Detecting and Designing Synchronous Channel and Floodplain Habitats

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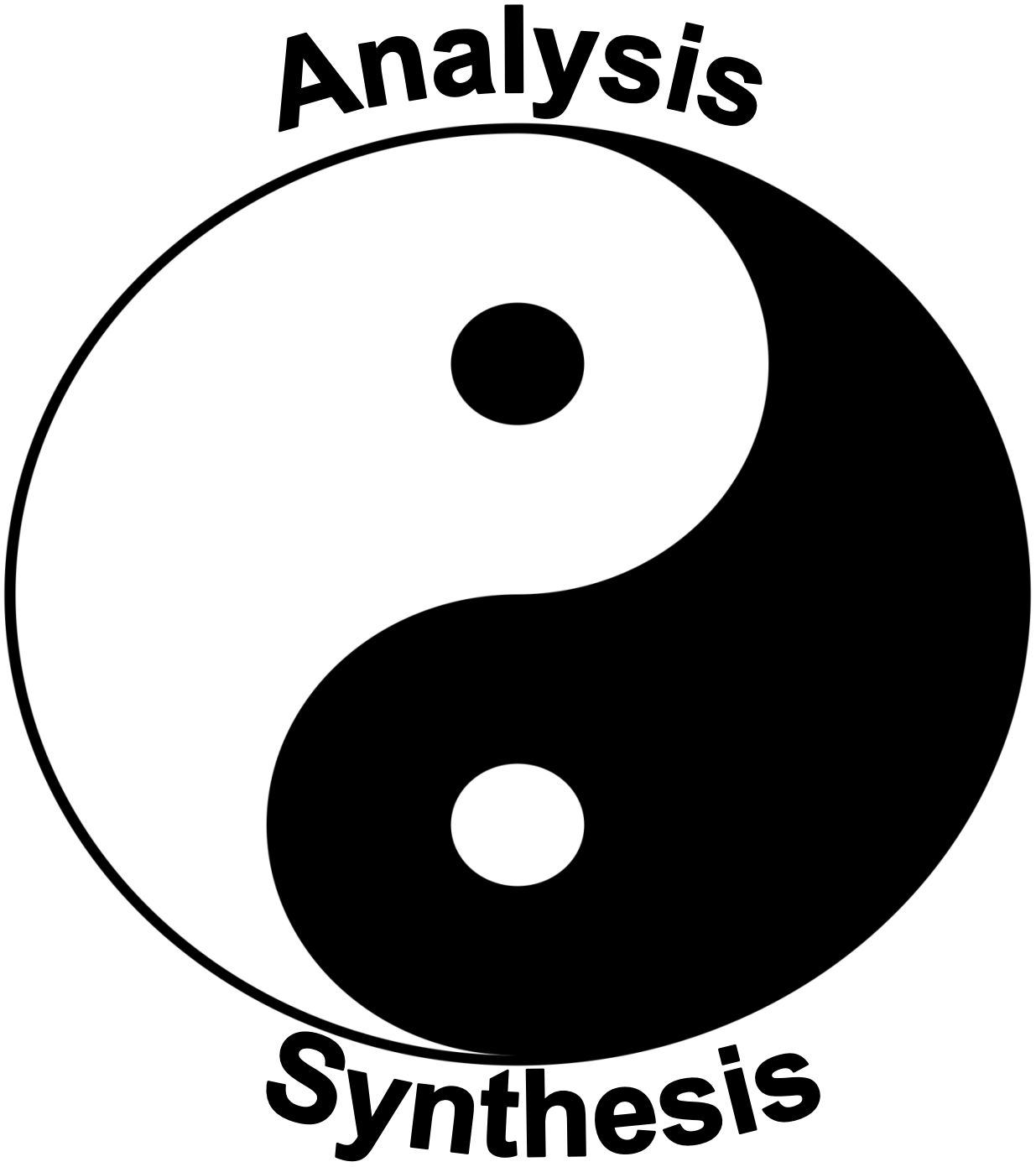
ESA/ UC Davis

ESA

Images: Nat Geo


Analysis
Synthesis

Synchronicity

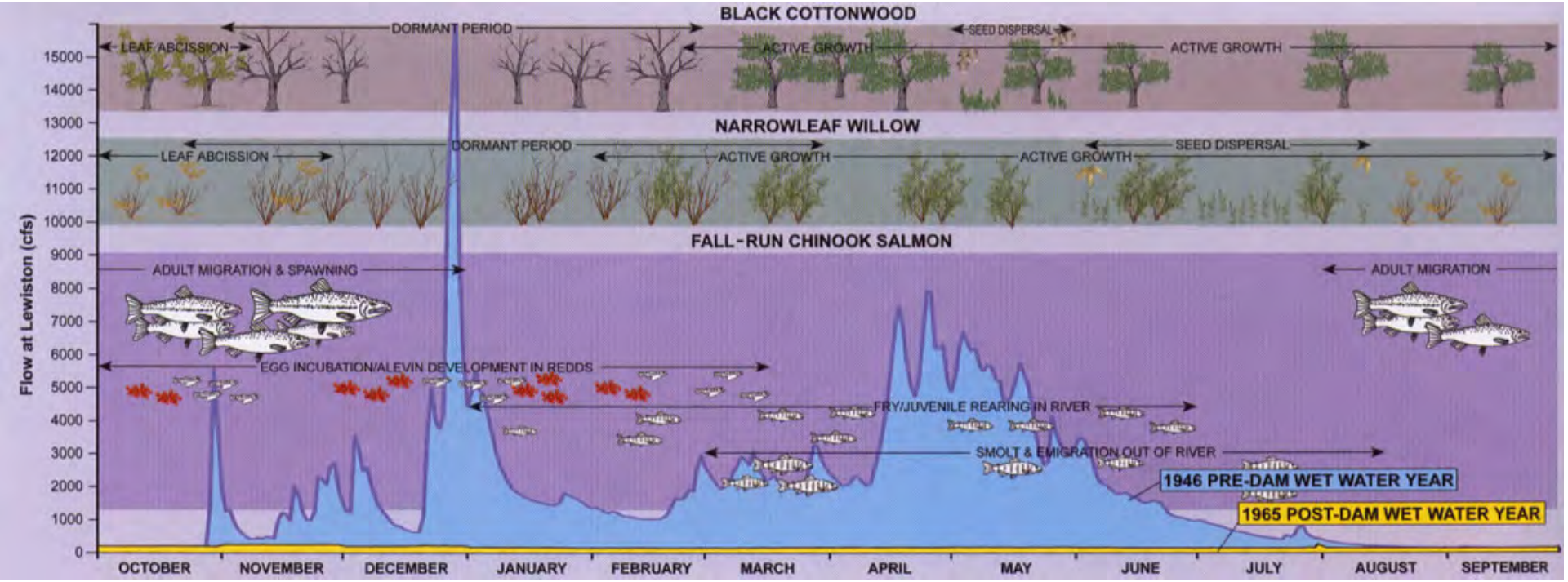
- Defined:

  Synchronous channel-floodplains

  Channel and floodplain are hydrologically, hydraulically, geomorphically and ecologically connected such that key processes are coupled in time (sort of…) and space

Image: TNC.org

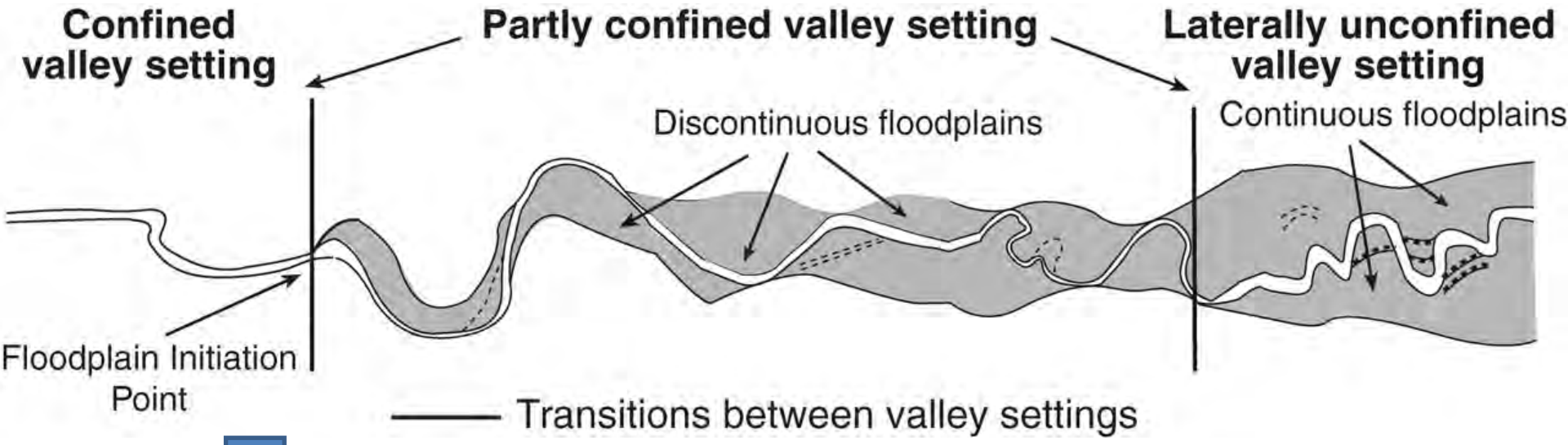
Salmon ecosystems are synchronous



Comparison of pre and post dam hydrology of the Trinity River with life history timing for Black Cottonwood, Narrowleaf Willow, and Fall-Run Chinook Salmon.
Source: TRRP.net

Key aspects of life history are coupled to seasonal changes in discharge

Spatial synchronicity



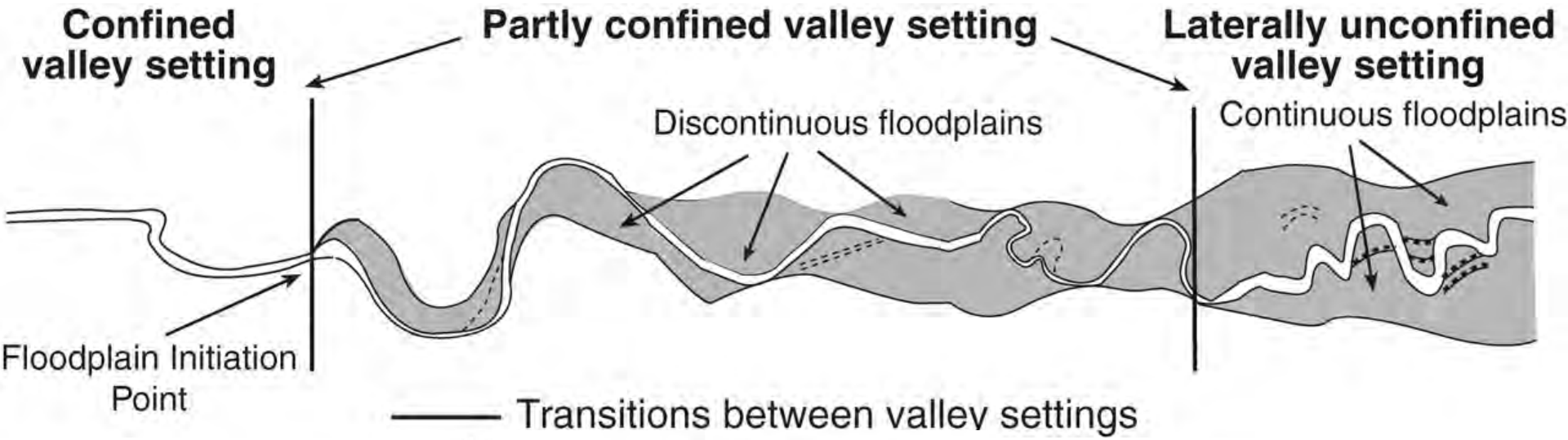
Flashy hydrology
Sediment production

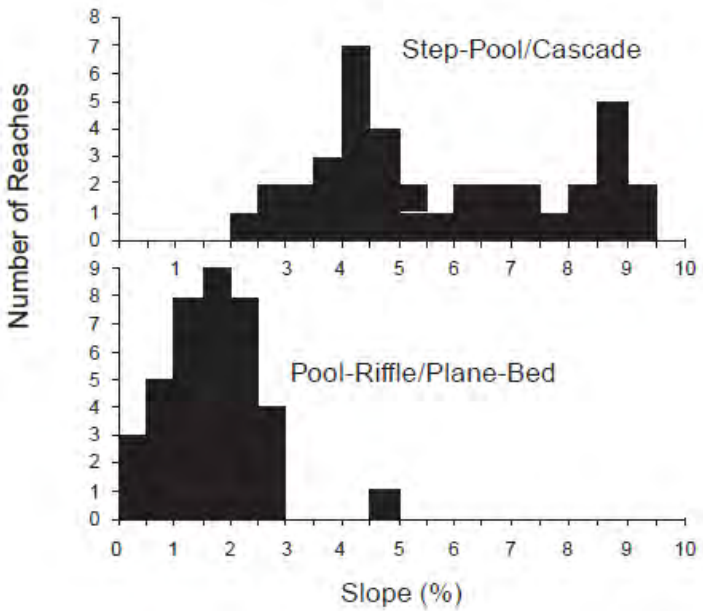
Mixed hydrology
Sediment transfer

Dampened hydrology
Sediment storage

Top figure from Fryirs & Brierley. 2013 Floodplain forms and processes

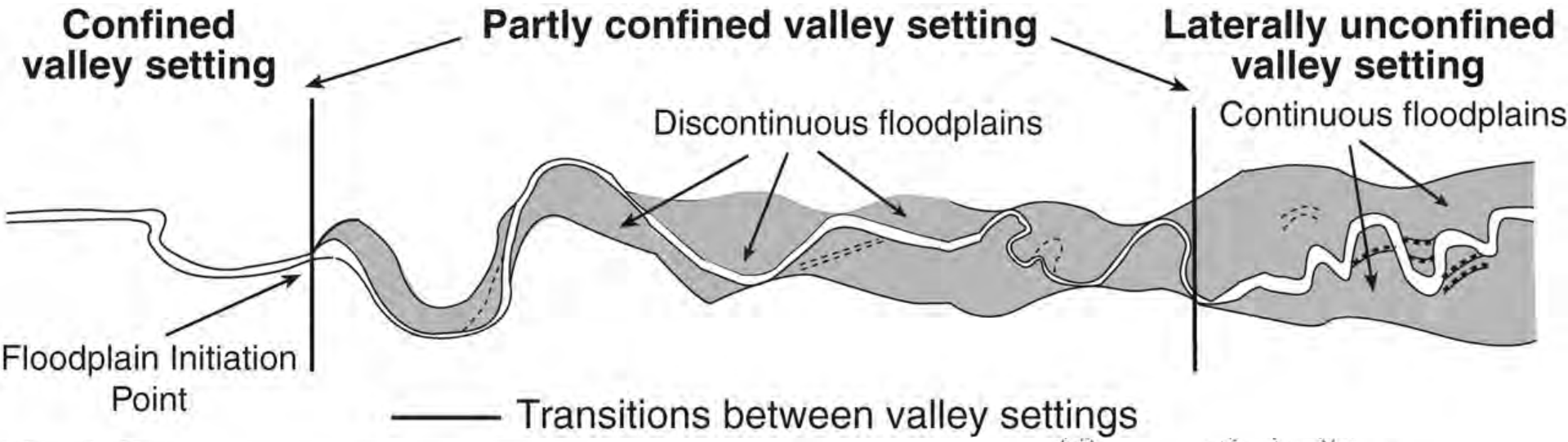
Spatial synchronicity

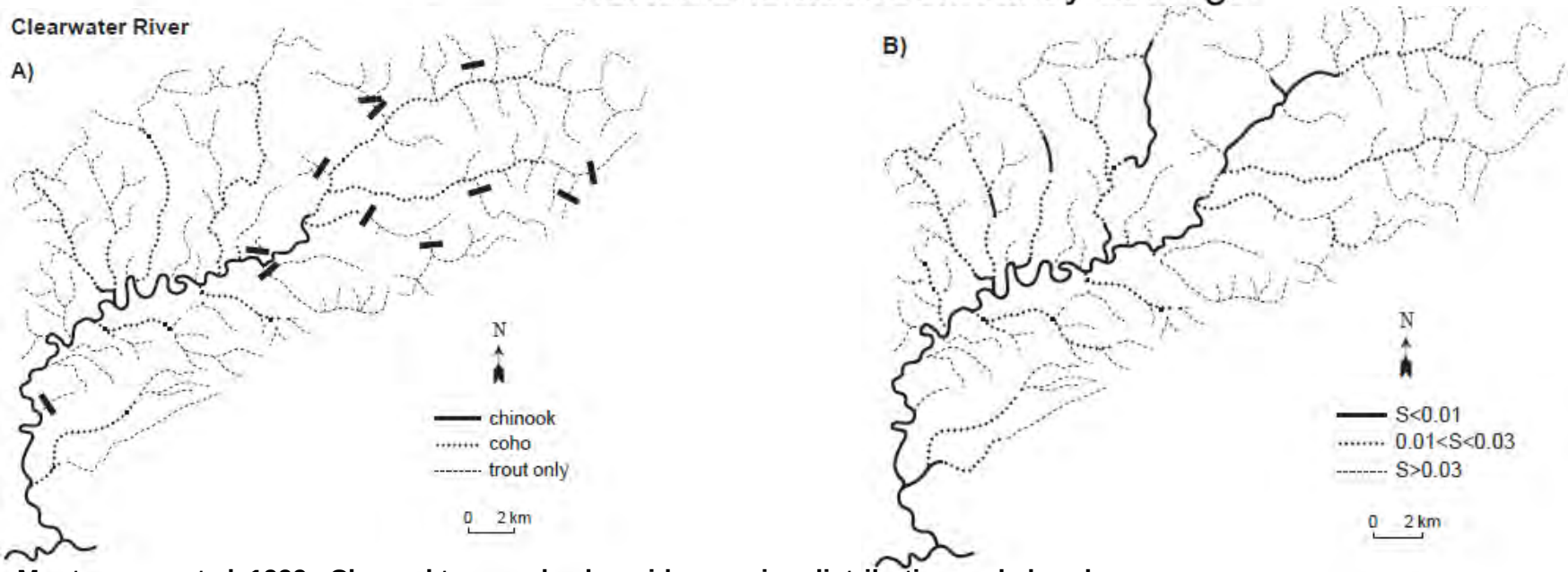




Montgomery et al. 1999. Channel type and salmonid spawning distribution and abundance

Spatial synchronicity





Montgomery et al. 1999. Channel type and salmonid spawning distribution and abundance

We’ve flipped the script!

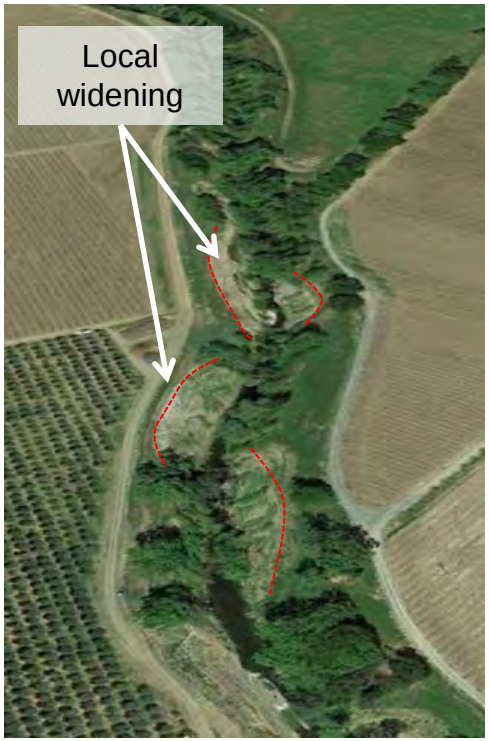
- Many rural and urban rivers are partially confined via incision, development, and vegetation

Floodplain restoration in practice

Buy land and/or set back levees

Aerial view of the Bear River levee setback restoration site. Photo by Tom Griggs. www.riverpartners.org

Design secondary channels and floodplains within newly confined corridor



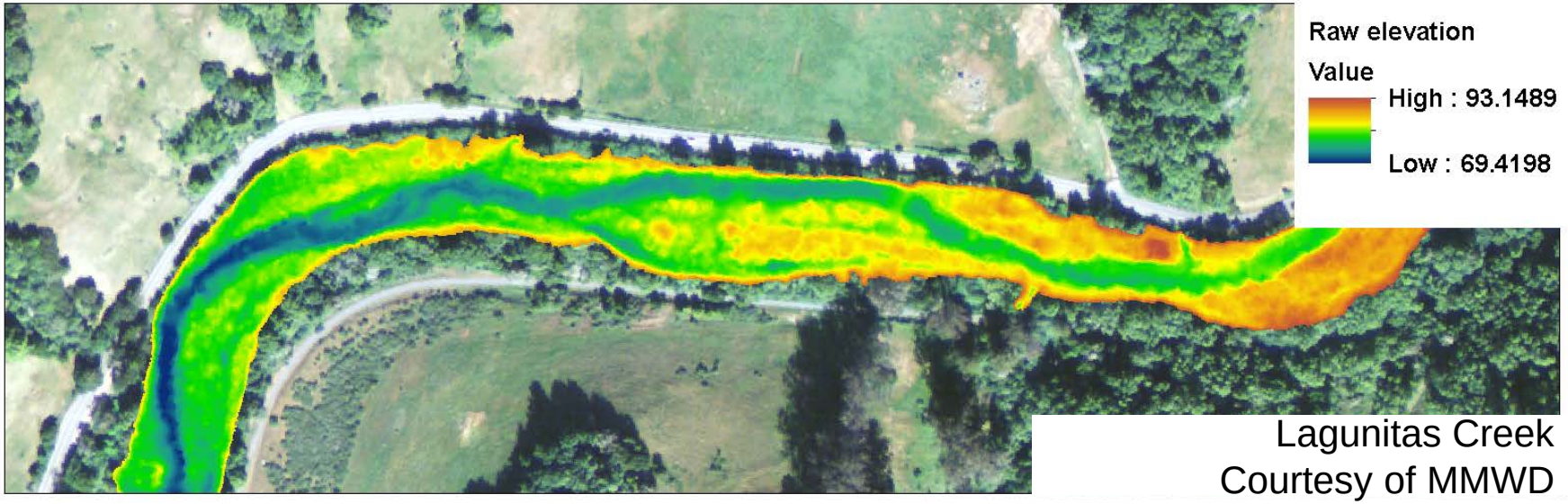
Aerial view graded inset terraces on the Napa River © Google Earth

Detecting for function

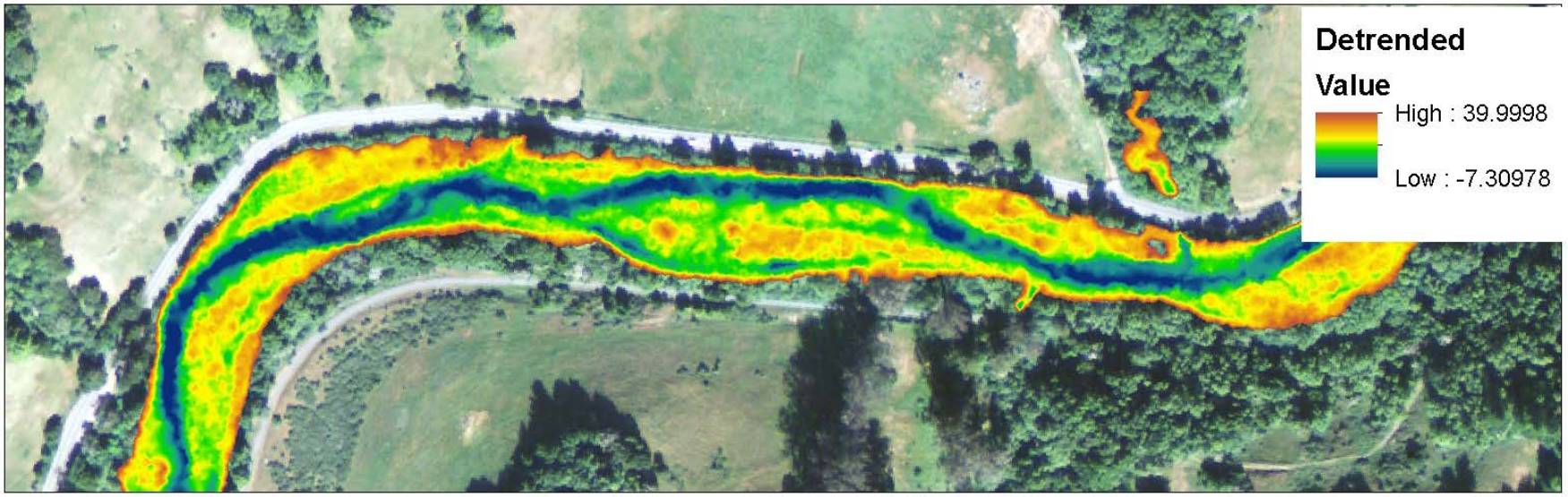
- As a profession we are relatively good at identifying what's wrong (provided we have the data)
  - Use of models
  - Advances in topographic and vegetation mapping
  - Ecohydraulic design
  - Over 10,000 journal articles on floodplain restoration!

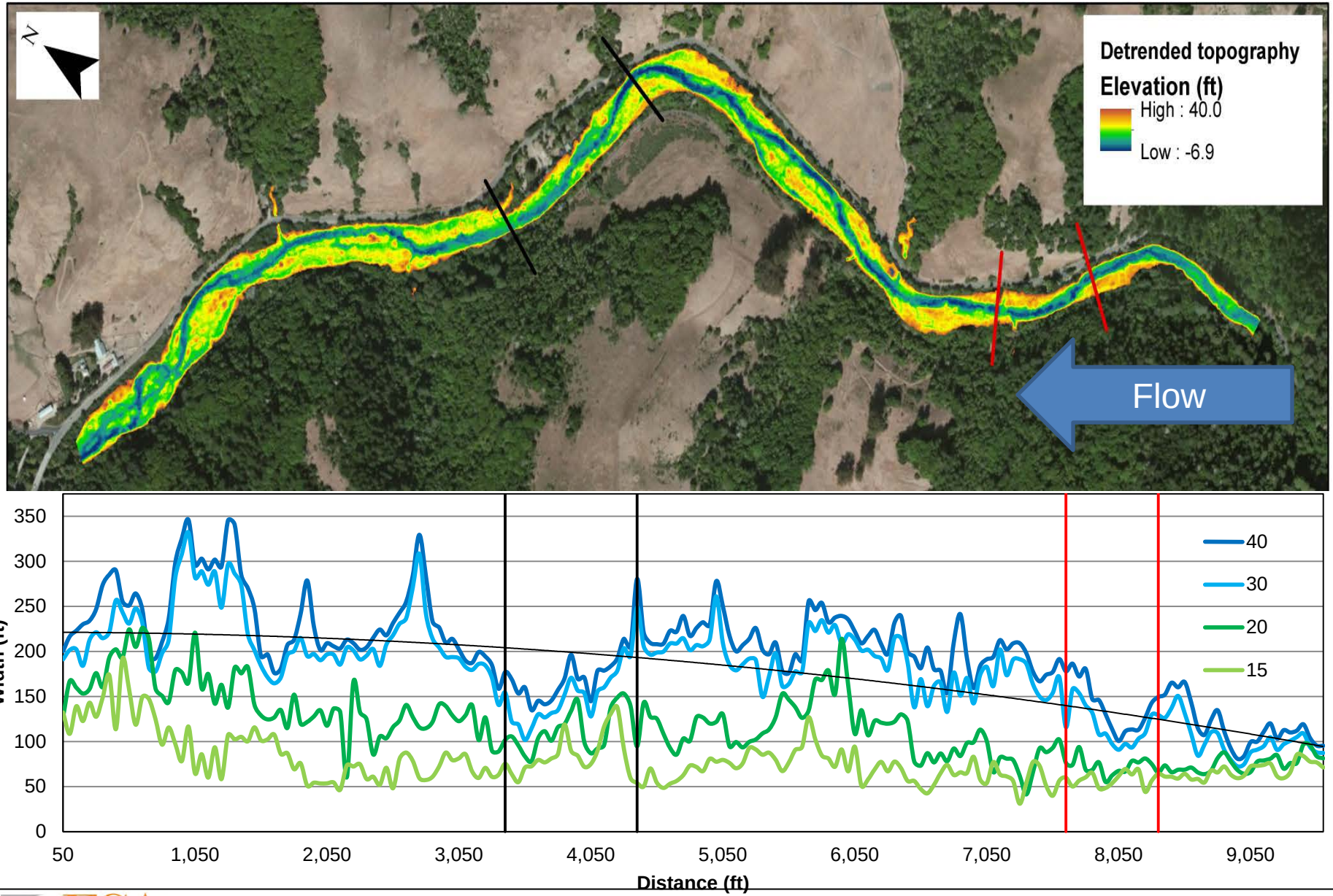
Journal articles discussing floodplain restoration	Number
Wiley (all)	**5,744!**
Springer (all)	**4,296!**

Detrended topographic analysis



Lagunitas Creek
Courtesy of MMWD





Source:
Detrended topography derived from 2009 LiDAR data set provided from MMWD

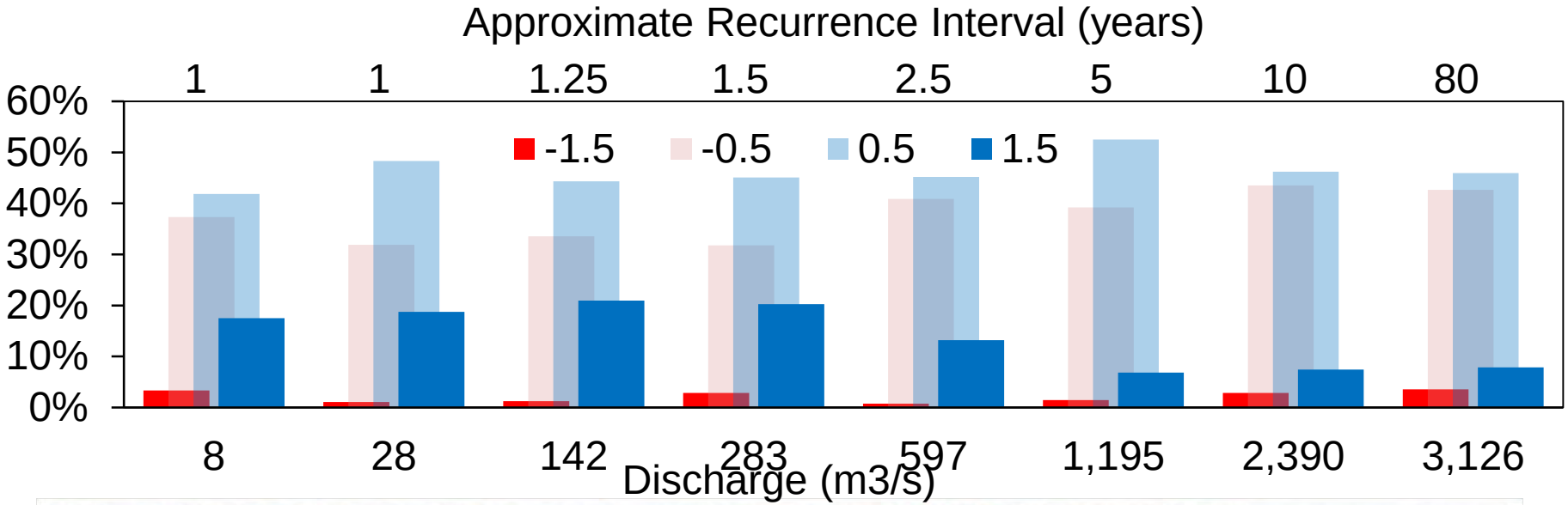
ESA Project D120160

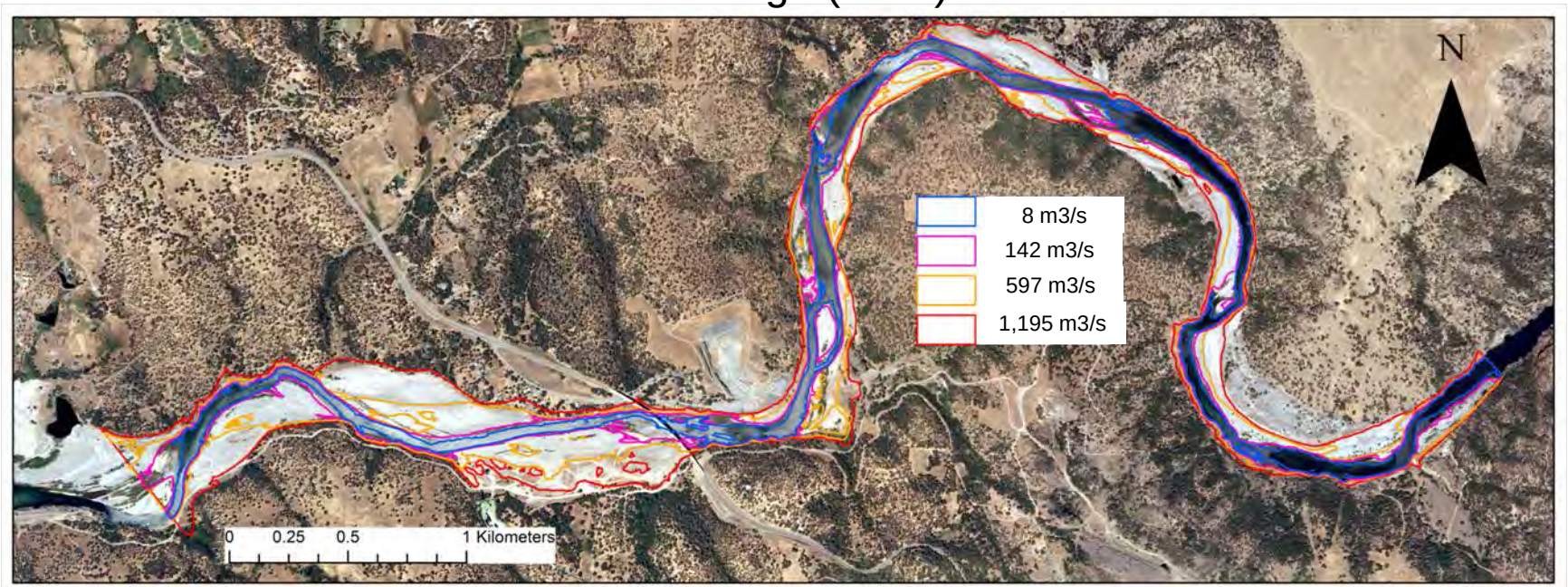
Figure 3

Detrended topographic map of a section of the Lagunitas Creek corridor encompassing the project reach (top) and valley width series plot at 4 elevation intervals (bottom)

Analysis of topographic connectivity

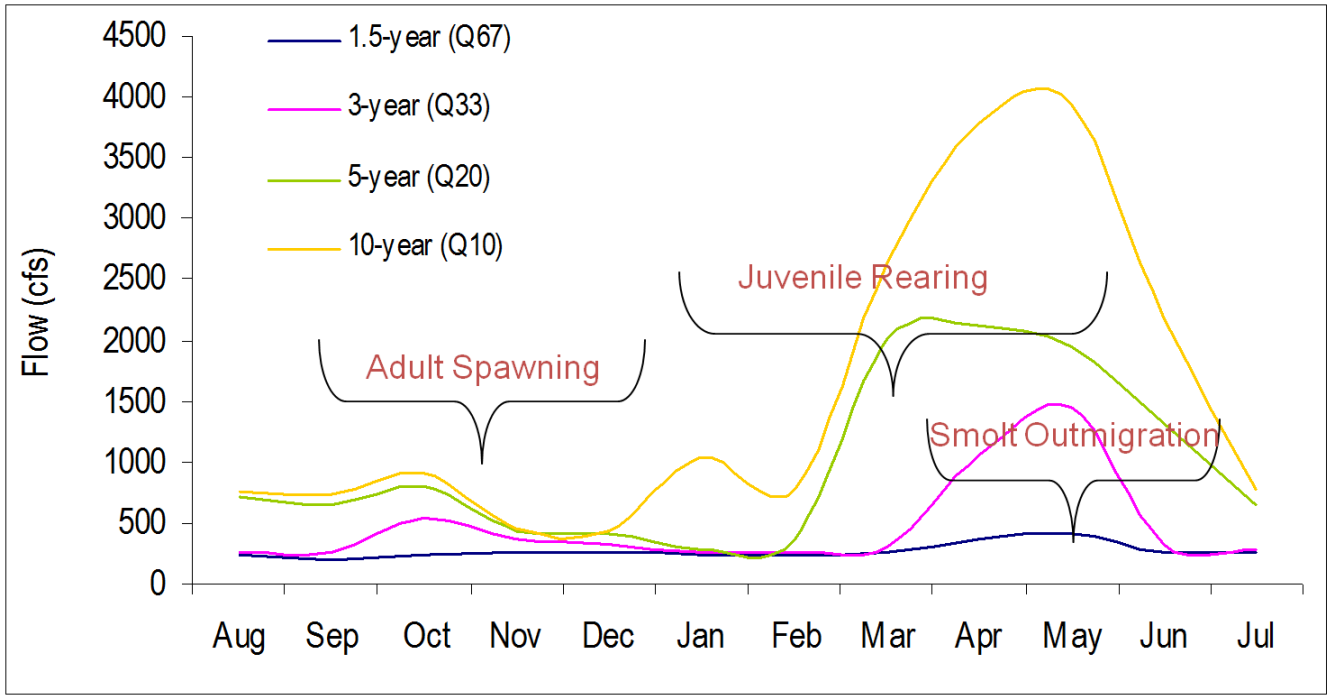
Histogram of $C(Z,W^j)$ for 9km of lower Yuba River





Ecohydrologic analysis

- Couple salmonid ecology and hydrology to determine functional flows

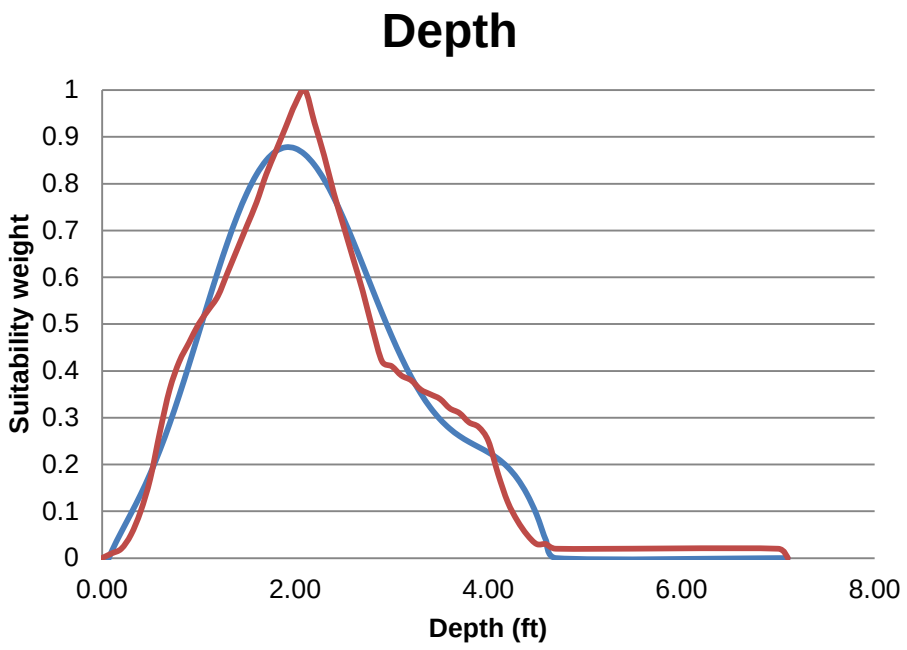


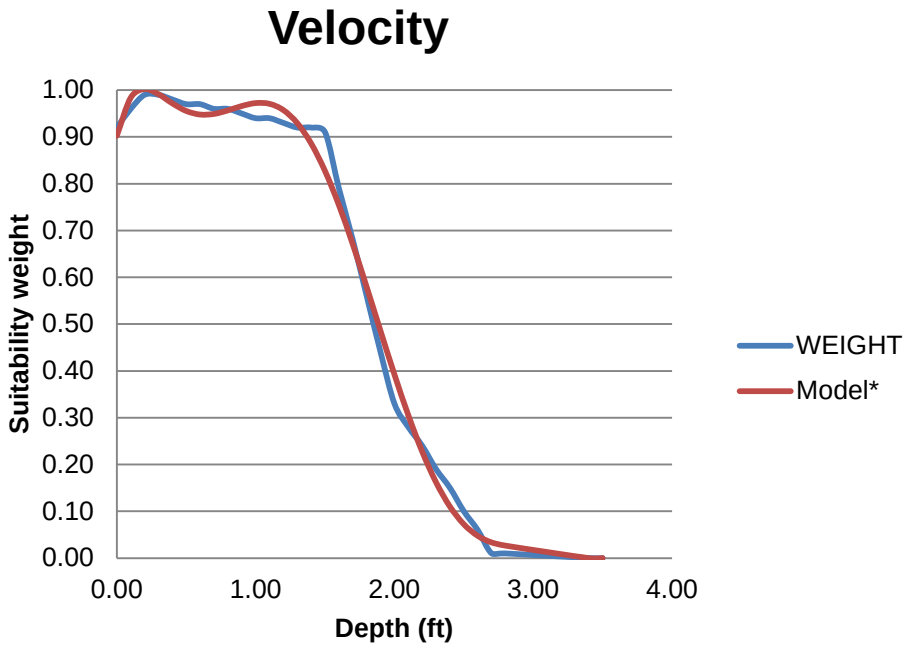
Coupling available flow to salmonid life cycle

(Courtesy of Joe Merz, PhD of Cramer Fish Sciences)

Ecohydraulic analysis and design

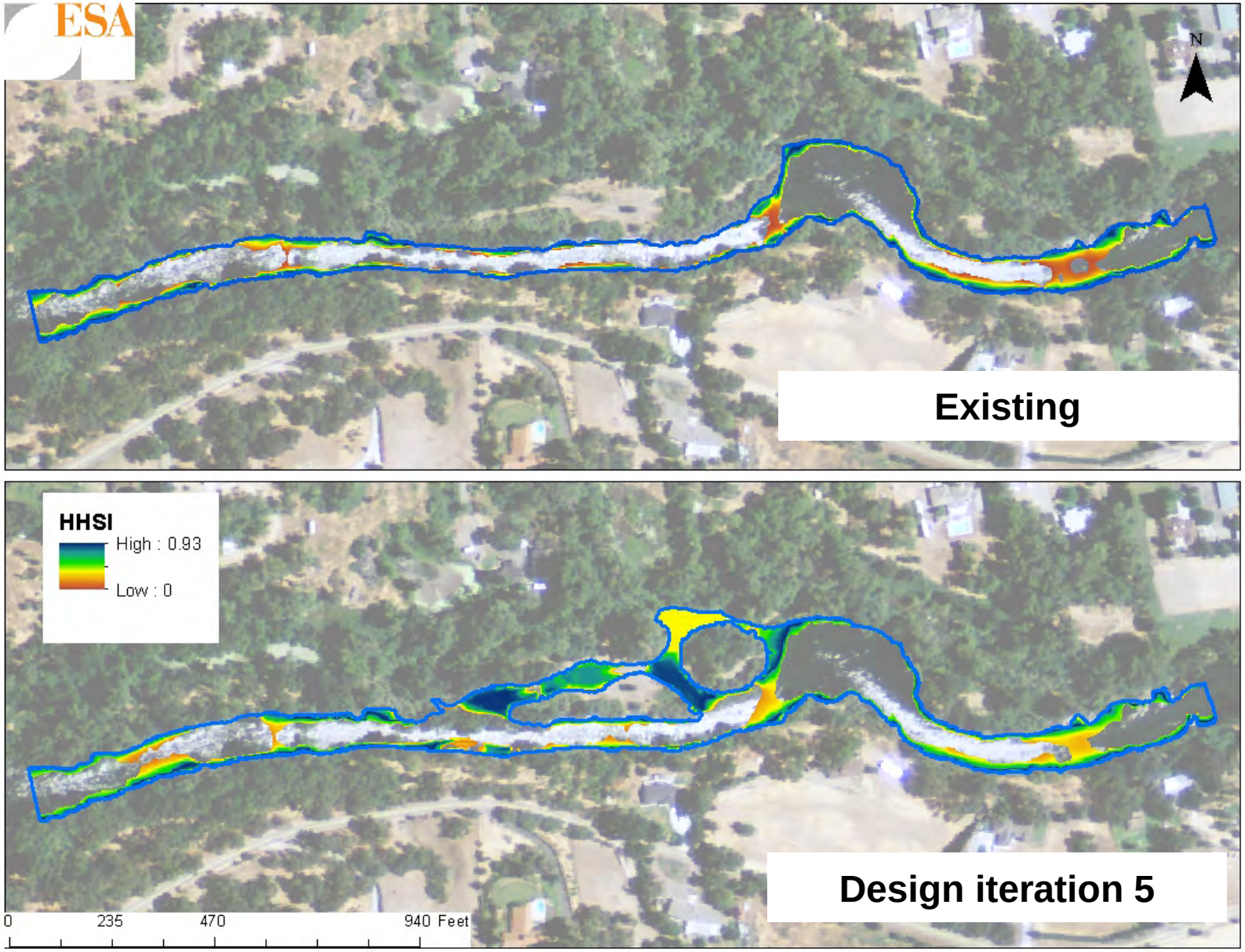
- Couple salmonid habitat preference with hydraulic parameters such as depth and velocity with hydrodynamic modeling





Ecohydraulic suitability curves for juvenile chinook salmon

Ecohydro analysis and design



Ecohydro analysis and design

→Model results can be used to systematically optimize designs before projects are built to assess their worth

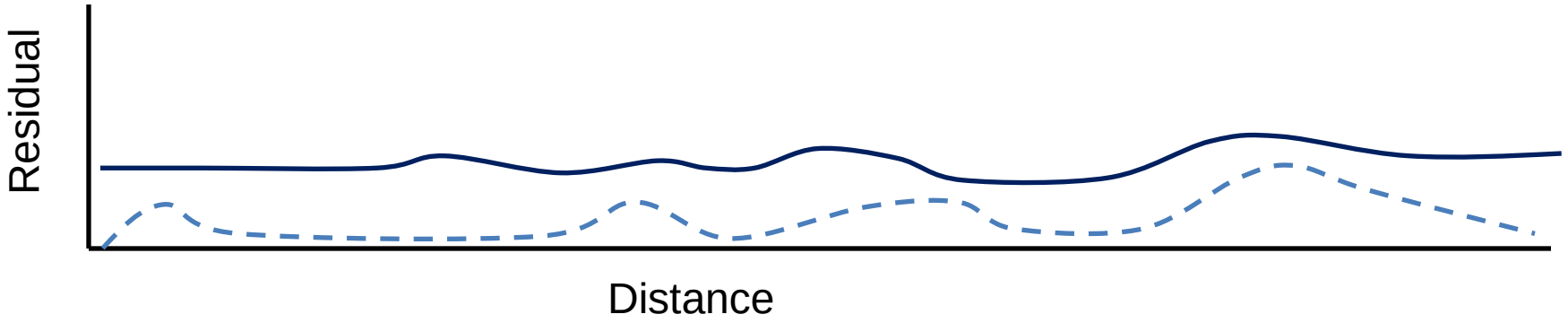
Syncing channel patterns

Syncing inset floodplains

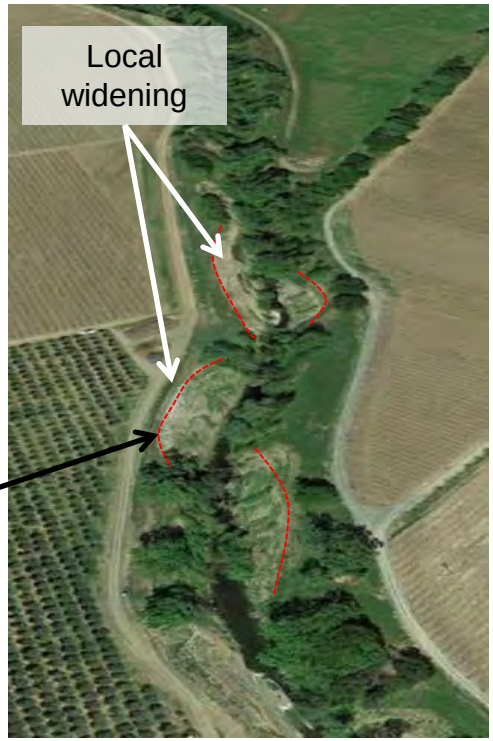
- Target inset floodplain locations to coincide with riffles
- Riffles can help maintain connection

Bed Elev.

Existing Width at Qbf



Syncing inset floodplains



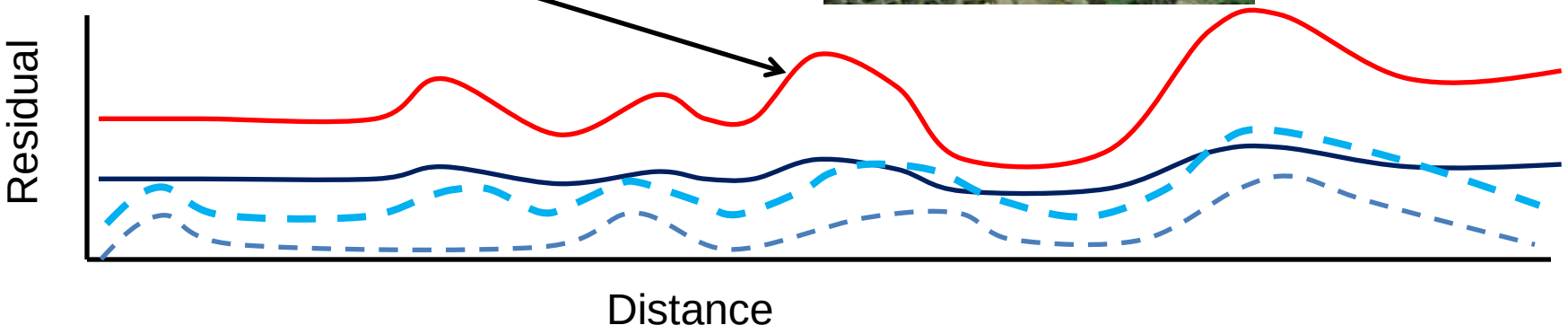
Hypothesized Bed Elev.

Bed Elev.

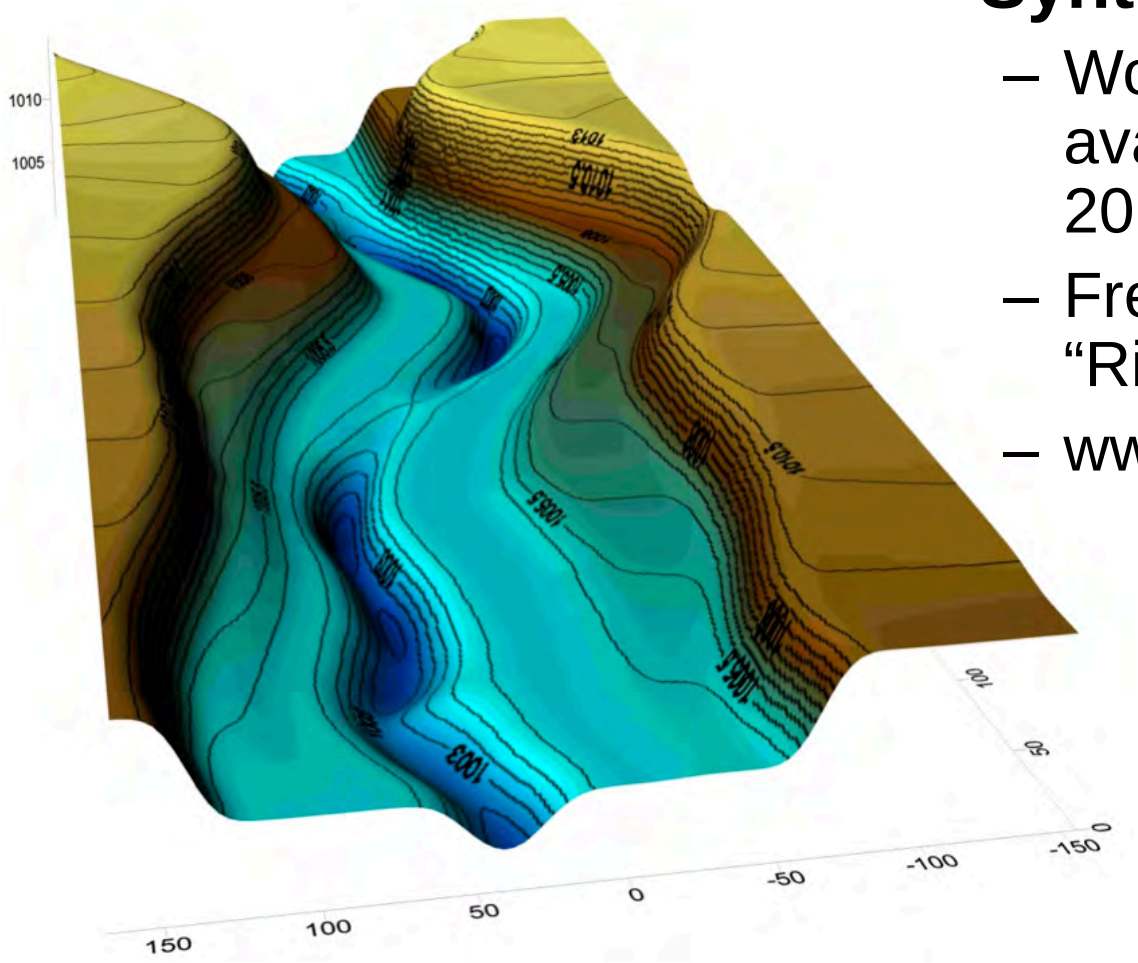
Existing Width at Qbf

Design Width at Qbf

Amplify width signal for enhancement



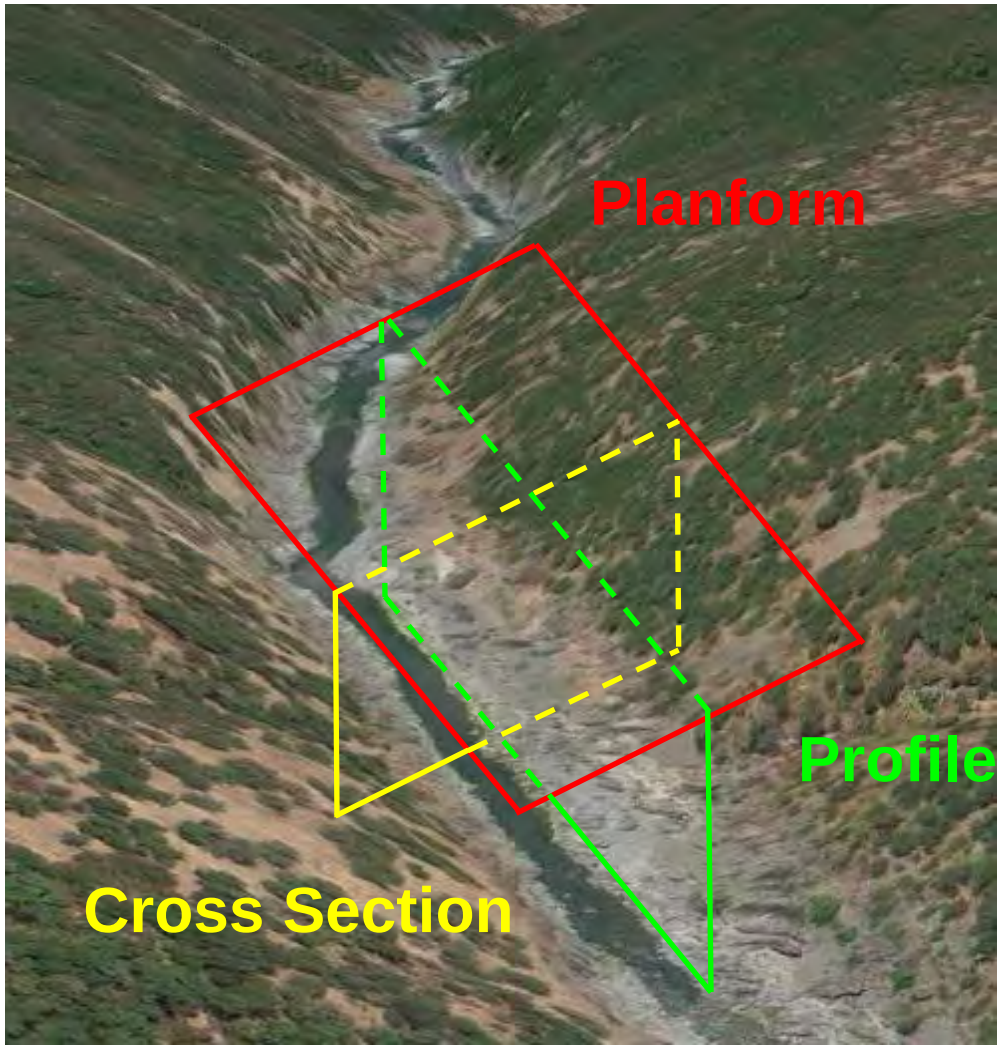
The future is scenario analysis: what can we do with what have?



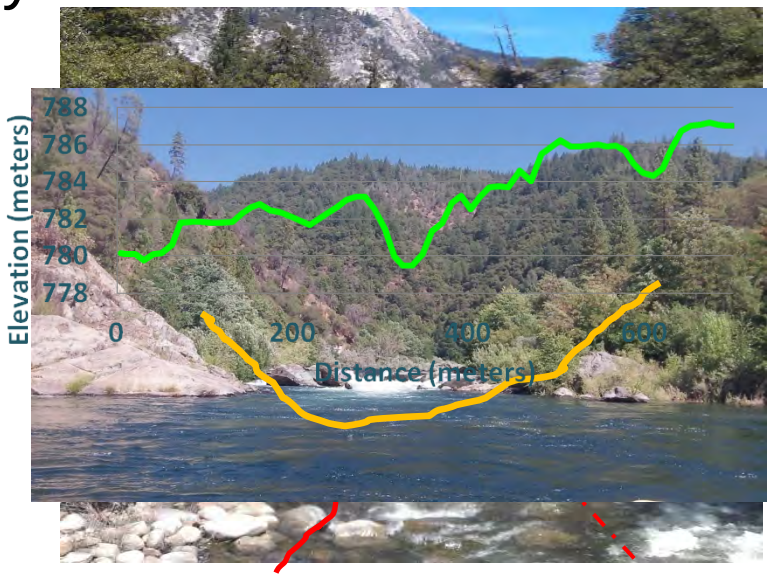
- **Synthetic River Valleys**
  - Workflow and theory for available in Brown et al. 2014
  - Free excel program “RiverSynth” available at
  - www.rockobrown.com

Brown, R.A., Pasternack, G.B., Wallander, W.W., Synthetic river valleys: creating prescribed topography for form-process inquiry and river rehabilitation design, Geomorphology (2014), doi: 10.1016/j.geomorph.2014.02.025

The basic idea of an SRV

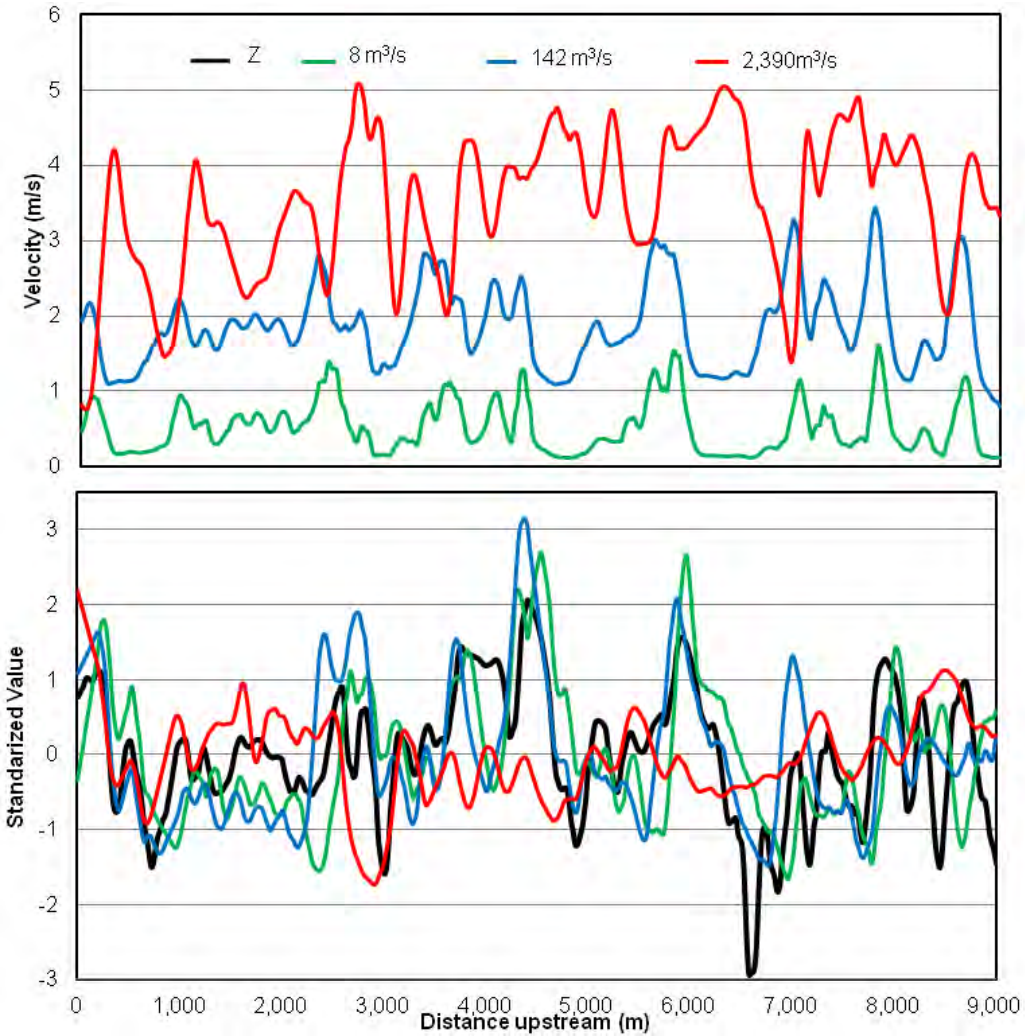


- Couple plane dependent mathematical models of fluvial elements
- **<u>adjustable</u>** topographic models of channel-floodplain systems

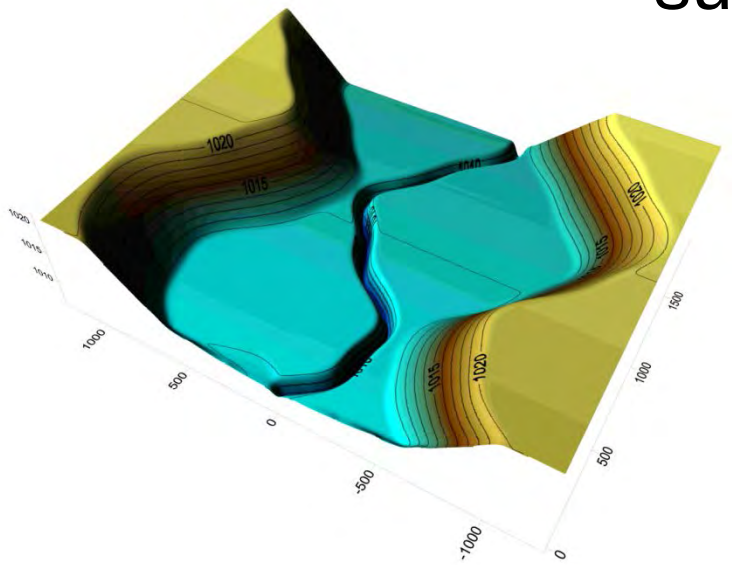


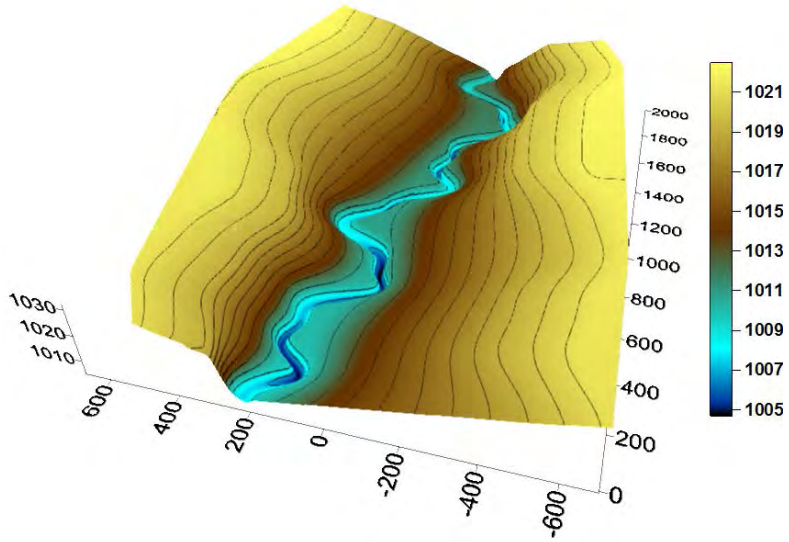
Brown, R.A., Pasternack, G.B., Wallander, W.W., Synthetic river valleys: creating prescribed topography for form-process inquiry and river rehabilitation design, Geomorphology (2014), doi: 10.1016/j.geomorph.2014.02.025

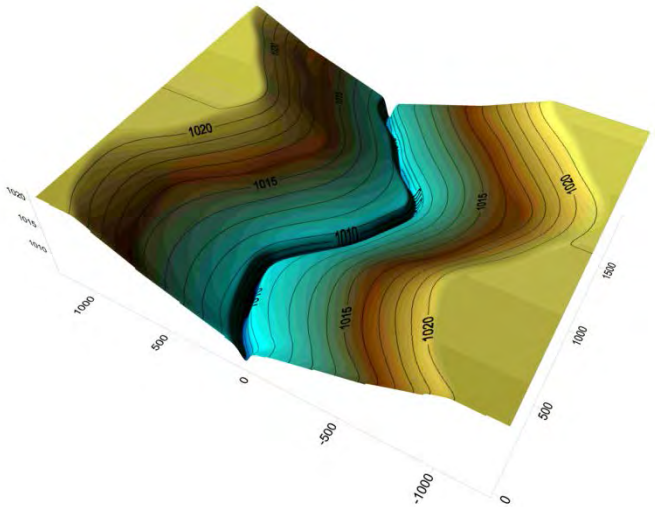
Start with topographic signatures of functional systems?

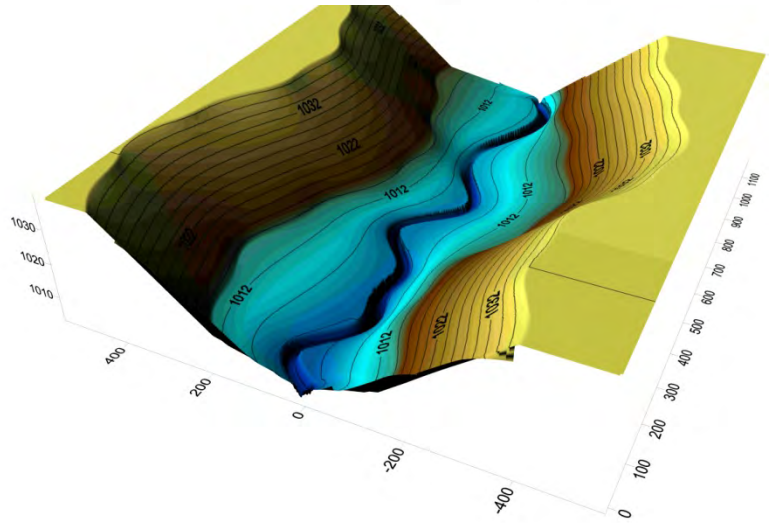


Given a corridor, what is the most optimal configuration for juvenile salmon that is also geomorphically sustainable?



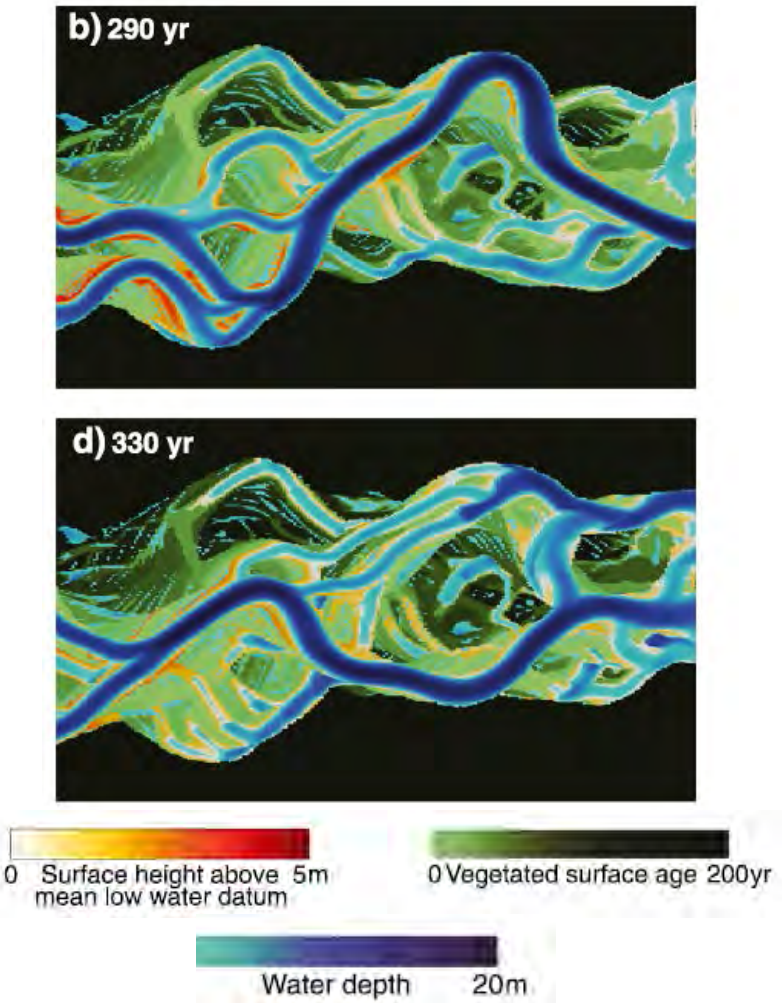






How will managed and constructed floodplains evolve over time?

- Ecogeomorphic feedbacks with flow, sediment and vegetation require a holistic approach to understanding system evolution
  - Morphodynamic models with vegetation establishment can help us



Nicholas, 2013. Modeling the continuum of river channel patterns

Concluding remarks

- Floodplain restoration does not suffer from a lack of science
  - Our ability to detect floodplain synchronicity exceeds
sign such environments

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