

Does Salinity Mediate the Toxicity of Perfluorooctanesulfonic Acid in Estuarine Larvae and Embryos?

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INTRODUCTION

- PFOS is one of the most commonly detected PFAS in estuarine environments
- Data is biased towards freshwater species
- Tested under brackish (10 ppt) and marine (30 ppt) conditions
- Hypotheses: 1) PFOS influences growth and survival of sheepshead minnows in a dose dependent manner and 2) salinity and PFOS non-additively interact to influence growth and survival

METHODS

1. Tested 1, 10, 100, 1,000, and 10,000 ppb PFOS at 10 and 30 ppt salinity for 96 hours
2. Collected mass, length, and time to hatch

RESULTS

- Embryonic survival was not impacted by salinity, PFOS or their interaction
- Time to hatch was delayed in high PFOS concentrations (1,000 and 10,000 ppb)

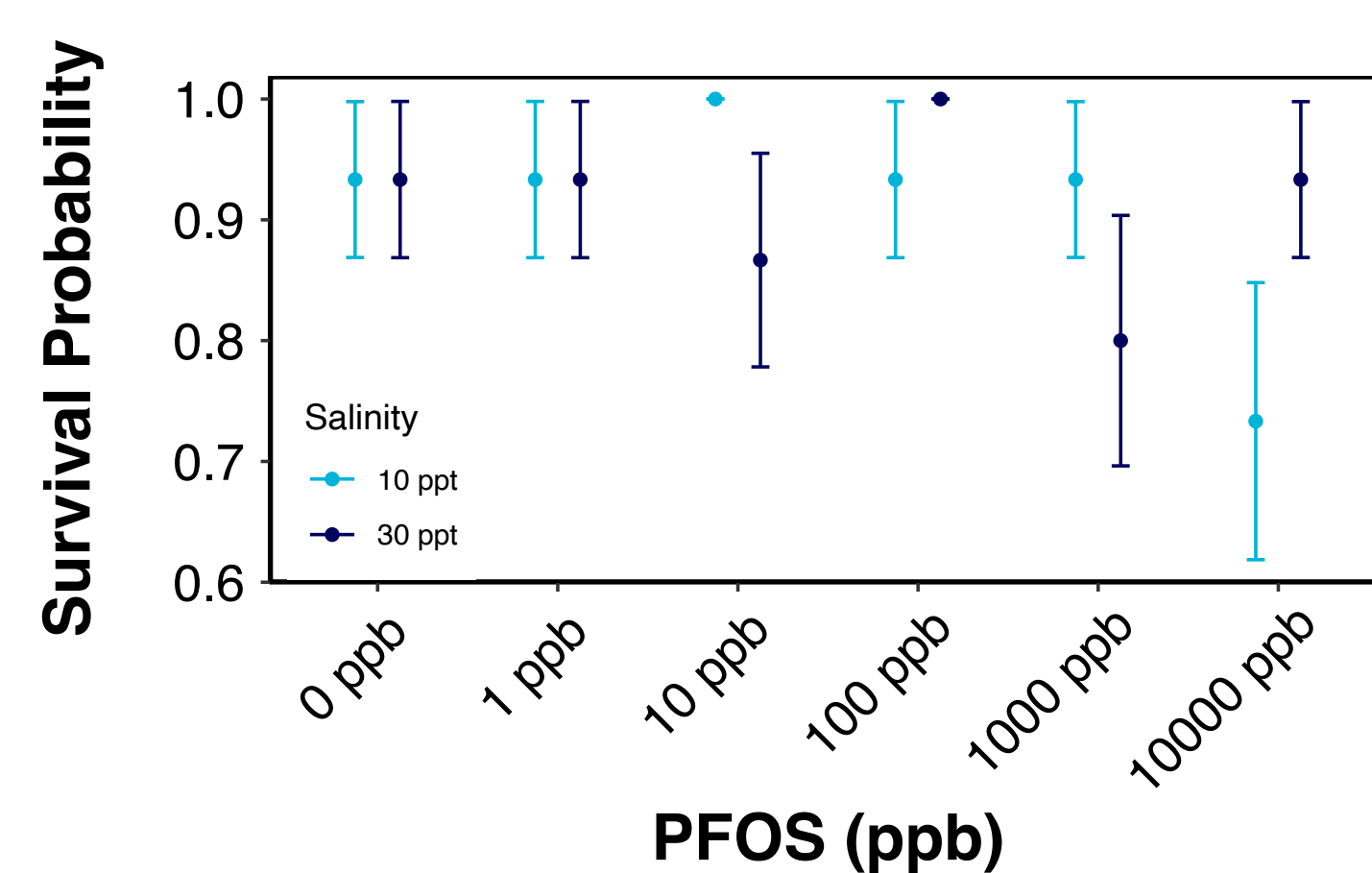


Fig. 1: Estimated embryo survival probabilities from categorical logistic regression. Error bars are ± 1 S.E.

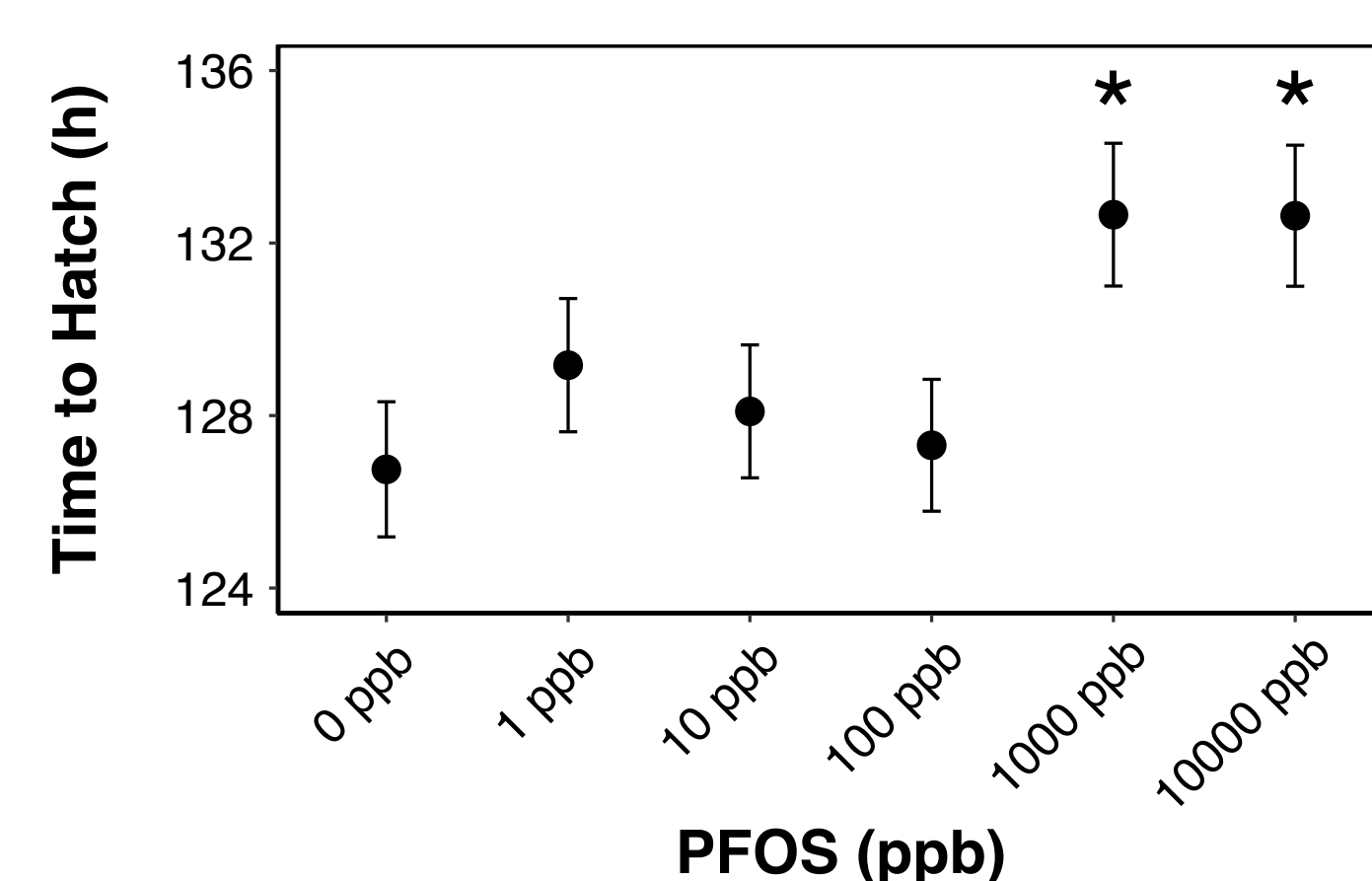


Fig. 2: Marginal means of the effect of PFOS on time to hatch from 2-way ANOVA. Treatments with asterisks differed from the control based on a Dunnett's test ($\alpha = 0.05$). Error bars are ± 1 S.E.

Salinity mediates PFOS toxicity in estuarine larvae but not in embryos



Modified from: Lencer E.C., Warren, W. C., Harrison, R., & McCune, A. R. (2017). The *Cyprinodon variegatus* genome reveals gene expression changes underlying differences in skull morphology among closely related species. *BMC Genomics*, 18(1), 424–424. <https://doi.org/10.1186/s12864-017-3810-7>

ABSTRACT:

Per- and polyfluoroalkyl substances (PFAS) are a class of ubiquitous environmental contaminants commonly found in estuarine environments. Estuaries are dynamic systems with regular, dramatic fluctuations in abiotic factors such as salinity, dissolved oxygen, and temperature. Despite this, how abiotic factors mediate PFAS toxicity remains unexplored. We tested the hypothesis that salinity mediates toxicity of perfluorooctane sulfonate (PFOS) in embryonic and larval sheepshead minnows (*Cyprinodon variegatus*; a model estuarine fish). In two factorial experiments, we exposed embryos through hatching and larvae to PFOS for 96 hours at 1, 10, 100, 1,000, and 10,000 parts per billion (ppb) across two salinity levels (10 and 30 parts per thousand (ppt)). In the embryonic exposure, we measured survival, size, and rate of development and in the larval exposure, measured survival and size. Although we found no effects on embryo survival, we observed increased time to hatch at 10,000 ppb PFOS, but no salinity by PFOS interactions. In contrast, larval survival was significantly reduced by PFOS, and PFOS was 3 times more toxic at 30 ppt relative to the 10 ppt salinity (LC50, 30 ppt = 1,108 ppb, LC50, 10 ppt = 3,106 ppb). Measured PFOS concentrations in water suggest that salinity may have influenced bioavailability of PFAS, which could explain the observed PFOS by salinity interaction on the larval LC50. Our results warrant more work aimed at assessing if/how PFAS toxicity is mediated by salinity and/or other factors that fluctuate under field conditions.

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RESULTS cont.

- Larval survival was decreased by exposure to increased concentrations of PFOS
- Ratio test: LC50s are significantly different ($p < 0.0001$)
- PFOS was more toxic when coupled with the higher (30 ppt) salinity

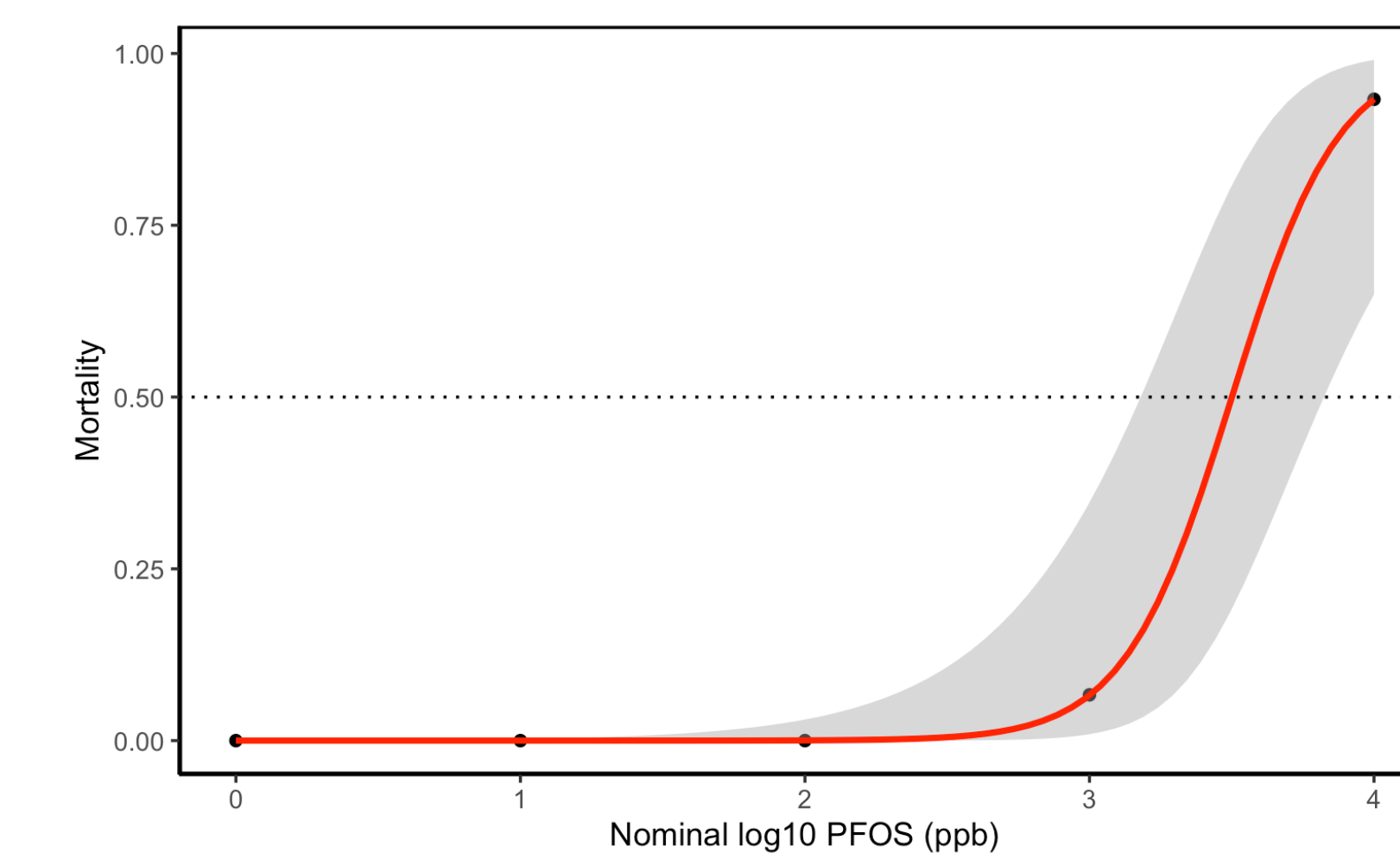


Fig 3: 10 PPT: LC50 for 10 ppb is 3166.24, p of slope < 0.00026 , SE = 1.45053

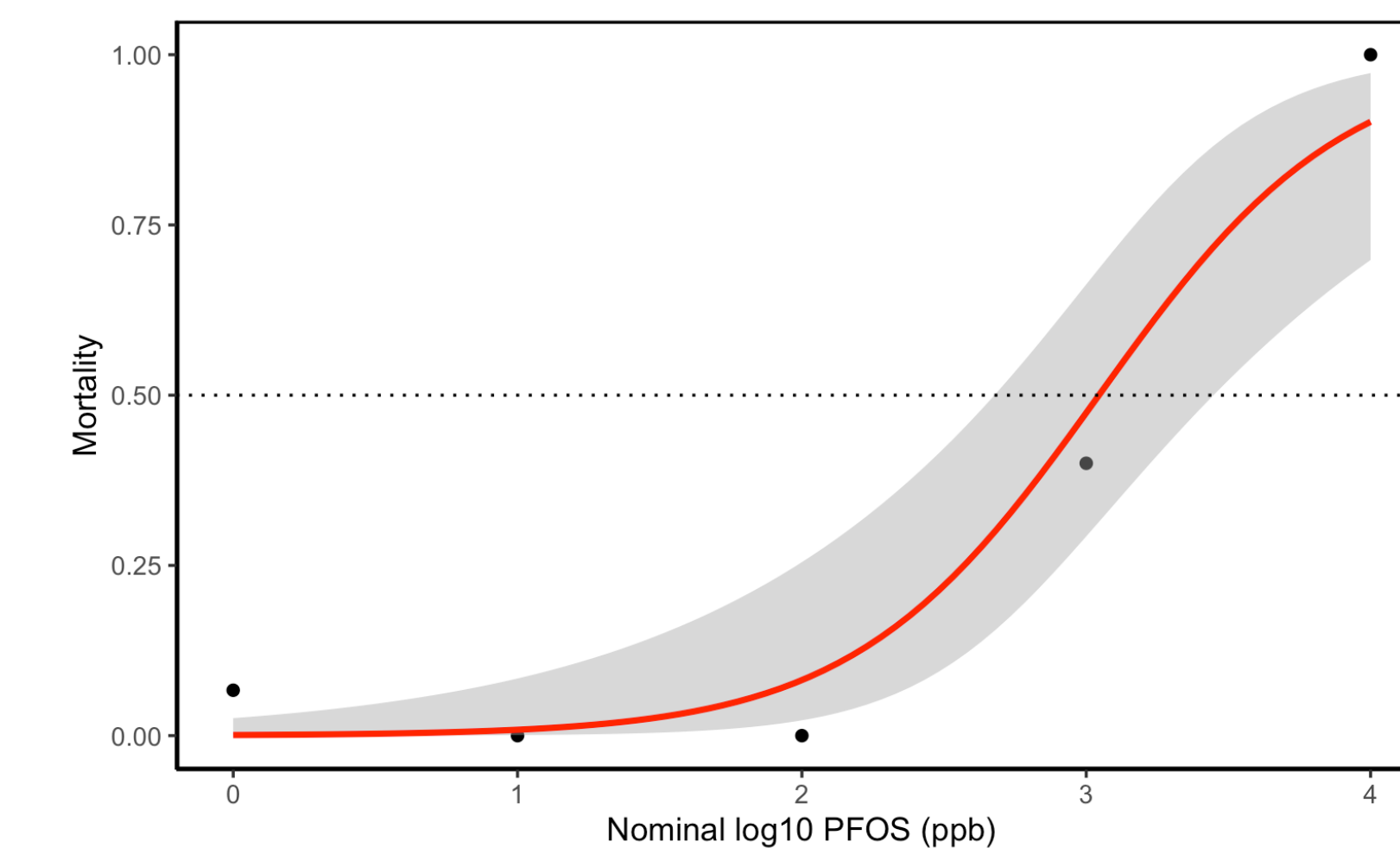


Fig. 4: 30 PPT: LC50 = 1108.57, p slope < 0.0001 , SE = 0.569.

DISCUSSION

- We are unlikely to see adverse effects at these PFOS concentrations
- PFOS-mediated delayed hatching can increase embryo's susceptibility to predators
- Larvae are more sensitive to PFOS exposure

FUTURE DIRECTIONS:

- Test other PFOS (>4,500 in existence)
- Other abiotic factors (O₂, UV, temperature)
- Multiple stressors

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