February 6, 2024 Cumulative Effects on Southern Resident Killer Whales and Contaminants of Emerging Concern

Follow-up

The slides and recording are available on the Salish Sea Science Roundtable webpage. The recording is the best place to see the questions that were answered live during the roundtable. This follow-up resource is not a comprehensive summary of the roundtable. Rather, we wanted to follow up on a few questions we didn't get to and elaborate on some key themes.

Inbreeding

Question: Even if the historically identified threats are mitigated, will this be enough to overcome the recently described effects of inbreeding (Kardos paper)?

Rob Williams: I am not a geneticist, so I asked our coauthor, Dr. Robert Lacy, this question. He wrote, "The several recent population viability analyses used data on the reproductive and survival rates experienced by the SRKW over the past few decades and, therefore, these rates reflect whatever damage has already been done by the inbreeding to date. Those analyses indicate that with aggressive action to reverse existing threats, the population can achieve positive population growth. However, quick action will be needed to achieve growth before further inbreeding leads to irrecoverable decline."

Additional reflections from participants:

- **Cindy Elliser:** "Genetic diversity: to Rob's point on how lethal the deleterious genes are, for Vaquita they have been inbreed for so long, that there are very few bad genes. So researchers determined that even though there are about 10 left, the low genetic diversity wouldn't be an issue for the population to recover. So it depends on what the genes are in SRKW now."
- **Deborah Giles:** "If enough harmful mutations build up in a population, that will result in a condition known as inbreeding depression. But inbreeding doesn't always mean a slow slide into genetic degradation. Even in very small populations, natural selection has a way of cleaning up a species' genome. It's called genetic purging, and according to new research led by Timothy Frasier, a biologist at Saint Mary's University in Nova Scotia, the struggling North Atlantic right whale population seems to be ditching some of its detrimental genes."

Pinniped-Predation (harbor seals, Steller sea lions, and California sea lions)

The Washington Academy of Sciences produced a review of pinniped predation on all salmonids. While they do eat a lot of salmon (both juvenile and adult), it wasn't clear if the predation was additive or compensatory.

6-PPD-Q & Southern Resident Killer Whales

Andy James and Ruth Sofield: Our work didn't include 6-PPD-Q for several reasons. Our focus is to highlight the chemicals that are present in Puget Sound at high enough concentrations to affect aquatic wildlife but are understudied. Our work relied on many years of monitoring data of contaminants of emerging concern (CECs) in biota and water samples. 6-PPD-Q was not one of those chemicals in our monitoring database. 6-PPD-Q is well demonstrated to have an impact on coho. There is a range of sensitivities amongst the salmon and fish species with coho being more sensitive.

- Lo et al. reported that, "Juvenile coho were 3 orders of magnitude more sensitive …(than) juvenile Chinook, with 24-h median lethal concentration (LC50) estimates of 41.0 and more than 67,307 ng/L, respectively." https://doi.org/10.1002/etc.5568
- French et al. reported some mortality to steelhead (4%–42%) and Chinook (0%–13%) (but not sockeye) to exposures to 100% (undiluted) stormwater for 24 hours. https://doi.org/10.1021/acs.estlett.2c00467
- Brinkmann et al reported acute LC50s for 6PPDq exposure in brook trout (590 ng/L) and rainbow trout (1,000 ng/L), but no sensitivity for char or sturgeon at measured concentrations as high as 14,200 ng/L) https://doi.org/10.1021/acs.estlett.2c00050

Additional reflections from participants:

- **Tim Rodgers**: "For Chinook, Lo et al. saw <50% mortality up to the solubility limit - still saw some but acute impact was at a level higher than most environmental exposures (from Tanya Brown's group) (https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.5568)"
- **Jay Davis:** "More on Chinook sensitivity to 6PPD: Urban roadway runoff is lethal to juvenile coho, steelhead, and Chinook salmonids, but not congeneric sockeye. Environmental Science and Technology Letter, 9 (9):733–738. (https://doi.org/10.1021/acs.estlett.2c00467)."

Additional Resources

The following resources were kindly shared in the chat by both presenters and participants.

- Southern Resident Killer Whales Zotero
- A cumulative effects model for population trajectories of resident killer whales in the Northeast Pacific by Cathryn Murray at DFO also updated Lacy's PVA work in 2021 and looked at multiple stressors, but it assumed the same functional relationship between salmon and SRKW demography as Lacy et al. (2017). The new PVA updates that fundamental prey-demography relationship using an integrated population model by Dr Ben Nelson and others
- 2020 Southern Resident Killer Whale Contaminants Technical Working Group Accomplishment Highlights and Recommendations provides a good intro to historical contaminants of concern for Southern Resident Killer Whales
- Rob's model used the following to inform declining PCBs:
    - Trends in harbor seals (Ross et al., 2013)
    - This model links annual PCB accumulation rate to calf survival (Hall et al. 2018)
- Right Whales Are Losing the Right Genes (Hakai Magazine, 2024)
- Pinniped Predation on Salmonids in the Washington Portions of the Salish Sea and Outer Coast (Washington State Academy of Sciences, 2022)
- These Vets Make House Calls for Killer Whales (New York Times, 2023)