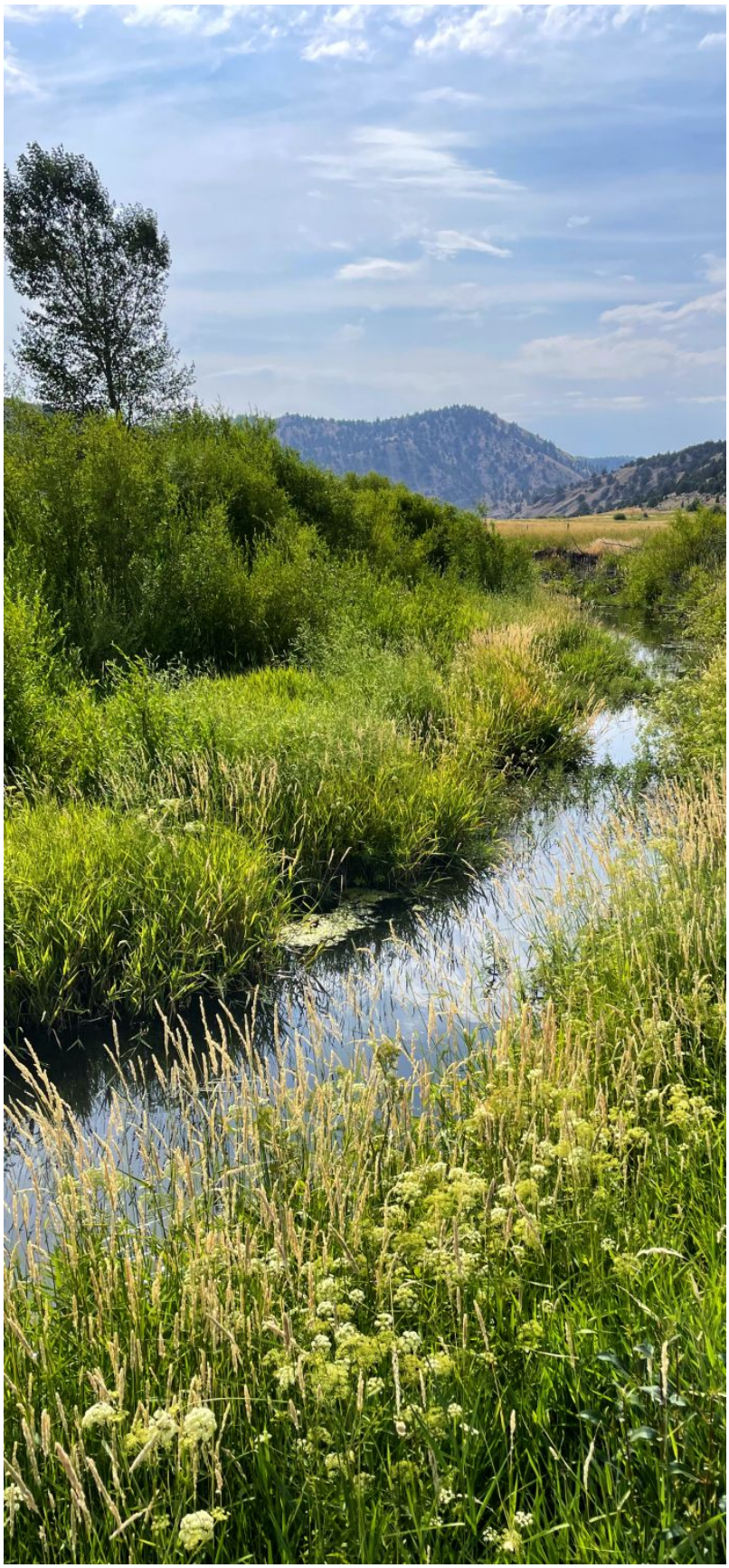
2022 BIOASSESSMENT OF THE SOUTH FORK JOHN DAY RIVER



FINAL REPORT

PREPARED FOR

SOUTH FORK JOHN DAY RIVER WATERSHED COUNCIL

BY
MICHAEL B. COLE
&
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COLE ECOLOGICAL, INC.

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EXECUTIVE SUMMARY

In 2000, the Grant Soil and Water Conservation District initiated a riparian, instream habitat, and biological monitoring program in the upper South Fork of the John Day River to evaluate the effects of instream and riparian restoration efforts. Monitoring occurred in 2000, 2001, 2002, 2004, and 2006. Through funding from the Oregon Watershed Enhancement Board, the South Fork John Day Watershed Council implemented a Rapid Riparian Re-vegetation (R3) effort in 2017 to promote re-establishment of natural riparian conditions by planting over 2,500 hard wood plants per acre and along both sides of four miles of the river on the St. Clair and Keerins' ranches. Complimenting this project was the installation of beaver-dam analogues that are intended to slow channel incision and re-connect the floodplain in order to provide water to the riparian plantings. The objective of this restoration project was to address reasons the South Fork John Day River has been listed on the 303d list: reduce stream temperature, improve the biological integrity and increase dissolved oxygen. Riparian, instream habitat and biological monitoring occurred in the project area in 2017 immediately prior to implementation of the R3 project.

With the support of an ORDEQ 319 grant, another bioassessment round was performed in 2022 in five reaches within the restoration project area to evaluate the effects of the R3 project to date on the ecology and habitat in the upper South Fork of the John Day River. Instream habitat conditions were generally similar to those measured in 2017, with some habitat conditions shifting modestly in the five-year period. Instream habitat within the project area is dominated by glide and pool habitat and fine sediments. Modest increases in water depths were measured in the three St. Clair project reaches, potentially as a result of the beaver analog installations. As in prior sampling years, riparian habitat in the three St. Clair monitoring reaches continues to be largely dominated by herbaceous ground cover that extends marginally into the understory layer. Conditions are generally similar to those measured in 2017, with a very heavy and uniform dominance of reed canary grass as ground cover. The three St. Clair monitoring reaches presently support modest levels of willow cover in the understory layer.

Macroinvertebrate communities sampled in the project area in 2022 continue to show uniformly degraded conditions. After more than twenty years of monitoring macroinvertebrate communities in this section of the upper South Fork of the John Day River, these conditions remain unchanged. Moving forward, monitoring should focus on the river's thermal regime, riparian conditions and river-floodplain connectivity. Until measurable changes in these attributes occur that would be expected to benefit macroinvertebrate communities, macroinvertebrate monitoring will in all likelihood continue to produce the same results as it has for the past two decades. Accordingly, these macroinvertebrate community data that now span over twenty years represent a comprehensive baseline against which future change can be evaluated once improved physical conditions suggest that biological change should be expected.

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ACKNOWLEDGEMENTS

This work was made possible through a 319 grant from the Oregon Department of Environmental Quality. Thank you to Amy Stiner of South Fork John Day River Watershed Council for securing and administering this grant. Field work occurred exclusively on the St. Clair and Izee ranches with the permission of the landowners. Chris Burtch of Cole Ecological, Inc. led field sampling efforts with assistance from Amy Stiner and Hannah Latzo of the South Fork John Day Watershed Council. Macroinvertebrate samples were processed by Cole Ecological, Inc. biologist Chris Burtch and identified by Society for Freshwater Science-certified taxonomists Michael Cole and Ann Gregoire.

INTRODUCTION

Monitoring of instream and riparian conditions in the upper South Fork John Day River occurred between the mid 1990s and mid 2000s in association with instream and riparian enhancement projects voluntarily implemented by landowners with technical assistance from the Grant Soil & Water Conservation District (SWCD). Early monitoring efforts in the 1990s were performed on a limited and largely volunteer basis. In 2000, the Grant SWCD initiated an instream habitat and biomonitoring program in eleven stream and river reaches throughout the watershed. This program was intended to evaluate the effects of instream and riparian restoration efforts on the St. Clair and Izee ranches. In 2004 and 2006 the monitoring program was expanded to include seven additional instream monitoring reaches, and upland vegetation monitoring was included in 2004 to examine the effects of juniper removal and noxious weed control efforts (Cole et al. 2005, Lemke and Cole 2006). Until 2017, no instream assessment or monitoring work had occurred in the upper South Fork since 2006.

Through funding from the Oregon Watershed Enhancement Board (OWEB), the South Fork John Day Watershed Council (SFJDWC) implemented a Rapid Riparian Re-vegetation (R3) effort in 2017. The R3 technique is intended to re-establish natural riparian conditions by planting over 2,500 hard wood plants per acre and along both sides of four miles of river. Complimenting this project was the installation of beaver-dam analogues that are intended to slow channel incision and re-connect the floodplain in order to provide water to the riparian plantings. The objective of this restoration project was to address reasons the South Fork John Day has been listed on the 303d list: reduce stream temperature, improve the biological integrity and increase dissolved oxygen.

Through support from the Western Native Trout Initiative, the SFJDWC was able to install temperature loggers to measure the effect of the project on instream temperatures. Through support from the Charlotte Martin Foundation, the original bioassessment performed from the 1990's until 2006 was repeated in 2017, immediately prior to R3 project implementation (Cole and Burtch 2017). The 2017 assessment occurred in three previously assessed reaches on the St. Clair ranch, where the revegetation project has since occurred.

As of summer 2022, nearly five years had passed since the R3 project was implemented in late summer 2017. With the support of an ORDEQ 319 grant, another bioassessment round was performed in five reaches within the restoration project area to evaluate the effects of the R3 project to date on the ecology and habitat in the upper South Fork of the John Day River. The results of the 2022 bioassessment were compared to those from the 2001, 2004, 2006, and 2017 monitoring efforts in order to make interferences about changes since in the implementation of the R3 project. The collection of these data is essential to assist with assessing the utility of these restoration techniques in eastern Oregon. These data will support evaluation of the effectiveness of this new technique and provide a solid foundation for assessing the continuation or cessation of this approach in the watershed and potentially elsewhere. This report documents the methods used in the 2022 bioassessment, reports on the results of this effort, and compares the results with those from previous years (prior to R3 project implementation). From these comparative results, this report describes the current ecological and habitat conditions in this section of the upper South Fork of the John Day River and evaluates the effects of the R3 project on this section of the river to date.

STUDY AREA

The South Fork of the John Day River flows for 55 miles north through Grant County, Oregon, before emptying into the mainstem of the John Day River at Dayville. Small portions of the watershed extend into Wheeler County to the west, and the headwaters originate as far south as northern Harney County. The subbasin encompasses 389,600 acres, almost half of which occur within the Ochoco and Malheur National Forests. The dominant land uses within the subbasin are grazed forestland (216,200 acres) and range/pastureland (163,800 acres). Approximately 20% of the subbasin is privately owned; most private ownership occurs in the valley bottoms and foothills of the upper portion of the subbasin above the Izee Falls at river mile 28. The five assessment sites included in this study occur within the four-mile project area on the St. Clair and Izee ranches beginning at approximately river mile 38 in Izee, Oregon. The three sites along two miles of the project area on the St. Clair ranch have each been previously assessed at least four difference years between 2000 and 2017. The two reaches on the Izee ranch were sampled for the first time in 2022. All five sample reaches occur within the 4-mile R3 project along the river.

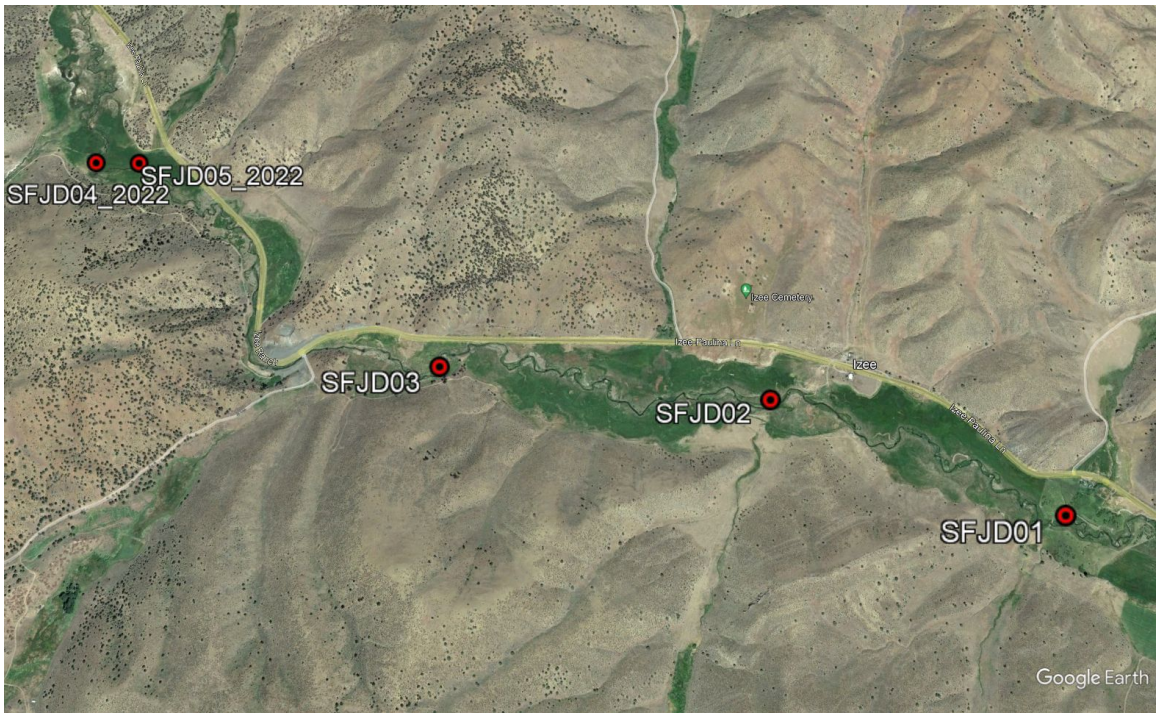

Figure 1. Locations of reaches assessed in the upper South Fork of the John Day River in August, 2022.

METHODS

INSTREAM PHYSICAL, CHEMICAL AND BIOLOGICAL SAMPLING

Instream and riparian field data collection was performed on August 1 and 2, 2022. Field sampling occurred approximately one month earlier in 2022 than in prior years over concerns of decreasing summertime flows in 2022 potentially producing complete flow cessation by late August. Monitoring of instream physical and biological conditions followed standard methods previously used in the upper South Fork watershed to assess aquatic resource conditions (e.g. Cole 2002, Lemke & Cole 2006, Cole and Burtch 2017) and were executed in accordance with Sampling and Analysis Plan DEQ21-VOL-0021-SAP (Cole 2021).

Physical habitat assessments were performed at each site using relevant protocols from USEPA's National Rivers and Stream Assessment Field Operations Manuel for Wadeable Rivers and Streams (USEPA 2013). At each site, a representative stream reach measuring 150 m was first measured and flagged. The physical habitat assessment consisted of three components: a thalweg profile, woody debris tallies, and channel and riparian cross sections. At each of 11 channel cross sections within each monitoring reach, channel dimensions, bank height, undercut angle (rod and clinometer), and riparian *overhead* cover (densiometer) were measured (USEPA 2013). Substrate size, embeddedness, riparian vegetation attributes were also recorded. Along the thalweg profile, we measured depth, classified habitat units, and determined the presence of soft/small sediment at 10 equally-spaced intervals between each pair of cross sections (USEPA 2013).

Macroinvertebrate samples were collected following ODEQ standard operating procedures for sampling macroinvertebrates, "Standard ODEQ Targeted Riffle Habitat Sampling" (ODEQ 2009). Using this methodology, macroinvertebrate samples were collected from available riffle habitat within each monitoring reach. In one reach, where riffle habitat was no longer present, macroinvertebrates were collected from riffle habitat immediately upriver of the 150-m reach. Macroinvertebrates were collected with a D-frame kick net (12-in wide, 500-µm mesh opening) from eight locations within available riffles. First, larger substrates were hand-washed inside the net, and then placed outside of the sampled area. The sampled area was then thoroughly disturbed by hand (or by foot in deeper water). The 8-kick composite sample was placed into one or more 1-L polyethylene wide-mouth jars, labeled, and preserved with 95% ethanol for later sorting and identification at the laboratory. Concurrent with macroinvertebrate collection at each site, instantaneous measurements of water temperature, dissolved oxygen, and conductivity made with a YSI Model 556 multi-parameter meter.

Table 1. List of reaches assessed in the upper South Fork of the John Day River in August, 2022.

		Years Sampled						
Site	Location Description	2000	2001	2002	2004	2006	2017	2022
SFJD01	St. Clair: upper pasture	X	X	X	X	X	X	X
SFJD02	St. Clair: middle reach	X	X	X			X	X
SFJD03	St. Clair: lower pasture	X	X	X	X	X	X	X
SFJD04	Izee Ranch: reach 1 (lower)							X
SFJD05	Izee Ranch: reach 2 (upper)							X

RIPARIAN CONDITIONS SAMPLING

Monitoring riparian vegetation occurred adjacent to reaches established for long-term monitoring of instream conditions. Riparian assessment methods also followed those used for the USEPA's National Rivers and Streams Assessments (USEPA 2013). Riparian vegetation structure was measured in 10 x 10 m plots on each bank at each channel cross section (refer to instream habitat assessment). Within each plot, the dominant vegetation type(s) were classified within three layers: canopy, understory, and ground cover, and aerial cover within each layer was estimated. Riparian overhead cover was measured at each channel cross section with a spherical densiometer using standard methods (USEPA 2013) to quantify stream shading in each monitoring reach.

MACROINVERTEBRATE SAMPLE SORTING AND IDENTIFICATION

Laboratory analysis of the macroinvertebrate samples followed ODEQ standard operating procedures for macroinvertebrate identification (ODEQ 2009), using a Caton gridded tray (Caton 1991). Samples were first subsampled and sorted to remove a 500-organism subsample from each preserved sample. Contents of the sample were first emptied onto the gridded tray and then floated with water to evenly distribute the sample material across the tray. Squares of material from the 30-square gridded tray were removed to a Petri dish which then was placed under a dissecting microscope at 7-10X to sort aquatic macroinvertebrates from the sample matrix. Macroinvertebrates were removed from each sample until at least 500 organisms were counted, or until the entire sample had been sorted. Following sample sorting, all macroinvertebrates were identified to standard taxonomic levels for the Pacific Northwest (PNAMP 2015).

DATA ANALYSIS

Physical Habitat Data

Physical habitat data were summarized for each site by calculating reach-wide means for embeddedness, substrate particle size, water depth, wetted width, bankfull

width, bankfull height, overhead cover index. These summarized data were then tabulated and/or graphed for direct comparison among reaches and across sampling years.

Analysis of Macroinvertebrate Samples

2022 macroinvertebrate taxonomic data were analyzed using three approaches: multimetric analysis, the PREDATOR (PREDictive Assessment Tool for Oregon) predictive model, and stressor models. Multimetric analysis has historically been used to determine the condition of macroinvertebrate communities in the upper South Fork because only this tool was available at the onset of regular biological monitoring in the South Fork in the early 2000s. Multimetric analysis employs a set of metrics, each of which describes an attribute of the macroinvertebrate community that is known to be responsive to one or more types of pollution (e.g., organic enrichment, temperature, sediment) or habitat degradation. Each community metric is converted to a standardized score; standardized scores of all metrics are then summed to produce a single multimetric score that is a numeric measure of overall biological integrity. The Oregon Department of Environmental Quality (DEQ) originally developed a 10-metric set for use with riffle samples (WQIW 1999).

The DEQ 10-metric set includes six positive metrics that score higher in less disturbed systems, and four negative metrics that score lower as conditions improve. The Modified Hilsenhoff Biotic Index (HBI), originally developed by Hilsenhoff (1982), computes an index to organic enrichment pollution (and attendant low dissolved oxygen) based on the relative abundance of various taxa at a site. Values of the index range from 1 to 10; higher scores are interpreted as an indication of a degraded (i.e., pollution tolerant) macroinvertebrate community. Sensitive taxa are those that are intolerant of warm water temperatures, high sediment loads, and organic enrichment; tolerant taxa are adapted to persist under such adverse conditions. We used DEQ's taxa attribute coding system to assign these classifications to taxa in the data set (DEQ, unpublished information). Metric values first were calculated for each sample and then were converted to standardized scores using DEQ scoring criteria. The standardized scores were summed to produce a multimetric score ranging between 10 and 50. Reaches were then assigned to a level of impairment based on these total scores.

Macroinvertebrate data from the South Fork John Day River were also analyzed using ODEQ's PREDATOR model. PREDATOR is a predictive model that evaluates macroinvertebrate community conditions based on a comparison of observed (O) to expected (E) taxa (Hawkins et al. 2000, Hubler 2008). The observed taxa are those that occurred at the reach, whereas the expected taxa are those commonly occurring (>50% probability of occurrence) at regional reference reaches. The expected taxa, therefore, are taxa that are expected to have at least a 50% probability of occurring within a reach in areas with little or no disturbance. PREDATOR is now widely used for determining biological conditions in Oregon's wadeable rivers and streams. Three regional PREDATOR models are currently in use in Oregon; one of these three models – the Western Cordillera and Columbia Plateau (WCCP) Predictive Model – encompasses the entire South Fork of the John River subbasin (Hubler 2008). Biological condition is determined with PREDATOR by comparing the O/E score to the distribution of reference reach O/E scores in the model. One strength of PREDATOR over the multimetric approach is that a single predictive model can be constructed to assess biological conditions over a wide range of environmental gradients such as stream slope, longitude,

or elevation, whereas separate multimetric tools would have to be developed to more accurately assess conditions over this wide range of natural environmental gradients. Once predictor variables and taxonomic data have been input into the model, the probability of occurrence of each taxon at a given test site is calculated. With this information, the model calculates the O/E score for each site. Using the WCCP biological condition thresholds (Hubler 2008), higher-gradient streams with O/E scores ≤0.78 (≤10th percentile of reference site scores) were classified as "most disturbed", 0.79 to 0.92 (>10th to 25th percentile) as "moderately disturbed", and 0.93 to 1.23 (25th to 95th percentile) as "least disturbed."

Stressor models developed by ODEQ were also used in this analysis for the first time in 2022 with these South Fork data (Huff et al. 2006). These models identify changes in macroinvertebrate assemblage composition that implicate either fine sediment or thermal pollution in the degradation of biological conditions. The models are to be used as screening tools to detect likely sources of stress to macroinvertebrate communities in wadeable Oregon streams. Stressor values calculated from test sites are compared to values previously derived from regional reference sites to determine whether changes in assemblage-level preferences for temperature or fine sediment have likely occurred in response to changing ambient thermal or fine-sediment conditions (Huff et al. 2006). The 75th percentile of the distribution of inferred temperature and fine-sediment values from regional reference sites is used to determine whether the community at a particular site is potentially affected by one or both of these stressors. In the analysis for this study, temperature stress and fine-sediment stress weighted-average inference models were first run to derive estimates of inferred water temperature and sediment levels in each sample reach. 2017 (pre-R3 project implementation) data from the three St. Clair Ranch sites were also analyzed using the stressor models to provide a baseline of stressor model scores. The DEQ's thresholds of 18.4°C for temperature and 13% for fine sediment (10th percentile of the distribution of DEQ Blue Mountain reference site scores; Huff et al. 2006) were used to determine whether each was functioning as a likely stressor to South Fork macroinvertebrate communities and whether their relative effect had changed from 2017 to 2022.

RESULTS

INSTREAM HABITAT

In the St. Clair Reaches SFJD01 through SFJD03, instream habitat conditions were generally similar to those measured in 2017, with some habitat conditions shifting modestly in the five year period (Table 2). Embeddedness and percent sand fines appears to have increased, while percent coarse substrates has decreased in reaches 02 and 03. These conditions appear to have remained more similar over of the five-year period in reach 01 (Table 2). Substrate conditions in reaches 01 and 03 appear to be similar to those initially measured in 2001 (Table 2), while those in reach 02 are showing an increase in course substrate in the reach, despite a near complete loss of riffle habitat from the reach since 2001. All three St. Clair Ranch reaches were once again dominated by depositional (glide and pool) habitats. Proportionately, depositional habitat in reaches 02 and 03 remained almost unchanged from 2017 to 2022 and increased from 90% to

100% in reach 02 in the same period (Table 2). In 2022, riffle habitat occupied 9% and 2% of the reach length in reaches 01 and 03, respectively, and was absent from reach 02.

Change in the average thalweg depth from 2017 to 2022 was most evident in reach 02, where the average increased from 43 cm to 59 cm (Table 2). This increase in mean depth in reach 02 is expectedly commensurate with the increase in pool habitat and loss of riffle habitat in the reach. Thalweg depths decreased modestly from 2017 to 2022 in reaches 01 and 03 where changes in the relative proportions of different habitats types were also less pronounced. Thalweg depths have generally increased, if even modestly, across the three reaches since 2001, and the percent of riffle habitat has generally decreased (Table 2). The standard deviation of the thalweg depth – a measure of variability of depths in each reach – has remained similar in the three St. Clair reaches since 2001 (Table 2), suggesting the range or breadth of habitat conditions has not changed appreciably.

Measured for the first time in 2022, instream habitat conditions in the two Izee Ranch reaches (reaches SFJD04 and SFJD05) were similar to those measured in the St. Clair reaches (Table 3). Both reaches 04 and 05 were heavily dominated by pool habitat, resulting in a predominately sand and fine-substrate river bottom (Table 3). Thalweg depths and channel dimensions including wetted widths and bankfull widths were also generally similar to those measured in the three St. Clair reaches. These results suggest that habitat conditions are generally similar across the monitoring five reaches within the project area.

RIPARIAN HABITAT

As in prior sampling years, riparian habitat in the three St. Clair monitoring reaches continues to be largely dominated by herbaceous ground cover that extends marginally into the understory layer (0.5 – 5.0 m high; Table 4). Conditions are generally similar to those measured in 2017, with a very heavy and uniform dominance of reed canary grass as ground cover. All three St. Clair reaches presently support modest levels of willow cover in the understory layer (Table 4). The average woody cover class in the understory layer in reach 01 has increased from 0.1 to 1.1 from 2006 and 2022 (Table 4), corresponding to averaging almost 0% cover to over 10% cover through the reach. Reach 02 supported the highest average woody cover in all three riparian vegetation layers (Table 4). While reach 03 continues to support the lowest woody cover among the three reaches, the average woody cover class in the understory layer in this reach has increased from 0.2 to 0.8 from 2006 to 2022 (Table 4).

Mid-stream canopy cover, as measured with a densiometer from near the water's surface along the center of the stream channel in each reach, increased in all three St. Clair reaches between 2017 and 2022 (Table 2). This increase was most pronounced in reach 01, where cover increased from 10% in 2017 to 50% in 2022. More modest, yet positive changes, occurred from 2017 to 2022 in reaches 02 and 03, where canopy cover increased from 1% to 8% and from 1% to 26%, respectively (Table 2). Dense and tall growths of reed canary grass were noted by field staff as being primarily responsible for these increases in canopy cover. Mid-stream canopy cover in reach 04 and 05 were notably lower than that in reaches 01 through 03 (Table 3); this was almost exclusively a result of reed canary grass growth being shorter in this section of the river than on the St. Clair section of river.

WATER QUALITY

Instantaneous water quality measurements were made in each of the five assessment reaches at the time of macroinvertebrate sampling. Because time of day was not standardized, the data represent measurements taken at different times of the day across the five sample sites, resulting in a wider range of water quality conditions among sites than would have occurred if sampling had occurred at the same time at each site. Considering that these measurements were made at different times of the day, comparisons among sites cannot be made. Rather, earlier AM measurements can be used to infer daily minimum dissolved oxygen concentrations in the early morning hours, while afternoon temperature measurements (particularly on warm days, such as August 1, 2022 when air temperatures exceeded 100 F in Izee) can be used to infer maximum water temperatures during these peak stress weather periods of mid-to-late summer. Dissolved oxygen concentrations were 4.28 mg/L at 07:18 on August 1, 2022 and SFJD03 and 3.16 mg/L at 06:44 on August 2, 2022 at SFJD01 (Table 5). Each of these two measurements fails to meet the state standard of 6.5 mg/L as an absolute minimum for waters identified by ODEQ as providing cool-water aquatic life (ODA 2019). Water temperature measured at SFJD02 at 13:28 on August 1, 2022 was 23.25°C. Continuous water temperature data collected in 2022 by the SFJDWC in the reach of river on the St. Clair Ranch registered a maximum temperature of 23.28°C (source: Hobo data provided by Amy Stiner, SFJDWC). The 7-day average maximum water temperature (calculated from these continuous data) in the week prior to the 2022 macroinvertebrate sampling was 23.21°C. These continuous data reveal the severe thermal conditions that can occur in the upper South Fork when sufficiently dry and hot weather conditions persist. Soon after the 2022 field sampling, approximately 200 yards of river channel within the project area through SFJD03 went completely dry, and approximately 17 miles of the South Fork ceased to flow further downriver, speaking to the severity of conditions in the South Fork in late summer 2022.

Table 2. Physical habitat conditions measured from three stream reaches on the St. Clair Ranch in the upper South Fork of the John Day River, Oregon between 2001 and 2022.

	Reach 1 (upper)					Reach 2 (middle)			Reach 3 (lower)				
Year	2001	2004	2006	2017	2022	2001	2017	2022	2001	2004	2006	2017	2022
% Embeddedness	87	76	71	75	79	86	63	85	89	84	70	73	89
% Sand/Fines	48	64	36	49	48	56	22	59	61	80	32	35	62
% Coarse Substrate	29	25	22	20	24	4	43	29	7	8	35	26	19
Cross Sect Water Depth (m)	0.22	0.18	0.31	0.36	0.36	0.18	0.25	0.45	0.23	0.26		0.29	0.49
Wetted Width (m)	4.1	3.5	4.3	4.3	3.6	4.2	4.2	5.0	4.7	4.8	3.8	4.5	4.7
W:D Ratio	18.0	20.0	14.0	12.0	9.8	24.0	17.0	12.0	20.0	18.0		15.0	9.2
Bankfull Width (m)	5.2	5.0	6.2	6.6	6.8	6.1	5.1	7.5	7.3	6.5	7.1	5.2	8.3
Thalweg Depth (cm)	44	46		60	50	40	43	59	53	62		62	59
SD Thalweg Depth (cm)	18	23		39	23	21	19	21	28	26		26	34
% Mid-Stream Can Cover	0	13	3	10	50	0	1	8	0	23	0	1	26
% Riffle Habitat	14	26		12	9	31	10	0	25	9		5	2
% Depositional Habitat	86	74		88	91	69	90	100	75	91		95	98

Table 3. Physical habitat conditions measured from two stream reaches on the Izee Ranch in the upper South Fork of the John Day River, Oregon in August, 2022.

	Reach	
Habtiat Parameter	4	5
% Embeddedness	96	96
% Sand/Fines	63	49
% Coarse Substrate	25	39
Cross Sect Water Depth (m)	0.24	0.38
Wetted Width (m)	3.8	4.3
W:D Ratio	16.0	12.0
Bankfull Width (m)	8.0	10.6
Thalweg Depth (cm)	44	46
SD Thalweg Depth (cm)	21	23
% Mid-Stream Can Cover	2	3
% Riffle Habitat	10	8
% Depositional Habitat	90	92

Table 4. Riparian vegetation structure on stream reaches in the upper South Fork of the John Day River, 2004-2022. Numbers reported are cover classes. Cover classes are 0 = no cover, 1 = sparse: <10%, 2 = moderate: 10-40%, 3 = heavy: 40-75%, 4 = very heavy >75%.

	Reach 1				Reach 2		Reach 3				Reach 4	Reach 5
Variable	2004	2006	2017	2022	2017	2022	2004	2006	2017	2022	2022	2022
Canopy												
Dom.Veg. Type	None	None	None	None	Decid	Decid	None	None	None	None	None	Decid
Big Trees	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2
Small trees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	1.1
Understory												
Dom. Veg. Type	Decid	None	Decid	Decid	Decid	Decid	Decid	None	Decid	Decid	Decid	Decid
Woody Shrubs	0.1	0.1	1.1	1.0	1.7	1.7	0.7	0.2	0.6	0.8	0.3	1.2
Non-Woody	1.7	1.7	1.3	3.7	0.7	2.6	2.3	0.1	0.6	1.6	4.0	4.0
Groundcover												
Woody	0.1	0.1	0.9	0.8	1.5	1.5	0.7	0.1	0.4	0.5	0.4	1.1
Herbac.	3.4	3.4	3.9	4.0	3.7	2.6	3.2	3.6	3.6	3.0	4.0	4.0

Table 5. Instantaneous water chemistry measurements made in five stream reaches sampled for macroinvertebrates in the upper South Fork of the John Day River, August 2022. DO measurements taken at SFJD02 were flagged and omitted owing to suspected measurement error.

			Parameter				
Site	Date	Time	Temp ºC	Cond (µS/cm)	Spec Cond (µS/cm)	DO %	DO mg/L
SFJD03	8/1/2022	7:18	19.53	575	643	46.8	4.28
SFJD02	8/1/2022	13:28	23.25	624	625	flagged	flagged
SFJD01	8/2/2022	6:44	18.25	564	648	33.6	3.16
SFJD04	8/2/2022	9:45	19.43	533	633	57.6	5.29
SFJD05	8/2/2022	12:11	18.97	559	632	75.8	7.02

MACROINVERTEBRATE COMMUNITIES

Raw macroinvertebrate taxonomic and count data, as well as all community metrics calculated are presented in Appendices 1 and 2. Macroinvertebrate community multimetric scores ranged from 16 to 20 among the three St. Clair reaches sampled in 2022 (Table 6 and Figure 2), corresponding to conditions ranging from moderately to severely disturbed. Multimetric scores indicate that conditions are generally similar to those last measured in 2017 (Table 6 and Figure 2). The multimetric score in reach #1 decreased from 28 to 20 from 2017 to 2022, following in increase at this site from 20 in 2006 to 28 in 2017. These interannual differences are likely the result of temporal variability and variability among samples rather than an actual changes in the reach-wide community conditions resulting from restoration activities.

Across the 22 years of sampling, total scores have ranged by 12 multimetric scores points in reach #1, by 4 points in reach #2, and by 14 points in reach #3. The lack of correspondence of high and low scores among sites across years further suggests that this variability results more from spatial variability than from actual inter-annual variability in biological conditions. Collectively, multimetric scores suggest no significant changes in biological conditions over the 22-year period during which monitoring has occurred. Multimetric scores from reaches 04 and 05 were very similar to those in reaches 01-03; reach 04 received a score of 20, while reach 05 received a score of 22, each representing the low end of the moderately disturbed condition range of values.

2022 PREDATOR WCCP model scores ranged from 0.43 in reach 02 to 0.77 in reach 05 (Table 7), suggesting persistently disturbed biological conditions throughout this section of the river. PREDATOR results corroborated results of the multimetric index with respect to overall macroinvertebrate community conditions. This range of O/E scores is remarkably similar to the range measured among sites 01 and 03 in 2017 (Table 7), lending further evidence that biological conditions have remained unchanged since the implementation of the R3 restoration activities in 2017.

To assist with interpreting the results of the broader macroinvertebrate tools used in this analysis (the multimetric index and the PREDATOR model), ODEQ stressor models were used to determine whether elevated water temperatures and fine sediments are contributing to the degradation of biological communities in this section of the South Fork. Temperature stress scores ranged from 24.2 to 25.4 across the five SFJD sample sites (Table 8), far in excess of ODEQ's threshold of 18.4 which corresponds with a "stressed" community condition in relation to elevated water temperature. These temperature stress scores were similarly high in 2017 (Table 8), suggesting that the macroinvertebrate community in the upper South Fork continues to consist almost exclusively of organisms that are very tolerant of elevated water temperatures.

Similarly, fine sediment stressor scores suggest that the South Fork macroinvertebrate community comprises organisms that are very tolerant of elevated fine sediment (Table 8). 2022 fine sediment stress scores ranged from 37.3 to 57, well above the 13% threshold for "poor" (stressed) conditions. 2017 fine sediment scores for site 01 through 03 were lower (19.8 to 27.3), but also significantly exceeded the threshold (Table 8). The apparent increase in community-level tolerance to fine sediment in the three St. Clair reaches was primarily driven by a large number of amphipods occurring in the 2022 samples. While some amphipods have occasionally occurred in South Fork samples is previous years, never has sampled abundance been as high as in 2022. This high abundance seemed to generally accompany the larger amount of instream vegetation growth that was observed in 2022 (see photos in appendix), likely as a result of persistently low flows and predominantly depositional habitats occurring in more recent years. The type of habitat currently created by the beaver analogs and low flows would tend to favor amphipods and potentially other macroinvertebrate taxa that would not occur in as much abundance in sections of the river with a more regular alternating riffle-pool sequence.

In accordance with the Sampling and Analysis Plan prepared for this project (Cole 2021), one of the six samples was resorted as a quality control check on sorting efficacy. Percent sorting efficacy (PSE) was calculated by the formula: PSE = [n0 / (n0 + nr)/ * 100, where n0 = original # of specimens found by sorter, and nr = # of recoveries (i.e., the number found by the reviewer). The resorted sample (27-125-04) passed with a 99.5% sorting efficacy, passing the 95% data quality objective.

One of the six macroinvertebrate samples was also re-examined by a second taxonomist to determine the accuracy of identifications and enumerations. Primary and quality assurance identification similarity was 98.8% using the Bray-Curtis community similarity (1-B) measure. The percent difference in enumeration (PDE) between the primary and QA taxonomist was -0.10 % (99.9% agreement), while PTD was 1.82% (98.18% agreement).

Also, in accordance with the Sampling and Analysis Plan prepared for this project (Cole 2021), a duplicate field sample was collected at one site (SFJD01). This sample was processed and analyzed in the same manner as were the five primary samples to assess the precision (repeatability) of sample collection and processing. The Relative Percent Difference (RPD) of O/E scores were used to evaluate the difference in results between two replicate samples: RPD = [(result1 – result2) / (result1 + result 2)] * 100. The O/E score RPD of the primary and duplicate samples was 6%, which meets the < 20% data quality objective stablished for this measure for the project.

Table 6. Multimetric scores of macroinvertebrate communities sampled from 3 stream reaches sampled in the upper South Fork of the John Day River, Oregon between 2000 and 2022. Yellow-highlighted cells indicate scores occurring in the "moderately" disturbed conditions class; orange-highlighted cells indicate scores occurring in the "severely" disturbed condition class.

	Multimetric Score							
St Clair Reach	2000	2001	2002	2004	2006	2017	2022	Reach Mean
1 (upper)	22	16	20	18	20	28	20	20.6
2 (middle)	18	14	14			16	16	15.6
3 (lower)	18	14	12	16	26	22	18	18.0
Annual Mean	19.3	14.7	15.3	17.0	23.0	22.0	18.0	18.1

Table 7. PREDATOR WCCP model O/E scores of macroinvertebrate communities sampled from 5 stream reaches sampled in the upper South Fork of the John Day River, Oregon, 2022. 2017 O/E scores are provided from three of the reaches for comparative purposes.

	WCCP O/E Score		
Reach	2017	2022	2022 Condition Class
SFJD01	0.427	0.683	most disturbed
SFJD02	0.598	0.427	most disturbed
SFJD03	0.769	0.598	most disturbed
SFJD04		0.682	most disturbed
SFJD05		0.768	most disturbed

Table 8. DEQ temperature and fine sediment stressor model scores of macroinvertebrate communities sampled from 5 stream reaches sampled in the upper South Fork of the John Day River, Oregon, 2022. 2017 stressor scores are provided from three of the reaches for comparative purposes.

	Temperature Stress Score			Fine Sediment Stress Score		
Reach	2017	2022	2022 Condition Class	2017	2022	2022 Condition Class
SFJD01	26.1	25.4	poor (stressed)	24.0	40.3	poor (stressed)
SFJD02	25.4	24.2	poor (stressed)	19.8	57.0	poor (stressed)
SFJD03	24.8	24.7	poor (stressed)	27.3	38.9	poor (stressed)
SFJD04		25.0	poor (stressed)		37.3	poor (stressed)
SFJD05		25.0	poor (stressed)		41.8	poor (stressed)

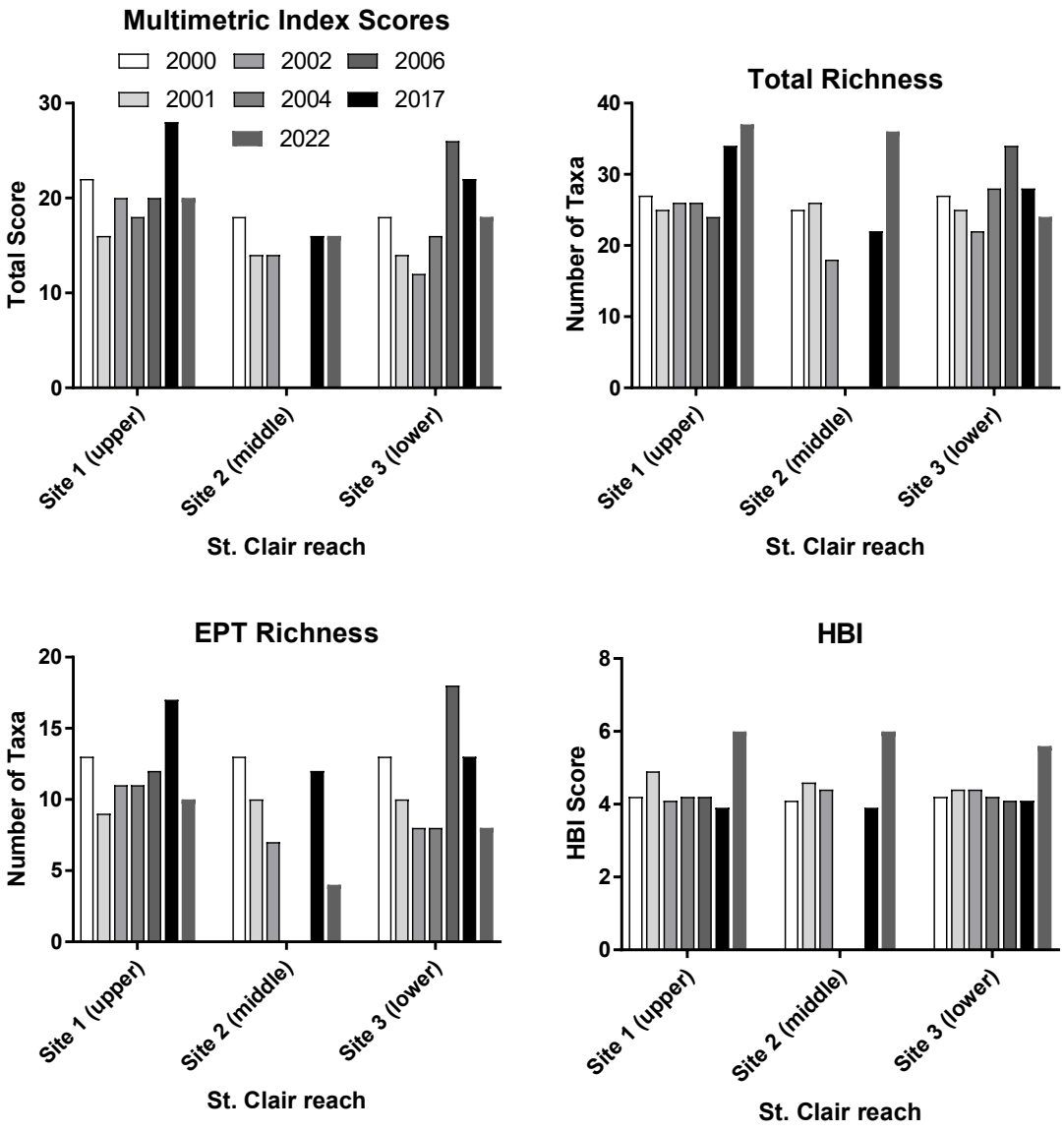

Figure 2. Multimetric scores and select individual metric scores calculated from macroinvertebrate communities sampled from three monitoring reaches in the upper South Fork of the John Day River, Oregon from 2000-2022.

DISCUSSION

Efforts to improve riparian and instream conditions in support of native fish and macroinvertebrate communities have occurred on the St. Clair ranch since the early 2000s. Local efforts have included extensive riparian fencing, development of off-channel watering sources, installation of rock grade-stabilization structures juniper rip-rapping to stabilize streambanks, riparian plantings, and installation of beaver-dam analogues to a re-aggrade the river channel and reconnect the channel and floodplain. Despite these efforts, macroinvertebrate communities in the upper South Fork of the John Day River in the project area continue to show uniformly degraded conditions. Since macroinvertebrate monitoring began in the early 2000s on the St. Clair ranch, ambient conditions, including the water temperature regime and streambed fine sediment conditions, have largely remained unaffected by the instream and riparian enhancement projects. This is likely a result of both the spatial scale of the restoration projects relative to the spatial scale of the affected area, as well as the length of time necessary for certain restoration activities to accrue benefits to the riparian zone and stream channel. While the project area on the St. Clair property encompasses approximately two miles of river channel and riparian corridor, nearly 150 river and stream miles occur upriver, which will continue to have a significant effect on thermal and sediment conditions occurring in the project area.

Efforts to re-establish a lush, willow-dominated riparian zone along the St. Clair project area on upper South Fork have now occurred for over twenty years. Willow growth has been thwarted by the dense growth of invasive reed canary grass, which now dominates most of the riparian zone along the upper South Fork. This general paucity of willows renders large sections of the river unappealing to beavers, whose dams are beneficial for re-aggrading river channels and re-connecting river and floodplains, which is in turn needed to promote growth of willows, dogwoods, and other desirable riparian species. The willows are needed to attract the beavers, yet without a sufficient density of willows, if the beavers arrive, they will potentially re-denude entire reaches of willow growth. Moreover, while cattle have been excluded from these riparian areas, elk still find their way in and browse on the young willows, further slowing the pace of willow regeneration. The last twenty years have taught local restoration practitioners that the pace at which riparian regeneration will occur in this section of the river will be slow and to a certain extent beyond the control of those working to improve these conditions.

These results also speak to the need to address legacy effects of past riparian grazing practices across the larger watershed area. These long-term effects have accrued over many decades and along many miles of river. Degraded conditions such as elevated water temperatures, disconnected floodplains, and elevated streambed sediment are cumulative consequences of past management practices in the *entire upriver watershed area* encompassing approximately 150 square miles. The 2019 ODA Agricultural Water Quality Management Plan for the South Fork states that DEQ computer simulation of heating along the Upper John Day River indicated that numeric water temperature standards based on fish use are *not attainable in much of the basin* (ODA 2019). Isolated restoration efforts on the landscape will likely not, particularly over the short term, result in sufficient localized improvements in water temperature, sedimentation, and habitat conditions that would measurably improve biological conditions. Moreover, the upper South Fork of the John Day River in the project area is a lower-gradient and sinuous section of river situated on a wide floodplain. The physical character of this section of

river would be expected to naturally differ from that of higher-gradient sections occurring in more confined valleys. Historically, this section of river was likely braided, lacked significant riffle habitat, contained higher levels of smaller substrates, and was heavily shaded by extensive willow growth. Efforts to recover this section of river should continue to aim to emulate these particular conditions, particularly with respect to riparian regeneration.

After more than twenty years of monitoring macroinvertebrate communities in this section of the upper South Fork of the John Day River, conditions remain unchanged. Moving forward, monitoring should focus on the river's thermal regime, riparian conditions and river-floodplain connectivity. Until measurable changes in these attributes occur that would be expected to benefit macroinvertebrate communities, macroinvertebrate monitoring will in all likelihood continue to produce the same results as it has for the past two decades. Accordingly, these macroinvertebrate community data that now span over twenty years represent a comprehensive baseline against which future change can be evaluated *once improved physical conditions suggest that biological change should be expected.*

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Appendix 1. Macroinvertebrate community metrics calculated from six samples collected from the upper South Fork of the John Day River, Oregon, in August 2022.

Metric	SFJD01	SFJD01 DUP	SFJD02	SFJD03	SFJD04	SFJD05
Taxa Richness	37	36	24	27	36	37
Mayfly Richness	4	5	3	1	3	5
Stonefly Richness	1	1		1	1	1
Caddisfly Richness	5	7	1	6	4	5
Sensitive Taxa	0	0	0	0	0	0
Sediment Sensitive Taxa	0	0	0	0	0	0
Modified HBI	6.0	5.6	6.0	5.6	5.5	5.6
% Tolerant Taxa	44.0	50.8	33.9	79.2	60.9	57.1
% Sediment Tol Taxa	9.0	5.6	8.1	2.3	7.2	5.9
% Dominant	34.0	33.0	42.0	63.0	28.0	41.0
Taxa Richness	3	3	1	1	3	3
Mayfly Richness	1	1	1	1	1	1
Stonefly Richness	1	1	1	1	1	1
Caddisfly Richness	3	5	1	5	3	3
Sensitive Taxa	1	1	1	1	1	1
Sediment Sensitive Taxa	1	1	1	1	1	1
Modified HBI	1	1	1	1	1	1
% Tolerant Taxa	1	1	1	1	1	1
% Sediment Tol Taxa	3	5	3	5	3	5
% Dominant	5	5	5	1	5	5
Multimetric Score	20	24	16	18	20	22

Appendix 2. Reach Photos

SFJD Reach 1

2022 Near survey start: downstream facing up

2017 Survey start: downstream end facing up

SFJD Reach 2

2022 survey start: downstream end facing up

2017 survey start: downstream end facing up

SFJD Reach 3

2022 survey start: downstream end facing up

2017 survey start: downstream end facing up

SFJD Reach 4 (Izee Ranch 1)

2022 near survey start: downstream facing up

SFJD Reach 5 (Izee Ranch 2)

2022 survey start: downstream end facing up