

Monitoring the Ocean's Pulse for

Offshore Aquaculture

By Kira Coley

In a time when aquaculture production has become the fastest-growing food-production sector in the world, marine monitoring technologies will be essential for reducing environmental impact. Aquaculture within the U.S. is set to increase by more than 50% over the next 5 years in a bid to reduce America's \$11 billion seafood trade deficit. Combining new sustainable aquaculture methods, real-time scientific monitoring and a marine technology testing centre, the Catalina Sea Ranch goes beyond traditional approaches to a centuries old challenge. By using the latest innovative techniques for offshore monitoring and mussel production, this novel venture is paving the way for a sustainable and efficient future for the aquaculture industry.

The National Oceanic and Atmospheric Administration (NOAA) launched a "National Shellfish Initiative" in 2011 with an emphasis on growing sustainable shellfish aquaculture within United States waters. As a solution to the U.S. seafood trade deficit, NOAA recently announced its "Marine Aquaculture Strategic Plan FY 2016-2020" which aims to more than double marine aquaculture activity by 2020.

Globally, filter-feeding shellfish are important for ecologically sustainable aquaculture and are successfully farmed throughout the world. Although mussel cultivation does not require highly sophisticated techniques, consideration of environmental, ecological and seasonal factors are essential for the health of the stock. As the industry looms on the verge of an 'aquaculture boom', any negative ecological impacts must also be minimised from increased production.

The United States produced \$1.2 billion of aquaculture seafood in 2012. NOAA's goal for a 50% increase amounts to over \$600 million or \$100 million a year. For this to be accomplished rapid permitting of aquaculture facilities would be needed, presenting an opportunity for innovative R&D programs and cost effective environmental moni-

toring packages. Advanced aquaculture husbandry technologies will also enable the production of higher crop yields, while innovative hatchery technologies can provide a competitive economic advantage for the early adopters.

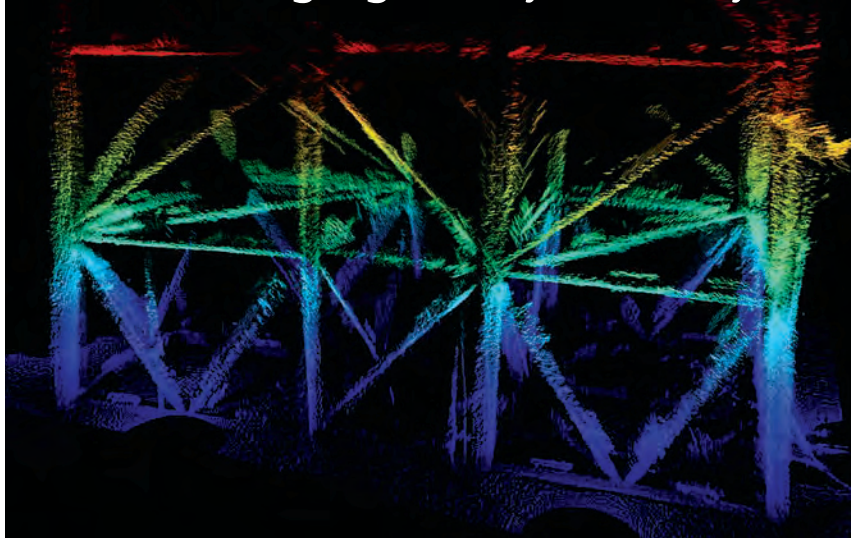
Recognizing the potential of mus-

sel cultivation, the Catalina Sea Ranch was proposed as the "First Open Ocean Shellfish Ranch in United States Federal Waters."

In July 2012, the Catalina Sea Ranch was awarded a permit from the U.S. Army Corps of Engineers to develop a

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100-acre shellfish farm on the San Pedro Shelf—a large underwater plateau about 150 feet deep that drops off to 3,000 feet, creating natural upwelling that delivers an abundance of nutrient-rich phytoplankton from the deeper water.

While mussel farming has been practiced for centuries, the Catalina Sea Ranch is reshaping the traditional approach by advancing cultivation techniques and pushing the industry into a new age of innovative real-time monitoring technologies. By collaborating with institutes such as SCRIPPS, Woods Hole Oceanographic Institute (WHOI) and the University of Southern California (USC), research objectives have been designed to expand scientific understanding on topics from ecosystem dynamics to ocean acidification.

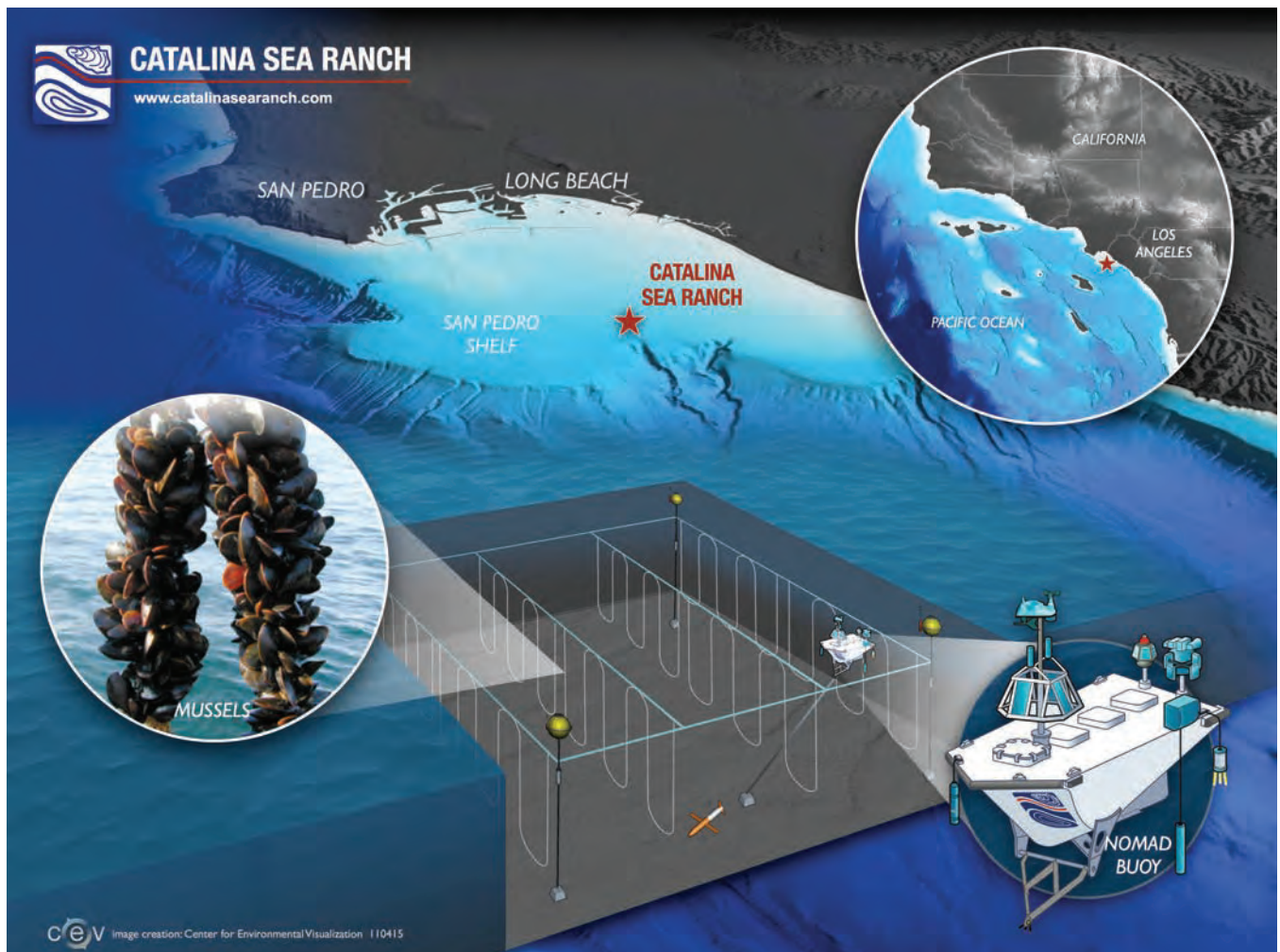
“It’s a really exciting time in the area of offshore technology, as the cost of data storage and microprocessors is plummeting: this couldn’t have been done two years ago,” said Phil Cruver, Founder, President and CEO of Catalina Sea Ranch, LLC. “We can now collect real-time data remotely at a fraction of the cost, which really changes the capability of the assessment, evaluation and for ‘taking the pulse of an area of the ocean’. This transparent data is then put onto the web so research scientists can conduct collaborative evaluations.”

Taking the Ocean’s Pulse

Traditionally it may take up to 6 months to assess negative impacts in the marine environment from aquaculture activities. Recent developments in marine monitoring technologies allows the Catalina Sea Ranch to identify any issues immediately and implement an adaptive management plan.

The ranch has three levels of real-time monitoring. The first monitors environmental data to comply with regulatory requirements such as biological impacts to water quality, seafloor composition, species quantity and other factors that could alter the environment in proximity to the shellfish facility. The second is husbandry data such as identifying thermoclines for the best depth to cultivate the shellfish and their carrying capacity to improve operations.

“Given the importance of phytoplankton in both sustaining the shellfish and the wider marine community, we want to know what is the carrying capacity of this ranch, i.e. would the mussels consume so much phytoplankton that it negatively effects other species access to this vital food source,” said Cruver. “So we monitor this in both the vertical and horizontal plain using low cost sensors and send all that data into Verizon’s cellular network. We can monitor massive amounts



of data in real-time with subject matter experts and make sure there is no problem. No one has ever done this before.”

The final level of monitoring is security. Perimeter buoys can be located around the ranch with warning lanterns and a real-time radar is fitted to the NO-MAD which serves as a corner marker buoy. In addition, the site is located within the scope of the Port of Long Beach, giving the United States Coast Guard access to the ranch quickly.

Double Act: A Test Center for Marine Technology

The advancement of novel technologies will be essential in the development of sustainable offshore aquaculture for both shellfish and seaweeds in the future. Both industries are recognised to have a major potential for achieving the 50% growth goal of NOAA’s Marine Aquaculture Strategic Plan.

Catalina Sea Ranch was awarded a \$481,550 grant contract by the South Coast Air Quality Management District to repower its Captian Jack Research Vessel with three new less polluting engines. The shuttle service brings scientists and ocean engineers to the RV where they can get access to a wet-laboratory. It is on this floating laboratory that the numerous participation PhDs, researchers and engineers seek to advance the science of marine aquaculture and real-time environmental assessments.

“With today’s shellfish aquaculture there really is no sophisticated technology. What we are doing that is really advanced for exploiting this huge market what we called ‘Ocean Internet of Things’ (IoT). According to the McKinsey Global Institute, by 2025 the Internet of Things will be an \$11 trillion market for connecting networks and sensors together,” said Cruver. “We have a whole stack of technologies, most of which have been designed especially for the purpose of the ranch, others have not been used before in this way.”

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The ranch uses a variety of remotely operated vehicles (ROVs) to help in underwater inspections throughout the site. A larger ROV inspects infrastructure integrity and collects scientific data, while a mini ROV is used for the inspection of the cultivation gear and anchors for maintenance, as well as mussel crops for growth and marine biofouling characteristics.


Above the water, Catalina Sea Ranch is developing its NOMAD buoy as a distinctive, one of its kind, IoT platform. The NOMAD is fitted with an array of sensors to collect bathymetric environmental data including temperature, salinity, pH, dissolved oxygen and phytoplankton density. The raw data is transmitted to computers on-board the buoy, allowing researchers and operation staff to quickly process and sort the data, before sending the valuable information back to Verizon's cellular tower.

Cruver and the team work closely with research institutions by providing platforms, such as the NOMAD, with the capability to transmit real-time automated data into the Internet cloud. By leveraging Verizon's network, the Catalina Sea Ranch intends to develop a proprietary automated offshore aquaculture monitoring system, for producing real-time data available for collaborative and transparent web-based scientific analysis.

"No one has ever used a cellular network to transmit that kind of signal from six-miles offshore. We started working with the CEO of Verizon as he is an advocate of sustainability, which resonates with our project." Explains Cruver, "Not only are today's sensors changing but the networks are changing. There is no one in the marine sector exploiting IoT technologies. We want to provide the platform for developing the latest innovative solutions for offshore monitoring and become leaders in 'Marine Big Data'."




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