



Principal Investigators - please use this form to submit your MPA Baseline Program project annual report, including an update on activities completed over the past year and those planned for the upcoming year. This information will be used by the MPA Baseline Program Management Team to track the progress of individual projects, and will be provided to all MPA Baseline Program PIs and co-PIs prior to the Annual PIs workshop to facilitate discussion of project integration. Please submit this form to California Sea Grant when complete (sgreport@ucsd.edu, Subject [Award Number, project number, PI, "Annual Report"].)

Project Information

Project Year: Year 1 (2011-2012) Study Region: Southern California

Project Title & Number: Nearshore Substrate Mapping and Change Analysis using Historical and Concurrent Multi-spectral Aerial Imagery." R/MPA-30 Grant No 10-049

PI name: Jan Svejkovsky Co-PI name: [empty]

PI Contact Info Co- PI Contact Info (please list additional PIs and contact info in the "Project Personnel" section if necessary)

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Project Goals & Objectives

The overall goal of this project is to create a baseline data base of kelp canopy, shallow subtidal and intertidal bottom substrate, at very high spatial resolution (40cm-2m) covering all Marine Protected Areas (MPAs) in the California South Coast (CSC) region. The goals of the project's first year were to: 1) acquire multispectral aerial imagery of inter/subtidal zones within and around CSC MPAs, 2) begin processing of the acquired imagery, 3) conduct partial field sampling for classification results validation, and 4) collect kelp canopy imagery for 2011 and process the imagery for kelp classification. The progress toward these goals is discussed in the next section.

## Summary of Project Activities Completed to Date

### Overview of Project Year 1 Activities, including progress towards meeting goals & objectives

- 1) **Inter/subtidal imagery acquisitions:** The originally proposed work plan included the use of Ocean Imaging's (OI's) DMSC-MkII aerial system for these image data acquisitions. Subsequently, in 2011 OI got the opportunity to utilize a Microsoft UltraCamX aerial sensor, albeit at a higher acquisition cost. OI decided to take advantage of this opportunity and has and will finance the increased cost (approximately \$16,000) internally as co-funding.

Digital multispectral data are being acquired using a Microsoft UltraCamX Digital Sensor (UCX). This sensor is a 16-bit, 4000x4000 pixel, 4-channel instrument imaging in the red (580-700nm), green (480-640nm), blue (380-540nm) and near-infrared (680-960nm) wavelengths flown in tandem with a high accuracy airborne geographical positioning system (ABGPS) and inertial measurement unit (IMU) to achieve high geolocation accuracy and precision. The data are being acquired at a ground sampling distance (GSD – i.e. horizontal spatial resolution) of 30 cm. during specific tide, sun angle and weather conditions. This reduces the possibility of sun glint contamination and ensures an acceptable level of solar illumination during times when as much of the substrate/vegetation in the intertidal zone is exposed as is possible. Requirements dictate that the data be collected during periods of seasonally low tides within a 3 hour time window, +/- 1.5 hours from the mean low water level (MLW). In most cases thus far, the data have been acquired +/- 1.5 hours of the mean lower low water level (MLLW) which is lower than the required level.

Imagery from the UCX sensor is being used in place of the proposed DMSC sensor for a variety of reasons. The bit depth of the UCX is 16-bit as opposed to the DMSC's 12-bit sensitivity which offers greater spectral fidelity and hence improved ability to classify substrates. Given the wide swath width of the UCX, 30 cm spatial resolution can be collected for the entire study region compared to the proposed 1 meter and 35 cm data which would have been collected with the DMSC. This will provide more detailed and precise imagery resulting in a better classification product. Finally, geolocation capability of the UCX is superior to that of the DMSC, delivering more geographically accurate imagery and data products.

To date, approximately 55% of the imagery covering the MPA regions as defined in the proposal have been collected at 30 cm resolution, georeferenced, orthorectified and mosaicked by aircraft flight line. Based on tidal levels and weather conditions, the existing data were acquired on separate days: 06/07/12, 06/08/12 and 06/25/08 (see Figure 1). All other possible days during low tide months so far this year experienced either excessive cloud cover and/or inclement weather conditions preventing the acquisition of data. The next low tide days during which OI plans to collect data for the remaining MPAs are 10/14/12 - 10/16/12 and 11/12/12 – 11/15/12.

- 2) **Inter/subtidal image data processing:** As stated above all of the image data so far collected have been georeferenced, orthorectified and mosaicked into geographical segments based on the flight lines. The imagery is of very high quality and shows excellent spectral and spatial definition. Water penetration in areas of calm seas appears to be more than sufficient to classify submerged substrate including subsurface, offshore kelp. See Figures 2 and 3 for sample RGB and NIR-GB UCX imagery.

Classification of the data into the macro and micro substrate classes has begun and is ongoing. As was done for the Northern California classification work also funded by Sea Grant, the intertidal region is first segregated into elevation sections within and above the intertidal zone in order to eliminate cross correlation of reflectance values for marine and terrestrial vegetation with similar radiometric signatures. Where available, LIDAR data are being used to accurately aid in this segmentation process. The different elevation segments are then classified and ultimately merged together into a final product. Given the high quality and resolution of the data, we have been able to confidently distinguish and map the following classes:

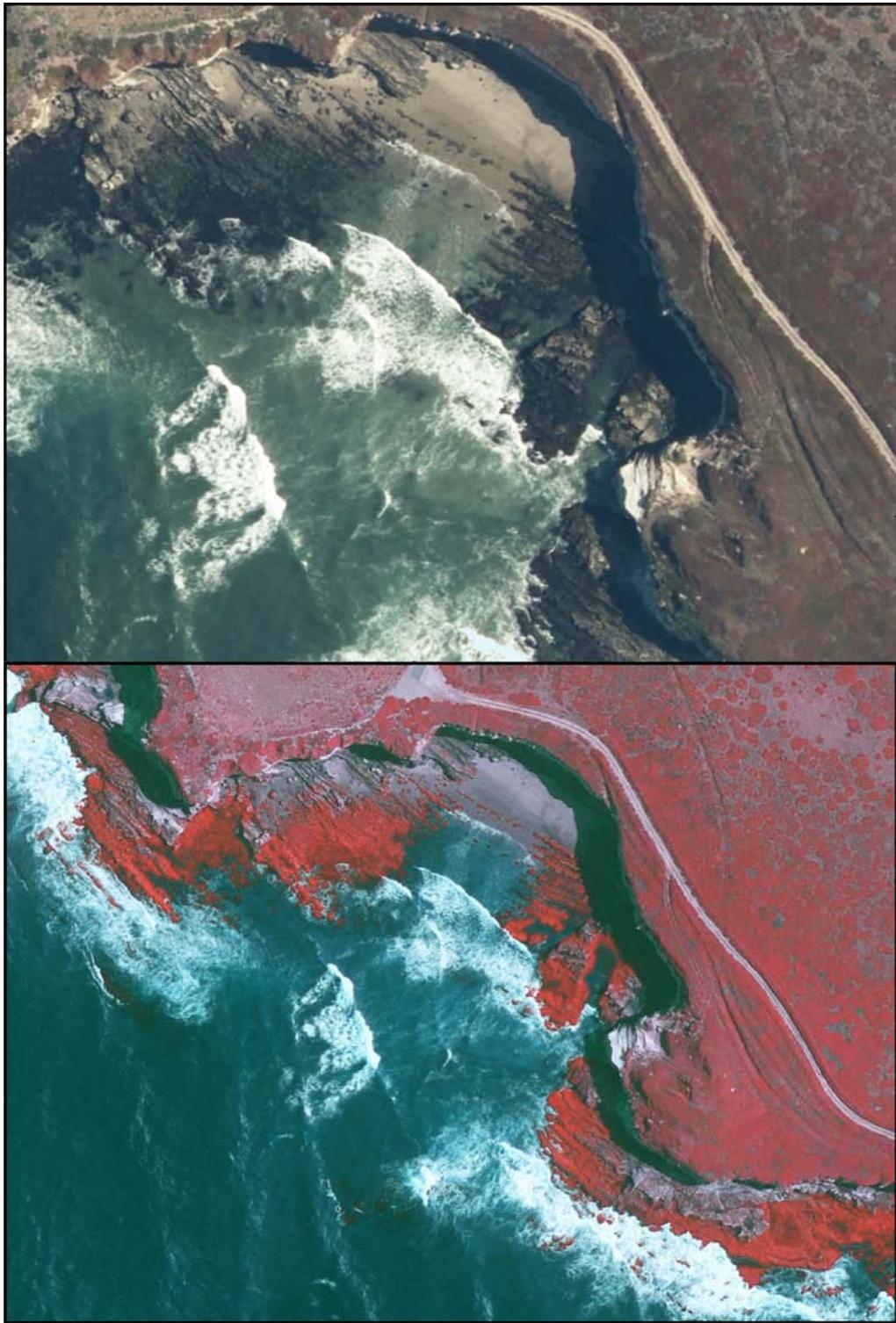
MPA Baseline Program Annual Report

- Cobble
- Bare/Unvegetated rock
- Red/brown algae
- Green algae
- Surf Grass
- Eel Grass
- Kelp
- Terrestrial vegetation
- Salt marsh vegetation
- Driftwood
- Wrack
- Manmade structures
- Deep water
- Whitewash (if present)

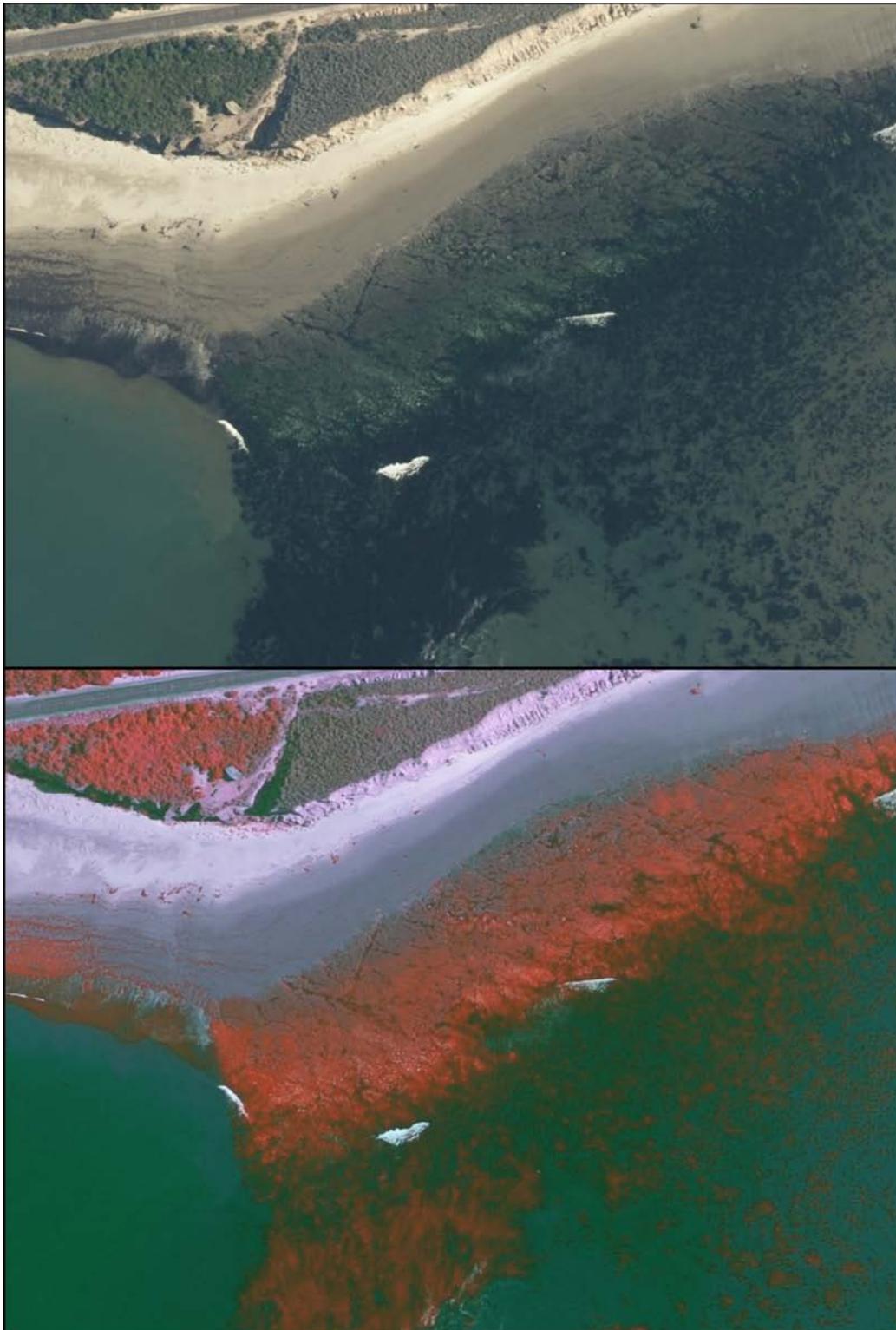
Work continues on the classification of the acquired data sets and is proceeding on schedule. Once complete the imagery and thematic map data products will be re-mosaicked into MPA regions for delivery.



**Figure 1:** UCX image data collection as of 10/01/12. Scheduled tide and weather windows for remaining data acquisitions are 10/14/12-10/16/12 and 11/12/12-11/15/12



**Figure 2:** Sample RGB (top) and NIR-GB (bottom) UCX imagery from the Point Conception SMR



**Figure 3:** Sample RGB (top) and NIR-GB (bottom) UCX imagery from the Kashtayit SMCA

**3.) Begin field sampling:** A limited amount of field sampling work was done along San Diego county. The majority of field sampling is now planned to be done during the project's second year. Of particular focus will be high volume sampling around the Channel Islands. OI has secured a vessel charter for this work and has deemed it prudent to do the field work when the data from image data from those regions has already been run through the initial classifications so that it can be directly compared to actual field samples on-site.

**4.) 2011 kelp canopy aerial image collection and processing:** As per original work plan, an aerial imaging survey of the entire CSC region was conducted in late November-early December 2011 with OI's DMSC-MkII sensor. The data were classified for kelp and the processing has been completed. The final classifications were quality assessed by Navy and CDFG personnel. As is stated in the original proposal, the kelp surveys are being funded through separate Navy funds and constitute partial co-funding for this project.

*Highlights from project progress so far, such as successes achieved or interesting stories from the past year*

As OI has done in processing of imagery data for the NCC region, Lidar topographic data collected by Fugro Earth data as part of work funded by the California Coastal Conservancy are being utilized to improve the inter/subtidal substrate classification product. They were made available to Ocean Imaging and the SeaGrant Program through Fugro and NOAA's Coastal Services Center.

The Lidar data have proven to be extremely valuable when applied to the processing for two specific purposes: 1) To maximize the efficiency and substrate class resolving power of the multispectral classification algorithms, it is best (and sometimes necessary) to first isolate the intertidal zone (i.e. the area of interest) from the many multispectral signature terrestrial targets further inland. Prior to this project, no very high resolution (i.e. around 1-2 meters) "shoreline" data base existed that could be used as an accurate cutoff boundary between the intertidal and terrestrial habitats. NOAA's and USGS' "shoreline" data bases have spatial resolutions far too inadequate for this work, and do not conform to a suitable intertidal vs. terrestrial cutoff. The Fugro Lidar data have 1m horizontal resolution and 9.25cm vertical RMS accuracy. Ocean Imaging staff utilized the multispectral imagery and field photos to identify (as best as possible based on vegetation and ground substrate type) the upper limit of the intertidal zone within each shoreline section, then matched these determinations within the Lidar data set to create a novel, high resolution "coastline" boundary. This boundary was then used to isolate the region of interest for the multispectral classification. Additionally, the Lidar data were used to subdivide the intertidal zone into several subzones that were classified separately – which further increased the accuracy of the final classification product.

Both the Coastal Conservancy and NOAA CSC have expressed high enthusiasm for Ocean Imaging's utilization of the collected Lidar and ADS-40 data for this SeaGrant project, which adds value for their initial data collection investments.

*Description of any unforeseen events and substantial challenges, and resulting effect on data collection*

Weather conditions unfavorable for the aerial imaging surveys (i.e. persistent low cloud cover) in the first half of 2012 during appropriate low-tide windows prevented completion of all the data acquisitions at that time. Since it is very important to collect the imagery during peak low tides to expose as much of the intertidal habitat as possible, the next opportune low-tide/low sun angle windows occur in October, 2012. We hope to finish all remaining acquisitions at that time.

*MPA Baseline Program Annual Report*

*Data status (i.e., paper/raw format or digitized; if digitized, what format?)*

All data, including DMSC and UltraCamX multispectral, LIDAR and field survey photo imagery are in digital formats compatible with standard (e.g. ARC-GIS) GIS software systems. Ancillary data such as geolocation and ground substrate type/species information for the field sample locations are in MS Excel file format.

**Activities Planned for following Project Year 2** – *Please describe remaining work and approximate timelines for completing that work, including any anticipated budget variances necessary to complete the project.*

As stated above, we aim to complete all remaining inter/subtidal image acquisitions early in the project's second year. As per original project schedule, this project's Year 2 activities will also include continued processing of the imagery, extensive field data collections, initiation of change-detection analysis between the newly collected data and archived data from the previous decade, and the annual Navy-funded kelp survey.

**Project Personnel** – *Please indicate additional project personnel involved in your MPA baseline project, including students and volunteers, or additional PI contact information if necessary.*

	<i>Students Supported</i>	<i>Student Volunteers</i>
<i>K-12</i>		
<i>Undergraduate</i>		
<i>Masters</i>	Ms. Kimberly Aardal - intern	
<i>Masters</i>	Michael Lekan	
<i>PhD</i>		

*Number of other Volunteers not counted above:*

Additional PI contact info not listed on first page:

**Cooperating Organizations and Individuals** - Please list organizations or individuals (e.g., federal or state agencies, fishermen, etc.) that provided financial, technical or other assistance to your project since its inception, including a description of the nature of their assistance.

<i>Name of Organization or Individual</i>	<i>Sector (City, County, Fed, private, etc.)</i>	<i>Nature of cooperation (If financial, provide dollar amount.)</i>
NOAA Coastal Services Center	Federal	Lidar & ADS-40 Data Clearance
California Coastal Conservancy	State	Lidar & ADS-40 Data (financed original collection by Fugro and released data to SeaGrant)
Fugro Earth Data	Corporation	Provides Lidar & ADS-40 data and support
Keystone Aerial Surveys	Corporation	Provides UltraCamX data collection support

**Additional Information** – Please provide any other project-relevant information, such as descriptions of attached materials, media coverage your project has received, etc.