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April 11, 2001

To: Senate Health and Human Services Re: SB 99

SB 99 uniformly demands fluoride be added to public water supplies, without consideration of local conditions that might make this unwise.

One condition that may make this unwise is the effect on the aquatic communities of all of this fluoride passing into the natural waters of Oregon.

Fluoride in Salt/Water Homeostasis of Aquatic Organisms
Unlike living in the oceans, where organisms must actively acquire water and eliminate salts, organisms living in fresh water must instead actively eliminate water and concentrate salts. We all know the lament of the Ancient Manner "Water, water everywhere…", but are less acquainted with the fact that a rainbow trout, living in freshwater, takes on and must eliminate its own body mass of water every two and a half hours! While living in the ocean is tough – a salmon there must keep the salts in its plasma at about one-fourth of the concentration of the surrounding seawater –, living in freshwater is almost miraculous – a trout in the McKenzie must keep a salt concentration in its plasma about 2,500 times that of the surrounding freshwater!

Fish do this by pumping salts through membranes, primarily in kidneys and gills. These ion pumps work by first actively transporting the positive ions such as sodium, Na^+ – and then allow the resulting positive electrical potential to pull the negative ions-such as chloride, Cl^- – through a small anion channel. Now here is the important point. They say that size doesn't matter, but here it does. A fluoride ion, being smaller than a chloride ion, goes right up the small ion channel, too.

Any fish trying to actively concentrate salts from its environment will pick up fluoride, as well as chloride, or any other small anion (hydroxide, cyanide, …), for that matter. Usually, chloride is by far the major anion pumped this way, because it is the most prevalent small ion in natural waters. This all changes when fluoride is present at concentrations anywhere comparable. Then fluoride is significantly transported into the organism.

That is the simple physical chemistry.

Does this have any practical effect? Well, yes.

Acute Toxicity of Fluoride to Fish
Acute lethal toxicity of fluoride (half dead in 480 hours) is about LC_{50} =3.6 parts per million (2.7-4.7 ppm at 95% C.L.) for rainbow trout in fresh water. [Neuhold and Sigler, 1960. Effects of sodium fluoride on carp and rainbow trout. Trans. Am. Fish. Soc. 89:358-370.]

Symptoms of acute fluorosis in adults include

> "Apathy and anorexia were followed by a period of violent, sporadic movement, loss of equilibrium, and finally, death."

Acute mortality is not the whole story, as also pointed out by a DEQ toxicologist: “However, this was just one study and additional studies using different methods and exposures may show effects at lower concentrations. As an example, the endpoint used was mortality and the more subtle effects, such as altered histology, may occur at lower concentrations.” [E. Foster, DEQ (July 28, 1997), private communication.]

Chronic, Developmental, and Behavioral Effects in Fish

Although primarily focused upon lethal effects, Neuhold and Sigler mention developmental results of fluorosis in embryos, [Neuhold and Sigler, 1960. Effects of sodium fluoride on carp and rainbow trout. Trans. Am. Fish. Soc. 89:358-370.]

> “If the vitelline membrane ruptured, the embryo invariably left the egg sac headfirst. Not infrequently, embryos were caught in the membrane. If these fish lived, they often had deformed spines.”

At about a tenth of the concentrations causing acute mortality in trout, fluoride certainly does affect salmon. [Damkaer and Dey, 1989. Evidence for Fluoride Effects on Salmon Passage at John Day Dam, Columbia River, 1982-1986. N. Am. J. Fish. Management. 9:154-162.]

The Damkaer and Dey study focused primarily on the delays of salmon caused by fluoride levels much lower than those acutely toxic, but they also compared their fluoride measurements to interdam losses documented by Washington Department of fisheries. A few quotes give the flavor of the effects that they observed:

> “... From 1980 to 1982, the time (>150 h) required for upstream migrants to pass John Day Dam and the mortality (>50%) of migrants between Bonneville and McNary dams (below and above John Day Dam) were unacceptably high. …”;
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> “... The delay of nearly 1 week at John Day Dam appeared to contribute to increased mortality ...”;
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> [after fluoride reduction] “...substantially fewer salmonid carcasses were observed below John Day Dam than in 1982”;
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> “Radio-tagging and tracking studies form 1980 to 1982 determined that fish passage times were unacceptably long at John Day Dam (there were no passage studies in 1983). Analysis of fish counts at the dams revealed an average ‘unaccountable loss’ of 55% of fall fall chinook salmon passing Bonneville Dam and expected to reach McNary Dam during 1980-1982 (J. DeVore, Washington Department of Fisheries, personal communication)....”; and
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> “In 1985, [after fluoride reduction,] median passage time for spring chinook salmon was 28 h (Peters et al. 1985) and the unaccountable loss of fall chinook salmon was near 5% (G. Norman, Washington Department of Fisheries, personal communication).”

Although chronic toxicity of fluoride is documented, including the increased toxicity of fluoride in fresh water, no chronic toxicity studies have been done on fish species native to Oregon waters.

Acute toxicity of fluoride to invertebrates has also been observed in fresh water, at levels lower than 0.2 ppm. Chronic toxicity studies are lacking for invertebrate animals and aquatic plant species in the food chain of fish.

Fluoride Levels in Oregon Waters.
Should the fluoride levels of Oregon waters be of concern? Yes.

Although the EPA has set human health maximum contaminant levels as 4.0 ppm, those levels would be acutely toxic to trout. The EPA has not yet set safe levels of fluoride for aquatic species.

The Neuhold and Sigler study would indicate that at a 1.5 ppm concentration (the drinking water health advisory level) 10 percent of rainbow trout would die within twenty days. [E. Foster, DEQ (July 28, 1997), private communication.]

Based upon the studies performed on Oregon's own northern border, the Columbia River, British Columbia set a regional advisory level of 0.2 ppm for fluoride in "soft water"-i.e., water with low dissolved solids. If we take this as our standard, we already find Oregon surface waters that exceed this level as the result of human activity.

The Tualatin river already runs about 0.5 ppm fluoride during the summer. How do I know? In 1997 I was asked to be on a League of Women Voters panel in Hillsboro to discuss the water supply problem in the Tualatin Valley. From just looking at the engineering studies, it was easy to see that the most acute problem they were facing was not getting water – they could get more – but in getting rid of it once they had used it – there was no place to put the extra effuent. A back of the envelope calculation predicted that the Tualatin was already running about half a part per million fluoride during the summer low flows. I had my students measure it. Sure enough, it runs at about 0.5 ppm, levels of fluoride that Damkaer and Dey had already identified as interfering with salmon on the Columbia.

If the Tualatin is a ghost of Christmas past, the Deschutes, is a ghost of Christmas future, should SB 99 pass. While the Tualatin has not been an active fishery since the middle of the last century, currently the Deschutes is a major recreational fishing stream.

The major danger that SB 99 poses is in requiring fluoride be added indiscriminately to Oregon waters without regard for potential harm.

Sincerely,

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