Sea Grant California

The effects of freshwater flows on the native Olympia oyster in San Francisco Estuary

Andrew Chang, former Delta Science Fellow

BACKGROUND

After heavy winter storms, salinity levels in the San Francisco Estuary can drop precipitously, stressing and sometimes killing organisms such as the native Olympia oyster (*Ostrea conchaphila*) and invasive Mediterranean mussel (*Mytilus galloprovincialis*).

Conversely, prolonged drought conditions can favor the bivalves' proliferation by maintaining higher salt levels.

PROJECT

This project examines two closely linked questions with direct implications for restoring the native oyster and managing the invasive mussel in the San Francisco Estuary:

1) How are local populations of the two species interconnected?

2) How do freshwater flows during the rainy season affect species' fitness and reproductive output?

To answer these, the Delta Science Fellow tracked abundances and size classes (ages) of native oysters and non-native mussels at 10 long-term monitoring sites in the upper estuary, where the water is brackish and the salt content is highly influenced by local runoff and river inputs.

Trace elemental fingerprinting was used to determine natal origins and fate of bivalves' larvae throughout the estuary. Laboratory experiments were conducted to further investigate and quantify low-saline stress-effects on molluscan heart rate, reproduction and survival.

> "Olympia oysters are one of the few native Pacific coast estuarine species. Yet, relatively little is known about some of the major factors controlling their numbers and where they show up."
>
> -Andrew Chang, former Delta Science Fellow

Olympia oysters, *above left*, are a foundational estuarine species in California and are the target of ongoing restoration efforts. *PHOTO: NOAA*

Andy Chang, *left*, conducts a shoreline survey of oyster abundance and size at Point Orient in Richmond, Calif. *PHOTO: UC Davis*

RESULTS

Results to date indicate a clear link between freshwater flows and several stages of the oyster's life cycle. Adult oyster numbers in the upper estuary were high during dry, low-flow conditions and low during sustained wet, high-flow conditions.

In particular, there were high numbers of adult oysters in the upper estuary at China Camp State Park in 2009 – the last year of a three-year drought – and in 2010, when the drought ended and more freshwater began entering the estuary.

Oyster densities remained very high until the spring of 2011 when heavy rains caused mass die-offs of the animals. The resulting distribution of adult oysters in 2011 was very similar to that observed by other researchers in 2006 following a season of above-average precipitation.

The Delta Science Fellow also found strong correlations between freshwater inputs and the timing and location of maximum oyster recruitment and settlement on shore. Recruitment in 2009 was very high at China Camp, in areas with the highest adult oyster densities on shore. As the drought ended (2010) and shifted to a wet year (2011), oyster recruitment was observed to occur progressively later in the season and further downstream, where salinities were less affected by freshwater inputs.

"Where oyster densities were highest in the estuary depended on both how wet the most recent winter was and how long it had been since the last severe wet winter," Chang said.

The fellow is still analyzing much of the data collected during this project. He plans to combine his field data with other datasets to parameterize models that might be able to describe bivalve population dynamics in response to freshwater flows. If these models can be developed, they could be used to predict shellfish responses to future freshwater flow regimes, as altered by climate change, water diversions, invasive species and watershed management.

MANAGEMENT APPLICATIONS

The information on oyster recruitment that has been gathered during this project can be used to help decide when and where to place hard substrate on the bottom to increase the amount of settlement habitat for new oysters.

PRESENTATIONS

Chang A.L., A.K. Deck, P.D. Malm, K. Willits, S. Attoe, J.L. Fisher, & S.G. Morgan. (2012) Location, location, location: What is the best place for Olympia oysters growing up in San Francisco Bay? Delta Science Conference, Sacramento, Calif.

Chang A.L., A.K. Deck, P.D. Malm, K. Willits, S. Attoe, J.L. Fisher, & S.G. Morgan. (2011) Great place to live, but I wouldn't want to raise my kids there: Linking habitat quality and population dynamics of Olympia oysters in San Francisco Bay. State of the San Francisco Estuary meeting, Oakland, Calif.

Chang A.L., A.K. Deck, P.D. Malm, K. Willits, S. Attoe, J.L. Fisher, & S.G. Morgan. (2011) Going with the flow or staying close to home? Linking habitat quality and population dynamics of Olympia oysters in San Francisco Bay. Ecological Society of America meeting, Austin, Texas.

Chang A.L., S. Attoe, P.D. Malm, K. Willits, A.K. Deck, J.L. Fisher, & S.G. Morgan. (2010) Going with the flow or staying close to home? Population connectivity, freshwater flow, and native oyster restoration in San Francisco Bay. Western Society of Naturalists meeting, San Diego, Calif.

RESEARCH MENTOR

Steven Morgan, Bodega Marine Laboratory, UC Davis

COMMUNITY MENTOR

Natalie Cosentino-Manning, NOAA Fisheries Restoration Center, Santa Rosa

CONTACT

Andrew Chang, Ph.D.
Postdoctoral Researcher
Bodega Marine Laboratory
UC Davis
530-400-9410
andchang@ucdavis.edu

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