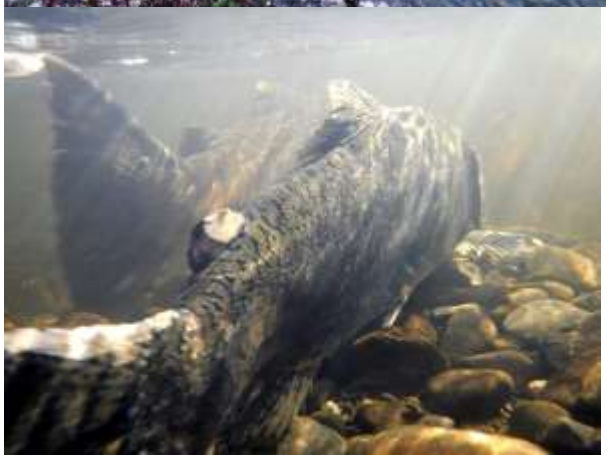
Eel River 2017 Channel Change Duality: Rejuvenation of Salmonid Juvenile Habitat and Potential Egg Mortality





By: **Patrick Higgins, Consulting Fisheries Biologist**
For: **Friends of Van Duzen River & Trees Foundation**
Funded by: **The U.S. Forest Service/Six Rivers National Forest - More Kids in the Woods**

January 8, 2018

Acknowledgements

The Friends of Van Duzen River (FOVDR) is very thankful to the U.S. Forest Service and Six Rivers National Forest for providing funds for youth education since 2013 in the Van Duzen River basin. This is the third More Kids in the Woods grant and we are seeing many students that now identify themselves as young scientists, and are more inclined to pursue a natural resource science career path. This is a long-term objective of FOVDR and provides continuity with the previous Young Scientists project. The support and involvement of Hydesville, Cuddebach, Bridgeville and Van Duzen Elementary Schools is hugely appreciated and we want to commend the students, teachers and student aids involved.

Since FOVDR is not a 501c3 corporation, we are also grateful to the Trees Foundation for their fiscal sponsorship and administration of this grant. FOVDR is continuously cooperating with the Eel River Recovery Project and some elements of this report rely on photos and documentation from ERRP's wider efforts to track fall Chinook salmon and to assess flow and temperature conditions of tributaries.

Background

The Friends of Van Duzen River (FOVDR) has been awarded three More Kids in the Woods grants by the U.S. Forest Service in 2013, 2016 and 2017. Students are involved in temperature monitoring and habitat surveys annually, as well as river related art and video projects. Lower Grizzly Creek has been one of the monitoring locations and on December 2, 2016 students witnessed dozens of Chinook salmon spawning there. However, on December 2, 2017 when the same location was visited, the conditions had dramatically changed from the previous year and there were only two redds in the reach where there was more than a dozen in 2016. This raised the question as to whether the changes in bed conditions had occurred before last year's Chinook eggs had been able to hatch and emerge as fry. FOVDR Project Leader Sal Steinberg asked fisheries biologist Patrick Higgins, who is also the ERRP Managing Director, to write a short white paper on bedload movement and Chinook egg and alevin survival in lower Grizzly Creek or other areas where ERRP has noted similar changes.

In addition to Grizzly Creek at the Van Duzen River, ERRP noted major bed changes in Chamise Creek east of Garberville, Sproul Creek, Tenmile Creek near Laytonville, and the Middle Fork Eel River at the Round Valley Indian Reservation (RVIR) boundary below Williams Creek. As an additional tool to monitor longer term channel change, Google Earth is used to contrast changes over time. Because ERRP has time lapse cameras on both Chamise and Sproul Creek that take a picture during daylight hours all year long, there are photo sequences for high flow periods that likely caused bedload change. The purpose of this report is not to definitively answer questions, but rather to frame the issue of sediment transport and Chinook egg survival so that it can be the focus of further study.

Young scientists with mentors in the field at Shakefork Farm. July 2016.

Channel Changes Documented

Channel changes observed during the More Kids in the Woods project and by ERRP at other locations in the Eel River basin during 2017 are documented below. High flows that likely triggered bedload movement, and the spawn timing and egg and alevin gestation are explored in sections later in the report.

Grizzly Creek at the Convergence with Van Duzen River: While the More Kids in the Woods project caused closer scrutiny of this location, the reach is a depositional environment and its propensity for aggrading was noted as far back as January 1, 1997 after intensive watershed management (Higgins 2009).

Aerial photographs of the mouth of Grizzly Creek are available on Google Earth back to 1998, but the quality of photos is highly variable. The 1998 photo shows this location as highly aggraded in August 1998 (Figure 1) as a result of major sediment over-supply with no possibility of establishment of willows. By 2006 (Figure 2), the channel has cut down and is bifurcated, with most flow in the northern channel, but has no sign of willow or alder establishment. By 2014 (Figure 3), there is well established willow across the bar, which was likely aided by the 2013-2014 drought. Flow of Grizzly Creek just above the Van Duzen in this reach had stabilized on the north side of the channel and had developed good riparian canopy. The 2016 photo (Figure 4) shows the Grizzly Creek channel had shifted to the center of the floodplain. The large cobble and small boulders visible in the aerial photo are indicative of bed coarsening, which co-related with sorting of smaller (hard ball to soft ball sized) suitable for Chinook salmon spawning.

Ground photos taken on FOVDR field trip to the mouth of Grizzly Creek show bedload transport on the order of 6-10 feet as indicated by the height of the delta (Figure 5). A photo from the same period looking upstream towards Highway 36 also shows major terrace features indicating the previous winter's bedload transport (Figure 6). The stream bed remains dominated by gravel less than 40 mm, which is indicative of recent disturbance and sediment over-supply (Knopp 1993).

The More Kids in the Woods field trip of December 2, 2017 found ideal Chinook salmon substrate and Chinook salmon spawning actively (Figure 7). Where there were copious spawning gravels in 2016 and little fine sediment, by a year later conditions had reversed and there was far less spawning substrate and more sand and silt present (Figure 8). There we just two redds in the reach that had more than a dozen the year before. Did the bed change during the incubation of eggs that the students saw deposited and before the emergence of alevin as fry that could escape high flows? (See Peak Flow and Bedload Movement).

Chemise Creek Below Island Mountain Road – Chemise Creek joins the middle-main Eel River well upstream of Alderpoint and just upstream of Keekawaka Creek. ERRP has monitored water temperature in both pools and riffles since 2012, and has operated a time-lapse camera since 2015, in cooperation with land owners Proud and Maria Savage. Chamise Creek lost surface flow in the summer 2013, 2014, and 2015, but pools maintained hyporheic connection and suitable for steelhead rearing.

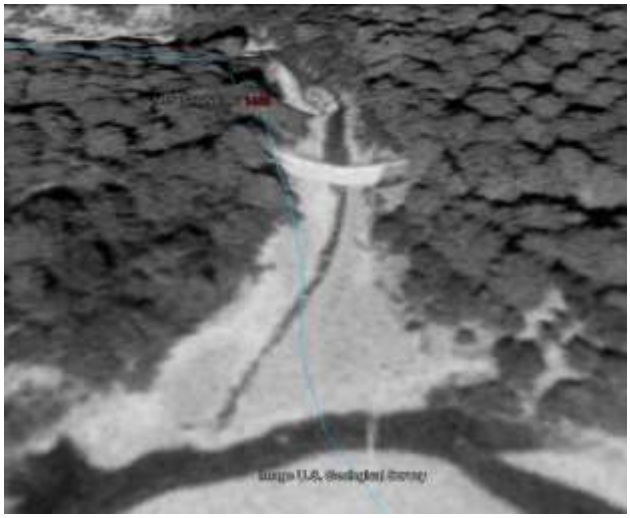


Figure 1. Grizzly at Van Duzen - August 1998.

Figure 2. Grizzly at Van Duzen - May 2006

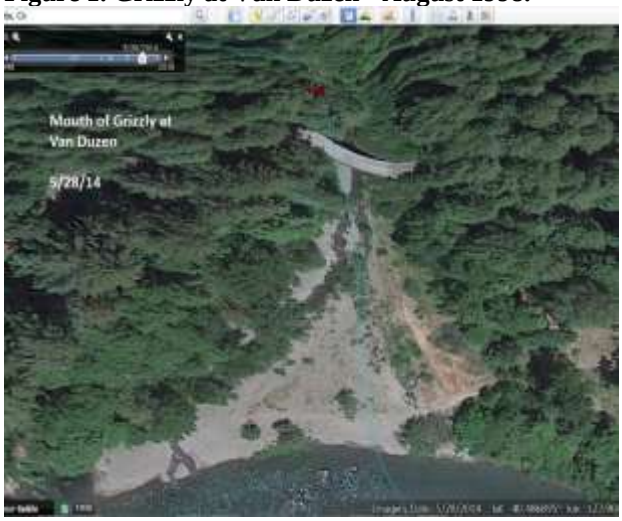


Figure 3. Grizzly at Van Duzen - May 2014

Figure 4. Grizzly at Van Duzen - May 2016

While high flows in the 2015 WY had causes some bed movement, major channel changes were evident towards the end of the 2016WY in July 2017. Figure 9 shows channel conditions in 2013 and Figure 10 is from 2017. Where Chamise Creek formerly had gravel bars with rocks less than the size of a golf ball, the winter flows flushed them downstream leaving a coarser stream bed and deeper pools and pockets for fish habitat. Figure 11 shows suspended alder tree roots indicating stream incision and Figure 12 is a cross section view of the cobble terrace that eroded during high flows in the 2016 WY. Where steelhead juveniles present before down-cutting were typically young of the year, yearling and older steelhead were present in 2017. A time-lapse camera placed on Chemise Creek shows flow flux and flow peaks that caused bedload movement (Figure 13 & 14).

Lower Sproul Creek: ERRP Volunteer Larry Bruckenstein maintains a timelapse camera and deploys water temperature gauges on Sproul Creek on his property, not far upstream of the convergence with the South Fork Eel River. Timelapse camera images show low (Figure 15) and high flows (Figure 16). Figures 17 and 18 show Sproul Creek before scouring flows in the 2016 WY. The increased depth and complexity improved steelhead rearing habitat (Figure 19)

Figure 5. Delta at the mouth of Grizzly Creek 6-10 feet high. July 2003.

Figure 6. Grizzly Creek looking upstream from the mouth with Highway 36 Bridge for reference. Terraces and small D50 of material in transport indicate high annual bedload mobility and scour and fill that would kill salmon eggs. July 2003.

Figure 7. Spawning Chinook salmon in Grizzly Creek. 12/2/2016. Screen grab from Sal Steinberg video: https://vimeo.com/196968491

Figure 8. Grizzly Creek channel at same location as 2016 spawning, but bed had changed dramatically, including an increase in fine sediment and a decrease in optimal Chinook spawning substrate. 12/2/2017.

Figure 9. Pool on Chamise Creek in August 2014. Note how small inlet is at top.

Figure 10. Chamise Creek pool scoured deeper and inlet broadened and down cut. July 2017.

Figure 11. Chamise Creek scour evident from hanging alder roots with channel deep enough to hold older age steelhead. July 2017.

Figure 12. Cross section of cobble terrace in place since 1964 and more than 2 feet of incision in 2016 WY.

Figure 13. Low flows in early December 2016.

Figure 14. Chamise – January 8, 2017.

Tenmile Creek.at Black Oak Ranch: ERRP found substantial numbers of spawning fall Chinook in Tenmile Creek in November 2016 and video documented spawning on the Black Oak Ranch not far downstream of Streeter Creek (Figure 20). The ideal spawning conditions were in a pool tail crest just above where the channel of Tenmile Creek flowed into a channel on the eastern bank (Figure 21) that had been in part created by a previous bioengineering project.

Figure 15. Sproul at Bruckenstein's – October 2015.

Figure 16. Sproul Cr. at Bruckenstein's, July 2017.

Figure 17. Sproul at Bruckenstein's – 9/28/16

Figure 18. Sproul at Bruckenstein's – 1/10/17

Figure 19. Several age classes of steelhead feeding in rejuvenated Sproul Creek habitat. 7/23/17.

Figure 20. Spawning fall Chinook in Tenmile Creek at Black Oak Ranch. 11/16/16.

Sometime during high flows in the 2016 WY, a whole tree with its root ball facing upstream lodged below the spawning area, created scour, and caused the channel to braid (Figure 22). This likely also caused bedload shift of sufficient magnitude to cause egg and alevin mortality.

Middle Fork Eel Below Williams Creek: ERRP monitors the Middle Fork Eel just downstream of Williams Creek with the Round Valley Indian Tribes Environmental Protection Agency for both temperature and cyanotoxins. The MF Eel has recovered substantially from past flood effects and there are indications that salmon spawning substrate conditions are ideal throughout most of the watershed, including tributaries Williams and Murphy Creek and the Black Butte River (Higgins 2013, 2014, 2016, 2017). These channels are widely used by Chinook salmon depending on the available flow, but aerial photos of the MF Eel below Williams Creek show considerable shift in channel location from 2005 to 2017 (Figures 23-26). Channel migration in some years likely entails scour and fill processes that dislodge eggs and alevin and cause decreased survival in years of high flow.

Stream Flow in 2016 WY and Salmon Egg and Alevin Survival

There are a number of factors that have bearing on the strength of a year class or brood arising from annual Chinook salmon spawning in the Eel River. High flow years that are not major floods causing elevated erosion are considered generally better for salmon survival based on the assumption that fish are able to distribute themselves throughout the Eel River watershed. Headwater areas are often more intact and less subject to wide flow fluctuations caused by cumulative effects. Also, fish often seem to select against spawning in lower river locations, possibly driven by instinct, which may limit egg and alevin mortality. However, there was a significant incidence of bedload movement at at least two locations where Chinook salmon are known to have spawned that likely shifted and caused egg mortality. Bed movement and channel migration in the Middle Fork Eel River in the 2016 WY would have been sufficient to cause egg mortality, but it is unknown if Chinook salmon spawned there in the 2016-2017 brood year. Eel River flow at Scotia (Figure 27) January 10 and February 10 flows over 200,000 cubic feet per second (cfs) that would have been periods of bedload mobility. Chinook salmon eggs take about 30 days to hatch and another 30 days before alevin emerge as fry. Eel River Chinook spawning begins about November 7 and can extend through January or later in drought years.

Figure 21. Tenmile Creek at Black Oak Ranch Chinook salmon spawning area. 11/16/16.

Figure 22. Tenmile Creek at Black Oak Ranch with new side channel below spawning beds. 11/27/17.

Figure 23 . MF Eel below Williams Cr. August 2005

Figure 24 . MF Eel below Williams Cr. April 2010.

Figure 25 . MF Eel below Williams Cr. May 2014.

Figure 26 . MF Eel below Williams Cr. May 2014.

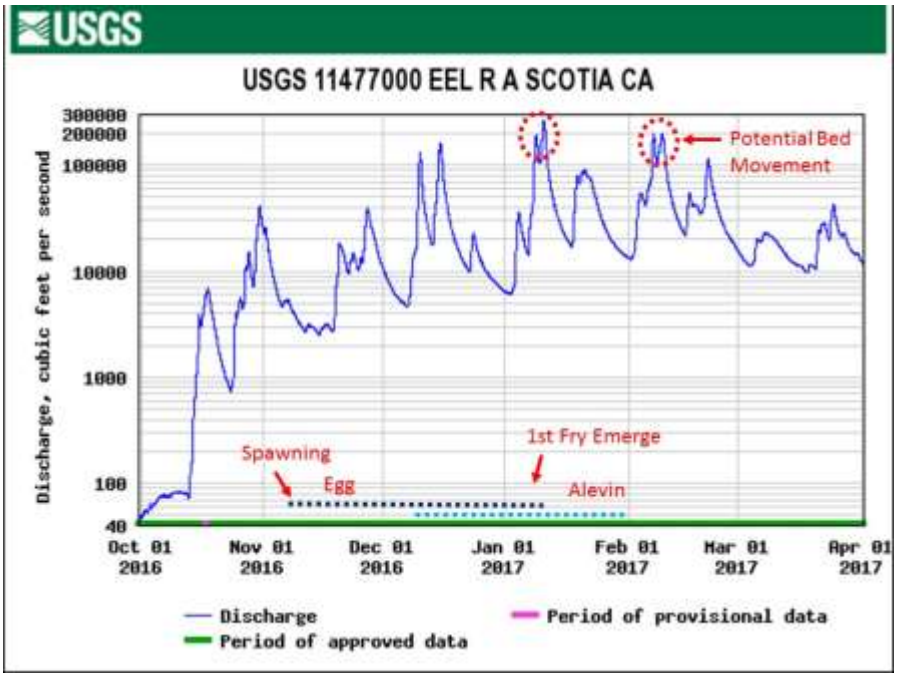


Figure 27. USGS flow data from Scotia gauge with spawning and emergence timing.

Figure 28 shows the flow of the Van Duzen River at Bridgeville during the winter of WY 2016 and has the same timing of flow peaks as the main Eel at Scotia, with the January 10 peak slightly greater than February 10. Although there is high local variability of the intensity of rainfall, if the Bridgeville gauge is indicative of Grizzly Creek flow peaks, then bedload may have occurred then, resulting in high egg mortality in the reach just above the convergence with the Van Duzen River. However, spawning higher in the watershed also occurred and Chinook eggs and alevin likely survived at upstream locations.

The flow of the Middle Fork Eel River at Dos Rios (Figure 29) indicates the timing of flow peaks were also around January 10 and February 10 with the first also slightly larger. Therefore, the January 10 event would likely have caused scour and fill at location below Williams Creek. Again, Chinook were know to have spawned widely in the Black Butte River and in Williams and Murphy creeks. Consequently, even if main river channels shifted, tributaries likely had good egg and alevin survival.

The Cahto Creek USGS gauge results (Figure 30) are useful for understanding potential scour of Tenmile Creek at the Black Oak Ranch, as Cahto is one of Tenmile's major tributaries. Flow peaks of 1360 cfs (12/10/16), 1370 cfs (1/10/17) and another of 1360 (2/7/17) all could have been associated with bedload movement and two of those peaks were during the incubation period; therefore, bed shift at Black Oak Ranch likely caused egg/alevin mortality.

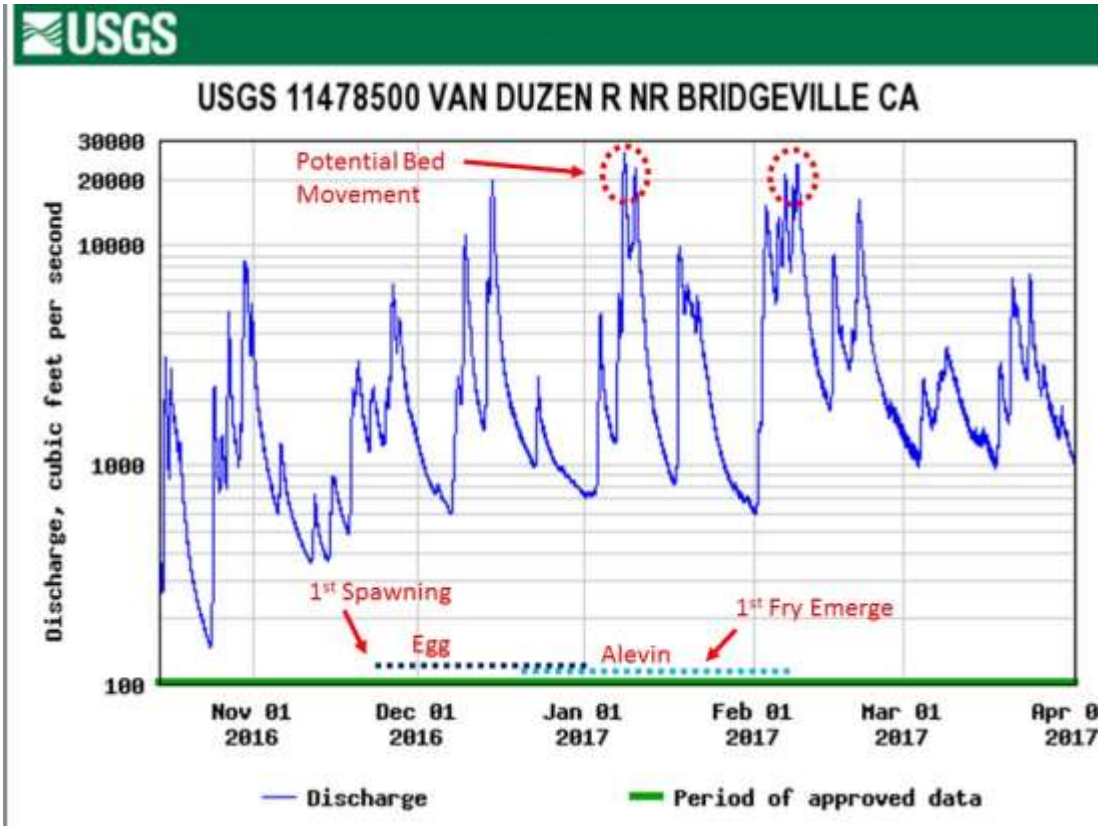


Figure 28. USGS Van Duzen flow data from Bridgeville gauge with spawning and emergence timing.

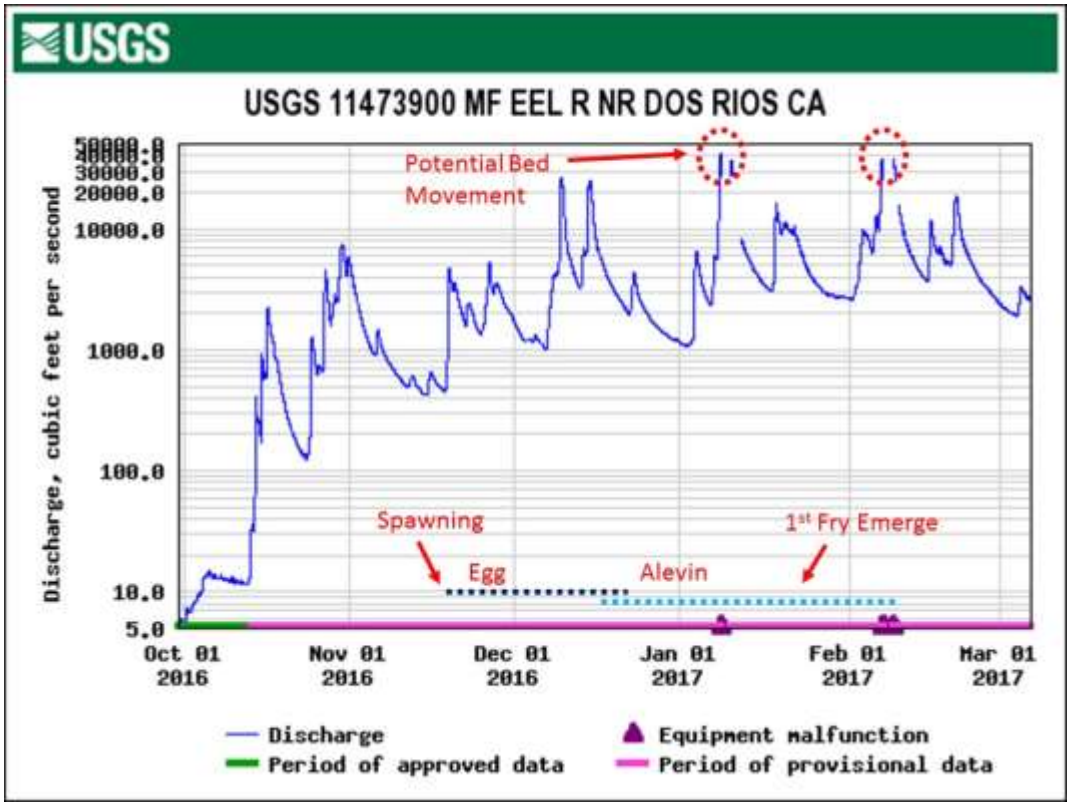


Figure 29. USGS MF Eel flow at Dos Rios with Chinook salmon spawning information annotated.

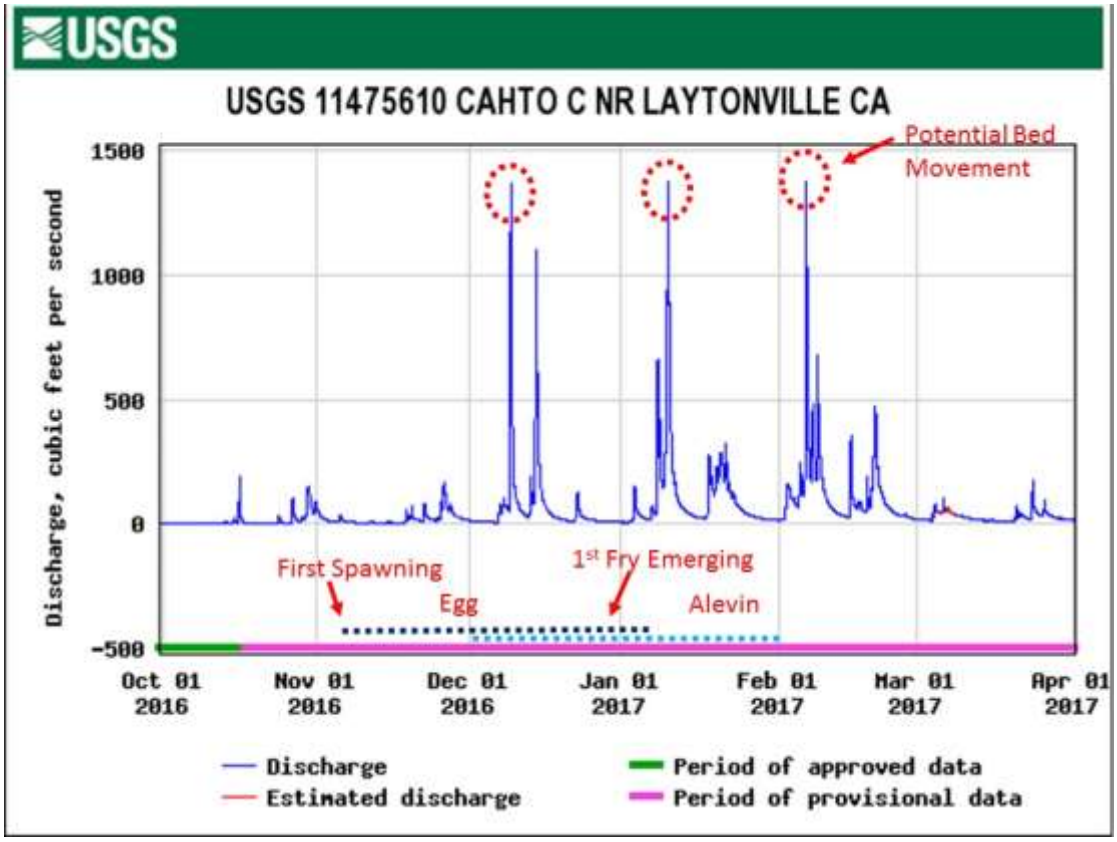


Figure 32. USGS Bull Creek flow with Chinook salmon spawning information annotate.

Elder Creek is just to the west of the Tenmile Creek basin and, its flow regime from October 2016 to April 2017 (Figure 31) is interesting from two perspectives. Flow peaks are much more dampened than in Cahto Creek, which is likely due to cumulative effects in the Cahto Creek watershed causing increased peak flows. Also, the flow peak on January 10 would be earlier than steelhead spawning and Elder Creek is too steep for steelhead spawning. Therefore, there is no indication of problems for steelhead egg and alevin survival in the 20016 WY.

Bull Creek is of special interest to ERRP because of surveys conducted there by ERRP Fall Chinook Coordinator Eric Stockwell. Spawn timing versus USGS flow gauge results (Figure 32) show that early spawners may have had success. The biggest flow peak, likely associated with bedload movement was in early February, more than 60 days after spawning in Bull Creek began.

Conclusion

Moderate flood flows (in the range of 25-35 year flood recurrence interval) can cause beneficial channel channel scour and rejuvenation of steelhead rearing habitat, as noted above in Sproul and Chamise Creek. Sustained high flows can also cause scour of redds and mortality of eggs and alevin. Changes in watershed hydrology can exacerbate flood peaks, increase bed shear stress and mobility and elevated mortality of Chinook eggs and alevin. Every year is a crap shoot on an evolutionary time scale, with bumper years of Chinook production punctuated by major floods that wash out redds over a widespread geographic area. In watersheds like Salmon Creek and Tomki Creek, increased flood peaks in combination with increased sediment yield have changed these streams from sources of Chinook salmon juveniles to sinks where spawning is not successful (Higgins 2017).

Watershed development that can cause increased peak flows include:

- High road densities
- Compacted areas due to logging, vineyards or other development
- Increased total impervious areas, such as in cities

The 2016 WY may have produced a brood that was less strong than anticipated because of egg mortality at some locations. This is not conclusive, however, because density related effects where fewer survivors from reaches where beds did not shift have less competition for food on their downstream migration and in the estuary.

Bedload movement and spawning success can be measured using scour chains, similar to methods described by Nawa and Frissell (1993). The periodicity of mortality associated with bed mobility in Eel River tributaries needs more exploration.

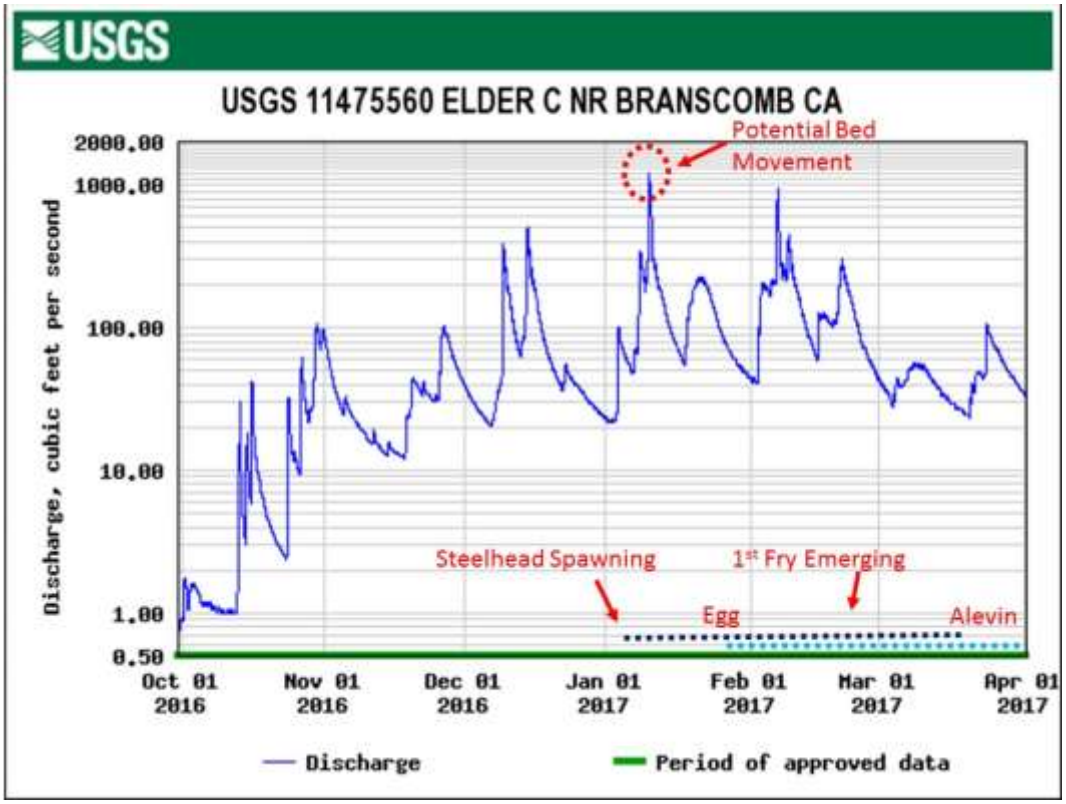


Figure 31. Elder Creek USSGS flow data with steelhead spawning information annotated.

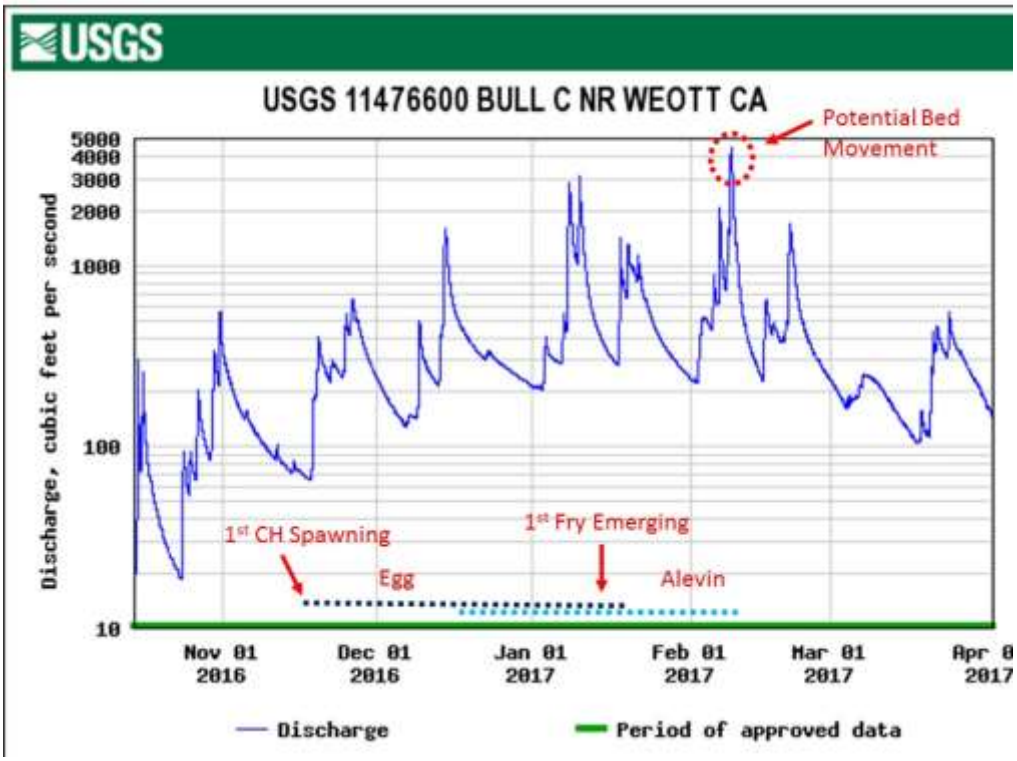


Figure 30. USGS Cahto Creek flow with Chinook salmon spawning information annotate.

References

Higgins, P.T. 2008. Comments on Van Duzen River and Yager Creek Sediment TMDL with Notes on Need for Implementation Action and Monitoring. Performed for Friends of Van Duzen River for SWRCB 319h grant by Patrick Higgins, Consulting Fisheries Biologist, Arcata, CA. 43 p.

Higgins, P.T. 2013. Final Report: 2012 Lower Eel River Volunteer Fall Chinook Dive Census. Published January 31, 2013. Performed under contract to the Trees Foundation for the Eel River Recovery Project with funding from Patagonia and Rose Foundation. ERRP, Arcata, CA. 37 p. http://www.eelriverrecovery.org/doc/ERRP_Higgins_Chinook_Dives_2012_Final.pdf

Higgins, P.T. 2014. Final Report- Eel River Recovery Project Eel River Basin 2013-2014 Fall Chinook Salmon Monitoring. Performed under contract to the Trees Foundation for the Eel River Recovery Project with funding from Patagonia and the Salmon Restoration Association, and the Humboldt and Mendocino Redwood Companies. ERRP, Arcata, CA. 43 p.

Higgins, P.T. 2015. Eel River Recovery Project Fall Chinook Salmon 2014-2015 Citizen Monitoring. Performed under contract to the Trees Foundation for the Eel River Recovery Project with funding from Patagonia, the Salmon Restoration Association, and the Humboldt and Mendocino Redwood Companies. ERRP, Arcata, CA. 25 p.

Higgins, P.T. 2017. Eel River Recovery Project Final Report: Citizen Assisted 2016-2017 Fall Chinook Salmon Assessment. Performed under contract to the ERRP with funding from Patagonia and the Salmon Restoration Association. ERRP, Loleta, CA. 30 p.

Knopp, C. 1993. Testing Indices of Cold Water Fish Habitat. Final Report for Development of Techniques for Measuring Beneficial Use Protection and Inclusion into the North Coast Region's Basin Plan by Amendment of September 18, 1990. North Coast Regional Water Quality Control Board in cooperation with California Department of Forestry. 57 pp.

Nawa, R. K. and C. A. Frissell. 1993. Measuring scour and fill of gravel streambeds with scour chains and sliding-bead monitors. North American Journal of Fisheries Management 13(3):634-639.