**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

**NASA Jet Propulsion Laboratory**

**Southern California Oceans**

*Using NASA Earth Observations to Evaluate Grunion Response to Ecosystem Changes Forced by Recent Environmental Conditions in California’s Oceans*

**Project Overview**

***Project Synopsis*:** The California grunion, or *Leuresthes tenuis,* is an endemic fish species found exclusively along the coast of California and Baja California. Known primarily for the way in which they spawn on sandy beaches, grunion are vulnerable to changes in ocean and air temperature. The objective of this project is to help ocean management stakeholders to use remote sensing tools to observe the grunion spawning environment so they can make proactive decisions for the future management of this species’ habitat. This study will map the environmental conditions that influence grunion spawning runs, using sea surface temperature, chlorophyll-a, and salinity measurements from Landsat 7 ETM+, Landsat 8 OLI, Aqua MODIS, Suomi NPP VIIRS, and SMAP. The results from this project will support Dr. Karen Martin at the Grunion Greeters Project who will share the results with ocean management stakeholders to support their efforts to protect and conserve the beach habitats as well as the grunion population.

***Community Concern:*** California grunion are an endemic fish found historically in the coast of California between Point Conception and the Mexican border. Grunion spawning runs occur following the highest tide for several nights per month with the major spawning season occurring between March and August. As grunion are vulnerable to changes in water chemistry and temperature, increased salinity and changing climatic variables are shifting the spawning season and the health of embryos. In addition, it is believed that a changing climate is causing the spawning range to shift farther north up to Monterey Bay. There is concern that a difference in air temperature in northern California from the usual southern California spawning sites may impact grunion health. Tourism and construction is also a concern as these activities result in habitat loss of nesting areas due to erosion. There is also a concern for the grunion population due to over harvesting.

***Source of Project Idea:*** This project arose through discussions between DEVELOP Jet Propulsion Laboratory mentor Benjamin Holt and Dr. Karen Martin, professor of biology at Pepperdine University and an Executive Director of the Grunion Greeters Project, who is interested in beach management and ecology of marine animals.

***National Application Area Addressed:*** Oceans

***Study Location:*** California (CA)

***Study Period:*** 2013 – 2017 (March – August)

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

**Partner Overview**

***Partner Organization:***

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

***End-User Overview***

***End-User’s Current Decision-Making Process:*** Researchers at Pepperdine University work in partnership with Grunion Greeters Project, a collaboration of 30 different organizations including greater municipalities such as California Department of Fish and Game, US Fish and Wildlife Service, California State Parks, California Coastal Commission, and the California Coastal Coalition. The Grunion Greeters Project conduct hands-on studies of grunion spawning activity from March to June during the peak season. Volunteers submit population assessments, build staging tables for embryonic hatching mechanisms, and study the effects of altered salinity. These observations are then submitted online via Grunion.org, where results and datasets are then made available for use by scientists, beach managers and government agencies.

***End-User’s Capacity to Use NASA Earth Observations:***

*Grunion Greeters Project* – Our partner has minimal familiarity with using data from NASA Earth observations and datasets collected by Citizen Science do not include Earth observation data.

***Collaborator & Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**Dr. Karen Martin is a member of the Board of Directors from the Beach Ecology Coalition, a non-profit organization dedicated to improving beach management in ecologically-sensitive areas. She is also the Executive Director of Grunion Greeters Project, and plans to have any results created from this project available to the beach managers, municipalities, life guards, ecological scientists and beach equipment operators of both organizations.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team lead will be the main POC for the project for correspondence to end-user, Dr. Karen Martin. The team will conduct, at a minimum, weekly to biweekly telecon meetings to discuss methodology and progress of the project. The team lead will also send emails to Dr. Karen Martin to update her on the project's status if a telecon meeting is not possible.

***Transition Plan*:** The decision support tools and end products from this project will be emailed and presented to Dr. Karen Martin through a webinar (or in person) at the end of the term. The end products may also be shared with interested beach managers that Dr. Karen Martin works closely with. The time series maps will be available for the project partners to analyze grunion spawning behavior and decision-making process. The decision support tools from this project do not require software release.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 7 ETM+, Landsat 8 OLI** | Chlorophyll-a, sea surface temperature, ocean color | Time series analysis of chlorophyll-a and temperature to see correlations with the concentrations of grunion runs |
| **Aqua MODIS** | Chlorophyll-a, sea surface temperature | Time series of chlorophyll-a and sea surface temperature to assess trends over the study period |
| **SMAP** | Salinity | Observe changes in salinity patterns over the study area and study period to see a relationship between salinity and spawning locations |
| **SMOS** | Salinity | Observe changes in salinity patterns over the study area and study period to see a relationship between salinity and spawning locations |
| **Suomi NPP VIIRS** | Chlorophyll-a, sea surface temperature, ocean color | Comparison with other times series maps from Landsat and MODIS of sea surface temperature and chlorophyll-a over the study area |

***Ancillary Datasets:***

Grunion Greeters Project – Partner *in situ* data – spawning locations of grunion and environmental conditions at field sites

***Software & Scripting:***

Esri ArcGIS – Data analysis, processing, and visualization

SeaDAS – Data analysis for MODIS

R – Data processing and statistical analysis

ACOLITE – Derive turbidity and chlorophyll-a from Landsat data

Google Earth Engine – time series and image processing of MODIS and Landsat data

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product(s)** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Time Series Maps of Sea Surface Temperature, Chlorophyll-a, and Salinity Conditions** | Project partners can visualize the environmental conditions that influence the locations where grunion spawns occur. Knowing the patterns that impact spawning range will help partners foresee where future spawns may occur. This will provide information for future management decisions on population and habitat management. | Sea surface temperature, ocean color, and chlorophyll-a concentrations will be analyzed over time to decipher patterns with grunion spawning range by looking at the data statistics to establish trends. | N/A |

***End-User Benefit*:** The time series map can be used to help the Grunion Greeters Project and other stakeholders predict where future spawns may take place by looking at the trends in sea surface temperature, chlorophyll-a, and salinity that bolster specific areas along California’s coast to have grunion spawns. This map will also help them save time and resources in guiding where to have their citizen scientists take *in situ* data. The end user will have an improved ability to assess their current management approaches and will be empowered to improve their conservation management practices based on the results of this project.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2017 Summer

***Related DEVELOP Work:***

2014 Summer (NASA Goddard Space Flight Center) – Argentina Oceans: Analyzing Harmful Algae Blooms in Southern right Whale Habitat Using a Suite of Satellite Earth Observations.

2015 Summer (NASA Goddard Space Flight Center) – Maryland Ecological Forecasting: Utilizing NASA Earth Observations to monitor and Strengthen the Survivorship of Maryland’s Sea Turtles

2017 Spring (NASA Langley Research Center & NASA Jet Propulsion Laboratory) – Mississippi Sound Water Resources: Synthesizing Trends in Water Quality Parameters that Affect Oyster Reef Health in the Mississippi Sound Using NASA Earth Observations

**Notes & References:**

***References:***

Martin, K., 2015, Science Foundation Chapter 3 Appendix 3.1 – Case Study California Grunion (*Leurethes tenuis)*, Baylands Ecosystem Habitat Goals Science Update, 0.1-4.

Martin, K., 2006, Introduction to Grunion Biology, [www.grunion.org](http://www.grunion.org)

Martin, K. L. M., C. R. Van Winkle, J. E. Drais, and H. Lakisic. 2004. Beach spawning fishes, terrestrial eggs, and air breathing. *Physiological and Biochemical Zoology, 7*, 750-759.

Martin, K. L., C. L. Moravek, and J. A. Flannery. 2009. Embryonic staging series for the beach spawning, terrestrially incubating California grunion *Leuresthes tenuis* (Ayres 1860) with comparisons to other Atherinomorpha.  *Journal of Fish Biology, 75*, 17-38.