SYSTEM OPERATIONAL REQUEST: #2022-4

Bureau of Reclamation – Columbia-Pacific Northwest – Interior Region 9

The following SOR was developed and is supported by the Idaho Department of Fish and Game

This SOR is also supported by: Idaho Governor's Office of Species Conservation; Henry's Fork Foundation; Committee of Nine – Water District 01

FROM: Jonathan D. Ebel, Idaho Department of Fish and Game

DATE: May 17, 2022

SUBJECT: Palisades Powerhead Water delivery for flow augmentation in 2022

SPECIFICATIONS: We request that the remaining Palisades Powerhead water in the Bureau of Reclamation reservoirs of the Snake River system above Milner Dam (53.3 kaf) be held in the storage system in 2022.

JUSTIFICATION:
Current water supply forecasts show continued drought in the Snake River basin, particularly in east Idaho, northwest Wyoming, and across the Snake River Plain. As a result, the Bureau of Reclamation will be unable to release the full volume of flow augmentation water described in the 2007 Upper Snake River Biological Assessment and 2008 Upper Snake River Biological Opinion (i.e., 427-487 kaf).

Extreme hot and dry conditions in 2021 resulted in November 01 active storage carryover in the reservoirs of the Snake River above Milner of approximately 827 kaf. The current Bureau of Reclamation May – July forecast for the Snake River above Heise is 2.2 MAF, or 76% of the 30 year average. Compounding the impact of low active carryover from water year 2021 was the release of ~94 kaf of Palisades Powerhead water in 2021 – a spring delivery in May 2021 and a summer delivery in late June – early July 2021 to meet federal salmon flow augmentation obligations. Depending on summer 2022 conditions, system storage in late summer and early fall 2022 may reach extremely low levels with potential serious, long-term consequences for resident fishes, particularly native fishes in the South Fork Snake River. Keeping Palisades powerhead water in the system rather than releasing it for salmon flow augmentation would allow for higher water levels in Palisades Reservoir and other reservoirs in late summer because it cannot be used for irrigation.

Potential impacts of <u>not implementing</u> the requested operation to Yellowstone Cutthroat Trout in the South Fork Snake River
The South Fork Snake River below Palisades Reservoir supports one of the few remaining large-river populations of Yellowstone Cutthroat Trout and one of the nation's premier wild native trout fisheries. This population is unique across its range in that it maintains all life history

strategies including mainstem spawners and residents, tributary residents, and tributary spawning individuals with extensive fluvial migrations. The Idaho Department of Fish and Game (IDFG) has monitored this population for years (Figure 1; P. Kennedy and B. High, *personal communication*; Oldemeyer and Van Kirk 2018; McCormick and High 2020) and conducted numerous management actions to reverse the long-term decline of this population following hydrologic alteration and Rainbow Trout invasion (Figure 1; P. Kennedy and B. High, IDFG, *personal communication*).

The low carryover in the upper Snake River after the 2021 water year combined with a another year of low water supply in 2022 threatens native Yellowstone Cutthroat Trout by increasing the probability of a high magnitude sediment mobilization event at Palisades Reservoir and consequent deposition in Yellowstone Cutthroat Trout habitats in the South Fork Snake River. As reservoir storage declines to zero, the inflowing water mobilizes fine sediments that have accumulated on the reservoir bottom and export those sediments to lotic habitats below the dam. Controlled reservoir flushing is an increasingly studied technique in some systems to manage sediment accumulation (Espa et al. 2019); however, such releases are intensely monitored and target high flow periods or use a nearby reservoir dilution release to minimize deposition in nearby stream reaches. In the present case of the South Fork Snake River, sediment mobilized as water deliveries decline in late summer and early fall would likely be deposited in both primary and margin stream channel habitats below Palisades Dam with no ability to mitigate in the near term.

High rates of sedimentation at low flows can alter geomorphic characteristics and functions of river ecosystems by reducing pool depth and causing fine sediment infiltration into existing gravels (e.g., Evans and Wilcox 2014) with consequences for biological functions. High sedimentation can reduce basal ecosystem productivity and organic matter processing (e.g., Macarelli et al. 2015), alter macroinvertebrate communities by decreasing abundance, species richness and evenness (e.g., Relyea et al 2012; Quadroni et al. 2016), and impact the availability of juvenile fish habitat (Griffith and Smith 1993; reviewed by Cunjak 1996). Griffith and Smith (1993) found that juvenile cutthroat trout density in the South Fork Snake River is dramatically lower in habitats with embedded substrate. These processes have long-term impacts on fish population carrying capacity by reducing suitable habitat and prey availability for resident trout.

Sedimentation events are difficult to reverse and are damaging to aquatic health and fisheries (Gamblin et al. 1993; Sepulveda et al. 2015). For example, the emptying of Island Park Reservoir during the 1992 drought resulted in 90,000 tons of sediment being released from Island Park Reservoir and deposited in the Henry's Fork (i.e., North Fork of the Snake River) through the well renowned river reaches of Box Canyon, Last Chance, and the Harriman State Park. Initial efforts to remove sediments largely failed (Gamblin et al. 1993) and sediment from that event is still present in some areas. Another catastrophic sediment release in Idaho occurred on the Lower Payette River in 2013 when the Bureau of Reclamation drafted Black Canyon Reservoir to 2440' to study the ability to increase hydropower production, which had severe impacts to habitats and fish populations both in the reservoir and downstream (Kozfkay and Ward 2013).

Information from water quality sensors recently installed by the Henry's Fork Foundation at two sites in the South Fork Snake River suggest that drafting Palisades Reservoir to low levels may trigger a sediment mobilization event in 2022. Turbidity below Palisades Reservoir increased at the end of the summer 2021 as the reservoir reached its minimum volume (Figure 2) indicating that lower reservoir storage volumes could mobilize ecologically and socially significant amounts of sediment when the reservoir is drafted substantially lower than in 2021. Sediment deposition in the reach between Palisades Dam and the South Fork Canyon between September 14 and November 30 2021 was twofold higher than the same period in 2020, from 1094 tons to 2281 tons, which was deposited in late September and early October as flows declined to minimum discharge (Figure 3; Oldemeyer 2022).

The Oldemeyer (2022) analysis suggests that sediment mobilization in 2021 began at approximately 8% active storage capacity (Figure 4) or a forebay elevation of approximately 5513 feet. The bottom of active storage is at approximately 5498 feet and the top of dead storage is at 5452.4 feet.

The five lowest autumn period forebay elevations at Palisades Reservoir since the dam was completed in 1957 fell between 5499' – 5504 feet in years 1990, 2007, 1994, 1977, and 1960. These five years fall near the bottom of active storage at 5498 feet. Forebay elevation will be approximately 5467.5 (15 feet above dead storage; arrived at by linear interpolation) if all active storage in the entire upper Snake system is delivered *and* 53.3 kaf of Powerhead water remains in Palisades Reservoir. If Powerhead water is released for salmon flow augmentation, the Palisades forebay elevation could approach 5452 feet (i.e., dead storage). We do not know at what forebay elevation between 5452 and 5498 feet a catastrophic sedimentation event may occur.

Total system carryover above Milner Dam following water year 2022 may reach as low as 200-400 kaf, which underscores the importance of maintaining the remaining Palisades Powerhead water in the storage system above Milner Dam. Beyond sedimentation effects, low carryover in Palisades and across the system will continue to impact fish recruitment in the South Fork Snake River winter 2022-2023 as winter discharge continues to be at or below the 900 cfs minimum advised by IDFG (Figure 5; Oldemeyer and Van Kirk 2018; Oldemeyer et al. 2017) regardless of sedimentation. Additionally, Palisades Powerhead water is the absolute last-to-fill account in the storage system and its release may extend the threat of serious impacts for years into the future under prolonged drought.

Keeping the remaining 53.3 kaf of Palisades Powerhead water stored in the upper Snake River system provides Idaho Department of Fish and Game more flexibility to work with water users to prevent or, at least, minimize the impacts of extreme low water levels in Palisades Reservoir to Yellowstone Cutthroat Trout habitat in the South Fork Snake River and optimize conditions in other areas of the upper Snake River in 2022 in a situation where system storage is low, but not zero.

Potential impacts <u>of implementing</u> the requested operation on ESA-listed anadromous fishes

We acknowledge that keeping remaining Palisades Powerhead water in the storage system of the Snake River above Milner in 2022 will reduce flows in the lower Snake River to some extent with potential impacts on juvenile anadromous salmonid travel time. It is difficult to predict the exact decrease in discharge in the lower Snake River at any given time caused by keeping Palisades Powerhead in the storage system because of the re-regulation of federal salmon flow augmentation water by the Hells Canyon Complex (HCC). If we assume that the volume of physical water delivered to the HCC in the spring is incorporated into the refill curve of Brownlee Reservoir from the start of delivery to the completion of Brownlee Reservoir refill, then mean daily flow in the lower Snake River would be approximately 500-600 cfs higher than if the 53.3 kaf of remaining Palisades Powerhead was kept above Milner Dam. The impact of our request to fish travel time migrating during this period is real, but probably not measurable and difficult to reasonably estimate given that this volume of water translates to probably < 1% of total discharge at Lower Granite Dam for the remainder of the juvenile migration period in 2022.

This request will also decrease water available to guarantee a minimum discharge for the hatchery fall Chinook acclimation ponds at Pittsburg Landing on the Snake River below Hells Canyon Dam just prior to release given the current pump capability. Pumps at the facility require river discharges of 8000-8500cfs to adequately function. In 2021, the Bureau of Reclamation delivered a significant portion of federal flow augmentation water (~200 kaf) to guarantee minimum flows sufficient to operate the facility until subyearling releases at the end of May. In 2022, remaining Palisades Powerhead water would be the only volume available to deliver during this period and is likely insufficient to support the facility by itself (Table 1). IDFG will work with other Snake Basin fishery co-managers to adapt to the low water situations whether or not Palisades Powerhead water is delivered or remains in the storage system above Milner Dam. Recent weather patterns have maintained inflow to Brownlee Reservoir that may be sufficient to achieve the minimum flow for this hatchery program.

<u>Conclusion</u>:

In 2022, we contend the benefits of ~53.3 kaf of Palisades Powerhead water have greater potential benefit to Yellowstone Cutthroat Trout and ecosystems in the upper Snake River if stored in the storage system above Milner Dam than the potential benefit to anadromous fishes below the Hells Canyon Complex if the volume were delivered for salmon flow augmentation.

REFERENCES:

Cunjak, R. A. 1996. Winter Habitat of selected stream fishes and potential impacts from land-use activity. Canadian Journal of Fisheries and Aquatic Sciences 53:267-282.

Espa, P., G. Crosa, G. Gentili, S. Quadroni, and G. Petts. 2015. Downstream ecological impacts of controlled sediment flushing in an Alpine valley river: a case study. River Research and Applications 31:931–942

Evans, E. and A. C. Wilcox. 2014. Fine sediment infiltration dynamics in a gravel-bed river following a sediment pulse. River Research and Applications 30:372–384

Gamblin, M., T. J. Herron, B. A. Rich, and W. C. Schrader. 1993. Regional Fisheries Management Investigations: Upper Snake Region (Subprojects I-A, II-A, III-A, IV-A). https://collaboration.idfg.idaho.gov/FisheriesTechnicalReports/Mgt02-44Gamblin1994%20Regional%20Fisheries%20Management%20Investigations%20Upper%20Snake%20Region.pdf

Griffith, J. S. and R. W. Smith. 1993. Use of winter concealment cover by juvenile cutthroat and brown trout in the South Fork of the Snake River, Idaho. North American Journal of Fisheries Management 13: 823-830.

Kozfkay, J. and R. Ward. 2013. A mitigation plan for fish, wildlife, and habitat losses incurred due to additional hydroelectric power development at Black Canyon Dam, Idaho. Idaho Department of Fish and Game. Boise, ID. 16pp.

Marcarelli, A. M., C. J. Huckins, S. L. Eggert. 2015. Sand aggradation alters biofilm standing crop and metabolism in a low-gradient Lake Superior tributary. Journal of Great Lakes Research 41:1052-1059.

McCormick, J. L. and B. High. 2020. Using an integrated population model to evaluate Yellowstone cutthroat trout responses to management actions. Transactions of the American Fisheries Society 149:135-146.

Oldemeyer, B. 2022. Understanding the relationship between Palisades Reservoir storage capacity and late summer through early fall sediment mobilization in the South Fork Snake River. Presented at the Idaho Water Quality Workshop, March 16-17, 2022, Boise, Idaho.

Oldemeyer, B. and R. Van Kirk. 2018. Analysis of relationships between streamflow and trout populations on the South Fork Snake River. Report to the Idaho Department of Fish and Game, 01 October 2018.

Oldemeyer, B., Flinders, J., C. Morrisett, and R. Van Kirk. 2017. Long-term effectiveness of flow management and fish passage on the Henrys Fork Rainbow Trout population. Wild Trout XII Symposium Proceedings. (Editor-reviewed publication).

Quadroni, S., M. L. Brignoli, G. Crosa, G. Gentili, F. Salmaso, S. Zaccara, P. Espa. 2016. Effects of sediment flushing from a small alpine reservoir on downstream aquatic fauna. Ecohydrology 9:1297-1288.

Relyea C. D., G. W. Minshall, and R. J. Danehy. 2012. Development and validation of an aquatic fine sediment biotic index. Environmental Management 49:242-252.

Sepulveda, A. J., M. Layhee, Z. A. Sutphin, and J. D. Sechrish. 2015. Evaluation of a fine sediment removal tool in spring-fed and snowmelt driven streams. Ecological Restoration 33:303-315.

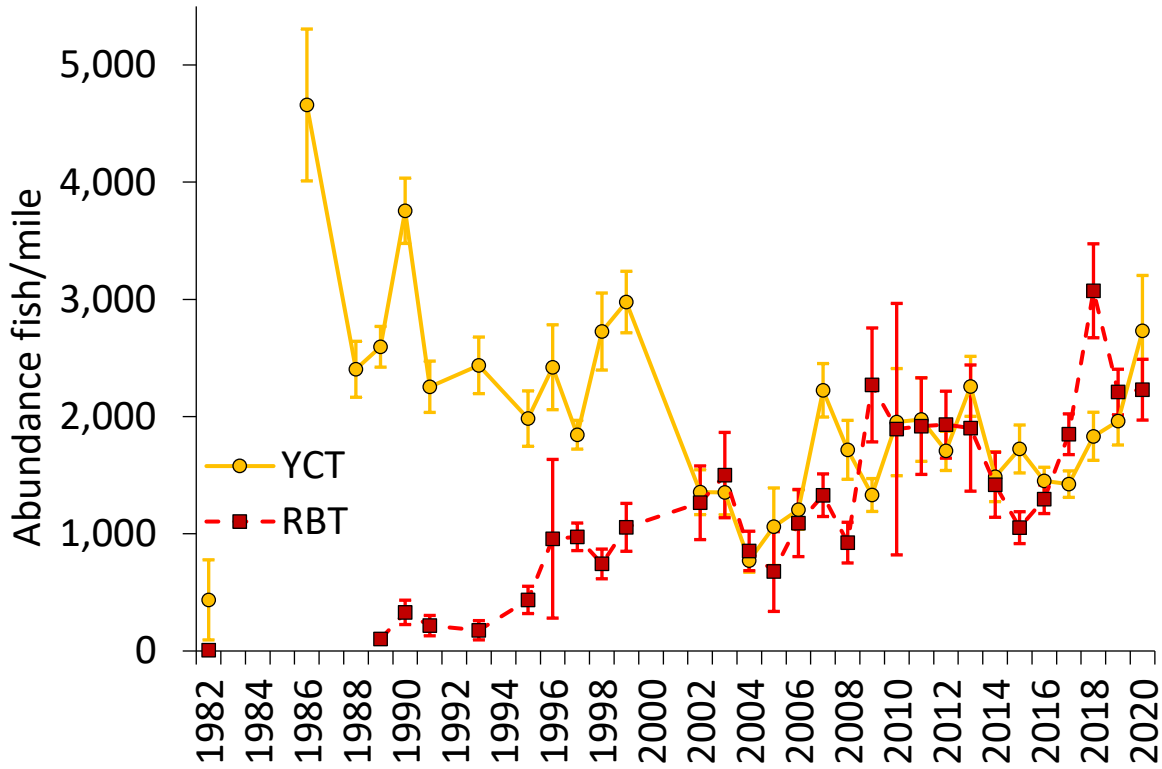

Figure 1. Yellowstone cutthroat trout (YCT; yellow) and rainbow trout (RBT; red) abundance in the Conant index reach of the South Fork Snake River (P. Kennedy, IDFG Regional Fish Biologist).

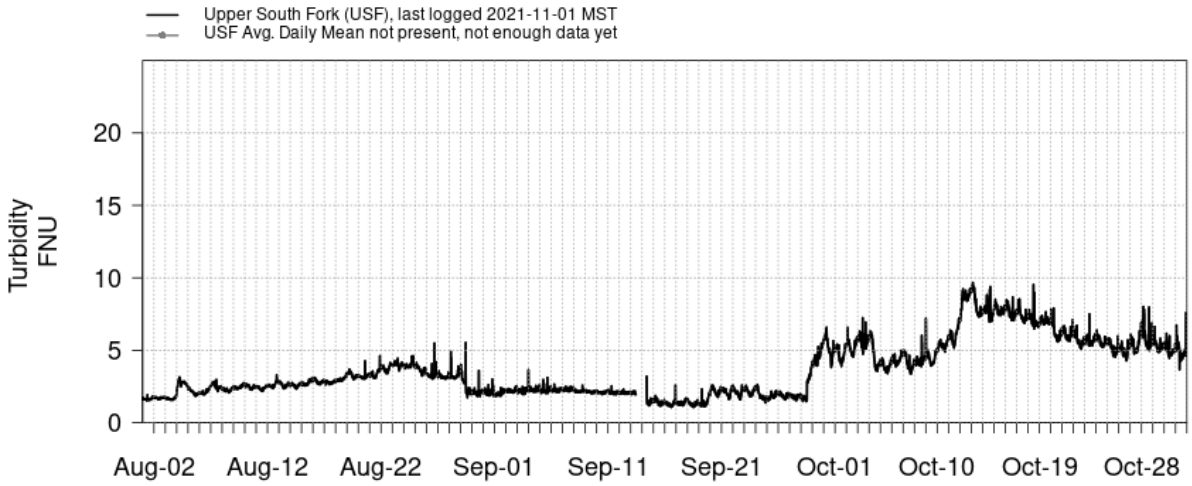

Figure 2. Turbidity of the South Fork Snake River near Palisades Creek. Data and graphic accessed through the Henry's Fork Foundation and found at https://henrysforkdata.shinyapps.io/scientific_website/.

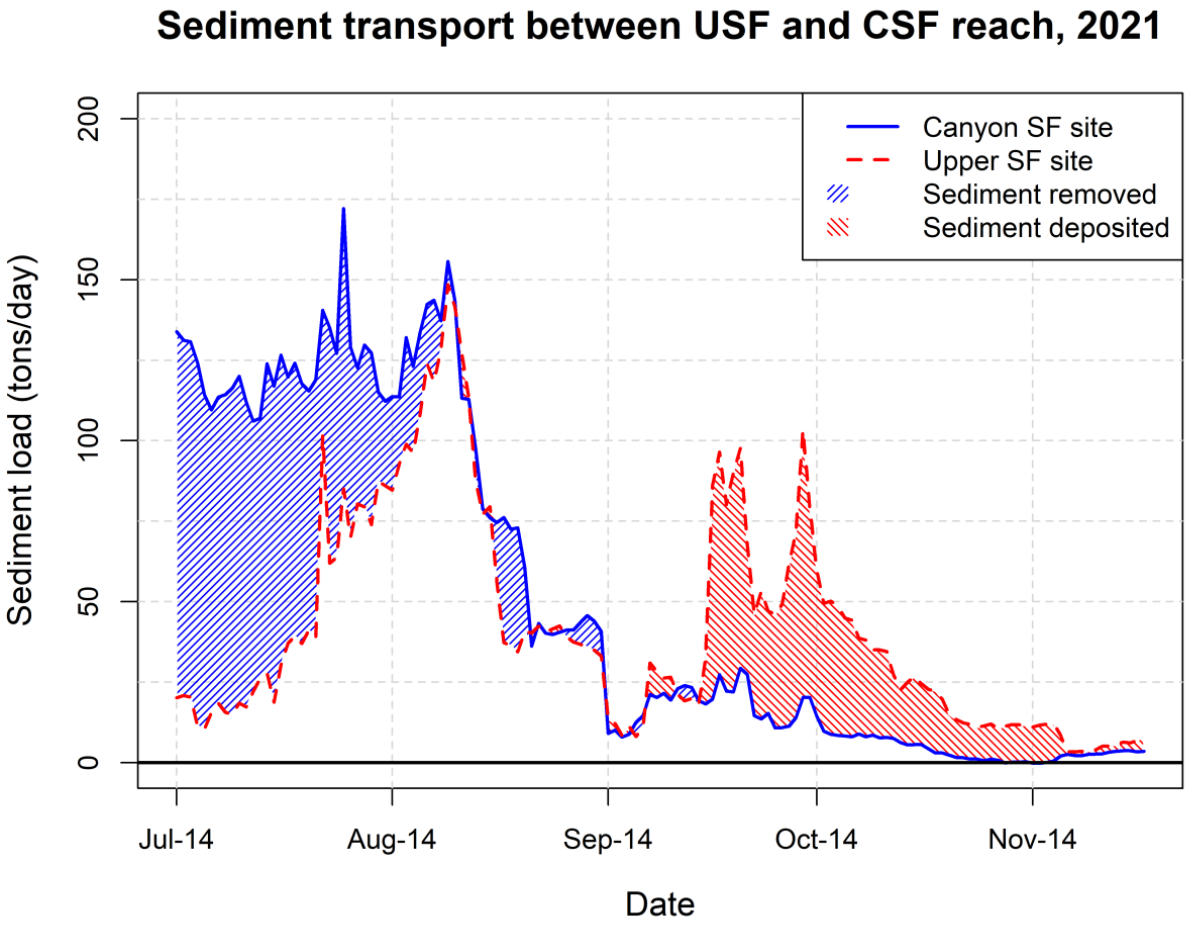

Figure 3. Sediment deposition in the South Fork of the Snake River during late summer and fall 2021 (Oldemeyer 2022).

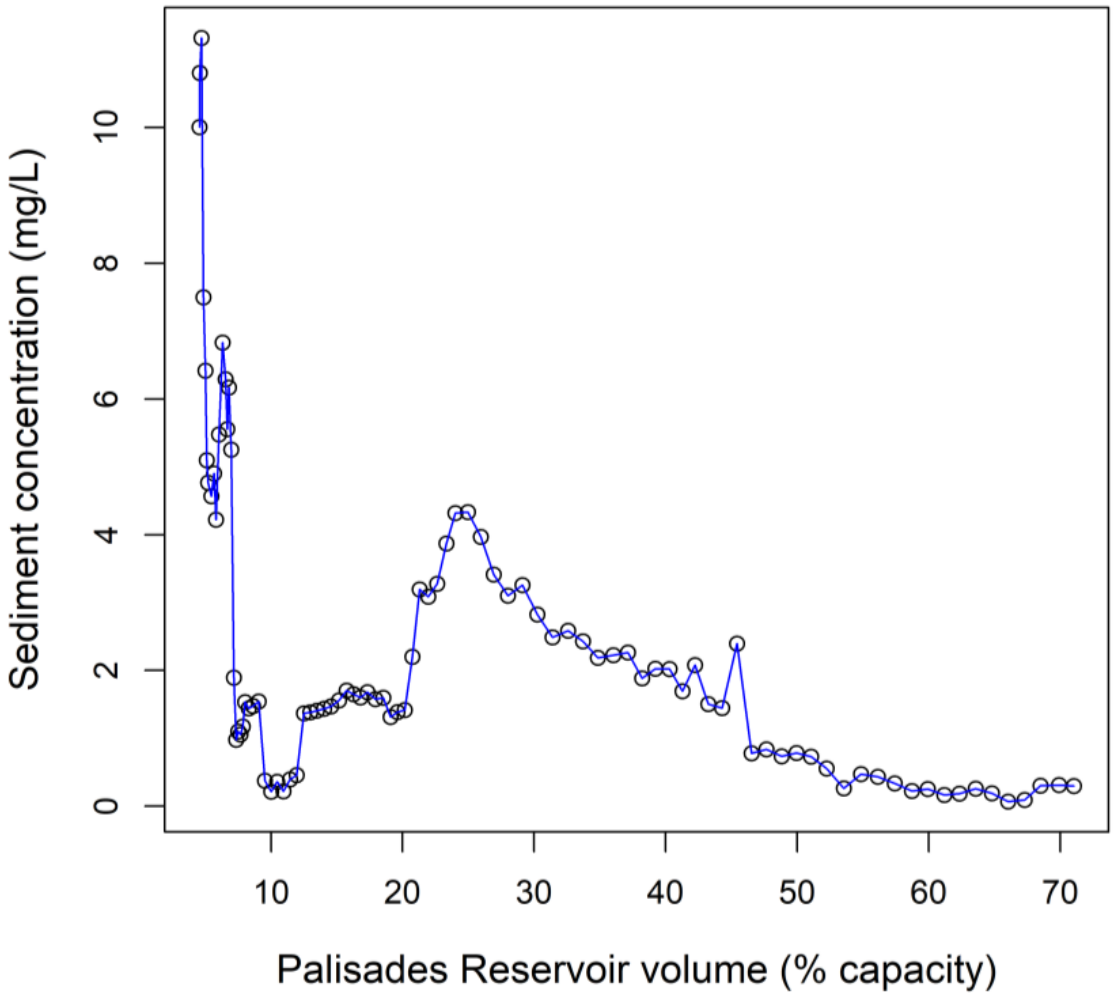

Figure 4. Relationship between sediment concentration at the upper South Fork monitoring site (USF) near Palisades Creek and reservoir active storage in Palisades Reservoir suggesting that sediment mobilization begins at approximately 8% active storage capacity (Oldemeyer 2022).

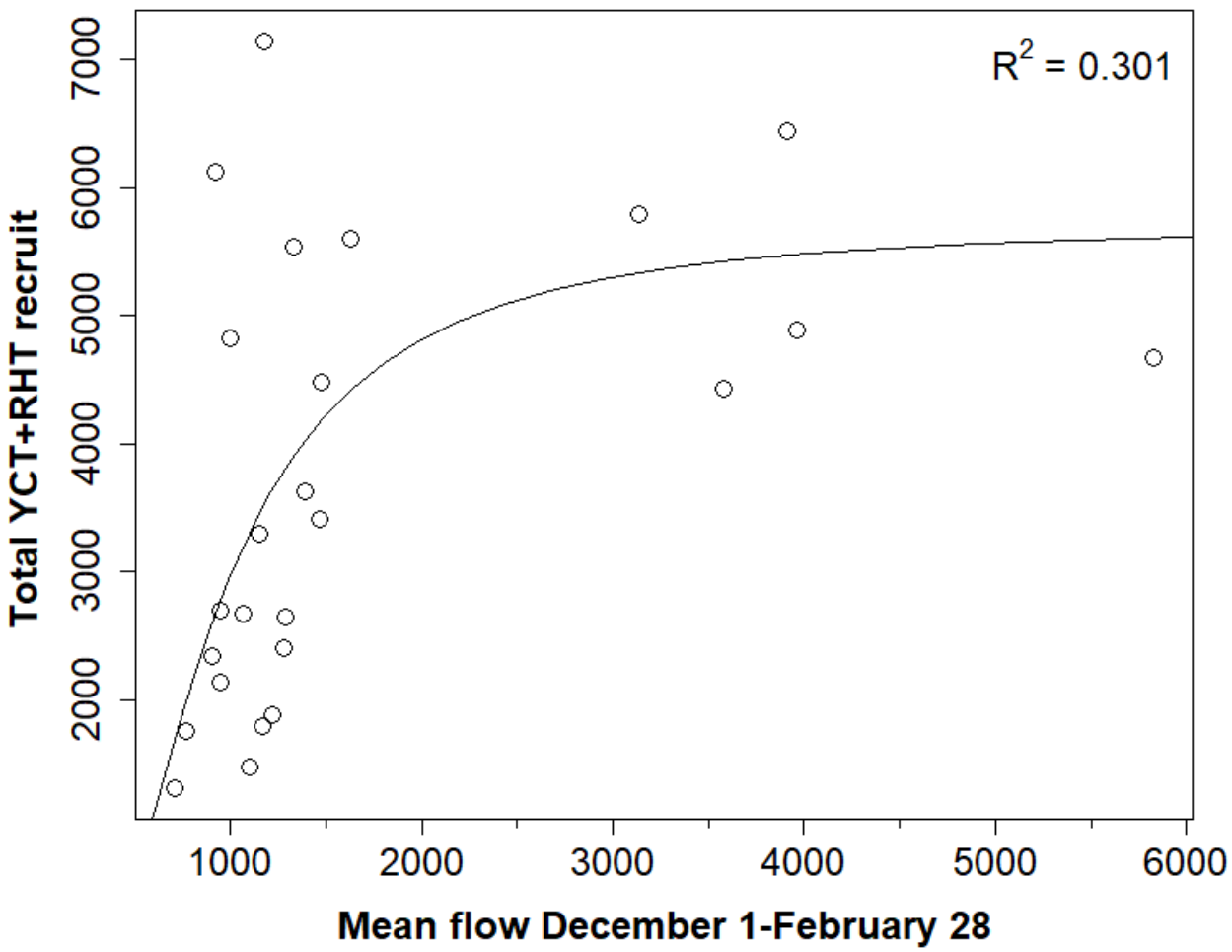

Figure 5. Age-1 recruitment of resident salmonids relative to mean winter discharge in the South Fork Snake River (figure from Oldemeyer and Van Kirk 2018).

Table 1. Delivery of remaining Palisades Powerhead water (~53.3 kaf) in terms of minimum flow guaranteed according to accounting procedures on the Snake River below Hells Canyon Dam at Johnson Bar. Hatchery fall Chinook salmon acclimation ponds require 8000-8500 cfs flow for adequate pump function.

Delivered water from Milner Dam (daily average cfs @ time *t*)	Guaranteed minimum flow on the Snake River at Johnson Bar (*t*+5 days)	Number of days water is available[1]
500	5500	54
1000	6000	27
1500	6500	18
2000	7000	13
2500	7500	11
3000	8000	9
3500	8500	8

[1] Assumes no ramping up or down at Milner Dam