Utilizing ArcGIS to describe geomorphometric characteristics of hydraulic mines in the Yuba River watershed

Brandon Ertis, Allan James, Carrie Monohan

Outline

- Historical Background & Significance
- Study Area, Airborne LiDAR Overview
- Objectives
- Methods
- Results and Review
- Questions

Acknowledgments

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Utilizing ArcGIS to Characterize Hydraulic Mines

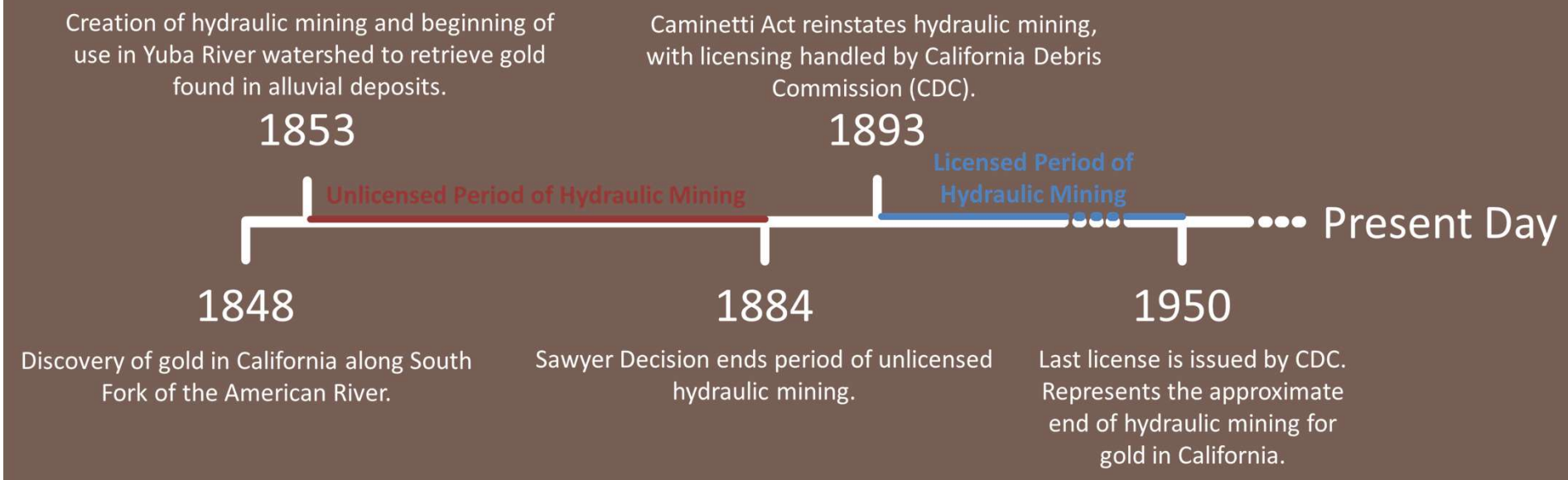
Historical Background

- California Gold Rush
- Hydraulic Mining for alluvial deposits

Photo: Malakoff Diggins
(South Yuba River, circa 1876)

Source: Carleton E. Watkins

Historical Background



References: 3, 6

Why do we care?

- Landscape Alteration and Sediment Production
  - "A million years is a small number on the geologic time scale, while human experience is truly fleeting… Only occasionally do the two time scales coincide. When they do, the effects can be as lasting as they are pronounced… They intersect when mining, of any kind, begins."
  - *John McPhee, Assembling California*

Why do we care?

- Landscape Alteration and Sediment Production
  - About 1.1 billion cubic meters of sediment and debris estimated to be removed during unlicensed mining period[3]
  - Portions of San Pablo Bay (northern Bay Area) lost more than 4 m in depth during this period[5]
  - Some of this sediment still remains in the environment; it is subject to reworking and mobilization and it is probable this will continue through the next millennium[7]

Why do we care?

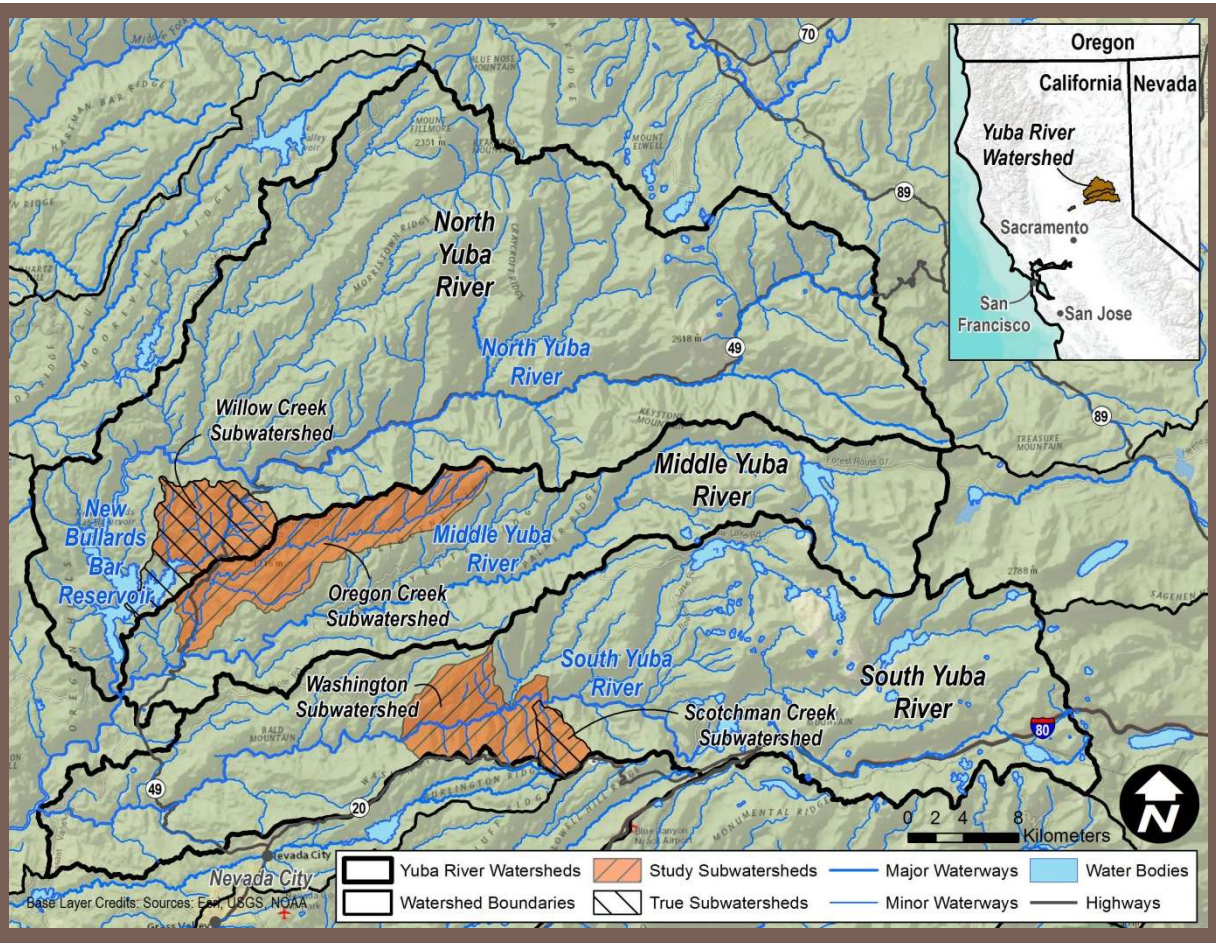
Source: www.periodictable.com

- Mercury was widely used in gold mining.
  - Approximately 11,800,000 kg in total[1]
- Mercury is a powerful neurotoxin.
- It has been documented at old mines, in mountain rivers and reservoirs, and in the Sacramento Valley[2,4,8]
- Mercury can be mobilized by large storm events[2]

Study Area

Yuba River Basin

- Most heavily hydraulically-mined basin in the Sierra Nevada[3]



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Source:
www.aurorasolar.com

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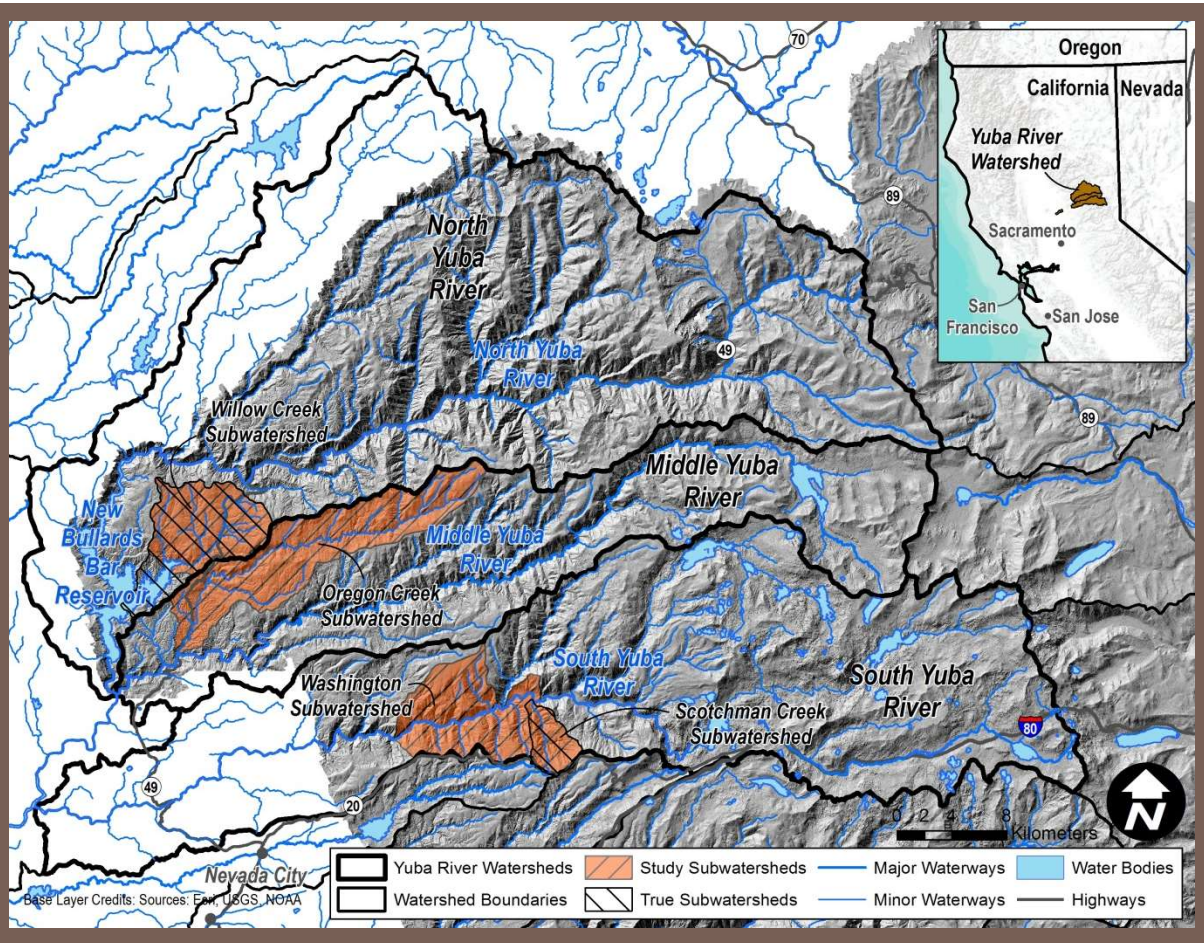

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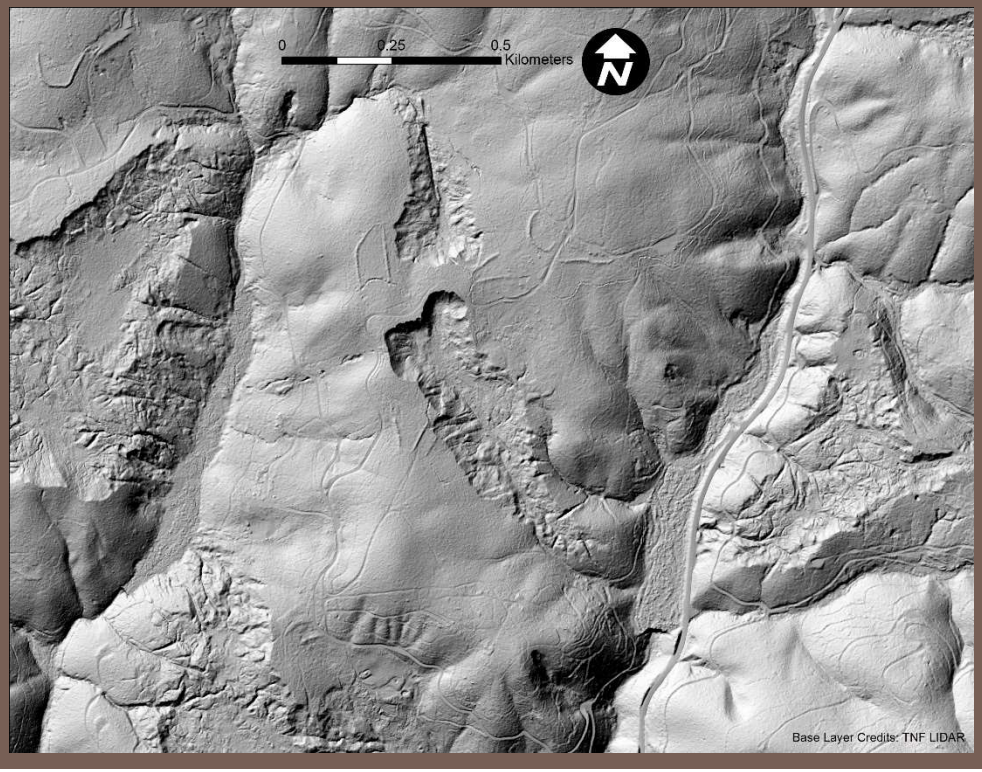
Objectives

1. Identify hydraulic mines
2. Estimate sediment volumes exhumed from hydraulic mine pits
3. Review results

Objectives 1 - Methods

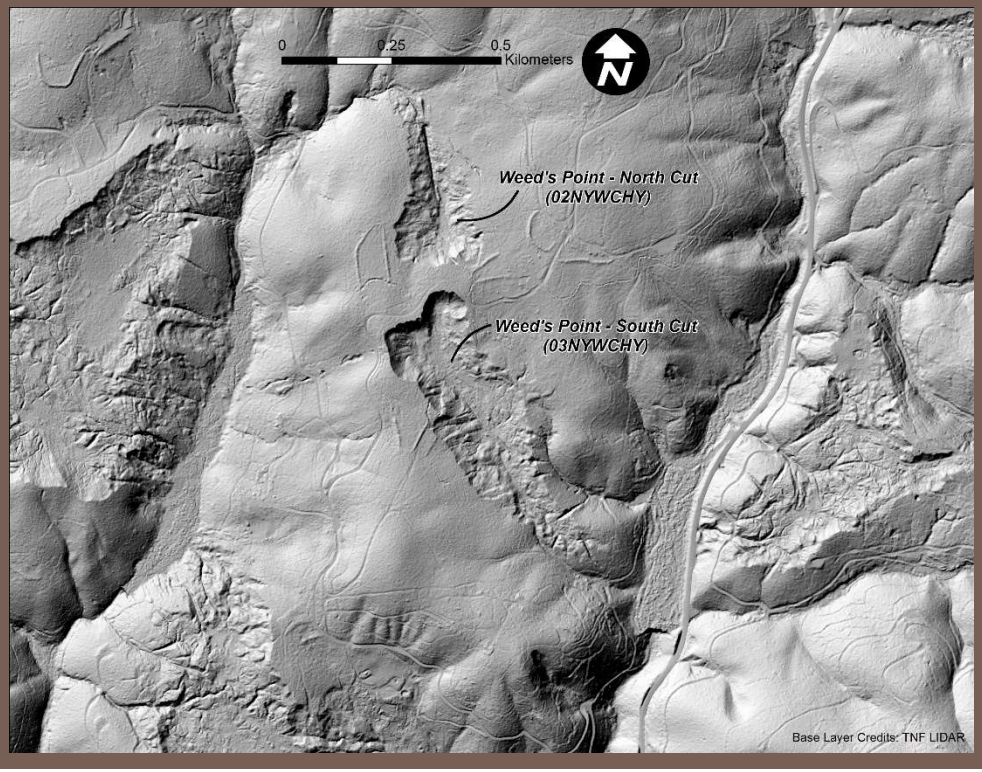
- Reference previous studies and sources:
  - NRCS SSURGO Soils Data, USGS Hydraulic Mining Pits Coverage, USGS Historical Topographic Maps, CDOC TOMS and PAMP Coverage, USFS DCD Locations
- Identify and manually delineate mines using LiDAR dataset

Objective 1- Methods



- Willow Creek Subwatershed
- How many hydraulic mines are pictured here?

Objective 1- Methods



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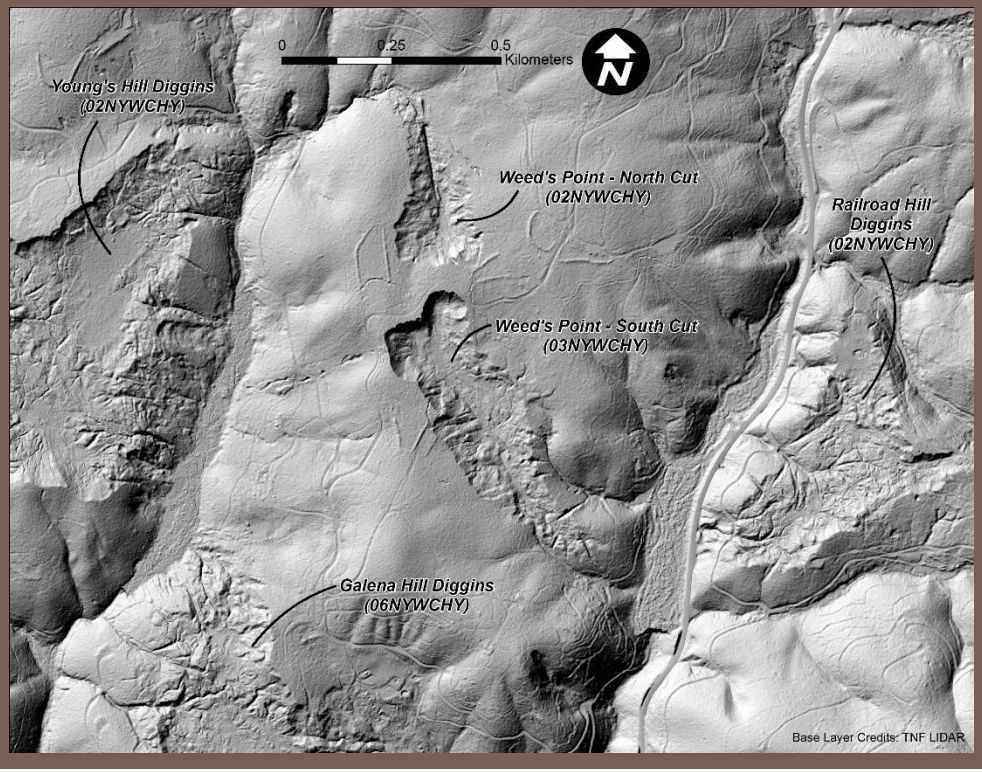
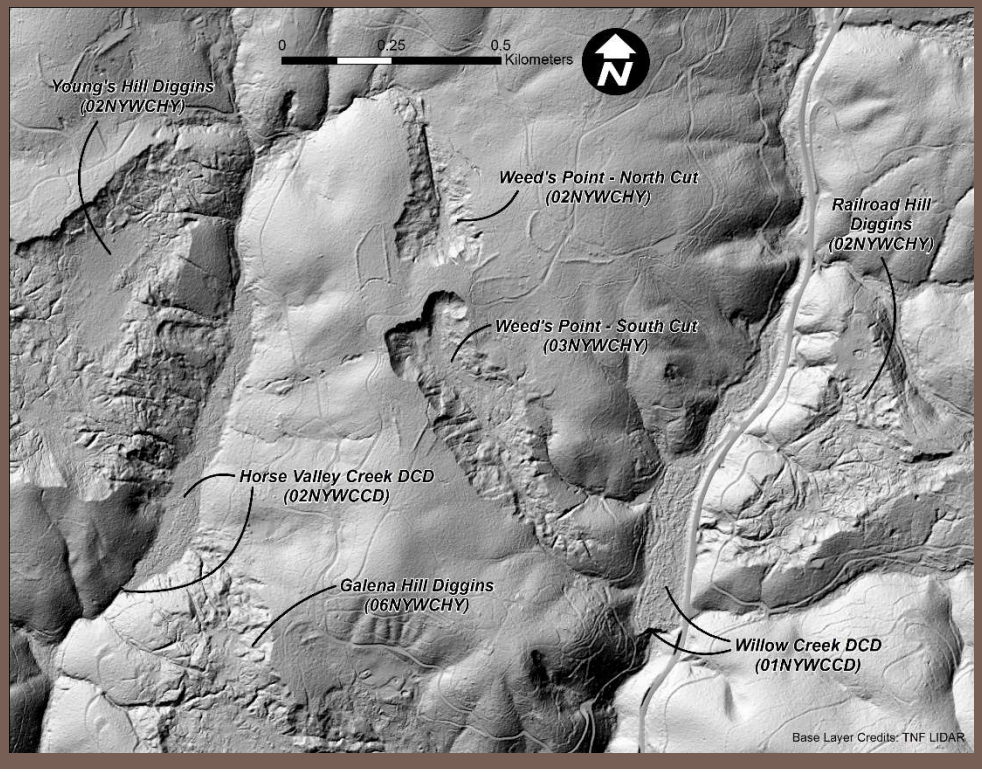
- How many hydraulic mines are pictured here?

Objective 1- Methods



- Willow Creek Subwatershed
- How many hydraulic mines are pictured here?
- <u>Five!</u>

Objective 1- Methods



- Willow Creek Subwatershed
- How many hydraulic mines are pictured here?
- <u>Five!</u>
- + 2 deposits with hydraulic mining sediment

Objective 2

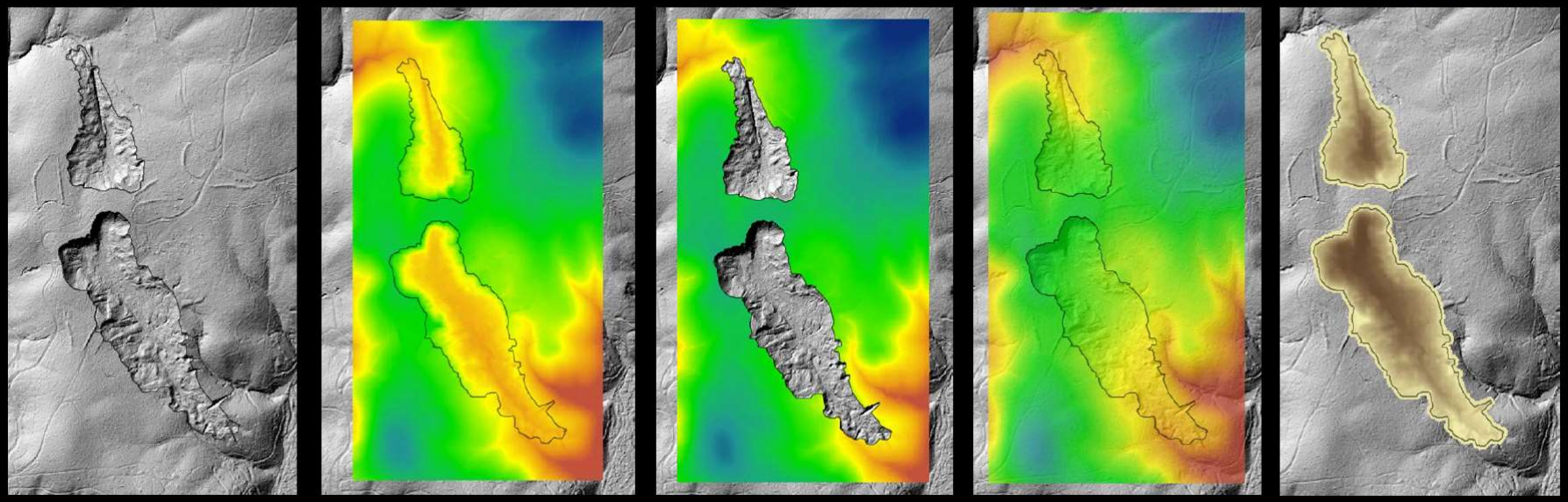
Estimate sediment volumes exhumed from hydraulic mine pits

(Two methods developed. Each requires a variety of geoprocessing tools, including those within the Spatial Analyst toolkit)

Objective 2 – Method #1

HMF Interpolation Technique for Hydraulic Mining Sites Using Surrounding Topography

1. Original | 2. Original DEM | 3. HMF Area Extracted | 4. Interpolation* | 5. Interpolation Minus Original



**Natural Neighbor Interpolation Results Shown in Image 4.*

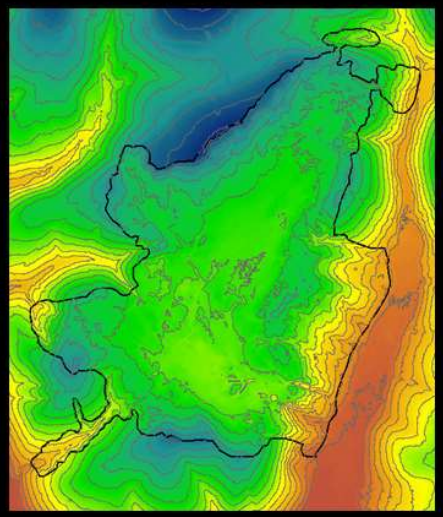
North Cut and South Cut of Weed's Point in Willow Creek Subwatershed Depicted in Images.

Objective 2 – Method #2

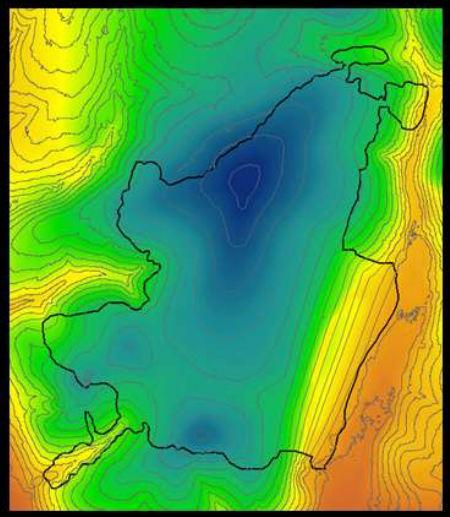
HMF Interpolation Technique for Hydraulic Mining Sites Using Reconstructed Contours

1. Original

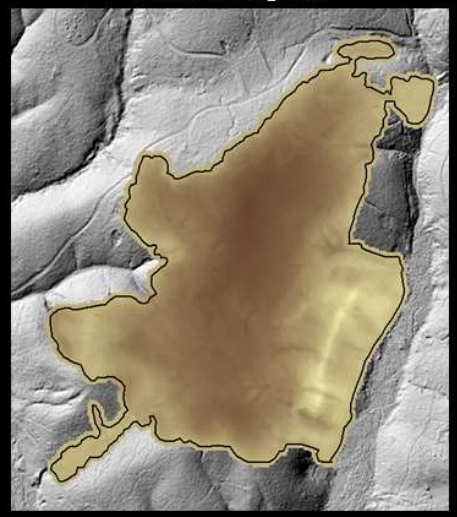
2. Original DEM



3. Reconstructed DEM*



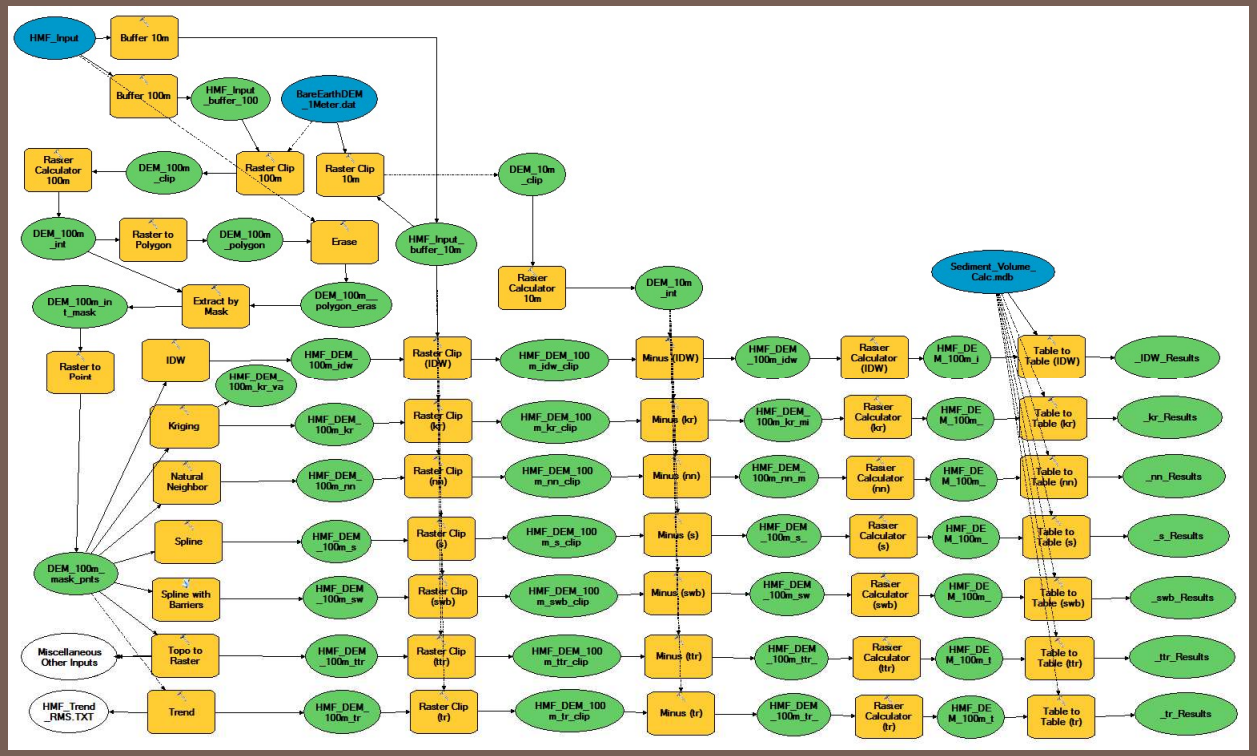
4. Reconstructed Minus Original



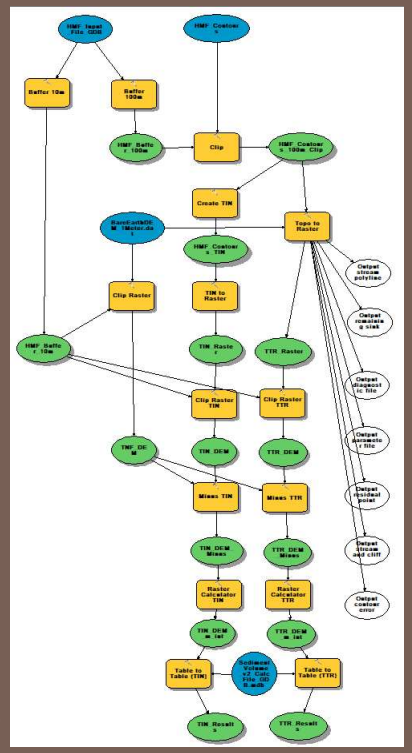
**Topo to Raster Interpolation Results Shown in Image 3.*

Youngs Hill Diggings in Willow Creek Subwatershed Depicted in Images.

Objective 2 – ModelBuilder



Method 1



Method 2

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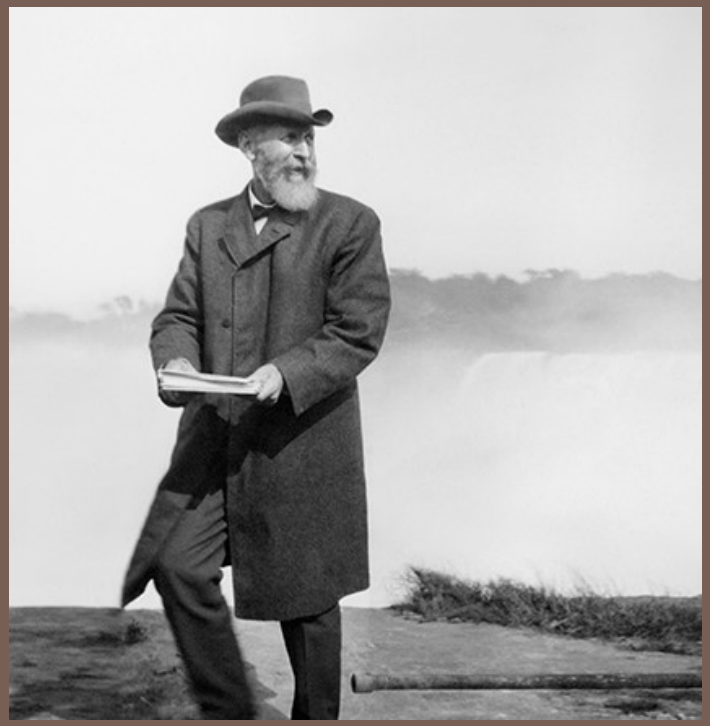
Objective 3 – Review Results



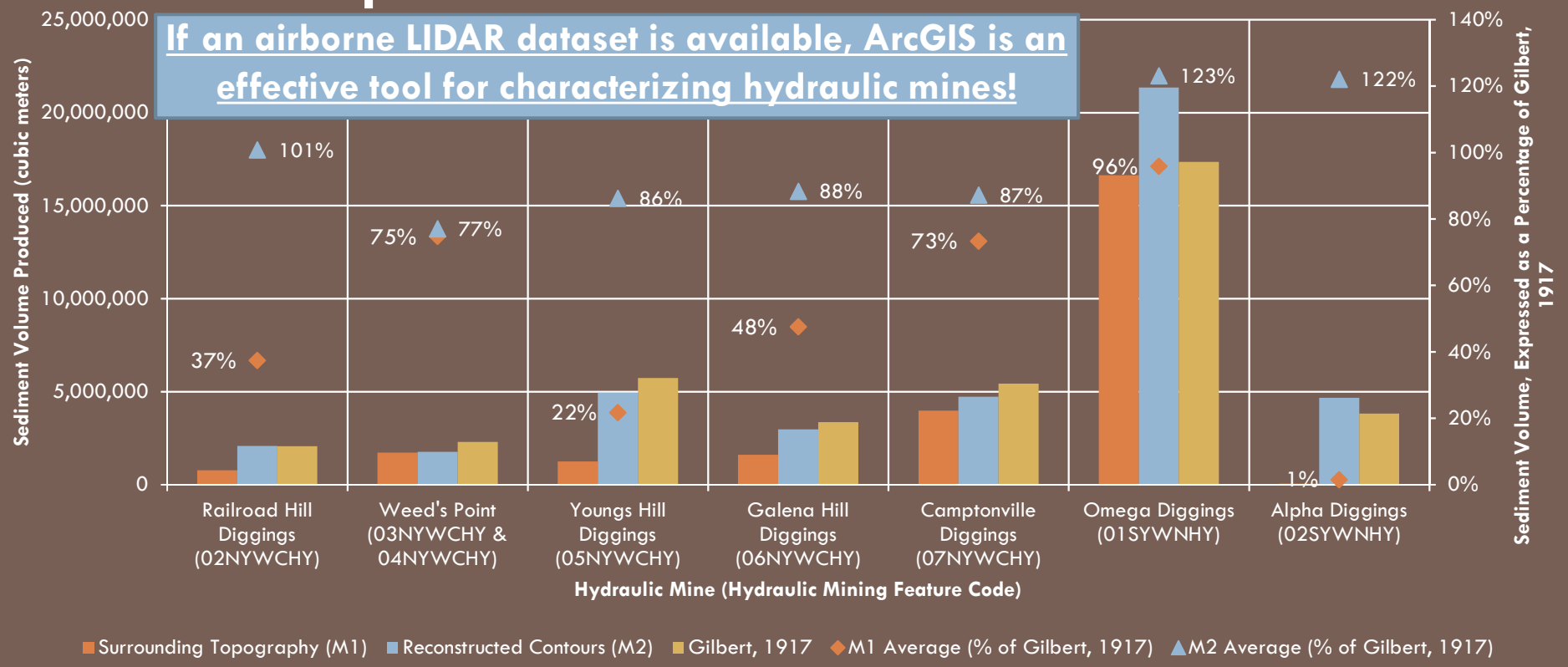
Source: National Geographic

Grove Karl Gilbert (1843-1918)

- Founder of National Geographic Society
- At the end of a long and successful career, studied the Sierra Nevada mountains and effects of hydraulic mining
- His work included estimates of sediment volume produced by hydraulic mines, using methods similar to this study (an excellent point of reference)

"It is the natural and legitimate ambition of a properly constituted geologist to see a glacier, witness an eruption, and feel an earthquake."

Objective 3 – Review Results



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Additional Information

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- Ertis, B.A. '*Using LiDAR, ArcGIS, and on-the-ground data collection to describe geomorphometric characteristics of hydraulic mining features in the Yuba River watershed*' [MS Thesis]: California State University at Chico. URL: http://hdl.handle.net/10211.3/208811. 2018.

Thank You! Questions?

Source: www.malakoffdiggins.org