



Lower American River FISH Group Biannual Meeting

August 8, 2023



AGENDA

- **Welcome & Introductions**
Jessica Law, Water Forum Executive Director
- **Presentation - LAR Corridor Habitat and Science Program Catch-up: 2019-2023**
Erica Bishop, Water Forum Program Manager
- **Presentation - Monitoring Summary, Genetics and Salmonid Life History Studies**
Kirsten Sellheim, Senior Scientist - Cramer Fish Sciences
- **Presentation - Substrate Mapping Research and Development**
Chris Hammersmark, Director/ecohydrologist – cbec
- **Questions / Future Topics**
- **Next Meeting – February 13, 2024**
- **Adjourn**





THE WATER FORUM

Coequal objectives:

- Provide a reliable and safe water supply for the region's economic health and planned development through the year 2030; and
- Preserve the fishery, wildlife, recreational, and aesthetic values of the Lower American River

FISH Group



- The Fisheries and Instream Habitat (FISH) Group functions as an informative venue for sharing timely fisheries and river science information and studies.
- Meetings are open to the public and attendance is not required.
- The FISH Group has met periodically since its formation in 2000 and consists of: (a) the Water Forum, which convenes the group; (b) Reclamation; (c) CDFW; (d) NMFS; (e) USFWS; (f) SAFCA; (g) Sacramento County Regional Parks, (h) river advocacy groups, (i) agency staff, and (j) other interested parties.
- FISH Group on hiatus since November 2019 – Welcome past participants and newcomers

Water Forum Habitat Program Overview

- **LAR Anadromous Salmonid Habitat Enhancement Program “gravel projects”**

- Spawning/rearing
- Upper river focus (River Mile 13-23)
- Full build-out/maintenance of current plan = ~70 ac each spawning/rearing
- Programmatic regulatory documentation in place

- **LAR Rearing Sites Planning**

- Rearing only
- Whole river potential (River Mile 0-23)
- ~200 acres potential perennial or seasonally inundated rearing habitat
- *Not currently funded, planning study funded by USFWS*

- **Cordova Creek Naturalization Planning**

- Multibenefit Improvements (juvenile salmonid refugia, recreational access/public safety, education)
- Phase 1 and Phase 2 complete, Phase 3 2024-2026 (final design, permitting, construction)
- *Funding: CA Wildlife Conservation Board (87% grant funded) and Water Forum cost-share*



LAR Salmonid Habitat Enhancement Program “gravel projects”

Program Goal: Enhance, create and maintain functional habitat for our native salmonids.

- 10 implementation and maintenance sites between Nimbus Basin and River Bend
- Focused on supporting natural spawners in the LAR.



PROJECT PARTNERS



— BUREAU OF —
RECLAMATION



City of
SACRAMENTO



CALIFORNIA
**NATURAL
RESOURCES**
AGENCY



SACRAMENTO
COUNTY



Leveraging Local, State and Federal Habitat Funding



- Water Forum: local water purveyors, City of Sacramento, and County of Sacramento fund the Habitat Management Element to support river corridor health improvements.
- ✓ Administered by joint City/County office



— BUREAU OF —
RECLAMATION

- CVPIA - Passed by Congress 1992 to mitigate impacts of Federal dams on fish with the goal of doubling natural fish production.
- ✓ Implemented by U.S. Bureau of Reclamation and local partners.
- ✓ Partner since 2009 – current agreement \$7.9M (2021-2025)



- Proposition 68 - Voter approved healthy watersheds bond measure passed in 2018.
- ✓ Implemented by CA Natural Resources Agency, DWR, and local partners.
- ✓ Partner since 2021 – current agreement \$5M (2022-2024)

LAR “Gravel” Projects History

2023 marks our 13th habitat project.

- Since 2008, 35+ acres of spawning habitat and 1.5 miles of side channels/rearing areas created/enhanced.
- ~92,000 cubic yards of spawning gravel placed since program inception.
- Ongoing implementation and maintenance necessary in a dynamic river
 - 30,000 tons (~21,000 cy) import allowed

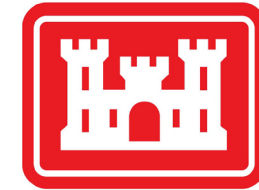
Implementation Date	Site	Habitat Acreage		Majority Funding Source
		Spawning	Rearing	
2008	Lower Sunrise (Sunrise Side Ch.)	0.0	2.0	Water Forum HME
2009	Upper Sailor Bar	2.2	0.0	CVPIA/HME
2010	Lower Sailor Bar	2.8	1.1	
2011	Lower Sailor Bar	2.8	1.1	
2012	Lower Sailor Bar	2.4	0.3	
2013	River Bend	4.1	5.5	
2014	Nimbus Basin	3.6	2.0	
2015	No Project	0	0	
2016	Sacramento Bar	6.1	6.8	
2017	No Project	0	0	
2018	No Project	0	0	
2019	Upper Sailor Bar	3.4	2.1	CVPIA/HME
2020	No Project	0	0	
2021	Ancil Hoffman	6.6	5.7	
2022a	Nimbus Basin	3.4	1.5	Prop 68/CVPIA/HME
2022b	Lower Sailor Bar	13.4	5.6	Prop 68/CVPIA/HME
2023	Upper River Bend - Phase 1	5.0	5.8	Prop 68/CVPIA/HME
Cumulative Acreage Since 2019		31.8	20.6	

Agency Review and Approvals

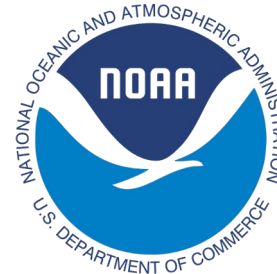
U.S. Army Corps of Engineers (404 and 408 Sections)
National Marine Fisheries Service (NMFS - ESA)
U.S. Fish and Wildlife Service (USFWS - ESA)
National Parks Service Wild & Scenic River Determination
State Historic Preservation Office/Section 106 (cultural/Tribal)
Central Valley Flood Protection Board – Designated Floodway
State Water Resources Control Board (H2O quality)
California Department of Fish and Wildlife (CDFW)
State Lands Commission (lease)
Sacramento County Regional Parks and Recreation Commission (incl. ARPAC)
Sacramento County Board of Supervisors
Sacramento City Council
U.S. Bureau of Reclamation (funding)
California Natural Resources Agency (funding)
Design vetting: Restoration-focused staff USBR, NMFS, USFWS and CDFW



— BUREAU OF —
RECLAMATION



US Army Corps of Engineers
BUILDING STRONG.



STATE OF CALIFORNIA
CENTRAL VALLEY
FLOOD PROTECTION BOARD



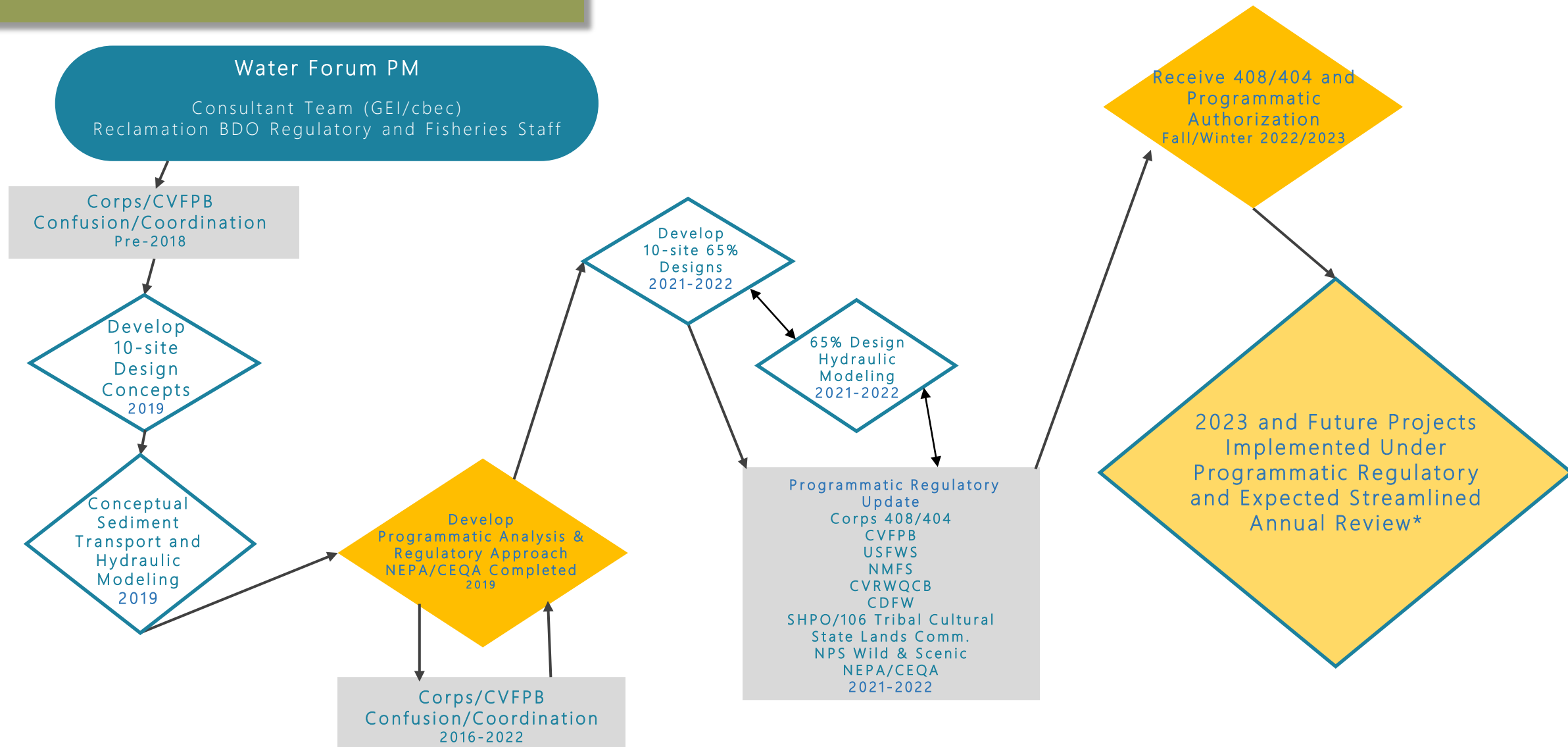
CALIFORNIA
STATE LANDS
COMMISSION



CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

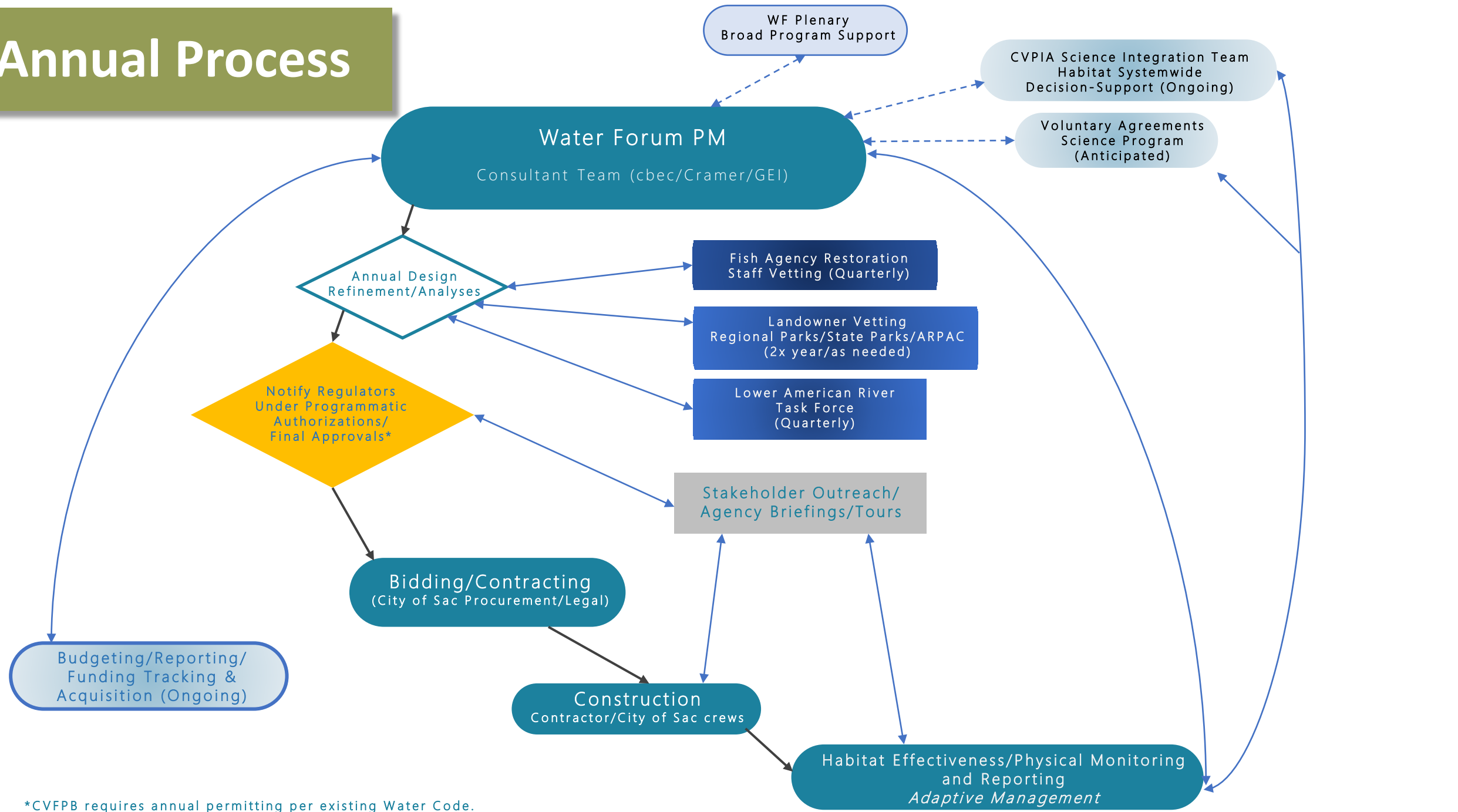


Programmatic Process



*CVFPB requires annual permitting per existing Water Code. Staff have been integrated in programmatic 408 review/approach.

Annual Process

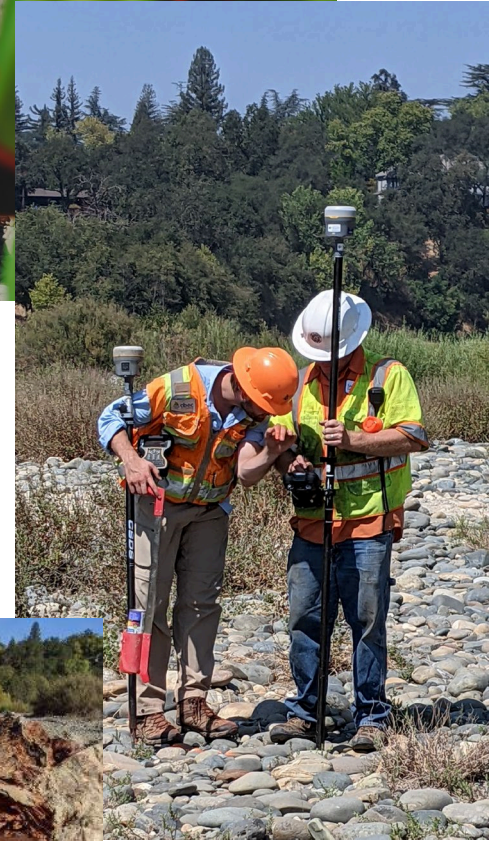


*CVFPB requires annual permitting per existing Water Code. Staff integrated in programmatic 408 review/approach.

Program Opportunities

Long-term implementation benefits from consistency

- Consistent funding source (recent)
 - Limited property owners (Regional Parks, State Parks)
 - Consistent local partner and support of diverse stakeholders
 - Extensive communication and outreach efforts
 - Consistent planning, design, and implementation teams
 - Long-term regulatory coverage – through 2034 (recent)
 - 5 to 10-year planning horizon to leverage funding and accommodate project lifecycle
- ✓ Maintain to As-Built under permits



Habitat Program Common Elements

- Spawning: Create/enhance riffles with clean “right sized” gravel
- Rearing: Create/enhance habitat by excavating side channels/alcoves or floodplain grading
- Add instream woody material and riparian plantings/seedling (*finally*)
- Sites use offsite borrow material or are “self-feeding”
- Test pits and hydraulic analyses inform annual design refinement from 65% to final

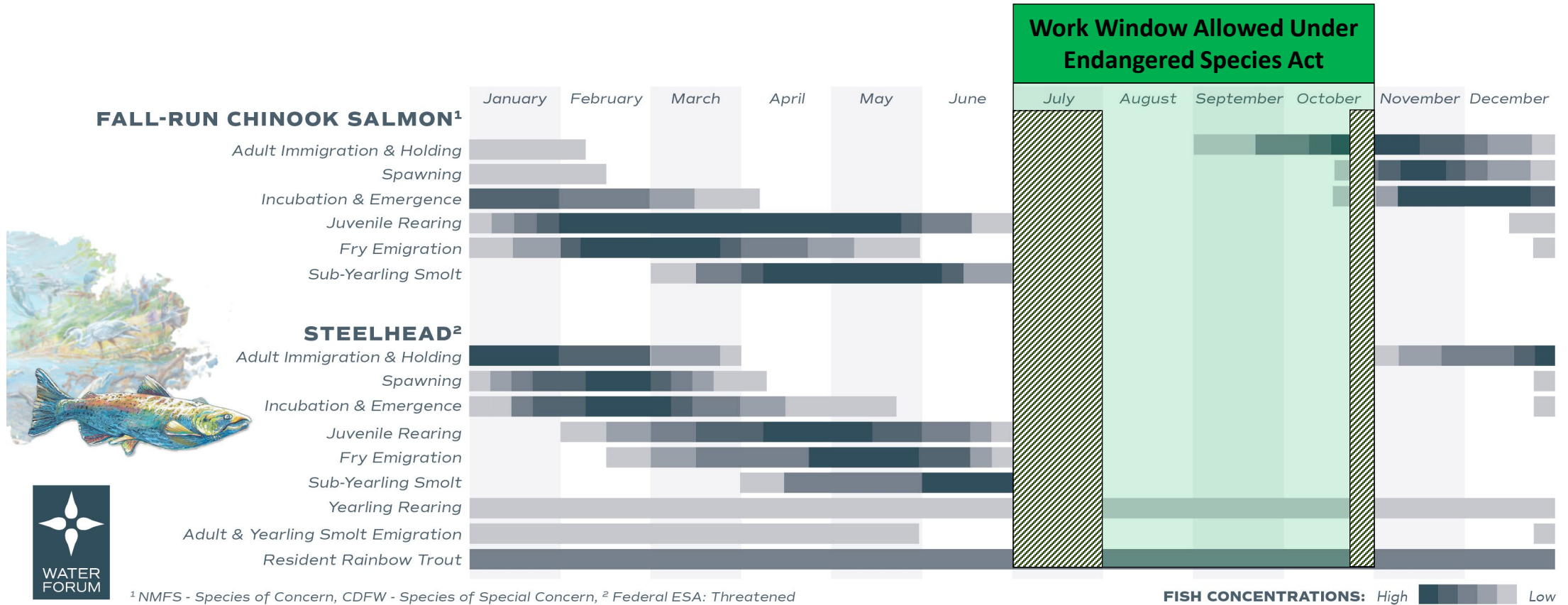


American River Parkway Constraints

- Heavy recreational use – 8 million/year
- Urban neighborhood, recreation and infrastructure concerns = additional analyses (depths, velocities, shear stress)
- Crews on site Monday - Saturday 6 a.m.- 6 p.m.
- River stays open while we work
- No in-river work on weekends/holidays (rec concerns)
- Coordinate work with Parkway/vendor program needs
 - “Good neighbor” improvements – Parks
- ✓ Limited in-river work window due to ESA and CVP operational needs



Work Window - Fisheries



¹ NMFS - Species of Concern, CDFW - Species of Special Concern, ² Federal ESA: Threatened

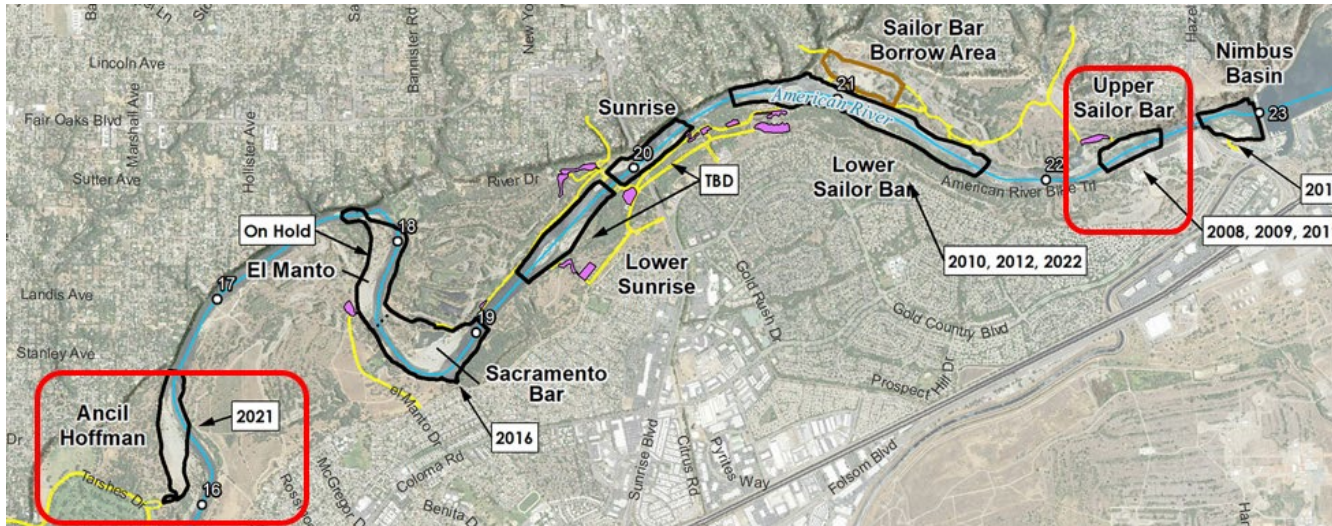
Recent Completed Projects – *Upper Sailor Bar and Ancil Hoffman Park*

2019 – Upper Sailor Bar

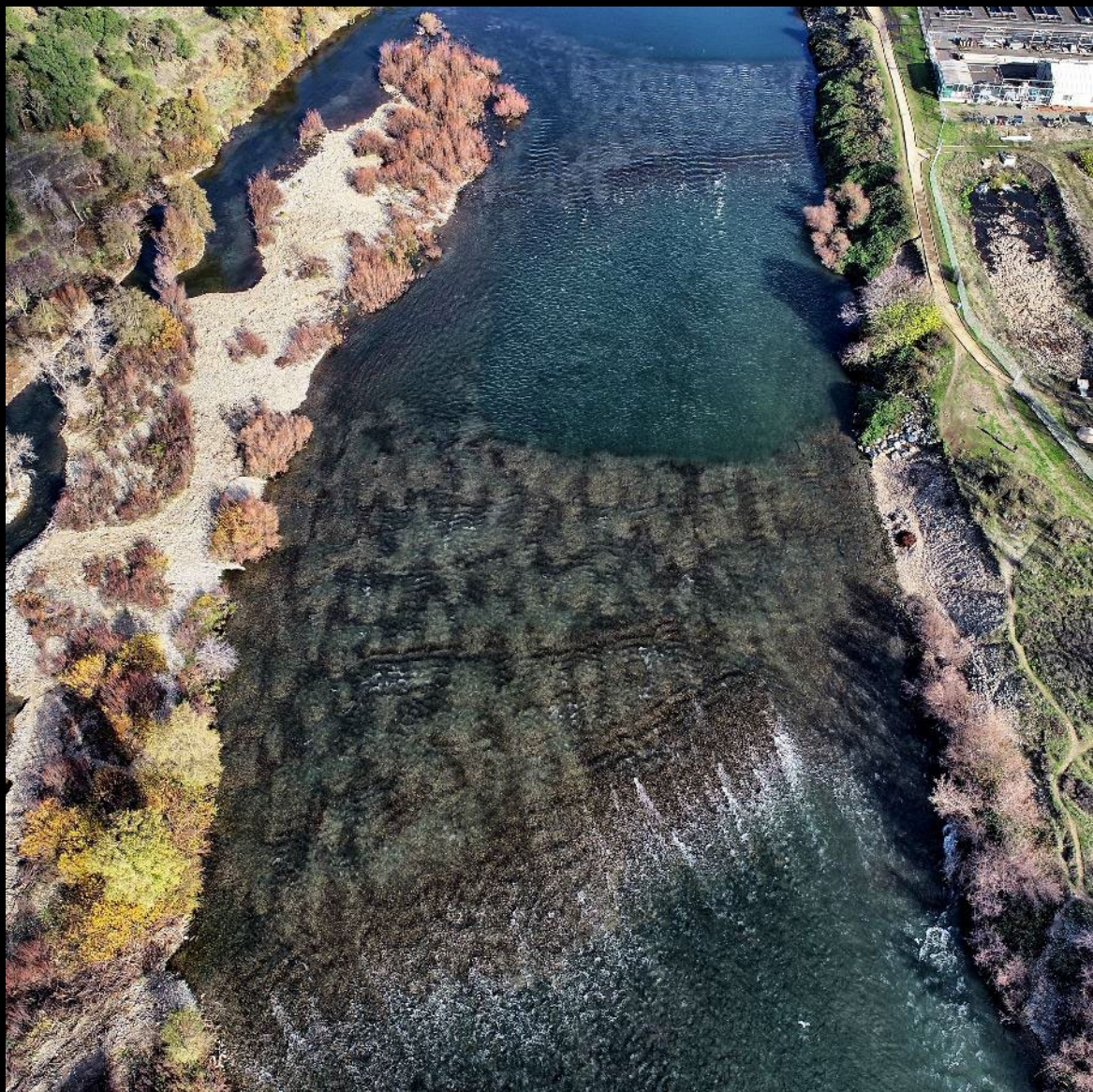
- Revisited site – heavy use
- Two riffles (3.3 ac spawning)
- 1,400-foot side channel (2 ac rearing)
- Offsite Borrow

2021 – Ancil Hoffman Park

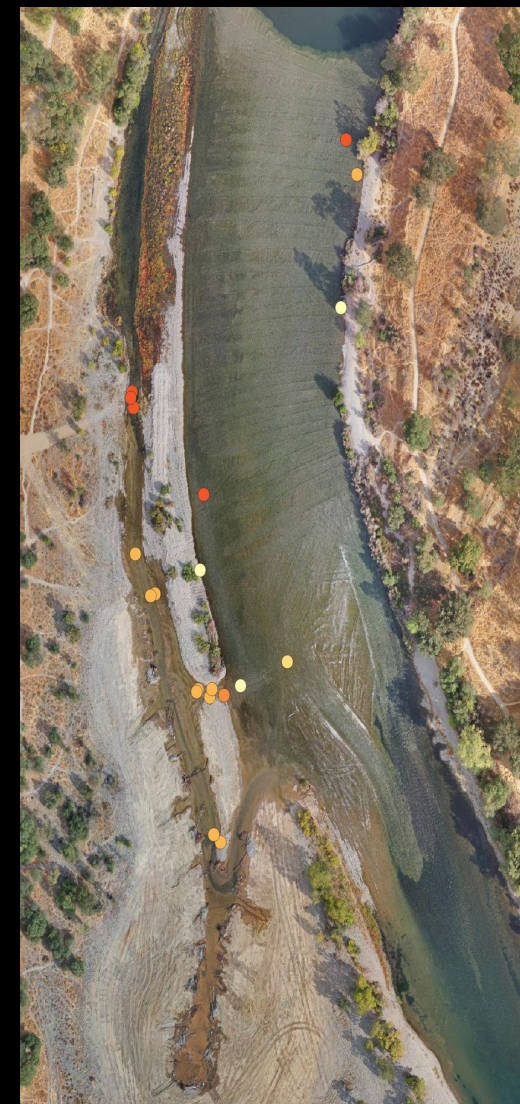
- New site
- One riffle (6.7 ac spawning)
- 1,000-foot alcove (5.7 ac rearing)
- Woody habitat structures (*finally*)
- Willow plantings and seeding
- Onsite borrow



Upper Sailor Bar Spawning - 2019



Ancil Hoffman Spawning - 2021



Year 1 (red) - Year 2
(blue) CHN Redds

Year 1 – STH Redds

2022 Projects – Lower Sailor Bar + Nimbus Basin

Lower Sailor Bar

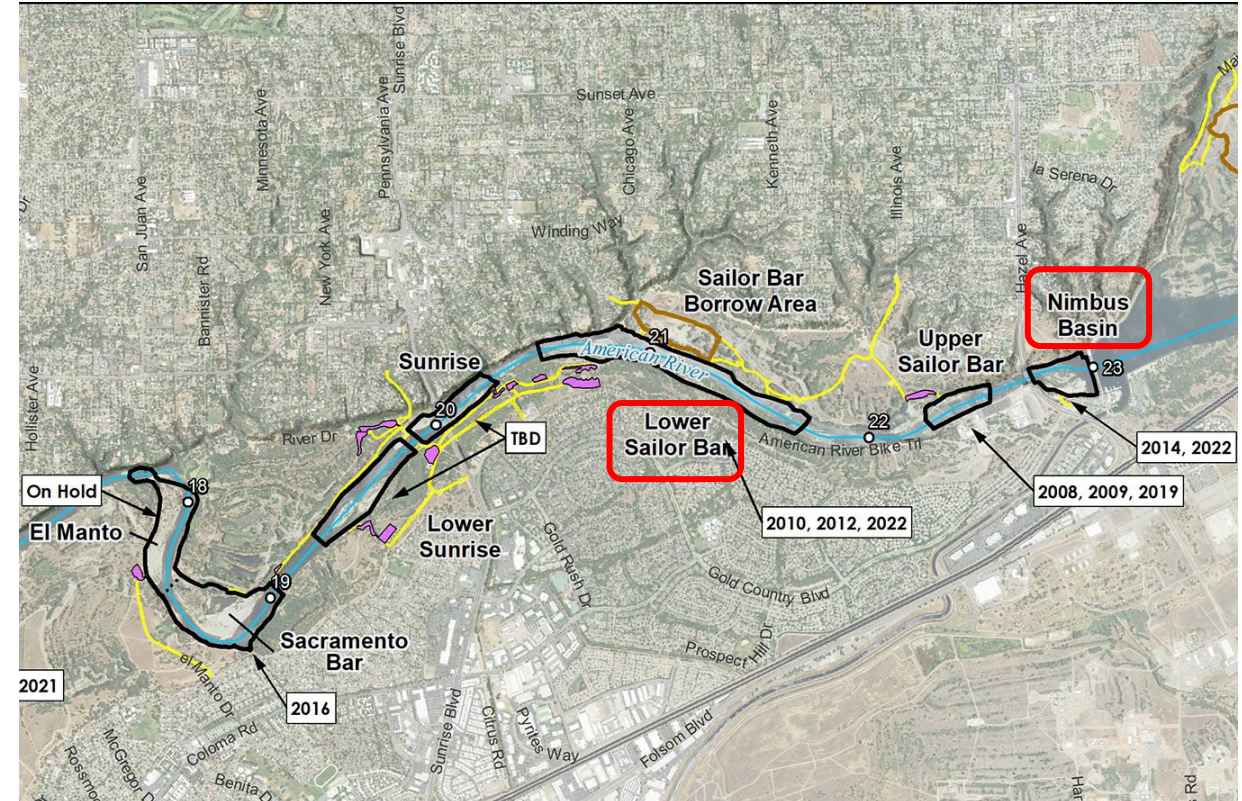
- Revisited/new site
- Three riffles (13.5 ac spawning)
- 2,500-foot side channel (5 ac rearing)

Nimbus Basin

- Revisited site
- One riffle (3 ac spawning)
- 800-foot side channel and floodplain grading complex (2.5 ac rearing)

State-Federal cost share (Prop 68/CVPIA)

- Design, modeling, permitting, construction, pre- and post-project monitoring.

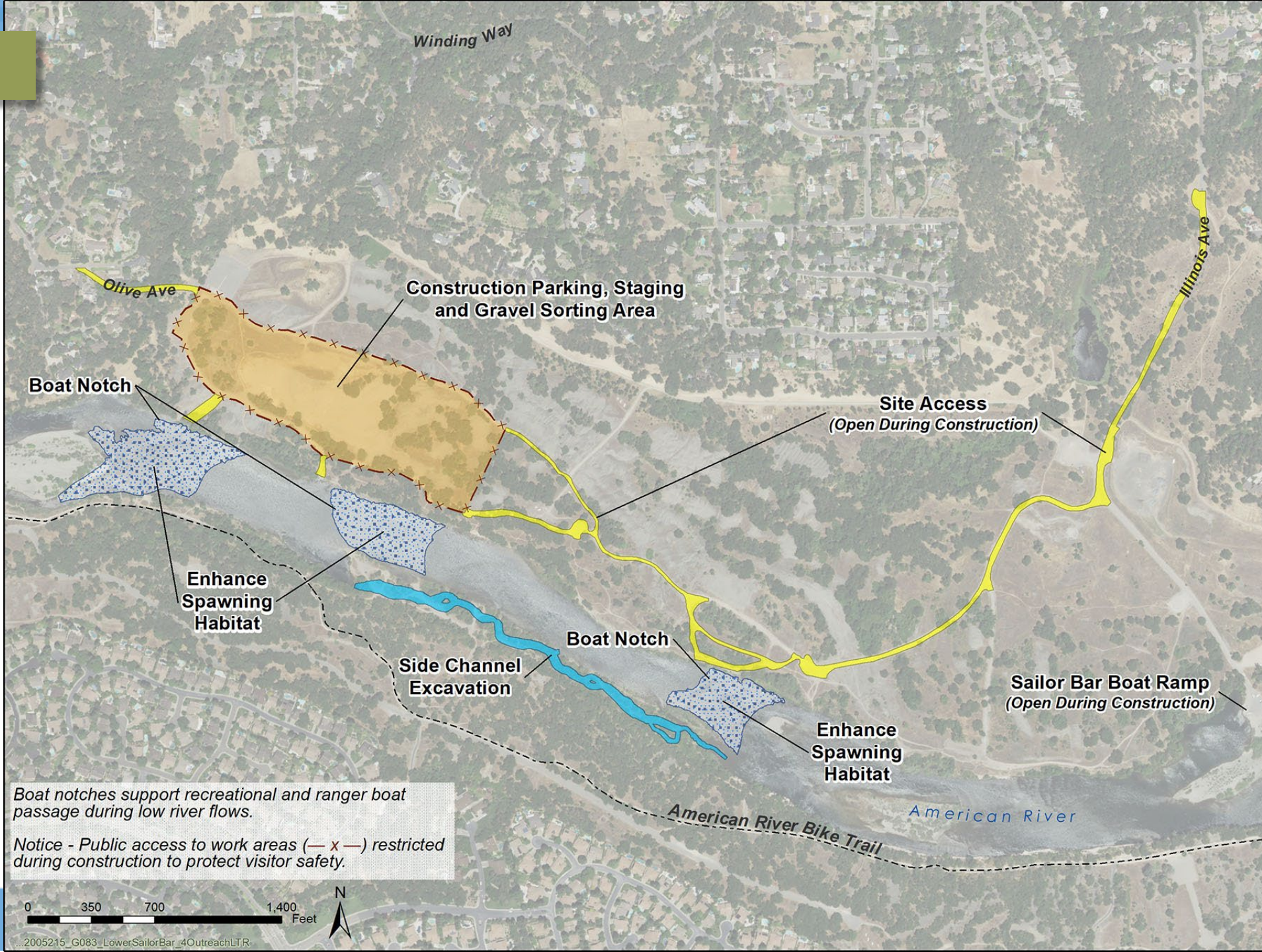


✓ *2022 was a milestone year = 16 ac spawning, 7 ac rearing created/enhanced!*

Lower Sailor Bar

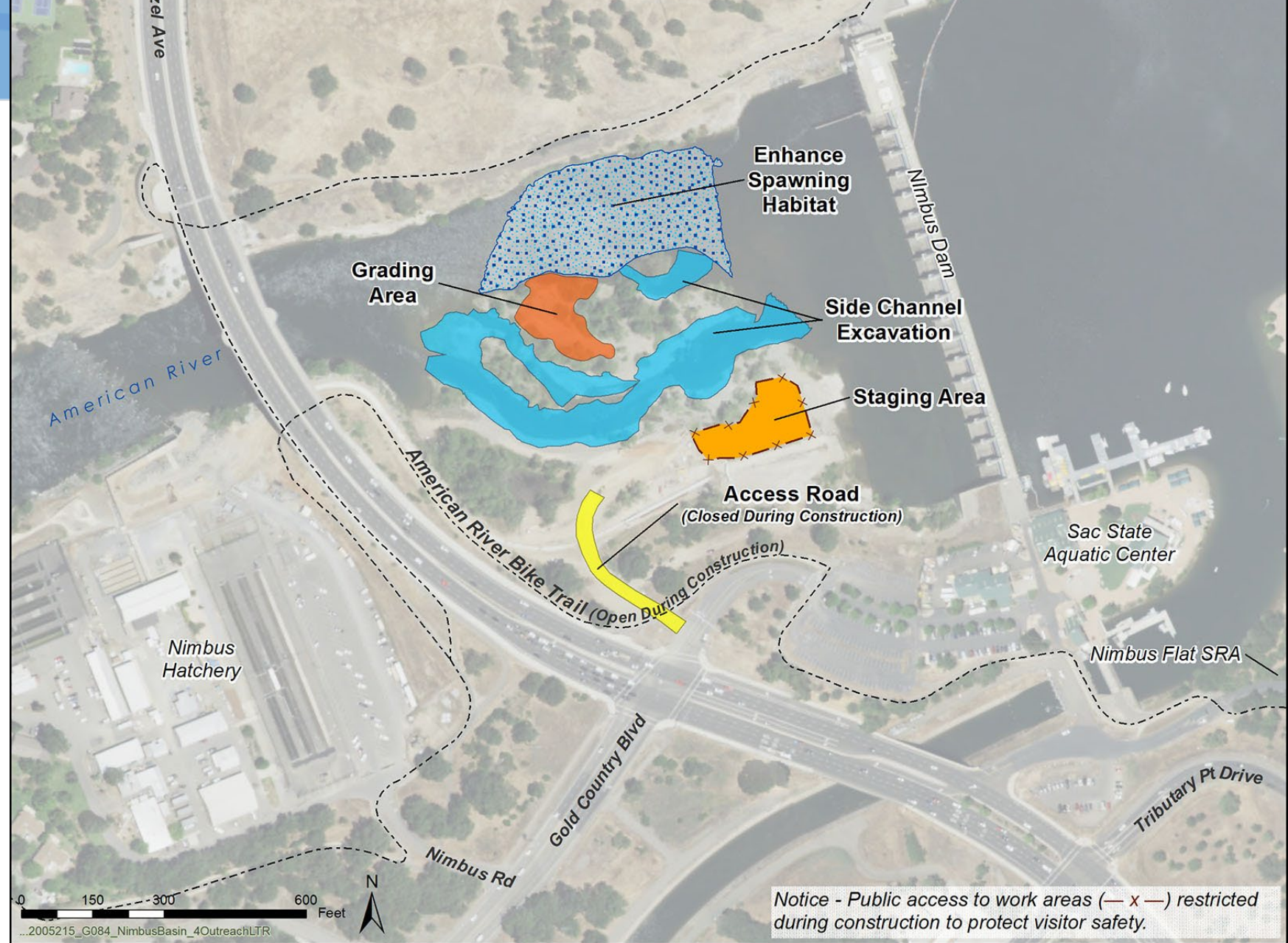
- Revisited/new site
- 3 spawning riffles (13.5 ac)
- 37,000 cy spawning gravel
- 2,500 ft side channel (4.9 ac)
- ~38 woody habitat structures
- Seeding – Fall 2022
- Onsite borrow

**Downstream riffle will reduce juvenile stranding in Upper Sunrise side channel at low flows.



Nimbus Basin

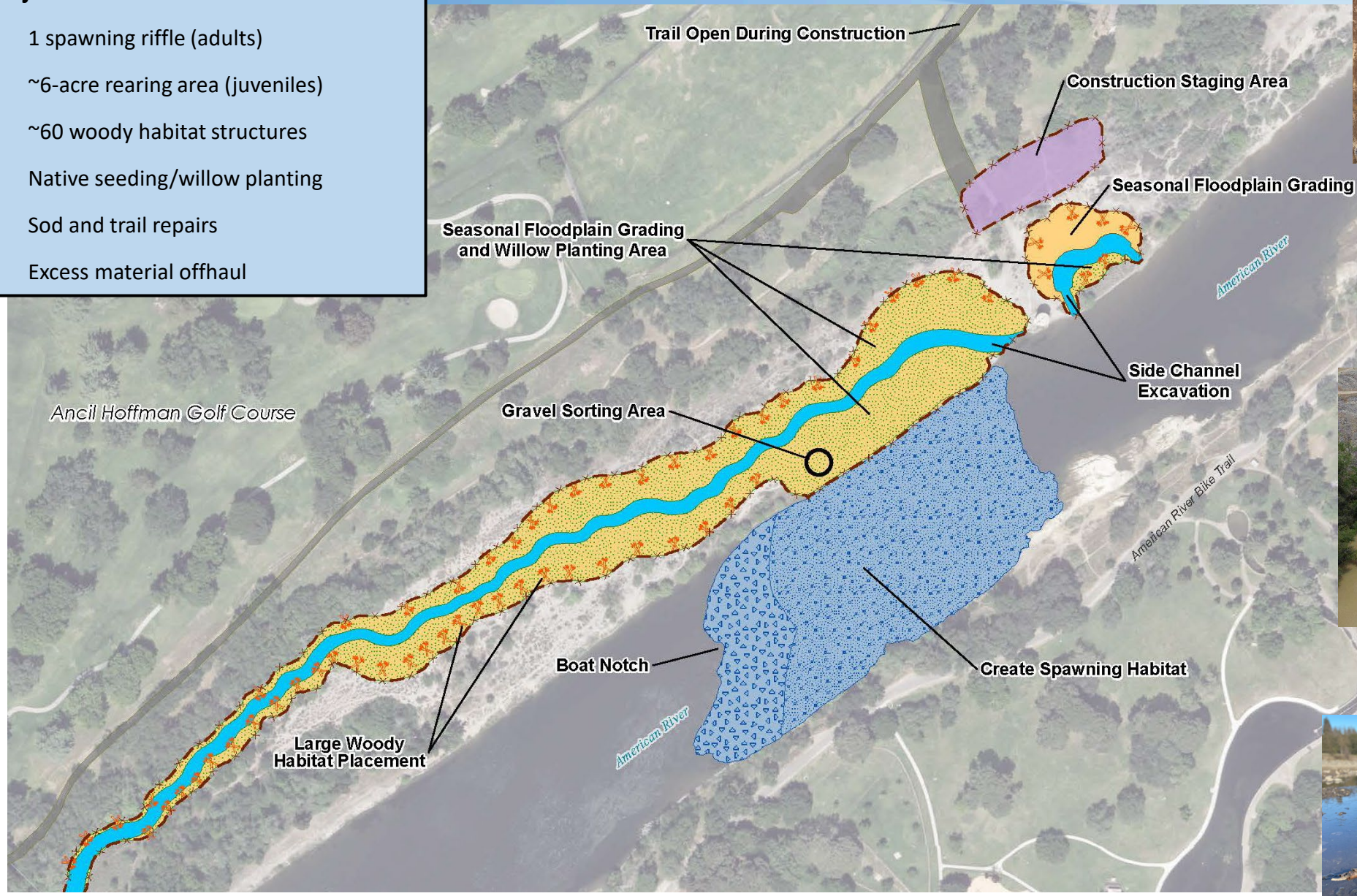
- Revisited site – heavy use
- 1 spawning riffle (3.7 ac)
- 4,200 cy spawning gravel
- 800 ft side channels and floodplain grading (2.5 ac)
- 20 woody habitat structures
- Seeding – Fall 2022
- Offsite borrow – haul from Mississippi Bar



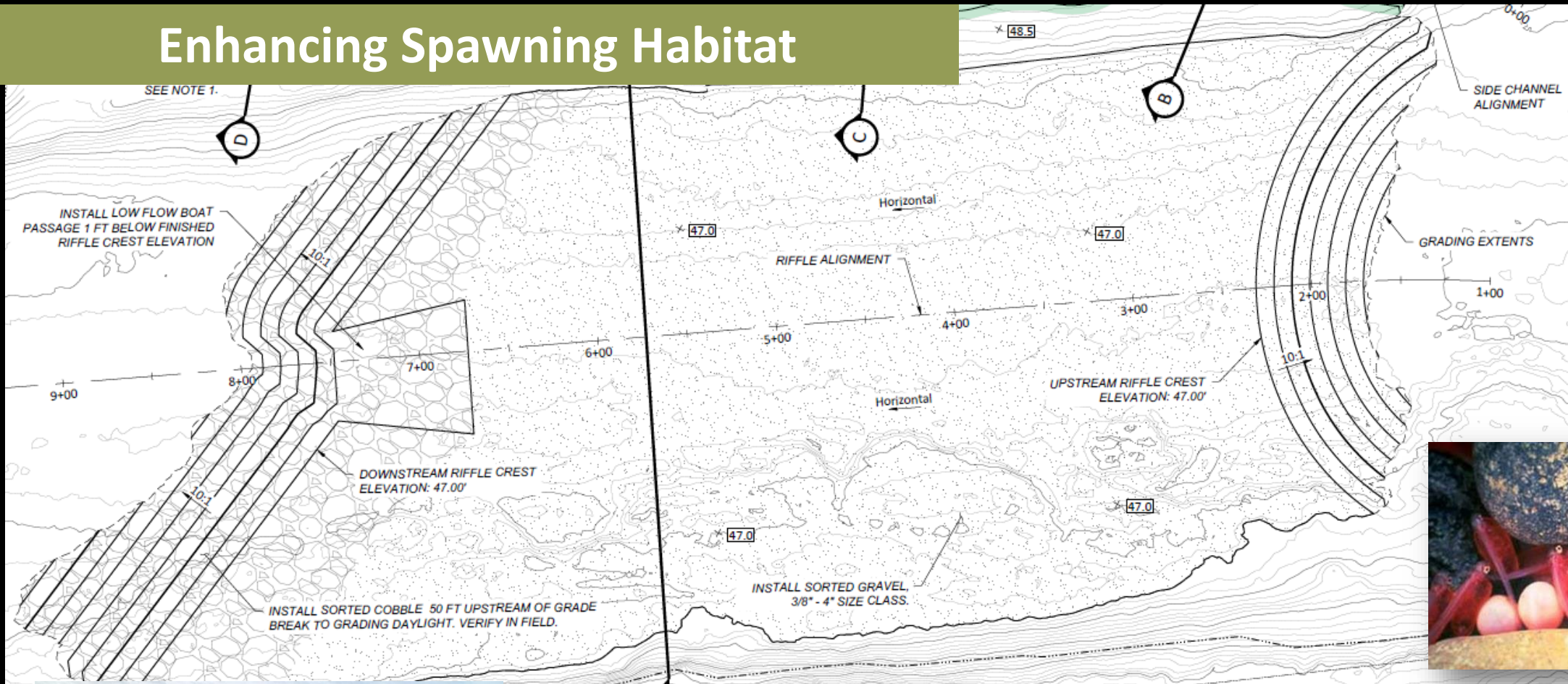
2023 Upper River Bend, Phase 1

Project Overview

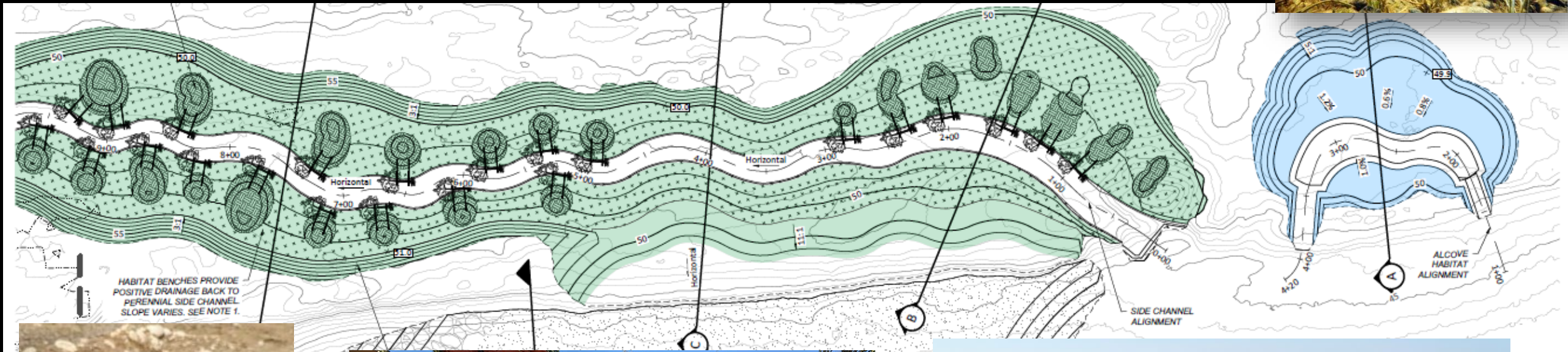
- 1 spawning riffle (adults)
- ~6-acre rearing area (juveniles)
- ~60 woody habitat structures
- Native seeding/willow planting
- Sod and trail repairs
- Excess material offhaul



Enhancing Spawning Habitat



Create/Enhance Rearing Habitat



Monitoring and Adaptive Management

Biological Monitoring

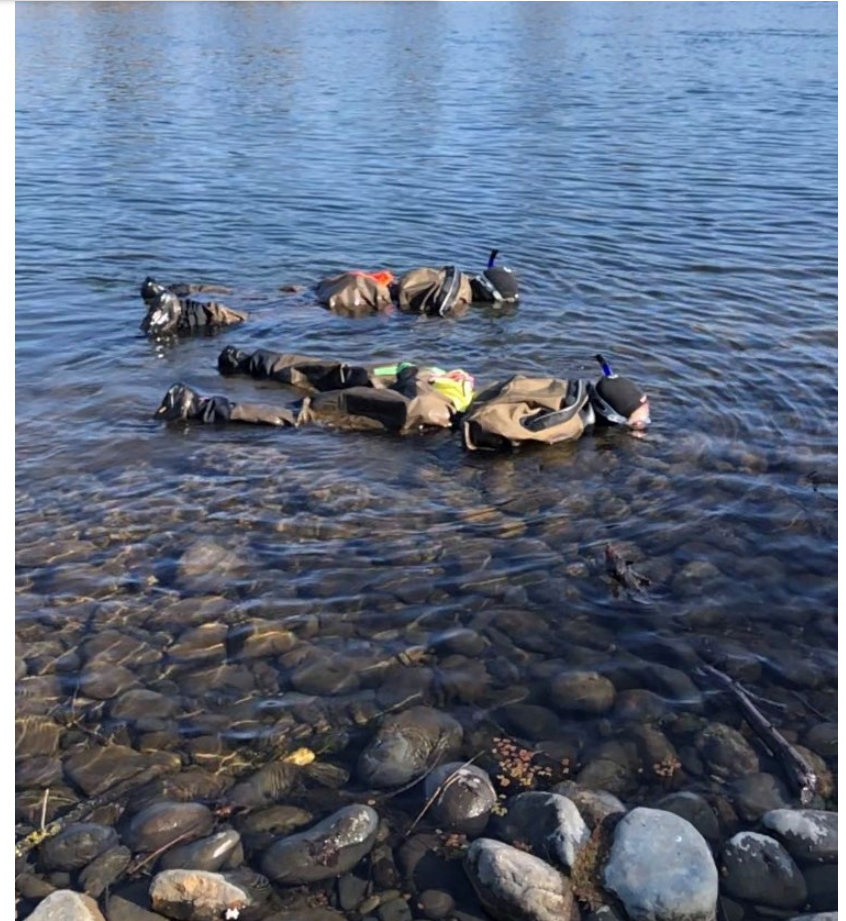
- Assess habitat effectiveness
 - Redd surveys
 - Snorkel surveys
- Genetics and life history studies
 - Mark-recapture/otoliths
- eDNA and water quality monitoring

Physical Monitoring/Analysis

- Topographic/bathymetric surveys
- LiDAR and 2D Model Update (2023 planned)
- WUA updates
- Development of gravel maintenance and adaptive management plan

Collaboration

- Data sharing to CVPIA Science Integration Team database
 - Coordination with DWR/SWRCB VA Science Committee
 - Coordination with CDFW field crews
- ✓ Publication, presentations and data – new website coming soon.





QUESTIONS?

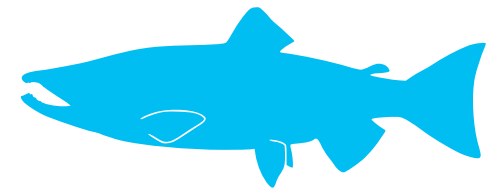
Contact: Erica Bishop, Program Manager

contact@waterforum.org

(916) 808-1997

Lower American River Monitoring Summary

- » **DOCUMENTING RESTORATION RESPONSE FOR KEY SALMONID LIFE STAGES**
 - adult spawners - aerial redd surveys, post-restoration ground redd surveys
 - rearing juveniles – post-restoration snorkel surveys, off-channel rearing seine surveys
- » **USING GENETIC MARK-RECAPTURE METHODS TO DIRECTLY MEASURE PRODUCTION FROM GRAVEL AUGMENTATION SITES**
- » **USING CHINOOK EYE LENSES AND OTOLITHS TO EXPLORE LIFE HISTORY VARIATION AND PHENOTYPE SUCCESS**
- » **STEELHEAD SPAWNING AND STRANDING SURVEYS**



Aerial Redd Surveys

- » Allow for whole-river quantification of redds that would be expensive with ground surveys
- » Support comparison with previous years of data
- » Status: Chinook Salmon redd counts from 2021 and 2022 aerial imagery complete
- » Standardized multi-reader QC methods

River Reach (River Mile)	Augmentation Year(s)	2021	2022
		Average # redds	Average # redds
Nimbus Basin - Main Channel (22) *	2014; 2022	19	229
Nimbus Basin - Side Channels (22) *	2014; 2022	0	144
Upper Sailor Bar - Side Channel (21)	2019	38	46
Upper Sailor Bar - Main Channel (22)	2008/2009; 2019	6	1
Sailor Bar (21)	-	86	91
Lower Sailor Bar (21)*	2012; 2022	81	92
Lower Sailor Bar - Side Channels (21) *	2012; 2022	0	13
Lower Sailor Bar - Upper Sunrise (21) *	2010/2011; 2022	0	159
Upper Sunrise - Main Channel and Above Side Channel (21) *	2010/2011; 2022	53	181
Upper Sunrise Side Channel (21)	-	0	75
Upper Sunrise - Main Channel and Below Side Channel (21/20)	-	4	42
Sunrise - Above Sunrise Bridge (20)	TBD	173	117
Sunrise - Below Sunrise Bridge (20/19)	-	0	4
Lower Sunrise - Above Side Channel (19)	2008	341	258
Sacramento Bar (18)	2016	55	160
El Manto (18)	On hold	33	56
Above San Juan Rapids (18)	-	0	15
Below San Juan Rapids (17)	-	0	1
Rossmoor (17)	-	6	12
Ancil Hoffman (16) **	2021	170	163
SMUD Lines (15)	2023 (Ph1 - in progress)	9	52
Upper Riverbend - Sarah Ct. (14)	TBD - Ph2	3	10
Riverbend (13)	2016	2	15
Riverbend - Braided Channels and Below Side Channel (13)	-	11	17
Below Riverbend (12)	-	58	63
Gristmill (11)	-	9	15
Below Gristmill (11)	-	0	5
Mayhew (10)	-	0	7
Watt - Above Bridge (9)	-	19	53
Watt - Below Bridge (9)	-	2	27
Above Paradise Beach (6)	-	0	1
Paradise Beach (5)	-	8	31
Total	-	1183	2147

* Gravel augmentation in 2022

** Gravel augmentation in 2021

Aerial Redd Surveys



Nimbus Basin – 10 Dec. 2021 (Pre – Construction)

662 cfs



Nimbus Basin – 28 Nov. 2022 (Post – Construction)

1,350 cfs

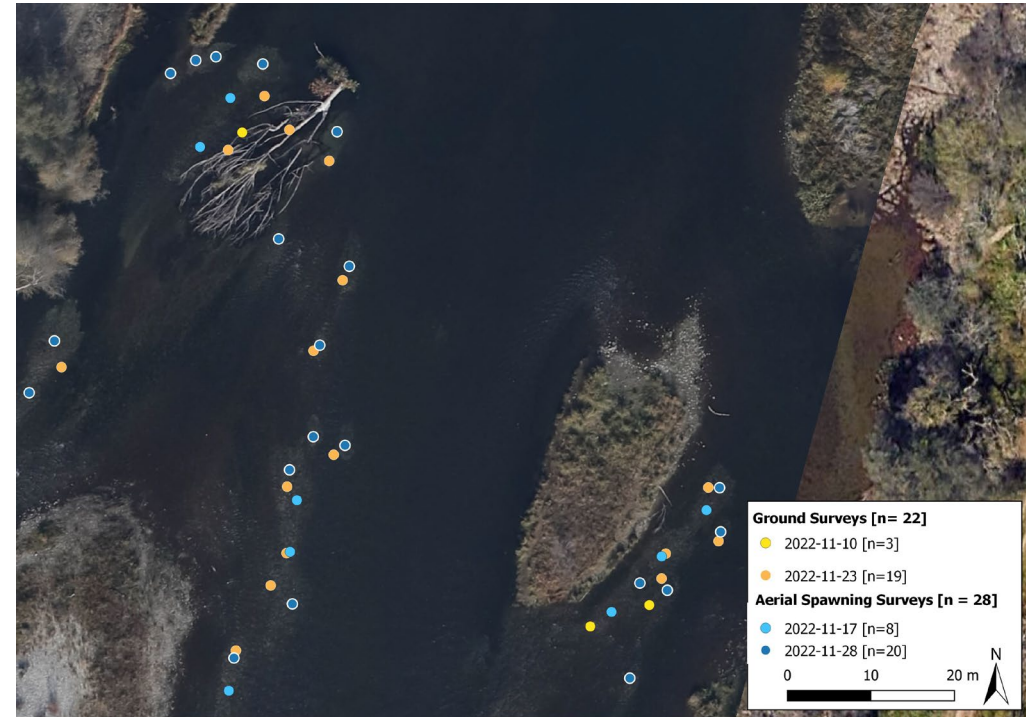
Pre/Post-Restoration ground-based redd surveys

» Chinook Salmon

- October – December 2022 (complete)
- Post – restoration redd surveys at Nimbus Basin, and Lower Sailor Bar
- Pre – restoration redd surveys at Upper Riverbend
- Coordination with CDFW
- Next steps: Post – restoration ground based redd surveys at Upper Riverbend October – December 2023

Site	Treatment	# Redds
Nimbus Basin	Post - Project	363
Sailor Bar	Control	247
Lower Sailor/Sunrise	Post - Project	334
Upper Riverbend	Pre - Project	95
Upper Riverbend	Pre - Project Control	80
Total		1119

Aerial VS. Ground-Based Redd Surveys



Pre/Post-Restoration snorkel surveys

- » Pre-restoration snorkel surveys – Nimbus Basin, Lower Sailor Bar and Upper Riverbend (Feb-June 2022)
- » Post-restoration (Nimbus Basin and Lower Sailor Bar) snorkel surveys and Year-2 of pre-restoration snorkel surveys at Upper Riverbend (Feb-June 2023)

» **Questions:**

Does juvenile salmonid density increase after restoration?

Is occupancy/higher density associated with particular environmental variables (depth, velocity, cover)?

Complete

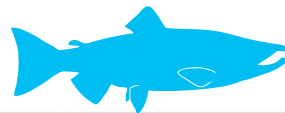
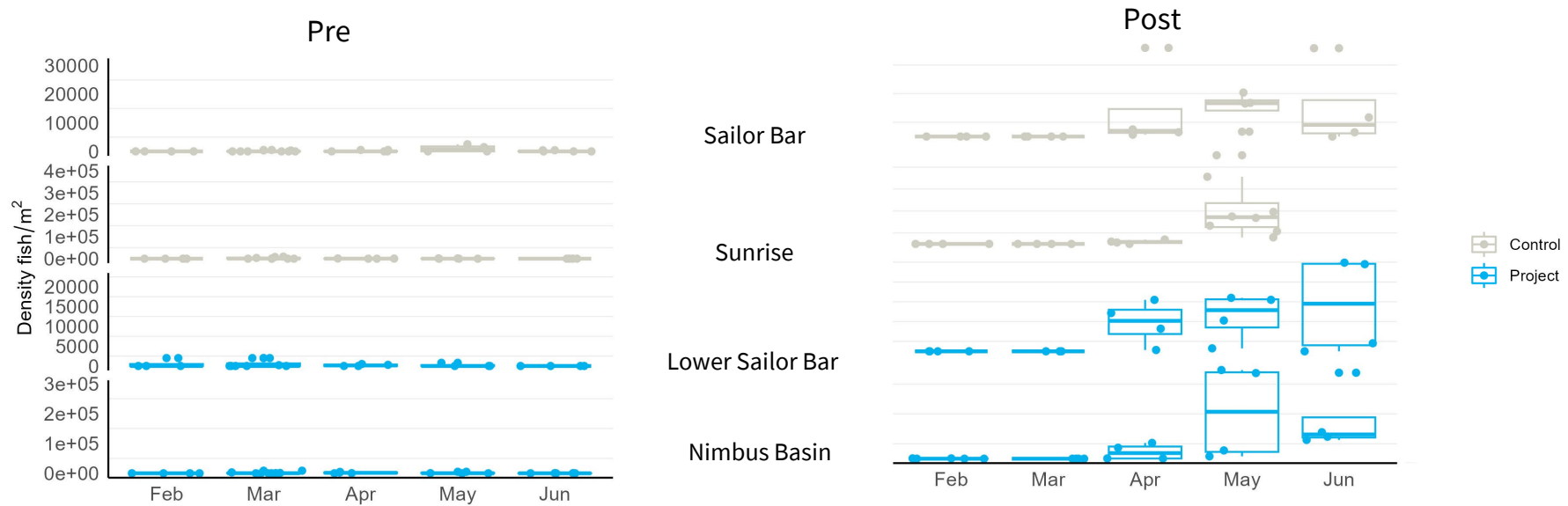
Formal analysis in progress



Pre/Post-Restoration snorkel surveys

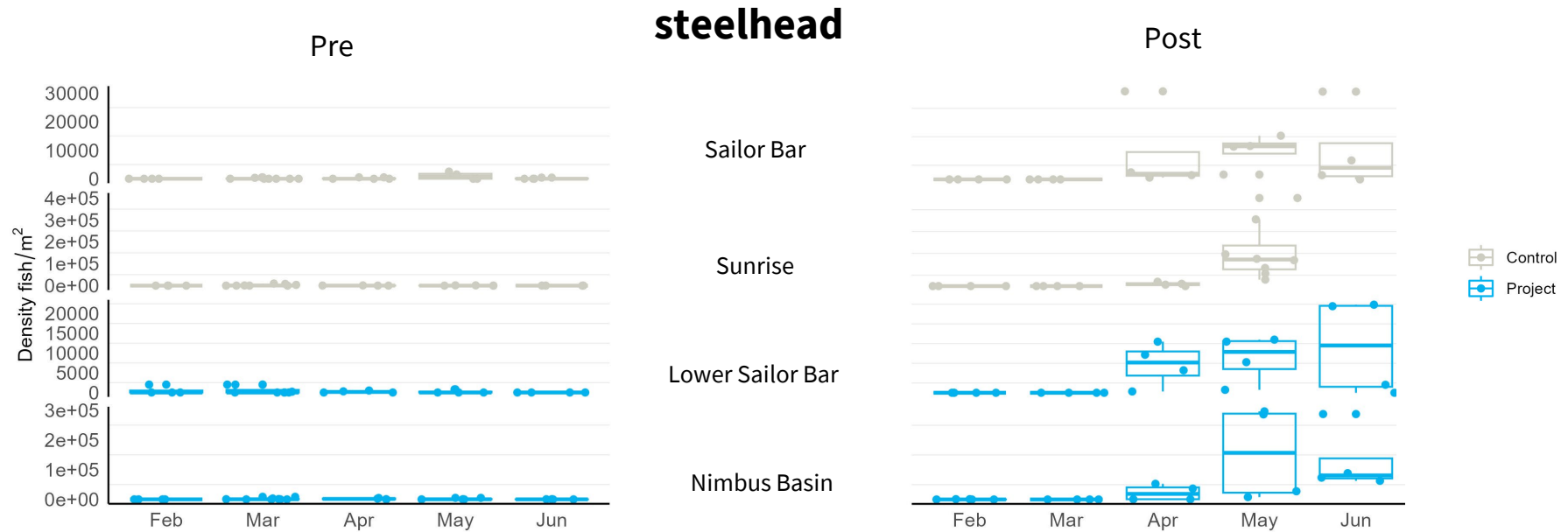
» Preliminary Results

Chinook Salmon



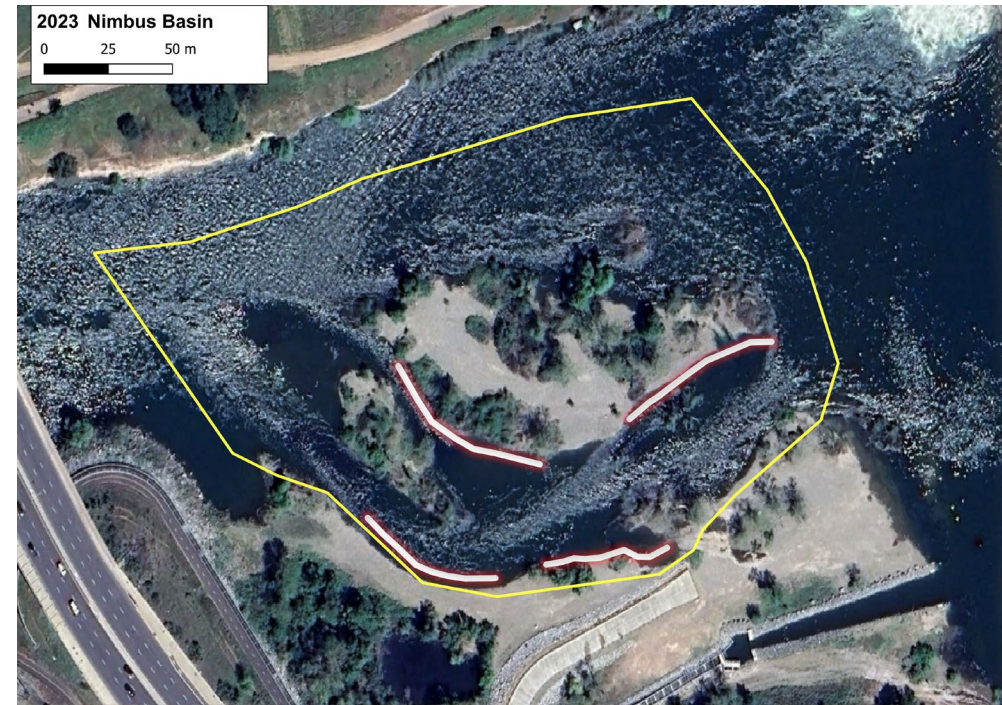
Pre/Post-Restoration snorkel surveys

» Preliminary Results



Pre/Post-Restoration snorkel surveys

» Contrasting water year types between survey years



Pre/Post-Restoration snorkel surveys

» Contrasting water year types between survey years



Season average flow: 1,700 cfs



Season average flow: 8,800 cfs

Off-channel juvenile rearing and growth study

- » Compared to unrestored main channel habitat, restored side channel/main channel sites will have:
 - longer residence time for juvenile salmonids
 - higher growth rates
 - higher juvenile salmonid densities
 - greater prey volume in stomachs and different diet compositions
 - greater proportion of native to non-native fish
- » 2021 and 2022 study activities halted due to drought/low flow conditions
- » 2023 study activities successful but high flows made recapturing tagged fish challenging

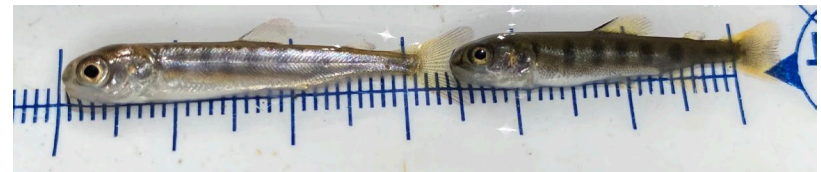
Off-channel juvenile rearing and growth study

» Preliminary Results

- 525 juvenile Chinook Salmon and 291 juvenile steelhead captured via beach seine Feb – June 2023
- All juvenile Chinook Salmon captured Feb – April were too small to pit tag
- 35 wild Chinook Salmon pit tagged in May 2023

Site	# pit tags
Ancil Hoffman*	4
Lower Sailor Bar	9
Sailor Bar Control	16
Upper Sailor Bar	6
Total	35

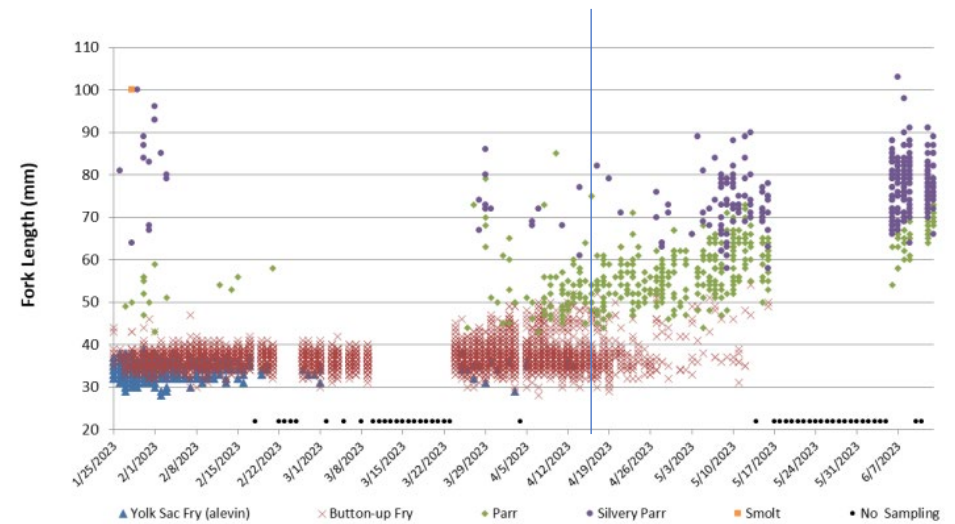
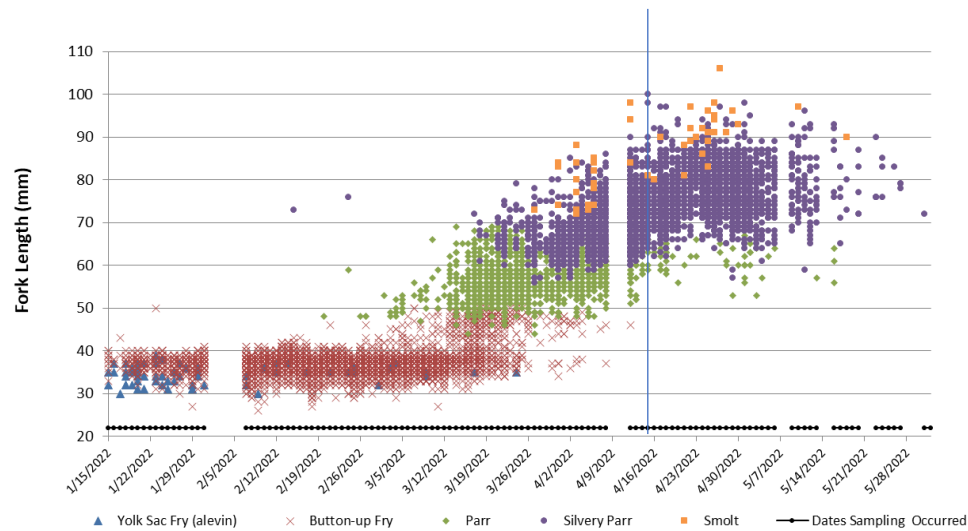
* 1 recaptured fish



Juvenile Chinook Salmon and juvenile steelhead <40 mm

Off-channel juvenile rearing and growth study

» Smaller fish observations in Feb – April similar to Watt RST



*RST data and figure presented at June 2022 and 2023 ARG meetings by Pacific States Marine Fisheries Commission (PSMFC)

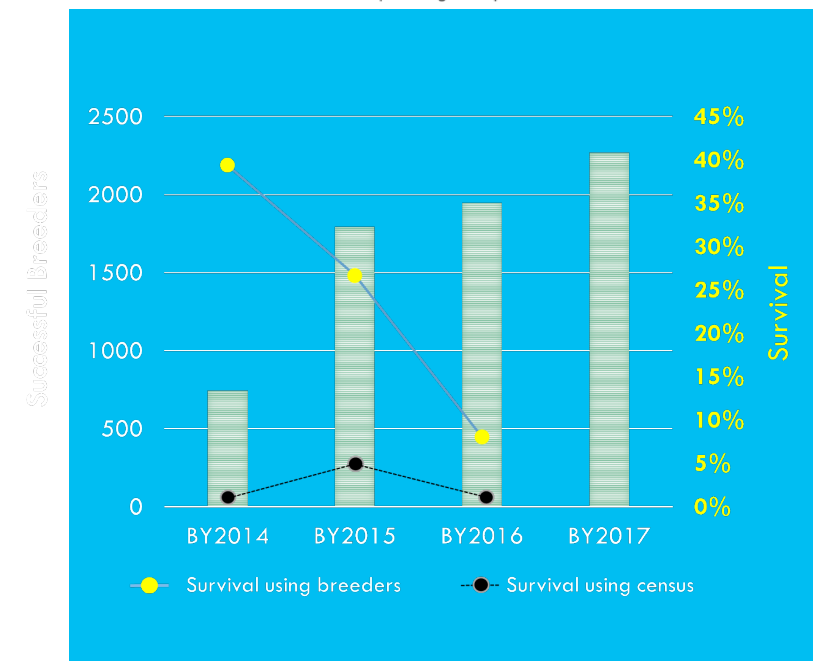
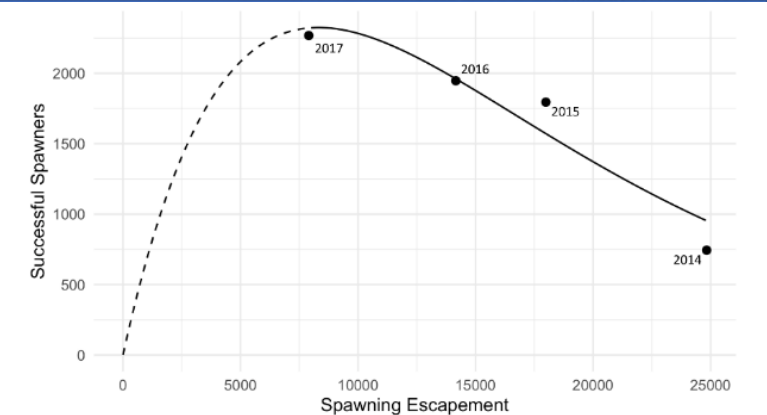
Close-kin mark-recapture study

- » Collect genetic samples from adult females during CDFW carcass surveys (2014 – 2021) with plans to collect samples in Fall 2023
- » Collect genetic samples from juveniles at Watt Avenue RST
- » Link moms to babies using genetic tools
- » Direct measurement of juvenile production from restored vs unrestored spawning grounds
- » Provides effective population size estimate and survival probability



Close-kin mark-recapture study

- » Restored and unrestored reaches have similar probability of producing offspring
- » Females spawning at restored sites have a higher chance of producing multiple offspring
- » Evidence for density dependence: inverse relationship between adult escapement and probability of juvenile survival
- » Population census \neq effective population size



Otolith microchemistry to reconstruct early life history strategies

- » Otolith (fish ear bones) strontium isotope ratios can be used to reconstruct river of origin and timing of outmigration for salmonids
- » Improve understanding of how different water year types influence out-migration timing
- » When paired with rotary screw trap data, can also provide information about the relative success of different outmigration strategies



Otolith microchemistry to reconstruct early life history strategies

- » Collected otoliths from unclipped adipose fin adult females during CDFW carcass surveys (2014 – 2021)
- » 2014 – 2017 otoliths processed in collaboration with UCD
- » 2018-2021 processing underway
- » Publication will be developed next summer
- » Fall 2023 sampling to begin early November



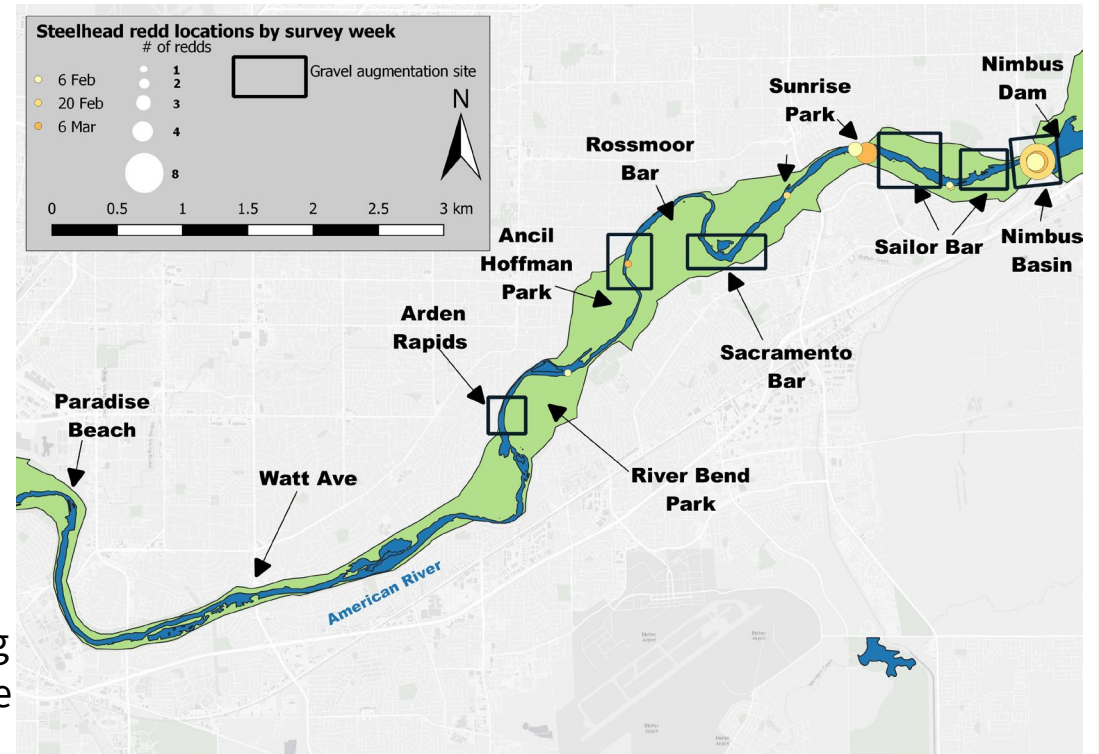
Using eye lenses to filter hatchery fish

- » Sulfur isotopes from eye lens core can be used to identify hatchery fish because marine-derived hatchery feed is higher in sulfur than river bugs
- » Lens extraction/processing is much less expensive relative to otoliths
- » 2018 – 2021 eye lenses sent to UC Davis for sulfur analysis in fall 2022 to determine wild vs hatchery
- » Results indicate high % of hatchery fish present



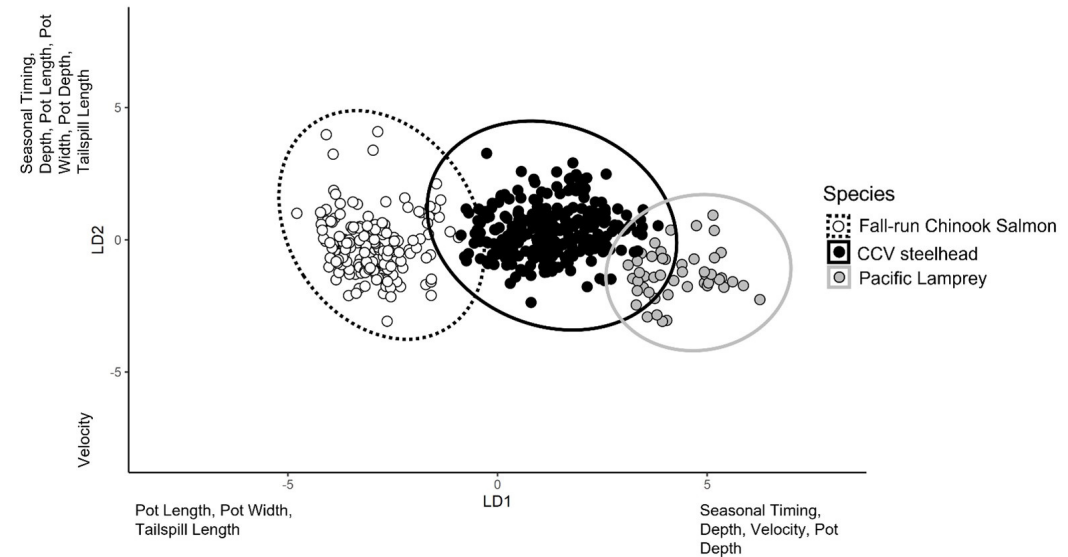
Steelhead spawning and stranding surveys

- » Annual spawning and stranding surveys conducted under contract with the Bureau of Reclamation
- » Collaboration with CDFW to conduct fish rescues from isolated pools following managed flow reductions
- » High flows and low visibility in 2023 limited survey efficiency
- » Majority of spawning activity in 2023 observed during successful surveys occurred in the Upper Sunrise side channel and Nimbus Basin side channels



Steelhead spawning and stranding surveys

- » Recent publication using redd dimensions and seasonality to predict species identity of unknown redds
- » Increase objectivity in redd identification when multiple species overlap
- » Model improves with time as additional “fish on” data is collected during steelhead and Chinook Salmon spawning surveys
- » Inform historical data when fish observations were not made



Sellheim K, Sweeney J, Merz J (2022) Increasing objectivity associated with anadromous fish redd identification using a discriminant function analysis. *Front Environ Sci* 10:1–15. doi: 10.3389/fenvs.2022.1085941

Lower American River Substrate Mapping



Data Collection Methods



Image-based Substrate Characterization



Image-based Substrate Characterization

- Riverbed photography from boat
 - The cbec "Benthometer" 2000 – A waterproof GoPro with scuba lights and a laser-scaler

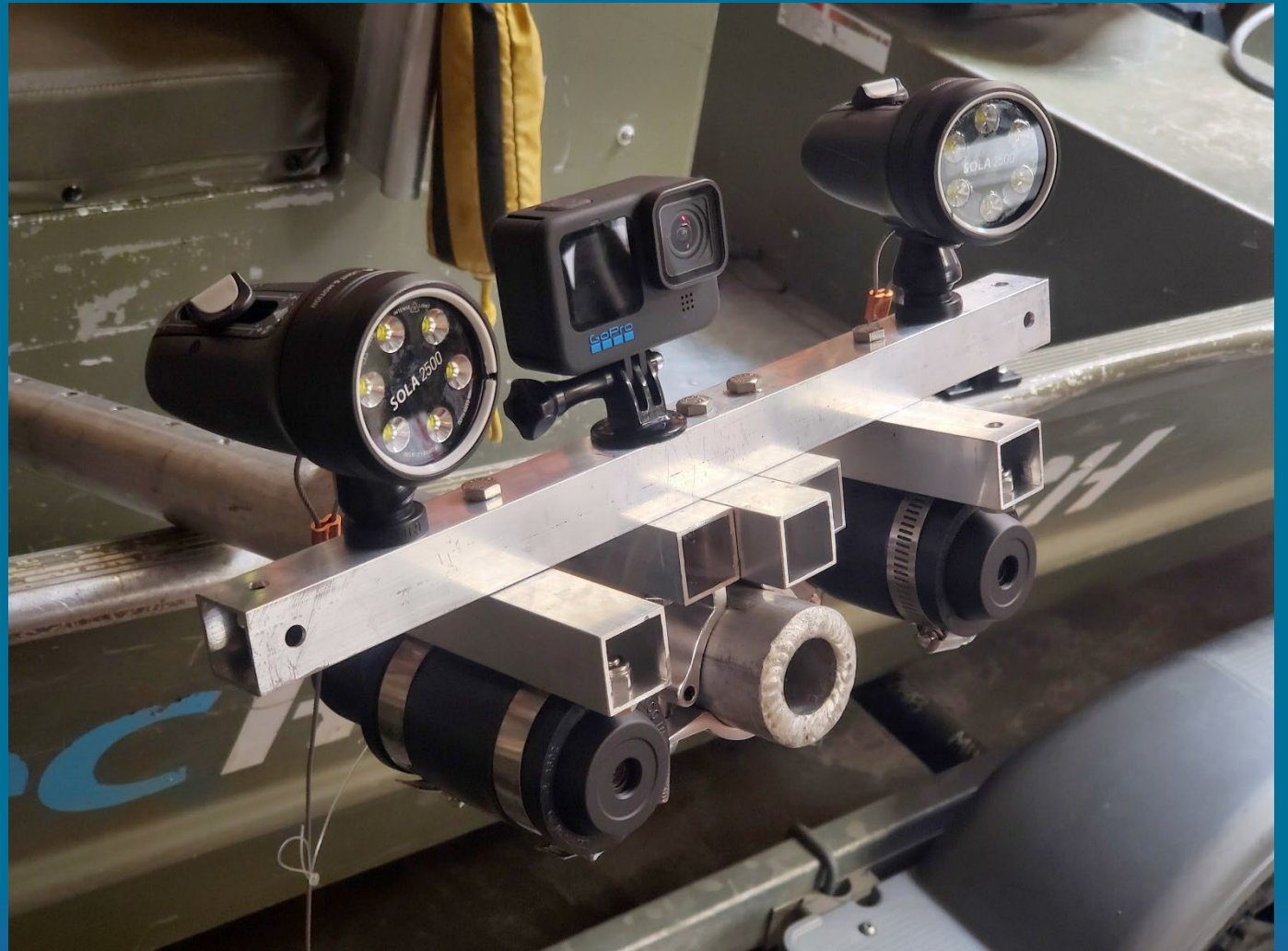


Image-based Substrate Characterization

- Riverbed photography from boat
 - The cbec "Benthometer" 2000 – A waterproof GoPro with scuba lights, and a laser-scaler
- Pole-mounted continuous imaging
 - One RTK GPS survey point for each photo



Image-based Substrate Characterization

- Riverbed photography from boat
 - The cbec "Benthometer" 2000 – A waterproof GoPro with scuba lights, and a laser-scaler
- Pole-mounted continuous imaging
 - One RTK GPS survey point for each photo
- Substrate images with scale

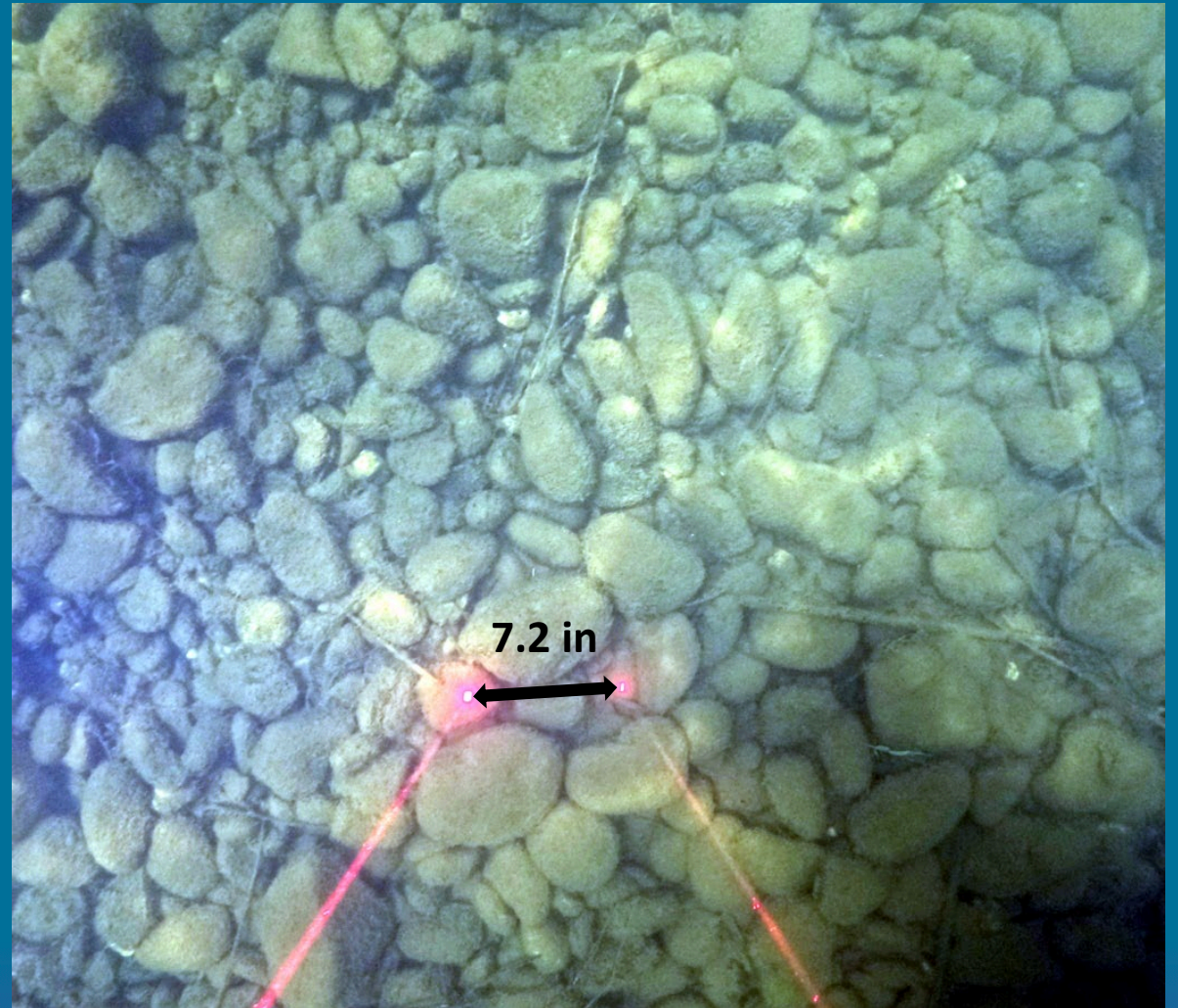
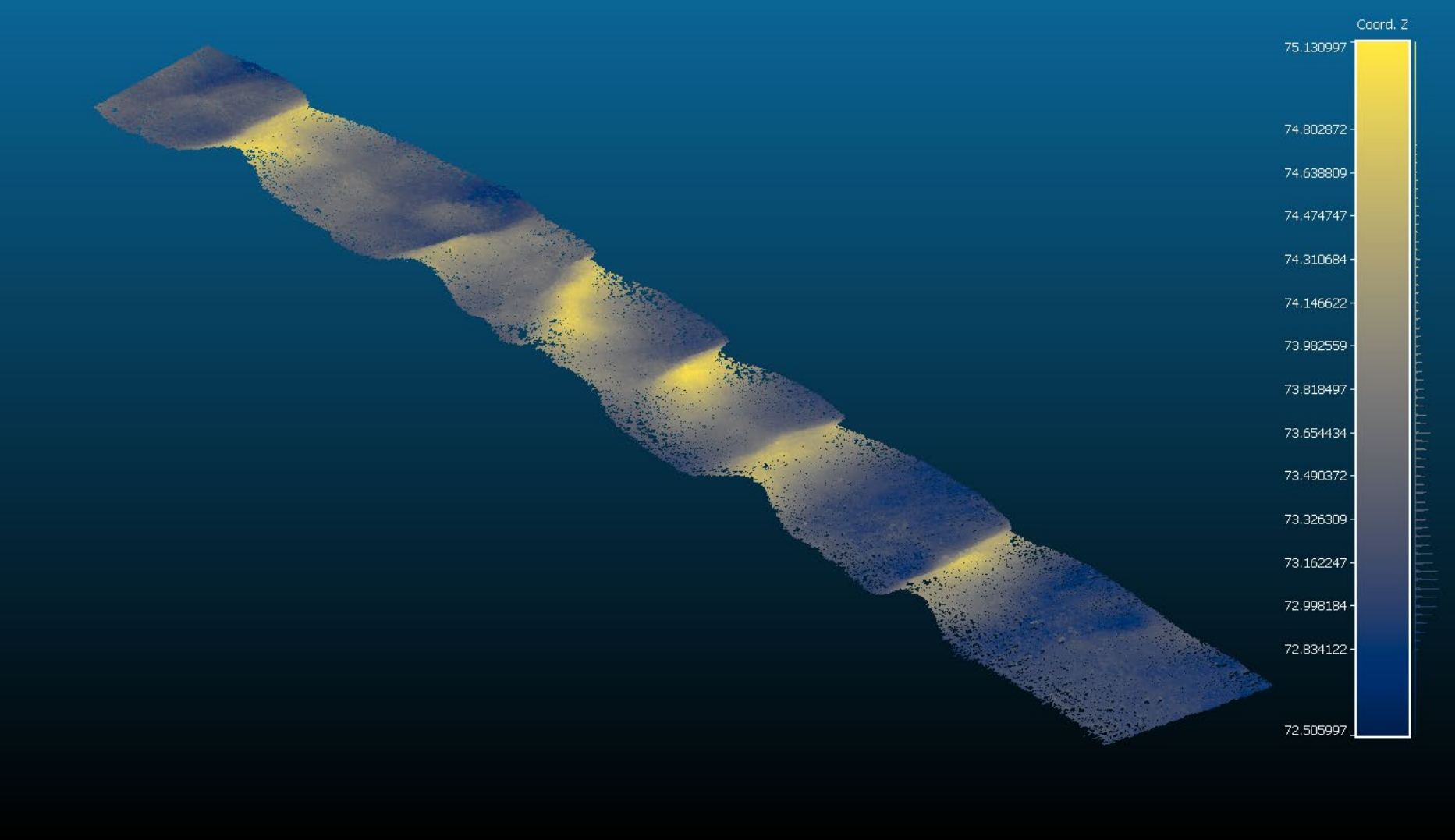


Image-based Substrate Characterization

- Riverbed photography from boat
 - The cbec "Benthometer" 2000 – A waterproof GoPro with scuba lights, and a laser-scaler
- Pole-mounted continuous imaging
 - One RTK GPS survey point for each photo
- Substrate images with scale
- Grain segmentation and measurement using Segment Anything Model (Deep Learning)



Multibeam Sonar



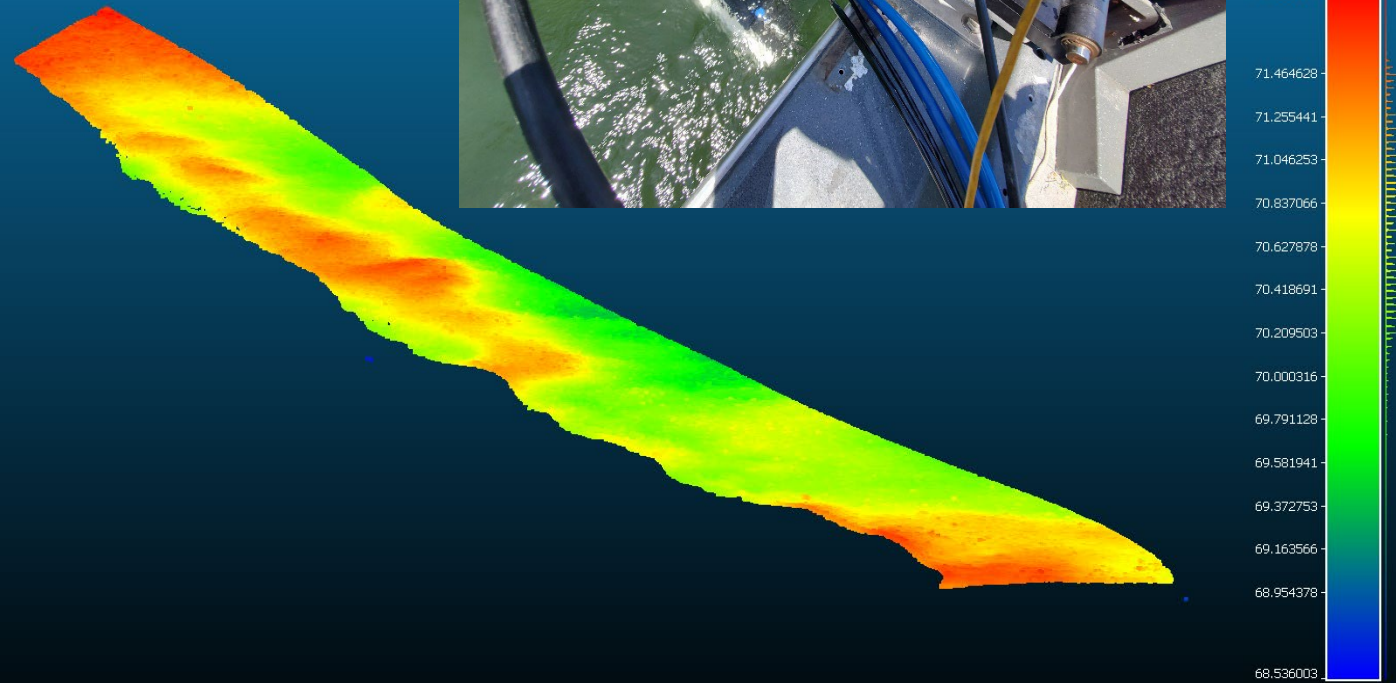
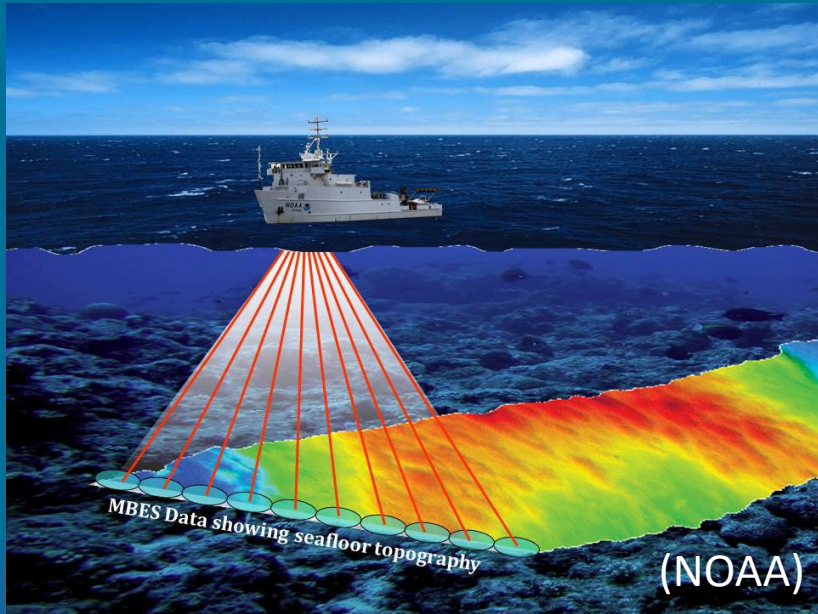
Multibeam Sonar

- High-resolution Multibeam Sonar Bathymetry
 - RESON Seabat T51 Multibeam Sonar mounted on our 16 ft Jon boat



Multibeam Sonar

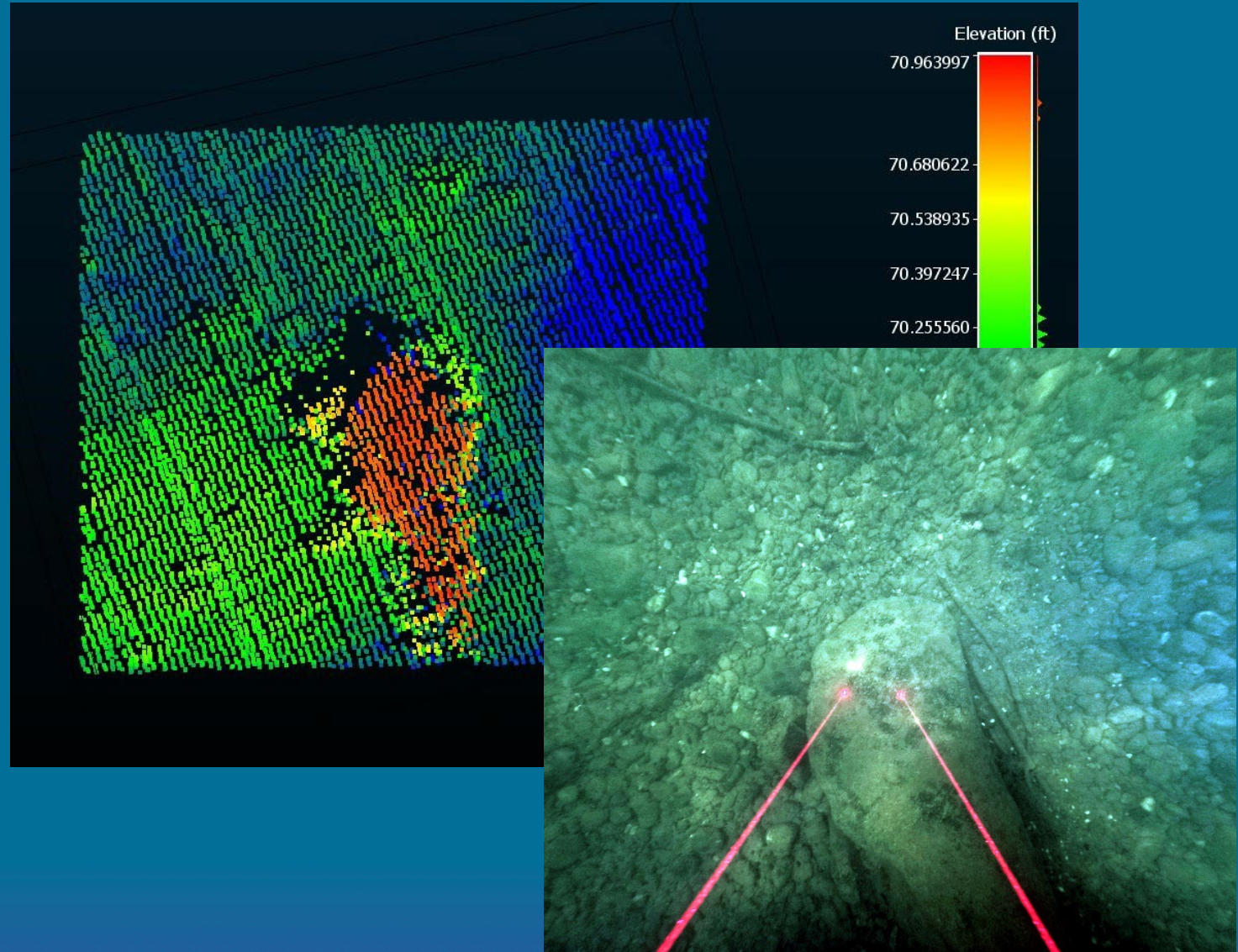
- High-resolution Multibeam Sonar Bathymetry
 - RESON Seabat T51 Multibeam Sonar mounted on our 16 ft Jon boat
- 1024 sonar beams arranged in a 135-degree fan pattern



Sample from Lower Sailor Bar

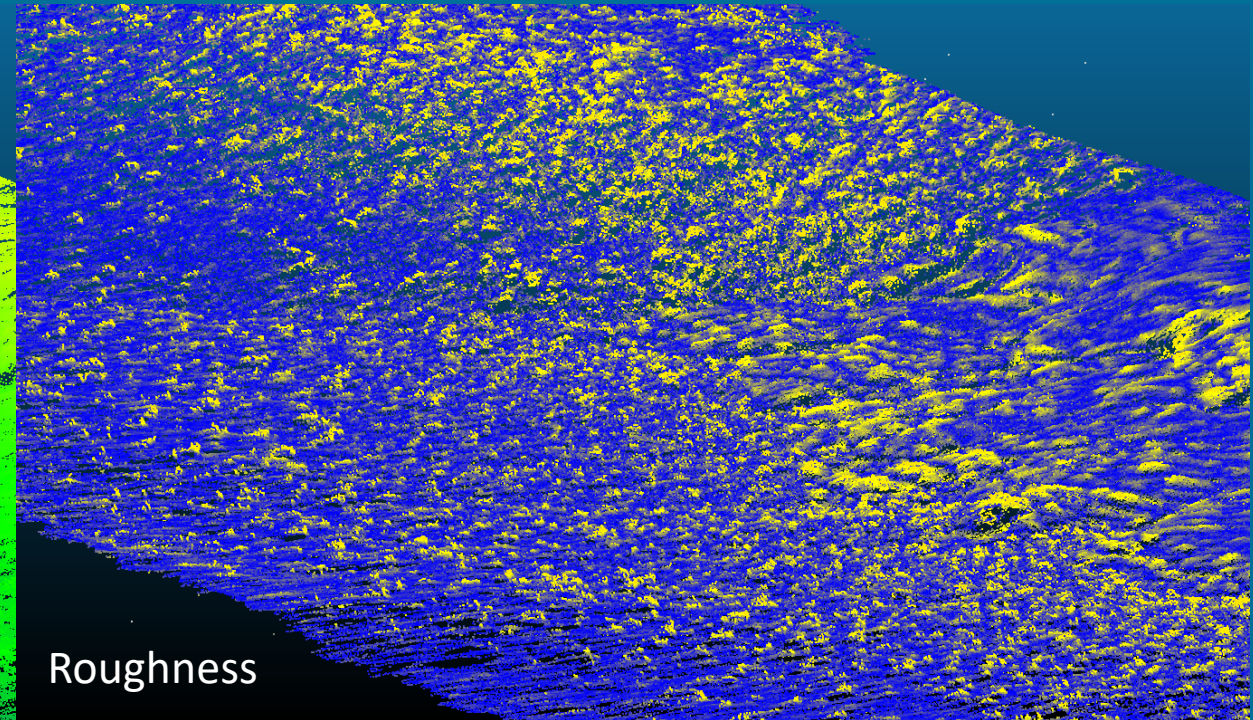
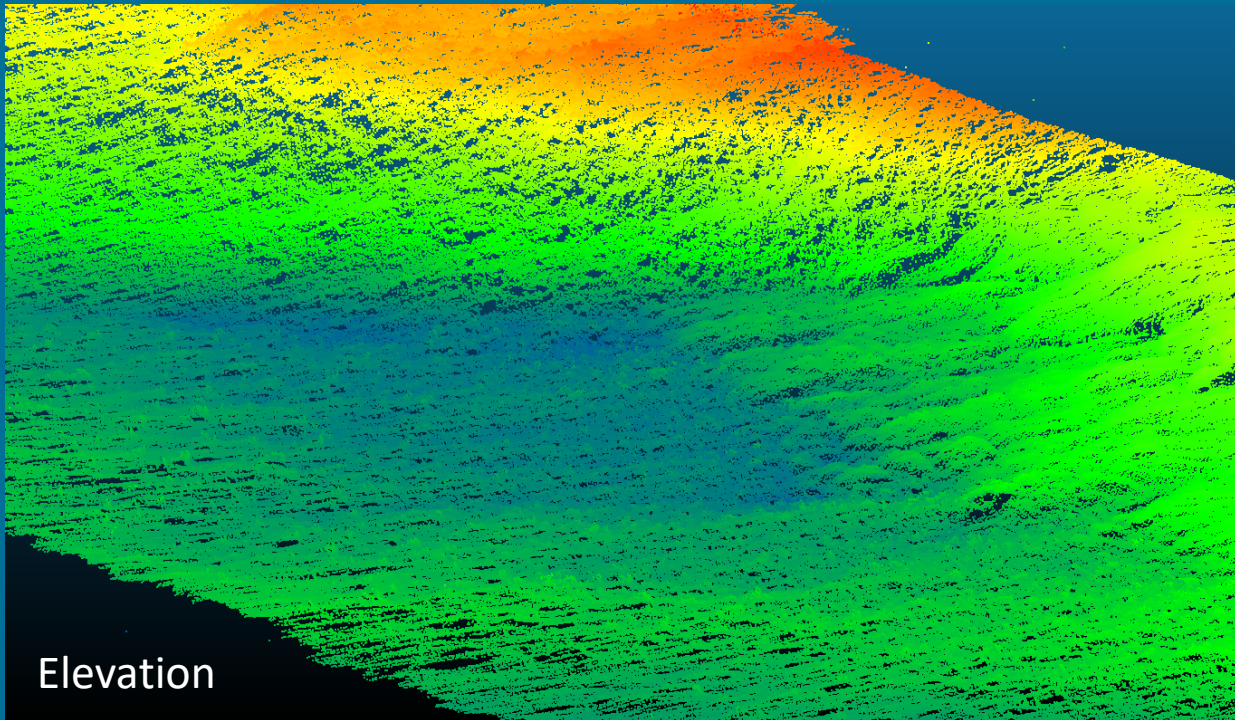
Multibeam Sonar

- High-resolution Multibeam Sonar Bathymetry
 - RESON Seabat T51 Multibeam Sonar mounted on our 16 ft Jon boat
- 1024 sonar beams arranged in a 135-degree fan pattern
- High point densities allow resolution of objects on the bed



Multibeam Sonar

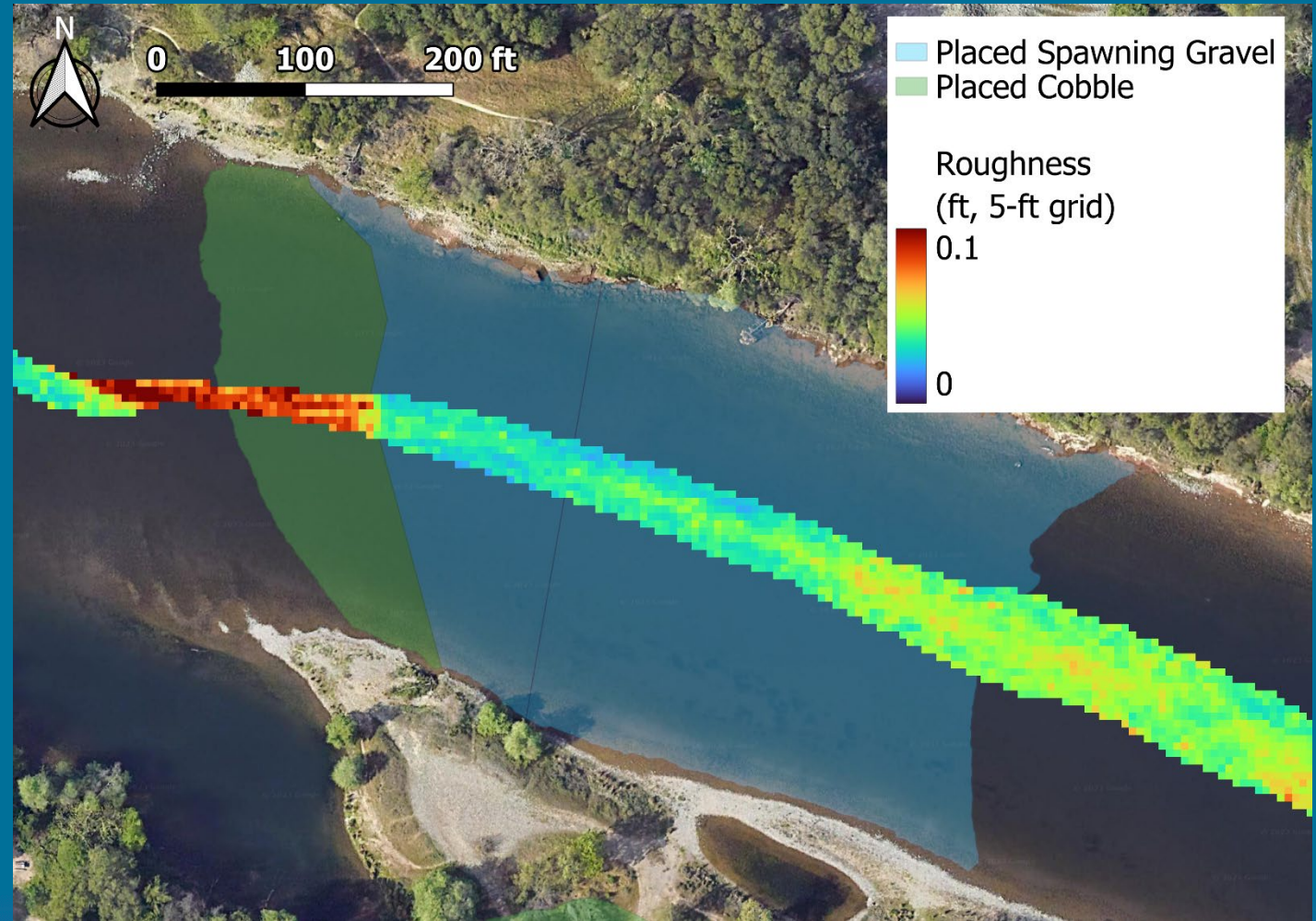
- “Roughness” calculated using the deviation of points from local average elevation



River-right bank at Lower Sailor Bar

Multibeam Sonar

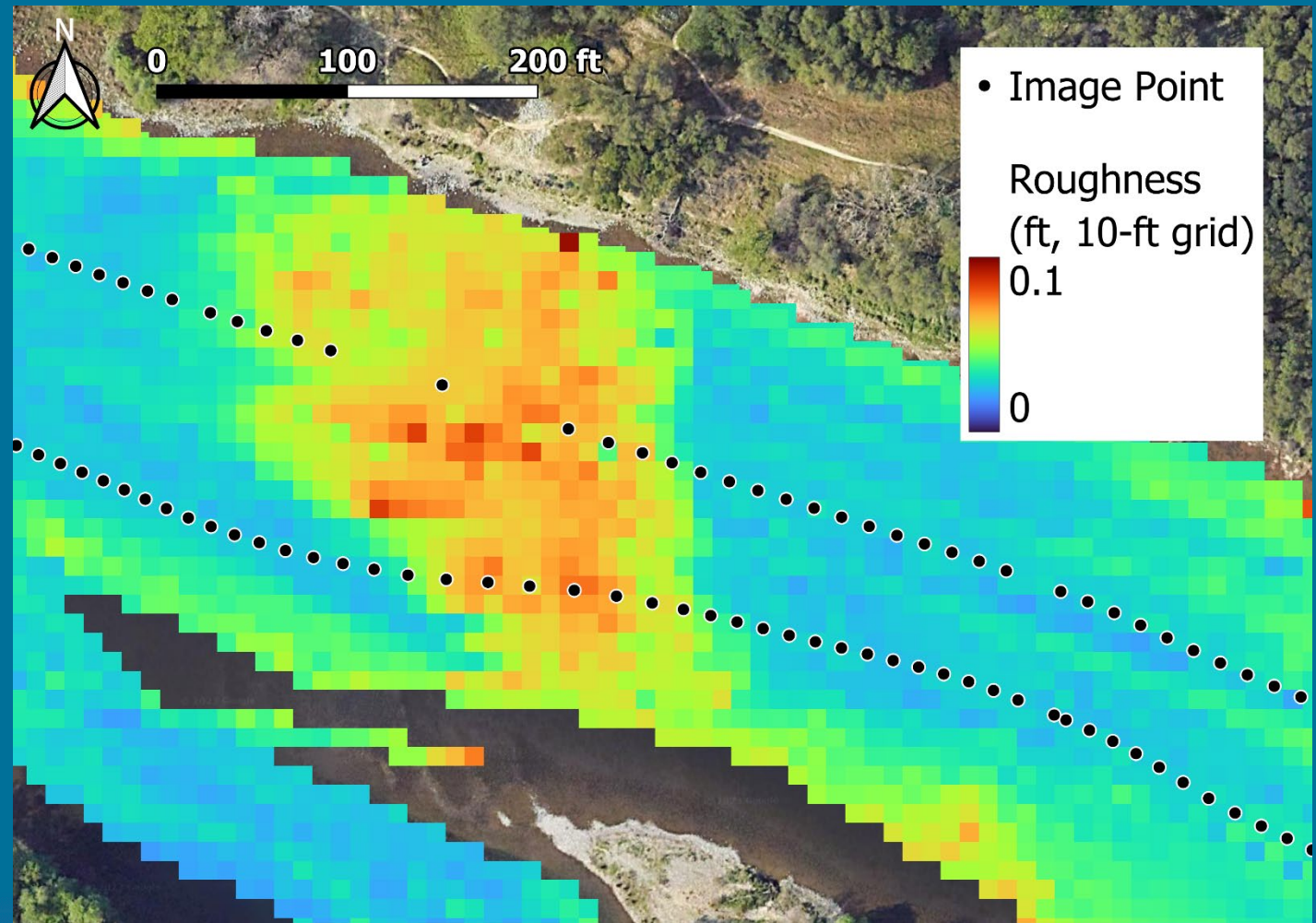
- “Roughness” calculated using the deviation of points from local average elevation
- Rasterized roughness map produced by taking the median roughness in each cell



Middle constructed riffle at Lower Sailor Bar

In Progress: Roughness-Substrate Relationship

- Use image results with Multibeam data to develop a relationship between roughness and a substrate metric, e.g., grain-size



Middle constructed riffle at Lower Sailor Bar