SAN DIEGO STATE UNIVERSITY
Research Foundation

May 1, 2009

Eileen Maher
Environmental Services Department
Port of San Diego
3165 Pacific Highway
San Diego, CA 92101

Re: RFP - Environmental Projects Benefiting San Diego Bay
Todd Anderson, PI
"Implementation of the Center for Bay and Coastal Dynamics: Habitat –dependent Processes in San Diego Bay."

Enclosed please find the original application plus two copies and (1) CD ROM for the above referenced proposal.

This proposal is being submitted by the San Diego State University Research Foundation (SDSURF) on behalf of Dr. Todd Anderson. SDSURF is a non-profit corporation under the laws of California, whose officers and members are administrators and faculty of San Diego State University. The Foundation handles the administration of grants and contracts for research and educational projects and will serve as the fiscal agent for this project. If awarded, funds should be drawn in favor of SDSURF.

SDSU Research Foundation takes exception to Item 16 (Ownership of Records) in the agreement template. As a state agency, SDSU is not allowed to give away ownership of the intellectual property its faculty develops while working on funded projects. Item 16 should be deleted from the agreement if Dr. Anderson's project is awarded.

Please direct communications regarding this application to:

Programmatic
Todd Anderson, PI
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Sincerely,

Eugene Stein

Eugene Stein, Director
TEL: (619) 594-5731
Sponsored Research Development
awards@foundation.sdsu.edu

Attachment(s)

SAN DIEGO STATE UNIVERSITY

May 4, 2009

Eileen Maher
Assistant Environmental Director
Environmental Services Department
San Diego Unified Port District
PO Box 120488
San Diego, CA 92112-0488

Dear Ms. Maher,

Please find enclosed our proposal entitled "Implementation of the Center for Bay and Coastal Dynamics: Habitat-dependent Processes in San Diego Bay". We are submitting this proposal to the Environmental Advisory Committee of the San Diego Unified Port District. This proposal directly assesses the interactions between habitat features and biotic processes as a theme in the form of four studies to be conducted within San Diego Bay.

The aim of our proposal and these studies is to explore in a specific context the role of eelgrass beds, soft-bottom sediments, and rocky substratum in (1) evaluating eelgrass habitat quality by the performance of fishes, (2) assessing the predicted effects of climate change on the distribution and physiology of seagrasses, including the role of eelgrass in sequestering carbon, (3) determining differences in the community structure of infaunal invertebrates among habitats, and (4) estimating the distribution and movement patterns of lobsters across soft-bottom and hard-bottom habitats. **Importantly, we aim to conduct these studies under the umbrella of the Center for Bay and Coastal Dynamics (CBCD).** These studies represent the initial implementation of the CBCD that provides a nexus for basic and applied science of interest to agencies, environmental organizations, and the public. The presence of the CBCD will serve to bring high visibility to the activities supported by the Port of San Diego along with its academic partners and serve as a focal point for regional environmental issues. This specific research under the CBCD will benefit San Diego Bay by contributing understanding to conservation and management issues, supporting marine ecological research, furthering the environmental education of graduate and undergraduate students, and disseminating this knowledge to increase the awareness of and appreciation for San Diego Bay.

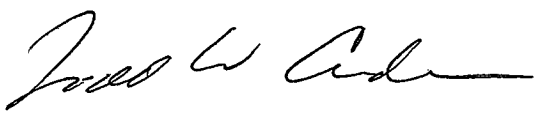
Taken together, the four interrelated studies proposed here not only have habitat-dependent processes as a common theme but include spatial and temporal variation in the coverage of habitats. Changes in the areal extent of eelgrass beds and in sediment transport, for example, can be determined from maps generated by Scripps Institution of Oceanography scientists using the seafloor mapping system recently provided by the Port of San Diego. In this fashion, our studies are enhanced by determining variation in the areal extent and configuration of habitats as

additional features that contributes important information on whether and how habitats and their associated organisms may change in San Diego Bay over time.

The primary contact for this proposed project is Dr. Todd Anderson, Associate Professor of Biology and Director of the Coastal and Marine Institute, San Diego State University (todda@sciences.sdsu.edu; phone: 619-594-0995). To conduct this integrative project, we request $263,845 in funding for a two-year period to begin work in Fall 2009. We provide substantial matching funds in the sum of $171,782 (total matching = 65%). Matching funds will come from donated time by the PIs, the use of dedicated research vessels operated by the PIs, use of image analysis systems, a CO_2 concentration system, CO_2 gases, a pulse amplitude modulated fluorometry (PAM) system, GPS units, and diving-related costs (SCUBA airfills).

We believe that this proposal to collectively examine habitat-dependent processes is a ***crucial step for implementing studies under the CBCD*** that will have great benefits for San Diego Bay and the Unified Port of San Diego.

Sincerely,



Todd W. Anderson
Associate Professor of Biology
Director, Coastal and Marine Institute

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Implementation of the Center for Bay and Coastal Dynamics: Habitat-dependent Processes in San Diego Bay

I. INTRODUCTION

The recent establishment of the Center for Bay and Coastal Dynamics (CBCD), composed of San Diego State University (SDSU), Scripps Institution of Oceanography (SIO), and the San Diego Unified Port District (SDUPD), with the establishment of an Advisory Committee, has now provided the framework for conducting ecological and environmental studies of interest in San Diego Bay. Based at the SDSU Coastal and Marine Institute Laboratory (CMIL) and jointly managed by SDSU and SIO to address issues important to SDUPD, the primary endeavor of the CBCD is

> *to employ the latest technology, data acquisition, and interpretation techniques toward understanding variation in the physical, chemical, and biological processes influencing San Diego Bay and surrounding coastal geo-ecosystems.*

The impetus for this collaboration and the formation of CBCD has been straightforward as an innate desire to investigate and understand the "entire system" of San Diego Bay using an integrated, cross-disciplinary approach. The Bay environment is dynamic (i.e. sediment coverage and habitat are variable), and thus recurring investigations and monitoring are required to establish time-dependent linkages in variation among processes. Through these proposed studies, the synergistic partnership of scientists from SDSU and SIO will establish world-class expertise in research and monitoring of the dynamic processes shaping San Diego Bay and the surrounding coastal region.

The overall vision of the CBCD, including the initial studies to implement the CBCD as outlined in this proposal, is intended to be a starting point for long-term research and sustained monitoring. Through project-based and process-oriented studies such as those proposed here, ***this proposal is crucial to the continued development of the CBCD*** and will spearhead a joint long-term relationship between SDUPD, SDSU, and SIO. Using joint resources as a catalyst, coupling biological studies and "groundtruthing" of habitat features by SDSU scientists with sophisticated habitat maps generated by SIO scientists will be used to determine the linkages between organisms and the habitats in which they reside at both small and large spatial and temporal scales.

II. PROJECT NARRATIVE

Overall project objective

The overall objective of this project is to implement four studies under the CBCD linked by a common theme to effectively explore habitat-dependent processes in (1) evaluating the quality of eelgrass beds as measured by fish performance, (2) determining differences in the community structure of infauna in sediments, within eelgrass beds and at the interface between these habitats, (3) assessing the predicted effects of climate change on the distribution and physiology

of eelgrass, including the role of eelgrass in sequestering carbon, and (4) estimating the distribution and movement patterns of lobsters across soft-bottom and hard-bottom habitats. We outline each of these four studies below.

A. Project Descriptions

Project 1. Evaluating Eelgrass Habitat Quality by the Performance of Recreationally Important and Other Fishes (PI: Anderson)

Background and Rationale

High-quality habitats are assumed to be those where the growth, survival, and future reproductive potential of organisms are optimized (Gibson, 1994). In evaluating the quality of eelgrass beds, some studies have emphasized the importance of growth rates of organisms (Sogard, 1992), whereas others have maintained that organism density may serve as a proxy for habitat quality (Gilliers et al., 2006). However, growth rates and densities in themselves may not mirror habitat quality because of potential differences in the condition (lipid content) and survival of organisms. Importantly, ***habitat quality itself can only be evaluated critically by the condition and survival of organisms that live within it***. To date, however, very little is known about variation in the quality of eelgrass habitats within embayments and how this may affect fish populations. The aim of this project is to evaluate the quality of eelgrass habitat within San Diego Bay as determined by the settlement (input of young fish from the plankton that have settled to eelgrass beds), growth, condition, and survival of recreationally important and other fishes. Specifically, we will select several sites to examine the input of young sea basses and other fishes to evaluate performance and assess their survival in determining habitat quality.

Approach and Methods

Objective 1: Determine eelgrass habitat attributes and settlement (input of young) of recreationally important and other fishes (sea basses) in eelgrass habitat at sites throughout San Diego Bay. Because structural habitat complexity often plays a role in survival of young fish from their predators (Anderson 2001), we will determine variation in several habitat characteristics of eelgrass, including shoot density and shoot height. These habitat attributes likely interact with survival rates of young fish, so they need to be documented among sites to use in independent estimates of survival as a measure of site quality (see Objective 3).

We will monitor settlement of sea basses (kelp bass and spotted bay bass) and other fishes (e.g., giant kelp fish) at 7-8 sites within San Diego Bay. Using multiple sites will allow us to evaluate whether there is a spatial gradient in site quality in terms of the number of fish that settle to each site, with sites arrayed from the front to the middle and south central sections of the Bay. Artificial Seagrass Units (ASUs) and Standard Monitoring Units for the Recruitment of Reef Fishes (SMURFS) will be deployed at all sites and sampled biweekly to determine the magnitude of settlement of fish among sites. A measure of settlement to these sites will provide us with the relative inputs of fishes spatially throughout the bay.

OBJECTIVE 2: DETERMINE THE GROWTH AND CONDITION OF YOUNG FISHES IN EELGRASS BEDS AMONG SITES. To determine the growth rates of individual fish from eelgrass beds after 2-3 months of residence of young fish within eelgrass beds, fish will be collected by beam trawl. Otoliths ("ear bones") will be extracted from individual fish, mounted on microscope slides, and examined using digital image analysis. The mean distance in microns between growth increments will be calculated to determine growth. We will also determine condition factor (length-weight ratios) and conduct lipid (fat) extractions as a measure of energy reserves and the overall health of the fish. Chloroform extractions will be used to distinguish total lipid content as an indicator of energy reserves. Using these data, we will differentiate high- and low-quality eelgrass habitat among sites based on the growth rate and condition of fish.

OBJECTIVE 3: DETERMINE WHETHER THERE ARE DIFFERENCES IN SURVIVAL OF FISH AMONG EELGRASS HABITATS WITHIN SAN DIEGO BAY. We will use combinations of eelgrass shoot density and height in laboratory mesocosms to assess survival of young fish. Using young fish of kelp bass and giant kelpfish, we will conduct predation trials in which 10 young of a species will be exposed to two older kelp bass as predators. Ten trials for each species and configuration of habitat structure will be conducted. Each trial will run for 15 hours, after which the number of surviving fish will be recorded. The degree of survival will serve as a proxy for estimating the degree of predation risk.

OBJECTIVE 4: ESTIMATE OVERALL HABITAT QUALITY AMONG SITES BY COMBINING SEPARATE MEASURES OF FISH PERFORMANCE. To provide a "common currency" in estimating settlement, growth, condition, and survival of fish for a given species, we will use non-metric multidimensional scaling (nMDS) to graphically represent similarities among sites. We will then use other multivariate techniques such as analysis of similarities (ANOSIM and SIMPER) to determine the relative importance of each parameter in contributing to habitat quality. We will also use the RELATE function in the software package PRIMER to determine if environmental parameters (temperature, distance to mouth of the bay, predator abundance, habitat attributes) are correlated with the performance of fishes.

Project 2. The Effects of Ocean Warming on the Health of Eelgrass in San Diego Bay (PI: Edwards)

Background and Rationale

The global climate is changing and the long-term impacts to our coastal ecosystems are largely unknown. Recent assessments by the United Nations Intergovernmental Panel on Climate Change Working Group (IPCC) noted that "observations since 1961 showed that the ocean has been absorbing more than 80% of the heat added to the climate system". Because the oceans cover over 70% of the world's surface, they will adsorb a significant fraction of the CO_2 derived from anthropogenic sources. This repartitioning of CO_2 into the marine environment as bicarbonate (HCO_3^-) will reduce the pH of the ocean. These changes likely will have dramatic impacts to the survival, growth and physiology of marine macrophytes such as seagrasses, ultimately altering primary production and the health of these vulnerable ecosystems. This, in turn, can have dramatic impacts on associated invertebrate and fish populations (see sections by

Drs. Anderson, Hentschel, and Hovel). Despite the impending increases in atmospheric CO_2 (by ~1.5 ppm y^{-1}), the impacts of the resulting warmer, more acidic ocean water on southern California eelgrass beds are largely unknown. We will study how predicted increases in ocean temperature and inorganic carbon, and deceases in pH, alter eelgrass primary production in San Diego Bay, assess the extent to which these beds sequester CO_2 from the surrounding water, and estimate their larger role in regional carbon budgets.

Approach and Methods

OBJECTIVE 1: ASSESSING THE IMPACTS OF CLIMATE CHANGE ON THE SURVIVAL, GROWTH, AND PHYSIOLOGY OF SAN DIEGO BAY EELGRASS (ZOSTERA MARINA) POPULATIONS. Several metrics of eelgrass demography, including distribution and abundance, growth, reproduction, photosynthetic performance, and tissue carbon and nitrogen content will be measured to quantify the health of eelgrass under conditions predicted with climate change. We will use field manipulations along with laboratory mesocosm experiments to investigate the effects of elevated CO_2 on adult, juvenile and embryonic life stages of eelgrass. This will be done by first assessing patterns of distribution and abundance of eelgrass throughout San Diego Bay, which will be done in collaboration with researchers from Scripps Institution of Oceanography, who will develop maps of eelgrass beds using a Port-supported multibeam mapping system. Once the major eelgrass beds have been identified and measured, we will outplant Onset Tidbit Thermographs to monitor changes in water temperature, and a combination of Onset light loggers and PAR sensors to monitor variation in irradiance.

To examine how increases in ocean temperature and inorganic carbon and decreases in pH will impact eelgrasses in San Diego Bay, we will grow eelgrasses in closed-circuit seawater mesocosms under conditions predicted with climate change. First, we will collect 80 eelgrass individuals from San Diego Bay and grow them in seawater tables at SDSU's Coastal and Marine Institute Laboratory under tightly controlled temperature, light, carbon and nitrogen conditions. These conditions will be based on field observations at the various sites identified in the above activities and from projected changes under current IPCC models. We will then monitor the eelgrasss for changes in growth, photosynthetic efficiency, and carbon/nitrogen tissue content. Specifically, we will establish eight experimental treatments (n = 10 individuals per treatment) consisting of combinations of high and low irradiances, ambient and elevated temperature, and ambient and elevated CO_2 concentrations. Lighting will be provided by full spectrum fluorescent lamps with irradiance set to mimic natural irradiances at the benthos in San Diego Bay during the midday and morning/afternoon. Because benthic irradiances are highly variable in the bay, we will repeat this experiment several times over the two-year study using different irradiances. Photoperiod will be controlled using automated timers and tanks isolated from one another with curtains. Water temperature will be controlled using aquaria heaters and chillers, with water circulation maintained using submersible pumps. CO_2 concentrations will be manipulated by bubbling CO_2 of varying concentrations through the water (note: concentrations for this will be ambient, 500, and 700 ppm (according to the IPCC). During each run of this experiment, the eelgrass will be monitored for growth by measuring their lengths and photosynthetic efficiency (ETR, effective quantum yield) using diving PAM fluorometry according to the methods outlined in Edwards & Kim (in review). After four weeks, the eelgrasses will be collected from the tanks and the thalli analyzed for Chl *a* pigment

concentration. Here, the thalli will be desiccated on silica gel (Actíva Products Inc.) for at least one week, after which they will be analyzed for nitrogen and carbon content using an elemental analyzer in SDSU's Ecology Analytical Laboratory**.**

OBJECTIVE 2: THE ROLE OF EEL GRASSES IN REGIONAL CARBON BUDGETS. Ocean waters play an important role in CO_2 uptake from the atmosphere. Some studies estimate the annual net uptake of CO_2 by the global oceans to be 2.0 to 2.2 Pg C yr^{-1}, though these estimates are highly sensitive to variation in wind speed. Comparatively, coastal waters may uptake as much as 0.45 pg C yr from the atmosphere, though this may vary between high and low latitudes and with ecosystem biodiversity (Borges et al. 2005). North Pacific coastal waters, for example, may account for ~5% of the total annual North Pacific CO_2 uptake, especially during upwelling seasons (Hales et al. 2005). Increases in pCO_2 in ocean surface waters may then set up feedback loops where the rate of additional CO_2 uptake is reduced, further exacerbating the problem (Thomas et al. 2007). Thus, processes that reduce surface water CO_2 may be crucial to maintaining CO_2 flux from the atmosphere. Much in the way terrestrial forests play a major role in the drawdown of atmospheric CO_2, marine eelgrass beds may be similarly important to local carbon fluxes.

Ocean pCO_2 measurements in and around San Diego Bay eelgrass beds will be made by collecting seawater samples from within the major eelgrass beds identified in the collaboration with Scripps Institution of Oceanography researchers. Seawater will be pumped from depth and collected in to 500-mL Pyrex bottles without introducing air bubbles. The seawater will immediately be fixed by adding of 100 µL of saturated mercuric chloride ($HgCl_2$) (DOE 1994). Following this, concentrations of total dissolved inorganic carbon (C_T) and total alkalinity (A_T) will be determined in the laboratory within one month following sample collection using potentiometric acid titration in a VINDTA system (Marianda, Kiel, Germany). The accuracy and precision of this system will be checked daily against seawater reference materials with known C_T and A_T values (certified by A. Dickson, Scripps Institution of Oceanography, San Diego, USA). The Values of CO_2 partial pressure (pCO_2) will then be calculated from measured C_T and A_T values using the thermodynamic model of Lewis & Wallace (1998). This will be repeated weekly during the two-year study to estimate temporal variation in CO2 concentrations, and throughout the day/night on at least five days to assess diel/diurnal variability.

Project 3. Community structure and recruitment dynamics in San Diego Bay sediments (PI: Hentschel)

Background and Rationale

The vast majority of San Diego Bay is sandy and muddy habitat. Sedimentary habitats are extremely dynamic, as even slight changes in near-bottom currents can alter the grain sizes of the deposits (Snelgrove and Butman 1994). The chemistry of sediments also is extremely complicated, especially in urban bays exposed to pollution. Small invertebrate animals such as worms, crustaceans, and clams have profound effects on the geophysical and geochemical features of the sediments in which the live. For example, many of these small infaunal animals build sand-castle tubes that can stabilize sediments in currents that would otherwise cause erosion (Thrush et al. 1996). Tube building and burrowing can physically mix sediments to various depths (i.e., bioturbation) and radically alter chemical profiles (Aller 1982). Dozens of

invertebrate species in San Diego Bay are deposit feeders that ingest vast amounts of sediment every day and, as a result of their feeding and digestive activities, can reduce the toxicity of some sediment-associated pollutants and serve as vectors for other toxins to enter higher trophic levels (Bryan and Langston 1992). In addition, the abundant invertebrates inhabiting shallow sediments are major food resources for many bottom-feeding fishes (and gray whales!) (Virnstein 1977, Dunham and Duffus 2001).

The structure of sediment communities (i.e., the abundances and different species living in a particular place) is greatly affected by the grain size of sediments and the geophysics of near-bottom currents and sediment transport. The dynamic geophysics makes it difficult to study organism-sediment relations without multidisciplinary collaboration and frequent monitoring of the dynamic habitats. Seafloor images and backscatter data acquired with the RESON 7125 operated by SIO geophysicists associated with the CBCD will facilitate unique monitoring of sedimentary habitats in San Diego Bay and manipulative experimentation on organism-sediment relations by Hentschel's laboratory. The following questions will be addressed: (1) How does the structure of the benthic community differ in sedimentary regions of San Diego Bay that are stable over time and areas of sediment that are more transitory due to dynamic geophysical processes or human disturbances such as dredging? (2) How does the recruitment of young life stages of infaunal invertebrates vary in space and time at different sites in San Diego Bay? (3) How rapidly are disturbed sedimentary habitats colonized by infaunal invertebrates? (4) How do community structure and recruitment vary on small spatial and temporal scales in relation to ripples, mounds, and other bedforms?

Approach and Methods

Hentschel and his students will work with the SIO geophysicists to identify at least three sites in San Diego Bay that appear to be relatively ephemeral sediment habitats (e.g., thin sediment deposits above harder substrates, areas subjected to frequent or recent geophysical disturbance such as dredging) and three relatively stable sites near each site that are likely to be unstable. In addition, we will use the seafloor images to identify at least three sites that show evidence of recently dredging or other human disturbance. At each site, several sediment cores will be taken at least four times each year to measure sediment grain size to ground-truth grain-size estimates from the acoustic backscatter mapping and to quantify the species composition and abundance of small infaunal invertebrates. When the high-resolution images of the seafloor indicate the presence of sediment ripples, mounds, or other bedforms on a scale of centimeters, cores for grain-size and infaunal analyses will be collected by divers from different locations near the bedforms (e.g., ripple trough and crest). Repeated imaging of the sediment sites likely to experience geophysical change during the months and years over which SIO geophysicists will be mapping and monitoring the Bay with the RESON 7125 will provide a unique opportunity to document changes in the infaunal community related to the geophysical changes.

In addition to monitoring the structure of sediment communities at different sites and at small spatial scales related to bedforms, every month divers will place replicate trays of defaunated sediment to measure the recruitment and colonization rates of infauna at each site (Smith and Brumsickle 1989). Natural sediment collected from each site will be frozen, thawed, and sieved to remove animals and the placed in trays that can be transported to the field sites and buried

flush with the surrounding sediment. Trays will be recovered after 1, 2, and 3 wk to count infauna and calculate rates of recruitment and recolonization. Defaunated trays provide a more reliable means to identify and count the very small post-larval and juvenile recruits of many species than do cores of the natural sediment. Defaunated trays also provide information on the rates at which sediments at each site are likely to be recolonized by various species if the site experiences disturbance, such as by dredging.

Project 4. Linking lobster abundance and movement behavior to habitat availability and configuration in San Diego Bay (PI: Hovel)

Background and Rationale

The California spiny lobster (*Panulirus interruptus*) supports significant and long-standing commercial and recreational fisheries in southern California. As such, fishing for *P. interruptus* contributes substantially to the economy and quality of life in San Diego County. California spiny lobsters also are ecologically valuable by virtue of their predatory effects on herbivores such as sea urchins in kelp forests, and on invasive species such as Asian mussels in eelgrass beds in San Diego Bay and Mission Bay, thereby enhancing biodiversity in these habitats. Whereas lobsters are principally thought of as open coast organisms, a significant portion of San Diego County's lobster population resides in subtidal rip-rap and eelgrass habitat adjacent to and inside San Diego Bay (SDB), where commercial fishing is prohibited. Mark-recapture surveys performed nearly thirty years ago estimated that SDB held ca. 17,000 – 21,000 lobsters. More recently, limited SCUBA-based surveys indicated that lobsters are locally dense along the edges of some eelgrass beds, particularly along the northern edge of Coronado Island and in beds near the mouth of SDB. Because commercial fishing is not allowed in the Bay, SDB may be acting as a *de facto* marine protected area for spiny lobsters, and SDB may have a major role to play when MPAs are established in Southern California as part of the Marine Life Protection Act (MLPA). Specifically, SDB may buffer coastal (= fished) lobster populations from fishing pressure via movement of lobsters between SDB and coastal habitats. Spillover from the Bay to the open coast may contribute substantially to the fishery, as the Point Loma fishing grounds are some of the most heavily fished in the state.

With funding from the Port of San Diego, Kevin Hovel (SDSU) and Doug Neilson (CADFG) presently are using mark-recapture techniques and acoustic tagging and tracking to determine the size of the spiny lobster population in SDB and how much exchange exists between discrete habitat patches (eelgrass beds and submerged rocky reefs) and between SDB and the open coast. The objective of the research proposed here is to determine how the availability and spacing of eelgrass and rocky reef habitat patches in San Diego Bay influence the habitat use, abundance, and movement of California spiny lobsters. We plan to combine our data with spatially explicit information on lobster abundance and behavior with a high-resolution habitat map of SDB generated with the Reson multibeam bathymetry system for high-resolution mapping of habitat in completing our objective.

Approach and Methods

DATA COLLECTION: LOBSTERS AND HABITAT MAPS. Using previously awarded funds from the Port of San Diego, in 2009-2010, Hovel and Neilson will deploy baited lobster traps to catch lobsters at 20 sites throughout the northern and central ecoregions of SDB. Lobsters captured in traps (up to 2100 individuals) will be tagged with t-bar tags to identify individual lobsters and released. Systematic recaptures over a 4-month period will provide data for a population size estimation using standard Jolly-Seber methodology and Program MARK (http://welcome.warnercnr.colostate.edu/~gwhite/mark/mark.htm). A subset of lobsters (up to 90) will be fitted with sonic tags and their movements tracked with automated receivers deployed throughout the northern and central ecoregions of SDB. Combined with diver surveys of discrete areas of SDB, this project will provide information on the abundance of lobsters within different areas of SDB and rates of exchange between discrete habitat patches as well as SDB and the open coast.

B. Literature Cited

Aller, R. C. 1982. *In*: McCall, P.L., Tevesz, M.J.S. (Eds.), Animal –Sediment Relations. Plenum, New York, pp. 53–102; Anderson, T.W. 2001. Ecology 82:245-257; Borges et al. 2005. Geophys Res Lett 32, L14601, dol:10.1029/2005GL023053; Bryan, G. W., and W. J. Langston. 1992. Environmental Pollution 76:89-131; DOE. 1994. ORNL/CDIAC-74. Oak Ridge,Tenn.; Dunham J. S., and D. A. Duffus. 2001. Marine Ecology Progress Series 223:299-310; Gibson, R.N. 1994. Netherlands Journal of Sea Research 32:191-206; Gilliers, C. et al. 2006. Estuarine, Coastal, and Shelf Science. 69:96-106; Hales, B. et al. 2005. Global Geochemical Cycles. 19:GB1009; Lewis E, Wallace DWR. 1998. ORNL/CDIAC-105. Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge; Sogard, S.M. 1992. Marine Ecology Progress Series. 85:35-53; Smith, C. R., and S. J. Brumsickle. 1989. Limnol. Oceanogr. 34:1263-1277; Snelgrove P. V. R., and C. A. Butman. 1994. Oceanogr. Mar. Biol. Annu. Rev. 32:111–177; Thomas, H. et al. 2007. Global Biogeochemical Cycles: 21:GB4001; Thrush, S. F. et al. 1996. Ecology 77:2472–2487; Virnstein, R. W.,1977. Ecology 58:1199–1217.

C. Importance of Proposed Project

This project examines the "health" and quality of multiple habitats within San Diego Bay, including eelgrass beds, soft-bottom sediments, and rocky bottoms. Coupled with knowledge of the areal extent of these habitats, their configuration, and the distribution and abundance of invertebrates and fishes provide a holistic view of the bay and knowledge of interactions between physical and biological processes. As importantly, these studies constitute the initial research under the Center for Bay and Coastal Dynamics, which is envisioned to become an important center for ecological, environmental, and geophysical research. The CBCD and the partnership between the Port of San Diego, SDSU, and SIO, will provide high visibility to environmental issues important at both local and regional scales. Findings from this study will be relevant to San Diego Bay and other embayments in San Diego County, southern California, and elsewhere with similar floral and faunal assemblages. The information gathered will provide managers critical information regarding the role of organism condition and survival and as a reflection of

the health of seagrass ecosystems that can be implemented in conservation and restoration efforts.

D. Project Benefits for San Diego Bay

- Fisheries: Sea basses (kelp bass, spotted bay bass) constitute an important recreational fishery for anglers in San Diego and elsewhere in southern California. In this case, knowledge of the factors that constitute high habitat quality in promoting the recruitment, growth, condition, and survival of these fishes provides for active management of eelgrass beds as important nursery grounds. Similarly, the California spiny lobster is the subject of both recreational and commercial fisheries, and knowledge of habitat use of lobster within San Diego Bay provides valuable information on future management of this species.
- Conservation: Seagrasses provide numerous ecosystem services, especially nursery grounds for economically important species. Although this protects eelgrass from some human activities, it does not address variation in the quality of the habitat that may serve to enhance the growth and survival of species that constitute important fisheries. By increasing our knowledge of the factors that influence the health of organisms living within various habitats. we will improve our ability to effectively conserve these important habitats.
- Restoration: Recent research suggests that biological and physical processes both may play a key role in maintaining seagrass habitats, and the results of this research will provide managers key information on the locations of higher quality habitat for fishes and habitat use of lobster, which in turn may influence where concentrated efforts to transplant eelgrass should be directed.
- Ecosystem Health: This research directly assesses the health of eelgrass beds and how predicted changes in climate change may affect eelgrass performance through physiological differences and potential changes in growth and survival in response to higher CO_2 and carbonate levels in the ocean.

E. Partnerships

This project takes advantage of ongoing work by SIO scientists who will be mapping San Diego Bay with a cutting-edge multibeam bathymetry system (see letter of collaboration/support from Dr. Jeff Babcock). The use of these sophisticated habitat maps enhances each of the four studies proposed here in providing high-resolution information on the areal extent, configuration, and sediment profiles of eelgrass, soft bottoms, and rocky bottoms. The RESON SeaBat 7125 system incorporates some of the latest technology and the highest resolution in shallow water multibeam bathymetry acquisition systems. The sonar system provides coverage of the sea floor with 256 focused 0.5 x 1˚ beams (at 400 kHz) and yields 130˚ swath coverage (4 x water depth) in water depths ranging from 0.5 – 200 m. The RESON 7125 produces estimates of bathymetry with resolutions in depth reaching ~2 centimeters, and horizontally of about a quarter-meter squared. The RESON SeaBat 7125 is the only true 0.5 degree multibeam system, offering incomparable resolution and feature detection performance compared to any other system. Bathymetry combined with backscatter information (also recorded on 7125 system) is an important tool in habitat classification.

III. Qualifying Experience

Dr. Anderson has conducted several projects on the population ecology of fishes (see below), including research with on the effects of habitat structure on fish recruitment and epifaunal diversity in San Diego Bay.

- Project: T.W. Anderson (2008). The role of fishes, trophic diversity, and ecosystem function in maintaining healthy eelgrass beds. San Diego Unified Port District. Contact: Eileen Maher – (619) 686-6254
- Project: T.W. Anderson (2004-08). The roles of predators and habitat in patterns of mortality of a temperate reef fish. National Oceanic and Atmospheric Administration, West Coast & Polar Regions National Undersea Research Center. Contact: Dr. Jennifer Reynolds – (907) 474-5871
- Project: T.W. Anderson (2005-07). Role of surfgrass as nursery grounds and habitat for near shore fishes. The San Diego Foundation. Contact: Dr. Emily Young – (619) 814-1318
- Project: K.A. Hovel and T.W. Anderson (2002-05). Evaluating eelgrass restoration: effects of habitat structure on fish recruitment and epifaunal diversity in San Diego Bay. San Diego Unified Port District. Contact: Eileen Maher – (619) 686-6254

Dr. Edwards has more than 20 years experience studying the ecology of southern California Dr. Edwards' research focuses on how environmental stressors impact marine plant communities, with attention to how eastern Pacific kelp communities vary from are impacted by catastrophic events such as El Niño.

- Project M.S. Edwards. (2008-current). The effect of climate change on the survival, growth and physiology of southern California kelps. In collaboration with KY Kim (supported with funds from NOAA/NURP).
- Project M.S. Edwards (2007-2010). The role of trophic cascades on eastern Pacific Kelp beds and their role in global carbon flux. National Science Foundation (contact: David Garrison, 703-292-8582).
- Project M.S. Edwards (2006-2009). The role of latitude in variation in the physiology and photochemistry of Pacific Kelp beds. National Oceanographic and Atmospheric Administration.
- Project M.S. Edwards (2004-2007). Using satellites to monitor latitudinal range shifts in Pacific kelps. National Aeronautics and Space Administration.

Dr. Hentschel has studied the ecology of meio- and macro-benthic invertebrates in soft-sediment communities for 24 years. Questions concerning the relationships between infauna, sediment transport, and near-bottom currents have been a major focus of Dr. Hentschel's research.

- Project: B.T. Hentschel, G.L. Taghon, and J. Shimeta (2000-2004). Effects of Flow on Feeding Behavior and Growth Rate of Interface-Feeding Benthos: Size-Dependent Changes and Recruitment Bottlenecks. Biological Oceanography Program, National Science Foundation. Contact: David Garrison – (703) 292-8582.
- Project: B.T. Hentschel (2006-2009). The Effects of Current Velocity and Creek Morphology on the Population Dynamics of Spionid Polychaetes in the Tijuana Estuary. California Sea Grant. Contact: Russell Moll – (858) 534-4440.

Project: B.T. Hentschel (2006-2011). CAREER: Consequences of short-term food variability during the development of marine invertebrate larvae. Biological Oceanography Program, National Science Foundation. Contact: David Garrison – (703) 292-8582.

Dr. Hovel has been studying the behavior, abundance and habitat use of California spiny lobsters for eight years through three research projects funded by California Sea Grant, the San Diego Foundation, and the Port of San Diego. To perform this research he has extensively used acoustic tracking and monitoring equipment and SCUBA surveys as well as GIS-based analyses on home range and movement behavior.

Project: Hovel, K.A. 2001-03. An evaluation of how shelter size and distribution within the Point Loma kelp forest influence California spiny lobster abundance, funded by the San Diego Foundation (contact: Emily Young, eyoung@sdfoundation.org, 619-235-2300)

Project: Hovel, K.A. 2007-09. An evaluation of how varying predation pressure between the Point Loma kelp forest and the La Jolla Ecological Reserve correlates with California spiny lobster shelter use behavior, funded by California Sea Grant (contact: Russ Moll, rmoll@ucsd.edu, 858-534-4440).

Project: Hovel, K.A. and C. Lowe. 2005-06. An evaluation of California spiny lobster movement patterns within the Point Loma kelp forest and within the La Jolla Ecological Reserve, funded by California Sea Grant (contact: Russ Moll, rmoll@ucsd.edu, 858-534-4440).

Project: Hovel, K.A. 2003-05. An evaluation of how eelgrass structure influences biodiversity in San Diego Bay, funded by the San Diego Unified Port District (contact: Eileen Maher, emaher@portofsandiego.org, 619-686-6200).

Project: Hovel, K.A., and D. Nielson. 2009-10. An evaluation of lobster population size and movement behavior in San Diego Bay, funded by the San Diego Unified Port District (contact: Eileen Maher, emaher@portofsandiego.org, 619-686-6200).

IV. Objectives of Grant Proposal

- Linking four studies on habitat-dependent processes to implement research under the Center for Bay and Coastal Dynamics. The research conducted over a 2-yr period will provide information on eelgrass performance, the quality of this habitat for recreationally important and other fishes, the influence of eelgrass and soft-bottom habitats on invertebrate fauna community structure, and movement and habitat use of the spiny lobster, an important fishery in locally and regionally in southern California.
- Integrating research by SDSU and SIO scientists in the use of high-resolution habitat maps on the areal extent, configuration, and profiles of eelgrass beds, soft-bottom sediments, and rocky substratum. SDSU scientists will "groundtruth" identified habitat in these maps and couple this information with the data obtained on habitat-dependent processes.
- Providing environmental education to support the thesis research of four graduate students, who will be pursuing M.S. degrees in gaining experience in conducting field research over this 2-yr period. The outcome of their training will result in four master's theses and subsequent publications in peer-reviewed journals.
- Providing information that will assist resource managers in a spatial assessment of habitat performance and quality as well as the interaction between habitat types and the ecology of organisms living with them.

V. Cost Proposal

Project expenses will include 1 month of salary for each PI, 1-year salaries for 4 graduate students, fringe benefits, boat and vehicle fuel, and expendable supplies to conduct field and laboratory work. An indirect rate of 15% applies, and cost share of over twice that required is included.

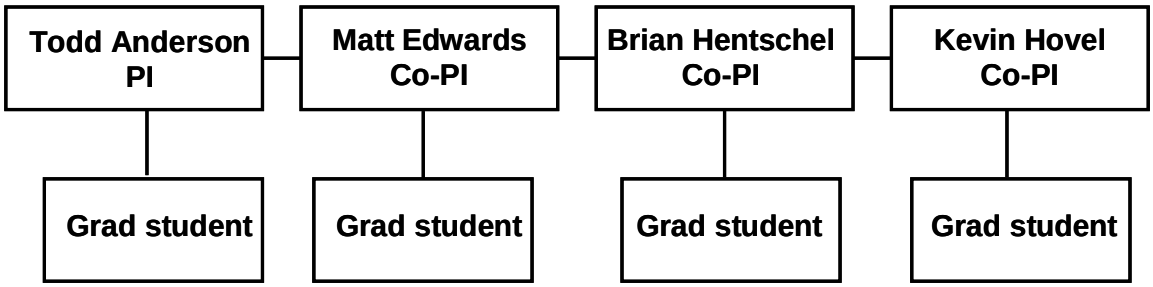
San Diego Unified Port District
Todd Anderson, PI
Center for Bay and Coastal Change - a collaboration of SDUPD, SIO, SDSU
October 01, 2009 through September 30, 2011

	# of Mos	FTE	Person Months	Salary Base	*10/01/09 09/30/10* YEAR 01 Requested	YEAR 01 Matching	*10/01/10 09/30/11* YEAR 02 Requested	YEAR 02 Matching	TOTAL
A. PERSONNEL									
Senior Personnel									
T. Anderson, PI	1.17	100.00%	1.17	7,705	9,000	7,705	9,000	7,705	33,409
M. Edwards, Co-PI	1.02	100.00%	1.02	8,829	9,000	8,829	9,000	8,829	35,658
B. Hentschel, Co-PI	1.05	100.00%	1.05	8,545	9,000	8,545	9,000	8,545	35,090
K. Hovel, Co-PI	1.02	100.00%	1.02	8,793	-	-	9,000	8,793	17,793
			Total Senior Personnel		*27,000*	*25,079*	*36,000*	*33,872*	*121,950*
Other Personnel	# Year 01	# Year 02							
Graduate Students	3	4		16,000	48,000	-	64,000	-	112,000
			Total Senior Personnel		*48,000*	-	*64,000*	-	*112,000*
			TOTAL PERSONNEL		**75,000**	**25,079**	**100,000**	**33,872**	**233,951**
B. FRINGE BENEFITS	*FDN*	*SDSU RT*							
Anderson @	25%	39.90%			2,250	3,074	2,250	3,074	10,648
Edwards @	25%	39.90%			2,250	3,523	2,250	3,523	11,546
Hentschel @	25%	39.90%			2,250	3,409	2,250	3,409	11,318
Hovel @	25%	39.90%			-	-	2,250	3,509	5,759
Grad Students @	19%	0%			9,120	-	12,160	-	21,280
			TOTAL FRINGE BENEFITS		**15,870**	**10,006**	**21,160**	**13,515**	**60,551**
C. TRAVEL									
Domestic									
Boat Fuel					2,000	-	3,000	-	5,000
Boat Use @ $300/day (6hr/day) x 82 days (year01)/94 days (year02)					-	24,600	-	28,200	52,800
Vehicle Fuel					400	600	-	-	1,000
Vehicle Use @ $50/day x 82 days (year01)/94 days (year02)					-	4,100	-	4,700	8,800
			TOTAL TRAVEL		**2,400**	**29,300**	**3,000**	**32,900**	**67,600**
D. Permanent Equipment									
Image Analysis System (Anderson - System Cost=$18K - 15% time/year)					-	2,700	-	2,700	5,400
Image Analysis System (Hentschel - System Cost=$17.5K - 15% time/year)					-	2,625	-	2,625	5,250
CO2 Concentration System (Edwards - System Cost=$17K - 25% time/year)					-	4,250	-	4,250	8,500
PAM Fluorometer System (Edwards - System Cost=$24K - 10% time/year)					-	2,400	-	2,400	4,800
			TOTAL EQUIPMENT		**-**	**11,975**	**-**	**11,975**	**23,950**
E. OTHER DIRECT COSTS									
Materials & Supplies					4,000	-	5,000	-	9,000
SCUBA Air Fills @ $5/ea x 2/day - 82 days (year01)/94 days year02					-	820	-	940	1,760
Acoustic Tags					-	-	3,000	-	3,000
Garmin Differential GPS Units (Hovel)					-	-	-	1,000	1,000
Certified CO2 Gases (Edwards)					-	200	-	200	400
			TOTAL OTHER DIRECT COSTS		**4,000**	**1,020**	**8,000**	**2,140**	**15,160**
TOTAL DIRECT COSTS					**97,270**	**77,380**	**132,160**	**94,402**	**401,212**
INDIRECT COSTS @ 15%		**0.00%**			**14,591**	**-**	**19,824**	**-**	**34,415**
TOTAL PROJECT COSTS					**111,861**	**77,380**	**151,984**	**94,402**	**435,627**

YEAR 01 Matching	**YEAR 02 Matching**
69%	**62%**

VI. Personnel

Organization Chart: (Todd Anderson, primary contact)



Brief Biosketches

TODD W. ANDERSON

a. Professional Preparation

California State University, Fresno	Plant Science	B.S. 1978
Moss Landing Marine Laboratories	Biology	M.A. 1983
University of California, Santa Barbara	Biology	Ph.D. 1993
University of Washington (FHL)	Postdoctoral Fellow	1994-1997

b. Appointments

2005-present	Associate Professor, San Diego State University
1999-05	Assistant Professor, San Diego State University
1997-99	Research Associate, Oregon State University
1996	Lecturer, Western Washington University

c. Five Selected publications

Galst, C.J., and T.W. Anderson. 2008. Fish-habitat associations and the role of disturbance in surfgrass beds. Marine Ecology Progress Series (in press).

Anderson, T.W. 2007. Guide to identification and surveying of near shore fishes. *In* Sampling biodiversity in coastal communities -- NaGISA protocols for seagrass and macroalgal habitats (P.R. Rigby, K. Iken, and Y. Shirayama, eds.). Kyoto University Press, Kyoto p. 90-92.

Steele, M.A., and T.W. Anderson. 2006. Predation. *In* Ecology of marine fishes: California and adjacent waters (L.G. Allen, M.H. Horn, and D.J. Pondella III, eds.) University of California Press, Berkeley, p. 428-448.

Andrews, K.S., and T.W. Anderson. 2004. Habitat-dependent recruitment of two temperate reef fishes at multiple spatial scales. Marine Ecology Progress Series 277:231-244.

Anderson, T.W. 2001. Predator responses, prey refuges, and density-dependent mortality of a marine fish. Ecology 82:245-257.

MATT S. EDWARDS

a. Professional Preparation

B.S.	University of California, Santa Barbara	Aquatic Biology	1990
M. S.	San Francisco State University	Marine Science	1996
Ph.D.	University of California, Santa Cruz	Biology	2001

b. Appointments

2008 – present Associate Professor of Biology – San Diego State University
2002 – 2008 Assistant Professor of Biology – San Diego State University
2001 – 2002 University of California Faculty Fellow - Researcher & Lecturer

c. Five Selected Publications

Edwards, M S. (1998). Effects of long-term kelp canopy exclusion on the abundance of the annual alga *Desmarestia ligulata*. Journal of Experimental Marine Biology and Ecology 228: 309-326.

Edwards, M. S. (2000). The role of microscopic life-history stages in the persistence of marine macroalgae in seasonally variable environments. Ecology 81(9): 2404-2415.

Edwards, M.S. (2004). Estimating scale dependency in disturbance impacts: El Niños and giant kelp forests in the Northeast Pacific. Oecologia 138: 436-447.

Edwards, M.S. and G. Hernández-Carmona (2005). Delayed recovery of giant kelp near its southern range limit in the North Pacific Ocean following El Niño. Marine Biology 147:273-279.

Edwards, M.S. and J. A. Estes (2006). Catastrophe, recovery, and range limitation in NE Pacific kelp forests: a large-scale perspective. Marine Ecology Progress Series 320: 79-87.

BRIAN T. HENTSCHEL

a. Professional Preparation

U. of South Carolina, Columbia	Marine Science & Honors College	B.S. 1988
U. of Washington, Seattle	Biological Oceanography	M.S. 1991
U. of Washington, Seattle	Biological Oceanography	Ph.D. 1995
U. of Oregon, Charleston	Postdoc in Larval Ecology	Jan 1996-Feb 1997
Rutgers Univ, New Brunswick	Postdoc in Marine Science	Mar 1997-Jul 1999

b. Appointments

August 2007 - pres.	Chair, Ecology Program, Dept. of Biology, San Diego State Univ.
August 2006 - pres.	Associate Professor (Marine Invertebrate Ecologist), Dept. of Biology, San Diego State University (SDSU), San Diego CA
August 2000 - 2006	Assistant Professor, SDSU
July 1999 - July 2000	Assistant Research Professor, Inst. of Marine & Coastal Sci. (IMCS); Science Director, Mid-Atlantic Bight Nat'l Undersea Research Center (MAB NURC), Rutgers University, New Brunswick, NJ

July 1998 - July 1999	Interim Science Director, MAB NURC, Rutgers University
March 1997 - July 1999	Postdoctoral Research Associate, IMCS, Rutgers University
Jan. 1996 - Feb. 1997	Postdoctoral Research Associate, Oregon Institute of Marine Biology (OIMB), University of Oregon, Charleston, OR
Sept. 1995 - Dec. 1995	Postdoctoral Teaching Assistant, Oceanography, Univ. of Washington

c. Five Selected Publications

Carson, H.S., and B.T. Hentschel. 2006. Estimating the dispersal potential of polychaete species in the Southern California Bight: Implications for designing marine reserves. Mar. Ecol. Prog. Ser. 316: 105-113.

Hentschel, B.T., and N.S. Harper. 2006. Effects of simulated sublethal predation on the growth and regeneration rates of a spionid polychaete in laboratory flumes. Mar. Biol. 149: 1175-1183.

Hentschel, B.T., and A.A. Larson. 2006. Hydrodynamic mediation of density-dependent growth and adult-juvenile interactions of a spionid polychaete. Limnol. Oceanogr. 51: 1031-1037.

Hentschel, B.T., and A.A. Larson. 2005. Growth rates of interface-feeding polychaetes: Combined effects of flow speed and suspended food concentration. Mar. Ecol. Prog. Ser. 293: 119-129.

Hentschel, B.T. 1998. Intraspecific variations in $\delta^{13}C$ indicate ontogenetic diet changes in deposit-feeding polychaetes. Ecology. 79: 1357-1370.

KEVIN A. HOVEL

a. Professional Preparation

Rutgers University	Environmental Science	B.S. 1991
SUNY at Stony Brook	Marine Environmental Science	M.S. 1995
College of William and Mary (VIMS)	Marine Science	Ph.D. 1999
NOAA/NOS Fisheries Research	Postdoctoral Fellowship	1999-2000

b. Appointments

2007-present: Associate Professor, Biology Department, San Diego State University, San Diego, California

2001-2007: Assistant Professor, Biology Department, San Diego State University, San Diego, California

2000 – 2001: Visiting Assistant Professor, Department of Biology, Sonoma State University, Rohnert Park, California

1999 –2000: National Research Council Postdoctoral Associate, NOAA/NOS Center for Coastal Fisheries and Habitat Research, Beaufort, North Carolina

1996 – 1999: Willard A. Van Engel Fellow, Department of Fisheries Science, Virginia Institute of Marine Science, Gloucester Point, Virginia

c. Five Selected Publications

Selgrath, J.C., K.A. Hovel, and R.A. Wahle. 2007. Effects of habitat edges on American lobster abundance and survival. Journal of Experimental Marine Biology and Ecology 353: 253-264.
Hovel, K.A. and H. M. Regan. 2007. Using an individual-based model to examine the roles of habitat fragmentation and behavior on predator-prey relationships in seagrass landscapes. Landscape Ecology DOI 10.1007/s10980-007-9148-9.
Sirota, L. and K.A. Hovel. 2006. Eelgrass (*Zostera marina*) structural complexity: relative effects of shoot length, shoot density, and surface area on epifaunal community composition in San Diego Bay, California, USA. Marine Ecology Progress Series 326: 115-131.
Reed, B.J. and K.A. Hovel. 2006. Seagrass habitat disturbance: how loss and fragmentation of eelgrass (*Zostera marina*) influences epifaunal abundance and diversity in San Diego Bay, California, USA. Marine Ecology Progress Series 326: 133-143.
Hovel, K.A. and M.S. Fonseca. 2005. Influence of seagrass landscape structure on the juvenile blue crab habitat-survival function. Marine Ecology Progress Series 300: 179-191.

VII. Subconsultants

None

VIII. Non-profit Status

Documentation is provided.

IX. Applicant Disclosure

No citations for environmental violations have been issued to the applicant within the last five years.

X. Agreement

The SDSU Research Foundation finds the insurance clause acceptable as written in the sample agreement.

X1. Conflict of Interest

The applicant is not performing services of any kind that would conflict with the services provided by this agreement.

XII. Additional Information

See accompanying letter of collaboration and support from Dr. Jeff Babcock, SIO.

UNIVERSITY OF CALIFORNIA, SAN DIEGO UCSD

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JEFFREY M. BABCOCK TEL: (858) 534-5223
INSTITUTE OF GEOPHYSICS AND PLANETARY PHYSICS FAX: (858) 822-3372
SCRIPPS INSTITUTION OF OCEANOGRAPHY (0225) EMAIL : JBABCOCK@UCSD.EDU
LA JOLLA, CALIFORNIA 92093-0225

April 30, 2009

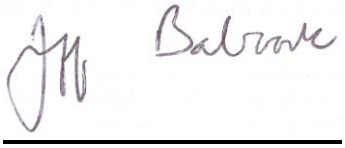
To: Todd Anderson, Professor and Director of Coastal and Marine Institute, Co-Director of Center for Bay and Coastal Dynamics, San Diego State University

Dear Todd,

As co-director of the Center for Bay and Coastal Dynamics (CBCD) I am extending my support of your proposal "Implementation of the Center for Bay and Coastal Dynamics: Habitat-dependent Processes in San Diego Bay" to the San Diego Unified Port District toward focused research within San Diego Bay. These efforts parallel the ongoing discussions between Scripps Institution of Oceanography and SDUPD toward the acquisition of a multibeam profiler and subsequent geophysical mapping campaign within the Bay. Partnered with the SDUPD and housed at the Coastal and Marine Institute Laboratory, the CBCD facilitates a synergistic collaboration between geophysicists at Scripps Institution of Oceanography and ecologists at San Diego State University. The Center will direct coordinated, cross-disciplinary research and long-term monitoring to critically evaluate the active processes shaping San Diego Bay and the surrounding coastal region.

The Bay environment is dynamic (i.e. sediment thickness and habitat are variable), and thus recurring investigations and monitoring are required to establish time-dependent linkages among processes. Commencing with the proposed complementary efforts in research and mapping, these initial efforts will establish an important baseline to be used in existing and future investigations within San Diego Bay. The joint success of this SDSU proposal and SIO discussions are also crucial beginnings for the CBCD, and I hope for a positive outcome in funding.

Sincerely,



Co-Director, Center for Bay and Coastal Dynamics

Internal Revenue Service

Date: May 11, 2005

SAN DIEGO STATE UNIVERSITY
FOUNDATION
% BUSINESS MANAGER
5250 CAMPANILE DR
SAN DIEGO CA 92182-1901 502

Department of the Treasury
P. O. Box 2508
Cincinnati, OH 45201

Person to Contact:
Ms. K. Hilson 31-07340
Customer Service Representative
Toll Free Telephone Number:
8:30 a.m. to 5:30 p.m. ET
877-829-5500
Fax Number:
513-263-3756
Federal Identification Number:
95-6042721

Dear Sir or Madam:

This is in response to your request of May 11, 2005, regarding your organization's tax-exempt status.

In May 1944 we issued a determination letter that recognized your organization as exempt from federal income tax. Our records indicate that your organization is currently exempt under section 501(c)(3) of the Internal Revenue Code.

Our records indicate that your organization is also classified as a public charity under section 509(a)(2) of the Internal Revenue Code.

Our records indicate that contributions to your organization are deductible under section 170 of the Code, and that you are qualified to receive tax deductible bequests, devises, transfers or gifts under section 2055, 2106 or 2522 of the Internal Revenue Code.

If you have any questions, please call us at the telephone number shown in the heading of this letter.

Sincerely,

Janna K. Skufca

Janna K. Skufca, Director, TE/GE
Customer Account Services

ATTACHMENT A

Proposer's Equal Opportunity Program
San Diego Unified Port District

Submitted to:
San Diego Unified Port District

Submitted by: San Diego State University Research Foundation

Request for Proposal
Environmental Projects Benefiting San Diego Bay

Date: April 30, 2009

RESPONDENT'S EQUAL OPPORTUNITY PROGRAM

Report all permanent full-time or part-time employees. Refer to Section D for instructions to complete this Section. In Section E, identify the working titles found within each job group.

A. Corporate Work Force Location: 5250 Campanile Dr., San Diego

Job Group	Total	Male					Female				
		WH	BL	HI	AP	AI	WH	BL	HI	AP	AI
Officials/Managers	29	7	1				18	1	1		1
Professionals	45	6		1			28	1	5	3	1
Technicians	50	3		3	2		26	3	6	3	4
Sales Workers											
Admin Support	20				2	1	8	3	3	2	1
Craft Workers	8	5	1	1	1						
Operators											
Laborers	2	1				1					
Service Workers											
Total:	154	22	2	5	5	2	80	8	15	8	7

B. San Diego Work Force Same as above

Job Group	Total	Male					Female				
		WH	BL	HI	AP	AI	WH	BL	HI	AP	AI
Officials/Managers											
Professionals											
Technicians											
Sales Workers											
Admin Support											
Craft Workers											
Operators											
Laborers											
Service Workers											
Total:											

C. Project Work Force

Job Group	Total	Male					Female				
		WH	BL	HI	AP	AI	WH	BL	HI	AP	AI
Officials/Managers											
Professionals											
Technicians											
Sales Workers											
Admin Support											
Craft Workers											
Operators											
Laborers											
Service Workers											
Total:											

Contact Person: S. Aileman
Signature: S Aileman
Title: HR Specialist

Phone: (619) 594-1085
Date: April 30, 2009
Company Name: SDSU Research Foundation

D. Explanation for Completing Employment Data

Employment data must include ALL current full-time and part-time employees. Employees must be counted by sex and race/ethnic category for each of the nine occupational categories. You may acquire the race/ethnic information necessary for this report either by visual surveys of the work force, or from post-employment records as to the identity of employees. Eliciting information on the race/ethnic identity of an employee by direct inquiry is not encouraged.

For the purpose of this report, an employee may be included in the group to which he or she appears to belong, identifies with, or is regarded in the community as belonging. However, no person should be counted in more than one race/ethnic group. The race/ethnic categories for this survey are:

WH - White (not of Hispanic origin) - All persons having origins in any of the original peoples of Europe, North Africa, or the Middle East.

BL - Black (not of Hispanic origin) - All persons having origins in any of the Black racial groups of Africa.

HI - Hispanic - All persons of Mexican, Puerto Rican, Cuban, Central/South American, or other Spanish culture/origin, regardless of race.

AP - Asian or Pacific Islander - All persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands. This area includes, for example, China, Japan, Korea, the Philippine Islands, and Samoa.

AI - American Indian or Alaskan Native - All persons having origins in any of the original peoples of North America, and who maintain cultural identification through tribal affiliation or community recognition.

Every employee must be accounted for in ONLY one of the categories. Employment data must be reported by job category. Report each employee in only one job category.

To assist you in determining where to place your jobs within the occupational categories, a description of job categories is as follows:

Officials and Managers - Occupations requiring administrative and managerial personnel who set broad policies, exercise overall responsibility for execution of these policies, and direct individual departments or special phases of a firm's operations. Includes: officials, executives, middle management, plant managers, department managers, and superintendents, salaried supervisors who are members of management, purchasing agents and buyers, and kindred workers.

Professionals - Occupations requiring either college graduation or experience of such kind and amount as to provide a comparable background. Includes: accountants and auditors, architects, designers, dieticians, editors, engineers, lawyers, personnel and labor relations specialists, and kindred workers.

Technicians - Occupations requiring a combination of basic scientific knowledge and manual skill, which can be obtained through 2 years of post high school education, such as, is offered in many technical institutes and junior colleges, or through equivalent on-the-job training. Includes: computer programmers, drafters, engineering aides, photographers, surveyors, technical illustrators, and kindred workers.

Sales Workers - Occupations engaging wholly or primarily in direct selling. Includes: advertising agents and sales workers, insurance agents and brokers, stock and bond sales workers, sales clerks, cashiers, and kindred workers.

Admin Support - Includes all clerical-type work regardless of level of difficulty, where the activities are predominantly non-manual though some manual work not directly involved with altering or transporting the products is included. Includes: bookkeepers, collectors (bills and accounts), messengers and office helpers, office machine operators (including computer), shipping and receiving clerks, stenographers, typists and secretaries, telephone operators, legal assistants, and kindred workers.

Craft Workers (skilled) - Manual workers of relatively high skill level having a thorough and comprehensive knowledge of the processes involved in their work. Exercise considerable independent judgment and usually receive an extensive period of training. Includes: building trades, hourly paid supervisors and lead operators who are not members of management, mechanics and repairs, compositors and typesetters, electricians, engravers, bakers, decoration occupations, and kindred workers.

Operators (semi-skilled) - Workers who operate machine or processing equipment or perform other factory type duties of intermediate skill level which can be mastered in a few weeks and require only limited training. Includes: apprentices, operatives, attendants, blasters, chauffeurs, delivery workers, equipment assemblers, and kindred workers.

Laborers (unskilled) - Workers in manual occupations which generally require no special training or perform elementary duties that may be learned in a few days and require the application of little or no independent judgment. Includes: garage laborers, laborers performing lifting, digging, mixing, loading and pulling operations, and kindred workers.

Service Workers - Workers in both protective and non-protective service occupations. Includes: professional and personal service, including nurses aides and orderlies, barbers, cleaners, cooks, counter and fountain workers, elevator operators, door keepers, janitors, police officers and detectives, waiters and waitresses, amusement and recreation facilities attendants, guides, ushers, and kindred workers.

E. Working Titles

List the working titles of all employees by category, e.g., Professionals: Civil Engineer, Structural Engineer; and Technicians: Drafter, Computer Programmer, Surveyor.

Officials/Managers	Professionals	Technicians
Administrator	Specialists	Payroll Technicians
Coordinator	Analysts	IT Analyst
	Accountants	IT Programmer
	Account Administrators	IT Consultant
		Accounting Technician II's
		Buyer
		Staff Services Technician
		Development Technician
		Sponsored Research Tech.

Sales Workers	Office/Clerical	Craft Workers
	Accounting Technician II	Maintenance Worker
	Admin. Support Assistant	

Operatives	Laborers	Service Workers
	Laborer	

Statement of Compliance

EQUAL EMPLOYMENT OPPORTUNITY

THE FOLLOWING CERTIFICATE SHALL BE SIGNED BY THE CHIEF EXECUTIVE OFFICER OF THE SERVICE PROVIDER AND SUBMITTED WITH SERVICE PROVIDER'S REQUIRED EQUAL EMPLOYMENT OPPORTUNITY PROGRAM.

Agreement Description: **Environmental Projects Benefiting San Diego Bay**

Service Provider/Lessee: SDSU Research Foundation

Address: 5250 Campanile Dr.

City, State, Zip Code: San Diego, CA 92182-1931

Telephone Number: (619) 594-5731

The Service Provider shall not discriminate against any employee or applicant for any employment action because of race, color, religion, sex, national origin, ancestry, physical or mental disability, veteran status, medical condition, marital status, age (40 years and older), sexual orientation or pregnancy.

Service Provider shall certify that Service Provider is in compliance with and throughout the term of the contract or lease will comply with: Title VII of the Civil Rights Act of 1964, as amended; the Civil Rights Act of 1991; the California Fair Employment Practices Act; and any other applicable Federal, State, and local law, regulation and policy including without limitation, those adopted by the District relating to equal employment opportunity, including any such law, regulation, and policy hereinafter enacted.

Eugene Stein

Signature of CEO

Eugene Stein

Printed Name

April 30, 2009

Date

Note: Please refer to the San Diego State University Research Foundation Board Resolution memo signed by Executive Director Mr. Dan Gilbreath designating Mr. Eugene Stein with signature authority.
Thank you for your consideration.

SAN DIEGO STATE
UNIVERSITY
Research Foundation

At a meeting of the Board of Directors held on October 9, 1975, the following resolution was adopted unanimously:

> **RESOLVED, That contracts and grants accepted on behalf of the University for research and educational projects may be signed by the Vice President of the Foundation, the Vice President for Business and Financial Affairs of the University, the Executive Director of the Foundation, or their designees.**

In accordance with the above action taken by the Board of Directors, I, Dan M. Gilbreath, Executive Director of San Diego State University Research Foundation, hereby designate: Melinda S. Coil, Chief Financial Officer; W. Timothy Hushen, Chief, Sponsored Research Services; Eugene L. Stein, Director, Sponsored Research Development; and Michèle G. Goetz, Director, Sponsored Research Administration, the authority to sign contracts and grants for research and educational projects accepted by San Diego State University Research Foundation on behalf of San Diego State University.

February 17, 2009
Date

Dan M. Gilbreath
Executive Director