



**National Estuarine
Research Reserve System**

Estuary Data Mystery

Title: How did the wild oysters in San Francisco Estuary mysteriously die off?

Reserve, State: San Francisco Bay Research Reserve, California

SWMP Station: Water Quality (WQ) China Camp

Parameters: Water temperature, turbidity, pH, salinity, precipitation

Start and End Dates: March 1, 2011, to April 30, 2011

Data: Available and easy to graph at nerrsdata.org

Investigate This: Scientific surveys in 2010 documented that China Camp State Park, part of the San Francisco Bay National Estuarine Research Reserve, was home to a thriving population of wild native oysters. Native oysters are not as abundant as they were historically in the San Francisco Estuary. Many scientists, policy makers, and landowners hope to encourage more oysters to grow in the estuary as a way to encourage healthy food webs and protect shorelines from waves and storms. Therefore, scientists from the National Estuarine Research Reserve monitor populations of oysters at China Camp State Park to understand how they might restore or expand oyster populations in other parts of the estuary.

Unexpectedly, in 2011 a mass mortality event left all the oysters at China Camp dead. What killed the oysters? Scientists used the System-Wide Monitoring Program data they had available to search for evidence and piece together an explanation of what happened to the oysters.

The System-Wide Monitoring Program (SWMP) water quality station at China Camp collects data on seven water quality parameters, including [salinity](#), temperature, [turbidity](#), and [pH](#), every 15 minutes. These data from March-April 2011 are in **Figures 1-4**. Examine each graph carefully. Look for patterns within each graph and between the graphs. Do you see any evidence that might suggest what caused the oyster die-off? Based on the evidence you have, develop an explanation for what may have caused the oysters to die.

Figure 1: Water temperature at China Camp pier from March 1 through April 30, 2011

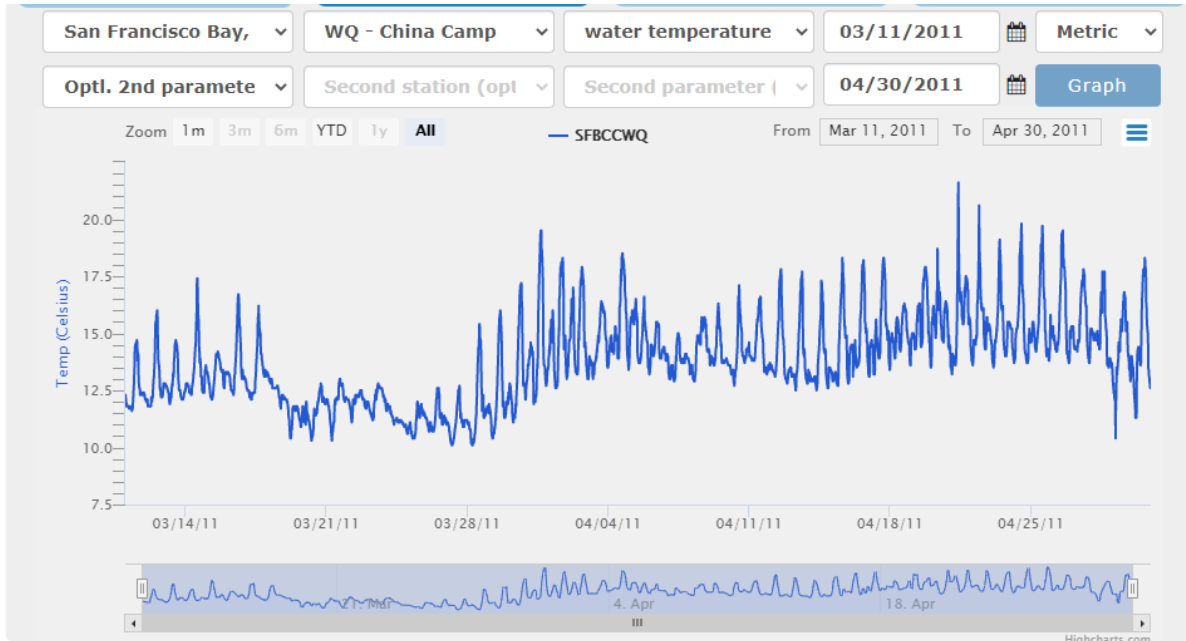


Figure 2: Turbidity at China Camp pier from March 1 through April 30, 2011

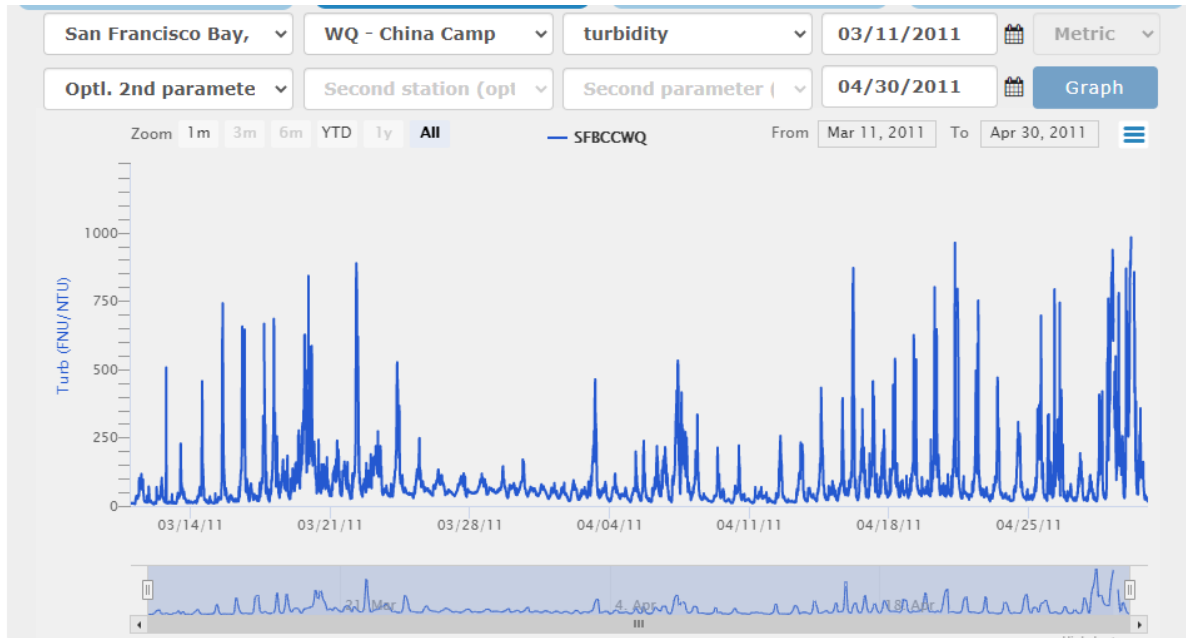


Figure 3: pH at China Camp pier from March 1 through April 30, 2011

Fluctuated between 7.5 to 8.5 with low point on March 21 and high point on April 23.

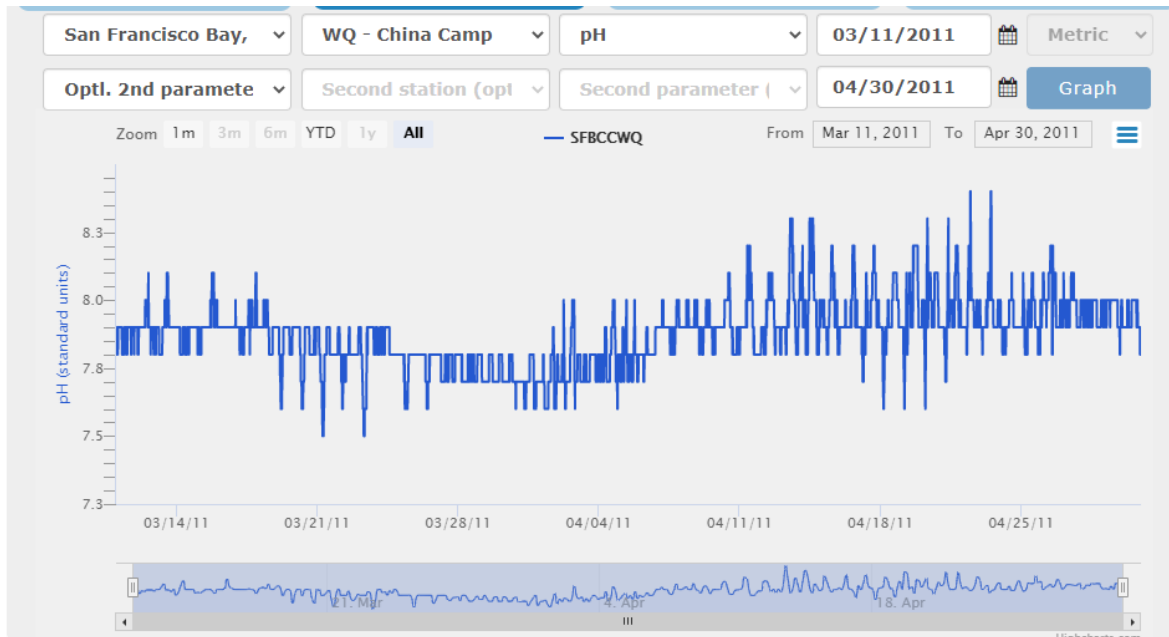
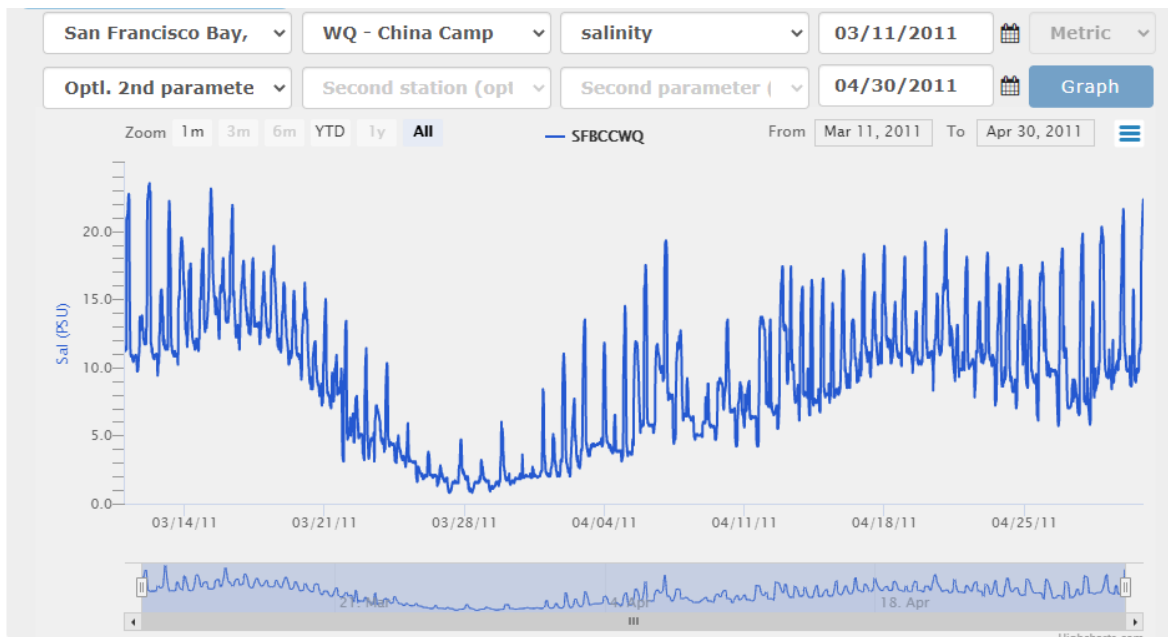


Figure 4: Salinity at China Camp pier from March 1 through April 30, 2011



Scientists also looked at weather data to look for explanations of the patterns they saw in the water quality data. There is no National Estuarine Research Reserve weather station at China Camp, but there is one about 25 miles away at Rush Ranch. Rush Ranch is also within the San Francisco Estuary watershed. Graphs of precipitation (rainfall) for March 1 through April 30 and for all of 2011 are shown in **Figures 5-6**. Does the rainfall data add to your explanation of what may have caused the oysters to die?

Figure 5: Total precipitation from March 1 through April 30, 2011, at Rush Ranch

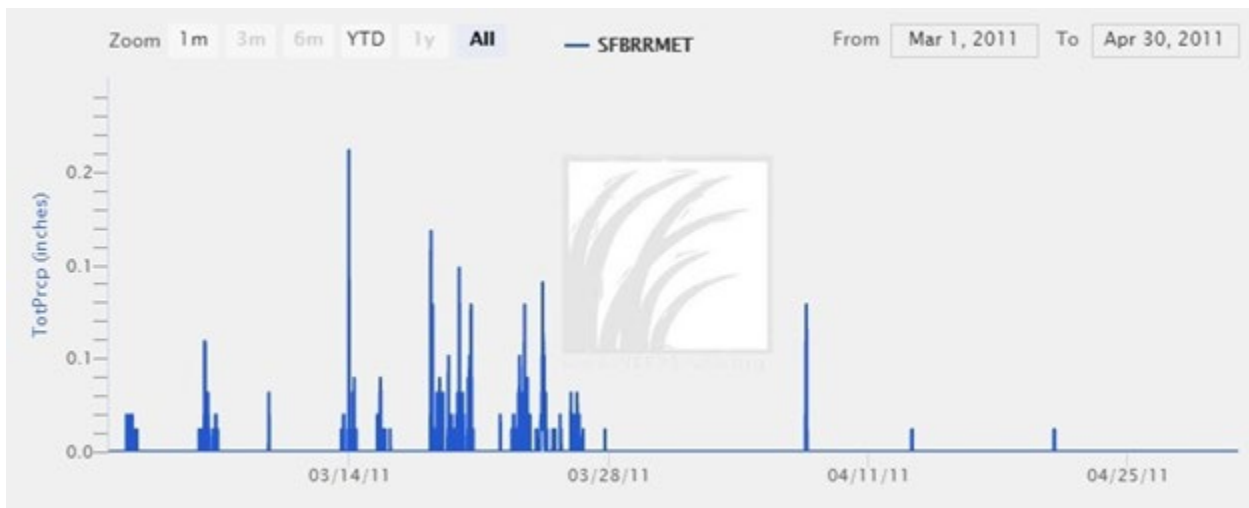
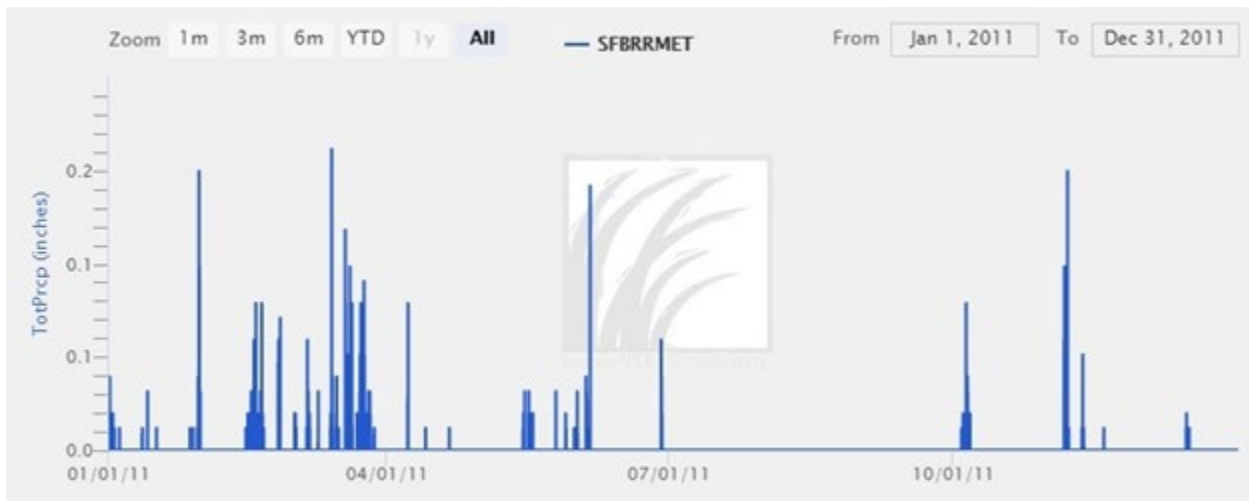


Figure 6: Total precipitation for all of 2011 at Rush Ranch. The oyster die-off occurred between the beginning of March and the end of April.



Extension Idea: Using the data for the China Camp water quality station, can you determine if there had been more recent storms that may have put the recovering oyster population at China Camp in danger?

Next Generation Science Standards Alignment

This SWMP Story can be used to teach Next Generation Science Standards Science and Engineering Practices of analyzing and interpreting data and engaging in arguments from evidence. This SWMP Story is one part of a three-part lesson available from the San Francisco Bay National Estuarine Research Reserve at www.sfbaynerr.org. Taught together, the three parts address the following performance expectation:

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

The science that this SWMP Story refers to has been published in several peer-reviewed articles, including:

Cheng, B.S., A.L. Chang, A. Deck, and M.C. Ferner. 2016. "Atmospheric Rivers and the Mass Mortality of Wild Oysters: Insight into an Extreme Future?" *Proceedings of the Royal Society B*. doi: 10.1098/rspb.2016.1462.