UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Blvd., Suite 1100
PORTLAND, OREGON 97232-1274

August 2, 2017

Paula Wilson
Idaho Department of Environmental Quality
1410 North Hilton Drive
Boise, Idaho 83706

Re: Comments Pertaining to the Selenium Aquatic Life Criteria (Water Quality Docket Number 58-0102-1701).

Dear Ms. Wilson:

On July 25, 2017, the Idaho Department of Environmental Quality (IDEQ) presented revised draft rule language regarding selenium (Se) aquatic life criteria. NOAA's National Marine Fisheries Service (NMFS) has reviewed the draft rule language and meeting materials and has a comment regarding the extent to which the site-specific criteria for non-sturgeon waters applies across the state. As discussed below, there appears to be discrepancies between graphical representations of criteria applicability across the state and the rule language.

In addition, questions have been raised during negotiated rulemaking meetings about whether the proposed adoption of the U.S. Environmental Protection Agency (EPA) 2016 National Recommended Aquatic Life Criteria for selenium (hereinafter referred to as "criteria document") would be consistent with the 2014 NMFS Endangered Species Act (ESA) Biological Opinion on EPA's Approval of the State of Idaho's Water Quality Criteria for Toxic Substances (hereinafter referred to as "Opinion") (NMFS # 2000-1484). In response to these questions, we have examined the analyses that supported the jeopardy determination and compared our reasonable and prudent alternative in the Opinion to the 2016 criteria values. The results of this analysis follow our comment below.

Comment Regarding the Draft Rule Language

During the July 25, 2017, negotiated rulemaking meeting, the IDEQ presented a figure (included as Attachment 1 to this letter) depicting where the EPA recommended aquatic life criteria would be applicable in Idaho. The IDEQ proposed to apply the criteria to all subbasins where sturgeon occur as well as to subbasins that support ESA-listed anadromous fish and/or their designated critical habitat. The draft rule language regarding applicable criteria in "non-sturgeon waters"

(IDAPA 58.01.02.287.03) is not consistent with what was depicted in the presentation and shown in Attachment 1. The draft language specifically states, "*All waters of the state except the main stems of the Kootenai, Salmon, and Snake Rivers, as well as 4th field HUCs* [hydrologic unit codes] *flowing directly into the aforementioned rivers."*

This language excludes six subbasins in the Clearwater River drainage and one subbasin in the Salmon River drainage that support ESA-listed anadromous fish and/or designated critical habitat. Those subbasins (names and 4th field HUCs) include the South Fork Clearwater (17060305), Lower North Fork Clearwater (17060308), Middle Fork Clearwater (17060304), Lochsa (17060303), Lower Selway (17060302), Upper Selway (17060301), and Upper Middle Fork Salmon (17060205).

NMFS recommends that the IDEQ alternatively consider specifically listing the subbasins where the "non-sturgeon waters" site-specific criteria apply rather than identifying where the criteria don't apply.

Consistency with the 2014 Opinion

The Opinion and the criteria document share the fundamental approach of estimating unacceptable risk as a function of trophic transfer and dietary exposure, expressed as concentrations of selenium in fish tissue. However, as the Opinion and criteria analyses were done independently, there are differences. In addition, the Opinion and criteria documents assessed water column concentrations that would be protective; however, both recognized that the relationship between selenium concentrations in the water column and fish tissue varies widely among aquatic systems. While the approaches used to estimate protective water column concentrations were both based on ecosystem food web modeling, there are differences requiring evaluation. NMFS has completed its analysis of the fish tissue criteria, which is summarized below. We are continuing to evaluate the draft water column criteria for lotic and lentic systems. This evaluation will require an understanding of how the water column criteria will be implemented in Idaho, which to our knowledge, hasn't been detailed to date.

The criteria document assumed that reproductive failure in fish resulting from maternal exposure and transfer to their eggs was the most sensitive effect likely from elevated concentrations of selenium in freshwater. In contrast, the Opinion assumed that reproductive impairment from maternal exposure was not relevant to freshwater risks to anadromous salmon, because females returning from the ocean to spawn in freshwater likely obtained their Se exposure while feeding and growing in the ocean. The freshwater residency of spawning females was assumed to be brief with minimal feeding. Therefore, the Opinion evaluated potential selenium risks to juvenile salmon and steelhead.

Using these different approaches, the 2014 Opinion estimated that a whole body selenium concentration of 7.6 milligrams per kilograms (mg/kg) (dry weight, [dw]) represented an approximate low risk threshold to salmon and steelhead, and the 2016 criteria document estimated that a whole body selenium concentration of 8.5 mg/kg (dw) represented a suitably safe threshold for fish in general. Both values represent a 10% effect concentration (EC_{10}), with the NMFS value calculated for reduced growth in juvenile salmon and the EPA value calculated for reduced reproductive success. This raises the question: *is the EPA 8.5 mg/kg value similar enough to the NMFS 7.6 mg/kg value to be considered consistent with the Opinion?*

The 7.6 mg/kg value was derived by non-linear regression using one of three statistical distributions supported by EPA's Toxicity Relationship Analysis Program. We reexamined these calculations using all three of the nonlinear distributions supported by the program and obtained EC_{10} estimates of 7.3, 7.6, and 8.9 mg/kg. As there is no compelling reason to consider any one of the statistical models as superior to the others, we consider that any of the three values represent equally plausible EC_{10} estimates for reduced growth associated with whole body selenium in juvenile salmon or steelhead. The 2016 EPA recommended whole body criterion value of 8.5 mg/kg falls between the equally plausible salmon reduced growth EC_{10} values of 7.3 to 8.9 mg/kg; thus, the recommended aquatic life criterion is statistically indistinguishable from the EC_{10} value used in the Opinion. These statistical calculations are shown in more detail in Attachment 2.

Considering the information above, the new information provided in the 2016 EPA criteria document reveals that effects of the prospective adoption of the nationally recommended fish tissue criteria may affect listed species or critical habitat in a similar manner and extent previously considered in our Opinion. Therefore, at this time, additional consultation for the fish tissue criterion does not appear to be warranted. However, additional analysis remains to be completed regarding the water column concentrations.

If you have any questions or would like to discuss the contents of this letter further, please contact Johnna Sandow, Fish Biologist, in the Southern Snake Branch Office, at (208) 378-5737.

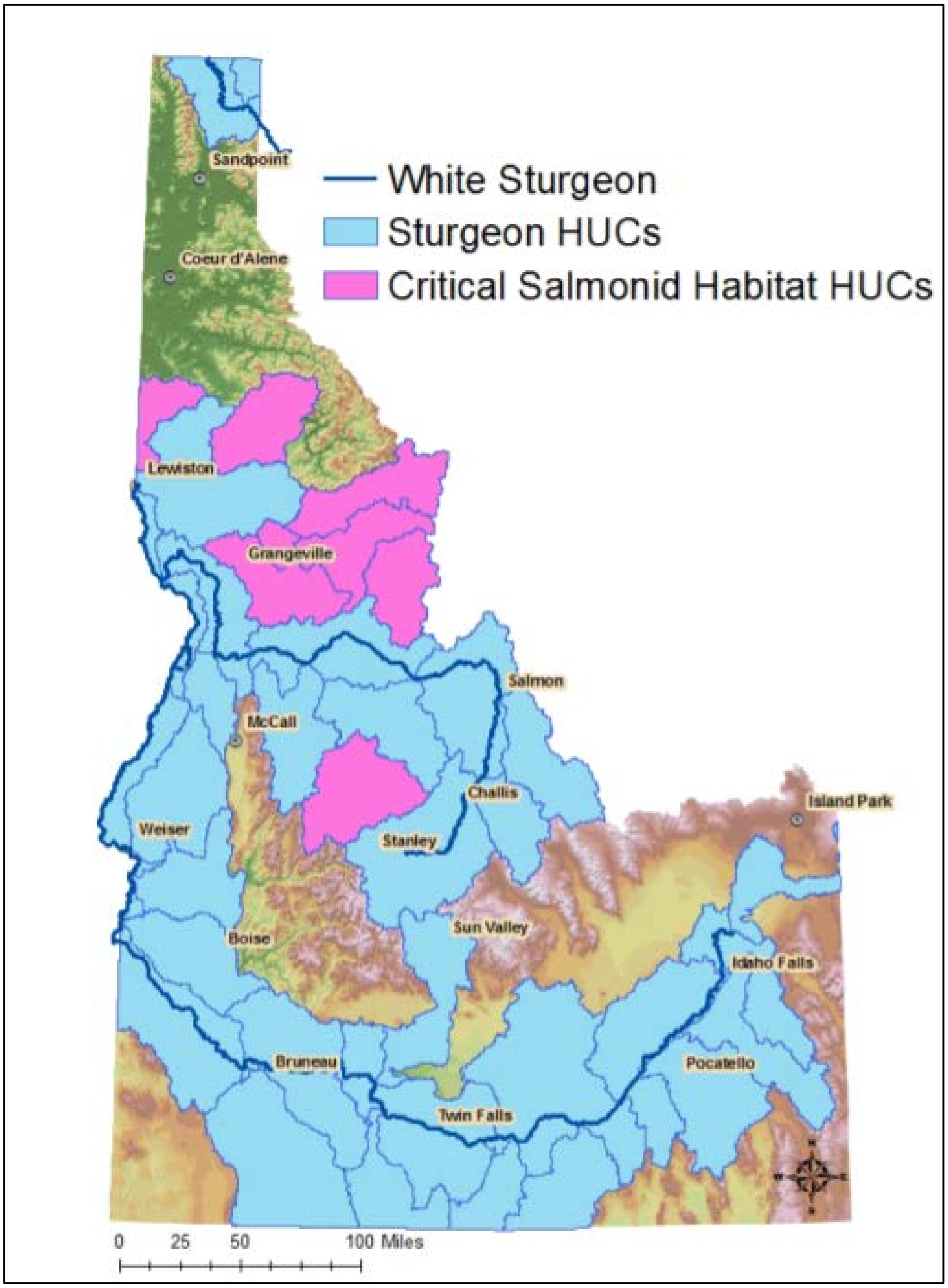
Sincerely,

Michael P. Tehan
Assistant Regional Administrator

Attachments (2)

cc: L. Macchio – EPA
R. Holder – USFWS
S. Fisher – USFWS
S. Jenkins – IDEQ

Attachment 1
Map of HUCs where the draft selenium criteria (footnote r to the criteria table in IDAPA 58.01.02.210.01) will apply in Idaho, as presented by IDEQ on July 25, 2017.



Attachment 2
Reconciliation of the Whole-body Selenium Tissue Thresholds Derived in the NMFS 2014 Biological Opinion and the 2016 EPA Selenium Aquatic Life Criterion
By Chris Mebane, U.S. Geological Survey

Without regard to procedural matters, there is a key question to reconcile between the proposed Idaho adoption of the 2016 U.S. Environmental Protection Agency (EPA) selenium (Se) aquatic life criteria (ALC) and data described in the NOAA's National Marine Fisheries Service's (NMFS) Biological Opinion (hereinafter referred to as "Opinion")(NMFS 2014): *Is the EPA 8.5 mg/kg whole body criteria close enough to the NMFS estimate of 7.6 mg/kg whole body value to be considered consistent with the Opinion?*

Issues Considered for the NMFS Opinion

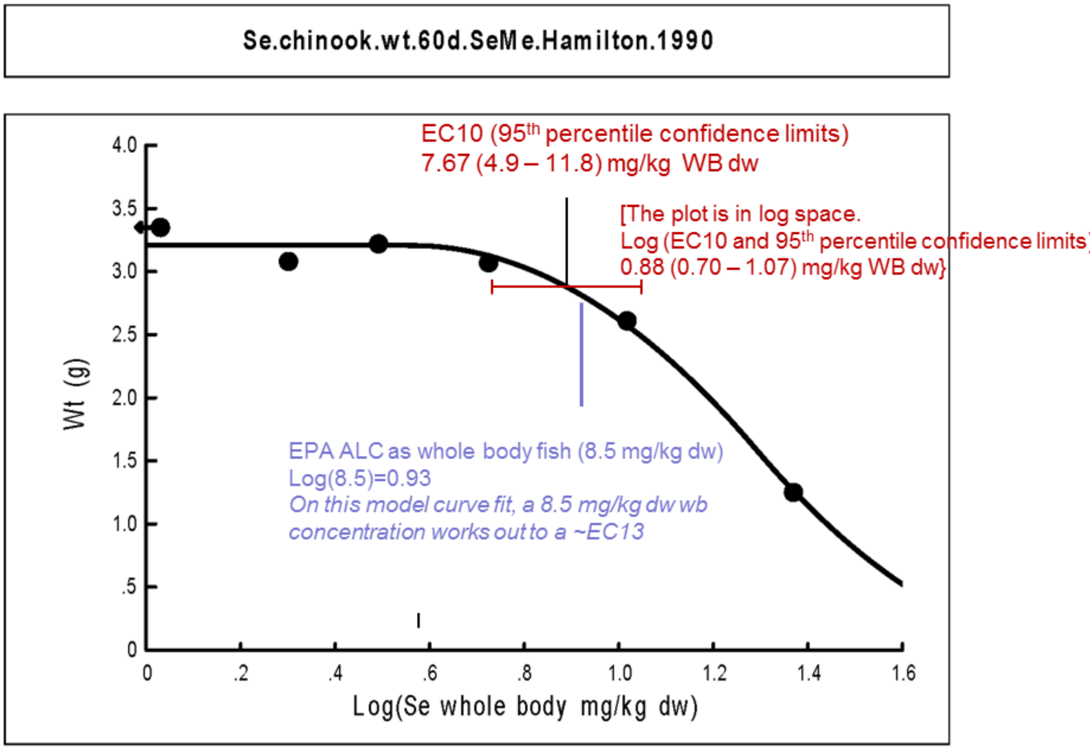
The reasons for differences between the EPA and NMFS "safe" estimates of whole body Se values in fish tissue are twofold. First, the Opinion preceded both the EPA's 2014 draft or 2016 final national aquatic life criteria document (EPA 2016). Second, the 2016 criteria were derived using concentrations causing a 10 percent effect (EC_{10}) for reproductive effects only. The reproductive effects occur as result of maternal exposures. The Opinion ignored reproductive effect values, on the assumption that adult anadromous fish returning from the ocean to freshwater to spawn likely obtained their Se exposure somewhere else, since Se exposures are predominantly from diet and since anadromous salmon tend not to feed much in freshwater during their spawning migrations.

The Opinion focused on potential growth or survival effects from Se to juvenile salmon and steelhead in freshwater. One study was particularly relevant for this question, in which juvenile Chinook salmon were fed pellets spiked with Se in one of two ways (Hamilton et al. 1990). In one dietary exposure method, the "SeMe diet," the feeding pellets were made using a ground up, freeze dried mosquitofish diet from a "clean" reference site, fortified with laboratory grade selenomethionine (SeMe). The second diet was the same, except instead of adding laboratory grade SeMe, fish were collected from an irrigation wastewater drainage ditch called the San Luis Drain (SLD) in the Central Valley of California that had elevated concentrations of at least Se, boron, and strontium (Hamilton et al. 1990). The results of the tests using the mixed SLD diet showed reduced growth in all Se treatments, even at very low doses. This suggested that some contaminants other than Se might present in the SLD wastewater, and the apparent effects might not all be from Se. No farm chemicals such as pesticides were measured. Thus, data quality for the results from the SLD diet experiment were considered unreliable. NMFS focused on the results of the "pure" SeMe test only; the SLD test was considered a site-specific mixture and was not relied upon.

Using the SeMe results, an EC_{10} for growth as weight was considered a low-effects threshold for Se. NMFS calculated an EC_{10} estimate of the 7.6 mg/kg (dry weight [dw]). Like all effect concentration (EC) values, this EC_{10} estimate has uncertainty associated with it. Commonly, the 95^{th} percentile upper and lower confidence intervals are associated with EC values, which can roughly be interpreted as a 95 percent probability that the "true" EC_{10} value lies between these bounds, at least for the particular model choices used. For the EC_{10} value of 7.6 mg/kg, the associated 95^{th} percentile confidence limits were 4.9 to 11.8 mg/kg (Figure 1). Applying EPA's

ALC of 8.5 mg/kg value to that same curve fit, would produce about a 13 percent weight reduction or an EC_{13} value. In other words, the projected effects to Chinook salmon growth reductions associated with the Opinion 7.6 mg/kg value and the EPA 8.5 mg/kg ALC value are similar.

Further, EC values will vary somewhat depending on the mathematical model selected to represent the biological responses. Other decisions such as whether to transform data, and starting conditions for the fits may produce quite different EC values. The 7.6 mg/kg EC_{10} value in the Opinion used a threshold sigmoid regression. EPA (EPA 2016, at p. 142) estimated an EC_{10} value of 7.3 mg/kg from the same data. While details were not provided, that 7.3 (4.6 – 11.8) mg/kg value can be reproduced using nonlinear regression with a logistic equation. Using nonlinear regression with a piecewise linear equation, an EC_{10} of 8.9 (6.8 – 12) mg/kg is produced (Figure 2). The influence of these and other statistical approaches to evaluating effects data were considered in Appendix B of the Opinion. That appendix concluded that while there are no obvious statistical or biological reasons why the logistic, threshold sigmoid, or piecewise nonlinear models provide superior effects estimates to one another, the use of the threshold sigmoid or piecewise regression had the advantage of being able to calculate an EC_0 concentration. An EC_0 is a true no-effects concentration (in a statistical sense), which is easier to interpret in an endangered species context than low adverse effect concentrations such as an EC_{10}. ***As the 2016 EPA ALC whole body value of 8.5 mg/kg, falls between the equally plausible Chinook salmon growth EC_{10} values of 7.3 to 8.9 mg/kg, the ALC is thus statistically indistinguishable from the Opinion EC_{10} value.***



Parameter Summary (Threshold Sigmoid Regression Analysis)

Parameter	Guess	FinalEst	StdError	95%LCL	95%UCL
LogX50	1.3148	1.2871	0.0268	1.2017	1.3725
S	0.6971	1.3758	0.1861	0.7836	1.9679
Y0	3.217	3.207	0.066	2.998	3.416

Effect Concentration Summary

%Effect	Xp Est	95%LCL	95%UCL
50.0	19.369	15.912	23.578
20.0	10.470	7.645	14.340
10.0	7.679	4.992	11.813
5.0	6.167	3.633	10.471

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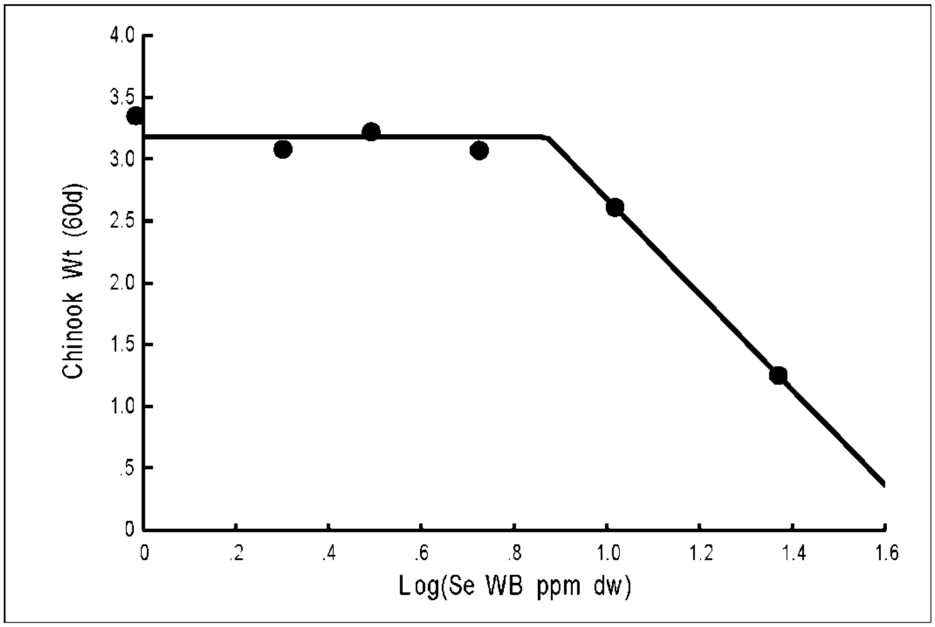
Figure 1. A 10 percent reduction in weight for juvenile Chinook Salmon exposed to dietary was used as a low-effect threshold in the NMFS Opinion. While independently obtained, this estimate is similar to the 8.5 mg/kg 2016 whole-body aquatic life criteria. The Xp is the effect concentration (EC) values for a given % effect. Data from Hamilton et al.'s (1990) 60-day feeding trials with selenomethionine. Overlay lines were drawn by hand and are not exact.

Hamilton.Chinook.SeMe.60d.weight.piecewise



Parameter Summary (Piecewise Linear Regression Analysis)

Parameter	Guess	FinalEst	StdError	95%LCL	95%UCL
LogX50	1.2895	1.2812	0.0284	1.1907	1.3717
S	1.4564	1.2144	0.1691	0.6762	1.7525
Y0	3.180	3.180	0.066	2.969	3.391

Effect Concentration Summary

%Effect	Xp Est	95%LCL	95%UCL
50.0	19.106	15.513	23.532
14.0	9.654	7.183	12.976
10.0	8.949	6.486	12.348
5.0	8.140	5.699	11.626
0.0	7.403	5.000	10.961

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Figure 2. The same data in Figure 1 can be fit equally well using a piecewise regression model, producing a Se EC_{10} of 9 mg/kg whole body dw. The U.S Environmental Protection Agency aquatic life criteria of 8.5 mg/kg falls between the different EC_{10} values for reduced growth in Chinook salmon.

The range of plausible EC values is used as the test of similarity rather than the statistical confidence limits of each estimate. This follows complaints that sometimes little confidence should be placed in statistical confidence limits, as they can be misleadingly narrow or wide in relation to the underlying data, depending on factors such as the distribution of the data, number of samples, and distribution of partial effects. Rather, the credibility of the EC estimates can be judged by how well the effects concentrations correspond to the underlying response data (Mebane 2015). Thus the emphasis on the range of plausible EC_{10} estimates, rather than their statistical confidence limits. We recognize that there are many other nonlinear regression models beyond the three discussed here, but the discussion is limited to these three models because these were the three considered in the original Opinion and are freely accessible via EPA's Toxicity Relationship Analysis Program software.

A section of the EPA 2016 criteria document titled "*6.4.1. Special Consideration for Pacific Salmonid Juveniles*," discusses similar considerations as this memo. It relies in part on the same Chinook study (Hamilton et al. 1990) in calculating effects concentrations based on growth reductions of juvenile salmon in freshwater. Unlike the Opinion which rejected the SLD experiment because of data quality concerns (Se dose was a component mixture of other measured and likely unmeasured contaminants), EPA pooled the results from the "pure" SeMe test and the SLD field-collected diet which contained a mixture of Se and other contaminants. This is an unusual step in criteria documents, as EPA's guidelines for deriving ALC specifically require for rejecting data from mixture exposures (Stephan et al. 1985, p.22). The rationale for including data that would normally not be used in criteria calculations was not given, but by doing so produced a recommended juvenile Chinook salmon EC_{10} estimate (9.1 mg/kg dw) for special consideration for Pacific salmonid juveniles that was greater than the 8.5 mg/kg whole body tissue criterion. EPA calculated the 9.1 mg/kg value as the geometric mean of the pure SeMe diet EC_{10} (7.3 mg/kg) and the mixed contaminants SLD diet EC_{10} (11.1 mg/kg dw). Interestingly, when evaluating and rejecting the SLD mixture test as a line of evidence in the Opinion, NMFS calculated an EC_{10} of 4.6 mg/kg as opposed to the 11.1 mg/kg EC_{10} calculated by EPA (Opinion, p. 174; ALC document, p. 144) (Figure 3). The EC_{10} values are very different because the curve fit performed for the Opinion (Figure 3, Panel A) estimated a 10 percent reduction from close to the control, but the curve fit performed for the ALC (Figure 3, Panel B) effectively ignores the control and estimates a 10 percent reduction from the nearly flat section of the curve. In the Opinion, the responses from this test were considered unreliable; therefore, the study was not relied upon because all responses were lower than the controls, but did not further decline as a function of Se except in the higher treatment. This suggested that the test should be considered compromised as a Se test in that something other than Se was contributing to the effects. However, in the EPA analyses, this test was given equal footing as a companion test using a diet fortified with pure SeMe. These different nonlinear regression solutions and decisions about data validity account for the differences between the Opinion and EPA ALC values to protect juvenile Pacific salmon.

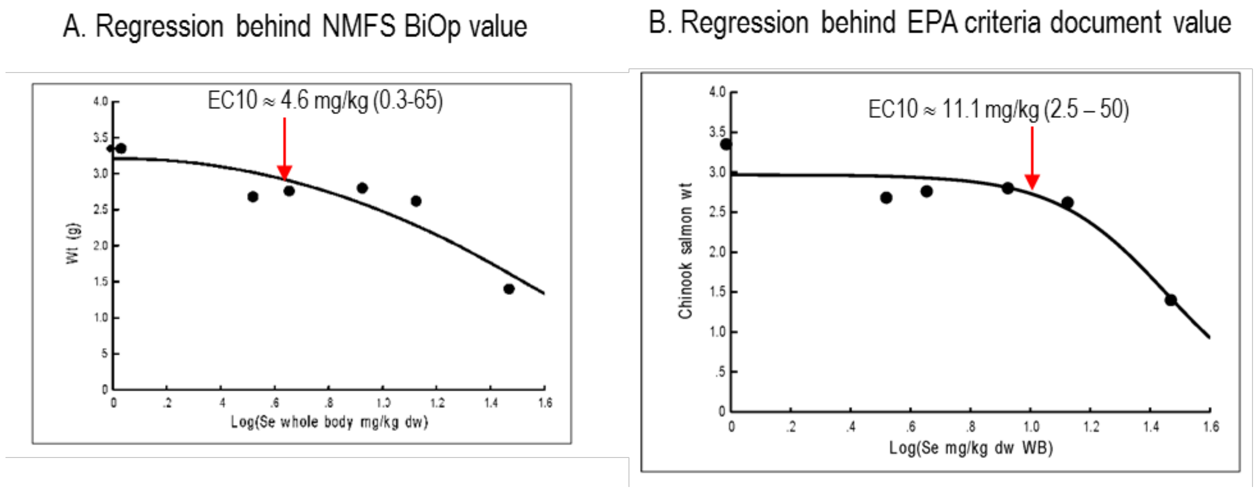

Figure 3. **Logistic regressions of juvenile Chinook salmon growth reductions fed a diet made using ground up mosquitofish collected from the San Luis Drain, California containing elevated boron, molybdenum, and selenium (Hamilton et al. 1990). Although using the same data, the logistic regressions converged to different curves (non-unique solutions) depending on the starting values. In panel (A), the logistic regression solution that produced the 4.6 mg/kg dw EC_{10} mentioned in the Opinion did a reasonably good job fitting the control (lowest, leftmost point), but did not fit the other points well. In panel (B), the logistic regression solution that produced the 11.1 mg/kg dw EC_{10} used in the U.S. Environmental Protection Agency criteria did a poor good job fitting the control (lowest, leftmost point), but fit other points well.**

References

Hamilton, S.J., K.J. Buhl, N.L. Faerber, R.H. Wiedmeyer, and F.A. Bullard. 1990. Toxicity of organic selenium in the diet to chinook salmon. *Environmental Toxicology and Chemistry*. 9(3): 347–358. http://dx.doi.org/10.1002/etc.5620090310

Mebane, C.A. 2015. In response: Biological arguments for selecting effect sizes in ecotoxicological testing. *Environmental Toxicology and Chemistry*. 34(11): 2440–2442. http://dx.doi.org/10.1002/etc.3108

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