**NASA DEVELOP National Program**

**** NASA Jet Propulsion Laboratory

*Summer 2017*

**Short Title: Southern California Oceans**

**Subtitle:** Analyzing NASA Earth Observation Data to Evaluate Grunion Response to Ecosystem Changes Forced by Recent Environmental Conditions in California’s Oceans

**VPS Title:** Grunions: See How They Run

**Project Team**

**Project Team:**

Lael Wakamatsu (Project Lead), [laelwakamatsu@gmail.com](mailto:laelwakamatsu@gmail.com)

Sol Kim

Ariana Nickmeyer

**Advisors & Mentors:**

Benjamin Holt (NASA Jet Propulsion Laboratory, California Institute of Technology)

**Project Overview**

**80-100 Word Objectives Overview:**

The California grunion, *Leuresthes tenuis*, is a species native to southern California and northern Baja California whose population has expanded north, spawning as far as the San Francisco Bay. This unusual behavior has enabled researchers to observe grunion spawning locations and population numbers by looking at the effects of beach loss as well as air and ocean temperature changes. The time series end product aims to provide sea surface temperature and chlorophyll-a patterns to help predict and monitor where the fish will spawn next.

**Abstract:**

California grunion are an endemic fish species vital to the California coast, acting as a versatile food source for many species such as seabirds, large mammals, and other fish in the food web. This species, known primarily for the unique way in which they spawn, have two specialized regions. Historically, they only occur in Southern California and northern Baja California and are vulnerable to air and ocean temperature changes. In the last 16 years, scientists recorded grunion spawning further north to the San Francisco Bay area. In response to air and ocean temperature increases, the fish migrate to cooler waters they are more adapted to. This is an issue due to the fact that the grunion found here are much smaller in size, indicating the north coast may not be as suitable for the species. Increased beach activity, beach cleaning practices, and coastal erosion significantly contribute to the decrease in population and the significant shift of spawning areas. This project, in collaboration with the Grunion Greeters Project, used Aqua MODIS satellite data for sea surface temperature (SST) and chlorophyll-a concentration to create a time series of the California coast from 2003 – 2017. Analyzing this product will help predict grunion spawning areas and can be used to develop beneficial management practices as well as establish new protective areas to keep the species thriving and safe.

**Keywords:**

MODIS Aqua, ocean color, remote sensing, time series analysis, habitat restoration

**Partner Organizations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Grunion Greeters Project | Dr. Karen Martin, Professor of Biology, Pepperdine University | End User | Yes |

**Community Concerns:**

* California grunion play a critical role in the marine food web acting as a versatile food source for marine mammals, seabirds, invertebrates, and fishes. Losses to their populations will negatively influence species abundance and diversity at these higher trophic levels.
* Due to beach grooming, coastal armoring, and other anthropogenic beach activity, grunion populations have decreased drastically.
* Grunion runs are a singular phenomenon which visitors can actively engage with and learn from, strengthening empathetic connections between humans and nature and inspiring personal investment in the future of California wildlife within the upcoming generations. A decrease in the population leads to a decrease in these educational activities and programs.

**Current Decision-Making Practices & Policies**:

Dr. Karen Martin at Pepperdine University has created the Grunion Greeters Project to collect *in situ* data on the grunion numbers during runs and ensure that the species and their eggs are protected from as many harmful anthropogenic sources as possible. The project is a collaboration between 30 different organizations, including the California Department of Fish and Game, US Fish and Wildlife Service, California State Parks, California Coastal Commission, and the California Coastal Coalition. Under this project there is a constant influx of data to Grunion.org throughout the peak spawning season (March to June) by citizen scientists, who document the status of the fish on beaches all along the California coast. These datasets can subsequently be accessed and used by scientists, beach managers, and government agencies in their decision making practices. A policy currently in effect in some areas in southern California balances the issues of beach grooming to support tourism and recreation while leaving grunion nests undisturbed. Additionally, throughout California, there is a “no-take” policy during the closed season from April and May. During the rest of the season, however, visitors may only use their hands to catch the grunion and persons over 16 years of age require a fishing license.

**Decision Support Tools & Benefits:**

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software**  **Release** |
| Time Series Maps of Sea Surface Temperature and Chlorophyll-a | Aqua MODIS | These maps will allow partners to predict future scenarios of grunion migration patterns from the temperature and chlorophyll changes. This will simplify and enhance management practices to help sustain the spawning habitat of the fish. | N/A |

**Project Benefit to End User**:

The introduction of NASA Earth observations will provide grunion scientists with a remote sensing approach to monitor grunion and their changing environment. As grunion are vulnerable to changing SST, chlorophyll levels based on their diet, and ocean chemistry, grunion scientists will have the ability to study the relationship of these variables to on-site grunion spawning numbers and behavior. Utilizing NASA Earth observations will enable our partner to see any visible relationships or trends of these variables shift on the California coast as well as several specific, targeted locations where grunion have historically run and areas where they are predicted to move.

**Project Details**

**Applied Sciences National Applications Addressed:** Oceans

**Study Area:** Coastal California (CA)

**Study Period:** 2003 – 2016 (April – August)

**Earth Observations & Parameters:**

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| Aqua MODIS | Chlorophyll-a | This satellite will be processed and analyzed for the time period of 2003 – 2016 during the months April –August to create the time series of chlorophyll concentrations. |
| MUR | Sea surface temperature | This data includes the satellite Aqua MODIS which will be processed and analyzed to create the sea surface temperature time series. |

**Ancillary Datasets Utilized:**

* NASA Jet Propulsion Laboratory, MUR SST, daily level 4 and 1 km resolution – Sea surface temperature data
* NOAA NESDIS, 8 day composite level 4 and 1 km resolution – Chlorophyll-a data
* NOAA NESDIS, World Ocean Database 2013 – *in situ* air temperature data

**Software Utilized:**

* MATLAB – data processing for time series analysis
* Esri ArcGIS – map creation and data analysis of Aqua MODIS
* QGIS – map creation and visualization
* SeaDAS – website imagery creation

**Project Handoff Package**

**Transition Plan:**

We will deliver our end product of time-series maps of SST and chlorophyll-a in a format compatible with ArcGIS and QGIS. The time series will also include the data of the grunion runs to look at variable patterns. The end products will be shared via NASA LFT along with the DEVELOP deliverables. Handoff will happen during week 10 via teleconference.

**Team POC:** Lael Wakamatsu, laelwakamatsu@gmail.com

**Partner POC**: Karen Martin, karen.martin@pepperdine.edu

**Handoff Package:**

* Time-series maps of SST and chlorophyll-a for grunion specific beaches
* MATLAB plots of air and water temperature of the selected locations
* DEVELOP Deliverables
  + Project summary, tech paper, poster, presentation, video, study area shapefiles, website images