

TIMOTHY G. COCHNAUER, Ph.D*Expert Witness Report***September 11, 2023****Prepared for Protestants Save the South Fork Salmon**

BEFORE THE DEPARTMENT OF WATER RESOURCES FOR THE STATE OF IDAHO

In the Matter of Applications for Permit Nos. 77-14377, 77-14378, 77-14379;
Applications for Transfer Nos. 85396, 85397, 85398, 85399;
and Application for Exchange 85538
In the Name of Perpetua Resources Idaho, Inc.

1. I am Timothy Cochnauer. I am a retired fishery biologist with 30 years of experience with the Idaho Department of Fish and Game (IDFG). I have worked exclusively on fish resources on streams throughout the state. My initial project with IDFG was developing minimum stream flows for fish on a number of streams throughout the state. I was assigned to the Instream Flow Group, U.S. Fish & Wildlife Service, during the initial stages of the Instream Flow Incremental methodology.

ASSIGNMENT

2. I have been retained by Save the South Fork Salmon, Inc. to evaluate the impact of the proposed water diversions under the Water Rights Application and Transfer Application Nos. 77-14377, 77-14378, 77-14379, 77-7122, 77-7141, 77-7285, and 77-7293, submitted by Perpetua Resources Idaho to the Idaho Department of Water Resources for the Stibnite Gold Project on fish and fisheries habitat.

QUALIFICATIONS

3. I have a Bachelors in Science in Zoology (1967) from the University of Oklahoma; an Master degree in Zoology (1973) from the University of Oklahoma; and a Ph.D. in Fisheries

Resources (1983) from the University of Idaho. My curriculum vitae is attached as Appendix 1.

4. During the period 1974-1979, I was the principal investigator for establishing minimum stream flows for fish and wildlife in the State of Idaho. I traveled the state to measure instream habitat and utilizing that data in modeling changes in instream habitat, or weight usable area (WUA). Based on the predictive changes in instream habitat, I defined minimum stream flows to protect aquatic communities. Many of those findings are now incorporated as water rights within the State of Idaho.
5. In addition to the work accomplished in Idaho, I was assigned the U.S. Fish and Wildlife Service Instream Group as it was first organized in the mid-1970s. I worked with group for six months developing the now-established Instream Flow Incremental Methodology (IFIM).

DOCUMENTS REVIEWED

6. As part of my assignment, I have reviewed the Water Rights and Transfer Applications referenced above in Paragraph 2, filed by Perpetua Resources Idaho, formerly Midas Gold, in this case and (reports, OSC letter and technical document, ...). I have also reviewed a number of background documents, including . . . A complete list of the documents reviewed by me for this report is listed in the references section at the end of this report.

BACKGROUND

7. I understand that Perpetua Resources Idaho proposes to acquire new and transferred water rights for a total of 11.14 cfs of surface and/or groundwater flow in and around the East Fork of the South Fork Salmon River (EFSFSR) and within the proposed Stibnite Gold Project mine facility.

8. I understand that these new and transferred water rights are being challenged by SSFS on the grounds that the proposed diversions will negatively impact fish and fish habitat.
9. The EFSFSR has been officially designated as critical habitat for Chinook Salmon and steelhead by the National Oceanic and Atmospheric Administration. Additionally, the U.S. Fish and Wildlife Service has designated the EFSFSR as critical habitat for Bull Trout.
10. The EFSFSR also supports critical habitat for four U.S. Forest Service Regions 1 and 4 Sensitive Aquatic Species (Pacific Lamprey (*Entosphenus tridentatus*), westslope Cutthroat Trout (*Oncorhynchus clarki*), interior Redband Trout (*Oncorhynchus mykiss*), and Columbia spotted frog (*Rana luteiventris*).

INSTREAM FLOW INCREMENTAL METHOD ANALYSIS

11. Instream Flow Incremental Method (IFIM) was used to provide an assessment of instream flows for select fish species within the East Fork South Fork Salmon River (EFSFSR) both downstream and upstream from its confluence with Sugar Creek.
12. Data was used from a Payette National Forest IFIM study conducted in Sugar Creek for the Snake River Adjudication on July 24, and 20, 1990. The IFIM analysis computed Weighted Usable Area (WUA) by increments of streamflow for four life stages (adult, spawning/incubation, fry rearing and juvenile rearing) of anadromous steelhead Rainbow Trout (*Oncorhynchus mykiss*) and Chinook Salmon (*Oncorhynchus tshawytscha*) and three life stages (adult, spawning/incubation and juvenile rearing) of Bull Trout (*Salvelinus confluentus*). All three of these species are native to EFSFSR and officially listed under the U.S. Endangered Species Act (ESA).

13. The IFIM and its associated Physical Habitat program (PHABSIM) is a methodology used to quantify reserved instream flow water rights. The methodology simulates a relationship between streamflow and physical habitat for various life history phases of fish species.
14. The IFIM/PHABSIM methodology is the most widely used method for the quantification of reserved minimum instream flow water rights today.
15. The purpose of the methodology is to "simulate a relationship" between streamflow and physical habitat for various life stages of a species of fish. The methodology has two basic components, the hydraulic component and the habitat simulation component, both of which are estimated by utilizing defined hydraulic parameters and habitat suitability criteria. The overall goal is to develop to usable habitat by species and life history phase associated with a specific streamflow measured in cubic feet per second (cfs).
16. Generated habitat/flow curves estimate flows that correspond to the available amount of habitat. Figures 1 and 2 show relationships of flows and WUA, noting that available habitat decreases significantly at lower flows.

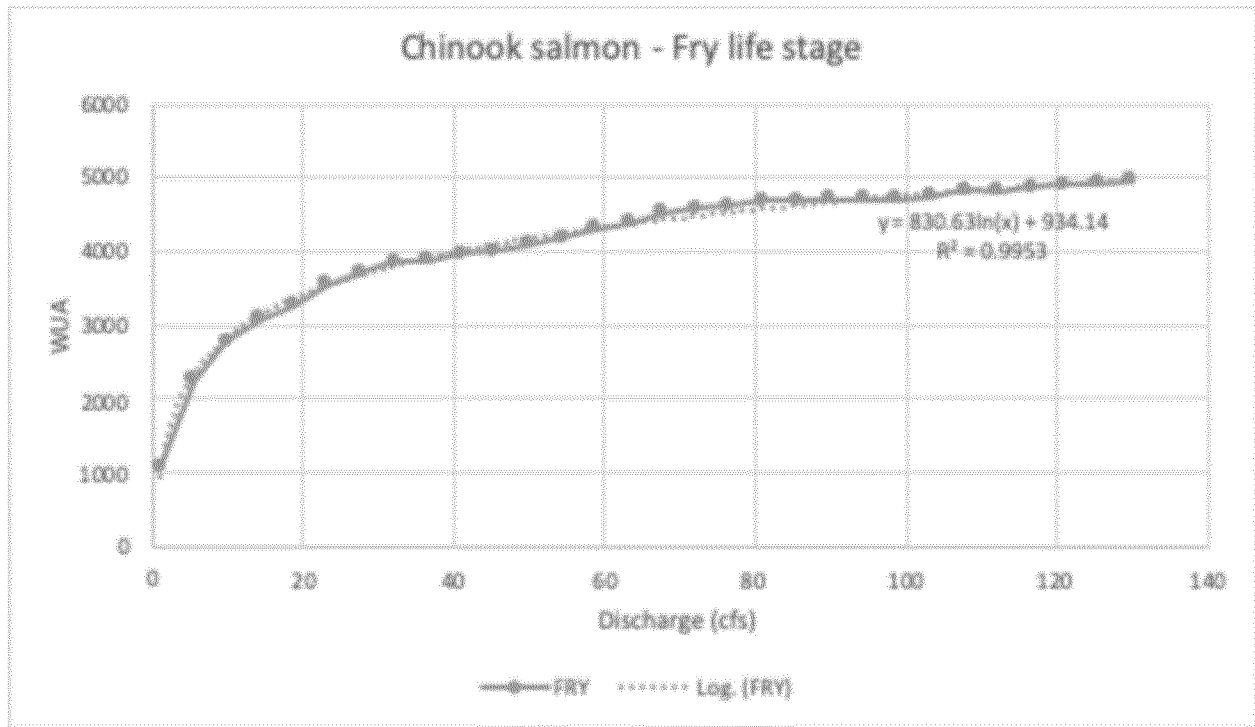


Figure 1. Plot and line equation illustrating the relationship between WUA versus Discharge for Chinook Salmon fry. I applied a 1.44 multiplier to extrapolate Sugar Creek data to the EFSFSR downstream from Sugar Creek.

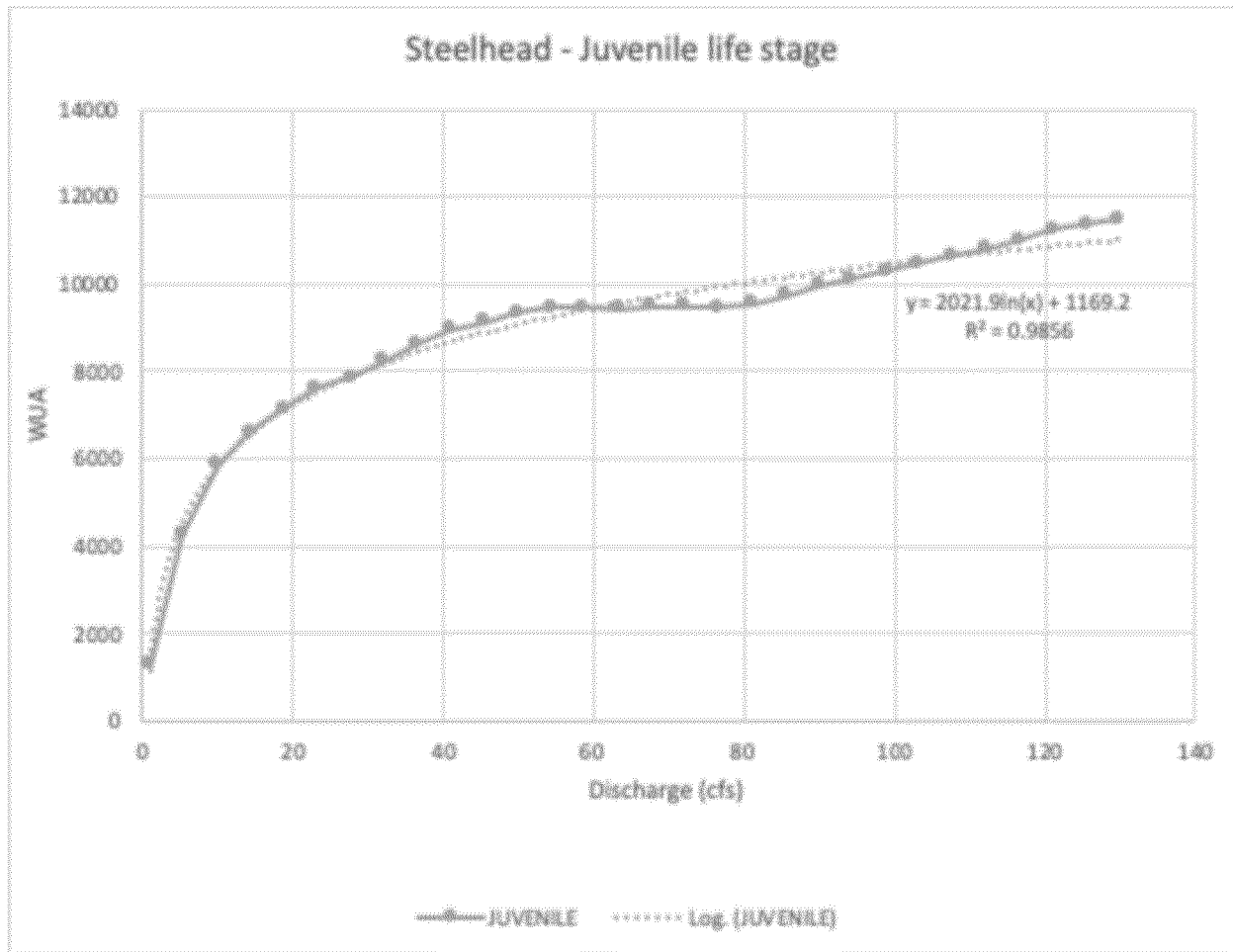


Figure 2. Plot and line equation illustrating the relationship between WUA versus Discharge for Chinook Salmon fry. I applied a 1.15 multiplier to extrapolate Sugar Creek data to the EFSFSR upstream from Sugar Creek.

ANALYSIS

17. For this analysis, there are two stream sections of the EFSFSR of interest above and below Sugar Creek. There was no IFIM analysis work done on either of the two sections of EFSFSR, consequently it was necessary to extrapolate the Sugar Creek IFIM data to the two sections of interest in the EFSFSR.
18. To extrapolate WUA from Sugar Creek to the EFSFSR below Sugar Creek, I used StreamStats to model estimates of bankfull width for Sugar Creek and the EFSFSR below

Sugar Creek. Based on that analysis, I applied a multiplier of 1.44 to extrapolate WUA to the EFSFSR downstream from Sugar Creek.

19. Further, to extrapolate WUA from Sugar Creek to the EFSFSR above Sugar Creek, I used StreamStats to model estimates of bankfull width for Sugar Creek and the EFSFSR above Sugar Creek. Based on that analysis, I applied a multiplier of 1.15 to extrapolate WUA to the EFSFSR upstream from Sugar Creek.

STREAM DISCHARGE

20. The U.S. Geological Survey (USGS) currently operates two stream gages used in this analysis: on Sugar Creek just upstream from the EFSFSR (USGS 13311450), and on the EFSFSR just upstream from Sugar Creek (USGS 13311250). USGS data and USGS application StreamStats are shown in Appendix 2 and Appendix 3.
21. *Downstream from Sugar Creek:* Data compiled from the two above-referenced USGS stream gages for Sugar Creek and the EFSFSR above Sugar Creek recorded mean monthly flows (in cfs) for the period from October 2011, through September 2022, as:
- 57 cfs in July;
 - 28 cfs in August; and
 - 22.4 cfs in September.

Based on StreamStats, the 24 hour (1 day) 10-year low flow equaled 15.5 cfs.

22. *Upstream from Sugar Creek:* Data compiled from the above-referenced USGS stream gage for the EFSFSR above Sugar Creek recorded mean monthly flows (in cfs) for the period from October 2011, through September 2022, as:
- 33 cfs in July;
 - 16 cfs in August; and
 - 13 cfs in September.

Based on StreamStats, the 24 hour (1 day) 10-year low flow equaled 8.97 cfs.

WATER WITHDRAWAL AMOUNTS

23. Perpetua Resources has filed applications with the Idaho Department of Water Resources for four transfers of existing water rights and five new water rights. The total of these applications within the upper EFSFSR Basin is 11.14 cfs. To assess potential effects on WUA, I applied this 11.14 cfs water withdrawal in the EFSFSR both downstream from- and upstream from- Sugar Creek.
24. The Brown and Caldwell “Simulated Hydrologic Site Model” predicted a reduction in baseflow of 2.5 cfs. Consequently, to assess potential effects on WUA, I also applied this 2.5 cfs water withdrawal in the EFSFSR both downstream from- and upstream from- Sugar Creek.
25. In a June 27, 2022 letter from the Office of Species Conservation and the Idaho Department of Fish & Game, Perpetua Resources proposed the following voluntary condition on their new water right applications (Haslam, 2022):

Perpetua Resources proposes the following voluntary restrictions on diversions to be placed on water right 77-14378 as a condition of approval. ... Net diversions from EFSFSR and groundwater under water rights 77-7122, 77-7285, 77-7293, and 77-14378 shall not cause more than 20 percent depletion to the unimpaired streamflow in the EFSFSR below its confluence with Sugar Creek when unimpaired flow is less than 25 cfs.

As a result, I also evaluated the potential effects on WUA of removing 20% of the flow when EFSFSR flows downstream from Sugar Creek are less than 25 cfs.

WUA VERSUS STREAM DISCHARGE CALCULATIONS

26. I plotted WUA versus stream discharge data in Sugar Creek with WUA as the dependent (Y) variable, and flow as the independent variable (X). Next, I applied the appropriate multiplier for the EFSFSR downstream from (I) and upstream from (II) Sugar Creek, respectively, to estimate WUA in the EFSFSR for each of the eleven salmonid life stages described above.

Finally, I calculated the equations for each of the plotted lines using either a log linear regression or a polynomial.

EFSFSR Downstream from Sugar Creek

27. I applied the 1.44 multiplier described above to estimate WUA in the EFSFSR downstream from Sugar Creek for each of the eleven salmonid life stages also described above. Finally, I calculated the equations for each of the plotted lines using either a log linear regression or a polynomial. The R^2 for these equations ranged from 0.92 to 0.995 (see Figure 1 and Reference #4). I entered the flow of interest (August mean flow of 28 cfs, for example) in the equation and calculated the WUA under that flow. Next, I subtracted 11.14 cfs and then 2.5 cfs from that flow, re-calculated the WUA, and calculated the % change in WUA.

28. I assumed a reduction in WUA will result in less suitable habitat for the respective species and life stages examined. I repeated this analysis for each species and life stage. Finally, I applied the same method to assess the effects of a 20% reduction in flow for the September mean flow and the 24 hour 10-year low flow.

29. Results are listed below by species and life stage:

- a. Steelhead: Available spring spawning steelhead habitat was substantially reduced for each of the four life stages I evaluated. For the 11.14 cfs withdrawal, the largest predicted reductions occurred during the adult and spawning/incubation stages with 56.9 to 69.6% less WUA after water withdrawal during the lowest flows. Habitat availability was also reduced by water withdrawal in August and September and ranged from 10% to 31% less WUA across all four life stages. For the 2.5 cfs withdrawal, the largest predicted reductions occurred during the adult, spawning/incubation, and juvenile stages with 5.3 to 9.6% less WUA after water

- withdrawal during the lowest flows. A 20% reduction in flow during flows less than 25 cfs (as offered by Perpetua Resources), resulted in reductions of WUA ranging from 3% to 12.2% with reductions exceeding 10% in 3 of 8 scenarios tested.
- b. Bull Trout: Fall spawning Bull Trout habitat was substantially reduced by water withdrawals during each of the three life stages I evaluated. For the 11.14 cfs withdrawal, very large, predicted reductions occurred during the adult, spawning/incubation, and juvenile stages with 65.8%, 53.7%, and 48.7% less WUA, respectively, during the lowest flows. Habitat availability was also reduced by water withdrawals in August and September and ranged from 15.8% to 34.5% less WUA across all three life stages. For the 2.5 cfs withdrawal, the largest predicted reductions occurred during the spawning/incubation stage with 10.5% less WUA. Predicted WUA reductions for the adult and juvenile stages ranged from 5.2 to 9.1% less WUA after water withdrawal during the lowest flows. A 20% reduction in flow during flows less than 25 cfs (as offered by Perpetua Resources), resulted in reductions of WUA ranging from 7.5% to 13.1% with reductions exceeding 10% in 4 of 6 scenarios tested.
- c. Chinook Salmon: Similar to Bull Trout, spring/summer spawning Chinook Salmon habitat was substantially reduced by water withdrawal. For the 11.14 cfs withdrawal, very large, predicted reductions occurred during the adult, spawning/incubation, and juvenile stages with 69.6%, 58%, and 64.1% less WUA, respectively, during the lowest flows. Habitat availability was also reduced in August and September and ranged from 11.4% to 31.4% less WUA across all four life stages. For the 2.5 cfs withdrawal, the largest predicted reductions occurred during the adult,

spawning/incubation, and juveniles stage with 5.0 to 9.6% less WUA. A 20% reduction in flow during flows less than 25 cfs (as offered by Perpetua Resources), resulted in reductions of WUA ranging from 5.2% to 12.2% with reductions exceeding 10% in 4 of 8 scenarios tested.

30. Summary: Designated critical habitat for spring spawning steelhead, fall spawning Bull Trout, and spring/summer spawning Chinook Salmon was substantially reduced by water withdrawals from the EFSFSR downstream from Sugar Creek. For the 11.14 cfs withdrawal, the largest reductions in WUA occurred during the adult, spawning/incubation, and juvenile stages for steelhead, Bull Trout, and Chinook Salmon. Under several of the scenarios I analyzed, WUA was reduced by 50% up to 69.6% during the lowest flows. Although reductions in WUA were less during August and September water withdrawals, habitat availability was still substantially reduced and ranged from 10% up to 34.5%. For the 2.5 cfs withdrawal, reductions in WUA exceeded 5% in 64% (7/11) of the scenarios tested during the lowest flows and in 45% (5/11) of the scenarios tested in September. The 20% reduction in flow during flows less than 25 cfs (as offered by Perpetua Resources), resulted in reductions of WUA ranging from 3% to 13.1%. Reductions in WUA exceeded 10% in 50% (11/22) of the scenarios tested. It is important to emphasize that, for ESA listed species at risk of extinction, even a relatively small percent reduction in critical habitat can have a disproportionately large, negative effect on a small fish population.

EFSFSR Upstream from Sugar Creek

31. I applied the 1.15 multiplier described above to estimate WUA in the EFSFSR upstream from Sugar Creek for each of the eleven salmonid life stages also described above. Finally, I calculated the equations for each of the plotted lines using either a log linear regression or a

polynomial. The R^2 for these equations ranged from 0.932 to 0.995 (see Figure 2 and Appendix 5). I entered the flow of interest (August mean flow of 16 cfs, for example) in the equation and calculated the WUA under that flow. Next, I subtracted 11.14 cfs and 2.5 cfs from that flow, re-calculated the WUA, and calculated the % change in WUA. I assumed a reduction in WUA will result in less suitable habitat for the respective species and life stages I examined. I repeated this for each species and life stage.

32. Results are listed below by species and life stage:

- a. Steelhead: Available spring spawning steelhead habitat was substantially reduced for each of the four life stages I evaluated. The 11.14 cfs withdrawal removed all the instream flow resulting in a complete loss of habitat for all four life stages during the lowest flow. Large August and September reductions in WUA also occurred during the adult and spawning/incubation stages and ranged from 53.7% less WUA to a complete loss of habitat. Habitat for the juvenile life stage was also substantially reduced in August and September with reductions ranging from 35.6% to 61.9%. Fry habitat was reduced by 17% to 29.3% in August and September. For the 2.5 cfs withdrawal, the largest predicted reductions occurred during the adult, spawning/incubation, and juvenile stages with 11.8% to 25.6% less WUA after water withdrawal during the lowest flows. In September, the largest predicted reductions occurred during the adult and spawning/incubation stages with 10.6% to 12.9% less WUA.
- b. Bull Trout: Fall spawning Bull Trout habitat was substantially reduced by water withdrawals during each of the three life stages I evaluated. The 11.14 cfs withdrawal removed all the instream flow resulting in a complete loss of habitat

for the adult and juvenile stages during the lowest flow. Large reductions in WUA also occurred during August and September for all three life stages with reductions ranging from 45.3% to complete dewatering. The 2.5 cfs withdrawal resulted in predicted habitat reductions during the adult, spawning/incubation, and juvenile stages with 15.9% to 23.7% less WUA during the lowest flows. Habitat availability was also reduced by water withdrawals in August and September and ranged from 6.5% to 12.75% less WUA across all three life stages.

- c. Chinook Salmon: Available Chinook Salmon habitat was substantially reduced for each of the four life stages I evaluated. The 11.14 cfs withdrawal removed all the instream flow resulting in a complete loss of habitat for all four life stages during the lowest flow. Large, August and September reductions in WUA also occurred during all four life stages and exceeded a 54% reduction in 88% (7/8) of scenarios tested. July reductions in WUA ranged from 8.9% to 15.9%. For the 2.5 cfs withdrawal, the largest predicted reductions occurred during the adult, spawning/incubation, and juvenile stages with WUA reductions ranging from 11.9% to 25.6% during September and the lowest flows. In August WUA reductions ranging from 7.6% to 9.2% occurred during the adult, spawning/incubation, and juvenile stages.

- 33. Summary: Designated Critical Habitat for spring spawning steelhead, fall spawning Bull Trout, and spring/summer spawning Chinook Salmon will be substantially reduced by water withdrawals from the EFSFSR upstream from Sugar Creek. The largest reductions in WUA occurred during the adult, spawning/incubation, and juvenile stages for steelhead, Bull Trout, and Chinook Salmon.

CONCLUSIONS

34. Under several of the scenarios I analyzed, withdrawal of 11.14 cfs completely dewatered the stream with a complete loss of fish habitat. For the 2.5 cfs withdrawal, reductions in WUA exceeded 10% in 78% (14/18) scenarios tested and ranged up to 25.6% for adult, spawning/incubation, and juvenile stages in September and the lowest flows. It is important to re-emphasize that, for ESA listed species at risk of extinction, even a relatively small percent reduction in Critical Habitat can have a disproportionately large, negative effect on a small fish population particularly during the warmer low flow months (July-October).
35. Of particular concern is the construction of a ‘pipeline’ in the EFSFSR above Sugar Creek. The proposed tunnel is untested as effective for trout and salmon migrations. The mile-long structure can result in much higher velocities than would occur in a mile of natural habitat, with overflow channels, pools, boulders, etc. These natural features enable salmon and trout to ascend waterfalls, cascades and other obstacles.
36. Fatigue, stress related physiological impacts, energy loss, injury, etc., are all potential impacts to adult fish trying to navigate upstream during high flows. Additionally young fish moving downstream for rearing and overwintering will potentially “shoot” uncontrollably through the tunnel.

Appendix 1

CURRICULUM VITAE—TIMOTHY (TIM) G. COCHNAUER

ADDRESS: 883 Lemmon Road
Port Angeles, Washington 98362

EDUCATION:

University of Oklahoma	B.S. in Zoology, 1967
University of Oklahoma	M.S. in Zoology, 1973
University of Idaho	Ph.D. in Fishery Resources, 1983

AWARDS AND HONORS:

U.S. Army Commendation Medal, 1968
U.S. Army Bronze Star Medal, 1969
Idaho Department of Fish and Game Employee of the Year, 1983
Life Time Achievement Award, Idaho Chapter American Fisheries Society, 2004

EXPERIENCE:

U.S. Army, 1966-69
Teaching Assistant, University of Oklahoma, 1972
Biological Aide, Idaho Department of Fish and Game, 1972
Environmental Health Specialist, South Central Health District, Twin Falls, ID, 1973-74
Fishery Research Biologist, Idaho Department of Fish and Game, 1974-81
Principal Fishery Research Biologist, Idaho Department of Fish and Game, 1981-91
Regional Fishery Manager, Idaho Department of Fish and Game, 1991-2001
Fishery Research Biologist, Idaho Department of Fish and Game, 2001-2003
Adjunct Faculty, Division of Natural Sciences, Lewis-Clark State College, 1995-Present
(Courses instructed: Resource Management, Environmental Impact Assessment, Mountain Lakes Investigations, Evolution, and Ichthyology)
Affiliated Faculty, Department of Fish and Wildlife, University of Idaho, 2003-present
(Course instructed: Fish Ecology, Management of Long-Lived Fish Species)

PERTINENT WORK REGARDING STREAM FLOW

During the period 1974-1979, I was the principal investigator for establishing minimum stream flows for fish and wildlife in the State of Idaho. The crew and I traveled the state to measure instream habitat and utilizing that data in modeling changes in instream habitat (weight usable area-WUA). Based on the predictive changes in instream habitat, we defined minimum stream flows to protect aquatic communities. Many of those findings are now incorporated as water rights within the State of Idaho.

In addition to the work accomplished in Idaho, I was assigned the U.S. Fish and Wildlife Service Instream Group as it was first organized in the mid-1970's. I worked with group for six months

developing the now established Instream Flow Incremental Methodology (IFIM). After the IFIM was developed, I attended one of the first hands-on educational workshops.

SOCIETIES:

American Fisheries Society

Past President Idaho Chapter American Fisheries Society, 1996-97

PUBLICATIONS:

Claire, C.W., T.G. Cochnauer, and G. W. LaBar. 2007. Pacific Lamprey *Ammocoete* Habitat Utilization in Red River, Idaho. American Fisheries Society, Symposium 53.

Cochnauer, Timothy G. 2002. Response of a White Sturgeon Population to Catch and Release Regulation—Now What? Pages 83-88 *in* W. Van Winkle, P.J. Anders, D.H. Secor, and D.A. Dixon, editors. Biology, management, and protection of North American sturgeon. American Fisheries Society, Symposium 28, Bethesda, Maryland.

Cochnauer, T.G., J.R. Lukens, and F.E. Partridge. 1985. Status of white sturgeon, *Acipenser transmontanus*, in Idaho. *In* F.P. Binkowski and S.I. Doroshov, editors. North American sturgeons. Dr. W. Junk Publishers, Dordrecht, The Netherlands.

Servheen, G., T. Cochnauer, J. Adams, B. Stotts, W. McLaughlin, and N. Sanyal. 1996. Development and Implementation of an Integrated Process for Improved Fish and Wildlife Management. Wildlife Society Bulletin 24(4):667-672.

Appendix 2

Summary of Active USGS Stream Gages in the Vicinity of Stibnite, Idaho

April 28, 2023

<https://waterdata.usgs.gov/id/nwis/current?type=flow&group key=basin cd&search site no station nm=>

Salmon River Basin

13295000	VALLEY CREEK AT STANLEY ID	04/28 09:00 MDT	1.33	245	--	291
13296000	YANKEE FORK SALMON RIVER NR CLAYTON ID	04/28 08:15 MDT	7.59	314	1.3	366
13296500	SALMON RIVER BL YANKEE FORK NR CLAYTON ID	04/28 08:45 MDT	3.68	1,270	--	1,250
13297330	THOMPSON CREEK NR CLAYTON ID	04/28 08:45 MDT	3.58	26.8	--	27.0
13297350	BRUNO CREEK NR CLAYTON ID	04/24 13:15 MDT	2.64	0.26	--	1.10
13297355	Paasasikwana Naokwaide bl Bruno Ck	04/28 08:30 MDT	3.81	53.7	--	46.0
13297380	SALMON RIVER AB EAST FORK NR CLAYTON ID	04/28 09:00 MDT	24.22	1,650	--	836
13302005	PAHSIMEROI RIVER AT ELLIS ID	04/28 09:00 MDT	1.60	222	--	184
13302500	SALMON RIVER AT SALMON ID	04/28 09:00 MDT	2.71	1,700	--	1,890
13304050	Big Timber Creek Abv Mouth at Leadore ID	04/28 08:45 MDT	7.09	3.71	2.7	2.00
13304700	Lemhi River near McFarland, ID	04/28 09:00 MDT	3.39	132	--	---
13305000	LEMHI RIVER NR LEMHI ID	04/28 09:00 MDT	4.07	206	--	246
13305310	LEMHI RIVER BELOW L5 DIVERSION NEAR SALMON, ID	04/28 08:15 MDT	1.89	199	--	156
13306370	PANTHER CREEK AT COBALT, ID	04/28 08:45 MDT	4.95	100	--	172
13306385	NAPIAS CREEK BELOW ARNETT CREEK NEAR LEESBURG, ID	04/28 09:00 MDT	5.76	43.1	--	41.0
13307000	SALMON RIVER NR SHOUP ID	04/28 08:30 MDT	2.90	2,370	11.9	2,800
13309220	MF SALMON RIVER AT MF LODGE NR YELLOW PINE ID	04/28 08:45 MDT	3.39	2,700	--	2,520
13310199	MF SALMON RIVER AT MOUTH NR SHOUP, ID	04/28 08:45 MDT	34.66	4,400	--	4,630
13310700	SF SALMON RIVER NR KRASSEL RANGER STATION ID	04/28 08:45 MDT	4.06	1,020	--	923
13311000	EF OF SF SALMON RIVER AT STIBNITE, ID	04/28 09:00 MDT	5.06	20.8	0.7	32.0
13311250	EFSF SALMON R ABV SUGAR CRK NR STIBNITE, ID	04/28 08:15 MDT	10.69	27.9	--	53.0
13311450	SUGAR CREEK NR STIBNITE, ID	04/28 08:15 MDT	7.13	28.2	1.6	37.0
13313000	JOHNSON CREEK AT YELLOW PINE ID	04/28 09:00 MDT	2.86	357	--	533
13316500	LITTLE SALMON RIVER AT RIGGINS ID	04/28 09:00 MDT	4.97	1,460	--	1,409
13317000	SALMON RIVER AT WHITE BIRD ID	04/28 07:45 PDT	16.30	12,300	--	15,300

Appendix 3

USGS 13311000 EF OF SF SALMON RIVER AT STIBNITE, ID

DESCRIPTION:

Latitude 44°54'20.6", Longitude 115°19'46.2" NAD83
 Valley County, Idaho, Hydrologic Unit 17060208
 Drainage area: 19.3 square miles
 Datum of gage: 6,466 feet above NAVD88.

AVAILABLE DATA:

Data Type	Begin Date	End Date	Count
<u>Current / Historical Observations</u> (availability statement)	1986-10-01	2023-04-28	
<u>Daily Data</u>			
Temperature, water, degrees Celsius	2011-09-21	2023-04-28	7208
Discharge, cubic feet per second	1928-06-15	2023-04-27	15197
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2011-09-21	2023-04-27	7460
pH, water, unfiltered, field, standard units	2011-09-20	2014-09-29	1610
<u>Daily Statistics</u>			
Temperature, water, degrees Celsius	2011-09-21	2023-01-24	2289
Discharge, cubic feet per second	1928-06-15	2022-10-25	15013
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2011-09-21	2022-10-25	2295
<u>Monthly Statistics</u>			
Temperature, water, degrees Celsius	2011-09	2023-01	
Discharge, cubic feet per second	1928-06	2022-10	
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2011-09	2022-10	
<u>Annual Statistics</u>			
Temperature, water, degrees Celsius	2011	2023	
Discharge, cubic feet per second	1928	2023	
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2011	2023	
<u>Peak streamflow</u>	1929-06-16	2022-06-12	41
<u>Field measurements</u>	1982-10-07	2023-04-26	243
<u>Field/Lab water-quality samples</u>	1983-01-25	2022-06-29	179
<u>Water-Year Summary</u>	2011	2022	12
<u>Revisions</u>	Available (site:0) (timeseries:1)		

USGS 13311000 EF OF SF SALMON RIVER AT STIBNITE, ID

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in ft3/s (Calculation Period: 1928-07-01 -> 2022-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1928							29.9	13.4	10	10.5	9.4	8
1929	7	6	6.19	7.27	40.6	96.2	25.1	11	8.73	8.19	7.7	8.74
1930	7.32	7	7.35	21.1	81.9	124	24.6	13.8	11.5	12.3	9.67	7
1931	6	6	8.03	14.8	61.6	24.9	9.68	6.55	6.3	6.65	6.53	6
1932	6	6	6.52	13.7	90.2	128.5	43.5	15.8	12.4	10.1	11.1	7.06
1933	6.65	5.82	6	11.4	41.3	205.6	31.3	15.4	9.43	8.52	8.43	4
1934	5.1	7.71	20	64.9	70.4	30.5	13.3	8.68	9.17	9.06	8.4	8
1935	8	8	8	13.8	60.3	93.5	24	12	10.4	9.29	9.23	6.03
1936	7	7	7	34.6	112.9	71	19.4	10.6	9.07	8	7	7
1937	7	7	7	11.7	66.2	52.6	18.3	9.9	8.8	7.13	6.3	12
1938	6	6	6	22.7	84.3	153.8	47.7	16.7	11.4	12.3	10.1	9
1939	8	7	9	32.5	75.5	34.1	15.4	7.77	7.17	6.9	7.67	8.06
1940	8.45	7.9	9.81	24.7	102.5	62.7	18.1	10.2	12.9	14.5	9.83	7
1941	6	6	7.71	20.2	84.9	67.7	24.4	14.5	12	14	20.5	
1942						100.3	41.1	17.1	13.6	10.7		
1982										18.4	12.8	9.38
1983	8.32	7.04	8.06	12.4	78.1	169.9	69.1	30.8	18.9	16.1	20.2	11.6
1984	8.95	7.21	7.18	14.4	73.1	162.2	72.3	21.5	15.9	11.8	10.4	8.96
1985	8.36	7.49	7.24	22.8	92.6	67.1	19.2	12.5	12.4	11.6	10.5	8.52
1986	7.73	7.98	12.3	31.5	95.6	144.5	32.8	16.4	14.1	12.1	10.4	9.12
1987	8.64	8.25	8.24	24.1	56.1	27.1	14.3	10.5	8.21	7.12	8.2	9.22
1988	7.01	6.52	6.91	19.5	47.6	43.2	13.3	7.6	6.08	5.46	5.87	5.16
1989	4.95	4.77	5.85	17.6	60.5	78.7	22.4	11.3	8.41	8.96	7.44	7.64
1990	7.96	7.36	8.18	26.8	44	62.4	22.7	12.3	9.19	9.16	8.02	6.56
1991	6.7	6.58	5.81	7.63	35.1	87.1	35.7	11.9	8.27	6.72	8.03	6.73
1992	6	6.07	8.95	19.6	56.7	22.8	12.4	7.08	6.49	6.33	6.57	4.84
1993	4.99	5.18	6.71	9.13	93.7	122.7	42.6	18.7	12.4	11.1	8.56	7.82
1994	7.29	6.36	6.64	17.2	51	33	12.7	7.45	6.19	7.25	7.03	6.59
1995	6.33	7.95	9.55	13.7	56.9	141.8	70.5	19.8	11.4	12.1	12.7	15.5
1996	10.1	9.82	9.31	21.5	77.3	194.5	59.4	19.2	14.3	12.6	16.3	13.1
1997	17.3	11.1	11	20.9	130.5	183	56.6	22.5				
2010										12.5	12.8	11.3
2011	10.6	9.79	9.49	11.1	83.9	222.4	95.9	24.4	14.9	15.1	10.9	9.67
2012	9.44	8.8	9.96	57.4	127	114.2	34.1	15.9	11.8	13.6	13.3	13.2

2013	9.43	9.54	10.1	23.3	114.3	66.7	22.7	12.9	15.4	18.8	12.4	9.16
2014	9.2	8.95	11.1	26.5	134	109.2	28.9	16.1	11.5	12.3	12.2	10.4
2015	9.78	11.4	24.5	39	90.5	43.8	18.1	11	9.9	9.51	9.61	8.75
2016	7.44	8.66	10.9	63.1	124.8	68.1	21.3	12	11.2	14.3	16.8	10.3
2017	8.56	11.8	23.5	31.1	168.6	206.3	40.6	18.5	15.1	14.9	19.8	17.9
2018	12.8	11.4	10.3	33.6	181.5	87.2	25	13	9.65	11.7	10.4	8.61
2019	7.92	7.65	7.32	35.1	118.8	112.5	24.7	12.8	10.6	9.79	8.38	7.84
2020	7.61	7.55	7.87	22.6	109.8	112.7	33.3	13.5	10.1	10.6	9.3	8.73
2021	8.32	7.75	8.03	21.2	72.2	52.3	15.5	10.6	8.62	9.93	10.3	8.33
2022	7.64	7.4	10.2	15.5	76.4	146.9	37.6	15.6	10.7			
Mean of monthly Discharge	7.9	7.7	9.3	24	86	101	32	14	11	11	11	8.8

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in ft³/s (Calculation Period: 1928-10-01 -> 1941-09-30)											
	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1928										10.5	9.4	8
1929	7	6	6.19	7.27	40.6	96.2	25.1	11	8.73	8.19	7.7	8.74
1930	7.32	7	7.35	21.1	81.9	124	24.6	13.8	11.5	12.3	9.67	7
1931	6	6	8.03	14.8	61.6	24.9	9.68	6.55	6.3	6.65	6.53	6
1932	6	6	6.52	13.7	90.2	128.5	43.5	15.8	12.4	10.1	11.1	7.06
1933	6.65	5.82	6	11.4	41.3	205.6	31.3	15.4	9.43	8.52	8.43	4
1934	5.1	7.71	20	64.9	70.4	30.5	13.3	8.68	9.17	9.06	8.4	8
1935	8	8	8	13.8	60.3	93.5	24	12	10.4	9.29	9.23	6.03
1936	7	7	7	34.6	112.9	71	19.4	10.6	9.07	8	7	7
1937	7	7	7	11.7	66.2	52.6	18.3	9.9	8.8	7.13	6.3	12
1938	6	6	6	22.7	84.3	153.8	47.7	16.7	11.4	12.3	10.1	9
1939	8	7	9	32.5	75.5	34.1	15.4	7.77	7.17	6.9	7.67	8.06
1940	8.45	7.9	9.81	24.7	102.5	62.7	18.1	10.2	12.9	14.5	9.83	7
1941	6	6	7.71	20.2	84.9	67.7	24.4	14.5	12			
Mean of monthly Discharge	6.8	6.7	8.4	23	75	88	24	12	9.9	9.5	8.6	7.5

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in ft3/s (Calculation Period: 1982-10-01 -> 1996-09-30)											
	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1982										18.4	12.8	9.38
1983	8.32	7.04	8.06	12.4	78.1	169.9	69.1	30.8	18.9	16.1	20.2	11.6
1984	8.95	7.21	7.18	14.4	73.1	162.2	72.3	21.5	15.9	11.8	10.4	8.96
1985	8.36	7.49	7.24	22.8	92.6	67.1	19.2	12.5	12.4	11.6	10.5	8.52
1986	7.73	7.98	12.3	31.5	95.6	144.5	32.8	16.4	14.1	12.1	10.4	9.12
1987	8.64	8.25	8.24	24.1	56.1	27.1	14.3	10.5	8.21	7.12	8.2	9.22
1988	7.01	6.52	6.91	19.5	47.6	43.2	13.3	7.6	6.08	5.46	5.87	5.16
1989	4.95	4.77	5.85	17.6	60.5	78.7	22.4	11.3	8.41	8.96	7.44	7.64
1990	7.96	7.36	8.18	26.8	44	62.4	22.7	12.3	9.19	9.16	8.02	6.56
1991	6.7	6.58	5.81	7.63	35.1	87.1	35.7	11.9	8.27	6.72	8.03	6.73
1992	6	6.07	8.95	19.6	56.7	22.8	12.4	7.08	6.49	6.33	6.57	4.84
1993	4.99	5.18	6.71	9.13	93.7	122.7	42.6	18.7	12.4	11.1	8.56	7.82
1994	7.29	6.36	6.64	17.2	51	33	12.7	7.45	6.19	7.25	7.03	6.59
1995	6.33	7.95	9.55	13.7	56.9	141.8	70.5	19.8	11.4	12.1	12.7	15.5
1996	10.1	9.82	9.31	21.5	77.3	194.5	59.4	19.2	14.3			
Mean of monthly Discharge	7.4	7	7.9	18	66	97	36	15	11	10	9.8	8.4

USGS 13311000 EF OF SF SALMON RIVER AT STIBNITE, ID

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in ft3/s (Calculation Period: 2011-10-01 -> 2022-09-30)											
	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011										15.1	10.9	9.67
2012	9.44	8.8	9.96	57.4	127	114.2	34.1	15.9	11.8	13.6	13.3	13.2
2013	9.43	9.54	10.1	23.3	114.3	66.7	22.7	12.9	15.4	18.8	12.4	9.16
2014	9.2	8.95	11.1	26.5	134	109.2	28.9	16.1	11.5	12.3	12.2	10.4
2015	9.78	11.4	24.5	39	90.5	43.8	18.1	11	9.9	9.51	9.61	8.75
2016	7.44	8.66	10.9	63.1	124.8	68.1	21.3	12	11.2	14.3	16.8	10.3
2017	8.56	11.8	23.5	31.1	168.6	206.3	40.6	18.5	15.1	14.9	19.8	17.9
2018	12.8	11.4	10.3	33.6	181.5	87.2	25	13	9.65	11.7	10.4	8.61
2019	7.92	7.65	7.32	35.1	118.8	112.5	24.7	12.8	10.6	9.79	8.38	7.84
2020	7.61	7.55	7.87	22.6	109.8	112.7	33.3	13.5	10.1	10.6	9.3	8.73
2021	8.32	7.75	8.03	21.2	72.2	52.3	15.5	10.6	8.62	9.93	10.3	8.33
2022	7.64	7.4	10.2	15.5	76.4	146.9	37.6	15.6	10.7			
Mean of monthly Discharge	8.9	9.2	12	33	120	102	27	14	11	13	12	10

USGS 13311250 EFSF SALMON R ABV SUGAR CRK NR STIBNITE, ID

DESCRIPTION:

Latitude 44°56'05.2", Longitude 115°20'12.1" NAD83
 Valley County, Idaho, Hydrologic Unit 17060208
 Datum of gage: 5,944 feet above NAVD88.

AVAILABLE DATA:

Data Type	Begin Date	End Date	Count
<u>Current / Historical Observations</u> (availability statement)	2011-09-15	2023-04-28	
<u>Daily Data</u>			
Temperature, water, degrees Celsius	2012-04-28	2023-04-28	9842
Discharge, cubic feet per second	2011-09-15	2023-04-27	4242
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2012-04-29	2023-04-27	9750
pH, water, unfiltered, field, standard units	2012-04-29	2014-09-30	1618
<u>Daily Statistics</u>			
Temperature, water, degrees Celsius	2012-04-29	2022-10-08	3078
Discharge, cubic feet per second	2011-09-15	2022-10-25	4059
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2012-04-29	2022-10-08	3043
<u>Monthly Statistics</u>			
Temperature, water, degrees Celsius	2012-04	2022-10	
Discharge, cubic feet per second	2011-09	2022-10	
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2012-04	2022-10	
<u>Annual Statistics</u>			
Temperature, water, degrees Celsius	2012	2023	
Discharge, cubic feet per second	2011	2023	
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2012	2023	
<u>Peak streamflow</u>	2012-04-26	2022-06-12	11
<u>Field measurements</u>	2011-09-08	2022-10-26	101
<u>Field/Lab water-quality samples</u>	2011-09-21	2022-06-29	67
<u>Water-Year Summary</u>	2012	2022	11
<u>Revisions</u>	Available (site:0) (timeseries:1)		

USGS 13311250 EFSF SALMON R ABV SUGAR CRK NR STIBNITE, ID

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in ft3/s (Calculation Period: 2011-10-01 -> 2022-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011										18.5	14.1	11.3
2012	11.8	11.3	13.3	74.3	153	131.7	39.1	17.4	13.4	14.2	14.2	15
2013	11.1	11.6	12.3	27.8	137.5	81.2	26.4	14.7	17.6	22.2	14.8	10.9
2014	10.5	10.3	13.5	33	161.8	129.7	35.6	19.5	13.7	15	15.1	13.2
2015	12.1	15.7	34.3	51.8	110.7	54.6	21.5	12.8	10.4	9.74	10	10
2016	8.25	9.33	12.9	84	145.9	83.1	24.3	14	12.4	15.8	18.4	13.1
2017	11.1	16.9	33.7	43.5	204.5	246.5	52.1	20.9	16.3	15.6	22.9	22.1
2018	14.5	13.2	12.2	47.7	220.5	106.4	29.1	16.4	13.2	13.2	11.7	9.32
2019	8.47	8.04	8.43	51.3	151.7	142.6	32.5	17.5	15.1	14.1	11.5	9.88
2020	8.58	9.8	8.82	24	137.5	127.5	38.2	16.6	12.6	11.1	10.7	10.2
2021	9.77	9.32	9.66	25.9	90	65.9	19.7	11.4	9.92	10.9	12.8	10.3
2022	10.2	10	14.1	20.6	102.4	186.8	47.1	18.9	11.6			
Mean of monthly Discharge	11	11	16	44	147	123	33	16	13	15	14	12

USGS 13311450 SUGAR CREEK NR STIBNITE, ID

DESCRIPTION:

Latitude 44°56'10.9", Longitude 115°20'14.0" NAD83
Valley County, Idaho, Hydrologic Unit 17060208
Datum of gage: 5,950 feet above NAVD88.

AVAILABLE DATA:

Data Type	Begin Date	End Date	Count
<u>Current / Historical Observations</u> (availability statement)	2011-09-17	2023-04-28	
<u>Daily Data</u>			
Temperature, water, degrees Celsius	2012-04-29	2023-04-28	6463
Discharge, cubic feet per second	2011-09-17	2023-04-27	4241
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2012-04-29	2023-04-27	6491
pH, water, unfiltered, field, standard units	2012-05-18	2014-09-30	1514
<u>Daily Statistics</u>			
Temperature, water, degrees Celsius	2012-04-29	2022-10-25	1998
Discharge, cubic feet per second	2011-09-17	2022-10-25	4057
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2012-04-29	2022-10-25	1965
<u>Monthly Statistics</u>			
Temperature, water, degrees Celsius	2012-04	2022-10	
Discharge, cubic feet per second	2011-09	2022-10	
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2012-04	2022-10	
<u>Annual Statistics</u>			
Temperature, water, degrees Celsius	2012	2023	
Discharge, cubic feet per second	2011	2023	
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	2012	2023	
<u>Peak streamflow</u>	1969-12-31	2022-06-12	12
<u>Field measurements</u>	2011-09-08	2023-04-26	100
<u>Field/Lab water-quality samples</u>	2011-09-21	2022-06-29	67
<u>Water-Year Summary</u>	2012	2022	11

EFSFSR Below Sugar Creek – Sum of USGS 13311250 & 13311450
(compiled by Nick Gerhardt)

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in ft³/s (Calculation Period: 2011-10-01 -> 2022-09-30)											
	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011										30.7	23.3	18.8
2012	19.3	18.3	22.7	119.9	238.9	209.0	65.2	28.8	22.0	22.6	22.5	23.2
2013	17.9	18.8	20.0	45.7	219.5	133.8	46.0	25.4	28.1	34.3	22.7	17.1
2014	17.2	18.3	22.6	54.9	262.8	212.1	62.4	32.2	22.9	23.9	25.1	22.6
2015	21.4	29.6	59.8	84.9	171.6	91.6	35.8	21.9	17.9	16.8	17.2	16.8
2016	13.9	17.0	23.2	136.7	230.0	136.3	42.3	24.3	20.7	24.6	27.7	20.6
2017	18.1	26.8	55.2	69.3	325.4	373.8	87.9	38.2	29.5	28.3	41.3	35.8
2018	23.6	24.8	20.7	82.9	325.8	176.2	50.8	29.0	22.8	22.1	20.4	15.8
2019	14.8	14.2	16.2	84.2	223.6	208.7	50.7	29.6	23.8	21.9	18.2	16.0
2020	14.1	15.2	15.3	46.7	217.6	220.6	67.5	29.8	22.3	19.8	18.6	17.4
2021	16.5	15.0	18.1	49.7	139.7	111.7	33.8	20.7	17.1	18.4	20.7	16.6
2022	16.6	17.0	26.4	36.6	157.1	296.5	83.2	34.6	22.6			
Mean of monthly Discharge	18	18.7	28	74	228	197	57	28	22.4	24.4	23.2	19.8

USGS 13311450 SUGAR CREEK NR STIBNITE, ID

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in ft3/s (Calculation Period: 2011-10-01 -> 2022-09-30)											
	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011										12.2	9.21	7.53
2012	7.49	7.02	9.37	45.6	85.9	77.3	26.1	11.4	8.63	8.36	8.33	8.21
2013	6.79	7.21	7.68	17.9	82	52.6	19.6	10.7	10.5	12.1	7.86	6.17
2014	6.66	6.71	9.07	21.9	101	82.4	26.8	12.7	9.16	8.92	9.96	9.42
2015	9.29	13.9	25.5	33.1	60.9	37	14.3	9.14	7.52	7.06	7.19	6.79
2016	5.68	7.67	10.3	52.7	84.1	53.2	18	10.3	8.3	8.82	9.32	7.55
2017	7.01	9.92	21.5	25.8	120.9	127.3	35.8	17.3	13.2	12.7	18.4	13.7
2018	9.09	7.95	8.46	35.2	105.3	69.8	21.8	12.6	9.58	8.92	8.71	6.5
2019	6.28	6.15	7.75	32.9	71.9	66.1	21.6	12.1	8.65	7.76	6.69	6.08
2020	5.56	5.4	6.45	22.7	80.1	93.1	29.3	13.2	9.7	8.71	7.89	7.24
2021	6.77	5.69	8.47	23.8	49.7	45.8	14.1	9.32	7.21	7.55	7.86	6.27
2022	6.42	6.98	12.3	16	54.7	109.7	36.1	15.7	11			
Mean of monthly Discharge	7	7.7	12	30	81	74	24	12	9.4	9.4	9.2	7.8

Appendix 4

**WUAs vs Flow Calculations to assess effects of Water Withdrawals
on 3 ESA-Listed Salmonid Species in the
EFSFSR Downstream From Sugar Creek**

> 50% reduction in WUA
10 to 49.9% reduction in WUA

5 to 9.9% reduction in WUA
< 5% reduction in WUA

Species	Life Stage	Discharge cfs	Description	Equation (Multiplier)		
Steelhead	Adult	57	July Mean	$y = 2958.9 \ln(x) - 2720.7$		
		28	Aug Mean	2958.9	4.043051	-2720.7
		22.4	Sept Mean	2958.9	3.332205	-2720.7
		15.5	24hr 10-year Low	2958.9	3.109061	-2720.7
	Spawning	57	July Mean	$y = 2567.2 \ln(x) - 1419.4$		
		28	Aug Mean	2567.2	4.043051	-1419.4
		22.4	Sept Mean	2567.2	3.332205	-1419.4
		15.5	24hr 10-year Low	2567.2	3.109061	-1419.4
	Fry	57	July Mean	$y = 1646 \ln(x) + 6683.7$		
		28	Aug Mean	1646	4.043051	6683.7
		22.4	Sept Mean	1646	3.332205	6683.7
		15.5	24hr 10-year Low	1646	3.109061	6683.7
	Juvenile	57	July Mean	$y = 2911.6 \ln(x) + 1683.7$		
		28	Aug Mean	2911.6	4.043051	1683.7
		22.4	Sept Mean	2911.6	3.332205	1683.7
		15.5	24hr 10-year Low	2911.6	3.109061	1683.7
		57	July Mean	2911.6	2.74084	1683.7
		28	Aug Mean	2911.6	2.74084	1683.7
		22.4	Sept Mean	2911.6	2.74084	1683.7
		15.5	24hr 10-year Low	2911.6	2.74084	1683.7

WUA
(No Withdrawal)

Substract 11.14 cfs

II
Equation (Multiplier)

WUA_2 % WUA change

9242.284396
7138.959925
6478.700471
5389.171547

45.86
16.86
11.26
4.36

$$y = 2958.9 \ln(x) - 2720.7$$

2958.9 3.825593 -2720.7
2958.9 2.824944 -2720.7
2958.9 2.421257 -2720.7
2958.9 1.472472 -2720.7

8598.848 -6.96188
5638.027 -21.0245
4443.556 -31.4128
1636.198 -69.6392

8959.921215
7135.035419
6562.181294
5616.884509

45.86
16.86
11.26
4.36

$$y = 2567.2 \ln(x) - 1419.4$$

2567.2 3.825593 -1419.4
2567.2 2.824944 -1419.4
2567.2 2.421257 -1419.4
2567.2 1.472472 -1419.4

8401.663 -6.23061
5832.796 -18.2513
4796.45 -26.9077
2360.73 -57.9708

13338.56239
12168.50862
11801.21434
11195.12268

45.86
16.86
11.26
4.36

$$y = 1646 \ln(x) + 6683.7$$

1646 3.825593 6683.7
1646 2.824944 6683.7
1646 2.421257 6683.7
1646 1.472472 6683.7

12980.63 -2.68347
11333.56 -6.86157
10669.09 -9.5933
9107.389 -18.6486

13455.44807
11385.74665
10736.04189
9663.929814

45.86
16.86
11.26
4.36

$$y = 2911.6 \ln(x) + 1683.7$$

2911.6 3.825593 1683.7
2911.6 2.824944 1683.7
2911.6 2.421257 1683.7
2911.6 1.472472 1683.7

12822.3 -4.70553
9908.807 -12.9718
8733.431 -18.6532
5970.95 -38.2141

Subtract 20% from cfs (Low Flows Only)	III Equation (Multiplier)	WUA_3	% WUA change	Subtract 2
	$y = 2958.9 \ln(x) - 2720.7$			
45.6				54.5
22.4				25.5
17.92	2958.9 2.885917 -2720.7	5818.441	-10.1912	19.9
12.4	2958.9 2.517696 -2720.7	4728.912	-12.2516	13
	$y = 2567.2 \ln(x) - 1419.4$			
45.6				54.5
22.4				25.5
17.92	2567.2 2.885917 -1419.4	5989.327	-8.72963	19.9
12.4	2567.2 2.517696 -1419.4	5044.03	-10.1988	13
	$y = 1646 \ln(x) + 6683.7$			
45.6				54.5
22.4				25.5
17.92	1646 2.885917 6683.7	11433.92	-3.11234	19.9
12.4	1646 2.517696 6683.7	10827.83	-3.28084	13
	$y = 2911.6 \ln(x) + 1683.7$			
45.6				54.5
22.4				25.5
17.92	2911.6 2.885917 1683.7	10086.34	-6.05162	19.9
12.4	2911.6 2.517696 1683.7	9014.225	-6.72299	13

IV					
.5 cfs	Equation (Multiplier)			WUA_4	% WUA change
y=2958.9ln(x)-2720.7					
	2958.9	3.998201	-2720.7	9109.576	-1.43588
	2958.9	3.238678	-2720.7	6862.226	-3.87639
	2958.9	2.99072	-2720.7	6128.541	-5.40479
	2958.9	2.564949	-2720.7	4868.729	-9.6572
y=2567.2ln(x)-1419.4					
	2567.2	3.998201	-1419.4	8844.781	-1.28506
	2567.2	3.238678	-1419.4	6894.935	-3.36509
	2567.2	2.99072	-1419.4	6258.376	-4.62964
	2567.2	2.564949	-1419.4	5165.338	-8.03909
y=1646ln(x)+6683.7					
	1646	3.998201	6683.7	13264.74	-0.55346
	1646	3.238678	6683.7	12014.56	-1.2651
	1646	2.99072	6683.7	11606.42	-1.65059
	1646	2.564949	6683.7	10905.61	-2.58609
y=2911.6ln(x)+1683.7					
	2911.6	3.998201	1683.7	13324.86	-0.97051
	2911.6	3.238678	1683.7	11113.44	-2.39168
	2911.6	2.99072	1683.7	10391.48	-3.2094
	2911.6	2.564949	1683.7	9151.807	-5.29933

>50% reduction in WUA
10 to 49.9% reduction in WUA

5 to 9.9% reduction in WUA
<5% reduction in WUA

Species	Life Stage	Discharge cfs	Description	Equation (Multiplier)			
Bull Trout	Adult	57	July Mean	$y = 1454.4 \ln(x) - 1184.1$			
		28	Aug Mean	1454.4	4.043051	-1184.1	
		22.4	Sept Mean	1454.4	3.332205	-1184.1	
		15.5	24hr 10-year Low	1454.4	3.109061	-1184.1	
	Spawning	57	July Mean	$y = 0.0112x^3 - 2.9082x^2 + 225.38x + 715.26$			
		28	Aug Mean	2074.162	-9448.74	12846.66	715.26
		22.4	Sept Mean	245.8624	-2280.03	6310.64	715.26
		15.5	24hr 10-year Low	125.8815	-1459.22	5048.512	715.26
	Juvenile	57	July Mean	$y = 1934.4 \ln(x) - 269.92$			
		28	Aug Mean	1934.4	4.043051	-269.92	
		22.4	Sept Mean	1934.4	3.332205	-269.92	
		15.5	24hr 10-year Low	1934.4	3.109061	-269.92	

WUA
(No Withdrawal)

Substract 11.14 cfs

II
Equation (Multiplier)

WUA_2 % WUA change

$$y = 1454.4 \ln(x) - 1184.1$$

4696.113764	45.86	1454.4	3.825593	-1184.1	4379.843	-6.73474
3662.25824	16.86	1454.4	2.824944	-1184.1	2924.498	-20.1449
3337.718259	11.26	1454.4	2.421257	-1184.1	2337.376	-29.9709
2802.177731	4.36	1454.4	1.472472	-1184.1	957.4634	-65.8315

$$y = 0.0112x^3 - 2.9082x^2 + 225.38x + 715.26$$

6187.3398	45.86	1080.24	-6116.35	10335.93	715.26	6015.076	-2.78413
4991.7336	16.86	53.67731	-826.684	3799.907	715.26	3742.16	-25.0329
4430.435117	11.26	15.98944	-368.724	2537.779	715.26	2900.305	-34.5368
3551.66235	4.36	0.928277	-55.2837	982.6568	715.26	1643.561	-53.7242

$$y = 1934.4 \ln(x) - 269.92$$

7550.958372	45.86	1934.4	3.825593	-269.92	7130.308	-5.57083
6175.896404	16.86	1934.4	2.824944	-269.92	5194.652	-15.8883
5744.247519	11.26	1934.4	2.421257	-269.92	4413.759	-23.1621
5031.960942	4.36	1934.4	1.472472	-269.92	2578.43	-48.7589

Substract 20% from cfs
(Low Flows Only)

III

Equation (Multiplier)

WUA_3

% WUA change

Substract 2

$$y = 1454.4 \ln(x) - 1184.1$$

45.6							54.5
22.4							25.5
17.92	1454.4	2.885917	-1184.1	3013.178	-9.72341		19.9
12.4	1454.4	2.517696	-1184.1	2477.638	-11.5817		13

$$y = 0.0112x^3 - 2.9082x^2 + 225.38x + 715.26$$

45.6							54.5
22.4							25.5
17.92	64.45135	-933.9	4038.81	715.26	3884.621	-12.3196	19.9
12.4	21.35419	-447.165	2794.712	715.26	3084.161	-13.1629	13

$$y = 1934.4 \ln(x) - 269.92$$

45.6							54.5
22.4							25.5
17.92	1934.4	2.885917	-269.92	5312.599	-7.51445		19.9
12.4	1934.4	2.517696	-269.92	4600.312	-8.57814		13

.5 cfs	IV			WUA_4	% WUA change	
	Equation (Multiplier)					
	$y = 1454.4 \ln(x) - 1184.1$					
	1454.4	3.998201	-1184.1	4630.883	-1.38903	
	1454.4	3.238678	-1184.1	3526.234	-3.71422	
	1454.4	2.99072	-1184.1	3165.603	-5.15668	
	1454.4	2.564949	-1184.1	2546.362	-9.12916	
	$y = 0.0112x^3 - 2.9082x^2 + 225.38x + 715.26$					
	1813.041	-8638.08	12283.21	715.26	6173.43	-0.22482
	185.7114	-1891.06	5747.19	715.26	4757.104	-4.70036
	88.26271	-1151.68	4485.062	715.26	4136.908	-6.62523
	24.6064	-491.486	2929.94	715.26	3178.321	-10.5117
	$y = 1934.4 \ln(x) - 269.92$					
	1934.4	3.998201	-269.92	7464.199	-1.14898	
	1934.4	3.238678	-269.92	5994.98	-2.9294	
	1934.4	2.99072	-269.92	5515.328	-3.98519	
	1934.4	2.564949	-269.92	4691.718	-6.76164	

>50% reduction in WUA
10 to 49.9% reduction in WUA

5 to 9.9% reduction in WUA
<5% reduction in WUA

Species	Life Stage	Discharge cfs	Description	Equation (Multiplier)		
Chinook Salmon	Adult	57	July Mean	$y = 2958.9 \ln(x) - 2720.7$		
		28	Aug Mean	2958.9	4.043051	-2720.7
		22.4	Sept Mean	2958.9	3.332205	-2720.7
		15.5	24hr 10-year Low	2958.9	3.109061	-2720.7
	Spawning	57	July Mean	$y = 2567.2 \ln(x) - 1419.4$		
		28	Aug Mean	2567.2	4.043051	-1419.4
		22.4	Sept Mean	2567.2	3.332205	-1419.4
		15.5	24hr 10-year Low	2567.2	3.109061	-1419.4
	Fry	57	July Mean	$y = 830.63 \ln(x) + 934.14$		
		28	Aug Mean	830.63	4.043051	934.14
		22.4	Sept Mean	830.63	3.332205	934.14
		15.5	24hr 10-year Low	830.63	3.109061	934.14
	Juvenile	57	July Mean	$y = 1548.4 \ln(x) - 1182.4$		
		28	Aug Mean	1548.4	4.043051	-1182.4
		22.4	Sept Mean	1548.4	3.332205	-1182.4
		15.5	24hr 10-year Low	1548.4	3.109061	-1182.4

WUA
(No Withdrawal)

Substract 11.14 cfs

II
Equation (Multiplier)

WUA_2 % WUA change

9242.284396
7138.959925
6478.700471
5389.171547

45.86
16.86
11.26
4.36

$y = 2958.9 \ln(x) - 2720.7$
2958.9 3.825593 -2720.7
2958.9 2.824944 -2720.7
2958.9 2.421257 -2720.7
2958.9 1.472472 -2720.7

8598.848 -6.96188
5638.027 -21.0245
4443.556 -31.4128
1636.198 -69.6392

8959.921215
7135.035419
6562.181294
5616.884509

45.86
16.86
11.26
4.36

$y = 2567.2 \ln(x) - 1419.4$
2567.2 3.825593 -1419.4
2567.2 2.824944 -1419.4
2567.2 2.421257 -1419.4
2567.2 1.472472 -1419.4

8401.663 -6.23061
5832.796 -18.2513
4796.45 -26.9077
2360.73 -57.9708

4292.419675
3701.969032
3516.619304
3210.763949

45.86
16.86
11.26
4.36

$y = 830.63 \ln(x) + 934.14$
830.63 3.825593 934.14
830.63 2.824944 934.14
830.63 2.421257 934.14
830.63 1.472472 934.14

4111.793 -4.20805
3280.623 -11.3817
2945.308 -16.246
2157.219 -32.8129

5077.860583
3977.185464
3631.669989
3061.516693

45.86
16.86
11.26
4.36

$y = 1548.4 \ln(x) - 1182.4$
1548.4 3.825593 -1182.4
1548.4 2.824944 -1182.4
1548.4 2.421257 -1182.4
1548.4 1.472472 -1182.4

4741.149 -6.63098
3191.743 -19.7487
2566.674 -29.3252
1097.576 -64.1493

Subtract 20% from cfs (Low Flows Only)	III Equation (Multiplier)	WUA_3	% WUA change	Subtract 2
	$y = 2958.9 \ln(x) - 2720.7$			
45.6				54.5
22.4				25.5
17.92	2958.9 2.885917 -2720.7	5818.441	-10.1912	19.9
12.4	2958.9 2.517696 -2720.7	4728.912	-12.2516	13
	$y = 2567.2 \ln(x) - 1419.4$			
45.6				54.5
22.4				25.5
17.92	2567.2 2.885917 -1419.4	5989.327	-8.72963	19.9
12.4	2567.2 2.517696 -1419.4	5044.03	-10.1988	13
	$y = 830.63 \ln(x) + 934.14$			
45.6				54.5
22.4				25.5
17.92	830.63 2.885917 934.14	3331.27	-5.27068	19.9
12.4	830.63 2.517696 934.14	3025.414	-5.77276	13
	$y = 1548.4 \ln(x) - 1182.4$			
45.6				54.5
22.4				25.5
17.92	1548.4 2.885917 -1182.4	3286.155	-9.51396	19.9
12.4	1548.4 2.517696 -1182.4	2716.001	-11.2858	13

.5 cfs	IV			WUA_4	% WUA change
	Equation (Multiplier)				
	$y = 2958.9 \ln(x) - 2720.7$				
	2958.9 3.998201 -2720.7			9109.576	-1.43588
	2958.9 3.238678 -2720.7			6862.226	-3.87639
	2958.9 2.99072 -2720.7			6128.541	-5.40479
	2958.9 2.564949 -2720.7			4868.729	-9.6572
	$y = 2567.2 \ln(x) - 1419.4$				
	2567.2 3.998201 -1419.4			8844.781	-1.28506
	2567.2 3.238678 -1419.4			6894.935	-3.36509
	2567.2 2.99072 -1419.4			6258.376	-4.62964
	2567.2 2.564949 -1419.4			5165.338	-8.03909
	$y = 830.63 \ln(x) + 934.14$				
	830.63 3.998201 934.14			4255.165	-0.86791
	830.63 3.238678 934.14			3624.283	-2.09849
	830.63 2.99072 934.14			3418.322	-2.79523
	830.63 2.564949 934.14			3064.664	-4.55032
	$y = 1548.4 \ln(x) - 1182.4$				
	1548.4 3.998201 -1182.4			5008.414	-1.36764
	1548.4 3.238678 -1182.4			3832.37	-3.64116
	1548.4 2.99072 -1182.4			3448.43	-5.0456
	1548.4 2.564949 -1182.4			2789.168	-8.89589

Appendix 5

**WUAs vs Flow Calculations to assess effects of Water Withdrawals
on 3 ESA-Listed Salmonid Species in the
EFSFSR Upstream From Sugar Creek**

> 50% reduction in WUA
10 to 49.9% reduction in WUA

5 to 9.9% reduction in WUA
< 5% reduction in WUA

Species	Life Stage	Discharge cfs	Description	Equation (Multiplier)		
Steelhead	Adult	33	July Mean	$y = 2363 \ln(x) - 2172.8$		
		16	Aug Mean	2363	3.496508	-2172.8
		13	Sept Mean	2363	2.772589	-2172.8
		8.97	24hr 10-year Low	2363	2.564949	-2172.8
	Spawning	33	July Mean	$y = 2050.2 \ln(x) - 1133.5$		
		16	Aug Mean	2050.2	3.496508	-1133.5
		13	Sept Mean	2050.2	2.772589	-1133.5
		8.97	24hr 10-year Low	2050.2	2.564949	-1133.5
	Fry	33	July Mean	$y = 1314.5 \ln(x) + 5337.6$		
		16	Aug Mean	1314.5	3.496508	5337.6
		13	Sept Mean	1314.5	2.772589	5337.6
		8.97	24hr 10-year Low	1314.5	2.564949	5337.6
	Juvenile	33	July Mean	$y = 2325.2 \ln(x) + 1344.6$		
		16	Aug Mean	2325.2	3.496508	1344.6
		13	Sept Mean	2325.2	2.772589	1344.6
		8.97	24hr 10-year Low	2325.2	2.564949	1344.6

WUA
(No Withdrawal)

Substract 11.14 cfs

II
Equation (Multiplier)

WUA_2 % WUA change

6089.447368
4378.827151
3888.175332
3011.351853

21.86
4.86
1.86
0

$y = 2363 \ln(x) - 2172.8$
2363 3.084658 -2172.8
2363 1.581038 -2172.8
2363 0.620576 -2172.8
2363 #NUM! -2172.8

5116.248 -15.9817
1563.194 -64.3011
-706.378 -118.167
0 -100

6035.039803
4550.861398
4125.159173
3364.404413

21.86
4.86
1.86
0

$y = 2050.2 \ln(x) - 1133.5$
2050.2 3.084658 -1133.5
2050.2 1.581038 -1133.5
2050.2 0.620576 -1133.5
2050.2 #NUM! -1133.5

5190.667 -13.9912
2107.945 -53.6803
138.8059 -96.6351
0 -100

9933.75919
8982.167875
8709.22593
8221.462721

21.86
4.86
1.86
0

$y = 1314.5 \ln(x) + 5337.6$
1314.5 3.084658 5337.6
1314.5 1.581038 5337.6
1314.5 0.620576 5337.6
1314.5 #NUM! 5337.6

9392.384 -5.44986
7415.875 -17.4378
6153.348 -29.3468
0 -100

9474.679382
7791.423297
7308.620246
6445.822974

21.86
4.86
1.86
0

$y = 2325.2 \ln(x) + 1344.6$
2325.2 3.084658 1344.6
2325.2 1.581038 1344.6
2325.2 0.620576 1344.6
2325.2 #NUM! 1344.6

8517.048 -10.1073
5020.831 -35.5595
2787.564 -61.8592
0 -100

Subtract 2.5 cfs		III Equation (Multiplier)			WUA_3	% WUA change
y=2363ln(x)-2172.8						
30.5	2363	3.417727	-2172.8	5903.288	-3.05708	
13.5	2363	2.60269	-2172.8	3977.356	-9.16847	
10.5	2363	2.351375	-2172.8	3383.5	-12.9798	
6.47	2363	1.867176	-2172.8	2239.337	-25.6368	
y=2050.2ln(x)-1133.5						
30.5	2050.2	3.417727	-1133.5	5873.523	-2.67631	
13.5	2050.2	2.60269	-1133.5	4202.534	-7.65409	
10.5	2050.2	2.351375	-1133.5	3687.29	-10.6146	
6.47	2050.2	1.867176	-1133.5	2694.584	-19.909	
y=1314.5ln(x)+5337.6						
30.5	1314.5	3.417727	5337.6	9830.202	-1.04248	
13.5	1314.5	2.60269	5337.6	8758.836	-2.4864	
10.5	1314.5	2.351375	5337.6	8428.483	-3.22351	
6.47	1314.5	1.867176	5337.6	7792.003	-5.22364	
y=2325.2ln(x)+1344.6						
30.5	2325.2	3.417727	1344.6	9291.498	-1.93338	
13.5	2325.2	2.60269	1344.6	7396.374	-5.07031	
10.5	2325.2	2.351375	1344.6	6812.018	-6.79475	
6.47	2325.2	1.867176	1344.6	5686.158	-11.7854	

> 50% reduction in WUA
10 to 49.9% reduction in WUA

5 to 9.9% reduction in WUA
< 5% reduction in WUA

Species	Life Stage	Discharge cfs	Description	Equation (Multiplier)			
Bull Trout	Adult	33	July Mean	1161.5	3.496508	-945.62	
		16	Aug Mean	1161.5	2.772589	-945.62	
		13	Sept Mean	1161.5	2.564949	-945.62	
		8.97	24hr 10-year Low	1161.5	2.193886	-945.62	
	Spawning	33	July Mean	323.433	-2528.66	5939.67	571.21
		16	Aug Mean	36.864	-594.432	2879.84	571.21
		13	Sept Mean	19.773	-392.418	2339.87	571.21
		8.97	24hr 10-year Low	6.495608	-186.83	1614.51	571.21
	Juvenile	33	July Mean	1544.8	3.496508	-215.56	
		16	Aug Mean	1544.8	2.772589	-215.56	
		13	Sept Mean	1544.8	2.564949	-215.56	
		8.97	24hr 10-year Low	1544.8	2.193886	-215.56	

I

$$y = 0.009x^3 - 2.3225x^2 + 179.99x + 571.21$$

$$y = 1544.8 \ln(x) - 215.56$$

WUA
(No Withdrawal)

Substract 11.14 cfs

II

Equation (Multiplier)

WUA_2

% WUA change

3115.573533
2274.741801
2033.568679
1602.578213

21.86
4.86
1.86
0

1161.5 3.084658 -945.62
1161.5 1.581038 -945.62
1161.5 0.620576 -945.62
1161.5 #NUM! -945.62

2637.211 -15.3539
890.7561 -60.8414
-224.82 -111.055
0 -100

$$y = 0.009x^3 - 2.3225x^2 + 179.99x + 571.21$$

4305.655
2893.482
2538.435
2005.385699

21.86
4.86
1.86
0

94.0141 -1109.59 3934.581
1.033121 -54.8447 874.7514
0.057914 -8.03319 334.7814
0 0 0

571.21 3490.216 -18.9388
571.21 1392.15 -51.8867
571.21 898.0161 -64.6232
571.21 571.21 -71.5162

$$y = 1544.8 \ln(x) - 215.56$$

5185.844881
4067.535058
3746.773767
3173.554592

21.86
4.86
1.86
0

1544.8 3.084658 -215.56
1544.8 1.581038 -215.56
1544.8 0.620576 -215.56
1544.8 #NUM! -215.56

4549.62 -12.2685
2226.828 -45.2536
743.1066 -80.1668
0 -100

Substract 2.5 cfs	III				WUA_3	% WUA change
	Equation (Multiplier)					
30.5	1161.5	3.417727	-945.62		3024.07	-2.93699
13.5	1161.5	2.60269	-945.62		2077.404	-8.67517
10.5	1161.5	2.351375	-945.62		1785.502	-12.1986
6.47	1161.5	1.867176	-945.62		1223.105	-23.6789
$y=0.009x^3-2.3225x^2+179.99x+571.21$						
30.5	255.3536	-2160.04	5489.695	571.21	4156.218	-3.47071
13.5	22.14338	-423.185	2429.865	571.21	2600.034	-10.1417
10.5	10.41863	-256.001	1889.895	571.21	2215.523	-12.7209
6.47	2.43756	-97.201	1164.535	571.21	1640.982	-18.1713
$y=1544.8\ln(x)-215.56$						
30.5	1544.8	3.417727	-215.56		5064.144	-2.34679
13.5	1544.8	2.60269	-215.56		3805.075	-6.45256
10.5	1544.8	2.351375	-215.56		3416.844	-8.80569
6.47	1544.8	1.867176	-215.56		2668.854	-15.9033

> 50% reduction in WUA
10 to 49.9% reduction in WUA

5 to 9.9% reduction in WUA
< 5% reduction in WUA

Species	Life Stage	Discharge cfs	Description	Equation (Multiplier)		
Chinook Salmon	Adult	33	July Mean	$y = 2054.8 \ln(x) - 1889.4$		
		16	Aug Mean	2054.8	3.496508	-1889.4
		13	Sept Mean	2054.8	2.772589	-1889.4
		8.97	24hr 10-year Low	2054.8	2.564949	-1889.4
	Spawning	33	July Mean	$y = 1782.7 \ln(x) - 985.68$		
		16	Aug Mean	1782.7	3.496508	-985.68
		13	Sept Mean	1782.7	2.772589	-985.68
		8.97	24hr 10-year Low	1782.7	2.564949	-985.68
	Fry	33	July Mean	$y = 576.83 \ln(x) + 648.71$		
		16	Aug Mean	576.83	3.496508	648.71
		13	Sept Mean	576.83	2.772589	648.71
		8.97	24hr 10-year Low	576.83	2.564949	648.71
	Juvenile	33	July Mean	$y = 1075.2 \ln(x) - 821.09$		
		16	Aug Mean	1075.2	3.496508	-821.09
		13	Sept Mean	1075.2	2.772589	-821.09
		8.97	24hr 10-year Low	1075.2	2.564949	-821.09

WUA
(No Withdrawal)

Substract 11.14 cfs

II
Equation (Multiplier)

WUA_2 % WUA change

5295.223737
3807.715306
3381.05794
2618.596287

21.86
4.86
1.86
0

$y = 2054.8 \ln(x) - 1889.4$

2054.8 3.084658 -1889.4
2054.8 1.581038 -1889.4
2054.8 0.620576 -1889.4
2054.8 #NUM! -1889.4

4448.956 -15.9817
1359.318 -64.301
-614.239 -118.167
0 -100

5247.54403
3957.013915
3586.85522
2925.359995

21.86
4.86
1.86
0

$y = 1782.7 \ln(x) - 985.68$

1782.7 3.084658 -985.68
1782.7 1.581038 -985.68
1782.7 0.620576 -985.68
1782.7 #NUM! -985.68

4513.341 -13.9914
1832.837 -53.6813
120.6217 -96.6371
0 -100

2665.600457
2248.022353
2128.249738
1914.209075

21.86
4.86
1.86
0

$y = 576.83 \ln(x) + 648.71$

576.83 3.084658 648.71
576.83 1.581038 648.71
576.83 0.620576 648.71
576.83 #NUM! 648.71

2428.034 -8.91232
1560.7 -30.5745
1006.677 -52.6993
0 -100

2938.35493
2159.997394
1936.743549
1537.775879

21.86
4.86
1.86
0

$y = 1075.2 \ln(x) - 821.09$

1075.2 3.084658 -821.09
1075.2 1.581038 -821.09
1075.2 0.620576 -821.09
1075.2 #NUM! -821.09

2495.535 -15.0703
878.8425 -59.3128
-153.846 -107.944
0 -100

Subtract 2.5 cfs		Equation (Multiplier)			WUA_3	% WUA change
III						
y=2054.8ln(x)-1889.4						
30.5	2054.8	3.417727	-1889.4	5133.345	-3.05707	
13.5	2054.8	2.60269	-1889.4	3458.607	-9.16845	
10.5	2054.8	2.351375	-1889.4	2942.206	-12.9797	
6.47	2054.8	1.867176	-1889.4	1947.273	-25.6367	
y=1782.7ln(x)-985.68						
30.5	1782.7	3.417727	-985.68	5107.101	-2.67635	
13.5	1782.7	2.60269	-985.68	3654.135	-7.65423	
10.5	1782.7	2.351375	-985.68	3206.117	-10.6148	
6.47	1782.7	1.867176	-985.68	2342.935	-19.9095	
y=576.83ln(x)+648.71						
30.5	576.83	3.417727	648.71	2620.157	-1.7048	
13.5	576.83	2.60269	648.71	2150.019	-4.35951	
10.5	576.83	2.351375	648.71	2005.054	-5.7886	
6.47	576.83	1.867176	648.71	1725.753	-9.8451	
y=1075.2ln(x)-821.09						
30.5	1075.2	3.417727	-821.09	2853.65	-2.88274	
13.5	1075.2	2.60269	-821.09	1977.322	-8.45721	
10.5	1075.2	2.351375	-821.09	1707.109	-11.8568	
6.47	1075.2	1.867176	-821.09	1186.498	-22.8433	