Monitoring the Northern San Francisco Bay Water Quality with Landsat-8

Nicholas B. Tufillaro, Curtiss O. Davis, and Jasmine Nahorniak

Oregon State University, Corvallis, OR, 97331, USA

Introduction

The goal of this NASA Interdisciplinary Science project is to put in place the tools and modeling framework for an ecosystem approach to the stewardship of the San Francisco Bay and Delta Ecosystem (SFE). Here we highlight using Landsat 8 OLI for remote sensing of the Delta, Sacramento, and San Joaquin Rivers.

Landsat 8-OLI Processing Methods

Landsat-8 OLI San Francisco Bay Atmospheric correction uses an iterative SWIR method optimized for highly turbid waters (Vanhellemont & Ruddick 2014) using the 'Acolite' processor created by Vanhellemont and coworkers. Total Suspended Sediment (TSS) maps (Nechad, Ruddick, and Park 2010) typically show an increase of turbidity in the lower Sacramento River and North San Pablo Bay. Product maps like these are used for the calibration and validation of the SFE model. The product maps are 'regionally tuned' using *in situ* observations.

21 March 2015. LT 06:47 0.0 HT 13:20 5.8. Landsat-8 Image and Total Suspended Sediment (TSS). olden Gate. Rio Vista Tides lag 4-5 hours



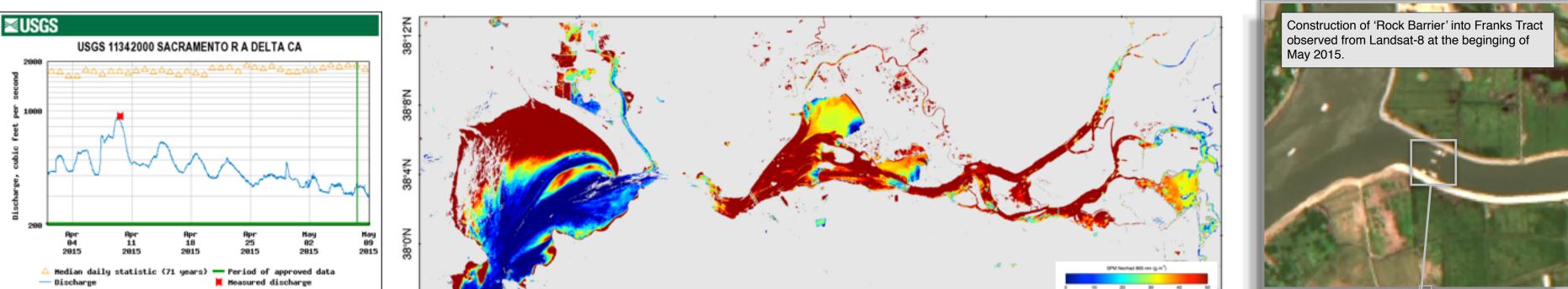
Field Operations

Coordinated field operations, with cruises out of the San Francisco State Romberg-Tiburon Center (RTC), including data collections by the RTC, Oregon State University (OSU), and the US Naval Research Laboratory (NRL).

Biogeochemical *in situ* data samples include: Secchi depth, chl-T, chl-F, TSS, HPLC (RTC); above and in water spectrometry, HPLC (OSU); TSS, CDOM, particle analysis (NRL). Instrument deployments include: Filter Rigs, PhytoFlash (RTC), HyperPro and Spectral Evolution spectrometer (OSU); LISST, AC-S (NRL).

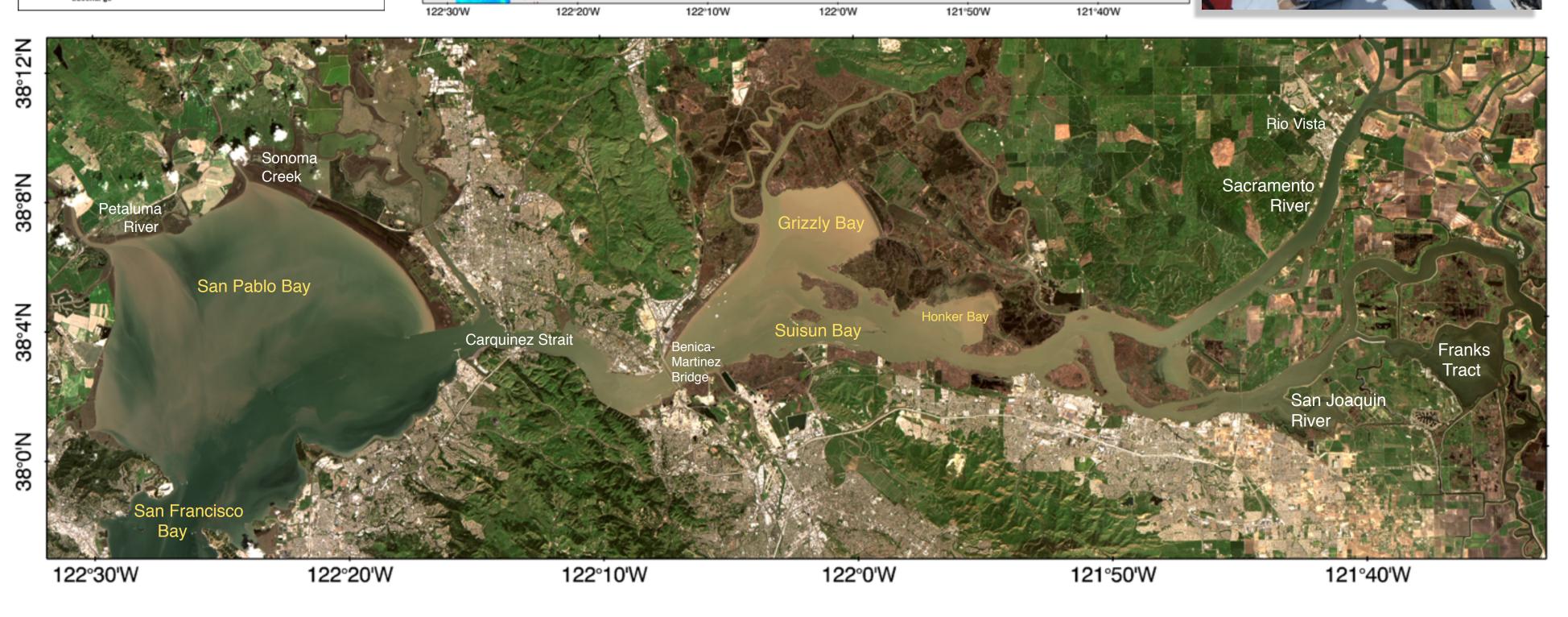
Team members responsible for data collection, and coordination with San Francisco Bay Stake holders, include: Frances Wilkerson, Dick Dugdale and Sarah Blaser (RTC); Alex Parker (CSU Maritime Academy); Steve Ackelson and Joe Rhea (NRL).

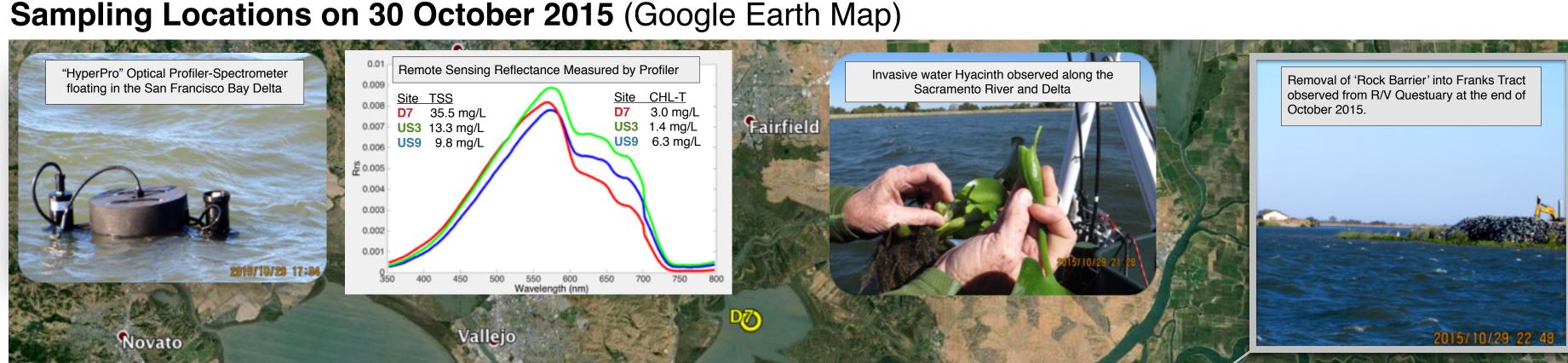
08 May 2015. LT 09:12 -0.7 HT 16:39 4.4



121°40'\

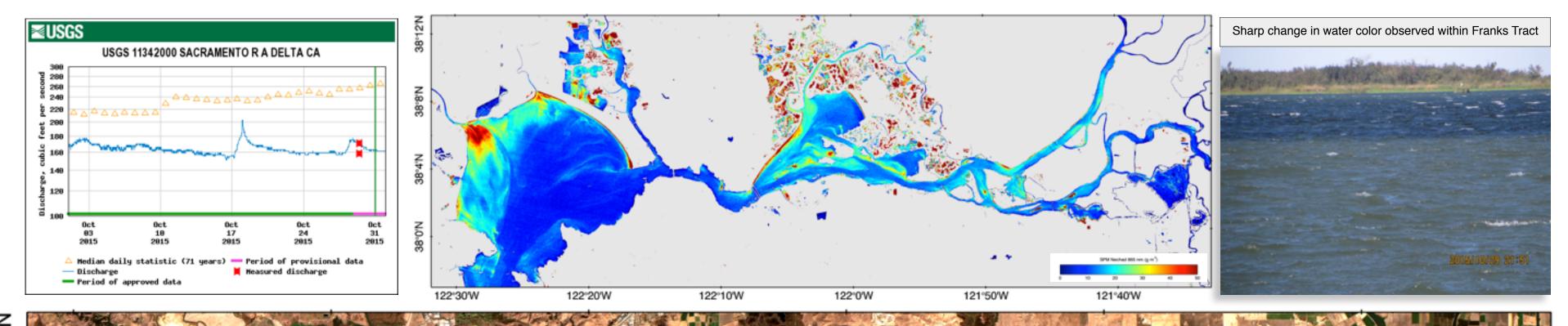
Cruise Dates 2014 May 28-29 October 15-17 2015 March 24-25 May 28-29 October 28-30 2016 March 8-30 May 18-24





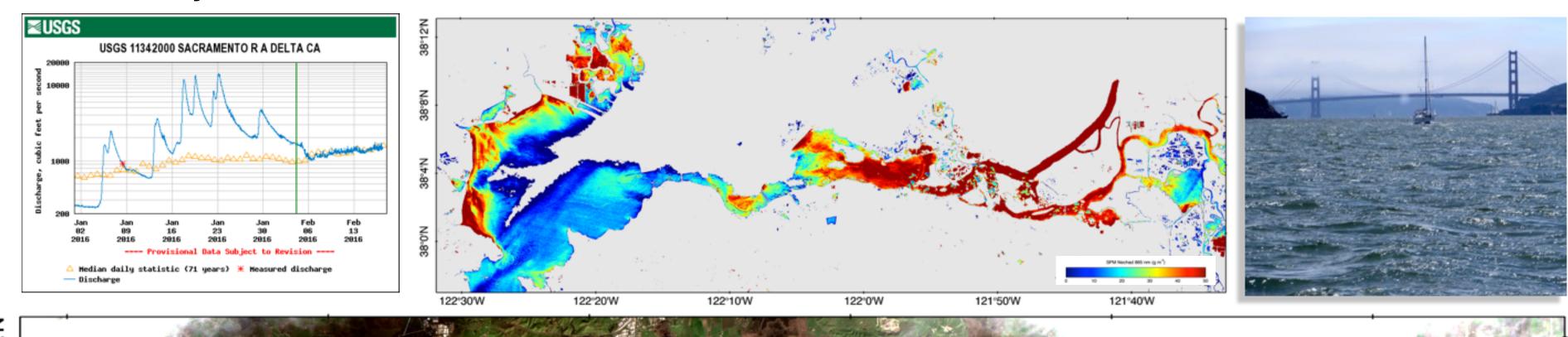
122°10'W 121°50'W 121°40'W 122°30'W 122°20'W 122°0'W

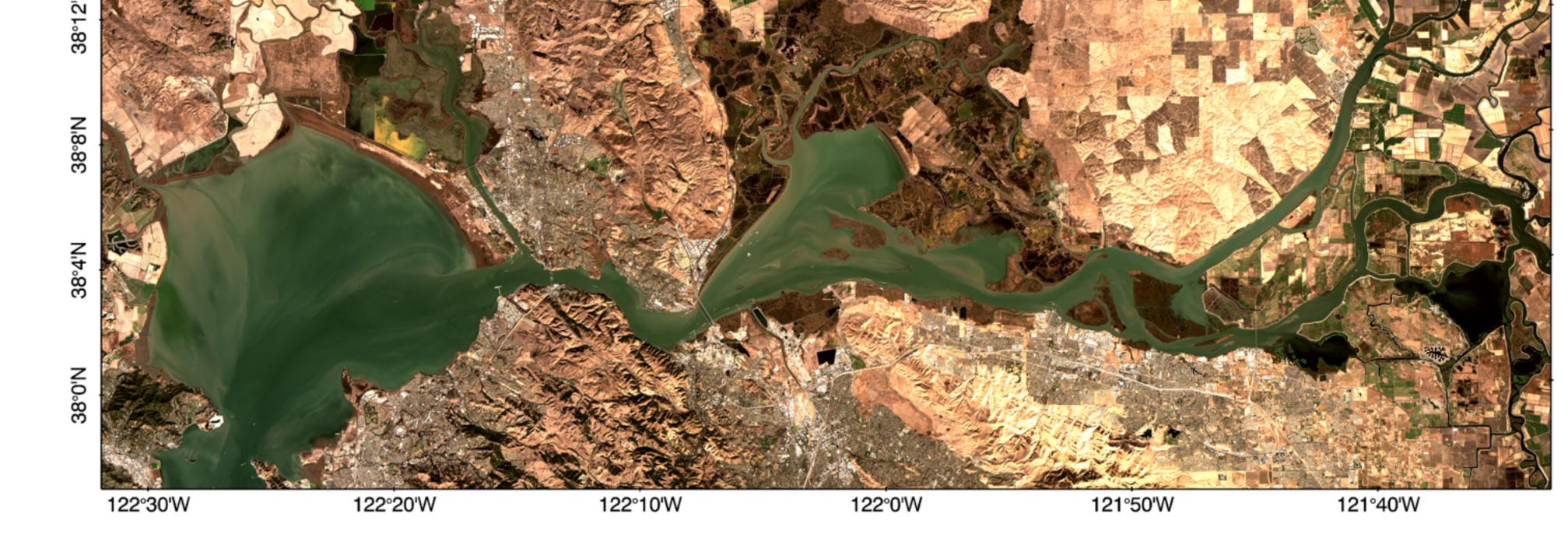
31 October 2015. LT 08:43 2.5 HT 14:44 5.9



	US9 O	O USZ	US5 OUS4 OU	O JS3		12303	
US13 O	Pinole	nez •	A Carlos and	Antioc	h		Red
San Rafael • O US15	Part Contract		Concord				
	Richmond		ATER				
NEW CASHERINA DE			And And And And	Contraction			diamas (in south
A REPORT OF							
		Time (local)	Station	Secchi	SAL	CHL-T	TSS
		24 hr	Name	m	psu	μg/L	mg/L
Tiburon	Berkeley	24 hr 09:41	Name US3	m 0.80	psu 8.04	μg/L 1.35	mg/L 13.33
Sausalito Tiburon	Berkeley	24 hr	Name	m	psu	μg/L	mg/L
Sausalito O Tiburon	Berkeley	24 hr 09:41	Name US3	m 0.80	psu 8.04	μg/L 1.35 2.41 1.56	mg/L 13.33
Sausalito Tiburon	Berkeley	24 hr 09:41 10:05	Name US3 US4 D9 US5	m 0.80 0.90	psu 8.04 8.15	μg/L 1.35 2.41 1.56 2.59	mg/L 13.33 21.67
Sausalito O Tiburon	Berkeley	24 hr 09:41 10:05 10:29	Name US3 US4 D9	m 0.80 0.90 1.70	psu 8.04 8.15 9.33	μg/L 1.35 2.41 1.56	mg/L 13.33 21.67 9.67
Sausalito Priburon	Berkeley	24 hr 09:41 10:05 10:29 10:44	Name US3 US4 D9 US5	m 0.80 0.90 1.70 1.00	psu 8.04 8.15 9.33 9.80	μg/L 1.35 2.41 1.56 2.59	mg/L 13.33 21.67 9.67 13.67
Sausalito Tiburon	Berkeley	24 hr 09:41 10:05 10:29 10:44 11:20	Name US3 US4 D9 US5 D7	m 0.80 0.90 1.70 1.00 0.50	psu 8.04 8.15 9.33 9.80 12.23	μg/L 1.35 2.41 1.56 2.59 2.98	mg/L 13.33 21.67 9.67 13.67 35.50
Sausalito San Francisco	Rerkeley	24 hr 09:41 10:05 10:29 10:44 11:20 11:46	Name US3 US4 D9 US5 D7 US7	m 0.80 0.90 1.70 1.00 0.50 0.90	psu 8.04 8.15 9.33 9.80 12.23 14.83	μg/L 1.35 2.41 1.56 2.59 2.98 2.12	mg/L 13.33 21.67 9.67 13.67 35.50 22.67

04 February 2016. HT 07:49 5.9 LT 14:48 0.1 **HIGH FLOW**





CONCLUSIONS

Landsat 8 OLI data provides a valuable new tool for remote sensing of rivers and estuaries. It is the first Landsat data to have sufficient SNR and additional blue band for coastal ocean remote sensing. Products from *Acolite* algorithms are being validated with RIO-SFE in situ data. The time series of Landsat data combined with in situ data from the RIO-SFE Project provides a unique new view of upper San Francisco Bay and Estuary.

RIO-SFE Related Presentations at Ocean Sciences 2016

EC21B-06: Using Remote Sensing to Determine the Spatial Scales of Estuaries



HI34A-1801: Suspended and Dissolved Matter in the Sacramento River and Delta Region Under Drought Conditions

HI34A-1802: Nutrients and Phytoplankton Productivity in the Sacramento River and San Francisco Bay Delta **Region Under Drought Conditions**

HI34A-1796: A Modeling Study of the San Francisco Bay and Delta Ecosystem in High and Low River Flow Years

HI34A-1803: Towards a real-time forecasting system for the San Francisco bay/estuary and rive delta B14A-0291: Effects of Ammonium-rich Wastewater Effluent on Phytoplankton Productivity in Experimental Mesocosms from the northern San Francisco Estuary

<u>Funding</u>

This work is supported by the NASA Grant: NNX14AD79G: IMPACTS OF POPULATION GROWTH ON THE SAN FRANCISCO BAY AND DELTA ECOSYSTEM (RIO-SFE). With special thanks to the RIO-SFE teams from USF-RTC, NRL, U. Maine and RSSI for their contributions to this project.