Great Horned Owl © Estate of Roger Tory Peterson.

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March 1, 2013

Peter Goodman, Assistant Director
Kentucky Division of Water
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Email: DOWPublicNotice@ky.gov

Dear Mr. Goodman:

Please accept these comments as a supplement to those hand delivered to the legislature and the Division of Water on February 11, 2013 on behalf of Appalachian Mountain Advocates, Sierra Club, Kentuckians for the Commonwealth, Kentucky Waterways Alliance, Appalachian Citizens' Law Center and Appalachian Voices. After spending more time with Kentucky's proposal, we are even more certain that Kentucky's triennial review of water quality standards and revisions to the water quality criteria for the toxic pollutant selenium proposed by the Kentucky Division of Water ("DOW") on February 5, 2013 does not comply with federal law and that it will lead to significant harm to the Commonwealth's waters. The proposed revisions are seriously flawed and should be withdrawn. It is unconscionable that DOW would, either knowingly or carelessly, harm the environment it is charged to protect by weakening its laws to accommodate the coal industry. Tellingly, each of the many errors made by DOW in its proposal is biased in favor of weakening the standard rather than strengthening it.

As part of these comments, we include by reference 19 studies listed at the end of these comments and included our submission.

DOW Failed to Provide for Adequate Public Participation

The Division of Water's revisions to Kentucky's water quality standards are governed by Section 303(c) of the CWA, 33 U.S.C. § 1313(c), and implementing regulations. The "triennial review" process is mandated by Section 303(c)(1), which states that DOW "shall from time to time (but at least once each three year period beginning with October 18, 1972) hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards." EPA's regulation at 40 C.F.R. § 131.20(b) governs public participation in State review and revision of water quality standards, including the hearings required by Section 303(c)(1). That regulation mandates that "[t]he State shall hold a public hearing for the purpose of reviewing water quality standards, in accordance with provisions of State law, EPA's water quality management regulation (40 CFR 130.3(b)(6)) and public participation regulation (40 CFR

Part 25). The proposed water quality standards revision and supporting analyses shall be made available to the public prior to the hearing." EPA's public participation regulation requires that notice of the hearing must be provided at least 45 days prior to the date of the hearing, unless EPA determines that special circumstances warrant a shorter time frame, which circumstances are not present here. 40 C.F.R. § 25.5(b). Furthermore, "[r]eports, documents and data relevant to the discussion at the public hearing shall be available to the public at least 30 days before the hearing. Earlier availability of materials relevant to the hearing will further assist public participation and is encouraged where possible." *Id.*

DOW has not complied with those regulations with respect to its proposed revisions to the selenium criteria. DOW originally proposed changes to Kentucky's water quality standards and published the proposed revision in the Administrative Register of Kentucky on Sept. 1, 2012. The cabinet held a public hearing on Sept. 27, 2012 and received public comment on the proposed standards through Oct. 1, 2012.[1] Those revisions, however, did not include the current proposals to increase the acute criterion by more than twelve times or to replace the current chronic water column criterion with a set of weak tissue-based criteria. The previous public process thus provided no opportunity for input on the proposed revisions to the selenium criteria.

Nor have any of the subsequent limited opportunities for comment provided an opportunity for meaningful public input. DOW provided notice to the public of the current proposed revisions on February 5, 2013, less than a week prior to the February 11, 2013 hearing before the Administrative Regulations Review Subcommittee (ARRC). *Id.* On February 12, 2013, DOW provided notice that it would be accepting public comment on the proposed criteria through March 1, 2013, and held two "stakeholder" meetings on February 22 and 26, which were not open to the public. Those meetings do not constitute public hearings. Such a short time is insufficient to allow the public to develop complete comments on the very complex, technical issues involved in the DOW's weakening of Kentucky water quality protections. To properly develop such comments, the public needs time to solicit and incorporate the views of experts in the complex field of selenium toxicity. DOW's action violates 40 C.F.R. § 25.5(b)'s requirements that notice of hearings on proposed revisions be given 45 days in advance and that relevant reports, documents and data be provided at least 30 days prior to the hearing.

Furthermore, because the proposed revisions to the water quality standards are not properly considered "amendments after hearing," but are rather entirely new proposals, DOW has not complied with its obligations under KRS § 13A.

Additionally, the process that followed DOW's submission of the proposed changes to the selenium standards to the ARRC does not constitute true public participation, as defined by EPA regulations, because DOW's decision was predetermined. The agency has not provided meaningful opportunities to incorporate and respond to the public's concerns as part of the regulation review process. According to EPA's regulation, "Public participation includes

[1] *See* http://water.ky.gov/waterquality/Pages/ WaterQualityStandards.aspx (last visited Feb. 9, 2013).

providing access to the decision-making process, seeking input from and conducting dialogue with the public, assimilating public viewpoints and preferences, and demonstrating that those viewpoints and preferences have been considered by the decision-making official." 40 C.F.R. § 25.3. The regulations make clear that "[m]erely conferring with the public after an agency decision" does satisfy the agency's obligations to involve the public in its decision-making process. *Id.* at § 25.4(d). That is precisely what has taken place here, where DOW is only accepting public comments after making its decision.

Introduction

Selenium is an element. It cannot be destroyed. Once it enters Kentucky's waterways it will persist in the aquatic environment harming aquatic life in streams. It will likely be incorporated into detritus and small organisms at the bottom of reservoirs downstream from mining operations, presenting a long-term problem. Because, lakes and reservoirs act as selenium sinks, the bioaccumulation in lakes and reservoirs is often even more severe than in freely flowing rivers.

Dr. A. Dennis Lemly explains, "large portion of the total selenium in a stream or reservoir may be present in sediments, deposited directly from water or from plants and animals as they die and decompose. However, this pool of selenium is not permanently removed from the system. Biological activity, water chemistry changes, and physical disturbance can mobilize selenium back into water and organisms. Accordingly, the selenium in sediments remains active, and provides a significant source of pollution to bottom dwelling invertebrates and the fish that feed on them. Case studies show that selenium in sediments can cycle into the water and food chain for decades after selenium inputs are stopped."[2]

As shown below selenium bioaccumulation in a reservoir in West Virginia downstream from a large mining complex has led to severe deformities in fish.

 [3]

[2] Lemly expert report at 1-2.

[3] The selenium induced facial deformity in a large mouth bass and spinal deformity in a blue gill sunfish are from fish taken from the Upper Mud River Reservoir downstream from a large mining complex in Lincoln County, West Virginia. See WVDEP 2010 at 48-49.

The bioaccumulation of selenium begins at the bottom of the food chain in the tiny organisms that live there. These organisms are the prey of successively larger organisms. Since there is thirty-eight fold variability[4] in the assimilation efficiency between invertebrate species, food preference is an important factor in the amount of selenium a species will bioaccumulate.[5] Luoma et al summarize the risk factors for a specific predator species: "(1) the likelihood of high exposures of the organism in the environment as determined by its feeding habits (*viz* does its prey efficiently bioaccumulate Se?); (2) the inherent sensitivity of the species relative to concentrations in its reproductive tissues as accumulated from diet; and (3) the demographics of the organism in terms of susceptibility to a reproductive toxicant."[6] It is critical to consider these factors when setting state water quality criteria for selenium. The level of protection provided by implementation of those criteria must prevent significant impacts to the most sensitive aquatic species.

DOW's calculation of final chronic values for selenium will not protect sensitive and recreationally important species in Kentucky's waters

DOW proposed the use of 8.6 µg/g dw as a final chronic value (FCV) for whole body fish tissue and 19.2 µg/g dw as a FCV for egg/ovary tissue. As explained in our initial comments, those levels are insufficient to protect selenium-sensitive species such as bluegill and channel catfish in Kentucky. Data on the effects of selenium on channel-catfish were not included in the development of the criterion, and the Genus Mean Chronic Value (GMCV) for bluegill (Lepomis) was skewed as a result of DOW's inappropriate inclusion of some studies and flawed interpretation of others. In addition to those errors (which are more fully discussed in other sections of the comments) DOW's calculation of the FCVs for both whole body and egg/ovary is inappropriately lax because it is not derived to protect the most sensitive recreationally-important species in Kentucky's waterways.

To calculate FCVs, DOW included the GMCVs from four separate taxa: *Lepomis* (bluegill), *Salvelinus* (Brook Trout), *Esox* (Northern Pike), and *Micropterus* (Largemouth Bass). Even if the GMCVs derived for each of these taxa were accurate (and they are not), the consideration of four genera, rather than the most sensitive species, is inappropriate. EPA Guidelines for deriving water quality criteria do not allow for the extirpation of commercially or recreationally important species.[7] Both bluegill—the most sensitive species for whole body fish tissue selenium—and brook trout—the most sensitive species for egg/ovary selenium—are important recreational species in Kentucky. Rather than considering multiple species, DOW should have considered the most sensitive species in calculating final FCVs for both whole fish tissue and egg/ovary selenium concentrations. To do otherwise is contrary to the established guidelines.

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[4] Luoma 2009 at 8486.
[5] Id.
[6] Id.
[7] *Guidelines for Deriving Numericla National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses* (Stephens et al. 1985) at 1-2.

DOW inappropriately picked some studies used to calculate the criteria and misinterpreted others.

Our earlier comments outline a number of errors in DOW's proposed criteria. For example, DOW rejected the Lemly winter stress study as the driver of criteria based on several scientifically unjustified claims. DOW also relied on the conclusions in the McIntyre et al. 2008 study, even though that study was fatally flawed.[8] Further, DOW wrongly concluded that the Hermanutz et al. 1996 and Hamilton et al. 2002 studies mimic the conditions of the winter stress study. DOW stated "[e]ach study exposed test organisms to multiple water and dietary selenium concentrations; however, neither study reported excessive additional mortality of selenium-exposed test organisms during winter months. Therefore, these studies do not support sole application of the Lemly (1993) "winter stress" study to Kentucky waters."[9] DOW's conclusions are incorrect. Winter stress occurs in juvenile fish, not adults. Hermanutz and Hamilton used adult fish in their studies; those studies, therefore, do not refute or change the conclusions of Lemly 1993, which the scientific community acknowledges is the sole study to properly evaluate winter stress.

DOW introduced additional errors to the proposed criteria by using an all-species equation to translate whole body to egg ovary numbers. This equation is flawed because there are significant differences in the species compartmentalization between whole body and egg ovary.[10] Further, since there are numerous studies for bluegill with egg/ovary and or whole body information there is no need to translate one tissue level to another—that translation simply introduces more error into the calculations. DOW also failed to include data on catfish, including the catfish component of the Doroshov study, despite the wide presence of catfish in Kentucky.[11] DOW used four fish species of varying tolerances to calculate the final whole fish criterion as opposed to basing the criterion on the most sensitive species. [12] This means that by intention DOW is protecting the average of those fish and not more sensitive economically important fish such as bluegill and catfish prominent in Kentucky. In addition, DOW used composite species samples and various averaging schemes to make determinations adding significant error to the calculations.

All of the flaws we identified introduce error in one direction—to create more lenient and less protective criteria.

DOW's conclusions, as explained in the details of criteria development, were significantly based on two papers written by GEI Consultants, Inc. One was written on behalf of Conoco-Phillips

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[8] For a detailed critique of the McIntyre study, see Letter to Charles Delos, USEPA, from Margaret Janes, Appalachian Center for the Economy and the Environment, RE: Docket ID No. EPA–HQ–OW–2004–0019. November 24, 2008. Included in earlier comments.

[9] Update at 20.

[10] Osmundson, Barbara C. USFWS. Poster. Selenium in Fish tissue: Prediction Equations for conversion between Whole Bady, Muscle, & Eggs. Included in earlier comments.

[11] See Update at Table 1

[12] Update at 26.

and the other was submitted to the North American Metals Council-Selenium Working Group, an advocacy group for North American metals producers.[13] Those industry advocacy papers are not peer-reviewed or done by a state or federal agency; nonetheless, they are frequently relied upon and cited throughout the Update by DOW.[14]

Remarkably, one of the industry advocacy studies done by GEI was also used by DOW to calculate the criteria. It reports the highest whole body and egg/ovary numbers of all the studies used by DOW and significantly skews the end results. Those studies should have been rejected by DOW.

Another industry paper used to calculate the criteria was done by the staff of Carolina Light and Power ("CLP"). Again, that paper is not peer reviewed and should have been rejected because it is biased.

Yet another paper, NewFields 2009, while not included in the list of Literature Cited or described in any other way than "NewFields 2009" is actually a report done by the consulting firm NewFields for the J.R. Simplot Company.[15] Simplot is seeking site specific selenium criteria related to pollution from its Smoky Canyon Mine and impacts on brown trout. The proposal was so controversial that Senator Barbara Boxer requested that the United States Fish and Wildlife Service ("FWS") review the report.[16] Realizing the controversial nature of the report, the FWS had its critique of NewField 2009 reviewed by outside experts.[17] The peer reviews were in overwhelming support of the FWS opinions that the NewField report was unreliable.[18]

The conclusions of the FWS that invalidated the report included:

- The lack of valid field controls for interpretation of subsequent toxicity testing
- The failure to properly incorporate complete absence of "swim-up" among some experimental groups into exposure-response toxicity modeling
- Systematically biased low and environmentally unrealistic quantification of larval deformity rates
- Unjustified extrapolation of the brown trout ratio for partitioning of selenium between egg tissue and whole body tissue to all other co-occurring species of fish
- The absence of any wildlife risk analysis despite the Clean Water Act's explicit mandate for protection of fish, shellfish and wildlife[19]

[13] See http://www.namc.org/
[14] See numerous sections of DOW's selenium criteria update document. ("the Update")
[15] Newfields 2009.
[16] FWS at pdf 4.
[17] Id. at pdf 49.
[18] Id. at pdf 3.
[19] FWS 2012 at pdf 3.

In the end, despite data issues, an attempt by FWS "to make reasonable data corrections and recalculate the exposure-response relationship for the larval deformity endpoint produced EC-10 and EC-20 point estimates that were substantively lower than those originally proposed in the draft report."[20] Thus, DOW's use of the NewFields 2009 is scientifically unfounded and the study should be withdrawn from consideration.

DOW inappropriately included another study, Muscatello et al, 2006. In that study, fish were exposed to a wide variety of pollutants. The study should not have been used at all because there is no way to isolate impacts from selenium alone.

Other papers were misinterpreted by DOW. For example, in Table 2 of the Update, DOW states that Lemly 1993[21] found a LOEC (Lowest Observed Effects Concentration) for juvenile mortality of bluegill of 7.91 µg/g.[22] Juvenile mortality is not the most sensitive end point caused by selenium toxicity. Lemly and others explain the same error made by EPA in 2004 when it proposed the first whole body criterion.

> The proposed chronic criterion value of 7.91 µg/g selenium on a whole-body fish tissue basis was developed from the USEPA's interpretation of an overwintering survival endpoint (Lemly 1993b). However, reproductive impacts manifested through the selenium accumulated in ovaries and eggs are normally considered to be the most sensitive fish and wildlife biological effects endpoints for selenium (USEPA 2004a).[23]

And further.

> The controlling study for the criterion indicated a steep rise in selenium-related mortality following the onset of cold water temperature, and characterized the condition as Winter Stress Syndrome (Lemly 1993b). Cold water temperature caused young bluegill to reduce their food intake sharply and, consequently, their selenium intake. However, loss of lipids and lower body weights created an offsetting rise in selenium concentrations. The result was that a whole-body tissue concentration of selenium approaching 5.8 µg/g—although considerably lower than the proposed criterion value and innocuous in summer—became a grave risk in winter conditions.[24]

In an earlier paper Skorupa, Lemly and other experts from federal agencies explained,

> the controlling study for EPA's draft tissue-based chronic criterion, and the only study that incorporates a clearly demonstrated and environmentally widespread modifier of

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[20] Id.

[21] Note in our original comments we state that DOW rejected the winter stress study. To clarify, DOW rejected the winter stress study as the primary study for criteria development. Update at 20. In addition, the 7.91 µg/g value appears to be taken directly from EPA's highly criticized 2004 proposal with no independent evaluation.

[22] See our earlier comments on critique of EPA's 2004 criteria.

[23] Skorupa 2007 at 554.

[24] Id. at 553.

> selenium toxicity (winter stress), is best interpreted as having demonstrated 50% lethality associated with a whole-body selenium concentration of 5.8 ug/g. The 50% lethality is not in question. Whether that effects level is judged by EPA to be associated with a tissue concentration of 5.8 or 7.9 ug/g is a matter of interpretation; however, either number would have to be substantially reduced to be an appropriately protective criterion, that is, to get the expected effects level down to the 0-10% level that is EPA's traditional goal for aquatic life water quality criteria (45, 50, 66). We believe that regardless of EPA's choice of interpretation, the appropriate criterion indicated by the Lemly winter-stress study (20) will likely need to be <5.8 ug/g on a whole-body fish tissue basis. [25]

Part of EPA's mistake in proposing 7.91 µg/g tissue criterion was that the agency failed to appreciate that by day 120 of the study many fish were already dead.[26] Clearly, DOW's identification of 7.91 µg/g as the CV for the Lemly 1993 study is too high and would have to be substantially reduced to reflect an EC_{10}, the end point DOW claims to have used.[27]

Another study DOW used to develop criteria, McIntrye 2008, was commissioned by EPA to reexamine Lemly's winter stress syndrome paper. As we showed in our original comments, it fails to do so. The United States Fish and Wildlife Service ("FWS") was also critical of the McIntrye 2008 as a replicate of the Lemly study. "[A]s noted in the FWS Commentary, there are important differences in potentially different strains of fish (wild caught were used in Lemly (1993) while McIntrye used fish from a commercial source (Osage Catfisheries, Osage Beach, MO), differences in acclimation periods and temperature reduction, and different light regimes. The latter is noted in the FWS Commentary and is especially important, because light cues are important for reproductive timing and energy metabolism shifts. The FWS Commentary also notes that lipid depletion determined by Lemly was not reported in McIntrye et al. (2008)."[28] In essence, the McIntrye study has no applicability to the real world.

DOW also misused Hermanutz et al. 1992 and 1996. DOW improperly used an end point of larval edema instead of the most sensitive end point found in the study, hemorrhaging.[29] Further it is unclear how DOW calculated the egg/ovary CV of 30 µg/g.[30] The study makes clear that an egg value of 7.2 is appropriate.[31] Again if the correct end point had been used, the CV for those studies would have been significantly lower.

For the Doroshov bluegill study, DOW calculated the CV (EC10) for egg/ovary at 18.3 µg/g. Yet in reviewing the study the LC50 for egg is only15.0 µg/g for eggs and 9.7 µg/g for ovary.[32]

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[25] Skorupa 2004 at 13.
[26] Id. at 10-11.
[27] Update at 18.
[28] FWS 2012 at 2-3.
[29] Hermanutz 1996 at Table 11.
[30] Update at 21.
[31] Hermanutz at Table 6 see study 2 at 2.5 ug/l, 1.82 wet weight X4 =7.2 µg/g dry weight.
[32] Doroshov at 68.

Remarkably, DOW has calculated an EC10 significantly higher than the LC50. We cannot reconstruct DOW's calculations or reasoning.

Thus, *at least* 8 of the 15 studies used by DOW to calculate genus mean chronic values were either misinterpreted or should not have been used at all. We expect that if we had more time we could find even more errors in the proposal, and it is doubtless that upon scrutiny by experts reviewing DOW's ill-considered proposal other errors will be uncovered.

DOW's criteria for study inclusion

Generally, the screening criteria used by DOW to include or exclude studies are adequate. However, the criterion based simply on whether a control was used is insufficient. A classic control is a zero exposure group. That is inappropriate for selenium because selenium is an essential nutrient. Thus, controls must be a nutritionally sufficient exposure group. If the controls are exposed below the nutritionally sufficient level, then it biases the toxicity results in the direction of overestimating the EC-10 or EC-20 tissue values. These errors are significant. Proper control groups for fish would be those that are producing eggs with 1-3 ppm Se on a dry weight basis, and that should have been reflected in the criterion used by DOW to evaluate studies.

In addition, data for eggs should trump data for ovaries. Ovary data should be used only when that is the only data available or when the study didn't separate eggs from ovary tissue for chemical analyses.

Conditions in Kentucky are sufficient to induce winter stress

DOW questions regarding the relevance of Lemly's winter stress study (Lemly 1993) are based on a flawed evaluation (our comments on DOWs evaluation are above and in our original comments) of several studies. DOW states that "[g]iven these recent study results it is not thought the winter stress component of the USEPA's 2004 draft chronic criterion is applicable to all species or locations."[33] DOW apparently used this rationale to go to its flawed four species approach.

In general, winter is a time of stress for juvenile bluegill.[34] A drop in water temperature alone (without photoperiod alterations) causes increased mortality in young bluegill.[35] A study in which bluegill were held in tanks and water temperature was dropped to 4° C or 9° C, showed increase mortality in juvenile bluegill from the drop in temperature alone starting on day 40.[36] Shoup et al found "[o]ur laboratory results suggest size-specific overwinter mortality could also occur at warmer temperatures such as those experienced at the southern extent of the range, at least when cold temperature (≤9◦C) lasts more than about 65 d without food or 110 d with

[33] Update at 20.
[34] Shoup et al 2011 at Abstr. and 1302.
[35] Id.
[36] Id. at 1300.

more abundant food resources." And "[h]igh overwinter mortality of age-0 fish has also been found in other species when food was available."[37]

As shown by Lemly 1993, adding stressors to juvenile fish during winter months when they are already compromised, will lead to increased mortality. For the study juvenile fish were placed in water at 4 ° C. and photoperiods reflected winter conditions.[38] Winter stress compounded by stress from selenium was evident in juvenile fish by day 60 as shown by increased mortality over all other groups.[39] The timing of this finding is consistent with the finding of Shoup et al for stress from temperature drops. The increase in mortality at day 60 was approximately an EC 10 effect and was correlated with body burden of 5.85 µg/g.[40] More devastating effects and mortality occurred in juvenile fish as the experiment continued to day 120.[41]

During the winter months, streams in central Appalachia experience temperatures sufficient to cause selenium related winter stress. Although we have little confidence in the dataset, Kentucky stream temperature data on or after 12/21 and on or before 3/21from DOW[42] show that an average stream temperature in 3rd or 4th order streams is 6.37° C, well below the Shoup et al threshold. The database in Kentucky is sparse and there are few data points for any given season for individual streams. The available data are insufficient to determine with any confidence the winter stream temperature levels in mining regions of Kentucky. More robust data from southern West Virginia show that winter temperatures from a continuous monitor in the Mud River averaged 4.75° C for a 6 week period starting in early winter in 2010.[43] Temperatures for another heavily mined stream, Twentymile Creek, taken in the winter of 2003/2004 averaged 4.14°C at MP .3, 3.5°C at MP 1.1, 3.23°C at MP 7.2, 5.02°C at MP 15.2, 1.63°C at MP 21.5 and 4.23°C at MP 26.9 during a three month period.[44]

Thus, DOW must consider the role of selenium related winter stress as a driver in setting criteria in order to protect bluegill as an important recreational species.

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[37] Id. at 1302.
[38] Lemly 1993 at Abstr.
[39] Lemly 1993 at 148.
[40] Lemly 1993 data sheet.
[41] Lemly 1993 at 146-148.
[42] Data was obtained from Duke University. Duke obtained the data through an open records request. The data are spotty and unreliable, to say the least. The available Kentucky data are sparse and not representative of several years or consistent sampling. It would take years to develop a data set adequate to reach any reliable conclusion and all available reliable evidence indicates that if a rigorous and reliable dataset were available, it would show that the water is cold enough to cause stress in fish exposed to selenium. We believe, therefore, that there is insufficient temperature data to reach any reliable conclusion regarding winter water temperatures in Kentucky, particularly eastern Kentucky. The more robust West Virginia dataset should be used to "ground truth" the Kentucky data, even if eastern Kentucky and southwestern West Virginia may have slightly different average water temperatures. In summary there is insufficient data in the record, or anywhere else, to justify Kentucky's apparent conclusion that winter stress related to selenium exposure is insignificant in Kentucky.
[43] Data from the WVDEP from 12/1/09 to 1/12/10.
[44] Data from the WVDEP.

DOW's reliance on fish tissue sampling in streams does not account for species already extirpated or protect stream uses

Compliance with DOW's criteria requires site specific species composite fish tissue data.[45] This approach will obviously not protect species that have already been extirpated from a site due to selenium or other mining related pollution. Nor will it allow sensitive fish to recolonize those streams. If sensitive species are missing for, whatever reason, that will greatly distort evaluation of whether discharges are complying with water quality standards including protection of stream uses. It will mean that high selenium inputs could be authorized despite pollution that has already led to the elimination of sensitive species.

For example, for a federal hearing related to selenium discharges from a mining operation in southern West Virginia, Professor Jay Stauffer, Distinguished Professor of Ichthyology from Penn State University, wrote a report describing the loss of species downstream from mining operations. He commented on fish sampling done by a mining consultant, "[t]heir collections in Bells Creek (JB12, JB13) yielded only one sunfish (*Lepomis* spp.), *Lepomis cyanellus*, Green Sunfish. In 1999, as part of a characterization of stream fish assemblages in selected regions of mountain top removal, my colleagues and I collected 9 species of fish in Hughes Fork, a 2nd order tributary of Bells Creek, and again the only sunfish species present was (*Lepomis cynaellus*). In 1976, Hocutt et al. (1979) collected 15 species from Bells Creek and no *Lepomis cyanellus*. The Green Sunfish is an opportunistic species that is tolerant to a wide range of pollutants (Lee, 1986)."[46] Further he explained, "Postesta & Associates captured the highest number of species at stations associated with unimpaired tributaries."[47] And "[t]he number of fish species captured at sites located within the streams that drain mining activities is lower than those found at sites located near or on streams that do not drain mining activities."[48]

DOW's criteria do not protect streams already impaired by selenium or where other pollutants have already eliminated sensitive fish species. If a species such as bluegill were present in a stream at the time the Clean Water Act was passed, protecting the use of that stream as a bluegill fishery is mandated now. DOW's requirement to site specifically sample fish *impermissibly fails to guarantee protection of stream uses.*

The proposed acute criterion

In comments previously submitted, we included a number of important reasons why the proposed acute criterion would lead to devastating impacts on aquatic life. We stated that the use of traditional guidelines for criteria development intended for non bioaccumulative toxins is inappropriate for selenium because that method does not consider additional toxicant loads to a watershed or incorporate the food web as the route of exposure. Thus, the methodology

[45] Update at 28. Also we have already commented on the inappropriate use of composite samples to determine compliance with the criteria.
[46] Stauffer at pdf 3.
[47] Id.
[48] Id.

used by EPA and DOW is inappropriate. It is our understanding and belief that EPA withdrew the 2004 selenium proposal partly based on a similar error.

In addition, DOW's distinction between the toxicity of selenate versus selenite *in the field* is false and should not be considered for waters where sulfate is less than 44 mg/l. In recent research, Conley et al show that the initial oxidation state of selenium made no difference in selenium levels in periphyton.

> Here we provide an example of a complex, natural freshwater periphyton assemblage which clearly favored SeO3 uptake over SeO4. However, organisms within this natural periphyton assemblage were able to reduce SeO4, apparently via a dissimilatory pathway (i.e., enzymatic reduction that is independent of Se assimilation37), generating dissolved SeO3 and leading to enhanced primary producer bioconcentration. The end result was a similar distribution of Se species in the periphyton, regardless of initial oxidation state of inorganic Se in the exposure.[49]

Periphyton are important since they are at the bottom of the food web and their ability to reduce selenate sets the stage for greater bioaccumulation in higher trophic levels.[50] Thus, due to chemical and biological processes that occur in natural waterways, consideration of the different toxicities of selenate and selenite are inappropriate in setting criteria.

Impacts of selenium on aquatic species other than fish

Our earlier comments outline why it is important to consider impacts to aquatic life other than fish. Recent research supports the conclusions cited in our comments. Conley et al found impacts to invertebrate species:

> Overall, the combined results from these three experiments highlight the potential for adverse effects to occur in aquatic insects exposed to dietary Se and support the suggestion by deBruyn and Chapman that some invertebrate species may suffer adverse effects of Se exposure at levels considered to be safe for higher trophic level consumers.[51]

Swift also found that several macroinvertebrates were dramatically reduced with moderate increases in selenium in the water.[52]

In addition, Peterson et al found that "there was widespread agreement that chronic exposure to dietary concentrations > 5 mg/kg (ppm) selenium can produce toxic or adverse reproductive

[49] Conley et al, 2013 at pdf 14.
[50] Id at pdf 15.
[51] Id. at pdf 16.
[52] Swift 2002 at Abstr.

effects in some birds and mammals"[53] and that water levels of around 1 µg/l are toxicity thresholds for a number of fish eating birds.[54]

DOW's exclusive focus on fish impermissibly leads to criteria that fail to protect a diverse aquatic community or the mammals and birds that rely on that community for food.

Instream selenium levels of 5 µg/l can lead to significant impacts on aquatic life.

A number of leading experts promote reducing the existing national water column criterion to a level lower than 5 µg/l. Swift recommends a criterion of 2µg/l.[55] Lemly and Skorupa criticized the existing 5 µg/l and recommended:

> The USEPA last promulgated an updated national chronic criterion for selenium in 1987, some 20 years ago, setting the criterion at 5 µg Se/L on an acid-soluble basis (USEPA 1987). Since that time, serious weaknesses in the national criterion have been revealed. For example, several reviewers of more recent selenium literature suggested that the criterion should be 2 µg/L or less (DuBowy 1989; Peterson and Nebeker 1992; Swift 2002).[56]

United States Environmental Protection Agency ("EPA") researchers found significant effects in bluegill progeny with instream selenium concentrations of 2.5 µg/l. "Mean ranks of % edema, % lordosis, and % hemorrhaging in egg cup samples were significantly affected by selenium streams from which they came ($p<0.01$, $p<0.01$, $p<O.OS$). Mean ranks were significantly higher for the 2.S and 10 ug/L treatments than for the control ($p<O.OS$)."[57] They concluded that the EPA criterion of 5 µg/l might be too high considering their findings.[58]

DOW's proposed screening level of 5 µg/l is, therefore, not protective and does not comply with the Clean Water Act.

DOW's proposed whole-body fish tissue criterion of 8.6 µg/g is too high

In a peer reviewed critique of EPA's 2004 proposed whole body fish tissue criterion (7.91 µg/g) experts explained that a whole body fish tissue concentration "approaching 5.8 µg/g – although considerably lower than the proposed criterion value and innocuous in summer – became a grave risk in winter conditions."[59] In other words, for a criterion to be protective in the winter months when fish are stressed, the whole body criterion has to be less than 5.8 µg/g.

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[53] Peterson et al 1992 at 158.
[54] Id.
[55] Swift 2002 at Abstr.
[56] Lemly Skorupa 2007 at 552.
[57] Hermanutz 1996 at 17..
[58] Hermanutz 1996 at 19, 20, 23
[59] Id. at 553.

Dr. Lemly, the researcher who discovered "winter stress syndrome" in fish, explains:

> This study examined the effect of reductions in water temperature and photoperiod, mimicking winter conditions, on the toxicity of combined dietary (5.1 µg/g dry weight) and waterborne (4.8 µg/l) selenium to juvenile bluegill (Lepomis macrochirus). Elevated selenium caused hematological changes and gill damage that reduced respiratory capacity, while increasing respiratory demand and oxygen consumption. Elevated selenium in combination with low water temperature (4°C) caused reduced activity and feeding, depletion of 50-80% of body lipid, and significant mortality within 60 days. Fish in warm-water selenium exposures continued to actively feed and lipid depletion did not occur despite increased oxygen consumption. The combination of stress-related elevation in energy demand and reductions in feeding due to cold temperature and short photoperiod, leading to severe depletion of stored body lipid, is given the name Winter Stress Syndrome. This syndrome caused bluegill to undergo an energetic drain that resulted in death of about one-third of the fish.[60]

And further.

> Findings from previous studies which suggest that 5 µg/l selenium in water poses little threat to fish should be re-evaluated in the context of Winter Stress Syndrome. Waterborne concentrations of selenium in the 5 µg/l range are known to accumulate in fish food organisms to levels of 5 µg/g dry weight or higher (Besser et al., 1993; Cumbie and Van Horn, 1978), which equal or exceed the dietary concentrations fed in the present study. Winter Stress Syndrome has the potential to markedly lower the amount of selenium necessary to kill fish. Responses that would be sublethal for most of the year could become lethal during brief periods of cold-water temperature.[61]

DOW misapplied this seminal study in favor of other studies that failed to control for photo period or consider juvenile fish. Consideration of those factors would have led to a substantially lower criterion. This omission is one of the key failures of DOW's proposal.

Also, in support of a significantly lower tissue criterion than proposed by DOW, a well-known selenium expert from the United States Geological Survey found, "[t]he convergence of laboratory and field data shows 4 µg/g to be a conservative value for a national tissue-based criterion for selenium."[62, 63] DOW's proposal is over 200% higher.

DOW's proposed egg/ovary criterion of 19.3 µg/g is too high

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[60] Lemly 1993 at Abstr.
[61] Lemly 1993 at 152. Also see Lemly 1996 for corrected summary tables.
[62] Hamilton 2002 at Abstr.
[63] Also see Hamilton 2003 at Abstr.

Many studies show significant harm to fish at egg/ovary concentrations far below the concentration proposed by DOW. For example, Doroshov conducted selenium toxicity studies on bluegill and catfish. DOW fails to even mention the Dorshov catfish studies. Doroshov found that the selenium concentration of 7.7µg/g in fertilized catfish eggs led to 50% mortality of progeny.[64] Egg/ovary concentrations between 14.19 and 19.06 µg/g led to nearly 100% mortality in embryos by day 28.[65]

EPA researchers "found progeny effects at parental ovary concentrations of 4.4 to 4 5 ppm. Gillespie and Baumann [5] found similar progeny effects where the parental ovaries contained about 6 to 8 ppm."[66] Later EPA studies also showed larval abnormalities at egg/ovary tissue levels significantly lower than those proposed by DOW.[67]

Conclusion

In sum, DOW's proposed criteria rely on flawed, discredited science, will not protect fish, aquatic life, or other wildlife, do not comply with the CWA and are effectively unenforceable. We ask DOW, upon consideration of our original comments and this supplement, to abandon its effort to unjustifiably weaken the protections on the Commonwealth's waters and to require the coal industry to meet its obligations to reduce selenium discharges.

Sincerely,

Margaret Janes
Senior Policy Analyst

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[65] Id. at 17.
[66] Hermanutz 1992 at 223.
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