<center>**Data Management Plan**</center>

Data Policy Compliance
The project will comply with the NSF OCE Data and Sample Policy. Upon award notification we will contact the Biological and Chemical Oceanography Data Management Office (BCO-DMO) and provide metadata for the project. We will use BCO-DMO as the primary location for metadata and data for the project.

Description of Data Types
<u>Observational data</u>
Data collection will take place over 6 weeks from late spring through summer at two kelp forest locations per year along the coast of Southern Monterey Bay in Central California. During the proposed project we will collect environmental (DIC, pH, pCO_2, TA, dissolved oxygen, nutrients, PAR, seawater temperature, velocity, and salinity) and ecological data (benthic organism abundance, kelp abundance and growth rates, phytoplankton abundance and composition).
Environmental data
Continuous environmental data will be collected with sensors for water column velocity, temperature, dissolved oxygen, and benthic pH and PAR. Twice-weekly measurements of DIC, TA, and nutrients will be collected via water samples that will be subsequently analyzed at Stanford University along with CTD casts yielding measurements of temperature, salinity, density, dissolved oxygen, fluorescence, and PAR. Three 48-hour high frequency sampling events will take place at each kelp forest yielding measurements of pH, pCO_2, TA, and DIC at 8 locations throughout the water column every 4 minutes.
Ecological data
During 6-week study periods we will quantify the percent cover of benthic understory algae, calcifying species, and giant kelp, kelp canopy biomass, and kelp growth weekly, measure phytoplankton community composition twice-weekly, and will measure the extent of the kelp forest biweekly.

<u>Simulation Data</u>
Observational data will be used in a statistical model to examine relationships between environmental conditions, kelp forest community characteristics, and carbonate chemistry. These relationships will be used to make predictions of carbonate chemistry for other forests and under future environmental conditions predicted in the IPCC reports. All simulation data will be created in Matlab or R and analysis and model code and results will be made available.

<u>Derived Data</u>
This project will generate large amounts of analytical data and metadata. We will archive and make publicly available all raw and QC'ed project data following the NSF OCE Data and Sample Policy. In our experience it is essential from the standpoint of data utility to archive 1) raw data from all C system analytical streams; 2) all instrument/sensor setup parameters; 3) a detailed list of steps used to convert raw data to quality-checked and calibrated research data; 4) research quality data; 5) details on all calibration materials and standards; and 6) the subset of released data that is actually used in peer-reviewed publications. The requirement here is that a knowledgeable data user can check our conversion of raw to QC'ed research data via replication. This also means that if new information about standards or calibration procedures emerges an improved research data set may emerge.
This project will also generate summary reports of results and implications aimed at the management community (Monterey Bay National Marine Sanctuary, California Department of Fish and Wildlife).

Data and Metadata Formats and Standards
Metadata and all data will be submitted to BCO-DMO as comma- or tab- separated ASCII files (.csv, .txt). Analysis and model code will also be submitted as .m (Matlab) or .R (R). Observational data sets will include information on date and time of data collection, latitude and longitude of data collection, and

depth. Datasets will also include 'ReadMe' files that provide detailed explanations of any post data collection sample processing.

Data Storage and Access During the Project
Project data will be stored, accessed, and shared among project participants during data collection and analysis phases via a shared network drive. Data will be stored and backed-up via servers housed at California State University Northridge's Department of Biology. Duplicate copies of all data will also be backed up to servers at Stanford University.

Mechanisms and Policies for Access, Sharing, Re-Use, and Re-Distribution
Data and model results generated during the project will be contributed to the BCO-DMO system. We will work with BCO-DMO staff to manage data. Project data will be available online through BCO-DMO in compliance with the NSF OCE Sample and Data Policy. Data will be made publically available no later than two years after collection. Data deposited in BCO-DMO may be embargoed to allow final publications. This will only occur if publication is expected within a timely manner and after consultation with the NSF Program Officer and BCO-DMO staff.
We encourage re-use of our data, particularly for comparative studies and reviews of other systems with submerged aquatic vegetation. PI contact information will be available in metadata of data sets and we will encourage data users to contact the PIs when using the data to facilitate collaboration.

Plans for archiving data and preservation of access
After data contributed to BCO-DMO are online and fully documented, BCO-DMO will ensure that the data are archived properly at the appropriate National Data Center (e.g. NODC) for long-term archive preservation.
Data will also be archived at Stanford University via the Stanford Digital Repository, a university supported resilient data storage and delivery system (http://library.stanford.edu/research/stanford-digital-repository).
The Stanford Digital Repository is a service offered by the Stanford University Libraries that provides digital preservation, hosting, and access services that enable researchers to preserve, manage, and share research data in a secure environment for long-term citation, access, and reuse.
By depositing data into the SDR Stanford research projects:
  * Obtain a permanent, reliable data web link (persistent URL) that will not change over time
  * Control when research data are made public (following NSF guidelines)
  * Make your data easy for other researchers to discover
  * Ensure that the information is preserved into the future
Dunbar has long maintained a commitment to open access data archiving and availability, starting with data lodged with the NOAA Geophysical Data Center (NGDC) in the early 1990's. Independent of the Stanford Digital Repository, Dunbar has maintained a backed-up and secure data server at Stanford, one that has been in use for over 10 years (see Hydrography Reports from NSF funded cruises to Antarctica at: ftp://pangea.stanford.edu/pub/dunbar/CORSACSHydrographyReports/). This directory contains examples of C system data collected from discrete samples taken during a hydrography campaign in the Southern Ocean. There is also a detailed description of how the data was post-processed and quality controlled.

Roles and Responsibilities
PI Dunbar will be responsible for managing all biogeochemical data and PI Nickols and the postdoctoral researcher will be responsible for managing oceanographic, ecological, and modeling data. PI Nickols will ensure compliance with the Data Management Plan. The postdoctoral researcher will work with PI Dunbar and PI Nickols to come up with a standardized procedure for documenting and organizing all metadata and data sets in a consistent format.