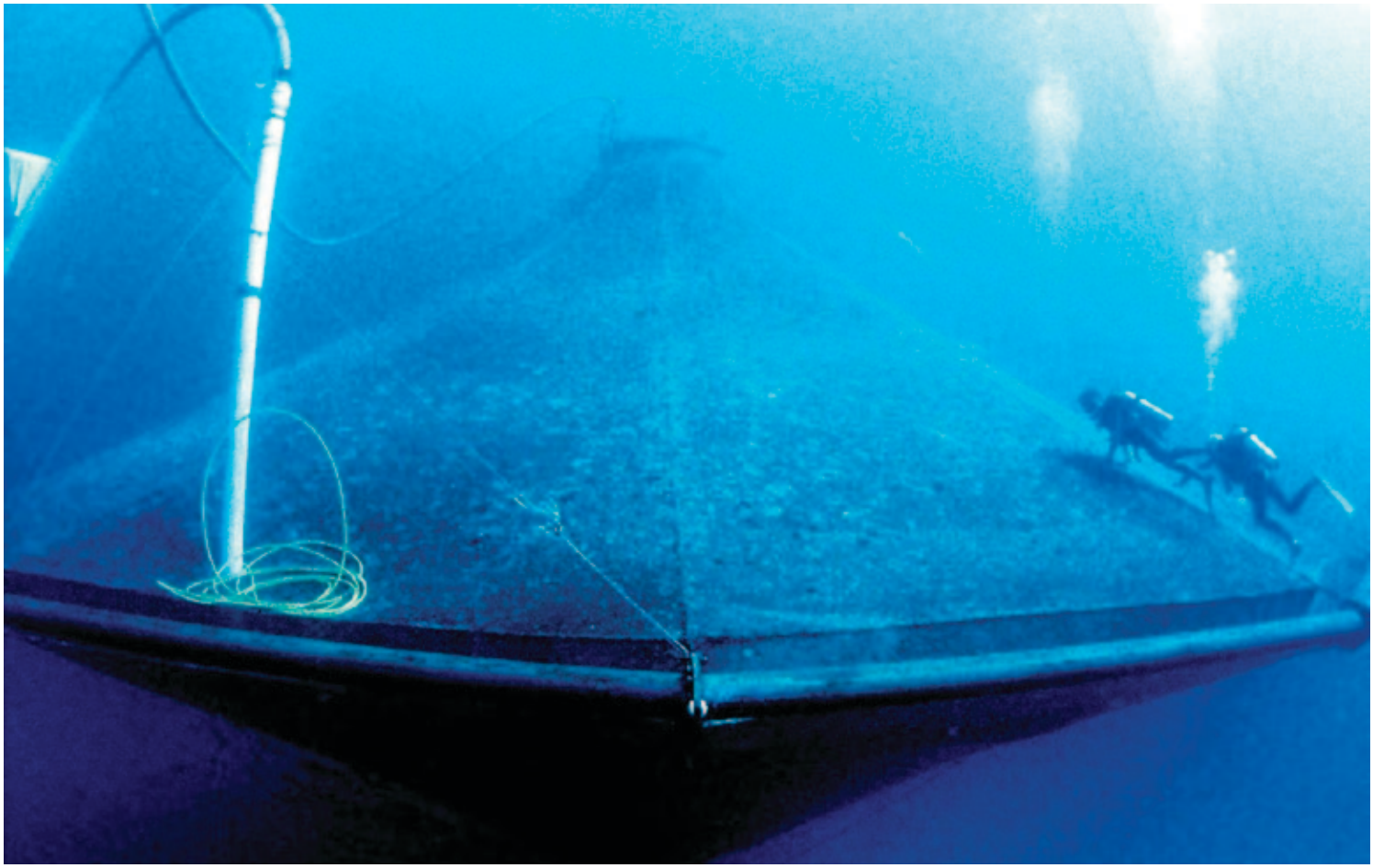
OFFSHORE AQUACULTURE
in the Southern California Bight

April 28-29, 2015



NOAA

Sea Grant

Aquarium of the Pacific

Offshore Aquaculture
in the Southern California Bight

This summarizes the major findings and recommendations of an aquaculture workshop held on April 28-29, 2015 at the Aquarium of the Pacific. A list of participants and observers is located in Appendix 1. The meeting agenda, comprehensive minutes of the meeting, and copies of the slides used in the presentations and the report can be found at: www.aquariumofpacific.org/mcri/info/offshore_aquaculture_in_the_southern_california_bight

Image courtesy of Blue Ocean Mariculture

Acknowledgements

The workshop and proceedings are a result of work sponsored by the California Sea Grant College Program, Project R/Q-136, under Award NA140AR4170075 from National Sea Grant, NOAA, U.S. Department of Commerce, with funds from the State of California.

The workshop organizers would like to thank the many people who have contributed time, expertise, and advice to this project. The workshop would not have been possible without the dedicated efforts of all the participants. In particular, we are grateful to Linda Brown for orchestrating the workshop and preparation of workshop materials. We give special thanks to Molina Health Care for making their Event Space available for the meeting at no cost. Thanks to our rapporteurs, Annalisa Batanides, Rachel Fuhrman and Jonathan MacKay. We also thank Chris Hernandez, Derek Balsillie, and Victor Vallejo for AV support and Lisa Wagner for her advice on the development and distribution of the on-line workshop survey. We acknowledge with gratitude Rich Wilson, Seatone Consulting for his superb facilitation of the workshop. We would also like to thank Randy Lovell, state aquaculture coordinator with the California Department of Fish and Wildlife for his thoughtful comments on the drafting of this report.

The Steering Committee

James Morris

Paul Olin

Kenneth Riley

Jerry Schubel

Kim Thompson

Diane Windham

Back row from Left to right: Annalisa Batanides, Penny Ruvelas, Kim Thompson, Carol Price, Randy Lovell, Dale Kiefer, Russ Vetter, Don Kent, James Morris, Bryant Chesney, Walt Wilson, Letise LaFeir, Thomas Dempsey, Kevin Amos, Paul Olin, Mark Drawbridge, Michael Rust, Michael L. Van Houten, Linda Brown.

Front Row from left to right: Sandra Oh, Dave Caron, Rich Wilson, Amy Rens, Bonnie Rogers, Dan Swenson, Melanie Tymes, Rachel Fuhrman, Jerry Schubel, Diane Windham, Jonathan McKay, Ken Riley, Paula Sylvia.

Table of Contents

Introduction

Diver inspecting sea cage. Image courtesy of NOAA Fisheries

The *Sea Grant Workshop on Offshore Aquaculture in the Southern California Bight* (Aquarium of the Pacific, Long Beach, California, April 28-29, 2015) was convened to develop the frames of reference and rationale for creation of an offshore finfish aquaculture industry in southern California. The workshop was attended by 44 people that represented a cross-section of scientists, regulators, and industry practitioners with proven expertise in the field of aquaculture and environmental science. All state and federal agencies with regulatory responsibilities for permitting aquaculture were invited to participate and each agency was generally well represented. Workshop participants were asked to share and prioritize concerns regarding the complex, high-stakes environmental and resource issues often associated with coastal development activities. A professional facilitator guided conversations and consensus building activities, especially when tough policy questions combined lively politics and contested facts. While permitting remains an uncertain, uncoordinated, unstable, and inconsistent process for offshore farms in California, all workshop participants were requested to work together to formulate specific recommendations to improve the process for reviewing permits and obtaining approvals for aquaculture development projects.

While it was not the intention of the workshop, the Rose Canyon Fisheries[1] project became a focal point for much of the workshop discussion since its permit application is currently under review. Rose Canyon Fisheries proposes to establish the first finfish farming operation in U.S. federal waters. The farm will be sited 4.5 miles (7.2 km) from the San Diego coastline. The commercial demonstration project represents a partnership between Hubbs SeaWorld Research Institute and Cuna del Mar, a private equity fund for marine aquaculture development. The proposed project will produce 5,000 metric tons of yellowtail jack, white seabass, and striped bass in sea cages with harvested product landed along traditional working waterfronts in the region. The review and discussion on the Rose Canyon Project provided a basis for a greater discussion on the risks and rewards for offshore aquaculture development in the region.

Goal of the Workshop

As stated in the workshop agenda:

"The goal of the workshop is to develop the frames of reference and rationale for creation of an offshore finfish aquaculture industry in the Southern California Bight. Offshore aquaculture development has been a subject of intense debate in coastal communities around the nation. Large barriers to starting new offshore aquaculture ventures are public perception and regulatory concern that industry development will have significant environmental impact. A critical element needed by coastal managers and stakeholders is awareness and confidence to use science-based decision tools to inform coastal ocean use plans and equitably resolve points of resistance to industry development."

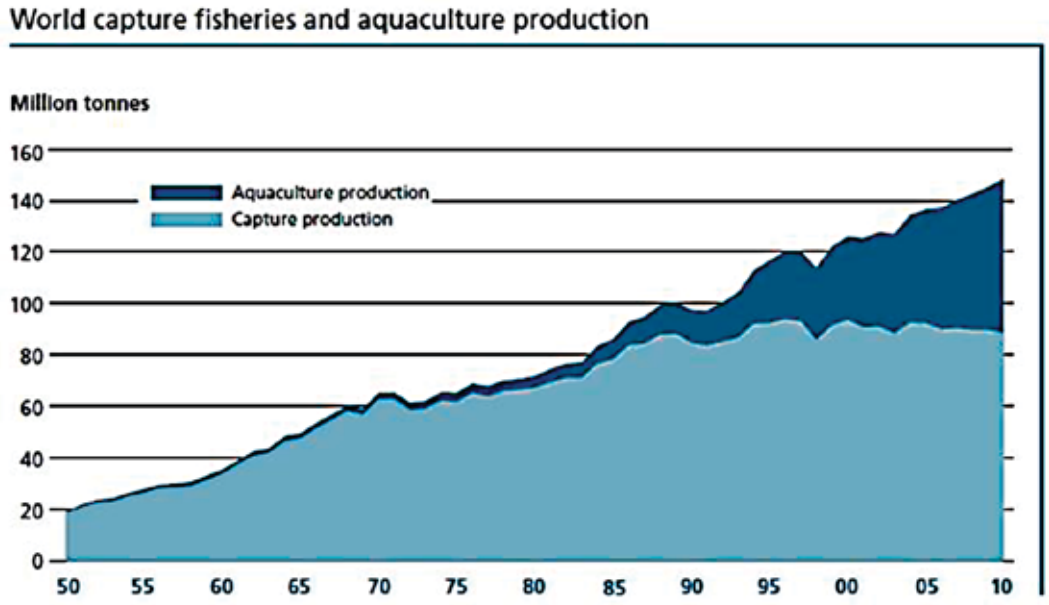
[1] A complete project description is provided in Appendix 2

The Need and the Opportunity for the U.S. and California to Take Leadership Roles in Offshore Aquaculture

Introduction

The production and consumption of energy and protein-rich food by humans have the greatest impact on natural resources globally. Increasing wealth and urbanization throughout the world drive the demand for more energy and food, creating increasing pressure on the planet's finite resources. With the world population expected to exceed 9 billion by 2050, the U.N. Food and Agriculture Organization (FAO) estimates that food production will have to increase by 70 percent to meet the growing demand, and needs to accomplish this while adapting to climate change and combating global hunger and poverty (FAO 2011). A promising opportunity to meet these challenges internationally and domestically is to invest in people and provide resources to expand the availability of protein sources through production of seafood. Seafood is a healthy protein source that has great potential to help meet the burgeoning need for protein rich foods while minimally impacting the environment.

Seafood is the primary source of protein for more than 3 billion people on the planet and is widely recognized as contributing to a healthy diet. A desire for seafood, coupled with growing and more affluent global populations mentioned above, has created a



Source: FAO (2012) "State of the World Fisheries and Aquaculture"

TABLE. COMPARISON OF SUSTAINABILITY INDICATORS AMONG ANIMAL PROTEIN PRODUCTION SYSTEMS

	Food conversion (kg feed/kg edible weight)	Protein efficiency (%)	N emissions (kg/ton protein produced)	P Emissions (kg/ton protein produced)	Land (tons edible product/ha)	Consumptive freshwater use (m^3/ton)
Beef	31.7	5	1,200	180	0.24–0.37	15,497
Chicken	4.2	25	300	40	1.0–1.20	3,918
Pork	10.7	13	800	120	0.83–1.10	4,856
Finfish (average)	2.3	30	360	48	0.15–3.70	5,000*
Bivalve mollusks	not fed	not fed	-27	-29	0.28–20.00	0

*Note: Consumptive use is difficult to compare across the wide spectrum of aquaculture production systems. In the vast majority of cases, water outfalls from aquaculture are much cleaner and more easily recycled than for land animals.

Source: Phillips, Beveridge, and Clarke 1991; FAO 2003; Hall et al. 2011; Bouman et al. 2013.

dramatic increase in seafood demand. Wild-capture fishery harvests have remained essentially flat since the late 1980's and have been unable to satisfy growing demand. Since then, seafood consumption has roughly doubled and this was made possible in part through increasing production of farmed fish, shellfish, and aquatic plants. As it has for the past 25 years, aquaculture will play a substantial role of meeting society's need for increasing food supplies into the future.

It is no surprise that aquaculture is the fastest-growing food production sector in the world and the FAO estimates that an additional 27 million metric tons (mmt) of farmed seafood products will be needed to meet projected demands by 2030. Farmed seafood accounts for more than half of our seafood supply and production of farmed seafood by weight recently surpassed that of beef.

Marine aquaculture offers many environmental benefits, and relative to other forms of animal protein production, marine aquaculture is an attractive option for expanding production. Aquaculture operations in the marine environment typically generate fewer greenhouse gas emissions, have a smaller carbon footprint, use less land and fresh water, and are very efficient at converting feed into edible protein (Welch et. al. 2010; Torrissen et. al. 2011; and Troell et. al. 2014). Aquaculture also has the potential to reduce pressure on wild fisheries while also increasing the availability of safe, secure, seafood products.

Why Marine Aquaculture?

To feed the current global population of 7.3 billion people, 75 percent of developed land is used for terrestrial agriculture production, including livestock, that consumes 70 percent of all freshwater resources. Despite this, more than 800 million people are chronically undernourished. The ocean covers more than 70 percent of the Earth's surface yet capture fisheries and a small marine aquaculture sector produce only 2 percent of the global food supply. One way to meet growing seafood demand while minimally impacting the environment is to expand marine aquaculture. Well-designed and well-managed marine aquaculture farms utilizing best management practices can provide seafood to improve human health and create economic development without unacceptable environmental impacts.

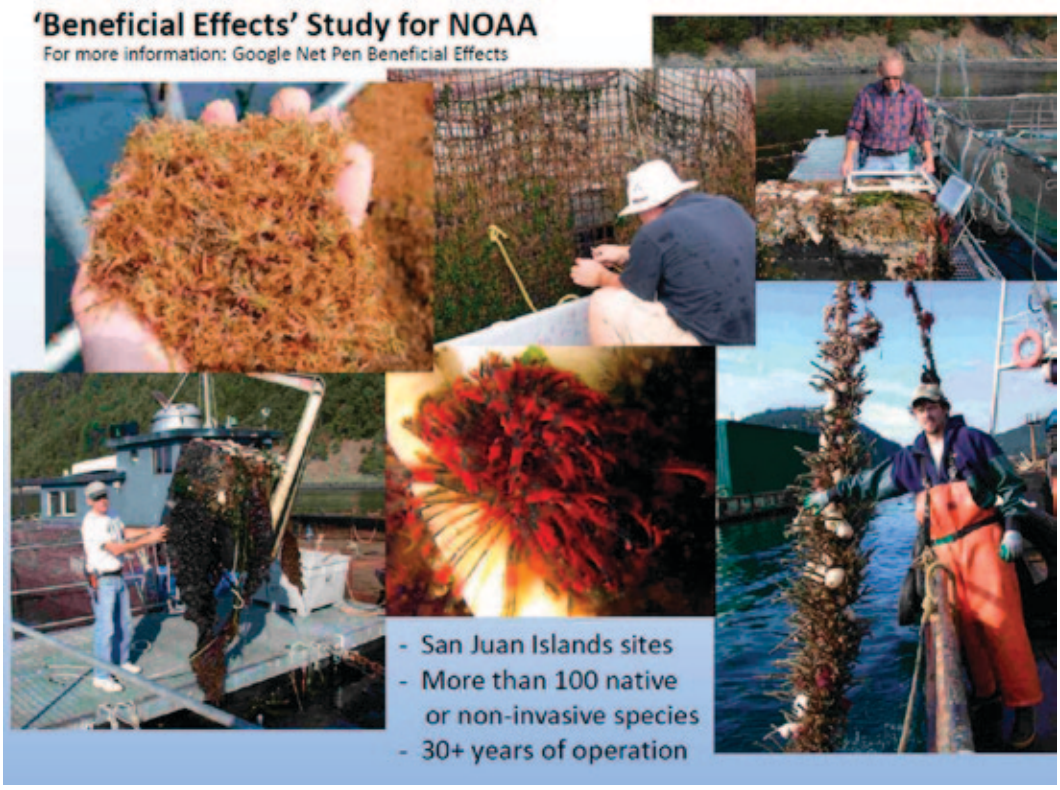
The majority of the world's aquaculture production occurs in freshwater systems. The application of modern technology in cage design, mooring, feed formulation and operations to marine aquaculture is rela-

tively new, but it is successfully practiced in many parts of the world. Proper siting that accounts for current speed, depth, sensitive habitats, and competing uses coupled with best management practices can produce high quality seafood without unacceptable environmental impacts. Moored marine fish cages often function as habitat attracting wild fish seeking food and refuge, which in turn often attract local fishermen, divers, and even tourists.

Why domestic production in the United States?

More than 90 percent of all the seafood consumed in the U.S. is imported, resulting in a growing annual seafood trade deficit exceeding $10 billion in recent years. In 2012 the U.S. contributed just over 0.5 percent to the global farmed seafood supply while Asia produced 88 percent, most of which was from freshwater farms in China. Asian countries have some of the world's highest population densities and their rapidly growing and increasingly affluent middle classes are expected to consume more of the seafood they produce. This scenario will likely increase cost and competition in the future for available seafood, while leaving less available for export to major importing countries like the U.S.

There is potential to develop a robust and diverse marine offshore aquaculture industry in the U.S., which has the largest exclusive



A study of biological colonization on nets, anchor lines and floats at a commercial net-pen fish farm site in North Puget Sound Washington indicated the presence of a diverse community of over 100 species of native seaweeds or invertebrate species. These species and nearby benthic species provided an important component of the food web for a variety of marine life. Biofouling on properly located fish farms thus may include a diverse assemblage of species, many of which could be considered important prey items in the marine food web and a beneficial effect of net pen aquaculture (Rensel and Forster 2007).

economic zone (EEZ) of any country in the world, with waters ranging from arctic to tropical. The U.S. also has the most area suitable for aquaculture production in the marine environment in terms of desirable depth, current speed, and access to coastal infrastructure (Kapetsky et. al. 2013). These conditions facilitate the growth of many different species that can be farmed using multiple production technologies (Rubino 2008).

Domestic marine aquaculture could produce 1 million tonnes per year worth more than $2 billion by 2025. The lion's share of this production will have to come from marine finfish production (Nash 2004).

The U.S. has some of the most comprehensive environmental, seafood safety and regulatory programs in the world and they are often used as models by other countries. These regulations protect water quality and ensure food safety; regulate the use of drugs and therapeutants; prevent or minimize the introduction of aquatic invasive species; and protect natural resources. We have the science and technology to launch this industry and the research capacity to solve problems that may arise, facilitating use of adaptive management to move this industry forward in a responsible manner. This foundation, coupled with development of a transparent and predictable regulatory framework, would be conducive to industry development.

Why California?

California's Aquaculture Development Act (Public Resources Code §826-828) states that:

> *It is in the interest of the people of the state that the practice of aquaculture be encouraged in order to augment food supplies, expand employment, promote economic activity…and protect and better use the land and water resources of the state.*

The demand for seafood in California is among the highest in the nation, and yet the vast majority of its supply is imported. Production in the Southern California Bight (SCB) would benefit from close proximity to one of the most populous regions in the state, with built-in demand, and access to existing processing, distribution, and marketing infrastructure for commercial fisheries. A strong aquaculture industry could reinvigorate California's working waterfronts that have supported well-managed fisheries and coastal communities, benefiting tourism, local business, and residents.

California has a long history of aquaculture production in freshwater and coastal bays. Shellfish production is thriving in Humboldt, Tomales, Monterey, and Morro bays, coastal and offshore Santa Barbara, and in Carlsbad. The California Shellfish Initiative was launched in 2013to bring together federal, state, and local regulatory agencies, along with shellfish industry and restoration interests in a collaborative effort to expand sustainable shellfish farming and wild shellfish restoration by developing a more efficient approach to permitting. These efforts seek to encourage responsible growth of the shellfish aquaculture industry without unacceptable environmental impacts.

Farming of marine finfish in the ocean remains more controversial than shellfish aquaculture. However, the California State Legislature recognized the opportunities afforded by marine finfish aquaculture, and also the need for a regulatory framework to ensure responsible development of the industry in State waters. California Public Resources Code Section 30411(e) mandated the development of a Programmatic Environmental Impact Report (PEIR) for coastal and marine aquaculture. The PEIR will serve as a framework for managing marine finfish aquaculture in an environmentally responsible manner. It has been in development for many years and is anticipated to be completed within the year.

The Southern California Bight (SCB) is one of the most extensively-studied areas of the ocean. There is a wealth of oceanographic data and information that exists for the SCB,

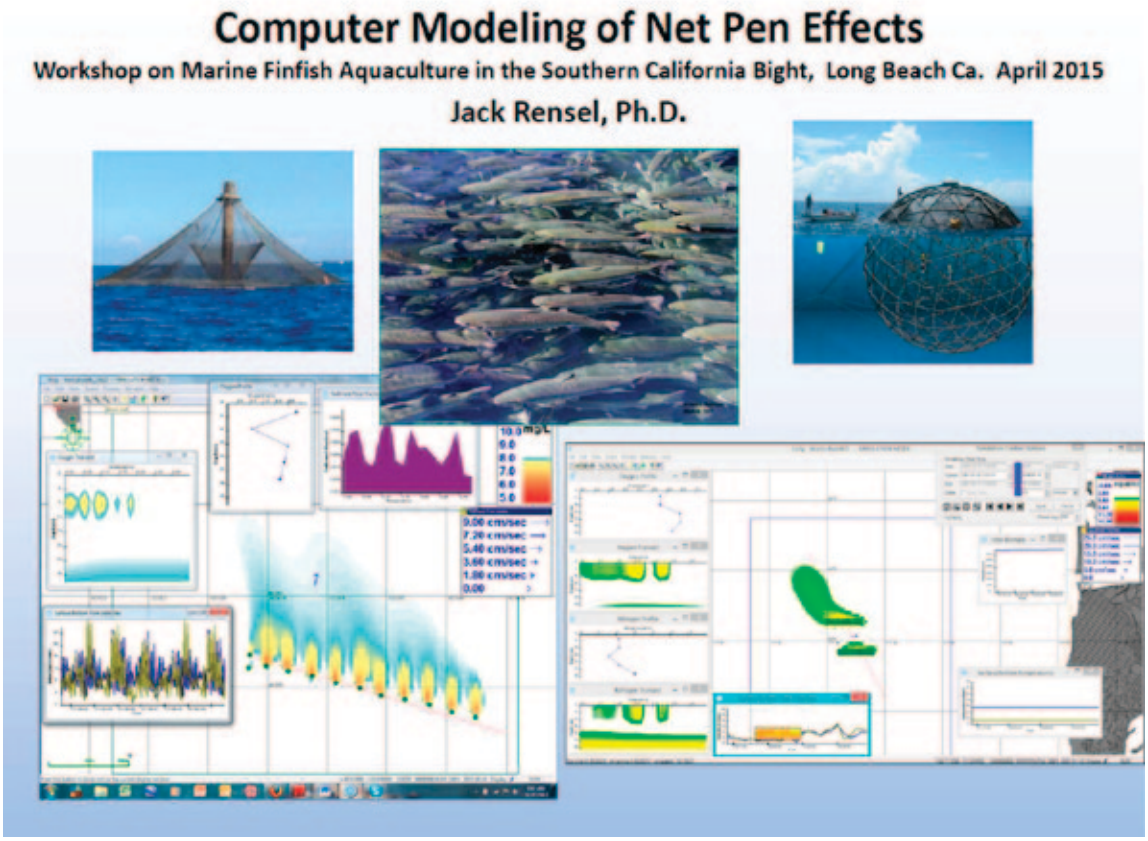
much of which suggests that there would be minimal impacts to the benthos or water quality impacts in the region because of the depth, substrate composition and motion and mixing of the waters. Preliminary marine spatial planning research suggests that more than 500 square kilometers of coastal ocean in the SCB could support environmentally-sustainable marine aquaculture development (Riley and Morris 2015).

California has set a standard for the nation, using science and stakeholder involvement to identify and protect biologically important areas of the adjacent coastal ocean through the Marine Life Protection Act of 1999. Similar tools can be used to identify offshore areas both in state and federal waters that could support commercial marine aquaculture and benefit the State's economy in a manner compatible with environmental quality. In spite of California's strong environmental regulations, some stakeholders have lingering concerns about marine aquaculture.

Issues and Concerns Associated with Marine Aquaculture

Aquaculture production in the offshore marine environment is not without its challenges. Fish are raised in an open system that can have serious consequences for ocean ecosystems if they are not sited, designed, and managed properly. There have been numerous examples of poor production practices that have impacted the surrounding environment by exposure to external stressors, such as: disease, chemicals, and therapeutants; excess nutrients that can impact biodiversity in benthic habitats; the release of non-native species that compete with native wild species; and potentially fatal interactions with wild species that are entangled in gear or intentionally killed as a perceived threat to the farmed stock. The perceived pressure put on wild stocks to use fishery products (fish meal and fish oil) to feed farmed fish, coupled with water quality and benthic effects from fish food and feces is another concern. While these are all relevant concerns, research has shown that proper siting and husbandry practices, best management practices, and the use of appropriate technologies and tools result in greater productivity while greatly minimizing and even eliminating some of these stressors altogether (Price and Morris 2013). The U.S. has the tools to develop a comprehensive regulatory framework and the resources to conduct proper oversight of the best management practices and ensure the use of the appropriate tools required for environmentally-responsible domestic marine aquaculture production.

Image courtesy of Hubbs-Sea World Research Institute



AquaModel is a computational software tool within a 3D GIS used to forecast water column and sea bottom effects of fish aquaculture in nearshore and open ocean locations. It is being used to help design and configure the proposed RCF site offshore of San Diego to avoid adverse impacts, while achieving optimum fish production but avoiding trial and error approaches. AquaModel is being used by NOAA National Ocean Survey in this case and is used elsewhere in the world by government agencies and industry. It can evaluate the cumulative effects of many farms and provide regional carrying capacity estimates by utilizing 3D ocean circulation model data. See www.AquaModel.org for more information.

Key Findings

Image courtesy of Hubbs-Sea World Research Institute

Issues of Concern

Surveys were conducted before and during the workshop to assess regulator and stakeholder concerns associated with offshore aquaculture development. Participants were asked to rank concerns based on their ability and confidence to access and use the best scientific information available to permit and regulate offshore aquaculture operations. These issues were chosen based on general perceptions about the impacts of aquaculture.

The following issues were assessed:

- Siting – Ocean use and viewshed aesthetic impacts
- Nutrient enrichment – water quality and benthic impacts
- Protected species – interactions with threatened, endangered, and protected species
- Chemicals (heavy metals)
- Drugs and therapeutants
- Feeds (feed conversion and growth efficiency)
- Feeds (fishmeal)
- Escapes (offspring and adults)
- Disease
- Invasive species and nonnatives
- Biodiversity and ecology
- Genetic risk

The pre-workshop survey conducted online revealed that the primary areas of concern in terms of potential environmental impacts among the participating regulators and stakeholders were: disease; invasive species and nonnatives; impacts on endangered, threatened, and protected species; and benthic impacts. Only 20 out of the 44 total workshop participants took the online survey.

The survey conducted during the workshop elicited lively responses and became a point of contention as some participants were concerned about the negative context associated with listing these topics as "concerns" rather than as "issues or areas that need to be addressed." In the context of the latter, participants chose "siting" and the "permitting process" as the primary areas needing to be addressed. Because "siting" encompasses many of the other issues identified it was seen as an "umbrella" category. The "permitting process" was a close second. Many participants, including regulators, expressed concern that the permitting process is an issue that requires resolution. Because

California and the West Coast Region lack a well-developed permitting framework, the permitting process presents a major barrier to the growth of marine aquaculture. Workshop participants agreed that without an active project in the water, it is a challenge to fully understand and anticipate what the specific impacts will be in the offshore marine environment of the SCB, which in turn limits our ability to study an operational project and fully understand how to apply adaptive management techniques for offshore marine aquaculture in the region. This can best be accomplished through permitting a demonstration or pilot project. This should be a project that can be scaled up if it meets the permit conditions.

Adequacy of the Science

As the workshop developed it became clear that one of the challenges to permitting an offshore marine aquaculture projects assessing and understanding the adequacy of existing science. In order to have confidence in siting and operating an offshore finfish aquaculture facility in the SCB in state or federal waters, the science must provide tools that facilitate predictable and manageable effects on the environment, marine life, and on other ocean uses. Adequacy was assessed through the lens of scientists and industry representatives, and through the lens of regulators who must provide guidance and make permitting recommendations and/or decisions on permit applications with confidence in the adequacy of the science to support their decisions.

There were many points of agreement among scientists, regulators and aquaculture practitioners in the workshop that the science—both from the industry technology perspective and the environmental perspective—may be adequate to design, site, and operate an offshore finfish aquaculture facility in the SCB, with an appropriately robust monitoring and adaptive management framework that can be informed by existing and additional future research. The existing state of scientific knowledge about marine aquaculture technology and practices as it relates to our understanding of the environmental setting and ecology of the SCB needs to be informed by ongoing research in order to adequately assess the potential risks. Adequacy of the science from the perspective of the regulators is confounded by public perceptions and varying understanding of the state of the science and adaptive management approaches in resource management. There was strong agreement that these need to be addressed.

Public Perceptions of Offshore Aquaculture

It became clear during the workshop that perceptions, both public and regulatory agency, question the development of an offshore marine aquaculture industry. Opposing opinions in the group suggested that these perceptions often are based on misinformation, based on outdated information that is limited in scope and context. These concerns must be understood and effectively addressed. Additional research needs to be conducted to understand the drivers of misperceptions and what information could better inform those perceptions. There was agreement that those involved in the research, policy and management, and industry of offshore marine aquaculture need to "tell the story of marine aquaculture" in clear, concise and readily understandable terms that address such concerns. They must use and translate the best available science describe marine aquaculture in the context of global food supply. This story needs to be developed and conveyed by those with adequate knowledge and credibility to appropriate audiences that influence or are decision-makers. Working with communications professionals in the regulatory agencies, academia and NGOs will unify messaging and consistency.

The Precautionary Principle

There are multiple definitions and interpretations of the precautionary principle that are likely influenced by the perceptions of those implementing it. One presenter suggested that there are two primary interpretations specific to offshore aquaculture in the SCB, both of which are a question of scope and context and whether or not scientific risk assessment is adequate to manage the associated risks. The interpretations are as follows:

1. To invoke the precautionary principle to strictly regulate and restrict aquaculture development due to concerns about issues such as: the use of wild stocks to feed farmed fish, escapes, the use of therapeutants, and pollution.

2. To aggressively develop aquaculture to ensure adequate seafood supplies, prevent unnecessary malnutrition and human mortality, and to reap the economic and employment benefits that accrue, while managing risk and protecting the environment (Olin 2015).

The workshop participants discussed and suggested that aquaculture needs to be addressed in terms of the global food supply, rather than as its own entity and that further discussions on how to address public perceptions under the global purview are necessary. The validity of the current science and whether or not it is adequate to enable managers to reduce risk was discussed at length. Many agreed the second interpretation is more relevant for furthering sustainable marine aquaculture development in the SCB.

Opportunities and Challenges in State versus Federal Waters

Obtaining a lease for offshore finfish aquaculture in state waters is specifically prohibited until regulations can be established governing the activity. Until the state promulgates regulations (which depend upon completion of a California Environmental Quality Act (CEQA) review and the PEIR as well as crafting the regulatory language itself), the only option to start offshore finfish aquaculture in California at this time (2015) is in federal waters, and it is being pursued under permits, without a lease being issued.

In federal waters, no legislation currently authorizes a specific federal agency to issue a marine finfish aquaculture lease. Absent a leasing mechanism, offshore aquaculture project applicants (for both shellfish and finfish projects) face a confusing regulatory permitting process. Most marine aquaculture activities are subject to section 10 of the Rivers and Harbors Act, which the US Army Corps of Engineers (Corps) implements; thus, an applicant needs to seek a Section 10 permit from the Corps. Additionally, if the project is a finfish aquaculture proposal, it is also subject to EPA's National Pollution Discharge Elimination System permit (NPDES). A NEPA determination is also necessary and again, it remains unclear who the lead federal agency would be under NEPA, and is determined on a case by case basis. Thus, there is no one lead federal agency clearly designated for permitting offshore marine aquaculture in federal waters. While NOAA has distinct expertise and policies supporting marine aquaculture development, they have no legislative authority to issue leases or permits at this time. Their expertise is engaged through the NEPA process and throughout the Section 10 and NPDES permit processes. What is clear is that multiple federal agencies have authorities and concerns that may affect permitting and therefore must be included and engaged with early in project development and siting to avoid various user conflicts; these agencies include the US Coast Guard, Bureau of Energy Management (BOEM), Bureau of Safety and Environmental Enforcement (BSEE), US Fish and Wildlife Service and possibly others.

On Monitoring Offshore Finfish Aquaculture Operations

Monitoring of offshore finfish aquaculture operations to ensure regulatory compliance is required as federal and state permit conditions. Monitoring allows for early detection of deleterious impacts, and be the trigger for implementing early adaptive management strategies. Monitoring efforts must be conducted comprehensively and rigorously to ensure project operations are in compliance with regulatory requirements, demonstrate project effects are as anticipated and demonstrate the environmental sustainability of the project. As the marine aquaculture industry grows, it is imperative that monitoring requirements be consistent and appropriate for the type of aquaculture being permitted – development of standardized offshore marine aquaculture activities would create greater efficiency in permitting and tracking of monitoring efforts, such as establishing a regional or even state-wide monitoring program, with broad participation from multiple research organizations, academia, industry and regulatory/resource agencies.

Monitoring plans should be developed to ensure good ocean stewardship and lead to a better understanding of the ecological role of fish farms in the ocean, without being overly burdensome to farm owners and operators. Initiating a cost effective environmental monitoring starts by developing a diagnostic monitoring program that is designed to address specific answerable questions identified by regulators, and informed by researchers/academia. Collecting data for the sake of collecting data should be avoided. To design a diagnostic monitoring program, operators and regulators should work with experienced scientists to design monitoring programs specific to each proposed aquaculture project or geographic region.

Finally, monitoring programs can be more efficient and effective by building off of a number of excellent oceanographic and environmental monitoring programs that have been in place in the Southern California Bight for decades. For instance, the monitoring requirements for most facilities will likely involve measuring benthic infauna near the facility. The Southern California Coastal Water Research Project Authority has been conducting regional monitoring of the infauna for decades and may have several nearby stations that could serve to define the reference condition. Similarly, it is likely that the monitoring requirements will involve assessment of local circulation patterns near the facility; the Southern California Coastal Ocean Observing System maintains a 24/7 surface current monitoring program that would be responsive to this need. Moreover, they have developed models of local circulation patterns which could potentially be used in lieu of, or in combination with, site-specific measurements.

On The Importance of a Project

Throughout the workshop there was interest and potential support for an actual project, properly sited, at an appropriate scale, and with an appropriate monitoring program to ensure compliance with performance standards codified in the permit. The theory of adaptive management suggests that the greatest environmental benefit can be achieved by operating a smaller scale project with strict monitoring requirements and flexibility to adapt to data collected. A project designed at a small scale to achieve this yet at large enough scale to also demonstrate it can be viable economically is ideal.

An initial project needs to employ adaptive management strategies as new data and information are gathered. It needs to be reversible, down-sized, and even potentially cease operations and be removed if it fails to meet conditions of the permit after a prescribed period of time adequate to soundly make such determinations. If a project meets or exceeds permitting and monitoring requirements, the ability to expand the project, if desired by the operator, should be possible through permit

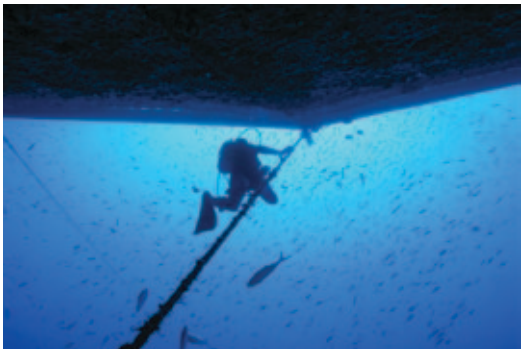
revisions or amendments. The project should be a priority for targeted research to address data gaps and other issues of concern. The proposed Rose Canyon Fisheries project is the only offshore finfish project that has been formally proposed to date. It could become an important opportunity to validate the technological and environmentally sensitive project design, thereby guiding and informing developing the future of offshore finfish aquaculture in the SCB.

On Scale: From Demonstration to Mature Farm

There is often a desire to start small and scale up, especially with marine aquaculture but the uniqueness of the offshore environment may make scaling up a demonstration farm challenging. The types of cages and service vessels needed for an offshore operation will need to be technically advanced to ensure efficiency and the ability to maintain their structural and operational integrity through rough seas. A cadre of skilled workers will be required to operate the vessels, gear, and equipment. The costs of monitoring offshore locations due to depths, distances, ocean wave conditions, and a variety of other factors may also add to the financial challenges of scaling up in the offshore environment.

Aside from proving the sustainability of the production methods, one of the main purposes of conducting an initial project is to make a compelling case to investors for further growth potential of the business. To be a compelling case for further investment, a project must be of sufficient scale to demonstrate:

1. Environmental impacts are measurable, predictable and manageable. If a project is too small, the first argument will be that the impacts were not detectable because of the scale of the project. For opponents of aquaculture projects, the lack of measurable impacts will help them make the case that the project requires further study – a "no impact" finding will not be credible. The number of fish and amount of feed in the initial stage should be large enough to demonstrate impacts that are localized and limited, but measurable. The initial project scale should not create more doubt and uncertainty that leads to a request for further study. Modeling is a useful tool to inform siting and forecast interactions between aquaculture farms and the environment. Sophisticated 3-D and 4-D models (e.g. AquaModel) can be used by coastal managers to address environmental concerns. Monitoring data collected at an aquaculture site over time is useful to assess the accuracy of models and to adjust them if needed, to improve accuracy and precision of environmental forecasts.



Diver inspecting sea cage. Image courtesy of NOAA Fisheries

2. Seaworthiness of structures and vessels. The initial scale must demonstrate that cage structures and vessels used are consistent with what is proposed at scaled-up levels when the farm is mature. Farmers must demonstrate an ability to keep the livestock safe and healthy, conduct routine activities including feeding, harvesting, removal of dead fish, etc. If the long-term proposal calls for stocking 50,000 fish in a 45m diameter cage fed on a daily basis and harvested after 2 years, it does little to justify further investment if in the initial stage, a substantially different cage structure is used and fish are fed only sporadically because of an inability to regularly access the farm.

3. Market production – the amount of fish produced in the farm's initial stages must be significant enough to demonstrate commercial acceptance and give some indication of economic return. Many projects attempt to extrapolate pricing based on extremely small production volumes sold to niche markets. While not an exact representation of commercial scale, a compelling commercial scale trial is likely closer to 1,000 mt of production than it is to 100 mt, unless, the project calls for production of a species where market pricing and volumes are well known.

   The other key piece that needs to flow from a demonstration project is a relatively clear path to the development of a business that is robust and has a sufficiently diversified risk base. In the case of salmon farms, the objective is generally to build to 25,000 mt of annual production spread across about 10 production sites. This gives enough scale to distribute risk at one or more production facilities without jeopardizing the ability to continue operating. If there is no clear path for growing the business to the appropriate scale, it will make it hard to justify the investment and the risk.

The Ad-Hoc Inter-Agency Working Group

There was consensus among workshop participants that the ad hoc inter-agency working group for the Rose Canyon Fishery Project (RCF), convened by the NOAA Fisheries Aquaculture Coordinator in California, should be expanded to function as an Offshore Aquaculture Interagency Working Group. The RCF will continue its function focused specifically on Rose Canyon Fishery project, but will also be part of the broader Offshore Interagency Working Group. This larger forum will be modeled after the successful working group chaired by Alan Everson, NOAA Fisheries Aquaculture Coordinator for the Pacific Islands Region in Hawaii. The Hawaii Offshore Aquaculture Interagency Working Group includes about 40 participants representing state and federal government agencies, academia, and industry representatives.

The workshop participants identified the following recommendations, based in part on Everson's lessons learned, for an Offshore Aquaculture Working Group/Forum were:

- The group needs to include representatives with decision-making authority from all the relevant federal, state and local agencies.
- The group needs to meet often enough and long enough to establish trust among the individuals in the group and in the process.
- Subtle peer pressure among agencies often helped facilitate resolution on issues that got in the way of making decisions.
- The group facilitates cooperative, collaborative decision-making.
- The group facilitates the sharing of existing data, information and knowledge and the identification of information gaps.
- The group helps identify and secure funds for needed research.
- Appoint a Science Advisory Panel

Although Everson did not mention it, others commented that his strong leadership played a major role in the success of the group.

In the absence of any officially designated "lead federal agency" in federal offshore waters in California, the ad hoc Offshore Aquaculture Working Group/Forum take on added importance in the permitting process for offshore aquaculture in California. Many workshop participants felt that effectiveness would be enhanced if it had official standing. How this "official standing" could be most effectively achieved remains an open question and will be addressed by the group/forum at its kick-off meeting. Official designation should include a charter along with

Image courtesy of aquaculturematters.ca.gov

recommendations on initial membership. Clearly all relevant agencies at the federal and state levels that have a role in the permitting process need to be represented. The Offshore Aquaculture Working Group should have the ability to appoint sub-committees to address specific issues such as science, monitoring and modeling. This would increase the efficiency and effectiveness of the Working Group/Forum overall without becoming unmanageably large.

The Offshore Aquaculture Working Group could become the interface between aquaculture initiatives in federal and state waters. It can help link the community to and utilize emerging information-sharing and decision-making tools. It can develop and articulate a road map or framework for the permitting process to make it more transparent and predictable. Transparency of this group is important.

The workshop participants also noted that the nine research areas designated by the National Strategic Plan for Federal Aquaculture Research need to be advanced and thought that the Offshore Aquaculture Working Group should take a lead role. The following recommendations for roles of the group included:

- Provide regional input to the research plan,
- Provide a link between research priorities and available funding needs and
- Incorporate data and modeling into the plan.

Identifying Research Needs and Data Sharing Platforms

Research Needs and Priorities

Participants recognized the need to identify and advance research priorities on the national and state levels. Among the recommendations proposed was to advance the nine research areas designated by the National Strategic Plan for Federal Aquaculture Research. It was also recommended that the Interagency Working Group work to advance these priorities and incorporate region-specific needs.

The academic representatives were vocal about the need to link research priorities with available funding sources. They suggested that research priorities be put into the "request for proposal" (RFP) database and liked with local Sea Grant programs.

Data and Information Sharing

A centralized information and data source, intended to heighten awareness of aquaculture in California is among the objectives of a new website called "Aquaculture Matters". Established by the State Aquaculture Coordinator on behalf of the State and federal agencies with aquaculture oversight in California, the site will spotlight contributions from various viewpoints, and be a source for educational materials, legal and policy discussions, and news affecting the activity. It can be found at: aquaculturematters.ca.gov

Contributions of data, information, and references relevant to aquaculture in California are encouraged. For suggestions or inquiries, email: aquaculturematters@wildlife.ca.gov.

THE NINE RESEARCH AREAS DESIGNATED BY THE NATIONAL STRATEGIC PLAN FOR FEDERAL AQUACULTURE RESEARCH

Strategic Goal 1
Advance Understanding of the Interactions of Aquaculture and the Environment

Strategic Goal 2
Employ Genetics to Increase Productivity and Protect Natural Populations

Strategic Goal 3
Counter Disease in Aquatic Organisms and Improving Biosecurity

Strategic Goal 4
Improve Production Efficiency and Well-Being

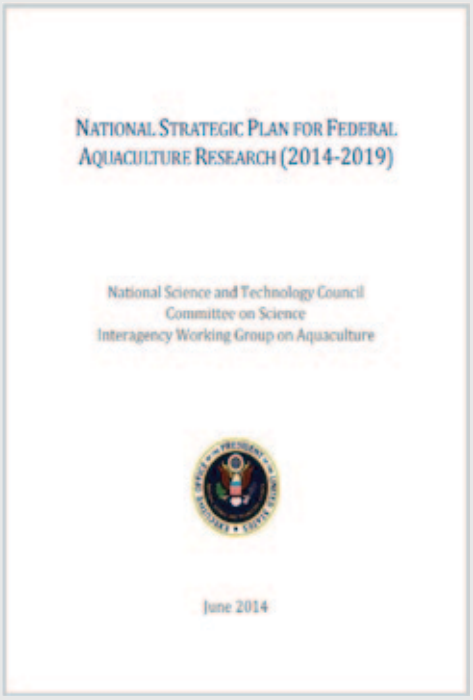
Strategic Goal 5
Improve Nutrition and Develop Novel Feeds

Strategic Goal 6
Increase the Supply of Nutritious, Safe, High-Quality Domestic Seafood

Strategic Goal 7
Improve Performance of Production Systems

Strategic Goal 8
Create a Skilled Workforce and Enhance Technology Transfer

Strategic Goal 9
Develop and Use Socioeconomic and Business Research to Advance Domestic Aquaculture



Summary of Recommendations

1. Advance the nine research areas designated by the National Strategic Plan for Federal Aquaculture Research.

2. Expand the function and membership of the Rose Canyon Fisheries Inter-Agency Working Group to form the Offshore Aquaculture Working Group/Forum for the SCB. The Working Group/Forum should:
   - Obtain "official standing." How to do this remains a question, but official designation should include a charter along with recommendations on initial membership. All relevant agencies at the federal and state levels that have a role in the permitting process need to be represented. The Offshore Aquaculture Working Group/Forum should have the ability to appoint sub-committees to deal with specific issues such as science, monitoring, modeling, etc; and also appoint a Science Advisory Panel
   - Take a lead role in the advancement of the nine research areas designated by the National Strategic Plan for Federal Aquaculture Research. The following recommendations for roles of the group included:
     - Provide regional input to the research plan,
     - Provide a link between research priorities and available funding needs and
     - Incorporate data and modeling into the plan.

3. Link grant research priorities to available funding sources.
   - Research should be put into the "request for proposal" (RFP) database and liked with local Sea Grant programs.

4. Continue dialogue on how to address public perception.

Another recommendation from the project's steering committee is to elicit feedback from the regulators to inform the aquaculture modeling efforts. This feedback will be an important step to increase regulatory stakeholder confidence in the utilization of tools like the AquaModel to anticipate and minimize impacts.

References

Alexandsratos, N. and J. Bruinsma, 2012. World Agriculture Towards 2030/2050: The 2012 Revision. Rome, FAO.

Food and Agricultural Organization of the United Nations. 2011. FAO Food Outlook: Global Market Analysis. FAO Trade and Markets Division Report. Rome, FAO. 1856 pp.

Kapetsky, J.M., Aguilar-Manjarrez, J. & Jenness, J. 2013. A global assessment of potential for offshore mariculture development from a spatial perspective. FAO Fisheries and Aquaculture Technical Paper No. 549. Rome, FAO. 181 pp.

Nash, C.E. 2004. Achieving policy objectives to increase the value of the seafood industry in the United States: the technical feasibility and associated constraints. *Food Policy 29* (2004):621-641.

Olin, P. 2015. Offshore aquaculture in the Southern California Bight: rationale, current status, challenges and opportunities. Presentation at: Offshore Aquaculture in the Southern California Bight. Sea Grant Workshop at the Aquarium of the Pacific; Long Beach, California, April 28-29, 2015 (pptx).

Price, C.S. and J.A. Morris Jr. 2013. Marine cage culture and the environment: twenty-first century science informing a sustainable industry. NOAA Technical Memorandum NOS NCCOS 164. 158 pp.

Rensel, J.E. and J.R.M. Forster. 2007. Beneficial environmental effects of marine finfish mariculture. Prepared for U.S. National Marine Fisheries Service. Office of Oceanic and Atmospheric Research. NOAA Award #NA040AR4170130 Final report.

Rensel, J. 2015. Offshore net pens: benthic effects & prevention of coastal eutrophication. Presentation at: Offshore Aquaculture in the Southern California Bight. Sea Grant Workshop at the Aquarium of the Pacific; Long Beach, California, April 28-29, 2015.

Riley, K. and J.A. Morris Jr. 2015. Offshore aquaculture in California: science tools to support coastal planning and decision making. Presentation at: Offshore Aquaculture in the Southern California Bight. Sea Grant Workshop at the Aquarium of the Pacific; Long Beach, California, April 28-29, 2015 (pptx).

Rubino, M. (editor). 2008. Offshore Aquaculture in the United States: Economic Considerations, Implications & Opportunities. U.S. Department of Commerce; Silver Spring, MD; USA. NOAA Technical

Torrissen, O., R.E. Olsen, R. Toresen, G.I. Hemre, A. Tacon, F. Asche, R. Hardy, and S. Lall. 2011. Atlantic salmon (*Salmo salar*): The "super chicken" of the sea? *Reviews in Fisheries Science* 19(3):257-278.

Troell, M., M. Metian, M. Beveridge, M. Verdegem, and L. Deutsch. 2014. Comment on 'Water footprint of marine protein consumption—aquaculture's link to agriculture'. *Environmental Research Letters* 9(2014):109001. 4pp.

Welch, A., R. Hoenig, J. Stieglitz, D. Benetti, A. Tacon, N. Sims, and B. O'Hanlon. 2010. From fishing to the sustainable farming of carnivorous marine finfish. *Reviews in Fisheries Science* 18(3):235-247.

Appendix 1

Participants and Observers

NAME	AFFILIATION
Kevin Amos	NOAA Fisheries Office of Aquaculture
John Bannon	U.S. Coast Guard
Dave Caron	University Southern California, Dornsife
Alan Cook	Icicle Seafoods
Thomas Dempsey	The Nature Conservancy
Mark Drawbridge	Hubbs-Sea World Research Institute
Alan Everson	NOAA Fisheries Pacific Islands Region - Aquaculture
Steve Gaines	University of California, Santa Barbara, Bren School of Environmental Science and Management
Michael Jones	The Maritime Alliance
Don Kent	Hubbs-Sea World Research Institute
Dale Kiefer	University Southern California, Dornsife
Logan Kock	Santa Monica Seafood
Letise LaFeir	Monterey Bay Aquarium
Randy Lovell	California Department of Fish and Wildlife
Sonke Mastrup	California Fish and Game Commission
Jaron Ming	Bureau of Safety and Environmental Enforcement
Chris Mobley	NOAA National Marine Sanctuaries/Channel Islands National Marine Sanctuary
*James Morris	NOAA National Ocean Service, National Centers for Coastal Ocean Science
*Paul Olin	California Sea Grant/University of California, San Diego, Scripps Institution of Oceanography
Corey Peet	Monterey Bay Aquarium/Seafood Watch
Carol Price	NOAA National Ocean Service, National Centers for Coastal Ocean Science
Amy Rens	U.S. Coast Guard
Jack Rensel	Systems Science Applications, Inc.
*Ken Riley	NOAA National Ocean Service, National Centers for Coastal Ocean Science
Bonnie Rogers	U.S. Army Corps of Engineers – LA District
Mike Rust	NOAA Fisheries Office of Aquaculture
Penny Ruvelas	NOAA Fisheries West Coast Region, Protected Resources Division
*Jerry Schubel	Aquarium of the Pacific
Dan Swenson	U.S. Army Corps of Engineers – LA District
Paula Sylvia	NOAA Southwest Fisheries Science Center
Kim Thompson	Aquarium of the Pacific/Seafood for the Future

Mike Vanhouten	U.S. Coast Guard
Russ Vetter	NOAA Southwest Fisheries Science Center
Steve Weisberg	Southern California Coastal Water Research Project (SCCWRP)
Cisco Werner	NOAA Southwest Fisheries Science Center
*Diane Windham	NOAA Fisheries West Coast Region, California - Aquaculture
Walt Wilson	U.S. Navy

OBSERVERS

Bryant Chesney	NOAA Fisheries West Coast Region, Protected Resources Division
Rebecca Gentry	University of California, Santa Barbara, Bren School of Environmental Science and Management
Krista Kamer	California State University, Council on Ocean Affairs, Science and Technology (COAST)
Shauna Oh	University of California, Davis
Melanie Tymes	U.S. Army Corps of Engineers – Carlsbad Office

RAPPORTEURS

Annalisa Batanides	NOAA Fisheries West Coast Region, CA -Sea Grant Fellow - Aquaculture
Rachel Fuhrman	Aquarium of the Pacific
Jonathan MacKay	California Department of Fish and Wildlife-Sea Grant Fellow

FACILITATOR

Rich Wilson	Seatone Consulting

*Workshop Steering Committee

Appendix 2

Rose Canyon Fisheries Project Description

Executive Summary

Rose Canyon Fisheries, Inc. (RCF) is a partnership between Hubbs-SeaWorld Research Institute (HSWRI), a 501(c)(3) research organization, and Cuna del Mar (CdM), a private equity fund dedicated to developing sustainable aquaculture. RCF will permit, establish and operate a commercial-scale fish farm off the San Diego, CA coast. This will be the first operation of its kind in federal waters of the United States. By combining the scientific and environmental expertise of HSWRI with the mission focus and direct open ocean aquaculture experience of Cuna del Mar, RCF will help pioneer environmentally and economically sustainable methods for providing healthy seafood to meet our Nation's growing demand for healthy seafood.

CdM and HSWRI through RCF share a vision to feed future generations in harmony with the ocean. The RCF collaboration is dedicated to fulfilling a major void in our Nation's seafood industry – a reliable, sustainable source of healthy, premium fish, grown with care in a clean, natural and regulated environment. RCF is committed to improving the standards of the aquaculture industry through safe and sustainable innovation. As RCF continues to innovate and improve culture protocols, it hopes to provide locally produced seafood thereby greatly reducing the energy requirements of transporting fish to the US market, while creating and demonstrating a sustainable and domestic solution.

Over the past five decades, HSWRI has provided global leadership in marine conservation research, including studies in marine aquaculture. HSWRI operates two marine fish hatcheries in southern California and several cage sites in California. HSWRI has expertise in fish nutrition, reproduction, health, genetics, and physiology, as well as site selection and permitting, systems engineering, and environmental monitoring.

Since 2010 CdM has been advancing the development of sustainable marine fish farming by providing investment capital to expand established and start-up farms in Latin America as well as to further develop open ocean marine farming equipment. CdM has financial and management interests in shellfish farms on the Pacific Coast of Baja California as well as in fish farms in La Paz, Mexico and along the Gulf Coast of Panama. CdM has like interests in two US based companies that design, fabricate and install open ocean marine fish cages.

Together, HSWRI and CdM have formed RCF that incorporates the combined expertise of both organizations to demonstrate how a commercial scale fish farm can provide new job opportunities for commercial fishermen and support existing seafood processing and distribution jobs while respecting the environment of southern California. The proposed farm will also provide an invaluable benefit to resource agencies charged with balancing commercial uses of the ocean with the need to conserve the invaluable marine ecosystem for the benefit of future generations of both animal and human populations.

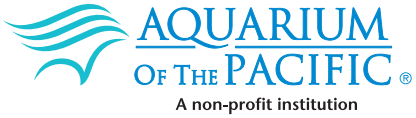
This project is being driven by the growing global demand for healthful seafood and a lack of domestic production. Traditional harvest fisheries are fully exploited and cannot meet this increasing demand. The expanding market is fueled by an increasing world population and the growing per capita consumption of seafood. In the US, more than 91% of seafood is imported and half of that supply comes from aquaculture. This represents a $10.4 billion contribution to the US trade deficit.

The proposed project will annually produce 5,000 metric tons (MT) of yellowtail jack and other local species in sea cages that will be located 4.5 miles (7.2 kilometers) from the San Diego shoreline. Yellowtail jack has been chosen as the initial species as cultured juveniles are readily available from HSWRI hatcheries. The site will also be permitted for other local species which will be interchangeable with yellowtail jack when the project has become operational and depending on availability of juveniles and permit conditions. Production will be phased, beginning at 1,000 to 1,500 MT in the first production cycle in order to achieve operational efficiency and ensure environmental compatibility. Based on these data, the project will gradually expand to 5,000 MT annual production, which is expected by year eight. Initially, recently developed submersible cages will be deployed, but the farm will have the capacity to test new containment systems as they are developed over time.

If successful, this project will serve as a model for the development of offshore aquaculture in California and the United States. It will create jobs, including new opportunities for commercial fishermen, and it will ensure that the existing jobs and infrastructure for fish processing and distribution have a viable future. The consumer will benefit from a year-round supply of high quality seafood that is safe and healthful. The environment will benefit as high quality seafood is produced significantly more efficiently than land-based practices can achieve. In addition, the supplemental supply of high quality farmed fish will complement the supply available from wild fisheries.

An electronic version of this report and supplementary materials are available at: aquariumofpacific.org/mcri/info/offshore_aquaculture_in_the_southern_california_bight


Sea Grant


AQUARIUM
OF THE PACIFIC
A non-profit institution