Predicting Grunion Migration Patterns and Spawning Areas in Response to Changes in California's Oceans

Abstract

The California grunion (*Leuresthes tenuis*) is a species of fish endemic to the California coastline that plays an important role in the marine food chain as a consumer of zooplankton and a food source for larger marine creatures. Grunion spawning events, commonly referred to as "grunion runs," occur when the tide is highest during nights surrounding a new or full moon, allowing the fish to "run" up the beach to deposit and fertilize their eggs before returning to sea. These runs happen most frequently during the summer months along beaches in Los Angeles, Orange, and San Diego counties. However, spawning events documented over the last three decades in the San Francisco Bay suggest a pattern of northern migration caused by changes in ocean conditions and increased human beach activity. In collaboration with the Grunion Greeters Project and the California Department of Fish and Wildlife, the team evaluated oceanic environmental and ecological factors that affect grunion spawning patterns. Earth observation data products, including NASA Multi-scale Ultra-high Resolution Sea Surface Temperature (MUR SST) and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) chlorophyll-a (chl-a), were used to create time series of the California coastline and nearby Pacific Ocean from 2003 to 2018. Upwelling, sea surface current, air temperature, and harmful algal bloom (HAB) data were also considered to derive correlations between the above parameters and grunion spawning events. Analyzing how a changing ocean affects the California grunion will allow for more accurate predictive modeling of spawning behavior and will provide the knowledge base needed to protect this unique species.

Objectives

- **Create** time series of satellite Earth observations and ocean observation *in situ* data
- **Compare** time series at different latitudes as well as calculate anomalies of ocean observation and satellite data to determine factors affecting grunion spawning patterns
- **Develop** a dynamic tool for the project partners to easily replicate methods for future satellite and *in situ* data

Study Area

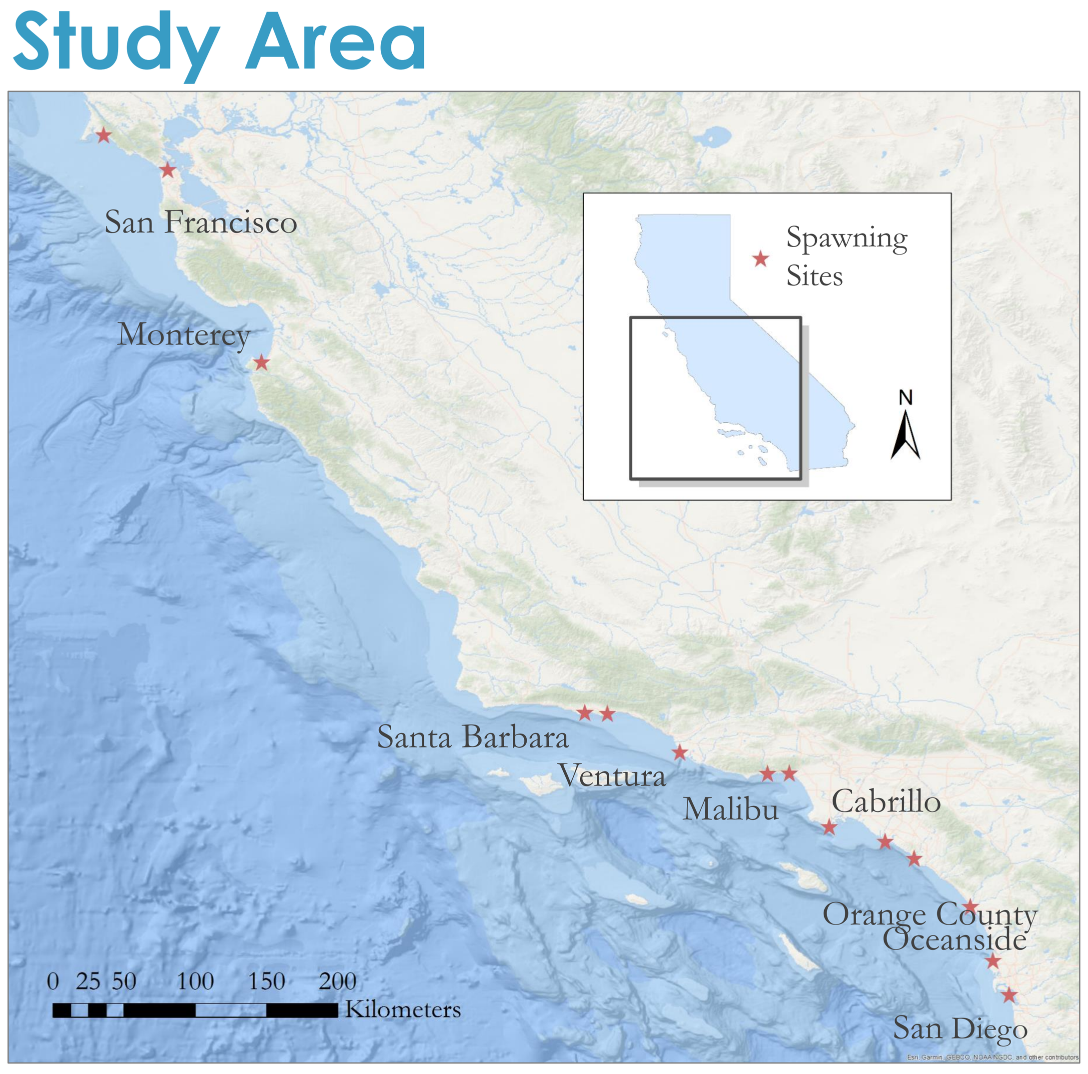
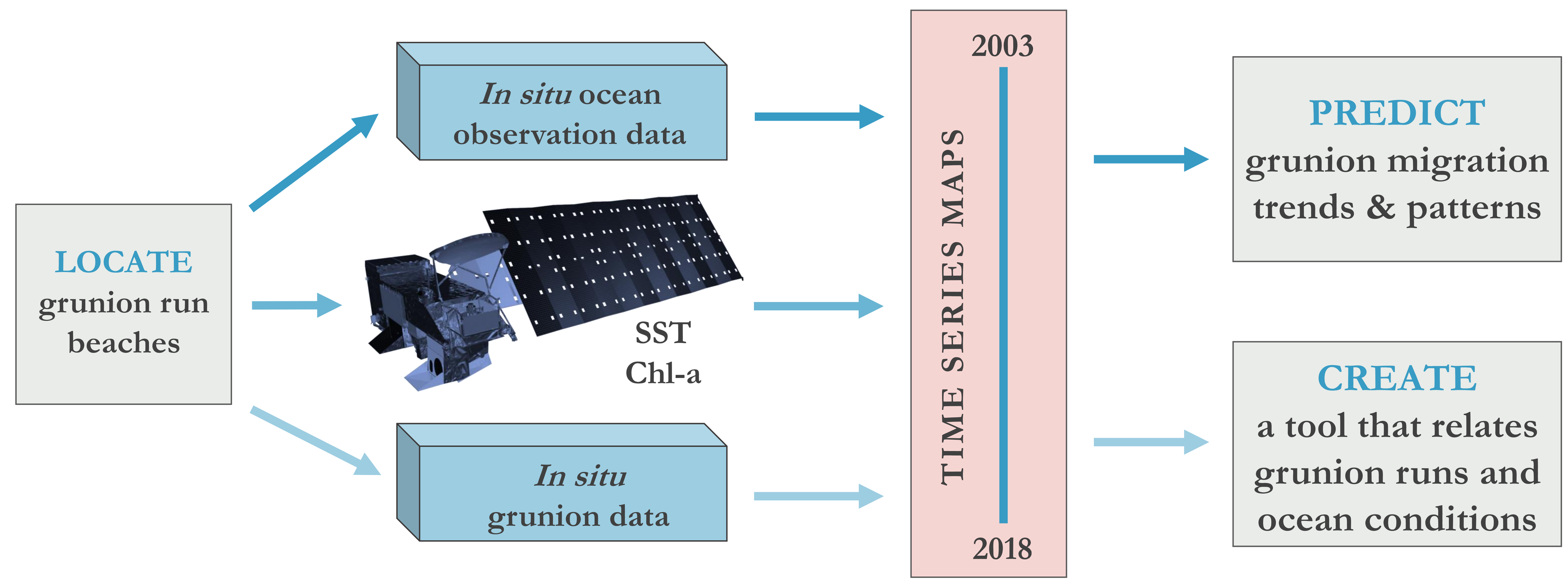


Figure 1. Portion of the California coast encompassing grunion range, including beaches used in analysis (Northern: San Francisco, Monterey; Central: Santa Barbara, Ventura; Southern: Malibu, Cabrillo, Orange County, Oceanside, San Diego)

Methodology



Results

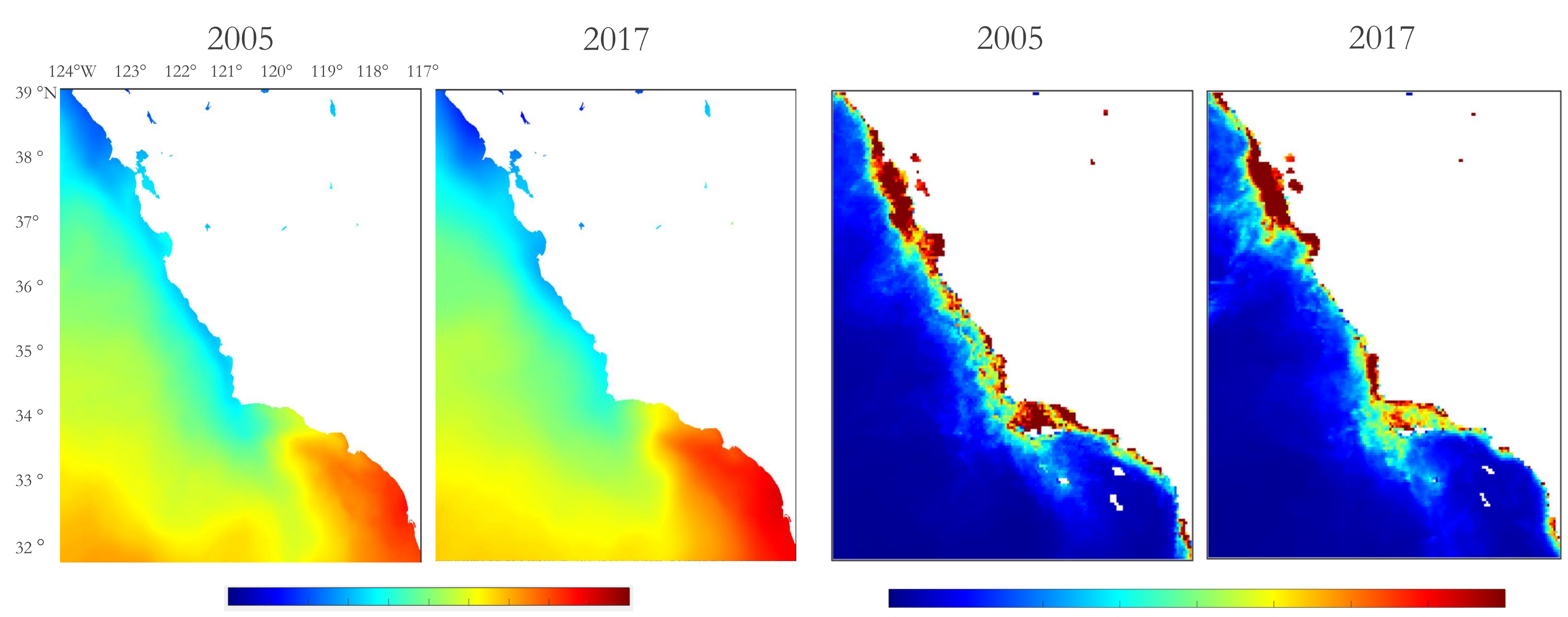


Figure 2. MUR SST data averaged over grunion spawning season (March to August)

Figure 3. Aqua MODIS chlorophyll-a data averaged over grunion spawning season (March to August)

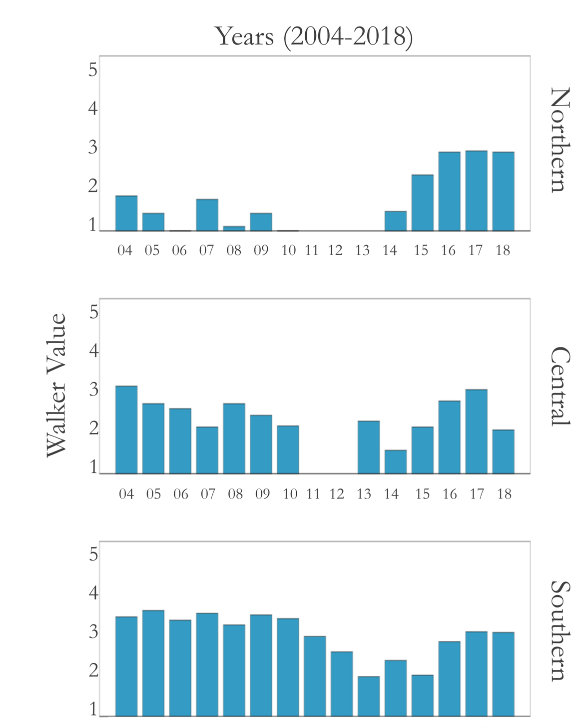


Figure 4. Annual average Walker values (integer 0-5 representing grunion run size and intensity) by California region

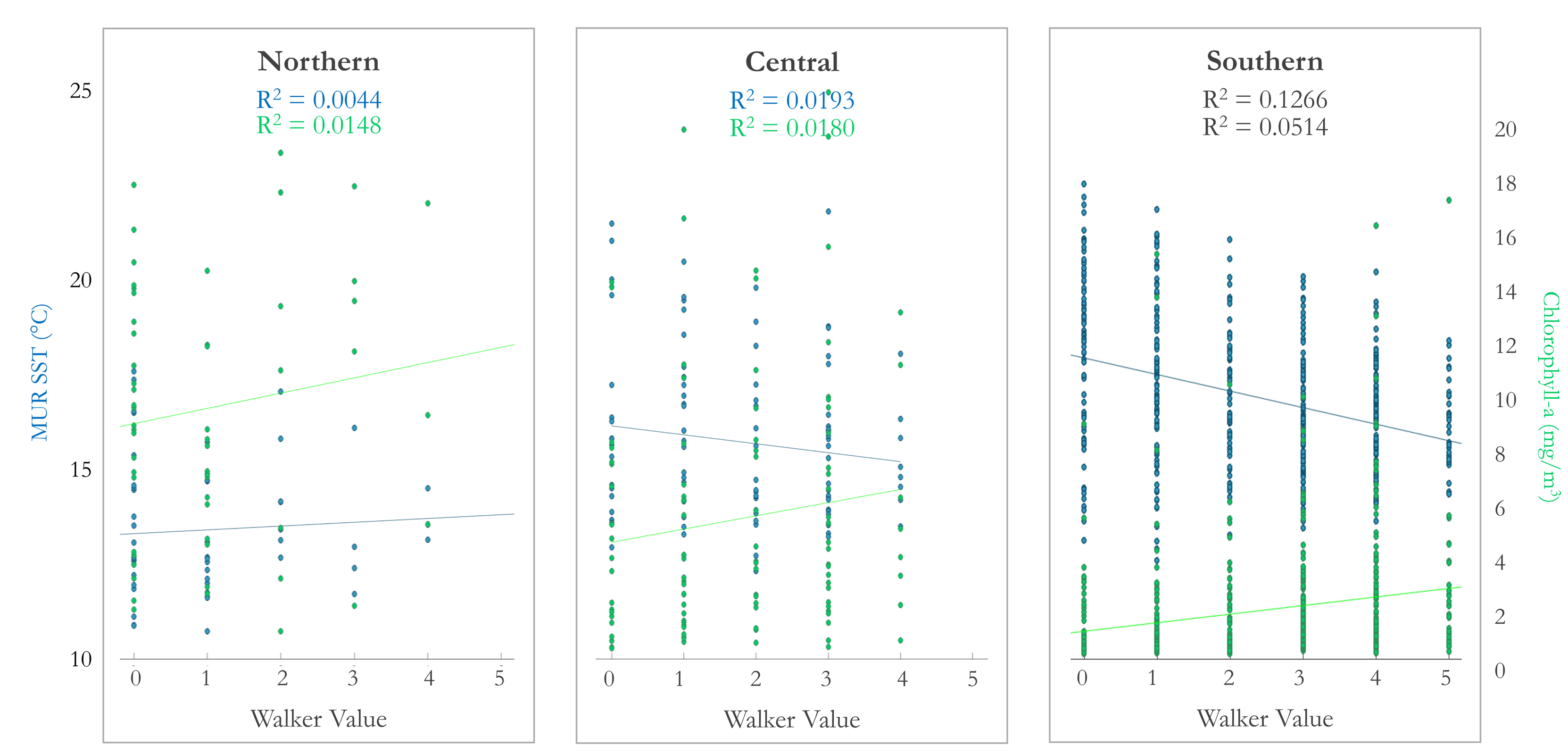


Figure 5. MUR SST versus Walker value overlaid with Aqua MODIS chlorophyll-a versus Walker value by region

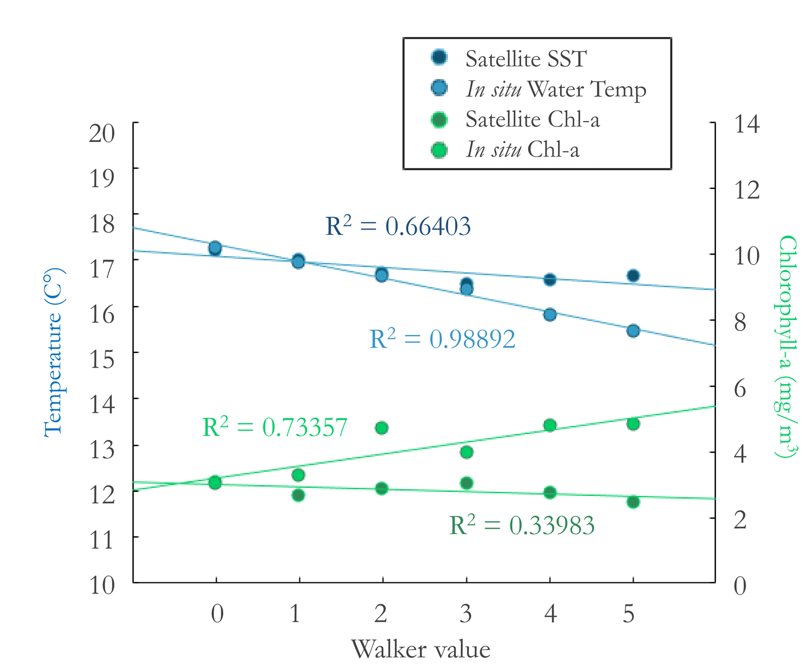
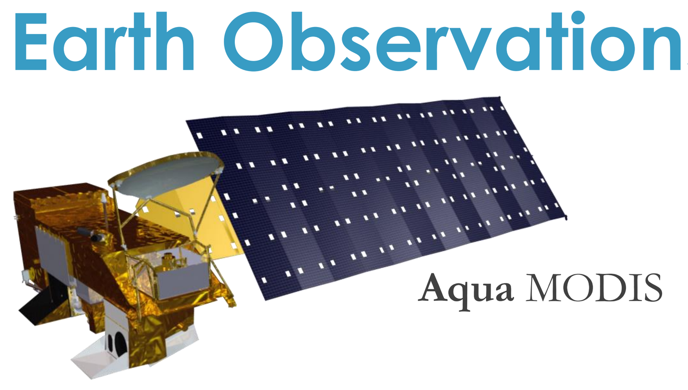


Figure 6. Compiled mean ocean temperatures and chlorophyll-a values by associated Walker values for entire study range

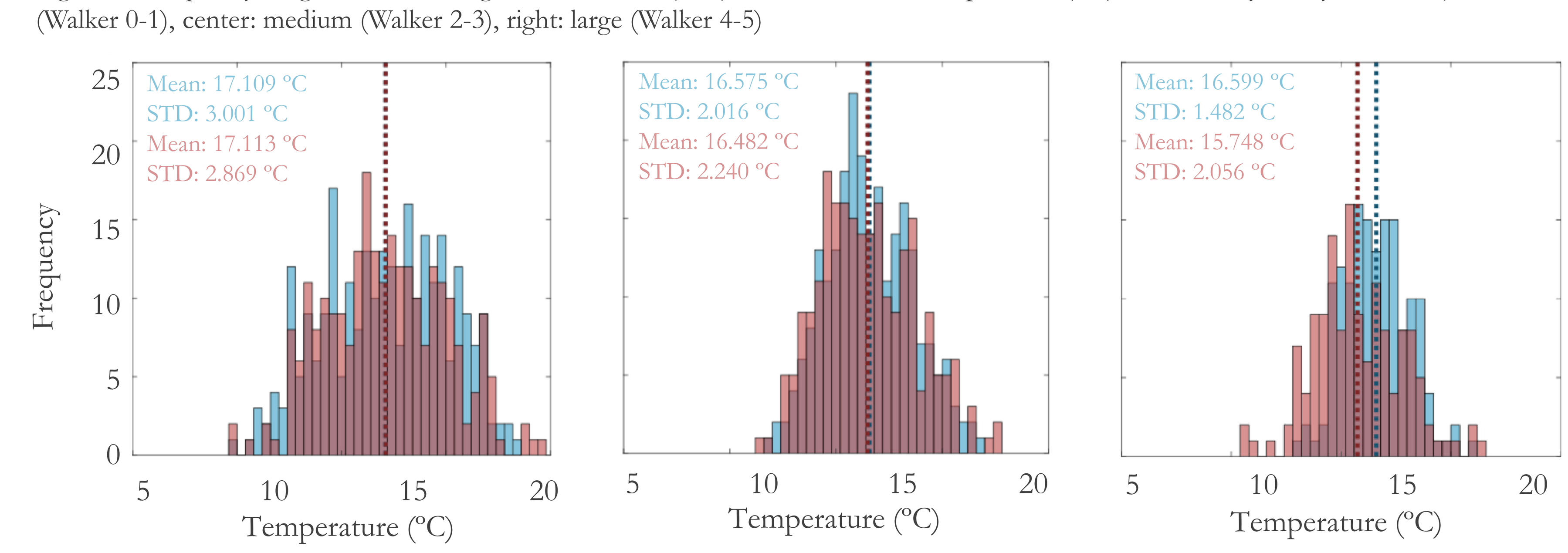
Earth Observations



Project Partners

- **Grunion Greeters Project**
- **California Department of Fish and Wildlife**

Figure 7. Frequency of grunion runs at given MUR SST (blue) and *in situ* water temperature (red) values, analyzed by run size (left: small (Walker 0-1), center: medium (Walker 2-3), right: large (Walker 4-5)



Team Members

Alexandra Jones, Project Lead
Harrison Knapp
Annemarie Peacock
Lael Wakamatsu

Conclusions

- NASA Earth observation satellite data and end products can be used to analyze oceanographic trends that correspond with grunion migration patterns.
- The size of grunion spawning events has a negative correlation with increased coastal ocean temperatures, and a positive correlation with increased chlorophyll-a.
- Changes in ocean conditions along the California coastline are likely driving grunion migration northward, with water and sea surface temperature having the strongest influence.

Acknowledgements

Previous Contributors: **Sol Kim** & **Ariana Nickmeyer** (DEVELOP, California - JPL)
Benjamin Holt (NASA Jet Propulsion Laboratory, California Institute of Technology)
Dr. Karen Martin (The Grunion Greeters Project)
Loni Adams (California Department of Fish and Wildlife)

This material is based upon work supported by NASA through contract NNL16AA05C and cooperative agreement NNX14AB60A. Any mention of a commercial product, service or activity in this material does not constitute NASA endorsement. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organizations.