of San Francisco in 1850

Non-Native Population of California:

- 1848: 15,000
- 1854: 300,000

GOLD RUSH!
Historical Context for Early Settlers Before 1862 Flood

The City of Sacramento Waterfront during the Great Flood of 1850
### Historical Context for Early Settlers Before 1862 Flood

**Source:** ‘Floods of the Sacramento and San Joaquin Watersheds’ (Taylor, 1913)

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<th>River</th>
<th>Drainage area above station (square miles)</th>
<th>Maximum flood discharge (cubic feet per second recorded)</th>
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<td>Mississippi above Missouri River</td>
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<th>6.1</th>
<th>2.4</th>
<th>2.3</th>
<th>23.1</th>
</tr>
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</table>

1 Estimated, 1907–1909.
Historical Context for Early Settlers Before 1862 Flood

The response by early settlers was:

- Build levees in hindsight...high enough to protect from the last “big flood”.
- Frontier mentality...protect yourself and let the people downstream worry about protecting themselves.
- Result: Fragmented system of inadequate flood protection that persisted for decades.
The 1862 Flood

- A very large flood that created an “inland sea”

- Unprecedented, but most settlers here only 10 – 15 years.

- Historical accounts from 1805 describe a previous very large “inland sea” flood.

- Subsequent “inland sea” floods in 1879, 1907, and beyond demonstrate that 1862 was not a one-time occurrence.
Hydraulic Mining

- Ongoing from 1853 to 1884
- Mining debris worsened 1862 flooding by choking rivers with sediment.
- Total impact: 1.3 billion cubic yards entered Sacramento River system from 1853 to early 1900s.
- Today, major rivers and sediment loads have adjusted to pre-mining levels, for the most part.
Sacramento River Valley Timeline

Topic 3: Integration of Geomorphic Function into the Sacramento River Flood Control Project design

- 1800: Natural River System
- 1848: Gold Discovered
- 1850: California Statehood
- 1884: Sawyer Decision
- 1917: Flood Control Act (Jackson Plan)
Integration of Geomorphic Function into the Sacramento River Flood Control Project Design

- The modern day levee and bypass system routes flood flows through the historic flood basins.
- System of weirs mimic function of sloughs and crevasses by routing flows from rivers to flow bypasses.
- Result is that the majority of flood flows are not carried by lower Sacramento River but through flood basin bypasses, just as in the early 1800s.
Summary

➔ Before levees and dams, seasonal floods on the Sacramento River would regularly inundate adjacent flood basins.

➔ Very large floods (such as in 1862) would ‘fill’ the Sacramento Valley.

➔ Early settlers lacked an appreciation of this process, and of the extremes in annual flow variability and flood magnitude found on the Sacramento River system.

➔ The modern flood control system mimics natural geomorphic function by routing seasonal floods through the Sutter and Yolo bypasses.
Natural rivers are not static, they are always moving and evolving.

The Sacramento River is a meandering river system. It has shifted 100s to 1000s of feet over the last 100 years.

This leads to varying types of sedimentary deposits (geomorphic units) that characterize deposits the river leaves behind.
1800 – Natural River System

- Numerous seasonal and perennial lakes and ponds occupy low points in flood basins

Dozens of ponds dot the Colusa flood basin bottom

Source: USGS (1906)
Since then, several thousand vertical feet of deposition has occurred, filling the inland sea.

Source: Norris and Webb (1990)
1800 – Natural River System

The same is true for the Feather River.

Source: (National Elevation Dataset)
The Flood Basins - Great Expanses of Tule Marsh

Source: John Bidwell (1848)
Source: William Hammond Hall (1887)