Proposal –Site-Specific Selenium Criteria for the Crow Creek Watershed

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FORMATION

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LIST OF ABBREVIATIONS

µg/L	Micrograms per liter
AMSL	Above Mean Sea Level
BAF	Bioaccumulation Factor
BURP	Beneficial Use Reconnaissance Program
CEMPP	Comprehensive Environmental Monitoring Program Plan
CF	Conversion Factors
EC10	10% Effect Concentration
EC13	13% Effect Concentration
EC24	24% Effect Concentration
EF	Enrichment Factor
EPA	United States Environmental Protection Agency
HUC	Hydrologic Unit Code
IDAPA	Idaho Administrative Procedure Act
IDEQ	Idaho Department of Environmental Quality
mg/kg dw	Milligrams per kilogram, dry weight
NOEC	No Observed Effect Concentration
NFSC	North Fork Sage Creek
PCC	Pole Canyon Creek
SETAC	Society for Environmental Toxicity and Chemistry
SSD	Species Sensitivity Distribution
SSSC	Site-Specific Selenium Criterion
SWE	Snow-Water Equivalent
WTP	Water Treatment Plant
WY	Water Year
YCT	Yellowstone cutthroat trout

EXECUTIVE SUMMARY

Idaho's aquatic life criteria for selenium were developed following United States Environmental Protection Agency (EPA) national water quality criteria for selenium (EPA 2021). Idaho adopted into their administrative rules the national criteria for the state and went one step further and adopted a site-specific selenium criterion (SSSC) for non-sturgeon water bodies of the state (Idaho Administrative Procedures Act [IDAPA] 58.01.02). The premise of the waterbody-specific non-sturgeon water criteria comes from the national criteria which states, "All four elements of the freshwater selenium criterion may be modified to reflect site-specific conditions where the scientific evidence indicates that different values will be protective of aquatic life and provide for the attainment of designated uses" (EPA 2021). This same premise was utilized by Simplot to develop SSSC for two stream reaches in the vicinity of the Smoky Canyon Mine (Formation 2017): Crow Creek downstream of its confluence with Sage Creek to the Wyoming Border, and Sage Creek, Hoopes Spring, and South Fork Sage Creek. These SSSC were approved by EPA in 2019.

As currently adopted in Idaho administrative rules at IDAPA 58.01.02, several different selenium aquatic life criteria currently apply within the Crow Creek watershed as shown in Table ES - 1 below:

Table ES - 1. Existing Selenium Aquatic Life Criteria Adopted in the Crow Creek Watershed

Waterbody	Egg/Ovary (mg/kg dw)	Whole-Body (mg/kg dw)	Water (Lotic) (µg/L)
Upper Crow Creek & Deer Creek[1]	19.0	9.5	3.1
Sage Creek[2]	20.5	13.6	16.7
Lower Crow Creek[3]	20.5	12.5	4.2

Different tissue-based criteria are utilized in these Crow Creek stream reaches despite the brown trout (*Salmo trutta*) being the most sensitive species present in the drainage. Site-specific adult reproduction studies for brown trout and Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*), extensive review of existing literature, and continued fish population monitoring efforts confirm that throughout the larger Crow Creek drainage, brown trout is the most selenium-sensitive fish species present in Crow Creek and its tributaries.

The proposal provided herein seeks to unify the tissue-based criteria utilized for the Crow Creek watershed to a brown trout-based criteria and adjust the water quality criteria elements where new data indicate that a change is warranted. In a separate proposal, the site-specific criteria elements for the North Fork Sage Creek are presented. Table ES - 2 defines the proposed changes for the different segments of Crow Creek.

[1]Tissue criteria are derived from the non-sturgeon water EC10s developed as part of Idaho's statewide SSSC.
[2] Tissue criteria are from site-specific adult reproduction studies using brown trout.
[3] Egg/ovary criterion is based on brown trout while the whole-body tissue criterion is based on Rainbow Trout.

Table ES - 2. Proposed Criterion Elements for Two Segments of the Crow Creek Watershed

Waterbody	Egg/Ovary (mg/kg dw)	Whole-Body (mg/kg dw)	Water (Lotic) (µg/L)
Lower Crow Creek – downstream of Sage Creek	20.5	13.6	8.8
Upper Crow Creek and Tributaries – upstream of Crow Creek	20.5	13.6	3.1

1 Introduction

The Simplot Company (Simplot) is proposing a change to the existing fish tissue-based criteria for the Crow Creek watershed, where two separate egg/ovary and whole-body criteria (IDAPA 58.01.02.287) are currently in effect, to use uniform tissue criteria. This proposal will provide the rationale for why uniform egg/ovary and whole-body tissue criteria should be applied throughout the Crow Creek drainage, and why applicable surface water criterion elements based on those criteria should be standardized. Briefly, rationale for changing the tissue criterion elements is based on the species present, the sensitivity to selenium for the species present, and the need to provide clear and uniform tissue thresholds for the drainage, in which an inconsistent set of thresholds are currently in effect. In addition to the proposed change to the fish tissue criteria elements, this proposal seeks to change the water criterion element for lower Crow Creek.

The proposed changes would apply only to the Crow Creek watershed which includes several intermittent and perennial tributary streams. This document does not propose making any changes to the criteria currently in effect for Hoopes Spring, Sage Creek, and South Fork Sage Creek. A separate site-specific selenium criteria (SSSC) proposal for North Fork Sage Creek (NFSC) has been submitted under separate cover. The SSSC proposal for NFSC and PCC is based on site-specific data collected from September 2020 to May 2025 to derive a SSSC water column element. The water element is derived from site-specific data relative to tissue thresholds for egg/ovary and whole-body tissue concentrations in brown trout (*Salmo trutta*).

The inconsistent application of varying egg/ovary and whole-body tissue thresholds to different portions of the Crow Creek watershed results in inconsistent application of regulations across the drainage. As currently implemented, some of the tissue criteria in effect do not represent the species present and neglect the fact that brown trout is the most sensitive species to selenium exposure found in the drainage. Because the tissue criteria form the basis from which the water element criteria are derived, the practical approach in connected waterbodies with similar species present is to use the same tissue thresholds, particularly those that have been developed based on site-specific studies from within the drainage. Standardization of the tissue thresholds would provide a more consistent and technically defensible application of the selenium effects data that have been collected in the drainage for many years.

2 Tissue and Water Criteria Currently Adopted for the Crow Creek Drainage

Site-specific selenium criteria were adopted and approved in Idaho for Sage Creek, Hoopes Spring, South Fork Sage Creek, and lower Crow Creek (from the confluence with Sage Creek to the Idaho-Wyoming border) (IDAPA 58.01.02.287; Environmental Protection Agency [EPA] 2019). These criteria were based on site-specific studies which identified brown trout as the most sensitive species in the streams evaluated.

2.1 Sage Creek, Hoopes Spring, and South Fork Sage Creek

In Sage Creek, Hoopes Spring, and South Fork Sage Creek, the site-specific egg/ovary value adopted is 20.5 milligrams per kilogram, dry weight (mg/kg dw), while the whole-body value is 13.6 mg/kg dw. The associated water column criterion is equal to 16.7 micrograms per liter (µg/L). These criteria elements were derived from site-specific data collected from 2006 to 2011. Adult reproduction studies using wild fish from these streams and upper and lower Crow Creek were used to derive the egg/ovary criterion element and whole-body tissue element (Appendix A). An empirical bioaccumulation factor (BAF) approach described in Appendix K of the United States Environmental Protection Agency's (EPA) Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater (EPA 2016; 2021) was used to derive the water criterion element.

2.2 Crow Creek Downstream of Sage Creek

For Crow Creek, downstream of Sage Creek to the Wyoming State Line, the same brown trout egg/ovary criterion (20.5 mg/kg) was adopted. However, the whole-body threshold for brown trout was not adopted, rather a whole-body threshold from rainbow trout (12.5 mg/kg dw) was adopted for this segment of Crow Creek because it was deemed, at the time, to be the more sensitive whole-body threshold. The water criterion element derived for lower Crow Creek (4.2 µg/L) was, however, based on the brown trout egg/ovary criterion and site-specific BAF data.

EPA (2016; 2021) evaluates species sensitivity based on individual tissue types, even though selenium effects are manifested in larval fish from eggs of the maternal parent's exposure. EPA (2016; 2021) indicates that "The most well-documented, overt and severe toxic symptoms in fish are reproductive teratogenesis and larval mortality" and "Egg-laying vertebrates appear to be the most sensitive taxa, with toxicity resulting from maternal transfer to eggs". That is, selenium effects are manifested through the egg/ovary tissue not other tissues such as whole-body or muscle. Other tissues such as whole-body or muscle are converted from the egg/ovary tissue effects thresholds using conversion factors (CFs) based on ratios of egg/ovary to whole-body or muscle, or through linear-regression techniques that statistically relate egg/ovary concentrations to whole-body or muscle tissues. These independent strategies for tissue criteria can lead to assigning an egg/ovary tissue threshold based on one species and a whole-body or muscle tissue threshold based on another species as is the case in Lower Crow Creek.

Recent reanalysis of the *Oncorhynchus* genus and rainbow trout species conversion factors (CFs) indicate that the value used to convert egg/ovary data to whole-body is flawed and is lower than the current value used (CF = 1.96 from USEPA 2021). In fact, a proposal is currently being considered by Idaho Department of Environmental Quality (IDEQ) to alter the rainbow trout whole-body tissue threshold used in the Blackfoot River based on a revised CF (from 1.96 previously used to 1.43) which would change the whole-body tissue concentrations currently in effect for the Blackfoot River. Assuming the same CFs are applicable in Crow Creek for the rainbow trout egg/ovary to whole-body tissue criteria, the new whole-body tissue criterion element would be about 17.1 mg/kg dw which is greater than the brown trout value of 13.6 mg/kg dw. The contradiction is apparent, thus the proposal to utilize consistent tissue criterion elements for the drainage using the most sensitive species for reproductive effects is being proposed herein.

2.3 Crow Creek upstream of Sage Creek

Upstream of Sage Creek, the currently applicable water quality criteria for Crow Creek are based on the Idaho non-sturgeon water tissue thresholds. The thresholds (egg/ovary = 19.0 mg/kg dw, whole-body = 9.5 mg/kg dw, and lotic water = 3.1 µg/L) represent data from a number of species but are driven by data collected for multiple species that are not present in the drainage (IDEQ 2017). These include fish from the genera *Esox* (pike), and *Lepomis* (sunfish). *Lepomis* were the most sensitive genera in the dataset used to calculate the egg/ovary and whole-body criterion. *Esox* and *Lepomis* species are not present in Crow Creek. Implementation of the brown trout tissue criteria would complete the unified and consistent application of the most sensitive species tissue criteria within the drainage.

The non-Sturgeon criteria "*does not include site-specific water column criterion elements because [IDEQ does] not have the necessary site-specific bioaccumulation information to calculate them using the empirical BAF approach*" and "*The data are too few and variable to adequately describe the mean lotic BAF within the Site*" (IDEQ 2017). Due to the lack of adequate data to derive the water criterion elements set out in the statewide rule (footnote *r* in IDAPA 58.01.02.210.01) for the water bodies identified in this SSC for non-sturgeon waters, the lotic water criterion is the default value of 3.1 µg/L (IDEQ 2017).

3 Setting, Study Area, and Scope of Applicability

3.1 Setting

The Smoky Canyon Mine extracts phosphate ore from the Phosphoria Formation in a series of open pits referred to as mine panels. Phosphate ore is milled on site and then a slurry of phosphate ore is pumped to the Don Plan in Pocatello, Idaho. Weathering overburden waste shales containing selenium provides the release mechanisms for selenium to surface water and groundwater.

The mine is in Caribou County, Idaho, within the Southeastern Idaho Phosphate Mining District, approximately 10 miles west of Afton, Wyoming and 23 miles east of Soda Springs, Idaho (Figure 1). Situated on the eastern edge of the Webster Range overlooking Sage Valley to the east, the mine elevations range from 6,500 feet to 8,300 feet above mean sea level (AMSL).

The closest main population center to the mine is the Star Valley community, which includes the town of Afton, Wyoming, approximately ten miles directly east of the mine. The town of Afton has a population of approximately 2,280 (https://worldpopulationreview.com/us-cities/wyoming/afton). This region has a cool and dry climate, with typical prevailing winds and weather patterns moving from west to east. Meteorological data from the Slug Creek Divide SNOTEL station provides the basis for tracking temperature, precipitation, and snowpack at the site (Figure 2). Annual precipitation is typically in the range of 20 to 50 inches per year. The most abundant precipitation occurs in the spring and early summer months. The peak snowpack, measured as Snow-Water Equivalent (SWE) has ranged from 7.8 inches (Water Year [WY] 1992) to 32.1 inches (WY 1982) since WY 1981, and snow cover typically remains on the ground from November to April or May. Summer temperatures in the region normally range from 44 to 82 degrees Fahrenheit, while winter temperatures typically range from 4 to 28 degrees Fahrenheit (Mariah Associates 1980). The Smoky Canyon Ecological Risk Assessment provides a detailed description of the wildlife and plant species found in the area (Formation 2015).

Crow Creek originates on the east side of Meade Peak and flows east before turning north to north-east for the remainder of its distance. Along its path it is joined by many perennial and intermittent streams, including, from south to north: Beaver Dam Creek, Sand Wash, Clear Creek, White Dugaway Creek, Stuart Creek, Wells Canyon Creek, Warm Creek and Books Creek, Deer Creek, Manning Creek, Sage Creek, Rock Creek, and Hardmans hollow. Crow Creek flows across the Idaho-Wyoming border northeast to where it confluences with the Salt River near Afton, WY (Figure 3).

3.2 Geographic Scope of Applicability

The site-specific criterion is to be derived to provide adequate protection for the entire site however the site is defined (EPA 1994). In the general context of site-specific criteria, a “site” may be a state, region, watershed, waterbody, or segment of a waterbody; thus, the geographic scope of the “site” must be defined. For this effort, the Site or geographic scope of applicability includes Crow Creek and Deer Creek and the smaller perennial and intermittent tributaries (Figure 3).

The water bodies considered in the proposal are found within the Salt Subbasin, Hydrologic Unit Code (HUC) 17040105, of the Upper Snake River Basin. IDEQ’s Integrated Report (IDEQ 2024) identifies specific stream segments including the following:

- Crow Creek from source to mouth: ID17040105SK008_02
- Tributaries to: ID17040105SK08_02

Within the Integrated Report, streams are grouped by drainage and hydrologic subunits, and specific stream segments or assessment units that are defined relative to their use attainment status. Crow Creek is classified in the 2024 Integrated report as Category 5[4] and is included on the 303(d) list indicating it is not meeting the designated beneficial use of cold water aquatic life.

3.3 Monitoring

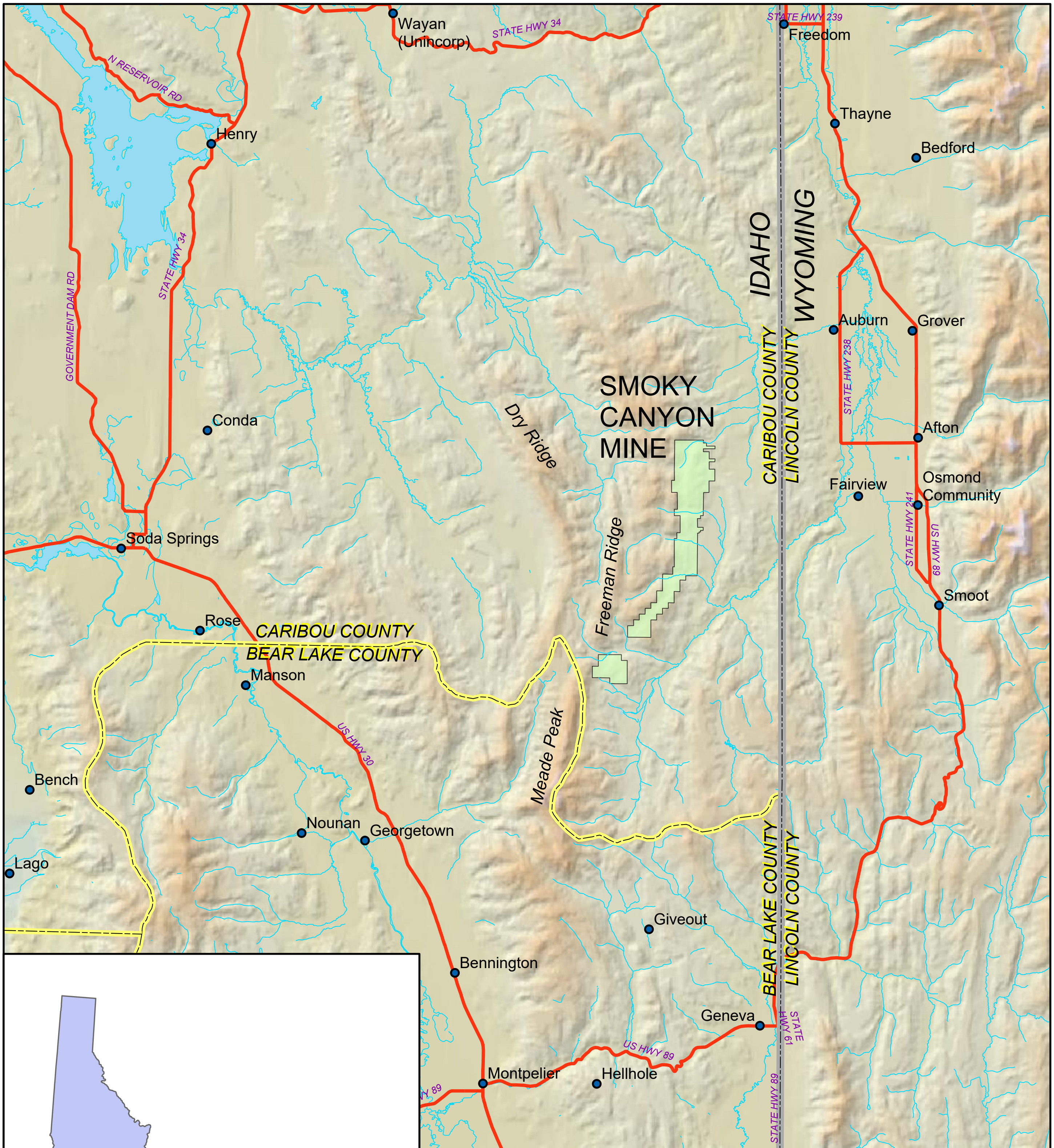
Simplot has monitored selenium in surface water and fish tissue, as well as several other biotic (periphyton, macroinvertebrates) and abiotic (sediment) media, in Crow Creek and its tributaries since 2006. Fish populations and habitat are also monitored. Monitoring has been implemented as a combination of several programs including the following:

- Studies for developing site-specific criteria - 2006 to 2008
- Panels F&G mitigation monitoring (begun in 2009 and extending a minimum of 50 years prior to reevaluation), conducted every 3rd and 6th year
- CERCLA monitoring 2009 and 2010
- Simplot Voluntary monitoring (commenced in 2010 and conducted annually at a suite of locations)

Monitoring conducted under these programs has provided a wealth of data for the drainage and specific streams to assess trends as well as current conditions. Required monitoring is described in detail in the Smoky Canyon Mine Comprehensive Environmental Monitoring Program Plan (CEMPP; Simplot 2023). Voluntary monitoring has followed the protocols initially laid out for the site-specific studies that were reviewed by a multi-agency group that collaborated on their development.

[4] Waters do not meet applicable water quality standards for one or more beneficial uses due to one or more pollutants; therefore, an EPA-approved TMDL is needed. Category 5 water bodies make up the § 303(d) list.

In addition to the extensive monitoring conducted by Simplot, IDEQ's Beneficial Use Reconnaissance Program (BURP) has monitoring locations sporadically throughout the watershed dating back to 1996 to assess beneficial designated use attainment. Reports for these assessments can be viewed on Idaho's Integrated Report Interactive map found at https://mapcase.deq.idaho.gov/wq2024.



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0 3 6

Miles

SIMPLOT COMPANY

SMOKY CANYON MINE

FIGURE 1

LOCATION OF THE SMOKY CANYON MINE

DATE: JANUARY 2026

By: WSB For: SMC

FORMATION ENVIRONMENTAL

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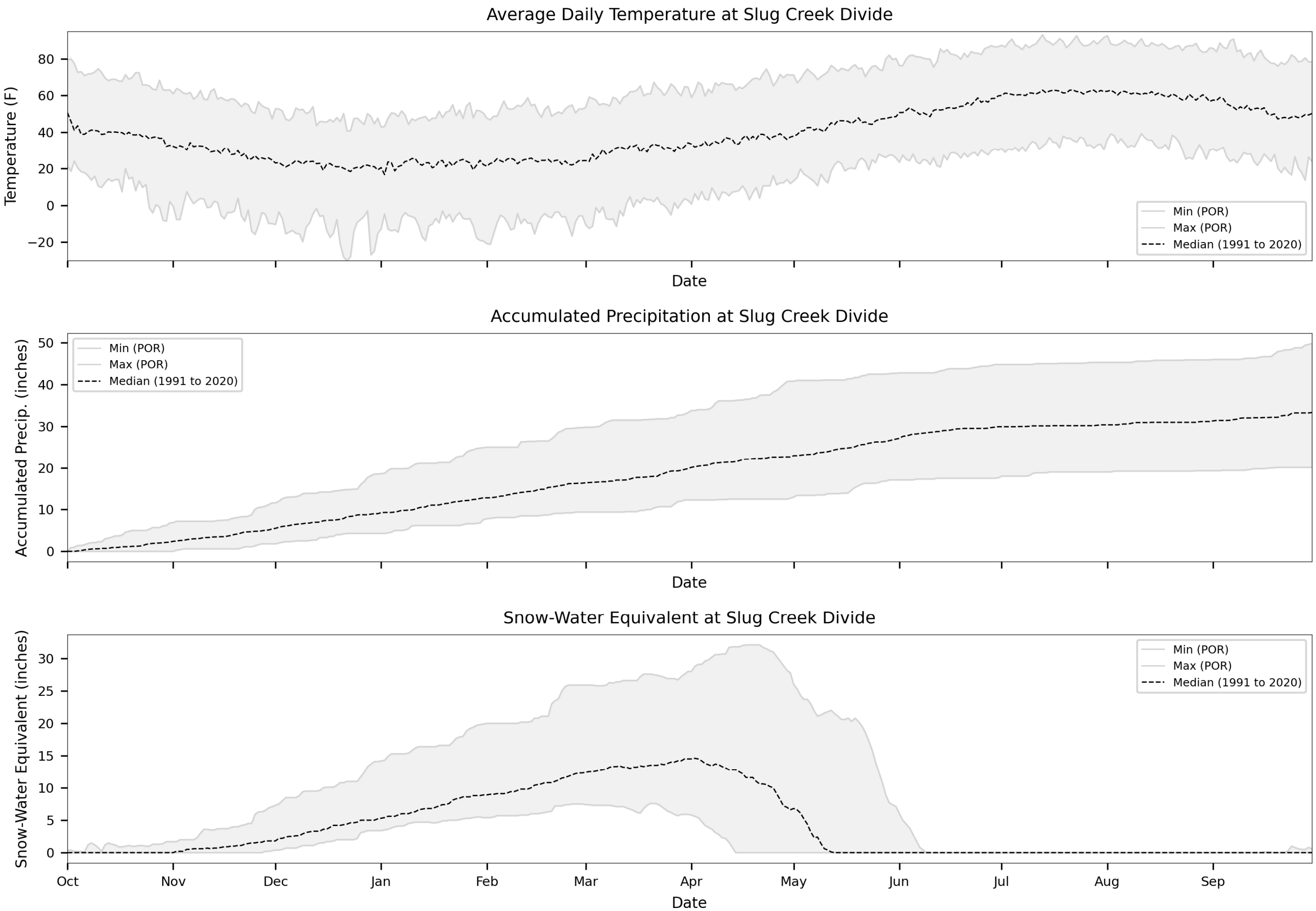

Notes:

1. Precipitation, SWE, and Temperature data from Slug Creek Divide Snowpack Telemetry (SNOTEL) station.
2. Minimum and Maximum data determined from station Period of Record.
3. 30-year Median data determined from 1991 to 2020.
4. POR = Period of Record
5. SWE = Snow-Water Equivalent
6. WY = Water Year

Simplot Company

SMOKY CANYON MINE

FIGURE 2

TEMPERATURE, CUMULATIVE PRECIPITATION, AND SWE - SLUG CREEK DIVIDE SNOTEL

DATE: MAY 2025

BY: WSB

FOR: SMC

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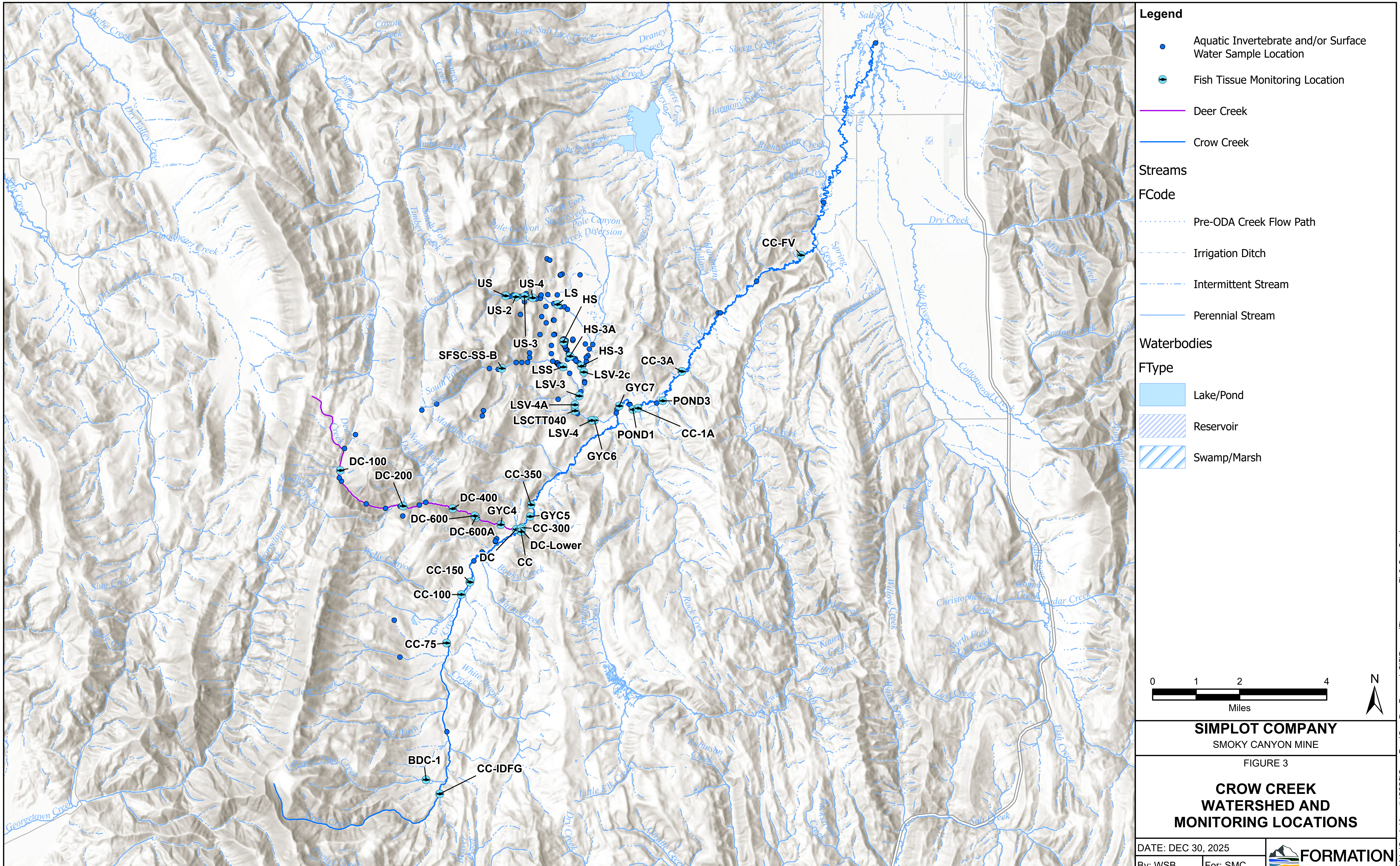

Legend
Aquatic Invertebrate and/or Surface Water Sample Location
Fish Tissue Monitoring Location
Deer Creek
Crow Creek
Streams
FCode
Pre-ODA Creek Flow Path
Irrigation Ditch
Intermittent Stream
Perennial Stream
Waterbodies
FType
Lake/Pond
Reservoir
Swamp/Marsh
0 1 2 4
Miles
N
SIMPLOT COMPANY
SMOKY CANYON MINE
FIGURE 3
CROW CREEK WATERSHED AND MONITORING LOCATIONS
DATE: DEC 30, 2025
By: WSB
For: SMC
FORMATION
US
US-4
US-2
LS
HS
HS-3A
US-3
HS-3
SFSC-SS-B
LSS
LSV-2c
CC-3A
LSV-3
GYC7
POND3
LSV-4A
LSCTT040
LSV-4
POND1
CC-1A
GYC6
CC-FV
DC-100
DC-200
CC-350
DC-400
GYC4
GYC5
DC-600
CC-300
DC-600A
DC-Lower
DC
CC
CC-150
CC-100
CC-75
BDC-1
CC-IDFG
S:\Jobs\Smoky\Aquatic\SSSC\Crow_Deer\CrowDeerProposal_GIS\ProposalFigures.aprx Fig3_CrowCreek

4 Site-Specific Selenium Criteria Elements

EPA (2016; 2021) recommends that states adopt four criteria elements applicable to all waterbodies for selenium, including an egg/ovary tissue element, a whole-body and/or muscle tissue element, and a water element. As discussed in Section 2, there are three separate lotic water, egg/ovary and whole-body tissue criteria applied within the Crow Creek drainage. The standardization of the tissue criteria used throughout the watershed will allow for better consistency of the water criteria elements derived from the site-specific data to translate tissue criteria to water criteria.

4.1 Rationale for Tissue Criteria Elements Change

The standardization of the tissue thresholds used throughout the Crow Creek drainage is well supported given the available site-specific data collected from the drainage over the past two decades. Standardization would eliminate reliance on thresholds for species that are not present in the drainage and would focus the regulation of selenium through SSSC on species that are present throughout the drainage that is supported by over two decades of ongoing monitoring at numerous locations throughout the watershed. The primary rationale for changing the currently applied tissue criteria elements are as follows:

- The species assemblage for Crow Creek is more diverse than that found in Sage Creek or within the other tributaries that have been sampled, however, brown trout are found throughout and are consistently the most sensitive species present.
- The thresholds developed for brown trout egg and whole-body tissues have been approved by EPA and integrated into Idaho state standards for Hoopes Spring and Sage Creek.
- The brown trout tissue threshold developed using trout from the local area and site-specific exposures is directly applicable to the Crow Creek drainage.
- The non-sturgeon water criterion tissue elements are not specific to Crow Creek or its tributaries.
- A tissue criterion based on brown trout data provides a consistent basis of tissue thresholds from which the water criterion elements throughout the drainage can be derived.

Because of the specificity and sensitivity of the brown trout tissue criterion elements, they are the most directly applicable thresholds for use in deriving surface water SSSC in Crow Creek and its tributaries.

4.1.1 Species Assemblage Present

Sampling conducted within the Crow Creek drainage indicates that the species assemblages throughout the watershed are similar. This includes both Crow Creek, Sage Creek, and the tributaries to both. The fish species present at each monitoring location are shown in Table 1.

Brown trout, Yellowstone cutthroat trout (YCT), and Paiute sculpin (*Cottus beldingi*) are present at all the monitoring locations throughout the drainage. The sole exception is the upstream reaches of Deer Creek, where only a single brown trout was captured at DC-600 in 2017 and no brown trout have been captured

Table 1
Fish Species Present During Monitoring from 2006 to 2025

Family/Common Name (Species)	Upper Crow Creek			Deer Creek		Lower Crow Creek		
	CC-75	CC-150	CC-350	DC-600[1]	DC-100	CC-1A	CC-3A	CC-FV
Salmonidae								
Brown Trout *(Salmo trutta)*	√	√	√	√		√	√	√
Yellowstone Cutthroat Trout (*Oncorhynchus clarki bouvieri*)	√	√	√	√	√	√	√	√
Brook Trout (*Salvelinus fontinalis*)						√	√	√
Mountain Whitefish *(Prosopium williamsoni)*		√	√			√	√	√
Cuttbow hybrid trout *(Oncorhynchus clarki bouvieri x Oncorhynchus mykiss)*						√		
Cottidae								
Paiute Sculpin *(Cottus beldingi)*	√	√	√	√		√	√	√
Mottled Sculpin *(Cottus bairdi)*	√	√	√			√	√	√
Cyprinidae								
Longnose Dace *(Rhinichthys cataractae)*		√	√			√	√	√
Speckled Dace (*Rhinichthys osculus*)		√	√			√	√	√
Redside Shiner *(Richardsonius balteatus)*		√	√			√	√	√
Northern Leatherside Chub *(Lepdomeda copei)*			√					
Catostomidae								
Utah Sucker *(Catostomus ardens)*		√	√			√	√	√
Mountain Sucker *(Catostomus platyrhynchus)*			√			√		
# of Species	**4**	**9**	**11**	**3**	**1**	**12**	**10**	**10**

Notes:
[1]Only a single brown trout has been observed in Deer Creek. This occurred at DC-600 in 2017.

upstream of that monitoring location. Brook trout (*Salvelinus fontinalis*) and mountain whitefish (MWF; *Prosopium williamsoni*) are consistently captured in the downstream portions of the drainage, both in Sage Creek and Crow Creek. Eight additional species have been captured throughout the drainage. The presence of brown trout throughout the Crow Creek drainage indicates that using the brown trout tissue thresholds watershed wide is representative and protective of the species present in the drainage.

4.1.2 Species Sensitivity

The prevailing scientific evidence supports the current thinking that effects to developing fish are among the most sensitive aquatic biological indicators of excessive selenium exposure (EPA 2004; Lemly 1996; Ogle and Knight 1996; Skorupa et al. 1996; Janz et al. 2010). EPA (2021) reviewed most of these studies in detail. Appendix A includes additional information about the field and laboratory brown trout and YCT site-specific studies conducted to characterize exposure environments and obtain selenium-toxicity response data that were used to derive the SSSC for Hoopes Spring, Sage Creek, and South Fork Sage Creek, because of their relevance to this SSSC proposal. Relevant effect thresholds determined for tissues and endpoints are provided in the discussion that follows (Table 2 and Table 3) together with studies not included within EPA (2021).

4.1.2.1 Egg/Ovary

Besser et al. (2025) evaluated the response of *C. dilutus* and *H. azteca* to selenium via dietary exposure using endpoints of survival, growth and biomass. Species mean chronic values converted to equivalent whole-body fish tissue concentrations were 18 mg/kg for *H. azteca* and 68 mg/kg for *C. dilutes* ranking 6th and 12th in the distribution of whole-body genera used to derive the whole-body tissue criterion for selenium. The four whole-body fish tissue thresholds used to generate the criterion are lower than the lowest of these two invertebrate species. These data indicate that the fish tissue threshold is protective of invertebrates further supporting the evidence that effects to developing fish are among the most sensitive aquatic biological indicators of excessive selenium exposure.

In the genus *Oncorhynchus*, no observed effect concentrations (NOECs) and 10% Effect Concentrations (EC10) range from >16.04 to 35.1 mg/kg dw (Table 2). Among the larger salmonid order, excluding Oncorhynchus data, NOECs and EC_{10}s in egg tissues range from 20.5 to 56.2 mg/kg dw. YCT data from Hardy (2005; 2010) provided an unbounded NOEC of >16.04 mg/kg dw. The EC_{10} for brown trout range is either 20.5 mg/kg dw (Covington et al., 2018) or 21 mg/kg dw (EPA, 2016; 2021). The rainbow trout EC_{10} was 24.5 mg/kg dw (Holm, 2002; Holm et al., 2003; Holm et al., 2005) while the Westslope cutthroat trout responses ranged from a NOEC of >21 mg/kg dw to an EC_{10} of 27.7 mg/kg dw (Kennedy et al., 2000; Rudolph et al., 2008; Elphick et al., 2009; and Nautilus, 2011). Covington et al. (2025) found an egg/ovary EC_{10} for larval survival of YCT equal to 35.1 mg/kg dw and 35.2 mg/kg dw for abnormalities confirming EPA's (2021) review of these data indicating effects for deformities were greater than 30 mg/kg dw.

Data for brook trout yielded an unbounded NOEC for larval abnormalities of >48.7 mg/kg dw (Holm et al., 2005), while the combined survival datasets of Holm et al., (2005) and Pilgrim (2009) yielded an EC_{10} for brook trout survival of 32 mg/kg dw. At the upper end of the salmonid effects ranges, Mountain whitefish and Dolly Varden char had EC_{10}s of >54 and 56.2 mg/kg dw, respectively. Of the Salmonids found in the

Table 2
Fish Species Sensitivity Data from Adult Reproduction Studies - Egg/Ovary

Species	Scientific Name	Source Study	Adult Exposure	Endpoint	Endpoint Statistic	Selenium (mg/kg dw)	Statistic Derivation Source
Rainbow trout	*Oncorhynchus mykiss*	Holm 2002; Holm et al. 2003; Holm et al. 2005[d]	Field	Larval abnormalities	EC10	24.5	b
Yellowstone cutthroat trout	*Oncorhynchus clarkii bouvieri*	Hardy 2005; Hardy 2010	Lab	Larval abnormalities/ mortality	NOEC	>16.04	b,c
		EPA 2016; 2021	Field	Larval abnormalities	NOEC	>30	b
		Covington et al. 2025	Field	Larval survival	EC10	35.1	a
Westslope Cutthroat trout	*Oncorhynchus lewisi*	Kennedy et al. 2000	Field	Larval abnormalities/ mortality	NOEC	>21	c
		Rudolph et al. 2008	Field	Alevin mortality	EC10	24.7	b
		Nautilus 2011; Elphick et al. 2009	Field	Alevin mortality	EC10	27.7	b
Brown Trout	*Salmo trutta*	Covington et al. 2018	Field	Larval survival	EC10	20.5	a
		USEPA 2016; 2021	Field	Larval survival	EC10	21	b
Brook trout	*Salvelinus fontinalis*	Holm et al. 2005	Field	Larval abnormalities	NOEC	>48.7	b
		Holm et al. 2005 and Pilgrim 2009	Field	Larval survival	EC10	32	e
Dolly Varden char	*Salvelinus malma*	McDonald et al. 2010	Field	Larval abnormalities	EC10	56.2	b
Mountain Whitefish	*Prosopium williamsoni*	Brix et al. 2025	Field	Larval abnormalities	EC10	>54	a
Northern pike	*Esox lucius*	Muscatello et al. 2006	Field	Larval abnormalities	EC24	34	b
White sucker	*Catostomus commersonii*	de Rosemond et al. 2005	Field	Larval abnormalities	EC13	40.3	b
Slimy sculpin	*Cottus cognatus*	Loe et al. 2014	Lab	Larval abnormalities/ mortality	NOEC	>22	a
Redside shiner	*Richardsonius balteatus*	Golder Associates 2020	Field	Larval abnormalities/ mortality	NOEC	>28	a
Desert Pupfish	*Cyprinodon macularius*	Besser et al. 2012	Lab	Lab	EC10	27	b

a Derived as part of the analyses included in this publication
b USEPA (2016, 2021)
c Deforest et al. (2012)
d EC10 values from combined datasets 2000, 2001, and 2002 for skeletal deformities as reported in USEPA (2021)
e Larval survival EC10 derived from the reported survival data in Holm et al. (2005) and Pilgrim (2009).
NOEC - no observed effect concentration

Crow Creek drainage for which reproductive toxicity thresholds are available, brown trout is the most sensitive species, well below the threshold defined for YCT.

Other cold-water species, including white sucker and northern pike have species effects thresholds (13% Effect Concentration [EC_{13}] to 24% Effect Concentration [EC_{24}]) at the upper end of the sensitivity distribution ranging from 34 to 40.3 mg/kg dw egg selenium (Table 2).

Golder and Nautilus Environmental examined the effects of dietary selenium on the reproductive capabilities of slimy sculpin (*Cottus cognatus*) (Lo et al. 2014) and found a NOEC egg tissue concentration of 22.0 mg/kg dw selenium, indicating that the effect threshold was greater than 22 mg/kg dw. Among the minnow species, two studies were found evaluating reproductive toxicity including one for desert pupfish and the other for redside shiners. The desert pupfish study conducted by Besser et al. (2012) yielded a larval survival EC_{10} of 27 mg/kg dw egg selenium. Although desert pupfish are not a cold-water species, the study provides representative reproductive toxicity data for the Cyprinid family. De Bruyn et al. (2023) found no effects to survival, growth or abnormalities in redside shiners up to 28 mg/kg egg selenium yielding an unbounded NOEC of >28 mg/kg.

Figure 4 organizes these data into a species sensitivity distribution (SSD) to illustrate the range of species sensitivities of a hypothetical cold water fish community comprised of secondary and tertiary consumers. Species sensitivity distributions model the variation in the sensitivity of different species to a stressor by relating them to the proportion of species expected to be affected at prescribed concentrations (Neter et al 1990; Posthuma et al. 2002, and EPA 2005). Clearly, many of these species are not found in the Crow Creek drainage and at least one is not a cold-water species (desert pupfish). But this range of fish species and families and their respective sensitivity allow for a visualization of the range of selenium sensitivity across a wide range of fish taxa. Brown trout is the most sensitive species based on its egg EC_{10} threshold. It represents a significantly lower proportion of species potentially affected indicating the brown trout EC_{10} is sufficiently low to be protective of other less sensitive species.

4.1.2.2 Whole-body

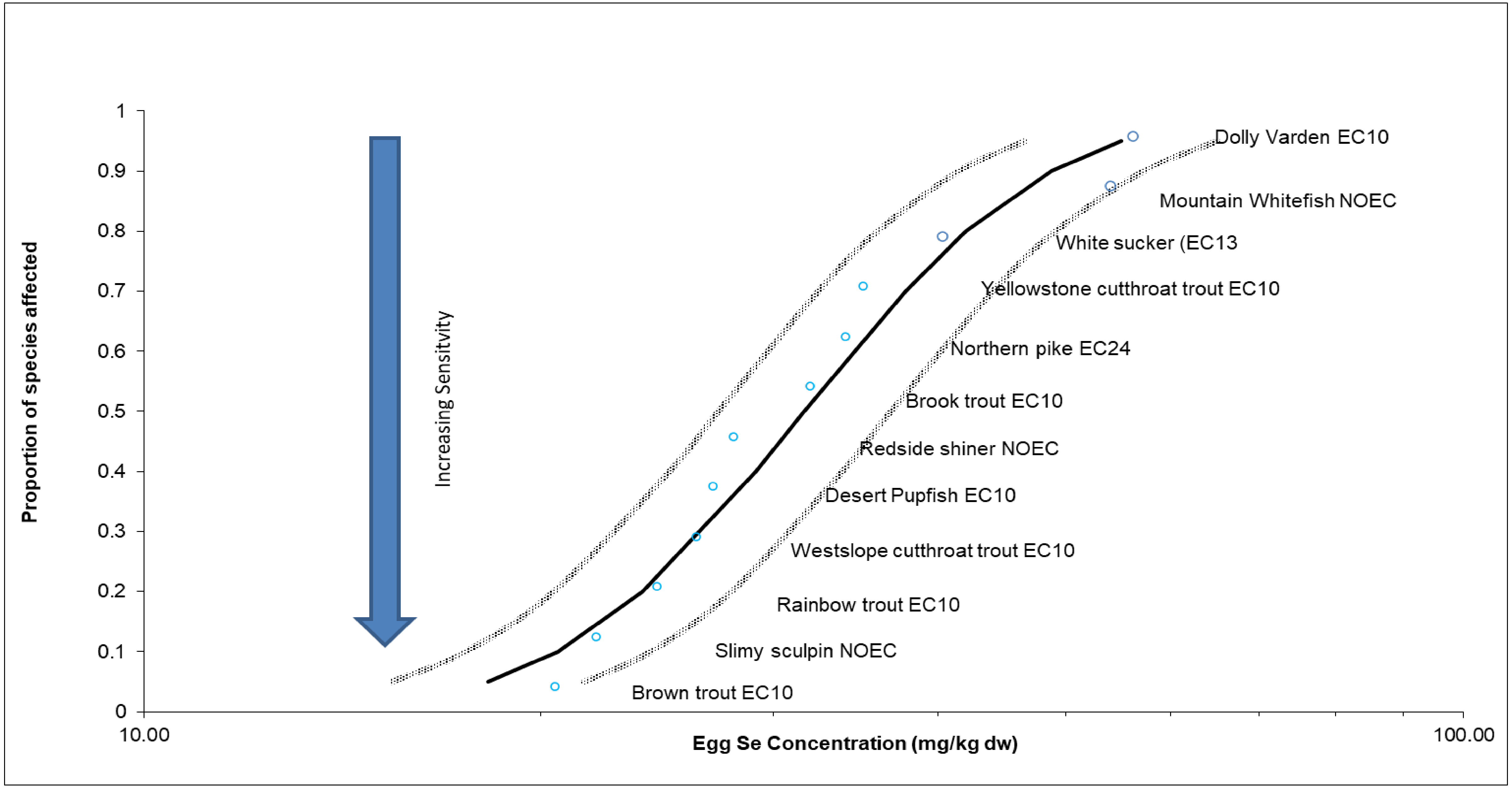
Despite the inherent cause and effect relationship of egg/ovary selenium concentrations and manifestation of effects in young fish, the current guidance derives effects for different tissues independently, as such this subsection examines the sensitivity of species based on whole-body selenium concentrations. The egg/ovary effects thresholds shown in Table 2 and Figure 4 were converted to whole-body tissue equivalents in Table 3 and the whole-body SSD shown in Figure 5. As noted in Table 3, the CF for brown trout is shown as geometric mean, which is based the information presented in the 2017 proposal adopted by IDEQ and approved by EPA that two defensible whole-body concentrations for brown trout are available from EPA's calculations and Simplot's calculations for CFs. As proposed and adopted, the geometric mean value of the two whole body values (13.2 and 14 mg/kg) was used to arrive at a whole-body tissue concentration of 13.6 mg/kg dw for brown trout.

For most species shown, egg/ovary to whole-body CFs were obtained directly from EPA (2021). Egg to whole-body CFs for *Oncorhynchus* species were different than those used in EPA (2021) based on the current scientific findings that the CFs used for rainbow trout and Westslope cutthroat trout are likely

Table 3
Fish Species Sensitivity Data from Adult Reproduction Studies - Whole-Body

Species	Scientific Name	Source Study	Adult Exposure	Endpoint	Endpoint Statistic	Egg/Ovary Selenium	Whole Body Selenium	Conversion Factor (CF)	CF Source
Rainbow trout	*Oncorhynchus mykiss*	Holm 2002; Holm et al. 2003; Holm et al. 2005	Field	Larval abnormalities	EC10	24.5	17.10	1.43	Proposed Blackfoot
Westslope Cutthroat trout	*Oncorhynchus lewisi*			Geometric mean EC10s	EC10	26.2	18.32	1.43	
		Rudolph et al. 2008	Field	Alevin mortality	EC10	24.7		1.43	
		Nautilus 2011; Elphick et al. 2009	Field	Alevin mortality	EC10	27.7		1.43	
Yellowstone cutthroat trout	*Oncorhynchus clarkii bouvieri*	Covington et al. 2025	Field	Larval survival	EC10	35.1	24.50	1.45	Source study[a]
Brown Trout	*Salmo trutta*	Covington et al. 2018	Field	Larval survival	EC10	20.5	13.60	geometric mean	Source study[a]
Brook trout	*Salvelinus fontinalis*	Holm et al. 2005	Field	Larval abnormalities	NOEC	>48.7	>35.29	1.38	Brook trout[b]
		Holm et al. 2005 and Pilgrim 2009	Field	Larval survival	EC10	32	23.19	1.38	
Dolly Varden char	*Salvelinus malma*	McDonald et al. 2010	Field	Larval abnormalities	EC10	56.2	34.90	1.61	Dolly Varden[b]
Mountain Whitefish	*Prosopium williamsoni*	Brix et al. 2025	Field	Larval abnormalities	EC10	>54	31.58	1.71	Salmonid[b]
Northern pike	*Esox lucius*	Muscatello et al. 2006	Field	Larval abnormalities	EC24	34	<17.2	2.39	Northern Pike[b]
White sucker	*Catostomus commersonii*	de Rosemond et al. 2005	Field	Larval abnormalities	EC13	40.3	29.20	1.38	White sucker[b]
Slimy sculpin	*Cottus cognatus*	Loe et al. 2014	Lab	Larval abnormalities/ mortality	NOEC	>22	>15.2	1.45	Cottus[b]
Redside shiner	*Richardsonius balteatus*	Golder Associates 2020	Field	Larval abnormalities/ mortality	NOEC	>28	>14.36	1.95	Cypinid[b]
Desert Pupfish	*Cyprinodon macularius*	Besser et al. 2012	Lab	Lab	EC10	27	22.60	1.2	Desert pupfish[b]

a Derived as part of the analyses included in this publication
b USEPA (2016, 2021)
NOEC - no observed effect concentration



Notes:
1. SSD = Species Sensitivity Distribution
2. EC10 = 10% Effect Concentration
3. EC13 = 13% Effect Concentration
4. EC24 = 24% Effect Concentration
5. NOEC = No Observed Effect Concentration
6. mg/kg dw = milligrams per kilogram, dry weight

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FIGURE 4

Species Sensitivity Distribution for a Hypothetical Cold Water Fish Community Based on Egg/ovary Selenium Tissue Concentrations

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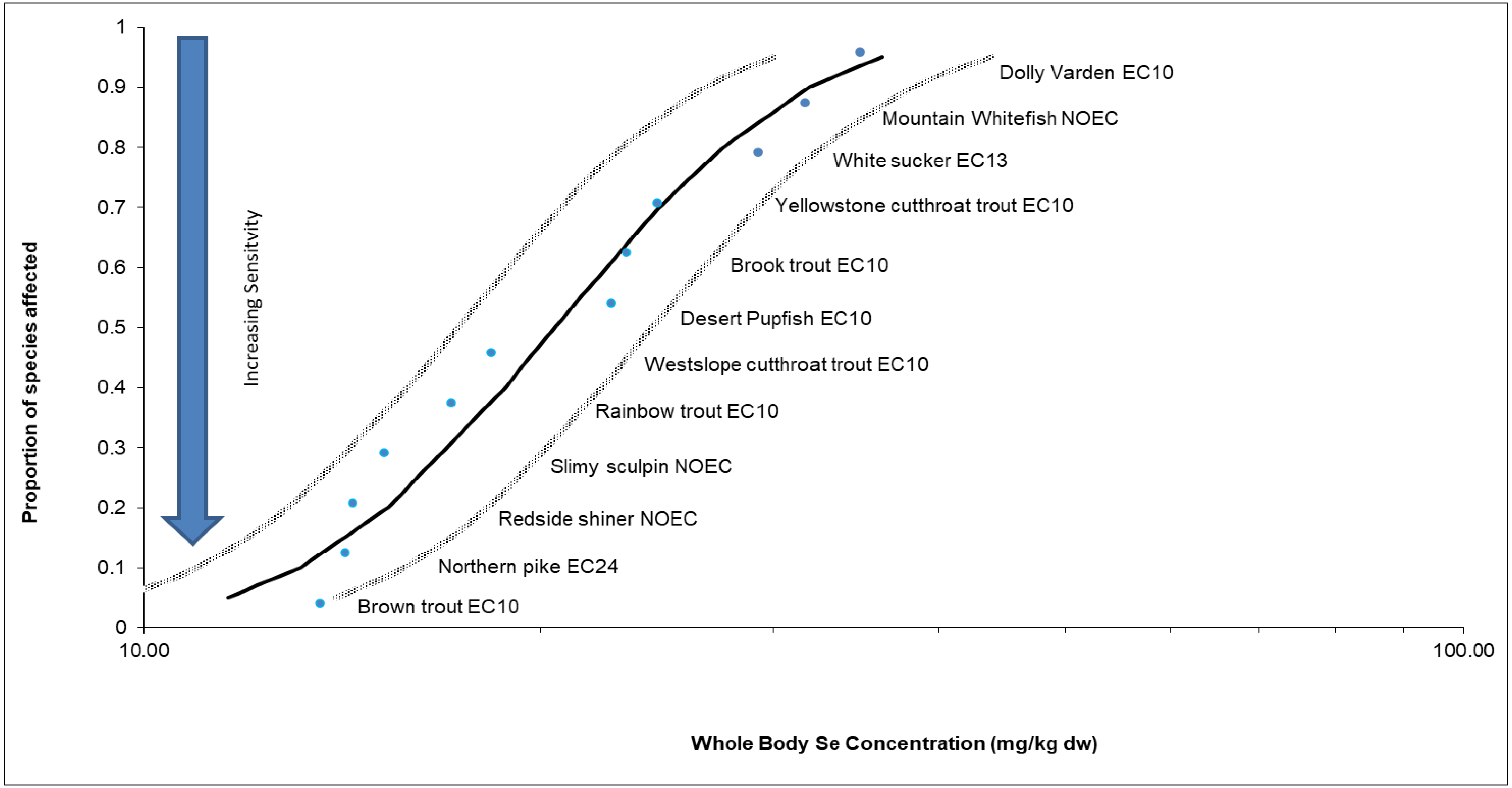

Notes:

1. SSD = Species Sensitivity Distribution
2. EC10 = 10% Effect Concentration
3. EC13 = 13% Effect Concentration
4. EC24 = 24% Effect Concentration
5. NOEC = No Observed Effect Concentration
6. mg/kg dw = milligrams per kilogram, dry weight

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FIGURE 5

Species Sensitivity Distribution for a Hypothetical Cold Water Fish Community Based on Whole-Body Selenium Tissue Concentrations

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lower than 1.96 (Detering et al. 2025). Further the findings in Covington et al. (2025) and Detering et al. (2025) indicate that the YCT conversion factor is also likely lower than the CF value for *Oncorhynchus.*

For mountain whitefish, the CF used in EPA (2021) was 7.39 which is based on an egg/ovary to muscle then muscle to whole-body CF. Brix et al. (2025) provides updated assessments and new data for mountain whitefish effects thresholds. For whole-body, Brix et al. (2025) found the following:

> "The USEPA (2016) previously reported a significant relationship between MWF muscle and ovary (not egg) Se based on data collected from Elk Valley. However, the relationship slope is extremely steep (m = 5.8) compared with most other species (typically slope ~1–2). Data from the current study using egg Se rather than ovary Se suggests the apparent relationship in USEPA (2016) is spurious, as we observed no relationship using a larger data set. Our observations are also supported by a more recent analysis of fish tissue ratios that evaluated a larger ovary data set and similarly found no relationship with muscle Se concentrations (Detering et al., 2025). Among species that have a sufficiently large data set with ovary/egg Se concentrations spanning at least a factor of 5, MWF appear to be unique in lacking a relationship between these two tissues."

Because of this lack of relationship, for the purpose of the whole-body SSD figure, the salmonid CF provided in USEPA (2021) was utilized for mountain whitefish. As shown in Figure 5, brown trout are the most sensitive species of the species assembled for this distribution. The northern pike whole-body threshold is based on an EC_{24} and a corresponding EC_{10} would likely be lower than that observed for brown trout. However, northern pike are not found in these streams nor serve as a surrogate for any species in these streams.

Other trout, sculpin, and minnow species found or potentially found in the Crow Creek drainage are less sensitive than brown trout. Based on a most sensitive species approach, a whole-body brown trout tissue threshold is demonstrably protective of other species present and potentially present.

4.2 Water Criteria

According to EPA guidance (2021), a protective water concentration may be developed from the site-specific egg/ovary, whole-body, or muscle criterion elements. Translation of the fish tissue criterion to a protective water concentration can be performed in a manner that accounts for site-specific conditions. Two approaches for developing a protective water criterion from tissue thresholds are offered as valid approaches. These include: (1) use of a mechanistic modeling approach (Presser and Luoma 2010) to model selenium through the food chain, or (2) use of an empirical BAF approach. Appendix K of EPA (2021) outlines the two approaches and discusses their advantages and disadvantages. Protective water selenium concentrations can be derived using either method because sufficient data are available from the Crow Creek drainage to evaluate the similarity and/or dissimilarity between them. By using a standardized implementation of the brown trout egg and whole-body tissue criteria, a consistent and segment-specific water column element can be derived using empirical data from either approach without conflict of protection for downstream uses.

Due to the simplicity of data inputs required and the large amount of data already available for brown trout whole-body tissues, the empirical BAF approach is proposed as the derivation mechanism for the Crow Creek drainage.

The empirical BAF approach relies on site-specific, field measured BAFs, which are selenium tissue concentrations divided by dissolved selenium concentrations in surface water. The BAF is a direct measure of selenium bioaccumulation into fish, without the trophic steps, and requires no assumption of the dietary intake required under the trophic transfer model. BAFs tend to decrease as water selenium concentration increases, and the range and variability of whole-body concentrations and BAFs are higher at low water selenium concentrations compared to higher water concentrations.

The effects of higher BAFs at low water and diet selenium concentrations in predicting toxic effects in water and diet was documented using field collected data by DeForest et al. (2007) who showed a clear inverse relationship between water and selenium BAFs. This supports the findings by McGreer et al. (2003) who showed a similar relationship under laboratory settings. McGreer et al. (2003) observed that while it is possible to calculate BCFs and BAFs from concentrations expected under natural conditions (i.e. background), these are essentially meaningless when used to evaluate the potential for toxic effects from the metal.

Those results showed two important trends:

1) BAFs tend to decrease as water selenium concentrations increase.

2) The range and variability of whole-body concentrations and BAFs is higher at low water selenium concentrations compared to higher water concentrations.

Overall, these trends indicate that when setting the water column element of the selenium criterion, selection of the BAF used should consider the range of potential water column concentrations in which the criterion is expected to fall. Using BAFs at concentrations where selenium regulation is unnecessary (i.e., background concentrations) will generally result in overprediction of the tissue concentrations. This overprediction at low selenium concentrations was identified by EPA in their criterion document (EPA 2021).

The second trend is important because it affects the ability to identify the effect of water column concentration on whole-body (or other tissue) concentrations. When calculating the water column element of the criterion, the selected BAF must be representative of the water and fish tissue concentrations present to ensure that the criterion is protective without being under or overprotective. Stephan et al. (1985) note that “[c]riteria should attempt to provide a reasonable and adequate amount of protection with only a small possibility of considerable overprotection or under protection.”

Simply using a BAF in conditions where elevated selenium concentrations are not expected will result in a back-calculated water concentration (i.e., criterion) much lower than those that would be similarly protective due to the inverse relationship associated with the lowest exposure concentrations (as shown in Deforest et al. 2007).

5 Proposed Site-Specific Criteria

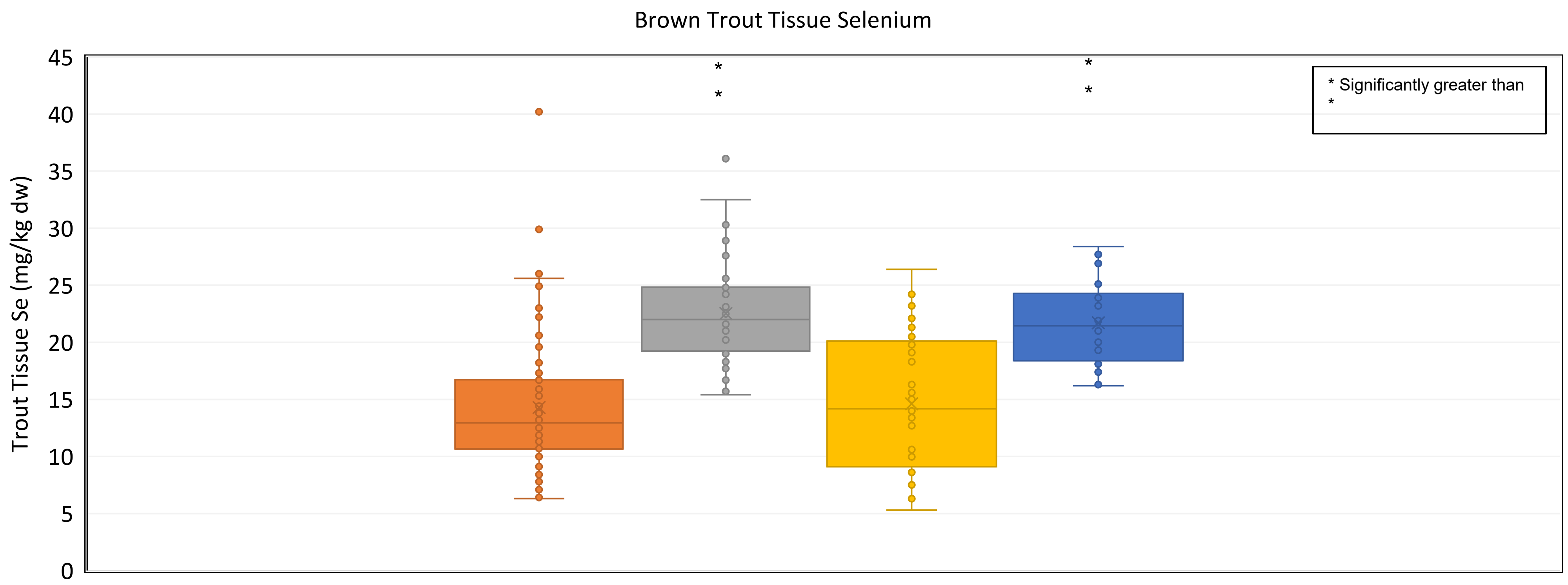
The primary change to existing criteria proposed herein is a unified adoption of the brown trout egg/ovary and whole-body tissue thresholds for the whole of the Crow Creek drainage. This drainage-wide adoption would mean that existing non-site-specific tissue thresholds be replaced with site-specific effects thresholds for brown trout. For the water criteria elements, the process is more complicated since the water elements must be derived from the tissue elements. Proposed water criterion elements for each of the segments of the Crow Creek drainage being considered under this proposal are based on standardized brown trout tissue threshold elements. The following sections present a summary of the proposed site-specific selenium criterion elements for the Crow Creek drainage.

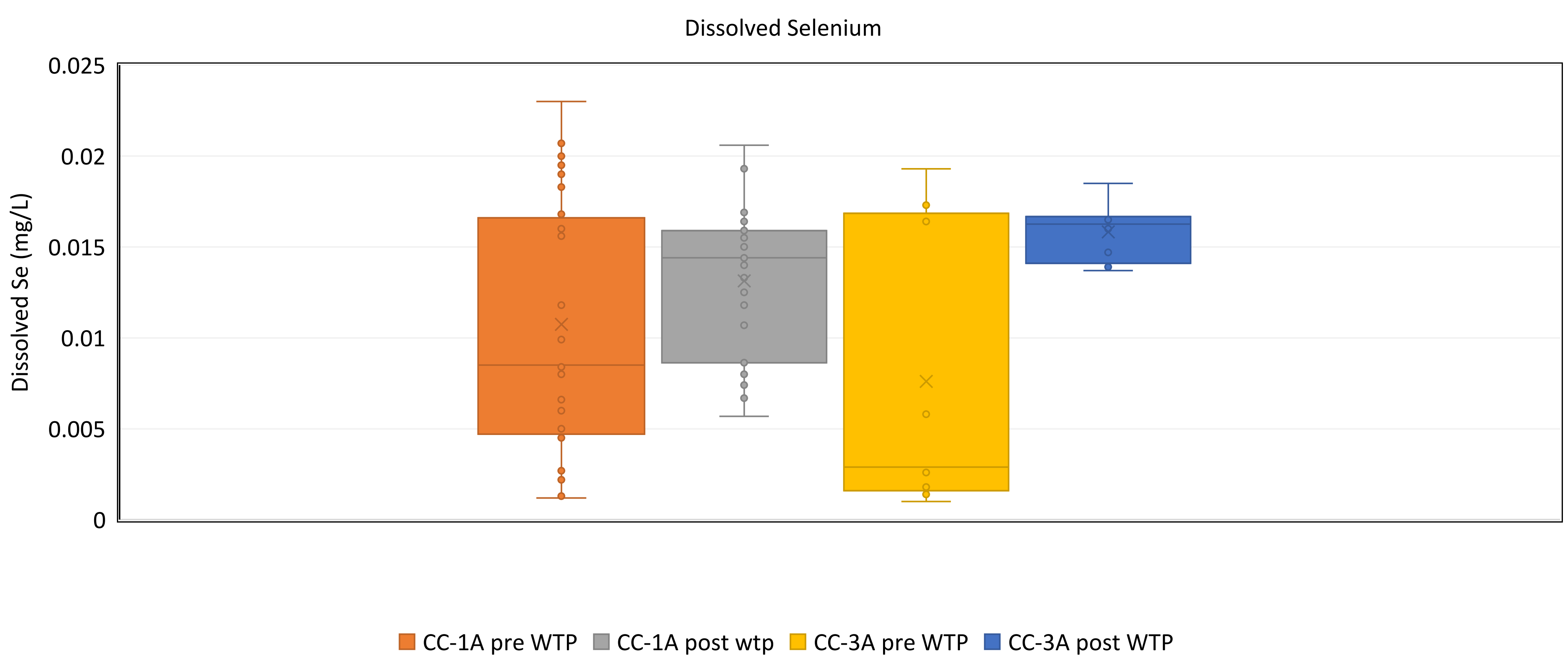
5.1 Crow Creek - Sage Creek to the Wyoming Stateline

In the segment of Crow Creek downstream of its confluence with Sage Creek, the current water quality criterion element was calculated assuming that allowable water concentrations would not exceed 4.2 µg/L as derived from the brown trout 20.5 mg/kg dw egg/ovary selenium effect threshold. The water element value was derived using an empirical BAF from 2006 to 2011 data. No changes are proposed for the current egg/ovary criterion element.

The current whole-body criterion element in this segment, based on rainbow trout (12.5 mg/kg dw), is proposed to be replaced with the brown trout whole-body tissue criterion of 13.6 mg/kg dw. This is a minor change since the brown trout egg/ovary criterion is already applicable as part of the rule for this segment (IDAPA 58.01.02.287). This is appropriate because the brown trout is present throughout the segment and represents the species within the segment that is most sensitive to selenium.

Since the time that the BAFs were developed using data from 2006 to 2011, considerable new data for water and fish tissue selenium concentrations have been collected. In late 2017, a water treatment plant (WTP) for selenium removal began operating at its design capacity of 2,000 gpm, removing selenium from Hoopes Spring water. Surface water selenium and fish tissue concentrations in Crow Creek downstream of Sage Creek have changed from 2008 to present. Figure 6 shows the pre (2006 to 2017) and post WTP (2018 to 2025) years for surface water and brown trout whole-body tissue data indicating a clear increase in both tissue and surface water concentrations. These concentrations would inevitably be much higher if it were not for the effective selenium removal provided by the WTP at Hoopes Spring. However, the treatment plant only treats about 50 percent of the flows from Hoopes Spring, thus treated low-selenium water discharged from the WTP mixes with untreated high selenium water from Hoopes Spring. This mixture of treated and untreated water creates a new selenium dynamic and equilibrium in the system. This new equilibrium of surface water and fish tissue concentrations, after implementation of the WTP treatment process, indicates that a new steady state condition has developed. As shown in the sculpin tissue data for lower Crow Creek locations (Figure 7), whole-body tissue concentrations vary among years since the completion of the WTP. Although concentrations differed among years overall (Kruskal–Wallis $p = 0.0188$), pairwise comparisons did not identify statistically significant differences between individual years (Dunns post-hoc, $p > 0.05$). Sculpin tissue data were used to assess the steady state condition





Notes:
1. mg/L = milligrams per liter
2. mg/kg dw = milligrams per kilogram, dry weight
3. WTP = Water Treatment Plant

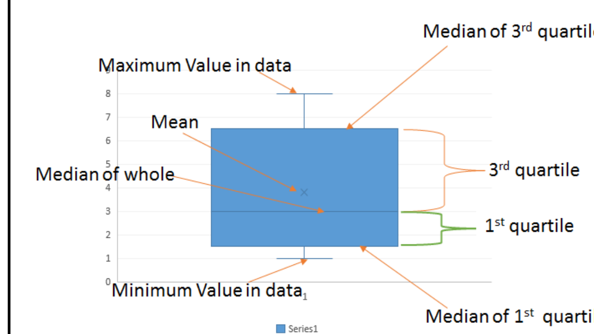


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FIGURE 6

Selenium in Brown Trout Tissue and Surface Water at Two Crow Creek Locations Pre- and Post- Treatment

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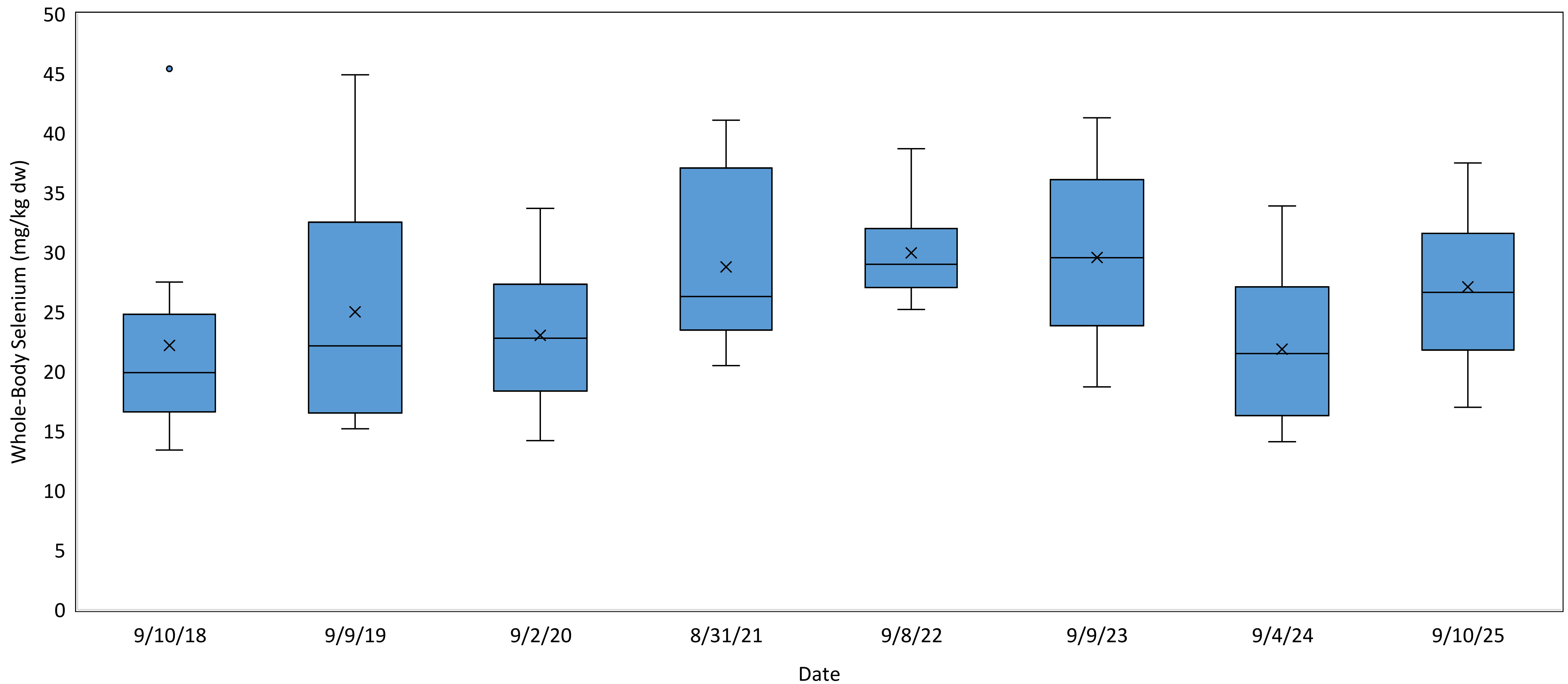

Notes:
1. mg/L = milligrams per liter
2. mg/kg dw = milligrams per kilogram, dry weight
3. WTP = Water Treatment Plant

Kruskal–Wallis Test

H statistic	16.79
p-value	0.0188

Dunn's post-hoc test (Holm-adjusted p-values):

Year	2018	2019	2020	2021	2022	2023	2024	2025
2018	1	1	1	0.826	0.1157	0.4307	1	1
2019	1	1	1	1	1	1	1	1
2020	1	1	1	1	0.4538	1	1	1
2021	0.826	1	1	1	1	1	1	1
2022	0.1157	1	0.4538	1	1	1	0.1598	1
2023	0.4307	1	1	1	1	1	0.5415	1
2024	1	1	1	1	0.1598	0.5415	1	1
2025	1	1	1	1	1	1	1	1

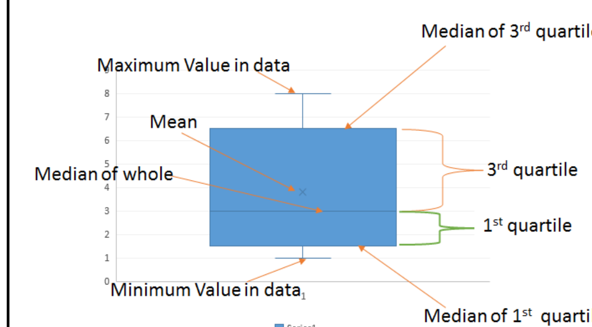

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FIGURE 7

Sculpin Whole-Body Selenium Concentrations 2018 to 2025

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Table 4 shows the surface water and brown trout whole-body tissue concentration data for each year from the two locations on Crow Creek downstream of Sage Creek. Site-specific brown trout whole-body tissue concentrations were converted to whole-body BAFs[5] to use as the divisor into the whole-body criterion (e.g., 13.6 whole body tissue criterion divided by the whole body BAF). This was done for each year, then the average of the complete range of data was used to derive a revised water criterion element of 8.8 µg/L. The change is based on the 2018 to 2025 BAFs that are based on fish tissue whole-body data considered to be at "steady state" based on annual location and time specific sculpin tissue data collected from the same time periods.

Criteria must consider downstream uses and be protective of those uses. In this case, Wyoming water quality standards are the downstream use that must be protected for Crow Creek in Wyoming where the standard is 5 µg/L total selenium. Since the Idaho selenium criterion is tissue-based and Wyoming's selenium criterion is based on older acute- and chronic-based water only values and does not consider tissue concentrations, the higher standard is not unexpected or inappropriate. Currently, Simplot is planning for expansion of the water treatment plant at Hoopes Spring to further reduce selenium concentrations within the surface water as part of the Record of Decision issued by the USFS (2024 USFS). Target goals for this plant are to meet instream water quality in Sage Creek and Crow Creek including Crow Creek at the state line in consideration of the Wyoming standard.

5.2 Crow Creek and Tributaries Upstream of Sage Creek

Upstream of Sage Creek, the Crow Creek watershed is large and includes multiple tributaries. The current selenium water quality criterion for this segment of the Crow Creek drainage is based on the non-sturgeon water criterion developed by the State of Idaho. The currently applicable tissue criterion elements for this segment are those identified by the State of Idaho for non-sturgeon waters. The egg/ovary criterion of 19.1 mg/kg dw and whole-body criterion element of 9.5 mg/kg dw are currently in place. It is proposed that the non-sturgeon tissue criteria elements be replaced with the brown trout criteria for egg/ovary and whole-body. Consistent with the downstream segments of Crow Creek, this is appropriate because the brown trout is present throughout the segment and represents the species most sensitive to selenium.

While there are known strongholds of YCT within Deer Creek, where the YCT is the primary salmonid inhabiting the segment, the brown trout tissue threshold is still applicable given that the published studies and EPA (2021) recognized that brown trout is more sensitive to selenium effects than YCT.

[5] Whole-body tissue data were converted to whole-body BAFs by dividing the average brown trout tissue concentration for a year by the site average surface water concentrations for high and low flows prior to the sampling event.

Table 4. Bioaccumulation Factors and Surface Water Criteria Derived from Brown Trout Whole-Body Tissue Se Concentrations

Station	Year	Surface Water Dissolved Se			Brown Trout Whole-Body Se			BAF_{wb}	SW Element	SW Element
		Avg	Min	Max	Avg	Min	Max			
CC-1A	2018	0.0152	0.0080	0.0207	22.7	16.8	27.6	1493	0.0091	9.1
	2019	0.0123	0.0074	0.0150	23.0	18.7	32.5	1874	0.0073	7.3
	2020	0.0139	0.0057	0.0206	21.4	18.3	24.2	1546	0.0088	8.8
	2021	0.0161	0.0125	0.0193	24.9	21.3	28.9	1547	0.0088	8.8
	2022	0.0119	0.0067	0.0172	30.2	24.9	36.1	2534	0.0054	5.4
	2023	0.0131	0.0086	0.0159		No BRN		--	--	--
	2024	0.0125	0.0069	0.0159	17.1	15.4	21.0	1368	0.0099	9.9
	2025	0.0138	0.0107	0.0155	20.6	17.8	25.2	1488	0.0091	9.1
CC-1A Average								1693	0.0080	8.3
CC-3A	2018	0.0160	0.0080	0.0207	25.7	23.2	28.4	1609	0.0085	8.5
	2019	0.0139	0.0074	0.0150	21.9	17.4	26.9	1577	0.0086	8.6
	2020	0.0185	0.0057	0.0206		No BRN		--	--	--
	2021	0.0166	0.0125	0.0193		No BRN		--	--	--
	2022	0.0167	0.0067	0.0172		No BRN		--	--	--
	2023	0.0137	0.0086	0.0159		No BRN		--	--	--
	2024	0.0151	0.0069	0.0227	17.1	16.2	19.3	1134	0.0120	12.0
	2025	0.0147	0.0107	0.0155	20.9	20.0	23.4	1422	0.0096	9.6
CC-3A Average								1435	0.0095	9.7
Average Crow Creek								**1599**	**0.0088**	**8.8**

Notes:

Only brown trout (BRN) whole-body tissue samples were included in the calculations; No BRN = No brown trout were sampled

BAFwb = Bioaccumulation Factor, whole body tissues

L/kg = liters per kilogram; mg/L = milligrams per liter; ug/L = micrograms per liter; mg/kg dw = milligrams per kilogram, dry weight

Criterion Elements:

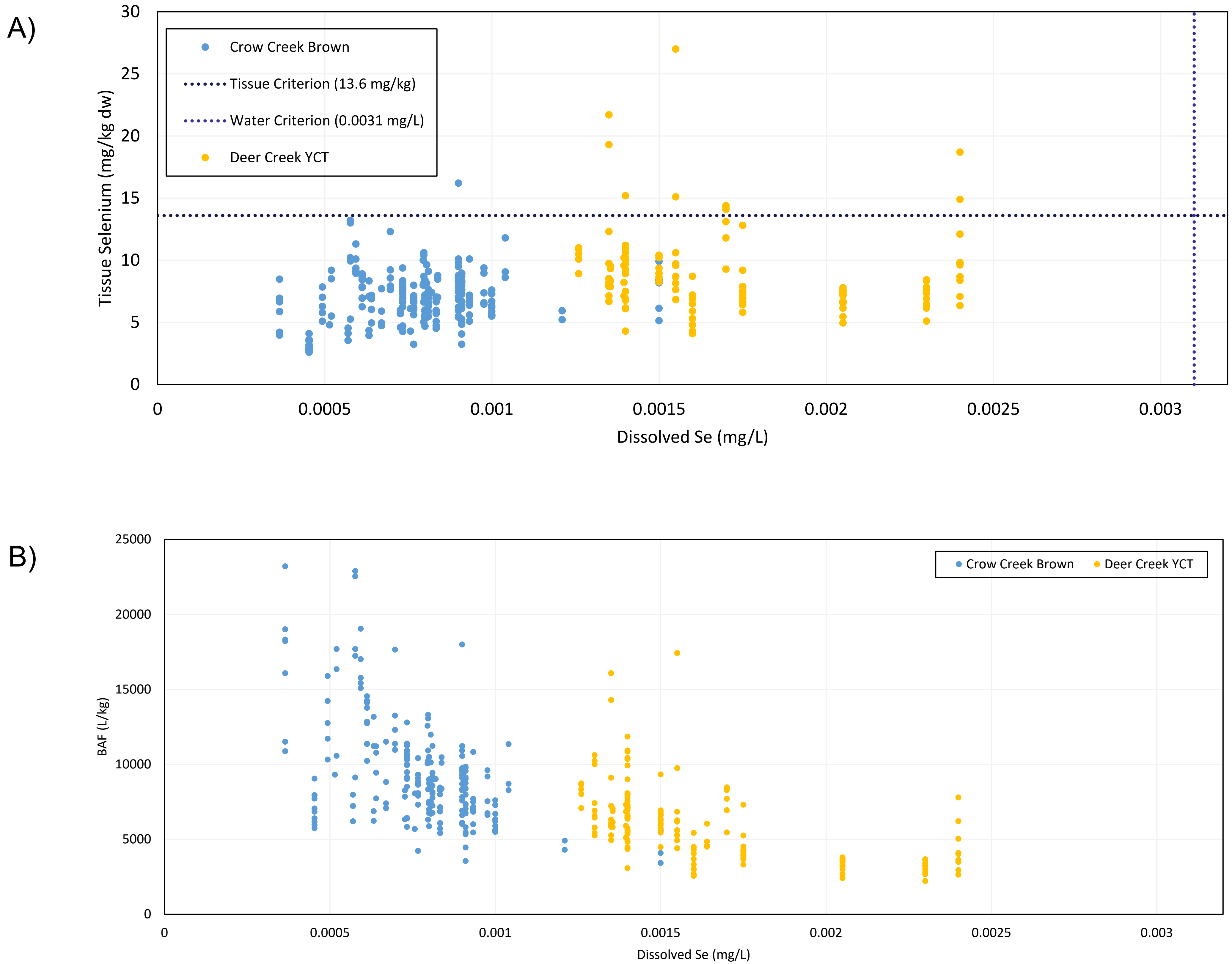
Egg-Ovary (BRN)	20.5 mg/kg dw
Whole-Body (BRN)	13.6 mg/kg dw

No change to the existing water criterion element is proposed because the existing criterion is adequately protective of the upstream Crow Creek drainage as well as the downstream Crow Creek drainage. In Crow Creek downstream of Sage Creek, the variability in whole-body concentrations led to a wide range of BAFs at the lowest water selenium concentrations (<3 µg/L). At higher water concentrations (e.g., above 5 µg/L), the range of BAFs decreased (Crow Creek, Sage Creek, South Fork Sage Creek). In Crow Creek upstream of Sage Creek and in Deer Creek, surface water selenium concentrations have always been less than 3.1 µg/L (Figure 8).

Despite the low selenium concentrations in water, tissue concentrations occasionally exceed the brown trout tissue threshold (Figure 8a) indicating that tissue concentrations can vary widely even at low surface water concentrations. Figure 8b shows the wide range of site-specific BAFs for upper Crow Creek and Deer Creek locations across a relatively narrow range of surface water concentrations, indicating that the conditions discussed in DeForest et al. (2007; Section 4.2) are present in the Crow Creek drainage. At these low concentrations, selenium uptake is active since selenium is an essential trace mineral required for all life and BAFs derived from these surface water and fish tissue data would ultimately be very high resulting in a water criterion element less than the current 3.1 µg/L value.

Since the measured selenium concentrations within the upper reaches of Crow Creek are not indicative of elevated selenium concentrations, the use of BAFs calculated from surface water data collected from that segment of the drainage are not appropriate for calculating a selenium water quality criterion (as discussed in Section 4.2). The default water column criteria element (3.1 ug/L) is recommended even though the brown trout tissue thresholds are applicable.

The tissue criteria elements are proposed to be changed from the existing non-sturgeon-water tissue criteria to the brown trout egg/ovary and whole-body tissue elements. However, no change is proposed for the water criterion element as the existing value of 3.1 µg/L is demonstrated to be protective of existing uses.



Notes:
1. BAF = Bioaccumulation Factor
2. mg/L = milligrams per liter
3. mg/kg dw = milligrams per kilogram, dry weight
4. L/kg = liters per kilogram
5. Brown trout (BRN) in Crow Creek were compared to Yellowstone cutthroat trout (YCT) in Deer Creek due to the absence of BRN in Deer Creek. BRN are preferentially sampled when both species are present.

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FIGURE 8

Whole-Body Tissue Concentrations (A) and BAFs (B) vs Dissolved Surface Water Selenium

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6 Crow Creek Drainage Summary

This document provides supporting rationale and scientific justification to update Idaho's egg/ovary and whole-body selenium criteria for Crow Creek and its tributaries to a unified consistent tissue-based criteria. Further, an updated water criterion element is proposed for Lower Crow Creek downstream of Sage Creek. A summary of the proposed site-specific criteria elements is provided below (Table 5).

Table 5. Summary of Proposed Changes to Criteria Elements for the Crow Creek Drainage

Waterbody	Egg/Ovary (mg/kg dw)	Whole-Body (mg/kg dw)	Water (Lotic) (µg/L)
Lower Crow Creek	20.5	13.6	8.8
Hoopes Spring, Sage Creek, and South Fork Sage Creek	20.5	13.6	16.7
Upper Crow Creek and Tributaries	20.5	13.6	3.1

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APPENDIX A - SUMMARY OF TROUT REPRODUCTION STUDIES

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1.0 Site-Specific Studies

To develop the science necessary for the proposed Site-Specific Selenium Criterion (SSSC), the Simplot Company (Simplot) completed a series of field studies that characterized (1) aquatic species, communities, and populations, (2) selenium exposure concentrations in water, sediment, dietary items, and (3) physical quality of the Study Area streams. Laboratory studies were conducted to assess responses of two primary management species to selenium exposure and maternal transfer.

The laboratory studies using brown trout and Yellowstone cutthroat trout (YCT) provided the selenium-toxicity response data necessary to derive the SSSC for Hoopes Spring, Sage Creek, and South Fork Sage Creek. Field monitoring studies provided for characterization of the exposure environment, the condition of the aquatic community, and the physical habitat. While the findings of the field monitoring studies are not used directly in the derivation of the proposed SSSC, they do provide additional support for the criterion.

Simplot conducted three laboratory studies to assess the effects of selenium in trout species present in the Study Area. Two reproduction studies evaluated maternal transfer of selenium and its effects on developing young brown trout and YCT. A third study early life stage (ELS) study evaluated the effects of selenium from aqueous and dietary exposure to developing young YCT that had no maternal selenium transfer. A brief description of the brown trout and YCT maternal transfer studies are provided below because of the importance of these studies in developing an SSSC.

The maternal transfer studies evaluated adult reproduction of wild trout from the Study Area and effects on developing young in a controlled laboratory setting. These studies were conducted independently, with one study using brown trout and the second using YCT. Trout were collected from different locations within the Study Area, covering a range of selenium exposure conditions during respective species spawning times. Eggs from females were fertilized in the field and transported to the laboratory for rearing. Method controls for the study were hatchery-raised fish. The full methods and results of these investigations are reported in the *Technical Support Document* (TSD)*: Proposed Site-Specific Selenium Criterion, Sage and Crow Creeks, Idaho* (Formation 2012) and AECOM (2009 and 2012) and summarized in EPA (2021):

- Final Brown Trout Laboratory Reproduction Studies Conducted in Support of Development of a Site-Specific Selenium Criterion (Formation 2011a).
- Yellowstone Cutthroat Trout Adult Laboratory Reproduction Studies for Developing a Site-Specific Criterion (Formation 2011b).

- AECOM - Reproductive Success Study with Brown Trout (Salmo trutta). Data Quality Assurance Report. Final. December 2012.

For both species, the effects of maternal selenium transfer in wild trout were evaluated by collecting eggs from females and milt from adult males from different locations representing a range of selenium exposure. Eggs were fertilized in the field and sent to the laboratory for rearing. Effects analyses evaluated egg selenium concentration versus survival, deformity (abnormalities), and growth endpoints. Data from both studies were submitted to EPA for use in their derivation of the National Criterion (EPA 2021).

While growth was examined, it proved to be an endpoint with minimal relation to egg selenium concentrations. Survival was assessed in both studies for hatch to swim up and hatch to test termination (15 days post swimup) as two phases of each study were implemented. Survival was based on simple counts of live organisms versus the starting number of organisms for each egg batch.

Deformity data were assessed as proportions and developed for dose-response analyses including the following conditions: graduated severity index (GSI) (0) the proportion of fry with no abnormalities (i.e., normal), GSI (0/1) the proportion of fry with GSI scores of zero or one across each of the abnormality categories, and GSI (0/1, ≤1) the proportion of fry with GSI scores of zero or one, with only a single abnormality from one of the four categories. These categories were developed because binary categorization of fry as normal vs. non-normal does not account for baseline levels of abnormalities that occur even at low, background levels of Se exposure when minor abnormalities may exist that do not affect an individual organism's ability to survive or reproduce. When normal fry were considered only those with zero abnormalities, the non-normal rate due to maternal Se exposure is likely overestimated because even at low Se exposure, the abnormality rate is greater than zero.

These studies were published in peer rviewed journalswith the brown trout study being published in Covington et al. (2018) and the YCT data being published in Covington et al. (2025).

1.1 Brown Trout

Simplot's brown trout studies were thoroughly vetted through numerous and rigorous evaluations. Analysis of the brown trout data by Simplot (Formation 2017) and EPA (2016) yielded EC10s for survival of 20.5 and 21.0 milligrams per kilogram dry weight (mg/kg dw) egg/ovary, respectively, using slightly different data sets.[1] Covington et al (2018) published the brown trout study results. The brown trout study utilized over 18,000 fertilized embryos from 12 hatchery maternal parents and 26 wild trout maternal parents. The survival hatch to test termination provided the data set with the best model fit resulting in an EC10 of 20.5 mg/kg dw. Both the GSI (0/1) and (0/1, ≤1) provided reasonable and similar model predictions that indicate the EC10 for deformities is likely between 21.1 and 21.8 mg/kg dw. The predicted

[1] EPA (2021) used the brown trout survival hatch to swim up portion of the data set, while Simplot's reevaluation of the data, using similar methods as EPA but using the survival to test termination portion of the dataset resulted in a slightly lower EC10. Both EPA (2021) and Simplot's reanalysis of the brown trout data utilized EPA's Toxicity Relationship Analysis Program (TRAP) (version 1.30a) (EPA 2013).

EC10 for survival was the more conservatice effects threshold and was selected as the primary effects endpoint.

1.2 YCT

Simplot's initial assessment of the effects of selenium exposure on survival and deformities for YCT were concluded to be at some concentration greater than 25 mg/kg dw in eggs. The EPA National Criterion (2021) suggested that the YCT data were highly variable and therefore a clear effect value could not be calculated from these data. EPA (2021) only looked at the data for the survival and deformities endpoints, each independently for the hatch to test end dataset. In their assessment of these data, a no observed effects concentration (NOEC) was suggested based on the individual endpoints up to 30 mg/kg dw in eggs with one treatment or egg batch showing 100 percent mortality at 40 mg/kg dw.

A reassessment of the YCT data was conducted in Covington et al. (2025). Both larval survival and frequency of abnormalities (e.g., deformities) were evaluated from over 17,000 fertilized embryos from either the Henry's Lake Hatchery maternal parent (n= 16) or wild site exposed maternal parents (n = 13). The log-logistic model provided best fit overall for the survival data resulting in a hatch to swim-up EC10 of 35.1 mg/kg dw. The best fit model for abnormalites was a log-logistic model from the hatch to test termination phase (GSI = 0/1) of the study which resulted in an EC10 of 35.24 mg/kg dw. In summary, the best dose-response model for the two endpoints assessed was based on survival (EC10 of 35.1 mg/kg dw). In the abnormality assessment, the importance of accounting for the baseline abnormality rates in control and test populations to avoid bias toward overestimating effect thresholds was uncovered. Use of more biologically relevant and meaningful metrics (i.e., GSI (0/1 or 0/1≤1) allowed for representative dose-response relationships to be developed without overestimating the resulting EC10s derived from the dose-response analyses.

1.3 Summary

These analyses indicate that brown trout and YCT responses to selenium exposure are different yet the survival and deformities/abnormalites endpoints yield very similar effects threhsolds for each respective species. Brown trout are more sensitive in their response to maternally-accumulated selenium and its effects on developing young than are YCT. This finding is consistent with studies that have utilized several different trout species indicating sensitivity differences among similar species (e.g., Hardy 2005, Hardy et al. 2010, Rudolph et al. 2008, Nautilus Environmental 2011, Holm et al. 2005).

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