

## Sigrid Salo

I live on the south end of Whidbey Island; fortunately not in the area where the wells are contaminated by polyfluoroalkyl chemicals from the Naval station (NAS) fire-fighting foam. Friends near Bangor are also lucky that they don't appear to be directly affected by ground water contamination from the submarine base, which is an EPA superfund site and disposal area with a long list of monitored chemicals. Your draft plan does discuss the groundwater contamination at the two sites.

However, in addition, a year ago, the Seattle Times wrote about a farmer near NAS whose fields were contaminated by runoff from the base. Surface water contamination has been seen in Europe ([www.eea.europa.eu/themes/chemicals/emerging-chemical-risks](http://www.eea.europa.eu/themes/chemicals/emerging-chemical-risks)) and on the east coast ("PFAS Found Throughout River Food Chain (from North Carolina State University, June 8, 2020). Since runoff from both bases must be reaching Puget Sound, isn't there concern about the effect of that contaminated runoff in the sound, not just local groundwater?

Although the PFAS at these two bases concern me, because of my proximity to them, I don't know if they are relatively important sources of PFAS to Puget Sound, or if the specific chemicals used there and their breakdown products are among the more toxic polyfluoroalkyl chemicals. However, the two sites would be useful to study because they are point sources where good records of the timing and types of PFAS used or disposed of at the sites should have been kept. The timing of different types of PFAS used might allow them to be used as tracers, like bomb-derived tritium, in the variety of current regimes and bottom sediments around the two bases.

I do realize the question of PFAS in Puget Sound is complex, given the number of PFAS and degradation chemicals, and the variability of Puget Sound and of its ecosystems. I have many more questions than suggestions. For example:

What are the major sources of PFAS in Puget Sound, how are they dispersed, how persistent are the PFAS, and what do they degrade to? Can they be dispersed by wind, either because of their own volatility or in dust? How soluble are they in fresh water, and what happens to their solubility in salt water and with the increased salinity of bottom waters of the Sound? Are they found throughout the water column or are they concentrated in the water above the sediments, or within the sediments themselves? Do currents carry them throughout Puget Sound, or do they get trapped and accumulate in basins? What happens with their solubility and/or reactivity or toxicity in anoxic waters? What effect does the type of substrate at the bottom have - for example, does clay or organic matter facilitate any reactions? (IE, Effects of salinity and organic matter on the partitioning of perfluoroalkyl acid (PFAs) to clay particles Jeon et al, J Environ Monit June 2011)

How toxic are the PFAS found in Puget Sound? European sources seem to regard PFAS as a greater problem than many US papers. Is this because they have higher concentrations of PFAS, or more toxic PFAS, or is their concern an illustration of their precautionary principle?

What organisms in Puget Sound are most affected by the dominant PFAS? For example, a 2020 paper (Evaluating exposures of bay mussels (*Mytilus trossulus*) to Contaminants of Emerging Concern through Environmental Sampling and Hydrodynamic Modeling, James et al, Science of the Total Environment, 2020) did not find high concentrations of PFAS in bay mussels in Puget Sound, possibly because bivalves may have a multi-xenobiotic resistance (MXR) transporter proteins that limit accumulation. So is this good news for mussels, clams, and oysters and the people who consume them?

But what about bioaccumulation up the food chain of organisms that do retain PFAS? Many articles and news items from the east coast and Europe warn about bioaccumulation and toxicity. I'm not a

chemist, so I may have misunderstood the details of the paper Bioaccumulation of per- and polyfluorinated alkyl substances (PFAS) in Selected Species from the Barents Sea Food Web, (Haukas et al, Environmental Pollution, Vol 148, Issue 1 July 2007). It states that PFOS is widespread over the northern hemisphere, and they found biomagnification up the food web they studied - amphipods, polar cod, black guillemots and glaucous gulls. That sounds like bad news for our plankton, fish, birds, and mammals, especially the resident inhabitants who are here full-time.