

# Connecting Local Chefs With Olympia oysters

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Photo credit: Sunset Magazine, [shellfish-store-seattle-served-on-](#)

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# Capstone Advisory Committee Final Capstone Signature Page

*Connecting Local Chefs with Olympia oysters*

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Capstone Project



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## Table of Contents

Connecting Local Chefs With Olympia oysters	1
Capstone Advisory Committee Final Capstone Signature Page	2
Acknowledgements	3
Introduction	5
Methods	8
Results	11
Product and Next Steps	14
Appendix 1	18

## Introduction

Molluscan shellfish, such as clams and oysters, often typify “sustainable seafood.” Most species filter feed turning the ocean’s primary productivity into protein biomass while providing ecosystem services, such as improving water quality. When properly regulated, as in the United States, shellfish farming can provide high rates of production of healthy, safe protein per unit area, can protect coastal ecosystems, and can provide livelihoods. Shellfish are a desirable farmed product, accounting for 25% of the world’s total aquaculture (FAO 2014). As of 2012, however 88.5% of global aquaculture came from the Asia-Pacific region and only 0.8% from the United States (FAO 2014). There is great potential for the United States to increase its contribution to the aquaculture sector and lead in sustainable aquaculture practices (FAO 2014). One way to do this is to incorporate native shellfish species in aquaculture; adoption of natives will diversify the available product portfolio which should increase both economic and ecological stability.

The Olympia oyster (*Ostrea lurida*) is the only oyster native to the West Coast of North America ranging from Southeast Alaska to Baja California (Couch and Hassler 1989). It is commonly found in tidal channels, estuaries, bays, sounds, and manmade hard surfaces like pilings and undersides of floats (Couch and Hassler 1989). The shell shape is extremely variable depending upon the substrate the oyster has grown as the shell will conform to the shape of the substrate (Marshall and Dunham 2013). The exterior of the shell can vary from dark purplish black to white, while the inner shell is white to olive green with a minimal adductor muscle scar (Couch and Hassler 1989). The meat can vary from dark purple to light

tan, and the flavor is often described as bright and earthy (Couch and Hassler. 1989). Olympia oysters are a smaller, slower growing species compared to other culinary popular species like the Pacific oyster (*Cassostrea gigas*). While the Pacific oyster can reach sizes of 20 cm, the Olympia oyster generally reaches 7.5 cm (Dumbauld et al. 2009). For centuries, the abundance of the Olympia oyster was much greater than it is today (Couch and Hassler 1989). Today, Olympia oyster abundance is estimated to be 65% that of the early 1900s, and it is even estimated that the abundance in the early 1900s could be lower than before then because that was the same time that commercial oyster farming became popular and lucrative (Ermgassen et al. 2012).

### **Aquaculture**

Shellfish aquaculture on the West Coast of North America is currently dominated by three species native to other parts of the world: Mediterranean mussel, and the Pacific oyster and Manila clam from Asia (Dumbauld et al. 2009; FAO 2014). Despite the popularity of these non-native shellfish there is a native oyster that was once a culinary favorite in the Western United States; the Olympia oyster. Native American populations subsisted on Olympia oysters, and they were a popular menu item in the mid-1800s during the Gold Rush Era in California (Conte and Moore 2001). Unfortunately, Olympia oyster populations along the West Coast of North America greatly declined due to anthropogenic activities like urban development and over harvesting (Couch and Hassler 1989). To this day the populations have not fully recovered (Hettinger, et al 2012, Ermgassen et al. 2012).

Today, only a handful of shellfish farms in America cultivate the Olympia oyster including Carlsbad Aquafarm, Inc., (CAI) the only shellfish aquaculture facility in Southern California. Unlike other shellfish farms along the West Coast which cultivate shellfish on mudflats, CAI uses a suspended rack system in open water. The suspended rack system allows the oysters to feed in the water column opposed to the bottoms or sides of the lagoon which can provide both “top-down” through grazer control on phytoplankton which leads to clearer waters and “bottom-up” nutrient control on phytoplankton production by chaining the nutrient regeneration process in the sediment, benefitting to the surrounding environment (Newell 2004). They cultivate the culinarily popular shellfish mentioned above in a lagoon fed by open sea water. Naturally recruiting larval marine species ranging from sponges to bivalves enter the lagoon and settle in the farm. One of these native species is the Olympia oyster. The Olympia oyster fouls racks and individuals of cultivated bivalve

species, like the Mediterranean mussel. Time, labor, and money are spent removing the Olympia oyster and other fouling organisms from the mussel by shaking them. The shaker knocks off fouling organisms and breaks apart the individual shellfish making them suitable for selling in the market. There has been relatively little demand for the oyster, however, so CAI places the loose Olympia oyster individuals into grow-out trays in the lagoon.

Taking advantage of native shellfish species in aquaculture can diversify the available products, and increase both economic and ecological stability (Pimentel et al. 1997). Biodiversity in the marine environment buffers the ecosystem against disease, collapse, extinction among many other threats, and biodiversity has become a high priority for researchers, managers, and farmers alike (Jones et al. 2007). Supporting the native biodiversity of the area through farming the native oysters provides increased resilience to change in both the habitat of the farm and the nature of seafood market (Beaumont et al. 2008).

Oysters provide many ecological benefits and are often considered a keystone species in an ecosystem (Cuddington et al. 2011). Oysters are filter feeders which leaves cleaner waters in the areas they grow (Couch and Hassler 1989). Unlike many other aquatic species, oysters remove nitrogen from the water column (Newell et al. 2005). Excessive levels of nitrogen in aquatic environments can be harmful in that it increases the growth of phytoplankton which prevents sunlight from reaching underwater plants and grasses that provide shelter. With an increase in phytoplankton comes an increase in bacteria that feeds on the dying phytoplankton. This bacteria uses the oxygen that was used by other marine organisms creating an aerobic environment harming the balance of the ecosystem (Newell et al. 2005). An economic benefit to farming oysters is that the meat does not become of less quality like other farmed fish. Oysters eat and reproduce as they would in the wild resulting in high quality shellfish (*The Economist* 2008).

## **Marketing**

In recent years, United States consumers have shown a strong preference for locally grown products, and a negative preference for imported foods (Onozaka and Thilmany 2011). Commonly, consumers are informed if a product is local by eco-labeling or advertisements in restaurants (Asche et al 2013). People also tend to pay more for local products compared to imports (Onozaka and Thilmany 2011). From an economic perspective, eco-labeling plays a large role in the seafood market. It is an important tool used to promote sustainable fishery

products around the world, and if consumers are paying a premium for sustainable practices, then it should result in a positive incentive for producers to incorporate sustainable practices to their business (Roheim et al 2011). Introducing the Olympia oyster from CAI to the



*Figure 1: left, CAI Olympia oysters, middle O. oysters in racks, right: single O. oyster*

Southern California seafood market would increase the options of local products for consumers. The local nature of the product could allow for a higher price point and provide more revenue for the growers, distributors, and chefs, thus boosting the seafood economy.

## **Project Goals**

Tapping into the diversity of native shellfish species provides economic and ecological stability by providing portfolio effects for each system. Thus, the goal of this project will use interdisciplinary methods to determine the marketing potential of native Olympia oysters to local restaurants and markets. With a team of experts from CAI, California Sea Grant Extension (CSGE), Scripps Institution of Oceanography (SIO), and University California San Diego (UCSD), this goal will be met by addressing barriers as so why there is currently no culinary demand in Southern California for the Olympia oyster. The project will look at the biological characteristics of the Olympia oyster as related to aquaculture and marketing, and the economic and social potential of this oyster as an avenue to enhance awareness of the product.

## **Methods**

Samples and photographs of the Olympia oysters individuals were collected in January 2014 from the CAI, located in Agua Hedionda Lagoon, Carlsbad, California. The oysters were



*Figure 2: Volunteer, Alissa Utter, taking photographs at CAI*

### **Olympia oyster Field Data Collections**

collected from mussels grown at the farm by CAI staff and placed into separate grow-out racks. This group of oysters was approximately 18 months old based on the data provided by CAI. Grow-out racks consisted of 10 - 12 trays on which the shellfish sit (Fig 1). Empty shells and other species, and specimens of the Olympia oyster were selected at random. Each Olympia oyster was numbered and weighed wet (grams). The individuals came in various states from clumped (multiple oysters together) to single oysters. Minimal cleaning was done before collecting the weight and so the whole weight includes a minimal amount of sediment and organisms such as sponges adhered to the shells.

Photographs were taken of each oyster for later analysis of length, width, depth. Two photos were taken of each sample (Fig 2). A black background with a (cm) scale was used in each photo. One photo was taken of the oyster lying flat. The other photo was taken with the oyster on the side. Every fifth oyster sampled was bagged and taken back to the lab for further analysis of meat weight, shell weight, and liquid volume. The remaining oysters were placed back in the tray they were collected from. A total of 518 oysters were weight and photographed; 116 oysters were collected and brought back to the lab.

### **Oyster Lab Data Collections**

The 116 oysters that were collected for lab analysis were frozen until data could be collected. In April 2014, the oysters were used to collect meat weight, shell weight, and

liquid volume. Each oyster was shucked, the meat was removed, and the liquid was separated from the meat. The empty shells were weighed and measured in grams. Aluminum foil boats were made and each meat sample received a boat. The boat weights were measured, the meat was placed on the boat and the wet meat weight plus boat weight was measured. Then it was placed into a drying oven at 55 degrees C for a minimum of 48 hours. Once the meat was dried, the samples were re-weighed to collect the dry meat and boat weight. The separated liquid (also known as liquor) was drained into a graduated cylinder and the volume was measured in mL.

### **Oyster Imaging Data Collections**

The software ImageJ (Rasband 2014) was used to analyze the photos of the oysters. A total of 300 oysters were measured. In ImageJ, a scale was set to a known size based on the cm scale set atop of the photo. The line tool was used to take measurements of length, width, and depth. The area tool was used to take measurements of the area of the oyster lying flat and again of the area of the oyster on its side. To maintain as much consistency as possible, the length was measured from the connective tendon of the shells to the end of the shell. The width measurement was taken from the widest points across the flat view of the oyster. The depth was measured at the widest points of the oyster from the side view. Area was measured by drawing a line around the circumference of the oyster shell from the flat view, and again from the side view. Data were entered into an Excel file where descriptive statistics were calculated. Relationships between mean weight and external characteristics of the oyster (whole organism weight, shell length, shell depth, shell area) were explored using simple regressions in JMP 10 Statistical Software.

### **Chef Survey**

In April 2014, a survey was administered that was designed to assess the awareness of the Olympia oysters and CAI, as well as to assess definitions and uses of the term “local”. Chefs were chosen as the target sample for the survey because they are a key stakeholder in the seafood market and they serve as an important component in the growing trend of consumer responsibility (Halweil 2006). Chefs and restaurant professionals make choices in purchasing seafood to serve to the customers, thus they consider the needs of their restaurant and their customers when choosing to purchase seafood items (Seafood Choices Alliance 2007). Accessing chefs for this project was an ideal choice to gain valuable insight to the

current awareness of Olympia oysters. If a restaurant is serving Olympia oysters on the menu, then presumably most of their clientele is familiar with the product, if not at least by name. Chefs could also be more aware of the impacts of seafood collection methods (i.e., aqua farmed or wild caught). The their choices in seafood reflect what sustainable-seafood-minded buyers are interesting in buying. Chefs also have the power to shift trends in the culinary world. For example, Chef Rick Moonen, a highly successful chef and leader in sustainable seafood, created a shift in the restaurant business away from serving overfished swordfish with the “Give Swordfish a Break” campaign in 1998. The campaign resulted in more than eight hundred chefs to stop serving the fish (Hooked 2006).

The website [surveymonkey.com](https://www.surveymonkey.com) was used to develop and administer the survey to chefs and professionals in the seafood restaurant industry. A variety of question styles were used in this survey. Question styles include: multiple choice, ranking, yes or no, and open ended answers (see end of report for survey sample). The survey totaled 20 questions in effort to keep the survey taking time short while gathering as much useful information as possible. The survey was sent to chefs via email, and a small incentive was offered to encourage participants to complete the survey. The incentive was offered as an option of entering participant’s contact information for a chance to win one of two \$50 gift cards. A list of chefs that have participated in prior seafood study events local scientists and the non-profit Slow Food Urban San Diego was used as a base for the participants in this survey. As more people were informed about the project through word of mouth and an introduction email, additional chefs interested in participating in the project were added to the participating list of chefs. Ultimately, 20 chefs were asked to participate in the survey. A total of 13 chefs responded to the survey and eleven participated in the incentive.

## Results

### Oyster Characteristics

Averages of Olympia oyster Measurements (Figure 3)

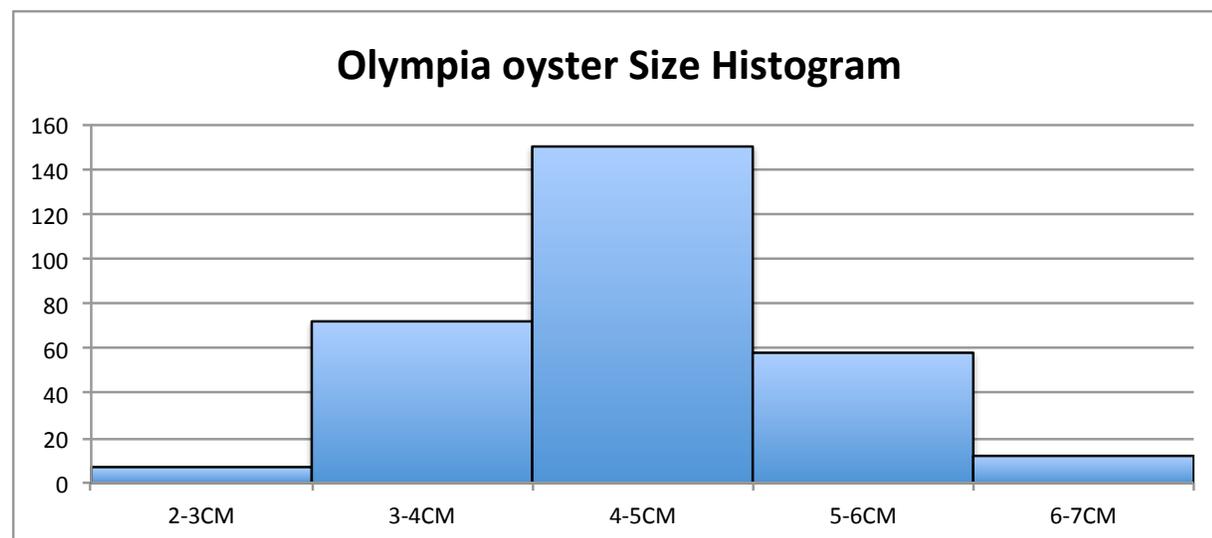
Length (cm)	Width (cm)	Front area (cm)	Depth (cm)	Side area (cm)	Whole wt (g)	Wet wt (g)	Liquid vol (ml)	Shell wt (g)
4.6±2.3	3.4±2.3	11.44±0.63	1.62±2.97	5.5±0.52	10.83±4.84	1.55±0.65	0.96±0.60	7.36±3.11

Figure 3 shows the averages of the key measurements of Olympia oysters taken in the field and in the lab. These descriptive statistics are valuable communication tools for farmers, like CAI, to share information about their products to buyers. They can be used to simply explain the product or to compare to other products through size, weight, or meat biomass if the buyer is unfamiliar with the Olympia oyster.

Average Percent of Olympia oyster parts (Figure 4)

Meat	Liquid	Shell
14% ± 6.06%	21% ± 15.84%	65% ± 27.03%

Figure 4 displays the % of meat, liquid, and shell weights that comprise the whole weight of an individual oyster. This information can be useful for communicating between CAI and chefs and other consumers to quantify how much liquid or meat the oysters offer. For chefs and others preparing dishes with Olympia oysters it maybe useful in determining the style of dish prepared (i.e., on the half shell or fried).



(Figure 5)

Figure 5 illustrates the length (cm) distribution of the Olympia oysters sampled (X=maximum length of shell, Y=number of individuals). Again this is important information for communicating a description of the product, and for consideration for preparation options. It is interesting to note that the majority of oysters sampled occur within the 4-5 cm range. According to the survey administered to chefs, most of the chefs bought Olympia

oysters in the 2.5-7.6 cm (1-3 inches) range. It is documented that the average time it takes for Olympia oysters to reach market size is 3-5 years (Couch and Hassler 1989; Beahrs 2012), and as mentioned above, the oysters sampled from CAI were approximately 18 months (1.5 years). This potentially faster growth rate is worth further research.

### **Correlation Results**

We ran external characteristics against meat weight to identify the best external characteristics that indicate the amount of meat inside an oyster. Whole weight and area of the flat view of the oysters had the strongest correlations with meat biomass. Meat biomass by whole weight ( $R^2=0.27$ ,  $p<0.001$ ,  $F_{1,100}=36.5$ ) and meat biomass by area ( $R^2=0.27$ ,  $p<0.001$ ,  $F_{1,56}=20.6$ ). Other external characteristics were either weakly correlated or not significant, for example, between shell length and meat biomass ( $p=0.6819$ ). For oyster farmers working in the field, whole weight is a simple and fast way to gauge the amount of meat biomass.

### **Chef Awareness**

The results of the survey revealed three trends about the level of awareness of Olympia oysters and reasons why they are not currently served, familiarity with CAI, and the importance of the term “local”. From the survey results we found that 84% of chefs are familiar with Olympia oysters, however only 27% currently serve the oysters. All of the chefs surveyed respond with ideas of how they would serve the oyster in their restaurants indicating potential for the use of the oyster should it become more available. Most chefs would serve the oysters in a classic raw or naked style. Some suggested serving them with a mignonette dress, or frying or grilling the oysters. To better understand why the Olympia oysters are well known, but only served in a few restaurants, the chefs were asked to identify the barriers they face in serving the oyster. The most common barrier reported was “A lack of customer awareness” followed by difficulty sourcing the product.

Nearly 77% of the chefs surveyed have heard of CAI and have purchased seafood products from CAI in the past. 100% of the chefs responded in the survey that the term “local” is important when selling seafood; 56% of which said that the term is “very important”. Over one-third of the chefs defined local as “Southern California”. These results on the importance of local align with the current trends of eating locally and selling foods with local eco-labels thus making locally grown Olympia oysters a product that could appeal to the local culinary trends in San Diego and the US (Onozaka and Thilmany 2011). With

high awareness of Olympia oysters and CAI among local seafood purveyors, and a high value placed on seafood sourced from Southern California, marketing the Olympia oyster harvested from CAI has great potential. The main barrier to overcome is customer awareness, and we could start to address this barrier through the correlations and descriptive statistics mentioned earlier, and educational tools like informational fact sheet. The second barrier of a lack of reliable source is addressed if CAI supplies the San Diego area with the oyster.

## **Demographics**

The chefs surveyed were selected based on their reputation on serving local sustainable seafood, thus they would be more inclined to serve the Olympia oyster. A majority of the chefs served participated in previous sustainable seafood events in San Diego. A total of 13 chefs and seafood restaurant purveyors responded to the online survey; 12 were from the San Diego area, and one was from Las Vegas, NV. The chef from Las Vegas, NV provided a different perspective on the term local as Las Vegas is far removed from the ocean, and yet it hosts a suite of seafood restaurants promoting sustainable seafood based on factors including distanced traveled. All participants were offered to enter the incentive. After asking if the survey takers would like to participate in the incentive drawing, the first question posed was, “How frequently do you serve oysters of any kind?” One responded stated they never serve oysters which ended the survey for that participant. The remaining 12 participants continued with the survey.

## **Product and Next Steps**

Joining a collection of seafood informational sheets created by the California Sea Grant Extension in collaboration with other organizations, an informational sheet about Olympia oyster was created. This handout can be used in a printed or digital format, and highlights key facts about the Olympia oyster such as biology, farming, and culinary applications. The purpose of this hand out is to offer Chefs and other seafood purveyors an easy to access reference guide they can use to educate themselves and their customers. The handout is also useful for the end consumer as it offers recipes and instructions on how to shuck an oyster. Making this information easily accessible for the people preparing the oyster in restaurants

and in personal settings increases their knowledge base of the product that extends beyond culinary applications (see Appendix 1).

The size measurements gathered in this project is just the beginning of data collection to be gathered from this unique resource. Continuing with measuring the Olympia oysters from CAI, additional research could look into growth rates and shape analysis. Growth rate measurements would enhance the understanding of how quickly the product reaches market size within the unique environment of CAI. Traditionally, Olympia oysters are cultivated in the Northwestern regions of North America, and it is possible the environmental parameters at the CAI lagoon could enhance or slow growth rates. Gaining insight to the growth rates of Olympia oysters at CAI would also help CAI predict amount of product available for harvest per season, predict profits, and the time and labor necessary to produce lucrative amounts of Olympia oysters.

Outreach materials and surveys to chefs and seafood restaurant affiliates are an important component of raising awareness of local sustainable seafood choices. Follow up surveys for the chefs that participated in this survey could be conducted to see if an increase in restaurants serving Olympia oysters has occurred. Additional ways to increase awareness of Olympia oysters include hosting tasting events that allow the chefs to become familiar with the product and experiment with ways they would prepare and server the oysters. Tasting events could increase communication between CAI and chefs, awareness of CAI and its other products, and strengthen the seafood community by providing a platform for stakeholders to discuss and exchange ideas. The informational sheet created in this project should also be periodically updated to reflect changes in environmental status, farming practices, and preparation suggestions. This would help keep people up to date with current trends and information about Olympia oysters.

Finally, connecting CAI with coastal restoration efforts to enhance Olympia oyster populations along the West Coast of North America would help support a market for this species. As previously mentioned, the Olympia oyster population never fully recovered from the early 1900s, and today many agencies including government, universities, and environmental organizations are organizing restoration efforts that aim to restore oyster populations. These efforts could result in enhanced costal protection, cleaner costal waters, and an increase in biodiversity as oyster beds serve as habitat for larval stages of many species. Collaboration among public and private organizations like CAI increases makes utilization of natural resources more effective and less cost prohibitive.

## Work Cited

- Asche, Frank, Thomas Larsen, Martin D. Smith, Geir Sogn-Grudvag, James A. Young. "Pricing of Eco-Labels for Salmon in UK Supermarkets." Duke Environmental and Energy Economics Working Paper Series. Organized by the Nicholas Institute for Environmental Policy Solutions and the Duke Energy Initiative. Working Paper EE 12-02. May 2013.
- Beahrs A. Heaven on the Half Shell. *Smithsonian* [serial online]. June 2012;43(3):62-69. Available from: Academic Search Complete, Ipswich, MA. Accessed May 24, 2014.
- Beaumont, N. J., et al. "Economic valuation for the conservation of marine biodiversity." *Marine pollution bulletin* 56.3 (2008): 386-396.
- Brett R. Dumbauld, Jennifer L. Ruesink, Steven S. Rumrill, The ecological role of bivalve shellfish aquaculture in the estuarine environment: A review with application to oyster and clam culture in West Coast (USA) estuaries, *Aquaculture*, Volume 290, Issues 3–4, 19 May 2009, Pages 196-223, ISSN 0044-8486, <http://dx.doi.org/10.1016/j.aquaculture.2009.02.033>. (<http://www.sciencedirect.com/science/article/pii/S0044848609001926>)
- Conte, F. S., and T. Moore. "Culture of oysters." *California's living marine resources: a status report*. California Department of Fish and Game, Sacramento, USA (2001): 500-506.
- Couch, D., and T.J. Hassler. 1989. Species Profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) — Olympia oyster. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.124). U.S. Army Corps of Engineers, TR EL-82-4. 8pp.
- Cuddington, Kim, et al. *Ecosystem engineers: plants to protists*. Vol. 4. Academic Press, 2011.
- Food and Agriculture Organization of the United Nations. Aquaculture Statistics. [www.fao.org/aquaculture/ten](http://www.fao.org/aquaculture/ten). Accessed May 24, 2014.
- Halweil, Brian. Catch of the Day. November 2006. Mastny, Lisa. Editor, Worldwatch Institute. Worldwatch Paper 172. ISBN 1-878071-80-7
- Harvey, David. United States Department of Agriculture, Economic Research Service. "Aquaculture Overview" *USDA*. May 27, 2012. Accessed May 24, 2014.
- Jones, Geoffrey P., and Maya Srinivasan. "Conservation of Marine Biodiversity." *Oceanography* 20.3 (2007): 100.
- Knecht, Bruce G. *Hooked: Pirates Poaching and the Perfect Fish*. Rodale, Inc. USA. 2006. Print.
- Newell, Roger IE, et al. "Influence of eastern oysters on nitrogen and phosphorus regeneration in Chesapeake Bay, USA." *The comparative roles of suspension-feeders in ecosystems*. Springer Netherlands, 2005. 93-120.
- Newell, Roger IE. "Ecosystem influences of natural and cultivated populations of suspension-feeding bivalve molluscs: a review." *Journal of Shellfish Research* 23.1 (2004): 51-62.
- NOAA Fisheries. Aquaculture in the United States. [www.nmfs.noaa.gov/aquaculture](http://www.nmfs.noaa.gov/aquaculture). Accessed May 24, 2014.
- Onozaka, Yuko, and Dawn Thilmany Mcfadden. "Does local labeling complement or compete with other sustainable labels? A conjoint analysis of direct and joint values for fresh produce claim." *American Journal of Agricultural Economics* 93.3 (2011): 693-706.
- Pimentel, David, et al. "Economic and environmental benefits of biodiversity." *BioScience* 47.11 (1997): 747-757.
- Rasband, W.S., ImageJ, U. S. National Institutes of Health, Bethesda, Maryland, USA, <http://imagej.nih.gov/ij/>, 1997-2014.
- Roheim, Cathy A., Frank Asche, and Julie Insignares Santos. "The elusive price premium for ecolabelled products: evidence from seafood in the UK market." *Journal of Agricultural Economics* 62.3 (2011): 655-668.
- R.D. Marshall, A. Dunham, Effects of culture media and stocking density on biofouling, shell shape, growth, and survival of the Pacific oyster (*Crassostrea gigas*) and the Manila clam (*Venerupis philippinarum*) in suspended culture, *Aquaculture*, Volumes 406–407, 25 August 2013, Pages 68-78, ISSN 0044-8486, <http://dx.doi.org/10.1016/j.aquaculture.2013.05.003>. (<http://www.sciencedirect.com/science/article/pii/S004484861300224X>)
- Seafood Choices Alliance. "The UK Marketplace for Sustainable Seafood." April 2007. <http://www.allianceproduitsdelamer.net/resources/documents/SCAUKMPReport.pdf>. Accessed May 24, 2013

- Zu Ermgassen, P. S., Spalding, M. D., Blake, B., Coen, L. D., Dumbauld, B., Geiger, S., ... & Brumbaugh, R. (2012). Historical ecology with real numbers: past and present extent and biomass of an imperilled estuarine habitat. *Proceedings of the Royal Society B: Biological Sciences*, 279(1742), 3393-3400.
- "Gem of the ocean; Oysters." *The Economist* 20 Dec. 2008: 83EU. *Business Insights: Global*. Web. 9 June 2014.

## Appendix 1

Species Information Sheet for the Olympia Oyster.

# Olympia oyster

*Ostrea lurida*

BIOLOGY  
FACT SHEET



Photo: Dominique Barnes

## San Diego seafood profiles

### Taxonomic description

- A marine bivalve mollusk, in the marine invertebrate group along with other oysters
- Often reaches 6-8 cm (2.4-3.1 inches) length and 2.5-3.5 cm (0.90-1.3 inches) thick [1]
- Shell shape variable, often forming to the shape of the surface on which it grew [1]

### Distribution

- Found on the west coast of North America, from southern Alaska to Baja California, Mexico [1,2,3]

### Life history

- Spawning is triggered by water temperature of 16-18C (60-64F) and

can occur 1-2 times per year between spring and fall [1].

- Broods; fertilized eggs develop in the female mantle [1]
- An average brood of larvae is between 250,000-300,000
- Maximum age is unknown

### Habitat

- Lives in estuaries, sounds, tidal channels, and bays.
- Filter feeder, eats microscopic algae and plankton [3]
- Many predators including birds, rays, and rock crabs.
- Sensitive to water temperature changes, but can tolerate short exposure to changes in salinity [1]

- Large amount of its natural habitat has been removed to due urban development and pollution [2]

### References

- [1] Couch, D. and T.J. Hassler. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) –Olympia oyster. U.S. Fish Wild. Serv. Biol. Rep. 82(11.124) U.S. Army Corps of Engineers, TR EL\_82-4. 8pp.
- [2] Timmins-Schiffman E, Friedman C, Metzger D, White S, Roberts S. Genomic resource development for shellfish of conservation concern. *Molecular Ecology Resources* [serial online]. March 2013;13(2):295-305. Available from: Academic Search Complete, Ipswich, MA. Accessed May 13, 2014.
- [3] <http://www.habitat.noaa.gov/restoration/techniques/oysters.html>
- [4] [http://w3.shorecrest.org/~Lisa\\_Peck/MarineBio/syllabus/chZinvertebrates/Invertwp/echino\\_wp\\_06/derek/structure.htm](http://w3.shorecrest.org/~Lisa_Peck/MarineBio/syllabus/chZinvertebrates/Invertwp/echino_wp_06/derek/structure.htm)

### Did you know?

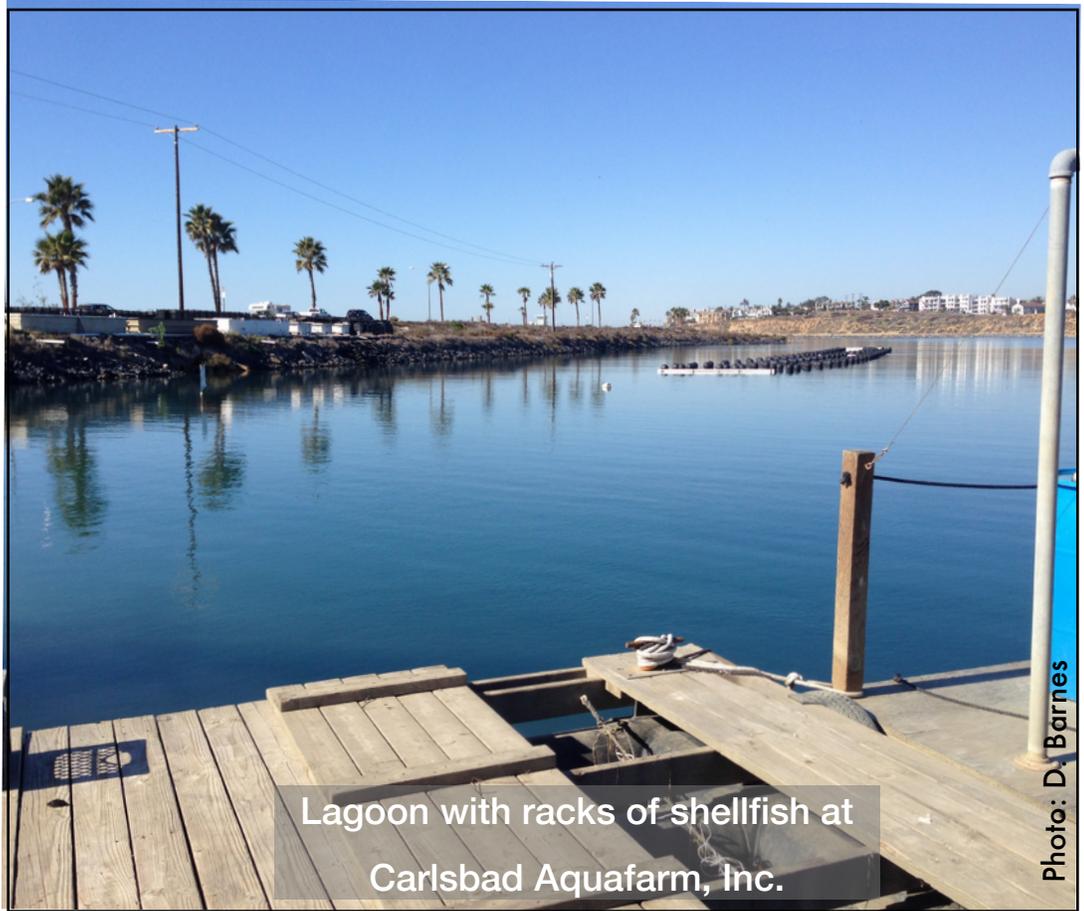
The Olympia oyster is the only oyster that is native to the west coast of North America.



# Olympia oyster

## FISHERY FACT SHEET

*Ostrea lurida*



Lagoon with racks of shellfish at  
Carlsbad Aquafarm, Inc.

Photo: D. Barnes

## San Diego seafood profiles

### Seasonal availability

- Shellfish farms often provide year round availability.

### Managing authority

- Farmed with strict governing by Federal Agencies: NOAA, Army Corps of Engineers, Fish and Wildlife Service, USDA, EPA, FDA, BOEM, and the Coast Guard [7]
- In states where recreational shellfishing is common, the state Department of Fish and Game regulate seasonal harvest [1]
- In Washington state, the minimum size for oyster harvest is 2.5 inches. The large minimum size is thought to prevent much collection of the oyster [1]

### Gear type

- Oyster farming in the U.S. began in 1890s in Puget Sound tidelands [2]
- Oysters are grown by on-bottom, off-bottom or suspended culture methods [7]

- The standard marketable size of an Olympia oyster is about the size of a silver dollar (3.5-4 cm) [2]

### Status of the fishery

- Native American harvested Olympia oysters for food [2]
- Production peaked from 1890s to 1900 but greatly declined after due to pollution and over harvesting [2]
- Larger, faster growing species, like the Pacific Oyster from Japan, continue to dominate oyster farming in the U.S. [3]
- It takes 3-5 years for an Olympia oyster to reach market size [2,3]
- A growing interest in the local food movement has increased interest in the Olympia oyster [6]

### Potential ecosystem impacts

- Oyster farms have minimal impacts to local ecosystems. [5]
- Oyster beds provide many ecosystem benefits such as: habitat for other species,

improved water quality, biodiversity support, reduced shoreline erosion, and enhanced restoration projects [4]

- Monterey Bay Aquarium's Seafood Watch classifies farmed oysters as three of its "Best Choices" for seafood options [5]

### References

- [1] Washington Dept. Fish & Wildlife. [http://wdfw.wa.gov/fishing/shellfish/ps\\_clam\\_oyster\\_faqs.html](http://wdfw.wa.gov/fishing/shellfish/ps_clam_oyster_faqs.html)
- [2] Couch, D. and T.J. Hassler. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) —Olympia oyster. U.S. Fish Wild. Serv. Biol. Rep. 82(11.124) U.S. Army Corps of Engineers, TR EL\_82-4. 8pp.
- [3] Behars, A. (2012). Heaven on the Half Shell. *Smithsonian*, 43(3), 62-69.
- [4] NOAA - Oyster Restoration - <http://www.habitat.noaa.gov/restoration/techniques/oysterrestoration.html>
- [5] Seafood Watch 2014 [http://www.seafoodwatch.org/er/seafoodwatch/web/sfw\\_factsheet.aspx?fid=82](http://www.seafoodwatch.org/er/seafoodwatch/web/sfw_factsheet.aspx?fid=82)
- [6] Sunset Magazine. Christopher Hall, *The West Native Oyster Makes a Comeback*. <http://www.sunset.com/travel/northwest/olympia-oyster>
- [7] FISHWATCH. U.S. Seafood Facts. NOAA. [http://www.fishwatch.gov/seafood\\_profiles/species/oyster/species\\_pages/pacific\\_oyster\\_farmed.htm](http://www.fishwatch.gov/seafood_profiles/species/oyster/species_pages/pacific_oyster_farmed.htm)

### Did you know?

During World War II, the U.S. military contracted with Washington oyster growers to provide oyster meats as source of nutritious protein for soldiers.



# Olympia oyster

## NUTRITION FACT SHEET

*Ostrea lurida*



Photo credit: Sunset Magazine <http://img4.sunset.com/1/>

## San Diego seafood

### Edible portions

- Everything but the shell is edible and is typically prepared
- Oyster shells should always be tightly closed prior to preparation [1]

### Description of meat

- Olympia oysters have a bright, earthy, coppery taste [2]; sometimes described as peppery

### Culinary uses

- Local Olympia oyster is often available fresh from the farm.
- Shucking the shell is manageable. Instructions can be found in multiple online resources (e.g., [4])
- Olympia oysters can be prepared many ways: Freshly on the half shell, fried, steamed, smoked, in soups and stew, and more [2]

### Nutritional information

- Low calorie, easier to digest than red meat, and high in vitamins [3]
- Raw Pacific oyster (50g or 1.8oz) [5]

Nutrition Facts	
Serving Size 50 g	
Amount Per Serving	
Calories 41	Calories from Fat 10
% Daily Value*	
Total Fat 1g	2%
Saturated Fat 0g	1%
Trans Fat	
Cholesterol 25mg	8%
Sodium 53mg	2%
Total Carbohydrate 2g	1%
Dietary Fiber 0g	0%
Sugars	
Protein 5g	
Vitamin A 3%	Vitamin C 7%
Calcium 0%	Iron 14%

\*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

NutritionData.com

### Toxicity report

- There are no reported contaminants from local farm raised oyster; wild caught oyster from San Diego are not recommended for consumption without bay water quality and oyster toxicity analyses.

### Seasonal availability

- Farm fresh year round

### References

- [1] Pacific Coast Shellfish Growers Association-PCSGA. <http://pcsga.org/buying-tips/>
- [2] Taylor Shellfish Farms. <http://www.taylorshellfishfarms.com/about-our-shellfish.aspx>
- [3] Sea Grant Washington. <http://www.wsg.washington.edu/oysterstew/news/nutritious.html>
- [4] Localfoods. How to Shuck Oysters. <http://localfoods.about.com/od/shellfishrecipes/ss/How-To-Shuck-Oysters.htm>
- [5] Seafood Health Facts. Pacific Oyster, 2013. [http://seafoodhealthfacts.org/seafood\\_choices/](http://seafoodhealthfacts.org/seafood_choices/)

### Did you know?

Olympia oyster was very popular in the 1800s during the Gold Rush. Mark Twain loved them so much he put them on his “fantasy menu” along with his other favorite foods.



# Olympia oyster

*Ostrea lurida*

## CULINARY INFO SHEET

### STEP 1: SHUCK

#### Tools:

- Shucking or oyster knife
- Garden gloves

#### Method:

1. **TWO TECHNIQUES** are side-entry and hinge-entry shucking, presented here is the hinge-entry shucking method [1]
2. **POSITION** oyster cupped side down, with the hinge facing you (Fig.1).
3. **SEPARATE** Insert the tip of the oyster twisting motion to gently pry the shells slightly apart. Move the blade forward along the "roof" of the top shell and sever the adductor muscle where it joins the top shell (approximately the "2 o'clock" position, fig. 2,3). When the muscle has been severed, the
4. **PRY APART** Gently pry the top shell away from the bottom shell with the knife blade. With the shells just slightly apart, use the knife blade to gently scrape any remaining oyster tissue off the inner top surface of the shell. Remove the top shell (Fig. 4).
5. **FINISH** Move the knife blade underneath the oyster meat and cut the adductor muscle where it is attached to the bottom shell (fig. 5)



### STEP 2: PREPARE **Appetizer | Baked Oysters Brownefeller**

From: Alton Brown, Food Network [3]

### San Diego seafood profiles

#### Appetizer | Grilled Oysters

Adapted from Simply Recipes [2]

#### Ingredients (serves 4):

- 24 whole live oysters
- 2 cloves garlic, finely minced
- 3 tbsl extra virgin olive oil
- 3 tbsl unsalted butter
- 1 tsp lemon juice
- 1/2 tsp chili pepper flakes
- 1/4 tsp salt
- cracked black pepper to taste
- 1 tbsl finely minced parsley



Photo: Jaden Hair [2]

#### Method:

1. Heat a small sauce pan over med-low heat, add olive oil & butter when hot.
2. Add garlic and sauté for about 30 sec, add rest of ingredients and turn off heat.
3. Place shucked oysters on a bed of rock salt or rice in a baking pan, spoon a little sauce on each oyster and place entire pan on a hot, pre-heated grill for about 5-6 min.

#### Ingredients (serves 4):

- 24-28 oysters on half shell with liquor
- 6 tbsl unsalted butter
- 3/4 c finely chopped onion
- 3/4 c finely chopped celery
- 1 tsp kosher salt, divided
- 1 tbsl minced garlic
- 14 oz artichoke hearts, drained, finely chopped
- 1 c panko bread crumbs
- 2 tsp finely chopped lemon zest
- 1/2 tsp freshly ground black pepper
- 1 tsp dried oregano



Photo: kolorblindmag.com

#### Method:

1. Preheat oven to 425°F. Melt butter in a 12" saute pan over med-low heat.
2. Increase heat slightly and add onion, celery, 1/2 tsp salt; cook for 5-7 min. Add garlic & cook for another 1-2 min.
3. Reduce heat to low; add artichoke, bread crumbs, zest, 1/2 tsp salt, pepper, oregano. Cook for 2-3 min, remove from heat.
4. Set shucked oysters on a bed of rock salt (4 c) on a sheet pan with sides, spoon mixture evenly over oysters.
5. Bake for 10-12 min until bread crumbs are lightly browned. Serve immediately.

#### SERVING SUGGESTIONS:

Unshucked oysters will open if placed in a pan on a hot grill for about one minute.

#### OTHER RECIPE IDEAS:

Oyster soup, or raw with a squeeze of lemon and dash of hot sauce



#### References

- [1] [http://wdfw.wa.gov/fishing/shellfish/oysters/how\\_to\\_schuck.html](http://wdfw.wa.gov/fishing/shellfish/oysters/how_to_schuck.html)
- [2] [http://www.simplyrecipes.com/recipes/grilled\\_oysters/](http://www.simplyrecipes.com/recipes/grilled_oysters/)
- [3] <http://www.foodnetwork.com/recipes/alton-brown/baked-oysters-brownefeller-recipe.html>