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Comment on "Wildlife and the Coal Waste Policy Debate: Proposed Rules for Coal Waste Disposal Ignore Lessons from 45 years of Wildlife Poisoning"

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A recent assessment of direct and indirect costs of fish and wildlife poisoning attributable to surface impoundments of coal combustion waste (CCW) was based on 21 surface impoundment case studies in the United States.[1] Selenium was the primary chemical stressor in 14 of the 21 case studies. For those 14 case studies the authors noted that the initial "Period of Damage" ranged between 1967 and 1981. This is prior to and during the time when the potential effects of elevated selenium concentrations on fish populations were just beginning to be understood, mainly due to the observations and research being conducted at Belews Lake (NC).

It is inappropriate to base an analysis of contemporary policy on sites with historical selenium inputs that are not allowed today. Of the total direct and indirect costs of fish and wildlife poisoning calculated by Lemly and Skorupa, 70% was for historical poisoning in Belews Lake, Hyco Reservoir (NC), and Martin Lake (TX), which in the mid- to late-1970s received discharges containing selenium concentrations of 150-200, 50-200, and 2,200-2,700 µg/L,[2] respectively. These concentrations are 30- to 540-fold greater than the U.S. Environmental Protection Agency's (USEPA's) current chronic selenium criterion (5 µg/L) which in fact was derived based on Belews Lake field data.[3] Since Lemly and Skorupa argue that surface impoundments of CCW should be prohibited, their analysis should have been based on case studies reflecting today's regulatory and management policies for CCW surface impoundments. Since 1982 the USEPA has prohibited the wet disposal of CCWs to surface impoundments for new power plants. Some utilities have already converted existing wet ash disposal to dry ash disposal, and others are in the process of doing so.

Our understanding of selenium fate and effects in aquatic systems has grown immensely over the last 30 years. A 2009 Society of Environmental Toxicology and Chemistry (SETAC) workshop on the *Ecological Assessment of Selenium in the Aquatic Environment* that engaged 46 selenium experts representing academia, government, industry, and nongovernmental organizations from four different countries exemplifies the progress that has been made. This workshop provided a comprehensive review of selenium fate and effects in aquatic ecosystems, and how to assess the potential risks from selenium exposure. The workshop publication provides a concise overview of the state-of-the-science.[4]

Lemly and Skorupa's cost analysis relies on numerous technical assumptions that deserve careful scrutiny, including issues of temporal and spatial scale of selenium concentrations in water bodies, consideration of multiple lines of evidence, and recovery time periods. One particularly important assumption is Lemly and Skorupa's use of a 4 mg/kg dry wt whole body fish selenium concentration for defining resource damages. A point of agreement in the 2009

SETAC workshop was that the critical exposure route for fish is dietborne organic selenium.[5,6] Based on our own review of several toxicity studies in which fresh water fish were exposed to a series of dietborne organic selenium concentrations,[7-14] effect levels for endpoints such as larval mortalities, deformities, and edema and juvenile survival and growth are insignificant (less than 10% relative to control) at whole body selenium concentrations ≤ 4 mg/kg dry wt. The lowest whole body fish selenium concentration at which statistically significant effects have been observed relative to control is 16 mg/kg dry wt. This casts doubt on the biological significance of the 4 mg/kg threshold.

There is also field evidence that a 4 mg/kg threshold of is a poor indicator of population-level effects. For example, Finley and Garrett[15] reported that median whole body selenium concentrations in representative species in Hyco and Belews, including recovered sensitive taxa previously extirpated from these systems such as bluegill, had median whole body selenium concentrations ranging from approximately 6 to 10 mg/kg dry wt. from 2003-2006 (wet fly-ash disposal was eliminated in 1985 and 1990 in Belews and Hyco, respectively). Second, whole body fish selenium concentrations near to or exceeding 4 mg/kg can be measured in fish from reference sites. Some studies have even reported comparable whole body selenium concentrations in control fish from laboratory studies, such as Vidal et al.[16] and Tashjian et al.[12] This further raises the question of whether a 4 mg/kg threshold is a relevant predictor of effects.

Finally, there is a general consensus that fish egg and ovary selenium concentrations are better predictors of selenium toxicity to fish than whole body selenium.[5,6] Lemly and Skorupa[1] did not include this line of evidence. Consideration of these data could have had an important influence on their analysis. For example, to interpret selenium concentrations in Mayo Reservoir (Case #3), Carolina Power and Light[17] conducted a reproductive study with largemouth bass and determined that an ovary selenium concentration of 19 mg/kg dry wt. was associated with a larval mortality rate of 1%. Ovary selenium concentrations in largemouth bass have not exceeded this 1% effect threshold and there has been no evidence of population-level effects in Mayo Reservoir.[18]

The sources of discharges in Lemly and Skorupa's case studies must also be considered. Most of the discharges were/are permitted releases, not accidental spills, seepage, or structural failure. If permitted discharges are resulting in concentrations that pose an unacceptable risk, the issue is not the surface impoundment *per se*, but permit limits. If on the other hand surface impoundments based on current technologies, are prone to spills, leaks, or structural failure, then those issues need to be weighed in assessing the development of additional controls for surface impoundments.

The question of developing appropriate controls for storage of CCW in surface impoundments is best addressed within a risk-based framework that will provide the regulatory decision makers the necessary information to make informed decisions.

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Author Contributions

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