Seeing Redds:
Aerial Photo Redd Surveys as a Snapshot of Restoration Results in the Lower American River

Katherine Perkins, Sacramento Water Forum; Lilly Allen, Sacramento Water Forum;
John Hannon, Bureau of Reclamation Bay-Delta Office; Ian Smith, Bureau of Reclamation Bay-Delta Office

Introduction

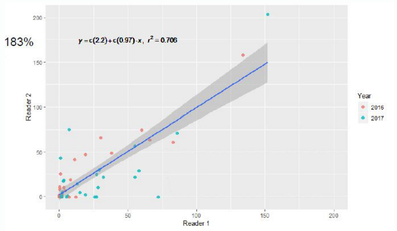
Folsom and Nimbus dams block Chinook salmon from accessing their historic spawning grounds in the Sierra Nevada foothills while also blocking sediment (e.g. gravel used by salmon to build redds) from moving past the dams. As a result, spawning habitat is limited in the remaining accessible waters of the urbanized lower American River. Restoration projects led by the Sacramento Water Forum and the Bureau of Reclamation have sought to increase the quantity and quality of spawning habitat through augmentation of suitably-sized gravels at the appropriate water depths and velocities during flows typical of the spawning season. Design and construction of restoration projects are informed by a comprehensive, multi-agency monitoring program - including a long-term dataset of aerial photography and redd counts.

Methodology

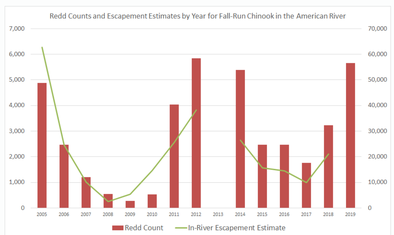
During redd construction, female Chinook salmon disturb and “clean” gravel, making their redd (nest) visually distinguishable as a light patch against the darker background of the river bed. In a relatively clear and shallow river like the lower American, redds are even visible from the air, making aerial photography a viable and cost-effective way to monitor Chinook salmon spawning via remote sensing. Each fall, high resolution aerial photos of the river are captured,usually with a film camera from a fixed-wing aircraft on three dates during the spawning season, supplemented by drone photography. The photos are geo-rectified in ArcMap and redd locations are digitized in a GIS point shapefile.

Water Forum and Bureau of Reclamation use both aerial and on-the-ground surveys to monitor salmonids in the lower American River. While redd surveys conducted by technicians in the river can provide more detailed information on redd characteristics such as depth, aerial surveys give a picture of spawning activity in areas of the river where velocity or depth would otherwise make surveying on foot impossible. The two techniques complement eachother and enable agencies to make informed adaptive management decisions.

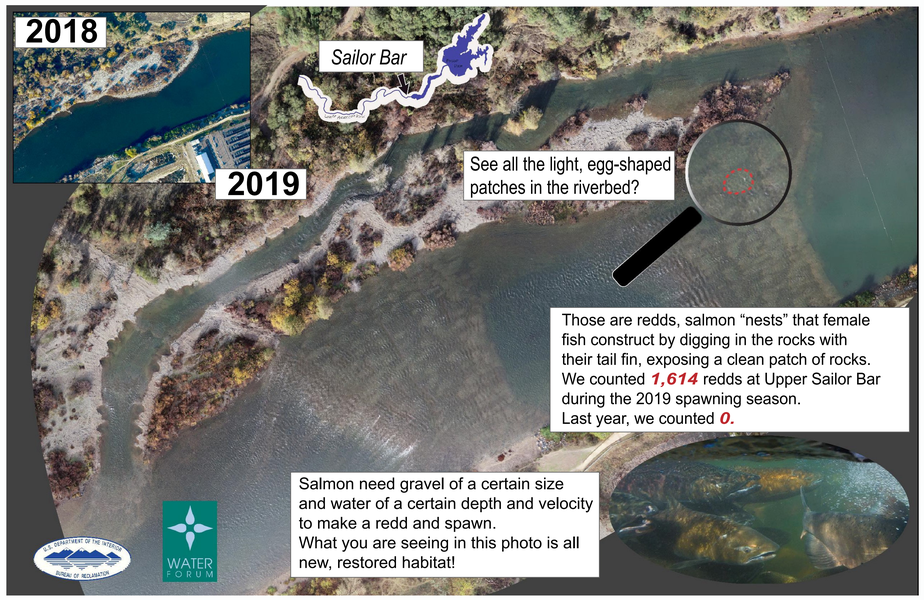
Aerial surveys have their limitations: the decision to count a feature as a redd is subjective. To investigate the accuracy and repeatability of aerial survey data, redd counts were performed independently by two technicians for two different years in 2017 and 2018. Although counts were positively correlated, there was high vaiability between readers. In order to improve accuracy in 2019, the same technician who performed aerial counts also completed wading surveys at Upper Sailor Bar, helping to calibrate her own redd detection in photographs with on-the-ground observations.



While there are challenges to aerial redd survey accuracy, aerial photo redd count data on the lower American River has tracked relatively well with escapement estimates - indicating it is an effective indication of the magnitude and distribution salmon spawning activity.



Sharing a Salmon Spawning Success Story: Restoration and Redds at Upper Sailor Bar



Aerial photographs are informative and beautiful, and when accompanied by a straightforward explanation of how redds are identified, these photos make a great tool for educating the public about the value of restoration for the adadromous native fish that depend on the urban lower American River to complete their life cycle. Water Forum shared this infographic on its social media, as well as on local TV, newspapers and in trade publications. A December 2019 post on Sacramento Water Forum’s Facebook page **@SacWaterForum** received over 4,000 engagements.

Riverwide Redd Distribution: 2018 vs. 2019

Aerial redd surveys provide a snapshot of spawning throughout the river. Looking at the change in the proportion of redds at Upper Sailor Bar, it’s clear that restoration activity at the site effectively increased habitat availability and use by Chinook salmon. **Redd counts at the site increased from 0% percent of spawning activity river-wide in 2018 to 28.6% percent in 2019.** While our agencies are only able to implement a restoration project at one or two sites each year logistically, we must consider the river at a whole system. In the lower American, a river in which salmonid spawning (and especially rearing) habitat is severely limited and superimposition of redds is common, we hope that an increase in habitat availabiliy at one site takes pressure off other, existing habitat. Unfortunately, we observed a high amount of superimposition in Nimbus Basin again during the 2019 Chinook salmon spawning season due to wier operations.

Informing Adaptive Management

The most recent restoration project at Upper Sailor Bar is a great example of adaptive management on the lower American River: this area just below Nimbus basin was restored over ten years ago and the gravel placed there had naturally been mobilized by high flows. Aerial survey data showed a clear decrease in spawning activity at the site. Post-restoration, spawning activity increased from nearly no spawning activity the previous year to over sixteen-hundred redds counted at the site in 2019. In addition to aerial photographs, we documented the locations, areas, velocities, and depths of redds at the site with on-the-ground surveys. This redd survey data informed dam operators’ decisions about how best to manage flows in order to minimize redd dewatering while preserving as sizable of a cold water pool as possible in a dry year. The graphic below was provided as part of documentation on redd surveys to the American River Group, a multi-agency advisory body which provides input on operations of Folsom dam.

The following data is provisional. The data is representative of redd depths at the Upper Sailor Bar restoration area. Upper Sailor Bar is located 0.5 km downstream of Nimbus Dams and Rifa weir.

Number of redds counted = **130**
Mean depth = **51 cm**

Table 1: Binned depths (10 cm) of redds. The number of redds detected in those depth ranges. The mean depth of each 10 cm bin.

Depth	N	Mean Depth
11-20	6	16
21-30	11	25
31-40	10	35
41-50	27	45
51-60	31	55
61-70	21	65
71-80	12	75
81-90	2	86
91-100	2	96
Total	**130**	**52.4**

- There were 47 redds found at depths *less than 50 cm*. The mean depth of these redds was 34 cm.
- There were 73 redds found at depths *greater than 50 cm*. The mean depth of these redds was 67 cm.

Restore, Monitor, Repeat: Lower American River Anadromous Fish Habitat Restoration Project

Over the last few years Water Forum and the Bureau of Reclamation have worked at developing and permitting a long-term approach to salmonid restoration in the lower American River, yet there’s still much work to be done. Spawning and rearing habitat for salmon and steelhead remains limited. Our agencies continue to push towards meeting the fish-doubling goal set up by the Central Valley Project Improvement Act, and to meet the region’s commitments to do more restoration for native fish. Meeting our goal means planning for in-river construction every fall, followed by monitoring that can inform adaptive management of the river system as a whole.

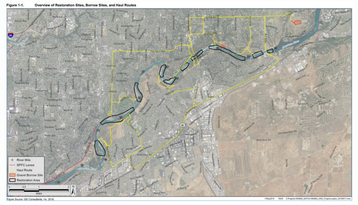


Table 2-1. Proposed Restoration Site Summary

Reach Name	River Mile Extent of Reach	Restored Spawning Gravel Area (acres)	Restored Spawning Gravel Channel Extent (linear feet)	Estimated Maximum Gravel Volume (tons)	Estimated Maximum Gravel Volume (cubic yards)	Side Channel Restoration Length (feet)	Habitat Structure Placement
Nimbus Basin	22.75-23	3.5	400	4,000	2,817	1,300	Placement occurs at locations identified as appropriate in the field during gravel placement and biological/channel creation/ enhancement activities.
Upper Sailor Bar	22.5-22.75	6	600	14,000	9,859	1,450	
Lower Sailor Bar	20.75-22	6.5	2,000	19,000	13,415	350	
Sunrise	19.75-20.5	4	300	13,500	9,507	1,700	
Lower Sunrise	19.25-19.75	2.5	600	3,000	2,113	1,200	
Sacramento Bar	18.5-19	13	500	6,000	4,225	1,750	
El Manto	18-18.5	7.5	700	13,500	9,507	1,150	
Ancil Hoffman	16-16.75	7	700	11,500	8,099	1,850	
Upper River Bend	14.5-15.5	14	4,000	24,000	16,900	5,000	
River Bend	13.25-13.75	4.5	250	4,500	3,169	1,450	
Approximate Annual Maximum Fill Total				**~ 20,000**	**~ 21,000**		
Approximate Maximum Fill Total (Years 2019-2034)				**~ 80,000**	**~ 450,000**		

Note: Restoration activities may occur at any point along the river mileage extent shown for each restoration reach, based on adaptive management and monitoring.

Source: LAR Anadromous Fish Habitat Restoration Project Environmental Assessment Initial Study, June 2019

Planning is already underway for another salmonid habitat restoration project at Ancil Hoffman Park in Fall 2020. A design team made up of fisheries biologists, hydraulic engineers and ecosystem managers facilitated by the Water Forum is working to design a project which improves rearing and spawning habitat, while balancing recreation concerns. Rather than carving out a side channel which creates an island which Park Rangers can not access, the 2020 design for Ancil Hoffman will likely create alcoves and lower elevations in the gravel bar to restore a flood plain area which becomes inundated at high flows. Not only will this project at Ancil Hoffman provide critical rearing habitat for salmonids, but it will give children and adults who visit nearby Effie Yeaw Nature Center a chance to learn about the ecosystem of the lower American River and their water source.

Visit waterforum.org/the-river/habitat-management to learn more