South Fork Clearwater River Sediment Assessment Plan (2023–2027)

Version 1.0



State of Idaho

Department of Environmental Quality

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Acknowledgments

The cover photo shows sediment from Crooked River flowing into the South Fork Clearwater River on August 7, 2023. A rain event caused a debris flow in an area of East Fork Crooked River headwaters severely burned by the 2022 Williams wildfire. This caused a large sediment pulse from Crooked River into the main stem. The photo was provided by Erin Grinde, Nez Perce-Clearwater National Forest.

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Online supporting materials for this document (data, R code, draft plan comment letters, related reports and documents, etc.) are available at *https://doi.org/10.17605/OSF.IO/KFMYR.*

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Abbreviations, Acronyms, and Symbols

µm	micrometer
AIM	Aquatic Inventory and Monitoring Program
AU	assessment unit
BA	Biological assessment under Endangered Species Act
BACI	before-after-control-impact
BLM	Bureau of Land Management
BMP	best management practice
BURP	Beneficial Use Reconnaissance Program
CWA	Clean Water Act
DEQ	Idaho Department of Environmental Quality
EPA	US Environmental Protection Agency
ESA	Endangered Species Act
ft	feet
FSBI	fine sediment biotic index
GIS	Geographic Information System
IDFS	Idaho Department of Fish and Game
IDL	Idaho Department of Lands
IDWR	Idaho Department of Water Resources
IPDES	Idaho Pollution Discharge Elimination System
IR	Integrated Report
ISWCC	Idaho Soil and Water Conservation Commission
km	kilometer
L	liter
m	meter
mg	milligram
mm	millimeter
MOU	Memorandum of Understanding
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPT	Nez Perce Tribe
NTU	nephelometric turbidity units
PIBO	PacFish/InFish Biological Opinion Monitoring Program
POO	plan of operations
PPBV	plains plateaus and broad valleys

SFCR	South Fork Clearwater River
SSC	Suspended sediment concentration
TMDL	total maximum daily load
USFS	US Forest Service
USFWS	US Fish and Wildlife Service
WAG	Watershed Advisory Group
yd	yard

Summary

Why was this document developed?

Human activities have affected aquatic life and salmonid habitat in the South Fork Clearwater River and some of its tributaries. People have altered the landscape, altered stream channels, and increased river sediment inputs, among other changes. The South Fork Clearwater River and several tributaries are listed as impaired by sediment under the Clean Water Act. Since 2000, government agencies spent over $25 million dollars across over 60 restoration projects in the watershed. However, stream responses are not clear due to limited monitoring, which frustrated many stakeholders. Government agencies are making important sediment management decisions without adequate monitoring data.

To address these concerns, the Idaho Department of Environmental Quality (DEQ) developed this plan. It describes a sediment monitoring and assessment approach for the South Fork Clearwater River and its tributaries. When implemented, the plan will document if and where Clean Water Act compliance for sediment is achieved. It will also produce data needed for other legally mandated management decisions and document sediment responses to management. This plan was developed using input from stakeholders through public meetings of the South Fork Clearwater Watershed Advisory Group from 2020 to 2023.

What are the main points?

The plan suggests DEQ and partner agencies cooperatively take five actions:

1. Evaluate if Idaho's sediment and turbidity water quality standards are achieved outside the Nez Perce reservation boundary using methods described in this plan.
2. Continue current suction dredge industry regulatory compliance monitoring.
3. Conduct a study to test for and measure any changes to several stream sediment indicators caused by suction dredging in the main stem.
4. Work together to make suction dredge permitting more user-friendly and efficient.
5. Implement multiagency technical workgroup process to identify and prioritize sediment management actions for nonpoint sources.

What happens next?

Some suggested actions have already started. Monitoring required for plan actions 1 and 3 began in 2023. Actions 1 and 3 are partially funded through 2026 by a grant from the Nez Perce-Clearwater National Forest. DEQ will hire an independent consultant to help increase efficiency of the suction dredge permit process (action 4). To fully implement the plan, DEQ, the Nez Perce-Clearwater National Forest, and Bureau of Land Management will need to allocate additional staff or funding. DEQ will organize annual public meetings to report progress, and, if needed, revise the plan. DEQ will use plan outputs to help revise the existing sediment total maximum daily loads after sufficient data are available. DEQ expects partner agencies to incorporate this plan into their decision-making. This plan documents how compliance with

Idaho's sediment and turbidity water quality standards must be assessed in this watershed outside the Nez Perce Reservation boundary. DEQ and partner agencies must cooperatively implement a feedback loop between monitoring and management to assess if management actions are sufficient to achieve Clean Water Act compliance.

Problem Statement - information gap the plan was developed to address

Government agencies with legal mandates for managing sediment in the South Fork Clearwater River watershed do not have adequate status and trend data for sediment and sediment-specific biological indicators. Improved status and trend monitoring data are needed to assess Clean Water Act compliance and for other mandated sediment management decisions (Table A).

Fundamental Objective - desired conditions the plan is intended to achieve

Human activities within the South Fork Clearwater River watershed do not cause stream and river sediment conditions to modify any major biological group (fish, macroinvertebrates, or algae) beyond explicitly defined sediment reference conditions that consider the natural range of variability. This objective statement was written so that, if achieved, Idaho's narrative sediment water quality standard would be achieved.

Evaluation Criteria - how do we determine if the fundamental objective is achieved?

Apply monitoring data in decision trees (section 5). The fundamental objective is met if physical and biological sediment indicators are equal to or better than reference conditions. Reference benchmark values were developed using monitoring data from streams across Idaho with limited human disturbance in their watershed.

Five Suggested Actions - what does the plan propose agencies to do?

Information Gap / Need	Action
1. Do sediment conditions in the main stem and tributaries outside the Nez Perce Reservation boundary achieve Idaho's narrative sediment water quality standard?	Start an annual main stem monitoring program. Use existing tributary data and collect additional tributary data if needed. Apply evaluation criteria (decision trees) to assess if the standard is achieved at the reach and assessment unit spatial scale.
2. Is the suction dredge industry in compliance with applicable regulatory requirements?	Continue current compliance monitoring. Evaluate compliance with permit requirements.
3. Does suction dredging cause measurable changes to stream substrate or macroinvertebrate indicators?	Develop and implement a monitoring program to answer this question. A pilot monitoring study began in 2023.
4. Improve the suction dredge permitting process for both applicants and agencies.	DEQ will hire an independent consultant to help diagnose and address permit process inefficiencies through a collaborative process that includes both agencies and dredgers.
5. Document human land uses contributing sediment and identify stream segments with the greatest restoration potential.	Technical workgroup to rank all HUC12 subwatersheds based on (a) human sediment impact magnitude, and (b) sediment restoration potential

Predictive Model - expected impacts of plan implementation

If agencies use information generated through components 1–5 to inform decisions in Table A, the plan evaluation criteria will be achieved or measured indicators will show decreasing trend over time. Consistent annual monitoring will document indicator responses to management.

Table A. Sediment management decisions that require monitoring data and this plan was developed to help inform.

Decision	Example Alternatives	Mandate	Timing	Decision Maker
Does sediment impair Cold Water Aquatic Life or Salmonid Spawning beneficial uses in stream segments outside the Nez Perce Reservation Boundary?	Yes / No	Clean Water Act, Idaho Water Quality Standards	Every 2 years	DEQ
Does water quality in the Nez Perce-Clearwater National Forest achieve Idaho Water Quality Standards?	Yes/No	Nez Perce-Clearwater National Forest Revised Forest Plan component FW-DC-WTR-05	Ongoing	USFS
Does water quality in Bureau of Land Management lands achieve Idaho Water Quality Standards?	Yes/No	Federal Land Policy and Management Act of 1976 Section 202 c(8).	Ongoing	BLM
Review and evaluate water quality standards, sediment targets, load allocations, assumptions, and analyses the existing sediment total maximum daily load (TMDL) was based on	Revise TMDL or not	Idaho Code § 39-3611(7)	Every 5 years	DEQ
Sediment effluent limits and other requirements for permitted suction dredging discharges to the main stem South Fork Clearwater River	Keep as-is or change	Clean Water Act / Idaho Pollution Discharge Elimination System (IPDES) requirements	2024 and every 5 years thereafter	DEQ
Sediment effluent limits and other requirements for municipal wastewater treatment plants outside the Nez Perce Reservation Boundary	Keep as-is or change	Clean Water Act / Idaho Pollution Discharge Elimination System (IPDES) requirements	Every 5 years	DEQ
Sediment-specific conditions in USFS and BLM Biological Assessment (BA) and Plan of Operations (POO) requirements for South Fork Clearwater River suction dredging	Keep as-is or change	Endangered Species Act (ESA) section 7	2026 renewal and every 10 years thereafter	USFS, BLM
Biological Opinion evaluating USFS and BLM BA, and whether or not to add additional conditions/requirements to prevent sediment impacts of dredging	Approve, disapprove, or add conditions	ESA section 7; Magnuson-Stevens Conservation and Fishery Management Act section 305(b)	2026 renewal and every 10 years thereafter	NOAA-NMFS, USFWS
Idaho Department of Water Resources (IDWR) suction dredge permit requirements related to sediment impacts of dredging	Keep as-is or change	Idaho Stream Channel Protection Act & other IDWR mandates	No specific timeline	IDWR
How to identify and prioritize sediment nonpoint source reduction needs	Restoration $ prioritization	Idaho Nonpoint Source Management Plan (2020-2025), mandates described therein, and associated MOU between DEQ, BLM, USFS.	Ongoing	USFS, BLM, DEQ, ISWCC, IDL, other agencies
How to design federal land management actions requiring ESA consultation and monitor their effectiveness	Action design, monitoring	Endangered Species Act (ESA) section 7	Ongoing	USFS, BLM, NOAA-NMFS, USFWS
Is available information sufficient to evaluate if state and federal sediment goals and management efforts are protective of tribal waters within the watershed?	Yes / No	Clean Water Act	Ongoing	EPA, NPT

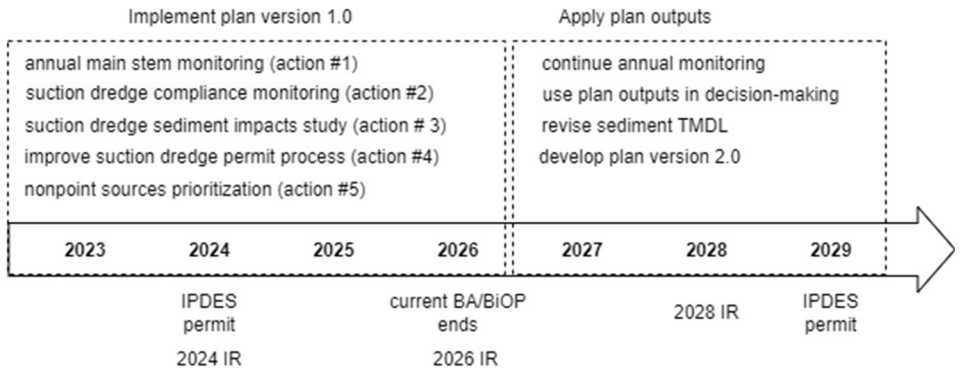


Figure A. Plan timeline.

Table B. Plan timeline.

Date	Task	Lead
2023	Annual main stem monitoring (action 1)	DEQ, USFS, BLM
	Suction dredge industry compliance monitoring (action 2)	USFS, BLM, IDWR, DEQ
	Suction dredge monitoring pilot study (action 3)	DEQ, USFS, BLM
	Host South Fork Clearwater Watershed Advisory Group (WAG) meeting about this plan document.	DEQ
	Effort to improve the suction dredge permitting process for both applicants and agencies, facilitated by an independent consultant (action 4)	DEQ, USFS, BLM, NMFS, IDWR
2024	Annual main stem monitoring (action 1)	DEQ, USFS, BLM
	Suction dredge industry compliance monitoring (action 2)	USFS, BLM, IDWR, DEQ
	Annual public WAG meeting about plan progress	DEQ
	Nonpoint source priorities workgroup (action 5)	All land management agencies
	Collect additional pilot suction dredge data if needed (action 3)	DEQ, USFS, BLM
	Develop detailed plan for suction dredge monitoring study and submit for independent peer review (action 3)	DEQ, USFS, BLM
	Implement kaizen event recommendations to improve suction dredge permitting process (action 4)	DEQ, USFS, BLM, IDWR
	Issue IPDES permit regulating small suction dredge activity in Idaho 2024–2029	DEQ
	Idaho's 2024 Integrated Report	DEQ
2025	Annual main stem monitoring (action 1)	DEQ, USFS, BLM
	Suction dredge industry compliance monitoring (action 2)	USFS, BLM, IDWR, DEQ
	Implement full suction dredge monitoring study (action 3)	DEQ, USFS, BLM
	Nonpoint source priorities workgroup (action 5)	All land management agencies
	Annual public WAG meeting about plan progress	DEQ
	Identify funding resources needed to continue monitoring beyond 2026	DEQ, USFS, BLM
2026	Annual main stem monitoring (action 1)	DEQ, USFS, BLM
	Suction dredge industry compliance monitoring (action 2)	USFS, BLM, IDWR, DEQ
	Annual public WAG meeting about plan progress	DEQ
	Nonpoint source priorities workgroup (action 5)	All land management agencies
	Additional suction dredge study monitoring (if needed)	DEQ, USFS, BLM

Date	Task	Lead
	Last year of Endangered Species Act Biological Opinion governing USFS and BLM suction dredging management. Extension, renewal or revision will be needed.	USFS, BLM, NMFS
	Idaho's 2026 Integrated Report	DEQ
	Allocate funding and resources needed to continue monitoring beyond 2026	DEQ, USFS, BLM
2027	Annual main stem monitoring (action 1)	DEQ, USFS, BLM
	Suction dredge industry compliance monitoring (action 2)	USFS, BLM, IDWR, DEQ
	Annual public WAG meeting about plan progress	DEQ
	Publish documents summarizing results of 2023–2026 main stem monitoring and suction dredge study.	DEQ

1 Background

The South Fork Clearwater River (SFCR) and several tributary streams are listed as impaired by sediment under the Clean Water Act (CWA) (Figure 1). The main stem was listed as impaired by sediment by the US Environmental Protection Agency (EPA) in 1994 (EPA 1994). EPA was sued for approving Idaho's 1992 list of impaired waters (called the 303(d) list). A subsequent court order led to EPA adding many water bodies to Idaho's 1994 303(d) list (EPA 1994, Idaho Sportsmen's Coalition v. Browner 1996). EPA listed the main stem as sediment-impaired based on information included in the Nez Perce National Forest's forest plan (USFS 1987) and in US Forest Service (USFS) and Idaho Department of Environmental Quality (DEQ) monitoring reports (DEQ, EPA, and NPT 2004). Tributaries on the Camas Prairie, including Cottonwood, Threemile, and Butcher Creeks were listed as sediment impaired by DEQ in the 1992 or prior 303(d) lists based on monitoring data collected by DEQ and other agencies (DEQ 1992; DEQ 2000; DEQ, EPA and NPT 2004).

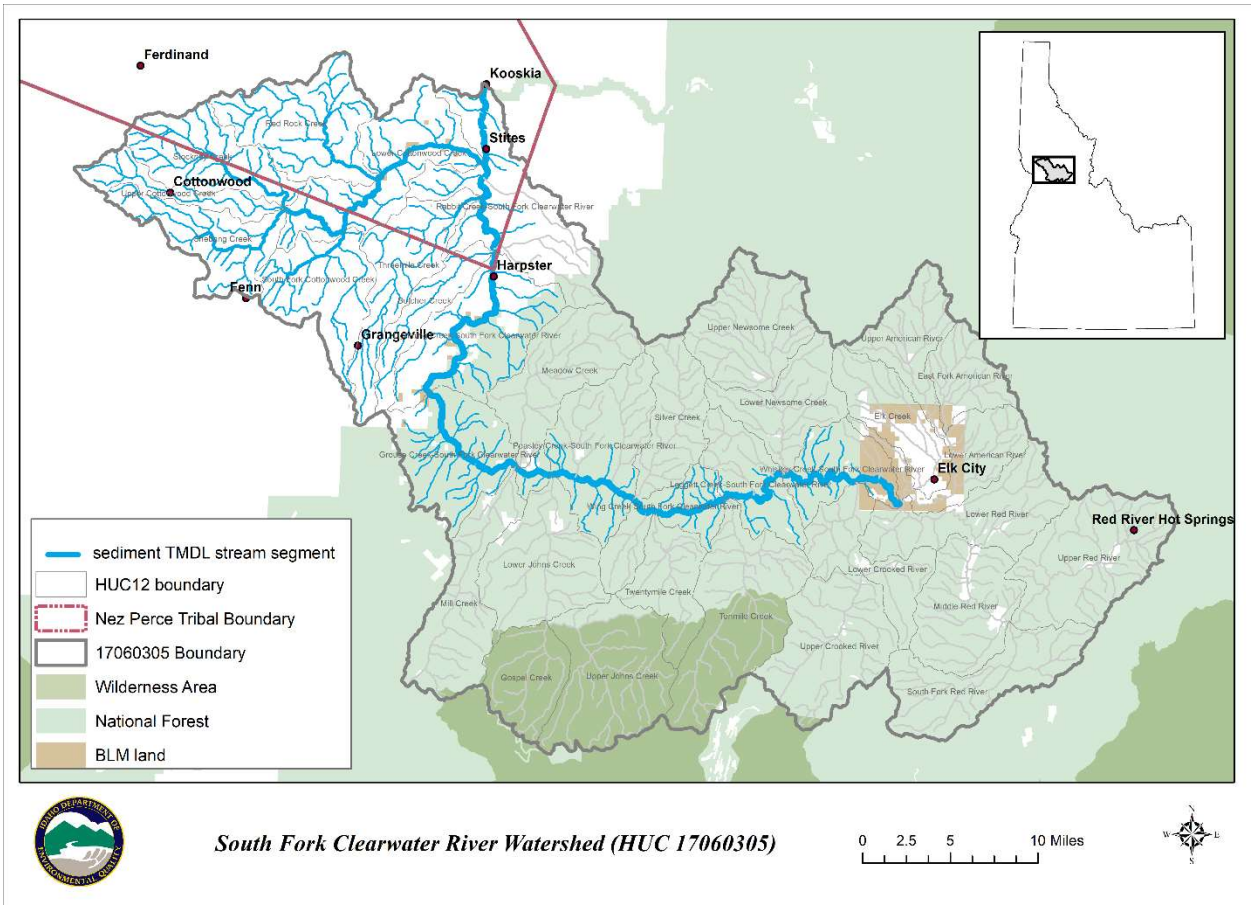


Figure 1. South Fork Clearwater River watershed. Blue stream segments are listed as sediment-impaired under the Clean Water Act with a sediment total maximum daily load.

The CWA requires states to develop a water quality improvement plan called a total maximum daily load (TMDL) for impaired waters. A TMDL defines the maximum allowable pollutant inputs

from point and nonpoint sources while still achieving state water quality standards. EPA must review and either approve or disapprove a TMDL. If EPA disapproves a TMDL, EPA must develop a TMDL that meets CWA requirements. DEQ, Nez Perce Tribe (NPT), and EPA cooperatively developed sediment TMDLs for the SFCR watershed. The TMDLs were developed through a public process with input from watershed stakeholders. Separate sediment TMDLs were developed and approved for the Cottonwood Creek watershed (DEQ, EPA, and NPT 2000) and the remainder of the SFCR watershed (DEQ, EPA, and NPT 2004) (Figure 1). The TMDLs defined suspended sediment concentration (SSC) (milligrams suspended sediment per liter [mg/L)] and suspended sediment daily load targets (tons suspended sediment/day) that must be met to achieve state water quality standards and protect aquatic life and salmonids.

State law requires DEQ to periodically review the adequacy of existing TMDLs (Idaho Code § 39-3611(7)). Starting in 2020, DEQ began gathering available information and evaluating progress towards achieving TMDL sediment goals. DEQ presented gathered information to the SFCR Watershed Advisory Group (WAG) and other stakeholders (DEQ 2020a, DEQ 2020b). From 2000 to 2020, over $25 million dollars were spent across over 60 water quality and stream habitat improvement projects in the watershed (inventory in Appendix A). However, it is not clear if these efforts decreased suspended sediment loads or achieved TMDL goals because limited TMDL compliance monitoring data were collected by government agencies (DEQ 2020a, DEQ 2020b).

Gathered information also indicated several assumptions used to develop TMDL sediment goals are likely not accurate.

- Excess sediment can affect aquatic life through suspended sediment and deposited sediment exposure pathways (conceptual model, section 2). The SFCR sediment TMDL identified excess deposited fine sediment as the primary exposure pathway causing sediment to impair cold water aquatic life and salmonid spawning beneficial uses under the CWA. However, the TMDL set suspended sediment concentration and load goals and required TMDL compliance to be measured based on suspended sediment. Both DEQ and EPA concluded deposited fine sediment and other stream substrate measures are a more direct measure of sediment impacts on aquatic life and salmonid habitat quality. Deposited fine sediment measures are likely better indicators of sediment impacts the TMDL was developed to address.
- Suspended sediment concentration and load targets for the main stem SFCR were developed based on USFS and DEQ modeling. Model outputs predicted most suspended sediment loading came from the lower watershed (Camas Prairie) downstream of the Nez Perce-Clearwater National Forest. In contrast, annual suspended sediment loads measured in 2006–2010 and in 2021 indicated the forest contributed 65%–91% (76.9% on average) of annual suspended sediment load (DEQ 2022a).
- Deposited surface fine sediment levels measured in 2006–2010 were better than benchmark values often cited as protective of salmonid habitat. USFS measured deposited fine sediment in five reaches of the main stem SFCR in 2006–2010 as part of a USFS TMDL compliance monitoring program. The TMDL recommended testing for a statistically significant decreasing deposited fine sediment trend in the main stem to

verify that restoration actions improve salmonid habitat (DEQ, EPA, and NPT 2004). The TMDL stated surface fines level of ≤ 20% are often considered protective of salmonid habitat based on agency guidelines (USFS 1992, CRITFC 1995, NMFS et al. 1998). In four of five monitored reaches, the 5-year average was less than the 20% benchmark (Table 1). The ≤ 20% benchmark was not achieved in all monitored reaches or all years (Table 1, Figure 2). However, measured surface fines levels were lower than assumed when the TMDL was developed. Surface fines trends in response to restoration are not clear because USFS stopped measuring main stem surface fines in 2010.

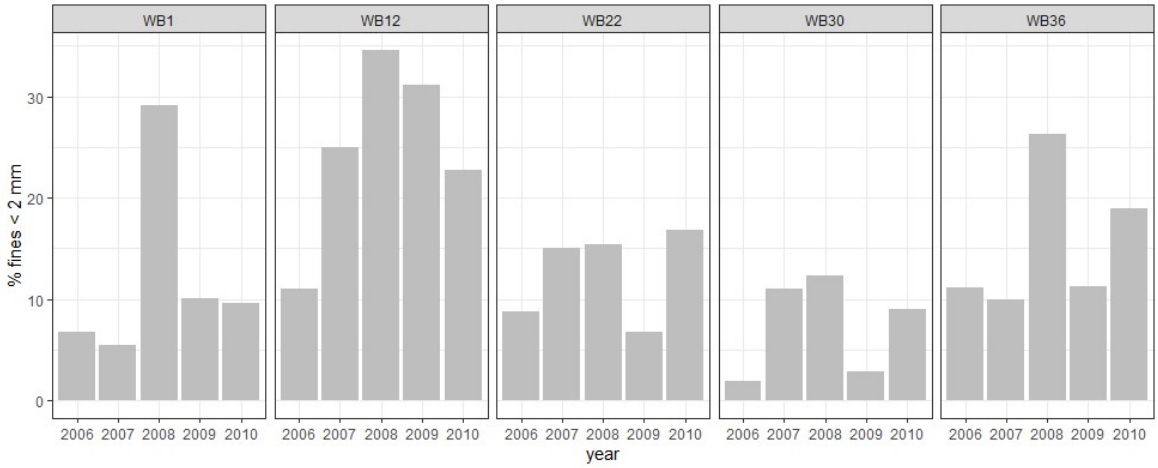


Figure 2. Main stem South Fork Clearwater River surface percent fines < 2 mm measured in 2006–2010.

Table 1. Main stem South Fork Clearwater River surface fines measured in 2006–2010 by USFS.

Site ID	Description	Surface % Fines < 2 mm		Surface % Fines < 6 mm	
		Mean	Range	Mean	Range
WB1	Near Stites and Rabbit Creek	12%	6–29%	14%	7–29%
WB12	Near Castle Creek	25%	11–35%	26%	12–35%
WB22	Just upstream of Cougar Creek	13%	7–17%	17%	7–28%
WB30	Near Leggett Creek	7%	2–12%	9%	3–14%
WB36	Upstream of Whiskey Creek	16%	10–26%	17%	11–27%

- Several assumptions used to develop the suction dredge industry wasteload allocation in the sediment TMDL are not accurate. The CWA requires TMDLs to define a wasteload allocation for each point source. A wasteload allocation is the maximum load (mass/time) a point source can discharge without violating applicable water quality standards (40 CFR 130.2h). Suction dredge discharge effluent in is considered a point source under the CWA (Idaho Conservation League v Poe, 2021). Monitoring data collected in 2016–2021 indicate TMDL wasteload allocation calculations overestimated the number of hours dredgers operate per day and volume of streambed material processed per hour (DEQ 2023).

Members of the SFCR WAG and other stakeholders expressed concern about these and other issues. Stakeholders had varying opinions about whether the current TMDL and other sediment-related regulations are adequate, underprotective, or overprotective. However, all agreed that the information currently available was not adequate to evaluate sediment status, trends, and effects, or to guide management strategies for achieving Idaho's water quality standards. Information gaps were largest for the main stem SFCR.

The sediment TMDLs should be revised to address the issues described above. However, revising the TMDLs requires adequate data documenting sediment status, trends, sources, effects, and stakeholder input. One goal of this plan is to produce information needed for a TMDL revision.

1.1 Plan Development History

This plan was developed based on stakeholder input DEQ received 2020 to present (Table 2). DEQ distributed a draft version of this plan to watershed stakeholders in August 2022. The current version reflects revisions made based on stakeholder input described in Table 2.

Table 2. Plan development history.

Date	Milestone
2018	DEQ issued a public call for water quality data in the SFCR watershed. The call for data was distributed to partner agencies and posted on DEQ's website. DEQ received data from EPA, NPT, USFS, US Geological Survey, Idaho Soil and Water Conservation Commission, and Idaho Department of Fish and Game (IDFG).
2020	In a series of public SFCR WAG meetings, DEQ summarized available sediment monitoring data and presented a draft sediment TMDL review document to the WAG. Stakeholders were frustrated by lack of monitoring data and suggested agencies collect more data before seeking WAG advice on sediment management. DEQ chose not to finalize the TMDL review document.
2021	DEQ, USFS, USGS, and NPT monitored stream flow and suspended sediment in the main stem SFCR and several tributaries. Results are described in a report (DEQ 2022a). Monitoring was funded by a North Central Idaho Resource Advisory Committee grant. In comments on DEQ's draft sediment TMDL review document, EPA staff (Lisa Kusnierz, EPA Region 10 and Phil Kaufmann, EPA Office of Research and Development) advised DEQ to consider focusing monitoring and assessment on deposited sediment and biological indicators rather than suspended sediment. They recommended substrate and biological indicators are more direct indicators of beneficial use support and are less expensive to monitor.
August 2022	DEQ distributed a first draft version of this sediment plan document to the WAG and partner agencies and requested written comments from partner agencies. Comment letters were received from USFS, Bureau of Land Management (BLM), EPA, National Marine Fisheries Service (NMFS), IDFG, NPT, and Tenmile Mining District (see linked supporting materials).
November 1, 2022	DEQ hosted a public meeting about the draft plan in Grangeville. Most stakeholders agreed the plan will fill important information gaps, but recommended DEQ form a technical workgroup to resolve some technical concerns.
January 24, 2023	DEQ hosted a technical workgroup meeting in Grangeville. The meeting was attended by several WAG members and staff from Nez Perce-Clearwater National Forest, USFS Region 1, IDFG, BLM, NMFS, and NPT Water Resources.
February 2023	The Nez Perce-Clearwater National Forest and North Central Idaho Resource Advisory Committee awarded USFS and DEQ a $44,000 grant for main stem SFCR sediment and macroinvertebrate monitoring described in the 2022 draft plan (plan actions 1 and 3).
Summer 2023	DEQ and USFS began annual main stem monitoring (plan action 1).

Date	Milestone
	DEQ and USFS conducted a suction dredge monitoring pilot study. The goal was to collect preliminary data need to identify the best sampling design for a suction dredge sediment impacts study (plan action 3).
Fall 2023	DEQ will host a WAG meeting to present version 1.0 of sediment plan and update stakeholders on ongoing monitoring efforts.

Compared to the August 2022 draft version, significant changes this version (Version 1.0) include the following:

- A problem statement, fundamental objective statement, and evaluation criteria statement were added based on input from stakeholders at a January 2023 technical workgroup meeting.
- A conceptual model for sediment ecological effects was added (section 2).
- Reference benchmarks and decision trees for assessing if Idaho's narrative sediment water quality standard is achieved were revised. They were revised in response to stakeholder requests to make benchmarks and decision trees compatible with DEQ (BURP), USFS, and BLM monitoring data rather than just with DEQ-BURP. Some additional revisions may still occur (section 5 and Appendix B).
- An additional plan component was added: a multiagency effort to make the suction dredge permit process more user-friendly and efficient (action 4).
- A recommended process for revising this plan was added (section 9).
- Associated documents (public comment letters on the draft plan, report documents cited, etc.) were made publicly available at *https://doi.org/10.17605/OSF.IO/KFMYR*L.

1.2 Relationship to Other Water Quality Plans

DEQ, USFS, BLM, and several Idaho state land management agencies all have a shared mandate: to achieve Idaho's water quality standards. DEQ, USFS, BLM, and the Idaho Department of Lands (IDL) signed a memorandum of understanding (MOU) stating that these four agencies will cooperatively manage nonpoint source pollution (Appendix C of DEQ 2020c). The MOU states the agencies will implement a feedback loop between monitoring and management, where the effectiveness of land management practices will be evaluated by comparing monitoring data to applicable Idaho water quality standards (Appendix C of DEQ 2020c).

In addition, the Nez Perce-Clearwater National Forest's Draft Revised Forest Plan (USFS 2020) sets a goal to have "no documented lands or areas that are delivering water, sediment, nutrients, and/or chemical pollutants that would result in conditions that violate the State of Idaho's water quality standards or are permanently above natural background levels" (USFS 2020, component FW-DC-WTR-05). Idaho Code also designates state land management agencies responsible for implementing best management practices (BMPs) and TMDLs (Idaho Code § 39-3602 (8)). Idaho Code requires those designated agencies to use TMDLs (Idaho Code § 39-3612) and BMPs to achieve water quality standards (IDAPA 58.01.02.010.09; IDAPA 58.01.02.350.03).

Several government agencies have developed separate planning documents that set a goal to achieve Idaho's water quality standards (SFCR WAG 2006, ISWCC 2014, Idaho County 2016, USFS 2020). The fundamental objective of this document is consistent with these plans because the goal is also to achieve Idaho's water quality standards. This document focuses specially on how to evaluate compliance with and achieve Idaho's sediment and turbidity water quality standards in the SFCR watershed.

This document supports and expands on these plans. While other plans only state that achieving Idaho's water quality standard is a goal, this document specifies how compliance with Idaho's narrative sediment standard and numeric turbidity standards should be evaluated for the SFCR watershed. The CWA requires states to assess and report compliance with state water quality standards, and EPA to review and approve or disapprove those assessments. This document includes decision trees specifying the monitoring data, lines of evidence, and decision logic DEQ plans to use to assess and report compliance with Idaho's sediment and turbidity water quality standards in the SFCR watershed (section 5).

DEQ believes that formally, publicly, and transparently documenting its proposed approach to evaluating compliance with Idaho's sediment and turbidity standards in the SFCR is important for several reasons. First, because multiple land management agencies face mandates to evaluate if their land management actions achieve Idaho's water quality standards, a shared understanding of how compliance must be evaluated is critical. Second, because Idaho's narrative sediment water quality standard simply states sediment must not exceed quantifies that impair beneficial uses (IDAPA 58.01.02.200.08), evaluating compliance with this standard is not straightforward. Articulating the monitoring data, lines of evidence, and decision logic for partner agencies with CWA mandates and EPA (which must approve CWA assessment decisions) is needed. Third, because DEQ and EPA both recognize existing TMDL targets based on suspended sediment are problematic, an alternative approach to assessing sediment standard compliance is needed until DEQ has sufficient data to revise the TMDL. Fourth, by developing this through a public process, DEQ enables stakeholder and technical expert input on its assessment approach. This plan is a living document that can be collaboratively revised if needed through a public process as additional information becomes available (section 9).

This document does not supersede or replace legal requirements for point sources established in existing TMDL documents or permits. Point source wasteload allocations defined in existing TMDL documents for the suction dredge industry, municipal wastewater treatment plants, or other point sources remain in place. Wasteload allocations can only be changed through a TMDL revision, which would need to be reviewed and approved by EPA. Point source requirements established in existing National Pollution Discharge Elimination System (NPDES) or Idaho Pollution Discharge Elimination System (IPDES) permits also remain in place. Those requirements can only be revised when a permit is revised and reissued. This plan is designed to produce data needed to revise the existing TMDLs and associated wasteload allocations, and to inform development of future IPDES permits.

In addition to the CWA, sediment management in the SFCR is affected by the Endangered Species Act (ESA). USFS and BLM developed a biological assessment (BA) document that

describes their plan for managing suction dredging activity in the main stem and associated measures to protect Snake River Basin steelhead and Snake River fall Chinook salmon (USFS and BLM 2016). The National Oceanic and Atmospheric Administration (NOAA) NMFS subsequently issued a biological opinion documenting whether NMFS believes USFS and BLM action described in the BA is likely to jeopardize the existence of these species, or cause destruction or adverse modification of their designated critical habitat (NMFS 2016). NMFS concluded management actions described in the BA would not have these effects (NMFS 2016). The BA and biological opinion establish procedures that miners, USFS, and BLM must follow to prevent or minimize effects of suction dredging activity on salmonid habitat, including sediment impacts from dredging.

Methods proposed here to assess if sediment conditions achieve Idaho water quality standards in the SFCR watershed are separate from methods USFS, BLM, and NMFS may use to evaluate if suction dredging activity meets ESA requirements. The biological opinion specifies thresholds for turbidity (turbidity does not exceed background beyond 150 feet downstream of dredging for more than 30 minutes), dredging effort (maximum 8 hours/day), and disturbed area (54,000 square feet [ft^2] annual maximum, or 27,000 ft^2 annual average over 10 years) that NMFS will consider exceeding acceptable impacts (i.e., incidental take) (NMFS 2016). Exceeding these thresholds would require USFS and BLM to reevaluate their dredge management approach under the ESA (NMFS 2016). USFS, BLM, and NMFS decisions about suction dredging compliance with ESA requirements will follow criteria established in the biological opinion until it expires in 2026, unless the BA and opinion are revised before then.

This plan will generate monitoring data in the main stem SFCR (action 1) and document suction dredging impacts on selected physical and biological indicators (action 3). Therefore, this plan will assist future revisions or updates to the BA and biological opinion by producing monitoring data relevant to ESA processes.

1.3 Relationship to Other Monitoring Programs

Several government agencies involved with this plan have their own ongoing stream monitoring programs (Table 3). This plan uses data collected by these programs and requires additional monitoring to fill information gaps not addressed by existing programs.

Methods used to evaluate compliance with Idaho's narrative sediment standard (section 5) will use some of the data collected by existing DEQ, USFS, and BLM monitoring programs. All three agencies routinely measure stream surface fine sediment and collect macroinvertebrate samples within wadable streams. Decision trees for evaluating compliance with Idaho's narrative sediment standard (section 5) can use surface fine sediment and macroinvertebrate data collected by any of these programs. An analysis of data comparability across these three programs was conducted and is documented in Appendix B. DEQ concluded surface fine sediment and macroinvertebrate measurements are sufficiently comparable for purposes of applying the decision trees (Appendix B).

However, existing monitoring programs do not generate some needed information. They do not routinely collect data in large rivers such as the main stem SFCR. The main stem is listed as sediment-impaired under the CWA. BLM's Aquatic Inventory and Monitoring (AIM) program has collected some data within the main stem, but only within upper reaches located within BLM land boundaries. This plan includes an annual main stem monitoring program (action 1) to produce data needed to evaluate if Idaho's narrative sediment water quality standard is achieved in the main stem. The annual main stem monitoring program is described further in section 6.1, and sampling protocols are included in Appendix C.

Existing monitoring programs also do not adequately document the presence, absence, or magnitude of suction dredging ecological effects (DEQ 2023). Current USFS and BLM suction dredging monitoring measures activity (number of dredgers, hours, dredged area) but does not measure dredging ecological effects. The suction dredge monitoring study included in this plan (action 3) is designed to test for the presence/absence of ecological effects caused by dredging and measure effect magnitude.

Table 3. Stream monitoring programs that include the South Fork Clearwater River subbasin.

	Beneficial Use Reconnaissance Program (BURP)	PacFish/InFish Biological Opinion Monitoring Program (PIBO)	Assessment, Inventory, and Monitoring Program (AIM)
Agency	DEQ	USFS, BLM	BLM
Purpose	Help assess beneficial use support for Clean Water Act assessments at assessment unit spatial scale	Assess if management is protective of salmonid habitat at large (subbasin, forest, region) spatial scales	Meet Federal Land Policy and Management Act Section 201(a) requirements, various spatial scales
Coverage	Idaho streams outside wilderness, including private and public lands	USFS and BLM lands	BLM lands
Stream types sampled	Wadable 1st–4th order	Wadable 1st–4th order streams with < 4% gradient with and ≥ 50% federal ownership	Wadable 1st–4th order streams, and some large rivers
Site selection	Targeted nonrandom	Probability survey design, plus some targeted nonrandom sites	Probability survey design, plus some targeted nonrandom sites
Repeat sampling of same reach across years?	No	Yes - most sites sampled every 5 years, a subset sampled annual or biennially	Yes - most sites sampled every 5 years
Sampled reach length	30 x bankfull width, 100 m minimum	20 x bankfull width, 160 m min and 500 m max length.	20 x bankfull width, 150 m min, 4 km max
Stream substrate measures	Modified Wolman pebble count, surface % fines, visual embeddedness	Modified Wolman pebble count, surface % fines, pool tail fines	Modified Wolman pebble count, surface % fines, pool tail fines
Stream physical measures	Bankfull width, flow, habitat types, bank stability, others	Bankfull width, cross sections, habitat type mapping, bank stability, gradient, others	Bankfull width, cross sections, habitat type mapping, bank stability, gradient, others
Macroinvertebrates	Composite of three 500 µm mesh Hess samples from three riffle habitats	Composite of eight 500 µm mesh Surber net samples from riffle habitats	Composite of eight 500 µm mesh Surber net samples from riffle habitats or of 11 Surber samples spanning multiple habitat types
Fish	Species presence and abundance based on an electrofishing survey	Not measured	Not measured

2 Conceptual Model

This plan is based on a conceptual model for how human activities can increase sediment delivery to streams and affect aquatic life (Figure 3).

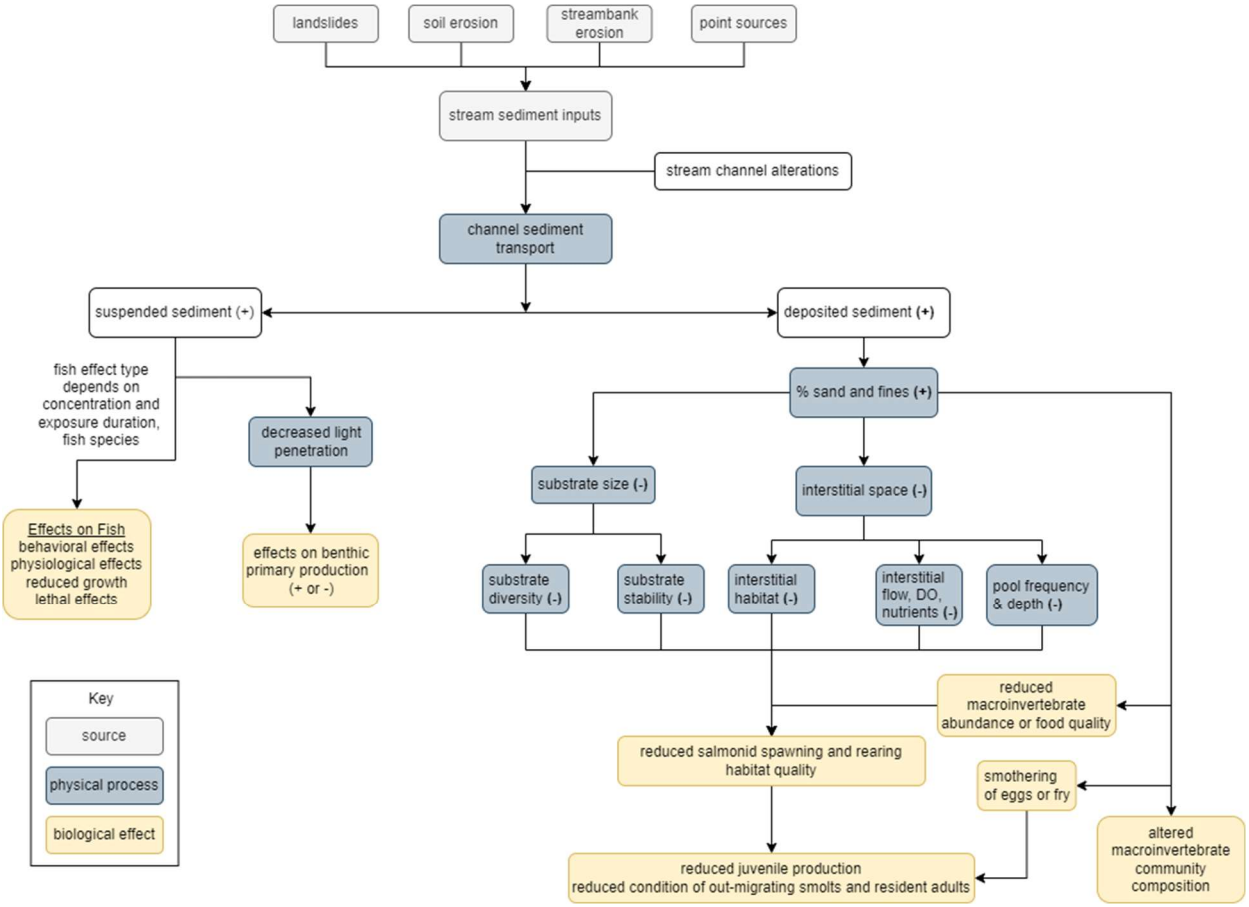


Figure 3. Conceptual model for stream sediment sources, processes, and effects (adapted from EPA 2006 and Clapcott et al. 2011). DO = dissolved oxygen. (+) and (-) indicate an increase or decrease in levels, respectively.

Potential sediment sources to streams include landslides, soil erosion, streambank erosion, and point sources. Landslides, soil erosion, and streambank erosion can be caused by both human and natural processes. Human activities such as urban development, agriculture, forestry, mining, and road development can increase soil and streambank erosion rates. Human-caused stream channel alterations include historic and current dredging activity, and channel modifications for agriculture, flood control, roads, and restoration projects. These channel alterations can affect stream hydrology and therefore channel sediment transport. Transported sediment can affect aquatic life through either suspended sediment or deposited sediment exposure pathways.

Deposited sediment is sediment that has settled out from the water column onto the streambed. Excess deposited surface fine sediment (small cobble, sand, and finer, typically measured as < 2 mm or < 6 mm diameter) can negatively affect both fish and invertebrates (DEQ 2003, EPA 2006). Increasing surface fine sediment affects the types of macroinvertebrate taxa present. Sediment-sensitive taxa are present at low percent surface fine sediment levels but are often absent as % surface fine sediment levels increase (Relyea et al. 2012). Changes to other macroinvertebrate measures such as overall abundance or relative abundance of specific

taxa groups (% Ephemeroptera, Plecoptera, Trichoptera) area also often associated with % surface fine sediment (EPA 2006, Jessup et al. 2014, Kusnierz et al. 2015, Larson et al. 2019).

Excess surface fine sediment can also affect habitat used by salmonids for spawning and rearing (DEQ 2003, EPA 2006). Fine sediment deposited on salmonid eggs can reduce exchange of dissolved oxygen and nutrients to eggs, increasing egg mortality. It can also clog spaces between rocks and below the streambed surface, increasing cobble embeddedness and subsurface fine sediment. Compacted fine sediment can prevent alevins from emerging from stream gravels. The percentage of eggs that survive, hatch, and successfully emerge decreases as fine sediment levels increase (Jensen et al. 2009). Reduced interstitial space also reduces habitat available to salmonids during rearing and for overwintering.

The direct effects of sediment suspended in the water column include behavioral avoidance responses, sublethal effects on growth and physiology due to ingestion or filtration of suspended particles, and at very high levels, lethal effects (DEQ 2003, EPA 2006). The severity of effect depends on suspended sediment concentration and exposure duration (Newcome and Jensen 1996). Extended periods of high suspended sediment are associated with reduced growth and reproduction of mussels and changes to the abundance, species composition and distribution of macroinvertebrates (EPA 2006). Suspended sediment can also affect the amount of light in the water column, which affects benthic primary production. Suspended and deposited sediment can either decrease or increase benthic primary production, depending on background ultraviolet light intensity, nutrient availability, and other factors.

This plan focuses primarily on the deposited sediment pathway for several reasons. First, the existing sediment TMDLs and NMFS biological opinion both concluded the deposited sediment pathway is the most important exposure pathway for salmonids in the SFCR and tributaries. Second, EPA recommended DEQ focus monitoring and assessment on deposited sediment pathways rather than suspended sediment (Table 2). Third, in large wadable rivers such as the SFCR, monitoring deposited sediment accurately is easier than monitoring suspended sediment loads. Decision trees for evaluating if sediment violates Idaho's narrative sediment water quality standard are based on this conceptual model and focus on deposited sediment (section 5). However, evaluation criteria for assessing compliance with suspended sediment through Idaho's numeric turbidity criteria are also included (section 5).

3 Problem Statement

DEQ developed the following problem statement based on input from watershed stakeholders and partner agencies during a January 2023 technical workgroup meeting in Grangeville, Idaho.

> *Government agencies (DEQ, USFS, IDWR, BLM, NOAA-NMFS, USFWS) with legal mandates for managing sediment in the South Fork Clearwater River watershed do not have adequate sediment and biological indicator status and trend data needed to inform various mandated or desired sediment management decisions specific to the watershed (Table A).*

4 Fundamental Objective

A fundamental objective is the desired condition a decisionmaker wants to achieve (Thompson et al. 2013). For government agencies fundamental objectives are typically based on legal mandates (Conroy and Peterson 2013). DEQ developed the following fundamental objective statement based on input from watershed stakeholders and partner agencies during a January 2023 technical workgroup meeting in Grangeville, Idaho. The fundamental objective of this plan is to ensure:

> *Stream and river sediment conditions resulting from human activities within the South Fork Clearwater River watershed do not modify any major biological group (fish, macroinvertebrates, or algae) beyond explicitly defined sediment reference conditions that consider the natural range of variability.*

This fundamental objective is based on mandates in the CWA and Idaho's "Water Quality Standards" (IDAPA 58.01.02). It was written so that, if achieved, Idaho's narrative sediment water quality standard would be achieved. The CWA and Idaho water quality standards are the basis for the fundamental objective because multiple agencies making sediment management decisions (DEQ, USFS, and BLM) are legally mandated to comply with the CWA and IDAPA 58.01.02 (section 1.1, Table 2). In addition, DEQ, USFS, BLM, and IDL signed a MOU stating the agencies will cooperate to manage nonpoint pollution in Idaho to comply with the CWA and IDAPA 58.01.02 (Appendix C of DEQ 2020c).

The goal of the CWA is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 U.S.C.§ 1251.101(a)). States must define water quality standards necessary to protect aquatic life, recreation, and other beneficial uses of water targeted for protection. EPA reviews and either approves each state-established standard or disapproves and promulgates a standard. Idaho's water quality standards define water quality criteria necessary to protect aquatic life, salmonid spawning, and other beneficial uses of water and thereby achieve the CWA goal. IDAPA 58.01.02.200.08 includes a narrative sediment criterion that applies to all state surface waters:

> Sediment shall not exceed quantities specified in Section 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information used as described in Section 350.

"Full Protection, Full Support, or Full Maintenance of Designated Beneficial Uses of Water" (IDAPA 58.01.02.42) defines the standard:

> Compliance with those levels of water quality criteria listed in Sections 200, 210, 250, 251, 252, 253, and 275 (if applicable) or where no major biological group such as fish, macroinvertebrates, or algae has been modified by human activities significantly beyond the natural range of the reference streams or conditions approved by the Director in consultation with the appropriate basin advisory group.

This plan's fundamental objective is specific to sediment; achieving it would not prevent major biological groups from being modified by other factors, such as elevated temperature or stream channel alterations. Although some streams in the watershed are also impaired under the CWA by other pollutants (temperature, nutrients, *Escherichia coli*) and impacted by historic stream channel alterations, the fundamental objective focuses only on sediment because pollutant sources, transport pathways, and management actions needed, and responses to management are predicted to be pollutant specific. A separate monitoring and assessment plan would be required for other pollutants.

The fundamental objective is also specific to effects of human activities within the watershed because IDAPA 58.01.02.63 defines natural background conditions as conditions "existing in a water body without human sources of pollution within the watershed". It is not designed to address human-caused adverse impacts on anadromous fish that occur outside the watershed or stressors with regional or global scale causes such as climate change and atmospheric deposition of pollutants.

If the fundamental objective is achieved, aquatic life or salmonid spawning beneficial uses may still not be fully supported in the SFCR or its tributaries for other reasons (other pollutants, regional or global stressors, legacy stream alterations). However, achieving the fundamental objective would achieve Idaho's sediment standard and be one important step towards achieving other objectives (full support of beneficial uses under the CWA and protecting ESA-listed species).

Developing and implementing a sediment plan based on this narrow fundamental objective does not preclude or prevent existing or future efforts to monitor, assess, or manage other causes of impairment under the CWA or efforts to achieve other objectives or legal mandates. Information generated by this plan will be useful for parallel efforts to achieve different objectives or meet different legal mandates.

4.1 Reference Conditions

The fundamental objective requires comparing data to "explicitly defined sediment reference conditions that consider the natural range of variability." IDAPA 58.01.02.83 defines a reference water body:

> A water body which represents the minimum conditions necessary to fully support the applicable designated beneficial uses as further specified in these rules, or natural conditions with few impacts from human activities and which are representative of the highest level of support attainable in the basin. In highly mineralized areas or in the absence of such reference streams or water bodies, the Director, in consultation with the basin advisory group and the technical advisors to it, may define appropriate hypothetical reference conditions or may use monitoring data specific to the site in question to determine conditions in which beneficial uses are full supported.

This plan considers reference conditions in two ways. First, decision trees used to evaluate if the fundamental objective is achieved are applied only where there is a potential upstream

human sediment source. If there is little or no upstream human disturbance, DEQ will assume there are no potential human sediment sources and will presume sediment and turbidity standards are achieved. DEQ analyzed human land use disturbances in each of the 37 subwatersheds (HUC12 subwatersheds) in the subbasin and concluded only upper John's Creek (mostly within the Gospel Hump Wilderness) and Twentymile Creek subwatersheds likely have no significant human sediment sources (section 5). Everywhere else, there is likely a need to collect data and assess if standards are achieved.

Second, decision trees used to evaluate if the fundamental objective is achieved require monitoring data to be compared to reference benchmarks. Reference benchmarks were calculated from monitoring data in streams throughout Idaho with limited upstream human disturbance. Separate reference benchmarks were defined for several stream types with naturally different sediment patterns. For example, benchmarks applied to assess if sediment affects macroinvertebrate community structure depend on stream order and associated landscape type because surface fine sediment and macroinvertebrate species composition vary naturally with these factors. The technical basis for reference benchmarks is discussed in more detail in Appendix B.

Reference sites DEQ used to develop benchmarks are different from but comparable to those used by USFS and BLM to identify reference sites for their monitoring programs. Stream reaches classified by DEQ and other agencies as reference often overlap. In addition, the decision tree DEQ developed for assessing sediment impacts on macroinvertebrates performed well when applied to reaches that meet PIBO reference criteria. The decision tree correctly predicted that there was no sediment impairment at 82% of sample events from USFS reference sites (N = 383), 78% of sample events from BLM reference sites (N = 37), and 93% of sample events from DEQ reference sites (N = 310). Relationships between framework predictions and other indicators of macroinvertebrate community status developed independently by USFS and BLM also indicated this framework successfully predicts macroinvertebrate community changes relative to reference conditions (Appendix B).

5 Evaluation Criteria

Evaluation criteria document the lines of evidence and decision logic that must be used to evaluate if the plan fundamental objective, and therefore Idaho's sediment standard, is achieved.

IDAPA 58.01.02.200.08 includes a narrative sediment criterion requiring that sediment does not "impair designated beneficial uses" of water. IDAPA 58.01.02.42 defines full support of aquatic life beneficial uses as "where no biological group such as fish, macroinvertebrates, or algae has been modified by human activities significantly beyond the natural range of the reference streams or conditions…." Based on these requirements, DEQ established guidance for applying Idaho's narrative sediment criterion (DEQ 2016). Identifying violations of the narrative sediment criterion requires multiple lines of evidence, including (1) evidence of at least one human sediment source in the watershed, (2) a potential transport pathway delivering

anthropogenic sediment to a water body, and (3) at least two lines of evidence for a measurable adverse effect of sediment on a beneficial use (DEQ 2016). Sections 5.2 and 0 document measurement data and logic for assessing compliance with Idaho's narrative sediment criterion based on these requirements.

Idaho's water quality standards also include numeric turbidity standards (IDAPA 58.01.02.250.02.3.e; IDAPA 58.01.02.401.02a). These standards address the suspended sediment exposure pathway (Figure 3). Section 5.4 documents requirements for evaluating if turbidity standards are achieved.

5.1 Spatial Scale

For CWA assessment and reporting purposes, DEQ divided Idaho streams into 5,908 assessment units (AUs) (DEQ 2022b). DEQ delineated AUs primarily based on stream order, although land use, management, and ownership were also considered. Generally, 1st and 2nd order streams with a contiguous 12-digit hydrologic unit code subwatershed were lumped into a single AU, each 3rd and 4th order stream were a discrete AU, and streams ≥ 5th order were divided into multiple AUs (DEQ 2022b, Williams 2023). Each AU is a subset of a water body specified in IDAPA 58.01.02.010. Each water body represents a specific reach or tributary within a subbasin (i.e., within an 8-digit hydrologic unit code). For each water body, Idaho's water quality standards define beneficial uses that must be protected and water quality criteria necessary to protect those beneficial uses. DEQ assesses and reports compliance with applicable water quality standards and develops TMDLs at the AU spatial scale. Achieving the administrative goals of the CWA and identifying the specific land management actions needed to restore beneficial uses within an AU usually requires diagnosing stressors at the AU or smaller sample reach spatial scale.

There are 146 AUs in the SFCR subbasin. 18 are inside the Nez Perce Reservation boundary and 128 are outside the boundary. DEQ will not apply these evaluation criteria to AUs within the Nez Perce Reservation boundary. DEQ does not assess and report support of beneficial uses within tribal boundaries in accordance with Idaho's tribal waters policy (DEQ 2022b). In Idaho's biennial Integrated Report (IR), DEQ lists all AUs within tribal boundaries as tribal/not assessed to comply with a tribal waters policy cooperatively developed by DEQ, EPA, and Idaho tribes (DEQ 2016, DEQ 2022b).

For each AU assessed, DEQ will publicly document the basis for all assessment decisions in the IR documents. State law requires DEQ to consult with WAGs about IR assessment decisions. DEQ will present assessment outcomes to the SFCR WAG before finalizing the IR documents. The public can also comment on DEQ's assessment decisions by submitting comments during public comment periods for the IR. EPA reviews and either approves or disapproves DEQ's assessment decisions by either approving or disapproving Idaho's 303(d) list. If EPA disapproves part or all of Idaho's 303(d) list, the CWA requires EPA to promulgate a revised list.

5.2 Does Sediment Impair Cold Water Aquatic Life Use?

Idaho's water quality standards require that cold water aquatic life use is protected in all river and stream segments within the SFCR subbasin. Waters protective of cold water aquatic life use are those with "water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species" (IDAPA 58.01.02.100.01a).

Figure 4 documents the measurement data and assessment logic that will be used to evaluate if sediment conditions violate Idaho's narrative sediment standard and impair cold water aquatic life use in the SFCR subbasin. The decision tree requires paired surface fine sediment (< 2 mm or < 2.5 mm) measured using pebble count methods and macroinvertebrate samples collected during the same sample event within a stream reach. Surface fine sediment and macroinvertebrate samples collected through either BURP, PIBO, or AIM programs can be applied in the decision tree.

Macroinvertebrate data must be used to calculate the macroinvertebrate fine sediment biotic index (FSBI). The FSBI is an index for assessing stream surface fine sediment (< 2 mm) impacts on macroinvertebrate community composition in northwest US streams (Relyea et al. 2012). FSBI scores generally range from 0 to 350. High scores indicate many sediment-sensitive taxa are present, and elevated surface fine sediment levels likely have not impacted macroinvertebrate community composition. Low FSBI scores indicate few sediment-sensitive taxa are present. FSBI has been applied for statewide stream condition assessments in Washington state (Larson et al. 2019) and for assessing effects of streambed instability on macroinvertebrates in Montana (Kusnierz et al. 2015). DEQ developed R software scripts for calculating FSBI from raw macroinvertebrate data (*https://github.com/jjwill2/FSBI_calculator*).

The decision tree compares paired surface fine sediment and FSBI measurements to reference benchmarks. Reference benchmarks depend on stream order and site class (ecoregion groupings) because surface fine sediment and macroinvertebrate community composition vary naturally with these factors. The technical basis for reference benchmarks applied in the decision tree are documented in Appendix B.

If the decision tree predicts excess surface fine sediment has altered macroinvertebrate community composition, DEQ will assume Idaho's narrative sediment criteria is not achieved and cold water aquatic life use is impaired by sediment within the sample reach and associated AU. However, if multiple reaches with an AU have paired fine sediment and macroinvertebrate data, or if data are available from one reach in multiple years, professional judgement is required before making a final AU-scale sediment impairment decision.

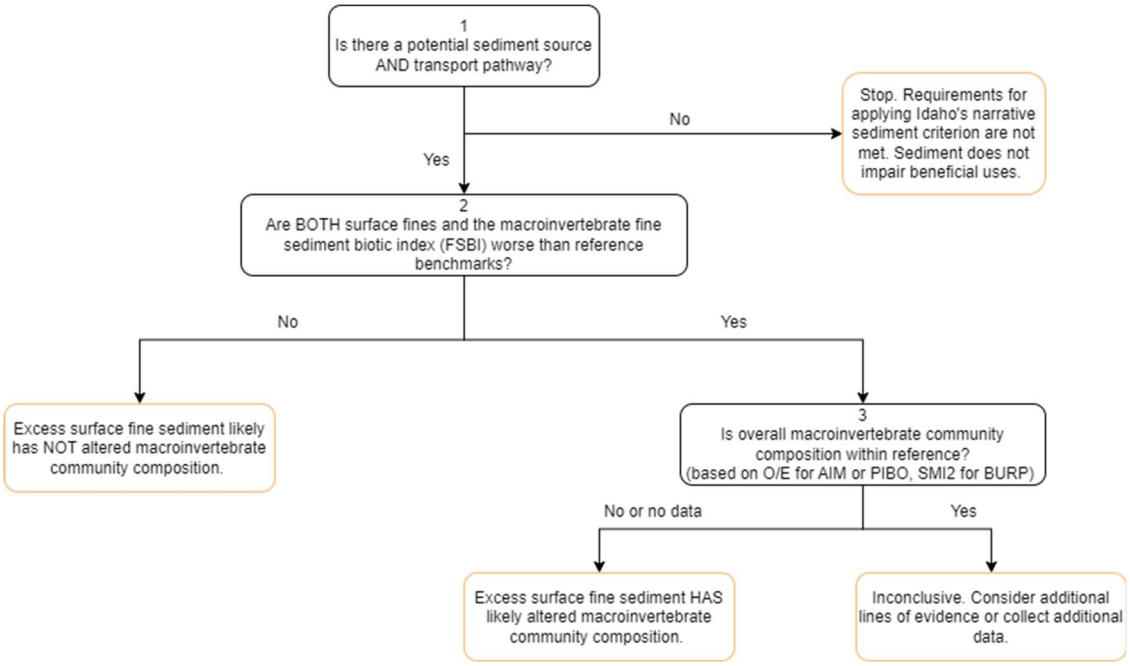


Figure 4. Decision tree for evaluating if sediment violates Idaho's narrative sediment standard and impairs cold water aquatic life use (details in tables below). DEQ will only apply this decision tree outside the Nez Perce Reservation boundary. Any data within the reservation will be shared with Nez Perce Tribe Water Resources.

Step	Description
1	To determine if there is a potential sediment source, evaluate characteristics of the associated HUC12 watershed. Those with < 5% grazed area, < 5% timber harvest, < 5% cropland, road density < 0.5 km/km2 and ≤ 1 mine will be assumed to not have sufficient human disturbance for a human-caused sediment impact. Two SFCR subwatersheds meet these criteria: upper Johns Creek (170603050601) and Twentymile Creek (170603050504). All other subwatersheds will be assumed to have a potential human sediment source and transport pathway. Characteristics of the catchment area upstream of a sampled reach may also be compared to the above criteria to assess potential for a human sediment source.
2	Compare paired measurements of surface fines and macroinvertebrates to reference benchmarks. Reference benchmarks depend on stream order for percent fines and site class for FSBI.
3	Do overall measures of macroinvertebrate community composition (i.e., measures that are not sediment-specific) indicate the community is worse than reference? For PIBO and AIM data, compare sample event macroinvertebrate observed/expected (O/E) value to the sample reach reference benchmark O/E (Table 3). For BURP data, evaluate if the BURP macroinvertebrate index (SMI2) is ≥ 2.

Indicator	Reference Benchmark Description	Site Class	Stream Order	Value
Surface fines	75% of reference sites have surface fine sediment (% particles < 2 mm or < 2.5 mm) better (less) this value	All	1st	39.5%
			2nd	28.3%
			3rd	23.6%
			4th	18.2%
FSBI	75% of reference sites have fine sediment biotic index (FSBI) score better (greater) than this value	Mountains	1st–4th	145
		Foothills	1st–4th	80
		PPBV*	1st–4th	20

*PPBV = plains plateaus and broad valleys. Note: for application in the main stem South Fork Clearwater River (5th order), 4th order surface fines benchmarks will be used. Data analyzed in Appendix B and data presented in Relyea et al. (2012) suggest surface fines patterns are similar in 4th and 5th order streams.

5.3 Does Sediment Impair Salmonid Spawning Use?

IDAPA 58.01.02.100.01.b. defines waters protected for salmonid spawning use as "waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes." Idaho's water quality standards designate waters where salmonid spawning use must be protected. In addition, Idaho's water quality standards and the CWA require existing uses to be protected. Existing uses are those that have been attained on or after November 28, 1975, whether or not they are designated for protection (IDAPA 58.01.02.10.38). DEQ considers salmonid spawning an existing use where there is documented evidence of spawning (e.g., documented redds, spawning observations, juvenile salmonids < 100 mm, and fisheries reports) on or after November 28, 1975. In the SFCR subbasin, salmonid spawning requires protection because it is either a designated or existing use everywhere except for several tributary streams in the lower watershed on the Camas Prairie (Red Rock, Stockney, Shebang, South Fork Cottonwood, and Long Haul Creeks).

Two conditions must be met to apply salmonid spawning evaluation criteria:

1. Salmonid spawning is a designated or existing use in the AU.
2. There is evidence of an upstream sediment source and a potential transport pathway for sediment delivery to the stream. All HUC12 subwatersheds except upper Johns Creek and Twentymile Creek will be assumed to have a potential human sediment source. Characteristics of the catchment area upstream of a sampled reach may also be compared to landscape criteria in Figure 4 to assess potential for a human sediment source.

Evaluation criteria for salmonid spawning use were adapted from a procedure for assessing spawning gravel quality developed by Kandolf (2000). Spawning gravel quality is assessed based on (1) whether surface particle size is suitable for redd construction, and (2) whether excess surface or subsurface fine sediment is likely to reduce egg-to-fry survival (Table 4, Figure 5).

5.3.1 Redd Construction Suitability

First, surface fine sediment data from pebble counts will be used to evaluate if surface particle size distribution is less suitable for redd construction than in similar reference streams (Figure 5). For spawning females to construct redds, streambed particles must be small enough for spawning females to move. The fraction of streambed particles smaller than the largest diameter particle a typical spawning female can move (F_m) (Riebe et al. 2014) will be calculated from pebble count data and typical spawning female fork length. The sample reach F_m value will be compared to a reference benchmark calculated from measured values in similar streams with limited upstream human landscape disturbance. Threshold particle size that a typical spawning female can move (D_T) will be calculated using an equation developed by Riebe et al. (2014) based on field measurements from Chinook, Sockeye, and Pink Salmon redds (Equation 1):

$$D_T = 115 * L / 600^{-0.62}$$

Equation 1. threshold movable particle size

where L is spawning female fork length.

In Equation 1, fork lengths reported by partner agencies for spawning females will be used to select a typical L value representative of the smallest fork length common among spawning females in the subbasin. Reach F_m will be calculated as the fraction of streambed particles measured during a pebble count that have a smaller intermediate axis diameter than D_T. Reaches where F_m is worse (less) than a reference benchmark have larger particles and less area suitable for redd construction than reference streams. Streams with a higher proportion of large particles than in comparable reference streams may be highly aggraded and affected by human stream channel physical and hydrologic alterations.

5.3.2 Fine Sediment Impact on Egg-to-Fry Survival

Two lines of evidence will be used to assess if excess deposited fine sediment likely reduces egg-to-fry survival relative to reference conditions. First, fine sediment (surface plus subsurface) < 0.85 mm will be measured using McNeil core or shovel sampling methods (Hedrick et al. 2013). Measured percent fine sediment < 0.85 mm will be compared to a minimal effects threshold of 10% and a reference benchmark calculated from measured values in similar streams with limited upstream human landscape disturbance (Figure 5).

Jensen et al. (2009) compiled and analyzed field and laboratory studies that measured the proportion of eggs that successfully emerged as fry across different substrate fine sediment levels. From these data, they developed empirical relationships between substrate percent fine sediment < 0.85 mm (surface plus subsurface) and percent egg-to-fry survival for multiple salmonid taxa (Chinook, Coho, Steelhead, Chum). They reported rapid decreases in survival rates when percent fines < 0.85 mm exceeded 10% (Jensen et al. 2009). Substrate fine sediment levels < 10% will be assumed to have minimal effect. Substrate fine sediment levels will be assumed to have an effect warranting management action if they exceed 10% *and* are greater than an appropriate reference benchmark (Figure 5).

Second, potential impacts of deposited surface fine sediment on egg-to-fry survival will be evaluated using pebble count data. Percent surface fines < 6 mm will be compared to a minimal effects threshold value of 20% and a reference benchmark calculated from measured values in similar streams with limited upstream human landscape disturbance (Figure 5). Percent fines < 6 mm < 20% will be assumed to have minimal impacts because the SFCR sediment TMDL and guidance documents from multiple agencies recommend this a s a threshold for protecting salmonid habitat (CRITFC 1995; NMFS et al. 1998; DEQ, EPA, and NPT 2004). Substrate fine sediment levels will be assumed to have an effect warranting management action if they exceed 20% *and* are greater than an appropriate reference benchmark.

Salmonid spawning use will be assessed as sediment-impaired if the following occurs:

1. Sediment impairs cold water aquatic life use. Salmonid spawning is a subcategory of cold water aquatic life and is impaired by default if cold water aquatic life use is impaired.

2. At least two lines of evidence in Figure 5 suggest sediment is likely to impact spawning habitat quality. Idaho's *Water Body Assessment Guidance* requires at least two lines of evidence for an adverse effect on a beneficial use when evaluating compliance with Idaho's narrative sediment criterion (DEQ 2016).

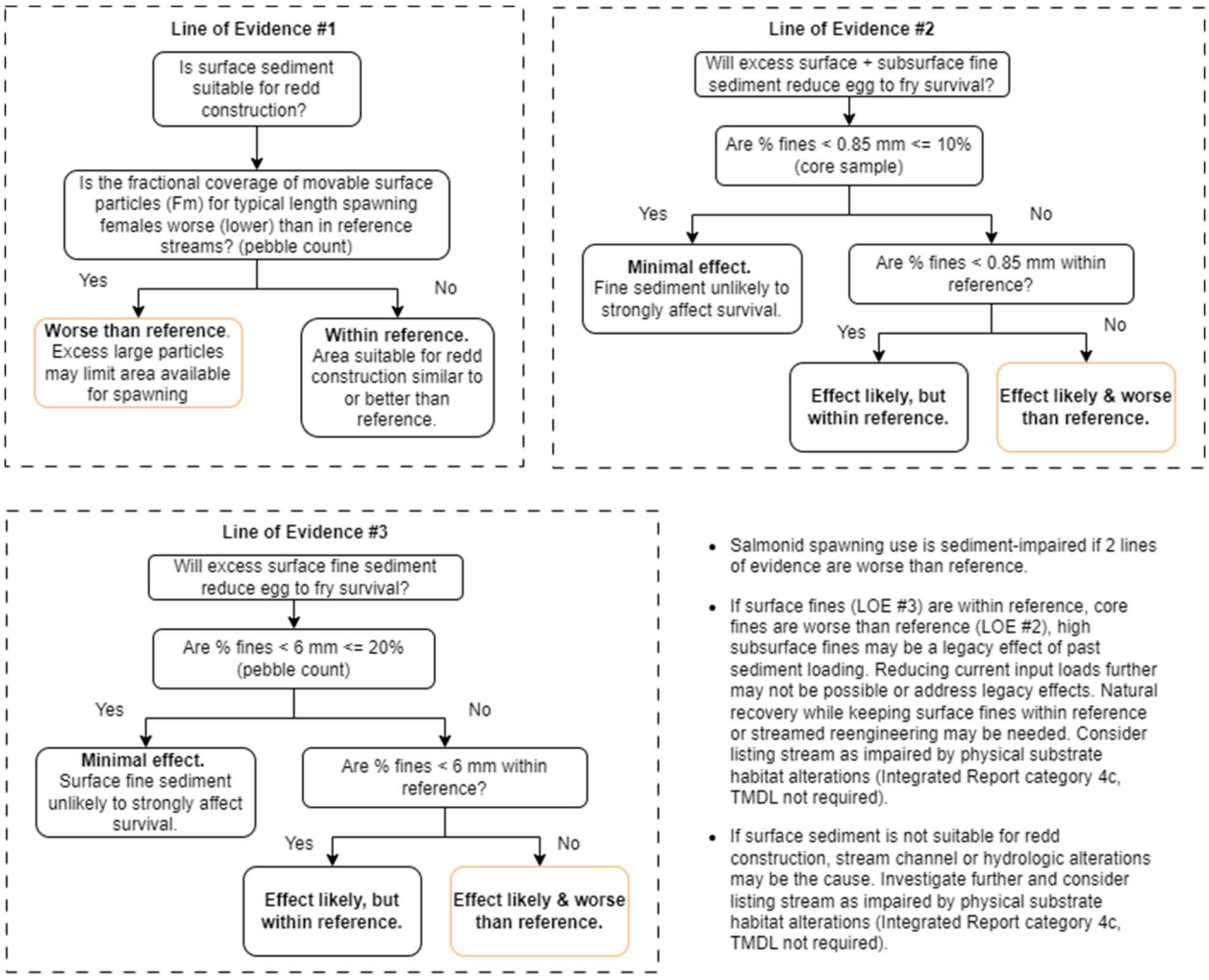


Figure 5. Evaluation criteria for assessing if sediment impairs salmonid spawning use. DEQ will only apply this decision tree outside the Nez Perce Reservation boundary. Any data within the reservation will be shared with Nez Perce Tribe Water Resources.

Table 4. How lines of evidence will be combined to make sediment impairment decisions.

	Line of Evidence 1 Sediment Suitability for Redd Construction	Line of Evidence 2 Will excess surface + subsurface fines affect egg to fry survival?	Line of Evidence 3 Will excess surface fines affect egg to fry survival?	Salmonid Spawning Sediment Impairment Status
1	Within reference	Minimal effect	Minimal effect	Not sediment impaired
2	Within reference	Minimal effect	Effect likely, but within reference	Not sediment impaired
3	Within reference	Minimal effect	Effect likely and worse than reference	Not sediment impaired[a]
4	Within reference	Effect likely but within reference	Minimal effect	Not sediment impaired
5	Within reference	Effect likely but within reference	Effect likely, but within reference	Not sediment impaired
6	Within reference	Effect likely but within reference	Effect likely and worse than reference	Not sediment impaired[a]
7	Within reference	Effect likely and worse than reference	Minimal effect	Not sediment impaired
8	Within reference	Effect likely and worse than reference	Effect likely but within reference	Not sediment impaired
9	Within reference	Effect likely and worse than reference	Effect likely and worse than reference	**Sediment-impaired**
10	Worse than reference	Minimal effect	Minimal effect	Not sediment impaired[b]
11	Worse than reference	Minimal effect	Effect likely but within reference	Not sediment impaired[b]
12	Worse than reference	Minimal effect	Effect likely and worse than reference	**Sediment impaired[b]**
13	Worse than reference	Effect likely but within reference	Minimal effect	Not sediment impaired[b]
14	Worse than reference	Effect likely but within reference	Effect likely but within reference	Not sediment impaired[b]
15	Worse than reference	Effect likely but within reference	Effect likely and worse than reference	**Sediment impaired[b]**
16	Worse than reference	Effect likely and worse than reference	Minimal effect	**Sediment impaired[b]**
17	Worse than reference	Effect likely an worse than reference	Effect likely but within reference	**Sediment impaired[b]**
18	Worse than reference	Effect likely and worse than reference	Effect likely and worse than reference	**Sediment impaired[b]**

a. Surface fines are within reference, but subsurface fines are not. There may be a legacy effect of past sediment loading. Reducing sediment input loads further may not be possible or address legacy effects. Investigate further and consider a physical substrate/habitat alteration listing if appropriate.
b. More large-size particles than in reference streams may result from stream channel or hydrologic alterations. Addressing underlying physical processes rather than sediment inputs may be needed. Investigate further and consider a physical substrate/habitat alteration listing if appropriate.

If substrate particle size distribution is not suitable for redd construction because surface particle sizes are too large, assessing the stream as impaired by physical substrate/habitat alterations should be considered. A high proportion of large-size particles can result from

channel alterations, hydrologic alterations, and resulting aggradation rather than excess deposited fine sediment. Reducing deposited fine sediment levels by reducing input loads from point and nonpoint sources will likely not address excess large size particles and aggradation. In such cases, stream power and channel sediment transport dynamics are often the underlying problem rather than sediment input loads. Addressing stream physical or hydrologic alterations may be needed rather than reducing sediment input loads though a sediment TMDL. Conduct further investigation and consider if listing the stream as impaired by physical substrate habitat alteration is warranted. The main stem South Fork Clearwater River is currently listed as impaired for both sediment and physical substrate/habitat alterations.

5.3.3 Reference Benchmarks for Salmonid Spawning Evaluation Criteria

Reference benchmarks required for salmonid spawning evaluation criteria have not yet been defined. Reference benchmarks for F_m and surface fines < 6 mm can be defined using existing DEQ, USFS, and BLM pebble count data. However, separate reference benchmarks should be developed for different stream types based on stream physical characteristics controlling indicator variability within reference streams. For example, reference benchmarks for percent fines < 2 mm were defined for different stream orders because stream order reflects impacts of stream power on percent surface fines. Analyses should be conducted to identify factors controlling F_m and surface fines < 6 mm variability and define reference benchmarks for appropriate stream type groupings. Developing reference benchmarks for core fines < 0.85 mm (Figure 5, line of evidence 2) will require collecting data in reaches that meet reference criteria and analyzing collected data to define benchmarks. DEQ will lead efforts to develop reference benchmarks in cooperation with partner agencies.

5.4 Are Numeric Turbidity Criteria Achieved?

Idaho's water quality standards include numeric turbidity criteria for protection of cold water aquatic life use (IDAPA 58.01.02.250.02.e; IDAPA 58.01.02.401.02a). If Tier 1 turbidity data are available and exceed numeric turbidity criteria, DEQ will classify sediment as impairing cold water aquatic life use. Tier 1 data are data with sufficient scientific rigor, relevance, and documentation to be used in 303(d) listing decisions. Tier 1 data must have an established monitoring plan with defined quality assurance protocols, among other requirements detailed in Idaho's *Water Body Assessment Guidance* (DEQ 2016).

To protect cold water aquatic life use, IDAPA 58.01.02.250.02.e requires that turbidity below any applicable mixing zone does not exceed background turbidity by more the 50 nephelometric turbidity units (NTU) instantaneously or more than 25 NTU for more than 10 consecutive days. In cases where a point source discharge is present upstream, these thresholds apply below any applicable mixing zone established by DEQ.

In addition, a separate turbidity criterion applies to point source discharges (IDAPA 58.01.02.401.02a) and is the basis for suction dredge wasteload allocation turbidity requirements established in the SFCR sediment TMDL (DEQ EPA and NPT 2004). In streams where background turbidity ≤ 50 NTU, such as the SFCR, turbidity downstream of a point source

(including a suction dredge) must not exceed background (upstream) turbidity by more than 5 NTU outside the point source mixing zone. DEQ defined a 500-foot mixing zone for suction dredges in the SFCR, so to achieve this turbidity criterion, turbidity 500 feet downstream of an operating suction dredge must be ≤ 5 NTU greater than turbidity upstream of the dredge.

Comparing measured turbidity data to these numeric criteria requires the following:

1. A sampling plan or other document describing measurement methods, instrument calibration procedures, and quality assurance/quality control procedures. Documentation of planned and implemented methods are needed to determine if turbidity data meet Tier 1 requirements.
2. Documentation of background turbidity levels. Background turbidity should be defined based on measurement data.
3. Verification that instruments and methods used can reliably measure the turbidity change magnitude of interest. For example, can instruments and methods used reliably measure a 6 NTU change over background when background is 10 NTU or less?

DEQ is not aware of continuous turbidity data in the SFCR subbasin that meets all the above criteria. Some continuous turbidity data have been collected in the main stem by USFS and BLM during suction dredge monitoring efforts. However, those data do not meet requirements 1 and 3 above. In addition, USFS fisheries biologist staff who conducted turbidity monitoring and other stakeholders advised DEQ that accurately characterizing turbidity patterns downstream of suction dredges requires monitoring staff to be present during discharges and periodically move the downstream turbidity sensor to keep it within the discharge plume, but staff limitations have prevented this.

If Tier 1 turbidity data that meet the above requirements become available, they will be compared to applicable numeric turbidity criteria to assess cold water aquatic life use support.

6 Plan Actions

Plan components are the actions and projects that must be implemented to achieve the fundamental objective (Section 4).

6.1 Action 1—Annual Main Stem Monitoring

Suggested implementing agencies: DEQ, USFS, and BLM

Action 1 is designed to assess if Idaho's sediment standard is achieved in the main stem SFCR. Annual monitoring will generate data needed to evaluate if sediment does not achieve Idaho's sediment standard and impairs cold water aquatic life or salmonid spawning use. Decision trees in section 5 will be used to assess if sediment impairs cold water aquatic life or salmonid spawning uses in the main stem.

Ten main stem reaches plus one reference reach (Meadow Creek, a tributary of the Selway River) will be sampled once annually (Figure 6, Table 5). Two reaches within each of the five

assessment units of the main stem SFCR were selected for monitoring. Each reach is 300 linear feet of wadable riffle or riffle/run habitat. Sampling will occur during baseflow in late August or early September after the suction dredge season ends. Measured parameters will include bankfull width, wetted width, bankfull height, bankfull depth, pebble counts (for % surface fines), McNeil core samples (for surface + subsurface fines), reach gradient, and macroinvertebrate fine sediment biotic index. Monitoring protocols are included in Appendix C.

Annual main stem monitoring is partially funded by a North Central Idaho Resource Advisory Committee grant from the Nez Perce-Clearwater National Forest. The grant funds costs of macroinvertebrate sample laboratory analysis and some equipment for 2023–2026. In 2023, DEQ led monitoring with field labor assistance from USFS staff. Stakeholder agencies will need to continue allocating necessary field labor or provide funding to hire seasonal field crews. McNeil core sampling is not included in 2023 monitoring but will be added starting in 2024. Data collected within the Nez Perce Reservation boundary will not be used to assess support of beneficial uses, consistent with Idaho's tribal waters policy. Data collected within the reservation boundary will be provided to Nez Perce Tribe Water Resources and used to help the tribe assess if watershed management actions outside the reservation are protective of tribal waters.

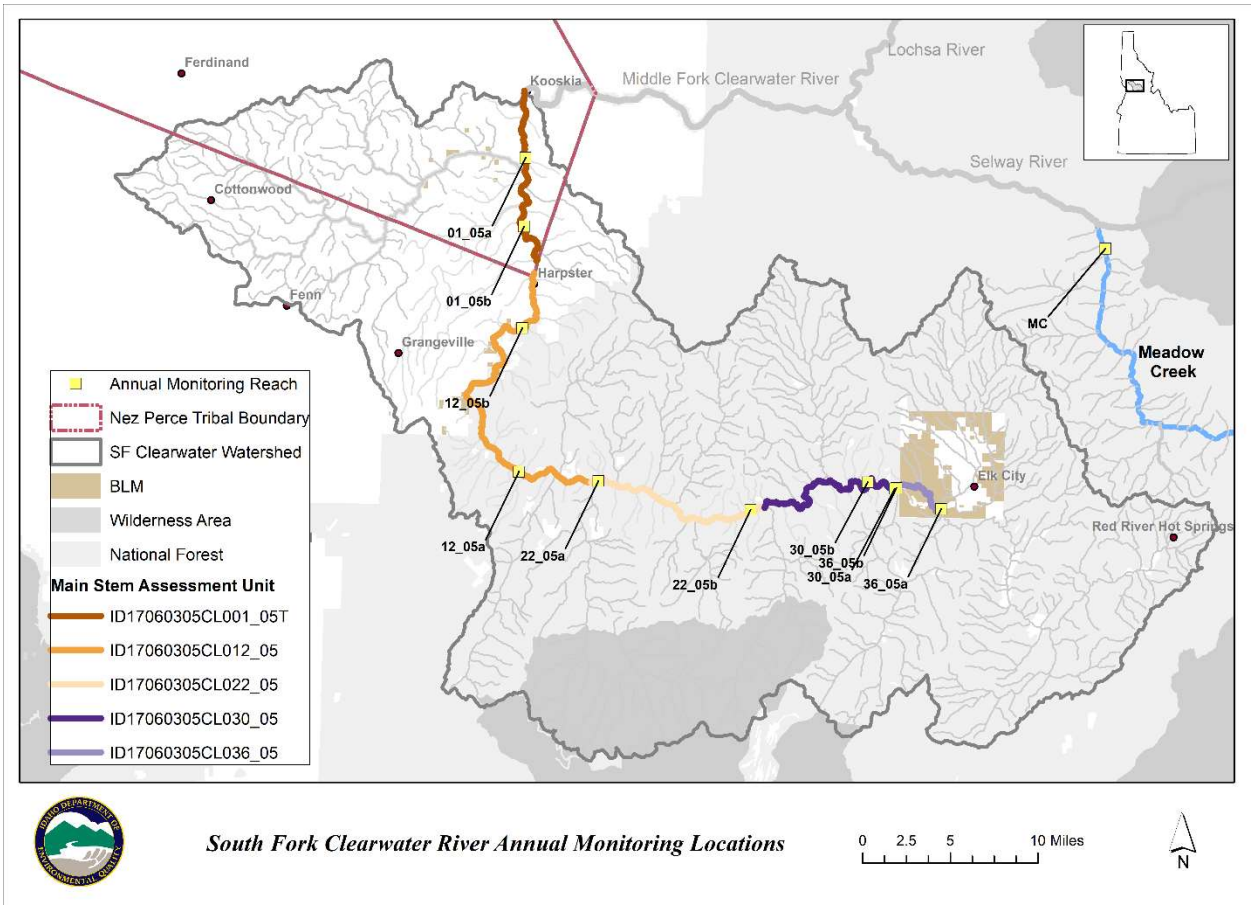


Figure 6. Annual monitoring reaches (action 1).

Table 5. Annual monitoring reaches (action 1).

Reach ID	Description	Upstream Latitude	Upstream Longitude	Downstream Latitude	Downstream Longitude
01_05a	SFCR just upstream of Stites bridge	46.09059	-115.97737	46.09128	-115.97791
01_05b	SFCR upstream of Threemile Creek	46.03401	-115.97694	46.03363	-115.97588
12_05b	SFCR upstream of Lightning Creek	45.95003	-115.97622	45.94994	-115.97505
12_05a	SFCR downstream of Castle Creek	45.83107	-115.97589	45.83187	-115.976646
22_05a	SFCR upstream of Johns Creek	45.82516	-115.88159	45.82465	-115.88249
22_05b	SFCR near Reed Cr	45.80427	-115.7008	45.80381	-115.70106
30_05b	SFCR between Dutch Oven and Center Star Creeks	45.82906	-115.56297	45.82832	-115.56349
30_05a	SFCR just downstream of Crooked River	45.8241	-115.53081	45.82389	-115.53201
36_06b	SFCR just upstream of Crooked River	45.8247	-115.52883	45.82447	-115.52985
36_05a	SFCR just downstream of American River and Red River confluence	45.80807	-115.47535	45.80765	-115.476288
MC	Meadow Creek near mouth	46.02532	-115.28616	46.02614	-115.28661

6.2 Action 2—Suction Dredge Industry Compliance Monitoring

Suggested implementing agencies: USFS, BLM, IDWR, DEQ

Action 2 documents if the suction dredge industry is meeting existing regulatory compliance requirements specific to impacts on sediment, aquatic life, and salmonids. This action requires continuation of existing compliance evaluation efforts. It does not propose new compliance monitoring.

This action facilitates comparison to outcomes of the suction dredge impacts study (action 3). If the industry achieves compliance with existing regulatory requirements (Table 6) based on measures of dredging activity, but the impacts study still documents measurable changes to sediment or biological indicators, this suggests existing regulations are not sufficient to prevent dredging-induced ecological changes. On the other hand, if the industry does not achieve compliance, but the impacts study indicates no measurable changes to indicators, this would suggest existing compliance measures are poor indicators of impacts, and revising regulations and compliance measures is needed.

DEQ will request USFS, BLM, and IDWR each provide an annual memo or report summarizing suction dredge industry compliance with agency-specific requirements. Each agency's report or memo should document at a minimum:

- Annual dredged area and volume (USFS and BLM)
- Number of reported and confirmed cases of unpermitted dredging (all agencies)
- Number of reported and confirmed compliance violations (all agencies)

Existing annual summary reports produced by agencies, such as USFS and BLM annual reports prepared by NMFS, can be used to provide this information. DEQ will also compile and make available the same information from the IPDES program. Information will be used to document presence/absence of compliance with Table 6 requirements each year. Industry compliance status will then be summarized along with results of the suction dredge impacts study (component 3) in 2027 to inform decision-making.

Table 6. Suction dredge industry annual compliance measures.

Measure	Requirement	Source
Location	Main stem upstream of Harpster; dredging in tributaries requires approved IDWR/IPDES joint permit and ESA section 7 compliance	NPDES Permit IDG37000
Timing	Dredging July 15–August 15 only	NPDES Permit IDG37000, TMDL
Number of operations	≤ 15 active operations/year	NPDES Permit IDG37000
Active hours per day	≤ 8 hours/day activity per operation	NPDES Permit IDG37000, NMFS Biological Opinion incidental take threshold
Operation volumetric material processing rate	≤ 2 yd^3/hour material processed per operation	NPDES Permit IDG37000
Industry daily dredge effluent load	≤ 314 tons/day industry annual dredge effluent load	TMDL wasteload allocation
Industry seasonal dredge effluent load	≤ 9,734 tons/season (314 tons/day x 31 days)	Calculated based on TMDL wasteload allocation
Turbidity impacts	Turbidity ≤ 5 NTU over background and no visible turbidity plume ≥ 500 ft downstream of dredges	NPDES Permit IDG37000, TMDL wasteload allocation, DEQ 401 certification of EPA's NPDES permit
Turbidity impacts	Turbidity exceeds background beyond 150 ft downstream of mining for more than 30 minutes	NMFS Biological Opinion incidental take threshold
Annual disturbed area limit	54,000 ft^2	NMFS Biological Opinion incidental take threshold
Average annual disturbance over 10 years	27,000 ft^2, calculated as 10-year average	NMFS Biological Opinion incidental take threshold
IPDES permit compliance violations	No violation of NPDES/IPDES permit requirements specific to sediment discharges	NPDES/IPDES permit
Plan of Operations (POO) permit compliance violations	No violation of POO requirements specific to sediment discharges	POO, NPDES permit, IDWR permit
IDWR permit compliance violations	No violation of IDWR permit requirements specific to stream alteration	IDWR permit, NPDES permit

6.3 Action 3—Suction Dredge Impacts Study

Suggested implementing agencies: DEQ, USFS, BLM

Action 3 tests if suction dredging activity causes measurable change for one or more sediment indicators within a dredged reach. Existing monitoring programs also do not adequately document the presence, absence, or magnitude of suction dredging ecological effects (DEQ 2023). Current USFS and BLM suction dredging monitoring measures activity (number of dredgers, hours, dredged area) but does not measure dredging ecological effects. This action is designed to test for the presence/absence of ecological effects caused by dredging and measure effect magnitude.

A pilot study began in 2023 to identify a sample design (number of dredging reaches to sample, statistical design, field methods, logistics, etc.) best suited for testing and measuring the stream substrate and macroinvertebrate impacts of suction dredging. The pilot study included two reaches with permitted dredging activity, associated local control reaches, and a regional control reach (Figure 7, Table 7). Field protocol documents are included in Appendix C. The pilot study is ongoing and preliminary results are not yet available.

Pilot study data will be used to develop a registered report for submission to a peer-reviewed scientific journal. A registered report is a detailed description of planned monitoring and data analysis methods that is submitted for peer review by independent experts before full data collection. The scientific journal selects the experts to perform the peer review. If the proposed methods pass peer review, data collection can then begin. The scientific journal agrees to publish the results of the study regardless of how they turn out, because the approach to collecting and analyzing the data was determined to be sound by the expert peer review process. This peer review process will likely not be complete before the start of the 2024 dredge season. Additional pilot monitoring or no monitoring may occur in 2024, depending on 2023 outcomes.

The pilot study uses a *before-after-control-impact* (BACI) sample design (Figure 7, Table 7). Reaches impacted by dredging and control reaches with no dredging activity will be sampled three times:

1. Before dredging activity occurs in 2023
2. After dredging (the season ends August 15) during the last week of August 2023
3. In 2024, before any dredging (i.e., after spring 2024 high flows but before any dredging in 2024)

Within a sample reach impacted by dredging, a measurable change in a parameter will be considered to occur when:

$$|\text{after} - \text{before}| \,/\, |\text{original} - \text{field duplicate}| > 1$$

Observed measurable changes will be assumed to be caused only by suction dredging activity if a measurable change is observed in the sample reach impacted by suction dredging but not in a local control reach just upstream of dredging activity and also not in a regional control reach with no dredging activity (Figure 7, Table 7). Parameters measured in the pilot study included surface fine sediment (< 2 mm, < 6 mm), stream instability index (Kusnierz et al. 2015), and macroinvertebrate FSBI (Relyea et al. 2012).

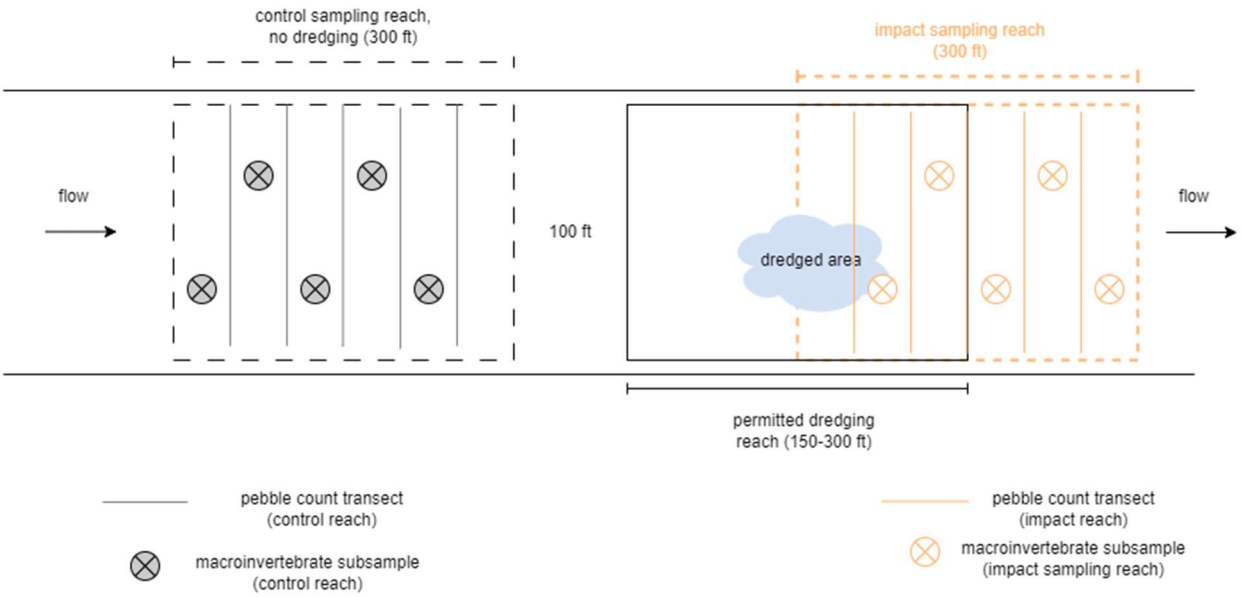


Figure 7. Example monitoring design used in the pilot study. Note the location and size of dredged area within the permitted dredging reach will vary depending on dredging activity.

Table 7. Suction dredge pilot study monitoring area descriptions.

Area	Description
Local control sampling reach (300-foot length)	A local control reach with no dredging activity. The downstream boundary of the control reach is 100-feet upstream of the upstream boundary of the permitted dredging reach. Local control reaches have no dredging activity within the reach but may have dredging activity 400 feet or more upstream. The local control will help confirm the source of any measurable changes observed within the impact sampling reach. If measurable changes are observed in the local control reach, measurable changes in the impact sampling reach may not be caused only by dredging activity within the permitted dredging reach.
Permitted dredging reach (150–300-foot length)	The area designated for permitted dredging activities. The length of the permitted dredging reach typically ranges from150–300 feet (300-foot maximum) and varies based on the dredging location requested by the miner and local habitat areas (pools, near tributary mouths, etc.) where dredging is prohibited. The lower 150 feet of the permitted dredging reach overlaps with the upper 150 feet of the impact sampling reach.
Impact sampling reach (300-foot length)	The area where short-term fine sediment accumulation resulting from dredging activity is most likely. The upper 150 feet of the impact reach overlaps with the lower 150 feet of the permitted dredging reach.
Regional control sampling reach	300-foot section of the main stem South Fork Clearwater River immediately below the confluence of American River and Red River. Dredging activity is not allowed in this reach or upstream. If measurable changes are observed in the regional control reach, this would indicate some measurable change can be attributed to background (nondredging) factors.

6.4 Action 4—Suction Dredge Permit Process Improvements

Suggested implementing agencies: DEQ, USFS, BLM, IDWR, NMFS

Since 2016, up to 15 suction dredge operations have been permitted to operate July 15–August 15 each year on the main stem SFCR upstream of Harpster, Idaho. Each operation requires written approval from three government agencies: DEQ, IDWR, and either USFS or BLM (DEQ 2023 describes the permit process).

The current suction dredging permit application and review process for the SFCR has been frustrating for both applicants and agency staff. Applicants fill out and submit three separate application forms, each with a large amount of overlapping information. A permitted dredging reach must be delineated and inspected by agency staff before permit coverage is issued. Short staffing and in some years high water have delayed timing of reach delineation and inspection. Permit approvals are also interdependent. The first 15 applicants with complete applications from all three agencies are given permit coverage. Coordination among the agencies has been difficult with limited staffing and high staff turnover. In most years, most applicants did not receive notice of permit approval or disapproval until only 1 or 2 days before the dredging season opened (July 15). In some years, several applicants did not receive notice until days or weeks after the 1 month-long dredging season began. These and other issues have reduced dredger and stakeholder confidence in the ability of government agencies to achieve their mandates and deliver government services.

DEQ will organize and fund an effort to improve efficiency of the suction dredge permit process for both applicants and agencies. DEQ will hire a consultant to identify and facilitate process improvements (Table 8). DEQ will request that representatives from each permitting agency (IDWR, DEQ, USFS, BLM, and NMFS) and 2 dredgers participate in this effort.

Table 8. Tentative structure of effort to increase suction dredge permit process efficiency.

Phase	Description
1	**Preworkshop interviews**. The consultant will conduct remote interviews with relevant staff from each agency and suction dredgers to gather information on the current application and permit approval process.
2	**In-person workshop in Grangeville, Idaho (3.5 days).** The consultant will facilitate an in-person workshop attended by relevant staff from permitting agencies and 1–2 dredgers. The workshop will include (1) diagraming all steps in the current process, (2) identifying failure points and steps with potential for improvement, (3) diagraming an improved process, and (4) establishing an implementation plan for the improved process.
3	**Implementation.** The consultant will organize a remote meeting to discuss ongoing implementation and provide advice. The consultant will create process documentation for both agencies and applicants.

The goal of component 4 is only to improve efficiencies of permit application, review, and award process. Specifically, to ensure agencies process permits in a timely manner, complete required work more efficiently, and make the application process more user-friendly for dredgers.

A revised process resulting from this effort must still comply with applicable legal requirements relevant to suction dredging in the SFCR. This component will not address or change existing regulatory thresholds (i.e., number of dredgers, suction dredge wasteload allocation, turbidity requirements, IPDES permit requirements, and biological opinion incidental take requirements). Existing regulatory thresholds can only be changed by following the appropriate legally mandated revision processes (TMDL revision, IPDES permit reissuance, BA and BiOP revision).

6.5 Action 5–Prioritizing Sediment Restoration Actions

Suggesting implementing agencies: DEQ, USFS, BLM, Nez Perce Tribe, Idaho Office of Species Conservation, Idaho Department of Lands, Idaho Soil and Water Conservation Commission, Idaho Department of Fish and Game, National Resources Conservation Service, and any other interested entities involved in funding or implementing restoration actions.

Action 5 identifies and prioritizes specific land management actions needed to reduce nonpoint source sediment inputs to streams and manage their effects. The workgroup will be tasked with ranking all 37 HUC12 subwatersheds within the subbasin based on (1) magnitude of human sediment impacts in the subwatershed, and (2) sediment reduction potential/feasibility.

DEQ will invite representatives with appropriate technical expertise from USFS Region 1, Nez Perce-Clearwater National Forest, Idaho Soil and Water Conservation Commission, Natural Resources Conservation Service, Idaho Department of Lands, Nez Perce Tribe Fisheries, Nez Perce Tribe Water Resources, Idaho Department of Fish and Game, and Idaho Office of Species Conservation to participate.

Workgroup meetings will be planned and facilitated by staff from one of the participating agencies or a contractor. The workgroup will meet at least twice per year during 2024–2027. The workgroup will develop methods for priority rankings. Information used for rankings should include, at a minimum:

- An evaluation of CWA compliance using evaluation criteria included in this document.
- Geographic Information Systems (GIS) analysis of human disturbances likely to impact stream sediment levels within each watershed.

Other information, such as sediment modeling and geomorphic assessments, should be used as deemed necessary by the workgroup. Workgroup outputs will be designed to inform efforts by land management agencies and organizations pursuing restoration project funding to identify and prioritize sediment reduction actions. The workgroup will report and summarize its efforts annually at a public WAG meeting.

Participating agencies will need to allocate staff and resources to this workgroup. Appropriate technical staff from agencies will need to participate. In addition, the workgroup will likely identify GIS and data analyses needed to achieve workgroup goals. Agency staff or their contractors will need to implement these analyses in a timely manner.

7 Predictive Model

In structured decision-making, a predictive model is “any conceptualization of the relationship between decisions, outcomes, or other factors” (Conroy and Peterson 2013). A predictive model can be a simple narrative statement, a flow diagram, or based on complex computer programs and models. For this plan, a simple narrative predictive model was developed to describe what outcomes are expected if agencies use information generated by plan components 1–5 to inform sediment management decisions (Summary, Table A).

If government agencies implement components 1–5 and use generated information to inform decisions in the Summary, Table A, sediment evaluation criteria will be achieved or measured indicators will show decreasing trend over time. Consistent annual monitoring will document indicator responses to management.

This is a generalized predictive model. Separate individual predictive models could also be developed for each decision listed in the Summary, Table A. This predictive model is consistent with the feedback loop between monitoring and management included in Idaho's 2020–2025 Nonpoint Source Management Plan (DEQ 2020c) (Figure 8). DEQ, USFS, BLM, and IDL have signed an MOU stating they agree to cooperatively manage nonpoint source pollution in Idaho by implementing the feedback loop in Figure 8 (DEQ 2020c, Appendix C).

The key point is that the effectiveness of any management action intended to achieve compliance with Idaho water quality standards must be evaluated by collecting monitoring data and comparing it to relevant Idaho water quality standards (Criteria in Figure 8). An action is effective in achieving CWA compliance when it causes targeted standards to change from not achieved to achieved or maintains existing compliance.

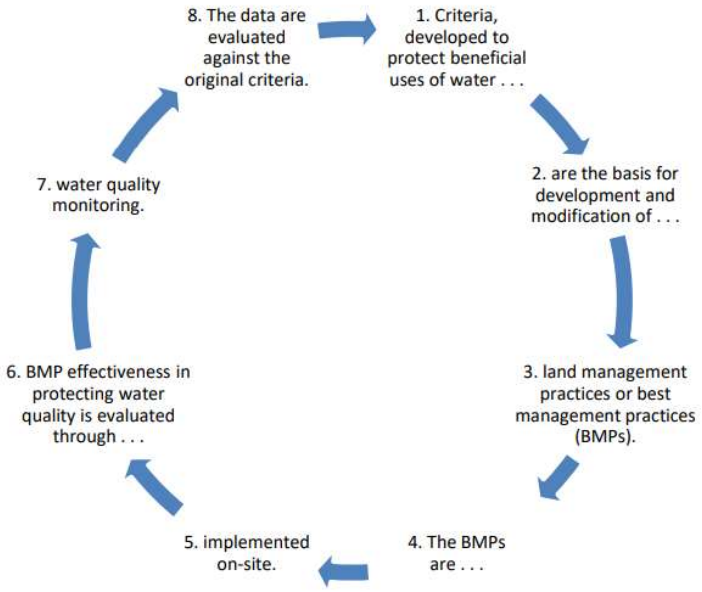


Figure 8. Idaho's best management practice feedback loop.

8 Funding and Resources

Partial funding for components 1, 3, and 4 is in place (Table 9). However, agencies still need to allocate additional resources to fully implement the plan through 2026. Additional funding will be required to continue annual main stem monitoring and other needed work beyond 2026.

Table 9. Estimated resources required for plan 2023–2026.

Component	Item	Annual Labor (hours)	Total Labor (hours)	Annual $	Total $ through 2026	Status
1	**Main Stem Annual Monitoring**					
	Macroinvertebrate lab sample analysis ($365/sample x 7 samples/year)			$2,555	$10,220	Funded by USFS RAC grant 2023–2026
	Field equipment			$500	$2,000	Funded by USFS RAC grant 2023–2026
	Field Labor, 6 staff x 4 days x 10 hours/day	240	960			Staff or contractor
2	**Suction Dredge Industry Compliance Monitoring**					
	Current field and office labor: IDWR		(not estimated)			IDWR staff
	Current field and office labor: USFS		(not estimated)			USFS staff
	Current field and office labor: BLM		(not estimated)			BLM staff
	Current field and office labor: DEQ		(not estimated)			DEQ staff
3	**Suction Dredge Sediment Impacts Study**					
	Macroinvertebrate lab sample analysis ($365/sample x 64 samples)				$23,360	
	Field equipment			$500	$2,000	
	Field Labor, 6 staff/reach x 4 hours/reach x 16 reaches x 3 sample events/reach		1,152			
	Labor—Develop registered report		120			DEQ staff
	Labor—Partner agency review/input for registered report		40			
	Registered report open access journal publication fee				$3,000	
4	**Suction Dredge Permit Process Improvements**					
	Hire consultant/facilitator				$20,000	Funded by DEQ
	Labor (staff participation in preworkshop interview, 3.5 day workshop, follow up), 15 staff x 8 hours/day x 4 days		480			Requires agency staff
5	**Prioritizing Sediment Restoration Actions**					
	Labor—Workgroup meeting organization/facilitation	80	320			Staff or contractor
	Labor—Workgroup participation (10 people x 2 days)	160	640			Requires agency staff

Component	Item	Annual Labor (hours)	Total Labor (hours)	Annual $	Total $ through 2026	Status
	Labor—Data analysis to generate needed information	80	320			Staff or contractor
	Additional tributary monitoring if workgroup determines it is needed for prioritization	TBD	TBD			Staff or contractor
	Other					
	Labor—Organize /facilitate annual WAG meeting	40	160	--	--	DEQ staff
	Labor—Develop report summarizing 2023–2026 annual main stem monitoring	--	120	--	--	DEQ staff
	Labor—Partner agency review/input on 2023–2026 annual main stem monitoring report	--	40	--	--	Requires agency staff
	Labor—Develop report summarizing suction dredge activity 2016–2026	--	120	--	--	DEQ staff
	Labor—Partner agency review/input on 2016–2026 suction dredge activity report	--	40	--	--	Requires agency staff
	Labor—Assessment unit beneficial use support decisions and documentation for partners	--	120	--	--	DEQ staff
	Labor—Partner agency review/input on assessment unit beneficial use support decisions	--	40	--	--	Requires agency staff
	Field labor—Monitoring needed to develop salmonid spawning reference benchmarks (3 staff x 6 weeks)	--	720			Requires agency staff or contractor
	Labor—Data analysis to develop salmonid spawning reference benchmarks		80			DEQ staff
	Total		**5,472**		**60,580**	

9 Plan Revision Process

This plan can be revised if needed. Potential reasons for revisions include, but are not limited to, changes to evaluation criteria or reference benchmarks, significant changes to one or more plan components, or changes to water quality standards or legal mandates the plan is based on.

Any plan revisions should occur through a transparent public process. At a minimum, the revision process should include the following:

- Make a revised plan document available to the SFCR WAG, partner agencies, and public.
- Holde a public WAG meeting that summarizes plan changes and allows for stakeholder feedback. Hold the meeting at least 2 weeks after the revised document is distributed.

- Make the final revised plan document available along with other related materials at *https://doi.org/10.17605/OSF.IO/KFMYR* or another permanent publicly available location.

10 Stakeholder Input

In August 2022, DEQ distributed a draft version of this plan to partner agencies, watershed advisory group members, and other stakeholders. DEQ received written comment letters from several stakeholders. DEQ also hosted a public WAG meeting where DEQ summarized the plan and received feedback from stakeholders. Written comment letters DEQ received on the draft plan and meeting minutes from the public meeting are included in online supporting materials (*https://doi.org/10.17605/OSF.IO/KFMYR*).

11 Supporting Materials

Online supporting materials are available at *https://doi.org/10.17605/OSF.IO/KFMYR*. Supporting materials include the August 2022 draft version of this plan, comment letters received, monitoring field protocol documents, referenced government reports, and data and R code used to develop reference benchmarks used for cold water aquatic life evaluation criteria.

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Appendix A. Watershed Restoration Projects 2000–2020

Many water quality improvement projects have been completed in the South Fork Clearwater subbasin since the Cottonwood Creek TMDL was finalized in 2000. In 2020, DEQ contacted the US Forest Service, Nez Perce Tribe, Bureau of Land Management, US Environmental Protection Agency, Idaho Department of Lands, Idaho Department of Fish and Game, Natural Resources Conservation Service, and Idaho Soil and Water Conservation Commission, and Idaho County Roads Department to request information related to water quality improvement projects completed in HUC 17060305 since 2000. DEQ used agency responses to develop an inventory of completed and ongoing water quality improvement projects. Since 2000, at least $25 million dollars have been spent across over 60 projects. This likely represents a low-end estimate. The inventory does not include projects financed by private landowners, NRCS funding for agriculture projects, USFS forestry and mining-focused projects, and some project dollar amounts do not include local matching funds. The inventory also has not been updated since 2020.

Many projects were not designed specifically to meet TMDL water quality goals. For example, some projects were designed to replace culverts for fish passage, restore fish habitat, or addressed streams in the upper watershed that are not listed as impaired by sediment under the Clean Water Act. However, nearly all projects included actions that should reduce stream sediment loading or improve stream substrate conditions, and thereby contribute to achieving sediment TMDL goals.

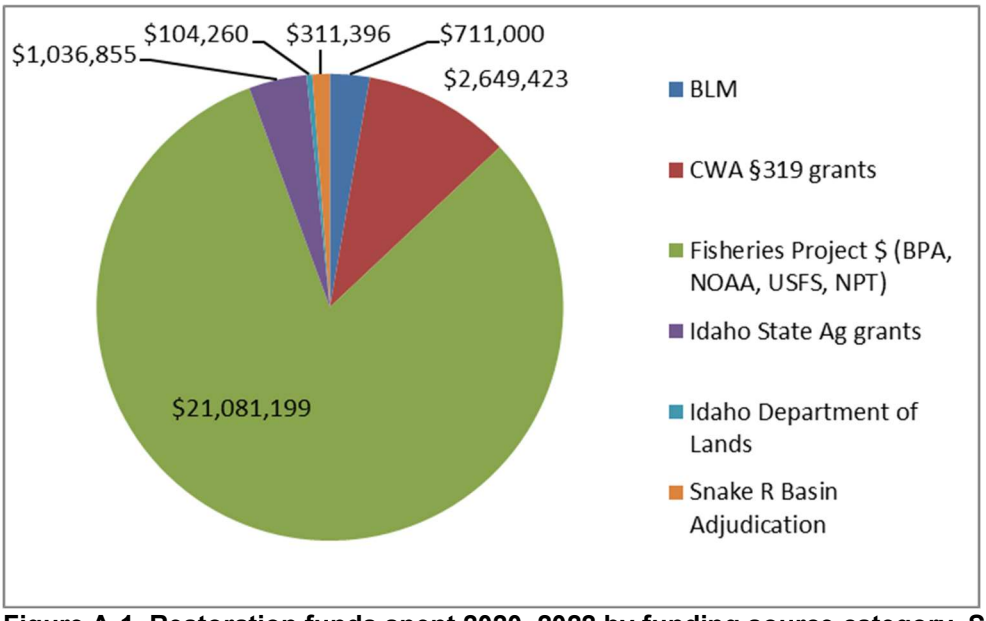


Figure A-1. Restoration funds spent 2020–2022 by funding source category. See Table A-1 for a full project list.

Table A-1. Inventory of HUC 17060305 water quality improvement projects 2000–2020. The inventory was last updated in 2020.

							Pollutants Addressed					
Area	**Category**	**Agency**	**Project Name**	**Years**	**Status**	**Focus BMPs**	**Sed**	**Bact**	**Nutr**	**Temp**	**Cost**	**Funding Source(s)**
Cottonwood Cr	Ag & Livestock	Idaho SWCD	South Fork Cottonwood Creek BMP Implementations	2001–2003	complete	Residue management, nutrient management, livestock facilities	x	x	x		$286,159	CWA §319 grant
Cottonwood Cr	Ag & Livestock	Idaho SWCD	Cottonwood BMP Implementations	2001–2004	complete	Residue management, nutrient management, livestock facilities	x	x	x		$208,604	Idaho WQPA
Cottonwood Cr	Ag & Livestock	Idaho SWCD	Cottonwood Creek Restoration	2011–2014	complete	Residue management, nutrient management, livestock facilities	x	x	x		$311,396	Snake River Basin Adjudication
Cottonwood Cr	Ag & Livestock	Idaho SWCD	Cottonwood Phase 2 BMP Implementations (§319)	2003–2007	complete	Residue management, nutrient management, livestock facilities	x	x	x		$247,974	CWA §319 grant
Cottonwood Cr	Ag & Livestock	Idaho SWCD	Cottonwood Phase 2 BMP Implementations (WQPA)	2003–2011	complete	Residue management, nutrient management, livestock facilities	x	x	x		$200,000	Idaho WQPA
Red Rock Cr	Ag & Livestock	Idaho SWCD	Red Rock Creek Livestock BMP Implementations—Phase 2	2019–2022	ongoing	Livestock facilities	x	x	x		$177,684	CWA §319 grant
Red Rock Cr	Ag & Livestock	Idaho SWCD	Red Rock Creek AFO Implementation Project	2017–2018	complete	Livestock facilities	x	x	x		$128,237	State Ag Fund
Threemile Cr	Ag & Livestock	PCEI	Addressing Temperature Issues in Three Mile Creek	2016–2018	complete	Riparian vegetation	x	x	x	x	$90,064	CWA §319 grant
Threemile & Butcher Cr	Ag & Livestock	Idaho SWCD	Threemile/Butcher BMP Implementations	2005–2009	complete	Livestock facilities, pastures	x	x	x		$248,736	CWA §319 grant
Threemile Cr & main stem	Ag & Livestock	PCEI	SF Clearwater Watershed Riparian Project	2006–2011	complete	Bank stabilization, livestock, riparian	x	x	x	x	$181,435	CWA §319 grant
Camas Prairie	Ag & Livestock	Idaho SWCD	Western Camas Prairie Culvert Replacement	2016–2018	complete	Sediment management	x				$184,925	CWA §319 grant

							Pollutants Addressed					
Area	**Category**	**Agency**	**Project Name**	**Years**	**Status**	**Focus BMPs**	**Sed**	**Bact**	**Nutr**	**Temp**	**Cost**	**Funding Source(s)**
Camas Prairie	Ag & Livestock	PCEI	South Fork Clearwater Watershed Vegetation	2010–2014	complete	Riparian vegetation, channel stabilization, drainage water management, wetland	x	x	x	x	$246,261	CWA §319 grant
Camas Prairie	Ag & Livestock	Latah SWCD	North Idaho Division II Animal Feeding Project	2002–2012	complete	Region-wide livestock project; subset of funds used locally		x	x		--	CWA §319 grant, Idaho WQPA
Camas Prairie	Ag & Livestock	Idaho SWCD	South Fork Clearwater River BMP Implementations	2007–2012	complete	Residue management, nutrient management, livestock facilities	x	x	x		$500,014	Idaho WQPA
Camas Prairie	Ag & Livestock	Idaho SWCD	South Fork Clearwater River BMP Implementations (§319)	2010–2013	complete	Residue management, nutrient management, livestock facilities	x	x	x		$250,000	CWA §319 grant
Grouse Creek	stream & habitat	NPT, USFS	Grouse Creek Culvert Replacement	2012	complete	reduce sediment, improve fish passage, reduce failure risk	x				$233,000	BPA, USFS
Sill Creek watershed	roads	IDL	Sill Creek Timber Sale	2013-2014	complete	Replacement of old culverts, new culvert installation, road surfacing	x				$80,183	Timber Sale
Sears Creek/Wall Creek watershed	roads	IDL	Seawall Timber Sale	2011-2012	complete	Cleaned ditches, culverts, and catch basins. Obliterated 0.25 miles of old road	x				$4,526	Timber Sale
Sally Ann Creek/Wall Creek watershed	roads	IDL	Sally Ann's Wall Timber Sale	2005-2006	complete	Replacement of old culverts, new culvert installation, road surfacing. Obliterated 0.56 miles old road	x				$13,310	Timber Sale

Area	Category	Agency	Project Name	Years	Status	Focus BMPs	Pollutants Addressed				Cost	Funding Source(s)
							Sed	Bact	Nutr	Temp		
Rabbit Creek watershed	roads	IDL	Rabbit Creek Timber Sale	1998-2000	complete	Replacement of old culverts, new culvert installation, road surfacing	x				$6,241	Timber Sale
Mill Creek	stream & habitat	NPT & USFS	Mill Creek Landslide Stabilization	2006-2011	complete	landslide stabilization, riparian planting, road crossing upgrading, trail reconstruction	x			x	$825,595	BPA, NPT, IDPR, USFS
Mill Creek Watershed	stream & habitat	NPT, USFS	Black George Culvert Replacement	2015	complete	reduce sediment, improve fish passage, reduce failure risk	x				$214,119	BPA, USFS
Mill Creek Watershed	stream & habitat	NPT, USFS	Adams Creek Culvert Replacement	2015	complete	reduce sediment, improve fish passage, reduce failure risk	x				$160,000	BPA, USFS
Mill Creek Watershed	stream & habitat	NPT, USFS	Mill Creek Trail Improvement	2014	complete	Reduce sediment	x				$187,000	BPA, USFS
Mill Creek Watershed	stream & habitat	NPT, USFS	Hunt Creek Culvert Replacement	2013	complete	reduce sediment, improve fish passage, reduce failure risk	x				$207,000	BPA, USFS
Mill Creek Watershed	stream & habitat	NPT, USFS	Realign Mill Creek Restoration	2010-2012	complete	Realign stream channel, reduce erosion and sediment, riparian shrub and tree planting, improve fish habitat, reduce failure risk	x			x	$439,603	BPA, USFS
Mill Creek Watershed	stream & habitat	NPT, USFS	Big Canyon Creek Culvert Replacement	2010	complete	reduce sediment, improve fish passage, reduce failure risk	x				$140,000	BPA, USFS
Mill Creek Watershed	stream & habitat	NPT, USFS	Mill Creek Bridge #3 Replacement	2010-2011	complete	reduce sediment, improve fish passage, reduce failure risk	x				$250,000	BPA, USFS

Area	Category	Agency	Project Name	Years	Status	Focus BMPs	Pollutants Addressed				Cost	Funding Source(s)
							Sed	Bact	Nutr	Temp		
Mill Creek Watershed	stream & habitat	NPT, USFS	Merton Creek Culvert Replacement	2008	complete	reduce sediment, improve fish passage, reduce failure risk	x				$96,000	BPA, USFS
Mill Creek Watershed	stream & habitat	NPT, USFS	Hepner Creek Culvert Replacement	2007	complete	reduce sediment, improve fish passage, reduce failure risk	x				$165,200	BPA, USFS, NOAA
Mill Creek Watershed	stream & habitat	NPT, USFS	Camp Creek Culvert Replacement	2006	complete	reduce sediment, improve fish passage, reduce failure risk	x				$30,683	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Meadow Phase IV Road Decommissioning	2013-2014	complete	Reduce sediment, restore hydrolaugic flow	x				$210,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	North Meadow Road Decommissioning	2011-2012	complete	Reduce sediment, restore hydrolaugic flow	x				$231,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Meadow Phase III Road Decommissioning	2011-2012	complete	Reduce sediment, restore hydrolaugic flow	x				$269,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	False Creek II Road Decom.	2010	complete	Reduce sediment, restore hydrolaugic flow	x				$185,480	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Farris Creek Culvert Replacement	2010	complete	reduce sediment, improve fish passage, reduce failure risk	x				$135,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	False Creek Rd 1851 Improvement	2010	complete	Reduce sediment, reduce future failure risk	x				$105,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Meadow Cr Phase II Decom	2008	complete	Reduce sediment, restore hydrolaugic flow	x				$112,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Whitman Cr Road Decom	2008-2010	complete	Reduce sediment, restore hydrolaugic flow	x				$209,000	BPA, USFS

							Pollutants Addressed					
Area	**Category**	**Agency**	**Project Name**	**Years**	**Status**	**Focus BMPs**	**Sed**	**Bact**	**Nutr**	**Temp**	**Cost**	**Funding Source(s)**
Meadow Creek Watershed	stream & habitat	NPT, USFS	False Cr Phase I Road Decom	2008-2010	complete	Reduce sediment, restore hydrolaugic flow	x				$148,659	BPA, USFS, NOAA
Meadow Creek Watershed	stream & habitat	NPT, USFS	Rock Cr Culvert Replacement	2010	complete	reduce sediment, improve fish passage, reduce failure risk	x				$62,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Orchard Cr Road Decom	2007	complete	Reduce sediment, restore hydrolaugic flow	x				$226,658	BPA, USFS, NOAA
Meadow Creek Watershed	stream & habitat	NPT, USFS	Covert Cr Culvert Replacement	2007	complete	reduce sediment, improve fish passage, reduce failure risk	x				$201,695	BPA, USFS, NOAA
Meadow Creek Watershed	stream & habitat	NPT, USFS	Storm Cr Culvert Replacement	2006	complete	reduce sediment, improve fish passage, reduce failure risk	x				$126,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Doe Creek Culvert #1 Replacement	2005	complete	reduce sediment, improve fish passage, reduce failure risk	x				$75,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Trib to Meadow Cr Cuvlert replacement	2005	complete	reduce sediment, improve fish passage, reduce failure risk	x				$11,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Erosion Control in McComas Meadows	2006	complete	Reduce sediment, restore hydrolaugic flow	x				$20,000	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT, USFS	Decontour/ Decom in McComas Meadows	2005	complete	Reduce sediment, restore hydrolaugic flow	x				$4,700	BPA, USFS
Meadow Creek Watershed	stream & habitat	NPT	McComas Meadows Fence Replacement	2017-2020	complete	improved fish and riparian habitat, cattle exclosure	x	x			$250,000	BPA
Meadow Creek Watershed	stream & habitat	NPT	McComas Meadows Revegetation	1999-current	ongoing	revegetation of riparian streambanks, inproved fish habitat, reduce stream temperatures	x				$500,000	BPA

Area	Category	Agency	Project Name	Years	Status	Focus BMPs	Pollutants Addressed				Cost	Funding Source(s)
							Sed	Bact	Nutr	Temp		
Peasley Cr	stream & habitat	ITD, NPT, USFS	Peasley Creek Culvert Replacement	2017	complete	reduce sediment, improve fish passage, reduce failure risk	x				$773,129	BPA, ITD, USFS
Peasley Cr	stream & habitat	NPT, USFS	Peasely Creek Road Improvement	2013-2014	complete	Reduce sediment, reduce future failure risk	x				$510,940	BPA, USFS
Tenmile Cr	stream & habitat	NPT, USFS	Tenmile Bridge Replacement	2012	complete	reduce sediment, improve fish passage, reduce failure risk	x				$149,000	BPA, USFS
Fall Creek	stream & habitat	NPT, USFS	Fall Creek Road Decom.	2011-2012	complete	Reduce sediment, restore hydrolaugic flow	x				$174,000	BPA, USFS
Leggett Cr	stream & habitat	NPT. ITD, USFS	Leggett Creek Culvert Replacement	2016	complete	reduce sediment, improve fish passage, reduce failure risk	x				$521,143	BPA, Pacific Coastal Salmon Recovery Fund, USFS
Moose Creek	stream & habitat	ITD, NPT, USFS	Moose Creek Culvert Replacement	2018	complete	reduce sediment, improve fish passage, reduce failure risk	x				$757,000	BPA, ITD, USFS
Red River	stream & habitat	NPT & USFS	Red River Restoration	2008-2014	complete	stream channel restoration, road crossing upgrading, road decommissioning, riparian revegetation	x			x	$2,778,466	BPA, NPT, USFS
Crooked River	stream & habitat	NPT & USFS	Crooked River Valley Restoration	2016-2022	ongoing	stream channel restoration, riparian revegetation	x			x	$5,596,007	BPA, NPT, USFS, Idaho Office of Species Conservation
Crooked River	stream & habitat	NPT, USFS, BPA	Crooked River Planting	2012	complete	riparian vegetation				x	$8,000	BPA, NPT

							Pollutants Addressed					
Area	**Category**	**Agency**	**Project Name**	**Years**	**Status**	**Focus BMPs**	**Sed**	**Bact**	**Nutr**	**Temp**	**Cost**	**Funding Source(s)**
Crooked River	stream & habitat	NPT, USFS, BPA	Trib to East Fork Crooked River Culvert Replacement	2014	complete	Sediment management	x				$29,850	BPA, NPT
Crooked River	stream & habitat	NPT, USFS, BPA	Fivemile Creek Culvert Replacement	2016	complete	Construct new stream channel, installation of embedded culvert	x				$120,000	BPA, NPT
Newsome Cr	stream & habitat	NPT & USFS	Newsome Creek Restoration	2011-2019	ongoing	stream channel restoration, road crossing upgrading, riparian revegetation	x			x	$2,783,658	BPA, NPT, USFS
American River	stream & habitat	BLM	Buffalo Gulch Culvert Replacements	2005	complete	Streambank stabilization & fish passage	x				$90,000	BLM
American River	stream & habitat	BLM	East Fork American River Culvert Replacement	2006	complete	Streambank stabilization & fish passage	x				$95,000	BLM
American River	roads	BLM	Buffalo Gulch Road Improvement and Erosion Control	2007	complete	Reduction of road related erosion	x				$35,000	BLM
American River	stream & habitat	BLM	American River Instream Habitat Improvement	2009	complete	Aquatic habitat improvement	x				$55,000	BLM
						GRAND TOTAL					**$25,894,133**	

Appendix B. Development and Evaluation of a Framework for Assessing Surface Fine Sediment Impacts on Macroinvertebrate Community Composition in Idaho Streams

Development and Evaluation of a Framework for Assessing Substrate Fine Sediment Impacts on Macroinvertebrate Community Composition in Idaho Streams

Jason Williams, Idaho Department of Environmental Quality, Lewiston Regional Office, jason.williams@deq.idaho.gov

August 2023

Note

The assessment framework and analyses described in this appendix have been reviewed by technical staff from USFS, BLM, and the National Aquatic Monitoring Center at Utah State University. Reviewers were generally supportive of the framework. Some reviewers expressed no significant concerns and others expressed a desire to test alternate approaches to calculating reference benchmarks before applying the framework within USFS and BLM lands. DEQ invited USFS and BLM to collaboratively revise this framework further. If USFS and BLM are willing to allocate necessary technical staff to assist revision and develop a collaborative scope of work, this framework and associated benchmarks may be revised in the future.

Acknowledgements

Carl Saunders (USFS) and Trip Armstrong (Utah State University) provided USFS PIBO data. Staff from the National Aquatic Monitoring Center at Utah State University (Trip Armstrong, Logan Shank, Jennifer Courtwright) provided BLM AIM data. USFS Region 1 (Justin Jimenez, Andy Efta), Nez Perce-Clearwater National Forest (Erin Grinde, Rob Lawler, Gage McKeag), BLM Cottonwood field office (Craig Johnson), EPA Region 10 (Jason Pappani), and attendees of a January 2023 technical workgroup meeting in Grangeville, ID provided helpful feedback on an earlier version of this analysis. Jennifer Courtwright (Utah State), James Feller (USFS Region 1), and Doug Peterson (USFS Region 1) also provided technical feedback. Brady Johnson (DEQ) conducted a quality assurance review of project R code.

Data Availability

Data and R code used for analyses described in this document are publicly available on github:

https://github.com/jjwill2/ID_sediment_benchmarks

https://github.com/jjwill2/FSBI_calculator

Companion ArcGIS Online Map

Sample reach sediment status predictions generated by the draft framework for all DEQ-BURP, USFS-PIBO, and BLM-AIM sites in Idaho with paired percent fines and macroinvertebrate data can be viewed at: *https://arcg.is/08Tiye0*

Summary

The study developed a framework for assessing if excess stream substrate surface fine sediment (< 2.5 mm or < 2 mm) alters macroinvertebrate community composition relative to reference conditions at the reach scale in Idaho wadable streams. The framework was designed to assess compliance with Idaho's narrative sediment water quality standard and to be compatible with data collected by either Idaho Department of Environmental Quality (DEQ), United States Forest Service (USFS), or Bureau of Land Management (BLM) monitoring programs.

DEQ data were used to define reference benchmarks for percent fine sediment, reference benchmarks for the macroinvertebrate fine sediment biotic index (FSBI), and stressor-response benchmarks indicating the percent fine sediment with a 75% probability that FSBI is worse than reference. A simple framework was developed for applying benchmarks. It requires paired fine sediment and macroinvertebrate samples from the same sample event within a sampled reach. The framework classifies reach-scale sediment-induced impacts as 'likely' if both reference benchmarks are not achieved and 'very likely' if all three benchmarks are not achieved.

Framework performance was tested by i) quantifying false positive and false negative rates when the framework was applied to DEQ, UFS, and BLM data, ii) comparing framework false positive and false negative rates to those for other assessment tools (BLM percent fines reference benchmarks, macroinvertebrate multimetric index (MMI) and macroinvertebrate observed vs expected (O/E) predictions), and iii) evaluating spatial and temporal consistency of framework predictions.

False positive rates were calculated as the percentage of sample events where the framework predicted sediment impacts within reference reaches. Framework false positive rates ranged from 7-22% across validation datasets (14% overall) and were lower than for percent fines reference benchmarks developed by BLM for Idaho streams (23-27%, 24% overall).

False negative rates were calculated as the percentage of sample events among Idaho streams with a sediment total maximum daily load (TMDL) where the framework did not predict sediment impacts. False negative rates were high (> 50%) for both the framework and other tools. For many reaches with false negatives, both the framework and other tools predicted macroinvertebrates were within reference condition. High false negative rates may be because the original sediment impairment was identified using different ecological receptors and exposure pathways (fish, suspended sediment, etc.), because sediment conditions have recently improved, or because the original sediment impairment determination was incorrect. Relationships between framework predictions and O/E values indicate the framework successfully predicts macroinvertebrate community changes relative to reference.

Potential framework users should evaluate performance documentation and consider if the framework is adequate for their intended application. Framework predictions are specific to substrate fine sediment effects on macroinvertebrate community composition. For Clean Water Act applications in Idaho, framework predictions should be used as one line of evidence in a weight of evidence approach when assessing if excess anthropogenic sediment adversely

impacts aquatic life. One potential approach for applying the framework to assess compliance with Idaho's narrative sediment criterion is described.

1.0 INTRODUCTION

Human land use activities can increase sediment delivery to streams. Excess sediment loading can affect aquatic life through suspended sediment and deposited sediment exposure pathways (Figure B-1). Excess sediment can cause changes to the composition, distribution, and abundance of aquatic life (Wood and Armitage 1997; EPA 2006). To prevent or manage undesirable ecological effects of excess sediment, aquatic resource managers need tools to identify if sediment conditions are likely to cause specific adverse ecological effects. In the United States, many states developed numeric water quality criteria under the Clean Water Act for water column suspended sediment or turbidity, but few have developed criteria focused on deposited sediment (EPA 2006). High natural spatial and temporal variability in substrate sediment levels and complex non-linear relationships between substrate sediment and ecological responses (Bryce et al. 2010; Relyea et al. 2012; Jessup et al. 2014) can make defining substrate sediment thresholds challenging.

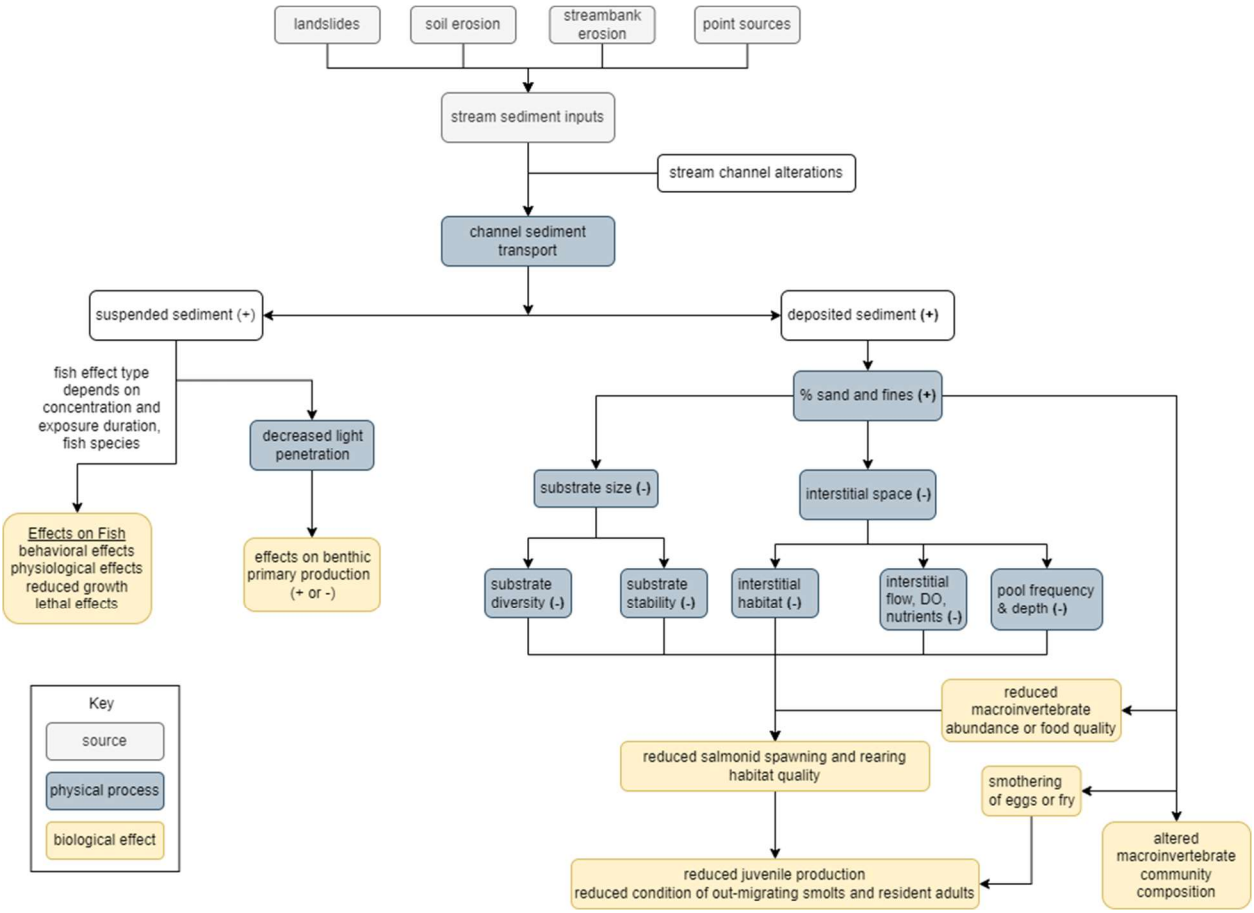


Figure B-1. Conceptual model for excess sediment effects on macroinvertebrates and salmonids in Idaho streams (adapted from EPA 2006 and Clapcott et al. 2011).

In Idaho, state quality standards (WQS) establish numeric water column turbidity criteria to protect aquatic life (IDAPA 58.01.02.250.02.3.e, IDAPA 58.01.02.401.02a). Idaho WQS also include a narrative sediment criterion requiring that sediment does not "impair designated beneficial uses" of water (IDAPA 58.01.02.200.08). Idaho WQS define full support of aquatic life beneficial uses as "where no biological group such as fish, macroinvertebrates, or algae has been modified by human activities significantly beyond the natural range of the reference streams or conditions approved by the Director in consultation with the appropriate basin advisory group" (IDAPA 58.01.02.42). Based on these requirements, the Idaho Department of Environmental Quality (DEQ) established guidance for applying Idaho's narrative sediment criterion (DEQ 2016). Identifying violations of the narrative sediment criterion requires multiple lines of evidence, including i) evidence of at least one human sediment source in the watershed, ii) a potential transport pathway delivering anthropogenic sediment to a water body, and iii) at least two lines of evidence for a measurable adverse effect of sediment on a beneficial use (DEQ 2016).

Stream macroinvertebrates are one useful indicator for evaluating compliance with Idaho's sediment criterion. Idaho WQS identify macroinvertebrates as one biological group that human activities should not modify beyond reference condition (IDAPA 58.01.02.42). In addition, multiple government agencies have established bioassessment monitoring programs, making stream macroinvertebrate data available within thousands of Idaho stream reaches. Since 1998, the U.S. Forest Service (USFS) and Bureau of Land Management (BLM) have implemented the PacFish/InFish Biological Opinion (PIBO) monitoring program on USFS and BLM lands to evaluate effects of land management practices on stream habitat quality for threatened and endangered salmonids (Kershner et al. 2004, Roper et al. 2019; Saunders 2022). Since 2013, BLM has implemented an Aquatic Inventory and Monitoring (AIM) program that includes stream macroinvertebrate monitoring within BLM lands (BLM 2015, Miller et al. 2021). Since 1993, DEQ has collected macroinvertebrate data in over 200 wadable 1st-4th order stream reaches each year (DEQ 2017; DEQ 2022). For each sampled reach, these monitoring programs use either a macroinvertebrate multimetric index (MMI) values or a comparison of observed macroinvertebrate species to those expected to occur under predicted natural conditions based on modeling (O/E) to score overall macroinvertebrate community status relative to that expected under program-specific reference conditions (Hawkins et al. 2000).

When these tools indicate macroinvertebrates are not within reference condition, there is a need to identify the specific stressor affecting macroinvertebrates at the reach scale. For waters not supporting beneficial uses, the Clean Water Act requires states to identify the specific cause of impairment and develop a total maximum daily load (TMDL) defining the maximum pollutant input load (typically expressed as lbs/day) that can occur while still meeting state water quality standards. Identifying the specific pollutant and associated human activities causing the biological impairment is also necessary to select local-targeted best management practices (BMPs) and restoration actions that will be most effective at restoring support of beneficial uses.

BURP, PIBO, and AIM monitoring and assessment programs have not developed standard procedures for diagnosing the specific stressor causing macroinvertebrates to deviate from

reference condition at the sample reach scale. Bioassessment program data have been used to define reference thresholds for surface fine sediment or other sediment-related parameters based on the statistical distribution of parameter values within reference sites in Idaho (Miller et al. 2021) and elsewhere (Bryce et al. 2010; Relyea et al. 2012; Jessup et al. 2014). However, surface fine sediment exceeding reference does not necessarily guarantee excess sediment is the cause of impaired macroinvertebrate condition. Macroinvertebrate sensitivity to sediment varies greatly across taxa and can even vary substantially within a genus (Relyea et al. 2012). Macroinvertebrate metrics also often show complex nonlinear responses to fine sediment that vary greatly across stream physiographic conditions (Bryce et al. 2010; Relyea et al. 2012; Jessup et al. 2014). Sediment-specific macroinvertebrate community measures and assessment procedures are needed to diagnose sediment-induced macroinvertebrate impairment with high confidence.

The objective of this study was to develop a method for assessing if excess substrate fine sediment alters macroinvertebrate community composition relative to reference conditions at the reach scale in Idaho wadable streams that i) meets requirements for assessing compliance with Idaho's narrative sediment criterion established by DEQ assessment guidance (DEQ 2016), and ii) can use data from either DEQ, USFS, or BLM bioassessment monitoring programs.

2. METHODS

2.1 General Approach

Analyses developed benchmarks and an assessment framework for assessing effects of deposited sand and fine sediment (< 2.5 mm or < 2 mm) on macroinvertebrate community structure (Figure B-1). This project focused on the deposited sediment exposure pathway because there are already Idaho water quality standards and assessment tools for assessing water column suspended sediment exposure pathways (Newcombe and Jensen 1996; DEQ 2003). This project focuses on surface fines effects on macroinvertebrates because paired surface fines and macroinvertebrate samples have been collected in thousands of Idaho stream reaches, allowing a robust empirical evaluation of stressor-response relationships. Analyses focused fines < 2.5 mm or < 2 mm because these fractions represent sand and fine sediment, and fines < 2 mm have been widely used in the literature to assess excess fine sediment impacts and develop benchmarks for macroinvertebrates and other aquatic life. Benchmarks were developed using surface fine sediment measured as fines < 2.5 mm from DEQ monitoring but validation datasets used for performance analyses measured fine sediment < 2 mm. These size fraction differences were assumed to be insignificant for purposes of framework application. Data comparability across programs is discussed and analyzed in detail below. The general approach was to i) develop surface fines benchmarks using DEQ data, ii) incorporate benchmarks into an assessment framework, and iii) document framework performance by applying it to independent data (USFS and BLM) not used for benchmark development.

2.2 BURP Data

DEQ Beneficial Use Reconnaissance Program (BURP) data were used to develop benchmarks. BURP is a bioassessment program that measures multiple stream physical, macroinvertebrate, and fish indicators in wadable 1st-4th order perennial and intermittent streams. BURP uses a targeted non-random sample design where crews select stream reaches representative of the associated stream assessment unit--the spatial scale used by DEQ for assessing support of beneficial uses under the Clean Water Act. Field crews delineate a reach with a length of 30 times bankfull width or a minimum of 100 m, and then measure multiple stream physical and habitat parameters, collect a composite macroinvertebrate sample, and document fish species present and their abundance using a backpack electrofishing survey. DEQ has collected BURP data in ~200 stream reaches during July-August each year in most years since 1993. BURP monitoring generally excludes federally-designated Wilderness areas, ephemeral streams, lake outlets, and reaches recently impacted by beaver activity or wildfire.

DEQ uses BURP data to calculate separate invertebrate, fish, and habitat multimeric index (MMI) scores determined to discriminate well between reference sites with limited upstream human landscape disturbance and stressed sites with high levels of upstream human disturbance (Jessup 2011, Jessup and Pappani 2015). Separate MMIs were developed for each of different three different site classes (Figure B-2, Table B-1). Site classes are ecoregion groupings that best explain macroinvertebrate community structure variability within Idaho reference sites. Site classes were defined by applying non-metric multidimensional scaling and principal components analysis statistical techniques to Idaho macroinvertebrate data within BURP reference sites (Jessup 2011, Jessup and Pappani 2015). Criteria for reference sites are discussed in section 2.3.

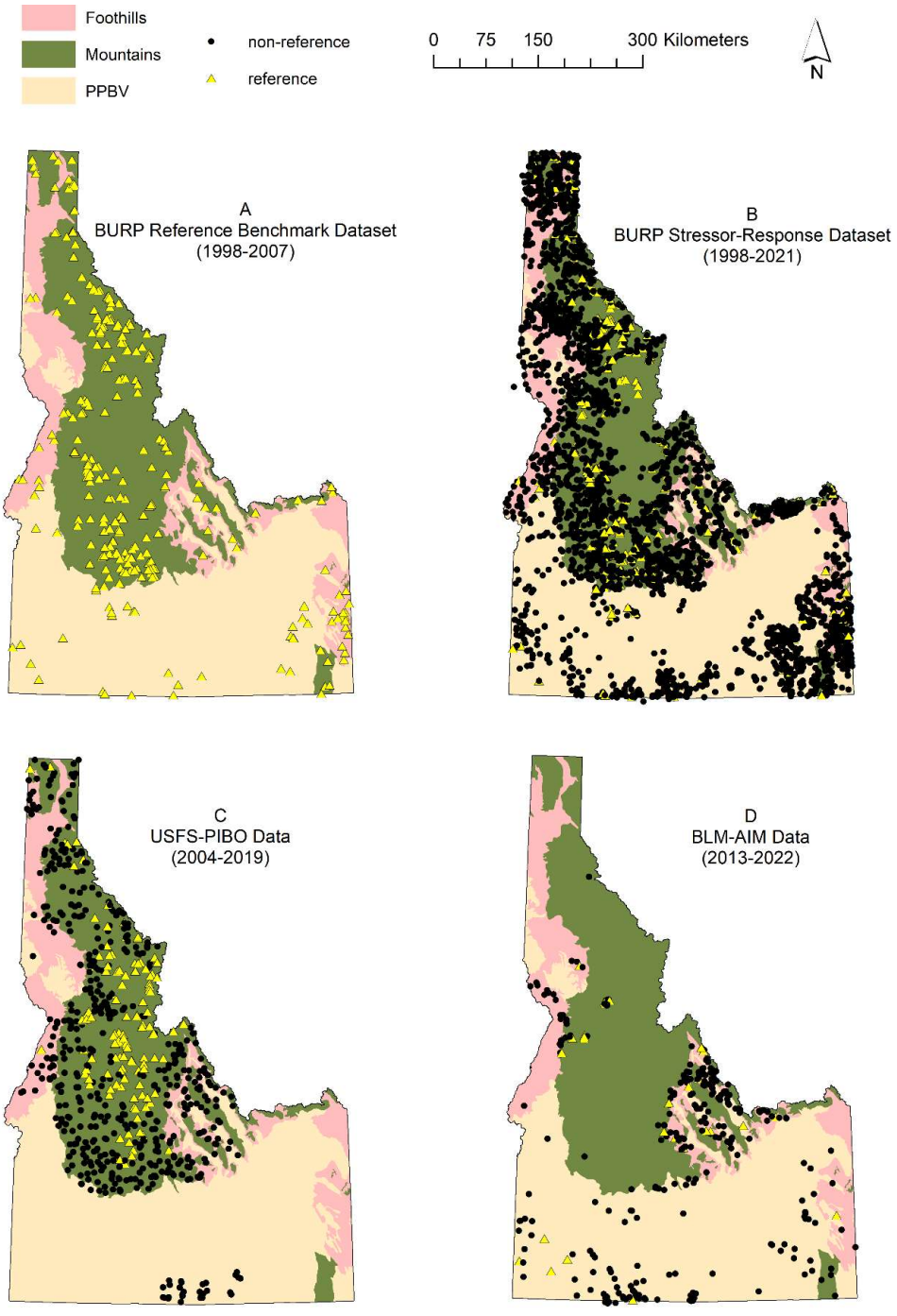


Figure B-2. Locations of BURP monitoring sites used to develop reference benchmarks (A), stressor-response benchmarks (B), and USFS-PIBO (C) and BLM-AIM (D) sites used for performance analyses.

Table B-1. BURP site classes defined by Jessup (2011).

Site Class	Level 4 Ecoregions
Mountains	The Wasatch-Unita mountains and selected sub-ecoregions of the Northern Rockies, Idaho Batholith, and the Middle Rockies (15i, 15o, 15p, 15y, 16 (except 16f), 17ad, 173, 19)
Foothills	The Blue mountains and selected sub-ecoregions of the Northern Rockies and Middle Rockies (11, 15j, 15f, 15m, 15n, 15s, 15u, 15v, 15w, 170, 17ab, 17j)
Plains Plateaus and Broad Valleys (PPBV)	The Columbia Plateau, Northern Basin and Range, Central Basin and Range, Snake River Plain, Wyoming Basin and selected sub-ecoregions of the Middle Rockies and Idaho Batholith (10, 12, 13, 17aa, 17n, 18, 80).

For each sampled reach, DEQ uses the average of invertebrate, fish, and habitat MMI scores to calculate an overall site condition rating. Site condition ratings are used along with other available lines of evidence to assess Cold Water Aquatic Life and Salmonid Spawning beneficial use support following protocols in DEQ's assessment guidance (DEQ 2016). A full description of BURP MMI development and application is described elsewhere (Jessup 2011, Jessup and Pappani 2015, DEQ 2016). BURP MMIs and site condition ratings are generalized indicators of stream conditions and are not specific to any pollutant or stressor. If they indicate a site is not within reference conditions, additional investigation is needed to identify the specific stressor causing site conditions to be worse than reference.

BURP substrate and macroinvertebrate data were used to develop sediment benchmarks. Macroinvertebrate samples were a composite of three samples, one from each of three separate riffle habitats within the sampled reach. In cases where three riffle habitats were not available within a reach, one or more samples were collected in a run. Samples were collected with a 500 µm mesh Hess sampler and composited and preserved with ≥70% ethanol in the field. Collected taxa were identified to the lowest taxonomic level (typically to genus or species) and enumerated by EcoAnalysts Inc. following methods described in Richards et al. (2018). Substrate particle size was measured using modified Wolman Pebble count methods (Wolman and Union 1954). Crews established three bankfull width cross section transects, with each transect located 1 meter upstream of a macroinvertebrate sample location. Pebble counts were always conducted after macroinvertebrate samples to avoid disturbing macroinvertebrates during pebble counts. Within each transect at least 50 particles were selected at approximately equidistant intervals (heel to toe or one pace distance, etc.) and the particle intermediate axis was measured and assigned to one of 11 size classes (< 1 mm, < 2.5 mm, < 6 mm, < 16 mm, < 32 mm, < 64 mm, < 128 mm, < 256 mm, < 512 mm, < 1024 mm, > 1024 mm). Particles within both the wetted and non-wetted portion of the bankfull channel were included in each transect. All particles collected across the three transects were used to calculate the percent particles in each size class.

Macroinvertebrate data were used to calculate fine sediment biotic index (FSBI) values for each macroinvertebrate sample. The FSBI is an index for assessing stream substrate fine sediment (< 2 mm) impacts on macroinvertebrate community composition in northwest US streams (Relyea et al. 2012). Relyea et al. (2012) used macroinvertebrate data from multiple government agency monitoring programs in the Pacific Northwest, including data from 813 BURP sites, to identify 206 common macroinvertebrate taxa. They assigned each taxa a sediment sensitivity

score based on the substrate percent fines < 2 mm associated with the taxa's 75th percentile occurrence. FSBI scores for a macroinvertebrate sample are then calculated as the sum of taxa-level scores (Relyea et al. 2012). FSBI is thus based on taxa occurrence only. FSBI scores generally range from 0-350; high scores indicate many sediment-sensitive taxa are present and therefore elevated surface fine sediment levels likely have not impacted macroinvertebrate community composition. Low FSBI scores indicate few sediment-sensitive taxa are present. FSBI has been applied in state-wide stream condition assessments in Washington State (Larson et al. 2019) and for assessing effects of streambed instability on macroinvertebrates (Kusnierz et al. 2015).

2.3 Reference Benchmarks

Reference benchmarks were defined using 1998-2007 BURP data from least-disturbed reference sites across Idaho (Figure B-2). Methods used to identify least-disturbed reference sites are described in detail elsewhere (Jessup 2011). Briefly, GIS analyses were used to measure 11 human disturbance indicators within the watershed of each 1998-2007 BURP site. Human disturbance indicators included population density, percent natural land use, land disturbance index (LDI), road density, stream length within 100 m of roads, mine density, water diversion density, National Pollution Discharge Elimination System (NPDES) permit density, riparian disruptive pressure based on field data, dam density, and presence/absence of grazing (Jessup 2011). Indicator values were used to assign a disturbance score to each BURP site, and the 10% lowest-scoring sites were classified as reference sites. These reference sites represent the 'least disturbed condition' (Stoddard et al. 2005) on the current landscape outside wilderness, and therefore represent realistically achievable conditions. The same reference definition and reference BURP site population were used to develop BURP MMIs were also used here to make benchmarks consistent with and comparable to other BURP indicators and MMIs.

FSBI reference benchmarks were defined as the 25th percentile FSBI value among reference sites (i.e., 75% of reference sites have a FSBI score better (higher) than this benchmark). Separate FSBI benchmarks were defined for each BURP site class used for developing to be consistent with BURP MMI and site condition ratings.

Sediment reference benchmarks were defined for using measured surface percent fines < 2.5 mm ($SF_{2.5}$). A reference fine sediment benchmark was defined as the 75th percentile $SF_{2.5}$ value within sites (i.e., 75% of reference sites have $SF_{2.5}$ better (lower) than this value). Separate $SF_{2.5}$ benchmarks were defined for each Strahler stream order (1st-4th order). Relyea et al. (2012) indicated percent sand and fines decreased with stream order, and the same pattern was present among BURP reference sites (Figure B-3). Exploratory plots and Pearson correlation coefficients examining patterns within BURP reference sites showed a stronger correlation between order and percent fines than stream gradient. Miller et al. (2021) also reported only a weak relationship between slope and fine sediment among Idaho streams monitored by BLM. For BURP data, variables correlated with stream order and with percent fines within reference sites were the same (elevation, catchment area, reach % riffle), suggesting order integrates multiple physical parameters affecting fine sediment levels. Correlations between percent fines

and physical variables were also similar within each site class as when all data were pooled across site class. Bracketing benchmarks by stream order only also allowed for a larger sample population for calculating benchmarks than when subdividing based on multiple factors.

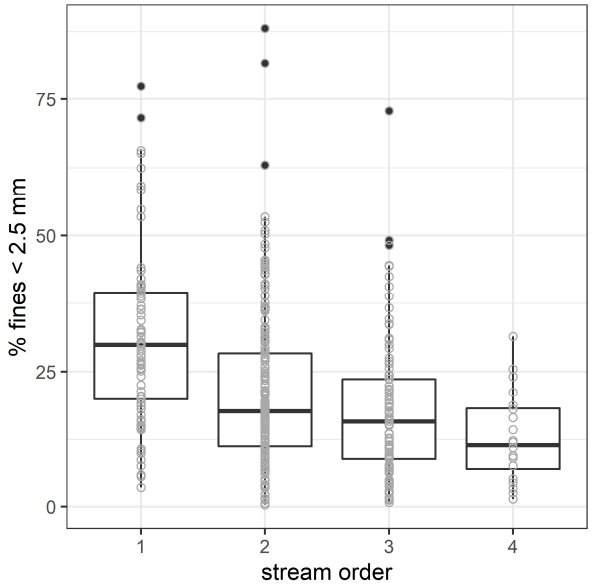


Figure B-3. Relationship between stream order and surface fines < 2.5 mm within 1998-2007 BURP reference sites. For box plots, box lower and upper ends are the 25th and 75th percentile, the horizontal line is the median, whiskers extend to 1.5 times the interquartile range (IQR), filled circles are data points > 1.5 times the IQR, and grey open circles are individual data points used to develop boxplots.

2.4 Stressor-Response Benchmarks

Stressor-response benchmarks were defined based on the relationship between $SF_{2.5}$ and FSBI, which shows a wedge-shaped pattern (Relyea et al. 2012). At low percent fines, FSBI values are highly variable, ranging from 0-350. As fines levels increase, both FSBI values and variability decrease. This pattern suggests fine sediment is only one of many factors affecting macroinvertebrate community composition at low fine sediment levels, and sediment becomes a primary factor affecting composition as fine sediment levels increase. This is an important consideration for applying fine sediment reference benchmarks. Due to high FSBI variability at reference $SF_{2.5}$ levels, exceeding $SF_{2.5}$ reference may not always cause FSBI values to be worse (less) than reference.

Logistic regression was used to predict the $SF_{2.5}$ levels with a high (75%) probability that FSBI would be worse (less) than reference for each stream order/siteclass combination. Regressions used all BURP data collected 1998-2021 (reference and non-reference), with $SF_{2.5}$ as the predictor variable and a binary value (1 or 0) indicating if FSBI was worse than reference as the response variable. Logistic regression was used because preliminary analyses indicated the relationship between $SF_{2.5}$ and FSBI was not appropriate for changepoint analysis methods commonly used to define stressor-response benchmarks (Qian et al. 2003, King and Richardson 2003, Daily et al. 2012, Burdon et al. 2013, Jessup et al. 2014). Because some common

statistical approaches to defining benchmarks (recursive partitioning, segmented regression, etc.) can in some cases define inaccurate threshold values or define a threshold when one is not present, Qian and Cuffney (2012) recommended applying multiple statistical models to evaluate if estimate changepoints are consistent across different statistical approaches. Preliminary analyses using recursive partitioning and segmented regression indicated very different threshold values, and locally estimated scatterpoint smoothing (LOESS) regressions did not indicate clear inflection points suggestive of a statistical changepoint. In contrast to changepoint techniques, logistic regression also better facilitates explicit discussion about what level of ecological impact is considered acceptable by stakeholders. Logistic regression curves enable stakeholders to visualize the probability of an ecological effect at different fine sediment levels and discuss what they consider acceptable for assessing sediment impacts (EPA 2006).

Logistic regressions were implemented using R software and the 'glm' function in base R. R code used is included in supporting materials. Regression model fit was documented using the model chi square statistic, odds ratio confidence intervals, and Hosmer-Lemeshow (HL) goodness-of-fit test (Hosmer et al. 1997; Hosmer et al. 2013). The chi square statistic quantifies the difference between deviance associated with a null model with an intercept only and model deviance. A large and statistically significant (< 0.05) chi square statistic provides evidence to reject the null hypothesis that the model does not perform better than random chance. The model odds ratio indicates how the odds of classifying a reach as having FSBI worse than reference increases for a 1% increase in $SF_{2.5}$. When lower (2.5%) and upper (97.5%) confidence intervals for model odds ratio values both exceed one, this provides evidence that increasing $SF_{2.5}$ reduces FSBI. The HL goodness-of-fit test describes the level of agreement between observed and predicted outcomes by decile of predicted probability. The HL null hypothesis is that the model provides a good fit. Low HL test p values provide evidence for rejecting the null hypothesis and concluding model fit is poor. These statistics and logistic regression plots included in Supporting Materials were used in a weight of evidence approach to evaluate whether developed regression models were adequate for purposes of defining stressor-response benchmarks.

2.5 Site Classification Framework

Benchmarks were used to develop a simple framework for predicting the potential for sediment-induced macroinvertebrate community composition changes at the reach scale (Figure B-4. The framework classifies a sediment effect as 'likely' if both reference benchmarks are not achieved, or 'very likely' if both reference benchmarks and the stressor response benchmark are not achieved. Classifying a sediment effect as 'likely' requires both reference benchmarks to be exceeded because of macroinvertebrate response variability associated with the 'wedged shape' $SF_{2.5}$-FSBI relationship (Figure B-4). In addition, DEQ guidance for implementing Idaho's narrative sediment criterion requires at least two lines of evidence for a measurable adverse effect on aquatic life uses.

FSBI	% fines	
No sediment effect both % fines and FSBI within reference	**Mixed evidence** % fines worse than reference, FSBI within reference	**Mixed evidence** FSBI within reference, % fines worse than reference and SME_{75}
Mixed evidence FSBI worse than reference, % fines within reference	**Sediment effect likely** both % fines and FSBI worse than reference	**Sediment effect very likely** both % fines and FSBI worse than reference, % fines also worse than SME_{75}

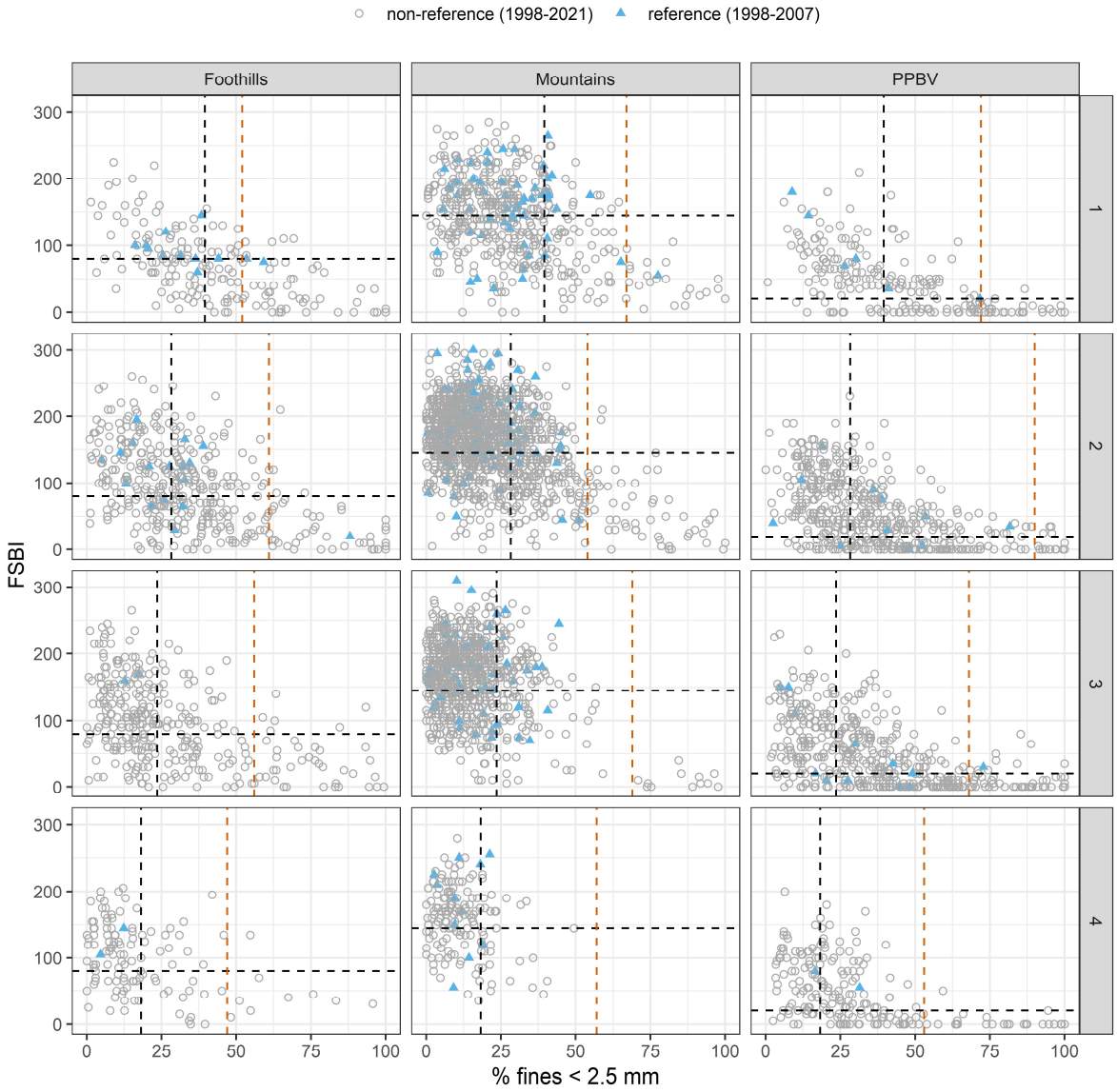


Figure B-4. Relationship between substrate $SF_{2.5}$ and FSBI by siteclass and stream order for BURP data. The dashed vertical and horizontal lines are % fines and FSBI benchmarks, respectively.

2.6 Performance Evaluation

Framework performance was evaluated by i) quantifying framework false positive and false negative rates, ii) comparing framework false positive and false negative rates to those for alternative assessment methods (Table B-2), and iii) evaluating framework prediction spatial and temporal consistency.

False positives were defined as cases where the framework predicted either 'likely' or 'very likely' sediment effects within reference sites. False negatives were defined as cases where the framework did not predict either 'likely' or 'very likely' sediment effects for streams with an EPA-approved sediment total maximum daily load (TMDL) or for streams predicted to have excess sediment by BLM based on BLM modeling (Jennifer Courtwright, Utah State University, personal communication 4/24/2023).

Table B-2. Alternative assessment methods included in performance evaluation for comparison.

Alternative Method	Sediment-specific?	Description	Reference
BLM % fines < 2 mm reference benchmarks for Idaho	Y	Reference benchmarks were calculated as the 70th percentile % fines value based on data from 226 reference sites in the inland Pacific Northwest sampled 2000-2009 through EPA monitoring programs (WSA, EMAP-West, NRSA). Northern Rockies ecoregion: ≤ 29% for streams < 10 m bankfull width and ≤ 15% for streams > 10 m bankfull width Nothern Xeric Basins ecoregion: ≤ 45% for streams < 10 m bankfull width and ≤ 44% for streams > 10 m bankfull width	Miller et al. 2021
RIVPACS macroinvertebrate O/E	N	PIBO: O/E ≥ 0.78 (applied to USFS lands only) AIM: O/E ≥ 0.63 for Columbia River Basin (applied to BLM lands only)	Miller et al. 2021
BURP macroinvertebrate MMI (SMI2)	N	SMI2 index rating value ≥ 2 indicates macroinvertebrate community condition is better than lowest 10% scoring BURP reference sites. (rating value≥ 2 corresponds to SMI2 index score ≥ 52 in mountains site class, ≥ 53 in foothills site class, ≥ 54 in PPBV site class). Index ratings ≥ 2 are considered within reference condition.	Jessup 2011, Jessup and Pappani 2015, DEQ 2016

False positive and false negative rates were quantified by applying the framework to three different datasets: DEQ BURP data, U.S. Forest Service (USFS) PacFish/Infish Biological Opinion (PIBO) monitoring program data, and BLM Assessment Inventory and Monitoring (AIM) program data. All three programs collect paired percent fines and macroinvertebrate samples, but have differing sample design, methods, and reference definitions (Table B-3). These differences may affect data comparability. There is currently no consensus in the scientific literature on how to define or measure data comparability within or across bioassessment programs or what level of comparability is adequate to combine data for specific applications (Cao and Hawkins 2011). Our approach was to quantify and compare false positive and false negative rates across assessment tools currently used in Idaho and let potential framework users decide if framework performance is adequate for their intended application.

Table B-3. Comparison of BURP, PIBO, and AIM bioassessment programs.

	BURP	PIBO	AIM
Agency	DEQ	USFS	BLM
Stream types sampled	wadable 1st-4th order	wadable 1st-4th order streams with < 4% gradient with and ≥ 50% federal ownership	Wadable 1st-4th order streams, and some large rivers using a boat-based protocol
Coverage	Idaho streams outside wilderness, including private and public lands	USFS and BLM lands	BLM lands
Sample design	Targeted nonrandom	Probability survey design, plus some targeted nonrandom sites	Probability survey design, plus some targeted nonrandom sites
Sample timing	Summer baseflow	Summer baseflow	Summer baseflow
Repeat sampling of same reach across years	No	Yes - most sites sampled every 5 years, a subset sampled annually or biennially	Yes - most sites sampled every 5 years
Reference sites used in this study	Among 1998-2007 BURP sites, 10% least-disturbed sites based on 11 different land use criteria (Jessup 2011, Jessup and Pappani 2015).	Sites within Wilderness or meet all of: no obvious mining, no grazing within 30 years, < 5% timber harvest, road density < 0.5 km/km^2	AIM sites presumed to have reference sediment conditions identified by BLM based on StreamCat landscape disturbance data (see Supporting Materials)
Reach delineation	30 x bankfull width, 100 m minimum	20 x bankfull width, 160 m min and 500 m max length.	20 x bankfull width, 150 m min, 4 km max
Pebble count	Modified Wolman method, % < 2.5 mm, based on at least 50 particles from each of 3 riffle transects	Modified Wolman method, % < 2mm, based on 5 particles from each of 20 transects within reach	Modified Wolman method, % < 2 mm, based on 10 particles from each of 21 transects within reach
Macroinvertebrate sample collection	Composite of 3 500 µm mesh Hess samples from 3 riffle habitats	Composite of 8 500 µm mesh Surber net samples from riffle habitats	Composite of 8 500 µm mesh Surber net samples from riffle habitats or of 11 Surber samples spanning multiple habitat types
Taxonomic laboratory	EcoAnalysts	Utah State University / National Aquatic Monitoring Center	Utah State University / National Aquatic Monitoring Center
Macroinvertebrate assessment approach	MMI (SMI2 ≥ 2)	PIBO RIVPACS O/E model; target O/E > 0.78	PIBO RIVPACS O/E model; target O/E > 0.63
FSBI calculation	Yes. Calculated for each BURP sample 1998-present. See methods in supporting materials.	Not calculated. Calculated for this study using methods described in supporting materials.	Not calculated. Calculated for this study using methods described in supporting materials.
Data used in this study	1998-2007 for reference benchmarks; 1998-2021 for stressor-response		

3.0 RESULTS AND DISCUSSION

3.1 Benchmarks

Assessment benchmarks reflect a mixture of science, policy, legal mandates, and stakeholder values. Scientific analysis quantifies the statistical distribution of a parameter within reference sites or the empirical relationship between a stressor and ecological response. However, selecting a benchmark value from a reference distribution or from a stressor-response relationship requires defining what ecological conditions are desired. This is a subjective process typically informed by relevant policy, legal mandates, and or stakeholder input. Benchmarks therefore are always specific to the ecological receptor and policy context they were developed for.

This study developed benchmarks (Table B-4) and an application framework (Figure B-3) for evaluating stream surface fine sediment effects on macroinvertebrate community composition. Benchmarks were developed to be used as one line of evidence for assessing if Idaho's

narrative sediment standard is violated at the reach scale. Idaho WQS state sediment should not "impair designated beneficial uses" (IDAPA 58.01.02.200.08) and define full support of beneficial uses as when no major biological group such as macroinvertebrates is modified by human activities significantly beyond the natural range of reference conditions (IDAPA 58.01.02.42).

Benchmarks defined here do not represent a 'bright line' or numeric water quality criterion beyond which Idaho's sediment criteria is automatically violated. If benchmarks are exceeded, one must also have evidence that observed surface fines and macroinvertebrate changes were caused by human activities. DEQ guidance for applying Idaho's narrative sediment criterion requires evidence of at least one human sediment source in the watershed, a potential transport pathway to delivering anthropogenic impacts to the stream, and at least two sediment-specific lines of evidence for a measurable adverse effect (DEQ 2016). When the framework presented here predicts a sediment effect is 'likely' or 'very likely', requirements for two lines of evidence for an adverse effect are satisfied, but documentation of a human sediment source and transport pathway would also be needed to conclude sediment impairs aquatic life beneficial uses. Even when a source, transport pathway, and adverse effect are all documented, a weight of evidence approach considering all available lines of evidence should be used for assessment decisions (DEQ 2016). One potential application approach is described in section 3.3 below.

Table B-4. Reference and stressor-response benchmarks. N indicates the sample size used for benchmark definition.

Benchmark Type	Indicator	Benchmark Description	Site Class	Stream Order	N	Value
Reference	$SF_{2.5}$	75% of reference sites have Wet$SF_{2.5}$ better (less) this value	All	1st	83	39.5%
				2nd	180	28.3%
				3rd	97	23.6%
				4th	20	18.2%
	FSBI	75% of reference sites have FSBI better (greater) than this value	Mountains	1st-4th	33	145
			Foothills	1s-4th	245	80
			PPBV	1st-4th	33	20
Stressor-Response SME_{75}	$SF_{2.5}$	$SF_{2.5}$ value with predicted 75% probability that FSBI is worse (lower) than reference	Mountains	1st	509	57%
				2nd	1,354	54%
				3rd	829	69%
				4th	159	57%
	$SF_{2.5}$	$SF_{2.5}$ value with predicted 75% probability that FSBI is worse (lower) than reference	Foothills	1st	177	52%
				2nd	397	61%
				3rd	316	56%
				4th	122	47%
	$SF_{2.5}$	$SF_{2.5}$ value with predicted 75% probability that FSBI is worse (lower) than reference	PPBV	1st	203	72%
				2nd	489	90%
				3rd	455	68%
				4th	205	53%

Reference $SF_{2.5}$ benchmarks (Table B-4) overlap with surface fines reference benchmarks reported in the literature (Figure B-5). To assess stream condition within BLM-managed lands in Idaho, Miller et al. (2021) defined reference benchmarks for surface percent fines < 2 mm for

Idaho using data from 226 Western U.S. reference reaches sampled 2000-2009 as across multiple EPA regional bioassessment monitoring programs (Olsen and Peck 2008, Stoddard et al. 2005, Herlihy et al. 2008). They chose to define benchmarks for small (≤ 10 m bankfull width) and large (> 10 m) streams within each of Northern Rockies and Northern Xeric Basins ecoregions, and used the 70th percentile of reference sites. Their reference benchmarks (15-45%, Table B-2) overlap with those defined here using independent data (18.2-39.5%, Table B-3). EPA defined surface fines < 2 mm reference benchmarks of 15% in the Northern Rockies and Pacific Mountains Region for the National River and Streams Assessment (EPA 2020), and 16.19%-29.52% for wadable streams in the interior Columbia River Basin (EPA 2007). For New Mexico streams, Jessup et. al (2014) calculated 75th percentile reference fines < 2mm as 20.6-74.3% for various ecoregional groupings. A table summarizing literature-reported benchmarks is included in Supporting Materials.

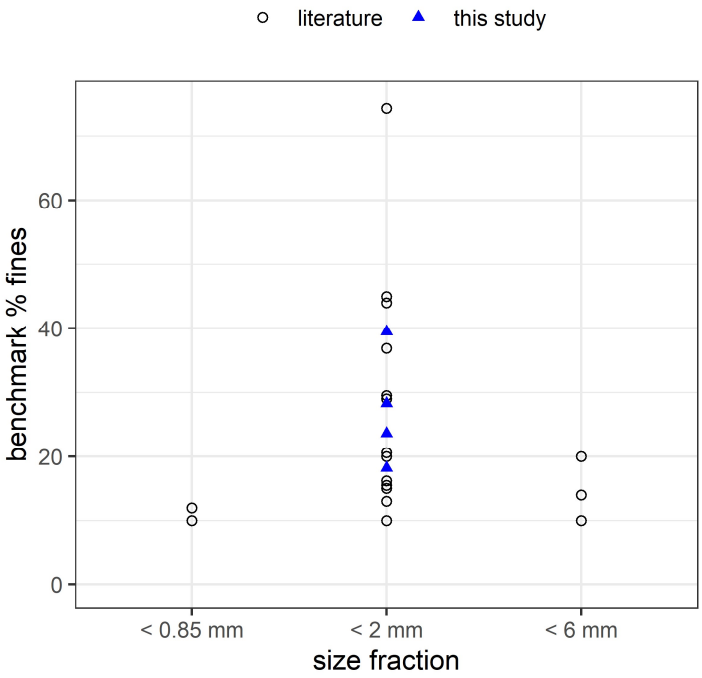


Figure B-5. Comparison of reference benchmarks defined in this study to reference and stressor-response benchmarks reported in the literature. See Supporting Materials for literature review and sources.

Stressor-response benchmarks are typically defined as a threshold at which a measurable ecological change first occurs or where the slope of the stressor-response relationship is greatest. Stressor-response benchmarks for fine sediment < 2 mm impacts on macroinvertebrates in New Mexico streams based on changepoint analysis ranged from 19.6-69.5% depending on the macroinvertebrate response metric used (Jessup et al. 2014). Response metrics analyzed included total number of taxa, number of ephemeroptera, plecopteran and trichoptera (EPT) taxa, % pollution-sensitive EPT taxa, count of pollution intolerant taxa, number of clinger taxa, and a macroinvertebrate MMI (Jessup et al. 2014). Using data from EPA's EMAP-West monitoring program, Bryce et al. (2010) defined fines < 2

mm stressor-response minimum-effect levels as 10% for macroinvertebrates and 13% for aquatic vertebrates (fish, amphibians). Several benchmarks for minimum effects on anadromous salmonids have also been defined for < 0.85 mm or < 6 mm size fractions and range from 10-20% (CTRIFC 1996, NMFS 1996, NOAA 1998, Jensen et al. 2009).

Stressor-response benchmarks defined here represent percent fines with a high probability of a biological response rather than a minimum effect level. This approach was used because the 'wedged-shaped' relationship between $SF_{2.5}$ and FSBI (Figure B-4) causes a relatively low probability of FSBI being worse than reference at reference $SF_{2.5}$ levels. All stressor-response benchmarks for a 75% probability of FSBI worse than reference were at least 20% greater than corresponding reference $SF_{2.5}$ levels (Table B-4). Logistic regressions indicate most reference fines benchmarks are associated with a < 50% probability of FSBI worse than reference. Logistic regression plots and statistical results are included in supporting materials.

FSBI is a sediment-specific macroinvertebrate indicator; it reflects both the number of sediment-intolerant taxa present at a site and the relative intolerance of taxa present. However, FSBI is also positively related to macroinvertebrate indicators that are not sediment specific (BURP MMI (SMI2) and USFS and BLM O/E) (Figure B-6). Larson et al. (2019) also reported FSBI is correlated with macroinvertebrate metrics such as EPT taxa richness that are not sediment-specific in Washington state streams. When MMI or OE values indicate macroinvertebrates are not within reference condition, the benchmarks and framework developed here are lines of evidence that can be used to help diagnose if sediment is likely the cause.

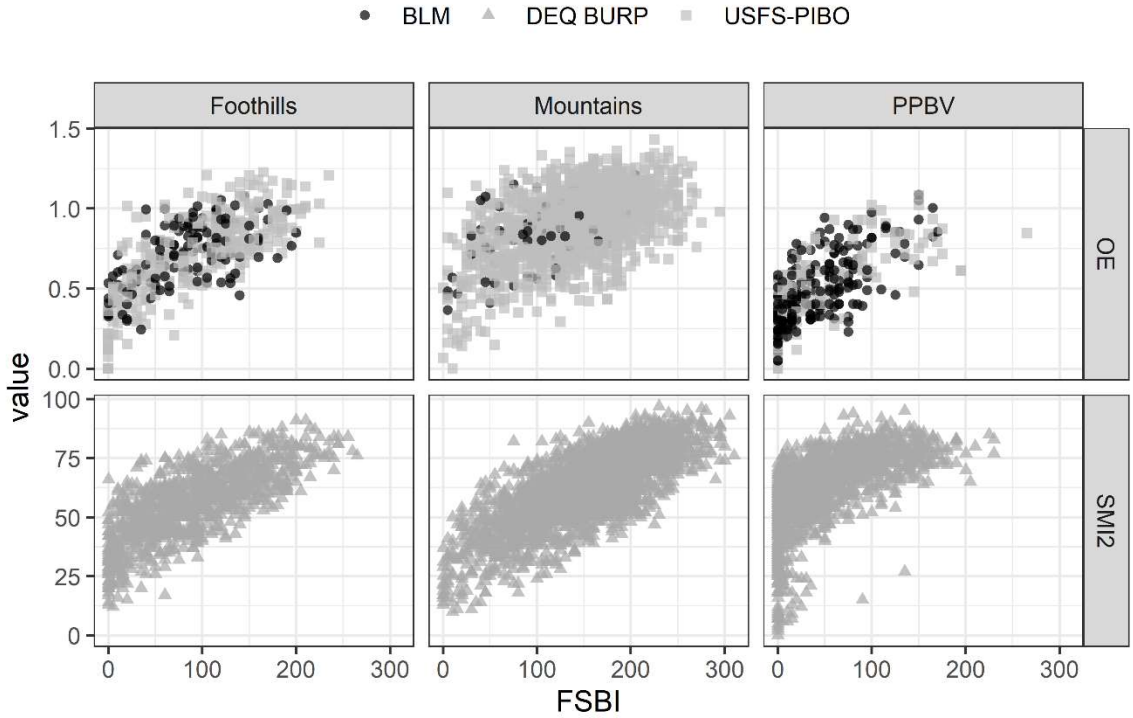


Figure B-6. Relationship between FSBI and other macroinvertebrate indicators used in Idaho.

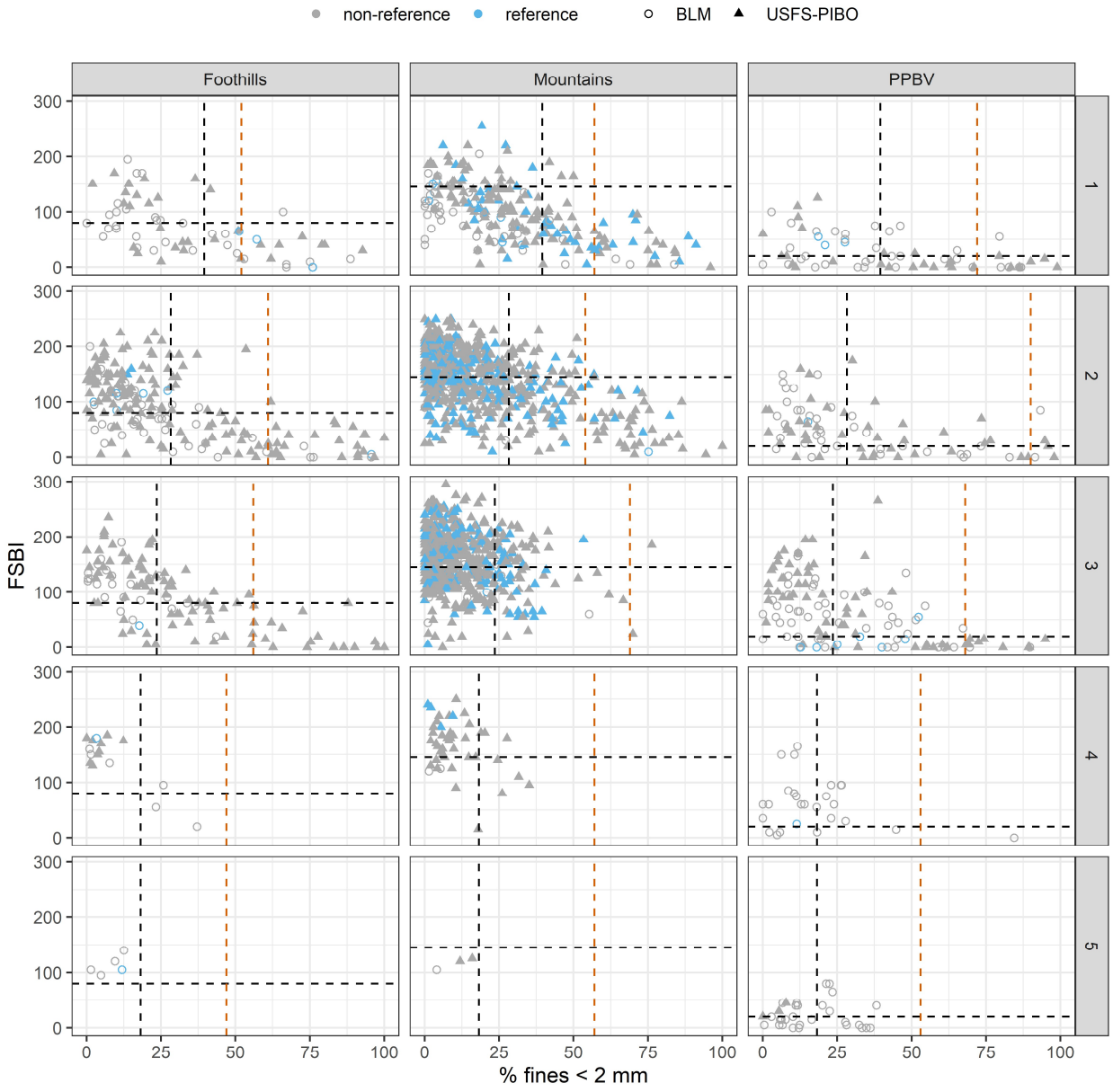


Figure B-7. Relationship between substrate % fines and FSBI by stream order and siteclass for USFS and BLM sample events where both % fines and macroinvertebrates were measured. The dashed vertical and horizontal lines are BURP-based percent fines and FSBI reference benchmarks, respectively.

3.2 Framework Performance

3.2.1 False Positives at Reference Sites

Framework false positive rates were calculated as the percentage of sample events within reference sites where the framework predicted a 'likely' or 'very likely' sediment impact. Framework false positive rates ranged from 7%-22% across validation datasets and was 14% when pooling all data (Table B-5). When applied to data from PIBO and AIM reference sites, the

framework had a lower false positive rate than BLM % fines reference benchmarks developed by Miller et al. (2021) (Table B-5). Among BLM sediment reference sites, the framework false positive rate (22%) was much lower than when applying BLM's macroinvertebrate O/E benchmark (46%) (Table B-5). Among PIBO reference sites, framework and USFS macroinvertebrate O/E benchmark false positive rates were the same (18%) (Table B-5).

Temporal consistency of false positive rates was evaluated at PIBO reference sites with at least 4 sample events across years (N = 9, Table B-6). The framework had the same or lower false positive rate than the BLM % fines reference benchmarks (Miller et al. 2021) for 7 of 9 reference sites (Table B-6). It had a lower false positive rate than PIBO O/E at 4 of 9 reference sites. PIBO O/E had the lowest false positive rates across these 9 sites. However, quantifying false positive rates based on PIBO O/E at PIBO reference sites is not an independent comparison because PIBO O/E benchmarks were developed using data from PIBO reference sites.

Table B-5. Predicted outcomes and false positive rates within reference sites for each assessment method.

	Sediment Assessment Framework (this study)						BLM % Fines Reference Benchmarks				O/E Reference Benchmarks (not sediment-specific)				BURP MMI Reference (SMI2) (not sediment-specific)			
Dataset	**N [a]**	**No sediment effect**	**Mixed Evidence**	**Effect Likely**	**Effect Very Likely**	**False Positive Rate**	**N [a]**	**Pass**	**Fail**	**False Positive Rate**	**N [a]**	**Pass**	**Fail**	**False Positive Rate**	**N [a]**	**Pass**	**Fail**	**False Positive Rate**
BURP reference	310	189 (61%)	97 (31%)	20 (6%)	4 (1%)	7% [b]	308	225	83	27%	--	--	--	--	309	281	28	9% [b]
BLM reference	37	16 (43%)	13 (35%)	4 (11%)	4 (11%)	22%	37	28	9	24%	37	20	17	46% [b]	--	--	--	--
USFS reference	383	185 (48%)	128 (33%)	52 (13%)	18 (5%)	18%	383	295	88	23%	383	313	70	18% [b]	--	--	--	--
TOTAL	730	390 (53%)	238 (32%)	76 (10%)	26 (4%)	14%	728	548	180	24%	420	333	87	21%	--	--	--	--

[a]: number of sample events with paired % fines and FSBI values

[b]: NOTE: rate was calculated based on comparison to same data used for benchmark development

Table B-6. False positive temporal frequency at PIBO reference sites with paired fines and macroinvertebrate data in at least 4 years.

PIBO Reference Site						Sediment Assessment Framework (this study)					BLM % fines Benchmark	PIBO O/E Benchmark
Subbasin	**Siteid**	**Stream**	**Siteclass**	**Order**	**Years**	**No sediment effect**	**Mixed evidence**	**Sediment effect likely**	**Sediment effect very likely**	**False positive Rate**	**False positive Rate**	**False positive Rate**
17010215	75	Hughes	Mountains	3	10 (2004-2015)	1	1	8	0	8/10 (80%)	6/10 (60%)	6/10 (60%)
17010301	89	Emerson	Mountains	2	10 (2004-2018)	6	4	0	0	0/10 (0%)	0/10 (0%)	1/10 (10%)
17060201	600	Meridian	Mountains	2	6 (2004-2015)	0	4	2	0	2/6 (33%)	3/6 (50%)	0/6 (0%)
17060201	683	Goat	Mountains	2	10 (2004-2013)	1	9	0	0	0/10 (0%)	0/10 (0%)	5/10 (50%)
17060207	442	Moose	Mountains	3	8 (2004-2013)	1	3	4	0	4/8 (50%)	2/8 (25%)	1/8 (13%)
17060207	451	Reynolds	Mountains	3	8 (2004-2017)	1	7	0	0	0/8 (0%)	0/8 (0%)	0/8 (0%)
17060301	409	Swet	Mountains	2	9 (2004-2014)	1	3	5	0	5/9 (55%)	6/9 (67%)	0/9 (0%)
17060303	375	White Sands	Mountains	2	8 (2004-2016)	5	3	0	0	0/8 (0%)	0/8 (0%)	3/8 (38%)
17060305	401	Twentymile	Mountains	2	9 (2004-2016)	0	4	3	2	5/9 (55%)	9/9 (100%)	2/9 (22%)

3.2.2 False Negatives in Streams with a Sediment TMDL

False negatives occur if the framework does not predict 'likely' or 'very likely' sediment impacts in reaches known to have macroinvertebrate communities impacted by excess anthropogenic fine sediment. There is no definitive approach for conclusively identifying such reaches, which is the reason this analysis was undertaken. However, absence of a definitive approach also makes testing for framework false negatives challenging. Other studies tested benchmark false positives using 'stressed' sites with high levels of upstream human landscape disturbance (Jessup et al. 2014; Jessup 2011, Jessup and Pappani 2015; DEQ 2016). However, landscape disturbance indicators used to identify 'stressed' sites (road density, land use, etc., mines, dams) are not sediment-specific and therefore some such 'stressed' sites may have macroinvertebrate communities altered by other stressors (temperature, pH, stream physical alterations, etc.) rather than substrate fine sediment.

False negatives were tested using stream segments with an EPA-approved sediment total maximum daily load (TMDL). Sediment TMDL streams are those where DEQ determined Idaho's narrative sediment criterion was violated because anthropogenic sediment inputs modified aquatic life "significantly beyond the natural range of the reference streams or conditions approved by the Director in consultation with the appropriate basin advisory group", and sediment-specific water quality targets have been developed (IDAPA 58.01.02.42).

While sediment-specific, these streams also have several limitations when evaluating framework false negatives. Using them assumes the original sediment impairment was identified based on surface fine sediment or macroinvertebrate data. However, DEQ has not always based sediment impairment decisions on surface fine sediment levels. DEQ's sediment assessment guidance was developed in 2003 and at the time concluded there weas limited literature on surface fines benchmarks or their ecological effects and recommended using other measures (DEQ 2003). For many streams, impairment decisions and sediment TMDL targets were based on water column suspended sediment concentration and exposure durations demonstrated to cause sublethal or lethal impacts on salmonids (Newcombe and Jensen 1996), streambank sediment erosion inventories, or assessor professional judgement. Evaluating framework outcomes in these streams assumes the framework and original assessment were based on the same exposure pathway and specific ecological effect, but that is likely not the case. In addition, for some streams sediment impairment listings may be incorrect. A systematic analysis of 2002-2022 Idaho Integrated Report data revealed that false positive impairment conclusions have historically been common due to coarse assessment methods used in the past, historic litigation, and other factors (Williams 2023). From 2002-2022, more Idaho stream km changed from not supporting to supporting beneficial uses because monitoring and investigation determined the original impairment decision was incorrect than because water quality improved (Williams 2023).

Framework false negative rates were very high (60-92%) when applied to BURP, BLM, and USFS data in streams with a sediment TMDL (Table B-7). However, false negative rates were also very high using BLM % fines benchmarks (Miller et al. 2021, 65-79%), and O/E benchmarks (43-56%) (Table B-6). Many sites in sediment TMDL streams with false negatives also had passing O/E or

MMI scores, suggesting the macroinvertebrate community was within reference condition. Among BLM sites in sediment TMDL streams with a false negative framework prediction, 31 of 59 (53%) sample events had a passing O/E score (Table B-7). Among PIBO sites in sediment TMDL streams with a false negative framework prediction, 55 of 83 sample events (66%) had a passing O/E score. Among BURP sites in sediment TMDL streams with a false negative, 498 of 609 (82%) events with a false negative framework prediction had a passing SMI2 score. These patterns strongly suggest that some false negatives occurred because sediment does not adversely affect macroinvertebrate community composition in at least some streams with a sediment TMDL. The relationship between framework predictions and O/E values across all sites (Figure B-8) indicates sites with predicted sediment effects do have more degraded macroinvertebrate communities than those without predicted sediment effects.

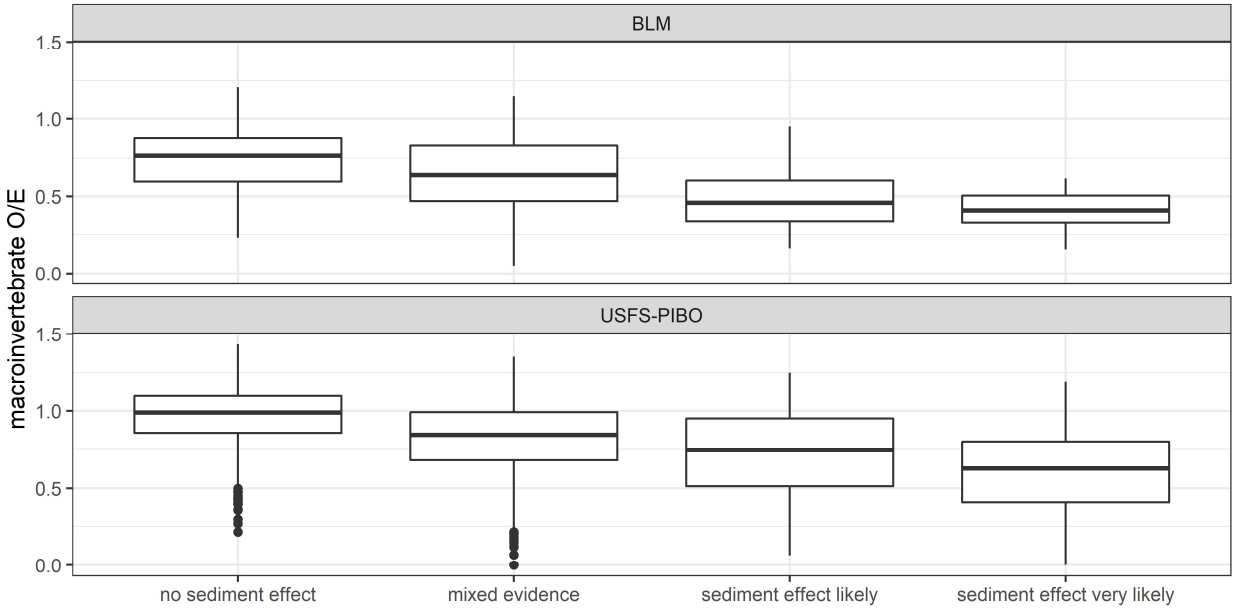


Figure B-8. Distribution of PIBO and BLM macroinvertebrate O/E values for each framework outcome class. Box lower and upper ends are the 25th and 75th percentile, the horizontal line is the median, whiskers extend to 1.5 times the interquartile range (IQR), and circles are data points > 1.5 times the IQR.

Table B-7. Predicted outcomes and false negative rates within sediment TMDL streams for each assessment method.

	Sediment Assessment Framework (this study)						BLM % Fines Reference Benchmarks				O/E Reference Benchmarks (not sediment-specific)				BURP MMI Reference (SMI2) (not sediment-specific)			
Dataset	**N [a]**	**No sediment effect**	**Mixed Evidence**	**Effect Likely**	**Effect Very Likely**	**False Negative Rate**	**N [a]**	**Pass**	**Fail**	**False Negative Rate**	**N [a]**	**Pass**	**Fail**	**False Negative Rate**	**N [a]**	**Pass**	**Fail**	**False Negative Rate**
BURP TMDL sites	999	268 (27%)	341 (34%)	156 (16%)	234 (24%)	60% [b]	964	543	421	56%	--	--	--	--	999	627	372	63%
BLM TMDL sites	75	21 (28%)	48 (64%)	5 (7%)	1 (1%)	92%	83	66	17	79%	76	32	51	42% [b]	--	--	--	--
USFS TMDL sites	117	47 (39%)	36 (32%)	21 (18%)	13 (11%)	71%	117	79	38	67%	117	66	51	56% [b]	--	--	--	--
TOTAL	1191	335 (28%)	426 (36%)	182 (15%)	248 (21%)	64%	1164	688	476	59%	193	98	102	51%	--	--	--	--

[a]: number of sample events with paired % fines and FSBI values

[b]: NOTE: rate was calculated based on comparison to same data used for benchmark development

Table B-8. Comparison of framework predictions and macroinvertebrate O/E outcomes for sites within sediment TMDL streams.

	BLM O/E			USFS O/E			BURP SMI2		
Framework Prediction	**N [a]**	**Pass**	**Fail**	**N [a]**	**Pass**	**Fail**	**N [a]**	**Pass**	**Fail**
No sediment effect	21	14	7	47	36	11	268	246	22
Mixed evidence	48	17	31	37	19	17	341	252	89
Sediment effect likely	5	1	4	21	9	12	235	95	139
Sediment effect very likely	1	0	1	13	2	11	155	34	122

3.2.3 *Performance at BLM 'Excess Sediment' Sites*

False negatives were also tested at sites predicted to have excess sediment by National Aquatic Monitoring Center staff. They provided a list of 5 AIM sites predicted to have fine sediment exceeding natural levels predicted based on modeling (Jennifer Courtwright, Utah State University, personal communication 4/24/2023). Framework performance at these sites is summarized in Table B-9. For one sample, the framework did not generate a prediction because the sample was collected in a 6th order stream. For three sites, the framework predicted a sediment effect was very likely, and in these cases the AIM O/E model also indicated macroinvertebrates were not within reference condition. For one site, the framework classified the site as having mixed evidence, and in this case the AIM O/E model predicted macroinvertebrates were within reference condition (Table B-9).

Table B-9. Framework predictions for AIM sites predicted to have excess sediment based on AIM site screening criteria.

Site ID	Site Name	Order	Siteclass	Sample Date	Sample ID	% Fines	FSBI	Fines Reference Benchmark Achieved?	FSBI Reference Benchmark Achieved?	Framework Outcome	O/E
BY-TR-15985	Raft River	4	PPBV	9/3/2021	178547	84.4	0	N	N	effect very likely	0.32 (fail)
CTG-SS-1001	Unnamed	1	Foothills	8/25/2019	172410	67.1	0	N	N	effect very likely	0.36 (fail)
JA-RV-41576	Salmon Falls Creek	6	PPBV	9/3/2020	176540	88.1	0	--	--	--	0.15 (fail)
JA-TR-88752	Columbet Creek	2	PPBV	9/16/2020	1765511	82.9	0	N	N	effect likely	0.36 (fail)
SA-LS-12318	Canyon Creek	3	PPBV	9/15/2016	157566	48.1	135	N	Y	Mixed evidence	0.78 (pass)
				7/26/2021	178581	34.2	100	N	Y	Mixed evidence	0.98 (pass)

3.2.4 Prediction Temporal Consistency

The PIBO sample design includes repeat sampling of some reaches across years. For PIBO sites with paired percent fines and macroinvertebrate data across at least 4 years, temporal consistency of framework predictions was examined (Figure B-9). Ideally, if a stream reach has no significant changes to watershed human land use over time and significant natural disturbances, framework predictions should be consistent across years; it should either predict no sediment effect or a sediment effect, but not both within the same sample reach across years. Among 24 time series sites, predicted outcomes included both no sediment effect and a sediment effect for 6 sites (25%). At all other time series sites, predicted outcomes were either consistent across years, or there was a mixture of 'mixed evidence' and one other specific outcome across years (Figure B-9). At one time series site (Grimes Creek, #811 in Figure B-9) site photos indicated the year where the framework predicted a sediment impact corresponded to a year when a beaver dam broke and increased surface fine sediment (James Feller, USFS Region 1, personal communication).

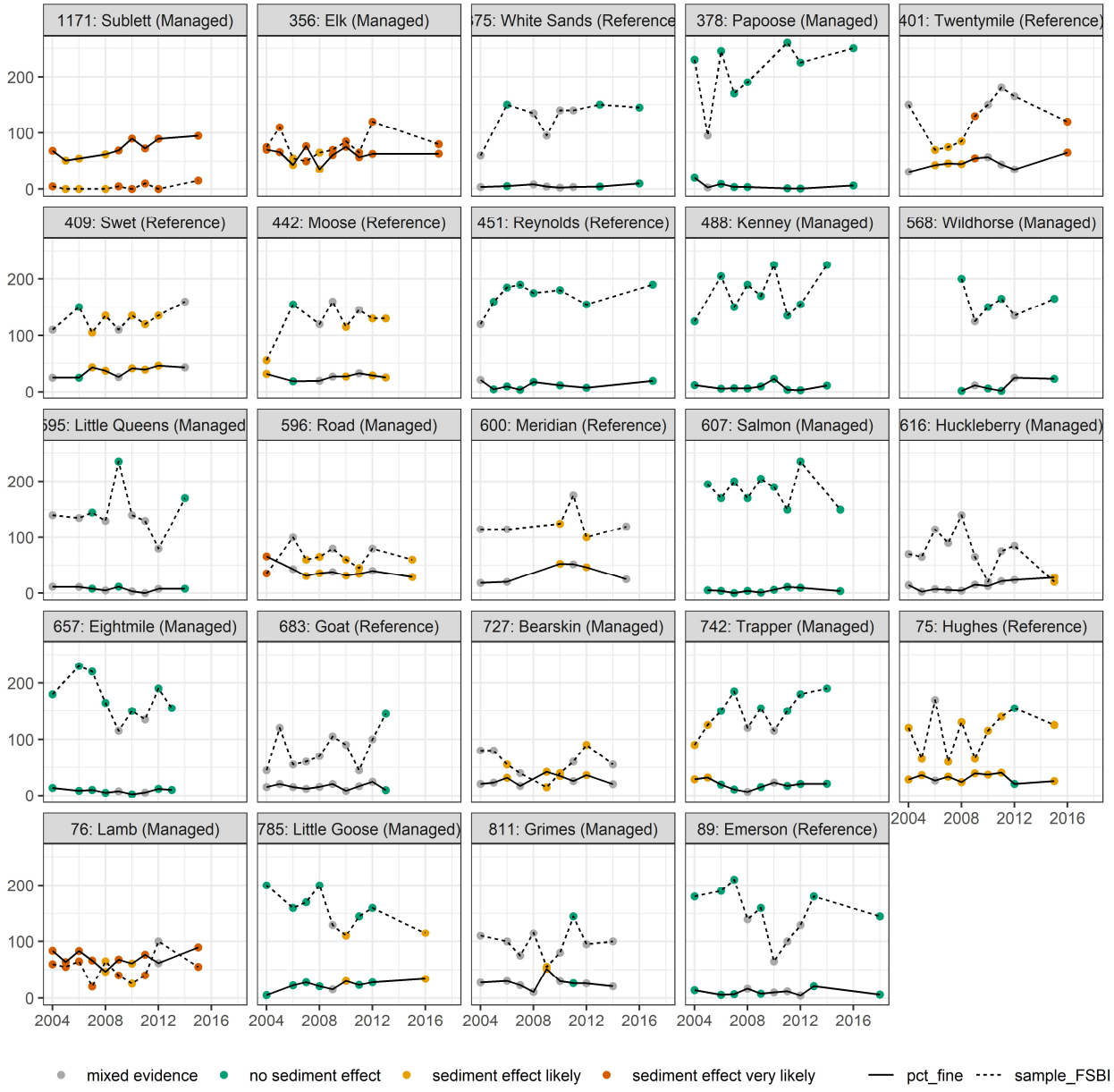


Figure B-9. Framework predictions at PIBO sites with paired percent fines and macroinvertebrate data in at least 4 years.

3.2.5 Prediction Consistency Across Monitoring Programs

Framework consistency prediction across monitoring programs was evaluated by analyzing reaches (national hydrography dataset plus version 2 COMIDs) with sample events from multiple programs. Specifically, three types of cases were evaluated:

- COMIDs with at least one sample event from each program (Figure B-10)
- COMIDs with at least 2 sample events from both BURP and PIBO (Figure B-11)
- COMIDs with at least 2 sample events from both BURP and AIM (Figure B-12)

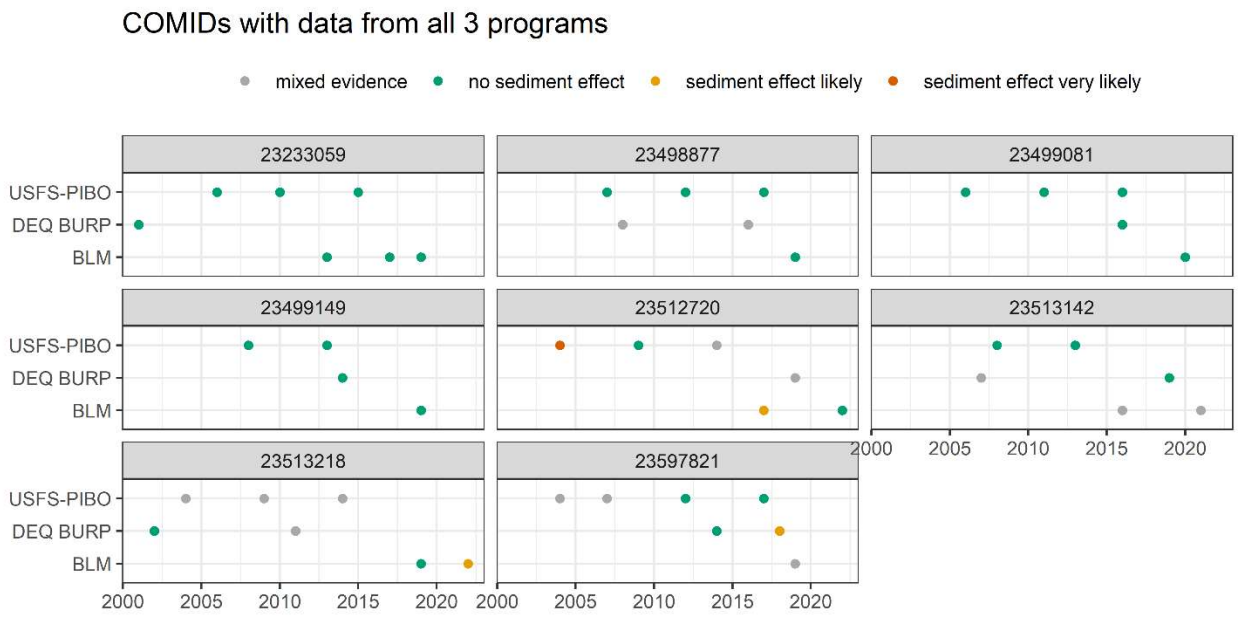


Figure B-10. Comparison of framework-predicted outcomes across programs for COMIDs with monitoring data from all three programs.

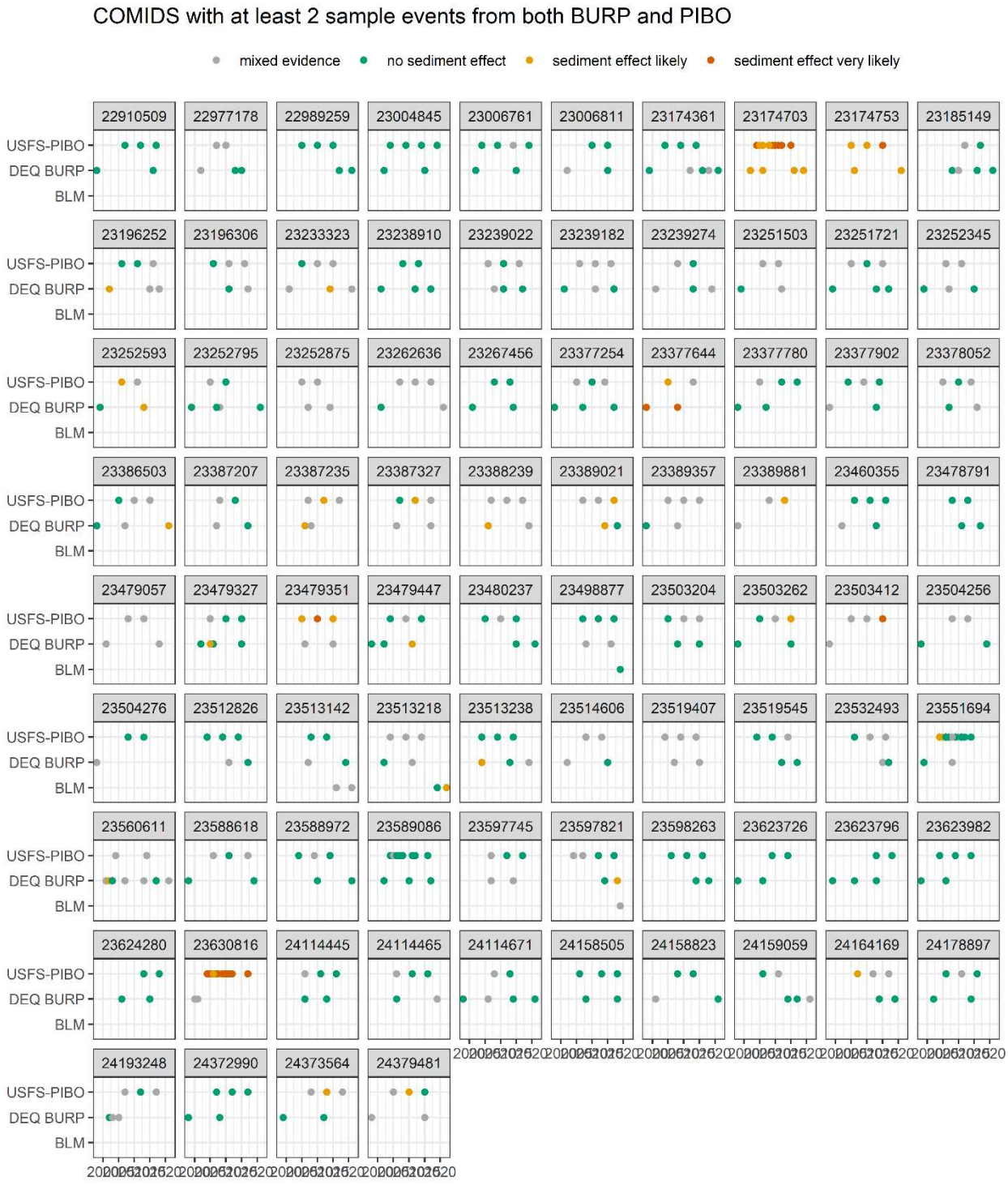


Figure B-11. Comparison of framework-predicted outcomes for COMIDs with at least 2 sample events by both BURP and PIBO monitoring programs.

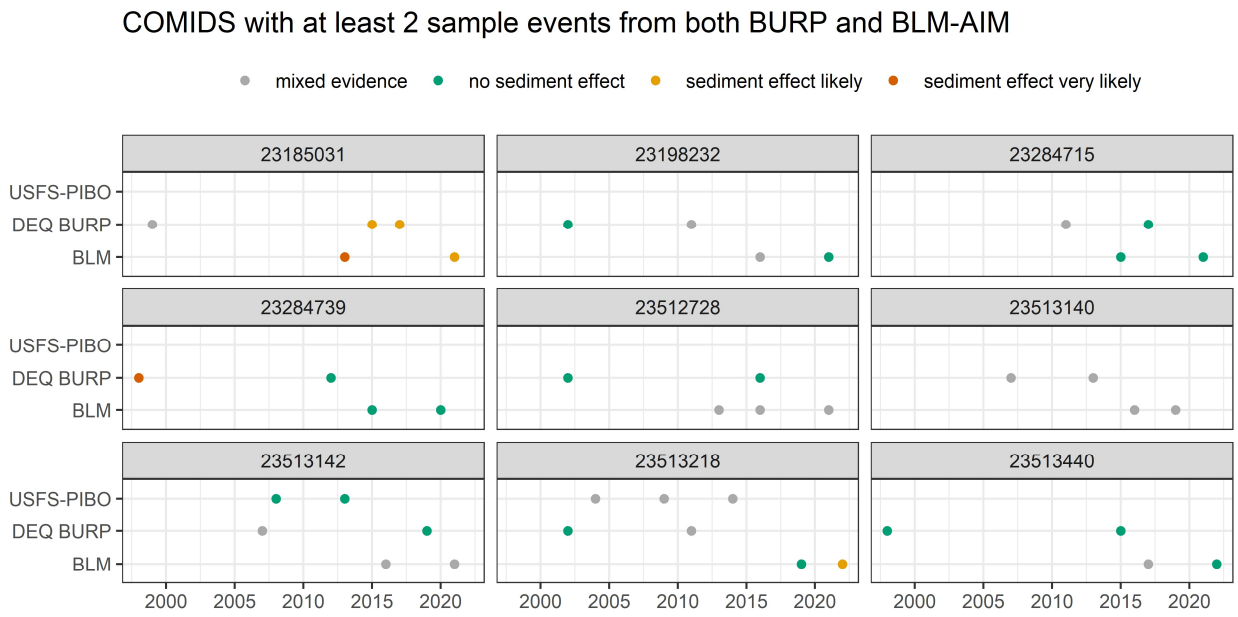


Figure B-12. Comparison of framework-predicted outcomes for COMIDs with at least 2 sample events by both BURP and BLM-AIM programs.

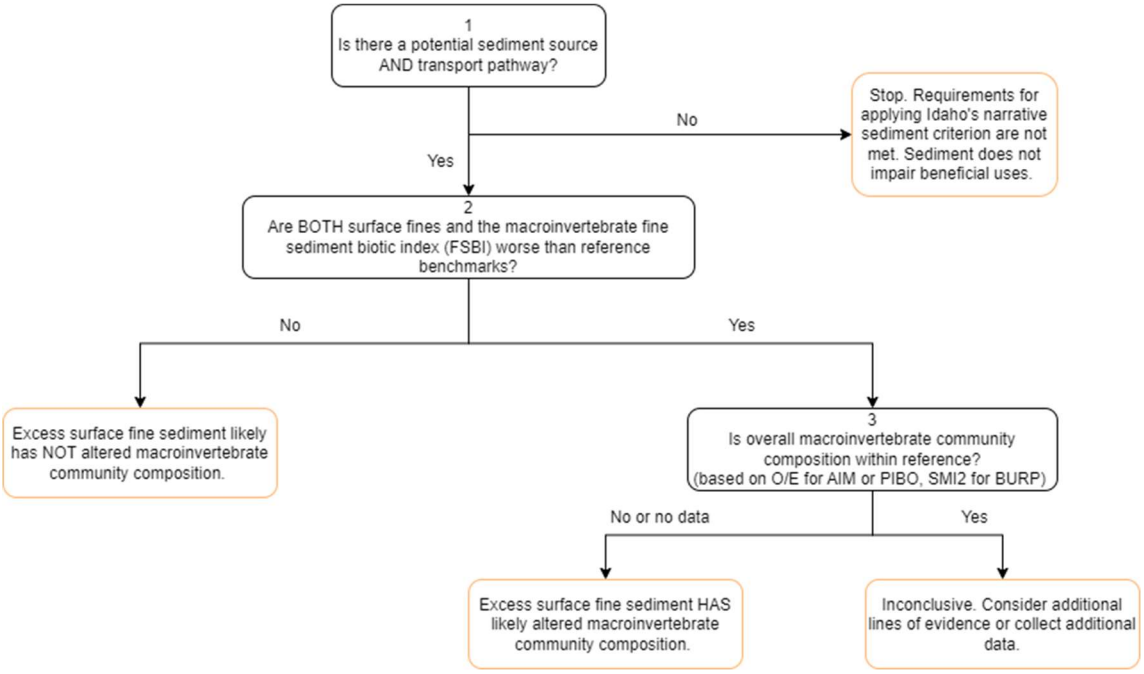
3.3 Potential Application

Potential framework users must decide if the assessment framework presented here performs adequately for their intended application. The performance level considered adequate for an assessment tool is subjective and application specific.

In Idaho, stressor identification is needed at the sample reach or assessment unit (AU) scale. For Clean Water Act assessment and reporting purposes, DEQ divided Idaho streams into 5,908 AUs (DEQ 2022). DEQ delineated AUs primarily based on stream order, although land use, management and ownership were also considered. Generally, 1st and 2nd order streams with a contiguous 12-digit hydrologic unit code subwatershed were lumped into a single AU, each 3rd and 4th order stream were a discrete AU, and streams ≥ 5th order were divided into multiple AUs (DEQ 2016, Williams 2023). Each AU is a subset of a water body specified in Idaho WQS (IDAPA 58.01.02.010). Each water body represents a specific reach or tributary within a subbasin (i.e. within a 8-digit hydrologic unit code). For each water body, Idaho WQS define beneficial uses that must be protected and water quality criteria necessary to protect those beneficial uses. DEQ assesses and reports compliance with applicable water quality standards and develops TMDLs at the AU spatial scale. Therefore, achieving the administrative goals of the Clean Water Act and identifying the specific land management actions needed to restore beneficial uses within an AU usually requires diagnosing stressors at the AU or smaller sample reach spatial scale.

Figure B-13 presents one potential approach to evaluating if human-caused excess substrate fine sediment likely has modified macroinvertebrate community composition beyond reference conditions and therefore violated Idaho's narrative sediment criterion at the sample event scale for a sampled reach. The decision tree requires paired percent fines and macroinvertebrate

data collected during the same sample event and should be used to predict an outcome that is specific to a sample event with a sample reach. The framework could be applied using either BURP, PIBO, or AIM data. In cases with multiple sample events across years for a reach, assessors should consider predicted outcomes for each sample event before making a final reach-scale sediment impairment decision and document the basis for the final reach-scale decision. In cases where there are multiple reaches with data within an assessment unit, assessors should consider predicted outcomes for each reach before making a final assessment unit scale sediment impairment decision and document the basis for the final decision.



Step	Description
1	To determine if there is a potential sediment source, compare watershed landscape characteristics for the sample reach watershed or associated HUC12 subwatershed to a set of landscape characteristic thresholds indicating limited human disturbance. Landscape criteria could be the same as those used to define reference sites, or could be location-specific or sediment-specific. A stream network represents a potential transport pathway for most potential sediment sources.
2	Apply the sediment benchmarks (Table 4) and assessment framework (Figure B3). Reference benchmarks depend on stream order for percent fines and siteclass for FSBI.
3	For PIBO and AIM data, compare sample event O/E to the sample reach benchmark O/E (Table B-2). For BURP data, evaluate if SMI2 ≥ 2.

Figure B-13. An example approach to evaluating if human-caused excess substrate fine sediment likely has modified macroinvertebrate community composition beyond reference conditions and therefore violated Idaho's narrative sediment criterion at the sample event scale for a sampled reach.

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Supporting Materials

Development and Evaluation of a Framework for Assessing Substrate Fine Sediment Impacts on Macroinvertebrate Community Composition in Idaho Streams

Landscape Criteria used by BLM to identify AIM sediment reference sites

Table S-1. Thresholds used by BLM to screen for sediment reference sites for BLM benchmark revisions and modeling. StreamCat data were used for reference site screening analyses.

Disturbance	Years & datasets used	Scale	Threshold	Unit
% ag	Avg of 2001 & 2019 NLCD	Cat, Ws	3	%
% urban	Avg of 2001 & 2019 NLCD	Cat, Ws	3	%
% ag + urban	Avg of 2001 & 2019 NLCD	Cat, Ws	5	%
% developed open space	Avg of 2001 & 2019 NLCD	Cat, Ws	7 Cat, 10 ws	%
Road density	2010 Tiger	Cat, Ws	1.5	km/km2
Road crossing density	2010 Tiger	Cat	0.241	Crossings/km
Mine density	2003	Ws	0	Mines/km
Superfund		Ws	0	#/ km2
Canal density	2014	Cat, Ws	0 cat, 0.075 ws	km/km2
Dam density	2012, NID	Cat	0	Dams/km
Dam within 2 km buffer[a]	NID	2 km buffer	Absent	NA
% forest loss	Difference of % forested between 2019 and 2001 NLCD	Cat, Ws	0.25 Cat, 1 Ws	%

Logistic Regression Results

Table S-2. Logistic regression model parameters and measures of fit. * indicates the model parameter is statistically significant (p < 0.05).

Siteclass	Order	Intercept (SE)	% fines B (SE)	Model X^2	Model X^2 p-value	Odds Ratio CI	HL p-value
Mountains	1	-1.2 (0.2)*	0.04 (0.006)*	55.5	< 0.001	1.03-1.05	0.08
	2	2.0 (0.12)*	0.06 (0.005)*	207	0.0	1.05-1.07	0.12
	3	-1.4 (0.13)*	0.04 (0.006)*	39.3	< 0.001	1.02-1.04	0.04
	4	-1.07 (0.29)*	0.04 (0.02)*	4.03	0.04	1.0-1.08	0.02
Foothills	1	-2.1 (0.43)*	0.06 (0.01)*	49.2	< 0.001	1.04-1.09	0.20
	2	-2.01 (0.25)*	0.05 (0.006)*	85.7	0.0	1.04-1.07	0.16
	3	-1.6 (0.22)*	0.05 (0.007)*	63.1	< 0.001	1.03-1.06	0.15
	4	-1.5 (0.32)*	0.05 (0.01)*	19.9	< 0.001	1.03-1.09	0.12
PPBV	1	-3.6 (0.49)*	0.07 (0.01)*	81.1	0.0	1.05-1.09	0.3
	2	-2.4 (0.24)*	0.05 (0.005)*	91.6	0.0	1.04-1.06	0.15
	3	-2.2 (0.23)*	0.05 (0.006)*	127	0.00	1.04-1.07	0.20
	4	-2.3 (0.36)*	0.07 (0.01)*	65.8	< 0.001	1.05-1.1	0.23

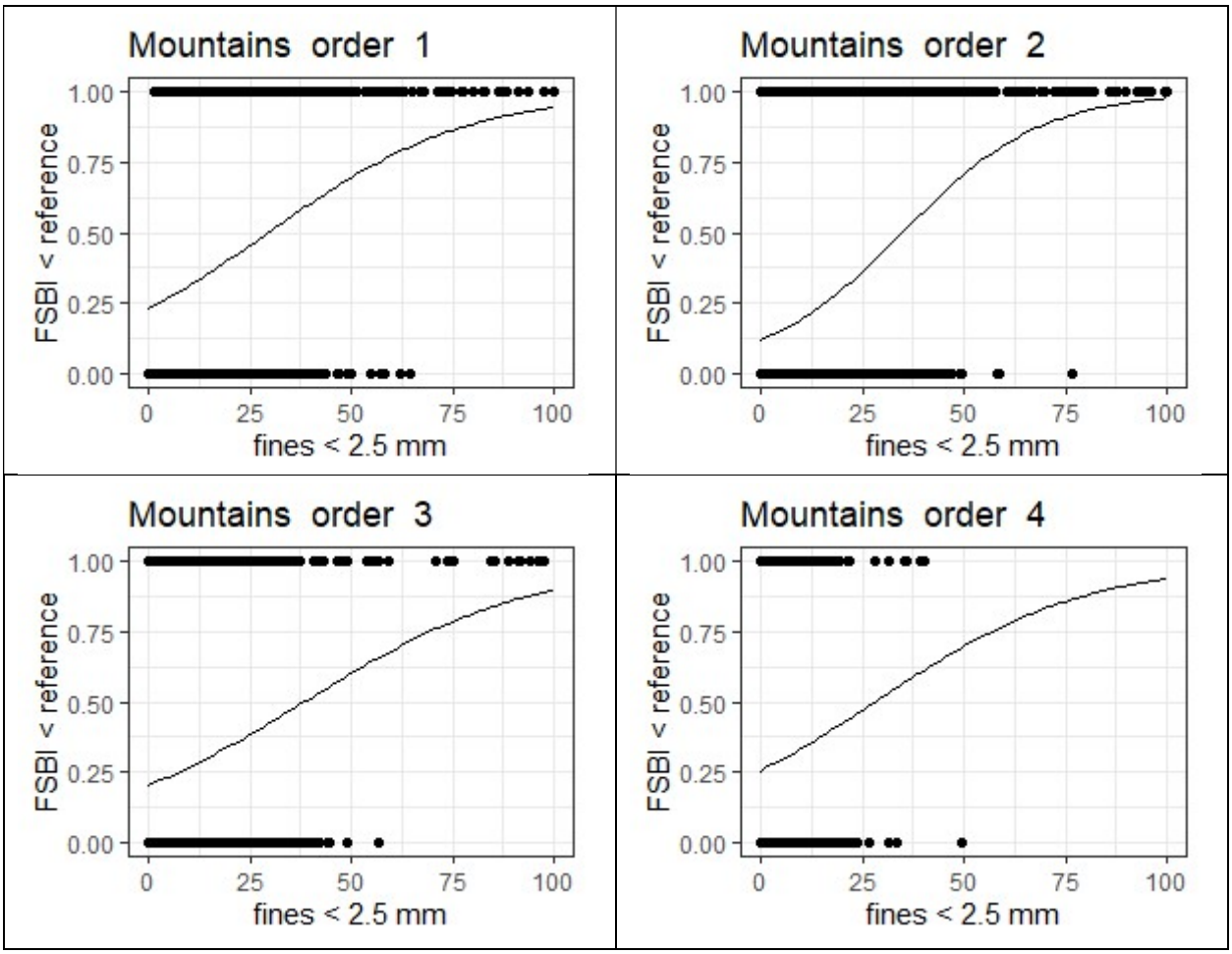


Figure S-1. Stressor-response logistic regressions for the Mountains siteclass.

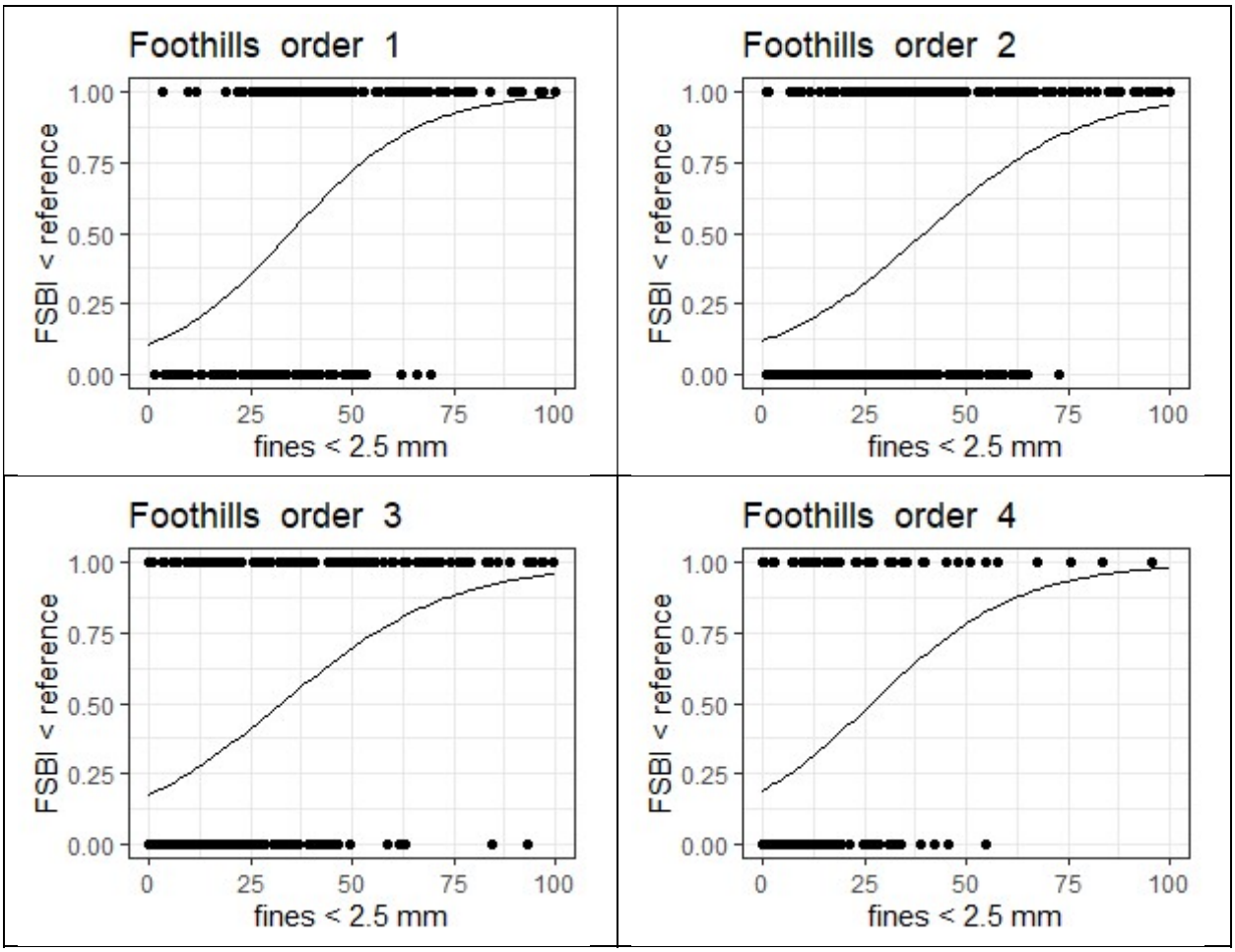


Figure S-2. Stressor-response logistic regressions for the Foothills siteclass.

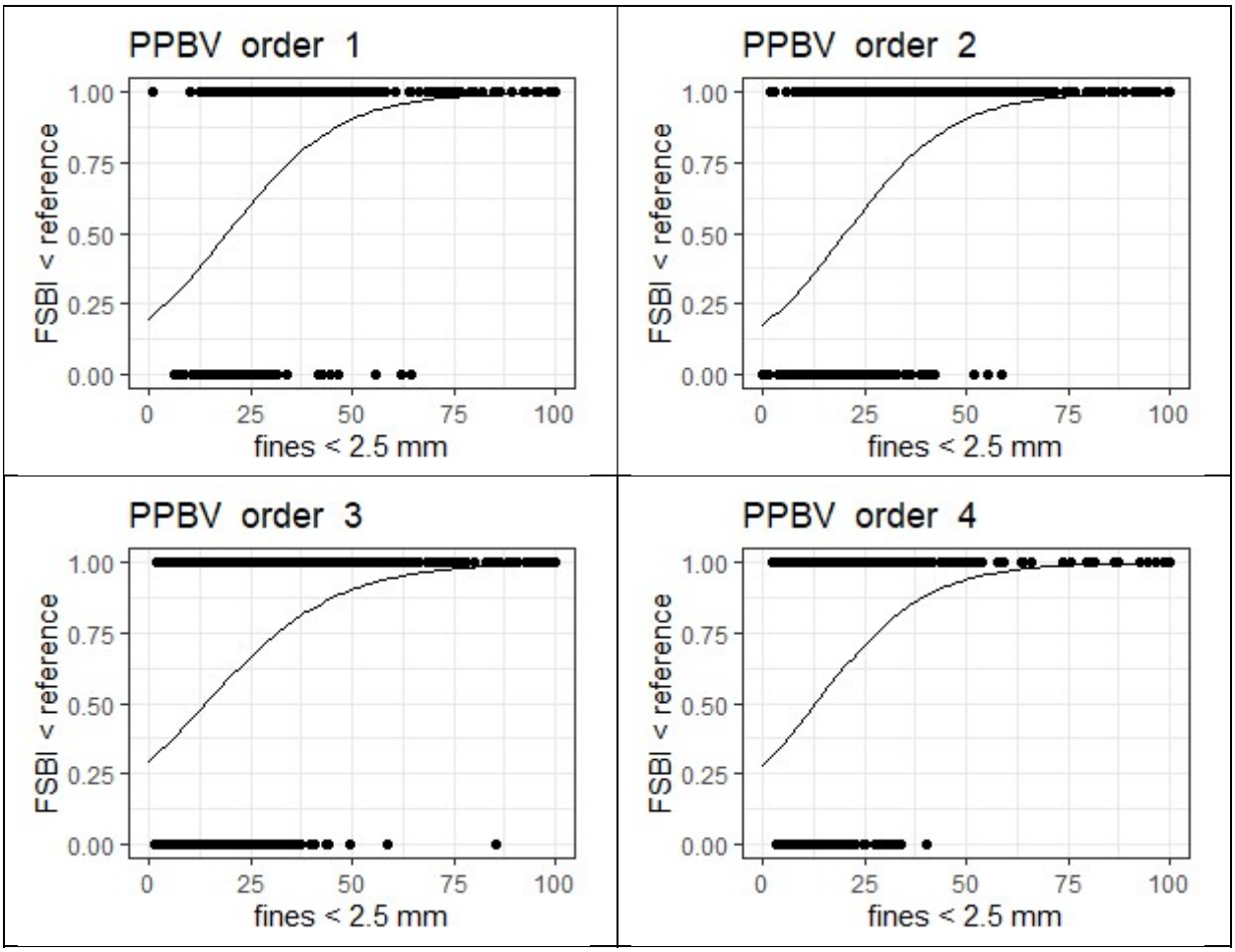


Figure S-3. Stressor-response logistic regressions for the Plains Plateaus and Broad Valleys (PPBV) siteclass.

FSBI Calculation Methods

BURP data

The taxonomic laboratory (EcoAnalysts) identified and counted all individuals within each macroinvertebrate sample to the lowest possible taxonomic resolution, usually to genus or species. DEQ then assigned each taxa reported by the laboratory to an operational taxonomic unit (called a 'validated taxa' by DEQ) prior to importing macroinvertebrate data in to DEQ's database. Validated taxa are those for which have taxa attributes (including a FSBI-level taxa score) in DEQ's database and were used for development of BURP MMIs. In cases where a taxa identified by the laboratory is not in DEQ's validated taxa table, DEQ staff either add the taxa and its attributes to the database, or assign the taxa to a higher level validated taxa if reasonable. For example, the laboratory reports Example species in results, but this species is not in the database but a record for the associated genus is, in some cases the taxonomic result was imported as Example sp. if DEQ staff determined attributes were similar. Sample FSBI was calculated as the sum of all taxa-level FSBI scores associated with validated taxa within a sample.

PIBO and AIM data

For the PIBO and AIM programs, the taxonomic laboratory (National Aquatic Monitoring Center at Utah State University) identified up to 600 individual specimens from each sample to the lowest possible taxonomic resolution, usually to genus or species. Raw laboratory taxonomic identifications were then assigned to an operational taxonomic unit used for purposes of O/E calculations. USFS and BLM then randomly subsampled identified taxa to create a list of 300 identified individuals for each sample.

At the time of this study, the PIBO and AIM programs did not calculate sample FSBI from their macroinvertebrate data. USFS and BLM provided harmonized subsampled macroinvertebrate data to DEQ for FSBI calculations. Based on Relyea et al. 2012, DEQ assigned a taxa-level FSBI score to each unique taxa name reported by the laboratory (ScientificName values) included in subsampled data. Sample FSBI scores were then calculated using an R tool developed for this project (*https://github.com/jjwill2/FSBI_calculator*). Sample FSBI scores were calculated as the sum of assigned taxa-level FSBI scores within a sample. Assigned taxa-level FSBI scores and R inputs and outputs are available through the github link.

Table S-3. Fine sediment benchmarks reported in the literature and used for comparison to calculate benchmarks.

Source	Benchmark Description	Biological Receptor	Sediment Size Fraction	Stream Size	Threshold Value
Bryce et al. 2010	Minimum effects threshold for Index of Biotic Integrity (IBI) value decreases in wadable Western U.S. mountain streams	aquatic vertebrates	≤ 0.06 mm	wadable	5%
		aquatic vertebrates	≤ 2 mm	wadable	13%
		aquatic macroinvertebrates	≤ 0.06 mm	wadable	3%
		aquatic macroinvertebrates	≤ 2 mm	wadable	10%
Jessup et al. 2014	Recommended reference benchmark for New Mexico streams in mountains site class, based on statistical distribution within reference sites and changepoint analysis for multiple biological indicators.	aquatic macroinvertebrates	≤ 2 mm	wadable	20%
Reylea et al. 2012	Percent fines levels at which sediment-sensitive macroinvertebrate taxa start disappearing from northwest US streams.	aquatic macroinvertebrates	< 2 mm	1-6th order	10-20%
Jensen et al. 2009	Threshold for rapid decreases of egg-to-fry survival, based on a meta-analysis of lab and field studies in peer-reviewed literature	Chinook, Coho, and Chum salmon, and steelhead trout	< 0.85 mm	NA (lab & field experiments)	10%
Jensen et al. 2009	Threshold for rapid decreases of egg-to-fry survival, based on a meta-analysis of lab and field studies in peer-reviewed literature	Chinook, Coho, and Chum salmon, and steelhead trout	< 3.4 mm, < 4.8 mm, < 6.4 mm	NA (lab & field experiments	25-30%
Burdon et al. 2013	Threshold above which rapid changes in pollution-sensitive invertebrates (% Ephemeroptera, Plecoptera, and Trichiptera) were observed across 20 New Zealand agricultural streams.	Aquatic macroinvertebrates	< 2 mm	1-3rd order	20%
EPA 2020 (Table 4.2)	Threshold used to identify reference sites within the Northern Rockies and Pacific Mountains region for the National River and Streams Assessment (NRSA)	NA (reference statistical distribution)	unclear	wadable & non-wadable	15%
EPA 2020 (Table 4.2)	Threshold used to identify most-disturbed sites within the Northern Rockies and Pacific Mountains region for the National River and Streams Assessment (NRSA)	NA (reference statistical distribution)	unclear	wadable & non-wadable	50%
EPA 2007	'Good' condition threshold used by EPA for assessing stream conditions in EMAP Report 'Ecological Condition of Wadable Streams of the Interior Columbia River Basin'. 'Good' percent fines condition was calculated as 75th percentile value among least-disturbed reference sites within Northern Rockies, Idaho Batholith, Middle Rockies, and Canadian Rockies ecoregions.	NA (reference statistical distribution)	< 2 mm	wadable	16.19%
EPA 2007	'Good' condition threshold used by EPA for assessing stream conditions in EMAP Report 'Ecological Condition of Wadable Streams of the Interior Columbia River Basin'. 'Good' percent fines condition was calculated as 75th percentile value among least-disturbed reference sites within Columbia Plateau and Northern Basin & Range ecoregions.	NA (reference statistical distribution)	< 2 mm	wadable	29.52%
BLM 2020	70th percentile value among Northwest U.S. stream reference sites within Northern Rockies level III ecoregion	NA (reference statistical distribution)	< 2 mm	< 10 m bankfull width	29%
BLM 2020	70th percentile value among Northwest U.S. stream reference sites within Northern Rockies level III ecoregion	NA (reference statistical distribution)	< 2 mm	> 10 m bankfull width	15%
BLM 2020	70th percentile value among Northwest U.S. stream reference sites within Xeric Basins level III ecoregion	NA (reference statistical distribution)	< 2 mm	< 10 m bankfull width	45%

BLM 2020	70th percentile value among Northwest U.S. stream reference sites within Xeric Basins level III ecoregion	NA (reference statistical distribution)	< 2 mm	> 10 m bankfull width	44%
USFS 1998	Recommended surface fine sediment levels developed by USFS and BLM for the Upper Columbia River Basin. Recommended values vary based on Rosgen channel type (A-C) and geology (plutonic, volcanic, or metamorphic rock). See also DEQ 2003.	Anadromous salmonids	< 6 mm	unclear	14-37%
USDA 1995	PacFish/InFish Environmental Assessment Alternative E ('which was not ultimately selected) stated "A Riparian Management Objective for sediment substrate would be established to be less than 20 percent fine sediment in spawning habitat" (USDA 1995, pA-16)	Anadromous salmonids	unclear	unclear	20%
CRITFC 1995.	Recommended surface fine sediment levels for an in-channel habitat condition coarse screening process. In cases where the benchmark is exceeded, land management actions to reduce sediment were recommended.	Anadromous salmonids	< 6 mm	unclear	20%
NOAA 1998	Recommended surface fines benchmark for use in making Endangered Species Act determinations of effect for individual or group actions at the watershed scale for the Clearwater Basin and Lower Salmon, applies to Rosgen channel type A & B	Chinook, Steelhead, and Bull Trout	< 6 mm	Not specified	≤10%
NOAA 1998	Recommended surface fines benchmark for use in making Endangered Species Act determinations of effect for individual or group actions at the watershed scale for the Clearwater Basin and Lower Salmon, applies to Rosgen channel type C & E	Chinook, Steelhead, and Bull Trout	< 6 mm	Not specified	≤20%
NMFS 1996	Recommended percent fines in gravel for streams classified as 'properly' functioning for purposes of making Endangered Species Act determinations of effect	Anadramous salmonids	< 0.85	Not specified	< 12%

Appendix C. Field Monitoring Protocol Documents

Monitoring protocol documents are publicly available at
https://doi.org/10.17605/OSF.IO/KFMYR