

Warren J. Baker Endowment

for Excellence in Project-Based Learning

Robert D. Koob Endowment for Student Success

Proposal Cover Page

Title of Project:

Evaluating recruitment seasonality of red abalone (*Haliotis rufescens*) to inform fisheries management and conservation policy

Proposal Author: Leslie Hart **Cal Poly Email:** lehart@calpoly.edu

Student ID: 012032094 **Signature (Optional):** 

Signature provides permission to check financial aid eligibility.

Previous Baker/Koob Endowment funding? (circle one): **Yes** **(No)**

Team Member(s)	Signature	Cal Poly Email	Department
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Faculty Advisor: Jennifer O'Leary **Department:** Biological Sciences

Faculty Advisor email: jkoleary@calpoly.edu **Telephone:** (805) 756-2896

Anticipated Start Date: January 2017

Anticipated End Date: November 2017

Total Funds Requested (\$): \$2500

Signature of Faculty Advisor:  **Date:** 11/9/2016

Proposal Narrative

I. Abstract

Understanding the seasonality of red abalone recruitment (larval settlement) and the relationship between recruitment and oceanographic conditions is critical for managing this economically important species. Red abalone, *Haliotis rufescens*, were historically part of a recreational and commercial fishery in southern and central California until overharvesting and disease rapidly decreased populations. Recruitment dynamics of red abalone are poorly understood. Previous research conducted at a central California site, Hopkins Marine Life Refuge (HMLR), from 2012-2015 reveal remarkably consistent recruitment rates of red abalone, while northern California recruitment greatly fluctuated within the same time period. To address this gap in our knowledge, I will investigate the seasonality of red abalone recruitment at HMLR in the central California population. This location provides an opportunity to ask this question in a unique location with consistent recruitment across years. To target early recruits, I will assess the numbers of new settlers monthly over the course of one year from July 2016-June 2017. I will simultaneously collect data at HMLR on temperature, wind, and wave forces to evaluate potential correlations between these factors and periods of high abalone recruitment. I hypothesize that seasons and physical oceanographic parameters work synchronously to maintain red abalone recruitment rates in central California, and predict a peak in red abalone recruitment between the months of August through November.

II. Introduction

Population growth of economically important species cannot be predicted without understanding recruitment: the addition to new individuals to a population. Most studies measure recruitment rates by days or months after settlement due to the difficulty of finding new settlers (Ebert et al. 1994, Gaines & Bertness 1992, Wing et al. 1995). However, in order to understand the processes affecting the arrival of recruits, it is critical to measure early recruitment before post-settlement mortality occurs. Most invertebrate species recruit from a pelagic larval form after broadcast spawning occurs (Roughgarden et al. 1988). Therefore, physical oceanographic forces (such as water movement) can have a strong impact on the delivery of pelagic larvae to benthic habitats.

California red abalone, *Haliotis rufescens*, once supported a commercially important fishery in southern California (Rogers-Bennett et al. 2002). As a result of overharvesting (Rogers-Bennett et al. 2002) and disease (Moore et al. 2000), rapid declines occurred in the abalone fishery from the 1960s to 1990s. The fishery closed south of San Francisco in 1997 because of the sharp decrease in population (Rogers-Bennett et al. 2002), and southern California red abalone have yet to recover (Karpov et al. 2000). Red abalone in central California experience population limitation by sea otters (Hines & Pearse 1982). However, these populations have been persistent for decades with 0.2 individuals/m² of red abalone (Micheli et al. 2008). In northern California, only recreational, free-dive red abalone fishing is permitted (Haaker et al. 1996) as a precautionary measure to protect the last remaining large abalone population in the state (Karpov et al. 2000). Population densities in northern California average 0.53 individuals/m², though some areas show signs of declines in abundance to 0.33 individuals/m² (CDFW 2010). Even in relatively dense abalone populations in northern California, recruitment has been difficult to track because there were previously no methods to survey early settlers (before post-settlement mortality can occur), and juveniles are highly cryptic. Data on juvenile red abalone populations in northern California shows large temporal gaps in recruitment of up to 10 years (CDFW 2010), but whether this is due to recruitment dynamics or post-settlement mortality is unknown.

Eight years ago, the California Department of Fish and Wildlife (CDFW) adopted a method to assess early abalone settlement by collecting cobbles (~15 cm diameter) covered with crustose coralline algae, a benthic substrate that provides a critical chemical settlement cue for abalone (Petrus de Waal et al. 2012, Rogers-Bennett et al. 2011, Roberts et al. 2004). The method consists of rinsing the collected cobbles, and sieving the collected material into jars, then sorting resulting samples microscopically to enumerate abalone settlers less than one month old (Rogers-Bennett 2016). Using this method, CDFW found that settlement in northern California is sporadic, with boom and bust, non-synchronous settlement across eleven sampled sites (Rogers-Bennett 2016). The factors contributing to recruitment fluctuations are unknown.

In contrast, in lower density central California (Monterey Bay), recruitment has been found to be consistent over the past several years (O'Leary 2015, pers. comm., October). The persistence of recruitment at IIMLR provides the opportunity to investigate variation in abalone recruitment within a year, and evaluate correlations between periods of high and low recruitment and changes in physical oceanographic parameters.

My research will answer the following questions: (1) Are there peak months in red abalone recruitment? and (2) Are peaks in red abalone recruitment correlated with temperature, wind, and wave forces?

If a settlement season for California red abalone can be determined, managers can survey recruitment strategically during peak months. Further, if oceanographic factors correlated with settlement can be determined, conditions leading to successful recruitment in the fished and managed range in northern California may allow predictive modeling of likely future population sizes and more suitable fisheries management strategies. Knowledge of recruitment seasonality and possible influential oceanographic parameters may also be used to identify optimal locations for restorative abalone outplanting in the depleted southern California range. By collaborating directly with CDFW (Dr. Laura Rogers-Bennett and team), my results will be immediately available to managers.

III. Objective(s)

- (1) Collect 30 cobbles with crustose coralline algae and count red abalone recruits each month for a year to evaluate recruitment rates.
- (2) Extract data produced by Hopkins Marine Station's Kelp Forest Array to search for a correlation between recruiting months and key physical oceanographic parameters.

IV. Methodology

This study will be conducted at HMLR in Pacific Grove, California. I will collect and enumerate abalone settlers (less than one month old) from cobbles monthly for a period of one year. I will collect 30 cobbles each month stratified across three depths (10, 20, and 30 feet), representing the entire depth range in the kelp forest at HMLR. Cobbles will have at least 50% cover of crustose coralline algae, which provides a critical chemical settlement cue for red abalone, without which, they will not settle (Morse & Morse 1984). In the laboratory, I will sort through the samples microscopically to determine the number of abalone recruits found.

To evaluate physical oceanographic parameters, I will utilize temperature data from Hopkins Marine Station's Kelp Forest Array. The Kelp Forest Array is a cabled platform deployed, in close proximity to the cobble collection dive sites (Lovers Point Marine Reserve), which measures temperature, salinity, current direction and velocity, pH (ocean acidification), and oxygen and carbon dioxide levels. Temperature at the Kelp Forest Array is measured using a SeaBird 56 temperature logger, with an accuracy of ± 0.02 degrees Celsius, and a SeaBird 16+ CTD (conductivity, temperature, depth) logger. Wind and wave action data will be retrieved

from nearby buoys maintained by the National Oceanic and Atmospheric Administration (NOAA). I will determine if there are any oceanographic factors such as temperature, wind, or wave action that change in correlation with peaks and troughs in red abalone settlement.

V. Timeline

2017 Timeline	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Nov-17
Monthly cobble collections										
Process abalone recruit samples										
Collect physical oceanographic data										
ESA Meeting										
WSN Meeting										
Data Analysis										

Cobble collections, sample processing, and physical oceanographic data collection will occur once a month for a year (data collection started in July 2016 and will end June 2017). Each cobble collection will occur on one day during each month. The rest of the month will be spent processing the 30 samples in the laboratory. Physical oceanographic data will be collected on cobble collection days. I will begin to analyze my data in July 2017. I plan to disseminate my results at two conferences: Ecological Society of America and Western Society of Naturalists in 2017.

IV. Final Products and Dissemination

I am conducting this study in close collaboration with the California Department of Fish and Wildlife to directly inform abalone management in northern California and recovery in southern California. I will present my research at professional conferences including the Ecological Society of America (August 2017) and Western Society of Naturalists (November 2017). My goal is to design outreach exhibits and interactive learning activities about my research and results for biannual public science demonstration events at the Cal Poly Pier Open House (>2000 attendees per event).

V. Budget Justification

To conduct this field study, \$2500 is necessary to cover research equipment, travel, and conference expenses. To extract abalone recruits from cobbles and process samples, I need 8 gallons of ethanol for sample preservation (\$286.48), approximately 320 Ziploc storage bags (\$68.92) to hold collected cobbles (2 bags for each cobble collected), and 10 pounds of dive weights (\$55) to retrieve the cobbles. The quantities of these items must last for half of my collection year as I have already started my research in July 2016. My research site, HMLR, is 145 miles away from my graduate institution, Cal Poly SLO. The cost of mileage is \$156.60 each month, resulting in \$939.60 for six months of cobble collection trips. \$1,150 will be utilized for travel (~\$700) and registration (~\$450) for two conferences in 2017: Ecological Society of America Meeting (Portland, Oregon) and Western Society of Naturalists Meeting (California).

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PROPOSAL BUDGET

Student Applicant(s): Leslie Hart	
Faculty Advisor: Jennifer O'Leary	
Project Title: Evaluating recruitment seasonality of red abalone (<i>Haliotis rufescens</i>) to inform fisheries management and conservation policy	Requested Endowment Funding
Travel <i>subtotal</i>	\$ 1,639.60
Travel: In-state	\$ 1,139.60
Travel: Out-of-state	\$ 500
Travel: International	\$
Operating Expenses <i>subtotal</i>	\$ 860.40
Non-computer Supplies & Materials	\$ 410.40
Computer Supplies & Materials	\$
Software/Software Licenses	\$
Printing/Duplication	\$
Postage/Shipping	\$
Registration	\$ 450
Membership Dues & Subscriptions	\$
Multimedia Services	\$
Advertising	\$
Journal Publication Costs	\$
Contractual Services <i>subtotal</i>	\$ 0
Contracted Services	\$
Equipment Rental/Lease Agreements	\$
Service/Maintenance Agreements	\$
TOTAL	\$ 2500

Dr. JENNIFER O'LEARY



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Letter of Support for **LESLIE HART**
Cal Poly San Luis Obispo Baker Koob Award

November 6, 2016

Dear Selection Committee:

I'm writing to strongly support Leslie Hart in her application for a Baker Koob Award. Leslie has been working with me for the last year and a half on developing a research project to assess recruitment dynamics of red abalone (*Haliotis rufescens*) in California to inform fisheries management and conservation policy. Leslie has developed this thesis based on her own review of the literature and guidance from me and the California Department of Fish and Wildlife (CDFW).

Leslie's proposed work is incredibly important for management and conservation. California red abalone are a key recreationally fished species in northern California, and in southern California, populations are nearing regional extirpation. To guide management of the ongoing (and economically important) recreational fishery in northern California, information on recruitment (the arrival and settlement of larvae or young) into the populations is critical. Recruits replace any adults removed through fishing, so management requires this information to set fishing limits. Leslie's work will evaluate the timing of abalone recruitment in central and northern California and determine oceanographic drivers of recruitment events. This will allow predictions of the likelihood of abalone replenishment as ocean conditions change in the future under global climate change predictions. Thus, Leslie's thesis is scientifically novel and provides crucial management information.

Leslie is seeking funds for basic field supplies for her research project, as well as travel to her field sites and travel to two key scientific conferences. In particular, going to scientific conferences will be critical for Leslie's career advancement. At these conferences, she will present her findings, network with key scientists, learn to present herself to the scientific world, and be exposed to other science being presented. Going to scientific conferences is often transformative for students and represents an ideal learning by doing experience.

I will support Leslie in her field and laboratory research as well as in the preparation for conferences. I will coach her in data analysis and writing, and help her prepare her talks and poster presentations. I will also coach and mentor her during these conferences, which I will also be attending.

I strongly support Leslie in this application. She is an exemplary student who is self-funding her graduate school experience. She is conscientious and diligent and reflects well on Cal Poly in all she does. The ability to attend these conferences comes at a critical point in Leslie's advancement in science and will immerse her in the regional scientific community. Please do not hesitate to contact me with any questions about Leslie Hart or her strong application.

Sincerely,

A handwritten signature in dark ink, appearing to read "Jennifer O'Leary".

Jennifer O'Leary, Ph.D

Appendix A

References

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