3. How do we foster successful restoration?

Data is typically scattered across different researchers, databases, and projects. This can make data acquisition tedious and difficult, especially if researchers are no longer involved with a particular project. We constructed an ArcGIS Story Map that is hosted by ESRI online which will serve as a single location for Olympia oyster restoration experts to input their spatial data. This allows all of the data to be centralized in one, easily accessible, location.

One issue with the lack of interest in native oyster restoration is that the public is largely unaware that native oysters exist even though there are efforts to restore them in place. We are creating two videos to help communicate the importance of restoration. Each videois tailored to a different audience, one for the coastal communities of Southern California and one for the managers of wetlands and estuaries whom do not typically consider oysters in their restoration plans

We hosted a forum at the Aquarium of the Pacific in Long Beach, California in March 2017, that brought together Olympia oyster researchers, restoration managers, and east coast oyster experts to discuss how to move forward with oyster restoration in Southern California. Our collective group planned the launch of a west coast wide restoration campaign throughout the Olympia oyster's natural range: British Columbia to Baja, California.

Conclusion and Recommendations

Through data collection and field surveys, we found Olympia oysters are present throughout Southern California, though populations are small and beds do not exist. We can conclude that there is a future for Olympia oyster restoration in Southern California. To incentivize these projects we have identified and quantified the effects of oyster beds on fishery production and shoreline stabilization. Additionally, we were able to stimulate a collaboration between different stakeholders and provide tools for planning future Olympia oyster restoration projects through our forum. We hope that with our project and the outcomes of this collaboration that we can incentivize future restoration projects that will restore ecosystem services to both people and wildlife along Southern California's coastline.

Acknowledgements

We would like to especially thank our faculty advisor, Dr. Hunter Lenihan for his guidance and big picture thinking. We would also like to think Dr. Andrew brooks, our PhD mentor, Jose Zenteno, and Dr. Danielle Zacherl. Special thanks to the Honda Marine Science Foundation for their support and the Carpinteria Salt Marsh Reserve.

Honda MARINE SCIENCE FOUNDATION

Carpinteria Salt Marsh Reserve
UNIVERSITY OF CALIFORNIA NATURAL RESERVE SYSTEM

Planning and Incentivizing Native Oyster Restoration in Southern California

Group Members: Colleen Grant, Brianna Group, Desmond Ho, Emily Read, and Erin Winslow
Faculty Advisor: Hunter Lenihan

Why the Olympia oyster?

There are almost 40 million people living in California today, and almost 90% of these people live in coastal communities. This extremely high density of people has led to the destruction of our coast- less than 10% of our wetlands remain today. it is now not only enough to conserve the remaining natural habitat we have, we need to begin to restore these areas. Oysters represent a key component to protecting and improving the health of these coastal ecosystems by providing a number of ecosystem benefits to both people and wildlife. These benefits include water quality improvement, shoreline stabilization, and the production of important nursery and foraging habitat for invertebrates and fish. The Olympia oyster, *Ostrea lurida*, is the only native oyster to the west coast of the US. Historical evidence suggests that California's bays and estuaries were once teeming with native oysters, however, due to pollution, overharvesting, and habitat modification their populations were drastically reduced by the 1950's.


Figure 1.


Figure 2.


Figure 3.

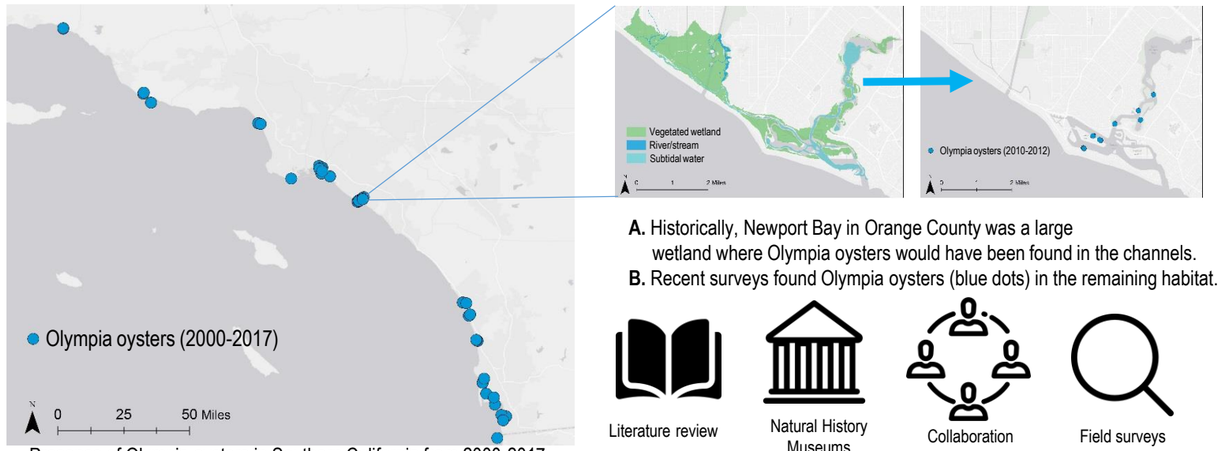
Today these oysters are found in small populations throughout the west coast. Figure 1 shows a thriving Olympia oyster bed in Canada. Figure 2 shows a recovering Olympia bed in San Francisco, and Figure 3 shows a few native oysters our group found in the Carpinteria Salt Marsh. The small population in Figure 3 is common in Southern California. Due to these small populations of Olympia oysters, society today is relatively unaware of their historical abundances and the ecosystem benefits oysters once provided-we call this a shifting baseline. Olympia oysters are no longer sold in Southern California, and they are typically not included in most management or restoration plans as a result of this shifted baseline.

Project Objectives

Our project focused on addressing these three objective questions:

1. Where are oysters in Southern California?
2. What are the incentives for restoring native oysters?
3. How do we foster successful restoration?

1. Where are oysters in Southern California?



Presence of Olympia oysters in Southern California from 2000-2017

A. Historically, Newport Bay in Orange County was a large wetland where Olympia oysters would have been found in the channels.
B. Recent surveys found Olympia oysters (blue dots) in the remaining habitat.

We conducted our own surveys and collected data from oyster experts and natural history museums to examine the current Olympia oyster range throughout Southern California. As a result, Olympia oysters were found in many of the bays, estuaries, and lagoons along the coastline. However, these populations were small and no longer form beds. There are many reasons as to why the Olympia oyster no longer forms historic beds, but potential reasons are coastal development, polluted waters, lack of suitable substrate, and lack of larvae. Future work is needed to identify the ecological bottlenecks preventing this species from forming beds in Southern California.

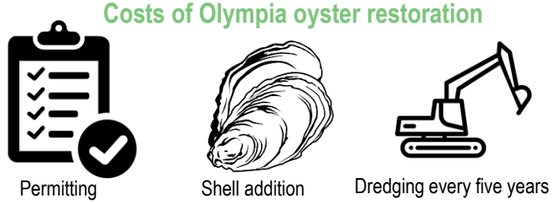
2. What are the incentives for restoring native oysters?

Cost Benefit Analysis

Wetlands are extremely important habitats along our coastline. They provide habitat for many marine and bird species, recreational habitat for people, help control flooding, and improve local water quality. Wetlands also act as a natural buffer between our coastal homes and the wave energy/storm action from the open ocean. Wetlands are extremely costly to maintain because heavy machinery is required to dredge out accumulated. Using oysters to stabilize our shorelines may be a cost-effective way to maintain our remaining wetland habitats.

We chose to analyze Batiquitos Lagoon because we found oysters in this specific area when we conducted our survey, indicating suitable habitat. Additionally, the Batiquitos Lagoon Foundation is responsible for maintenance, and the pool of money used for dredging is estimated to run out within the next 20 years unless an alternate management method is adopted.

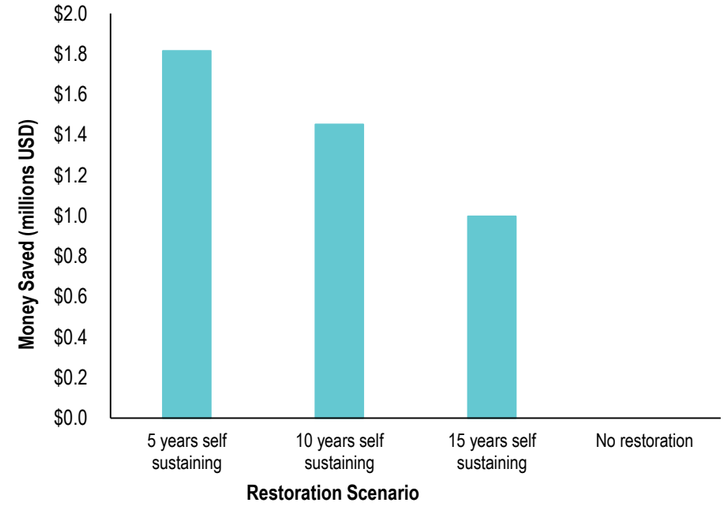
Costs of Olympia oyster restoration



To measure the erosion control capability of Olympia oysters, we compared the costs of business as usual wetland maintenance, to the costs of restoring oysters in the area highlighted in yellow above (0.2 hectares). Dredging occurs on an annual basis normally, but with restoration, we assume it would occur every five years instead. The costs we compared are dredging costs, restoration permit costs, and high end costs of shell addition..

We found that the Batiquitos Lagoon Foundation could save varying sums of money by using oysters to stabilize shorelines, depending on how long the oyster beds take to become self sustaining. A self sustaining bed no longer needs any human intervention to keep the beds alive and growing.

The most money is saved if the oyster beds only take five years to become self sustaining, just under $1.8 million dollars over a 30 year period. Even if the beds take 15 years to become self sustaining, the Batiquitos Lagoon Foundation would still save about $1 million dollars over a 30 year period.

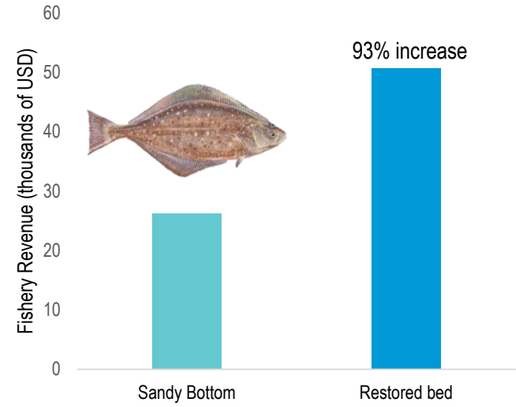


Bio-economic Model

Oyster reefs on the east coast are more valuable for their ecosystem services than they are for human consumption. One hectare (roughly one football field) of restored reef on the east coast is worth $100,000 in terms of ecosystem benefits, while it is worth only $50,000 for harvest and human consumption (Peterson et al., 2003). A main ecosystem benefit oysters provide is serving as food and habitat for commercially important fish and invertebrates. This valuation has not been conducted on a wide scale in California, so we modeled two west coast fish species that would likely benefit by restoring Olympia oysters.

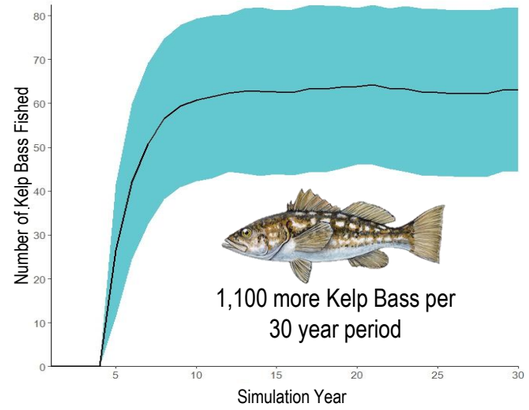
California Halibut

The California halibut is one of the most commercially important fish in Southern California, though commercial catch has been declining since 2000 (CDFW, 2016-2017). Its populations are predicted to be enhanced through oyster restoration. California halibut do not live directly on oysters, but the juveniles eat organisms that are more abundant on oyster beds. Through increased availability of food, we predict California halibut would grow faster and have higher survival with restored oyster beds. We modeled the increased abundance of California Halibut on one hectare of restored oyster bed, and found fishery revenue could increase by ~$25,000 over a 30 year period.



Kelp Bass

Kelp bass is one of the most recreationally important fish in Southern California. Kelp bass require hard substrate, such as rocks and reefs, in order to survive from juvenile to adult stages. Oyster restoration would increase the area for juvenile kelp bass to settle as restored oyster beds are often converted from sandy habitats. Its populations are therefore predicted to increase with oyster restoration. We modeled the increase in kelp bass fished and found that kelp bass catch could increase by about 1,100 over a 30 year period .



Number of additional Kelp Bass fished on one hectare of restored oyster reef. Teal band represents +/- 1 one standard deviation of the mean.