# Cardiac injury and reduced growth in Pacific herring exposed to urban stormwater runoff

Puget Sound Stormwater Science Team

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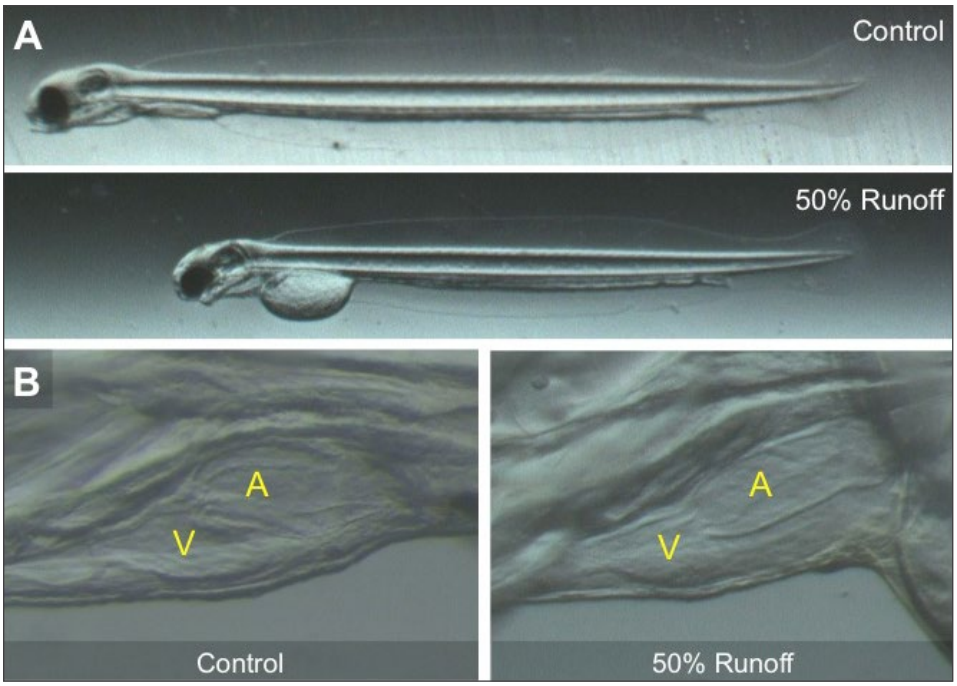
- **Stormwater exposed herring embryos exhibited cardiac injury consistent with PAH exposure.**
- **Stormwater runoff has the potential to cause delayed adverse outcomes for exposed herring.**

Pacific herring (*Clupea pallasii*) are a keystone species in Puget Sound. Like many forage fish species, they spawn adhesive eggs on intertidal and shallow subtidal substrates placing sensitive life history stages (embryos and larvae) in close proximity to land-based non-point source pollution such as urban stormwater runoff. Untreated urban runoff is chemically complex and highly toxic to aquatic life, including freshwater fish and invertebrates (McIntyre et al. 2015; Spromberg et al. 2016). However, very little is known about the impacts of urban runoff on nearshore marine fish. To examine the impacts of stormwater runoff on forage fish embryonic development, we exposed herring embryos to 0, 12, 25, or 50% stormwater runoff for 6 days beginning just prior to the onset of a visible heartbeat (5 dpf) through hatching (11 dpf). At the end of the exposure, water and tissue samples were collected for chemical and molecular analyses, and hatched larvae were imaged for morphological analyses.

Chemical analyses revealed that stormwater runoff contained a complex mixture of metals, polycyclic aromatic hydrocarbons (PAHs), and nutrients, as has been shown in previous studies (McIntyre et al. 2014). Stormwater runoff contained high levels of dissolved copper and nickel and a broad range of PAHs including naphthalenes, phenanthrenes, chrysenes, fluoranthenes, and pyrene. Total PAH concentrations in embryos were positively correlated with stormwater runoff concentration and contained similar percent PAH compositions as stormwater runoff.

Mean hatching occurred 12 days post fertilization for all treatment tanks and there was no significant difference in hatching rates across treatments. Preliminary results indicate that stormwater exposures caused significant reductions in larval length in embryos exposed to 50% stormwater runoff. In addition, herring exposed to stormwater runoff exhibited cardiac injury consistent with the known cardiotoxicity of PAHs to fish embryos (Incardona et al. 2004; 2009; 2016). For example, in larvae exposed to 25% or more stormwater runoff, the mean atrial area was increased and the shape of the ventricle was altered. The cardiac morphology exhibited in larvae exposed to stormwater runoff was very similar to the cardiac injury phenotype observed in herring embryos exposed to oil (unpublished data, John Incardona). This type of cardiac injury has been linked to reduced cardiorespiratory fitness suggesting that stormwater runoff exposure could result in delayed adverse outcomes for exposed herring (Incardona et al. 2015).




Representative images of larval herring bodies (A) and hearts (B, left lateral view) from control and 50% stormwater runoff exposure treatments. (A = atrium, V = ventricle)

# RECOMMENDED CITATION

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