



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 2 (2011-2012) Study Region: California North Central Coast

Project Title & Number: High Resolution Nearshore Substrate Mapping and Persistence Analysis with Multi-spectral Aerial Imagery. R/MPA17 09-015

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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, and estuarine ground cover at very high spatial resolution (40cm-2m) covering all Marine Protected Areas (MPAs) in the California North Central Coast (NCC) region. The goals of the project's second year were to: 1) continue processing the intertidal and estuarine image data into final substrate classifications, 2) conduct field sampling for classification results validation, 3) collect kelp canopy imagery for 2011, and 4) conduct a kelp persistence analysis using multiple archived data sets from previous years. The progress toward these goals is discussed in the next section.

Summary of Project Activities Completed to Date

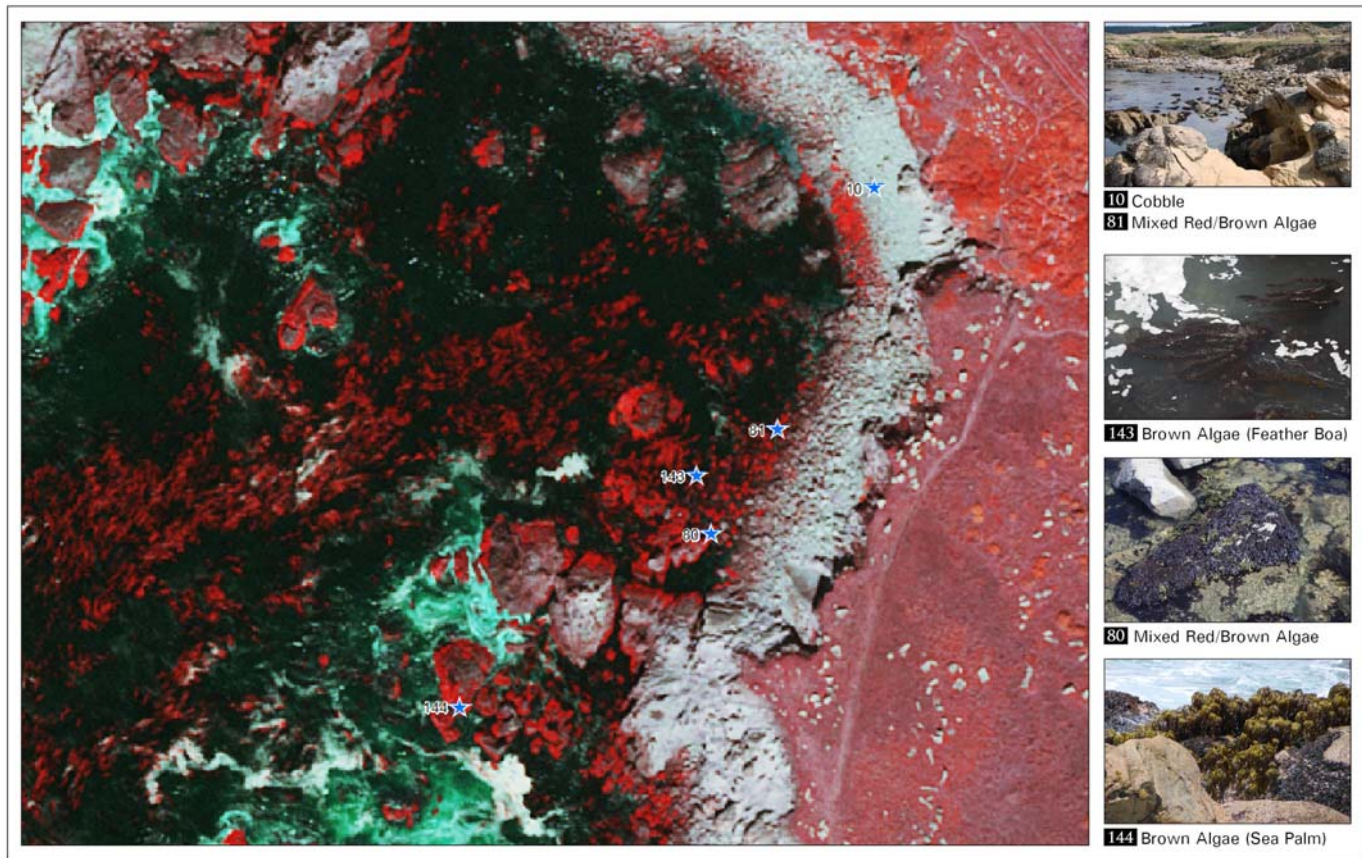
Overview of Project Year __ Activities, including progress towards meeting goals & objectives

Due to Ocean Imaging's extensive, federal government-requested involvement in the Deepwater Horizon oil spill response during summer 2010, some data processing and field work originally planned for the project's first year were postponed into the second year. These activities were successfully advanced during Year 2 to approach their original completion plan schedules.

- 1) **Continue processing the intertidal and estuarine image data into final substrate classifications:** As is described further in the next section, the intertidal multispectral image processing and substrate classification procedure was extensively altered from the much simpler, single data type approach originally proposed. This change was driven by both the added availability of unique remote sensing data sets and the advantages in substrate classification efficiency and accuracy they made possible. For processing purposes, the NCC shoreline was divided into sections corresponding to USGS' standard digital orthoquads, which were used as the base layer for accurate georeferencing of the multispectral imagery. Figure 1 shows the processing progress for each section as of 3/31/2012. All phases of the image processing were begun in the north of the NCC region and progressed southward. We estimate final completion of the full-coast classification by early end of May, 2012. This will then be followed by a careful classification accuracy/validation assessment using field data collected in summer, 2011.
- 2) **Conduct field sampling for classification results validation:** Field data work was conducted on 7/30/2011 through 8/4/2011, based out of Bodega Bay. The objective was to collect geoposition and photographic evidence of individual substrate targets within the intertidal and estuarine areas along large parts of the NCC coast. The initial sampling days were coordinated with UCSC's Dr. P. Raimondi's research staff who met Ocean Imaging's staff at some of their established intertidal study sites near Bodega and provided expertise in the substrate characterizations and identifications. Hundreds of intertidal substrate targets were documented between Pt. Arena to the North, and San Antonio Estuary to the South. In many cases, high cliffs paralleling relatively long stretches of intertidal shoreline allowed the inclusion of multiple substrate targets in a single photograph, which was then supplemented by further detailed hands-on documentation by climbing down to the intertidal zone. Figure 2. shows an example of relating the field –gathered observations to features in the collected multispectral imagery.
- 3) **Collect kelp canopy imagery for 2011:** Along with the field sampling work, our plan was to conduct additional aerial imaging over several selected sections of the intertidal areas at higher spatial resolution than was done in 2010, and also conduct the 2011 kelp survey along the NCC coast. A plane and pilot chartered out of Montgomery Field, San Diego FBO flew to meet part of the Ocean Imaging at Petaluma airport, which was used for the northern FBO from 7/31/2011 to 8/3/2011. Despite favorable weather forecasts for that time period, however, extensive coastal fog persisted throughout the coastal region during the (low tide) morning hours and into most of the afternoon each day. We thus made the decision to send the aircraft back to San Diego on 8/3 without being able to obtain any useful imagery. Following this time period, only 2 other low-tide vs. acceptable sun angle for imaging existed before major storms began hitting the NCC coastline, and neither of them provided sufficiently clear weather to commit to the flights. We were thus unable to collect high resolution kelp imagery for 2011 for the NCC region.
- 4) **Conduct a kelp persistence analysis using multiple archived data sets from previous years:** Data for this task have been compiled and are being processed. The 2010 kelp data set collected and processed as part of this project is being improved with additional processing and kelp classifications derived from the ADS-40 imagery made available to Ocean Imaging in 2011 (see below).



- **Figure 1.** Multispectral image data processing status as of 3/31/2012. The final product classification is shown in green.



- **Figure 2.** Multispectral aerial image of a small bay north of Bodega Bay (left) and geolocated field photos of different intertidal substrates (right). The exact locations of the photographed substrate types are shown on the multispectral image as numbered blue stars. Some of the field data were used to train the classification algorithms and the rest will be utilized for accuracy assessment of the final classification data base.

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

As was noted above, Ocean Imaging obtained during the second year additional data sets for use in creating the intertidal substrate classification product. These were Lidar topographic data and ADS-40 30cm resolution multispectral imagery collected over the NCC coastline during 2010 by Fugro Earth data as part of work funded by the California Coastal Conservancy. They were made available to Ocean Imaging and the SeaGrant Program through Fugro and NOAA's Coastal Services Center. The ADS-40 imagery's high resolution allowed better differentiation of detailed features in the upper intertidal zone. Unfortunately, the data were collected without low tide-level coordination, and hence their value is limited to the upper intertidal areas that were exposed at the time. However, the data still significantly enhance the initial multispectral imagery collected by Ocean Imaging in 2010.

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

As was noted above, unfavorable weather/fog problems prevented us from acquiring imagery for the annual NCC kelp survey. We are attempting to obtain alternate (satellite-based) kelp imagery which could be partially substituted to bridge the data gap while being obtainable within the project's existing budget.

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

All data, including DMSC and ADS-40 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 __ (if applicable) – Please describe remaining work and approximate timelines for completing that work, including any anticipated budget variances necessary to complete the project.

As per original project schedule, this project's Year 3 activities will include acquisition of the second set of estuarine imagery, its processing and evaluation of any environmental changes recorded between the 2010 and 2012 data sets. We will also complete the intertidal classification and compute its error statistics early in the year. Finally we will complete the kelp persistence analysis.

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>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	Provided Lidar & ADS-40 data and support
UCSC – Dr. P. Raimondi Group	State U./SeaGrant-funded	Provided staff for aid in field data collection

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

We are attaching to this report a detailed breakdown of the project's expenses incurred to-date. The project's original budget for aircraft charter was actually higher than the 2010 aircraft work required and with Sea Grant's permission (R. Madson e-mail 11/30/2010) were transferred to Year 2. We utilized these unspent funds during the second year for the additional labor required in the processing of the additional Lidar and ADS-40 imagery combined with Ocean Imaging's own DMSC image data.

We are also attaching (as a separate file) a short PowerPoint presentation that illustrates the above-described combined utilization of DMSC, ADS-40 and Lidar data sets for production of the final intertidal substrate classification product.