

## California's Aquaculture Journey: Where We've Traveled / Where We're Headed

What opportunities are available in California? What challenges are we facing? This session hopes to provide insight into these questions and many more, touching on a range of topics including the history of aquaculture in California, the current business and regulatory environment for both aquaculture and commercial seafood, aquaculture's roll in addressing and combatting climate change, feed and sustainability, opportunities for aquaculture expansion within California, and much more.

**Thursday, March 3, 2022, Town and Country Resort, San Diego**

**11:00AM – 11:30AM (30 MIN): FOUNDATIONS AND CORNERSTONES OF CALIFORNIA AQUACULTURE**

**Presenter:** Tony Vaught, ProAqua Inc.

**Summary:** Opening remarks with a brief review of the history of California Aquaculture covering shellfish, white sea bass, striped bass, catfish, live markets trout, sturgeon, largemouth bass, striped bass, liquid O2 systems, and more.

**11:30AM – 11:45AM (15 MIN): CUTTING THE BLUE TAPE IN CALIFORNIA: A CASE STUDY ANALYSIS OF BARRIERS AND OPPORTUNITIES TO IMPROVE CALIFORNIA'S PERMITTING PROCESS FOR COMMERCIAL AND CONSERVATION AQUACULTURE**

**Presenter:** Kimberly Thompson, Peter Okurowski, Darcy Wheelles, Seafood for the Future, Aquarium of the Pacific

**Summary:** California is poised to be a leader in contributing to the 10 million new green jobs that President Biden seeks, and an expanding marine aquaculture sector can be part of that green jobs growth. Data show that California is among the U.S. states with the greatest potential to support a robust marine aquaculture sector. The state was also recently granted an unprecedented opportunity by the National Oceanic and Atmospheric Administration (NOAA) to participate in a pilot project to support science-based zoning for responsible marine aquaculture. California has a unique opportunity to leverage these strengths and opportunities to integrate marine aquaculture into its economic recovery and aggressive climate action strategies. Unfortunately, California's permitting system often stifles growth by forcing applicants to navigate an uncertain, laborious, lengthy, duplicative, and very costly labyrinth of state and local barriers. These same barriers even hamper conservation aquaculture projects designed to help restore or enhance local ecosystems. While many of these barriers have been identified, discussed among stakeholders, and brought to attention of regulators and policy makers, there has not yet been an effort to methodically collect, synthesize, and aggregate experiences and stories from farmers, researchers, and others seeking permits for marine aquaculture production in California. The Aquarium of the Pacific's Seafood for the Future (SFF) program, in collaboration with CEA Consulting and a small group of stakeholders, is coordinating a project, titled: Cutting the Blue Tape for Marine Aquaculture in California. The project is designed to better understand the permitting barriers and identify opportunities to support a more efficient permitting process for conservation and commercial marine aquaculture in the state. Preliminary results from a series of case studies conducted for the project are providing a clearer picture of specific areas and

actors in the permitting process that pose the greatest challenges. More importantly, the results from the case studies are providing greater clarity on potential solutions and how to best achieve them.

**11:45AM – 12:00PM (15 MIN): THE POTENTIAL FOR OFFSHORE SEAWEED CULTIVATION IN SOUTHERN CALIFORNIA**

**Presenter:** Eliza Harrison, Ocean Rainforest, Inc.

**Summary:** Within the funding framework of the Advanced Research Projects Agency - Energy (ARPA-E) MARINER program through the U.S. Department of Energy, the MacroSystems project team has been asked to demonstrate the economic and social opportunities of offshore cultivation of seaweeds in the U.S. Primed by Ocean Rainforest, Inc. the project is specifically focused on the commercial feasibility of a species named *Macrocystis pyrifera*, more commonly known as Giant Kelp. During Phase 1 of the cooperative agreement (April 2018 – July 2019), the MacroSystems team designed a state-of-the-art cultivation structure that minimally impacts existing marine operations (e.g. navigation, commercial fishing, etc.) and supports ecosystem services in the surrounding environment. The goal for Phase 2 of the ARPA-E contract is to develop and upscale the necessary technology and machinery to de-risk the full chain from propagation to planting, cultivation and harvesting. Our team intends to demonstrate the capabilities of the design, as well as to optimize the aspects and factors that significantly affect the economics and scaling up of operations. In June 2020, the team formally launched a three-year demonstration project in the Santa Barbara Channel to test the durability of the cultivation system, as well as to better understand how to minimize its impact on marine industries and ecosystems. Since then, we have developed a hatchery facility, as well as executed the first successful trial of direct seeding Giant kelp. In partnership with Santa Barbara Mariculture, we've installed a collection of cultivation lines to begin to better understand the functionalities and challenges of the novel cultivation system. Our work at the hatchery and in the open ocean have provided key insights as to the opportunities of offshore seaweed cultivation in the U.S. In parallel to our work in the field, Ocean Rainforest has tackled an extensive permit and application review process for a small, demonstration project site in the Santa Barbara Channel. Since fall 2019, the team has worked extensively with all variety of regulatory agencies as we collectively navigate the permit requirements, siting analysis and monitoring expectations associated with offshore seaweed aquaculture. In October 2021, Ocean Rainforest won unanimous approval from the California Coastal Commission for their consistency certification: a critical aspect of their larger individual permit application to the U.S. Army Corps of Engineers.

**12:00PM – 12:15PM (15 MIN): FINDING THE WAY TO THE FUTURE BY LOOKING BACK INTO THE PAST**

**Presenter:** Bernard Friedman, Santa Barbara Mariculture

**Summary:** After 20 years of farming the sea off the coast of California, a tragic event leads to an epiphany of past and future examinations of the meaning of life. Santa Barbara Mariculture operates a 72 acre fully permitted offshore shellfish and algae farm 3/4 of a mile off the coast of Santa Barbara. Quietly busting down doors and breaking barriers, this one-man company has achieved the impossible. Growing up in a house built in the 1850s and walking the vineyards once cultivated for six generations, the speaker will take you on a journey from the hinterlands of Germany to the future of farming in California. Bridging the past to the future, lessons learned a long time ago prove to be leading the way. Despite common bravado, farming the ocean is a brand new frontier, the speaker will illuminate some skills you might need to keep afloat.

**12:15PM – 12:30PM (15 MIN): MYTILUS CALIFORNIANUS AS A POTENTIAL NEW SPECIES FOR AQUACULTURE PRODUCTION: A PROOF OF CONCEPT AND ESTABLISHED SEED TO FARM PIPELINE IN SOUTHERN CALIFORNIA**

**Presenter:** Nathan Churches, Holdfast Aquaculture LLC

**Summary:** Once a major staple of shellfish consumed along the US West Coast from pre-colonial through the late 1900s, depletion of wild stocks of the California mussel (*Mytilus californianus*, "CM") and a lack of hatchery-based aquaculture have eliminated market presence of this species. This is despite a historically high demand in seafood outlets, reaching peaks of 500 tons for annual North American landings through the 1980s. In the US, low-trophic aquaculture (e.g., seaweeds and bivalves) present both environmental and social benefit, and untapped economic opportunities for emerging native species via hatchery-based aquaculture. While oysters traditionally make up a large portion of global shellfish aquaculture, mussels production increased from 2010 to 2016 by ~23% for Mytilid and ~35% for Chilean varieties, demonstrating that demand for mussels, specifically, is on the rise. Here, a collaborative team from Holdfast Aquaculture, Santa Barbara Mariculture, and the Nuzhdin lab at the University of Southern California will report on findings from a USDA sponsored Small Business Innovation Research (SBIR) grant surrounding the amenability of CM to hatchery-based aquaculture. Further, we demonstrate a new seed-to-farm pipeline established exclusively in Southern California, filling an important economic niche for area industry. The team will show that there is potential to introduce CM as a new "California-raised" aquaculture product (trademarks pending), similar to New Zealand's Green Lipped Mussel (GLM) which is valued at ~\$200 million. NZ exports ~68 million pounds of GLMs annually, compared to the U.S. which exported 1.5 million pounds and imported 67 million pounds of mussels in 2019. In our research, the team demonstrated several key milestones for CM hatchery husbandry and spawning, including: 1) mass-spawns occur regularly, 2) spawn induction is possible (protocols developed), 3) potential amenability to Gamete Conditioning System ripening, 4) settlement onto fuzzy rope, 5) preference for fuzzy rope over other substrates, 6) retention during juvenile re-socking, 7) equal- or out-performance of other Mytilid market metrics (e.g. shell strength). Through grants and investments, new aquaculture facilities have been developed at AltaSea in Los Angeles, where Holdfast Aquaculture can produce 30,000-feet of seeded line per year, and Santa Barbara Mariculture is in the process of developing permits for CM out-planting on their 72-acre farm. The team's genomics studies demonstrate high mutational load for bivalves, which may impact any selective breeding programs developed for CM and other species. Together, the study data suggests that there is a significant opportunity for US West Coast aquaculture in CM, production of this native species through hatchery-based aquaculture is possible, and that CM performance matches or exceeds currently farmed mussel varieties for the region.

**12:30PM – 1:30PM (60 MIN): BREAK**

**1:30PM – 1:45PM (15 MIN): THE OREGON AQUACULTURE EXPLORER: CAN CONCEPTS FROM A NOVEL GEOSPATIAL AND FINANCIAL PLANNING TOOL HELP ADVANCE CALIFORNIA AQUACULTURE?**

**Presenter:** Gilbert Sylvia, Oregon State University

**Summary:** Not unlike California, Oregon faces a plethora of challenges hindering aquaculture development ranging from complex and inefficient regulations and policies, high costs, and lack of state-wide support. Like California, Oregon has a diverse and creative agriculture industry across varied landscapes but unlike California, Oregon's aquaculture industry is quite small, relatively homogeneous, and with little new investment. While there are several underlying causes, a fundamental problem is the lack of aquaculture experience, knowledge, and education. To address this issue and catalyze aquaculture investment, the Oregon Aquaculture Association, Business Oregon, Oregon State University, and Oregon Sea Grant have created the Oregon Aquaculture Explorer Platform. The platform includes on-line geospatial and financial tools that allow users (e.g., industry, state agencies/planners, investors) to make informed decisions about production systems and investment opportunities by exploring spatial resources linked to financial models.

The financial tool has been built and peer reviewed for three inland aquaculture species: tilapia and sturgeon in recirculating systems, and hybrid striped bass in ponds. We are now in the process of beta testing and expanding the tool to include coastal and marine systems (e.g., seaweed and shellfish culture), as well as additional inland systems. The platform allows the user to explore aquaculture related data layers across the state, select a site (choosing on a map or entering an address), develop an initial aquaculture resource site report, and then for any financial model, determine likely costs for inputs including energy, water, feed, seed, and labor. Each of these costs can be refined based on the user's estimates. A unique attribute of the platform is directly linking spatial data as inputs into the financial models. The tool allows the user to run multiple scenarios based on alternative production levels, costs, output prices, and resource constraints. Start-up costs, including construction and materials, are also considered. The tool provides a downloadable Excel file for the user to conduct more detailed and site-specific analysis. The goal of this presentation is to provide an introduction and overview of the Oregon Aquaculture Explorer Platform and discuss how a similar idea could potentially support California aquaculture development, particularly by acting as a catalyst to address a range of issues related to aquaculture investment. The presentation will highlight how potential users can benefit from the tools and elicit feedback and conversation around potential application in California as well as possible refinements and concerns.

**1:45PM – 2:00PM (15 MIN): WELFARE CHALLENGES ASSOCIATED WITH HANDLING AND SLAUGHTER OF LARGE CAVIAR FINFISH**

**Presenter:** Zarah Deutsch, UC Davis Aquaculture Extension

**Summary:** Due to size and behavior, large finfish, specifically caviar-ready adult female sturgeon (*Acipenser transmontanus*), present unique processing challenges for California and Idaho producers. During the slaughter process it is important to consider fish stress for a variety of reasons, including meat quality, animal welfare and consumer demand. Due to their size and strength, handling can pose a significant impediment to accurate and swift slaughter. Currently, most producers use blunt force trauma to initiate brain death as a 1st step slaughter method prior to exsanguination in an ice slurry as AVMA approved 1st and 2nd step methods. When struggling, large fish often require multiple blows, and some may still recover in the ice slurry reducing animal welfare and sustainability objectives. There are a variety of considerations towards minimizing stress during harvest and slaughter, including reduced transport and handling prior to slaughter and alternative first step slaughter methods. A few producers have now adopted pneumatic captive bolt technology as an alternative method for percussion stunning. One easily implemented solution is to ensure proper training and settings during captive bolt percussion stunning. Here, we use both microscopic and anatomical assessments of brains from white sturgeon to demonstrate the ideal location and applied force (PSI) to ensure first step slaughter occurs with minimal stress without repeated strikes or recovery of consciousness. The overall goal of this experiment is to achieve the highest fish quality for the consumer while maximizing fish welfare.

**2:00PM – 2:15PM (15 MIN): SEAWEED FARMING IN HUMBOLDT BAY**

**Presenter:** Rafael Cuevas Uribe, Humboldt State University

**Summary:** To present information of the new seaweed industry in Humboldt Bay. The collaborative effort between HSU and GreenWave and the establishing of the HSU ProvidenSea farm. Describe the results from Pacific dulse project and preliminary results on our new bull kelp system.

**2:15PM – 2:30PM (15 MIN): HUSBANDRY OF PISMO CLAMS IN A SAND-LESS CLOSED SYSTEM**

**Presenter:** Jessica Brasher and Nancy Caruso, Ocean Institute and Get Inspired Inc.

**Summary:** The Pismo clam, *Tivela stulturum*, once supported a robust commercial harvest. The commercial fishery was closed in 1947 but the recreational fishery remains open to this day despite being severely limited in range and abundance from Half moon Bay through Baja, California. The Pismo clam has played an important role in California history and culture with clam digging and clam bakes being part of most childhood memories up until the 1980's. Hopeful clam diggers can still be found with their shovels during seasonal negative tides on wide sandy beaches. Given its popularity and dwindling populations, we think the Pismo clam has potential as a new native aquaculture species in California. We have explored husbandry techniques for this species and want to share our findings to foster interest and pass on knowledge for further study. Although we have not yet been successful at spawning the species, we are exploring the ability to grow them without the sand. This information might be the key to growing this bivalve normally found buried in sand on wave pounded beaches along our coast.

## 2:30PM – 2:45PM (15 MIN): ANTIMICROBIAL USE IN CALIFORNIA AQUACULTURE: PRODUCTS, PURPOSE, AND STEWARDSHIP

**Presenter:** Alex Wright, UC Davis Aquaculture Cooperative Extension

**Summary:** California's complex and diverse aquaculture industry confronts many production and husbandry challenges; one of the most prominent and costly being infectious disease caused by microscopic organisms. Antimicrobial products are important tools used by aquaculture professionals to combat various pathogenic bacteria, parasites, fungi, and viruses. Antibiotics are within this group of products and have proven useful against infectious diseases outbreaks in humans and animals. However, antimicrobial resistance (AMR) is a developing concern within both agriculture and aquaculture, with potential human consequences. Bacteria develop resistance mechanisms and can transfer this information to other bacteria, meaning that in many cases, antimicrobial products become less effective. It is important for the growing aquaculture industry to be aware of antimicrobial product usage, issues associated with AMR, and to avoid contributing to further AMR development and spread. Likewise, to support the continued industry growth, it is important for public health organizations and research institutions to provide recommendations and resources to assist aquaculture producers in their decision-making process. Antimicrobial Use and Stewardship (AUS) in the California Department of Food and Agriculture is a statewide program intended to promote actions that will slow the development of resistant bacteria associated with animal production systems. Aquaculture Cooperative Extension at UC Davis is collaborating with AUS to better understand the types of antimicrobial products used in California aquaculture, the disease challenges experienced, and to provide resources intended to inform industry personnel of antimicrobial stewardship principles and disease management strategies. California aquaculture producers have been asked to participate in a survey designed to inform the AUS of the disease trends and industry needs surrounding animal health and biosecurity. Here we outline the types of antimicrobial products available for use by the aquaculture industry; the purpose of these products and how they are used onsite; and proper stewardship principles intended to help balance the AMR issue with the industry's need for antimicrobial products and disease management strategies.

## 2:45PM – 3:00PM (15 MIN): CALIFORNIA NEEDS TO GROW WHAT PEOPLE WANT TO EAT!

**Presenter:** Don Kent, Hubbs-SeaWorld Research Institute

**Summary:** Discussion of the limitations to the development of marine farming in California. A lack of regulatory understanding seriously limits marine farming, which could help to offset impacts from climate

change. Recent policy developments in California are superseding legislative mandates and limiting farming to species with less market value than those presently being imported into the U.S> California is known for its farming industry and its capacity to feed the Nation. A lost opportunity is resulting from poor policy decision and a thorough lack of understanding of the industry potential and of a willingness to adopt new management responsibilities.

**3:00PM – 3:30PM (30 MIN): BREAK**

**3:30PM – 3:45PM (15 MIN): AQUACULTURE TECHNIQUES ENHANCE THE POTENTIAL FOR PROLONGED SUCCESS IN THE RESTORATION OF BULL KELP, *NEREOCYSTIS LUETKEANA***

**Presenter:** Andrew Kim, Moss Landing Marine Labs

**Summary:** Bull kelp (*Nereocystis luetkeana*) is one of the primary canopies forming foundation species along the northeastern Pacific coast, supporting unique and biodiverse communities from central California to Alaska. Its role as a foundation species was recently exemplified when 95% of bull kelp was lost along northern California, with ensuing shifts in ecosystem state. Bull kelp is an annual species and persistence relies heavily on its ability to reach fertility and release spores prior to winter wave disturbance and senescence. Recent coincidence of marine heatwaves, sea-star wasting disease, and expanding sea urchin populations along northern California have resulted in severe interannual bull kelp population declines, posing direct risk to long-term persistence of bull kelp forests and their associated community. Restoration efforts have focused on sea urchin removals and active reseeded of bull kelp at different stages with mixed success. We utilized various aquaculture methods to simplify the cultivation of bull kelp for restoration purposes. Using land-based tanks, we developed low-cost techniques to complete the bull kelp life cycle with flow-through filtered seawater, aeration, and shading. We utilized our methodology to successfully produce gametophytes, free-floating sporophytes, seeded rock substrates, and a perennating sororal bank. Incipient *in-situ* testing of the efficacy of low-cost restoration methods capable of re-establishing bull kelp forests will inform managers for future restoration efforts.

**3:45PM – 4:00PM (15 MIN): EATING OUR WAY THROUGH A PROBLEM: MASTERING A RESTORATIVE SEAFOOD THROUGH AQUACULTURE TO RESTORE KELP FORESTS**

**Presenter:** Brian Takeda, Urchinomics

**Summary:** Who is Urchinomics? What do they do and how do they do it? They will present the challenges as well as the successes of ranching wild barren urchins with examples of multiple business cases. The team will also discuss the environmental issues we are facing in our oceans, the importance of our kelp forests and what Urchinomics plan is to help on a global level. Urchinomics will highlight some of the partnerships that have helped along the way both from a scientific standpoint and a non-profit standpoint and explain why collaboration and transparency is vital to the success of the operation.

**4:00PM – 4:15PM (15 MIN): USING SEAWEED FARMS TO REMOVE EXCESS NUTRIENTS FROM ESTUARINE WATERWAYS**

**Presenter:** Dr. Matthew Edwards, San Diego State University

**Summary:** Excess nutrient input into the marine environment has caused health concerns for many bays and estuaries. In particular, excessive use of fertilizers in urban and agriculture setting results in nitrogen and phosphorus being transported to the ocean, especially after heavy rain when runoff carries them to the sea. Seaweed farms may prove a promising way to remove these nutrients from the water, but it is unclear how the seaweeds will perform when salinities decrease following freshwater input. We studied the feasibility of using

Ulva lactuca to remove N and P from San Diego Bay during periods of reduced salinity. To do this, we grew U. lactuca under two salinities and three nutrient concentrations for six weeks. We measured U. lactuca growth, photosynthetic performance, nitrogen and phosphorus uptake, and the resulting tissue nitrogen, phosphorus and carbon contents. Our results show that while U. lactuca survived and grew in all salinity and nutrient combinations, its growth, steady-state photosynthesis, light harvesting, and tissue N and P contents were all affected by differences in salinity and nutrient availability. Specifically, low salinity and low nutrient availability negatively affected these parameters, while high salinity and medium-to-high levels of nutrients generally led increases in these parameters. Our study suggests that although its physiology may be negatively affected, growing U. lactuca on seaweed farms may be a feasible way to clean the water of organic pollutants, especially following rain events that increase nutrient input and lower salinity.

#### **4:15PM – 4:30PM (15 MIN): CLIMATE-ADAPTIVE AQUACULTURE: CAN WE FUTURE-PROOF CALIFORNIA SEAFOOD PRODUCTION?**

**Presenter:** Dr. Michael Graham, Harmony Coast Seafarms

**Summary:** California has the potential for significant development in the marine aquaculture sector. Although permitting and regulations have hampered the creation of new California offshore aquaculture companies, land-based opportunities can have an impact on local seafood production. Recently, a large defunct land-based aquaculture facility near Cayucos CA has become the new home of Harmony Coast Seafarms. Harmony Coast Seafarms is an integrated for-profit seaweed-shellfish aquaculture company that, in conjunction with the non-profit Harmony Coast Aquaculture Institute, is developing novel infrastructure to produce seafood in ways that minimize ocean acidification, reduce shellfish feed requirements, and create effluent of enhanced environmental value. The operations have the potential to climate-adapt seaweed and shellfish production at large commercial scales and serve as a focal point for education, conservation, and outreach activities that promote the positive benefits of sustainable aquaculture to local communities.

#### **4:30PM – 5:00PM (30 MIN): CALIFORNIA AQUACULTURE ASSOCIATION MEMBER MEETING**

#### **5:00PM – 5:30PM (30 MIN): CALIFORNIA AQUACULTURE ASSOCIATION BOARD OF DIRECTORS MEETING (CLOSED SESSION)**