US House of Representatives, Natural Resources Committee
Subcommittee on Oversight and Investigations
Virtual Meeting July 15,2021
RE: Coho salmon and 6PPD-quinone
Testimony of Witness Sue Kuehl Pederson, Self Represented

Introduction—I am honored to be here, and I hope my diverse background in fisheries science will be helpful to the matter before us. My perspective is an overarching one; a big picture view of what a Pacific salmon goes through during its lifetime, and how these considerations can complicate the application of scientific principles to environmental management on behalf of salmon.

Personal Background—My name is Sue Kuehl Pederson. My mother's family has lived in Washington for six generations, and many of my relatives have enjoyed sport and commercial salmon fishing. My father was a fish culturist for the US Fish & Wildlife Service for about 40 years, and our family was required to live on-site at a salmon hatchery, in case of a water or power supply emergency. I literally grew up alongside coho and chinook salmon, and I have always found them fascinating-- even inspirational. So it was natural for me to choose the profession of fish biologist.

Pacific Northwest Salmon Biology—Six species of salmon are native to the Pacific Northwest, all classified within the genus *Oncorhynchus*. Their most common names are "chinook" *(O. tshawytscha)*, "coho" *(O. kisutch)*, "sockeye" *(O. nerka)*, "pink" *(O. gorbuscha)*, "chum" *(O. keta)* and "steelhead" *(O. mykiss)*.

<u>Life Cycle</u>—If they are not confined to a lake or impoundment, our salmon generally share a complicated life cycle, which repeats with each new generation. I want to offer a simplified explanation of this life cycle to emphasize how tricky it can be to determine definitive causes and effects during any stage of a salmon's life.

I'll start with "spawning" under natural conditions (not in a hatchery). A spawning female digs a nest (called a "redd") with her tail. She then lays her eggs in gravel that must be clean and oxygenated by riffling water. A male hovers over the eggs and deposits sperm, called "milt." With the exception of steelhead, all the other adult Pacific salmon die after spawning. Adult steelhead can live on to repeat the cycle.

The fertilized eggs incubate in the gravel, which must stay clean and oxygenated, until they develop a rudimentary head, fins and tail, then they make their way downriver, eating and growing as they go, until they reach the ocean. In the estuary, their gills transform so they can enter saltwater. Different species, localized runs and even individuals tend to spend different lengths of time in the ocean, but generally speaking, from 2 years to 6 years the adults feed and swim long distances in saltwater. Some Columbia river salmon travel up the west coast to Alaska and even as far as Russia or Japan.

Eventually the salmon return home. Many years ago I wrote a research paper on homing migration and learned that salmon use their sense of olfaction, or smell, located in the lateral line on their sides, to detect minute molecular smells in the water. They somehow use a reverse sequence of the smells they encountered in their young journey to the ocean, to guide them back to their home stream as adults. This amazes me. They find the estuary where they first entered the ocean, and travel upstream to the same place where they were hatched, to start the cycle again. This last journey, swimming upstream against sometimes powerful currents, is made even more difficult because they tend to stop eating. But they use the last of their energy to reach the place where they started. Wild fish return to a specific gravel streambed, and hatchery fish to a familiar cement pond. And the cycle begins again.

Evolutionarily Significant Units (ESUs)—Given the number of Pacific salmon species (6) and the countless rivers, lakes and streams they occupy, it is helpful to recognize that under the Endangered Species Act of 1973 (ESA), west coast salmon species were subdivided into "evolutionarily significant units" or ESUs. These units were tied to the location where a salmon run originated. So, for example, Snake River sockeye were listed in 1991 as Endangered under the Act, but other unlisted sockeye are not deemed endangered or threatened. So for Pacific salmon, it is the ESU that gets listed, and not the species.

The concept of ESUs afforded more focus on specific sections of salmon spawning and migration routes pertaining to one run of a species, making it more feasible to identify recovery methods and tasks in targeted areas.

The title of this hearing, *"Are Toxic Chemicals from Tires and Playground Surfaces Killing Endangered Salmon?"* got me wondering about endangered or threatened coho in the Seattle area. Here is a current table from the NOAA Fisheries Species Directory, sorted for ESA Threatened & Endangered, coho species:

Species Name	Species Category	Species, Subspecies, or DPS	Status	Year Listed	Recovery Plan	Critical Habitat	Region
Coho Salmon (Protected) *Oncorhynchus kisutch*	Fish Protected Fish Salmon & Steelhead	Central California Coast ESU	ESA Endangered	2005; 1996 (original)	Final	Final	Alaska West Coast
		Lower Columbia River ESU	ESA Threatened	2005	Final	Final	Alaska West Coast
		Oregon coast ESU	ESA Threatened	2008	Final	Final	Alaska West Coast
		Southern Oregon & Northern California coasts ESU	ESA Threatened	1997	Final	Final	Alaska West Coast

Note that none of the endangered or threatened coho ESUs currently on the official Endangered Species List are from the Puget Sound region, where Seattle is located.

My Professional Fisheries Career—Because I am so enamored with salmon and their remarkable perseverance, I shaped my professional fisheries career to focus on various aspects of the salmon life cycle. In particular, I tried to learn more about the impacts we called the "4 H's"—hydropower, harvest, habitat and hatcheries. These, along with ocean impacts, categorize the gamut of challenges every salmon has to endure to fulfill its life history. In my career, I tried to help salmon overcome these various challenges, which resulted in me gaining a rare, big picture view of these impacts. I want to share my expertise in this regard to help further the research at hand.

Hydropower—

1. To pay for college, I took many quarters off to work for NOAA Fisheries (formerly National Marine Fisheries Service) and the Army Corps of Engineers on research projects at the large hydropower dams on the Columbia and Snake rivers. We inserted radio tags in adult salmon to track how they find fish ladders and pass upstream over the dams. Upon graduating with my Bachelor of Science in Biology, I

was asked to manage such a study, the largest yet, encompassing more than 100 miles of upstream passage over 3 dams on the Snake river. Results from all these radio tracking studies were used to recommend improvements to fish ladder attraction flows and to prevent fallback at the tops of the dams. This experience gave me huge respect and admiration for the powerful, focused swimming and navigation abilities of adult salmon.

2. In contrast are the relatively passive downstream journeys of juvenile salmon. I worked for 9 years at a private research company, BioSonics, that developed state-of-the-art hydroacoustic research equipment to study fish movements. I was in charge of setting up and managing experiments to observe juvenile salmon passage at many large dams on the mid-Columbia river, this time finding problem areas at various times and flows, and recommending retrofits to enhance downstream fish passage. I was also assigned to study fish distributions at power plants and rivers across the US and in South America.

<u>Harvest</u>—

1. While employed with the University of Washington and NOAA Fisheries, I served as the only US Observer on Japanese rockfish stern trawlers operating in the Gulf of Alaska. I subsampled the catches, keying out hundreds of marine species, including a few salmon, and submitted a full report after 3 months at sea.

2. Later I was hired as Puget Sound commercial harvest manager at the Washington Dept of Fish & Wildlife, where I set areas, schedules and quotas for the non-tribal purse seine and gill net fishing fleets, based on my team's catch data and statistics on various salmon runs.

<u>Habitat</u>—

1. The Washington Dept of Fish & Wildlife hired me as Habitat Manager for a region encompassing several counties. I oversaw state and federal regulations for development projects near salmon streams. Forestry permit review was also integral to my work, as forests and streams are inextricably linked, especially in the rainy Northwest. Our goal was to educate land use proponents in using minimal impact strategies to promote healthy salmon habitat.

2. I served as Manager of the King County, WA Jobs for the Environment program, training displaced timber and fisheries workers in the art of habitat restoration. Much of the work focused on opening up salmon migration routes in streams, and ensuring clean water for salmon survival and spawning beds. We identified problem areas such as undersized culverts or steep, eroding stream banks, and used geo-engineering and strategic vegetative plantings to:
    - stabilize slopes
    - calm or slow stormwater flows to minimize erosion
    - reduce sedimentation from any nearby source that could damage spawning gravel beds
    - filter and clean water through bioswales and restored wetlands, and
    - improve fish passage

3. Seattle City Light hired me as their environmental regulatory liaison, managing all permits associated with construction of a new hydropower plant and water pipeline. Over a two-year period, I successfully coordinated project requirements with 11 federal, tribal, state, county and city offices. When the project was completed, I engaged the same parties in developing a watershed plan for the area going forward, focusing on historical problem areas and scheduling projects to improve habitat.

Hatcheries—

1. I lived the beginning and end of the salmon life cycle as a child, watching the babies ("fry") emerge from the eggs, then they got transferred to the rearing ponds, until they were big enough (as"fingerlings") to be released into the river. The adults from a previous generation would return to spawn, and start a new cycle again. This I learned from my proximity to the hatchery, and because the seasonal salmon runs would dictate the rhythms of our family life.

2. The biologist at our hatchery, who became my mentor when I chose to become a fish biologist, would share his concerns with me. After his retirement, he was very contrite to realize that a procedural error had likely caused successive generations of hatchery salmon to have a compromised gene pool. That's because for years, most eggs and milt were taken from a relatively small subsample of the returning adults. They could get all the eggs and milt they needed for production from relatively few fish. To preserve genetic variability, it would have been preferable to take fewer eggs and sperm from more individuals.

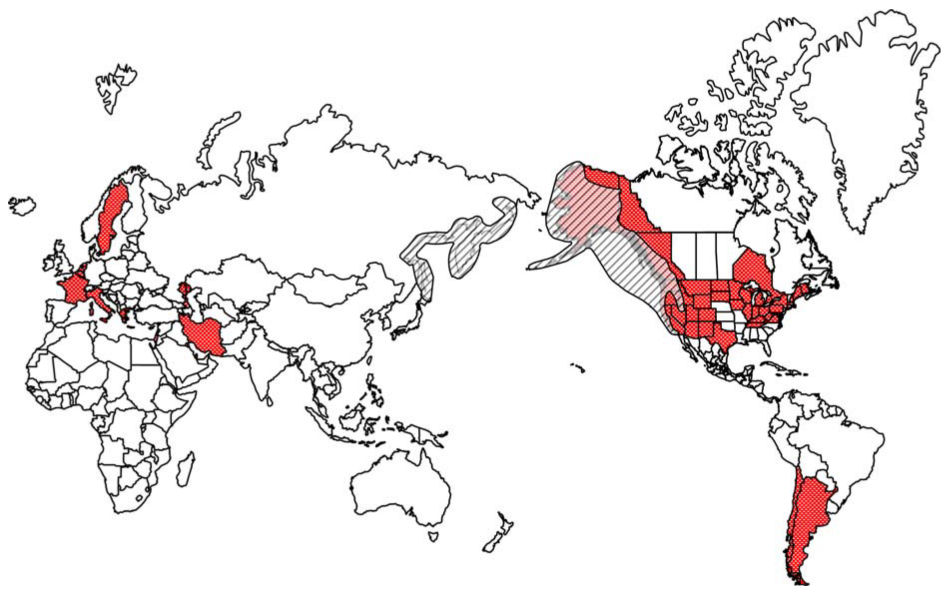
So, that's my background, and I want to use it to bring my broad fish biologist's perspective to the table. I will do so by asking questions that I hope will open the conversation on this new study into additional valid directions, if warranted.

Coho and 6PPD-quinone Research—I learned of the research on this subject in a Seattle Times article my sister sent me on December 8, 2020. I found the subject interesting, and wondered what would be done to further the research. It is not clear to me whether there has been follow-up research. One of the primary tenets of the scientific method is that, in order to support any study's results and conclusions, the study needs to be replicated by others, and derive similar results. You could say, science is not designed for "one and done" research. It is through repeated studies, by different scientists, showing consistent results that we gain confidence our hypothesis is true or not true. Scientific research must be iterative, or it is not considered valid. I hope the investigation into the apparent connection between coho and 6PPD-quinone has been or will be furthered by other researchers. Here are some suggestions for expanding the research in order to better understand the impacts, and to collaborate on problem solving.

Why these streams?—My understanding is that the current research has focused on urban streams in Seattle, although I did not find the names of the streams studied. I am aware of two Seattle streams that had been hidden underground for many decades, and were "daylighted" within the past several years. Could there be pollutants in these streams from all those years ago, which are being released now and affecting the results?

Other possible pollutants?—Along the same lines, I am aware that catastrophic wildfires caused thick white, very fine particulate smoke throughout much of the Northwest last year and since 2014. Could these environmental conditions have had an effect on the results of this study? (I'm not a chemist, so I don't know.) Although it seems to be a delicate subject, I also need to express my concern about what I presume is a significant increase in human urine and excrement entering streams due to unsanitary homeless camps, especially in urban areas. Could this also be something that is having a negative effect on the coho?

Why coho?—It's interesting to me that coho were the species studied. Are they the only salmon species present in these urban streams? I'm aware that coho are prized for sport fishing, as well as market value. I found an article from 2007 that compares how far and wide different salmonid species have been introduced across the globe. Here is a global map for coho, showing its large native area (black diagonal lines) all around the coastal northern Pacific ocean. And coho have successfully been introduced (red) across most of the US, as well as South America, and a few disconnected Eurasian countries. This makes me curious if there are coho in other parts of the world (but originating from the north Pacific ocean) that are exhibiting the same reactions to 6PPD-quinone. It would be interesting to replicate the UW study at these other locations.



Taken from S.S. Crawford and A.M. Muir, Global introductions of salmon and trout in the genus Oncorhynchus: 1870-2007. Their Figure 5. Native distribution of coho salmon (Oncorhynchus kisutch; black diagonal) and countries, states or provinces into which this species and been introduced (red). Rev Fish Biol Fisheries 19 October 2007.

Another factor to consider is whether the coho from the Suquamish hatchery (I understand these were the test subjects in the current study) are genetically robust. Given some genetic variability concerns about hatchery salmon, perhaps a different coho stock should be used in a study replication.

And as the UW researchers state, "It is unlikely that coho salmon are uniquely sensitive, and the toxicology of 6PPD transformation products in other aquatic species should be assessed." I agree that other species should be assessed, and would especially encourage studies of chum salmon. This species has been successfully introduced in other urban streams in Seattle. Chum salmon are naturally found in the lower portion of rivers and streams. They tend to adapt well to shorter streams, close to estuaries.

<u>Place and time</u>—With respect to salmon, it seems that the impacts of 6PPD-quinone in freshwater would not be uniformly occurring. Coho salmon are only in streams when migrating to the ocean as juveniles, and again when they are returning to their home streams to spawn. This usually happens for a couple of months each direction. Different "runs" or subpopulations of all Pacific salmon have their own timing for when these outward and returning migrations occur. Specific locations and timing of migrations is relevant to potential impacts.

Also, to the extent that weather conditions induce the formation of 6PPD-quinone, there could be significant seasonal differences in impacts. Do results change with different temperatures? With different concentrations?

<u>Environmental protections</u>—There are many, well-established tools for filtering pollutants from streams. Natural resource agencies in Washington state have been developing and using such methods for half a century, as our traditionally rainy weather would warrant. Starting with wetlands--the natural way to clean up polluted water--then applying techniques such as bio-swales, retention ponds, and other geo-engineered remedies, we have made a lot of progress in cleaning up our polluted streams, especially to protect our salmon.

Summary—It is my distinct honor to have a chance to share my expertise on Pacific salmon as it pertains to this important subject. An exciting discovery was made by these researchers. These are my recommendations for finding out more about the implications of the study, and expanding the scope to include necessary field observations.

A. My habitat work tells me, all streams are not the same. This study focuses on stormwater chemistry. If it has not been done already, I recommend conducting surveys of the subject streams to assess additional factors that could affect or mitigate the potential impacts of 6PPD-quinone. This could include:
    - natural and stormwater flows by season
    - 6PPD-quinone concentration measurements in the field, by season and location
    - water temperature ranges by season and location
    - habitat quality in various stream reaches
    - other water quality factors at different locations, including sedimentation
    - identifying locations that would benefit from more biofiltering and other stream protection
    - food supply

B. Similarly, not all salmon stocks of the same species are the same. One hatchery coho subpopulation might respond differently to specific environmental stresses than another, different hatchery coho subpopulation. Studying wild coho stocks could introduce even more variation. Coho introduced to other continents would be very interesting to evaluate. And other species of salmon could have completely different responses. I'm especially interested in whether chum salmon would be a better alternative than coho for stocking these urban streams.

C. I strongly encourage addition of a bio-engineering effort to investigate methods of removing 6PPD-quinone from stormwater, especially in the localized areas (like low spots and drainage outfalls) where stormwater enters urban streams.