Against the Current: The Critical Need for Large-Scale Floodplain Reconnection in the Central Valley

A Concurrent Session at the 43rd Annual Salmonid Restoration Conference
Santa Cruz, California, April 29 - May 2, 2025

Session Coordinator: Michael Rogner, Director of Science, River Partners

The industrialization of the Central Valley has resulted in the loss of over 90% of floodplain rearing habitat. The recovery of native fish populations in this region is complicated by the operation of State and Federal water projects and the infrastructure for these which includes 20 major dams, over 1,600 miles of levees, and hundreds of miles of bank revetment. These Projects, while essential for public safety and water reliability, place constraints not only on habitat for these fishes but also on floodplain restoration work within its boundaries, greatly increasing project timelines and costs. The state of anadromous fish in the Central Valley is an escalating, large-scale problem that requires large-scale solutions to be implemented in a shorter timeframe. This session will include examples of floodplain reconnection projects completed or in process on mainstem rivers in the Central Valley. The session will not only discuss different types of projects, but also the successes and setbacks experienced in reducing barriers to implementation.

Presentations

HELPING THE FISH BACK TO THE RIVER: INNOVATIVE FISH PASSAGE GATE ON REMNANT FLOODPLAIN

Presented at
43rd Annual Salmonid Restoration Conference
April 29-30, 2026

Dan Howes, Ph.D., P.E.
Chairman

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Michael Rogner, Director of Restoration Sciences

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PARTNERS

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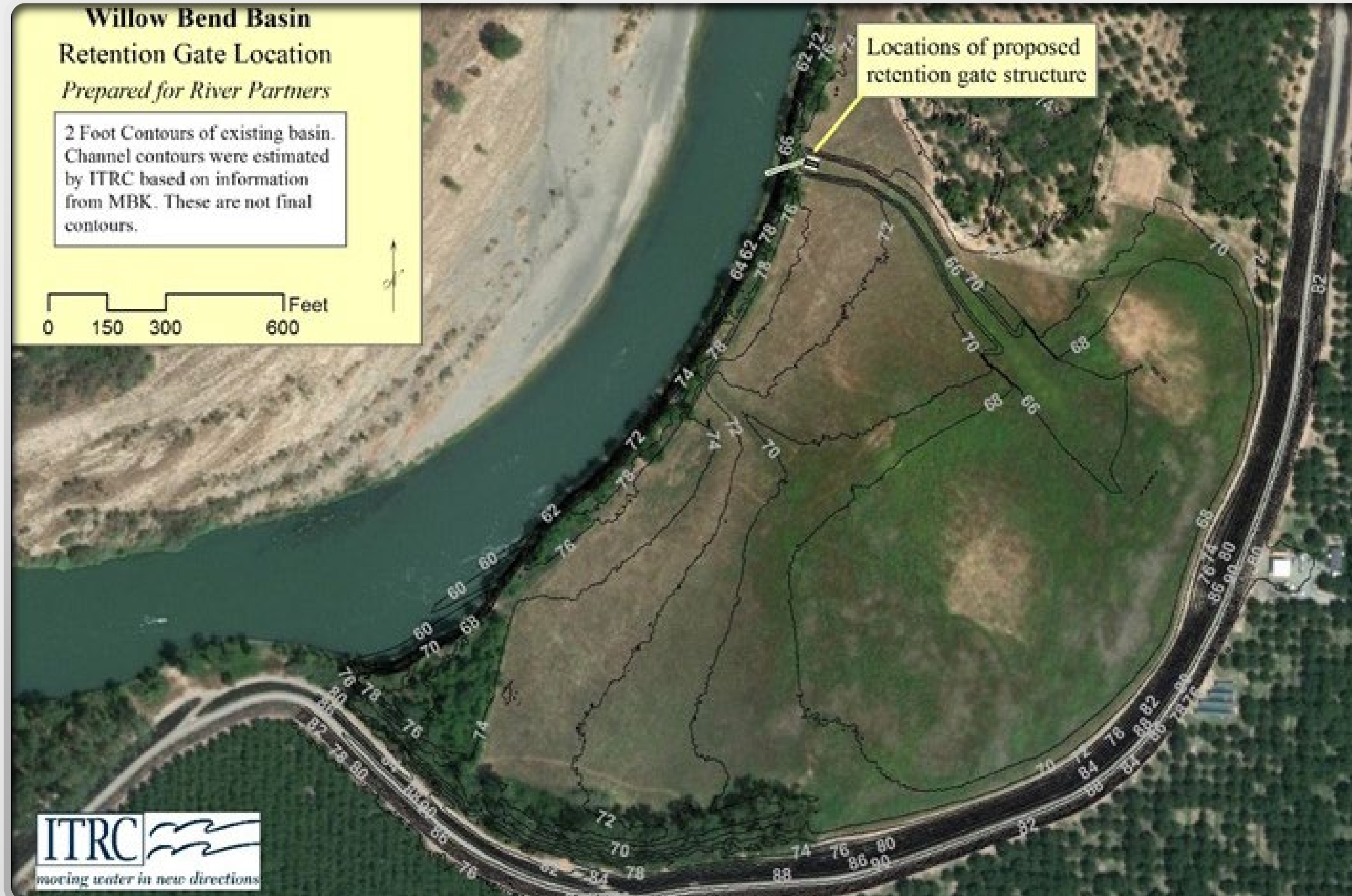
Overview

Problem

- Remnant flood plain north of Colusa inundates with water
- Juvenile salmon become trapped because of man-made flood control alterations
- Food source is abundant, but fish end up dying due to the steep hydrograph curve due to other flood control alterations

Question from River Partners

- How do we maximize the food production and juvenile salmon growth and protection
- AND get them back to the river



Pond has a potential storage of 67 AF

Constraints

The entire site, including the gate, can be under 10 feet or more of water (no electrically operated structures)

The site will need to be relatively maintenance free. Possibly 1 or 2 visits per year

Must be actuated automatically - Limited access during flooding.

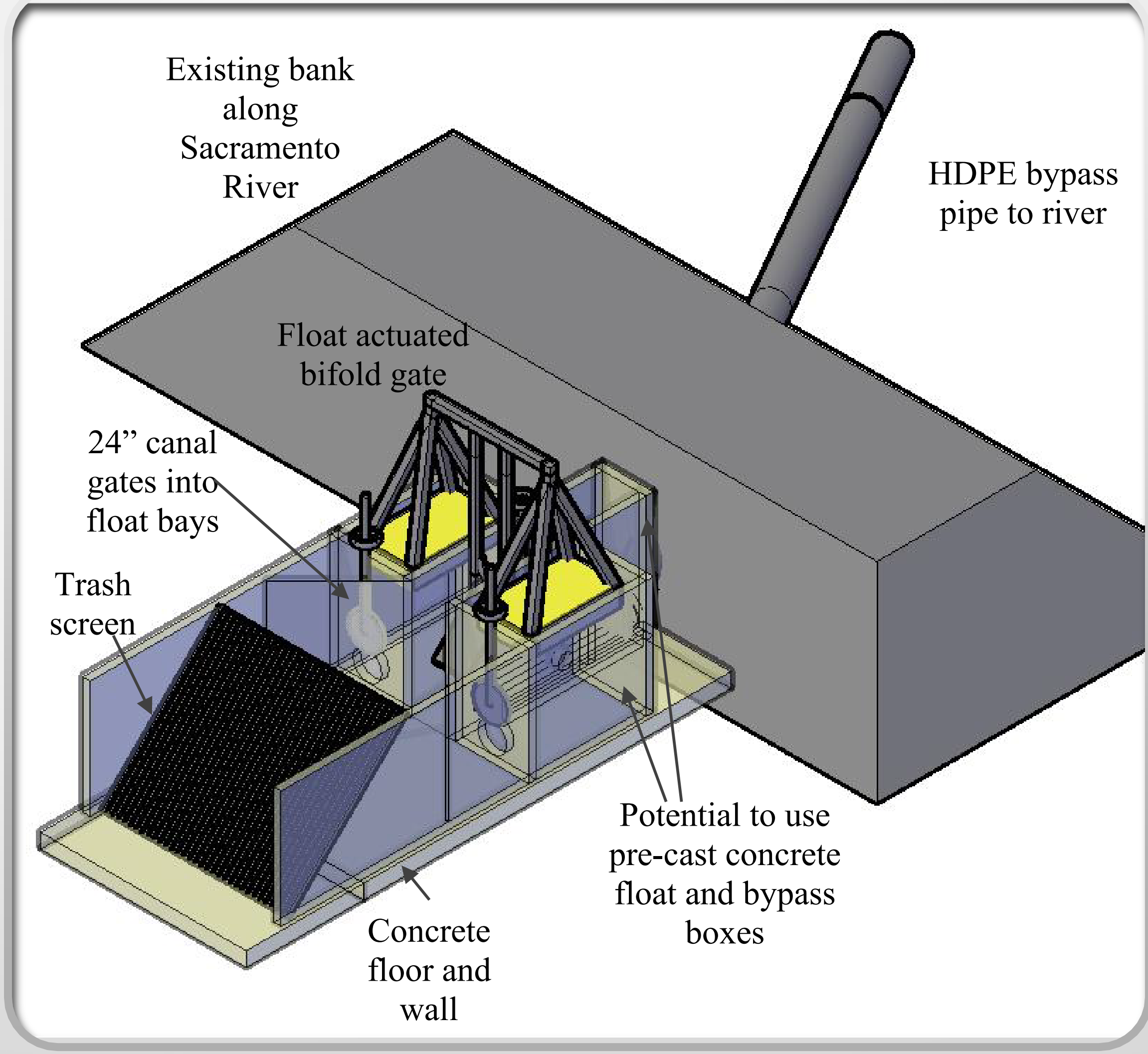
Must meet fish passage/bypass standards (NOAA)

Goals

- Dewater pond is approximately 16 days or more once fully flooded
- Have a continuous outflow so fish can decide when to exit pond
- Structure should work even if the world forgets about it
- Meet fish passage guidelines

Overall Gate Design

- Bifold gate
- Float actuated
- "Constant" outflow from full to empty
- Trash rack
- Fish passage and bypass guidelines met

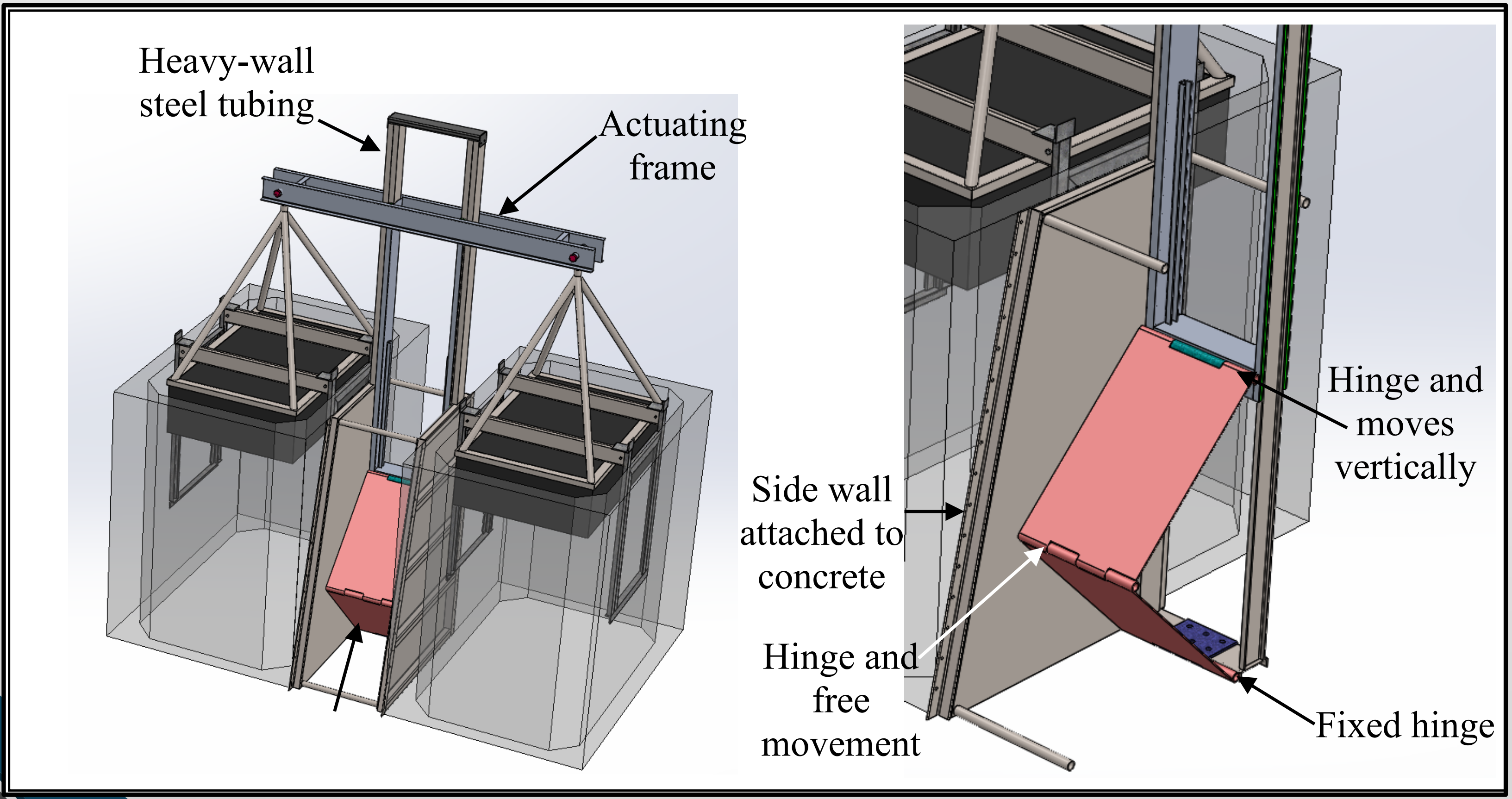


Float bays

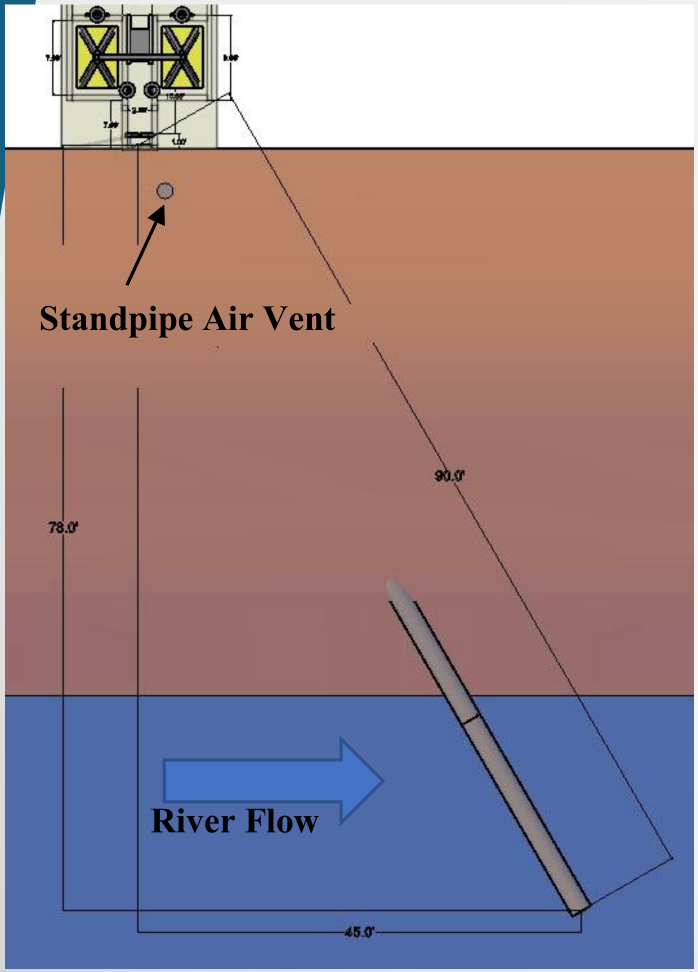
- Cast in place
- Canal gates on inlet normally open
- Canal gates for emergency release normally closed
- Bottom has to be flush with inlet/outlet bottom so fish do not get trapped.

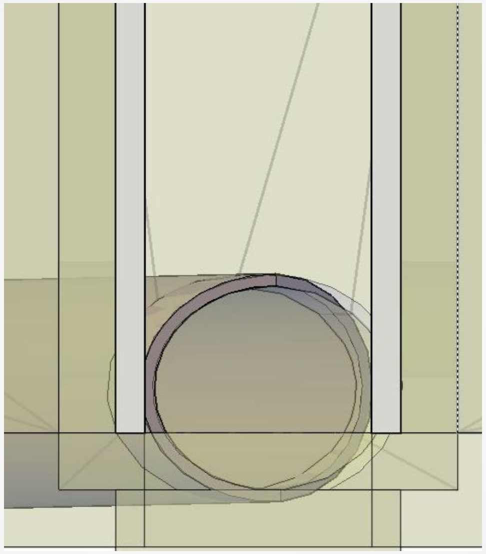
Bifold Gate

- Most efficient gate option
- Must be overflow outlet for fish passage
- Folds down nearly flat
- Floats are dock floats but must be held down during flooding above the structure



Fish Passage (3) Outflow Pipe

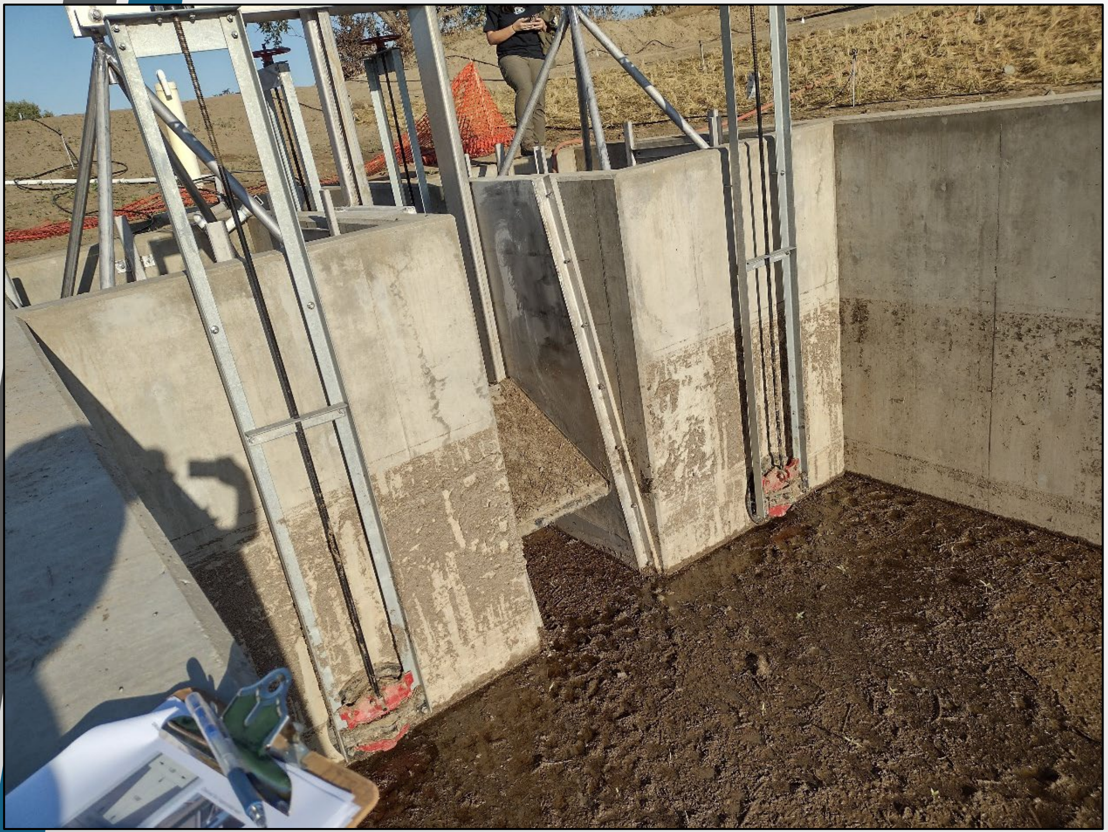




Floor downstream of trapezoidal weir is 0.5' lower matching the bottom of the pipe. Pipe entrance should be smoothed and slightly rounded.

- For 2 cfs the pipe slopes down at 1.2%
- Outfall must be into water under all river flow conditions
- Velocity of river at that locations should be >=4fps to prevent predators from sitting in one spot

Constructed in 2022



Float bays and Exit to River

2023 Operation

2023 Operation

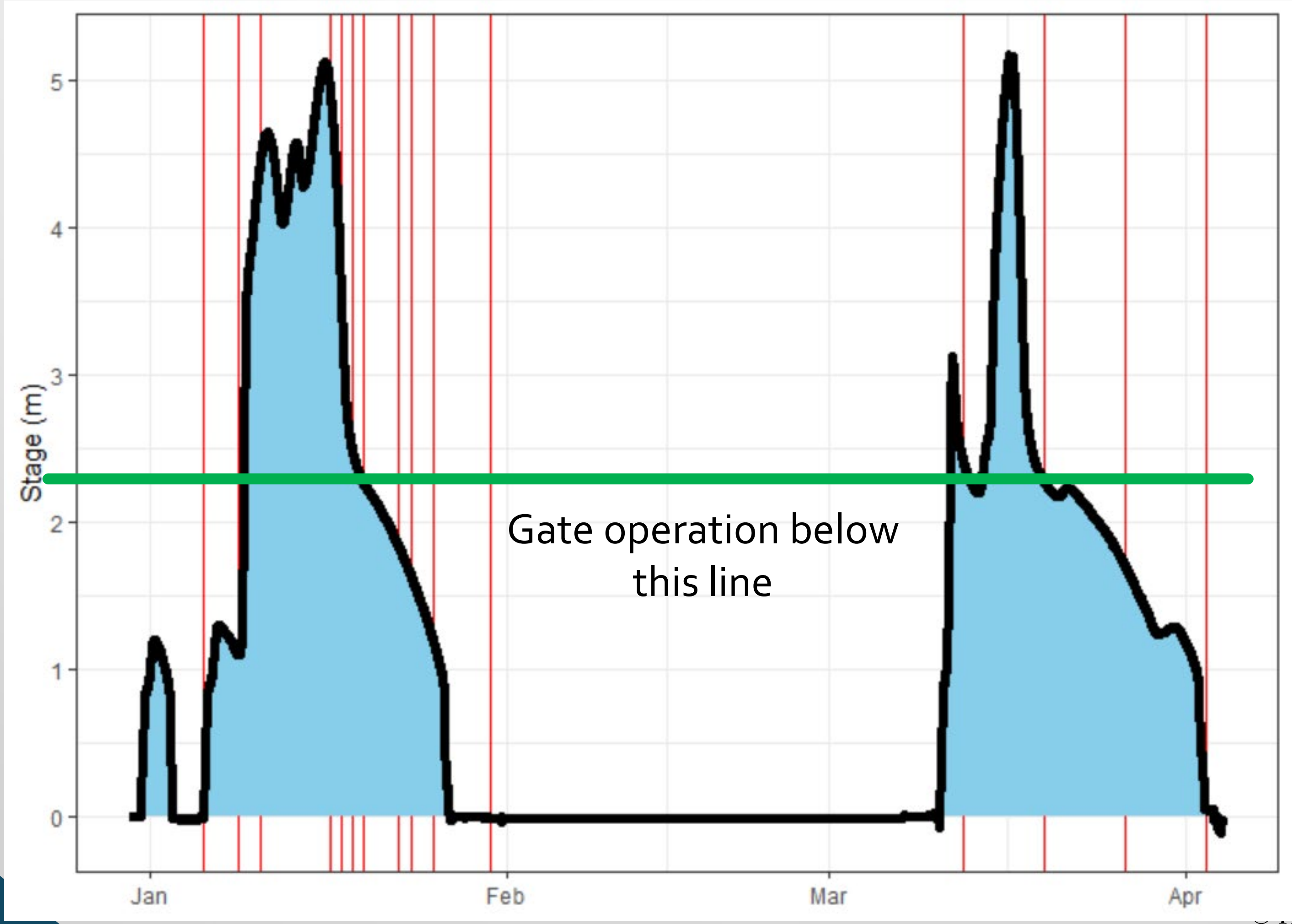
2023 Operation

Operational Information

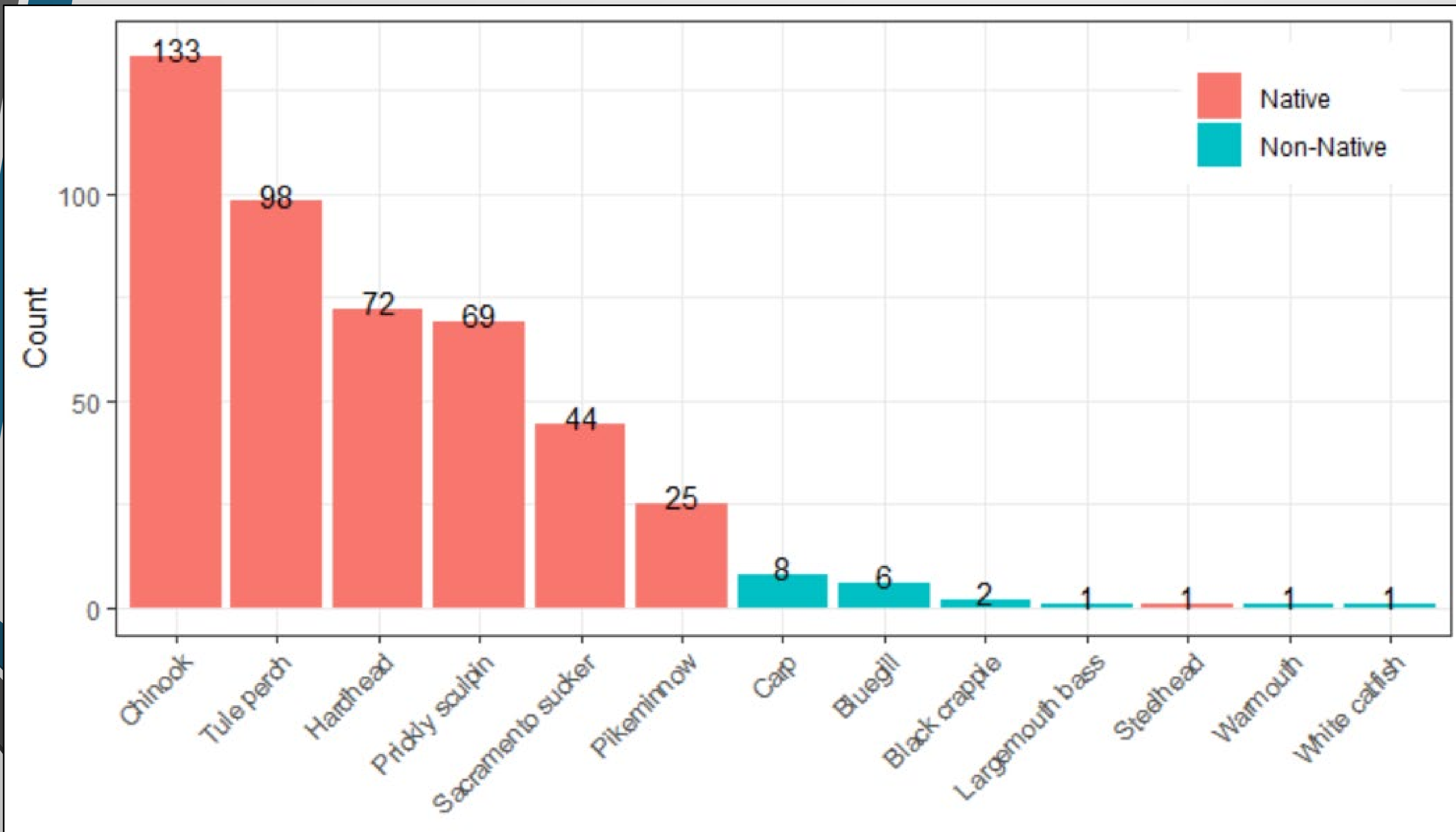
- Willow Bend floodplain fish and food web monitoring is completed by UC Davis biologists – Carson Jeffres, Mathew Salvador, and Eric Holmes

- 2023 results are summarized here

Water stage on Willow Bend Floodplain



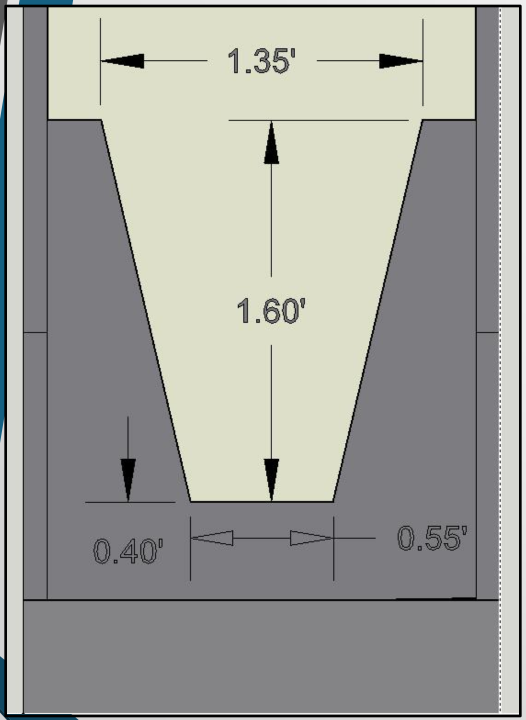
Species composition
Native group dominated



Future Operation

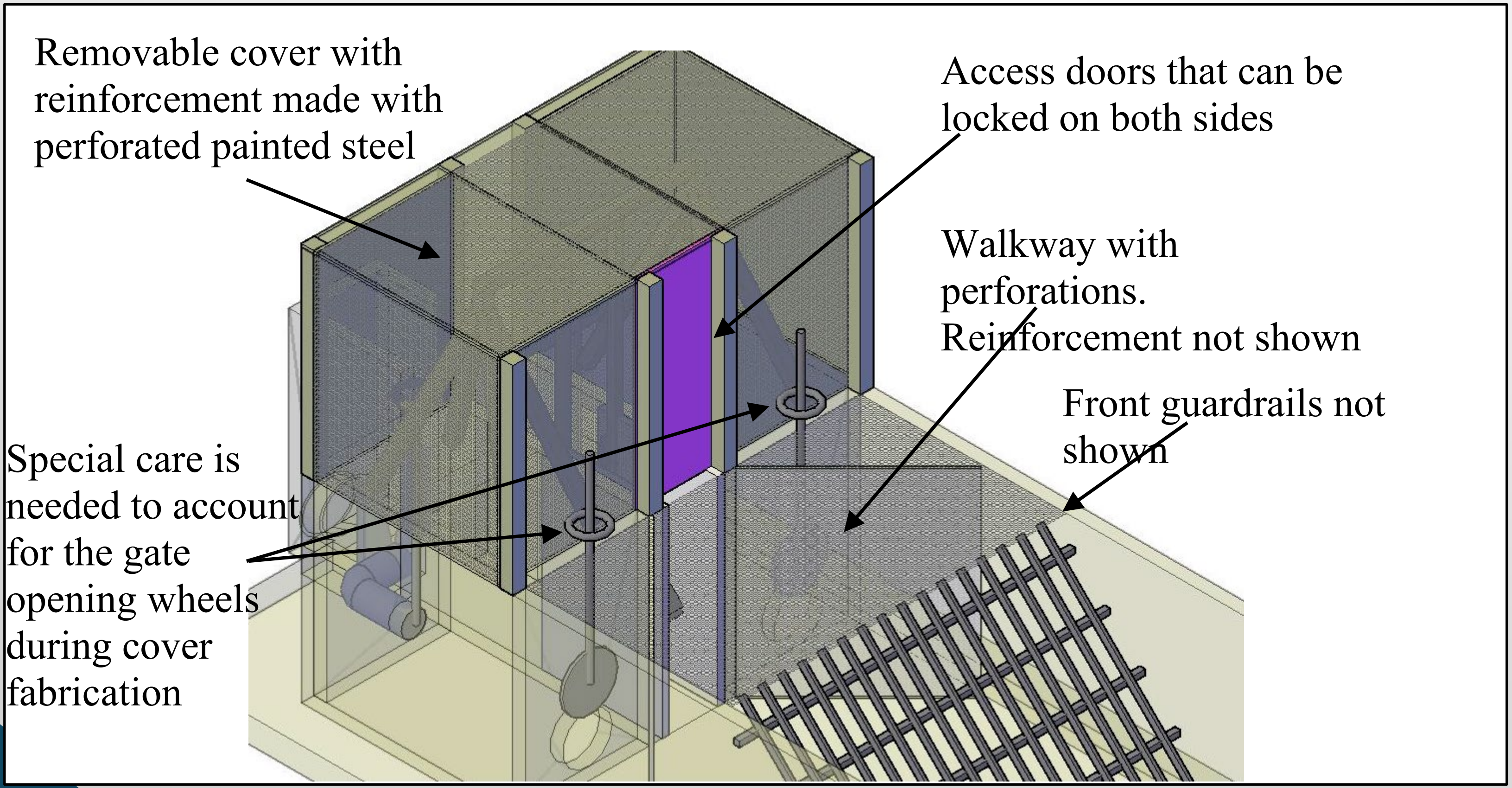
- Increasing residence time for the fish and floodplain is possible
- This should improve the food web generation

Fish Passage flow control



- Constant flow of 2 cfs using a removable trapezoidal weir on top of the bifold gate
- This flow can be reduced by contracting the weir further

Protection – Structure and fish Recently installed



Summary

- An innovative structure was design leveraging hydraulic structure types used in agriculture modified to meet the constraints and objectives of this project.
- The flood plain gate structure is operating as intended.
  - Practical designs were integrated to reduce risk
- It operates automatically, without electricity or external power
- Maintenance is minimal
  - Cleaning debris once or twice a year

We would like to thank the new owners of the site

Cachil Dehe band of Wintun Indians

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When the Levee is Breached:

Strategic Levee Breaching for Floodplain Restoration at Great Valley Grasslands State Park

Sarah Puckett, Central Valley Program Director

American Rivers

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American Rivers restores damaged rivers, protects wild rivers, and conserves clean water for people and nature.

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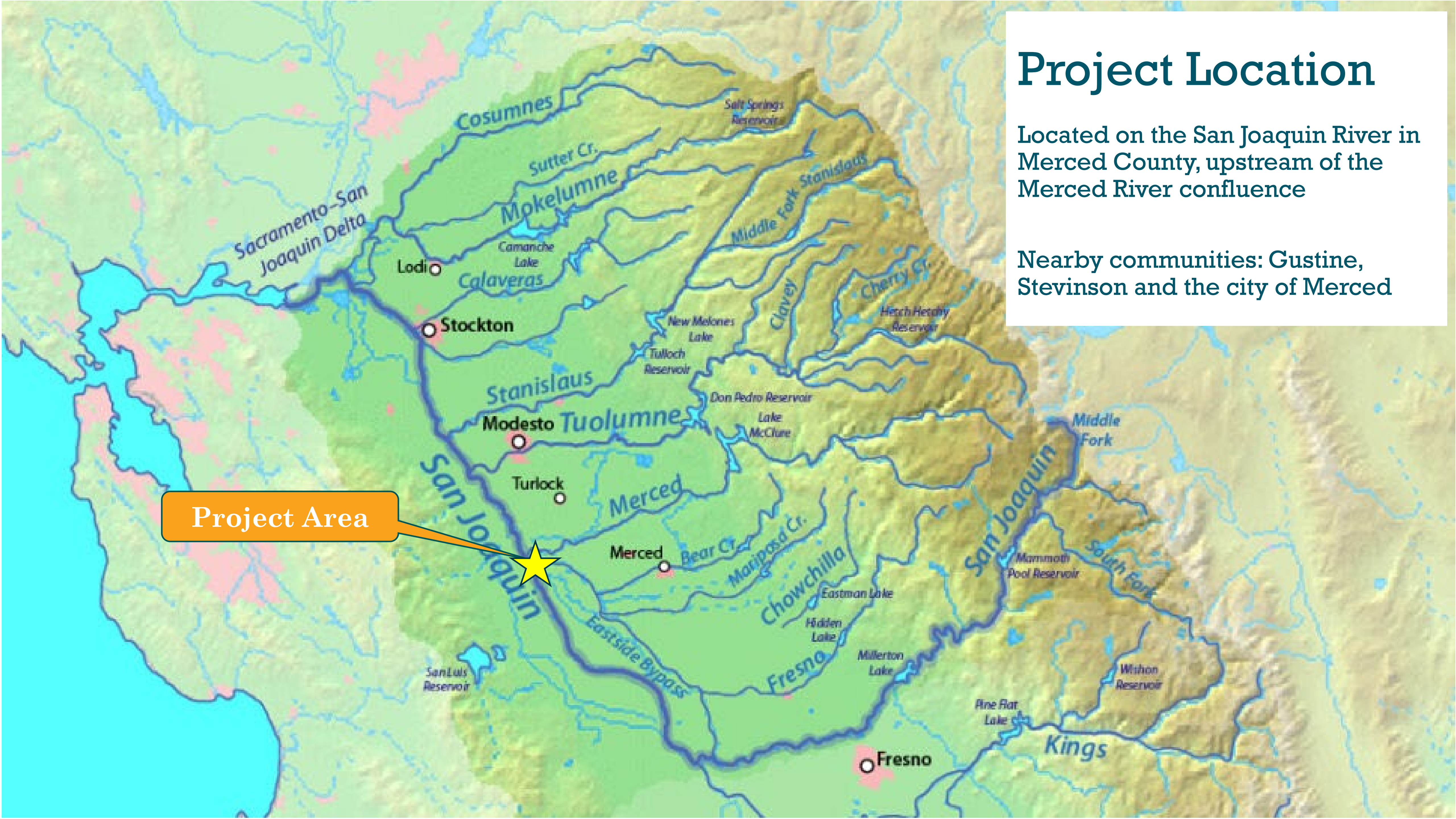
Project Location

Located on the San Joaquin River in Merced County, upstream of the Merced River confluence

Nearby communities: Gustine, Stevinson and the city of Merced

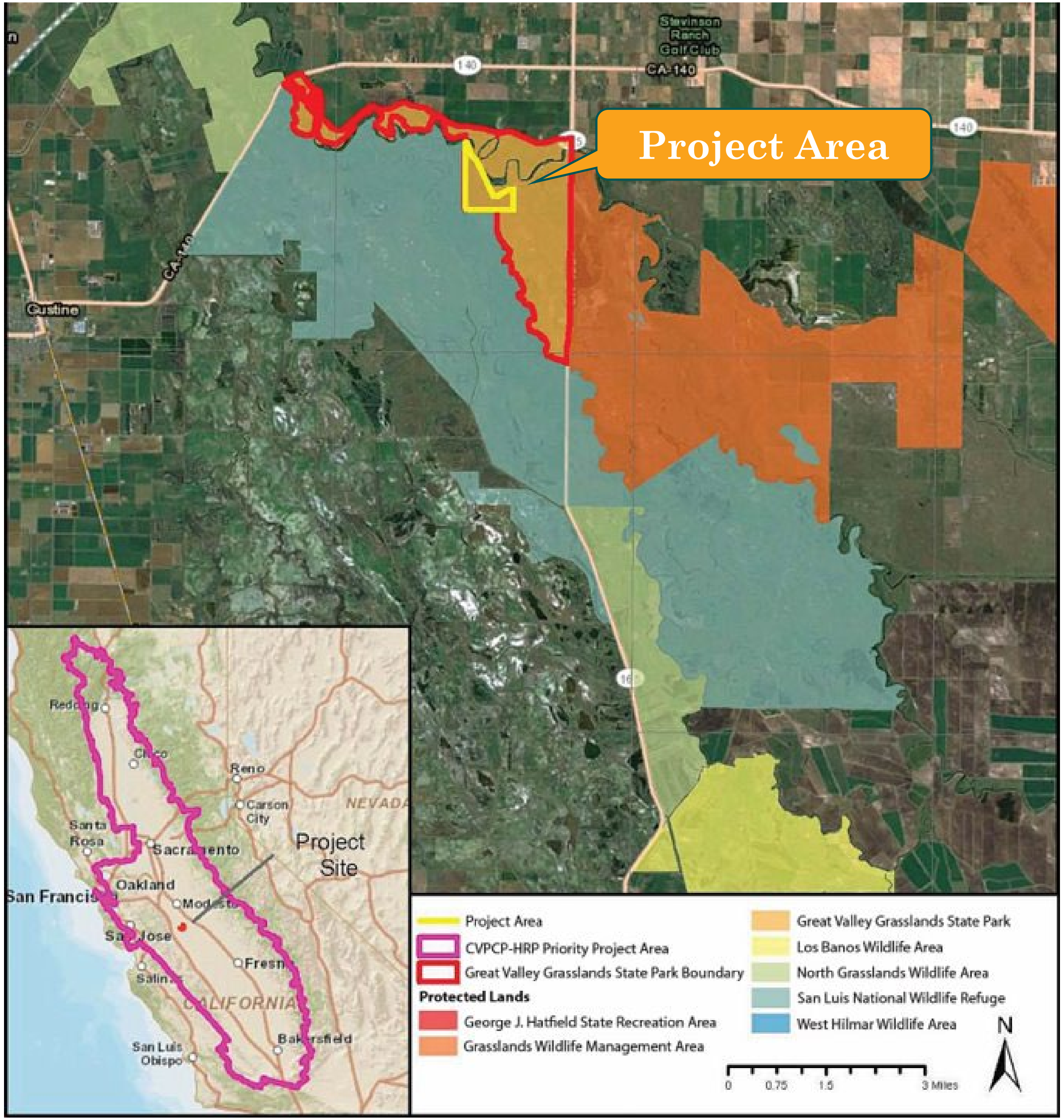


Project Location

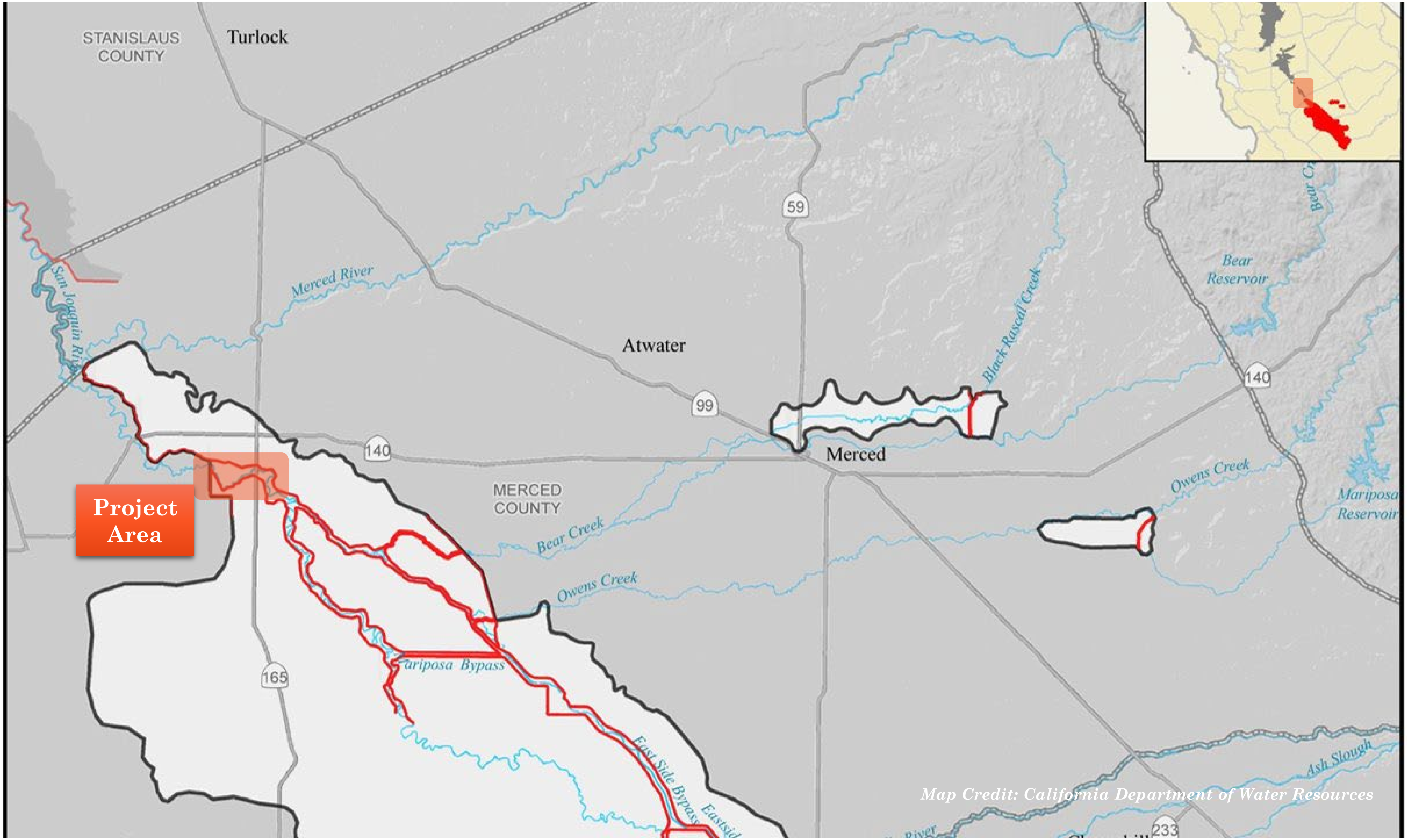
Undeveloped public park owned and operated by the California Department of Parks and Recreation

The park is part of the larger Grasslands Ecological Area (GEA) of federal, state, and private lands all managed for wildlife values

The GEA is 160,000 acres - the largest remaining contiguous block of wetlands in California



Map Credit: American Rivers

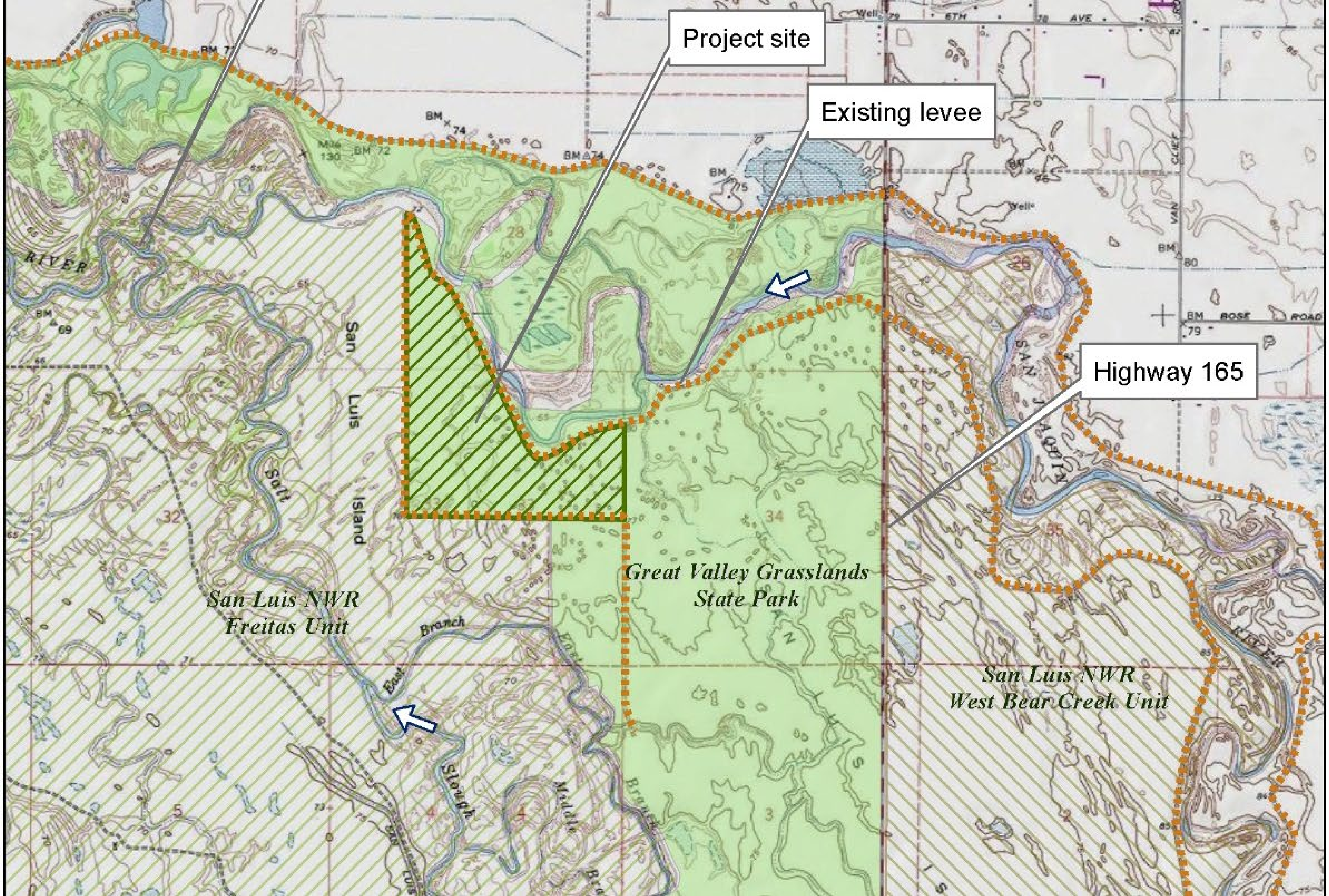

STANISLAUS COUNTY
Turlock
Merced River
San Joaquin River
Atwater
59
99
140
Merced
Black Rascal Creek
Bear Reservoir
Bear Creek
MERCED COUNTY
Owens Creek
Mariposa Reservoir
Project Area
Mariposa Bypass
165
East Side Bypass
Ash Slough
233
Map Credit: California Department of Water Resources

Project Background

Great Valley Grasslands State Park has the **largest expanse of native grasslands** within California's Central Valley.

- Levees were constructed for cattle grazing in the 1950s, disconnecting the San Joaquin River from its floodplain
- Disconnected floodplain → lack of seasonal flooding on floodplain → exotic grasses and other non-native vegetation
- Impacts to habitat for juvenile salmonids have been significant.

Photo Credit: American Rivers


Project site
Existing levee
Highway 165
San Luis Island
Great Valley Grasslands State Park
San Luis NWR Freitas Unit
San Luis NWR West Bear Creek Unit
Salt Slough
East Branch
River
San Joaquin River
Rose Road
6th Ave


Looking north-northwest,
along the San Joaquin River


Photo Credit: American Rivers

Project Objectives

- Reconnect 160 acres of historic floodplain habitat to the San Joaquin River.
- Reduce invasive, exotic vegetation and restore native grassland and riparian habitats.
- Increase habitat for native fishes, birds, and terrestrial species.
- Reduce flood stage and velocity.
- Reduce costs and ecological impacts of continued levee maintenance.
- Model for successful integrated flood management projects in the San Joaquin Basin.
- Enhance park visitor experience.

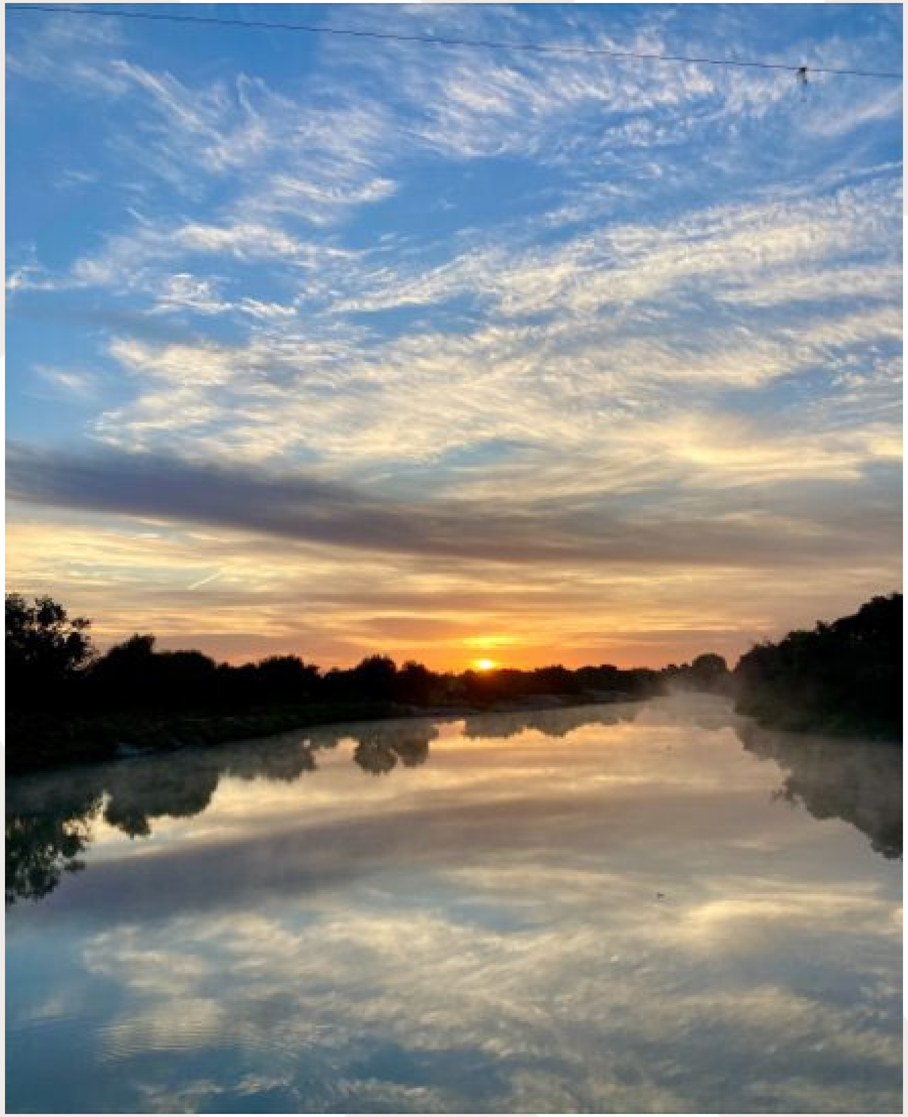
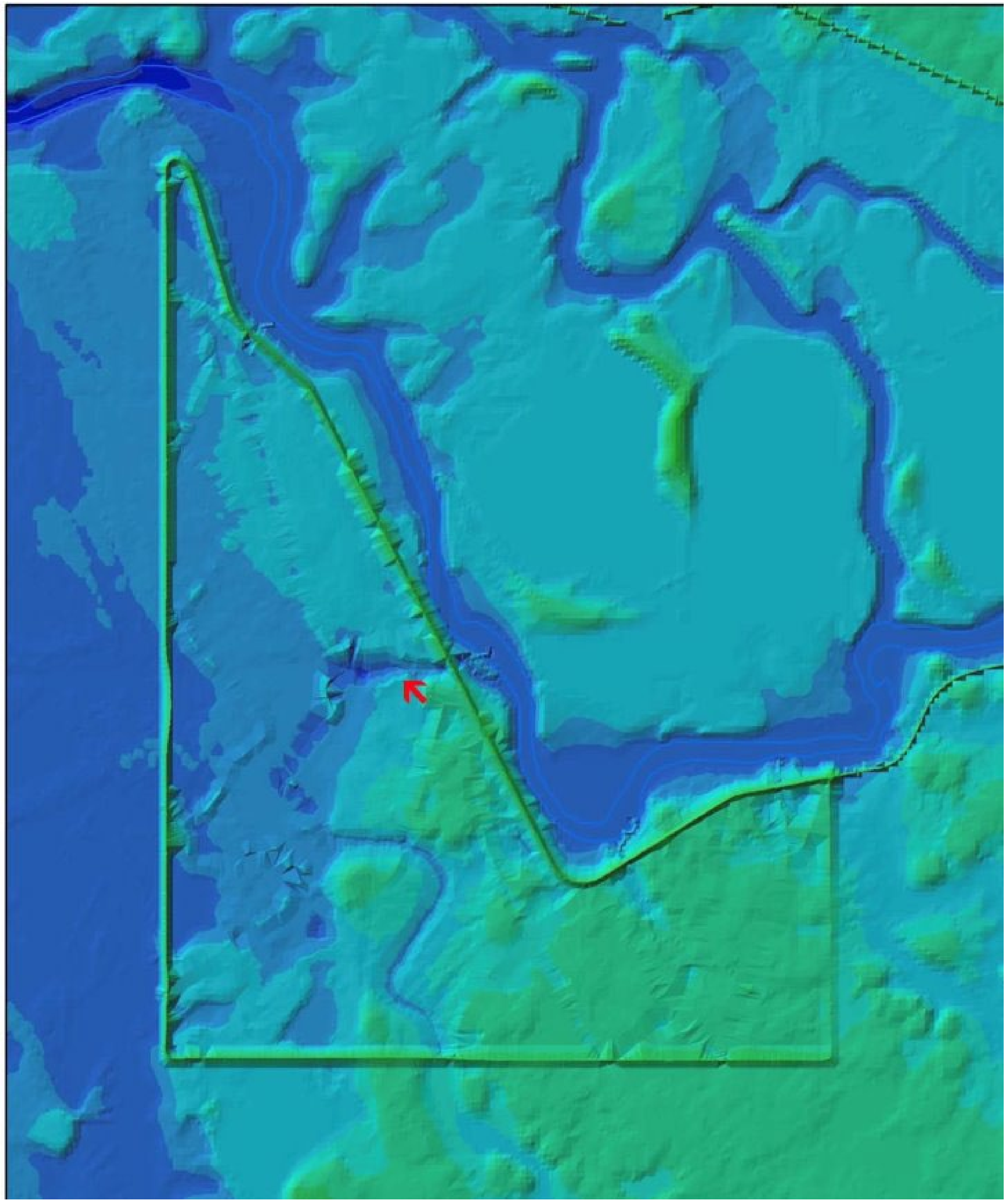


Photo Credit: Julia Sullivan, American Rivers

Site Topography



Map Credit: FlowWest

Map of Modeled Areas of Inundation

1,500cfs = 10% Daily Exceedance

44 acres flooded

Occurs in 22 of the 36 years in the period of record (61.1%)

Ecological Flow*

4,000cfs = 5% Daily Exceedance

160 acres flooded

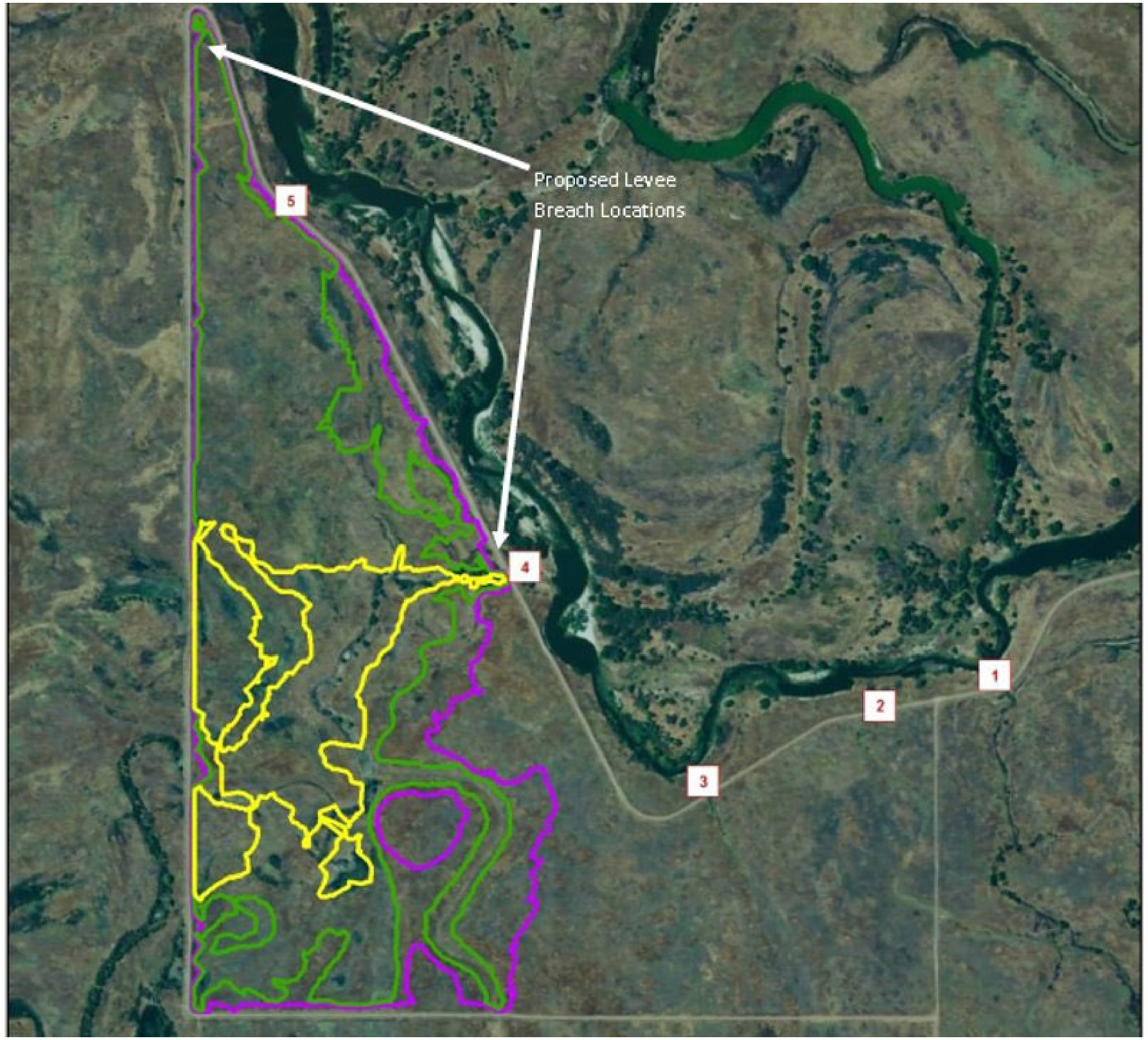
Occurs in 9 of the 36 years in the period of record (25%)

8,000cfs = 1% Daily Exceedance

211 acres flooded

Occurs in 3 of the 36 years in the period of record (8.3%)

Map Credit: FlowWest



Note: An* ***ecologically-relevant flow* *is a flow with frequency, duration, and timing characteristics capable of supporting more natural physical, biological, and chemical processes necessary to create and maintain habitat.*

Restoration Elements

- Lower San Joaquin Levee District transferred operation and maintenance of levees to CA State Parks

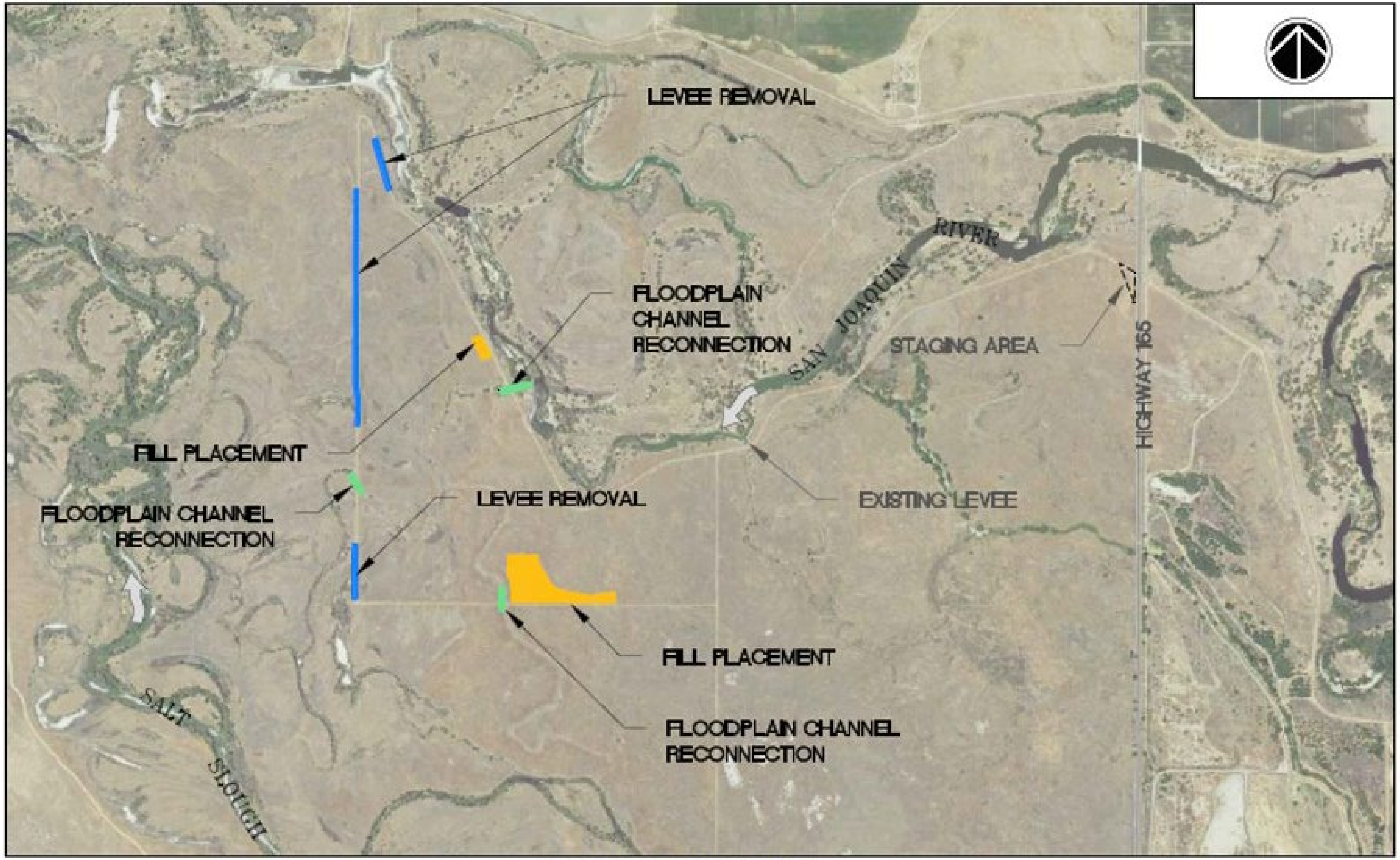
- Breach/remove strategic sections of levee
- **Levee breaches:** levees are notched and/or removed and allowed to erode over time
- **Channel reconnection areas:** sections of levee + defunct culverts removed from historic side channels

- Re-seed and plant restoration areas with native seed mix to encourage natural recruitment

- Post-implementation monitoring to track project effectiveness

Photo Credit: Sarah Puckett, American Rivers

Great Valley Grasslands 100% Designs



PROJECT OVERVIEW

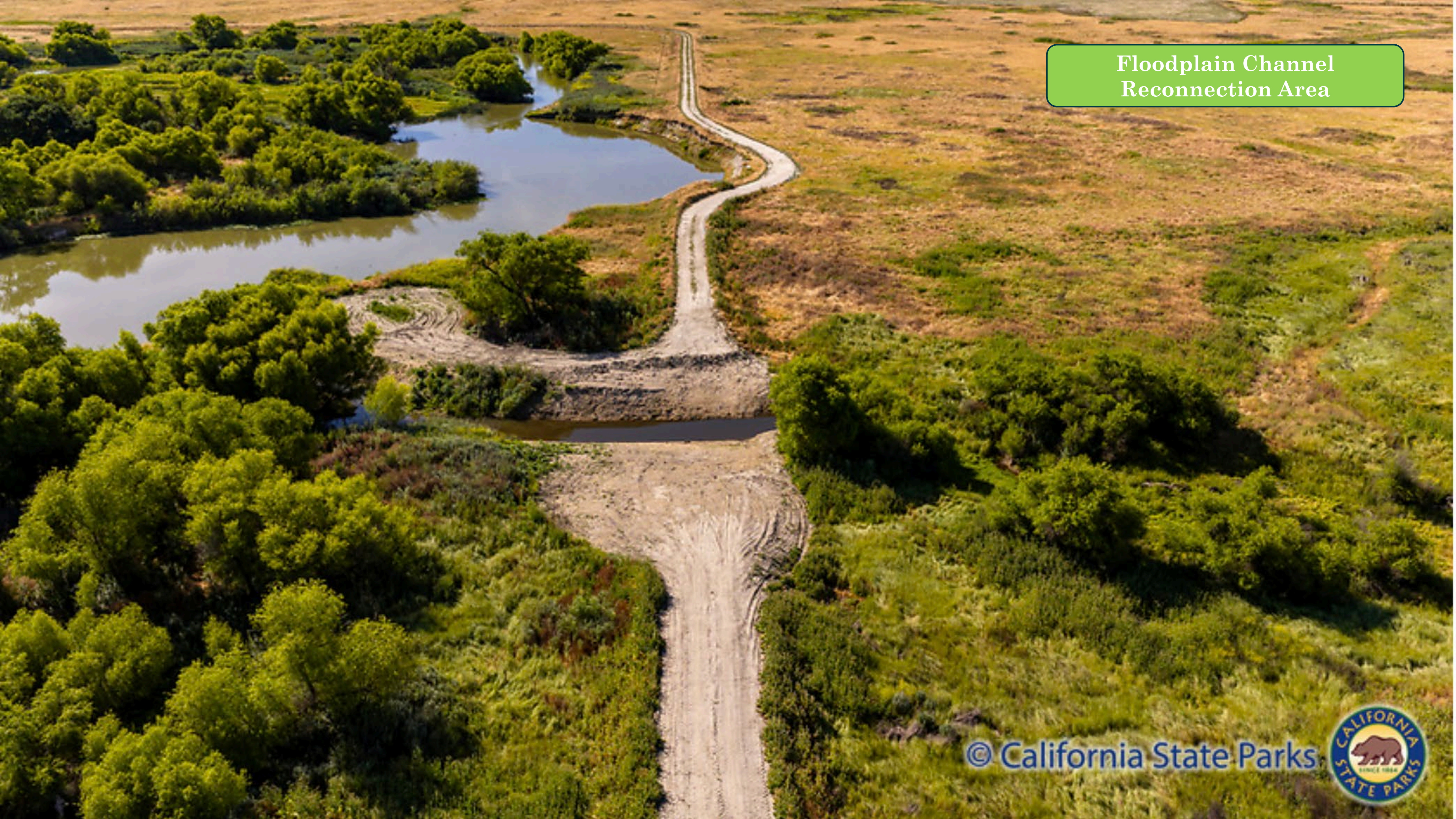
SCALE: 1" = 800'

0 400' 800' 1600'

Map Credit: FlowWest


Levee Breaches
Floodplain Channel Reconnection Area
Photo Credit: American Rivers


Levee
Breaches


Floodplain Channel
Reconnection Area
© California State Parks


California State Parks

California State Parks

Key Partnerships

Partner & Landowner: California Department of Parks and Recreation (CDPR)

Funders: California Department of Fish and Wildlife, Cox Enterprises, CDPR

Tribal Partner: Northern Valley Yokut Ohlone Tribe

Agency Partners: US Fish and Wildlife Service, California Department of Water Resources, Lower San Joaquin Levee District

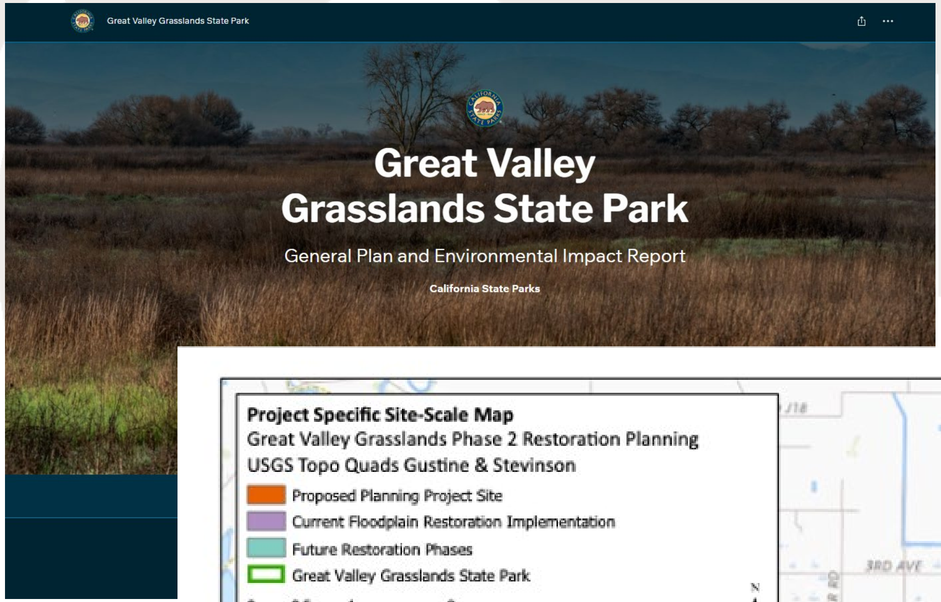
NGO Partners: River Partners

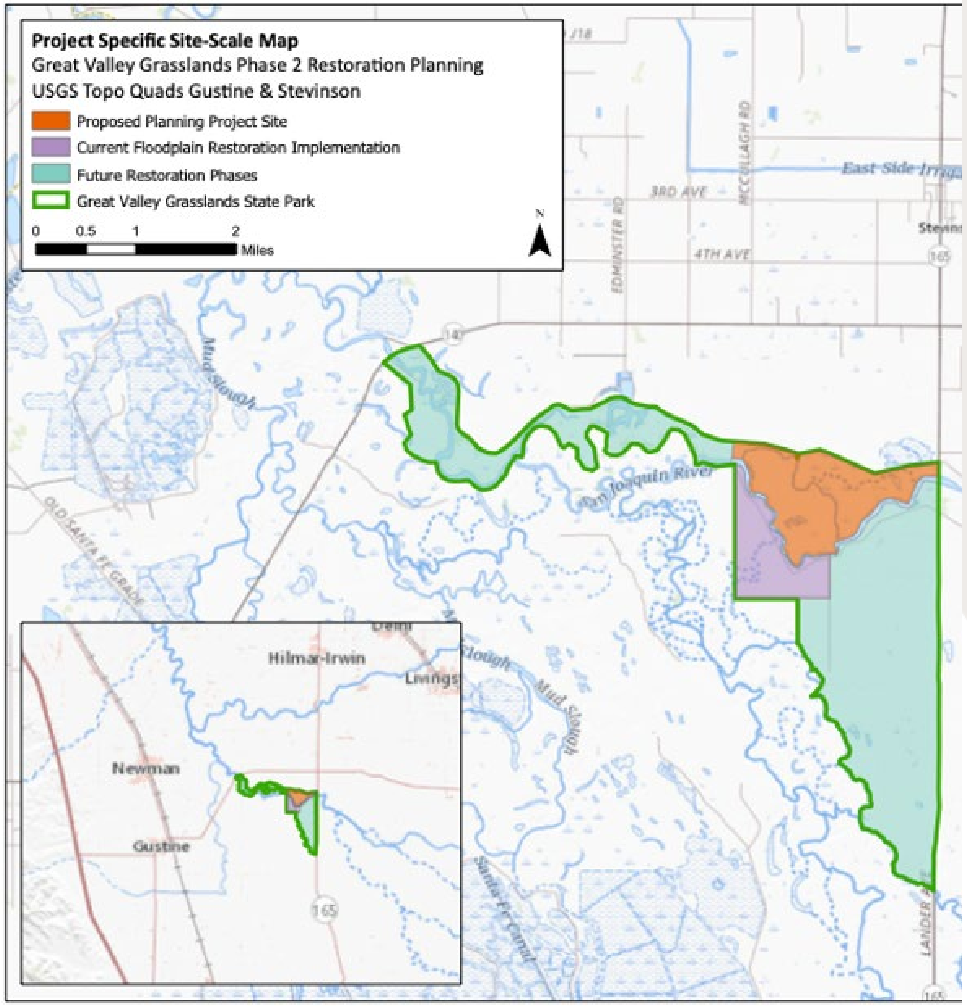
Consultants: FlowWest, FarWestern

Photo Credits (top to bottom): Sarah Puckett, American Rivers; Kristan Culbert, American Rivers

What's Next at Grasslands?

- Post-construction effectiveness monitoring
- Community-driven planning for public access and riparian restoration, funded by the CA Wildlife Conservation Board
- Great Valley Grasslands General Plan: an exciting vision for the park's future
- New partnerships with community-based organizations in nearby, "gateway" communities: Merced, Gustine, Stevinson, and Hilmar
- In partnership with tribal partners, cultural burning for vegetation management





Map Credit: American Rivers

Questions?

Life Depends on Rivers℠

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Recurrence Interval (years)	Likelihood of exceeding annual peak flows	Flows (cfs)
1.5	66%	500
2	50%	1200
5	20%	3500

Volumetric Water Benefit Accounting at Grasslands = 35.5MG

4 basketballs =1 cubic foot

Hydrologic and Hydraulic Modeling Yolo Bypass Cache Slough Master Plan (YBMP)

A Large-Scale Multi-Benefit Planning Effort for Flood Risk Reduction and Floodplain Restoration

2026 Salmonid Restoration Federation

April 30, 2026

Introductions

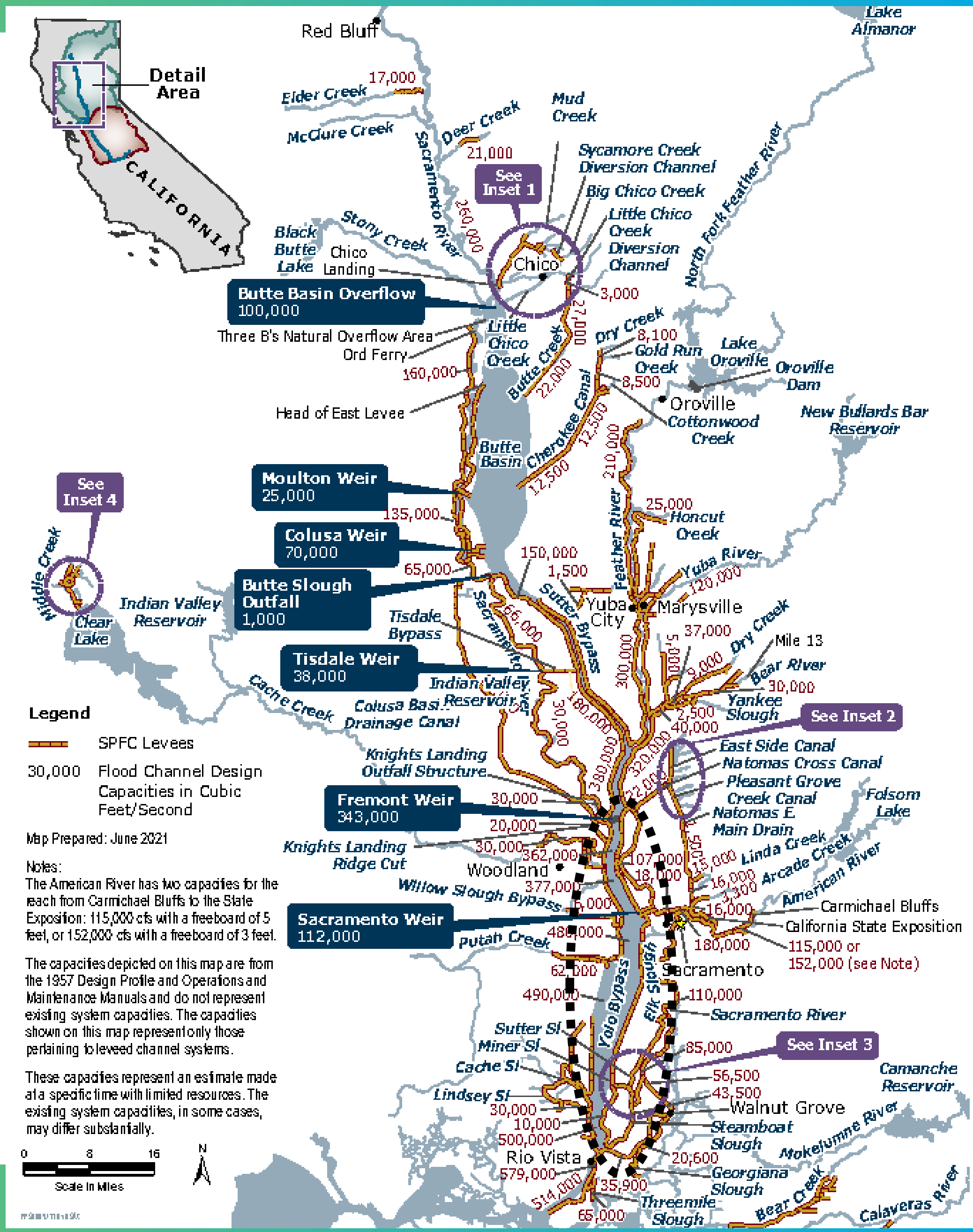
Speaker - Patrick Ho

- MBK Engineers, Sacramento, California
- Hydrology and Hydraulics (H&H)
    - California Central Valley
- Professional Civil Engineer, P.E.

Background

State Plan of Flood Control
Sacramento River Basin

- ~440 miles of river, canal, and stream channels,
- 1,000 miles of levees,
- Four relief bypasses (Sacramento, Yolo, Sutter, and Tisdale)
- Fiver major weirs (Sacramento, Fremont, Tisdale, Colusa, and Moulton weirs)

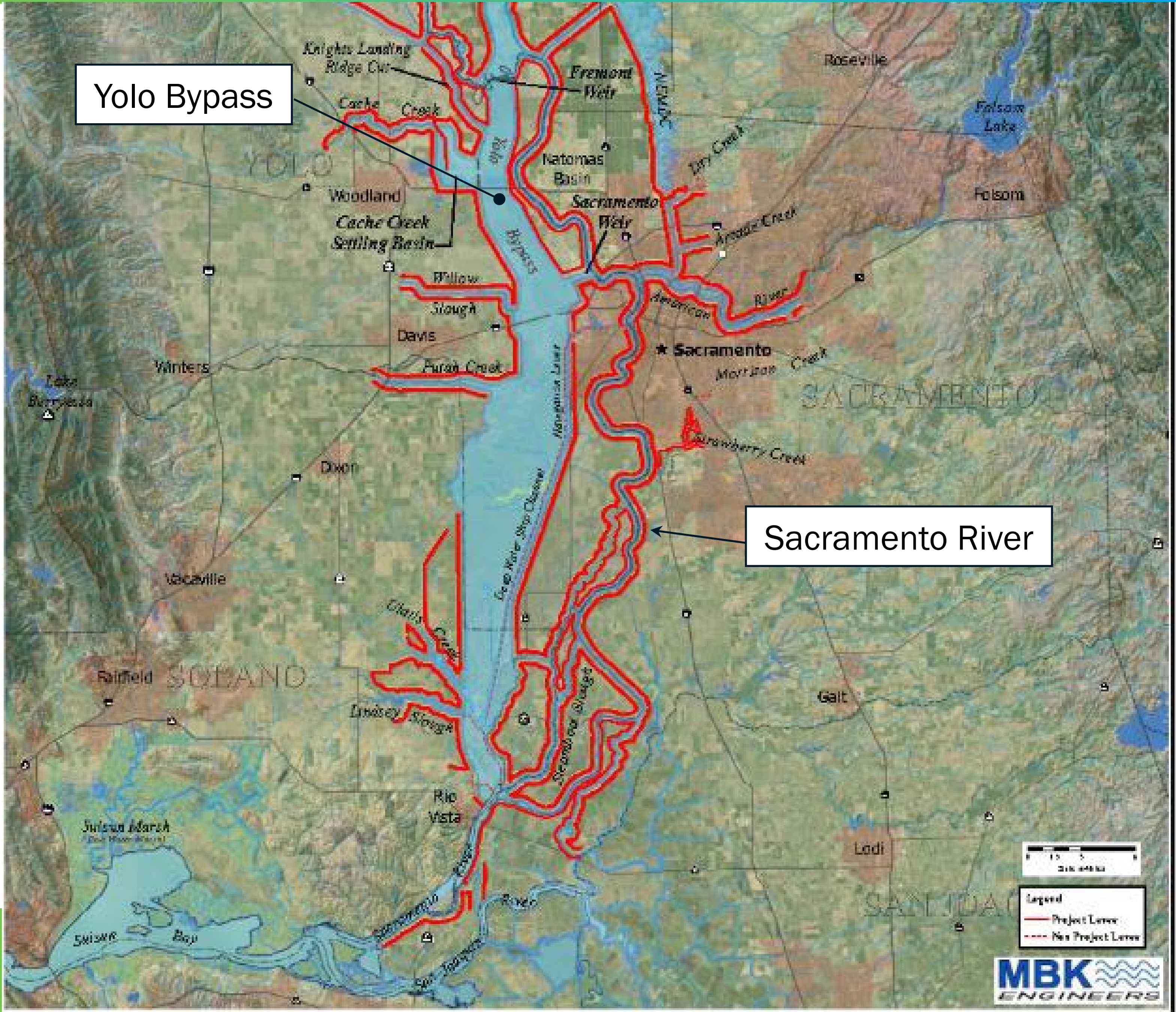


Yolo Bypass

- A 40-mile long, 59,000-acre federal flood management facility built in the 20th century to protect lives and property in the Sacramento River Basin. The whole of the Yolo Bypass extend from the Fremont Weir south to Rio Vista

- Historically supported thousands of acres of seasonal and tidal wetlands, riparian forests, and a complex of sloughs and tidal channels.

- YBCS region also supports important agricultural resources.

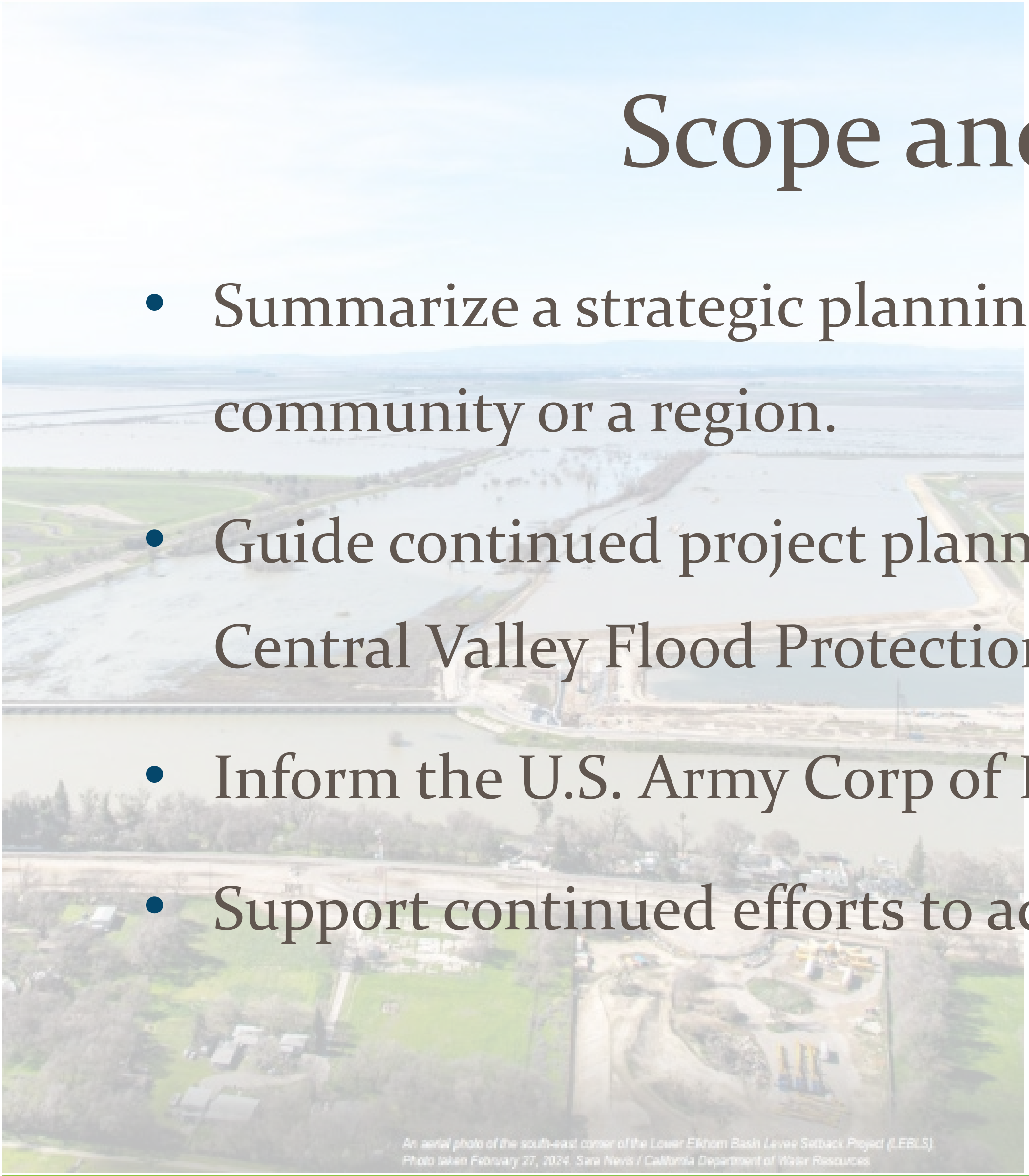


Yolo Bypass Master Plan

Yolo Bypass Cache Slough Partnership

Scope and Purpose of YBMP

- Summarize a strategic planning approach and to guide future actions in a community or a region.
- Guide continued project planning and implementation consistent with the Central Valley Flood Protection Plan (**CVFPP**) and its Conservation Strategy (**CS**).
- Inform the U.S. Army Corp of Engineers (**USACE**) Yolo Comprehensive Study.
- Support continued efforts to advance the goals of the YBCS Partnership.



An aerial photo of the south-east corner of the Lower Elkhorn Basin Levee Setback Project (LEBLS)
Photo taken February 27, 2024. Sara Nevis / California Department of Water Resources

Yolo Bypass Cache Slough (YBCS) Partnership

- California Department of Fish and Wildlife
- California Department of Water Resources
- California Natural Resources Agency
- Central Valley Flood Protection Board
- Central Valley Regional Water Quality Control Board
- County of Solano
- County of Yolo
- Reclamation District No. 2068
- Sacramento Area Flood Control Agency
- Solano County Water Agency
- State Water Resources Control Board
- U.S. Army Corps of Engineers
- U.S. Bureau of Reclamation
- U.S. Fish and Wildlife Service
- U.S. National Marine Fisheries Service
- West Sacramento Area Flood Control Agency

Technical Evaluations

- DWR and CVFPB initiated the YBMP in 2020 to fulfill the need to support a programmatic approach for a **Section 408 permission** request from USACE.

- Determine hydraulic performance and associated benefits to the overall flood control system from all locally sponsored projects.

- To support development and refinement of additional projects that will accommodate the multiple-benefits in the Yolo Bypass through the hydraulic effects and performance.

Regulatory

USACE Section 408

- The US Army Corps of Engineers (USACE) Section 408 program allows another party, such as a local government, company, or individual, to alter a USACE Civil Works project.

- The Section 408 program verifies that changes to authorized USACE Civil Works projects will not be injurious to the public interest and will not impair the usefulness of the project[1].

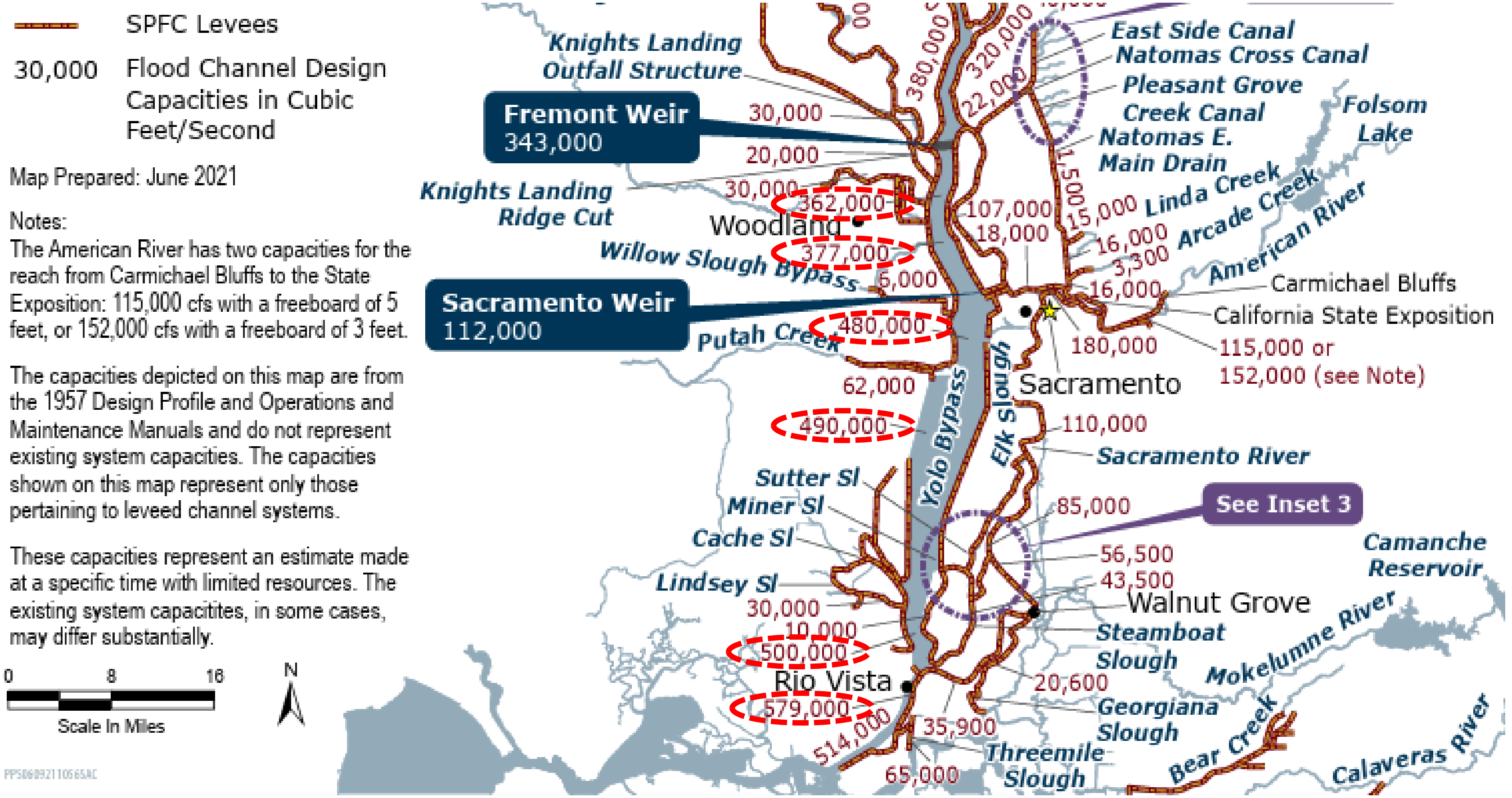
[1] Section 14 of the Rivers and Harbors Act of 1899 amended and codified at 33 U.S.C. 408.

Aerial photo shows the Yolo Bypass. Photo taken February 27, 2024.
Sara Nevis / California Department of Water Resources

USACE Civil Works Project

Source: Central Valley Flood Protection Plan 2022
State Plan of Flood Control

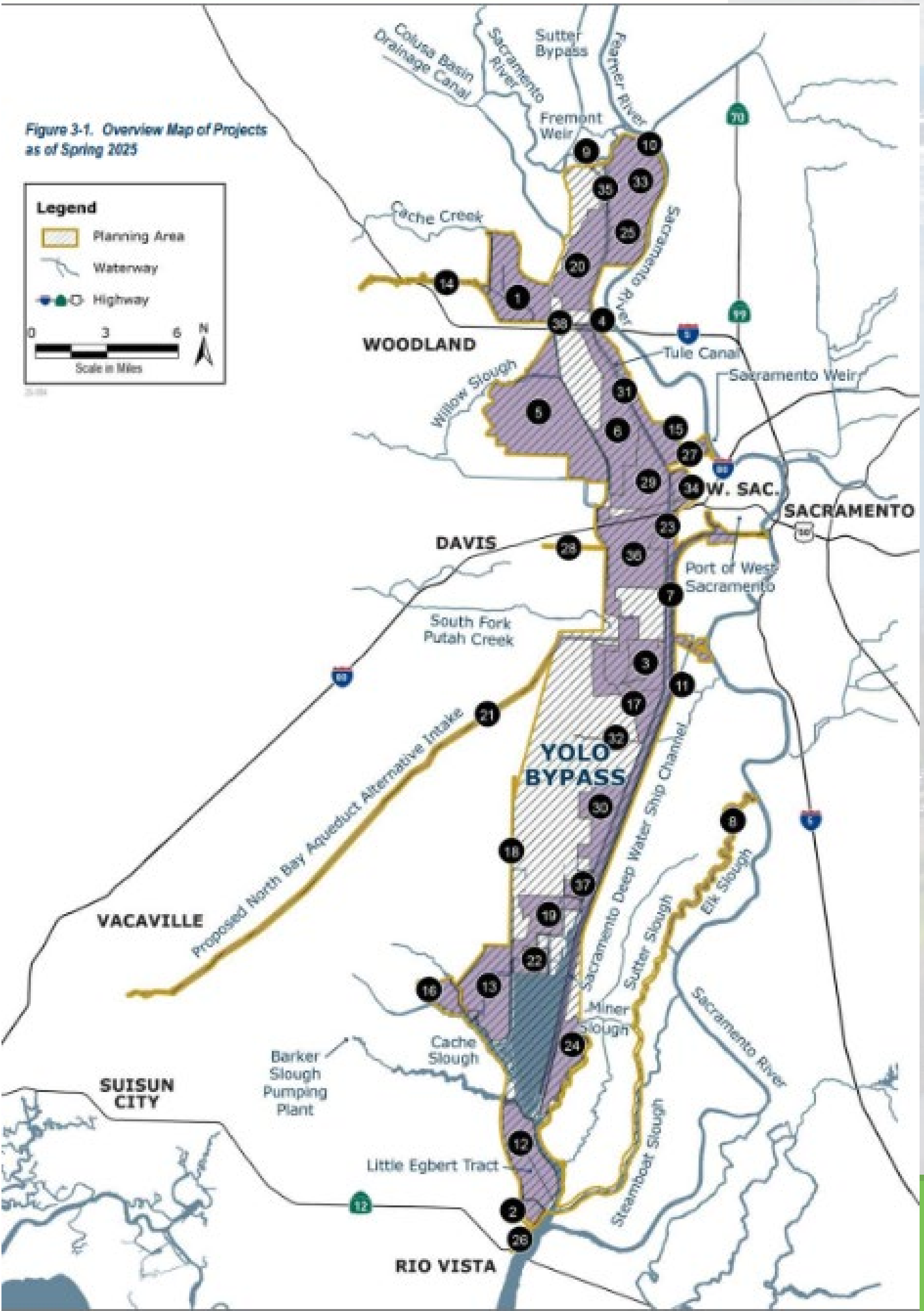
- Yolo Bypass Design Flow
  - **362,000 cfs** - Fremont Weir to Interstate 5
  - **377,000 cfs** – Interstate 5 to Sacramento Bypass
  - **480,000 cfs** – Interstate 80 to Putah Creek
  - **490,000 cfs** - Putah Creek to Cache Slough
  - **500,000 cfs** - Cache Slough to Sacramento River
  - **579,000 cfs** -downstream of confluence of Cache Slough and Sacramento River (Rio Vista)



Technical Evaluations

- The core hydrologic and hydraulic analysis is to demonstrate that changes to authorized USACE Civil Works projects will not be injurious to the public interest and will not impair the usefulness of the project.
  - System impacts due to change in frequency, depth, duration, or extent of flooding.
  - Full range of flood hydrologic conditions
  - Changes in water surface elevation
  - Changes in flow, velocity, frequency, and duration

H&H Modeling Approach



Sponsored Projects

Project Names and Locations

1. Cache Creek Settling Basin Project
2. Cache Slough Mitigation Bank
3. Central Yolo Bypass Wildlife Area Drainage Improvement Master Project
4. Conaway Main Supply Canal Augmentation
5. Conaway Ranch Levee Setback [a]
6. Conaway Ranch Salmonid Project [a]
7. Deep Water Ship Channel Improvements [a]
8. Elk Slough Fish Passage and Flood Improvement Project [a]
9. Fremont Weir Adult Fish Passage Modification Project [a]
10. Fremont Weir Expansion [a]
11. Lisbon Weir [a]
12. Little Egbert Multi-benefit Project [a]
13. Lookout Slough Tidal Habitat Restoration and Flood Improvement Project [a]
14. Lower Cache Creek Project [a]
15. Lower Elkhorn Basin Levee Setback Project [a]
16. Lower Peters Pocket Multi-benefit Project
17. Los Rios Check Dam Fish Passage Enhancement Project
18. Lower West Side Levee Improvements
19. Lower Yolo Ranch Tidal Restoration Project [a]
20. Nigiri – Knaggs Ranch [a]
21. North Bay Aqueduct Alternative Intake
22. North Delta Fish Conservation Bank [a]
23. Northern Yolo Bypass Wildlife Area Drainage Improvement Master Project
24. Prospect Island Tidal Habitat Restoration Project [a]
25. RD 1600 Pump Station and Gravity Drain Improvements
26. Rio Vista Small Communities Flood Risk Reduction Project [a]
27. Sacramento Bypass North Levee Setback and Sacramento Weir Expansion [a]
28. South Davis Pump Station and Gravity Drain Improvement
29. Swanston Ranch Master Plan [a]
30. Tide's End Project
31. Tule Canal Corridor Multi-benefit Enhancement Project [a]
32. Tule Ranch Canal and Pump Improvements
33. Upper Elkhorn Basin Expansion [a]
34. Yolo Bypass East Levee Improvement Project
35. Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Big Notch) [a]
36. Yolo Bypass Wildlife Area Habitat and Drainage Improvement Project [a]
37. Yolo Flyway Farms [a]
38. Yolo Rail Realignment

Bypass-wide:

Local Advancement and Agricultural Resiliency

Yolo Bypass Drainage Outlet Infrastructure Improvement Project

Programmatic Section 408

- A Programmatic 408 ~ cumulative rather than through separable elements.
- Individual projects "may" show projects effects that impair usefulness of the flood control project.

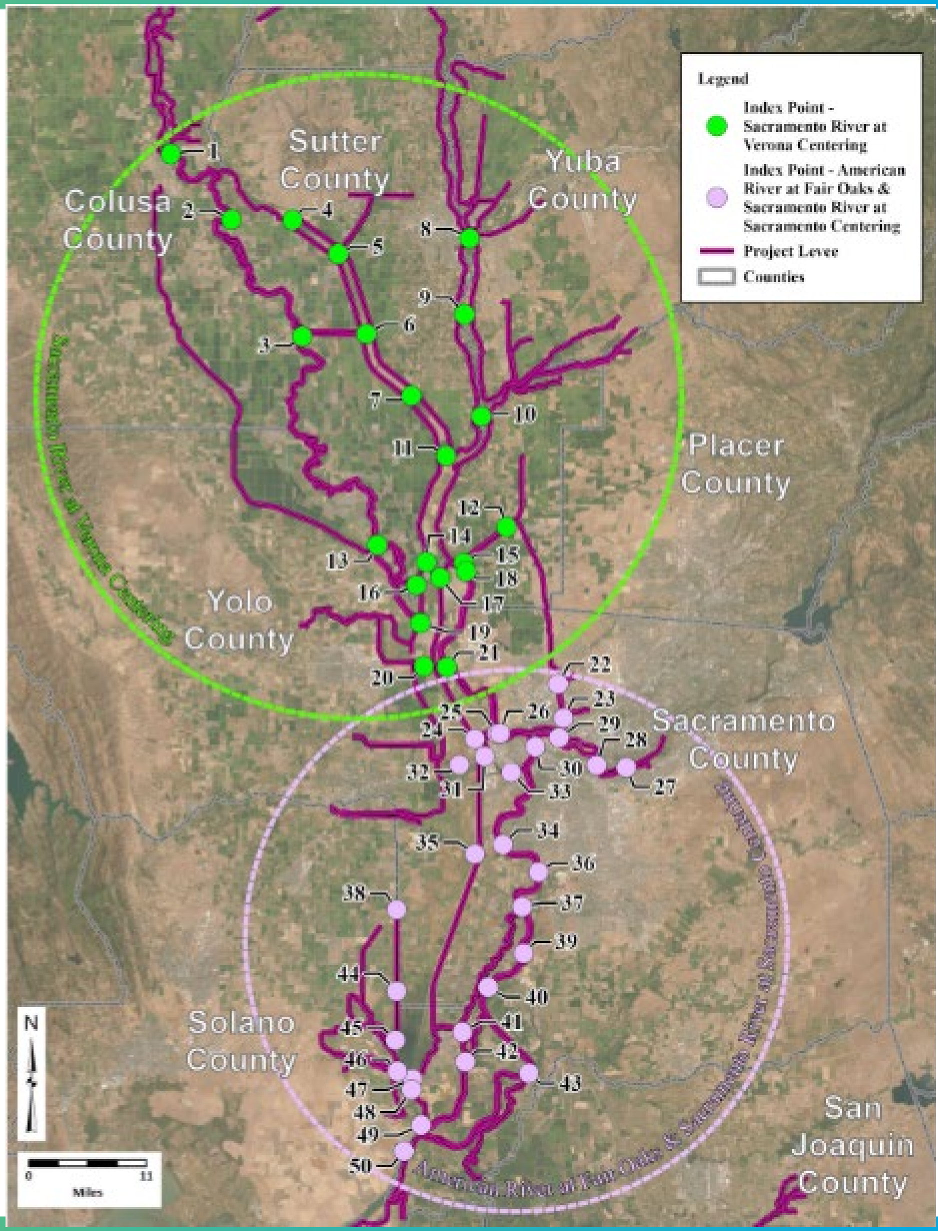
Plan of Study

- Phasing Rationale – Project Status
  - **Authorized or in-construction:**
    - Phase 1 Projects (6) – Near term implementation timeline; Projects have been authorized; secured funding for construction,
  - **Projects in Design and Planning**
    - Phase 2 Projects (5) – Improve *downstream* flow conveyance and ecosystem function,
    - Phase 3 Projects (4) – Improve *upstream* flow conveyance and ecosystem function,
    - Yolo Bypass Cache Slough Master Plan (7) – Evaluate additional projects that potentially meets multi-benefit pillars.

Salmon. Photo taken September 6, 2016.
River Partners

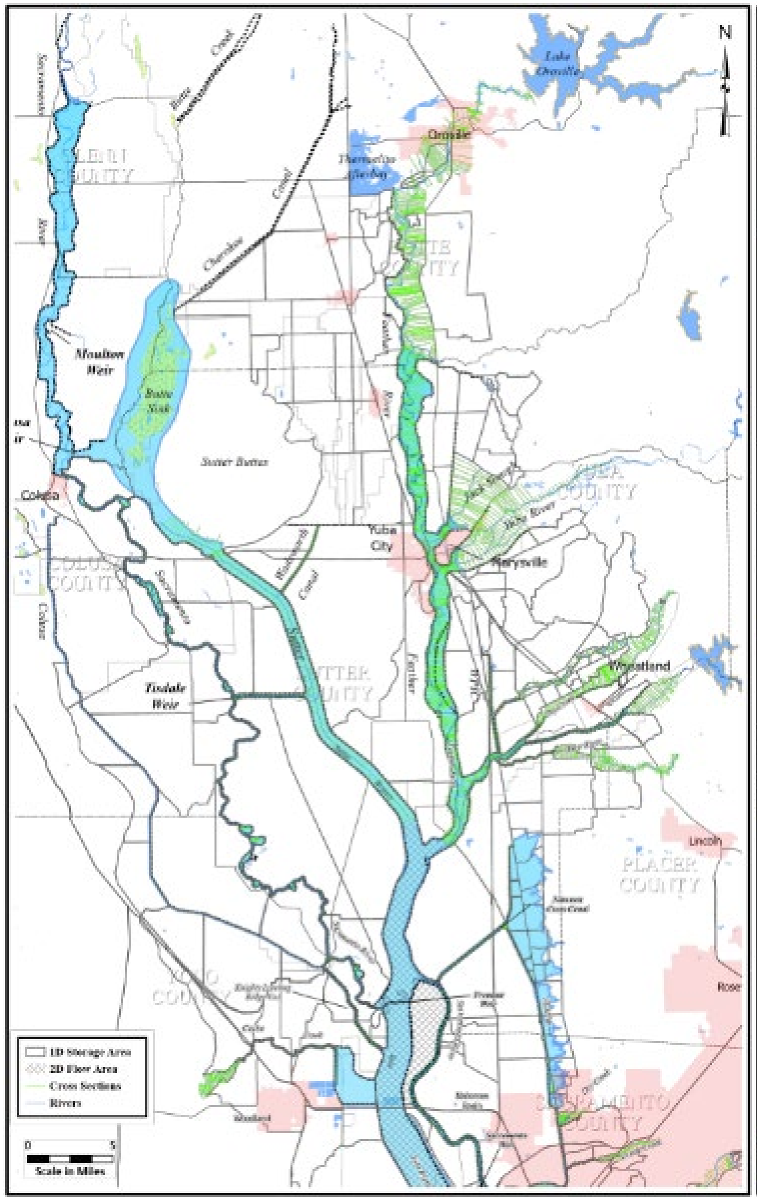
Plan of Study - Hydrology

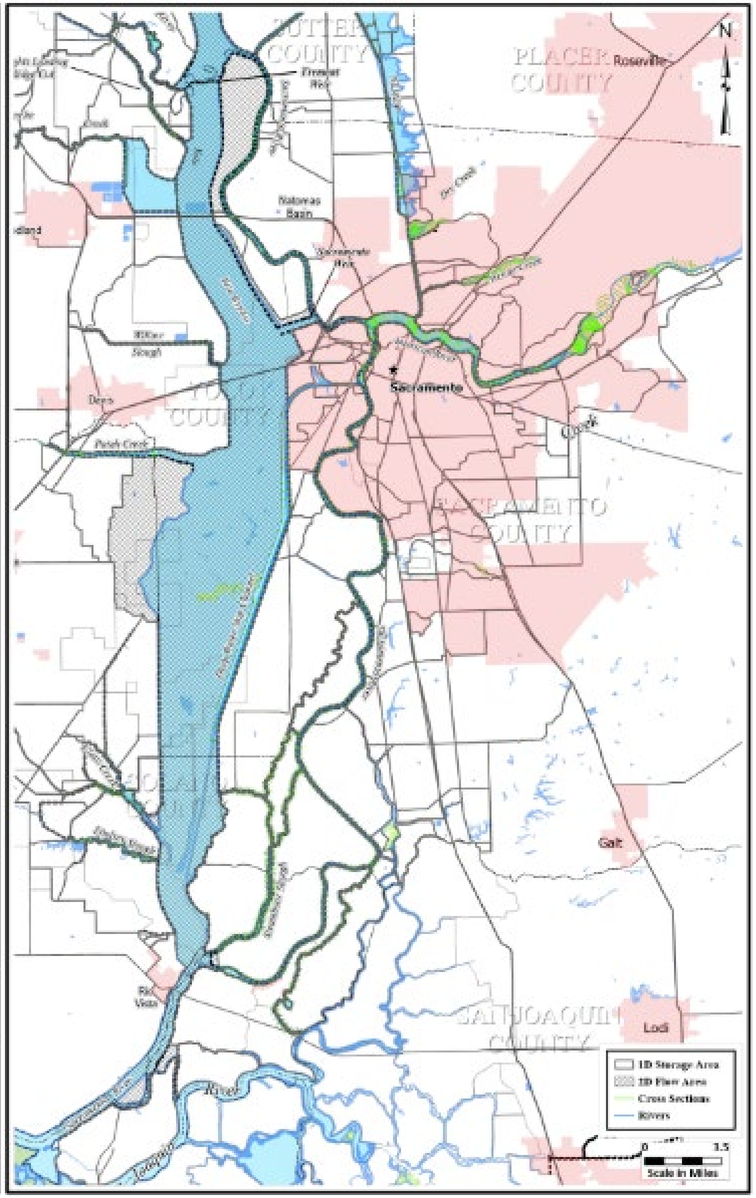
- Risk and Uncertainty Analysis
  - Simulate 'n'-year floods (2-, 5-, 10-, 25-, 50-, 100-, 200-, 325-, 500-year)
  - Two flood centering at 1.) the latitude of Verona and 2.) latitude of Sacramento / American River
- Evaluate changes in hydrodynamics under climate change projections from CVFPP 2022.
  - Low (Warmer, drier climate conditions),
  - Medium (Central tendency),
  - High (Hotter, wetter climate conditions).



Plan of Study - Hydraulics

- HEC-RAS model
  - 2D Model representation of the Sutter and Yolo Bypass from latitude of Nicolaus on the Feather to Rio Vista on the Sacramento River.
  - Otherwise, 1D Model representation which includes the Sacramento at Colusa, Feather, Bear, Yuba, and American Rivers. Also includes the Sacramento River Delta streams and Cache Slough Complex.



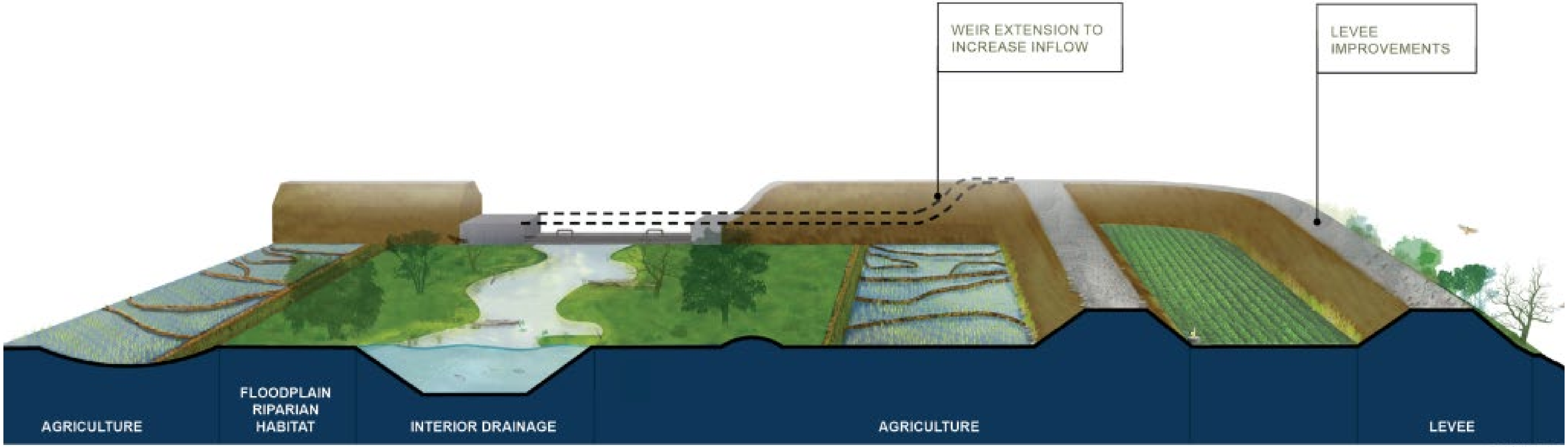


Pillars / Sponsored Projects

Flood Protection Pillar

POTENTIAL FLOOD PILLAR PROJECT FEATURES, CONTINUED

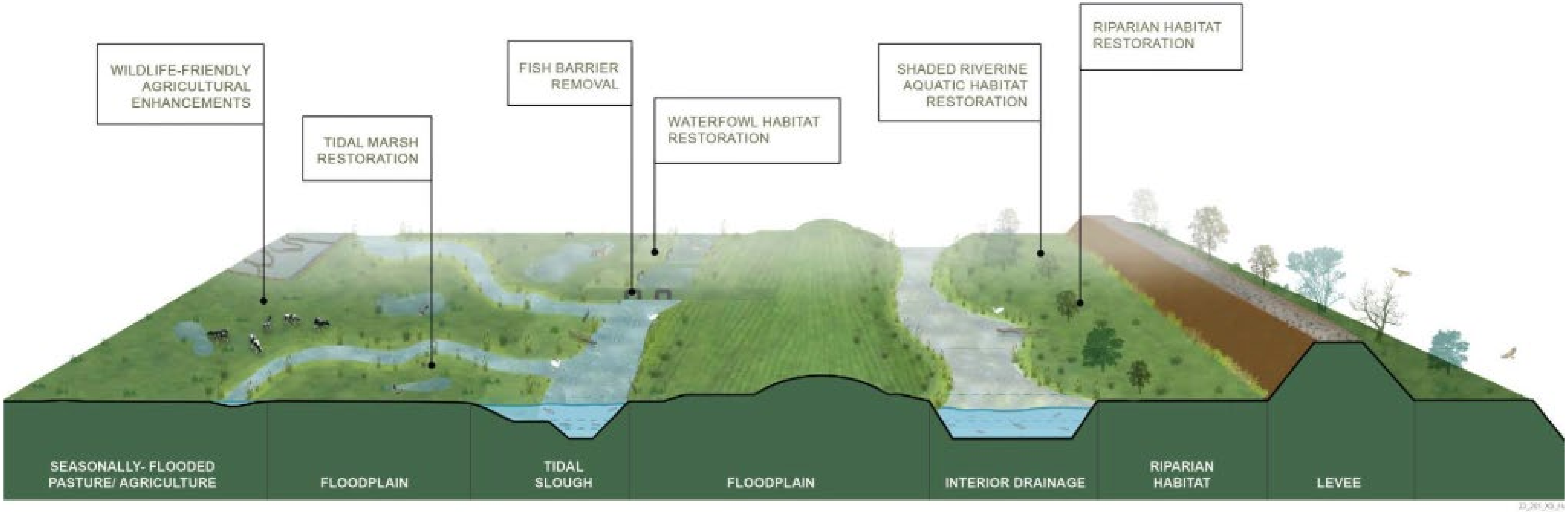
Artistic representation of example features that may contribute to the flood pillar only.
Not a depiction of the intended layout of the future YBCS landscape



Habitat Pillar

POTENTIAL HABITAT PILLAR PROJECT FEATURES

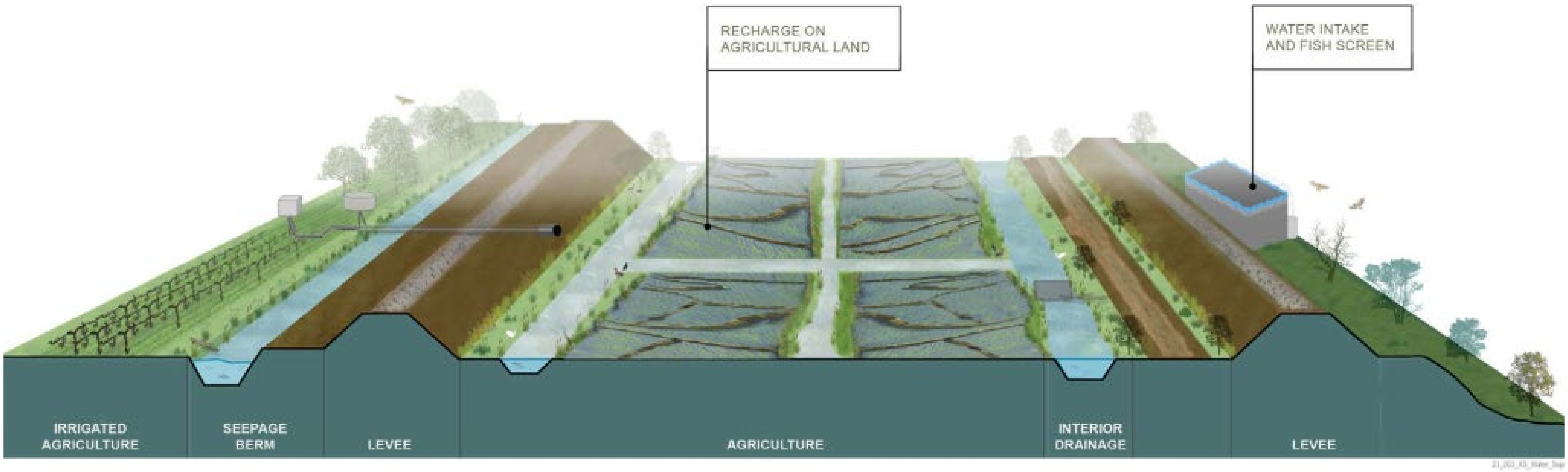
Artistic representation of example features in the Yolo Bypass that may contribute to the habitat pillar only. Not a depiction of the intended layout of the future YBCS landscape.



Water Supply Pillar

POTENTIAL WATER SUPPLY PILLAR PROJECT FEATURES

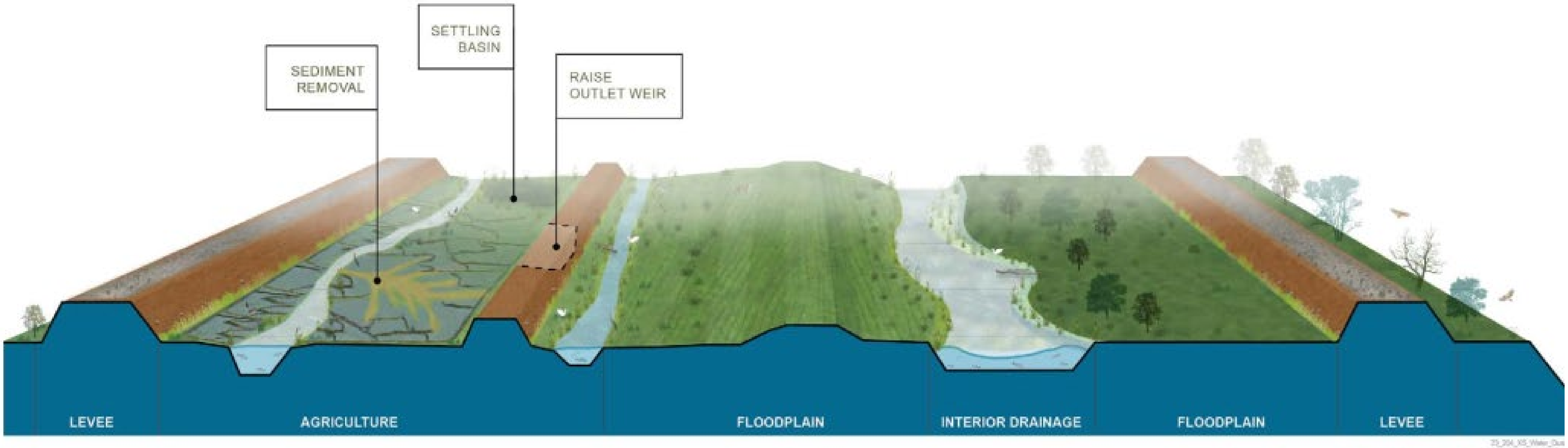
Artistic representation of example features that may contribute to the water supply pillar only.
Not a depiction of the intended layout of the future YBCS landscape.

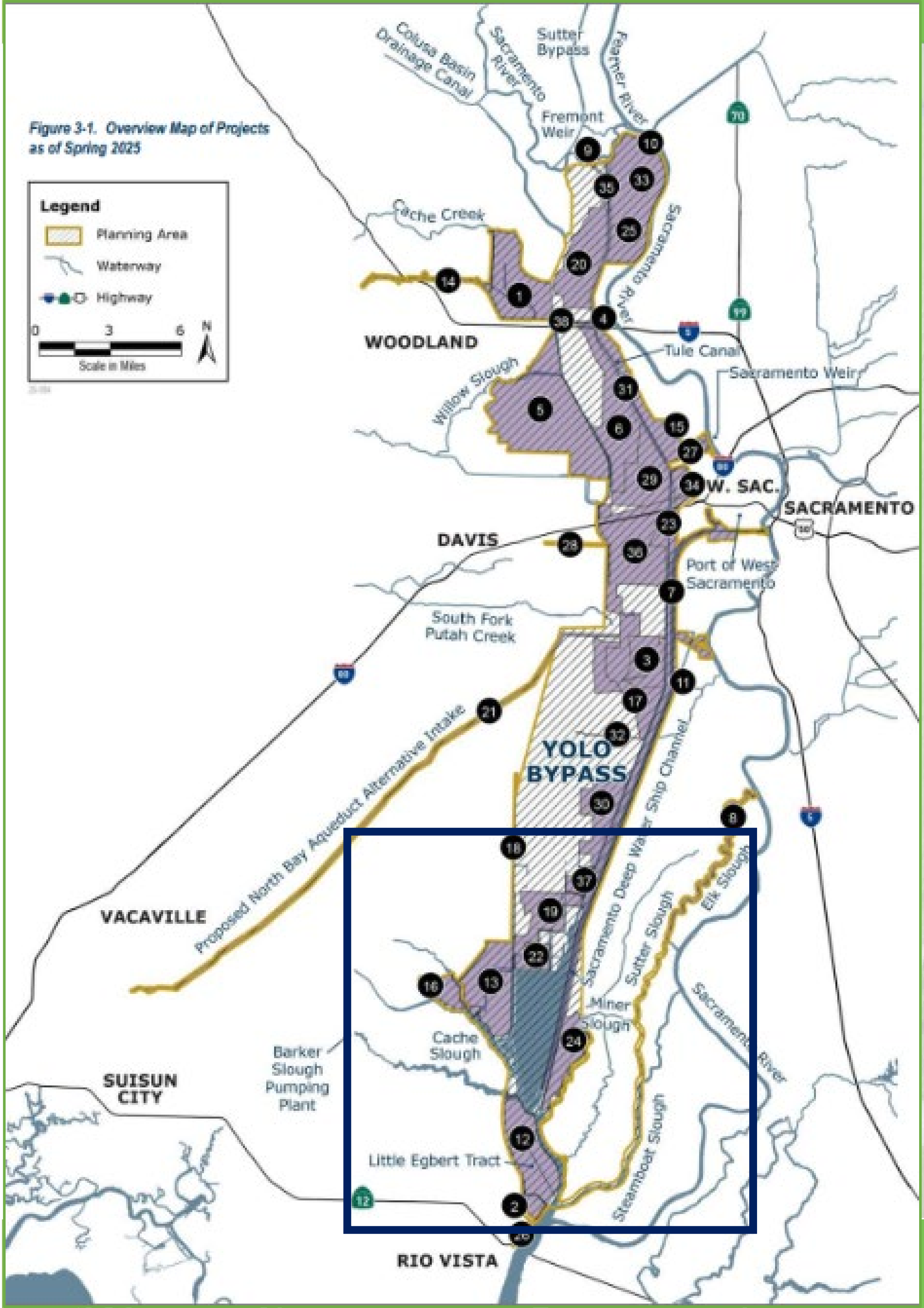


Water Quality Pillar

POTENTIAL WATER QUALITY PILLAR PROJECT FEATURES

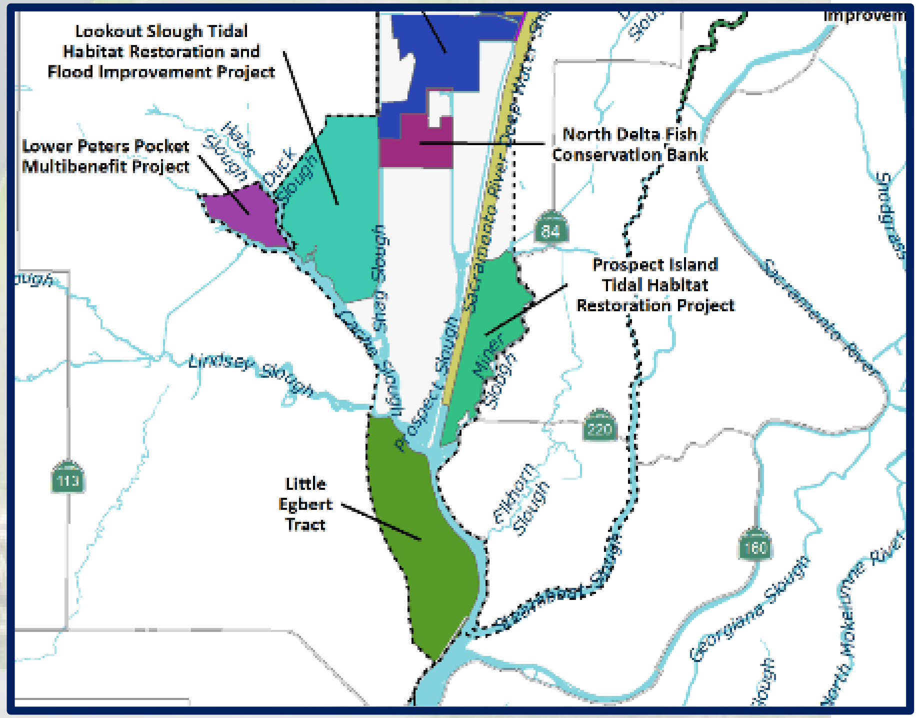
Artistic representation of example features that may contribute to the water quality pillar only.
Not a depiction of the intended layout of the future YBCS landscape.

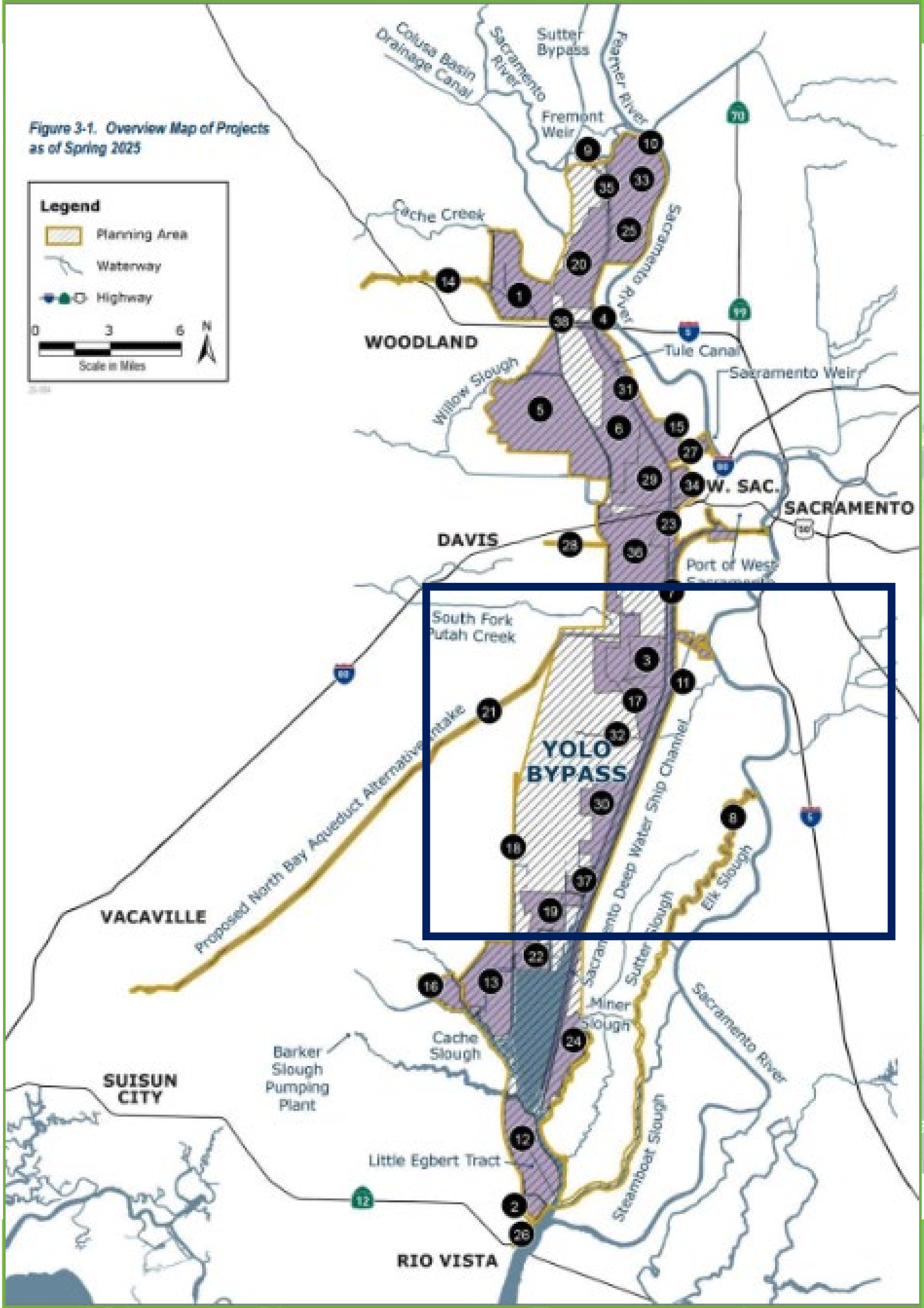




Lower Yolo Bypass

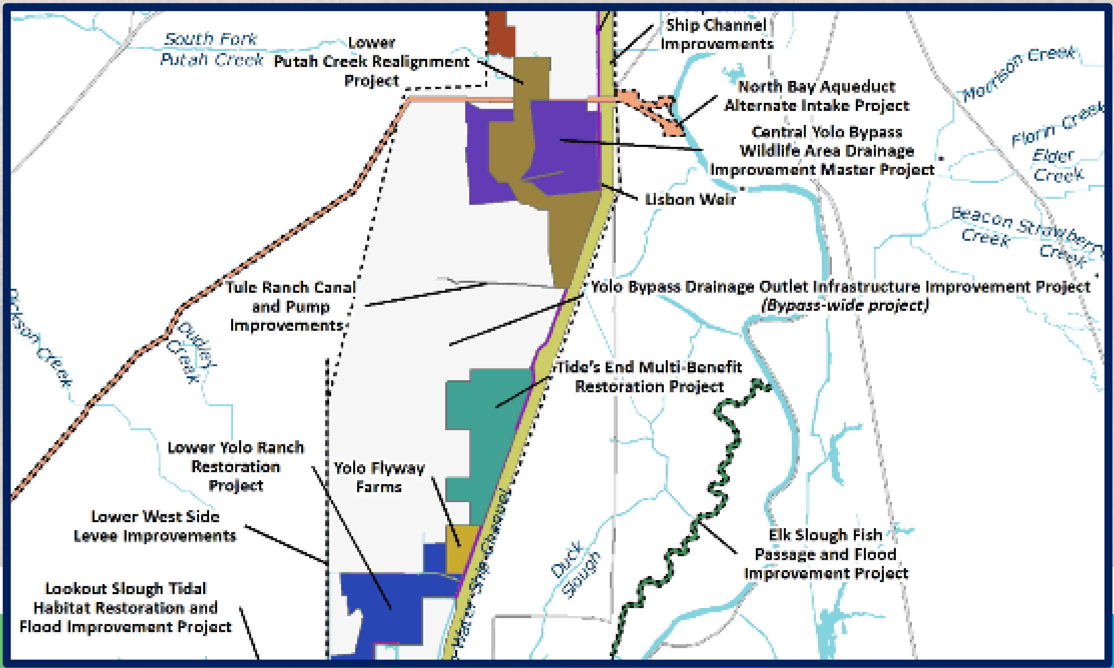
- Improve flood conveyance; provide transitory flood storage; restore tidal habitat and flow regime by degrading levees, construct habitat channels, and revegetate agricultural lands.

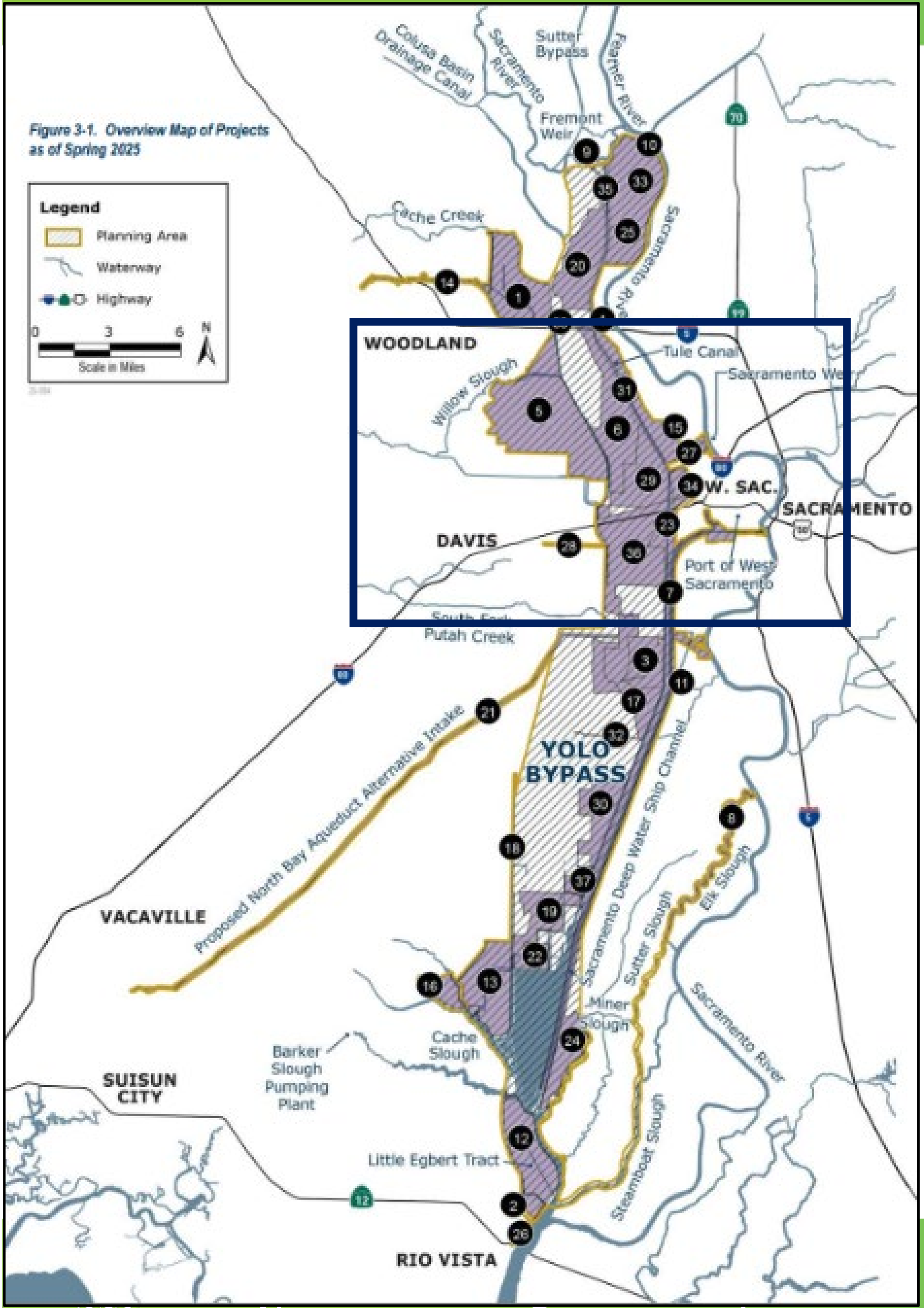




Yolo Bypass – Putah Creek to RD 2068

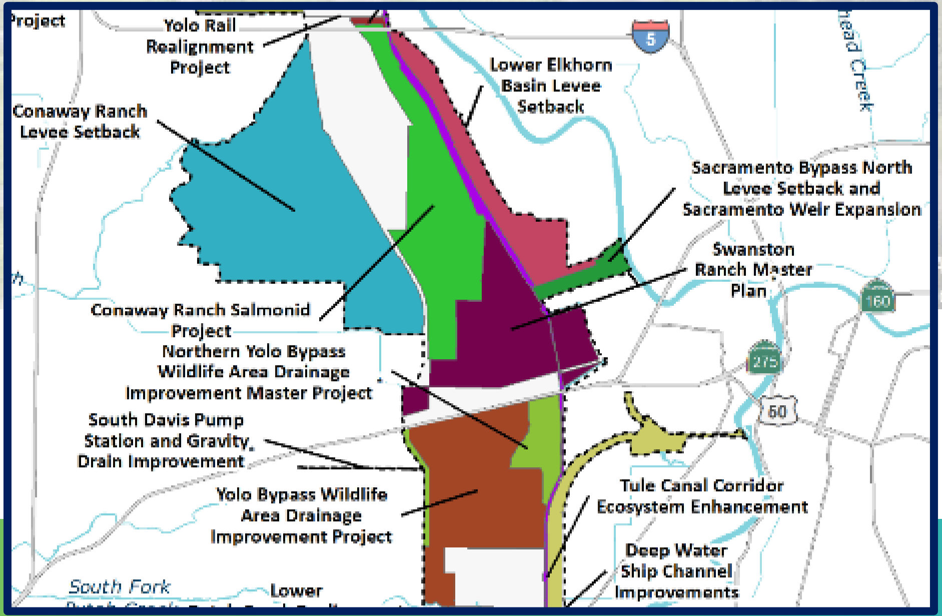
- Restore flood conveyance; restore tidal habitat; improve fish passage; and create riparian corridor.

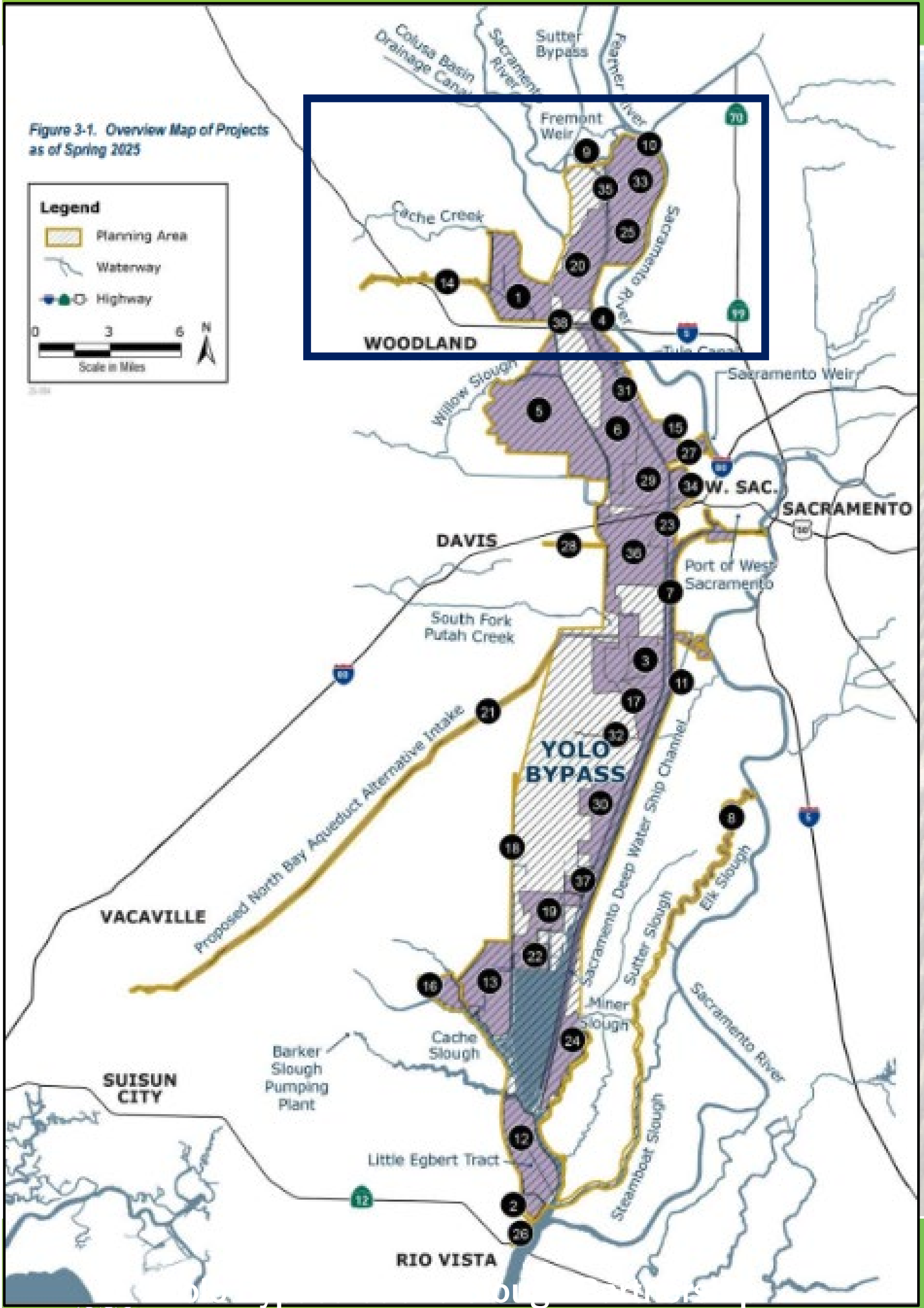




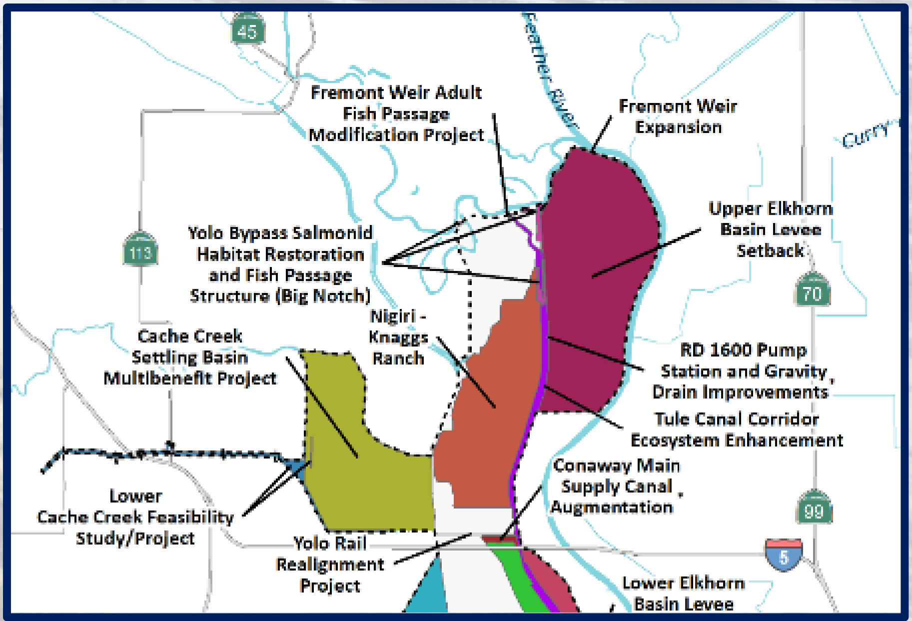
Yolo Bypass - Interstate 5 to Interstate 80

- Widen the Yolo and Sacramento Bypass; provide transitory flood storage; enhance juvenile salmon rearing habitat; improve fish passage; and construct riparian corridor.





Upper Yolo Bypass



- Expand Fremont weir; enhance juvenile rearing habitat; improve fish passage; create riparian corridor; and construct flood control levee.

Aerial photo of the Yolo Bypass Salmonid Habitat Restoration and Fish Passage (Big Notch) Project. Photo taken February 27, 2024.

Findings

Reporting Metrics
Changes in Water Surface Elevations

Sacramento River at Knights Landing (IP 13)

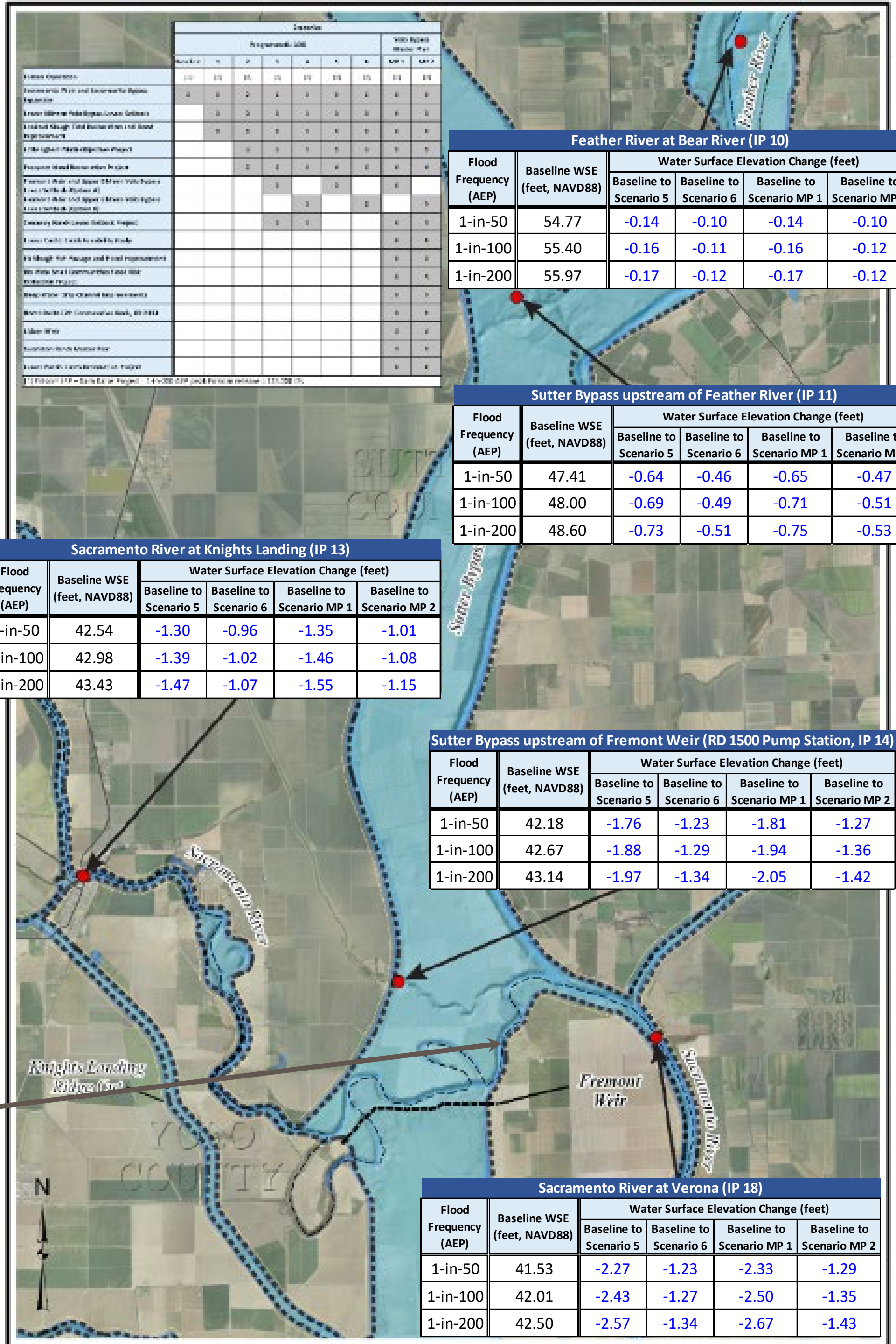
Flood Frequency (AEP)	Baseline WSE (feet, NAVD88)	Water Surface Elevation Change (feet)			
		Baseline to Scenario 5	Baseline to Scenario 6	Baseline to Scenario MP 1	Baseline to Scenario MP 2
1-in-50	42.54	-1.30	-0.96	-1.35	-1.01
1-in-100	42.98	-1.39	-1.02	-1.46	-1.08
1-in-200	43.43	-1.47	-1.07	-1.55	-1.15

Baseline Conditions Water Surface Elevation

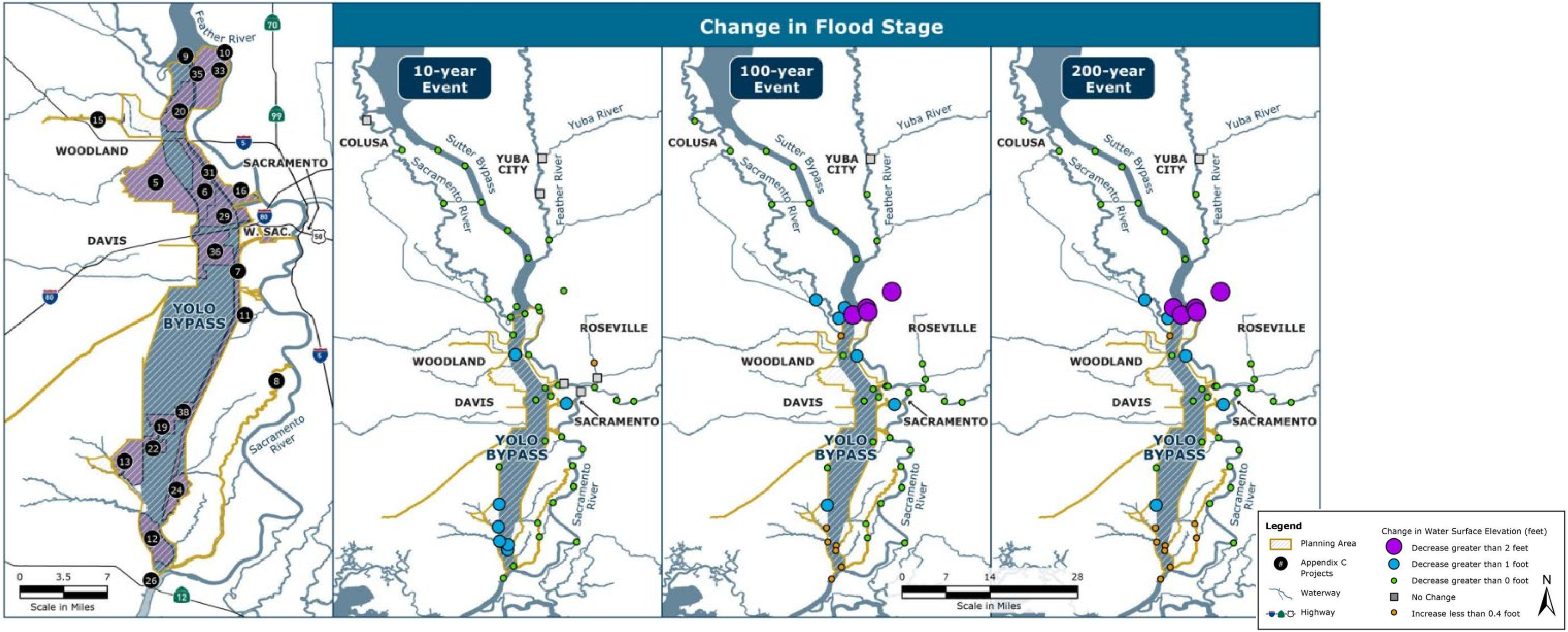
Scenario Water Surface Elevation
Minus
Baseline Conditions

Peak Flow over Fremont Weir (Spill into YBP)

Flood Frequency (AEP)	Baseline Peak Flow (kcfs)	Changes in Peak Flow (kcfs)			
		Baseline to Scenario 5	Baseline to Scenario 6	Baseline to Scenario MP 1	Baseline to Scenario MP 2
1-in-50	370	+23	+14	+23	+14
1-in-100	390	+27	+17	+27	+17
1-in-200	412	+31	+19	+30	+19



Flood Risk Reduction



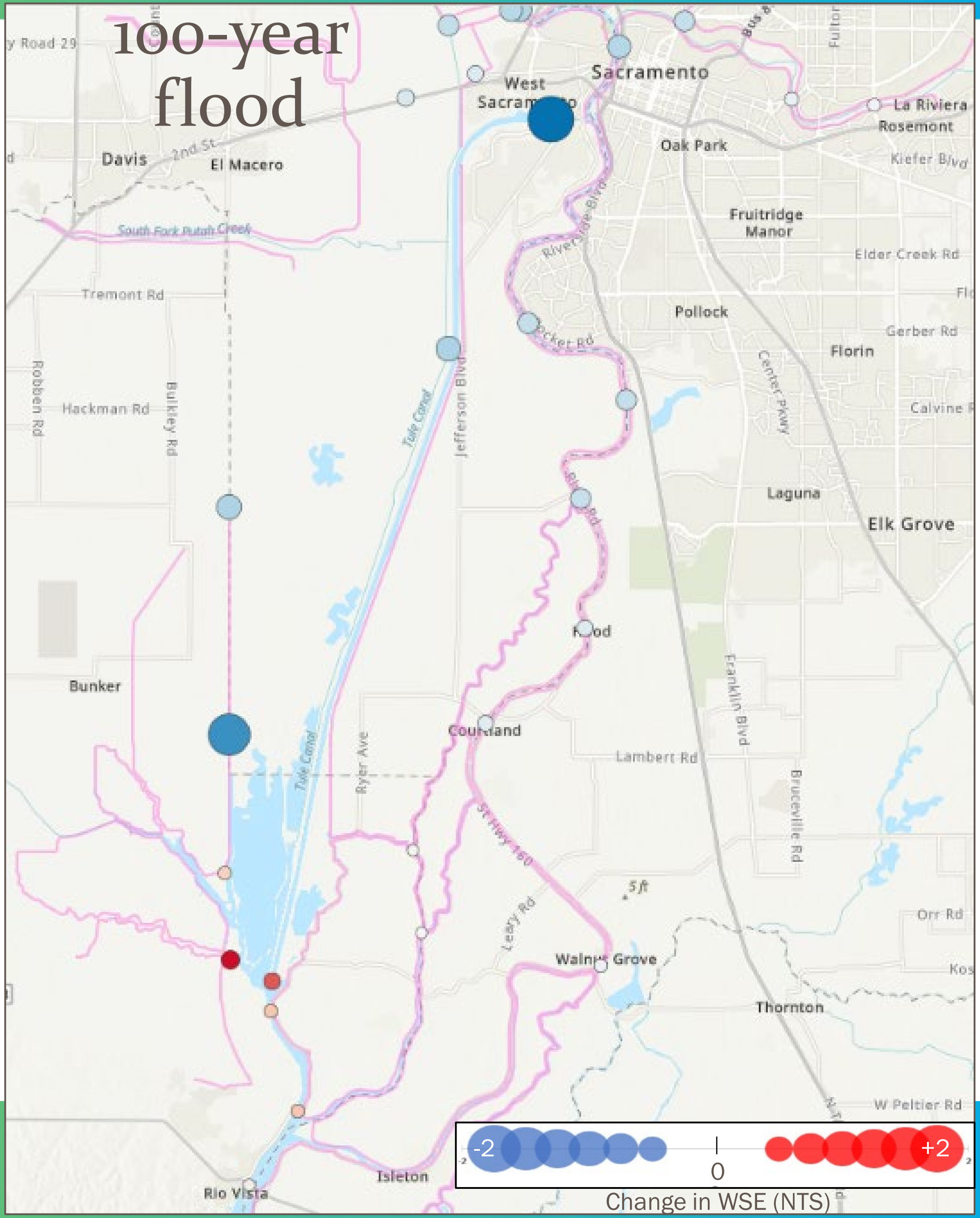
- Increases conveyance of floodwaters, provides attenuation, and reduces flood stages.

For a 10-year event, increases in flood stage are limited to 0.01 foot. For a 100-year event, increases in flood stage range from 0.02 to 0.26 foot, depending on location. For a 200-year event, increases in flood stage range from 0.01 to 0.31 foot, depending on location.

Lower Yolo Bypass / Lower Sacramento Delta

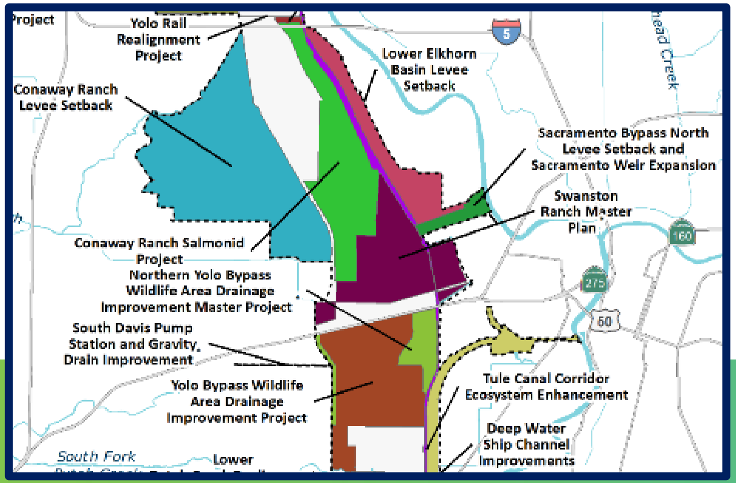
- Improved flood conveyance and transitory storage provided by,
  - Deep Water Ship Channel Improvements
  - Lookout Slough Tidal Restoration Project
  - Sacramento Bypass and Weir Expansion
  - LEMBP would provide flood stage reductions during frequent floods (1-in-10 year).

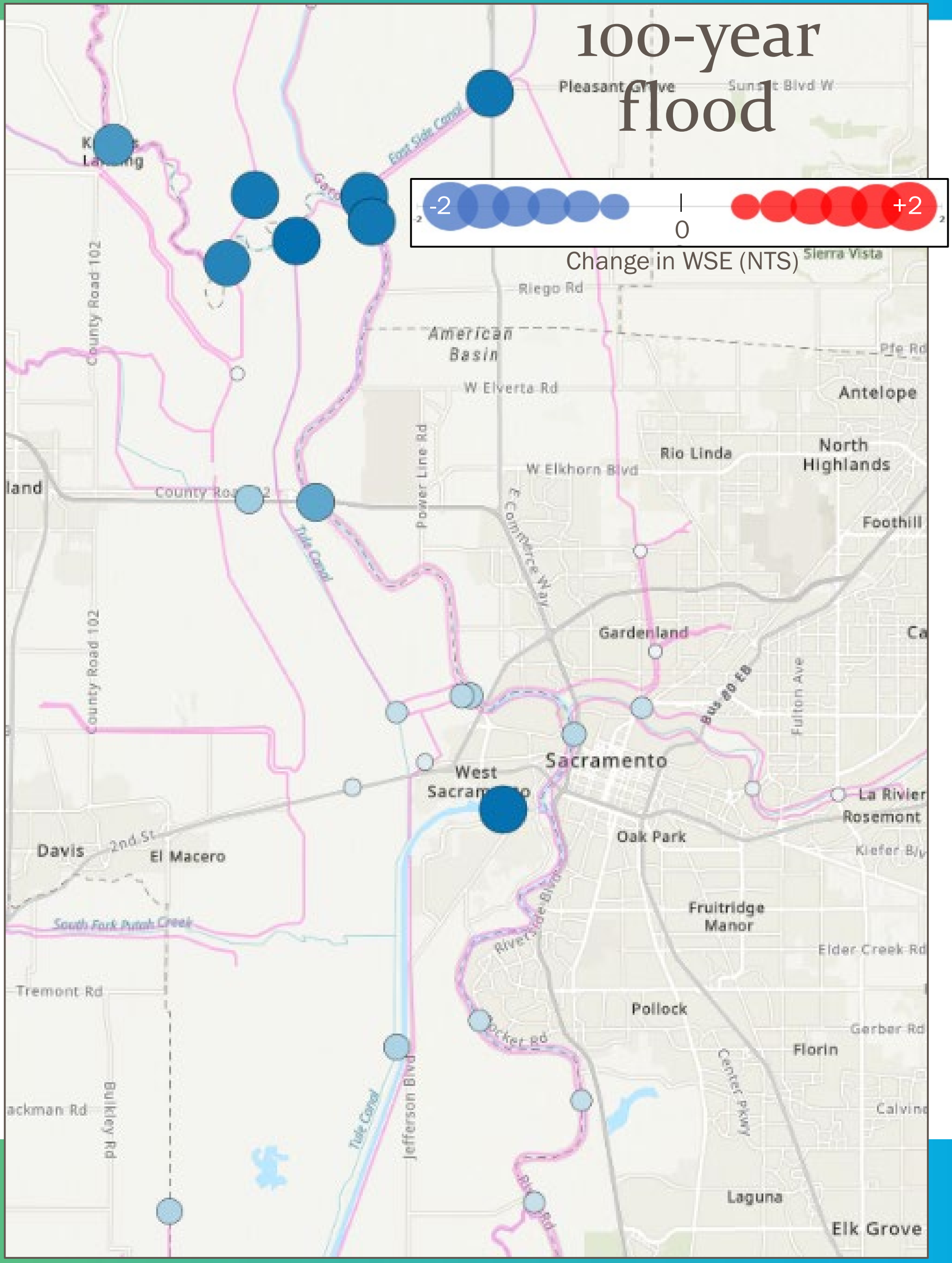
- Provides opportunities in the floodway for habitat, enhancement or drainage improvement projects,
  - Swanston Ranch Master Plan; Lower Putah Creek Restoration; Yolo Ranch, Flyway Farms; North Delta Fish Conservation Bank (RD 2093); Lookout Slough Project; Cache Slough Mitigation Bank; and LEMBP.



Upper Yolo Bypass Region

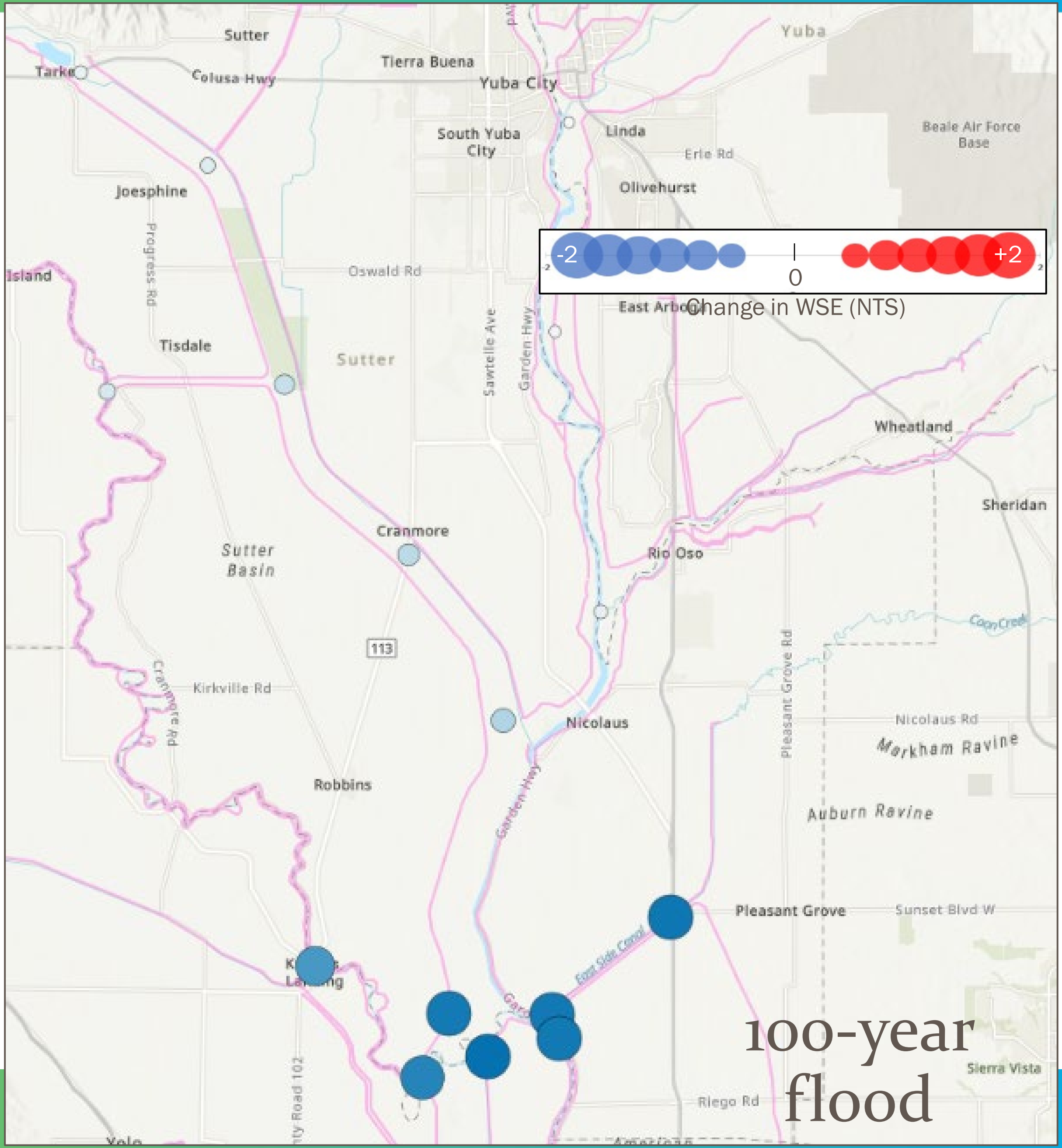
- Fremont Weir (FW) Expansion, FW Fish Passage Improvements, and Sacramento Weir Expansion redirects flows into the Yolo Bypass at more frequent intervals.
  - Lower Elkhorn, Upper Elkhorn, and Conaway Ranch Levee Setback Projects mitigate hydraulic impacts from the expansion of the Fremont Weir.
- Provides opportunities in the floodway for habitat, enhancement or drainage improvement projects
  - Tule Canal Corridor Enhancement; Knaggs-Nigiri Ranch Salmonid; and Conaway Ranch Salmonid Projects.





Mid-Sacramento River / Sutter Bypass Region

- While the study area is limited to the Yolo Bypass, the Fremont Weir Expansion potentially propagates flood protection benefits upstream
  - Reduction to the 100-year flood stage on the Feather River at Bear River (0.1 feet to 0.2 feet)
  - Reduction to the 100-year flood stage upstream of the Feather on Sutter Bypass (0.5 feet to 0.7 feet)
  - Reduction to the 100-year flood stage at RD 1500 Pump Station (1.3 feet to 1.9 feet)
  - Reduction to the 100-year flood stage on the Sacramento River at Knights Landing (1.1 feet to 1.5 feet)
  - Reduction to the 200-year flood stage to Sacramento River at Verona (1.4 feet – 2.6 feet)



Outcomes

- Programmatic Perspective
  - Demonstrates that the cumulative vision of the plan within the authorized flood control project would provide flood risk reduction and not affect the performance.
- Strategic approach to guide future actions for planning and design of Individual Projects and provides performance tracking.
- YBMP is not a regulatory document but has the technical foundations to plan for a programmatic approach.
- Inform planning of the Corps Comprehensive Study.

Thank you!

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Fish Go Where Water Flows: Examining Pre-European Flood Processes to Recalibrate Our Restoration Efforts for the Next Century

Thursday, April 30, 2026

43rd Annual Salmonid Restoration Conference
Redding, CA

Eric M. Ginney

Environmental Science Associates (ESA)

ESA

Thank you to my co-authors…

Alejo Kraus-Polk, PhD

Justin Gragg

Paul Stumpner

(Please read our abstract!)

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Outline

Context: Historic Sacramento Valley Geography

Floodplain Restoration Metrics: a brief history

Lateral Connectivity Metric

Take Aways

A Call for (Big) Actions

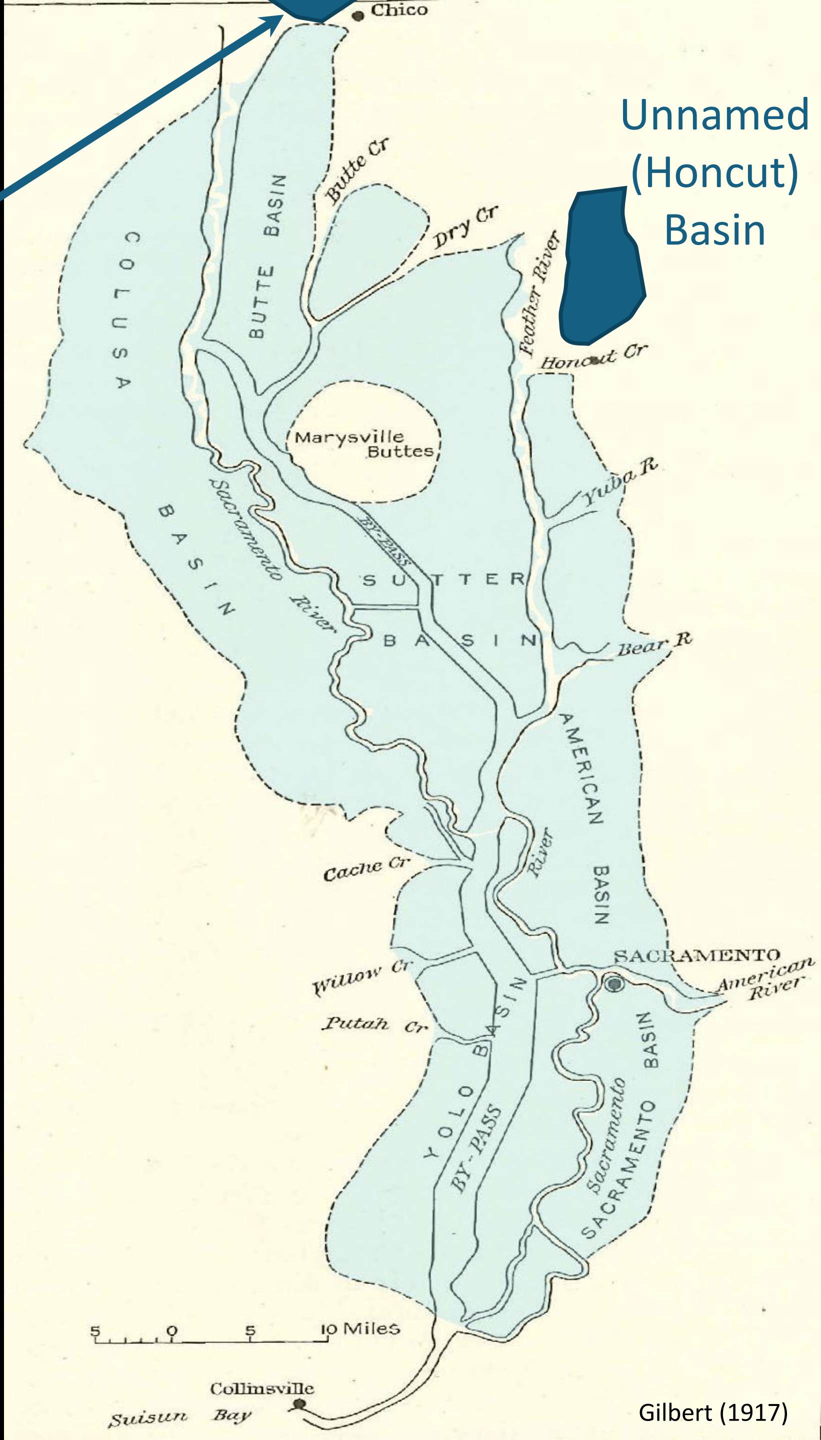
Sacramento River Flood Basins

Prior to the mid-1800s, California's Central Valley had about 4 million acres of seasonal wetlands that provided vital floodplain habitat and food for juvenile Chinook salmon.

Approximately 95% of these wetlands have been drained or are now inaccessible behind 2,100 miles of levees.

In the Sacramento Valley, most of these wetlands were historically found in flood basins located behind broad, low natural levees along major rivers, which were seasonally overtopped in numerous locations.

- 2,131 square miles of flood basins defined by G.K. Gilbert in 1917.



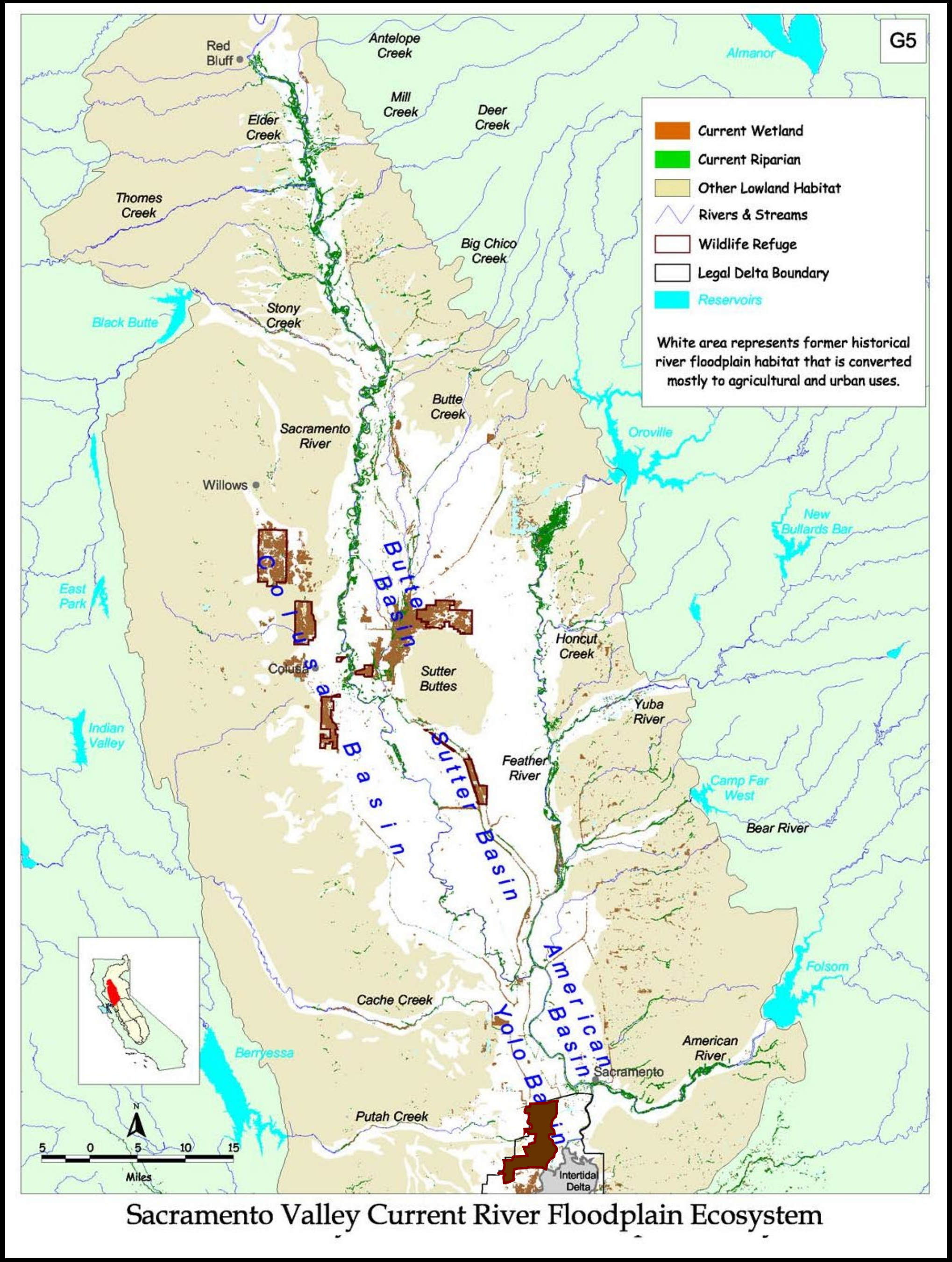
Gilbert (1917)

Historic:

Highly-connected riverine, riparian, wetland and flood basin system with which Chinook salmon and other species evolved.

TODAY:

- 95% of floodplains lost
- Basins largely cut off by levees (save for the Butte Basin)
- Remaining lands largely drained and converted to agriculture



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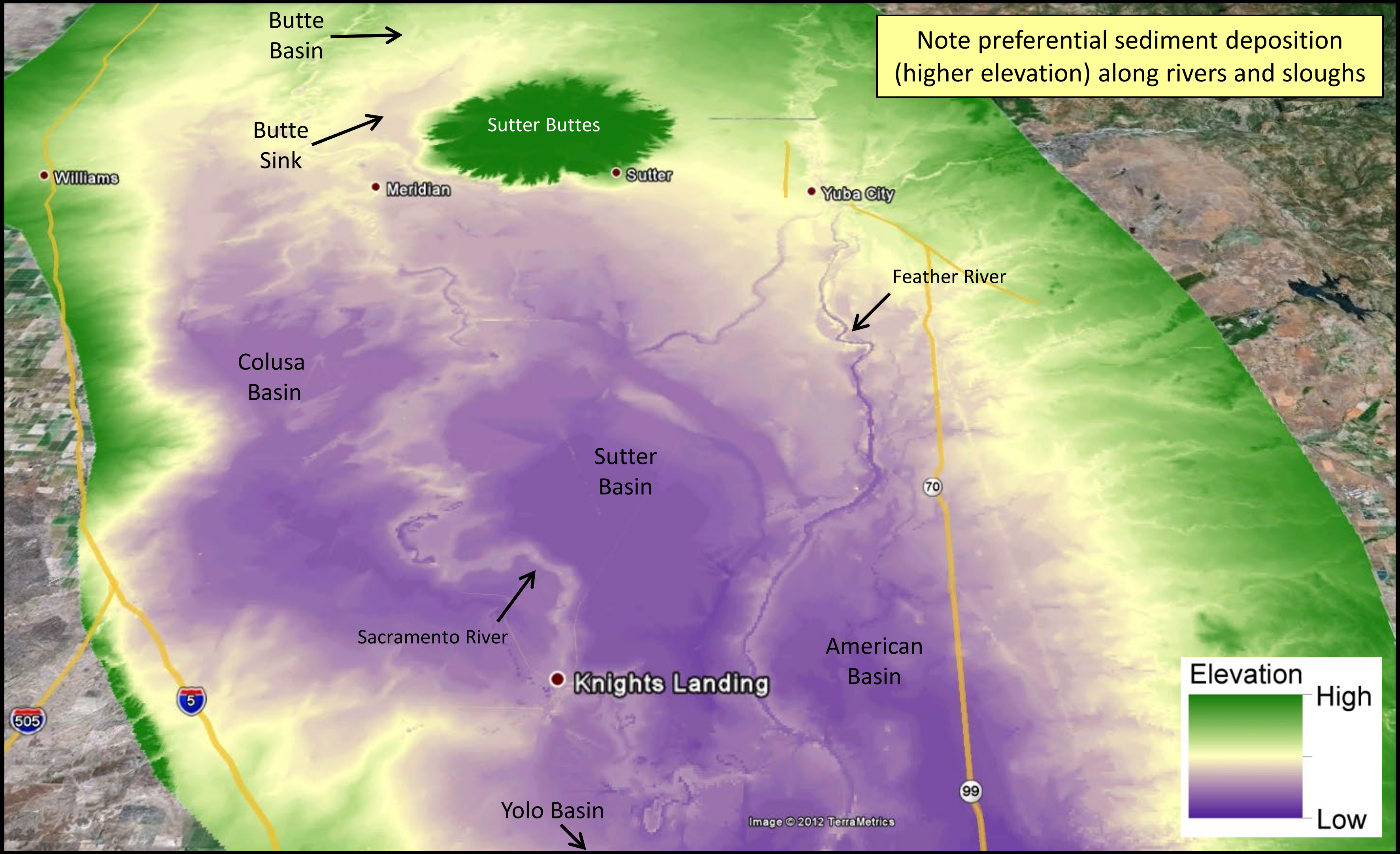
Southern Sacramento Valley Rivers and Flood Basins



Source: NED and Google Earth

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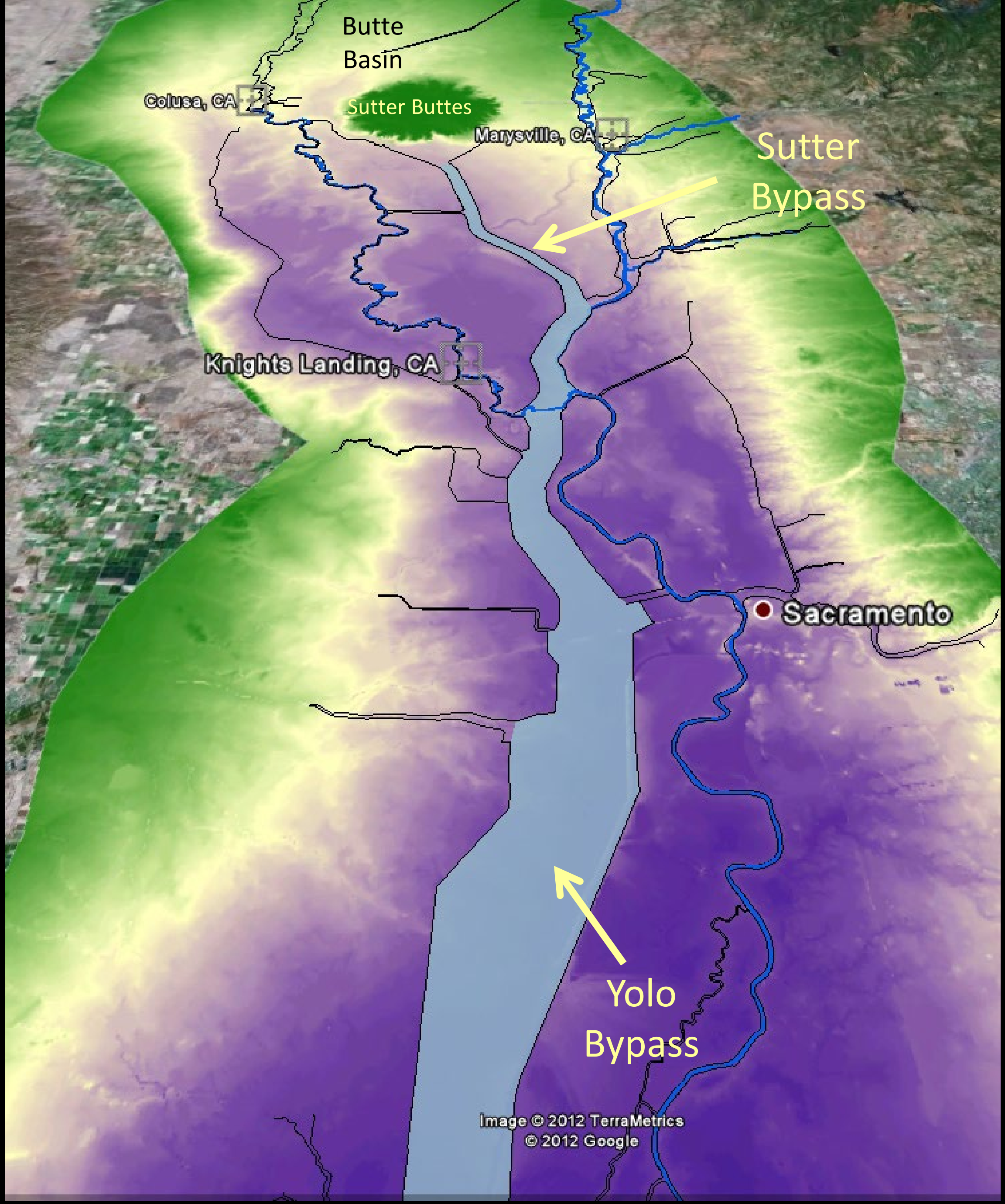
Flood Bypasses are not Flood Basins



Source: NED and Google Earth

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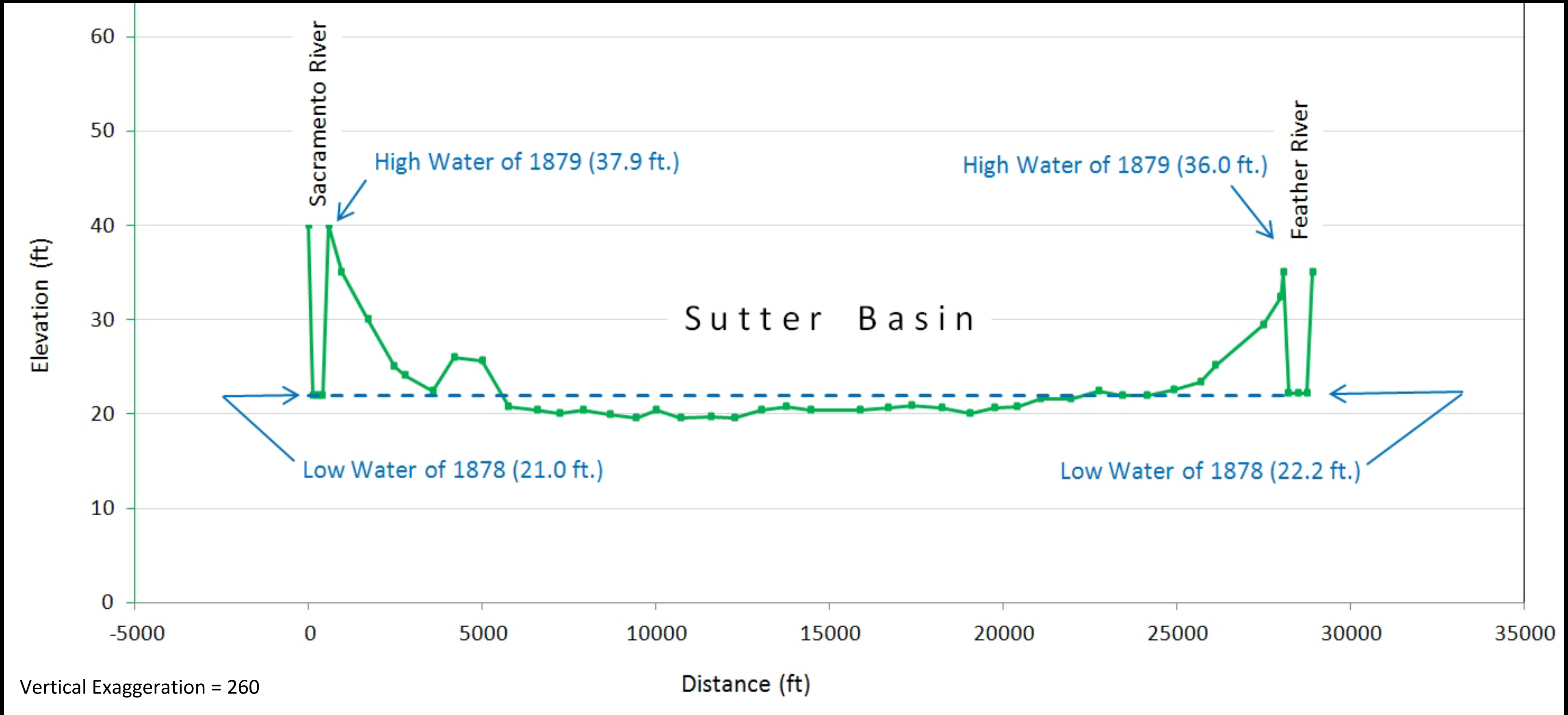
1895 – Natural Levees along Sacramento and Feather Rivers form Deep Flood Basins (bowls, not wide flowing channels)



1895 surveys show low water elevations in both rivers above that of the basin trough

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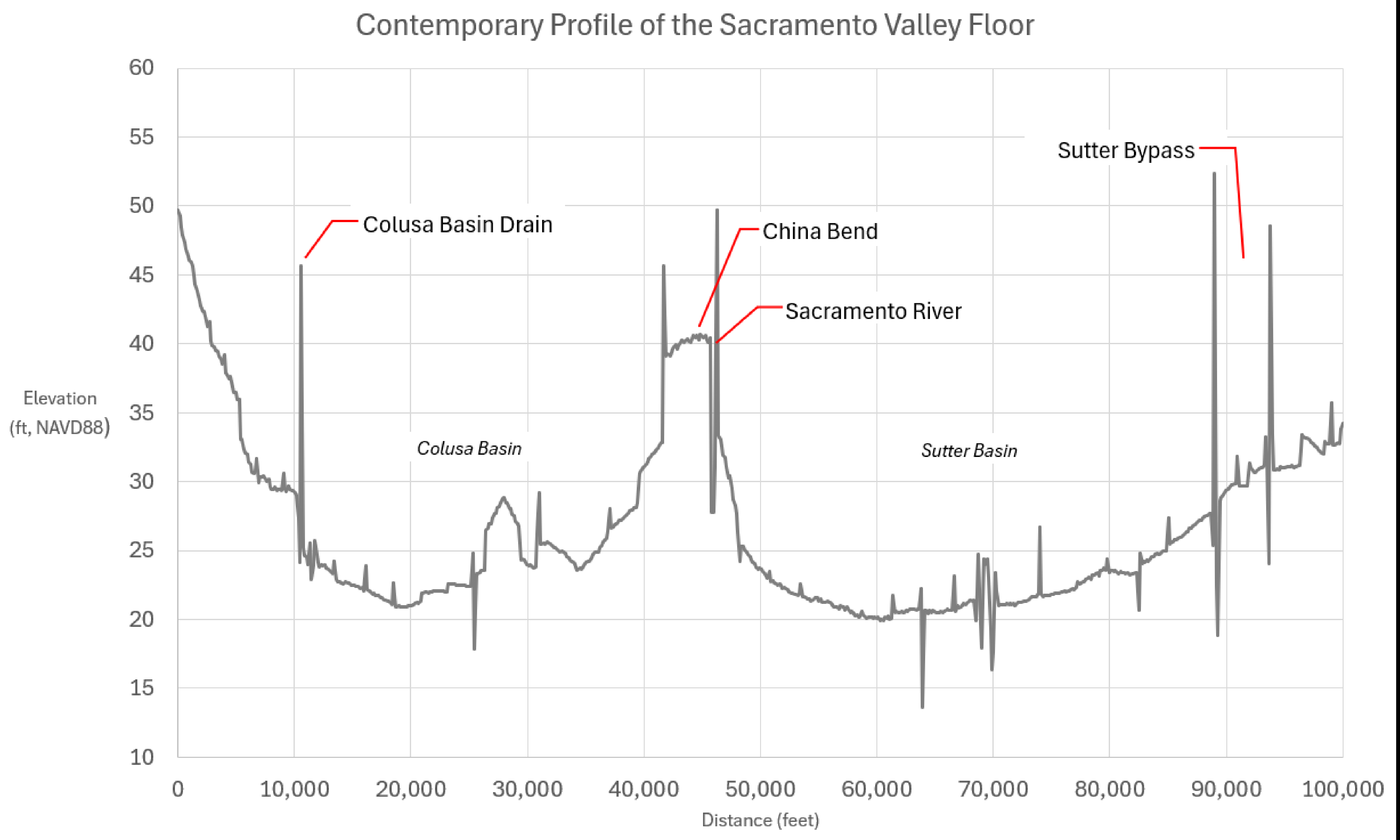
XS Location is 3.5 miles north of Knights Landing; view looking north.

Source: California Commissioner of Public Works, 1895



Contemporary Profile of the Sacramento Valley Floor
60
55
50
45
40
35
30
25
20
15
10
Elevation
(ft, NAVD88)
Colusa Basin Drain
China Bend
Sacramento River
Sutter Bypass
Colusa Basin
Sutter Basin
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
Distance (feet)

The Sacramento River Flood Management System Today -

- Five major weirs (Sacramento Weir, built in 1916; Fremont Weir, built in 1924; and Moulton, Tisdale, and Colusa weirs, built in 1932 and 1933)
- Four relief bypasses (Sutter, Tisdale, Sacramento, and Yolo bypasses)
- Two flood relief structures and one natural overflow area (M&T Flood Relief Structure, Three B's Natural Overflow Area, and Goose Lake Flood Relief Structure)
- Knights Landing Ridge Cut, connecting the Colusa Basin to the Yolo Bypass

Tisdale Weir

Colusa Weir

Moulton Weir

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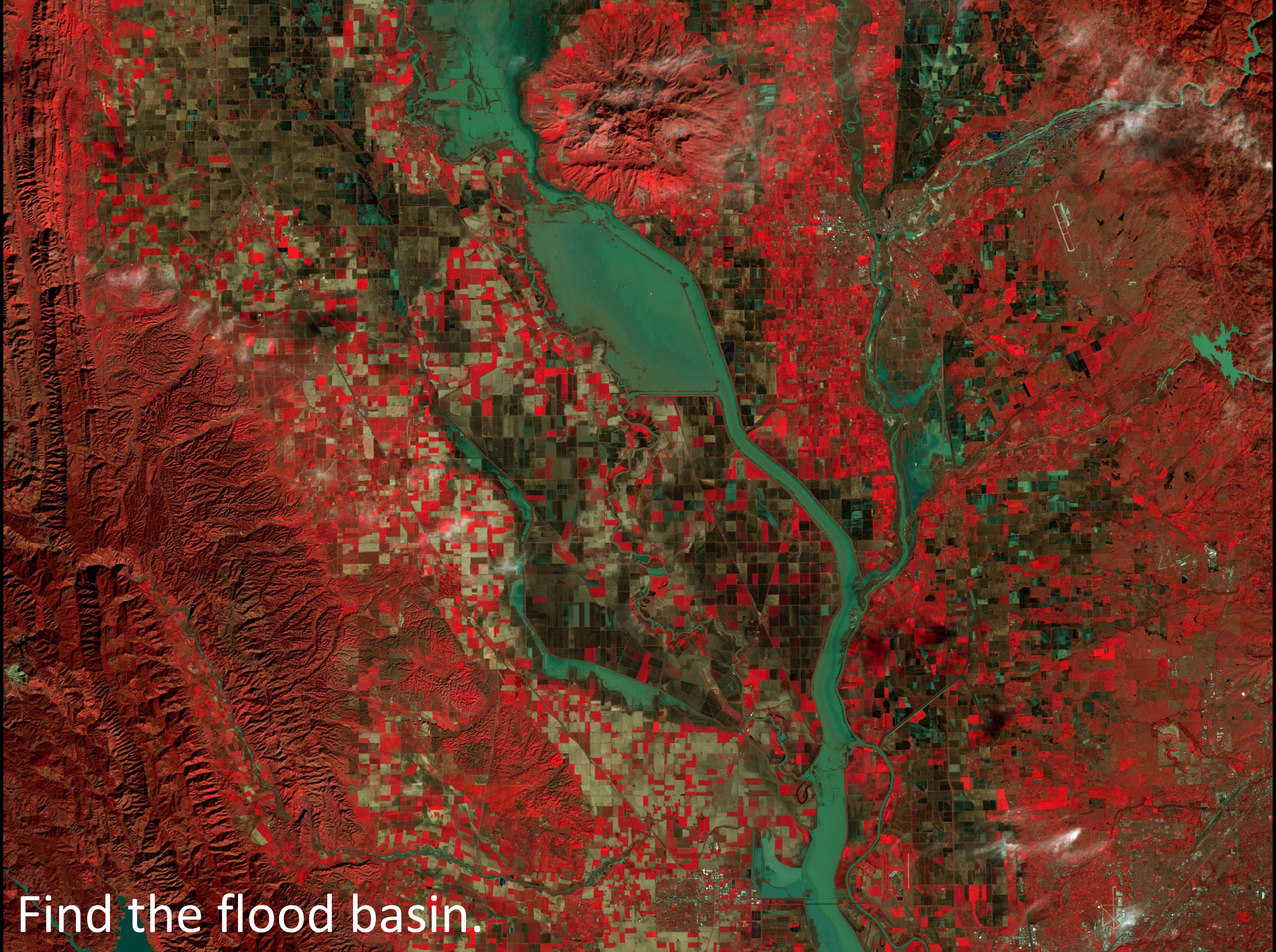
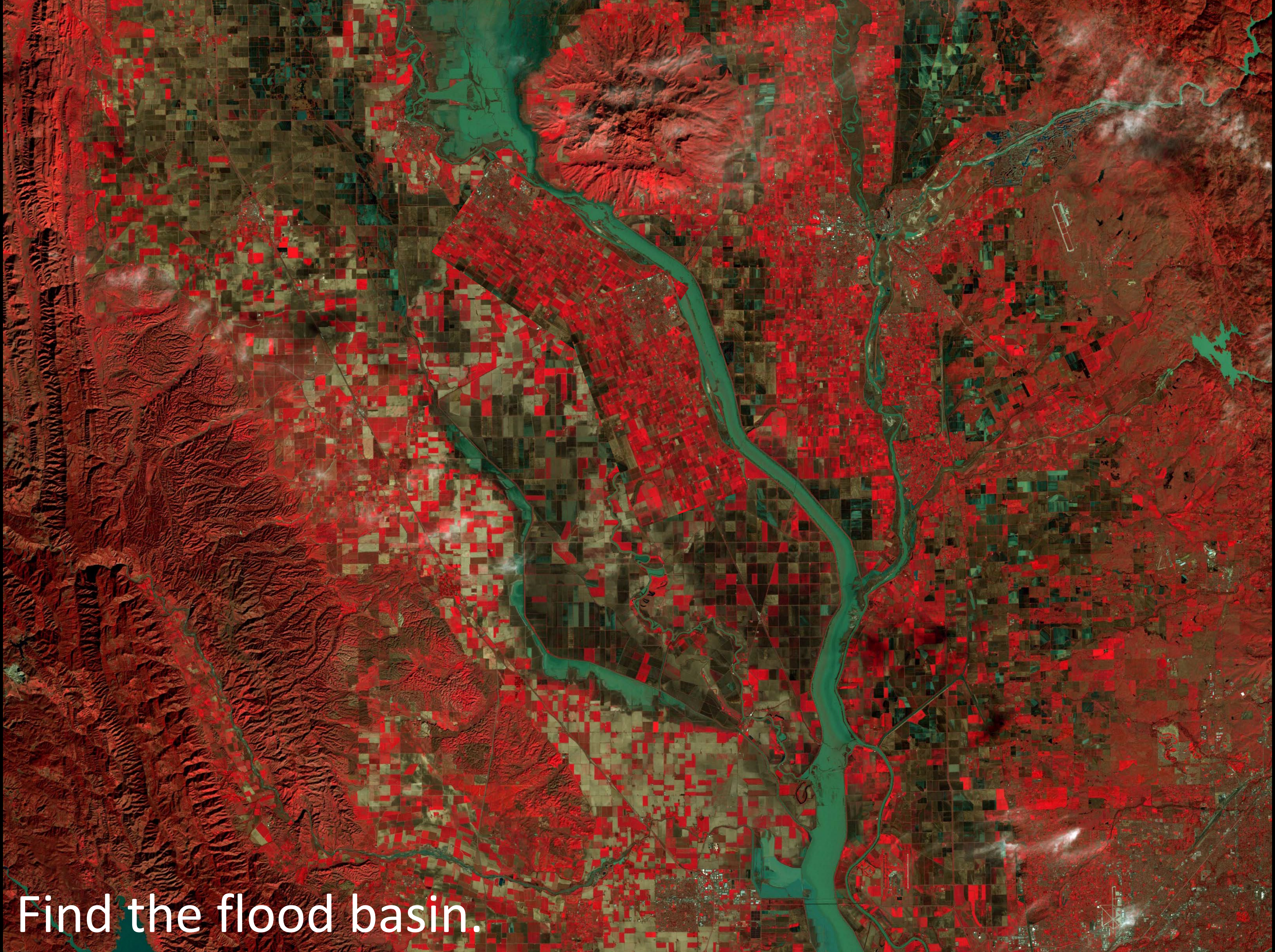
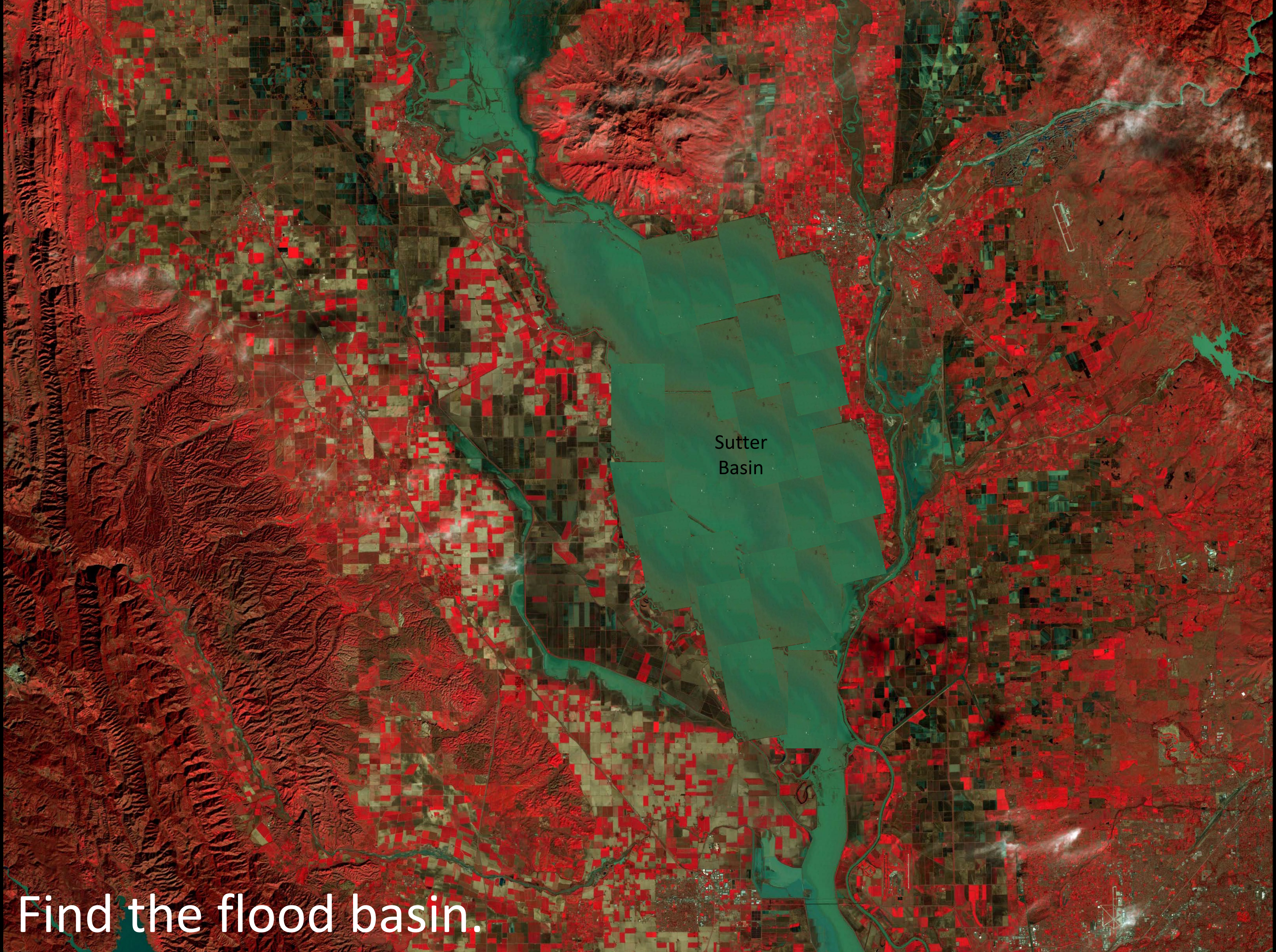
Goose Lake Flood Relief Structure



January 14, 1997



January 14, 1997



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January 14, 1997

CV Floodplain Restoration Metrics: a brief history (2000s – 2026)

(aka, the origin of the fish-acre day, which assumes water = fish)

The FAF = Floodplain Activation Flow for Sacramento River lowland floodplains (Williams et al., 2009)

"…the FAF is defined as the river stage [MAGNITUDE] that is exceeded in at least two out of three years [FREQUENCY] and sustained for at least seven days [DURATION] between March 15 and May 15 [TIMING]".

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SEPTEMBER 2009

SAN FRANCISCO ESTUARY & WATERSHED SCIENCE

Published by the California Bay-Delta Authority Science Program and the John Muir Institute of the Environment

Quantifying Activated Floodplains on a Lowland Regulated River: Its Application to Floodplain Restoration in the Sacramento Valley

Philip B. Williams[1], Elizabeth Andrews[1], Jeff J. Opperman[2], Setenay Bozkurt[3], and Peter B. Moyle[4]

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ABSTRACT

We describe a process and methodology for quantifying the extent of a type of historically prevalent but now relatively rare ecologically-valuable floodplain in the Sacramento lowland river system: frequently-activated floodplain. We define a specific metric, the "Floodplain Activation Flow" (FAF), which is the *smallest* flood pulse event that initiates substantial beneficial ecological processes when associated with floodplain inundation. The "Activated Floodplain" connected to the river is then determined by comparison of FAF stage with floodplain topography. This provides a simple definition of floodplain that can be used as a planning, goal setting, monitoring, and design tool by resource managers since the FAF event is the smallest flood and corresponding floodplain area with ecological functionality—and is necessarily also inundated in larger flood events, providing additional ecological functions. For the Sacramento River we selected a FAF definition to be the river stage that occurs in two out of three years for at least seven days in the mid-March to mid-May period and Activated Floodplains to be those lands inundated at that stage. We analyzed Activated Floodplain area for four representative reaches along the lower Sacramento River and the Yolo Bypass using stream gauge data. Some significant conclusions are: (1) The area of active functional floodplain is likely to be less than commonly assumed based on extent of riparian vegetation. (2) Levee setbacks may not increase the extent of this type of ecologically-productive floodplain without either hydrologic or topographic changes. (3) Within the Yolo Bypass, controlled releases through the Fremont Weir could maximize the benefits associated with Activated Floodplain without major reservoir re-operation or grading. This approach identifies a significant opportunity to integrate floodplain restoration with flood management by establishing a FAF stage metric as an engineering design criterion alongside the commonly-used 100-year flood stage for flood hazard reduction.

KEYWORDS

Floodplain restoration, functional floodplains, activated floodplains, floodplain activation flow, design criteria, regulated river, reservoir re-operation, Sacramento River, Yolo Bypass

DRERIP Conceptual Models Team –

Conceptual Model for Floodplains in the Sacramento–San Joaquin Delta

(published by Opperman in 2012)

ESA

OCTOBER 2012

SAN FRANCISCO ESTUARY & WATERSHED SCIENCE

A Conceptual Model for Floodplains in the Sacramento–San Joaquin Delta

Jeffrey J. Opperman[1]

ABSTRACT

Floodplains are among the most biologically productive and diverse ecosystems on Earth and they provide significant benefits to society such as attenuation of floodwaters, groundwater recharge, filtration of nutrients and sediments, carbon sequestration, fisheries productivity and recreation. However, floodplains are also among the most converted and threatened ecosystems. Floodplain habitats in the Sacramento–San Joaquin Delta (the Delta), and throughout California's Central Valley, have been greatly reduced from their historic extent and key processes that create and maintain floodplains, such as flood flows and meander migration, have been greatly altered. These widespread alterations to habitats and processes have lead to declines in many species' populations in the Delta and Central Valley, creating challenges for both environmental and water management. To address these challenges numerous entities and programs are now focused on restoring floodplains and other Delta habitats. This paper provides a conceptual model for floodplains that characterizes the key features and identifies the critical processes, drivers, and linkages that allow floodplains to produce a variety of functional outputs important to management. These outputs include: (1) the floodplain habitat mosaic, including riparian vegetation and its associated wildlife; (2) spawning and rearing habitat for native fish; and (3) food-web productivity that can support native fish on the floodplain as well as be exported to downstream ecosystems. The model emphasizes that the production of these outputs requires hydrological connectivity between river and floodplain across a broad range of flow conditions. For example, long-duration flooding in the spring promotes native fish spawning and food-web productivity that benefits native species.

KEY WORDS

Floodplain, riparian forest, floodplain food web, Chinook salmon, Sacramento splittail, Delta Regional Ecosystem Restoration Implementation Plan (DRERIP).

INTRODUCTION

The Sacramento–San Joaquin Delta, within California's Central Valley (Figure 1), encompasses a broad suite of habitat types including open water, tidal marsh, agricultural fields, and river-floodplain ecosystems (TBI 1998). The Delta's ecosystem has declined, with numerous species listed as threatened or endangered, and faces numerous ongoing threats (Sommer and others 1997; Lund and others 2007;

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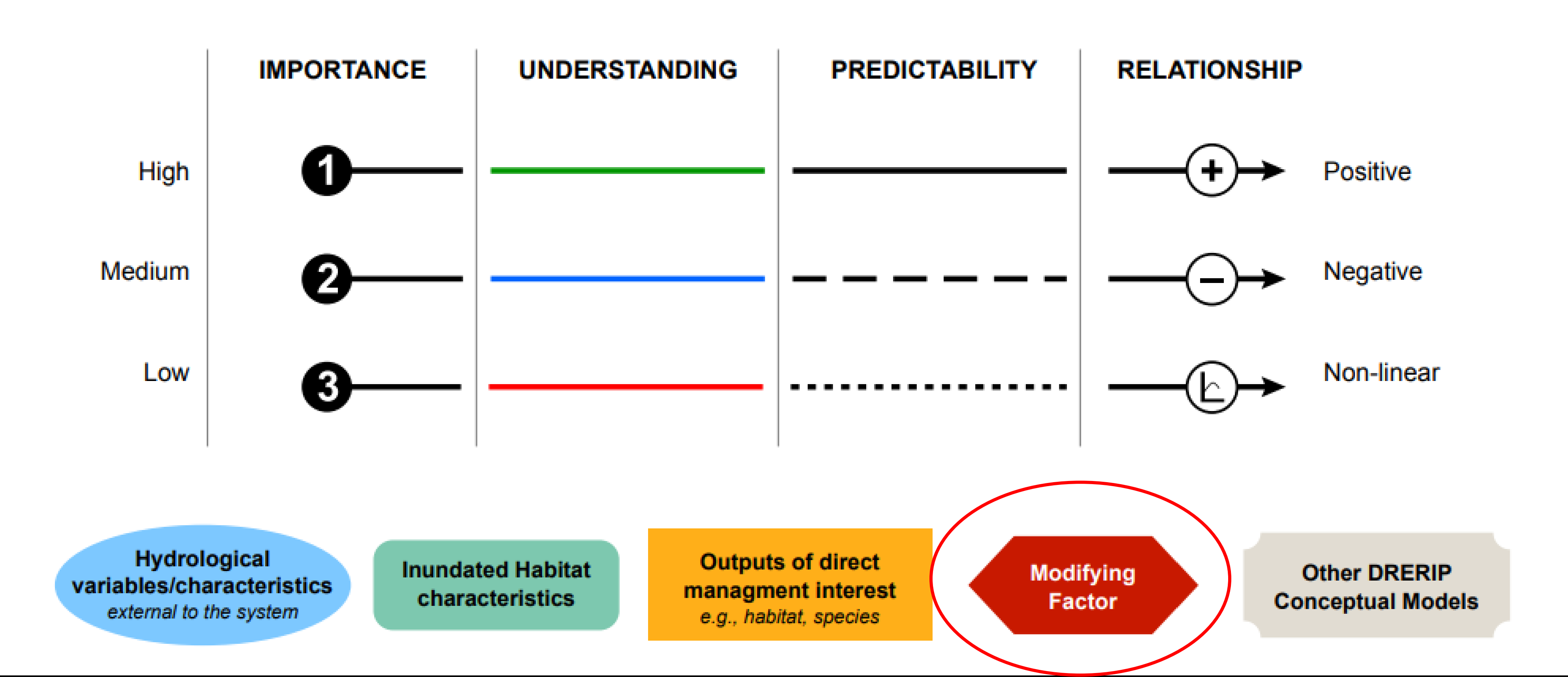
The Driver-Linkage Outcome (DLO) Model Framework



Model 1	
Hydrological patterns	Dams and Central Valley hydrology (Singer 2007) Indicators of Hydrologic Alteration (IHA) software; (Richter and others 1996; Mathews and Richter 2007) *http://www.conservationgateway.org/ConservationPractices/Freshwater/EnvironmentalFlows/MethodsandTools/IndicatorsofHydrologicAlteration/Pages/indicators-hydrologic-alt.aspx*
Geomorphic processes	Meander migration (Larsen and others 2006a, 2006b; Constantine and others 2009); Development of floodplain topography and sediment transport (Florsheim and Mount 2002; Florsheim and others 2006; Singer and Aalto 2009) Meander cutoffs and formation of off-channel waterbodies (Kondolf and Stillwater Sciences 2007)
Recruitment of riparian vegetation	Recruitment box model (Mahoney and Rood 1998); Seed release and flow regime in Central Valley (Stella and others 2006)
Development of floodplain mosaic	(Greco and Plant 2003) Sacramento River Ecological Flows Tool; (ESSA Technologies Ltd. 2007) *http://www.dfg.ca.gov/ERP/signature_sacriverecoflows.asp*
Model 2	
Water surface profiles; inundation of floodplain	HEC-RAS; *http://www.hec.usace.army.mil/software/hec-ras/*
Inundation of flood surfaces by specific flow types	Long-duration spring floods (Williams and others 2009) 3-year recurrence interval flood (Greco and others 2008)
Model 3	
Algal productivity	(Schemel and others 2004; Ahearn and others 2006)
Invertebrate productivity	(Sommer and others 2001, 2004; Grosholz and Gallo 2006)
Growth of juvenile salmon on floodplains	(Sommer and others 2001; Limm and Marchetti 2009; Jeffres and others 2008)

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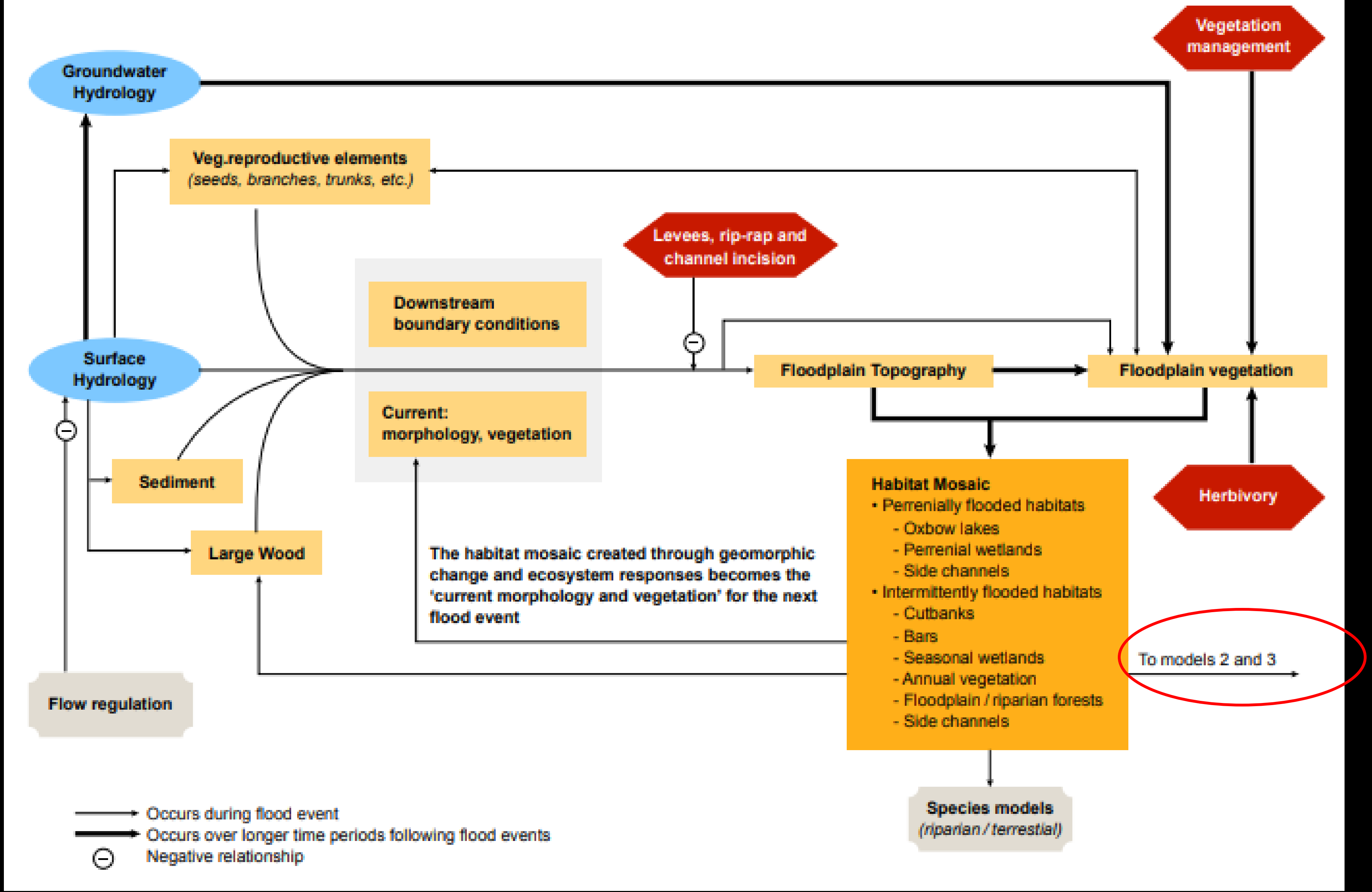
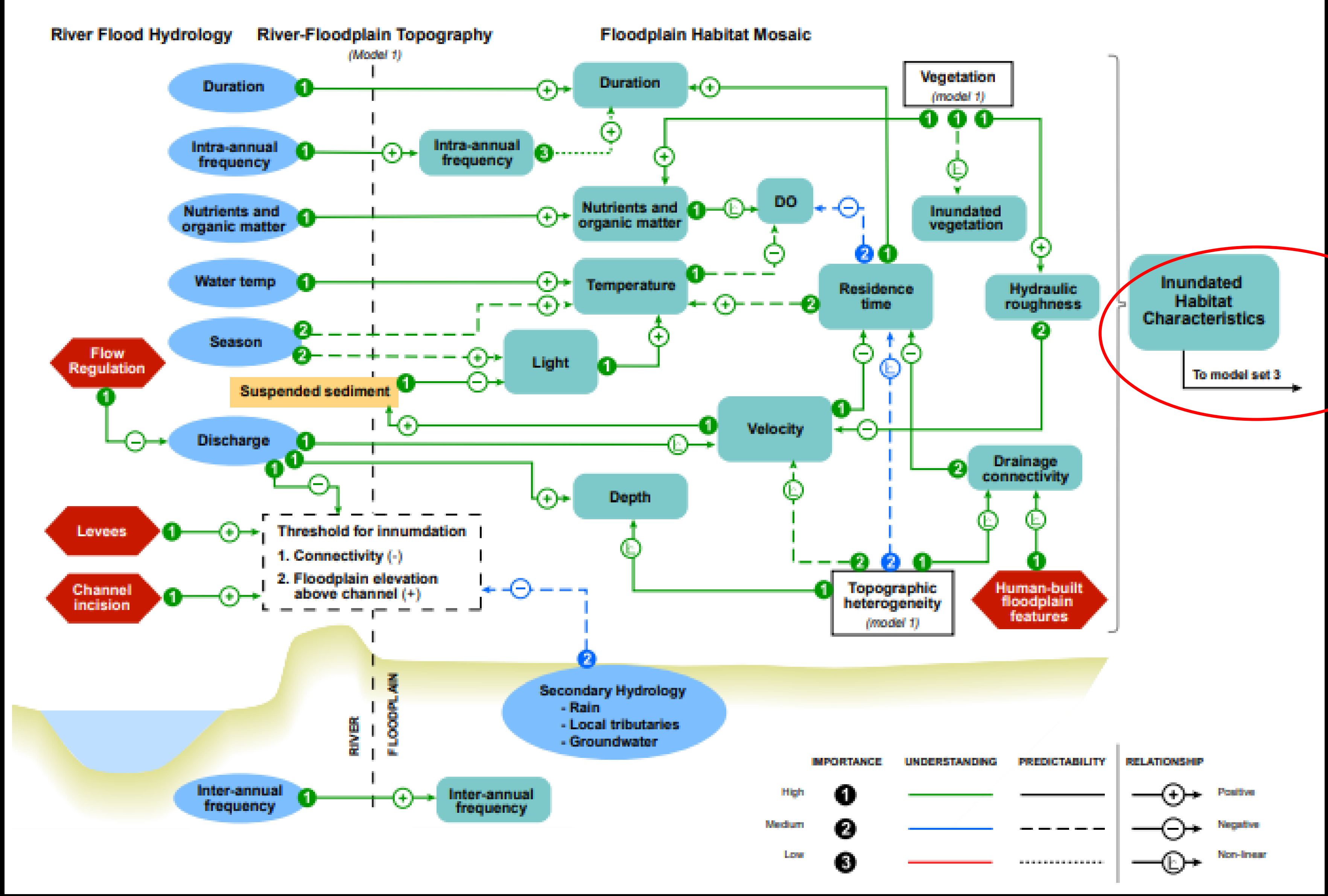


Model 1 - "Creating the Template" "Processes and linkages that collectively produce the habitat mosaic/the physical template of a given floodplain"



Model 2 - "Inundating the Template"

"Depicts how a given floodplain site, with features established by Model 1, is inundated by river flows and other sources of water to create specific hydrological conditions within the inundated floodplain that are important to the species or processes described in Model 3."

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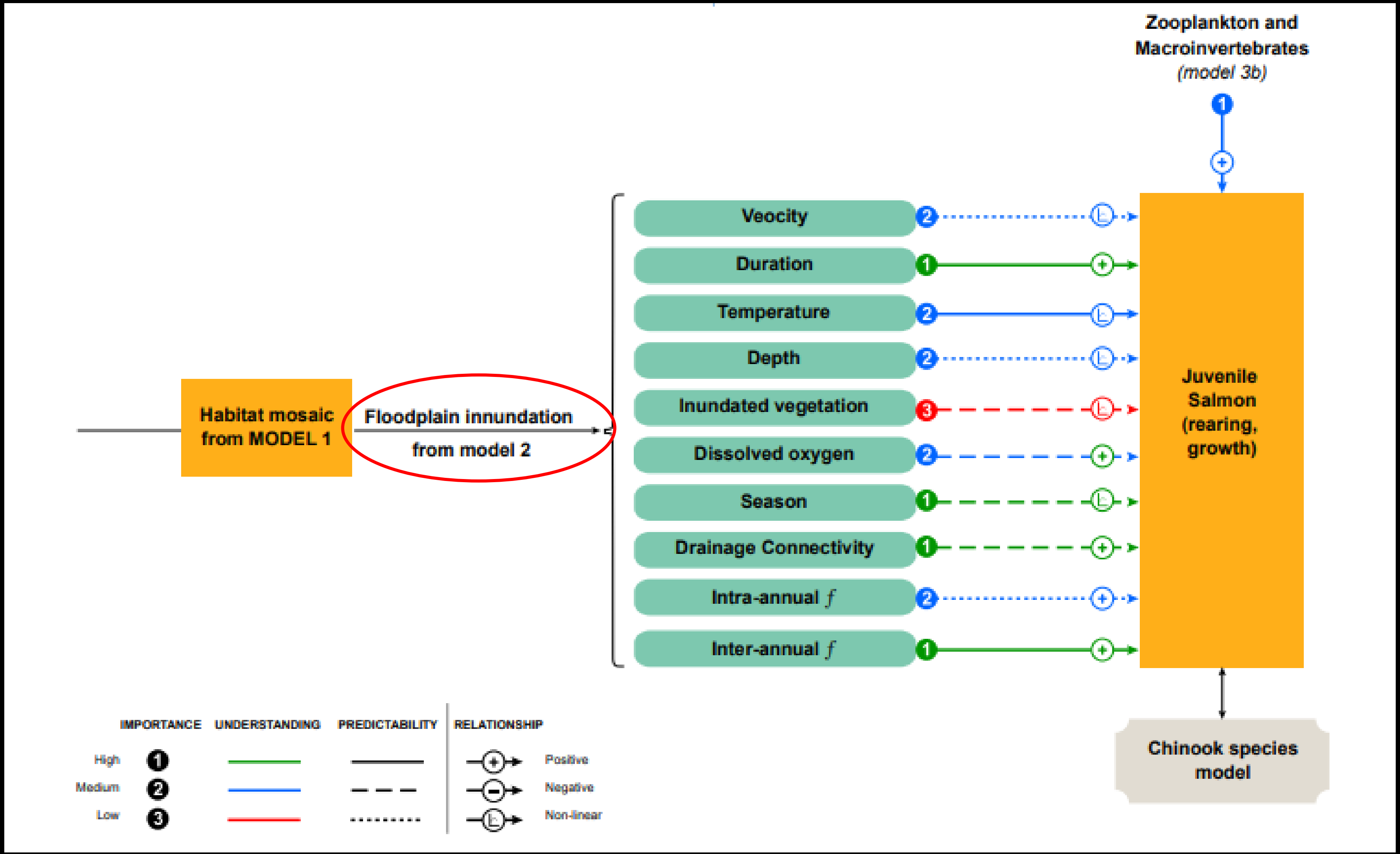

Model 3- " Management Outputs"

"Illustrates how the inundated habitat characteristics, developed in Model 2, influence the production of biota— including algae, zooplankton, and native fish—that directly of interest to restoration planners. Thus Model 3 focuses on several of the outputs of interest to management, while Model 1 focuses on the habitat mosaic, an important management output on its own."

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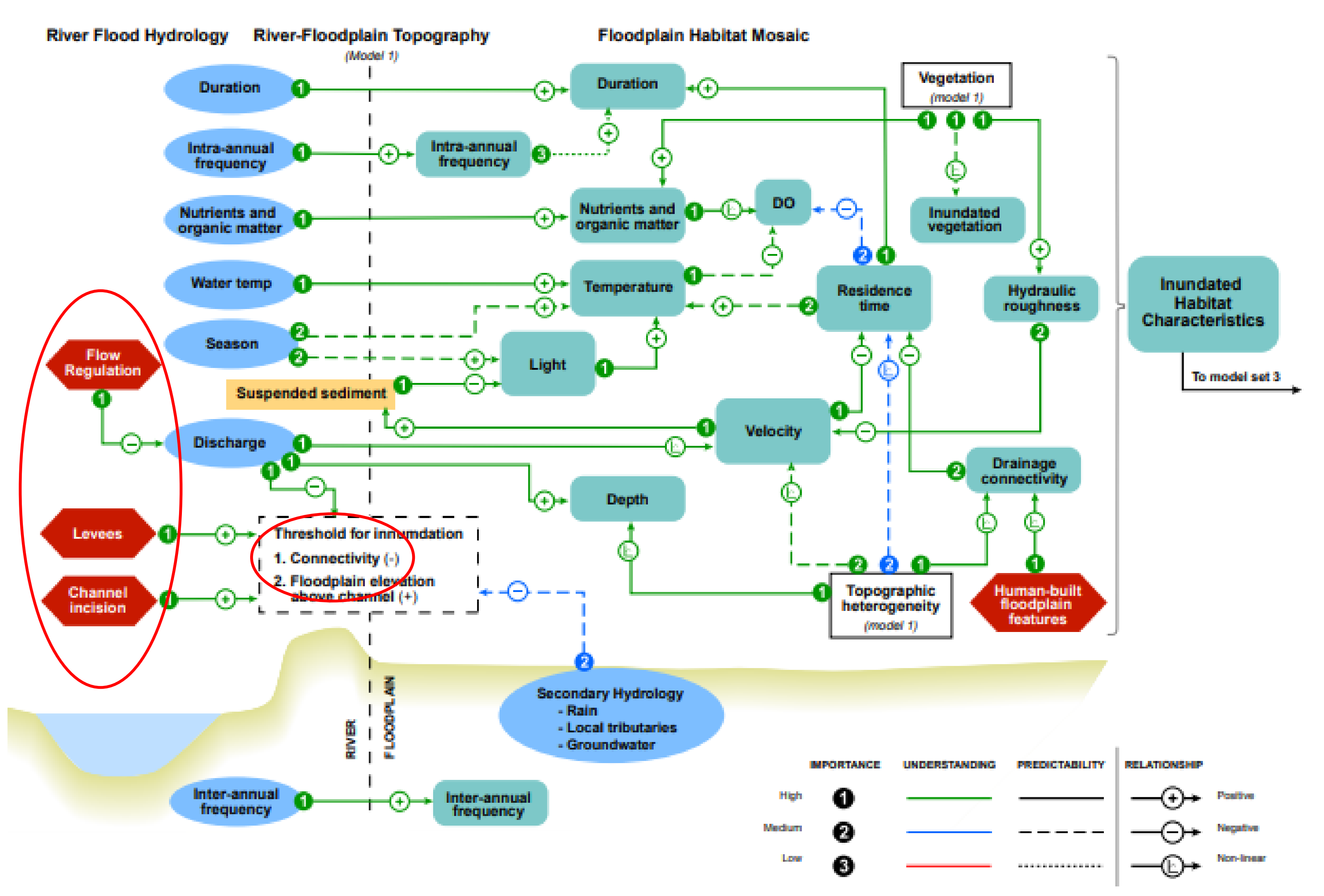


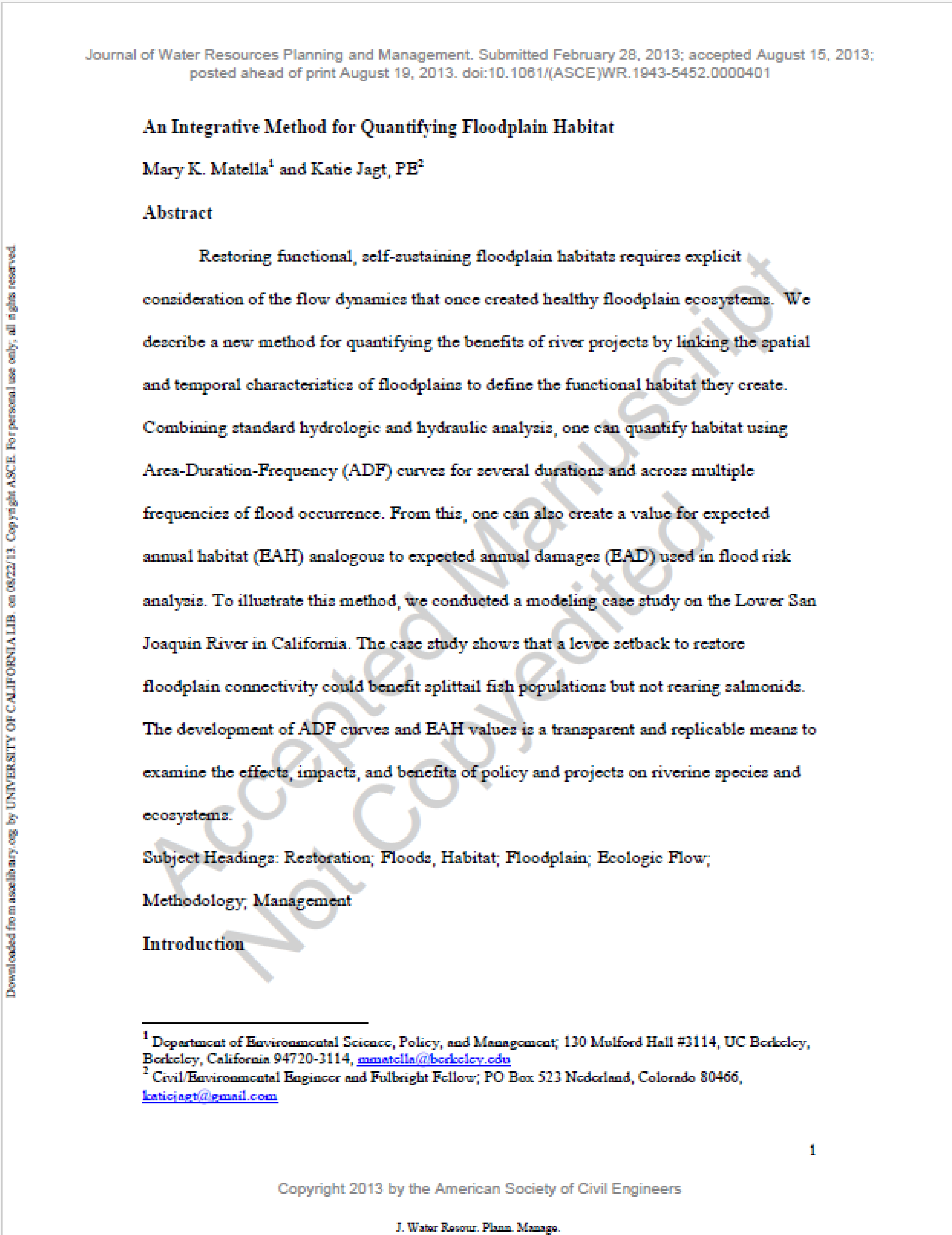
What happened to connectivity?

The Expected Annual Habitat (EAH) method (Matella & Jagt, 2016)

Analogous to expected annual damages (EAD) used in flood risk analysis.

Quantifies acres of floodplain habitat that are supported by FAF criteria. By merging flow-frequency relationships with inundated-area curves, an area-duration frequency curve is acquired that measures the amount of land inundated by an FAF flow.

Expected Annual Habitat (EAH) - Habitat acre-days; fish acre-days; wetted acre-days (WAD).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An Integrative Method for Quantifying Floodplain Habitat

Mary K. Matella[1] and Katie Jagt, PE[2]

Abstract

Restoring functional, self-sustaining floodplain habitats requires explicit consideration of the flow dynamics that once created healthy floodplain ecosystems. We describe a new method for quantifying the benefits of river projects by linking the spatial and temporal characteristics of floodplains to define the functional habitat they create. Combining standard hydrologic and hydraulic analysis, one can quantify habitat using Area-Duration-Frequency (ADF) curves for several durations and across multiple frequencies of flood occurrence. From this, one can also create a value for expected annual habitat (EAH) analogous to expected annual damages (EAD) used in flood risk analysis. To illustrate this method, we conducted a modeling case study on the Lower San Joaquin River in California. The case study shows that a levee setback to restore floodplain connectivity could benefit splittail fish populations but not rearing salmonids. The development of ADF curves and EAH values is a transparent and replicable means to examine the effects, impacts, and benefits of policy and projects on riverine species and ecosystems.

Subject Headings: Restoration; Floods, Habitat; Floodplain; Ecologic Flow; Methodology; Management

Introduction

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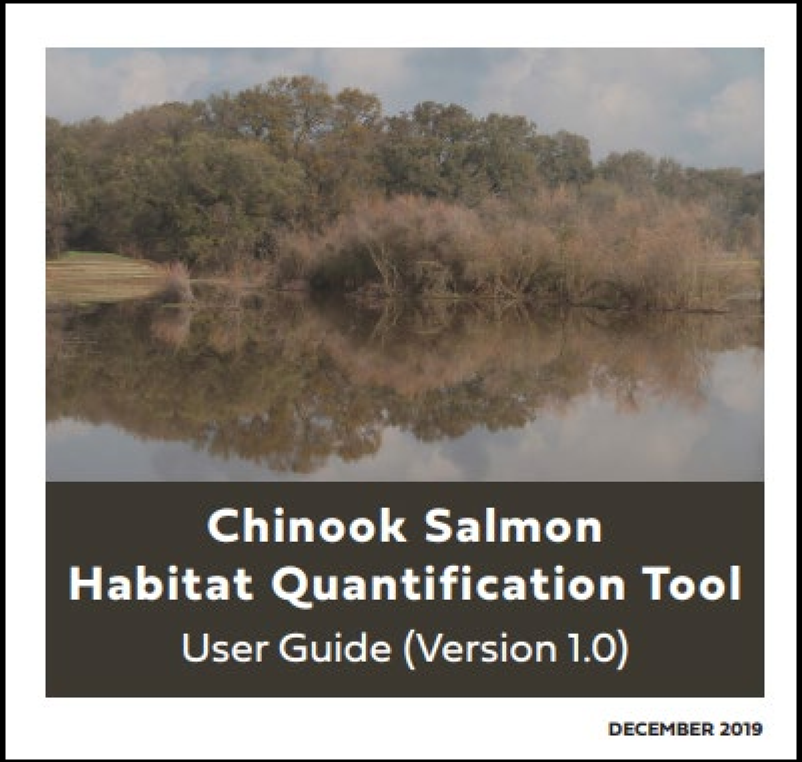
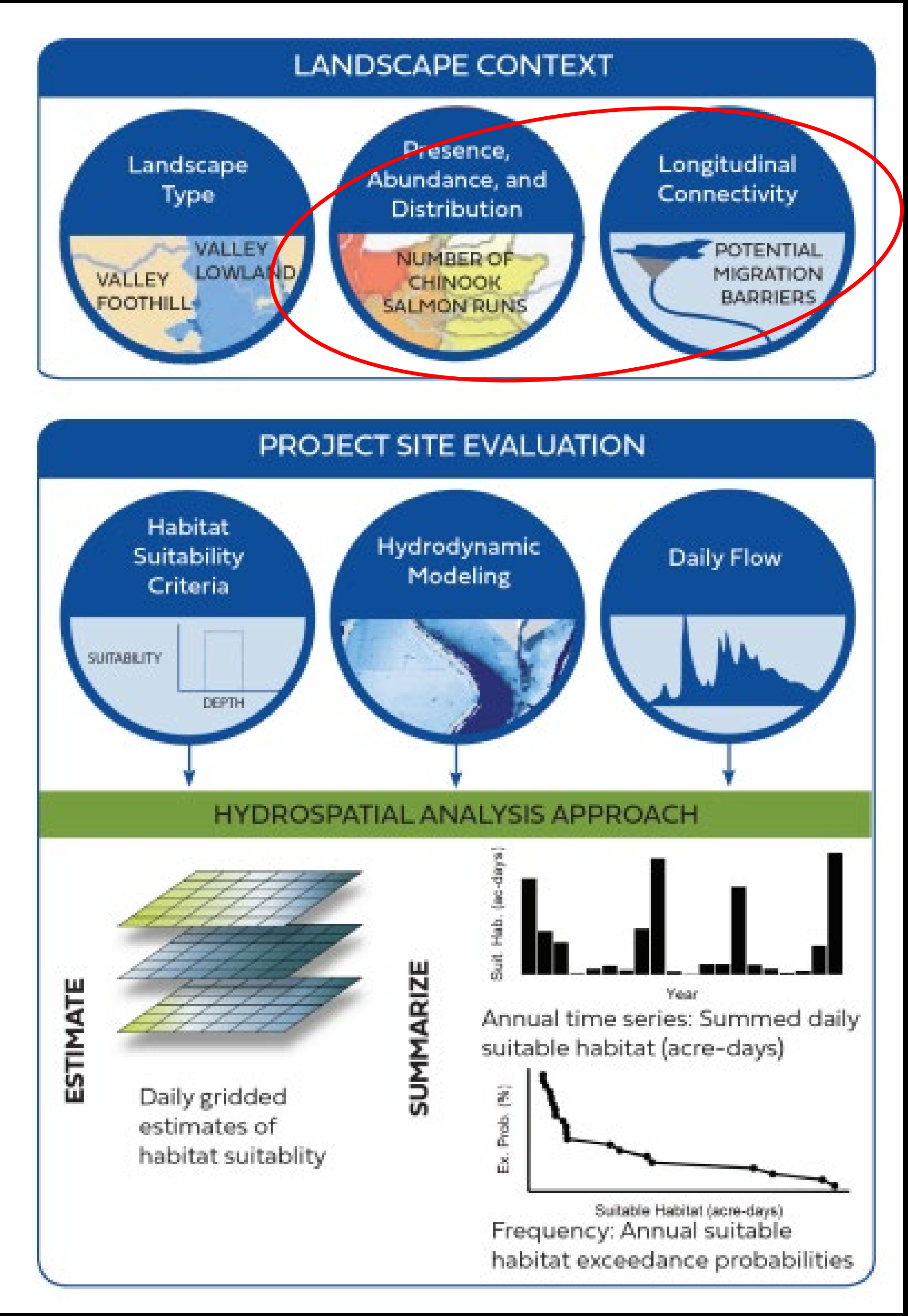
Chinook Salmon HQT (EDF et al., 2019)



Uses hydraulic modeling and an R package to generate maps and statistics for the frequencies with which given annual acre-days of suitable habitat are expected to be exceeded.



ESA

We are nailing the Hydrology.

But did we lose sight of the connectivity bit?

ESA

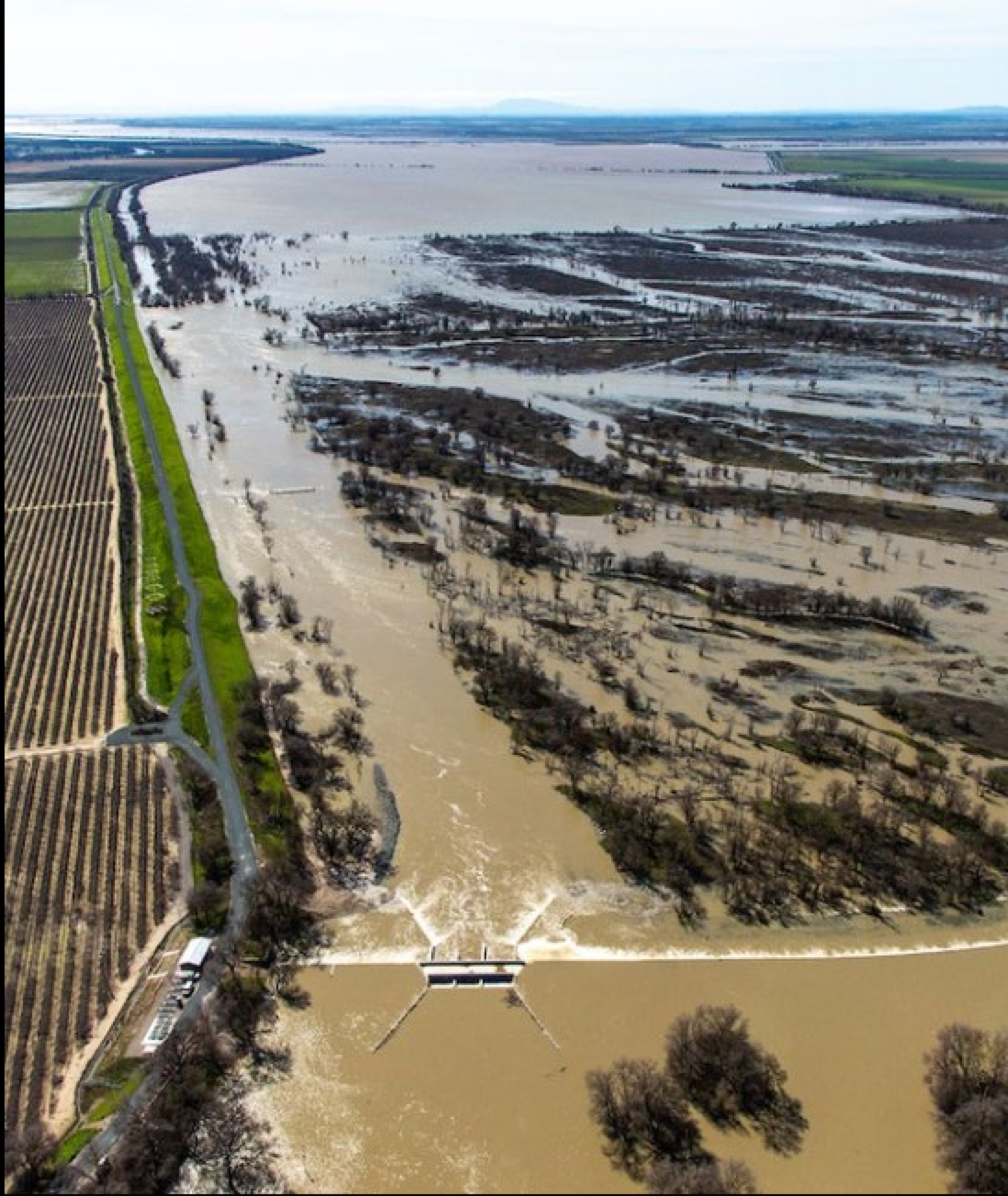
Yes, and…

Yes…and we are focused on increasing inundation.

Research shows that juvenile salmon can grow vigorously in the remaining "bypass floodplains."

Even inundated floodplains converted to agriculture can provide an important source of food for juvenile salmon.

Based on this growing body of research, particular planning efforts are now focusing on increasing the duration of inundation in the existing flood bypass system.



Fremont Weir (overtopping) and "The Big Notch"
(the little notch is for upstream fish passage; out of photo to right)

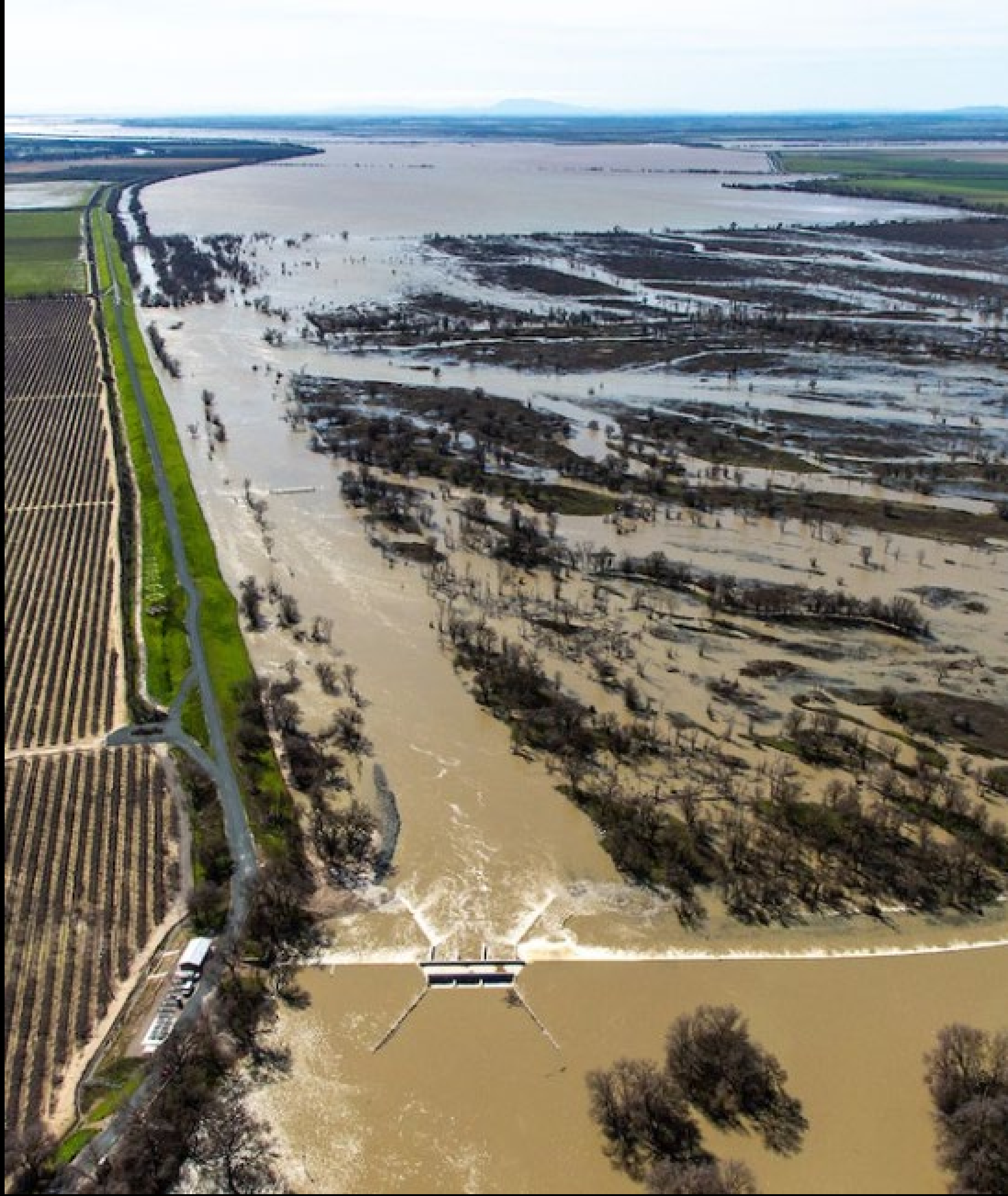
ESA

Yes, and increasing wetted acre days would be achieved by primarily by:

1) Modifying agricultural infrastructure at the field level (“holey boards”)

and

2) By ‘notching’ existing flood weirs to allow flows (and fish) at lower river discharge levels to reach the bypasses, thereby prolonging inundation, boosting food production, and extending the time this habitat is accessible.



Fremont Weir (overtopping) and “The Big Notch”
(the little notch is for upstream fish passage; out of photo to right)

ESA

Fremont Weir (not overtopping) and "The Big Notch"

ESA

Yes, do that!

Increasing the duration of connection of river water with flood bypasses is good.

Fish food production—on the wet side or the dry side—is good.

Yes, and…..flood bypasses are not flood basins.

While weir-notching and food export projects have demonstrated benefits, the species-level response remains unclear.

Recovery will require consideration and implementation of approaches beyond just these actions alone. Indeed, the scale of the salmon recovery problem is large, the scale of landscape modification is large, and so our response needs to be correspondingly large to yield desired outcomes.

So, yes, do that…AND…refocus on the importance of connecting fish and flood basins at a scale that may lead to recovery.

That means:

1) Refocusing on the DRIVERS→LINKAGES→OUTCOMES framework for salmonids engaging flood basins

2) Considering actions we previously never talked about, leading to projects we never considered probable.

Rethinking Connectivity –
a lateral connectivity metric?

ESA

The processes that route juvenile fish from rivers to flood basins have received little attention.

Critical physical (e.g., hydrologic and hydraulic) and biological conditions and cues = the process of fish→flood basin connectivity.

We must further explore the fundamental physical processes and coupled biological responses—specifically, the spatial and temporal aspects of juvenile fish, flows, physical habitat, and food.

Some Key Questions….

ESA

- How exactly did water (and fish) leave the river to interact with the flood basins?
    - Which morphology carried the most flow?
    - Is Q the most important, or for fish, do certain morphologies matter most?
    - What matters most at lower flood levels (e.g., during drier years)—the condition where we struggle most to deliver rearing habitat?

- Do fish, water, and food need to better align in time and space and in the same proportions and in the same types of habitats as under historical flood basin conditions?
    - Could it be long duration residence time of fish+water, in one place and not drifting down-bypass—not just inundation duration—is critical?

- Can addressing this be done within the Valley's altered physical template (i.e., narrow flood weirs compared to the broad overflow of natural levees)?

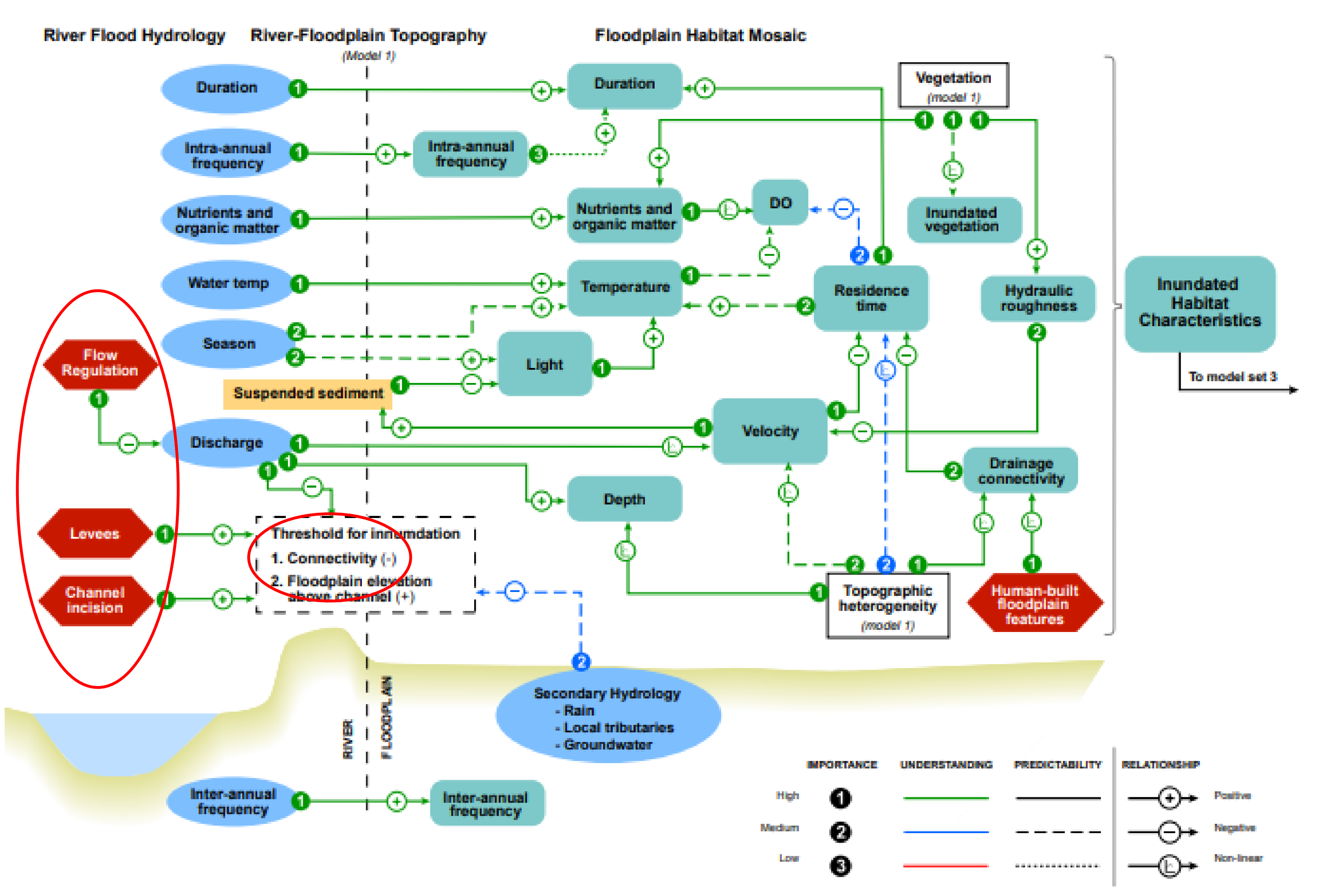
ESA

We propose to address these critical questions by carefully defining the DLO framework for Connectivity by using historical ecology, semi-quantified conceptual models, and finally new metric(s?) to support identification of restoration opportunities..

Our hope is that by identifying the critical flood processes and/or river-flood basin morphologic attributes that drive connectivity, we increase our chances at achieving recovery.

<u>Our working model is a Lateral Connectivity Metric</u>.

ESA



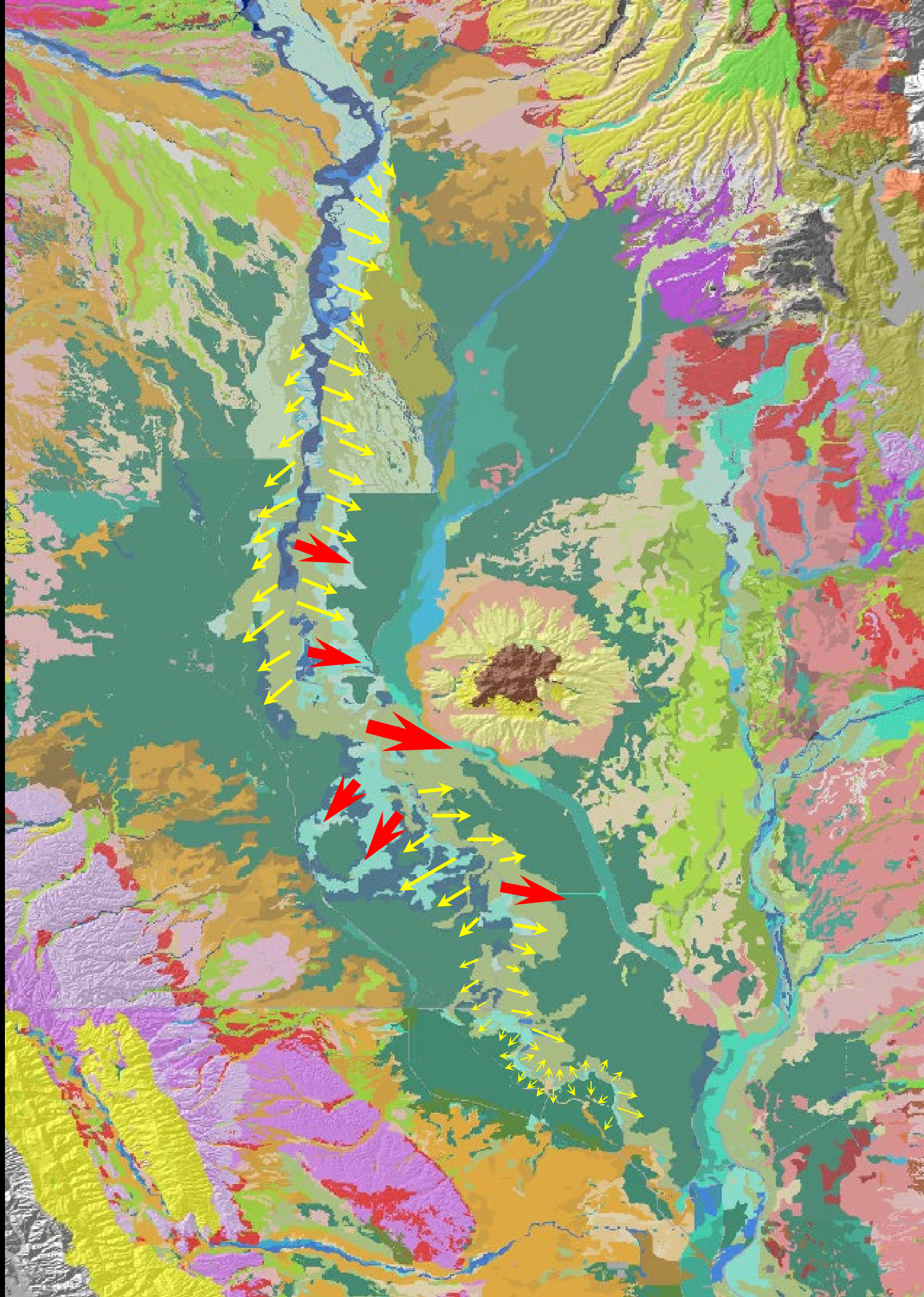
ESA

REVISIONS to ADDRESS: What happened to connectivity of organisms with the floodplain?? What drives fish access and connectivity? What are the outcomes—especially with the 'modifying factors'? Where's the planform??

Lateral Connectivity – Planform (and XS morphology) variables as a key missing link.

If we examine the river and basins in planform, we start to see a piece of the puzzle we've not spent enough time on.

- We know that while distributaries (e.g., Sycamore Slough, Butte Slough, and crevasse splays at existing weirs) were/are important, it's also all that remains.
- The river lost significant flow with distance downstream—across broad, low levees.
- And some of our distributaries now flow the wrong way (e.g. Butte Slough Outfall Gates, BSOG was a distributary and is now a drain).

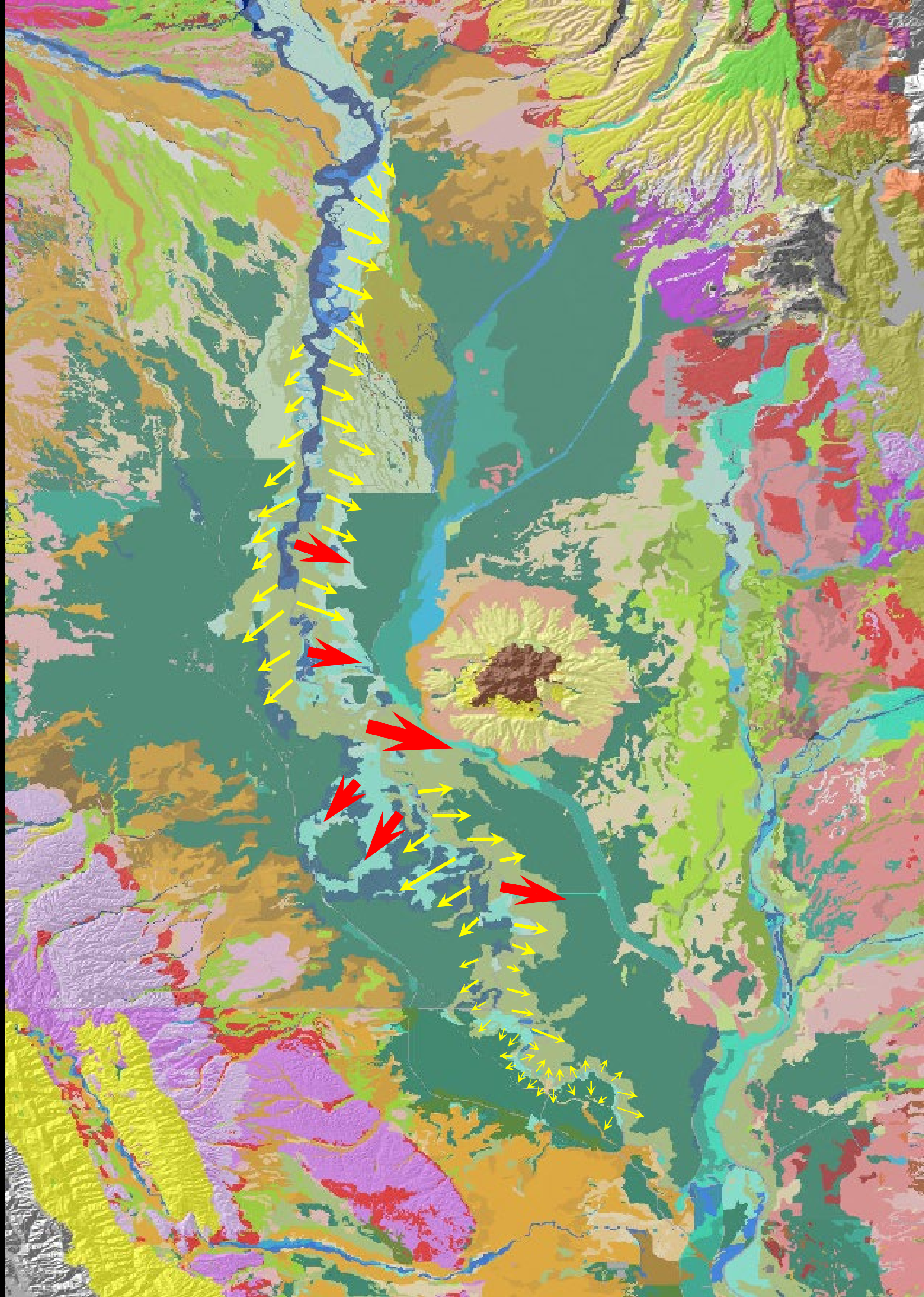


Lateral Connectivity Metric – still being defined

Morphology:
- Distributary or broad overflow?
- Ratio of XS area of river floodway to XS area of overflow area?
- Lateral extent (length) of overflow area to XS area or width of river floodway??

Hydrology: Relation to flood hydrograph, flow frequency, and species life history (timing, duration, frequency)

Landscape Position: Not all remaining floodplains/bypasses/basins are of equal importance. Selecting overflow location may be even more important in our heavily modified (leveed) system and may not look like pre-disturbance.



ESA

We'd never expect fish to leave the river through a pipe to go into a flood basin. But the scale of our current flood weirs (and new notches in them) are roughly approximate to just that: a small hole in an otherwise long barrier between two areas that we seek to get many organisms to move between.

Fremont Weir (the widest in the system) and the "Big Notch" - December 29, 2025

ESA

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ESA

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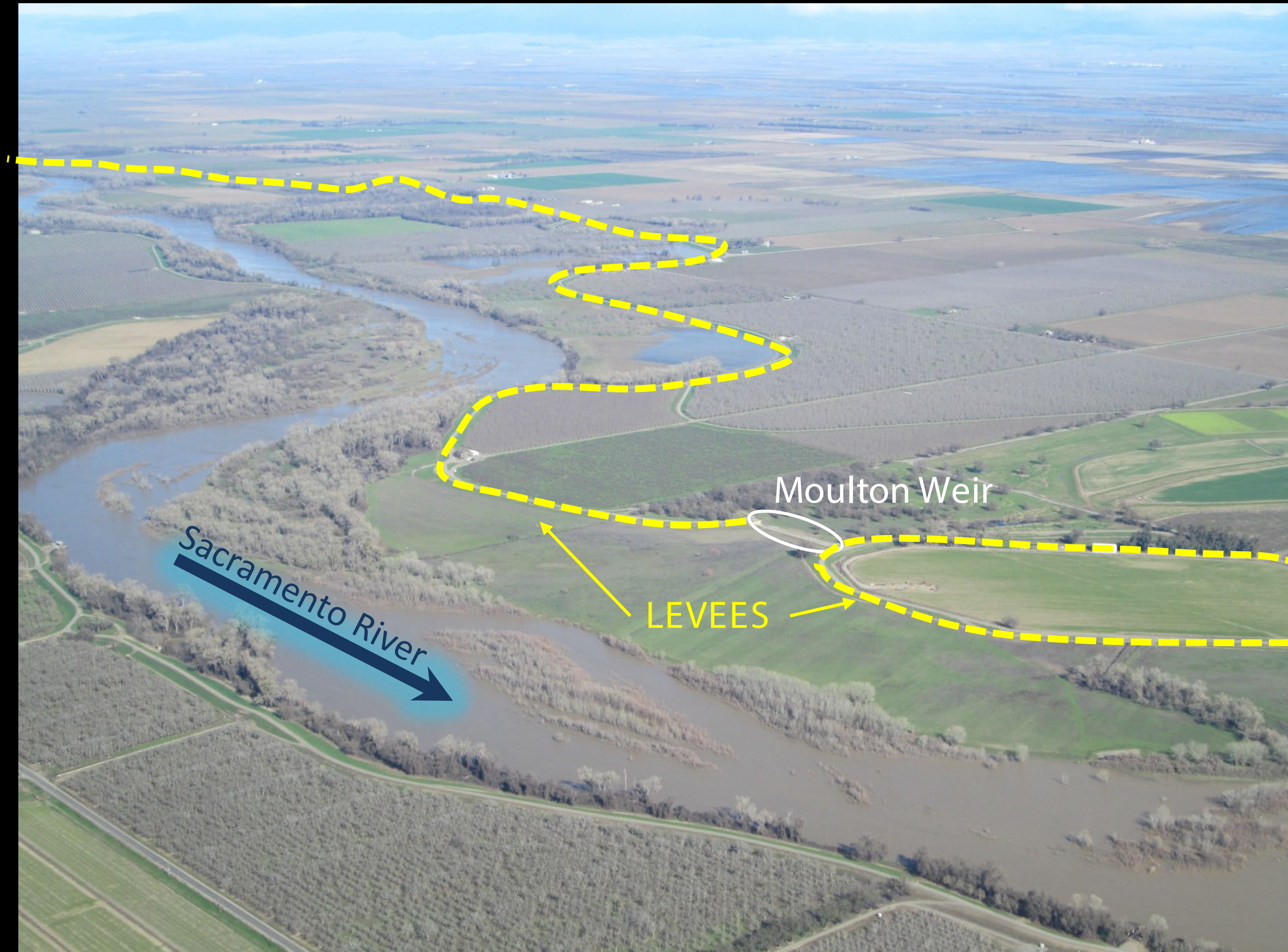


Take Aways:

Flood basins were deep bowls of standing water. Some places may have never drained.

Flood Bypasses are not Flood Basins.

We've missed something in focusing so much on just the hydrology. We need to work on connectivity.

Inundation in a flood bypass may still just function like a slow-moving, broad river.

Residence time (fish+water+in one place and not moving), not inundation duration, may yield inordinate value. Think about that at a landscape scale.

Not all flood existing overflows, bypasses, and basins are equal in terms of creating connectivity and residence time.

ESA

Actions:

The Healthy Rivers and Landscapes (HRL) Program envisions spending over $1B on non-flow actions to meet species' needs related to water quality standards. It's time to go big.

The new toolset:

- Multi-benefit projects that think about water at a landscape scale.
- Fix BSOG.
- Add new overflows (levees, not just weirs), setbacks, as well as levee raises coupled with increasing floodplain roughness to increase stage for a given Q.

It took nearly 20 years to go from FAF to HRL.
Let's think like a river (and a basin) and accelerate the path to species recovery.

ESA

BUREAU OF RECLAMATION

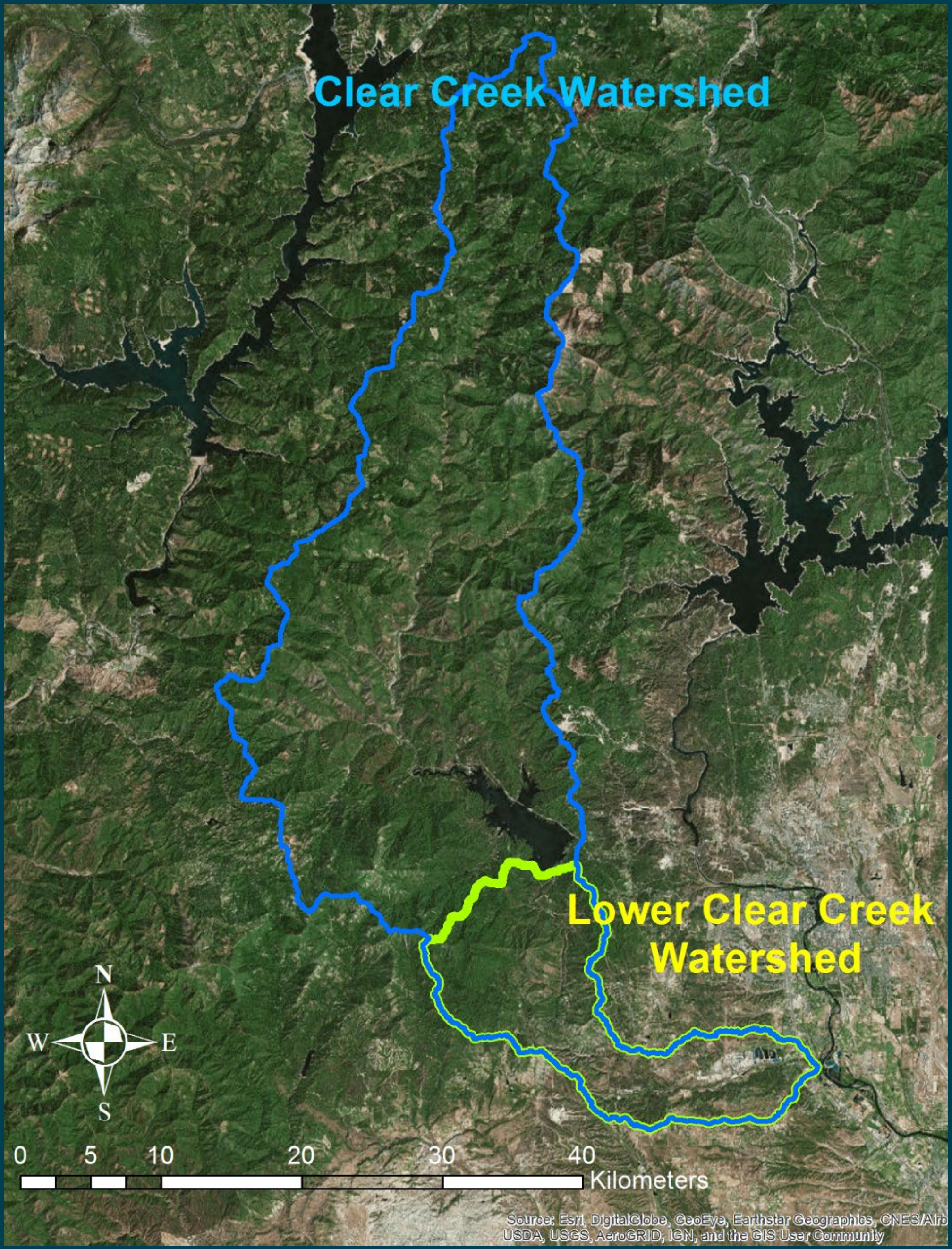
Evolving Stream Habitats And Managed Flow Regimes To Support Floodplain Rearing Of Juvenile Chinook Salmon

Derek Rupert M.S.

April 2026

Functional Floodplains

Lower Clear Creek



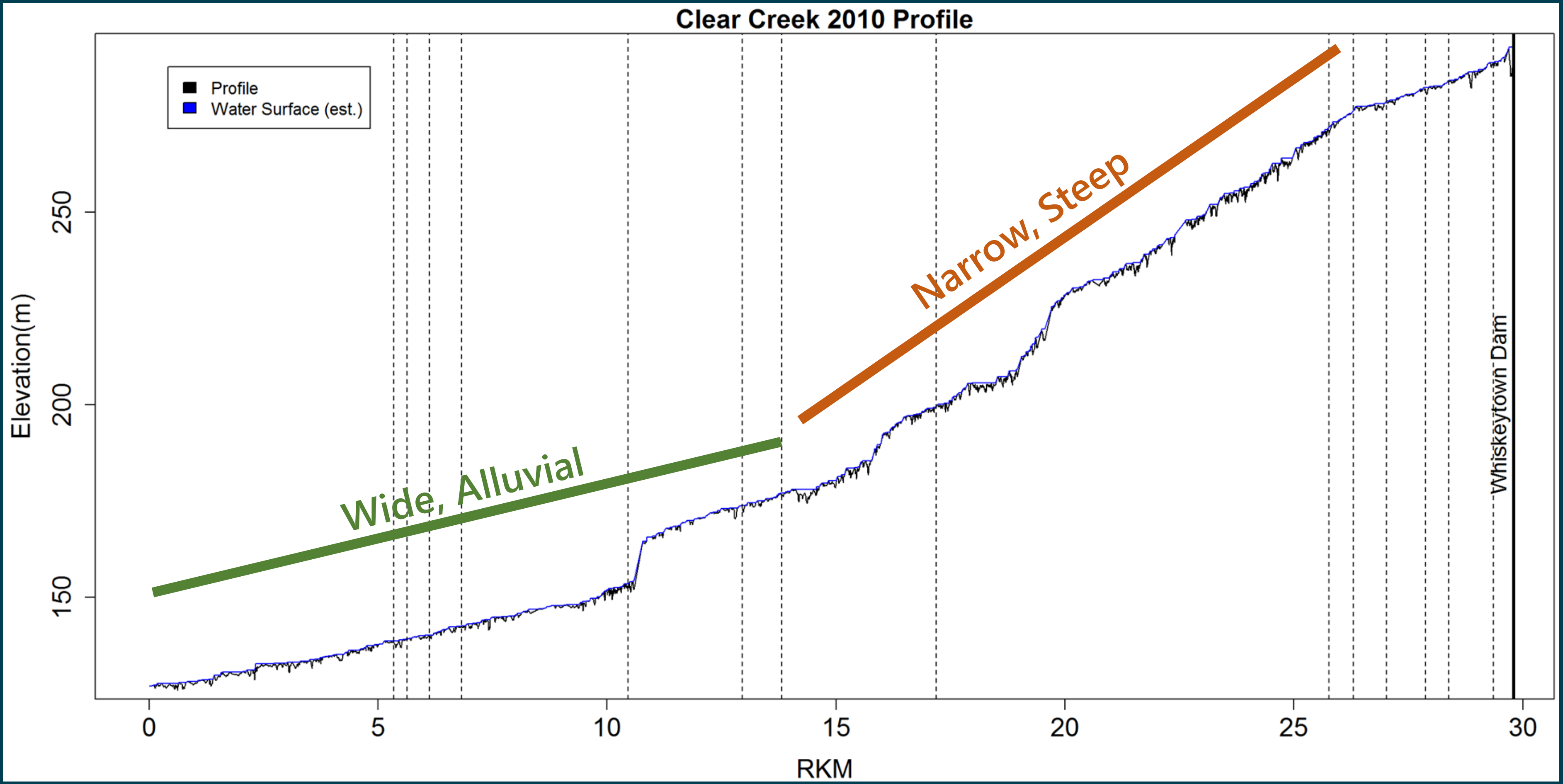
Clear Creek watershed:
~240 square miles
~60 miles of mainstem stream

Lower Clear Cr watershed:
~50 square miles
~18 miles of mainstem stream

Whiskeytown Dam is the limit to anadromy.

Several species and runs of anadromous fish are found downstream of WT Dam.

Lower Clear Creek

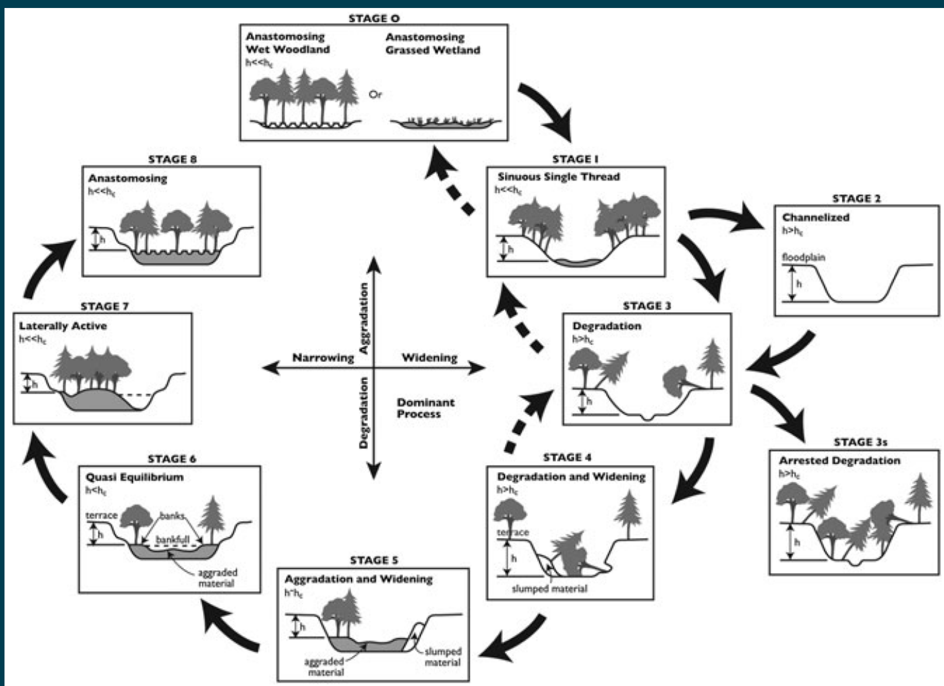


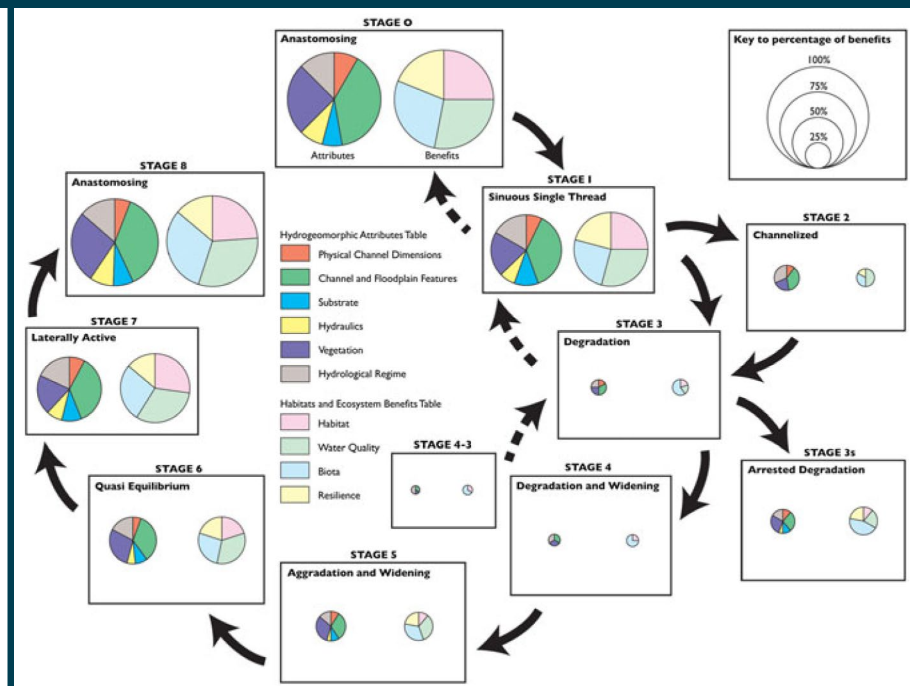
Upper reaches are defined by steep, narrow bedrock canyon.
Lower reach are defined by wide, alluvial valley.

Clear Creek stream profile from Graham Mathews and Associates, 2010.

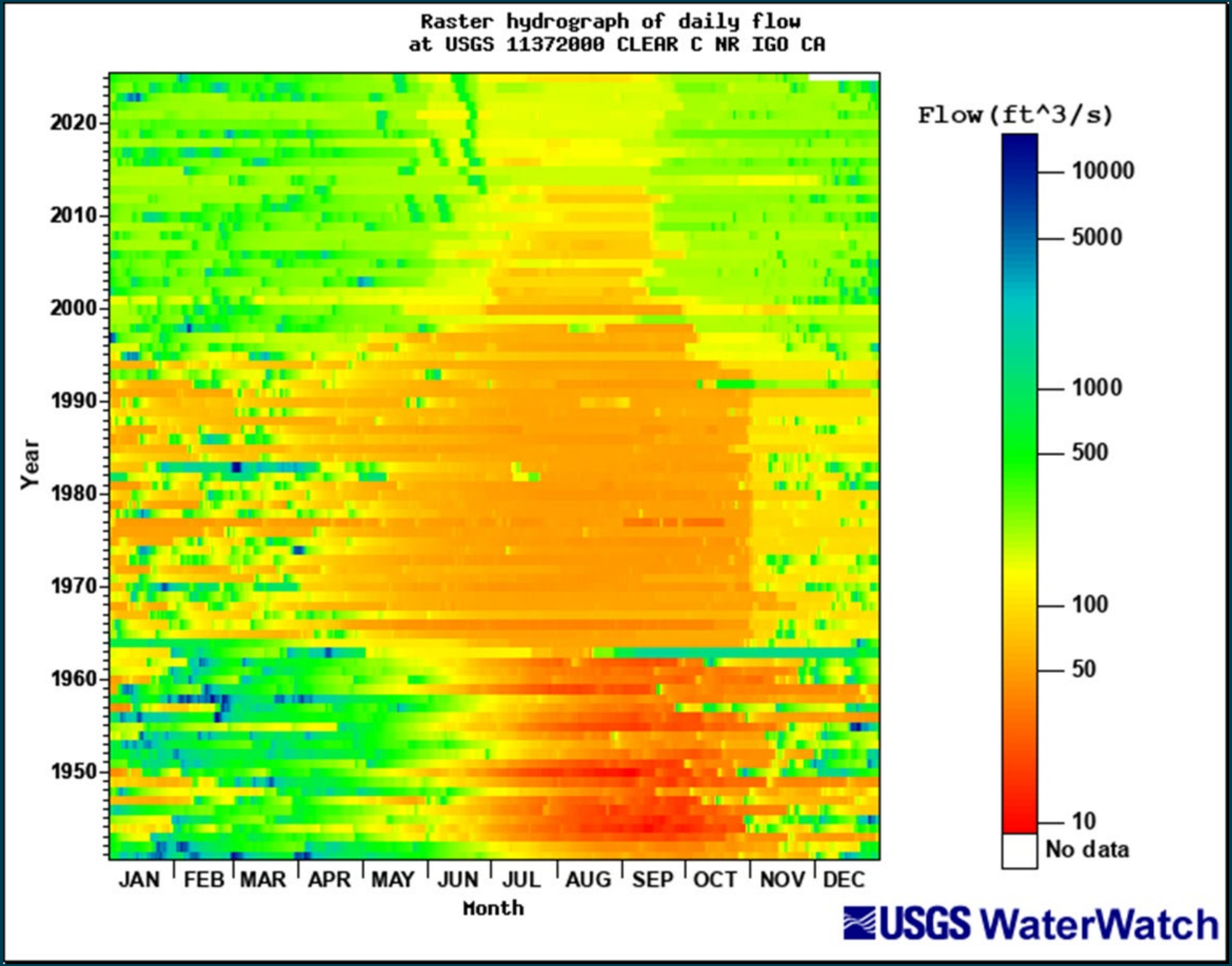
Stream Evolution Model

Cluer, B., & Thorne, C. (2014). A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications, 30(2), 135-154.

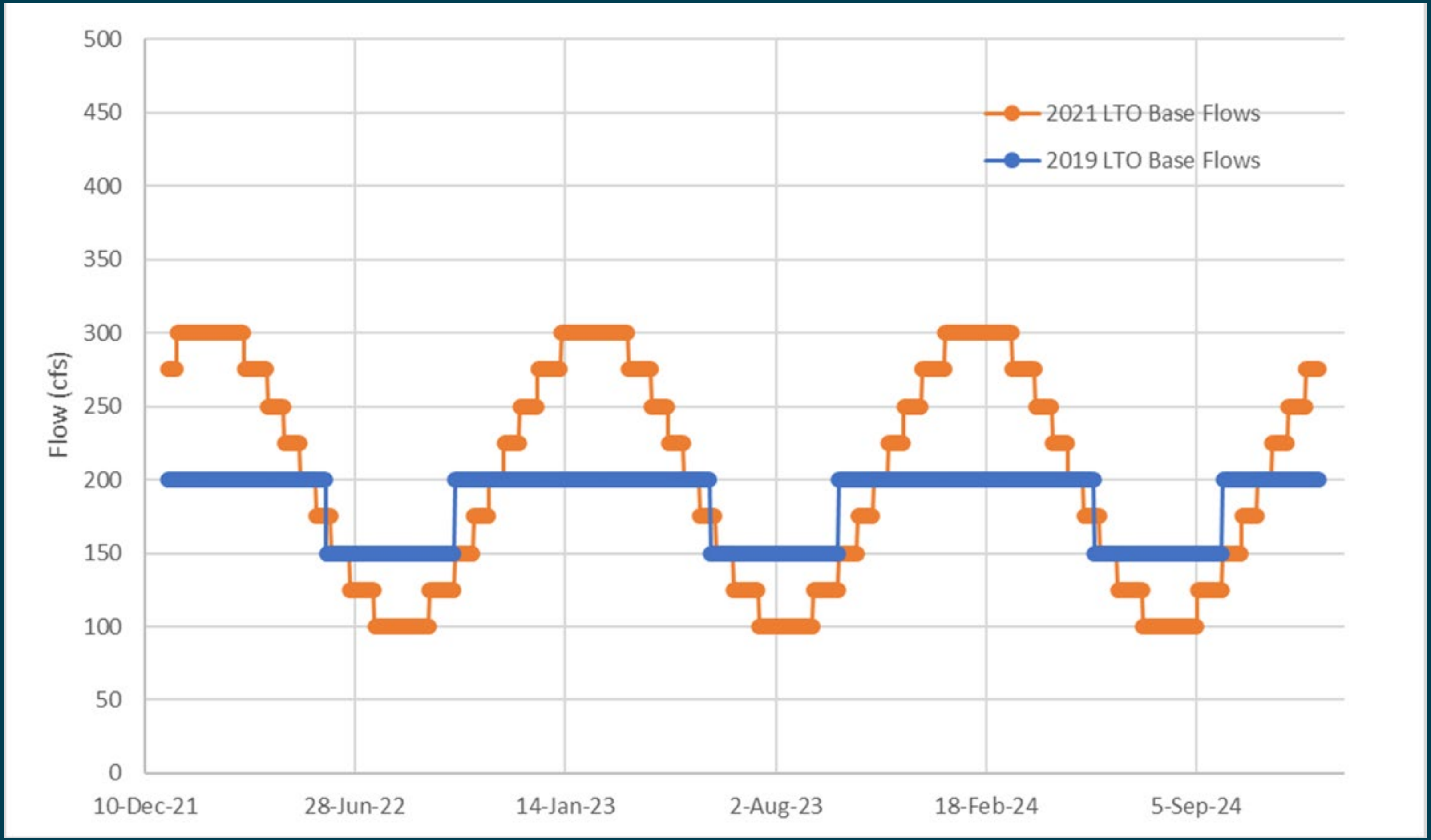




Evolving the Managed Flow Regime

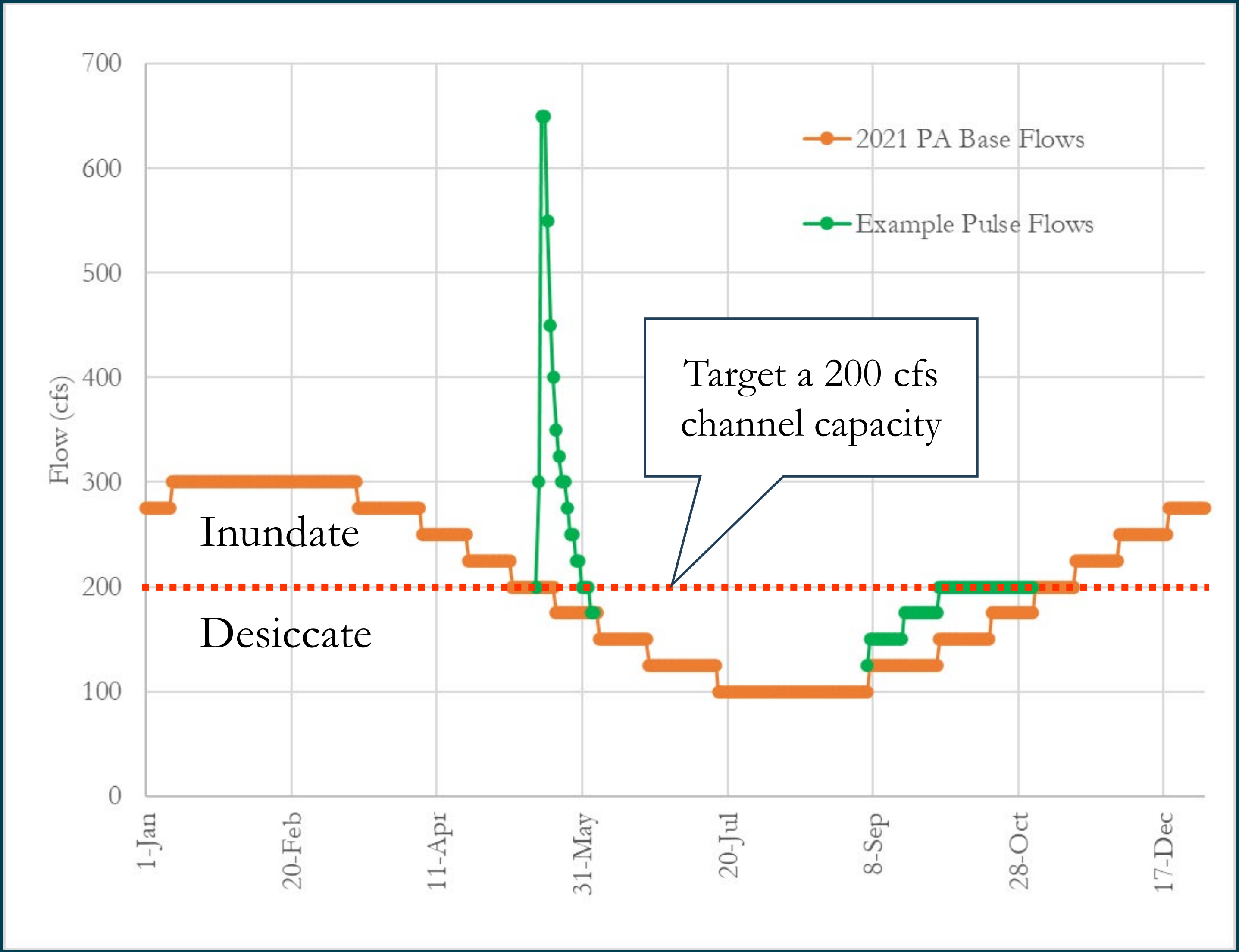


Evolving the Managed Flow Regime



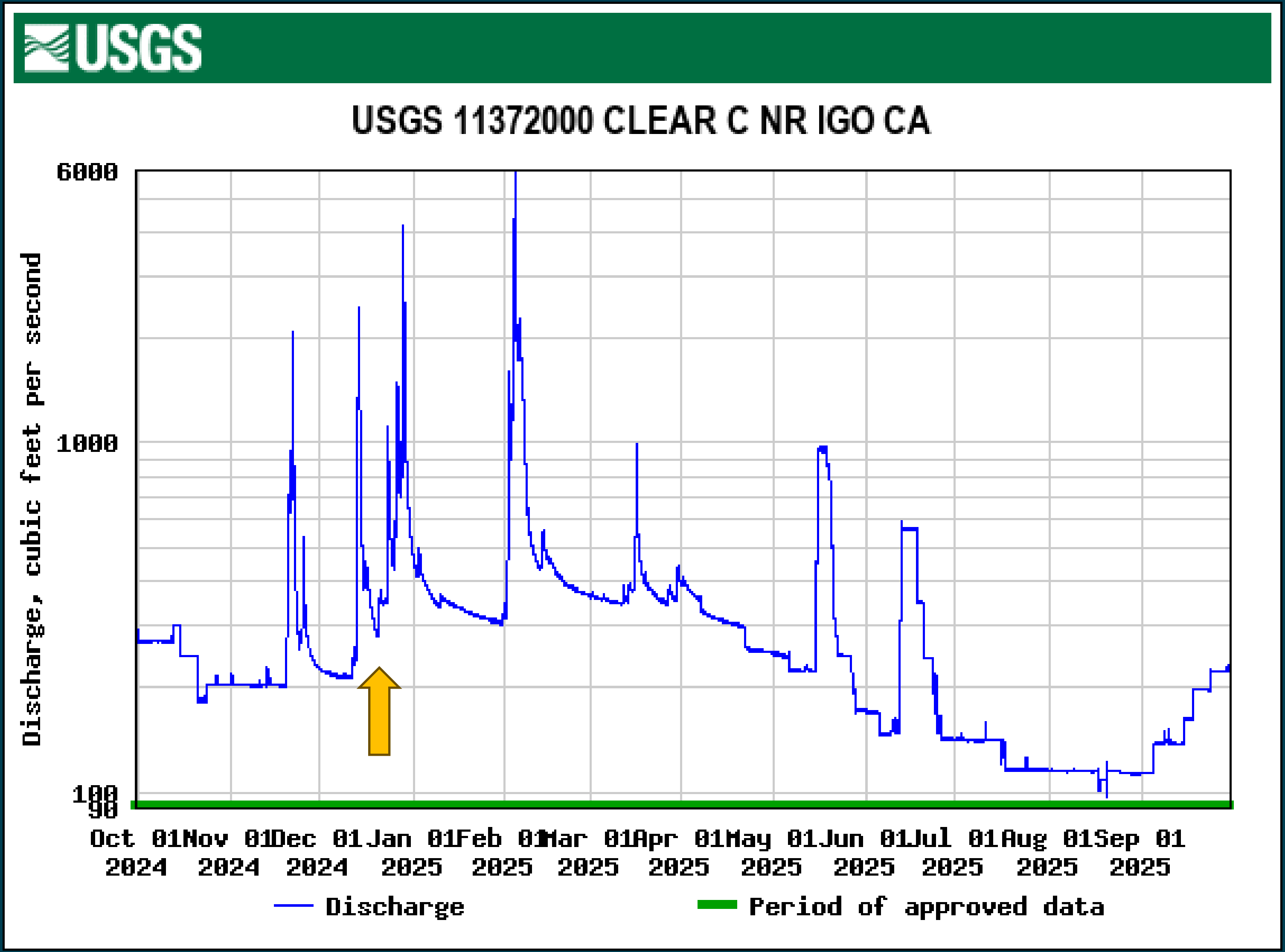
Comparison of past and current base flow, across three year.
*Arbitrary years shown.

Evolving the Managed Flow Regime



The new flow regime supports long-term, large-area floodplain inundation in winter months.

WY 2025 Flows at Igo



New flow regime started December 2025

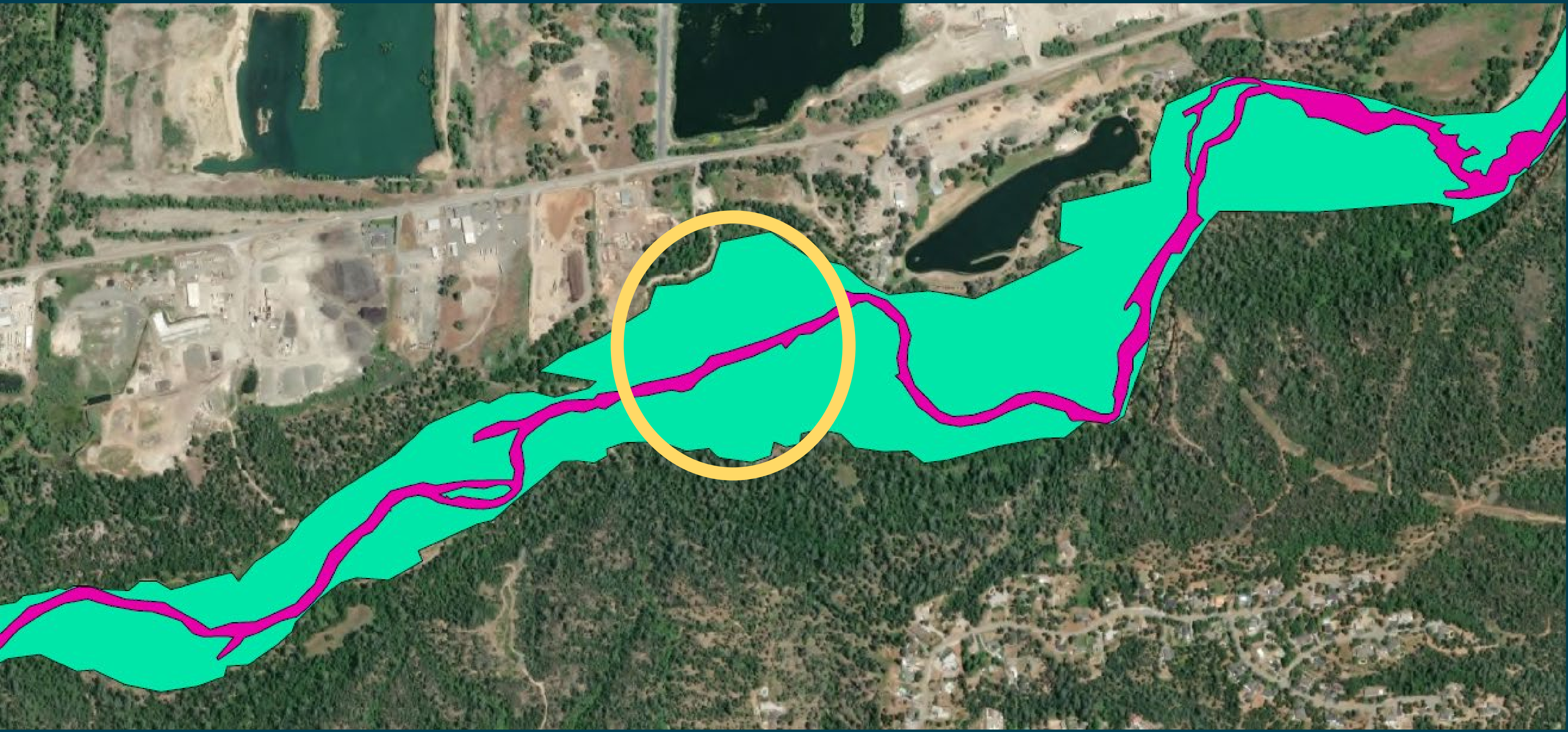
WY 2025 had 128 consecutive days above 300 cfs!

Habitat Evolution

Habitat Evolution

2023 Whiskeytown Dam Spill
Only very high flow events inundate floodplains.

Process Space



The Clear Creek restoration reach has very high inundation area potential (Teal) but is currently limited to the oversized channel (Pink).

Habitat Evolution

Adapted from: McBain and Trush, 2001. Geomorphic Evaluation of the Lower Clear Creek Downstream of Whiskeytown Dam, California.

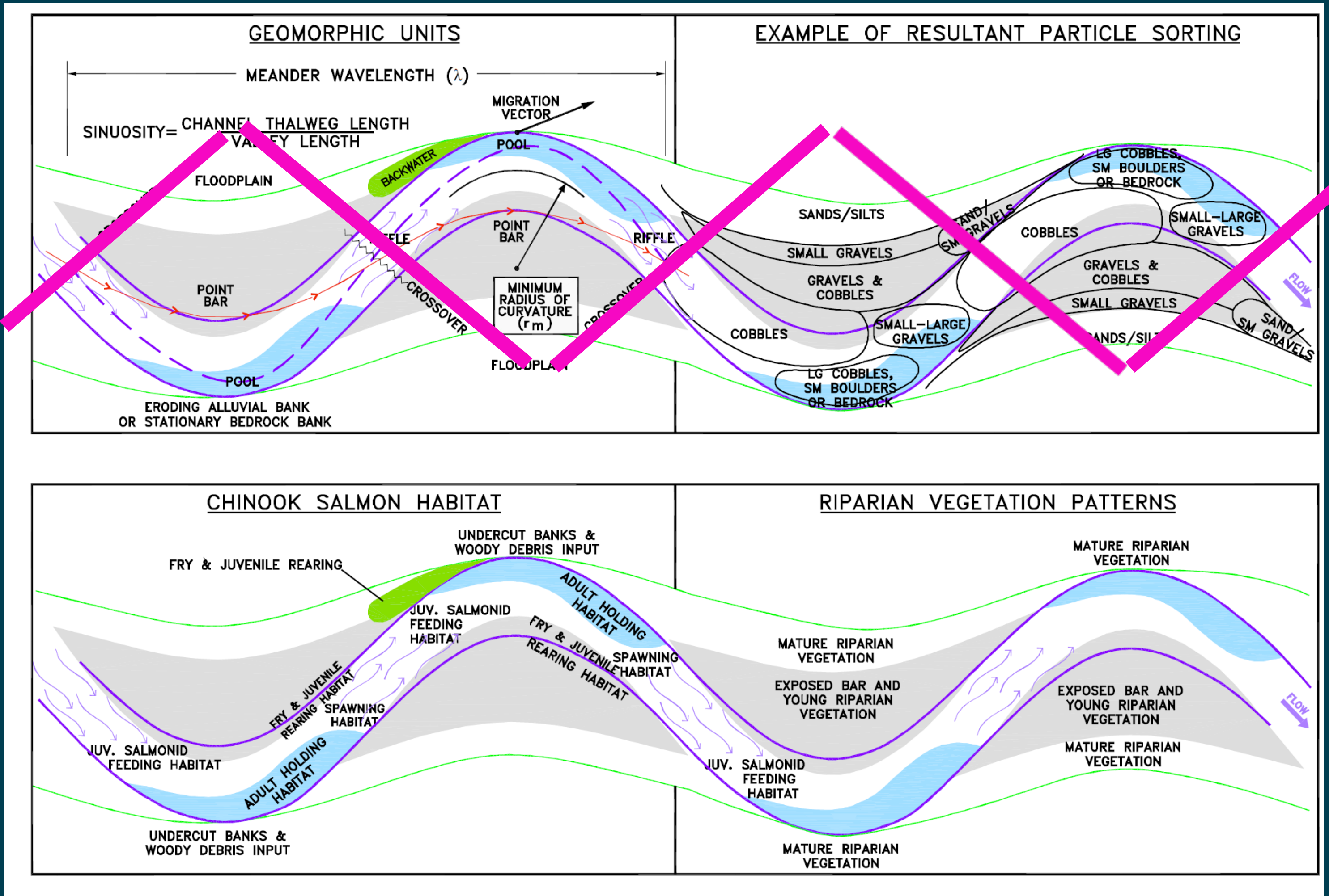
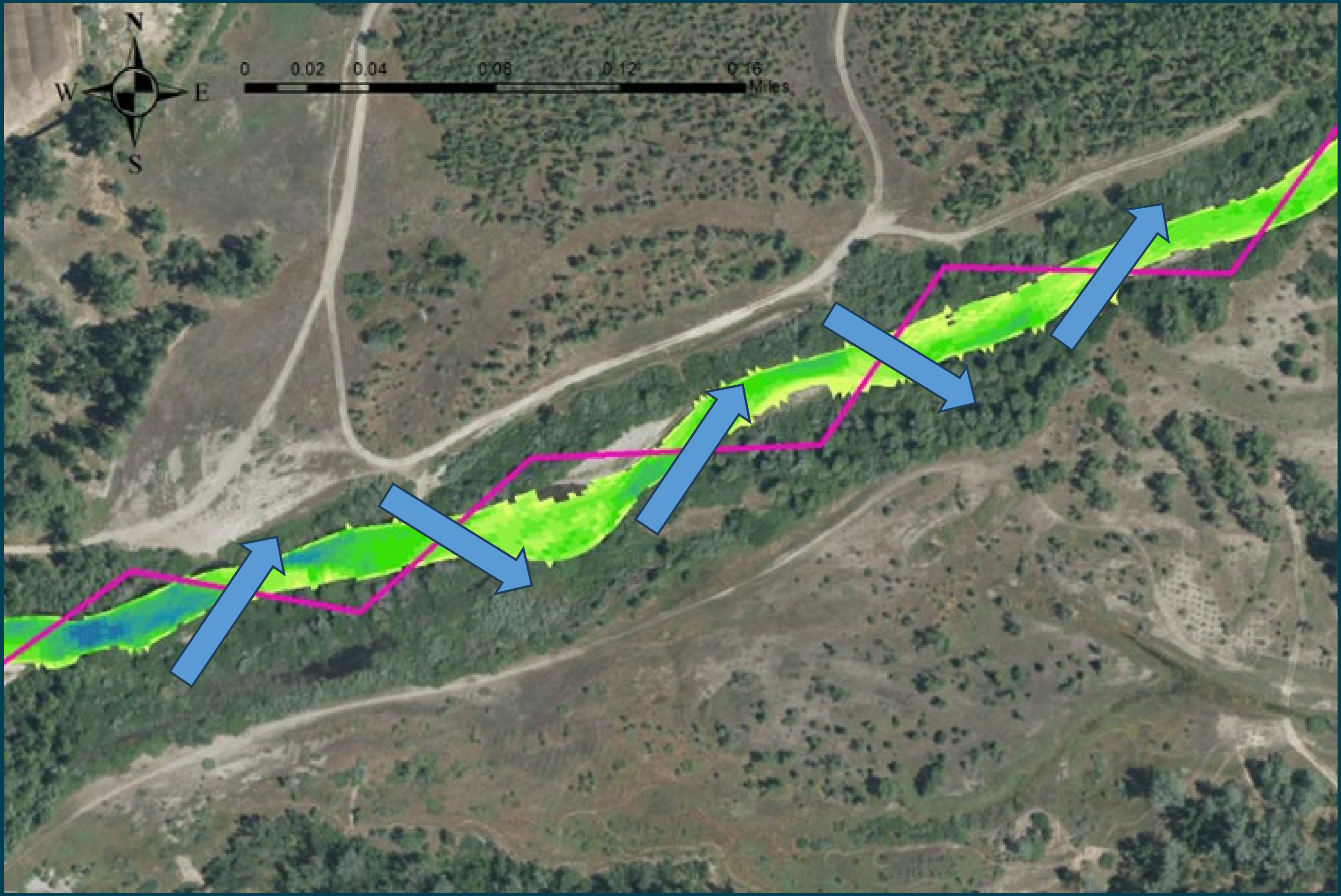


FIGURE 10. CONCEPTUAL ALTERNATE BAR UNIT OF MEANDERING AND SEMI-BRAIDED ALLUVIAL RIVERS, SHOWING RELATIONSHIP OF BAR UNITS TO PARTICLE DIVERSITY, SALMON HABITAT, AND RIPARIAN VEGETATION

Habitat Evolution



Each gravel bar raises the WSE and accentuates sinuosity.

Habitat Evolution

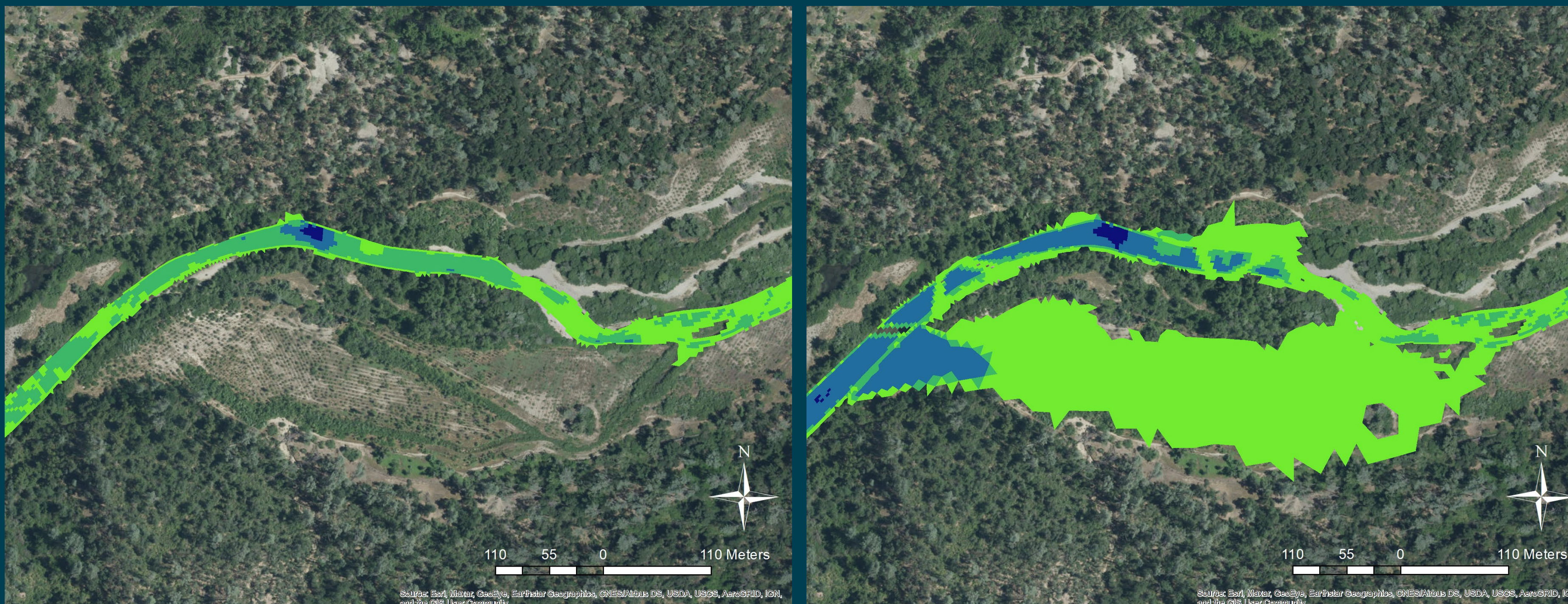
The start – First transverse bar placement.
July 2020

Habitat Evolution

Adding coarse sediment to Bar 2
June 2025

Hydraulic Modeling and Habitat

Reclamation’s Technical Service Center developed a 2D Hydraulic Model of Clear Creek downstream of Clear Creek Rd Bridge (i.e., the alluvial reach).

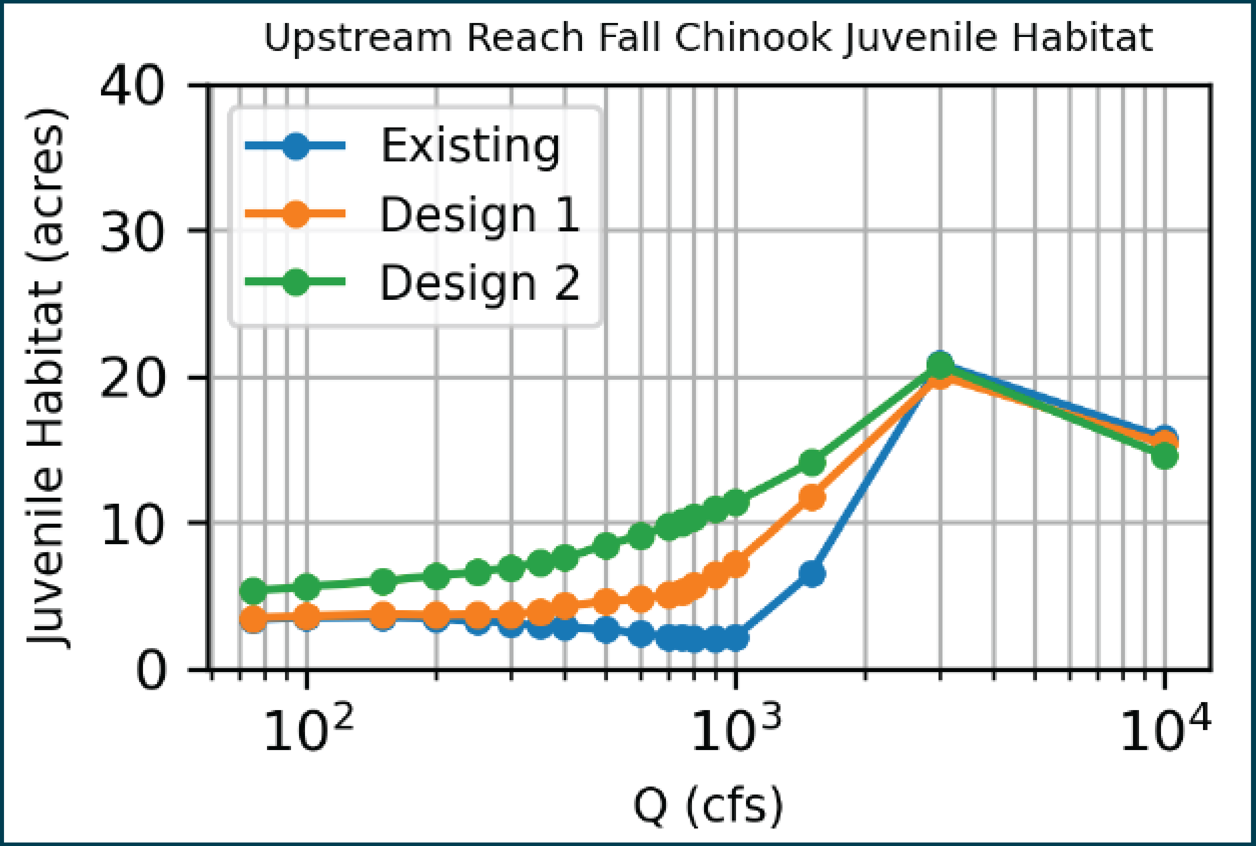


Relative water depth @ 350 cfs

<- Phase 3A current conditions With bars, BDAs and FP lowering ->

Large areas of rearing habitat potential on floodplains.

Hydraulic Modeling and Habitat



The current “habitat dip” is negative for salmonids.

Both morphology and hydrology must be adjusted together and work synergistically.

Habitat Conditions

Desiccate

Inundate

Habitat Conditions

Surrounding Ecosystem Adapting

New Beaver Dam – Dec 2025

Next Steps

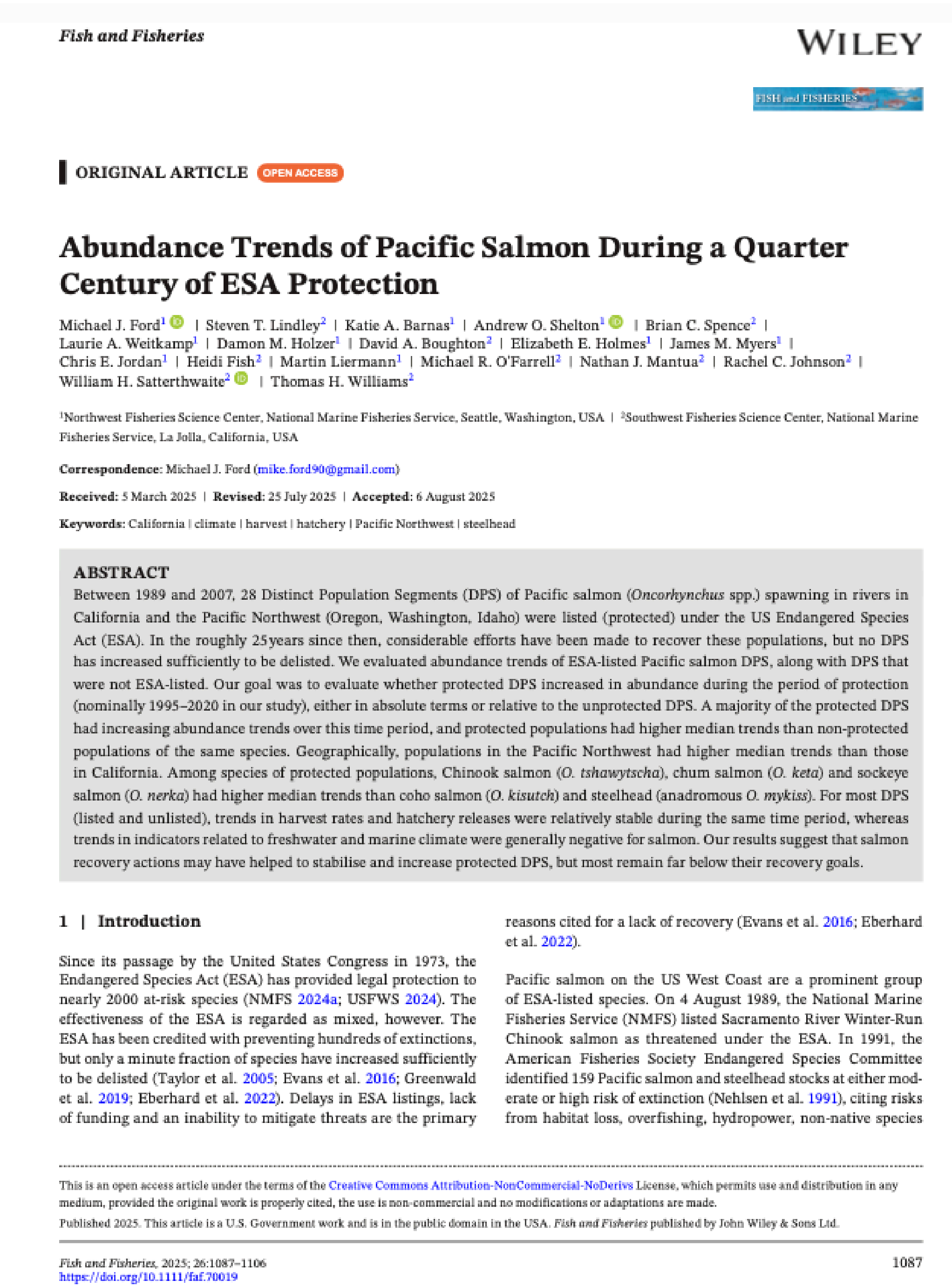
Anadromous Fish Habitat Restoration and Management Project (v.2)

- Expand project extents and restoration toolbox in areas downstream of CC Rd Bridge.
- Coarse sediment augmentations (cobble to pebbles)
- Boulders placements
- Wood structure supplementation
- Floodplain and vegetation management

Thank you! Questions?

Clear Cr October 2025

Contact:
DRupert@usbr.gov



Fish and Fisheries

WILEY

ORIGINAL ARTICLE OPEN ACCESS

Abundance Trends of Pacific Salmon During a Quarter Century of ESA Protection

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Keywords: California | climate | harvest | hatchery | Pacific Northwest | steelhead

ABSTRACT

Between 1989 and 2007, 28 Distinct Population Segments (DPS) of Pacific salmon (*Oncorhynchus* spp.) spawning in rivers in California and the Pacific Northwest (Oregon, Washington, Idaho) were listed (protected) under the US Endangered Species Act (ESA). In the roughly 25 years since then, considerable efforts have been made to recover these populations, but no DPS has increased sufficiently to be delisted. We evaluated abundance trends of ESA-listed Pacific salmon DPS, along with DPS that were not ESA-listed. Our goal was to evaluate whether protected DPS increased in abundance during the period of protection (nominally 1995–2020 in our study), either in absolute terms or relative to the unprotected DPS. A majority of the protected DPS had increasing abundance trends over this time period, and protected populations had higher median trends than non-protected populations of the same species. Geographically, populations in the Pacific Northwest had higher median trends than those in California. Among species of protected populations, Chinook salmon (*O. tshawytscha*), chum salmon (*O. keta*) and sockeye salmon (*O. nerka*) had higher median trends than coho salmon (*O. kisutch*) and steelhead (anadromous *O. mykiss*). For most DPS (listed and unlisted), trends in harvest rates and hatchery releases were relatively stable during the same time period, whereas trends in indicators related to freshwater and marine climate were generally negative for salmon. Our results suggest that salmon recovery actions may have helped to stabilise and increase protected DPS, but most remain far below their recovery goals.

1 | Introduction

Since its passage by the United States Congress in 1973, the Endangered Species Act (ESA) has provided legal protection to nearly 2000 at-risk species (NMFS 2024a; USFWS 2024). The effectiveness of the ESA is regarded as mixed, however. The ESA has been credited with preventing hundreds of extinctions, but only a minute fraction of species have increased sufficiently to be delisted (Taylor et al. 2005; Evans et al. 2016; Greenwald et al. 2019; Eberhard et al. 2022). Delays in ESA listings, lack of funding and an inability to mitigate threats are the primary reasons cited for a lack of recovery (Evans et al. 2016; Eberhard et al. 2022).

Pacific salmon on the US West Coast are a prominent group of ESA-listed species. On 4 August 1989, the National Marine Fisheries Service (NMFS) listed Sacramento River Winter-Run Chinook salmon as threatened under the ESA. In 1991, the American Fisheries Society Endangered Species Committee identified 159 Pacific salmon and steelhead stocks at either moderate or high risk of extinction (Nehlsen et al. 1991), citing risks from habitat loss, overfishing, hydropower, non-native species

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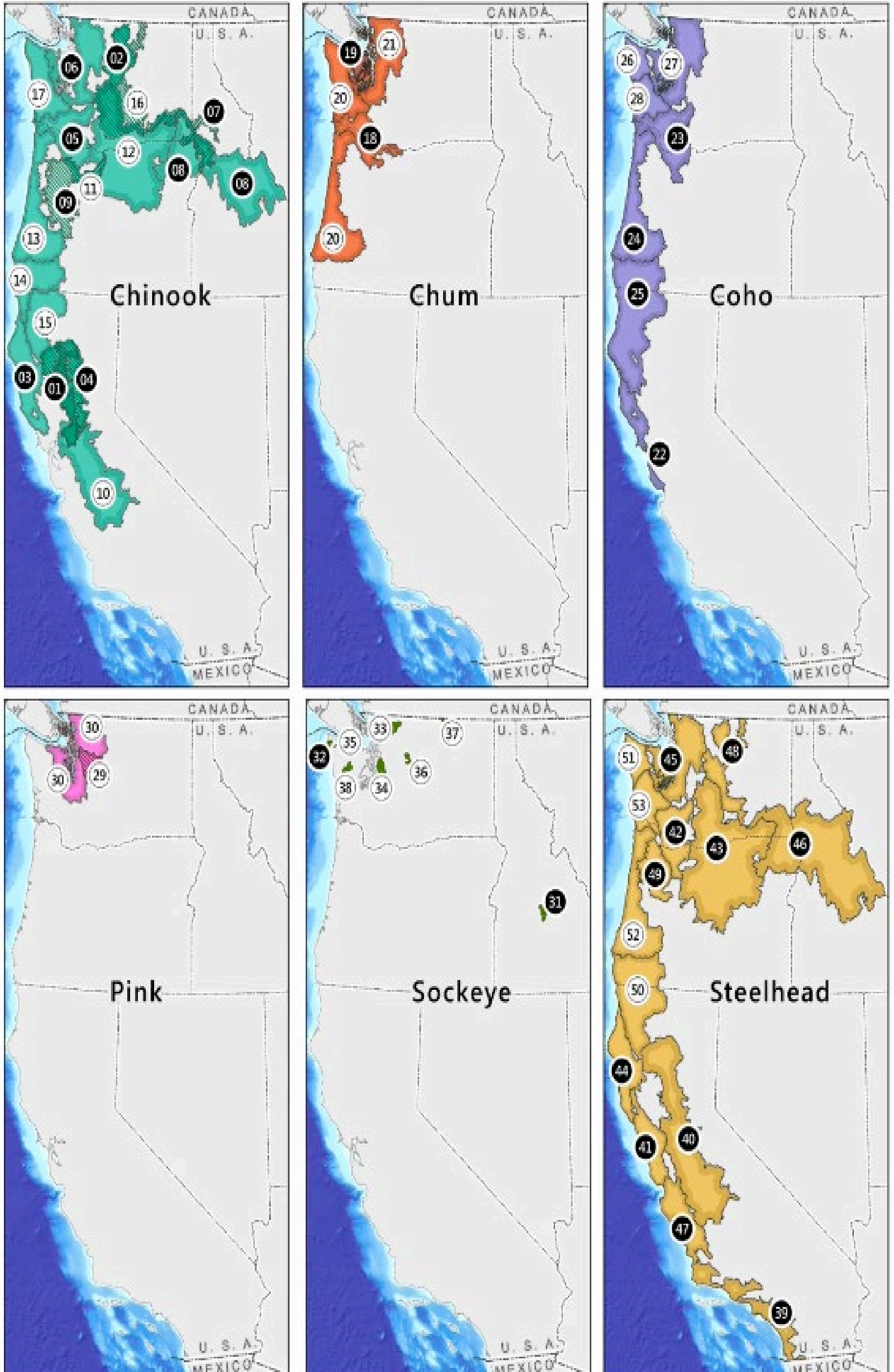
https://doi.org/10.1111/faf.70019 1087

Between 1989 and 2007, 28 Distinct Population Segments (DPS) of Pacific salmon were listed (protected) under the US Endangered Species Act (ESA).

In the roughly 25 years since then, considerable efforts have been made to recover these populations, but no DPS has increased sufficiently to be delisted.



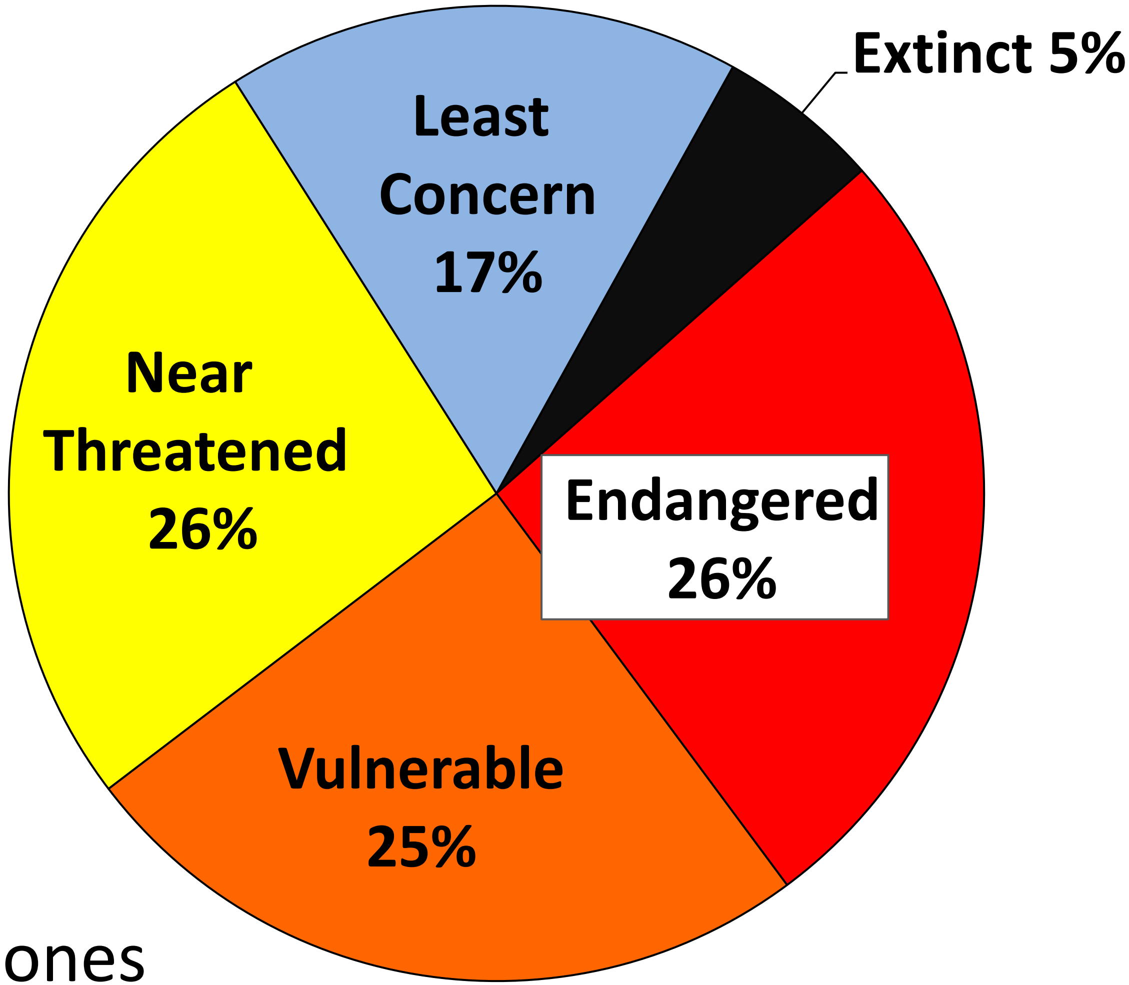
British Colombia

2/3 of populations in Decline

stateofsalmon.psf.ca

CA NATIVE FISHES

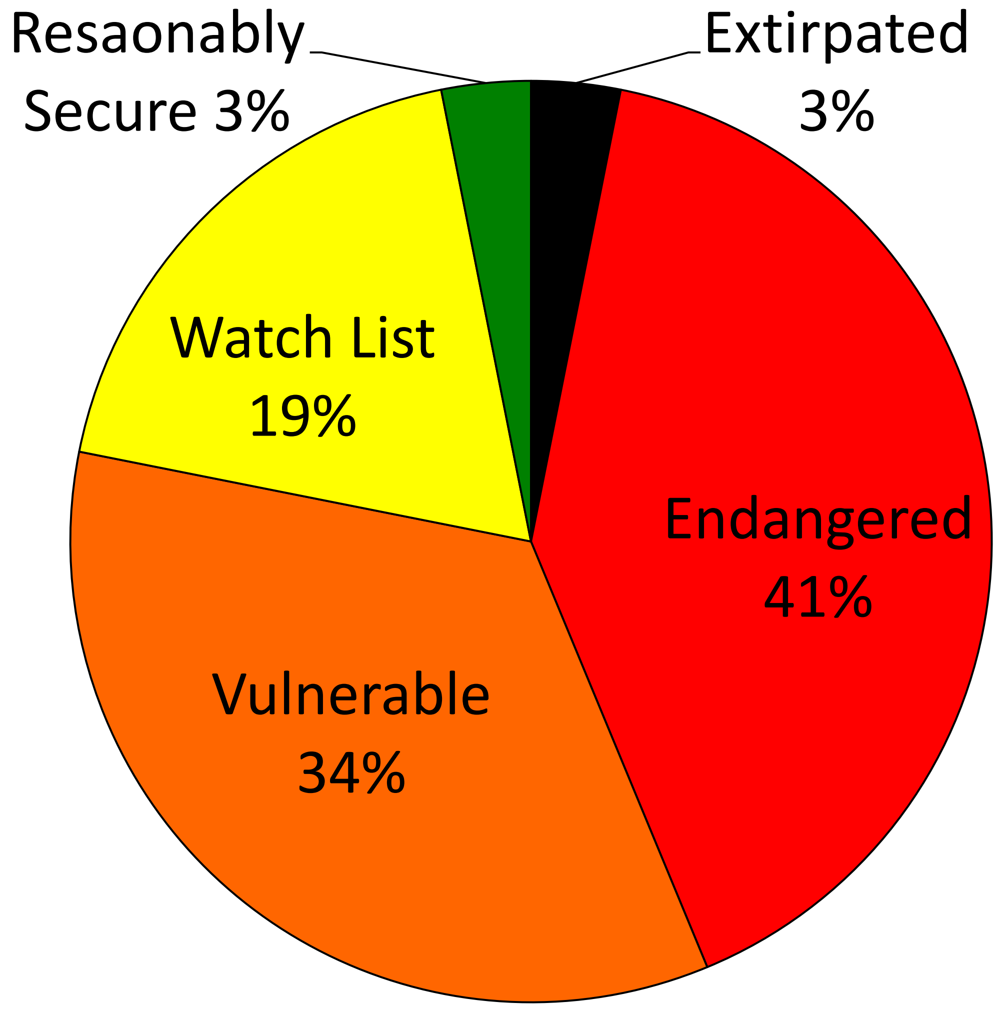
83%
Extinct or
in decline



Moyle, Katz & Quiñones
Biological Conservation,
Vol 144, issue 10, Oct. 2011

N=129

STATUS OF CALIFORNIA SALMONIDS
N = 32



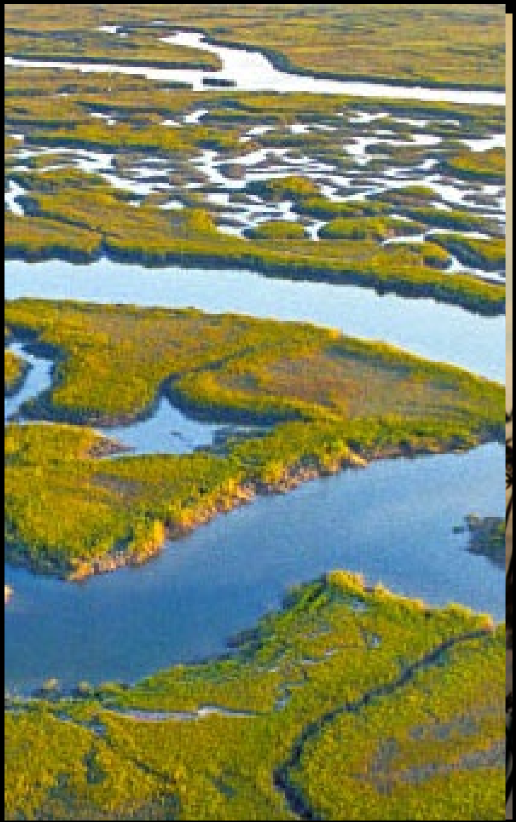
Summer 2027


Beyond
Extinction Prevention


Beyond
the thin blue line

Process-Based Reconciliation

Integrating a working knowledge of natural process, into the management of natural resources



Only when its recognized how human endeavor interrupts the landscape-scale bio-geo-morphic forces which create and sustain the mosaic of biophysical conditions, access to which facilitates each life stage to matriculate to the next, will we have a right to expect a population-level response – Recovery.

The Pivot to Process provides a means to identify where, and characterize how, human endeavor interrupts the capacity of riverscapes to provision the sequences of biophysical conditions required to produce resilient, abundant populations of anadromous salmonids.

A process-based definition of salmon habitat:

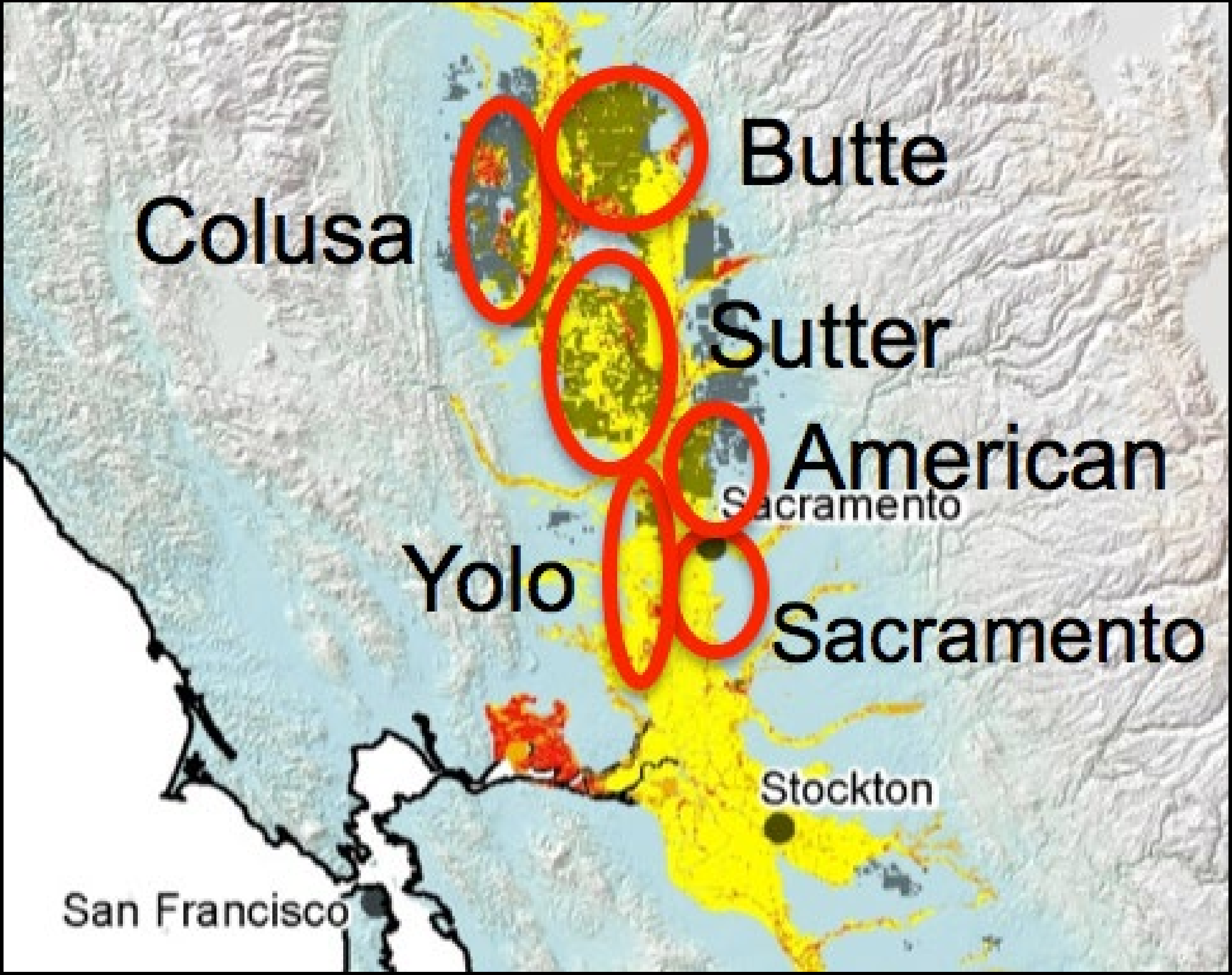
“The sequences of biological and physical conditions that arise (and to which salmon respond) as water interacts with the riverscape though which it flows."

RiverValley

- ***The Life Cycle***: Characterize each life stage (from gravel to gravel).
- ***The Niche Cycle:*** Characterize the ecological function(s) required for each life stage to matriculate to the next.
- ***The Habitat cycle:*** Characterize the sequence of bio-physical conditions required to fulfill each link in the niche cycle.
- ***The Process cycle:*** Characterize the landscape-scale biogeomorphic processes which synergistically interact to create and sustain the sequence of biophysical conditions (4-D habitat mosaic) needed to complete the niche cycle
- ***Life Cycle Interruption***: Identify and characterize the human infrastructure and land uses that interrupt the process cycle with cascading impacts to one or more life stages.

Sacramento Valley

Sac Valley Defined by its Puddles



Canalized

Thousands of miles of levees

The Land Divorced from the Water

Ubiquitous Drainage

95%

Central Valley wetlands drained

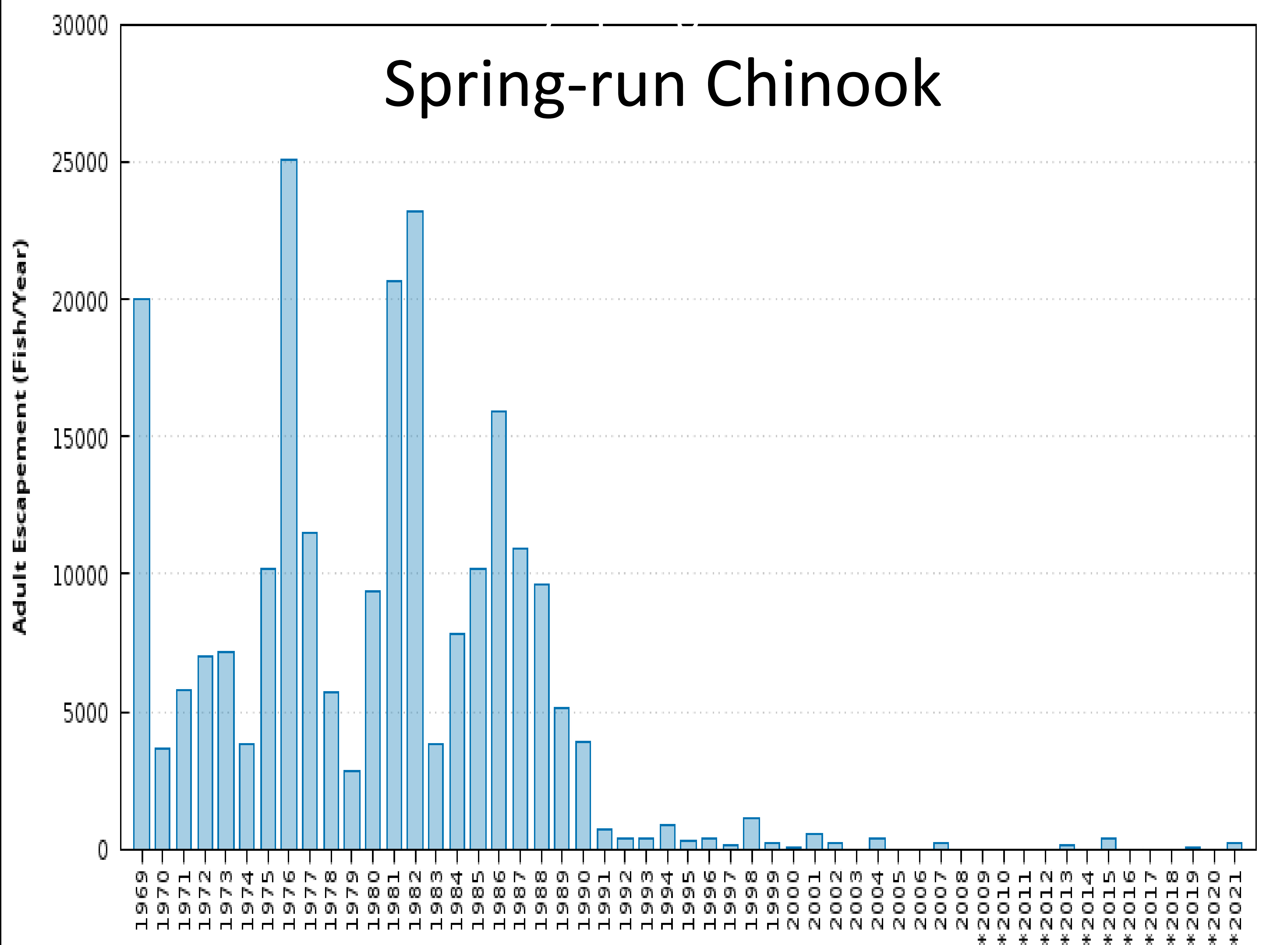
“The latest proposal to build canals or by-passes within the overflow basins, so that they will be readily drained as the river falls, would be the saving of myriads of fish, and especially of salmon fry, and should be encouraged.”

-N. Bishop Scofield, 1911

STATE OF CALIFORNIA FISH AND GAME COMMISSION FISH BULLETIN NO. 1

Fish belong in the river…

…and the river belongs in its banks.



Spring-run Chinook
Adult Escapement (Fish/Year)
30000
25000
20000
15000
10000
5000
0
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
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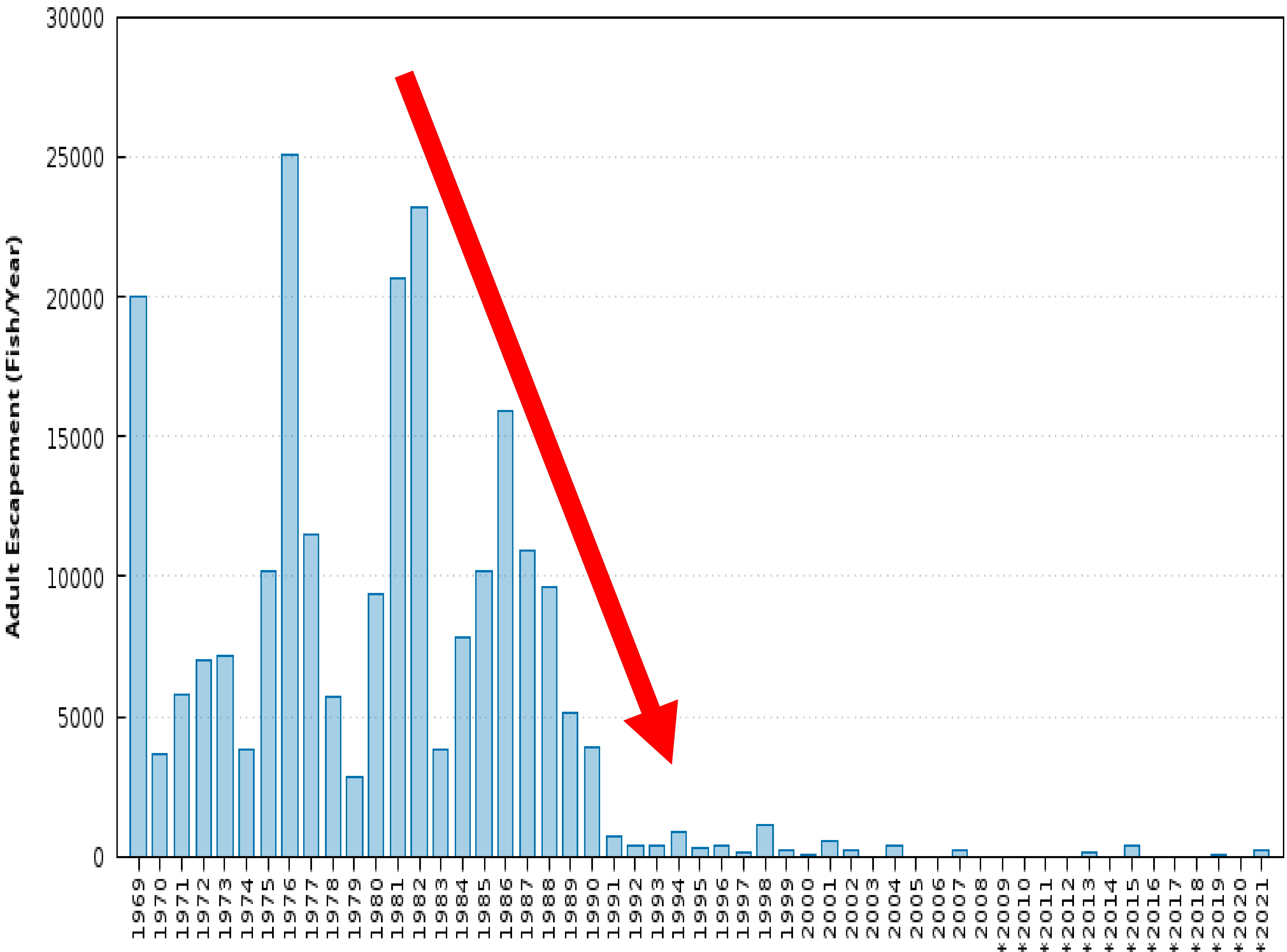
*2019
*2020
*2021



Adult Escapement (Fish/Year)
30000
25000
20000
15000
10000
5000
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1969
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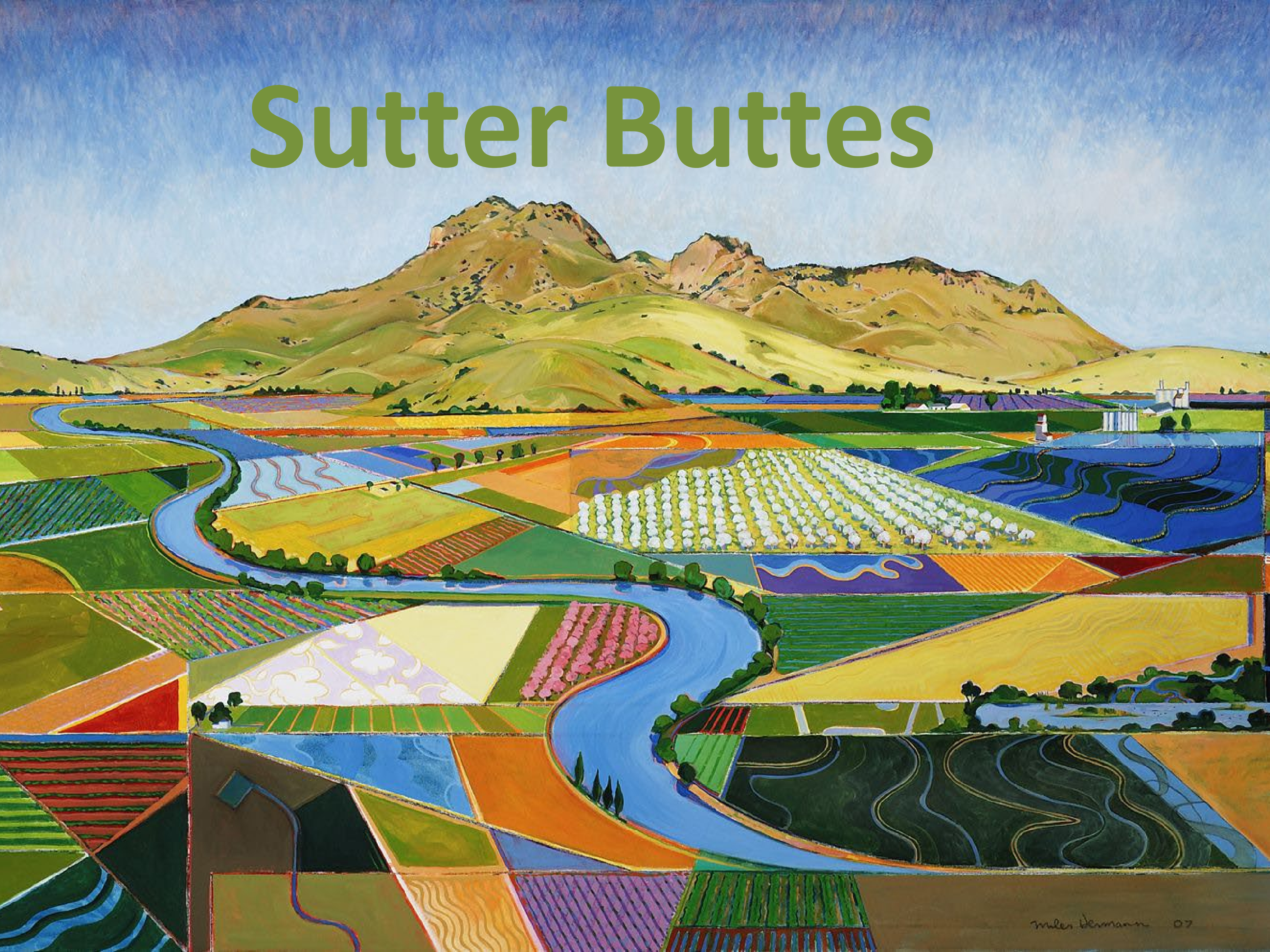
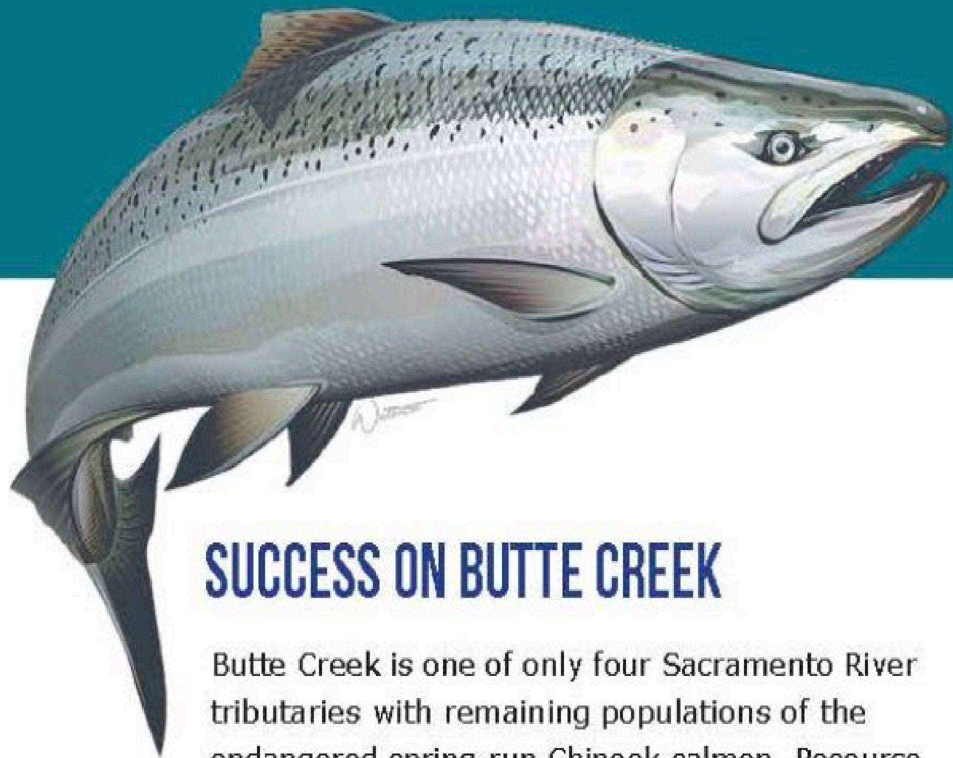
*2021

Sutter Buttes



SUTTER BUTTES AND ORCHARDS IN BLOOM



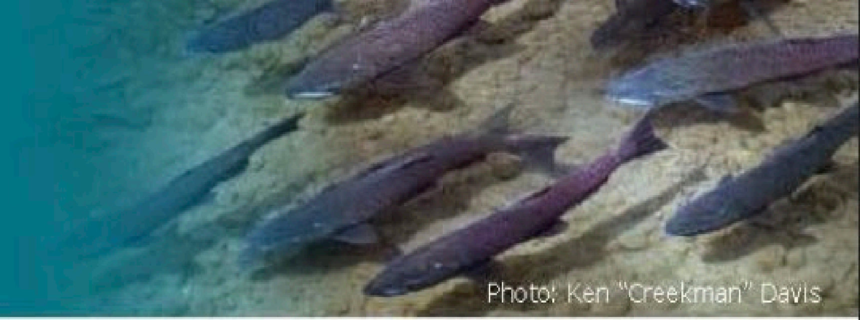
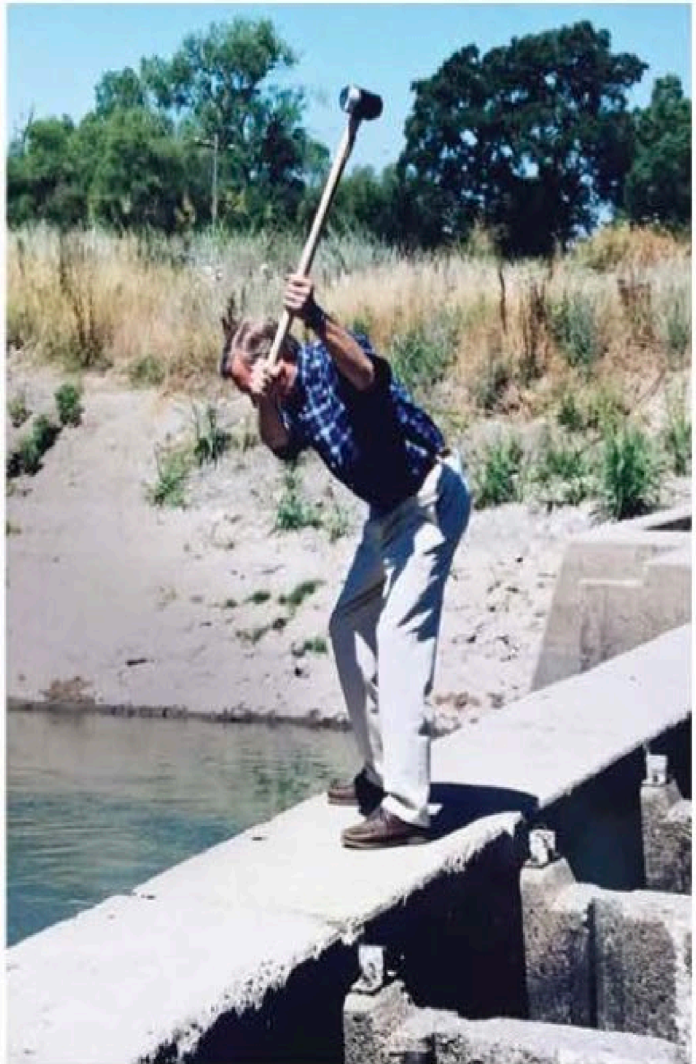


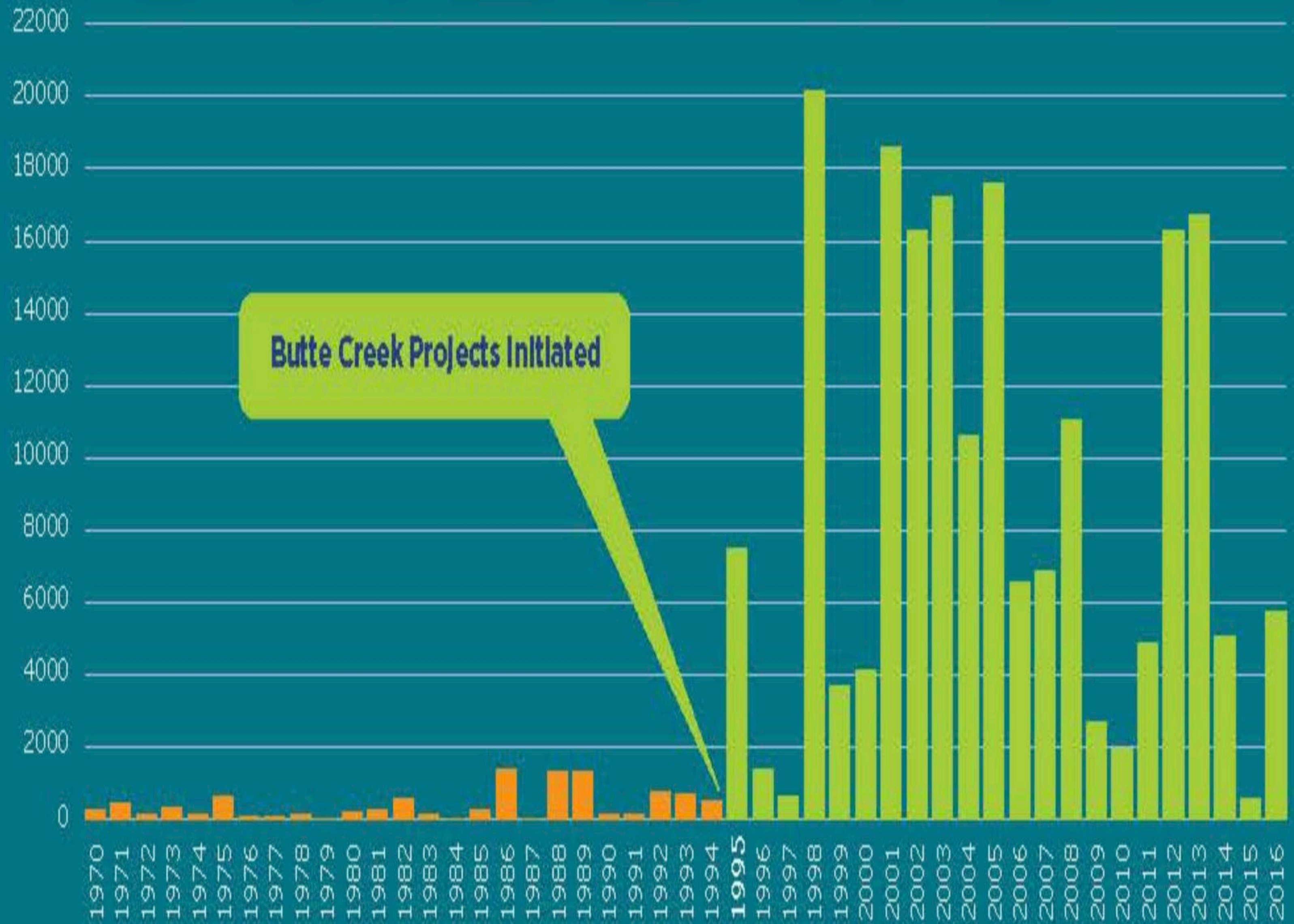
Photo: Ken "Creekman" Davis

SUCCESS ON BUTTE CREEK

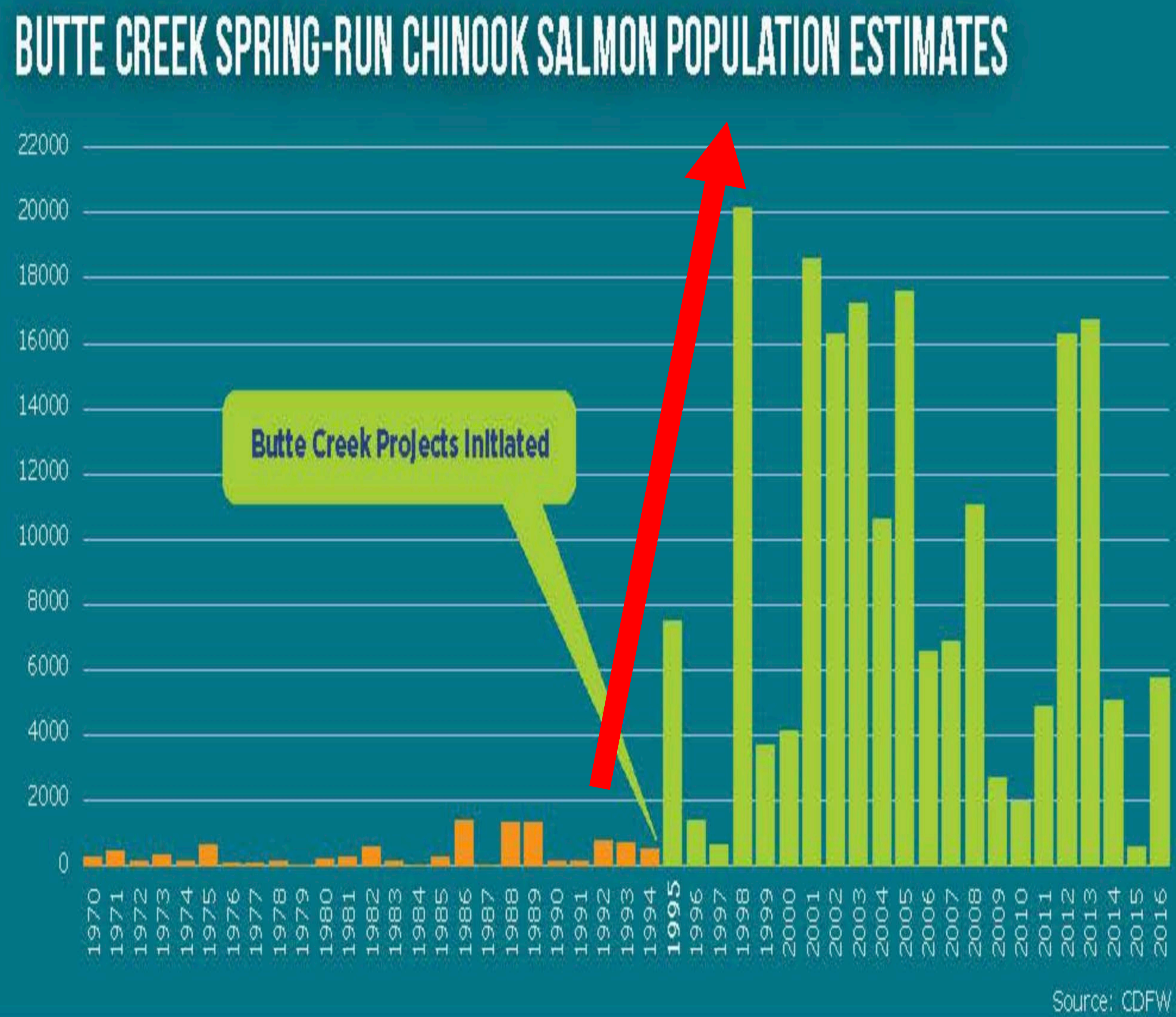
Butte Creek is one of only four Sacramento River tributaries with remaining populations of the endangered spring-run Chinook salmon. Resource agencies and conservation groups value Butte Creek as a keystone in preserving and recovering spring-run salmon, which in some years had dwindled to less than a 100 returning adults from 1970 to the early 1990s. Today, as a result of the Butte Creek Fish Passage Improvement projects, in tandem with a valuable food supply and safe rearing habitat in the Sutter Bypass wetlands, more than 10,000 spring-run salmon return on average to Butte Creek. These projects all provide multiple beneficial uses, serving water for fish, farms, birds and various other species.



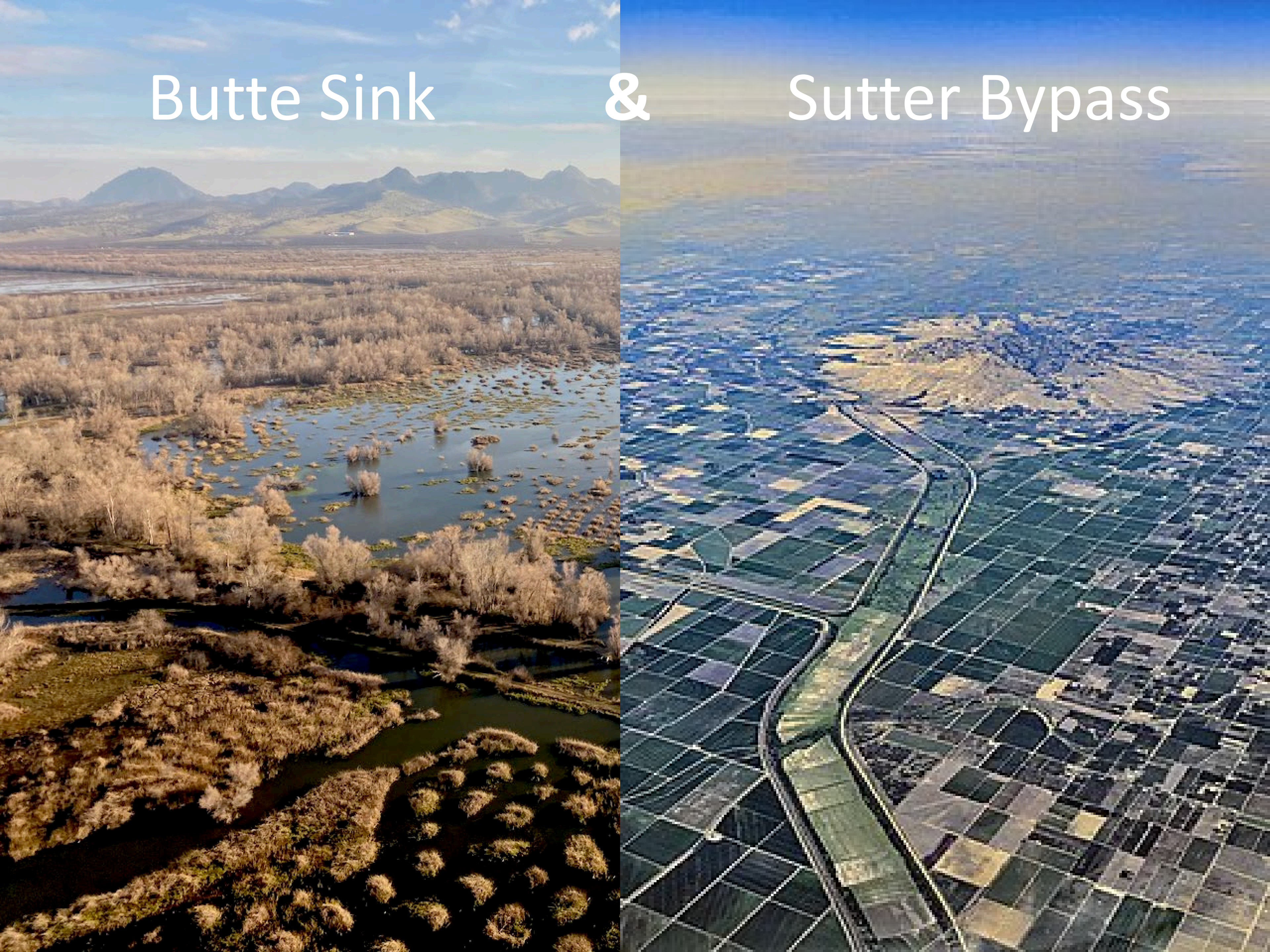
BUTTE CREEK SPRING-RUN CHINOOK SALMON POPULATION ESTIMATES



Source: CDFW


BUTTE CREEK SPRING-RUN CHINOOK SALMON POPULATION ESTIMATES
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Butte Creek Projects Initiated
1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Source: CDFW

Listen to the fish


Butte Sink
&
Sutter Bypass

Butte Creek Spring run smolts: Floodplain Fatties

FLOODPLAIN FORWARD

2025

CALIFORNIA TROUT

FISH · WATER · PEOPLE

FLOODPLAIN FORWARD

A 31-member organization representing landowners, irrigation districts, higher education, and conservation groups. The coalition, and the collaborative model of dynamic conservation, has resulted in farms, refuges, and managed wetlands providing essential habitat for waterfowl and shorebirds as well as potential food production for endangered fish species.

The Nigiri Project
CAL MARSH & FARM VENTURES
Conaway
PRESERVATION GROUP
LUNDBERG
FAMILY FARMS
MONTNA
FARMS
D
DAVIS RANCHES
SYCAMORE · CALIFORNIA
River Garden Farms
EST. 1861
Llano Seco
CHICO, CA

108
RECLAMATION DISTRICT
GCID
GLENN-COLUSA IRRIGATION DISTRICT
Ecosystem Investment Partners
Sutter Mutual Water Company
UC DAVIS
CENTER FOR WATERSHED SCIENCES
sacramento river forum
CALIFORNIA TROUT
FISH · WATER · PEOPLE

The Nature Conservancy
Protecting nature. Preserving life.
Point Blue Conservation Science
RIVER PARTNERS
DUCKS UNLIMITED
CSAC
AMERICAN RIVERS
YOLO BASIN
FOUNDATION
Sustainable Conservation
TROUT UNLIMITED

Environmental Defense Fund
NCWA
Northern California Water Association
RECLAMATION DISTRICT 1500
RCRC
RURAL COUNTY REPRESENTATIVES OF CALIFORNIA
BLACK FOX BRAND
ROBBINS RICE
Audubon
CALIFORNIA
California Rice
THE ENVIRONMENTAL CROP
CALIFORNIA WATERFOWL

Floodplain Forward MOU


2024

FLOODPLAIN FORWARD

California Floodplains at Heart of Landmark Agreement

Working Together to the Benefit of the entire Sacramento River Basin

Federal and State of California government agencies, overseeing water, agriculture, fish and wildlife, public lands and flood control have agreed to work together to enhance landscape-scale, multi-beneficial floodplain water projects in the Sacramento River Basin.

The agreement represents a growing effort by public and private stakeholders in creating long-term, sustainable solutions to protect and benefit people, fish, birds and wildlife. Through straightforward permitting processes and an increase in funding, we can work toward our floodplain activation goals.

"This state-federal partnership with support from wide-ranging stakeholders demonstrates the kind of collaborative solutions that can safeguard our communities, wildlife, businesses and water supplies in the face of climate impacts."

- Gavin Newsom, Governer of California

Read the Press Release

See Congressional Support

View the FFC Support Statement

Floodplains in Film

Watch Award Winning Floodplain Films

Floodplain Forward Packet

"Expanding floodplains is a cost effective, smart, proven, multi-beneficial investment in our future."

Wade Crowfoot,
California's Natural Resources Secretary

"In this time of climate change, which is fueling extended droughts and catastrophic fire, action is urgently needed to protect fish and wildlife resources and communities. Restoring floodplains through collaboration is a wonderful example of how we accomplish this task."

Paul Souza,
U.S. Fish and Wildlife Service, Pacific Southwest Regional Director

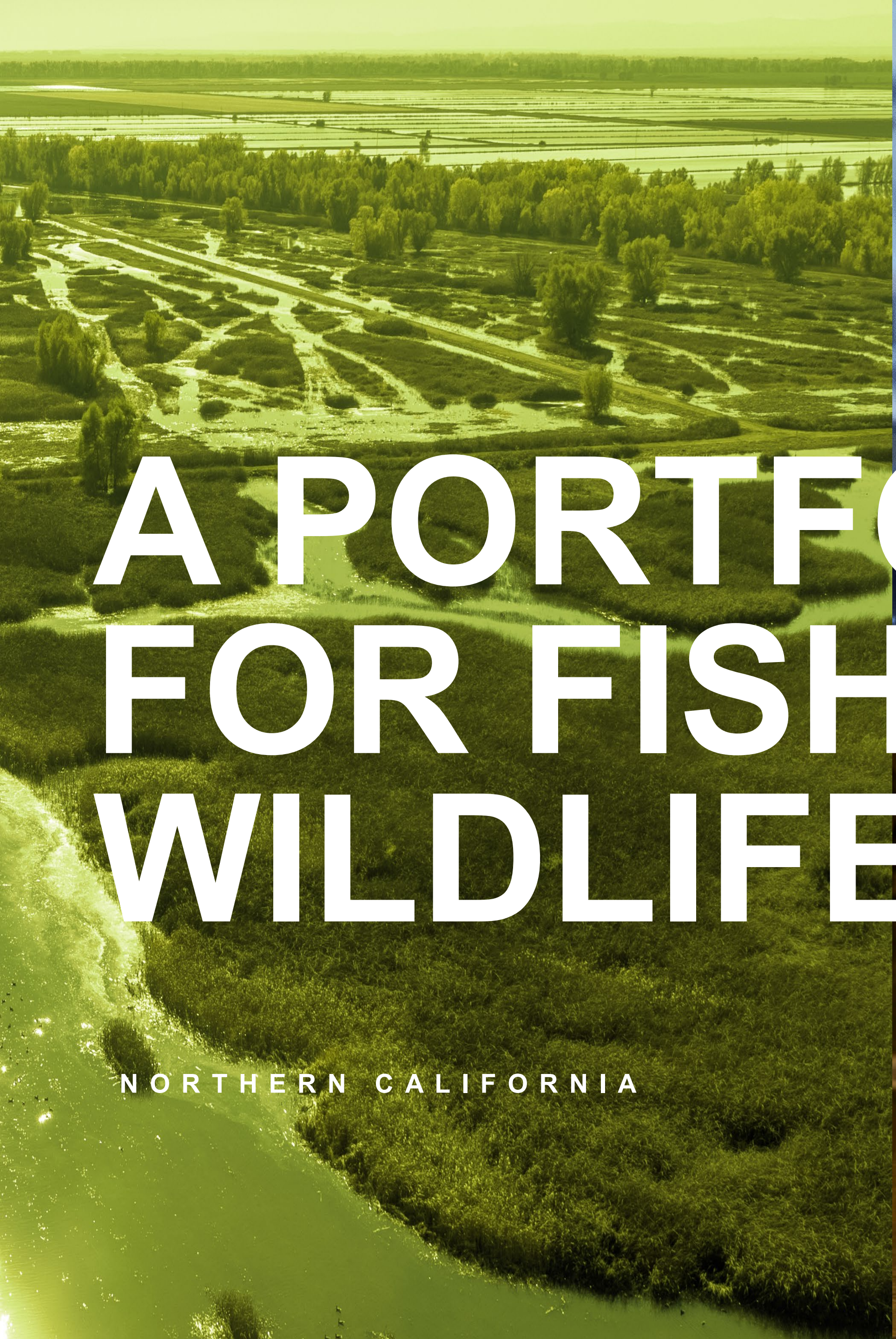
Floodplain Forward Coalition Partners

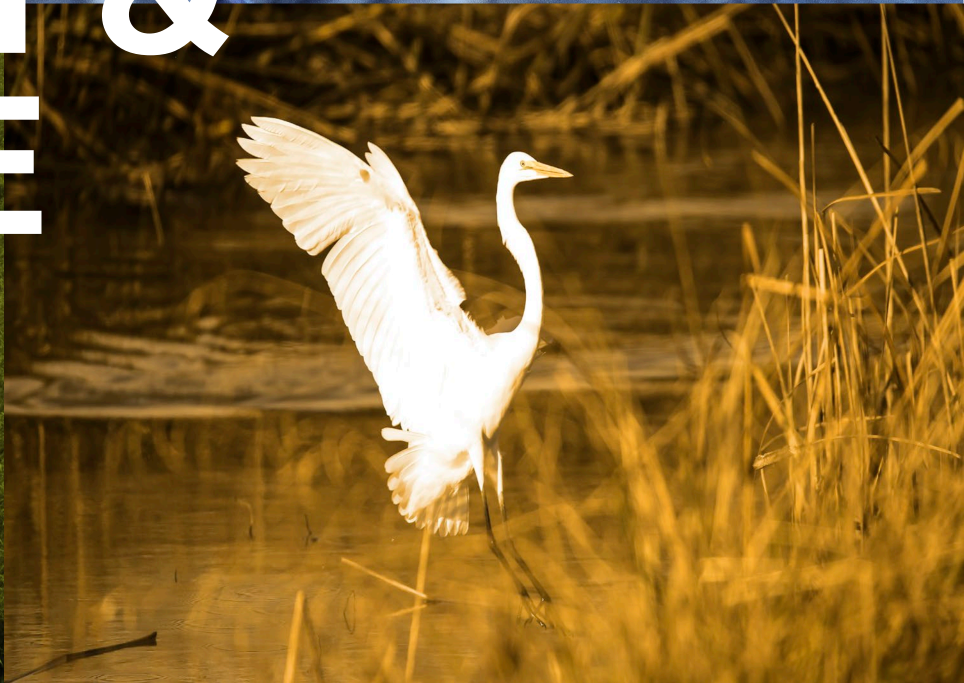
11 Agencies signed the MOU

ADVANCING FLOODPLAIN REACTIVATION

In the Sacramento River Basin

FLOODPLAIN FORWARD

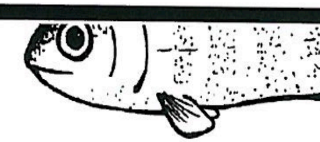




A PORTFOLIO FOR FISH & WILDLIFE

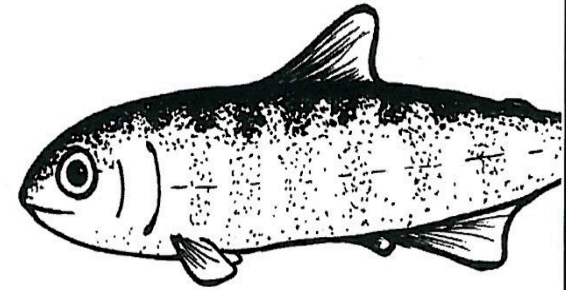
NORTHERN CALIFORNIA

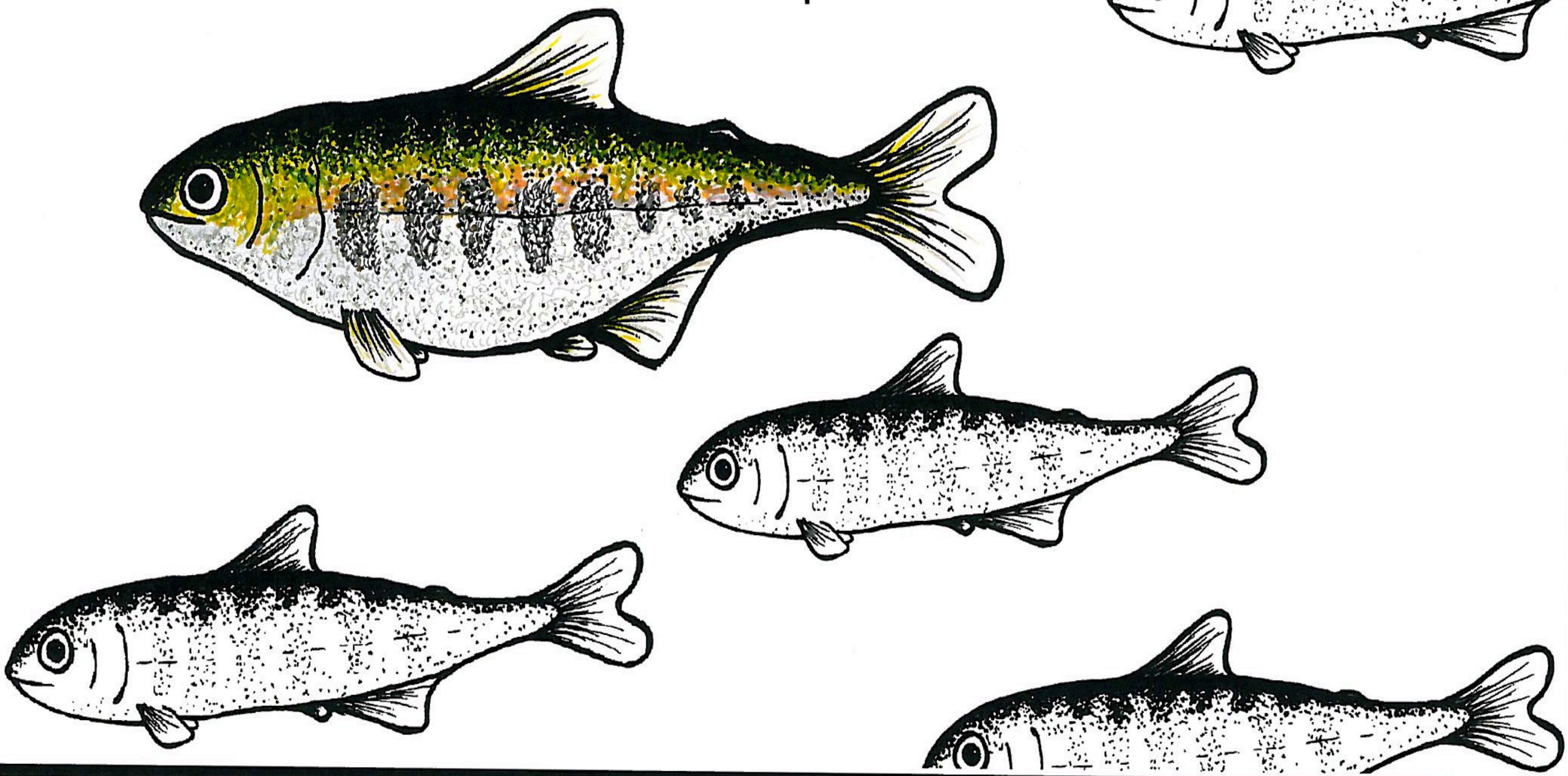
Wet Side

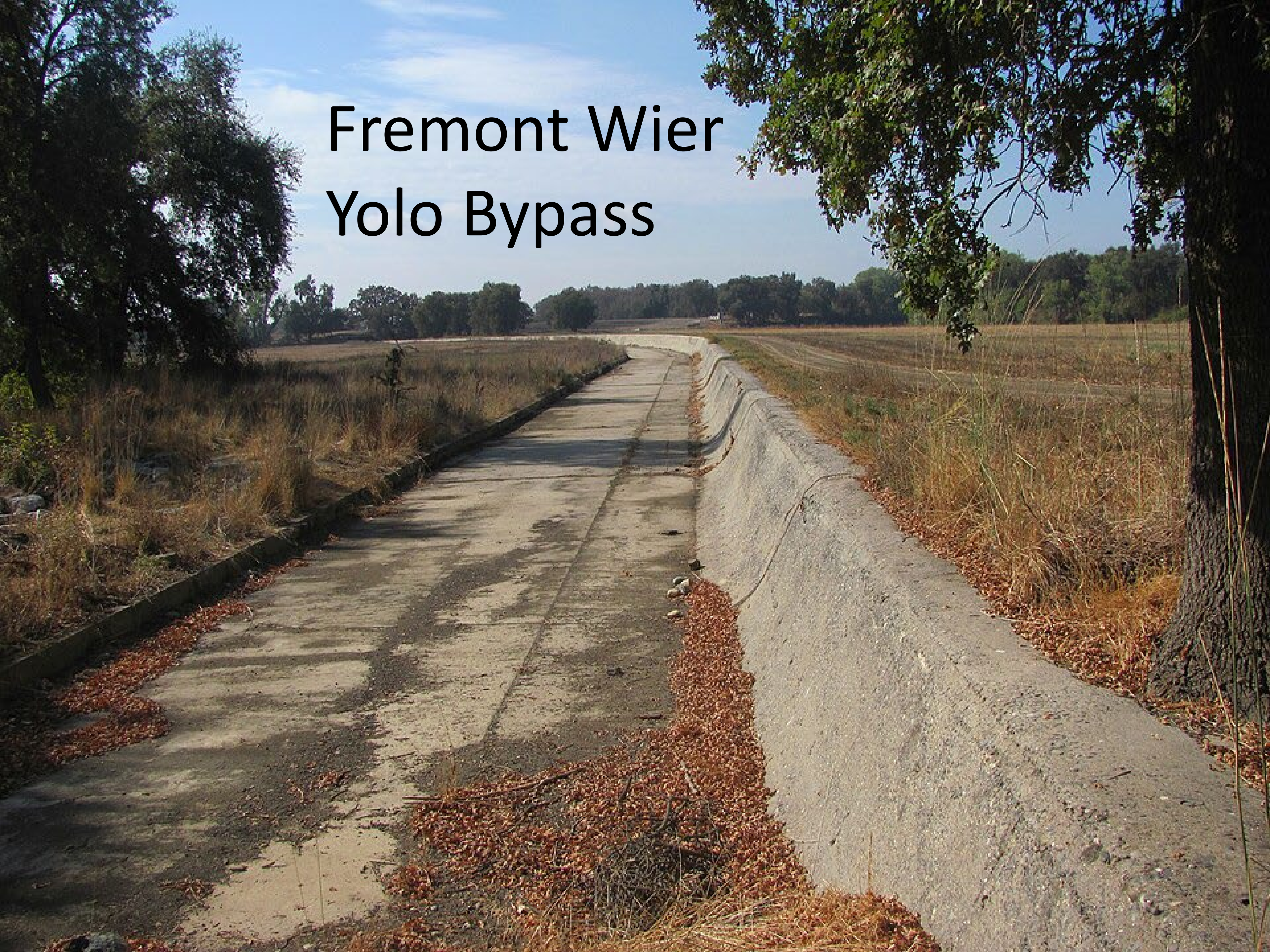


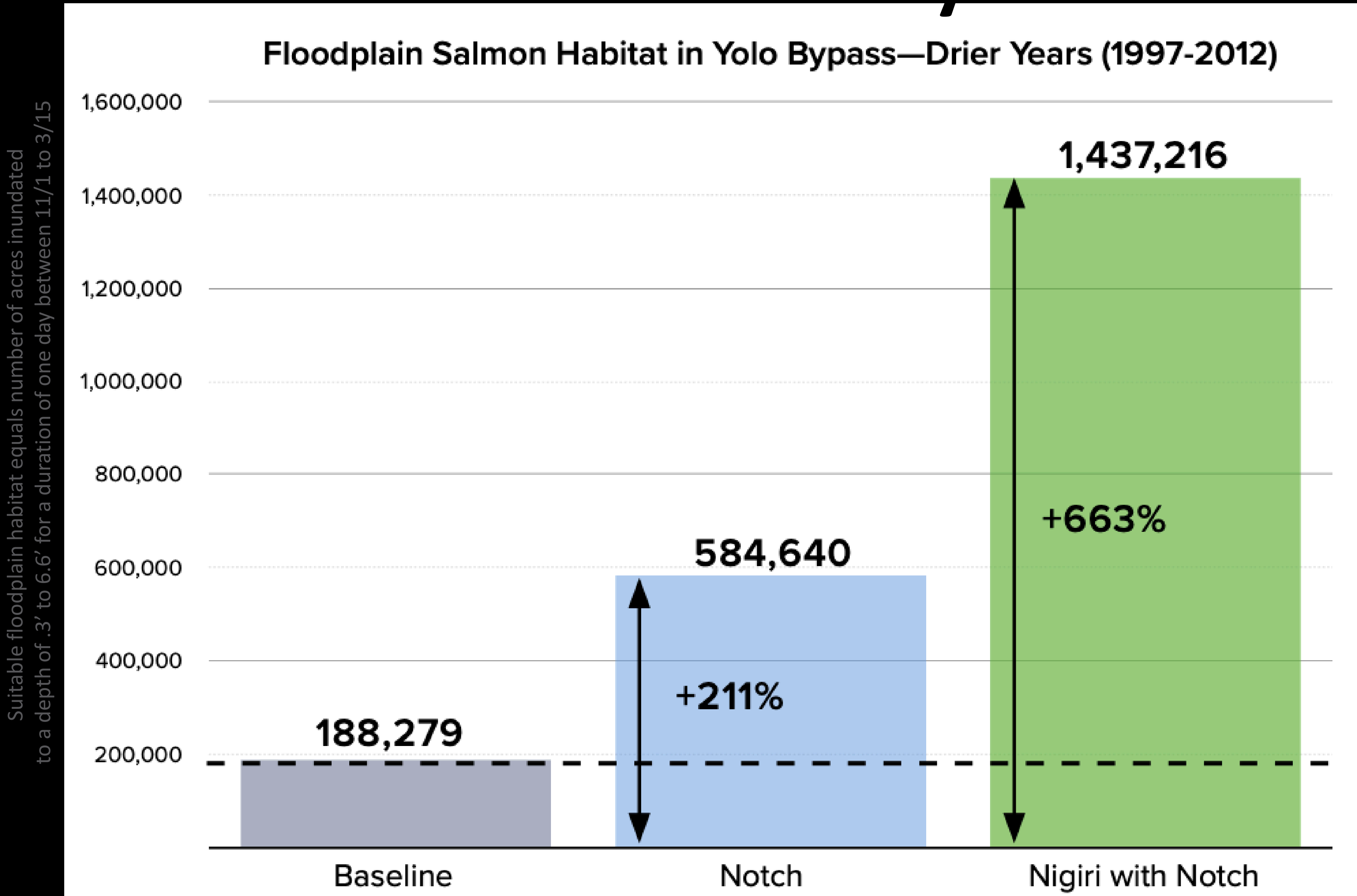
The Nigiri Project

Floodplain Fatties

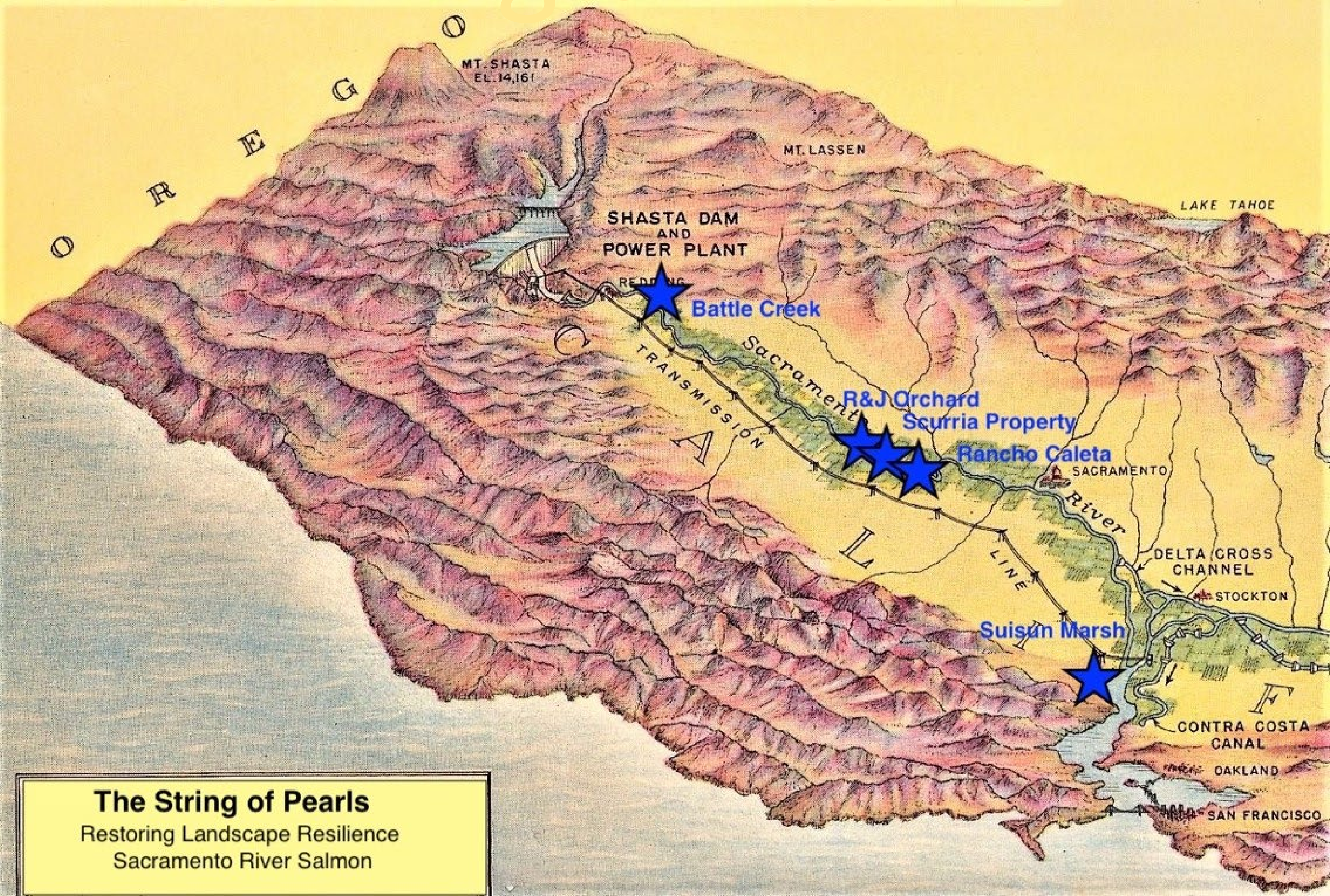


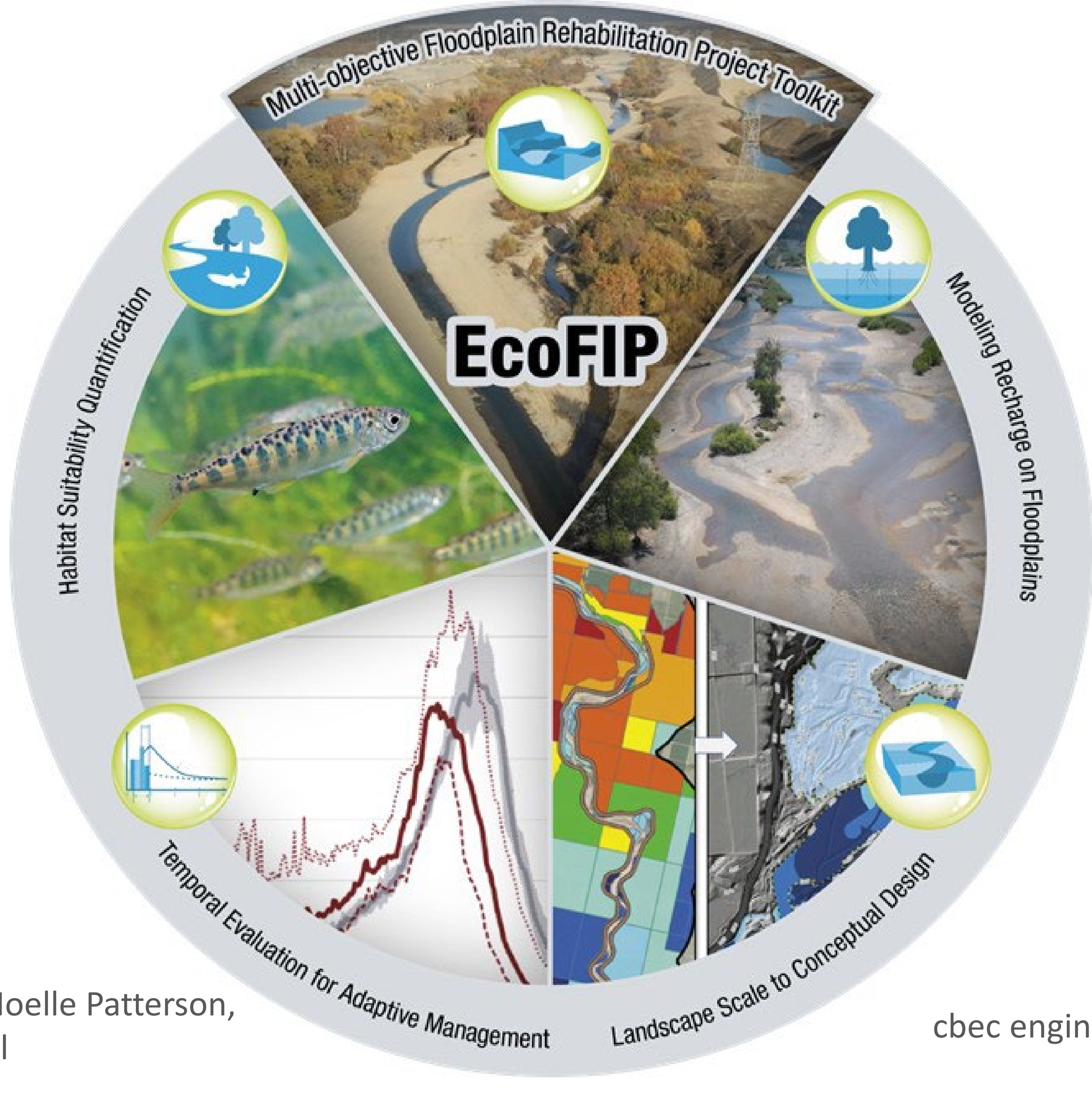



Fremont Wier
Yolo Bypass


Floodplain Salmon Habitat in Yolo Bypass—Drier Years (1997-2012)
Suitable floodplain habitat equals number of acres inundated
to a depth of .3' to 6.6' for a duration of one day between 11/1 to 3/15
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
188,279
584,640
1,437,216
+211%
+663%
Baseline
Notch
Nigiri with Notch

The String of Pearls

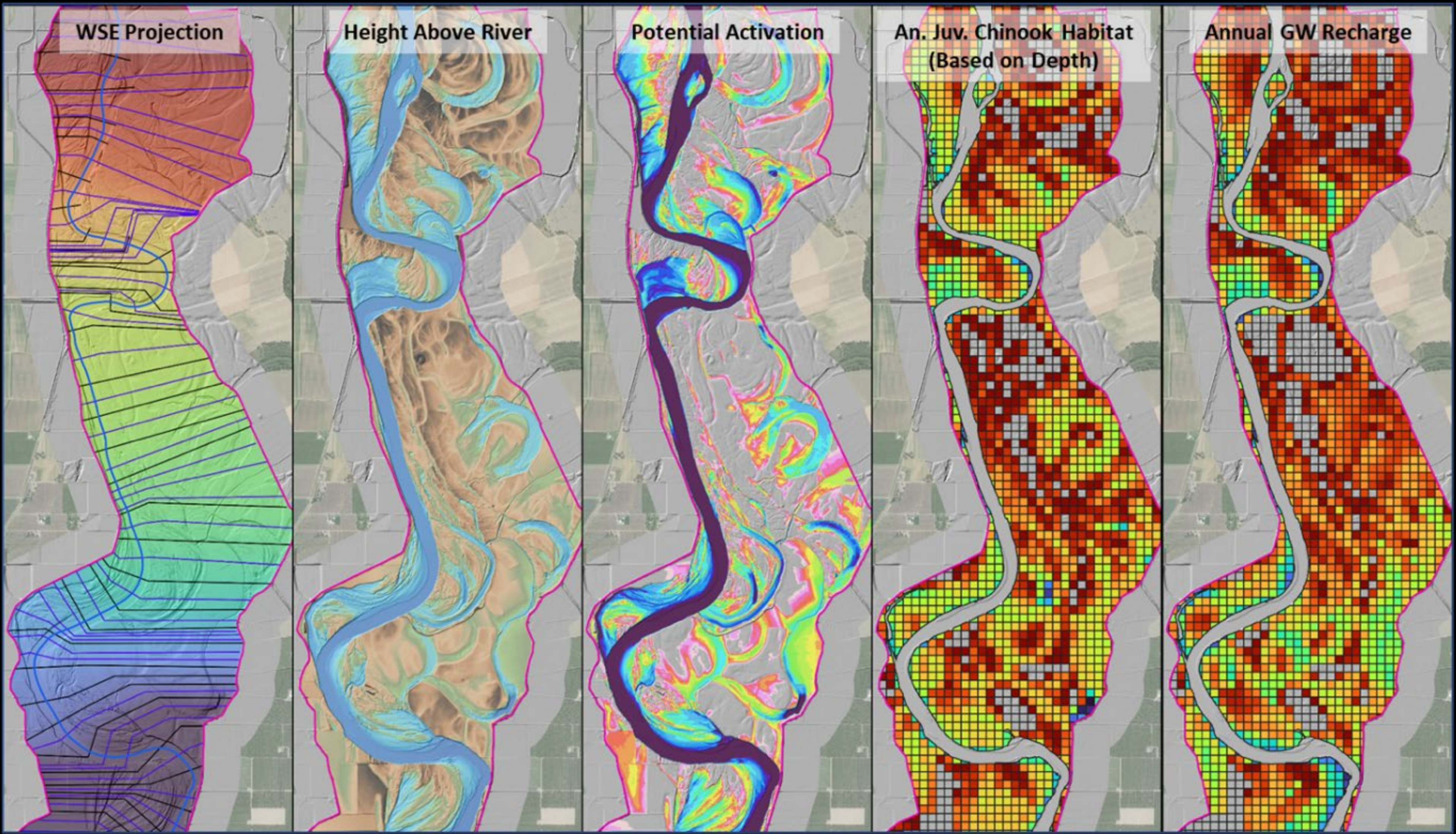




Luke Tillman, Noelle Patterson,
Chris Campbell

cbec engineering

Ecological Floodplain Inundation Potential



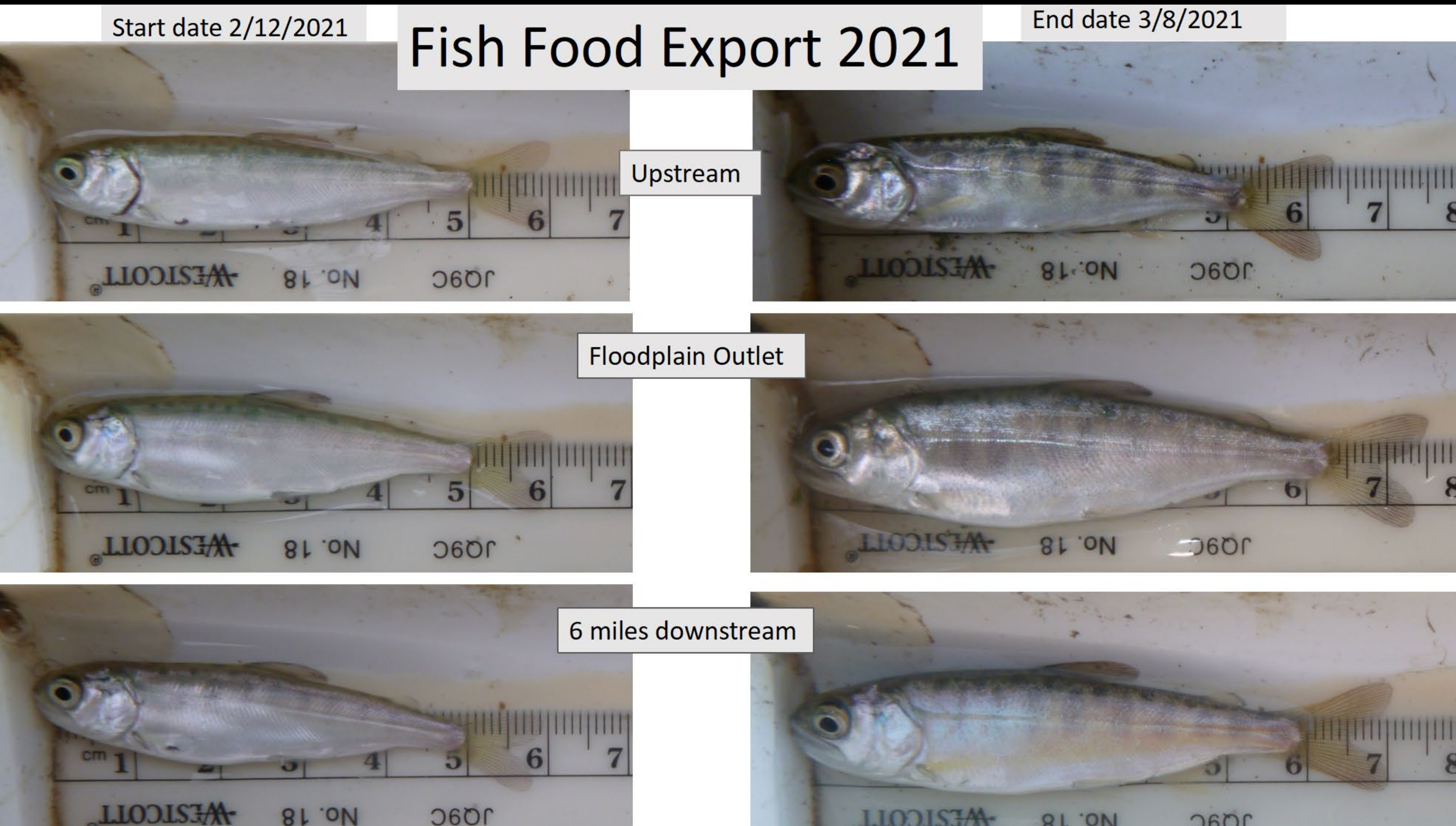

Dry Side
M. Wier

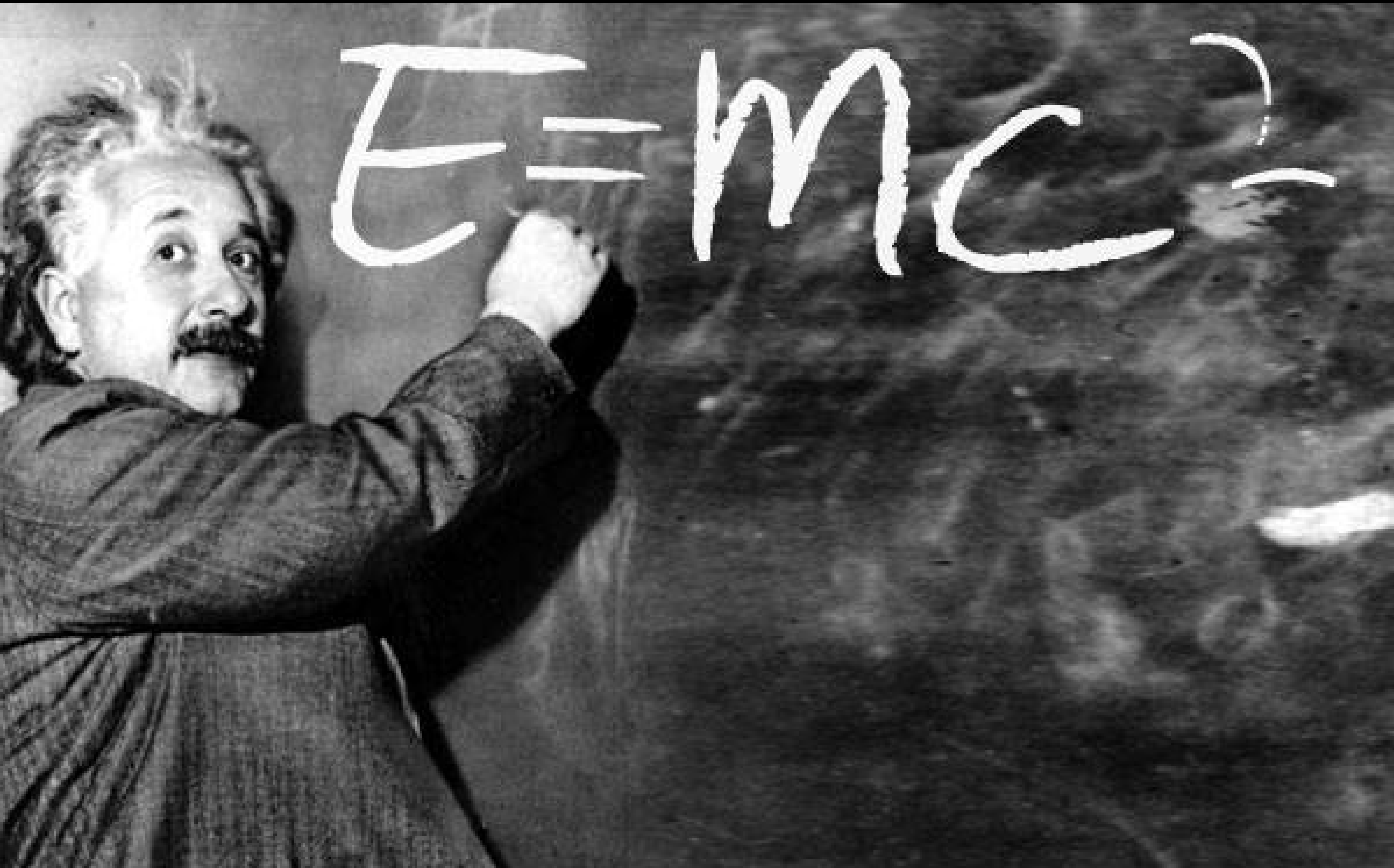

Fish Food
For Thought

Fish Food From Floodplain Farm Fields

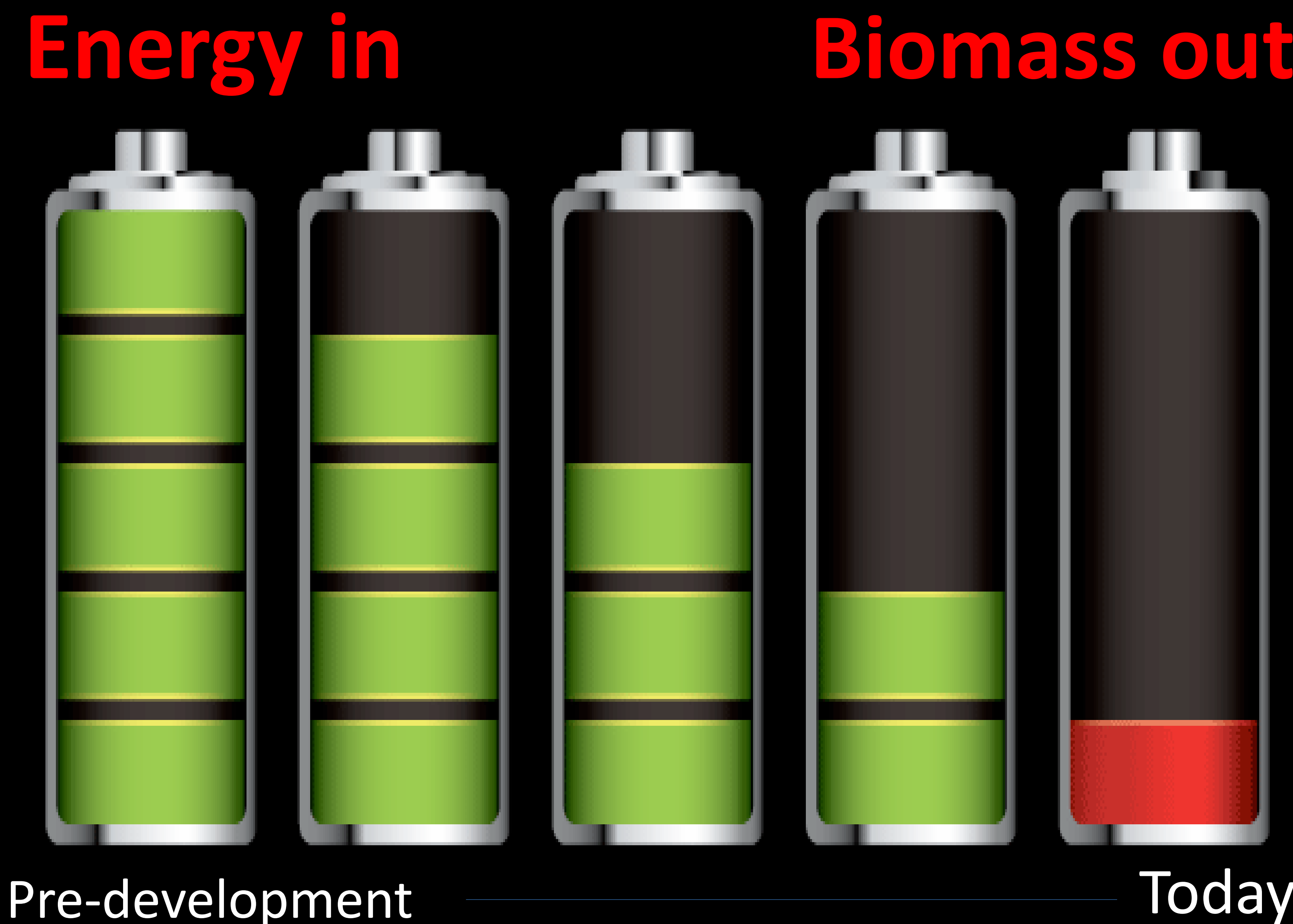

Landscape
Scale

Floodplain-derived food web subsidy to River channel habitats





The mathematics of recovery



Loss of Seasonally Inundated Floodplain

Spread it–Slow it–Sink it–Grow it

Harnessing Puddle Power

Puddle Power = Residence Time

A Return to Abundance

We don't manage salmon.

Nor, in truth, do we manage the rivers on which they depend.

Or even the landscapes through which those rivers flow.

What we manage (or have the potential to) is the behavior of people.

Questions?

Carson Jeffres

100 Years of "Floodplain" Research

Bjarni Serup

04/30/2026

CDFW

What Have we Learned?

- Do we know what a "floodplain" is in the Sac. Valley?
- Floodplains = Flood bypasses = Rice Fields?
- Is Connectivity the major issue?
- Are bypasses a net benefit for salmon?
- Are we too focused on salmon?
- Can we create floodplain habitat without flood flows?

WHAT IS A FLOODPLAIN?

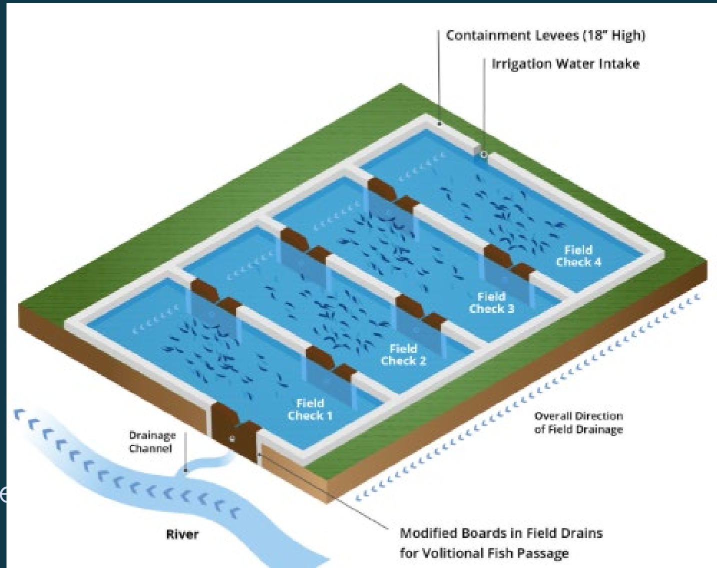
"A landscape feature that is periodically inundated by water from an adjacent river, with a focus on lowland floodplains that are generally associated with low gradient rivers within broad alluvial valleys and with an emphasis on geomorphic features, formed and influenced by river flows and sediment, upon which ecosystems develop and operate" (Opperman et al. 2010).

What is a Floodplain?
- In the Sacramento Valley



Management Actions

- Floodplain Restoration
- Bypass Improvement
- Actively Managed Floodplain



A 100 Years of Research

Managing floodplain inundation for native fish: production dynamics of age-0 splittail (*Pogonichthys macrolepidotus*) in California's Yolo Bypass

Rearing and migration of juvenile Chinook salmon (Oncorhynchus tshawytscha) in a large river floodplain

BUTTE CREEK SPRING-RUN
CHINOOK SALMON, *ONCORHYNCHUS TSHAWYTSCHA*,
JUVENILE OUTMIGRATION AND
LIFE HISTORY
1995-1998

Development of baseline data for fish growth and lower trophic production on the Sutter Bypass – 2018 pilot study

Farm to Fish: Lessons from a Multi-Year Study on Agricultural Floodplain Habitat

Growth and Methylmercury Accumulation in Juvenile Chinook Salmon in the Sacramento River and Its Floodplain, the Yolo Bypass

Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival

Variability in foodscapes and fish growth across a habitat mosaic: Implications for management and ecosystem restoration

The Good

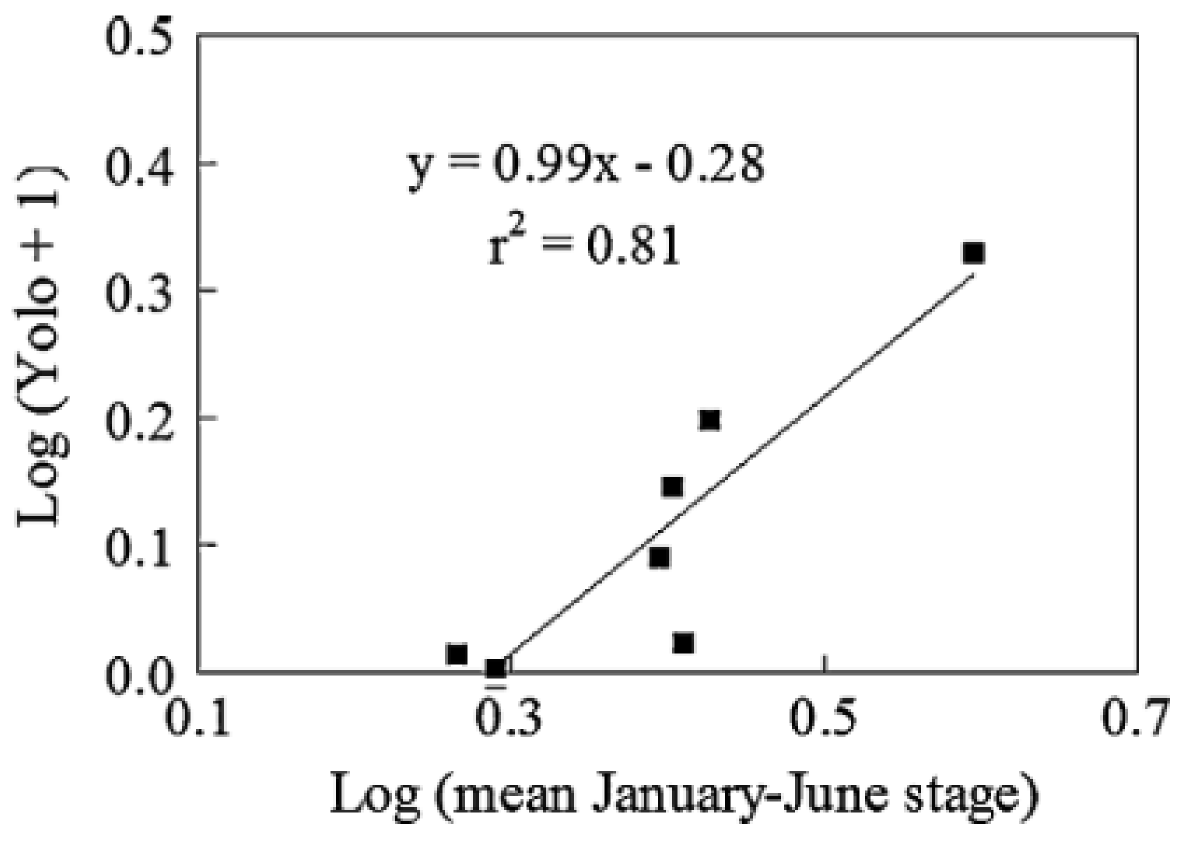
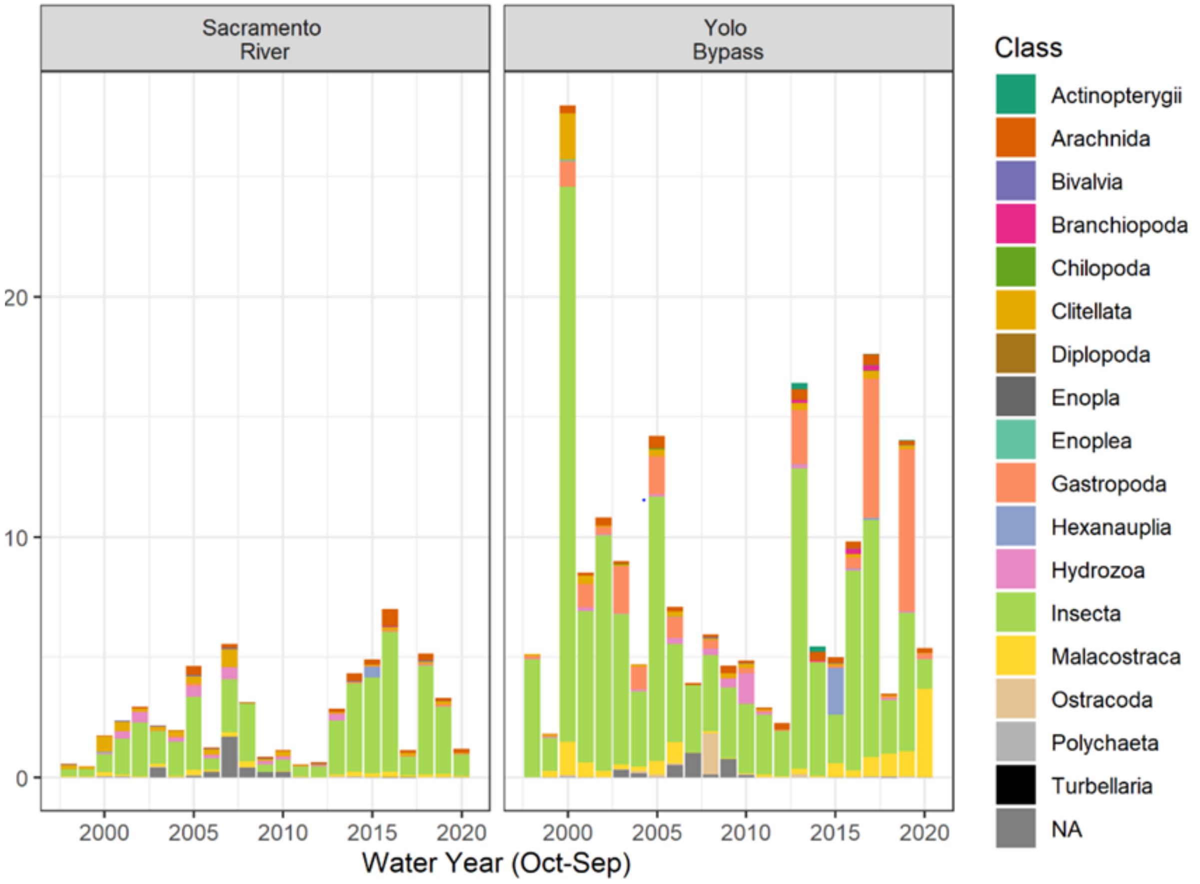


Figure 4. Linear regression model for the relationship between production of age-0 splittail versus mean January–June stage in Yolo Bypass.



The Bad

- Lack of Connectivity
- Land Use
- Contaminants

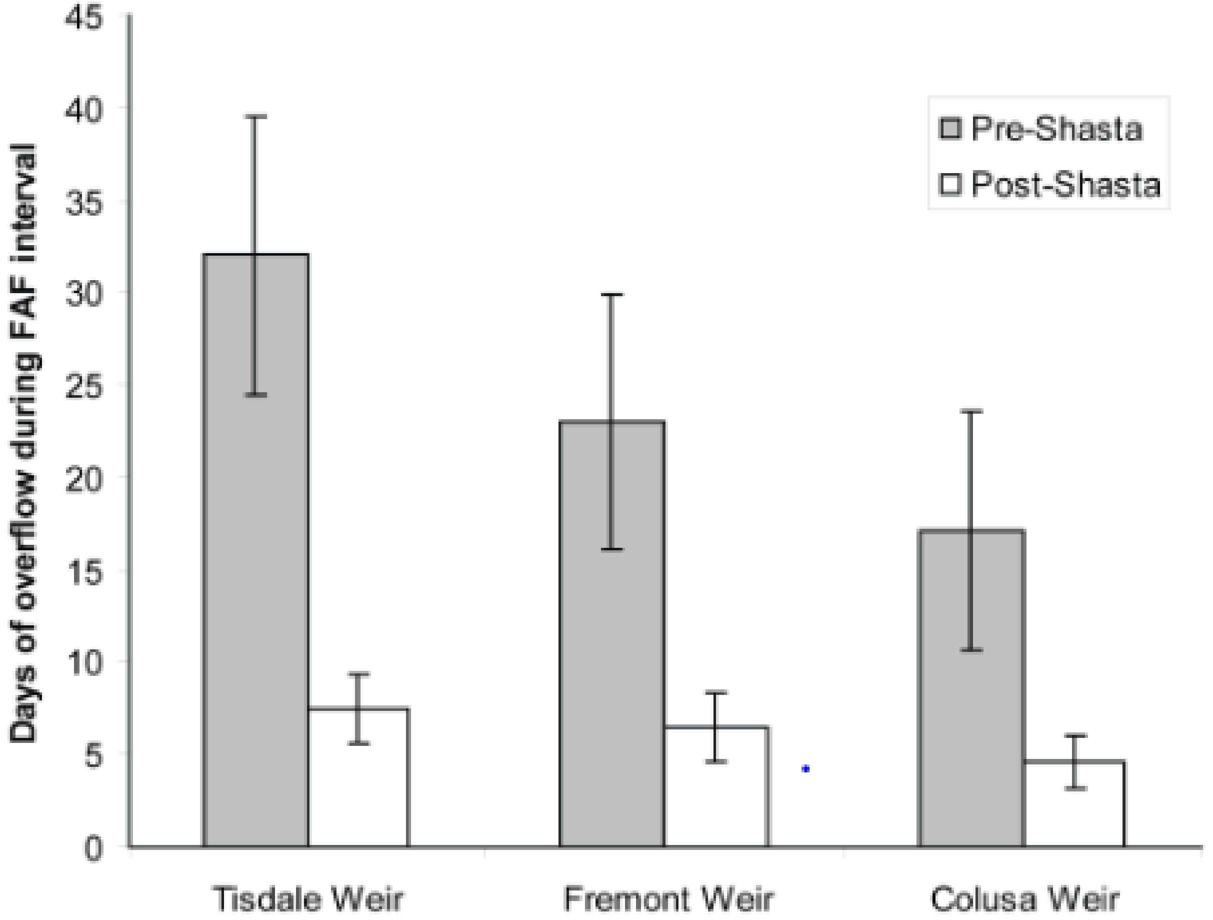
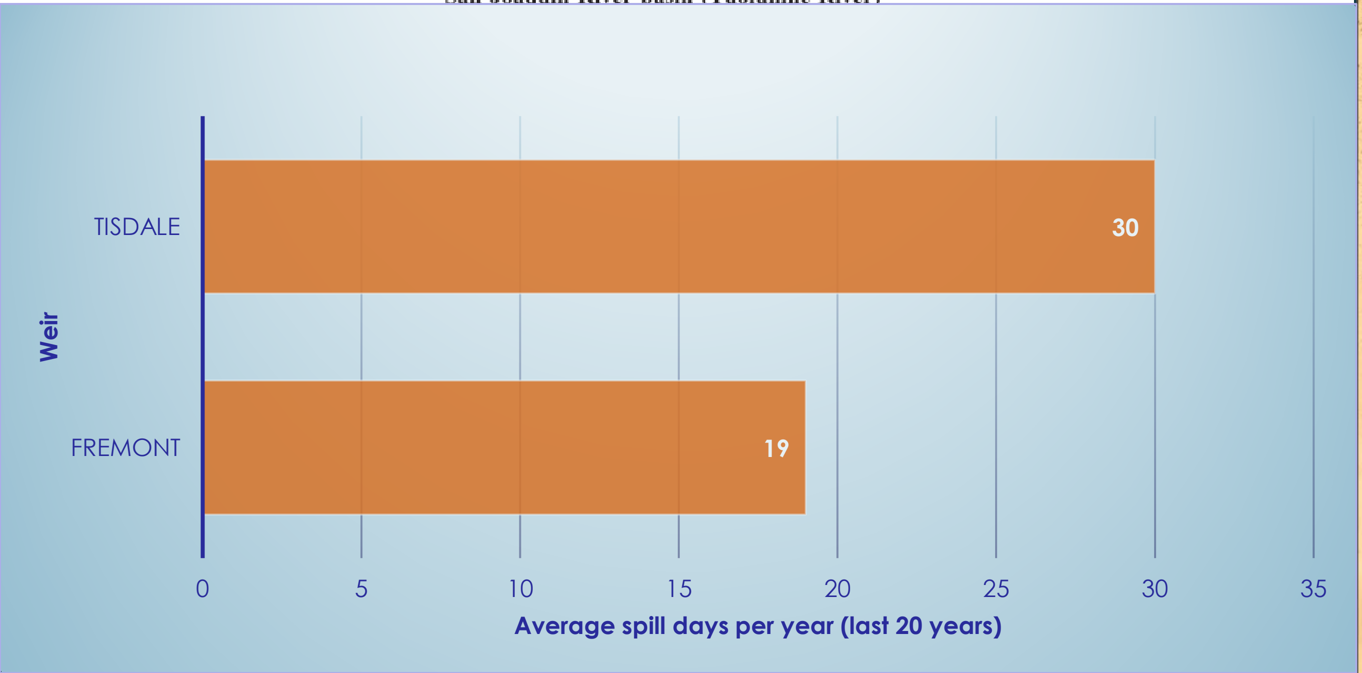


Figure 13 Days of overflow of Tisdale Weir into Sutter Bypass and Fremont Weir into Yolo Bypass, pre-Shasta and post-Shasta, within the FAF interval (March 15 – May 15)

Connectivity

TABLE 1.—Generalized life history timing of Central Valley chinook salmon runs (based on Fisher 1994; USFWS 1995).

Run	Migration	Peak migration	Spawning period: Total	Spawning period: Peak	Juvenile emergence	Juvenile stream residency (months)	Smolt out-migration
Sacramento River basin							
Late-fall	Oct–Apr	Dec	Early Jan–Apr	Feb–Mar	Apr–Jun	7–13	Nov–May
Winter	Dec–Jul	Mar	Late Apr–early Aug	May–Jun	Jul–Oct	5–10	Nov–May
Spring	Mar–Sep	May–Jun	Late Aug–Oct	mid-Sep	Nov–Mar	3–15	Mar–Jun and Nov–Apr
Fall	Jun–Dec	Sep–Oct	Late Sep–Dec	Oct–Nov	Dec–Mar	1–7[a]	Mar–Jul
San Joaquin River basin (Tuolumne River)							



CONNECTIVITY

2009 CVP/SWP Biological Opinion: Restore 17,000-20,000 acres

2012 Implementation Plan:

Table A.1. Densities of Chinook Salmon Collected in Beach Seine Sampling of Contiguous Water Sources (not including isolated ponds) During Yolo Bypass Drainage Events in 1998–2000

1998	1999	2000
68 fish/acre	125 fish/acre	187 fish/acre

"The timing and number of juvenile fishes exposed to available habitat may be more important than the amount of habitat available"

LAND USE

- Agriculture
  - Habitat destruction
  - Stranding/straying
  - Timing

- Waterfowl
  - Habitat/water management
  - Timing and recreation

"FISH VS. FOWL: PLAN TO INCREASE YOLO BYPASS FLOODING WILL REDUCE HUNTING OPPORTUNITY" CWA 2019

"SALMON KILLS START EARLY IN BUTTE CREEK WATERSHED IN CALIFORNIA THIS SPRING" Dan Bacher 2022

"DEAD IN DITCH: VALLEY DRAINAGE CANALS ARE FATAL DETOUR FOR SALMON" CalTrout 2014

Contaminants

- Sub-Lethal Responses of Delta Smelt to Contaminants Under Different Flow Conditions. 2024. https://escholarship.org/content/qt6589s8wg/qt6589s8wg.pdf?t=sf01ki

- Pesticide Concentrations of Surface Water and Suspended Sediment in Yolo By-Pass and Cache Slough Complex, California, 2019–2021. 2024. https://pubs.usgs.gov/publication/dr1195/full

- Influence of irrigation water and soil on annual mercury dynamics in Sacramento Valley rice fields. 2024. https://acsess.onlinelibrary.wiley.com/doi/abs/10.1002/jeq2.20557

- Bioavailability of legacy and current-use pesticides in juvenile Chinook salmon habitat of the Sacramento River watershed: Importance of sediment characteristics and extraction techniques. 2022. https://www.sciencedirect.com/science/article/pii/S0045653522006671?casa_token=-7lcoEHab70AAAAA:2PP2BcqV0CBtyXoe-8h_4VIY8cCAf1TTFTmMdUjDoAPGe6H6fWRfRfqdfWpAwC5GOIwnPRIXPw

- Pesticide residues in juvenile Chinook salmon and prey items of the Sacramento River watershed, California – A comparison of riverine and floodplain habitats. 2022. https://www.sciencedirect.com/science/article/pii/S0269749122003165

- The Contribution of Rice Agriculture to Methylmercury in Surface Waters: A Review of Data from the Sacramento Valley, California. 2017. https://acsess.onlinelibrary.wiley.com/doi/full/10.2134/jeq2016.07.0262

Science Needs

- Bypasses and Managed Floodplains

- Conceptual Models
- Quantification of Juvenile Fish Access and densities
- Quantification of Juvenile Benefit
- Adult Fish Impacts
- Effects of Contaminants
- Determine Net Population Benefits

Science Questions
- Bypasses and Managed Floodplains

- What problem are we solving?
  - Flow and temperature drives survival
- Can we grow salmon too fast?
  - No benchmarks for growth rates, condition factor or fish size
- What is a good survival rate while rearing?
  - What are we comparing to?
- What is a good emigration survival rate?
  - What are we comparing to?
- Are we producing more adults?
  - Metric of success?

Key Messages

- Do we know what a "floodplain" is in the Central Valley?
- Rice Fields ≠ Flood bypasses ≠ Floodplains
- Be careful when using rice field results as benchmarks for floodplain restoration projects.
- Connectivity is the major issue!
- We don't know if bypasses are a population source or sink
- Consider all life stages and other native fishes
- Don't take the flood out of floodplains. Disconnecting fish from the river hydrograph might not be a good idea