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SENT VIA EMAIL TO: paula.wilson@deq.idaho.gov

Ms. Paula Wilson
Idaho Department of Environmental Quality
1410 North Hilton
Boise, ID 83706

Dear Ms. Wilson:

The Department of Environmental Quality (Department) has proposed statewide and site-specific selenium criteria for aquatic life. During a negotiated rulemaking meeting on June 13, a number of technical and regulatory issues, besides potential rule language, were discussed. The J.R. Simplot Company (Simplot) has the following comments and recommendations for consideration by the Department on both (a) technical/regulatory and (b) rule language. The technical/regulatory topics include: (1) variability of selenium transfer in the aquatic environment and its implications for the criterion and steady-state conditions; (2) fish-less waters; (3) whole body tissue selenium concentrations relative to fish size. Comments on the proposed rule language include: (1) state-wide waters; (2) site-specific criteria for Sage, Hoopes and Crow Creeks, and (3) non-sturgeon waters.

A. Technical and Regulatory Topics

1. Selenium in the Aquatic Environment

1.a. Selenium Trophic Transfer and Bioaccumulation

As recognized in EPA's criterion document, organisms in aquatic environments accumulate selenium primarily through their diets, and not directly through water. The best science also indicates that selenium toxicity manifests itself in the form of effects to young developing fish primarily through transfer to the eggs. Thus, EPA developed a chronic criterion reflective of the reproductive effects based on selenium concentrations in fish egg-ovary tissues.[1]

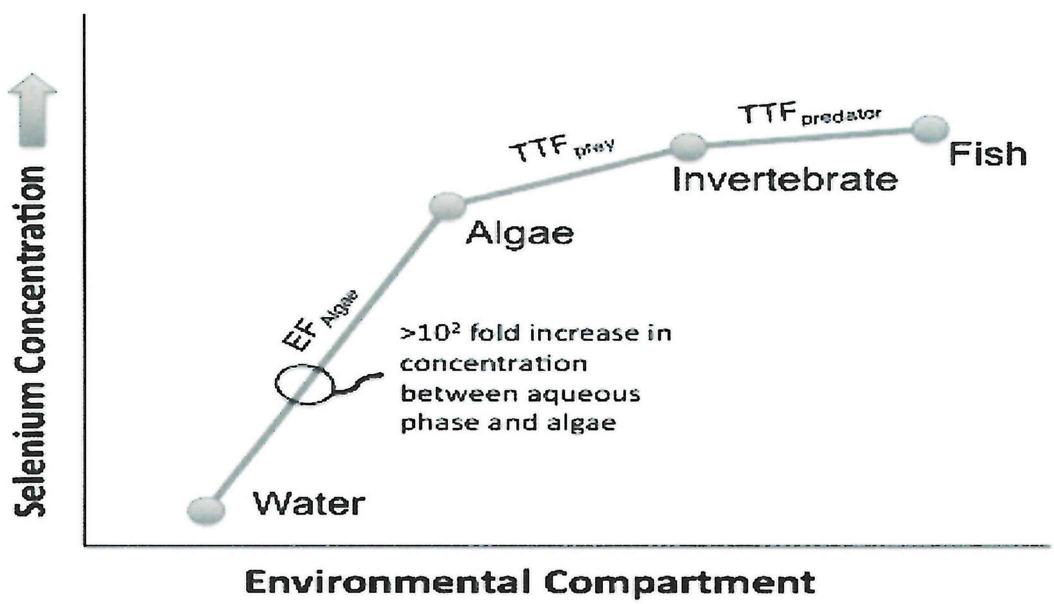
The implementation of a fish egg-ovary tissue criterion does have several challenges: (1) obtaining egg-ovary samples for analysis can be difficult, is seasonal and results in loss of fish; (2) while whole body or muscle tissues can be used as a suitable species specific surrogate, collection of these types of fish tissues may be seasonal and results in loss of fish; (3) implementation of current

[1] EPA. 2016. Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater, 2016"; p. xii.

EFs will typically occur at the lowest selenium concentrations, and lower EFs will typically occur at higher selenium concentrations. There are several other steps in the bioaccumulation process (algae to bugs, bugs to fish, fish to predatory fish) that will add uncertainty to the trophic transfer process and resulting efforts to derive a water column value. Chapman (2010) further elaborates on this:

> "Relating selenium sources to risks to sensitive taxa requires measurement of selenium accumulation at the base of the food web and in key linkages through the food web. The greatest degree of site-to-site variation in bioaccumulation occurs at the base of the food web but can be predicted by empirically derived site-specific enrichment functions (EFs). Uptake by individual species and in steps of the food web can be described by a trophic transfer function (TTF)."

Figure 1
General Trophic Transfer Model [3]



Simulations of the bioaccumulation function were conducted in Chapman et al. (2010) where different algal species were used as the base of the food chain. The authors note that "at similar selenium concentrations in water, outcomes for fish can vary widely, driven by differences in enrichment at the base of the food web and differences in trophic transfer to invertebrates rather than any change in selenium concentrations. A choice of a single, universal water quality guideline for selenium in these situations would under-protect some aquatic environments and over-protect others in term of food web exposures".

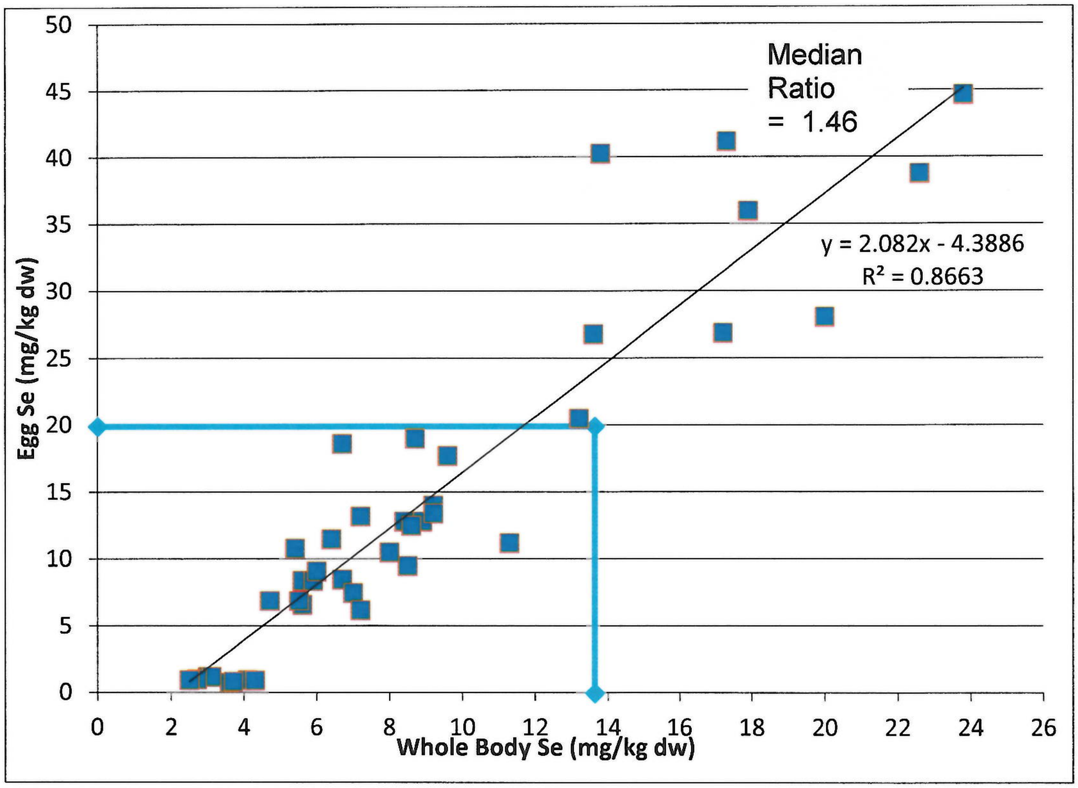
[3] Luoma S.N. and T.S. Presser. 2009. Emerging Opportunities in Management of Selenium Contamination. Environ. Sci. Technol. 43, 8483-8487.

Examination of the trophic transfer dynamics provides evidence why a water column value will likely over or under predict selenium effects in the aquatic environment. As noted before, this first step of accumulation is where the highest bioaccumulation rate occurs and it is also has the highest level of uncertainty due to variations in the accumulation rate. Variability also occurs, but to a lesser extent, for the trophic transfer factors from algae to invertebrate to fish. Clearly, modeling the bioaccumulation process of selenium from its aqueous state into the aquatic food web can be done, but the site-specific nature of this modeling and subsequent derivation of a water column criterion from it does not lend itself to wide scale use. Stephen et al. (1985) notes that "criteria should attempt to provide a reasonable and adequate amount of protection with only a small possibility of considerable overprotection or under protection. It is not enough that a national criterion be the best estimate that can be obtained using available data; it is equally important that a criterion be derived only if adequate appropriate data are available to provide reasonable confidence that it is a good estimate".[4]

While the egg-ovary selenium concentrations provide the best dose-response relationships for exposure effects, whole body fish tissue or muscle tissues can serve as a suitable surrogate for evaluating effects on a species-specific basis as long as appropriate egg/ovary to whole body or muscle tissue conversion factors are available. While these types of data are best if they are developed on a site-specific basis, if they are not they can still be used at other locations on a species-specific basis. Figure 2 shows actual brown trout fish whole body and corresponding egg selenium values. The "curve" for this comparison is relatively linear with an R^2 value of 0.87. The linearity of this curve provides confidence that the conversion of egg-ovary selenium concentrations to a whole body tissue selenium concentration (and vice versa) has a high degree of certainty.

[4] Stephen, C.E., D.I Mount, D.J. Hansen, J.R. Gentile, G.A. Chapman, and W.A. Brungs. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection Of Aquatic Organisms and Their Uses. Office of Research and Development, PB85-227049.

Figure 2
Relationship of Brown Trout Egg and Whole Body Se Concentrations



Thus, from the data collected in the field and the findings from other studies, the following can be concluded:

- Fish egg/ovary data is the best predictor of effects.
- A food web model can be used to predict selenium concentrations, however the confidence in the model output is dependent upon the certainty in the measurement data at each step in the trophic transfer process and the amount of site-specific data. The more site-specific data, the better.
- The relationship of egg/ovary selenium concentrations to whole body fish tissue selenium concentrations is strong particularly when the data are paired (e.g., egg/ovaries from maternal parent whole body fish).
- The greatest amount of uncertainty in the food web model is the bioaccumulation at the base of the food web. Additional trophic transfer steps add to this variation, thus, there is more uncertainty in predicting a water column concentration from the egg/ovary criterion.
- Of the potential criterion elements, (i.e., egg-ovary, whole body or muscle, and water column) the water column criterion is the most uncertain with the highest level of variability.

1.c. Steady-State

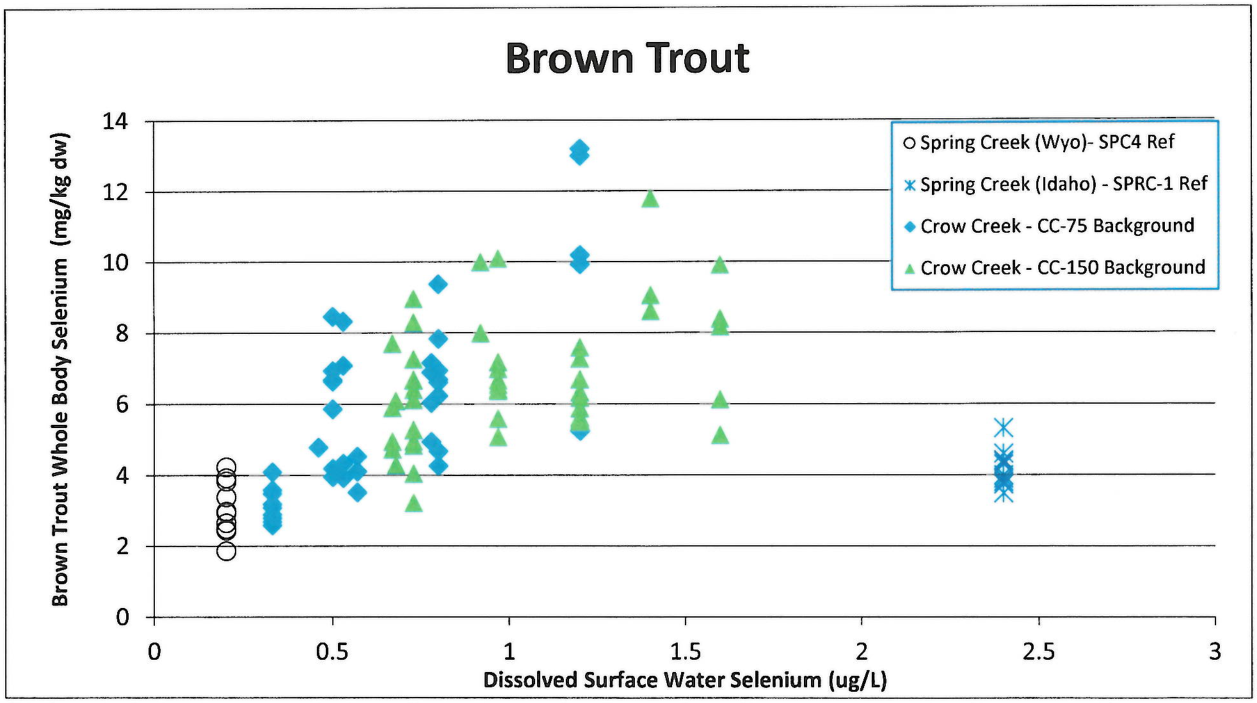
EPA's national criterion (EPA 2016) and Technical Support Document (EPA 2016b)[5] for implementing the fish tissue criterion indicate that for fish tissue measurements to be meaningful, the system from which the sample is taken should not be experiencing recent new inputs of selenium which are defined as new activities resulting in the release of selenium into a lentic or lotic aquatic system. The Department's proposed rule also integrates this concept based on their June 13th presentation.

The concept of steady state has two important considerations: 1) accounting for natural variation (i.e., how is "steady-state" defined for natural, biological systems such as aquatic systems that accumulate selenium); and 2) when there is an increase or decrease of selenium into an aquatic system, how long does it take for the aquatic system to adjust to a new steady state condition?

As Simplot stated in its May 2017 comments, there is no definition of what constitutes steady state conditions. Fish tissue concentrations are variable at a location within a single sampling season as well as between seasons and between locations. Figures 3 and 4 show brown trout and sculpin whole body tissue selenium concentrations relative to dissolved selenium concentrations in surface water at two background and two reference locations collected over different time periods. Note that the whole body concentrations displayed vertically at a given dissolved selenium concentration represent tissues collected during the same time period (i.e., at the same surface water concentration) unless the water concentrations were identical between years.

[5] EPA. 2016b. Draft Technical Support for Adopting and Implementing EPA's 2016 Selenium Criterion in Water Quality Standards. Office of Water, EPA 820-F-16-010, p.4

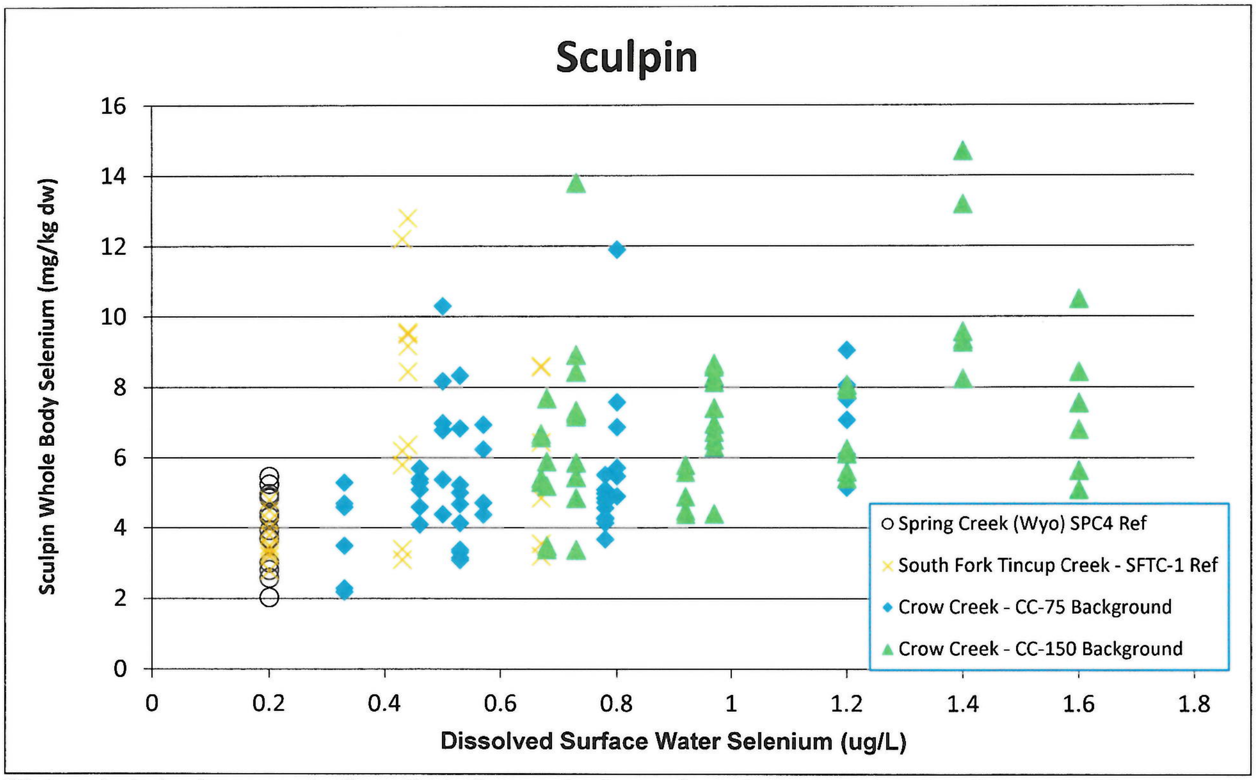
Figure 3
Brown Trout Fish Tissue and Water Concentrations of Selenium
in Background Waters



[Note: whole body concentrations that align vertically are from the same sampling time period.]

Background and reference areas were selected to illustrate the range of potential whole body fish tissue concentrations that occur even when surface water concentrations of selenium, that ultimately bioaccumulate into the food chain, are low. Figure 3 shows a wide range of trout tissue concentrations at the two background locations despite a relatively narrow range of dissolved selenium concentrations in water. Tissue data from the two reference locations are not as variable. Some may argue that the connectivity of some of these locations allows for downstream trout to migrate into upstream areas, thereby contributing to the wide range of selenium concentrations. A plot of the sculpin data (Figure 4) collected from background and reference locations shows a similarly wide variation in sculpin tissue selenium concentrations at the background locations as well as at one of the reference locations. Sculpin have small home ranges and do not migrate, thus they provide a good validation data set for trout observations. Given this demonstrated variability at a location during a single year and between years at a single location, it is clear that a definition of "steady state" could be interpreted very differently depending upon how these data are viewed.

Figure 4
Sculpin Fish Tissue and Water Concentrations of Selenium
<u>in Background Waters</u>



[Note: whole body concentrations that align vertically are from the same sampling time period.]

Changes of selenium (i.e., increases or decreases) in the aquatic environment will affect bioaccumulation and depuration in fish. Hardy (2009) looked at selenium concentrations in fish tissue as a function of diet.[6] Hardy showed that whole-body concentrations increased in proportion to dietary selenium levels but did not continue to increase in the fish fed the highest dietary level after 12 weeks. This observation suggests that continued dietary exposure is required to maintain high concentrations of whole-body selenium and that excretion rates vary depending on whole-body selenium concentration. The higher excretion rate occurs in fish with high tissue selenium concentration. Hardy concluded that:

- "Selenium concentrations in juvenile cutthroat trout exposed to high environmental selenium concentrations in contaminated primary nursery streams are likely to decrease when fish migrate downstream to less contaminated areas and possibly return to near-baseline; and

[6] Hardy R.W., L.L. Oram, and G. Moller. 2009. Effects of Dietary Selenomethionine on Cutthroat Trout (*Oncorhynchus clarki bouvieri*) Growth and Reproductive Performance Over a Life Cycle. Arch Environ Contam Toxicol.

- Depuration in the laboratory might not completely reflect conditions in the natural environment where the bioaccumulation of selenium in plants, sediments and macroinvertebrates will affect the surrounding habitat."

Hardy points out that further research is needed on the kinetics, mechanisms and variables of selenium depuration in cutthroat trout.

These data on bioaccumulation and depuration in trout provide strong evidence, at least for trout that steady state may be short lived based on exposure and unless increased exposure is maintained, fish will depurate selenium and achieve a new equilibrium with their diet.

In our May 2017 comments, we referenced a bioaccumulation factor (BAF) steady state definition provided in USEPA (2000)[7] where it defines the bioaccumulation factor (BAF) at steady state as "representing the ratio (in L/kg tissue) of a concentration of a chemical in tissue to its concentration in the surrounding water in situations where the organism and its food are exposed and the ratio *does not change substantially over time* (i.e., the ratio which reflects bioaccumulation at or near steady-state)".

Simplot recommends the use of a BAF ratio that does not change substantially over time to help define "steady state fish tissues"; an example is upper and lower bounds on the BAF ratio (e.g. confidence limits or some other acceptable statistical upper and lower limit). Site-specific conditions will likely govern the time function and the amount of change that is acceptable.

<u>1d. Implications for the Criterion and Implementation</u>

Based on EPA's criterion document and other research, Simplot recommends the following:

- That the selenium concentration in egg-ovary fish tissue is the appropriate measurement for determining whether or not selenium concentrations in a water body pose potential chronic effects to aquatic life.
- That the selenium criterion be based on an egg/ovary or a whole-body or muscle tissue measurement. The egg/ovary value supersedes any whole-body or muscle tissue value. This recommendation is based on the "bioaccumulation" curve in which there is more confidence in the correlation of tissue concentrations with effects or no effects.
- Water column selenium concentrations should be used only as a monitoring tool that triggers fish tissue monitoring. As described in these comments, the relationship between water column concentration and fish tissue concentrations can be considerably uncertain due to variability in

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[7] USEPA. 2000. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. Technical Support Document, Volume 2: Development of National Bioaccumulation Factors. EPA-822-R-03-030. U.S. Environmental Protection Agency, Office of Water and Office of Science and Technology, Washington, DC.

bioaccumulation at the base on the food web.[8] Because BAFs are the highest and the most variable at the lowest ambient selenium concentrations, this creates a situation in which false positive rates can be very high. As a result, the water concentration can be an unreliable predictor of adverse developmental effects at low water concentrations, and should be used only as a trigger for fish tissue monitoring.

- The concept of requiring steady state fish tissue concentrations is a direct result of a water column element being utilized. Aquatic systems are dynamic, thus if a BAF or other factor/data is used to define steady-state, it needs to account for typical variation as shown in Figures 3 and 4 through guidance for active field monitoring to characterize field conditions and attempt to define a baseline condition.[9]

2. Fish-less Waters

In our May 2017 comments, Simplot recommended that water column values not be used as the criterion for fish-less waters. As described in the May 2017 comments, in Appendix K Section 1.2.1.2 (USEPA 2016a) EPA states that the most sensitive downstream species may be used for modeling to identify the water concentration allowed relative to an egg threshold. Recommendations from Appendix K are consistent with current risk assessment methods in that consideration of exposure to a sensitive species is taken into account.

Simplot recommends that for fish-less waters, exceedance of the threshold water column concentration be the trigger for further analysis to determine if the tissue criterion is exceeded. This would include determining the selenium fish tissue concentration in the nearest downstream location where fish are present and utilization of the Appendix K methods to determine whether or not the criterion is being exceeded in the fish-less water.

3. Selenium Concentration in Whole Body Tissues versus Fish Length

The size of fish monitored for whole body tissue selenium concentrations to assess potential future compliance with a tissue criterion is important, particularly for trout. If the trout are too large, they may be migratory and move sometimes considerable distances. Also, trout greater than about 230 mm tend to be reproductive size fish, and sampling these larger reproductive fish, particularly females, can damage the population by removing spawning sized fish and the hundreds to thousands of eggs they lay each year.

[8] As described in these comments, EPA in its criterion document included a water quality value as a criterion (which could be superseded by fish tissue data). Simplot recommends that DEQ not have a water column criterion value for the reasons stated in these comments, but rather include water column value as a trigger value. As discussed in the EPA Criterion document, the document provides guidance to the States and Tribes and cannot impose legally-binding requirements on EPA, States, Tribes or the regulated community.

[9] If Simplot's recommendations are implemented with respect to using the water column values as threshold trigger values, the steady state fish tissue condition becomes less of an issue, because as a trigger value, additional tissue monitoring would be conducted to assess compliance.

The Idaho Fish Tissue Protocol workgroup convened in 2007 to minimize potential damage to trout populations due to oversampling and to focus on trout that are likely resident to where they were spawned. The general protocol focuses on sampling individual trout <100 mm in length, but allows for larger fish based on the needs of the sampling program or if insufficient numbers of <100 mm fish are present.

Using the dataset compiled for brown trout which included fish length (mm) and whole body selenium concentrations, an assessment of length versus whole body tissue concentrations was conducted. The data set spanned from 2006 to 2011 and focused on Sage Creek, Hoopes Spring, and Crow Creek downstream of Sage Creek (n = 265). Using the Fish Tissue Protocol upper limit of 100 mm, the whole body selenium concentrations between trout less than or equal to 100 mm and those greater than 100 mm were not significantly different (ANOVA, p = 0.9145)[10] (Figure 5).

Figure 5
Whole Body Selenium Content and Body Length

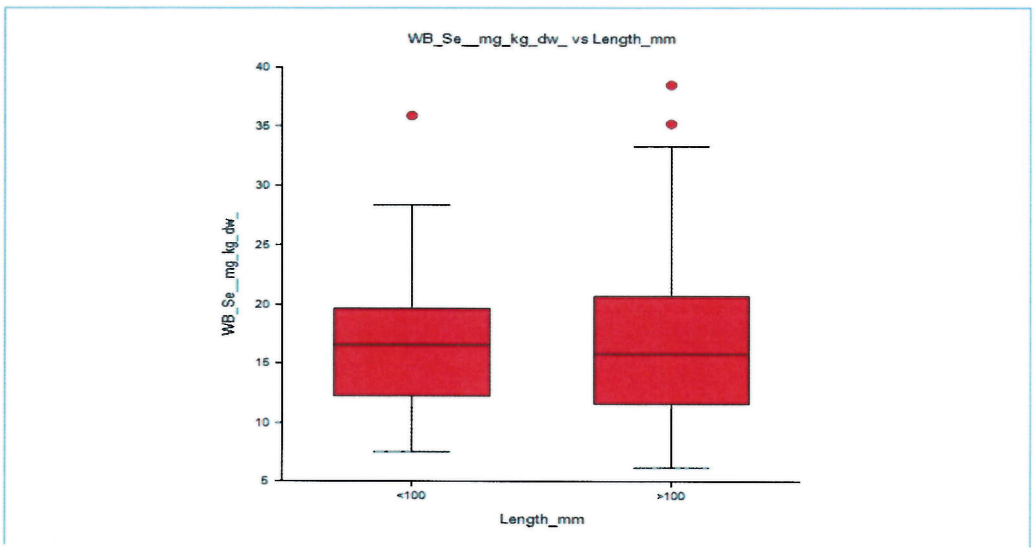

Figure 5

Using Idaho Department of Fish and Game (IDFG) size class distributions for approximate age at lengths, the whole body tissue selenium concentrations at different age-length breaks are significantly different (Kruskal Wallace one way ANOVA on ranks, p = 0.028) (Figure 6). As shown in Figure 6, approximate age 1 fish (<140 mm, n= 193) have slightly higher median tissue concentrations than older fish, but also are the most variable. Age 2 fish (>140 mm<216 mm, n=37) median tissue concentrations are slightly lower than age 1 fish. Age 3 (>216<277mm, n=12), age 4 (>277<333mm, n=16), and

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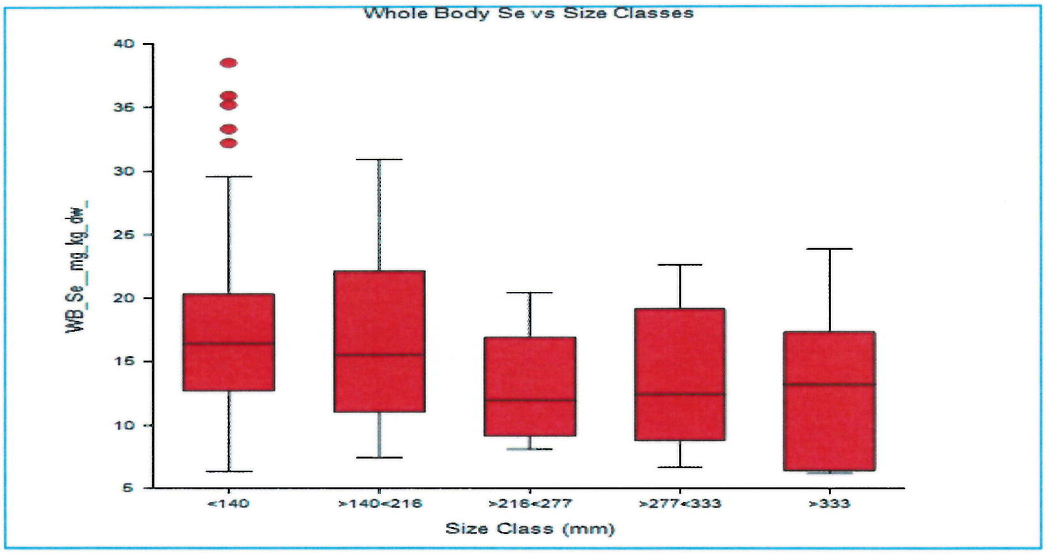
[10] For statistical tests such as this, reporting the actual probability (p) is preferable to simply stating that p >0.05 or <0.05. When p > 0.05 and alpha is set to 0.05, the null hypothesis is accepted and a decision that the means or medians are not different is concluded. When p <0.05, the null hypothesis is rejected, and a decision that the means or medians are different is concluded.

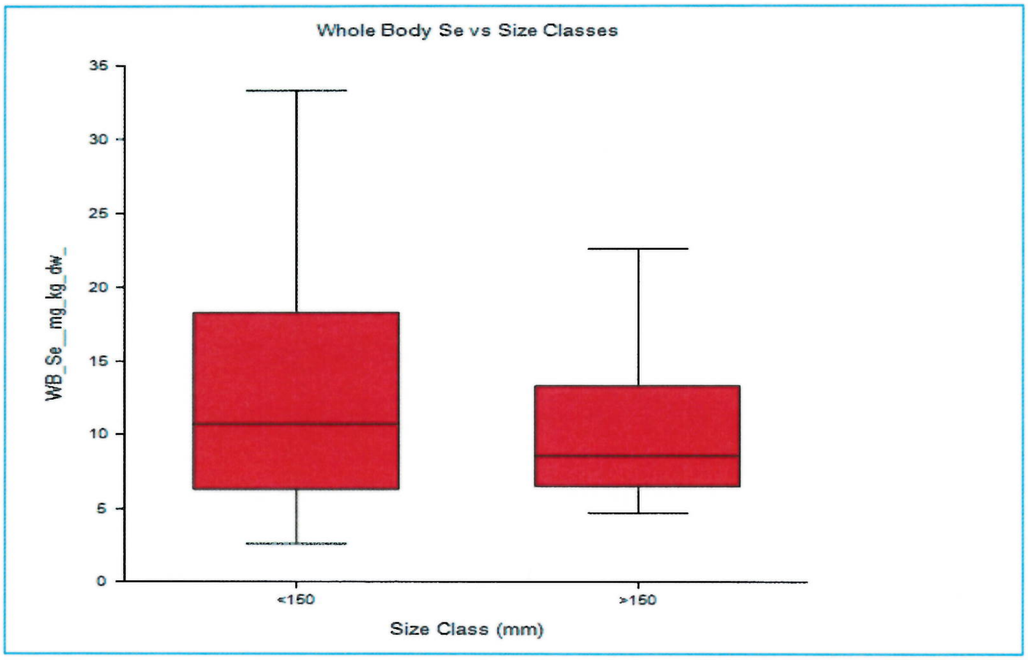
age 4+ (>333mm, n=7) have lower median tissue concentrations than age 1 or 2 fish but are relatively similar to each other.

Figure 6
Whole Body Selenium Concentration and Size Classes



For the 2012 Technical Support Document (Formation 2012), a similar analysis was conducted that examined the juvenile fish (up to 150 mm) collected during the same year (2007) and exposure conditions as those adult fish used for the reproductions studies. No significant difference in whole body tissue concentrations were observed between these adults and juveniles collected during the same time period (Kruskal Wallace one way ANOVA on ranks, $p = 0.192$) (Figure 7).

Figure 7
Whole Body Selenium Concentration and Size Class



Overall, these comparisons demonstrate the wide range of tissue concentrations that occur among fish of the different size classes which can be affected by location collected, the time period collected, and the size class collected. Based simply on a cutoff of <100 mm, fish tissue concentrations are no different, whereas based on age-length size classes across multiple years and several locations, tissue concentrations are different, but by small margins. Within the same year, juvenile and adult fish whole body selenium concentrations are not different. Given the variability observed, the statistical difference and lack of difference shown in Figures 5, 6, and 7 demonstrate that collection of juvenile fish as surrogates for adults for whole body tissue selenium measurement is practical and representative. The small differences observed are likely biologically insignificant.

B. Proposed Rule Language

1. State-Wide Waters

Simplot has the following specific comments on the June 8 draft rule:

> The June 8 draft proposes to use water column concentrations as a criterion. However, the water column criterion must be derived from the initial effect threshold, the egg-ovary criterion. As a criterion, and subsequent standard if adopted by the State, the water column criterion fails to meet sufficient scientific certainty to be a criterion. Simplot recommends that the water column numbers of 1.5 (lentic waters) and 3.1 (lotic waters) instead be threshold values that if exceeded result in fish tissue monitoring.

Footnote number 1 of the proposed rule has been revised to indicate that egg-ovary tissue is based on an average of tissue concentrations from the same species, not a single fish tissue concentration, which is consistent with USEPA's Draft Technical Support Document (USEPA 2016c).

Footnote number 2 from the first draft of the proposed rule has been deleted. Simplot agrees with this change. The Department explained in its presentation that the rationale for deleting this footnote was to make the selenium criterion consistent with all of the State's chronic criterion language. IDAPA 58.01.02.010.15 defines the frequency of chronic criteria exceedance as follows:

> "...Chronic criteria are expected to adequately protect the designated aquatic life use if not exceeded more than once every three (3) years..."

This change in the new draft rule for the chronic criteria exceedance frequency is consistent with EPA's guidance that indicates "not to be exceeded" language is not appropriate for a criterion (Stephan et al. 1985).

The new footnote number 2 establishes the precedence of whole body tissue data superseding water quality data when fish tissue data are available. To be consistent with footnote number 1, the word "Instantaneous" that begins the second sentence should be deleted. This footnote also establishes that fish of the same species and relative size (within the 75% rule) are to be collected for tissue concentration analysis.[11]

For footnote number 3, Simplot recommends the following language:

> Exceedance of water column values requires monitoring of fish tissue to determine whether or not the tissue criterion is exceeded. For fish-less waters, if the water column values are exceeded, then fish from the nearest downstream water will be analyzed for selenium to assess compliance (see EPA 2016, Aquatic Life Ambient Water Quality Criterion of Selenium, Appendix K). Steady state fish tissue concentrations only apply to new inputs from new activities.

2. <u>Section 287: Site-Specific Criteria for Selenium</u>.

Section 287 of the proposed rule is set aside for site-specific criteria. This section appears to be missing important information. As it is currently written, it only includes information about the basis for the water element of the multi part criterion. Simplot recommends the following language to describe the elements of a site-specific criterion.

[11] The 75% rule states that the smallest individual is no less than 75% of the total length (size) of the largest individual.

A site-specific criterion is to be comprised of at least two primary elements: a properly derived fish tissue (egg/ovary) and or whole body or muscle element. A water element may be derived as a monitoring threshold.

3. Section 287.02

Simplot recommends the following changes for section 287.02:

Section 287.02 Subsection of the Salt Subbasin, Sage Creek- source to mouth (unit US-9). The text of the proposed rule provides a complete description of the areas to which the site-specific criteria is to be applied. Given that the site-specific criteria is also applied to a subsection of US-8 (Crow Creek from its confluence with Sage Creek to the Idaho/Wyoming State line), we recommend that the title should be:

> 02. Subsection of the Salt Subbasin, Sage Creek- source to mouth (unit US-9), Crow Creek from Sage Creek confluence to Wyoming State line.

Section 287.02, footnote number 2, second sentence should be revised as follows. All fish tissue should be collected during a single time period.

Section 287.02, footnote number 4, revise the footnote as follows:

> Water column values are based on total selenium concentrations and are derived from the fish egg tissue criterion using the empirical bioaccumulation factor (BAF) approach and a site-specific dissolved to total surface water concentration translator (0.98). The water quality value is not a criterion; exceedance of water column values requires monitoring of fish tissue to determine whether or not the criterion is exceeded.

Section 287.02, footnote number 5, revise the footnote as follows:

> For fish-less waters, if the water column values are exceeded, then fish from the nearest downstream water will be analyzed for selenium to assess compliance (see EPA 2016, Aquatic Life Ambient Water Quality Criterion of Selenium, Appendix K).

4. Section 287.03, non-sturgeon waters.

Simplot agrees with the Department's proposal to include a non-sturgeon waters criteria. The approach has merit given that sturgeon are only found in select drainages statewide. By proposing a non-sturgeon criteria for selenium, the Department is recognizing that many of the State's waterways simply do not contain sturgeon, and therefore, the sturgeon criteria are not particularly applicable where sturgeon are not present. While the geographic scope of the non-sturgeon criteria is large, it does appear to fit within the State's rules for establishing a site-specific criteria as well as the intent of the language provided in Stephen et al. (1985). Based on the Department's presentation on June 13th, 2017 it appears that the non-sturgeon criteria are both applicable and scientifically defensible. Sturgeon are not a surrogate for other sensitive species where they are not present based on the species deletion process described. Further, the use of the 4th field (8 digit) HUCs to expand the watersheds beyond where sturgeon are found and accommodate waters that may flow into sturgeon bearing waters, while conservative, appears to be adequately protective. The resulting chronic criterion elements proposed by the State for non-sturgeon waters appear to also be protective given the species known to be present.

Because the non-sturgeon criteria amounts to a regional site-specific criteria, it seems appropriate that some additional guidance might be helpful on the target species for monitoring based on the tissue type to be monitored. For example, if whole body tissues are to be measured, the most sensitive species are Lepomis (warm water) and Oncorhynchus (cold water). In cold waters, Oncorhynchus may be targeted based on site-fidelity (if known). Conversely, in warm waters, Lepomis may be targeted as a representative species. This additional guidance may be supplemented by directing the reader to USEPA's (2016) Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion.

For the footnotes in 287.03, Simplot recommends the language provided earlier in these comments under our section 2 "State-wide waters". See Comments 1 through 4 above as they apply to the footnotes of the non-sturgeon waters criteria table.

The Department's consideration of these comments is appreciated.

Sincerely,

Alan L. Prouty
Vice President, Sustainability & Regulatory Affairs