Assessing prevalence, pathways, and impacts of selenium exposure for fish species of concern in the Sacramento-San Joaquin Delta

Annual Workshop
March 22-24, 2022

Frederick Feyrer[1], Robin Stewart[2], and Rachel Johnson[3]

[1]U.S. Geological Survey, California Water Science Center, [2]U.S. Geological Survey, Water Mission Area , [3]National Marine Fisheries Service and U.C. Davis

What is selenium?

Selenium is an essential nutrient required for oxidative and enzymatic processes. It is found naturally in soils and minerals. It is also a potent toxin at elevated concentrations.

When is selenium a problem?

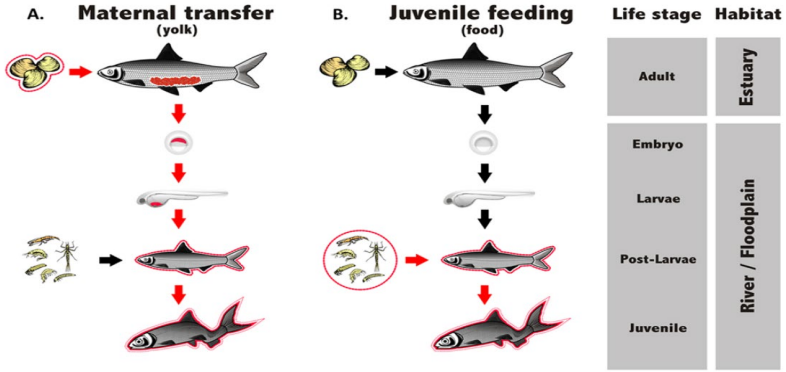
Excessive selenium can affect an organism's physiology, health, and fitness. Elevated dietary exposure exceeding 3 µg/g can disrupt protein synthesis by substituting selenium for sulfur in ionic disulfide bonds, induce oxidative stress, and modulate expression of genes controlling bone formation, resulting in deformities.

Toxic exposure in splittail

Note the curved spine, bulging eyes, and deformed skull and fins.

How are splittail exposed to selenium?

Splittail can obtain selenium via (A) maternal transfer, whereby reproductive females sequester selenium in eggs during vitellogenesis, and/or (B) direct ingestion of contaminated prey with elevated selenium.



Your help is needed !

Please save and freeze any deformed fish for further investigation.
Report observations of deformed fish to the authors:
ffeyrer@usgs.gov, rachel.johnson@noaa.gov, arstewart@usgs.gov

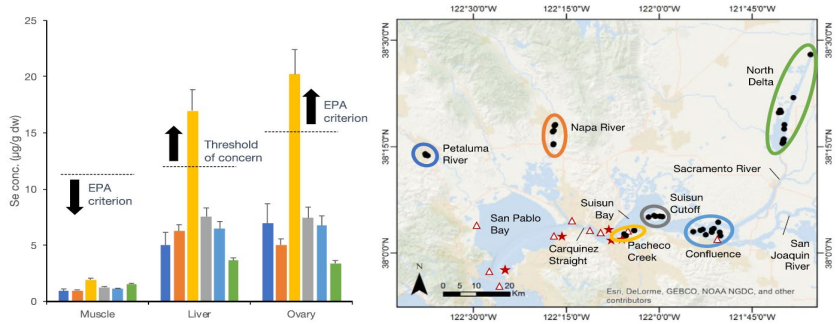
Sources of information

Johnson, R., Stewart, A.R., Limburg, K., Huang, R., Cocherell, D., Feyrer, F. 2020. Lifetime chronicles of selenium exposure linked to deformities in an imperiled migratory fish. Environmental Science and Technology https://dx.doi.org/10.1021/acs.est.9b06419

Stewart, A.R., Feyrer, F., Johnson, R. 2020. Resolving selenium exposure risk: Spatial, temporal, and tissue-specific variability of an endemic fish in a large, dynamic estuary. Science of the Total Environment https://doi.org/10.1016/j.scitotenv.2019.135919

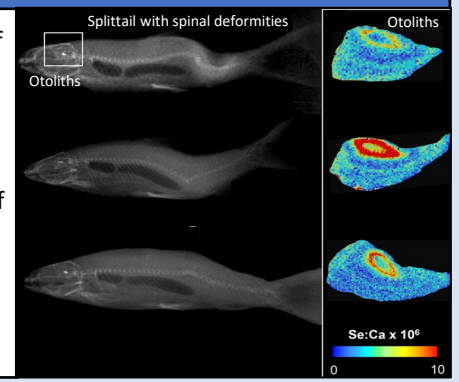
How should toxicity be measured?

Existing EPA criteria to measure selenium in muscle tissue underrepresents selenium exposure in splittail. Selenium measurements in liver and ovary tissue are needed to quantify spatial and temporal patterns of selenium exposure in adult splittail.



CSI: Reconstructing exposure history

Otoliths record the chemical environment of individual fish. A combination of inductively coupled mass spectrometry, X-ray fluorescence microscopy, and depositional chronology is used to reconstruct the location, life stage, duration, and intensity of selenium exposure in individual fish. These data can then be used in cohort reconstructions to identify population level impacts of selenium.



Funding provided by the U.S. EPA, U.S. Fish and Wildlife Service, Central Valley Regional Water Quality Control Board, and National Science Foundation.