SOUTH FORK SCOTT RIVER

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Preliminary Assessment of Bouvier Ranch for Coho Recovery

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South Fork Scott River

PRELIMINARY ASSESSMENT OF BOUVIER RANCH FOR COHO RECOVERY

INTRODUCTION

Private land conservation is increasingly recognized as the conservation approach with the highest potential for long-term species recovery and sustainability (Kamal et al. 2015). Private agricultural lands, defined as land or water held under private deed or title, comprise around 52% of all land in the United States; however, less than 1% has been placed in conservation easements (Kamal et al. 2015). As each private holding varies in size, location, and use, no common solution makes each holding a conservation success. Rather, the unique features of private property must be understood before its role in a broader conservation strategy can be identified.

Bouvier Ranch is a 1,596 acre private property located in the headwaters of the Scott River, Siskiyou County, northern California (Figure 1). Though privately owned, the property has been identified as a potentially valuable location that may support the broader recovery of Southern Oregon-Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*), which are listed as threatened under the federal and California Endangered Species Acts. In addition, the property supports a modest cattle grazing operation, as well as timber production. Finally, it is also the first location where water is diverted from the South Fork Scott.

Though land use and conservation are often presented as dueling objectives, multiple examples illustrate the potential for successful, co-equal management. In the Scott Valley, water rights holders have participated in California's only water trust program to balance summer irrigation activities with instream flow management for oversummering cold-water habitat (SRWT 2016). Flood irrigation of fields to capture winter flows has demonstrated how high-value agriculture and groundwater recharge can similarly be accomplished (Dahlke et al. 2018). In the Shasta Valley, successful applications to add environmental objectives as beneficial uses for private water rights, as well as the first Safe Harbor Agreement with a private landowner to provide regulatory protection against take under the Endangered Species Act, illustrates how conservation on agricultural lands can also include vital regulatory support and assurances for working ranches. However, the success of each of these efforts is defined not only by their existence, but by the conservation outcomes of each project. Such outcomes can only be achieved with a detailed understanding of how each property participates in the broader social and environmental ecosystem in each watershed.

The goal of this project is to identify the potential role Bouvier Ranch might play in a broader conservation strategy in the Scott Valley to support the recovery and management of coho salmon. It includes a preliminary assessment of streamflow and water temperature conditions on the ranch. The results of this project suggest that Bouvier Ranch identifies the upper boundary of where conservation activities may be effective to directly support coho by providing oversummering or overwintering habitat, but potentially plays a larger role by indirectly supporting desirable physical habitat conditions downstream of the ranch. However, additional data was gathered by the Siskiyou Resource Conservation District after the implementation of chop-and-drop instream habitat construction in Fall 2017. The results of those preliminary data suggests that the property can be modified to play a more direct role in coho recovery (Magranet 2018).

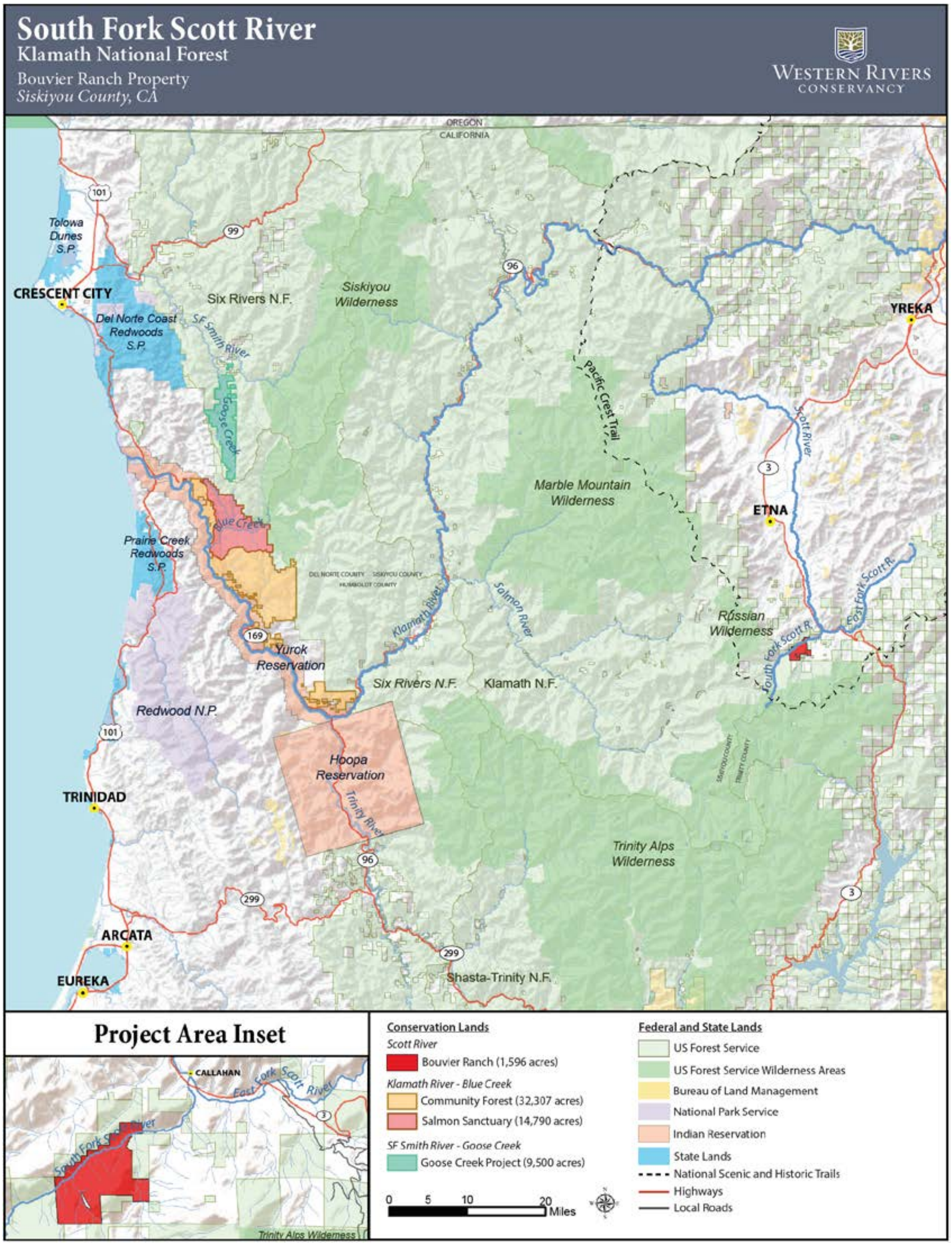

Figure 1. A map of the project area and its location in northern California. Source: Western Rivers Conservancy

PROJECT CONTEXT

Before presenting the methods and results of this preliminary assessment, important factors that define the context of this study are identified. First, data collection began during the end of the 2017 water year (October 1, 2016 through September 30, 2017), which ended as the wettest year on record in California. Thus, this data provides a snapshot of the highest potential for late-summer streamflow and water temperature conditions to date; in other words, an upper bound of what can be expected for ecological function. Second, while streamflow and water temperature conditions are important physical elements that define the potential for a robust ecosystem, chemical and biological elements such as nutrients, primary productivity, and food production similarly define whether that potential is enhanced or limited. This project focused primarily on streamflow and water temperature. Finally, data was collected during a season when water diversions and land use continued under a "business as usual" scenario. This provided an opportunity to explore instream physical habitat conditions given land use activities, an important part of any working landscape conservation assessment.

METHODS

A monitoring program was implemented on the 4.3 kilometers of the South Fork Scott River between river kilometers 3.5 and 7.8, which includes the confluences of Blue Jay Creek (rkm 7.7), Fox Creek (rkm 6.9), and a short stream reach downstream of the confluence with Boulder Creek (rkm 3.8) (Figure 2). Three monitoring sites were established to assess three locations:

- the upstream property boundary with Klamath National Forest (site KNF at rkm 7.8),
- a mid-property location that was downstream of both diversions, Blue Jay Creek, and Fox Creek (site BVR at rkm 5.1), and
- the downstream property boundary, shared with another private landowner (site DSB at rkm 3.5).

All sites were visited monthly from July 2017 through February 2018. The techniques and equipment used for streamflow and water temperature monitoring are detailed below.

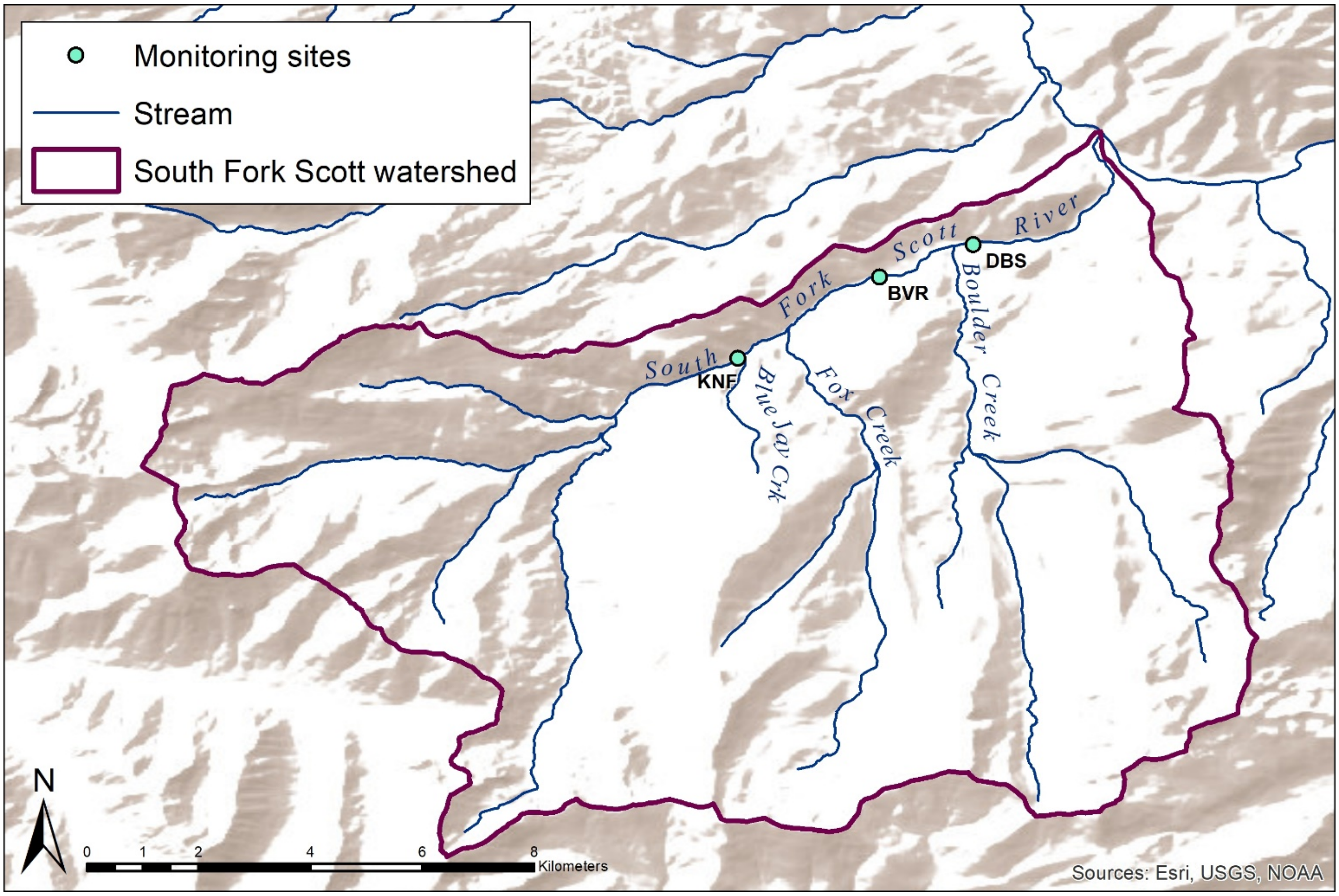

Figure 2. A map of the South Fork Scott River watershed, including monitoring sites.

Streamflow

Streamflow (also called discharge) was calculated using depth and velocity data collected at KNF and BVR. Bedrock and divided channel geometry prevented an accurate assessment of streamflow at DBS. At each site, a Solinst Levelogger pressure transducer was deployed in a stilling well, made from 1.5-in PVC mounted on a T-post that was driven into the streambed. Solinst Leveloggers have an accuracy of 0.3 cm over a depth range of 0-5 m, and were programmed to record river depth (stage) at 30-minute intervals. Because stage is measured as a function of pressure, and submerged Leveloggers are affected by both ambient water and air pressure, barometric data was collected using a Solinst Barologger to compensate for the effects of air pressure on the data series recorded by the Leveloggers. Solinst Barologgers have an accuracy of 0.3 cm over a range of 0-5m.

Periodic discharge measurements were performed across the range of observed streamflows at each monitoring site following standard measurement and computational methods (Rantz 1982). River stage-discharge relationships were quantified using standard rating methodologies (Rantz 1982), from which continuous streamflow time-series were generated. A rating curve was fit using a power function (i.e., non-linear regression), which generally replicates the physical relationship between depth and streamflow. The accuracy of the rating curve was statistically evaluated using the coefficient of determination, also called the R-squared (R^2) value. R^2 values range between zero and 1; models that closely fit the data have R^2 values closer to 1. For streamflow rating curves, R^2 values greater than 0.8 are desirable. Measured river stages greater than those observed during periodic discharge measurements were assessed only for flow patterns, rather than magnitudes.

Water temperature

Water temperature was monitored at 30-minute intervals at all three sites. Solinst Leveloggers recorded water temperature concurrently with stage at KNF and BVR; a HOBO water temperature logger was used at DSB. Solinst Leveloggers have an accuracy of 0.5°C over the range -20°C to 80°C; HOBO Water Temperature loggers have an accuracy of 0.2°C over the range -40°C to 70°C.

Stream temperature data provided a snapshot of thermal conditions during late summer through midwinter. While this period does not provide a comprehensive assessment of annual stream temperature patterns, they do provide a snapshot of conditions during periods when the annual maximum and minimum water temperatures are typically observed for precipitation-driven streams. To put the data in context of thermal conditions for coho salmon, temperature guidelines for various lifestages were used: 10-17°C for oversummering juvenile coho (USEPA 2003), with a maximum weekly maximum temperature (MWMT) of 18.1°C and a maximum weekly average temperature (MWAT) of 16.8°C (Welsh et al. 2001). Though no published guidelines were found recommending overwintering temperatures, minimum overwintering water temperatures of 5°C were suggested as desirable thermal conditions (*R. Lusardi, pers. comm.*).

RESULTS

Streamflow

Streamflow was measured between a minimum of 8.5 ft^3/s and maximum of 24.9 ft^3/s at KNF (Figure 3), and 10.2 ft^3/s and 34.8 ft^3/s at BVR (Figure 4). Rating curves developed for KNF and BVR provided a strong relationship between streamflow and stage, with an R^2 value of 0.9851 at KNF and 0.9819 at BVR. Thus, calculated streamflows using the rating curves developed at each site are generally accurate assessments of actual streamflow.

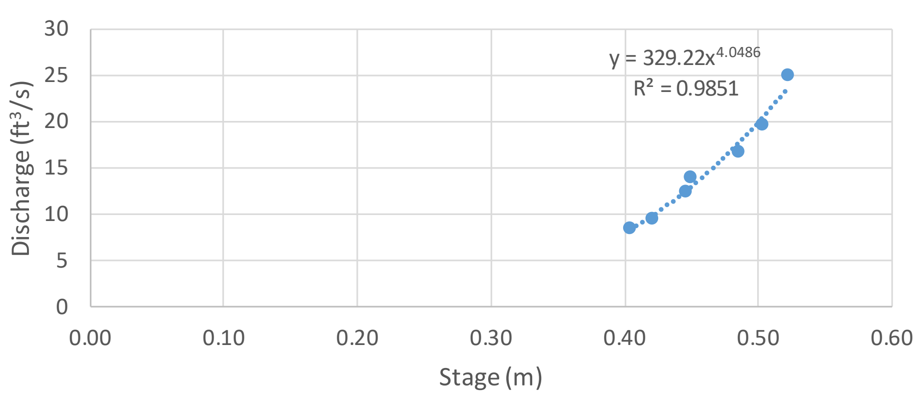

Figure 3. The stage-discharge rating curve for monitoring site KNF. The strong R-squared values indicates that the curve makes reasonable estimates of streamflow between the minimum and maximum measured points.

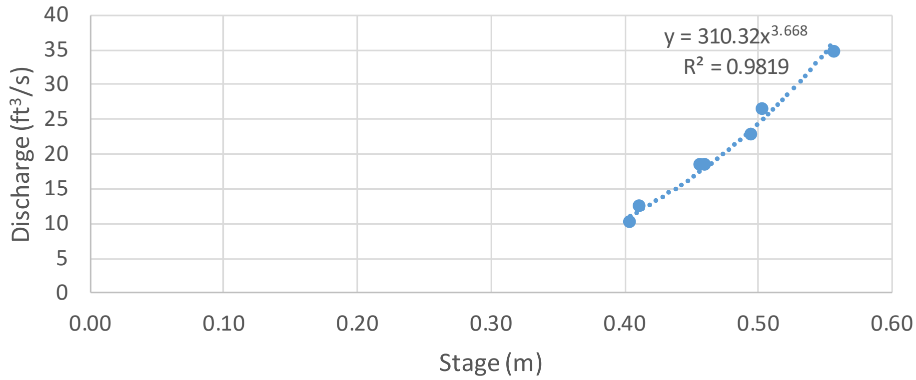

Figure 4. The stage-discharge rating curve for monitoring site BVR. The strong R-squared values indicates that the curve makes reasonable estimates of streamflow between the minimum and maximum measured points.

Streamflows gradually decreased from July through August, then remained relatively stable until precipitation events began in November. Baseflows during September and October were an average of 7.3 ft^3/s at KNF (Figure 5) and 8.9 ft^3/s at BVR (Figure 6). Because 2017 was the wettest water year on record, it's unclear how the time from snowmelt to baseflow, or the amount of baseflow, might change given drier conditions. Additional data collection during alternative water year types would improve understanding of the potential streamflow and habitat conditions.

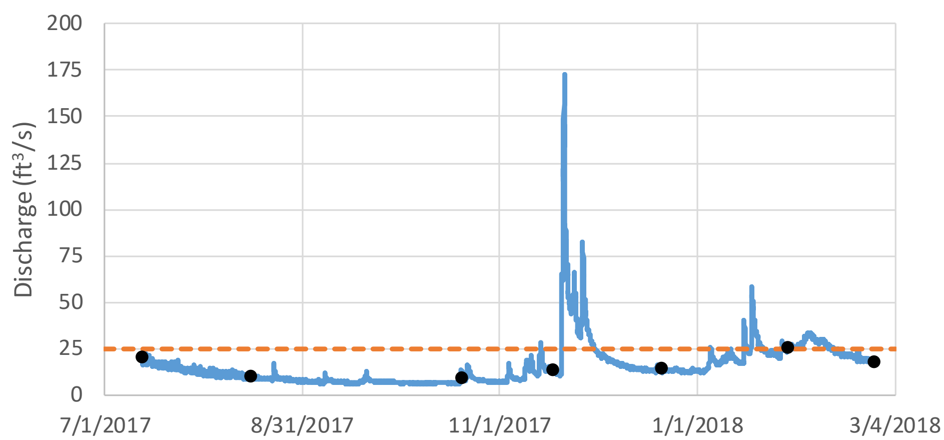

Figure 5. Calculated discharge at KNF. The dashed line shows the highest streamflow for which this site is rated. The black points show the sampling events.

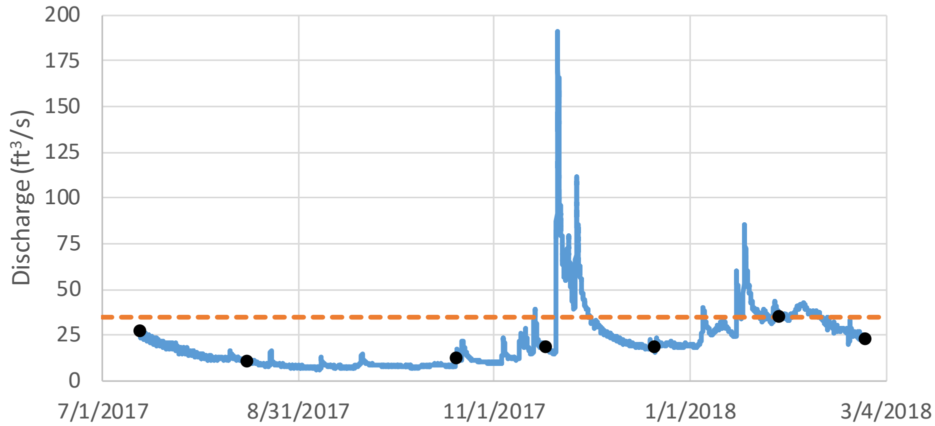

Figure 6. Calculated discharge at BVR. The dashed line shows the highest streamflow for which this site is rated. The black points show the sampling events.

A series of precipitation events in November 2017 provide some insight to hydrologic patterns in the South Fork Scott. On November 20, streamflows began to sharply increase until they peaked on November 21. Then, they generally declined until November 25, when they repeated a similar pattern and then tapered off to baseflow of approximately 12 ft^3/s at KNF and 18 ft^3/s at BVR. Though the magnitude of higher flows are beyond the flows covered by the rating curve, the shape of the hydrograph suggests that the South Fork Scott is a predominately rainfall-runoff and snowmelt stream. Thus, streamflow during any given year will be greatly influenced by winter precipitation, which will also influence seasonal patterns of water temperature, water quality, and available physical habitat. Additional data quantifying snowmelt runoff during the spring will indicate whether snowmelt or rainfall is the predominate source of flow for the South Fork Scott River.

Finally, the difference in discharge between KNF and BVR (i.e., Δ Discharge (ft^3/s) was calculated and examined for potential patterns. This method provides a coarse estimate of tributary and groundwater accretion between KNF and BVR. Because the calculated discharge was only meaningful within the range of measured discharge, calculated discharge that exceeded that range was not included in this part of the analysis.

The total difference in discharge between the two sites ranged from -3.7 ft^3/s to 13.4 ft^3/s (Figure 7). Negative difference indicate discharge was greater at KNF than BVR; positive values indicate discharge at BVR was greater than at KNF. The percent difference of discharge between the two sites as compared to total discharge at BVR was relatively steady at an average of 25%. During August, when minimal base flows are typically observed, the discharge difference between monitoring sites was negligible, suggesting that neither tributaries contributed much discharge to the South Fork Scott during this time.

At several points, more extreme differences are observed; however, these points tend to occur near the limits of the rating curve. These results likely indicate the limited range of the rating curve rather than extreme changes in streamflow. Similarly, tributary and base flow discharge contributions during the onset of snowmelt and seasonal discharge recession were not characterized during the study period. Additional data is needed to understand the seasonal and inter-annual differences in tributary and groundwater flows, as well as how they affect the South Fork Scott.

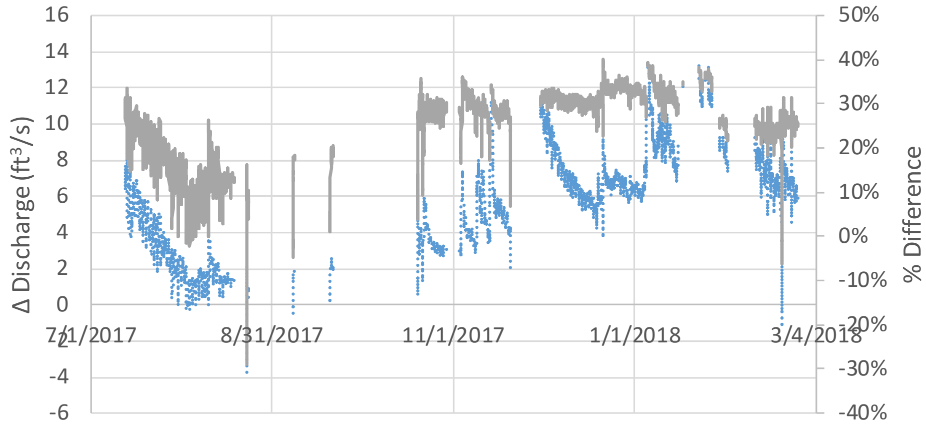

Figure 7. The difference in discharge between KNF and BVR (dotted blue line) and the percent difference in discharge between KNF and BVR (solid grey line).

Water temperature

An analysis of water temperatures at KNF show that thermal conditions met all guidelines for desirable oversummering habitat. Daily water temperatures from July through early September ranged between 11.6°C and 17.7°C (Figure 8), with a MWMT of 17.7°C and MWAT of 15.2°C (Table 1). By September 20, maximum water temperatures cooled below 14°C, but minimum water temperatures remained about 5°C until November 7. By November 29, maximum water temperatures cooled below 5°C and remained there throughout the rest of the study period (with the exception of several days in January). During late February and early March, water temperatures cooled below 1°C.

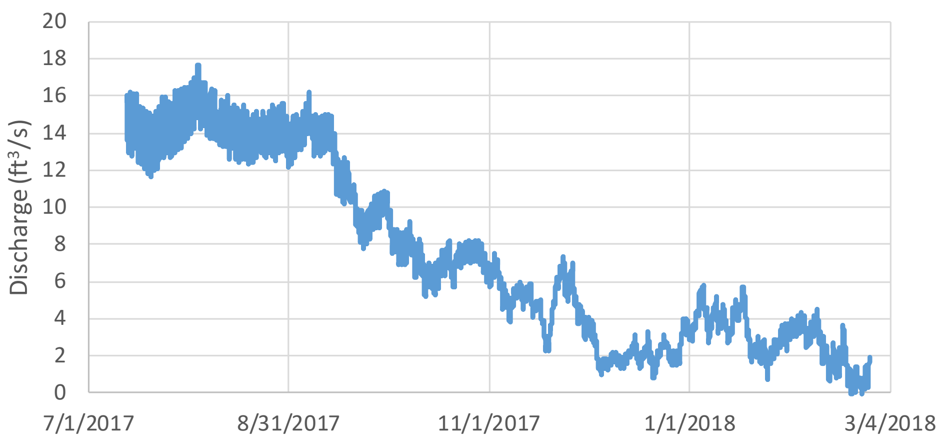

Figure 8. Measured water temperature at KNF. Recommended oversummering water temperatures for juvenile coho salmon are 10-17°C (USEPA 2003), with an MWMT ≤ 18.0°C and MWAT ≤ 16.8°C (Welsh et al. 2001).

Table 1. Maximum weekly maximum temperature (MWMT) and maximum weekly average temperature (MWAT) for each monitoring site. Recommended thresholds for juvenile coho salmon are MWMT ≤ 18.0°C and MWAT ≤ 16.8°C (Welsh et al. 2001).

Site	MWMT (°C)	MWAT (°C)
KNF	17.7	15.2
BVR	18.5	15.8
DSB	18.6	16.0

Water temperatures at BVR followed similar patterns to those observed at KNF, suggesting that while tributaries and groundwater accretion may contribute streamflow, they do not substantially alter water temperature trends. On average, water temperatures increased 0.4°C from KNF to BVR, a relatively modest change (Figure 9). A maximum water temperature of 18.5°C was measured on August 3, 2017; it was the only daily maximum water temperature that exceeded 18°C. During this period, the MWMT was 18.5°C and MWAT was 15.8°C. Water temperatures remained generally stable until September 15, when they gradually cooled until December 5 and subsequently remained below 5°C throughout the rest of the study period.

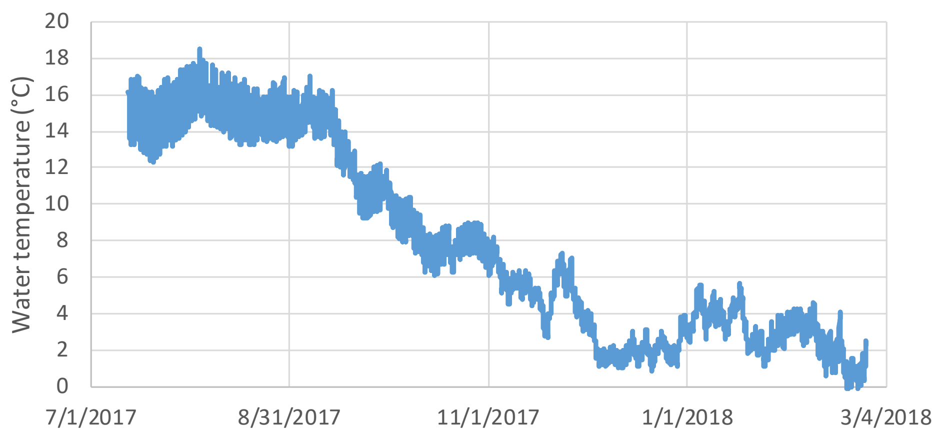

Figure 9. Measured water temperature at BVR. Recommended oversummering water temperatures for juvenile coho salmon are 12-14°C.

Water temperatures at the DSB followed similar patterns to those observed at both KNF and BVR; as with BVR, neither groundwater accretion nor tributary inflow (i.e., from Boulder Creek) appear to substantially alter water trends. On average, water temperatures increased 0.5°C from BVR to DSB (Figure 10), similar to the pattern observed between KNF and BVR. However, these warmer temperatures tended to occur as warmer average and minimum temperatures, while daily maximum water temperatures remained similar to those observed at BVR. A maximum water temperature of 18.6°C was observed on August 3, 2017; MWMT was 18.6°C and MWAT was16.0°C. Water temperatures generally remained stable until September 15, when they gradually cooled until December 5, after which they remained below 5°C. Due to high flow events, data collection at this site ended on December 21.

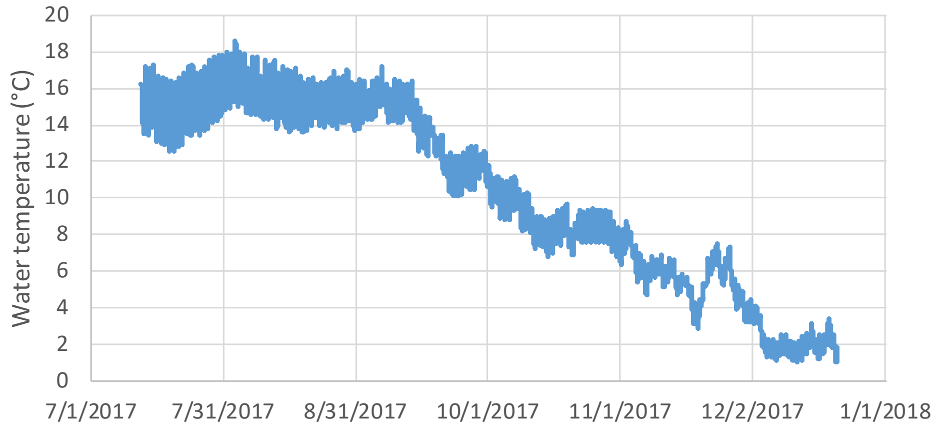

Figure 10. Measured water temperature at DSB. Recommended oversummering water temperatures for juvenile coho salmon are 12-14°C.

CONCLUSIONS AND RECOMMENDATIONS

Preliminary streamflow and water temperature monitoring on the South Fork Scott River suggest that Bouvier Ranch is the upper limit for various life stages of coho salmon. While summer water temperatures fall within the range of desirable rearing conditions, winter temperatures at the upstream boundary of the property barely exceeded freezing for extended periods. Food resources are an important component that help determine how juvenile coho can respond to water temperature conditions outside of the recommended ranges provided in the literature during the summer, but are not important during winter (Welsh et al. 2001, *R. Lusardi, pers. comm.*).

Following the data collection completed for this assessment, snorkel surveys were performed by the Siskiyou Resource Conservation District (SRCD) to evaluate the presence or absence of juvenile coho in a reach below site BVR, and compared those results to observations made at a control site. At the treatment site, "chop-and-drop" habitat construction was completed to promote channel complexity, including pools that included large woody debris (LWD). Field notes show that 312 juvenile coho were present in schools of 25-100 fish in and just downstream of the treatment area, but not at the control site (Magranet 2018). Though no pre-treatment data is available to indicate potential presence/absence prior to treatment, the similar water temperatures observed at BVR and DSB suggest that conservation activities may increase Bouvier Ranch's direct value to coho. Without such activities, Bouvier Ranch may have played a more indirect benefit to coho by providing a source of high quality streamflow and water temperature to downstream reaches with a more desirable combination of physical, chemical, and biological habitat conditions. However, without pre-treatment data, such conclusions are speculations, at best.

The data provided by the SRCD show that Bouvier Ranch currently possesses actively utilized oversummering habitat. Because observed water temperatures are near recommended thresholds for juvenile coho, additional sampling of water quality and macroinvertebrates are recommended to determine whether Bouvier Ranch also possessed the chemical and biological resources to support juvenile growth, particularly given the extreme winter temperatures. Finally, because this study coincided with a relatively wet year, additional monitoring is recommended to characterize physical, chemical, and biological conditions during drier water years to better characterize the limits of Bouvier Ranch's potential to support broader coho recovery and management strategies in the Scott Valley.

In summary, recommended future actions include:

1. Install a permanent streamflow and monitoring station to better characterize actively utilized habitat conditions. Temperature data will provide local, empirically relevant habitat criteria. Streamflow time series data will help identify periods when low flows may be augmented by limiting upstream diversions, as well as guide actions related to winter high flow management, when off-channel refugia may be desirable.

2. Analyze water quality and macroinvertebrate production of the study reach to determine whether sufficient food resources are produced to promote growth of oversummering juvenile coho.

3. Identify physical barriers to upstream passage and habitat types that are present downstream of those barriers to determine the spatial extent of existing or potential habitat.

4. Continue pre-treatment snorkel surveys of reaches where additional channel construction is planned. Such data will allow for a clearer determination of whether habitat in pretreated reaches is being utilized, and thus augmented by conservation activities, or converted from non-use to actively used, new habitat. These findings would help inform how the South Fork Scott fits into the broader conservation response occurring throughout the Scott Valley.

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