Warren J. Baker Endowment
for Excellence in Project-Based Learning
Robert D. Koob Endowment *for Student Success*

FINAL REPORT

I. Project Title

Quantifying reproductive output of marine benthic species *Kelletia kelletii* surrounding the 2016 El Nino event.

II. Completion Date:

5/30/16

III. Student(s), Department(s), and Major(s)

Justin Palmer, Biology, Biological Sciences

IV. Faculty Advisor and Department

Crow White, Biological Sciences

V. Cooperating Industry, Agency, Non-Profit, or University Organization(s)

CSU Fullerton, Dr. Danielle Zacherl
Universidad Autónoma de Baja California, Ensenada, Mexico (UABC)

VI. Executive Summary

Nearly all of the marine fish and shellfish living along coastlines release microscopic larvae into the open ocean. The larvae then disperse for weeks to months before settling back into coral reefs and kelp forests. The larvae are too small and they travel too far to be tracked directly. Yet, knowing where these larvae settle is important for conservation and management. By quantifying the origins of a reef's population, one can determine the extent to which that reef is dependent on other fish and shellfish populations for the replenishment of the next generation. Understanding these patterns of "connectivity" and "dependency" among reefs is critical for determining how to best protect, fish, and manage our coastlines.

To complicate matters, connectivity patterns change annually. An example of such changes along the Pacific Coast of North America has to do with El Niño's, which occur every few years, and generate warm, northward-flowing ocean currents that transport marine larva up the coast. Thus, it is hypothesized that El Niño's can make northern reefs dependent on southern populations for new supplies of fish and shellfish. There is evidence showing that El Niños will increase in frequency and intensity with the changing climate, and because strategic management of fisheries in relation to effects of El Niño on connectivity could produce large gains in catches and profit, such present and future implications of El Niño events highlight the importance of studying them when the occur.

The objective of this research was to test if El Niño oceanographic conditions drive the poleward geographic range expansion of coastal marine species, through the use of the kelp forest gastropod, Kellet's whelk (*Kelletia kelletii*), as a case study.

This specific project aimed at quantifying the reproductive output at the 25 known Kellet's whelk populations positioned along the North American coast that cover both the historical and expanded biogeographic range of the species. In order to quantify the reproductive output, SCUBA techniques where used to conduct six benthic transects surveys at each site. Every egg cluster encountered was quantified (length, width, % cover) and photographed. Samples of the ripe eggs where collected for future analysis. Once the data was collected, back at Cal Poly two teams worked on differing aspects of the reproductive output analysis.

My team focused on quantifying the number of capsules per cm^2. This was done through the image analysis software (Image J) and was performed by analyzing the photographs taken at each site. The other team focused on the quantification of the average number of larva per egg capsule in each site. This data was collected via petri dish transect mapping and estimation techniques. Both analyses were averaged for each site and combined to create the average number of larva per cm^2. This data was then combined with transect data indicating egg coverage on the benthos in order to produce an average reproductive output estimation for each site. Data from 2015 was compared with data obtained in 2016 to produce a comparison of pre and post El Niño seasons. Further research will consider 2017 data to produce a three-year distribution map of reproductive output hotspots. Many more aspects of *Kelletia kelletii* research are being conducted via other teams in the hopes of eventually creating a metapopulation map depicting the source and sink populations, along with predicting the location of future populations.

VII. Major Accomplishments

(1) Established a novel reproductive output quantification method of benthos marine species

(2) Combined data from three sources of reproductive output quantification methods (# of larva per capsule, capsules per m^2, egg mass area per transect) to produce total reproductive output at the 25 differing sites.

(3) Compared 2015 and 2016 reproductive outputs to quantify changes in source populations through the 2016 El Niño event

(4) Created coastal maps highlighting source populations of the *Kelletia kelletii* metapopulations, for 2015 and 2016 data.

VIII. Expenditure of Funds

The Baker-Koob Endowment funds were essential to the execution and success of this project. Funds were allocated to two main categories; travel, and equipment. Transects, mesh bags, dive slates, marker buoys, and scuba tank refills where purchased with equipment funds. A second portion of funds allocated to support travel fees, including gas, food, and lodging. Funds in both equipment and travel helped create necessary research quiver for accurate and safe data collection at the 25 sites along California.

IX. Impact on Student Learning

The most significant and lasting impact created through receiving this Baker-Koob endowment was the ability to experience and preform my own study—from designing the field study, to preforming the field work and analyzing the data. The freedom to engender an ecological study that interested me (outside of a classroom setting) is an opportunity that has propelled me to an interest in furthering my studies in graduate school. This grant provided me with the necessary equipment to practice research SCUBA and acquire other field research techniques and etiquette valuable to prospective employers.

Additionally, post data collection, I was able to collaborate with different teams focusing on differing aspects of *kelletia kelleti* reproduction, compile all the data and create a depiction representing the reproductive hotspots throughout the coast of California. This project not only directed me toward proper field study techniques, but also allowed me to lead a team of colleagues in collaboration with other teams, to accomplish a common goal. Overall this endowment provided me with the necessary tools to map out, and preform an ecological study, collaborate with fellow scientists, and become a leader of a project. All of these experiences are ones which cannot be paralleled or taught in a lecture hall, greatly exemplifying Cal Polys famous "learn by doing" motto.

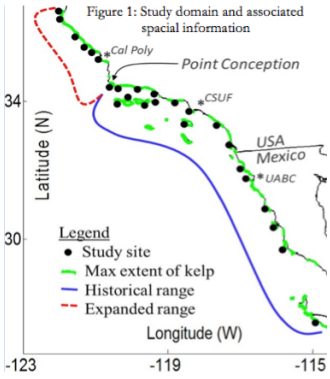

Figure 1: Map depicting the 25 dive sites up the coast of Mexico and California. Each site is a known population of *kelletia kelleti*

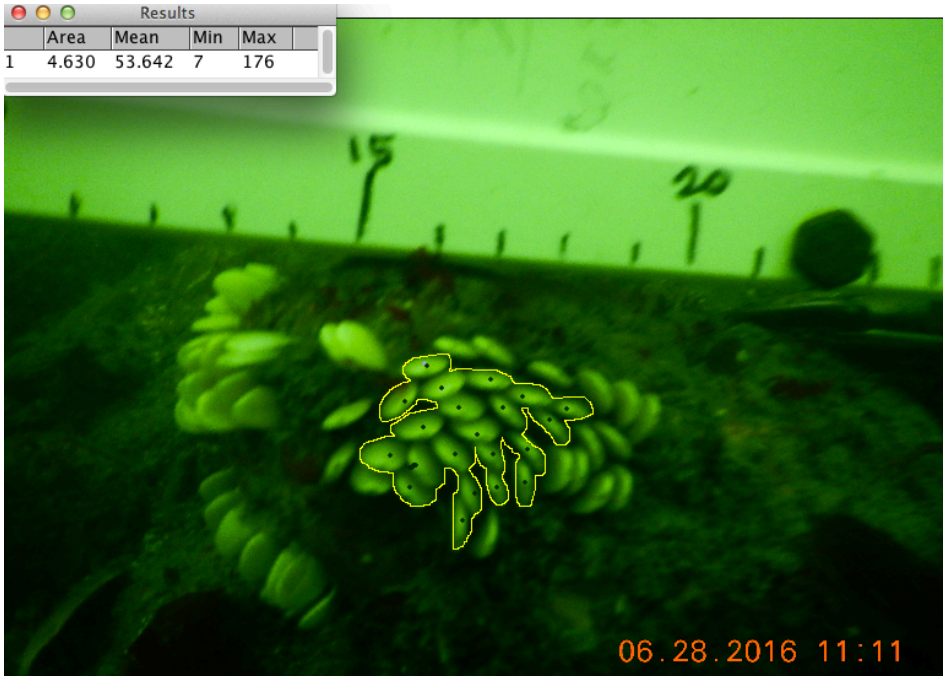

Figure 2: Photo analysis of an egg mass encountered on transect. Specific site: Italian gardens (Catalina). Pc: Justin Palmer