

Unicado

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Summary and Significance

In 2017, an unprecedented disease known as sea star wasting syndrome (SSWS) devastated sea star populations from San Mateo to Mendocino counties.¹ SSWS coincided with two different oceanic warming events in the eastern Pacific that exacerbated the fallout from the disease.² This series of ecological perturbations has resulted in an overabundance of purple urchins (*Strongylocentrotus purpuratus*) in Washington, Oregon, and northern California. Without predation from sea stars, purple urchins cluster into dense populations that quickly consume kelp forests. In three years, sea urchins have razed over 90% of northern California's bull kelp.³

Once the urchins consume their food source, they begin to starve. Purple urchins have adapted to these conditions by reducing their metabolism and dissolving nutrients from particulate matter.⁴ This metabolic alteration allows urchins to persist in barrens for years, or until more kelp is located. The urchin barren is an alternative steady-state ecosystem to kelp forests.⁵ Once established, urchin barrens can persevere for decades, even centuries.

A wide variety of marine species are reliant on the cover and biodiversity provided by kelp habitat. When urchins consume the actual structure of this ecosystem, they remove habitat extending the entire water column. From benthic substrate to canopy, urchin barrens displace abalone as well as sea otters. This ecological loss leads to economic pain, mainly for the tourism and fishing businesses that rely on the ecosystem services of kelp forests. Following the urchin barrens in 2017, two fisheries were shut down in northern California for a loss of approximately \$50 million.⁶ These losses are likely the harbingers of a rapid decline in coastal marine productivity that will compound for decades, or until kelp ecosystems are restored.

Eco-E Opportunity

Purple urchins are a delicacy around the world and especially in Japan. The briny umami sweetness of urchin gonads (known as uni) are often described as the "butter of the sea." High quality uni from California purple urchins is valued at over \$20/oz.⁷ The problem with selling purple urchins from California is that they are mostly void of uni. The starving urchins of the

¹ <https://www.nature.com/articles/s41598-019-51114-y?sf222971155=1>

² <https://www.nature.com/articles/s41598-019-51114-y?sf222971155=1>

³ <https://phys.org/news/2019-10-california-kelp-forest.html>

⁴ <https://royalsocietypublishing.org/doi/10.1098/rspb.2018.0340>

⁵ <https://royalsocietypublishing.org/doi/10.1098/rspb.2018.0340>

⁶ <https://www.sciencedaily.com/releases/2019/10/191021082738.htm>

⁷ <https://www.matis.is/media/matis/utgafa/10-17-Sea-Urchin-Market-Report.pdf>

barren do not have the energy to produce gonads.⁸ Their empty shells have no value and there is little market incentive for their removal.

Urchin roe enhancement is the process by which starving urchins are collected, fattened, and sold. The uni's price depends on the taste and color profiles which are both predominantly determined by feed.⁹ Though most feeds have successfully increased gonad mass, artificial feeds that improve the taste and color of purple urchin uni have yet to be fully recognized.¹⁰ Building on this research, Unicado will incorporate a blend of avocado, carrot, kale, and proteins from human waste streams to create an optimal roe-enhancement feed specifically for the purple urchin. By formulating a pelletized feed and modular roe-enhancement process, Unicado hopes to facilitate a market-based solution to urchin barrens before the scourge reaches southern California.

Background

The idea for Unicado evolved from a former eco-e proposal that explored ways to encourage kelp restoration. Through the process of customer discovery and opportunity analysis, the former proposal (Kelping the Planet) was determined to be premature and overly reliant on a local aquaculture industry that is still in its infancy. The more immediate need of urchin removal seemed like a logical transition for an endeavor focused on maximizing kelp habitat. The pivot to Unicado will build on the lessons from the former proposal to demonstrate how aquaculture can be a restorative force in marine ecosystems.

Objectives

1. Feed trials: Other animal feeds, such as the acorns selected for Spain's famous cured ham (jamon iberico), rely on high concentrations of oleic acids to enhance nutty and umami flavors in the final product. Avocados are filled with oleic acid and may enhance the nutty flavors in the uni of California's purple urchin. Unicado will use local food waste to blend avocado with carbohydrates, proteins, and carotenoids into a pelletized feed. With respect to flavor, color, size, and growth rate of the uni, what ratio of these food types will optimize outcomes?

2. Market research: Japan consumes 90% of the uni produced on the global market. The Japanese are willing to pay \$20/oz. for raw uni (¥12,000/tray) and they have an appetite for California purple urchin, importing an estimated 930 tons in 2004. Though U.S. consumers may be less discerning than the Japanese, Santa Barbara fishermen sell individual urchins for \$13 and usually run out of product before 8 am. Diners happily pay over \$20 for half of an urchin in one Santa Barbara restaurant, here too the uni is ephemeral. Both local and global markets demonstrate a willingness to pay premium prices for uni and show signs of major supply gaps. Questions remain about where the greatest unmet demand is to be found. Unicado will explore the extent to which local markets can absorb product and compete with Japanese demand.

⁸ <https://www.nationalfisherman.com/west-coast-pacific/purple-urchin-invasion-leads-to-a-low-harvest-high-prices-for-west-coast-urchins/>

⁹ https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12256?casa_token=ifeydeoFuTQAAAAA%3AnLvjelFp8ZeE3JrjAVXD3uvy2KP4zQhEKG7VuCPYIINHc3TUOuQXUUbwlFjyeLOYbrXYHN58yLWq2A

¹⁰ https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12256?casa_token=ifeydeoFuTQAAAAA%3AnLvjelFp8ZeE3JrjAVXD3uvy2KP4zQhEKG7VuCPYIINHc3TUOuQXUUbwlFjyeLOYbrXYHN58yLWq2A

How will local and global markets differ in their response to uni raised on various feeds? What branding strategies will reduce costs while increasing the customer's willingness to pay?

3. Business model: Though there is both local and global demand for uni, the domestic supply chain is rudimentary and underdeveloped. Purple urchins are harvested from the wild by hand, raised in basic saltwater tanks on various kelp feed, then delivered raw and unaltered to the consumer. There are opportunities for growth and consolidation throughout this process. From improving harvesting techniques and data collection, to creating feed types for specific market segments, to finding use for urchin biproducts; there are many paths to pursue. Accessing these opportunities will require strategic partnerships with onshore aquaculture facilities, urchin-divers, researchers, distributors, restaurants, food banks, regulators, and likely many other stakeholders. This interaction will inform industry perspectives and frame a fundamental question: what are the core competencies of Unicado and in which segment of the value chain will these competencies be most pronounced?

Available data

The last fifty years has produced ample research and literature on urchin feed trials. Market reports, environmental impacts, and industry specific data abounds in urchin aquaculture (echinoculture). Formal research on urchin roe enhancement dates back to the 1960s and there are dozens of feed trials that have been recorded around the world. Though many efforts have been made to cultivate urchin spat for breeding, only recently have scientists begun to focus on fattening the starving urchins from the barren. Luke Gardner (Moss Landing Marine Lab) and Carolyn Culver (Marine Science Institute) are two of the leading researchers in this field, having both run successful feed trials on starving purple urchins using artificial (non-kelp) feed. Both Culver and Gardner have agreed to be advisors on the project in order to share best practices and optimize pelletized feed from local food waste.

Possible approaches

There are no significant obstacles to producing and testing pelletized urchin feed made from food waste. Regulation, start-up costs, feed availability, tank space, and the requisite number of purple urchins are non-limiting factors and will not inhibit the initial feasibility of producing a pelletized feed prototype. Recombination of dietary ratios will produce variation along the uni's parameters. The different outcomes produced by different feeds will provide additional opportunities to test global and local market responses to the various uni being produced. In this way, Unicado can begin selling uni, while testing feed types and recording market response. Feed trials will serve as a starting point from which Unicado can choose to specialize in urchin feed, urchin harvesting, uni production, or all of the above.

Interviews

- **Dr. Steve Gaines.** Dean, Bren School of Environmental Science and Management. In person. (10/22)
- **Gracie White.** MESM 2020 student, founder of Symbrosia. In person. (10/25)
- **Dr. Robert Miller.** Research Biologist. Marine Science Institute. UC Santa Barbara. In-person. (10/28)
- **Dr. Ermias Kebreab.** Dean of Global Engagement in the College of Agricultural UC Davis. Call. (10/24)
- **Bernard Friedman.** Owner of Santa Barbara Mariculture. Call. (11/14)
- **Doug Bush.** General Manager, The Cultured Abalone. In-person. (11/13)
- **Dan Reed.** Research Biologist, Marine Science Institute. In-person. (11/18)
- **Lane Linthicum.** Project Manager at Driltek (Rincon Island). In person (11/7)
- **Emily Hazelwood.** Co-founder, Blue Latitudes. Call (11/11)
- **David Siegel.** Professor of Geography (UCSB), Principal Investigator ARPA-E MARINER. In person (11/13)
- **Milton Love.** Research Biologist, Marine Science Institute. In person. (11/14)
- **Ann Bull.** Research Biologist, Marine Science Institute (BOEM). In-person. (11/14)
- **Matt Ryan.** Sales Director, Ocean's Halo. Call (11/20)
- **Ronald Johnson.** Former Brigadier General US Marine Corps.. Call (12/19)
- **Dan Pullman.** Partner at Fresh Source Capital. In person (1/27)
- **Luke Gardner.** CA Sea Grant Aquaculture Specialist. Call. (1/23)
- **Blaine Grimes.** Chief Development Officer at Gulf of Maine Research Institute (GMRI). Call. (2/10)
- **Norah Eddy.** Associate Director, Oceans Program at The Nature Conservancy. Call. (2/12)
- **Jared Auerbach.** CEO of Red's Seafood. Boston, MA. Phone (2/3)
- **Tim Connolly.** Chef at Loquita, Santa Barbara. In person (2/7)
- **Peter Lee.** Head Chef at Loquita, Santa Barbara. In person (12/17)
- **Carolyn Culver.** Research Scientist at CA Sea Grant & Marine Science Institute. Call (2/13)

Citations

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3. Brothers, Cecilia, et al. June, 2018. "Ocean warming alters predicted microbiome functionality in a common sea urchin." [Royal Society Publishing](#)
4. Guðmundur, Stefánsson, et al. October, 2017. "Markets for Sea Urchins: A Review of Global Supply and Markets." [Matis](#)
5. Ess, Charlie. September, 2017. "Purple urchin invasion leads to a low harvest, high prices for West Coast urchins." [National Fisherman](#)
6. Lourenco, Silvia, et al. May, 2018. "Meta-analysis on nutrition studies modulating sea urchin roe growth, colour and taste." [Wiley Publishing](#)