



# Fish entrainment trends during hydraulic dredging in San Francisco Bay

## Dredging Operations Environmental Research (DOER) Program

U.S. ARMY CORPS OF ENGINEERS

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### Focus Area

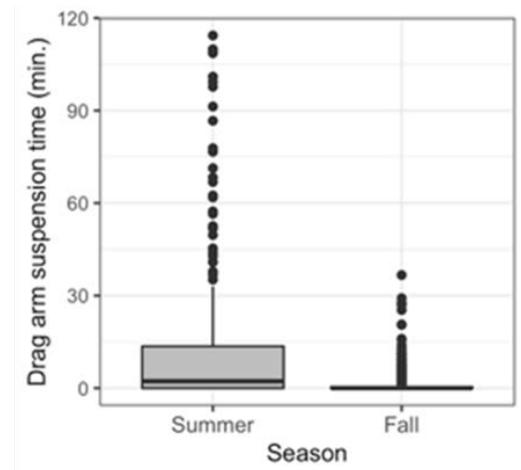
Environmental Resource Management

### Problem

Fish and invertebrate entrainment during hydraulic dredging is a constant concern worldwide but the problems magnitude and mitigation are always debatable. In San Francisco Bay, federal and state listed fish including the delta smelt (*Hypomesus transpacificus*) and longfin smelt, (*Spirinchus thaleichthys*) are entrained during ongoing dredging operations. Entrainment of these species has altered how the USACE does dredging in San Francisco Bay by changing the time of year dredging is preferred or requiring the use of clamshell dredging in certain locations. Fish entrainment is complicating the scheduling and fielding of dredging, impacting channel maintenance and increasing cost. This suggests a need to understand associations between dredge operations and fish entrainment.

### Study Description

Analysis is based on entrainment data collected aboard the Esayons. A subsample of dredged material is separated into a sampling basket that captures a sample of what is being entrained. Each hopper load is sampled and fish and invertebrates are identified and counted. The entrainment data is merged with the Dredging Quality Management (DQM) data to capture engineering data on dredging operations. The study questions we addressed are: 1) How do operational and environmental covariates influence the probability of entraining a fish/invertebrate? 2). How do operational and environmental covariates influence the number of fish/invertebrates sampled? We examined dredge volume, time drag arm was suspended in open water, season and vessel speed as operational covariates and salinity and median tide height as environmental covariates. Location was treated as a random effect. Initial results show that the entrainment probability increases with the amount of time drag arm is suspended in the water and with the total volume of dredged material. Seasonal effects are important as entrainment probabilities are greater in the spring/summer than fall.

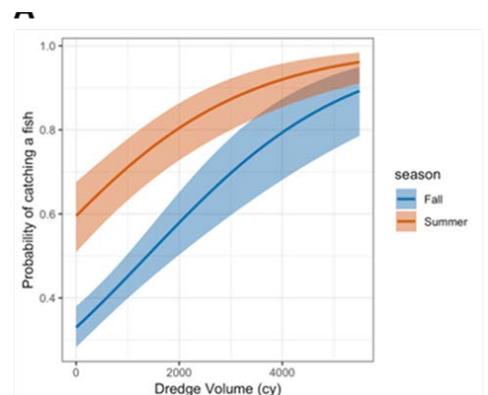


### Products

One report is drafted and has been reviewed by San Francisco District. We intend to produce a journal manuscript for submission this spring.

### Summary

The analysis suggest that we are entraining large numbers of fish and invertebrates which in turn increases probability of entraining federal and state listed species. Reducing overall fish and invertebrate entrainment would also reduce the entrainment of federal and state listed species. Understanding the data we have may help shape effective strategies to reduce entrainment and increase the USACE ability to dredge cost effectively.



Balancing operational and environmental initiatives and meeting complex challenges of dredging and dredged material placement in support of the navigation mission.