

Water Quality Effects on Survival, Growth and Feeding Performance in Larval Delta Smelt (*Hypomesus transpacificus*)

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The Sacramento-San Joaquin Delta (Delta) is a complex system of tidally-influenced, interconnected waterways that serves as a vital resource to both humans and wildlife. In recent years dramatic population collapses have been observed in a number of fish species, including the federally threatened delta smelt (*Hypomesus transpacificus*). A long history of industrial, agricultural and urban land use in the Delta has led to extensive environmental impacts from the release of anthropogenic contaminants, which have been widely recognized as a factor contributing to recent declines. However, contaminant impacts on delta smelt population dynamics remain poorly understood. The primary objective of this investigation is to assess sub-lethal, pathological and physiological stresses imposed on larval delta smelt by water-borne contaminants in the Delta. Bioassays were conducted using delta smelt eggs obtained from the Livingston Stone National Fish Hatchery's refugial population program. Eggs and larvae were reared in Delta water, and post-hatch survival, growth rate and feeding performance were monitored. During water collection for the bioassay tests additional water samples were collected for contaminant analysis. Samples underwent pyrethroid, organophosphate, organochlorine, and fungicide analysis to determine if sub-lethal impacts are correlated to concentrations of contaminants detected in water from the Delta. Although contaminant concentrations in the Delta may not be acutely toxic to delta smelt, they have the potential to elicit a host of sub-lethal effects that may be impairing growth, survival and reproduction. Assessing these sub-lethal effects will lead to a better understanding of the role contaminants play in recent population collapses.

Keywords: aquatic toxicity, delta smelt, pyrethroid, organophosphate, organochlorine, fungicide

Poster Cluster Title: Organic Contaminants 1

The Effects of a Commonly Used Pyrethroid, Bifenthrin, on the Reproductive Health of Steelhead (*Oncorhynchus mykiss*)

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The Bay-Delta is an important breeding and nursery ground for many species. Habitat quality and contamination of surface waters are limiting factors for ESA-listed fishstocks in watersheds with significant land use. Bifenthrin has received little attention regarding its effects on salmonid populations despite being detected in northern California runoff. While the potential for aquatic toxicity is evident, it is unknown what effect bifenthrin exposure has on the reproductive health of fishes. Plasma sex steroids and gonadosomatic index (GSI) were determined in juvenile steelhead exposed to bifenthrin (low: 0.028 ± 0.006 ug/L; high: 0.719 ± 0.073 ug/L) for 14 days and gonadal tissue was examined histologically. Females exposed to bifenthrin (high dose) had significantly ($p = 0.0251$) elevated estradiol-17 β (E2) levels. There was no difference in testosterone (T; $p = 0.1430$), 11-ketotestosterone (11-KT; $p = 0.0760$) or GSI ($p = 0.1937$). Although ovarian follicle diameter significantly ($p < 0.0001$) increased in bifenthrin-treated fish, widespread atresia was observed throughout the ovary (low dose $91.24 \pm 8.89\%$; high dose $82.76 \pm 10.84\%$). In male steelhead, sex steroids were not significantly altered (E2 $p = 0.0634$, T $p = 0.0833$, 11-KT $p = 0.3057$) after treatment. GSI was reduced ($p = 0.0231$), but the testis did not show measurable histological damage. These data indicate that exposure to bifenthrin results in reproductive dysfunction in female steelhead while males appear to be relatively unaffected. The ecological implications are uncertain, but further study is warranted. Additionally, given the increased urban use of bifenthrin and relatively high levels in the aquatic environment, a more comprehensive understanding of the impact of bifenthrin on wildlife will be imperative for improving risk assessment of pyrethroid use in the Bay-Delta in coming years.

Keywords: Steelhead, bifenthrin, pesticide, reproduction

Poster Cluster Title: Organic Contaminants 2

Monitoring Input of Current-Use Pesticides to the Sacramento-San Joaquin Delta

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Current-use pesticides in the Sacramento-San Joaquin Delta (Delta) are generally detected in seasonal patterns that depend on timing of application and transport mechanism. The two major inputs to the Delta are the Sacramento and San Joaquin Rivers, which drain 34,965 and 61,124 square kilometers, respectively. With large agricultural and urban areas, the two watersheds are a significant source of pesticides to the Delta. Current monitoring studies in the Delta analyze less than half of all pesticides applied in the watershed. The U.S. Geological Survey Pesticide Fate Research Group frequently updates their analytical methods to address changing use and to include newly-registered pesticides. Recent improvements to these methods include the additional analysis of 35 fungicides, six neonicotinoid insecticides, two rice herbicides (clomazone and propanil), and seven pesticide degradates. These analytical methods are currently being used in a monitoring study designed to characterize the input of dissolved pesticides to the Delta. Water samples are being collected from two sites (Sacramento River at Freeport and San Joaquin River near Vernalis) twice a month for one year. These water samples are filtered and are analyzed for over 100 current-use pesticides and pesticide degradates by GC/MS and LC/MS/MS. The results of this study will provide a robust dataset on current-use pesticides entering the Delta. This study will serve as a basis for additional targeted studies, which may focus on particular areas within the Delta, or the seasonality of pesticide occurrence. Future studies in collaboration with toxicologists and fisheries biologists may address the effects of particular pesticides or mixtures on sensitive species within the Delta.

Keywords: pesticides, fungicides, neonicotinoids, Sacramento River, San Joaquin River

Poster Cluster Title: Organic Contaminants 3