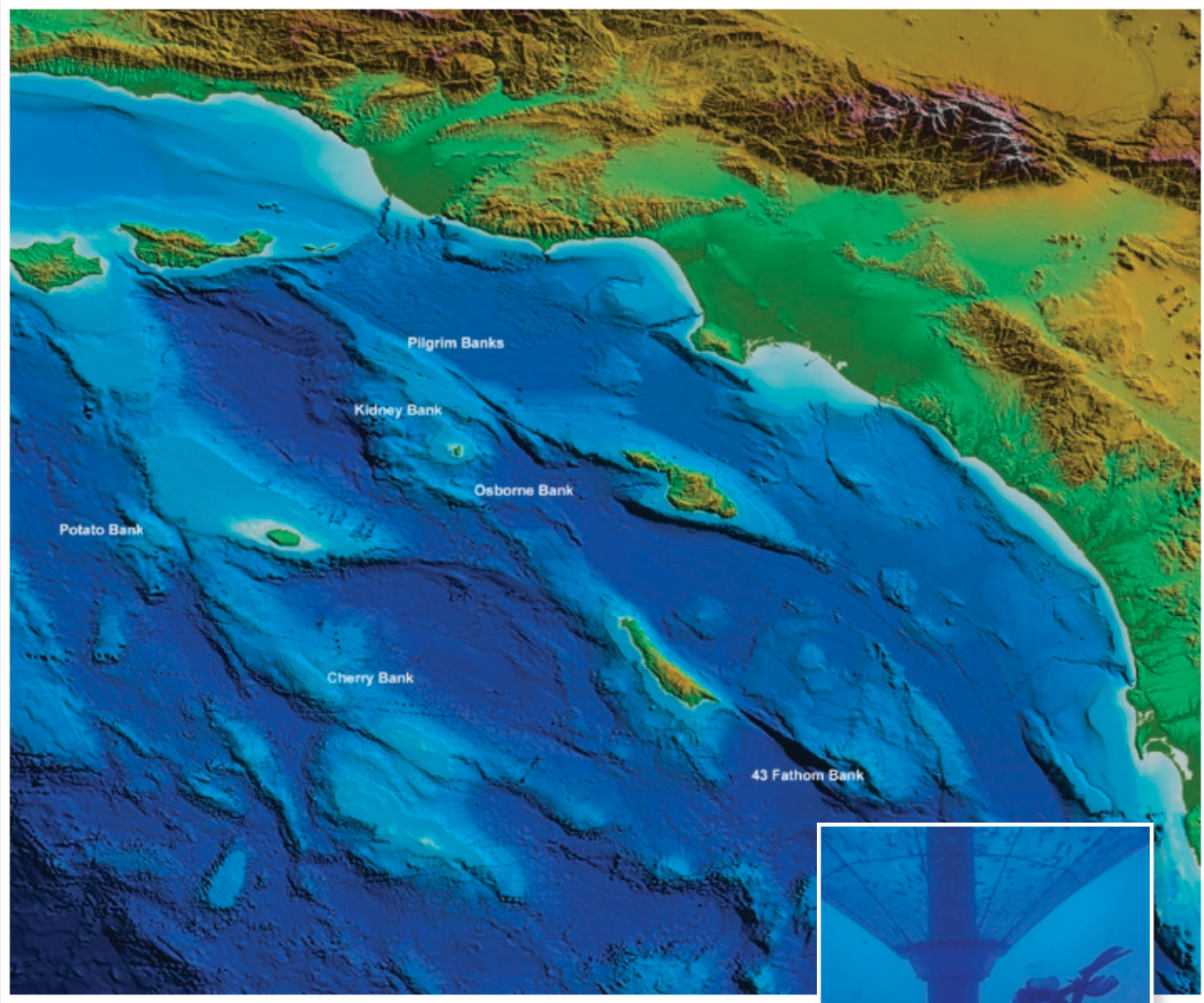

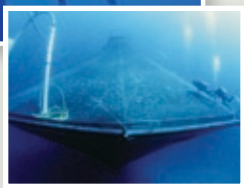

IS OFFSHORE FINFISH AQUACULTURE in the Southern California Bight an Idea Whose Time Has Come?

The results of a forum organized and facilitated by the Aquarium of the Pacific's Marine Conservation Research Institute.

DECEMBER 2008
MCRI Aquatic Forum Report
Reference Number 2008-4

Image of Southern California Bight sea floor: Permission of Dr. Chris Goldfinger and Jason Chaytor of Oregon State University's College of Oceanic and Atmospheric Sciences:

Image of underwater open ocean aquaculture cage spar and diver: Permission of Kona Blue Fish farms

Divers cleaning submersed cage: Courtesy of National Oceanic and Atmospheric Administration (NOAA):

IS OFFSHORE FINFISH AQUACULTURE In the Southern California Bight An Idea Whose Time Has Come?

The Results of a Forum
Organized and Facilitated
by the
Aquarium of the Pacific's Marine Conservation Research Institute

September 20-21, 2008

J. R. Schubel
Corinne Monroe

December 2008
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CONTENTS

Acknowledgements

Our thanks to:

The forum sponsors

The forum participants
who came together from academia, industry, organizations, and governmental agencies to share information, knowledge, strategies, concerns, technology, and experiences to help answer the question: "Is Offshore Finfish Aquaculture in the Southern California Bight An Idea Whose Time Has Come?"

The Chancellor's office of the California State University System
for making the administrative facility of the CSUS available to us

The Aquarium of the Pacific Staff
who provided audiovisual services, arranged the logistics, designed the report cover, and diligently took notes.

INTRODUCTION

THE FACTS:

- More than 80% of the seafood consumed in California is imported, mostly from Asia, contributing to food miles and the carbon footprint.
- The per capita demand for seafood in the greater Los Angeles area is twice the national average and growing.
- The Southern California Bight may be among the best and most suitable coastal areas in the entire U.S. for offshore aquaculture. It has favorable oceanographic conditions—infrequent major storms, relatively deep water with good exchange close to shore, and an array of high value, native species to choose from.
- The Southern California Bight has excellent coastal fisheries infrastructure and is close to major seafood markets.

THE QUESTION:

Is there an opportunity for development of offshore finfish aquaculture in the Southern California Bight?

Courtesy of NOAA

THE HYPOTHESIS:

Southern California could support an offshore finfish aquaculture industry that could become a $1 billion/year industry with only a very small percentage of State waters or the EEZ in the Southern California Bight dedicated to this purpose. A properly constructed and managed industry would provide a safe, secure, stable supply of healthful seafood to the region, would help relieve pressure on wild fish stocks, and would help conserve the remaining working waterfront—all without unacceptable adverse impacts on the environment and other uses of the ocean.

SEARCHING FOR THE ANSWER:

Stakeholders, policy makers, regulators, scientists, and a wide range of experts in aquaculture and fisheries—proponents, opponents, and the undecided—met on September 19-20, 2008 to test the hypothesis. This report is a result of their deliberations.

NOTE TO READERS

Participants in this forum were selected because of their scientific expertise and experience in ocean aquaculture. Included were individuals responsible for aquaculture at the state level in California (Devin Bartley) and at the federal level (Michael Rubino). Also selected were individuals from the

environmental NGO community whose organizations have been deeply involved in aquaculture, particularly in the search for sustainable approaches to fish farming.

It is the nature of science that hypotheses can never be proven; only disproven. Our strategy was first to make the strongest case we could in support of the hypothesis and then to attack it. Attacking it had two objectives: first to determine if the hypothesis was untenable as stated and second to identify those areas that compromise sustainability and make the hypothesis vulnerable. These should become topics for further research and development.

The premise of the forum reflects the philosophy of the Aquarium of the Pacific that if we are to meet the growing demand for seafood while protecting wild stocks, then aquaculture—including open ocean aquaculture—must play a significant role and it must be done sustainably. Aquaculture practices, past and present, have not always been sustainable, but we have the knowledge and the technology to do it sustainably. California has the ocean conditions, the infrastructure, the experience and expertise, and the ocean ethic to set high environmental standards that could serve as a model for sustainable offshore aquaculture for the rest of the nation and the world. We also have the demand.

Public forums and meetings will be required. It is clear that if open ocean aquaculture is to have a future in California, we will have to build an aquaculture constituency. This will require a major public outreach and education program.

Jerry R. Schubel
President and CEO
Aquarium of the Pacific
Long Beach, CA
December 2008

DAY 1: SEPTEMBER 19, 2008

OVERVIEW OF THE FORUM: CONTEXT AND PERSPECTIVE, FRAMES OF REFERENCE, OUTPUTS AND OUTCOMES Jerry R. Schubel

The desired outputs of the forum are to:

1) Create a report that will provide California's policy-makers with accurate, up-to-date, and unbiased information that will help them make informed decisions about the advisability, achievability, and value of nurturing development of a ***sustainable*** offshore finfish aquaculture industry in California with the emphasis on the Southern California Bight.
2) Foster a renewed spirit of optimism and entrepreneurial spirit among attendees that California could become a leader in ***sustainable*** offshore finfish aquaculture.

The desired outcomes to which this forum will make a small contribution are:

1) California becomes one of the world's leaders in ***sustainable offshore aquaculture***—both within state waters and in contiguous federal waters.
2) California's offshore ***sustainable aquaculture industry*** produces an array of seafood products with a distinctive California-grown brand that provides an appropriate complement to the State's agricultural products.

If aquaculture is **not sustainable**, it does not belong in California.

Forum participants will test this hypothesis.

> *Southern California could support an offshore finfish aquaculture industry that could become a $1 billion/year industry with only a very small percentage of State waters or the EEZ in the Southern California Bight dedicated to this purpose. A properly constructed and managed industry would provide a safe, secure, stable supply of healthful seafood to the region, would help relieve pressure on wild fish stocks, and would help conserve the remaining working waterfront—all without unacceptable adverse impacts on the environment and other uses of the ocean.*

You can never prove a scientific hypothesis, only disprove it, so our approach will be to build the strongest case in support of the hypothesis, and then attack it vigorously.

These are the rules for the day. Respect for the opinions of others. Respect for time. Keep 'ideas in play' and enhance them.

Discussion

Z. Grader: Expressed concern that the forum was one sided and not objective with all the participants in favor of aquaculture. Assured by Schubel that the forum attendance included supporters of conserving and enhancing the environment and supporters of sustainable, environmentally-friendly aquaculture, and that the forum would be objective.

FRAMING THE OPPORTUNITIES AND THE CHALLENGES: FOUR PERSPECTIVES

THE RESTAURATEUR'S PERSPECTIVE ON MARINE AQUACULTURE

SAM KING
President and CEO
King's Seafood Company

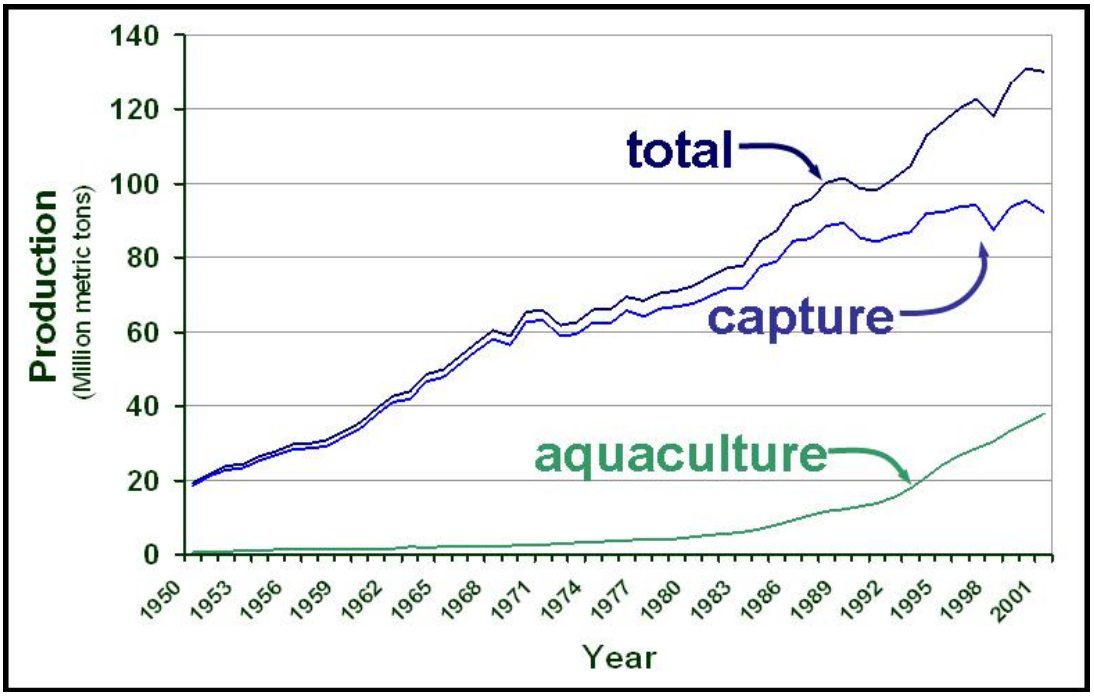
King's Seafood Company is in the top seven seafood restaurant groups nationally. Our goal is to be in the top three by 2012. There are now 12 King's Fish Houses in California, Nevada, and Arizona and we are growing. We intend to expand our operations to include seafood distribution so as to become a vertically-integrated seafood provider. We are in the business of providing the highest-quality seafood to our guests.

- We serve 2.5 million guests per year.
- We buy 2 million pounds of seafood per year worth $10 million, 45% of which is farm-raised seafood.
- Less than 1% of our purchases come from California, primarily mussels and oysters.

Today people order seafood in restaurants because of health: (64%), taste (60%), and variety (52%). Given the increased demand for seafood and the growth of our company, we project that we will need 5 million pounds every year over the next decade, worth an average of $27 million per year.

Our Concern: Where will the seafood come from?
Obviously wild fish stocks will not meet the demand. These stocks are "maxed out" while demand for seafood is markedly increasing. Aquaculture can make up the difference.

Capture and Farmed Production



United Nations FAO Fisheries, Data I Statistics Unit

According to NOAA's National Marine Fisheries Service, U.S. seafood consumption in 2000 was 15.2 pounds per person per year. By 2004 consumption had reached 16.6 pounds per person. Then in 2005, because of the many health benefits of seafood, the U.S. government released dietary guidelines advising people to double their consumption of seafood. If that advice is followed, consumption of seafood will reach 33.2 pounds per person by 2020.

Our Concern: What will the seafood cost?

The decline of wild seafood has had an impact on our company. While consumption and cost have increased dramatically, supply has decreased and become inconsistent.

Seafood	2004 price/lb	2008 price/lb
Alaskan halibut	**$9.50**	**$14.50**
Tuna	**$8.00**	**$11.00**
Salmon, farmed	**$3.50**	**$ 5.25**
Salmon, wild	**$8.50**	**$11.50**
Tilapia	**$4.50**	**$ 5.50**
Trout	**$5.00**	**$ 5.50**

In Summary:

- King's Seafood Company is committed to using our significant buying power to promote advances in aquaculture.
- We are intent on discovering and delivering the best products from the most capable, sustainable operations.
- We recognize these products will not all come from U.S. enterprises. We all respect the global nature of the seafood industry; however, we are eager to promote the 'California Grown' concept.

IS THERE AN OPPORTUNITY FOR DEVELOPMENT OF OFFSHORE FINFISH AQUACULTURE IN THE SOUTHERN CALIFORNIA BIGHT?

The United States, including California, has the opportunity to become the leader in developing sustainable aquaculture here and exporting our knowledge abroad—just as we have been leaders in virtually all forms of agriculture: grains, vegetables, fruits, and wine. The opportunity is here now.

THE FEDERAL PERSPECTIVE ON MARINE AQUACULTURE

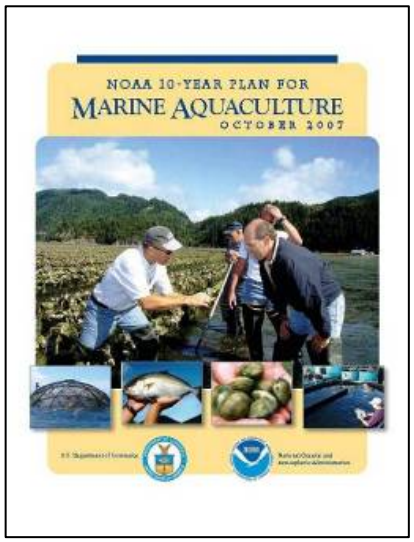
Michael Rubino
Manager, NOAA Aquaculture Program

With the earth's burgeoning human population to feed, we must turn to the sea with new understanding and new technology. We need to farm the ocean as we farm the land. Jacques Costeau-1973

In recent years there has been a series of national commission reports, studies, directives and meetings of experts and stakeholders to provide the federal perspective on aquaculture. Included in the drivers have been the U.S. Commission on Ocean Policy report, the U.S. Ocean Action Plan, and the *Summary of the National Marine Aquaculture Summit: April 2007.* It should be noted that the federal perspective on aquaculture is not just marine offshore—it encompasses aquaculture in general, both fresh water and marine, nearshore and offshore.

Federal agencies, not just the National Oceanic and Atmospheric Administration (NOAA), are charged with maintaining and managing the marine environment so as to have healthy wild stocks. The Magnuson-Stevens Act, recently re-enacted, authorizes NOAA to restore and rebuild marine fish stocks. NOAA is committed to doing so while protecting the marine environment. But federal regulations also charge us with developing both fresh water and marine aquaculture, and doing all this within an ecosystem-based management context.

Why do I need to talk about this? I think the rationale, the market drivers, have been the advice of physicians to eat more nutritious seafood; the growing supply and demand gap; the need for maintaining the local waterfront; and local food supply.



Responding to the charge to develop fresh and marine aquaculture, NOAA Fisheries Service did a nation-wide survey in which the question was asked: What kind of aquaculture program would you like to have that would fit your needs? Publication of the *NOAA 10 Year Plan for Marine Aquaculture*[1] *in* October 2007 was a result of this effort.

The U. S. Fish and Wildlife Service (USFWS) and the United States Department of Agriculture (USDA) are both developing five-year plans. USDA is the coordinating unit for agency-wide aquaculture activities, providing leadership for the federal Joint Subcommittee on Aquaculture, and coordinating the operations and activities of the five USDA Regional Aquaculture Centers.

NOAA**,** USDA, and USFWS are designing an aquaculture research plan for the federal government to coordinate efforts of the major agencies.

What is marine aquaculture in the United States? If this was a business and I looked at my clients, most would be commercial shellfish farmers. Next would be salmon farming in Maine and Washington State. Another large part would be use of hatcheries for stocking and replenishing commercial species such as salmon up and down the west coast, oyster restorations, and rebuilding California's white seabass population. Oyster gardening by ordinary citizens is a facet of the program as well.

1. http://aquaculture.noaa.gov/pdf/finalnoaa10yr_rweb.pdf. Goals of the 10 Year Plan: a comprehensive regulatory program for environmentally sustainable marine aquaculture; development of commercial marine aquaculture and replenishment of wild stocks; public understanding of marine aquaculture; and increased collaboration and cooperation with international partners

Why is 84 percent of our seafood imported? Why don't we have more aquaculture in the United States? One reason is our crowded coastlines. Many people don't look on areas where there is coastal eutrophication as a good place to grow seafood. Then there are a lack of infrastructure for research on and development of marine aquaculture, difficulty in obtaining permits, and complicated and over-lapping regulations. The greatest impediment to development of commercial aquaculture in the U.S. is a cumbersome and unpredictable regulatory framework. Aquaculture is easier to do in countries with fewer regulations and an easier, more transparent, and predictable permitting process.

Many aquaculture technologies that we export were developed in the U.S. Yes, we participate in the revenues realized from the export of those technologies—feed, equipment, and supplies—but we import the seafood: an example, production of brood shrimp stock in a key facility in Hawaii, a project that is part of the USDA polyculture-shellfish program. These brood stocks are exported all over the world. By one estimate, 50 percent of the shrimp imported **into the U.S**. started with these brood stocks **grown in Hawaii**. Are we going to do the same thing with other species we are developing? There are aquaculture operations using our offshore technology in U.S. waters in Puerto Rico and Hawaii that are considering moving to Mexico and Panama where the permitting process is less rigorous and there are less demanding standards. There is a variety of aquaculture operations just 20-30 miles south of San Diego multi-trophic farming, grow-out of captured juvenile tuna, etc.

So the crowded coastline, lack of infrastructure, and the regulatory system are forcing us to think not only about how to maintain healthy wild stocks or how we do more fresh water farming, but also about what our future options are. One is to bring aquaculture on land which has its own set of challenges and opportunities. Land use makes sense for hatcheries and may offer opportunities such as someday improving grow-out of finfish and shellfish. A second option is to move operations to other countries as much of the world industry is doing.

The legal and regulatory context for offshore aquaculture in the U.S. is complex. We have state waters and federal waters. There are ways to do aquaculture in state waters; however, the regulatory framework in federal waters is unclear as a result of the multiple federal agencies involved and the multiple mandates. This lack of clarity impacts the aquaculture business. Ask any aquaculture businessman and the response will be that the most important issue in making a business decision is regulatory certainty. The businessman wants to know what the rules of the game are. He isn't going to play if they are uncertain. He will go elsewhere to play.

National Offshore Aquaculture Act

In an effort to clarify the regulatory dilemma, NOAA, as a federal agency, was asked to come up with a framework, a strawman, for how aquaculture could be developed in an efficient way that would allow businesses to operate in a predictable manner in federal waters while safeguarding marine resources**.** The result was the introduction of the National Offshore Aquaculture Act in Congress in 2007. It has gone through several iterations since being introduced based on recommendations of a wide group of stakeholders and Senate staff. The committee draft reflects all of the provisions in California's offshore aquaculture bill, the Sustainable Ocean Act[2] (SB201).

Under the provisions of HR2010[3], S1609[4], NOAA is the coordinator for all federal agencies and is granted the authority to issue offshore aquaculture permits. S1609 amendments include qualifications of permit holders; EIR requirements under NEPA[5]; species genotypes; research and development

2. http://www.leginfo.ca.gov/pub/05-06/bill/sen/sb_0201-50/sb_201_bill_20060526_chaptered.pdf
3. http://www.govtrack.us/congress/bill.xpd?bill=h110-2010.
4. http://www.govtrack.us/congress/bill.xpd?bill=s110-1609
5. NEPA, the National Environmental Policy Act, requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

programs; and restrictions in certain waters in Alaska. The bill contains a number of safeguards including strong and effective protection of marine resources and provides for state consistency and consultation—clearly not a "one size fits all" approach.

The act is not just a bill providing for regulation of offshore aquaculture in federal waters. It is a marine aquaculture bill containing provisions for research and development for all marine aquaculture. It addresses a range of issues such as alternative feeds, concerns about shellfish farms, and marine stock enhancement— a broad picture of marine aquaculture

The act is now on hold in Congress. *Will there be champions in the 111th Congress willing to move the bill forward?*

If the National Offshore Aquaculture Act passes, there will still be a variety of steps and a wide range of actions that will need to be taken as part of the typical federal process to develop the necessary regulations for implementing the provisions of the act. These steps include:

- NEPA analysis
- Regional mapping
- Draft permit requirements
- Federal Register process
- Interagency consultations
- State, Fishery Management Councils, stakeholders, and expert consultations

Other ways of doing aquaculture in federal waters have surfaced. The Gulf of Mexico Fishery Management Council has proposed an aquaculture amendment to existing fishing regulations of the United Fisheries Law that would allow permitting of aquaculture in federal waters[6]. The council did not want to wait for federal legislation.

Economics of Aquaculture

For the past three years federal agencies have been working with fisheries and aquaculture economists and businessmen and with stakeholders representing economics, environment, and competition— sometimes all of these at the same time. Answers to the following questions have resulted.

1. Can you make any money at aquaculture?
2. What is going on in the market?
3. What are the impacts and effects of aquaculture? One of the key economic concerns is competing with existing wild stocks and commercial fisheries that are healthy in some areas of the country and in others in trouble because of high fuel prices and restriction on number of days of fishing and even closures such as salmon fishing in California.
    - Economic viability—yes, it is a reasonable risk assumption to predict that you can make money even though sites are farther from shore.
    - Economic impact—likely will happen slowly. If you look at any aquaculture industry worldwide, the first 10 years are spent in experimentation (size of pens, different types of operations, etc). If they work, or some combination works, the second 10 years is one of expansion. If that happens, through the value chain of the economy from hatcheries to grow-out to food and grain manufacturing to working waterfronts, marketing, processors, and cold storage, then the ripple effect from the waterfront to the heartland is significant.
    - Competition and synergies of fishing—everything competes. That is not going to change with development of domestic aquaculture whether it is on land, coastal, or offshore. Picture the competition in the shrimp and salmon industries. We live in a global economy where we are competing with seafood from around the world and with chicken, beef, and pork.

6. www.**gulf**council.org/Beta/GMFMCWeb/**Aquaculture**/**Aquaculture**%20FAQs%200908.pdf

4. *C*an we have a locally-grown seafood supply, not just an imported one? I think the real question for fishermen, given that aquaculture is here to stay, is how can we collectively use aquaculture as a tool to benefit us, our coastal communities, and our heartland?

There are examples around the country where wild catch fishermen have transitioned into aquaculture farmers, applying their knowledge and skills to develop successful farming operations, Most of these transitions have been into farming of shellfish—bivalves—but there have been finfish operations as well, for example, in Maine. Looking at the coastal U. S, there are successful small business operations, some of them pilot scale and Maine, where mussels and oysters are farmed alongside lobster pots; Hawaii and the Kona Kampachi® farm; New Hampshire and Rhode Island where three generations of watermen fish for lobster one day and farm oysters the next; North Carolina where a fifth generation fisherman is now a very successful clam farmer. Then there is an operation in Alabama, a Sea Grant funded program, involving a consortium of seven high schools growing a variety of species and managing the operations. King crabs are overfished in Alaska and local fishermen and coastal communities have asked Sea Grant and NOAA Fisheries to help develop a king crab enhancement project. It may take time, but the communities are committed to getting the job done.

Science – Environment – Innovation

The federal government has been doing its part in these areas. On the science side, university scientists, USFWS, NOAA Fisheries Service, and representatives of commercial aquaculture fisheries sit down and work on salmon aquaculture from both the conservation biology side and the commercial aquaculture side.

Environmental concerns are real. We have seen the problems in aquaculture operations around the world. We need to continue to be innovative and vigilant and set the right rules for the game. Federal agencies are working with a wide range of stakeholders and scientists to ensure that marine resources and human health are protected. Some on-going or about to start initiatives include:

- **NOAA/USDA Aquaculture Feeds Initiative[7]:** The purpose of the initiative is to identify alternative dietary ingredients that will reduce the amount of fish meal and fish oil contained in aquaculture feeds while maintaining the important human health benefits of farmed seafood.
- **NOAA National Symposium on Shellfish and the Environment[8]:** Information generated by the symposium will be used to facilitate public policy and resource management decisions for shellfish culture in the United States.
- **National Aquatic Animal Health Plan (NAAHP):** This plan was developed by the National Aquatic Animal Health Task Force, consisting of representatives of NOAA, USFWS, and the USDA. It provides a framework for protection of the nation's cultured and wild aquatic resources, facilitates safe commerce of live products, and improves the availability of diagnostic laboratories for aquaculture.
- **Offshore water quality effects**
- **Genetics:** studying the genetics of current stocks and how to maintain them.
- **Regional siting studies for aquaculture in federal waters:** Using GIS mapping we have identified the physical characteristics of the Gulf of Maine and overlain human uses to create a tool for commercial and recreational fishermen and boaters to figure out where the best areas are for aquaculture . Similar exercises will start through small grants that are about to be awarded to look at Southern California and the Gulf of Mexico.

We are also funding research studies and pilot projects through a grant process. Aquaculture research and demonstration projects across a range of scientific disciplines in nearshore, open water, or terrestrial environments currently underway include the National Marine Aquaculture Initiative[9] and

7. http://aquaculture.noaa.gov/news/feeds.html#overview
8. http://aquaculture.noaa.gov/news/shellfishsymposium.html
9. http://aquaculture.noaa.gov/funding/grants.html

mussels and cod in New England; Pacific Northwest species such as Pacific salmon and marine groundfish; king crab in Alaska; cobia; black sea bass in North Carolina; Hawaiian species; shellfish; hatchery technology, and polyculture (multi-trophic).

Where would a California aquaculture industry do well?
California might look to Maine's finfish and shellfish farms for examples. It is true that the salmon projects there have had their ups and downs but now, after shifting from Norwegian to local Maine stocks, salmon production is back up to historical levels. Today there are 30 sites in northern Maine, with 20 in production at any one time as part of a fallowing rotation. Mussel farms are placed among the sites and there is algae production to disrupt disease vectors.

Another area to consider is the multi-trophic approach—growing salmon, algae, and shellfish together as Maine and other sites globally are doing. While there are still some issues, universities, stakeholders, and federal and state agencies are working together on this approach to resolve salmon issues. In addition the University of Maine has a facility that is researching aquaculture of cod, halibut, sea urchins, and other species that might be integrated into the waterfront.

IS THERE AN OPPORTUNITY FOR DEVELOPMENT OF OFFSHORE FINFISH AQUACULTURE IN THE SOUTHERN CALIFORNIA BIGHT?

Where does California want to go? I think the federal agencies are very willing to listen to you and work with you to support the kinds of local and regional solutions you are putting together in this conference and will put together in the next few years.

Success will only come with the federal, state, academic, and private sectors all working together. NOAA is willing to listen, learn, and help.

THE STATE PERSPECTIVE

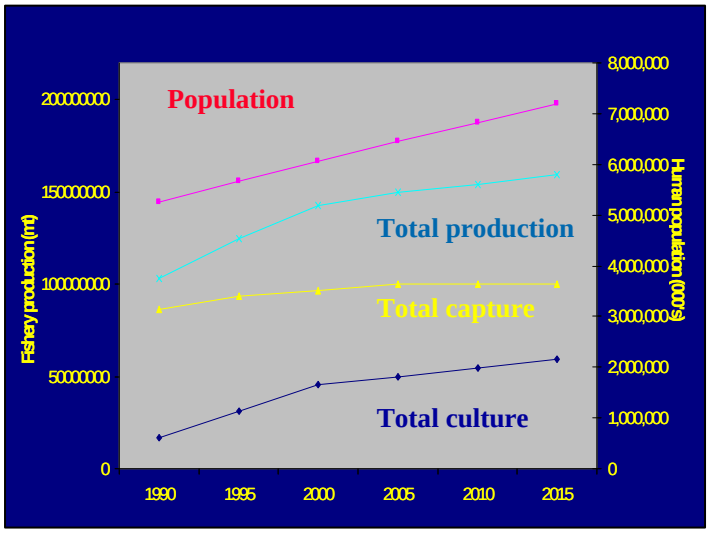
Devin Bartley
State Aquaculture Coordinator, California Fish and Game
Stephanie Showalter
Director of the National Sea Grant Law Center at the University of Mississippi.

To set the stage, today I'd like to talk about:

- The growth of marine aquaculture other than in California
- California's ocean economy
- The regulatory environment—the regulations we do have and the lack of a federal framework; and
- Briefly, a proposal about how we might move forward.

The United States

As the world's human population is increasing, populations of valuable marine species are being overfished or are decreasing. Total annual production has plateaued at 100 million metric tons per year (mt/yr). The plateau belies the fact that valuable marine fish species are being overfished and many stocks are being depleted beyond their natural reproductive capabilities. As a consequence, aquaculture has become the fastest growing food produce sector in agriculture, growing at nine percent per year.



In 2007 the consumption of seafood in the U.S. amounted to 5.8 billion pounds of which 4.8 billion pounds were imported. About 50 percent of that 4.8 billion pounds came from aquaculture farms in other countries. And the importation of seafood is increasing dramatically.

China is the largest exporter of seafood to the U.S. and there are concerns about the quality of these imports. Four hundred imported shipments from China were rejected recently. The EPA now lists seafood as the highest risk food factor.

The impact of the importation of seafood on our trade deficit is now nine billion dollars a year, making seafood one of the leading components of the trade deficit. The value of U. S. produced seafood is only about one billion dollars. The federal government has plans to increase that figure over the next decade.

California

California has 1,100 miles of coastline as the gull flies; 3,400 miles as the limpet crawls. While we have the largest ocean economy in the nation, California's aquaculture production may have a value of only $100 million. While we are not really sure of that figure, we do know that the state has not kept up with the global pace of aquaculture growth. There is no commercial marine finfish Mari culture and no new shellfish leases have been issued since the early 1900's. Aquaculture of salmonids, many non-native species, and genetically-altered species or species not native to California's waters is prohibited. This is because of competing priorities.

The economic value of our living resources sector—fishing, fish hatcheries, and fish farming—is far overshadowed in our ocean economy by the trade/transportation and tourism sectors, the dominant factors in our coastal environment.

Yet California does consider aquaculture as a valuable sector as shown in this Public Resources Code. **Public Resources Code Section 826**.

> The Legislature finds and declares 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, increase native fish stocks, enhance commercial and recreational fishing, and protect and better use the land and water resources of the state.

The code is a good declaration but I am not sure it is being put into practice.

Another resources code addresses the Marine Environment. **Public Resources Code Section 30230.**

> Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.

Some of the development of our coast doesn't quite seem to fit these ideals.

Then there is this section of the California Coastal Act of 1976[10]. **Section 30222.5.**

> Oceanfront lands; aquaculture facilities; priority oceanfront land that is suitable for coastal dependent aquaculture shall be protected for that use, and proposals for aquaculture facilities located on those sites shall be given priority, <u>except over other coastal dependent developments or uses. (Underline added for emphasis.)</u>

In my mind, this is a strange way to establish priorities.

Aquaculture in California

In California aquaculture is agriculture; however, it is regulated not by the Department of Agriculture, but by the Department of Fish and Game (DFG). It is not only regulated, it is highly regulated with a premium on environmental protection.

- Fish and Game Code—the legislative framework
- Title 14—the book of regulations
- California Coastal Act
- Marine Life Protection Act Initiative[11]—calls for a network of coastal marine protected areas to provide a variety of protection for marine environment ranging from areas of multiple uses to marine reserves, no-take zones, integrated with federal MPAs.
- California Sustainable Oceans Act (SB201)
- California Coastal Commission—does performance consistency review and has a very import role to play in California aquaculture.

The Sustainable Oceans Act (SB201)

The Sustainable Oceans Act is a very significant piece of legislation that is being looked at not only in California, but around the world. The act provides a framework of specific criteria to be addressed in the required coastal Programmatic Environmental Impact Report (PEIR) for managing marine finfish aquaculture in an environmentally sustainable manner that, at a minimum, considers all of these factors.

- Appropriate areas for siting marine finfish aquaculture operations to avoid adverse impacts, and minimize any unavoidable impacts on user groups, public trust values, and the marine environment
- Effects on
  - sensitive ocean and coastal habitats
  - marine ecosystems, commercial and recreational fishing, and other important ocean uses
  - other plant and animal species, especially threatened or endangered species, protected or recovering under state or federal law

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10. www.coastal.ca.govgov/coastact.pdf (as of January 1, 2008)
11. http://www.dfg.ca.gov/mlpa/pdfs/mpas_defined.pdf

- Effects of
  - use of chemical and biological products, pollutants, and nutrient wastes on human health and the marine environment
  - interactions with marine mammals and birds
  - escaped fish on wild fish stocks in the marine environment
- Cumulative effects of a number of similar finfish aquaculture projects on the ability of the marine environment to support ecologically significant flora and fauna
- Design of facilities and farming practices to avoid adverse environmental impacts, and to minimize any unavoidable impacts

The act also goes into great detail about the leasing of the seafloor in state waters for marine finfish farming. The California Fish and Game Commission and the State Lands Commission approve the leases as long as the sites are judged acceptable in the Programmatic Environmental Impact Report (PEIR) and follow best management practices (BMPs) such as annual monitoring and site inspections. The Fish and Game Commission may take remedial action if the farms are found in violation. Some other specifications include:

- Baseline surveys are to be done by the lessee with reporting to the appropriate regional water quality control board.
- Products are to be identified in an agreed way as coming from aquaculture so as to help with enforcement issues.
- Facilities are to be designed to prevent escapes and any escapes are to be immediately reported. Again, the commission may assess liabilities.
- Adherence to State Water Resources Control Board and regional boards' requirements are addressed including testing for effluents and reporting to the boards.

On the accounting side, the act specifies a filing fee of $500 and sets the terms for leasing. Leases are awarded to the highest bidder. Rent is a minimum of two dollars an acre if the site is more than 10 acres. If 10 acres or less, the rent is $10/acre. The length of a lease for marine finfish is a maximum of ten years with a five year renewal option. On termination of the lease, the lessee is required to restore the site and the commission is to make an assessment for any damages.

The PEIR, a key aspect of SB201 for evaluating the impacts of marine aquaculture under the current regulatory framework, is being prepared by a private consulting company with oversight by and funding from the Ocean Protection Council and with oversight also provided by the DFG. The PEIR should serve as an umbrella, a Tier 1, the first tier of the California Environmental Quality Act (CEQA) review for proposed aquaculture operations and a framework for managing marine finfish aquaculture. It is expected that with CEQA the lead agency for State leases, the Commission will rely heavily on the PEIR in considering individual lease sites and lease terms and conditions.

After I gave a similar talk in Oregon, the Daily Astorian, a newspaper, came out with this.

Friday, September 12, 2008

Farming heads out to sea
Experts gather in Newport to discuss offshore aquaculture

The fairly balanced article stated:

> *Gov. Ted Kulongoski and the Oregon Ocean Policy Advisory Council have taken a stand against offshore aquaculture development in Oregon, and California has employed a complex regulatory system to effectively block the industry from setting up off its shores.*

That was the impression that I guess my talk gave to the reporter and probably to many people in the audience. I think it speaks to the challenge that I and others in California have. None-the-less we are ready to go in California with species and technology.

Commercially valuable species that we have the technology to raise include: white seabass, California halibut, California yellowtail, California sheephead, rockfishes, capezon, and striped bass. All are native species with the exception of striped bass which is a naturalized species in California.

A Proposal to Move Forward
As the previous speaker, Mike Rubino, said, and as this quote of the next speaker, John Forster, states, we lack a federal framework.

> *The regulatory framework is missing. If America is to take the lead in this new industry or **if California is to take the lead as it can and should,** it is essential to provide a regulatory framework now that will allow a period of experiment and innovation to begin.* *J. Forster NOAA 2008*

In the absence of a structured federal regulatory system, our proposal is that

> ***California would register and regulate an offshore facility in federal waters with existing legislation, regulations, policies, and staff.***

Any federal offshore facility in federal waters would have to conform to a large degree with a facility located in California waters and to the:

- Coastal Zone Management Act: requires consistency certification, that is, any actions in federal waters must be consistent with actions in state waters if there is a possibility of a significant impact in state waters.
- Clean Water Act: States can review federal discharge.
- Fish and Game Code and regulations: governs transport of fish into California and through State waters.

COB or Covering our Backsides
When Stephanie Showalter, my co-author, gave me this information, she asked that I make this statement.

The information that follows is intended to be advisory research only and does not constitute legal representation of California Sea Grant, the California Department of Fish and Game, or their constituents. It represents our interpretations of the relevant laws and cases.

Justification for the proposal

Passage of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) reduced but did not eliminate state authority.

1. A state may regulate if the state has an interest and does not conflict with the Federal Fisheries Management Plan[12] (FFMP).
2. The state may regulate a fishing vessel if it is registered in the state.
3. The Extraterritorial Application of State Law regarding fishing, which falls under the purview of the act, is OK if there is "no conflict with federal or international law". When the state has a demonstrable strong interest and the state's action does not conflict with federal law, states may regulate—the effects doctrine[13].

Therefore, as long as California does not attempt to regulate the siting of offshore structures, which does come under federal jurisdiction, there is no conflict with federal law.

In regard to the commerce clause:

- Congress has authority "to regulate commerce with foreign nations, and among the several states, and with the Indian tribes."
- California would not be able to require registration of offshore facilities if such registration placed an undue burden on interstate commerce.

Registration would facilitate commerce.

- States regulate "in state" transport and commerce, i.e., to and from fish cages.

Registration would be viewed as an exercise of that authority.

- Permits to transport species and place them in federal waters. Under the Lacey Act, it is a violation to take, possess, transport, or sell species in violation of state law or regulation.

Federalizes state laws.

Outer Continental Shelf Alternate Use, Rights-of-Use, and Easements

The Minerals Management Service (MMS) has prepared a final programmatic EIS[14] in support of the establishment of a program for authorizing alternative energy and alternate use activities on the outer continental shelf. In addition to having jurisdiction over various types of alternate energy, MMS would also have jurisdiction over other activities that could make use of existing oil and natural gas platforms in federal waters on the shelf. In the U.S. oil platforms occur in waters of the Gulf of Mexico and off the coast of Southern California.

While the DFG has confirmed that aquaculture is an appropriate activity for these platforms, we have many of the same concerns that have been expressed about siting stand-alone fish farms. The farms would need to be registered. Other rule changes we have proposed cover environmental concerns; compensating fish framers if the farming is suspended for reasons beyond their control; and consideration of ancillary benefits of platform based aquaculture when assessing fees, e.g. diving.

Conclusions Regarding the Proposal

Extraterritorial application of state law

Until Congress enacts aquaculture legislation and evidences intent to preempt state authority with respect to registration, California should be able to apply its registration law extraterritorially.

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12. A *Federal fishery management plan* means a plan developed and approved under the Magnuson Fishery Conservation and Management Act (16 U.S.C. 1801 *et seq.*).

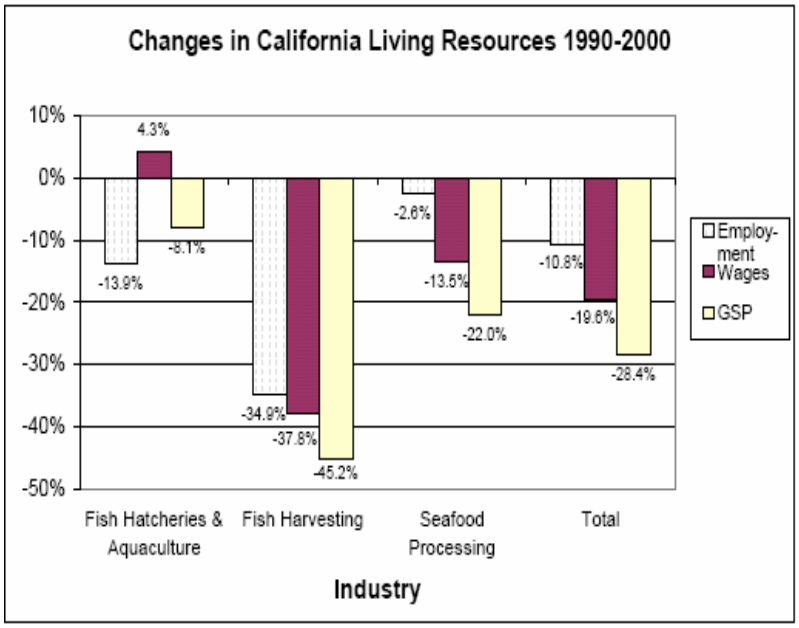
13. http://www.masgc.org/pdf/masgp/08-007-11.pdf. See page 3 of *State Regulations of Aquaculture Facilities in Federal Waters* .for discussion of the effects doctrine.

14, www.gulfcouncil.org/Beta/GMFMCWeb/Aquaculture/Aquaculture%20FAQs%200908.pdf

Some concerns

- All states would perform a consistency review, perhaps not an issue in the Southern California Bight, but it could be in Northern California. If state laws conflicted and burdened interstate commerce, then application of any state's law would be prohibited.
- Competition with capture fisheries: Retrain fishermen. Revitalization of coastal communities is especially important.
- Failure to contribute to state revenues: We believe it is exactly the opposite. Taxes, jobs, industries stay in the state and we think would contribute greatly to state revenues.
- Ownership by foreign countries or individuals: There would still be federal control of the leases and adherence to regulations of the state.
- Environmental safeguards: The early version of the U.S. Offshore Aquaculture Act was not strong enough in regard to environmental protection, but we were told in the previous talk that this is changing. California has some of the strictest environmental safeguards in the world. California registration = California compliance.

The Economic Perspective



The DFG reported that 2.6 million pounds of fish were caught off the coast of San Diego County in 2006, for an aggregate value of $7.1 million

It is estimated that the value of 3,000 tons (6 million pounds) of offshore aquaculture product could be about $22 million ($6.50–8.50/kg dockside value of striped bass).

IS THERE AN OPPORTUNITY FOR DEVELOPMENT OF OFFSHORE FINFISH AQUACULTURE IN THE SOUTHERN CALIFORNIA BIGHT?

I think it is time for "the period of experiment and innovation" to begin. The time is now!

THE AQUACULTURE INDUSTRY PERSPECTIVE

John Forster
President, Forster Consulting, Inc.

I am talking from the aquaculture industry perspective but I am not here to represent any particular aquaculture industry sector. The views I have about aquaculture have developed over a number of years in the industry. In the interest of complete disclosure, Hubbs SeaWorld Research Institute has recently formed a for-profit company to develop offshore aquaculture in Southern California. You will hear about the project later. I was asked to serve as a director of the company and was pleased to do so. I hope that did not and will not prejudice what I have to say. That will be for you to decide.

I will look at the opportunities and challenges and then look at what I think is both a long term challenge and an opportunity.

The Dollar-Wise Aquaculture Market Opportunities

From a global perspective, according to the Food and Agriculture Organization (FAO) of the United Nations, 40 million metric tons (mt) of aquatic food will be required by 2040 to meet the current per capita demand. If we were to put a money value on that, a landed price of $3/kg, this is a 125 billion dollar industry

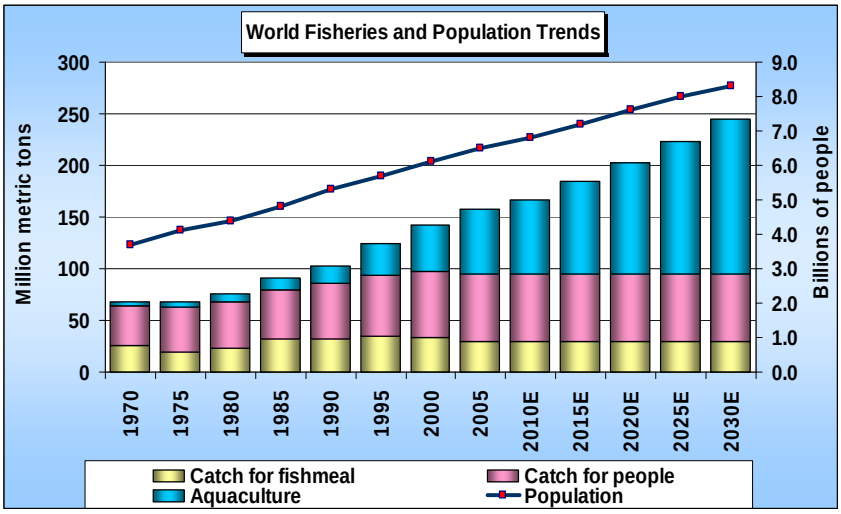
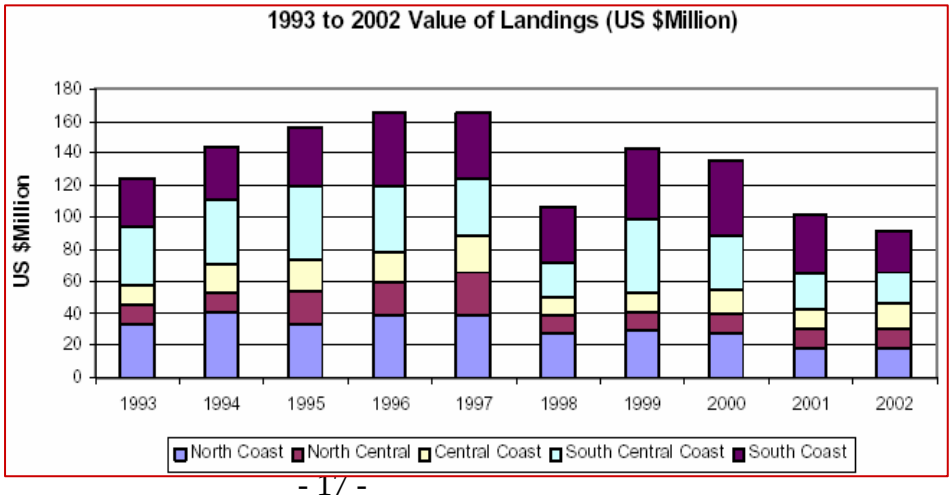


Fig.1 Trends in world fisheries, aquaculture and human population
Courtesy: Jingjie Cho & Anderson, NOAA Aquaculture

If we then use appropriate multiples to go from the landed price to the food chain value, the retail value is more than 0.5 trillion dollars. Not the biggest industry in the world but not trivial either. That gives you some idea of what the global opportunity is.

Source: California Ocean Economy (NOEP)



If we look now at Southern California, what might the market opportunities be? You can take any kind of number and extrapolate it to make a prediction. Assume a nice round number of 100,000mt per year as a goal or 0.25% of FAO projected needs. That tonnage is less than half the 230,000mt of catfish produced each year in the U.S. and only a fraction of the 22.2 billion mt of chicken broilers produced.

At $3/kg, the industry value would be $300 million and the food chain value, $1 billion. Not the biggest industry in a Southern California either until you look at it in terms of California's existing commercial fishing industry which is valued on a first sale basis of under $100,000.

Opportunities to Compete in the Aquaculture Industry

I think we have a number of opportunities in this industry to compete. So often you hear people say that California can't compete in the aquaculture industry for this reason or that. I disagree for several reasons. First, this is a technology-driven industry and California is a leader in the development of equipment. California has strong research and development; an educated workforce; high health management standards; produces quality feeds; an excellent coastal infrastructure; and excellent offshore mechanization. This, if anything, will be a highly mechanized industry using highly qualified people to operate sophisticated equipment. We can do that well. **Of course we can compete.**

We can also compete by being more efficient. Anyone who grows animals for a living knows that feed is what drives up the cost of land animal production. Efficient conversion of feed into animal growth drives up the cost and that is the same all over the world. We can become more efficient. We have quality feeds, good health care, good husbandry, and good facilities. If we weren't able to be efficient, we wouldn't have the largest chicken farm industry in the world.

We produce all the ingredients we need for feed domestically—oil seeds, cereals, animal byproducts, and fish meal oil and protein. Surely there is no sense in shipping these products overseas to have seafood shipped back to us. It makes even less sense as we become increasingly aware of food miles and especially our air food miles. Does it make sense to export fish foods and then import seafood that could be grown in our waters and sold here? From a competition point of view we can compete by being efficient.

We can use space efficiently. I took the 100,000mt production I mentioned previously and did these calculations.

- To produce 100,000mt at 2,500mt per farm = 40 farms
- A reasonable anchor footprint for each farm is 0.5mi^2 or a total of 20 mi$^{2.}$
- Using the DFG Fish Block table, these figures out to be only 0.103% of Southern California's Fish Blocks which total 19,400 square miles.
- Then if we look at productivity, the productivity of commercial fishing production per square mile is $1,340 and my calculations fish farms would yield $15,000,000.

At a meeting last week in Oregon, fishing communities said that there isn't enough space for offshore aquaculture but if you look at these figures, even if I am off by a factor of 10, these numbers suggest that there is and that we can use space efficiently.

We have laws that could give us a competitive edge: We often hear that we can't compete because our laws, particularly on the environment, are too strong. We need strong private property laws to protect against criminal acts by individuals and capricious acts by governments. Anyone who has tried to work overseas knows very well that you can't count on consistent ethical and legal treatment, but we can here and are very privileged to be able to do so.

Unless we have strong environmental laws that test us as we do our business and protect us as we seek to make it work, we won't make it work effectively. We shouldn't forget that we are a clean water industry and one that advocates clean water.

The Challenges
I believe that our overall challenge—and the biggest one—is to create a constituency among the various users.

> ***Marine aquaculture will not succeed in the United States until the public accepts that is a wise and necessary use of the ocean in just the same way as we generally accept agriculture as a wise and necessary use of the land.***

Our problem is that we do not have a strong industry to advocate for aquaculture**.** Would-be investors who might otherwise be strong advocates have a choice about whether they should spend a ton of money and a lot of time and beat their heads against the wall here or go overseas and try their luck there. Some are doing this.

As is the case with most contentious issues, there is a strongly motivated opposition and weakly motivated potential supporters. I can't argue with that. Most of the American public should be strong advocates of the industry. It is in its own best interest to have a supply of moderately priced healthy seafood but that is not enough to motivate the public. We do not have a seafood culture. I don't know what it will take to motivate people. We have been able to survive on our 80 percent of imported seafood and the amount is going up every year. **We certainly don't have a seafood crisis yet. But we will!**

It is a challenge to overcome the objections to aquaculture that include:
Fish farms pollute
Thanks to some really good scientists and good models that you will hear about later in this forum, the pollution problem has been addressed with rigorous science and research.

Fish farms spread disease
These claims are exaggerated but it is difficult to prove otherwise. More work is needed.

Escapees cause genetic pollution
This is based on salmon life history and on alarmism related to genetically modified organisms. But how big a risk is this really? I don't believe we have addressed this with the same rigor used when addressing the fish farms pollute issue. My guess is that these issues have been exaggerated through planting stories and through retelling those stories and they are much less an issue than they have been made out to be. But until we do the rigorous science to be able to demonstrate unequivocally that escapees do not cause genetic pollution, I think we are going to have to live with what we constantly see in the headlines—that escapees pollute.

Surely we have the basics to deal with this challenge. I am sure as an industry we can assemble the data to answer this question with assurance.

Farming carnivorous fish
The issue is about fishmeal.

> *In a world where fresh water and grain supplies are increasingly scarce, raising seafood like oysters, clams, catfish, and tilapia is many times more efficient than factory-farmed chicken or beef… But carnivorous species like salmon and shrimp, while increasingly popular, consume several times their weight in fish feed.*
>
> World Watch Inst. 9.10.08

The point about farmed chickens is incorrect. Chicken farms are incredibly efficient. They are such a model of efficiency that anyone in aquaculture should be thinking to emulate them. So that statement is wrong and shows misunderstanding.

> "Carnivorous fish like salmon and shrimp, which are incredibly popular, consume several times their weight in fish feed."

What is that—several times their weight? Taken literally the food conversion rate for food fed to salmon is 1:2:1 and for catfish, 2:2:1. We all know that "several times their weight", is code for moisture in the fish food and ultimately for discussion about fishing and fish meal. Looking at protein retention of the fed food, salmon retains 4 5 percent, catfish 38 percent, and chicken 33 percent. The issue is about fishmeal and everyone in this industry knows that a tremendous amount of work is being done at the moment on both protein and alternative sources for fish meal and fish oil such as single cell protein, GMO oil seed, and animal byproducts. The current salmon feed formulation is less than 20 percent fishmeal. Micro-algae and GMO oil seeds are sources of EPA and DHA omega-3 fatty acids.

The research effort will succeed and when it does, the question has to be: **What is the difference between herbivores and carnivores?** I don't follow the logic. In fact you can make a strong case for farmed fish. If you compare salmon with tilapia, the edible meat on a salmon carcass is 55 percent of total weight versus 32 percent on that of a tilapia, and FDA, DHA fatty acid content are 10 times greater. This is irrespective of the fact that the public prefers to eat salmon.

If freshwater is 'scarce', I find it rather strange that there are those who advocate growing more freshwater fish such as catfish. How does raising freshwater fish help the impending water crisis?

An Opportunity: An Obligation

> *It's going to be almost impossible to feed future generations the kind of diet we have now in Western Europe and North America*
>
> Anders Berntell, Stockholm International Water Institute

Another opportunity, one that I would suggest is also an obligation to do, relates more to food supply. I agree with the International Water Institute[15] that we have problems with our food supply. We have problems with our population growing and becoming increasingly affluent. We have problems with freshwater supplies in certain parts of the world where agriculture is contributing to food supply. We are just about to have to confront these problems. Only yesterday, (September 18, 2008), the director of the FAO said that we have a serious food crisis ahead of us and that we have to invest 30 billion dollars over the next 30 years if we are going to feed the world's population.

Farming the Ocean as We Farm the Land

What does this have to do with aquaculture? It has a lot to do with aquaculture. We all know that the ocean covers 70 percent of Earth. What we tend to forget is the productivity of the ocean versus productivity of the land. Contrasting ocean food calorie and protein yield with that of land shows that the ocean yields only 0.7 percent of food calories and 4.2 percent of food protein contributed by the land. Per acre we produce many times more food calories and 55 times more food protein from the land than from the sea.

It seems inconceivable to me that over the next 30-50 years we are going to accommodate the food needs of billions more people in total number, and several billion more with increased wealth and affluence, without making more productive use of some of our ocean space. How do we do that? I pose the question: ***Why can't we farm the sea as we farm the land?***

Looking at our land farming, our terrestrial agronomy processes plants into all kinds of products that we use. We could have a marine agronomy of plants with all kinds of nutrients that could be converted into a range of products as part of aquaculture as well. In contrast to terrestrial agronomy, plants in marine agronomy:

15. http://www.siwi.org/documents/Resources/Policy_Briefs/PB_From_Filed_to_Fork_2008.pdf

- Do not need freshwater or land to grow
- Need fertilizers in only some areas
- Remove excess nutrients (Seaweed could be used in areas where there are concerns about excess nutrients.)
- Sequester some CO2, but not a lot
- Contain protein and marine oils
- Can be processed like terrestrial plants into food, feed, and energy
- Ocean surface area usage is minimal.

While dangerous to do so, I extrapolated usage from China's experience. By my calculations 6.1 billion mt dry wt of seaweed could be grown by using 0.9 percent of the world's ocean surface. This may seem to be quite a lot of ocean surface but 6.1 billion is the same weight we produce by conventional agriculture. Surely the potential significance can't be lost— the fact that we have it in our path to use an area around us to double the world's food supply. It is something that people should take seriously.

With two billion more people seeking to consume as we do, don't we have to make more productive use of the sea? Why isn't this more central in the aquaculture debate? Of course there are all kinds of reasons why not and objections as well. Apart from the fact that none of these is insurmountable, throughout human history we have overcome more difficult challenges. Surely given the potential need, we can overcome some of these problems. Farming the sea as we farm the land is not a new idea. Why is it overlooked? We have been talking about the idea for a long time. It is just that we are being confronted with strains in our systems that compel us to look seriously at the opportunity again.

IS THERE AN OPPORTUNITY FOR DEVELOPMENT OF OFFSHORE FINFISH AQUACULTURE IN THE SOUTHERN CALIFORNIA BIGHT?

Doesn't California have an obligation to be a leader in the aquaculture effort?

You have benefited from the sea. You have some of the best oceanographic schools, some of the best scientists in the world, and some of the best ocean conditions. I would suggest that in light of these benefits, California has some obligation to be a leader in the future of the aquaculture industry.

THE FOUR PERSPECTIVES: COMMENTS AND QUESTIONS

Schubel:
Before opening up discussion, I would like to make a few observations on what I heard from these different perspectives on aquaculture in the Southern California Bight.

- California has a renowned scientific community with expertise in aquaculture, coastal oceanography, and technology. It also has very favorable oceanographic conditions in the Southern California Bight—no hurricanes, deepwater close to shore and good water exchange.
- There is a market in California for seafood with a per capita demand about twice the national average**.**
- Eighty percent of the seafood in the greater Los Angeles area is imported, mostly from China, leading to concerns about air miles and carbon footprints, and food safety.
- John Forster's concept, endorsed by Devin Bartley, is: "It's time to begin to experiment". If we do, I think we have to be sure the experiments are done in ways consistent with environmental quality, adhering to the same strong environmental ethic we have here in California.
- A challenge is to create a constituency. This is one of the Aquarium of the Pacific's interests. We have 1.5 million visitors a year with more than twice that many accessing our website, and we have extensive experience in educating the public. Once we are convinced that aquaculture is an appropriate industry for Southern California and the nation, the Aquarium has opportunities to involve stakeholders.

Fawcett: Often forgotten is the onshore impact of offshore operations. This has come up in respect to LNG facilities offshore. We tend to think of it as mainly a consistency issue, not the onshore impact. Offshore aquaculture operations could have a substantial onshore impact and the Coastal Commission will take direct responsibility for that. We can't ignore the onshore impact at least in the constellation of regulations that affect the industry.

Z. Grader: Devin (Bartley) indicated that no shellfish leases had been issued in California since the 1990s. Actually there have been three in the past several years. The Coastal Commission approved shellfish leases as late as 2001, perhaps 2002. I think only one of these has been acted on. Also a real problem here in the state is the abandonment of leases, something the DFG is going to have to contend with.

It was asked why isn't California a leader in aquaculture? Well, California took the effort to provide people with regulatory certainty. It appears that people just didn't like those regulations. I should add that the legislation passed with the support of the California Aquaculture Association (CAA).

Bartley: There are different types of leases, whether they are on private or state lands. Certainly there have not been many leases issued recently but I will check into the figures I gave that were given to me by a marine aquaculture specialist. In regard to your point about abandonment, we do have a proof of use requirement in our code of regulations that states that if the farms aren't producing, then the lessee loses the lease. There is a shortage of manpower in DFG but as I mentioned previously, our information in this sector needs to be greatly improved. This is what we are trying to do so we know the true value of the sector, what farms are or are not producing, and whether they are a drain or a benefit to the coastal area.

You are correct that SB201 was passed with input from CAA. There was also input from UC Sea Grant, and many other organizations and people. I probably should defer to CAA's, Mark Drawbridge, but it is my impression that many compromises were made in recognition that environmental safeguards were key with the result that a burden has placed on the industry.

Leonard: I have several points.
(1).Recognizing that the ocean is a public trust resource, I think the challenge is how to involve California stakeholders in what California should do in regard to its coastal ocean resources. A broader discourse is needed that involves the fishing community and all the other stakeholders as well.

(2). About Devin Bartley's proposal that California law might apply in federal waters in the absence of federal legislation. I am not a lawyer but I think it is an interesting concept. There is one question I think we would want to think about and that is to what extent would this set a precedent for other states to follow that might have weaker aquaculture regulations at a lower environmental bar than California's.

(3). We haven't talked a lot about environmental risks but I think one of the largest issues in understanding the environmental risks is the question of scale. I know there will be discussion later about demonstration projects. The question will be to what extent is there a linkage between individual projects and the environmental consequences of a much larger industry that would include a number of spatially explicit farms.

Sims: Good point about scale. The forum needs to think about this. My perspective on this is that as a commercial project, a demonstration project can be a little scary because it is often on a scale that looks like a demonstration project but is often a demonstration of how you can lose money in aquaculture. The economics of scale are a minimum size of what you want them to be.

The other thing we need to give even more consideration to is the underlying state of SB201. The bill may have been put forth with the best of intentions and with the best support but it is fundamentally flawed. One of the fundamental flaws that I see in the act, and Devin Bartley touched on this, is that when a lease is issued, it is put out for bid. This may seem like a fair way but it is not fair to the entrepreneur who spent a lot of time going through the permit process. Looking at it from the perspective of an entrepreneurs, I am one who spent the better part of three years massaging through a permit application in Hawaii and did it all with 'sweat equity'. I would not have been willing to make that investment if, when I got to the end of that process, this lease that I had worked toward for three years was then put up for someone else to snap up in a bidding process. To make this work you need to provide an incentive and an opportunity for entrepreneurs to put in the sweat equity and then reward them for the pioneering they have done.

SB201 needs to be modified. That is a horrifying thought for anyone who has had any dealing with legislation these days. It speaks to the need that legislation should allow regulations to guide the specifics, not specifics in legislation to guide regulations.

Foster: On this question of scale. What I heard George Leonard say was that we need individual projects to be actually quite substantial in scale, commercial scale, so that we can understand at least locally what the environmentally impacts may be. What George's concern is that having gone through one, you then need to do ten or a hundred to have the cumulative impact. That is an absolutely fair question and my question back to that is: How do we possibly answer a question about cumulative impacts unless we start with one? It seems to me that until and unless we actually get out in three dimensions and do something, we are going to constantly throw this concept back and forth.

Leonard: John (Foster), I think you captured it correctly. I do think if you are going to do demonstration projects, if we are trying to look for a link between such projects and commercial liability, then there needs to be an explicit link there with respect to environmental impacts. None of that gets us at the broader issue of scaling up of an industry. I would agree that there is not an easy answer. I don't know if it is more sophisticated modeling or if it is getting ecosystem thinking scientists involved particularly in looking at basic dynamics of disease and some of these other concerns, but I think we don't want to find ourselves on a trajectory is which all of a sudden there is an industry that

has clearly gone beyond some tipping point on some critical environmental perimeter. Then it becomes very difficult to back that out. I think there is some evidence in Chile right now that clearly there is a scale issue that has been exceeded and there then has been a sort of a desperate attempt to get back below those thresholds that are very difficult to predict in advance. I think we want to be very sure we are thinking long term, not just about farm level 10 year impacts.

González; I also think that Neil Sims' comment about the necessity of many experiments is very important. How many mistakes does NASA go through before success occurs? Can you bet the success of aquaculture based on one experiment? To limit the attempt to develop offshore aquaculture to one experiment would give a good chance to those who oppose to it to prove you wrong. I believe that the argument to support would be to allow a period of experimentation at a pilot scale until is proven that fish aquaculture is not something that should be done in California or that it is.

Schubel: Good points. Scaling up is a challenge: the number of farms, where they are located, how far apart, the stocking per farm. Jack (Rensel), are you and Dale (Keifer) going to address these in your model presentation?

Rensel: We only looked at single installations so we haven't addressed that in a quantitative way. It seems to me that if you have a demonstration farm or two or three and you have proper monitoring, that information with models can help you address the questions of scale. I think it is a straightforward approach to the problem. It is just that we need some data to work with. Models are only as good as the ability to validate them in the field so you have this need for field data. You also need the models for 'what if' scenarios. The scaling issue is essentially such a scenario.

Schubel: Modeling, monitoring, enforcement, and being willing to make tough decisions.

Rensel: I would add that we are not without a rudder on this ship. There is no fundamental difference in physics and biology offshore versus a lot of the nearshore. Aquaculture has gone through an evolution from the back waters in the 60's and '70's to the channels. Now it is going offshore. If you talk to modelers worldwide, and you can count them on two or three hands, we all agree we have the necessary perimeters and calibrations to model these things for the most part. We just haven't had the total resources to develop the far-field models we need. However, we are looking at far-field modeling in Hawaii and others, in Scotland in particular, have models that are able to do this sort of data gathering also.

Eichbaum: I just had a few questions on some comments made by one of the speakers. It was stated that open ocean aquaculture had to go forward in the context of ecosystem-based management. I have a two point question 1). Is that really true? Do we think that is a necessary ingredient for the success of the hypothesis? 2). Is the California argument for how it would exercise authority beyond its territorial limits sufficiently robust to apply principles of ecosystem- based management if this is a necessary component of meeting the hypothesis?

Z. Grader: First about what Devin (Bartley) said, I think he is absolutely right. California has exercised that authority clearly over its fisheries for over 60 to 70 years. The only thing that modified its authority was the passage of the Magneson-Stevens Act in 1976. The act did temper the state's management of such things as groundfish and salmon—fisheries that were under management plans. Certainly, absent federal regulations California probably would have, maybe not total control, but the same control over its fisheries it now has inside the three miles of state waters, control that is substantial. Actually, we found this to be true with offshore oil drilling that California can condition much of what occurs offshore if it has an impact onshore. Another example is the LNG issue referred to by a previous speaker.

As far as ecosystem-based management is concerned, the language is in the Magnuson-Stevens Act. I am not sure about SB201 on it but I think that, certainly from a political standpoint, even if it is not in the California legislation right now, if you are proposing offshore aquaculture in California and if you do not consider such management, I suspect you are going to have a very difficult time getting approval of a project.

> **Post forum note**: SB201 does not address ecosystem-based management in those words. Sections of the act state:
> Division 13 (commencing with Section 21000) of the Public Resources Code, the report shall provide a framework for managing marine finfish aquaculture in an environmentally sustainable manner that, at a minimum, adequately considers all of the following factors: …
> (3) The effects on marine ecosystems, commercial and recreational fishing, and other important ocean uses.
>
> Sec. 4 (4) Lessees shall establish best management practices, approved by the commission, for each lease site. Approved best management practices shall include a regular monitoring, reporting, and site inspection program that requires at least annual monitoring of lease sites to ensure that the operations are in compliance with best management practices related to fish disease, escapement, and environmental stewardship,…

Something I should mention separate and apart from this is that it has been mentioned several times this morning that we need to farm the sea as we farm the land, assuming that what we are doing on land is being done sustainably. Having dealt with agriculture in an effort to protect salmon fisheries, actually not much of our agriculture, particularly in California just now, is sustainable; for example growing cotton and corn in the San Joaquin Valley. It is done there only because of the availability of very cheap water. Because of farming of crops of this type, we don't have a salmon fishery in California this year. The reason is that it took too much water to grow crops that shouldn't be grown in what is basically a desert climate.

I think you have to very careful about trying to promote aquaculture offshore—even onshore—by saying we need to farm the ocean as we farm the land. We are finding out that the "Green Revolution" that occurred after World War II really wasn't so green after all.

Schubel: Other inappropriate crops include alfalfa and rice.

González; With all the information about what went wrong in Chile with salmon, would it not be easy to identify what went wrong and plan accordingly in a country like the U.S.? It is obvious that there was a lack of planning and enforcement in Chile. This is common in a relatively poor country, especially because of the fact that enforcement of good practices is too difficult in such remote and isolate areas where salmon is culture.

Rubino: Jacques Costeau wrote: **"…***We need to farm the ocean as we farm the land"* in 1973*.* I think if he were writing that statement today, he would use words such as sustainability. I would even throw out the challenge that if you listen to his son or his grandson, they would say that we need to farm the ocean more sustainably than we have farmed the land.

One could make the argument that aquaculture has to be environmentally sustainable if it is going to survive economically. There are market forces in terms of the feed issue; regulatory forces in terms of proper collective aquaculture; and then there are market forces in terms of certified aquaculture. The market is looking for certified fisheries. All of these are pushing aquaculture to be more innovative about how its products have been produced, leading the industry toward sustainability.

Sustainability is a little like democracy. It is a concept but it is certainly something we should work toward.

Schubel: In my opening remarks I said if aquaculture cannot be demonstrated to be sustainable both environmentally and economically, then it does not belong in California.

Fusaro: I am pleased that the ideas of modeling and sustainability were both raised. On the issue of the regulatory arena, look at California and the state's recent attempts to be a leader in global climate change. One of the outcomes of that effort has been attempts to regulate the energy sector, the transportation sector, and to a certain extent, aquaculture with respect to trying to modify and reduce its carbon footprint. I don't see the carbon footprint challenge listed anywhere on this forum's agenda. But as we think about how to make aquaculture a sustainable enterprise, I wouldn't mind seeing carbon footprint added. It may be if we import less, use less shipping, and grow locally, aquaculture may end up as a positive force. It is something that needs to be factored into this process.

Bartley: A comment on the ecosystem management approach which is impossible to do. We should keep in mind the expanded definition of ecosystem management which includes people as an integral part of the ecosystem. We are looking at flows and processes that include the human factor, not just the biological equation. It includes the social and economic processes as well.

Note: See page 88 for clarification of Bartley's comment.

Yarish: I want to point out that when you are dealing with an integrated multi-trophic approach, it **is** different from dealing with a polyculture approach. That is something that should not get confused. If you are dealing with two fish species, that is polyculture. An integrated multi-trophic approach is an opportunity to start looking at ecosystem services.

Another point is the very important extractive process. You have touched on nutrient issue. While that is a point, there are also other issues. I am pleased that the carbon footprint has been mentioned. Why? Because if you are using an IMTA, the seaweeds are not only extracting nitrogen and phosphorus from the environment that could offset some of the negative impacts attributed to aquaculture, they are also massive sequesters of carbon. That ability should not be overlooked when you look at the biomass. The seaweeds are pulling out a lot of carbon.

A NATIONAL IMPERATIVE—A CALIFORNIA OPPORTUNITY

Don Kent
President, Hubbs Seaworld Research Institute.

I don't know if anyone has a lot of practical experience with aquaculture in Southern California when you look at the breadth of issues and concerns out there. What I would like to do today is talk about what we know about here in California and what we know from other parts of the world and create a scenario by which we can answer your questions and discuss the concerns you have about offshore aquaculture in this part of California.

An Introduction to Hubbs SeaWorld Research Institute (HSWRI)
In 1963 Milton Shedd, one of the visionary founders of San Diego's SeaWorld met with Dr. Carl Hubbs, world-renowned marine biologist and probably one of the most prolific marine scientists to be set on Earth. They had a clear vision of a unique scientific research organization that would be independent, highly productive, creative, technology-driven, and results-oriented. The result of their meeting was the founding of a new institution for marine research, the Mission Bay Research Foundation, renamed Hubbs-SeaWorld Research Institute in 1977.

Milton Shedd was passionate about the sea and he loved using it. He had both commercial and recreational fisherman interests and he fished in the 1960s when white seabass were prolific in Mission Bay. This photo shows what was probably a contributing factor to why catches like this are no longer true. Milton was also a visionary conservationist who understood the intrinsic value of the oceans as a primary economic engine of the world that needed to be nurtured and cared for. As a result of his life-long marine conservation ethic, he was interested in having an institution that would "*return to the sea some measure of the benefits derived from it*".

That is how our institute came into being. We are problem solvers. We have the white seabass hatchery in Carlsbad where seabass are raised to be released into the sea, the laboratory on Mission Bay, and a new laboratory being built in Brevard County, Florida.

We have four core areas of research: ecology, bioacoustics, physiology and health, and aquaculture.

- **Ecology:** Understanding the oceans and its inhabitants. For example, how can we have development in the polar region without impacts on polar bears?
- **Bioacoustics:** It's not a silent world.
  - Assessing effects of noise
  - Understanding animal communication
- **Physiology and Ocean Health:**
  - Understanding how animals respond to a changing world
  - Discovering new marine mammal viruses and studying their impact on population health
  - Establishing cleaning and treatment protocols for marine animals after oil spills
- **Aquaculture**: Helping to feed a hungry world, for example, our full cycle work in our hatchery in Carlsbad. We actually bring all our core areas into play in our aquaculture research.

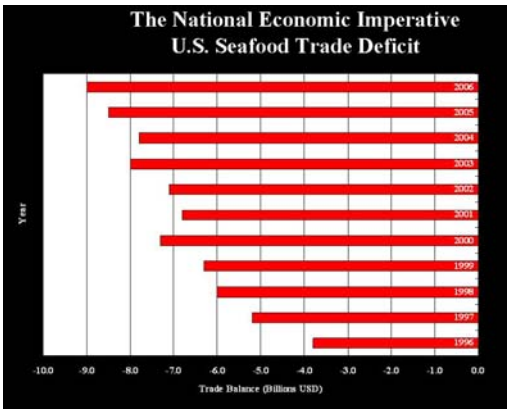
We work with our regulatory agencies and scientists around the world and trying to understand what is going on with endangered species. For example, we equipped a sea turtle with a satellite transmitter and tracked its movements across the ocean. One of the leading questions we focus on is why are our Pacific turtle stocks so depleted? We protect the beaches and don't allow takes of turtles

and yet the turtles get caught in fishing gear. We try to understand where sea turtles are so we can tell regulatory agencies this is where you may have to have closures or perhaps this is the way you need to change the gear in that particular area so you don't have these adverse impacts.

Ours is a non-advocacy organization advocating only for good science. We work with regulatory agencies, the fishing industry, and the military. We study the effects of military operations on wild animals. How can we have the U.S. Marine Corps training in Miramar not disturb threatened gnatcatchers? We have also worked with NATO in Mexico on the effects of noise on spotted owls.

We are also involved in marine pollution. Working with the Mineral Management Service we developed a procedure that could be used for cleaning sea otters involved in oil spills. We never thought we would have to use it in Southern California because of the moratorium on drilling for oil in our ocean waters. Yet when the Valdez spill occurred we had to go to Alaska to show those involved in the cleanup effort how to clean sea otters. We are part of the oil spill response program in California. We also work on animal diseases and the effects of pollution.

Economics and the Seafood Industry



This graph of the National Economic Imperative U.S. Seafood Trade Deficit shows what happened in the United States relative to the importation of seafood between 1996 and 2006. I have heard a numbers about the amount we import—85 percent, 83 percent, 80 percent. What any of the numbers amount to is that we are importing a lot of seafood and 50 percent of it is farmed.

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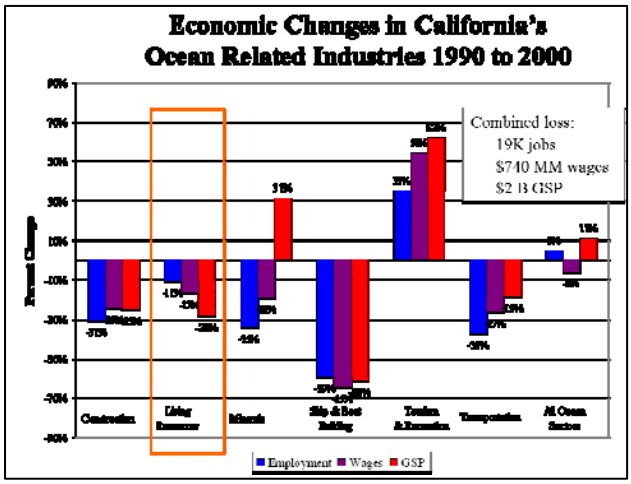
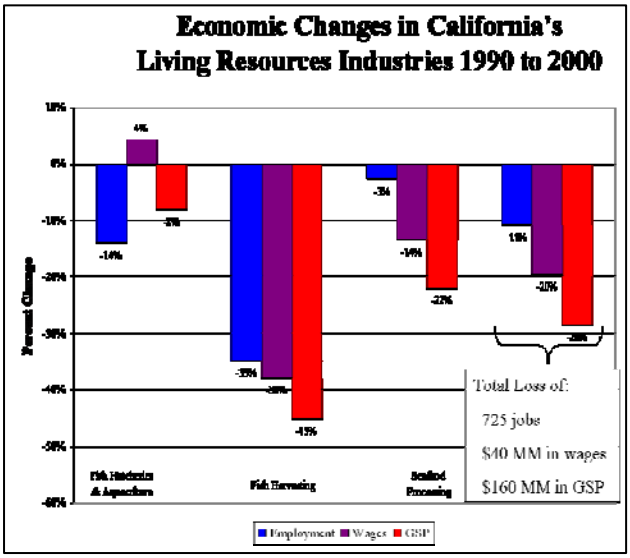
Economic Changes in California's Ocean Related Industries

According to NOAA's National Ocean Economy Program[16], California lost 19,000 jobs in the ocean related sector between 1990 and 2000; in contrast, there has been a large gain in the recreation-tourism sector, jobs that are low paying.





16. NOAA's Coastal and Ocean Resources Economics http://marineeconomics.noaa.gov/

During the same time period 700 of the 19,000 lost jobs were from the natural resources sector of fishing, aquaculture, and seafood processing, a value of $40 million. Some may say that $40 million dollars is not a great loss. It certainly is when you are a fisherman who does not have a job. There are a lot of fishing boats sitting at the docks right now. That means that not only are the fishermen out of jobs, but so is the person downstream.

What are the contributing factors to the on-going decline?

- Declining fish stocks causing diminishing yield per unit effort (i.e., more time at sea to collect fewer fish)
- More stringent fishing regulations and increased fishery closures. We have shut down areas to allow stocks to rebuild. We are taking areas and setting them aside as marine protected areas where there is no commercial take.
- Competition from foreign fleets
- Importation of more seafood and a resulting loss of jobs in the U.S. processing industry.
- Skyrocketing cost of fuel (48% in 2008).

HSWRI Aquaculture Program

When we started our white seabass replenishment program in 1983 the advisory group under DFG set these goals for replenishment research for an ocean resource and hatchery program. The goals that are bolded are the ones we think are consistent with what needs to be developed in an aquaculture program. These goals are 20 year old edicts that our program still operates on today.

- **Develop and implement hatchery methods that provide a supply of healthy and vigorous fish.**
- Quantify contributions to the standing stock in definitive terms.
- **Conduct the program in a manner that will avoid any significant environmental impacts.**
- Continue to develop, evaluate, and refine hatchery operations to maximize the potential for achieving the goal of the program.
- **Maintain and assess a broodstock management plan that results in progeny being released that have genotypic diversity very similar to that of the wild population.**

Re-circulating technology is one of the technologies we are using in our white seabass program. We are able to produce juvenile fish out of season with the result that we are a year-round operation in comparison to a salmon operation where you get only one crop a year. This is why our 20,000 square foot Carlsbad facility can produce over 5 million fish a year

Marine Finfish Nutrition

All the species we work with have their own nutritional requirements and every life stage also has its own nutritional requirements so when we talk about replacing one protein with another; we first have to figure out what the micronutrient requirements are.

When we talk about what is going on in Southern California, there are only a few species with which we have had a chance to work. Some of the larger problems we are looking at have to do with salmon. We have been culturing salmon for over 150 years and we still have multi-million dollar programs looking at resolving the problems related to growing salmon and putting them back in the ocean. What we have to learn for the species we want to grow here in California is that we have to have infrastructure in place to work with. One of the challenges facing aquaculture in California right now is do we have the infrastructure in academia to help us address the questions, such as the nutritional ones? What happens when the fish nutritionist at UC Davis fisheries school retires? How do we replace him? Is there a need to replace him?

Disease Research

We have done a lot of research on disease with researchers around the world. The veterinarian pathologist for the DFG's Southern California region is stationed at our site. We also work on clinical problems with the veterinarian school and wildlife health center at UC Davis. The reality is animals will

get sick. I can almost guarantee you as our aquaculture industry develops, we are going to encounter a disease that no one has experienced before.

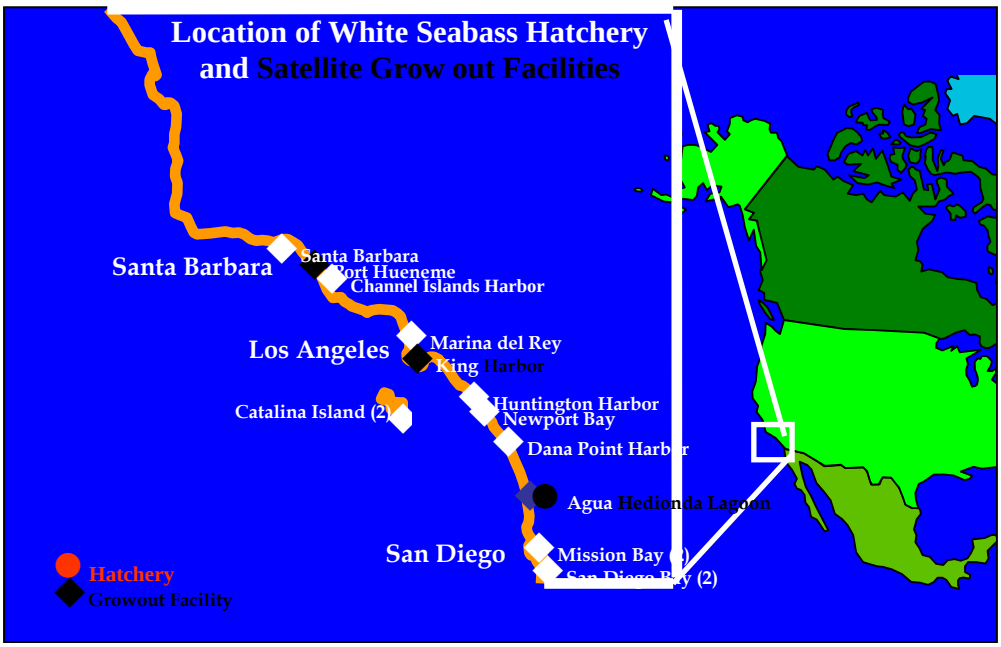
The important thing to do is to maximize the environment. A reason we have talked about for moving offshore to clear, clean water, away from contamination and crowding is so production can go on without weakening the fish and causing disease problems.

Our disease research includes:

- Diagnostic tools
- Biosecurity protocols
- Health management
- Treatment protocols
- Evaluation of wild populations

Hubbs' White Seabass Hatcheries

Hubbs' white seabass program has expanded and now includes an area from Santa Barbara to San Diego with 13 grow-out locations some of which are onshore in tanks, but with the majority in cages immediately offshore within the coastal zone. All of the cages, with the exception of the one in Santa Barbara which is in open water, are in harbors or embayments. We have acquired a great deal of experience with cages as a result of out seabass program. We do extensive site monitoring, including monitoring all are cages for bottom impacts.



One of the arguments I would like to make is that where salmon farming came from is salmon enhancement: where trout farming came from is trout enhancement. As we tried to keep these populations up by growing out these fish in a hatchery and then putting them in the wild, we created the necessary technologies to do it. The actual grow-out to marketable size is relatively easy. And that's where we think the next opportunity will be for the depressed fishing community here in Southern California.

Aquaculture Presents an Opportunity.

> *Aquaculture can help preserve the historic ties that fishing communities have to the oceans and create a new and vibrant means of job creation.*
>
> Honorable Carlos Gutierrez, U.S. Secretary of Commerce

If we don't make the right decisions as a nation in the coming years, we are going to have another situation where scientific advances that happen here fund economic development overseas. Michael Richard, Glitnir Bank

As Michael Rubino said earlier today in talking about fishermen who are now farmers, the people who are interested in working with us are fishermen. Many work for the supply chain and are actually part of the downstream processing of the fish. They are also interested in looking at alternative sources.

Demonstration Projects

There is a recognized need for demonstration projects. Regulatory uncertainty is the real issue for us. There is no difference, other than speaking Spanish, between the environment of Southern California and that immediately south of San Diego in Mexico. When we apply for permits in California we are faced with regulatory uncertainty. In Mexico we proposed a Sea Grant funded program to test a sea station next to a regular floating cage. It took us only three weeks to get an approval.

There is an incentive in Mexico for the industry to develop. The Mexican Minister of Fisheries service has visited our laboratory lab four times and asked:"Will you bring your technology to Mexico. We want it here?" Now we could say" Let them jump", but that doesn't do anything for our fishermen or for our working waterfront. It just means that 85 percent imported just became 87percent and we are going to be dependent on what they feed their fish and what they do to the environment. It is all a question of something completely out of our control.

Both the Pew Ocean Commission's *America's Living Oceans: A Course for Sea Change* and the U.S. Commission on Ocean Policy *An Ocean Blueprint for the 21st Century* reports cited earlier by Michael Rubino recognized the need to demonstrate how we can do aquaculture in the United States in a sustainable manner.

This is what I feel is needed for a domestic marine aquaculture industry. Demonstration projects that will:

- **Use existing technologies that are understood and well-engineered.** I think it is great that people are working on all these new technologies such as sea stations and other features, but in reality there is a world-wide industry that is using relatively simple floating cages, just a cage on the surface of the water with a predator net around it, a bird net over it, and an anchor. The engineering is all worked out. We can use the technology here.
- **Be large enough to clearly highlight potential problems and their solutions**. As mentioned earlier, a 50 ton project is great but what is that size in comparison to a commercial operation? John Forster gave a production number of 2,500 tons a year. That is not really a lot of seafood compared to what a bait boat or two might bring in yearly. Furthermore, it is not a lot of production compared to the need. Yet that's the size of what needs to be looked at in a very rigorous manner over time if we are going to get to a comfortable level—one in which we are willing to accept what the impacts on the environment are and develop some expertise in how to regulate the impacts. We need to be able to react down the road when we have 450 farms, if that ever happens.
- **Be scalable in a manner that is profitable on its smallest scale and controllable as the operation grows.** It has to be scaled in a manner that starts with profitability. I salute NOAA in its efforts to get demonstration projects underway but basically with a million dollars over two years, maybe you could grow out 30 tons of fish with that. I don't know. Commercial operations are going to be in the order of 500-1000 tons at an underwriting cost of 15-16 million dollars to get the project operational. You are going to have to start at such an operational level to get to a scale where you can assess the impacts. It also means you need to have profitability at this level before you jump to the next level.
- **Be high profile to ensure that the results that are observed are authoritative.** The public and others need to be able to visit the project and see what is going on. When we tried to build our hatchery in Carlsbad, we had people saying it was going to pollute with sewage. It's going to be noisy. It's going to be hideous. Small fish will be sucked into the intake. We tested all of these

assertions and none of them proved to be true. Now we have people coming by saying that this is the way it should be done. The California Coastal Commission has stated that our hatchery is an example of an effective mitigation program.

A California legislator visited us in 1983 at the start of the project in response to questions from commercial and recreational fisherman about increasing stock. They wanted to know why what we were doing couldn't be done with other species as had been done with salmon. The legislator went to NOAA's Southwest Fisheries Science Center and the response there was: "It can't be done". At Scripps Institution of Oceanography he was told it shouldn't be done; instead, we should manage our fisheries. Yes, we should manage our fisheries for long term sustainability. That barn door has been open for a long time. More fisheries need to be rebuilt. This is actually a national issue. When the legislator asked about doing a project at Scripps, the response was: "It's never been done before".

In my mind that's what science is about—the things that haven't been done before. That is why those of us who are scientists were put on Earth not just to build on what others have done, but to do the things that someone else hasn't done before or, if we didn't like what they did, figure out a way to do it better.

So we started a small demonstration project for white seabass in 1983 on the backside of Catalina Island that was funded by a NOAA Saltonstall-Kennedy grant. John Forster was the co-PI. We

located four cages 30x30x20 ft deep in depths of 5-50 ft within an existing leased mooring and guarded area well protected against rough sea conditions from three different directions. The cages were made of a much more rigid structure than used today so that they would stand up to 20 to 30 feet seas. The results in clean water only 20 miles from Los Angeles were: market size was reached in 18 months with 97% survival; no escapees or disease related mortality; and restaurateurs rated the product as excellent.

We have a NOAA Sea Grant funded demonstration south of us in Ensenada, Mexico near Punte Bandero which I mentioned earlier. It is in association with a tuna farm where fishermen, who formerly made their living catching fish, now make their living catching juvenile tuna, growing them out, and harvesting them for the sushi trade. Theirs is the infrastructure we are tagging on to.

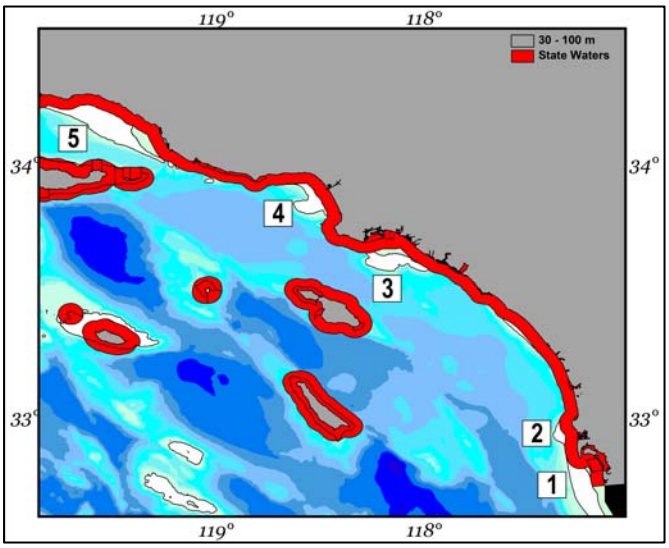
We feel that there are certain siting requirements needed to test the potential for offshore aquaculture in California. We worked on this list in July 2007 at an aquaculture siting workshop held at the Aquarium of the Pacific[17].

- The Southern California Bight offers an almost ideal ocean climate
  - Consistent (i.e., predictable) water temperature, relatively warm
  - Infrequent extreme weather and wave conditions as a result of shading by the Channel Islands, San Clemente, and Santa Catalina Islands

17. http://www.aquariumofpacific.org/images/mcri_uploads/AquacultureWorkshopReport0707.pdf

- Water
  - Depth at least 100 ft but no more than 350 ft, and preferably about 300 ft
  - Clean with consistent current
- Bottom
  - Sandy bottom (no kelp or hard-bottom habitat)
- Location
  - Outside of busy coastal zone (and contaminants)
- Avoids user and habitat conflicts, e.g., someone's primary fishing spot or a kelp restoration area
- Close to existing shore-based infrastructure
  - Commercial fishing industry
  - Market and distribution centers

The HSWRI Proposal for a Demonstration Project
In deciding on a site we looked at the Southern California Bight from Ventura to San Diego with the above requirements in mind.



#5: Ventura area close to shipping lanes, whale watching activities, pleasure boating, etc.

#4: Santa Monica Bay where the Montrose mitigation is being carried out.

#3: location of two of the world's busiest ports, Los Angeles and Long Beach

#2: right off Mission Bay where our laboratory is located

#1: off San Diego on the way down to Coronado Island

We decided to select one of these sites (#1) and develop a proposal for an offshore program that would test the feasibility and sustainability of offshore aquaculture in the Southern California Bight. Because HSWRI cannot go into for-profit enterprises, we formed a for-profit subsidiary of the institute, Pacific Ocean Fresh, that would allow us to develop the project with investors. . The intent was that that the institute in acquiring the permits to do the work would have control over the qualifications and usage of the permits in the demonstration project.

Through its subsidiary, "Pacific Ocean Fresh", Hubbs-SeaWorld Research Institute proposes to:
- Permit, install and operate a commercial scale fish farm located five miles off the coast of San Diego.
- Assess the ability to increase domestic supply of seafood in an environmentally sustainable manner.

California and Aquaculture Leadership
We believe 1.) the project and related activities could significantly increase ocean-related revenues to the southwest region of California and 2.) that California has the opportunity to lead the nation in the development of offshore aquaculture.

The question about California assuming a leadership role in aquaculture is being asked in many places. I believe California has the opportunity to lead the nation. How do we do this? Who is going to do it? How do we expand to other parts of the nation? We think that a Southern California aquaculture

industry could help the state and local economies by providing a new source of seafood, and new job opportunities for fishermen and processors who are having problems now bringing fish to the dock.

A question I am getting from colleagues across the country is why do you want to do this in California, the state that has the most stringent regulations and the toughest environmental laws anywhere in the country? The answer is I am a native San Diegan. I have spent my professional career here doing marine research. This is a problem we need to solve. This is what problem solvers do—they address the problem head on and that is why I am excited about this. I think we need to do this in California. If we want to set the standards for the nation, let's do it in the place that has the toughest environmental standards there is to do it in.

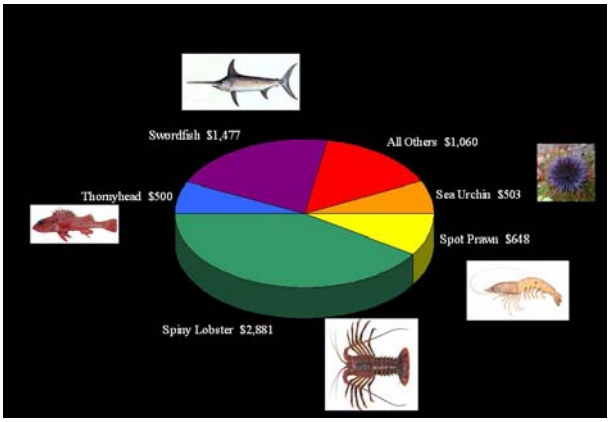
The Proposed Demonstration Site

Our proposed site is five miles offshore and right on the 300 foot contour. The water is a little warmer off San Diego than it is further north in the bight, an advantage in feeding efficiency and stimulation of fish growth. It avoids coastal conflicts, U.S. Navy operations, fishing grounds, kelp and reef habitats, and polluting runoff. We consulted with commercial and recreational fishermen about the site selection to be sure we were not interfering with their operations. We looked at traffic out of San Diego Bay and transiting up and down the coast. We started an evaluation providing information to the AquaModel people. (Later today Keifer and Rensel will talk about the model. We have put down an Acoustic Doppler Current Profiler (ADCP) meter at the site to measure currents, and have analyzed sediment types at the location. We are also doing an underwater video survey of the entire area.

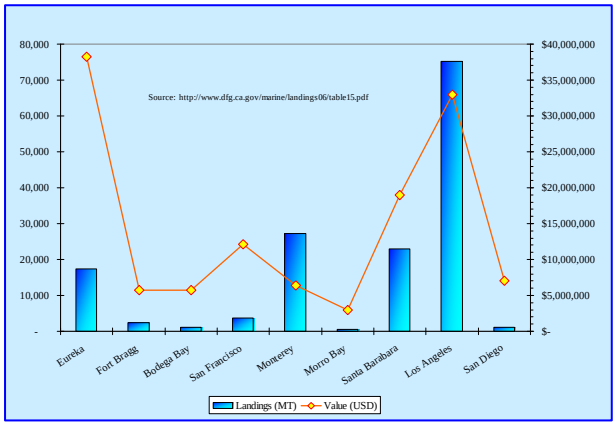
Impact on the nearshore has been mentioned at this meeting. We have talked about a working waterfront and lost jobs in processing. About 12 miles back in San Diego Bay there is a commercial base. This new source of protein can come into an existing infrastructure and all the downstream distribution of the product that is only 12 miles away.

The species we can grow are native California yellowtail, California halibut, white seabass, and a naturalized species, striped seabass. We have developed aquaculture capabilities for all four species in our experimental and production hatcheries.

In 2006 landings in San Diego had a product value of $7 million. While I believe there may have been more landings, that is the statistic given for the year. The vast majority of the landings were lobsters at $2.88 million with Pacific swordfish at $1.5 million. San Diego is a very backward port in terms of commercial wild catch coming in with a landed weight of only 1000 tons in 2006. The operation we are proposing would double that and potentially double the revenue coming into the port through the operation of one small demonstration project.



Value of Species Landed in San Diego in 2006



Value of Fish Landed in San Diego in 2006 (Values are in $1,000 USD)

Next Steps
A number of steps are being taken and will be taken to comply with regulations, laws, policies, and the need to involve stakeholders. This forum is one of stakeholder involvement.

- Federal permits
  - Army Corps of Engineers Section 10: NEPA Review. The EPA is handling the NEPA review
  - Environmental Protection Agency National Pollution Elimination System (NPDES) for a discharge permit
- US Coast Guard Aids to Navigation
- State Review
  - Department of Fish & Game aquaculture registration
  - California Coastal Commission consistency certification
- Stakeholder outreach and support
  - Business community
  - Public interest groups
  - Commercial and recreational fishing industries
  - Local government

What should the role of California be?
California should take a leadership role. We welcome that role. We want to seize that role. We want the state of California to be an integral part of this. If we are going to have the potential to expand this, we want to be able to first understand what the problems are and evaluate them. DFG has been designated as the aquaculture agency for the state so it is important that the agency learn, as we learn, the solutions to the equation.

I want to reiterate that the technology exists now and has been engineered to the proposed aquaculture demonstration site. What we have is the opportunity to build on what is being done successfully elsewhere and also to learn what everyone else did wrong in the past and not make the same mistakes again. We have the capability to work toward a program that can make a long term contribution to the economy of California, to California jobs and taxes, without having an appreciable impact on the environment. That is what HSWRI wants to do—to be a part of this, to really measure the impacts so they can be put out on the table and evaluated.

> *With the earth's burgeoning human population to feed, we must turn to the sea with new understanding and new technology. We need to farm the ocean as we farm the land.* Jacques Costeau-1973

> *California is a world leader in agriculture, why can't we be a world leader in aquaculture?* Devin Bartley, California DFG Aquaculture Coordinator

SUMMARY OF THE OPPORTUNITIES AND CHALLENGES: CREATING A MAP FOR THE REST OF THE FORUM

Schubel: I came away from the morning's session with the impression that there are both huge opportunities and challenges for development of an offshore aquaculture industry in the Southern California Bight, and that we can't forget either the challenges or the opportunities.

- If we are going to have an aquaculture industry here, it is clear it has to meet the highest environmental standards and the California ocean ethic.
- Onshore impact must be addressed and found acceptable. We have to maintain what we have left of our working waterfront.
- Regulatory predictability is critically important if we are going to attract and retain entrepreneurs.
- The cost to get into the game at a scale that makes sense is $15-60 million. If you make that kind of investment, you want some assurance that when you are all done and have met all the standards, the lease will be extended in time, and perhaps in space.
- Another concern, and one I find legitimate, is that unless we have a demonstration project, we are never going to have any environmental impact information upon which we can make decisions.
- A demonstration project has to be appropriately sited using the best modeling tools available.
- There has to be appropriate monitoring and as you begin to think about expanding, it must follow a conservative approach with adaptive management and enforcement.
- Multi-trophic aquaculture has benefits. It may contribute to enhancing water quality. The production of more than one product reduces the financial risk in that if one crop is lost, there is another from which to make money. Growing seaweed can contribute to a reduction in the carbon footprint.
- Diverse stakeholders need to be brought into the discussion. If this is going to be done, it needs to be done in a more systematic manner than has been done to date. I have experience with Larry Susskind of MIT who is very skillful at orchestrating conversations about complex and controversial issues. Involving him, or someone like him, in stakeholder meetings could be a great benefit.

Helvey: Don (Kent), you mentioned using seafood processors in San Diego Bay. Can you comment on how fishermen themselves could participate in the project?

Kent: The people who are going to make the industry work are the people who know how to work boats, how to work nets, how to work the product. We are going to have a shore-based infrastructure growing-out the fish to the juvenile sizes that will be taken out to the cages. That will take care of the farming group. The people who will actually work the cages and bring in the product are those in the commercial fish industry. They have existing know-how and expertise. They can be easily trained to watch fish grow and there has to be oversight to watch for disease. Most land farmers don't have degrees in agronomy. Just as land farmers have "green thumbs," we need people with "wet thumbs". We have already been approached by several fishing groups that want to be involved and want their vessels used in this program.

Bailey: There is a local food movement across the country. Local food, seafood, is actually what we are talking about. There is a positive spin on what we are doing in talking about growing foods locally and reducing the carbon footprint and food miles.

Jones: Don (Kent), you mentioned that Southern California has a relatively constant climate. There is some variability with El Niños and La Niñas that cause large swings in the life cycles of organisms. What is the reaction of the species being raised to climate changes such as these?

Kent: I think it touches on a couple of issues—the local food issue and the introduction of exotic species. We should be growing the species we find here in Southern California. We have grown white seabass in El Niño years, in La Niña years, and in more normal climate years. They basically adapt to temperature changes. They are temperate water species used to a wide variation so while a few degree changes on either end will affect productivity, it is not going to affect fish health over the long term. What you want to do is avoid importing a species that is keyed to another environment. An example, cobia, a fast-growing desirable fish found in the Gulf, doesn't do well in California. It is a practical issue when you are working with the biology of a species. It is also an environmental issue, growing species that are common to California.

Weaver: Remember that the Southern California Bight has s tremendous current flowing through it. We haven't talked about a small niche market for live product that can't be imported. Right now that means a couple of thousand metric tons a year going to the Asian live food market. If we could come up with an aquaculture supply, the Asian market would be very pleased and pay high prices for the product. This makes an economic stepping stone, a smaller 1,000 ton system, much more profitable and overcomes a lot of problems.

King: I have funding questions. How is it going? What kinds of promises are being given to your investor?

Kent: Rather than seeking investors, the institute has decided not to seek funds, but to acquire the permits on our own. It is a function of being certain that the environmental ethic on which we operate is maintained for the commercial offshore operation that has the permits. By being the organization that acquired and owns the permits, we are the responsible party. It is our reputation that is on the line and it is our ethics that will drive the program. We have dropped the investor search and are concentrating on getting the permits. Once we have those, I don't think it will be much of an issue to find the investors. There will be people who will want to be involved.

Grader: Has the institute looked at invasive species that now exist as a food source instead of fishing down forage stock, something that many people complain about? Are you looking at multi-trophic operations instead of just cages?

Kent: We are looking at more traditional food sources, alternate protein sources. The use of protein in fishmeal is dropping. It has been mentioned that feed for salmon is down to 20 percent fish meal. In Florida pompano is now down to 10 percent. We are working with NOAA and USDA on soy bean as a food source. Different species require different forms of protein requirements. What works for salmon won't work for California yellowtail. There are many ideas surfacing and being worked on, for example, in Colorado a group is looking at the bacteria byproduct from brewery water. Sam (King), you may be able to serve beer-battered fish from inside out.

When the infrastructure is out there, there is no reason why the operations cannot be multi-trophic. If engineered correctly, there may be some pickup of detritus. However as far as algae blooms are concerned, I think we will hear later from Dale Kiefer and Jack Rensel's presentation of their model, that if the production of algae could get picked up, the process is so long that the nutrients are far gone and so dilute that there is no benefit. However, there is no reason why you can't take advantage of the background level of nutrients, zooplankton and phytoplankton, in the water to grow mussels and other species. For now we are concentrating on finfish.

BREAKOUT SESSION REPORTS

After hearing the morning federal, state, and industry perspectives on framing the opportunities and challenges for an aquaculture program in the Southern California Bight, the forum participants broke into small special interest groups. The results of their discussions are presented here.

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AQUACULTURE AND WILD CAPTURE FISHERIES

Mark Helvey

Ass't. Regional Administrator for Sustainable Fisheries, NOAA's NMFS SW Region

Brief Overview of Demand for Seafood: According to wild catch records, 800,000mt of fish, including a lot of sardines, were caught in 1915. The catch dropped off in the 1950s with the decline in sardine stocks. None-the-less, in the 1960s there was still a sizeable catch of abalone, clams, black seabass, and off Mexico, large tuna. All that has changed. We will probably never see those "boom years" again. Yet today, the demand for seafood is increasing and one of the solutions to the supply problem is believed to be aquaculture.

Economics: What is the relationship between setting up aquaculture and the impact it will have on wild stocks? The group thought that what is missing is the economic issues between the two. There was also discussion about competition for market access. If aquaculture produces the same species as is being wild caught, will the public pay more for the wild species? If products are coming into the U.S. from another country and are being bought and sold at a cheaper price than the U.S. produces either by landing or aquaculture, how is price competition going to work?

Commercial Fishermen and Aquaculture: There was skepticism about the synergy we heard about this morning, i.e., fishermen participating in the aquaculture industry. Does it go beyond just support boats? Will fishermen be willing to convert or shift some of their efforts into aquaculture?

Forage Fish: In his presentation this morning on the industry perspective, John Forster discussed the conversion factor. What was not discussed was the impact of taking out one trophic level to feed another species that is being grown or cultured in an aquaculture facility.

Reducing Pressure on Wild Stocks: Can aquaculture reduce pressure on overfished wild stocks? Again, back to forage fish. Is taking away a trophic level of a forage fish really benefiting overfished wild stocks when some of their prey is being removed?

Growing Out Captured Fish: Capturing fish to grow them out to market size, such as is being done with bluefin tuna and hamachi, brings up the issue of spawning stock and recruitment of spawning stock to the biomass. What is the impact on wild fish stocks when the populations are pushed down to the ages where they are no longer reproducing?

QUESTIONS AND COMMENTS

Bartley: Did your group talk about market differentiation between wild fish and fish farming as a mechanism to reduce competition?
Helvey: We talked a little about what people are willing to pay for wild vs. farmed. Market forces are going to direct much of this.

Bartley: Will there be strategies to improve wild fish stocks but not at the expense of either farmed fish or wild fish?

Helvey: It wasn't discussed but it is a good question.

Schubel: Does King's Fish House promote both wild and farmed species?

King: Yes, we feature both on our menu and there is demand for both.

Rubino: Not many finfish are landed in the San Diego area. If you go to Gulf of Mexico restaurants, I doubt that you will find local fish on the menu. It will mostly be shrimp. Fish buyers in the Gulf say "we are losing our cultural heritage in terms of fishing". They are looking for other ways to find red snapper, redfish, and groupers.

This is the advice we are getting from fish buyers about price. If you bring a large quantity of fish on the market all of a sudden, of course you are going to affect prices. If you bring the supply on gradually and build a market as you go, then you can get good prices.

Z. Grader: Two points in regard to California.
1. Don't lose sight of the tremendous potential for recovery of salmon populations. Although zero now in California because of water management issues, we could conservatively produce 20-30 million pounds per year with proper water management.
2. Some species such as sardines, anchovy, and possibly herring, have the real potential of being food fish as we saw with squid several decades ago. This will have an impact on aquaculture. You have to look at each of these species to determine where we are. That is why we have to be careful about the data in some of the graphs presented this morning. They can be very misleading unless you know the details about some of these particular species.

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ECONOMIC VIABILITY

Benedict Posadas
Associate. Professor of Economics, Mississippi State University

We heard that it took 10 years to get a permit plus an additional three years to harvest the first product. Why does California want to develop an offshore aquaculture industry?

- To provide a local food supply and reduce the carbon footprint?
- To ensure environmental quality and food safety and security?
- To attempt to reduce the trade deficit?
- To take advantage of California's existing expertise, technology, and infrastructure?

What is needed to start and maintain a project?

- Determine the market
  - Customer preferences
  - Product form—live fish, whole fish, steaks, filet
- Identify new investors and the cost of capital
- Have insurance for workers, for natural disasters, and for product liability
- Produce a quality product in a consistent year-round supply
- Produce a product at a cost at which you can make a profit in California while competing in a global market with products grown in areas where labor and other costs are lower.
- Generate the needed environmental data--water quality, current data, and GIS mapping

Other issues/concerns that need to be addressed

- Siting and permitting. Giving a permit to a private company to lease an area of the ocean appears to be in conflict with the Law of the Commons.
- Costs. Can they be internalized?

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ESCAPEES

Dennis Hedgecock
Paxton H. Offield Professor of Fisheries Ecology, University of Southern California

We discussed three aspects of the issue: consequences, prevention, and the regulatory environment.

Concerns arise mainly from experiences with salmon farming. In general when we in California talk about marine species, we are dealing with local species as defined in California law—native species not exotic species. These marine species do not have the same population structure that salmon have.

Salmon are anadromous; they spend part of their life cycle at sea and come back to their native stream to spawn. One of the concerns is that escaped farmed salmon could breed with natives and ultimately disrupt the adaptive nature of the separate breeding populations. From a decade of study we know that large salmon populations swim in a very large sector of the ocean. The concerns for disrupting local populations are not scientifically valid.

Reduction of Biodiversity. There is a concern about reducing diversity. We have a hatchery program for fish from a very small genetic base. Initially there were some concerns that if they escaped, they could reduce the genetic diversity of the wild fish. We analyzed the white seabass enhancement program where all the framed fish are released into the wild. From results of that study, it appeared that there were no negative consequences and that there were positive benefits. So that doesn't seem to be a concern. Of course, in a farming situation you would want to keep the product to sell, not release them, so even in an extreme case where all were being released, the concern about reduction in biodiversity is not warranted. Genetic marking of every farm-reared fish to determine whether or not every wild-caught fish is an escapee is probably not practical at this stage.

Disease. The other potential consequence could be diseases. There is not much to say about this concern in the absence of any known diseases experienced in a marine demonstration project.

Competition with Wild Stocks. In regard to competing with wild stocks, it is difficult to assess this challenge with existing information.

Preventing Escapees. The best strategy is to do everything possible to eliminate escapes through proper cage design. We talked mostly about the physical gear problems, floating cages, which are designed to withstand sea conditions more extreme than those encountered in the Southern California Bight. It was felt that the gear that exists is probably robust enough to reduce the probability of escapees. The complete absence of escapees cannot be guaranteed. An analysis is needed.

One potential problem could be damage to cages and nets by predators, but the nets seem robust enough to withstand predators. Sea traffic, including barges coming through in the middle of the night, could of course wipe out net pens.

Security: This could be a serious problem in our urban coast. Then there is the potential for sabotage, something to be thought about from the social aspects standpoint. In the short term, 24 hour security might be necessary along with the installation of fencing and remote observation technology.

Genetic Impacts. Farming of native species is being proposed and at least in the initial stages of aquaculture, it would probably be important to keep the fish as genetically similar to the wild population as you can. The upside of this strategy is that if you did have escapes, you would not be introducing anything that wasn't found in wild populations. The downside is you can't take advantage of the efficiencies of domestication that are possible with advances in modern science.

Regulatory Concerns. SB201 states that liability has to be assigned and damages assessed, but there are a number of unanswered questions. What would the damages be? What constitutes an escapement event? Two fish that fall over the side? 10,000 fish that escape?

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FEED & FEEDING EFFICIENCIES

Robert Stickney
Director Texas Sea Grant College Program, Texas A&M University

Fish feeds are on a trajectory to sustainability. We have made significant gains but we still have a long way to go. It is going to take time, but we are getting much better.

Cost of Feed. One of the main reasons to reduce the amount of fish oil and fish meal as a diet for farmed fish is the high cost of these commodities. One point that was made clear was the impact of the Chinese aquaculture industry. There is no shortage of protein in the market place today. It is there in various sources, but it is being competed for as a commodity. In my view if aquaculture doesn't use fish oil and fish meal, another sector of the food industry will. There may be other sustainable sources of feed coming online that will also be competitive. There is a great deal of research going on to reduce the use of fish oil and fish meal in animal feeds.

Dallas Weaver told us about the use of stack gases from power plants as CO_2 sources to produce algae. If that could be done, it could support large scale aquaculture and reduce some of the global climate change problems. It's not clear how large the ponds would have to be.

A Driver for the Industry. In order for offshore aquaculture to develop as an industry, it has to address the underlying processes and have a driver—a driver for development of a modern industry. Right now there is some grant support from USDA & NOAA (largely through Sea Grant) in its aquaculture programs. The total amount of money available, however, is small. If we do not drive the process as an industry, we are going to be fairly slow in getting the needed research done. One of the ideas talked about to expand funding was development of a fisheries trust fund, the bottom line of which would be to produce a safe, secure seafood supply.

An act drafted in California to finance such a fund would involve a fee paid for every fish or other seafood product landed, imported, or cultured. This should be a country-wide fund that would support not only the aquaculture community, but also the wild fisheries sector. It is an interesting idea but its fate is unknown. Almost every commodity the USDA is involved with has a check-off in which money is raised for research. The U.S. catfish industry took off only after the industry got together and formed a cooperative with a funded program for research and marketing. The idea is certainly worth consideration.

Post-forum addition to the report.
In December 2006, the California Ocean Protection Council voted to provide seed money to establish the California Fisheries Fund. The Fisheries Fund was created to combat the problems of boom-and-bust cycles or steady declines in fish landings, revenue and employment. The fund offers loans to California fishing groups and businesses to assist them with a transition to more environmentally and economically sustainable fishing practices and governance.

Investing in the Future of California's Fisheries: "The California Fisheries Fund
http://www.resources.ca.gov/copc/02-08-07_meeting/0702COPC06_CFF_Ex1.pdf

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HATCHERIES

Dennis Weaver
President, Scientific Hatcheries

A hatchery is needed to make the offshore aquaculture operation work. It is straight forward in many ways, but still complex. We have to have a place to put the fish, so we have to have offshore facilities. It is the classic chicken and egg question.

The important point about a hatchery as it is done today is that access to the ocean is not a requirement. The HSWRI hatchery is now becoming more and more independent of the ocean. Practically all the water used is recycled. Since recycling water works very well for hatcheries, being independent of the ocean puts you outside the jurisdiction of most of the regulatory agencies and outside the jurisdiction of the California Coastal Commission, particularly advantageous in California.

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REGULATORY PREDICTABILITY AS A PRECURSOR TO PRIVATE SECTOR INVESTMENT

David Tze
Managing Director, Aquacopia

Three to five minutes is not enough time to draft a new version of SB201 or to improve on the U.S. Senate staff's draft of S1609. It is tempting to simply say we should look at Cousteau's statement and then regulate farming in the ocean as is done on land. That is not really fair given the difference between the two and the fact that we have not regulated the land sustainably.

Regulatory Predictability. It is important to realize that regulatory predictability is the definitive element that will determine global competitiveness. From an investor's viewpoint it often is the first thing looked at in terms of whether to invest money needed to encourage the start of offshore aquaculture.

Investors are demanding There are a number of dimensions of predictability they look at.

1. Investors want some predictability of outcome. Obviously if there were total predictability, there would not have to be an application process to know what these changes are in rough terms for permits.
2. Investors want to know what criteria will be applied. Preliminary briefings would give the potential applicant that information and describe the kind of process they will have to go through. Florida has state employees who help guide investors through the regulatory process.
3. Investors want transparency and predictability in the permitting process. Given the layers of government and different agencies currently involved in implementation of regulations nationally, a needed change that would improve on, if not resolve, many of the predictability issues and long delays would be to reduce the number of agencies involved in the permitting process. Having some sort of lead agency to coordinate would help remove some of the uncertainties from the applicant's perspective.
4. Investors don't like idea that their funds will be tied-up for an unspecified time.

Some other Issues. Security of tenure duration. The figure of 20 years is often used as a desirable one for permits for leases.

Environmental Standards. I noticed that even Jerry Schubel stated 'highest' environmental standards. Investors will require limits. Realistically we need to end with a more reasonable measure, a compromise between environmental impacts offshore, impacts which could be trivial, and the appreciable benefits for many offshore projects. One of the criticisms often made of SB201

is unlimited liability as far as the environmental impacts are concerned. I think there have to be limits to liability with the end result something that can actually be bonded.

Costs. Cost has to be predictable and reasonable as far as the full costs of the application whether we are talking about environmental consulting services, legal work, or modeling. These are all costs that could be enormous. The requirements of the application process from the investor's prospectus, the actual cost of the lease, the disadvantages of an auction-based system, and the undesirability of lease extinctions, all have been discussed previously.

Current Status. I don't often see news that aquaculture permits have either been approved, denied, or even that an application process has been initiated. This is indicative of the problems that exist now and the issues that need to be addressed

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Water and Sediment Quality

Burton Jones
Reseach Associate Professor, Dept. of Biological Sciences, University of Southern California

There are two components to the primary concerns we see from a water quality system standpoint:
1. dissolved components that go into the water column from a farm operation, and
2. particulate outputs that go into the benthos—the carbon and nitrogen components.

We believe that water column problems are not large. Of more concern are the benthic components but that is going to be an issue of scaling and may be location dependent. Even these may not be large problems. There is an advantage in putting the facilities offshore. As was stated earlier today, there are mechanisms for monitoring to use as a basis for any needed corrective actions.

Given the strength of the current system in the Southern California Bight and the history of outfalls, effects on water and sediment qualities are probably not large problems. A water quality study, (Southern California Bight Nutrient Loading Study), under SCCWRP that will take place in spring 2009 was funded by the California Ocean Protection Council. It is geared to study nutrient projects specifically in the Southern California Bight. Both an observational and modeling program, it will include both large and small scales. We think it is particularly relevant to the potential problems of aquaculture water and sediment quality impacts. As test sites are established, one issue will be appropriate monitoring that will enable us to determine the magnitude of these inputs. We believe that the mechanisms to study these are straight forward based on other programs that have gone on historically studying nutrient inputs from ocean outfalls.

Post-forum addition to the report
In December 2008, because of California's financial situation funding for the SCCWRP project was among the many grants frozen until further notice. [Communication from Steve Weisberg, Executive Director of SCCWRP])

Input from environmental groups

Our final statement. We believe we need to have input from environmental groups. Appropriate modeling and monitoring programs will respond to their concerns and provide the kinds of scientific data and information needed to properly site, operate, and manage offshore aquaculture farms.

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WORKING WATERFRONTS

James Fawcett

Director Marine Scientist & Policy Outreach for Sea Grant Program, University of Southern California

We have concerns about two issues involving the working waterfront.

1. Preserving resources on the working waterfront for commercial fishing, and
2. Preventing conversion of commercial fishing facilities on the working waterfront into other uses that are incompatible.

Dealing effectively with these concerns comes down to education and research.

Preserving the Working Waterfront. We discussed the nature of the problem in terms of whether or not there is a mechanism under coastal management regimes that provides a priority use for commercial fishing in working waterfront areas. In some cases, such as Southern California, there is. In other cases there is not. In the latter cases it becomes a highest and perceived best use issue. If someone comes along who wants to build 500 condominiums on the waterfront that would be good for the community economically, at least in the short term, the project probably would be approved.

The question then becomes how do you prevent such a thing from happening in the absence of either statutory or regulatory authority that would prevent premature or inappropriate conversion of these working waterfronts. Our group concluded that it is fundamentally a matter of education. The public needs to understand the social and economic consequences of having commercial fishing, whether it is aquaculture or traditional commercial fishing, and the potential downside of losing shore-side support facilities.

Waterfront Support of the Fishery Industry. We discussed inventory. What are the facilities in the seaport areas that support commercial fishing and offshore aquaculture? One of the suggestions was that to build support and a broader understanding of the consequences of the loss of these facilities would be through surveying the waterfront stakeholders. Academic researchers are not as attuned to the values of the working waterfront as are many in the local population and we discussed using graduate students to interact directly with the public to facilitate this process. It is a way of doing research inexpensively and graduate students are not nearly as threatening to the interviewees as many professors can be.

Public Outreach. We also need to find ways of getting people together to address their suspicions and misapprehensions about aquaculture operations. Earlier in the day Mike Rubino pointed out that it's less about the lack of scientific information than it is the lack of a good means of bringing people together to exchange views. How do you get a meeting of the minds? It was suggested that professional mediators be brought in to facilitate and hammer out some of these issues when you are contemplating offshore aquaculture operations. A less expensive but viable approach is to use Sea Grant. Sea Grant is viewed as an honest broker in bringing people together to gain consensus.

So fundamentally the issue is loss of commercial fishing facilities along the working waterfront, especially a loss by conversion into more intensive uses that would prevent commercial fishing from being viable in the port.

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HEALTHFULNESS OF SEAFOOD & AQUACULTURE PRACTICES THAT COMPROMISE IT

Charles Santerre

Professor of Food Toxicology. Purdue University

We know that the nutrients in fish are healthy for the human brain and eyes, and for the cardio-vascular system. We also heard from an earlier speaker that Americans are eating 15.3 pounds per

person per year and if we were to follow the recommendations of health professionals, individuals should eat eight ounces of fish per week, the intake would increase to 26 pounds of seafood per person per year. From a California standpoint, it is important to decide whether we are going to harvest that increase of 10 pounds per individual per year from wild fisheries, produce them from aquaculture operations, or a combination of the two.

Pollutants in Fish
Feed can be easily controlled in aquaculture operations. The issue of pollutants is those that get into the feed of the fish, then into the fish, and ultimately into the human consumer. If you control the feed, you control the quality of the harvested fish.

Therapeutics can be controlled through proper management. It is true there have been some abuses. For example, the improper rise of agricultural grade emanectin in salmon aquaculture in Chile may have caused resistance in sea lice and further spreading of infectious salmon anemia. Abuses have not occurred in Canada, Norway, or the U.S. where emanectin has been used responsibly.

Fish as a Functional Food
A last point—fish should really be examined as a functional food. A functional food is one that provides nutrients over and above typical nutrients such as vitamins and minerals. Farmed fish contain ingredients good for human health. For instance, we already know about the lipids DHA and EPA. There is some exciting research being done at Texas A&M on arginine. Some researchers are starting to look at fluorine, and other amino acids. There are some nutritionists researching polyphenols and that fish may be a way to convey them into the human diet. Bottom line is that if fish become a functional food, it could increase the value of fish and producers could gain a premium from selling these products.

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THE VALUE OF MULTI-TROPHIC AQUACULTURE COULD BRING TO THE BIGHT

Charles Yarish
Professor of Ecology and Marine Sciences, University of Connecticut

What is integrated multi-trophic aquaculture? Some people use the term polyculture but that does not describe the process clearly. The terms are not equivalent. Integrated multi-trophic aquaculture (IMTA) is the situation in which the producer is working with selected species in net aquaculture and balancing the impacts by growing species that are extractive: for example, mollusk species such as shellfish, as well as those that extract inorganic nutrients. It is growing producers and extractors together. The extractive species have to be selected based on the species in the net system, all of which produce different levels of waste products. The physiology of tuna is different from that of rockfish. While putting nets away from shore may get the grower away from the issue of nutrient enrichment in an area, dilution is not the solution to getting rid of the waste. All fish are not the same in terms of their waste products.

IMTA is really an ecosystem approach. It combines a linkage of biological diversity within a man-made system. It takes a lot of thought to do it right. The combination of species cannot just be thrown together. Growing seaweed is different from growing fish. The industry has its own issues.

Hatchery systems need to be created to feed the breed stock to these farms. Siting is important. Carrying capacity models are needed to set limits on expansion of farms without losing environmental quality. Diversity of stocks is important. There should be multiple species of a family within the same farm, not just one species of the food type. Mixing of products provides an opportunity for economic diversification. It will help cover risk of loss and soften the impacts of fluctuating prices.

What Is Needed In Southern California? A demonstration IMTA facility is needed here to show the industry and the public it will work. Canada has an excellent facility. We don't have one in the U.S

AQUAMODEL SIMULATION OF OPERATIONS AND ENVIRONMENTAL IMPACT OF NET PEN FISH FARMS

Dale A. Kiefer
Chief Scientist, System Science Applications
Jack Rensel
Senior Scientist, System Science Applications
Frank O'Brien
Director of Software, System Science Applications

I'm a professor at the University of Southern California. I have been active for many years in fish farm effects modeling and studies. My two co-authors are Jack Rensel and Frank O'Brien. Both are my associates at Systems Science Applications, Inc. Frank could not be with us today. Jack has over 30 years experience in benthic ecology and fish farm impacts since the first study of fish mariculture impacts in Puget Sound. He conducts routine monitoring for NPDES compliance and research at several net pen facilities in Puget Sound. Mr. O'Brien is a highly experienced modeler and software engineer. He wrote much of the underlying code for EASy and developed the Mariculture module with assistance from other team members.

A little history first. I have seen aquaculture evolve on the west coast of the United States. In the 1970's I was involved in a project near Seattle, Washington. There were problems—some big problems. Site locations were driven primarily by logistical support considerations so locations were commonly less than optimal. Essentially there were no monitoring requirements. The installation of an extremely large array of 160 cages in the moderate depths of Clam Bay had a marked adverse benthic impact that extended to depths from 150 to 450 meters. In the 1980's pens were sited behind a breakwater at Shoal Bay where water circulation was inhibited.

There has been a real learning curve as a result of lessons learned in those early years of coastal aquaculture. Impacts of currents, monitoring, feed selection, protection of the environment, and development of a computer model that simulates fish farm operations and environmental impact that enable us to select sites to minimize impacts. I will be describing the EASy AquaModel that has been used by HSWRI to select its proposed demonstration site off of the San Diego coast. Don Kent described this morning.

The AquaModel

System Science Application's results of runs of a computer simulation of fish farm operations and environmental impact for two large scale farms are shown and discussed in this presentation. Described first is the computer software, AquaModel, and then the mathematical basis and validation of the model, and finally the results of simulations to examine the operations and impact of an offshore demonstration fish farm proposed by Hubbs Sea World Research Institute (HSWRI) for a site off San Diego. After insuring that the simulation of the impact of a fish farm operating in the Puget Sound could be accurately measured, we then ran a one-year simulation for the offshore farm that was sited 6 km off San Diego in waters of 91m depth. The results of the study are presented in the conclusion section below.

Overview

To our knowledge our EASy AquaModel is the only software that provides a complete, dynamic model of farm operation and environmental impact. It is also the only software that fully integrates environmental information with model computations within a GIS. More information can be found at www.AquaModel.org and simplified demonstrations of model use can be found at http://netviewer.usc.edu/projects.htm (only use Internet Explorer and closely follow browser options). The GIS program EASy is described at http://www.runeasy.com.

AquaModel and the Underlying EASy GIS System:

- Provide a "home" for environmental information obtained from satellite-ocean thermal and color sensors and field surveys or remote sensing and reporting of currents, nutrients, oxygen, chlorophyll, and other related parameters.
- Contain a simulation of virtual fish farms that can be 'placed' within given water body and operated according to the conditions found at that location.
- Most importantly, the information system fully integrates field surveys of conditions in the water body with a dynamic model describing the growth and physiology of penned fish under any operating conditions selected by the user.

EASy Software Architecture and Data Itegration Processes.

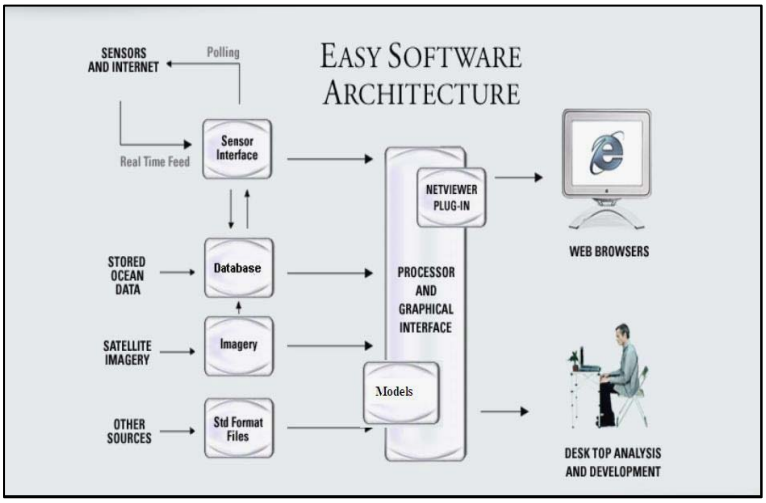

Fig. 1 The GIS software EASy provides a four dimensional framework (latitude, longitude, depth, and time) to run simulation models and analyze field measurements as graphical, numerical and statistical outputs. EASy, whose components are summarized here, is an advanced, PC-based geographical information system designed for the storage, dissemination integration, analysis, and dynamic display of spatially referenced series of diverse oceanographic data.

AquaModel graphically renders dynamically in time, within their proper geo-spatial context, both field and remotely sensed data and model outputs as diverse types of plots, including vector, contour, and false color images. A built-in data contouring feature is included. Vertical structure of data, critical in oceanographic applications, is depicted as vertical contours for transects or depth profiles at selected point locations. Time series for measurements and relationships such as vertical profiles within the database at individual stations can also be visualized interactively as X-Y plots.

Presently over 50 different X-Y plots are available for different parameters viewed as vertical profiles or horizontal cross sections that are dynamically updated in real time simulations. The software also provides access to data, integrated visualization products, and analytical tools over the Internet via Netviewer, a client-server, plug-in for EASy.

AquaModel consists of 4 components: a 2 or 3 dimensional description of water circulation, a description of the growth and metabolic activity of the cultured fish within the farm, a description of the planktonic community's response to nutrient loading, and a description of benthic effects (Figure 2 below). I will be talking about only the farm and benthic components.

The primary benthic parameter of interest is the loading of total organic carbon, but the model also simulates the status of sulfides, interstitial dissolved oxygen, aerobic and anaerobic bacteria biomass, carbon dioxide and related parameters in the sediments.

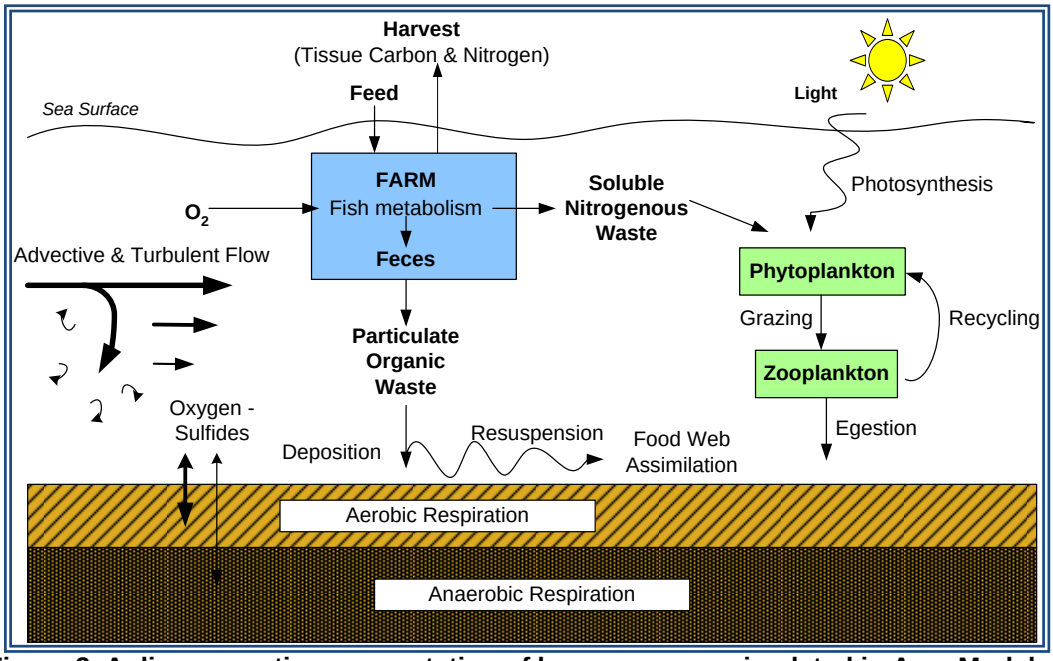

Figure 2. A diagrammatic representation of key processes simulated in AquaModel

Fish Physiology and Farm Module

A fish farm is characterized by its two main properties In AquaModel simulations,

1. the farm's physical settings and layout and
2. the farm's stocking, feeding, and harvesting regime.

The physical layout requires entry of these types of information:

- number of cages
- location of the cages as described by their geographic co-ordinates (latitude, longitude, depth)
- size of the cages length, width, height and slight adjustments to approximate fitting into the square grid system
- fractional difference between the current speed within the cages and ambient current speed

Farms operations require entry of this information for each cage.

- fish species
- metabolic model of the fish as described below. Although the system of equations describing growth and metabolism is invariant with species, the coefficients found within the equations likely vary with species
- mean weight of fish in grams wet weight at initial stocking or a selected time intervals
- density of fish in number of fish per cubic meter at initial stocking or at selected time intervals
- feed rate in grams dry weight of feed per day. This rate can be entered manually or calculated automatically by AquaModel as an optimal feed rate
- estimated percentile of uneaten feed loss from the cages

System Science Application has developed AquaModel's routine describing the metabolism of modeled fish. It is based on extensive review and parameterization of basic bioenergetics studies as well as some of our own unpublished laboratory experiments. (See Rensel, Kiefer and O'Brien 2006 for more background). **(*Note: Cited references are listed in the Appendix of the forum report*)**. Its unique feature is its inclusion of equations for oxygen-limited metabolism, a feature necessitated by its importance in farms where fish are cultured at relatively high densities in waters of moderate or lower dissolved oxygen concentration. Dissolved oxygen is a primary limiting factor to net pen carrying capacity and is, therefore, of considerable modeling interest. As indicated in Figure 3 below, the routine includes the processes of ingestion, egestion, assimilation, respiration, excretion, and growth.

Carbon, nitrogen, and oxygen fluxes are all computed, and of course the rates of these fluxes vary with operational and environmental conditions. The operational independent variables are listed above while the environmental variables that determine metabolism are:

- water temperature
- ambient oxygen concentration which is one of the determinants of the concentration of oxygen with a cage
- ambient current velocity, which is another determinant of oxygen concentration within the cage as well as a determinant of the respiration rate required of the fish to swim at a speed in order maintain their position within the cage.

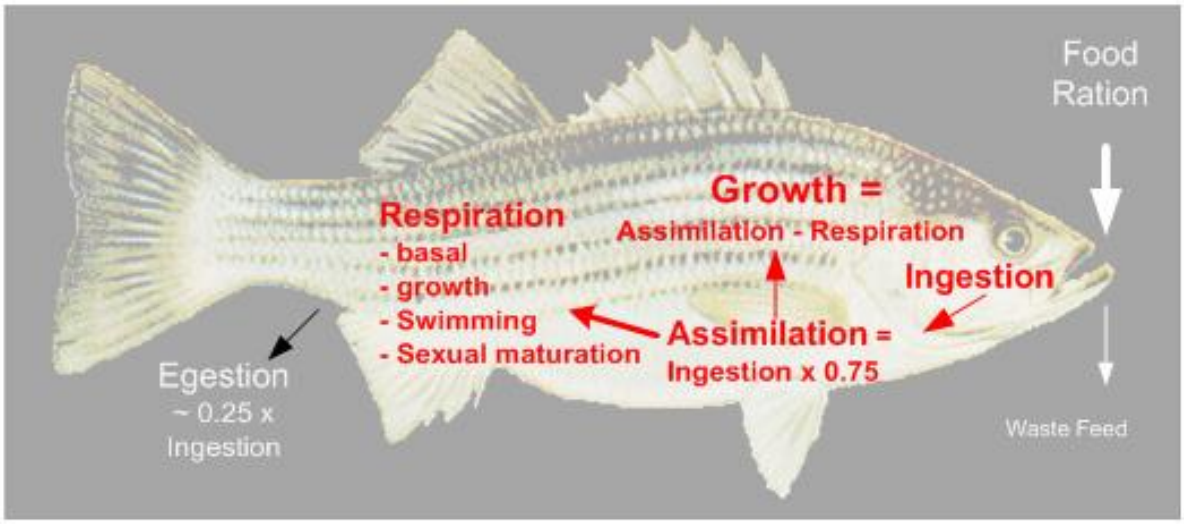

Figure 3. Generalized fish metabolic processes described by the routine for fish metabolism

Striped bass routine

The striped bass routine consists of a series of functions describing the fluxes of carbon, nitrogen, and oxygen as determined by the basic features of metabolism, ingestion, egestion, assimilation, respiration, and growth. Specifically, each element is tracked according to these five basic features, which are related to each other by conservation of mass:

1. Ingestion rate = egestion rate + assimilation rate
2. Assimilation rate = rate of respiration + rate of growth
3. Respiration rate = resting rate of respiration (i.e. basal) + respiration rate of activity (i.e. swimming) + respiration rate of anabolic activity (i.e. growth)
4. Rate of feces production = egestion rate
5. Rate of loss of uneaten feed = feed rate – ingestion rate

The functions for the five basic metabolic processes can be summarized as:

Equation 1. Ingestion rate is determined by both the rate of supply of food and rate at which the fish can assimilate ingested food.

- **Equation 5**. If the rate of supply of food exceeds the sum of the rate of egestion and the rate of assimilation, then a fraction of the food will be uneaten and contribute to the particulate waste produced by the cage As indicated in the figure above egestion is assumed to be a fixed fraction of ingestion as determined largely by the nutrient composition of the feed.
- **Equation 4**. The rate of egestion is in fact the rate of feces production.
- **Equation 2**. The assimilation rate of the fish will be a function of the size (age) of the fish, the temperature of the water, and the concentration of oxygen within the cage. The assimilated

nutrients are then either consumed by respiration or contribute to the growth of the fish. (We assume that there are no reproductive demands within the cage.)

- **Equation 3**. The rates of respiration, which include both the consumption of oxygen and excretion of nitrogen, are determined by three processes
  - basal metabolism, a function of water temperature and the size of the fish
  - swimming metabolism, a function of the fish's size and swimming speed
  - anabolic metabolism which is demanded by and proportional to growth. The growth rate of the fish is simply calculated by subtracting the rate of respiration from the rate of simulation.

Outputs from the simulation include three dimensional maps of the two types of waste plumes (dissolved and particulate) created by egestion, excretion, and respiration by the farmed fish. Outputs also include the growth rate and standing stock of the fish, and the concentrations of nitrogenous nutrients, oxygen, and particulate waste within the farm. Many other parameters and plots of vertical profiles or transects can be viewed simultaneously, and all data can be written to spreadsheet or database to allow statistical and other types of post-model processing.

Benthic Module

The benthic loading component of our model is based in part on the DEPOMOD model (Cromey et al. 2002a, 2002b) that in turn is based on the G-model of carbon degradation (Westrich and Bernier 1984 and subsequent papers). While both DEPOMOD and AquaModel describe the physical dynamics of waste transport through the water column and deposition to the sediments, AquaModel provides a more detailed description of the biological dynamics of waste assimilation and re-mineralization by the benthic community.

As uneaten feed and feces produced by fish in each cage sink through the water column, they are transported downstream of the cage. Since uneaten feed is larger and denser than feces, it must be treated separately. Not only will these different classes of particles sink at different rates and be transported at different distances from the farm, but when they reach the bottom boundary layer their shear thresholds for deposition and resuspension will also differ, leading to further separation. Eventually, both uneaten feed and feces will either be consumed by the benthos or consolidated into the sediments and no longer subject to resuspension.

The uneaten feed and feces produced by the farm are nutrient sources for the benthic community. Figure 4 shows the components and process that are described by our benthic routine. As shown the components of the routine consist of four dissolved compounds species, oxygen, sulfate, hydrogen sulfide, carbon dioxide, which flow between the suspension and sediment layer by diffusion. It also consists of particulate organic carbon (POC) produced in overlying waters from farm waste or the planktonic community, and the benthos, which consists of two groups of macro and microscopic organisms that mediate the chemical transformations.

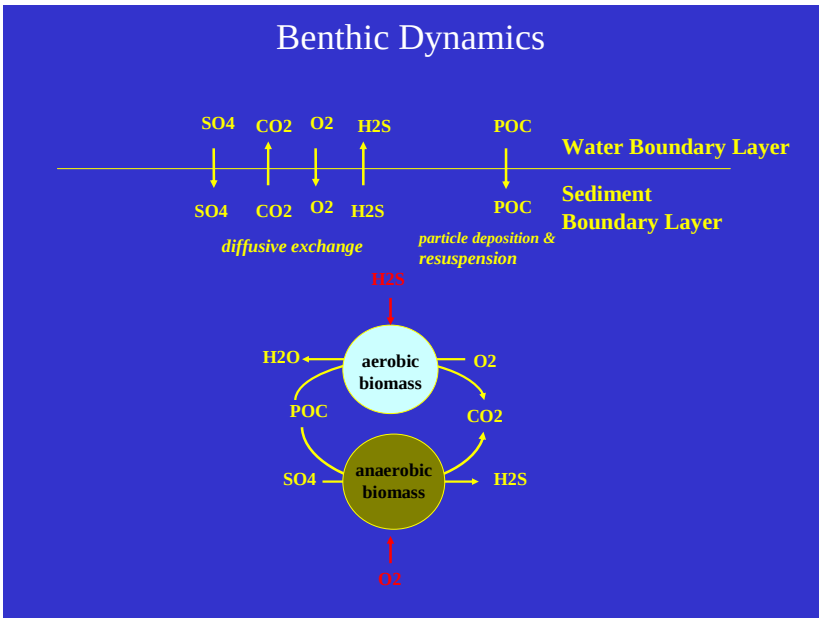

Figure 4. Conceptual model of benthic dynamics processes

The aerobes respire particulate organic material (POC in the diagram) and oxygen in order to grow and meet other metabolic needs. The main by-products of their metabolism are carbon dioxide and water. If either the concentration of oxygen or POC decreases below saturating concentrations, rates of growth and respiration will decrease. Furthermore, at the lower extremes of temperature, oxygen, or organic deposition, aerobe growth will stop and respiration will be reduced to a basal level. The anaerobes, which here consist only of the sulfate reducing microorganisms, respire POC and sulfate. The main by-products of their metabolism are carbon dioxide and hydrogen sulfide (or other reduced sulfur compounds). If either the concentration of sulfate or POC decreases below saturating concentrations, rates of growth and respiration will decrease. Additionally, at the lower extremes of temperature, oxygen, or POC growth will stop and respiration will be reduced to a basal level. If produced at a sufficient rate, the hydrogen sulfide produced by anaerobes will inhibit the growth of the aerobes. On the other hand, oxygen inhibits the growth of the anaerobes.

It is clear from Figure 4 that the size and growth rate of the aerobes can be limited by the supply of oxygen from the overlying water column. In our routine the rate of supply of oxygen to the sediments is determined by the diffusion of oxygen from the suspension layer into the sediment layer, and the rate of diffusion will be determined by the difference in the concentration of oxygen in the suspension layer and the sediment layer, and the thickness of the diffusion boundary layer at the interface. If the current speed in the suspension layer increases, the thickness of the boundary layer will decrease and the rate of diffusion will increase. The concentration of oxygen in the sediments is assumed to be in quasi-steady state such that the rate of oxygen consumption by the aerobes, which varies with the concentration of oxygen and the concentration of particulate organic carbon within the layer, is equal to the rate of oxygen supplied by diffusion.

Our simulation of benthic dynamics indicate that if the organic loading rate of the sediments is not too rapid, the respiratory activity of the benthic community will remineralize much if not all of the particulate organic material thereby releasing carbon dioxide into the sediments and water column. These predictions from our benthic routine have been confirmed by field studies such as those of Findlay and Watling (1997) and modeling work of Chamberlin and Stucchi (2007).

Results of Simulations

Figures 5, 6, and 7 are examples of recent simulations to determine the impact of a commercial-sized, offshore demonstration fish farm offshore that has been proposed by HSWRI. Specifically, we compared the fate of dissolved and particulate waste of the offshore San Diego demonstration farm with a comparison farm operating in Puget Sound. Although comparable in size and stocking density, the comparison farm “is growing” striped bass in a water column that is 25m deep and whose currents are dominated by semi-diurnal tides while the demonstration farm “cultures” a comparable biomass of the same species in a water column that is 91 m deep and whose currents are dominated by the wind. Since the impacts of Puget Sound salmon farms have been well documented, our Puget Sound simulation served as a standard help validate our model. The model was then applied to the proposed San Diego offshore farm site, well studied oceanographically but where fish farms have never been operated.

The types of information available at any time during a simulation are shown in Figure 5 below, which is a screen print of the results at a single time step after a period of deposition of waste early in The Puget Sound run. The figure shows a base map of the organic carbon in the sediments in units of gram of carbon waste per gram dry weight of sediment. As indexed by the color legend in the upper right corner, the background fraction of total organic carbon (TOC) in ambient sediments at 0.6% by dry weight as designated as white in color. This is typical of conditions at Puget Sound net pens that typically have 10 to 20% silt and clay. The TOC footprint of waste carbon from the 24 cages of the farm (shown as dark green circular dots) is shown in varying shades of color indicating concentration of TOC in the sediments.

- Light blue is an increase to a fraction of about 0.1%, which covers a relatively large area (~280 x 400m), but would not be measurable given sampling and analysis error and natural variation. This area would be considered the “halo” area where enrichment of the infauna will undoubtedly occur and likely will be measurable in terms of increased diversity and biomass as described in the classic paper of Pearson and Rosenberg (1978).
- Light green color indicates a region where TOC fraction is about 2% and is a region where measurable chemical and biological changes would occur. In regulatory language, this is the “sediment impact zone” or SIZ. It is shifted slightly south in accordance with the persistent north to south current direction in the current meter record.
- The narrow yellow regions are peak TOC values of about 3% where we would expect reduced diversity of infauna and occurrence of opportunistic species such as *Capitella capitata* that are able to tolerate the level of organic enrichment occurring here.
- The light red areas indicate a TOC fraction approaching about 4% which would have conditions similar to the yellow region but slightly more intense In the lower right corner is the simulation control panel which provides the means, sets the start and end times of the simulation as well as the time step at which the results of calculations are rendered on the computer screen.

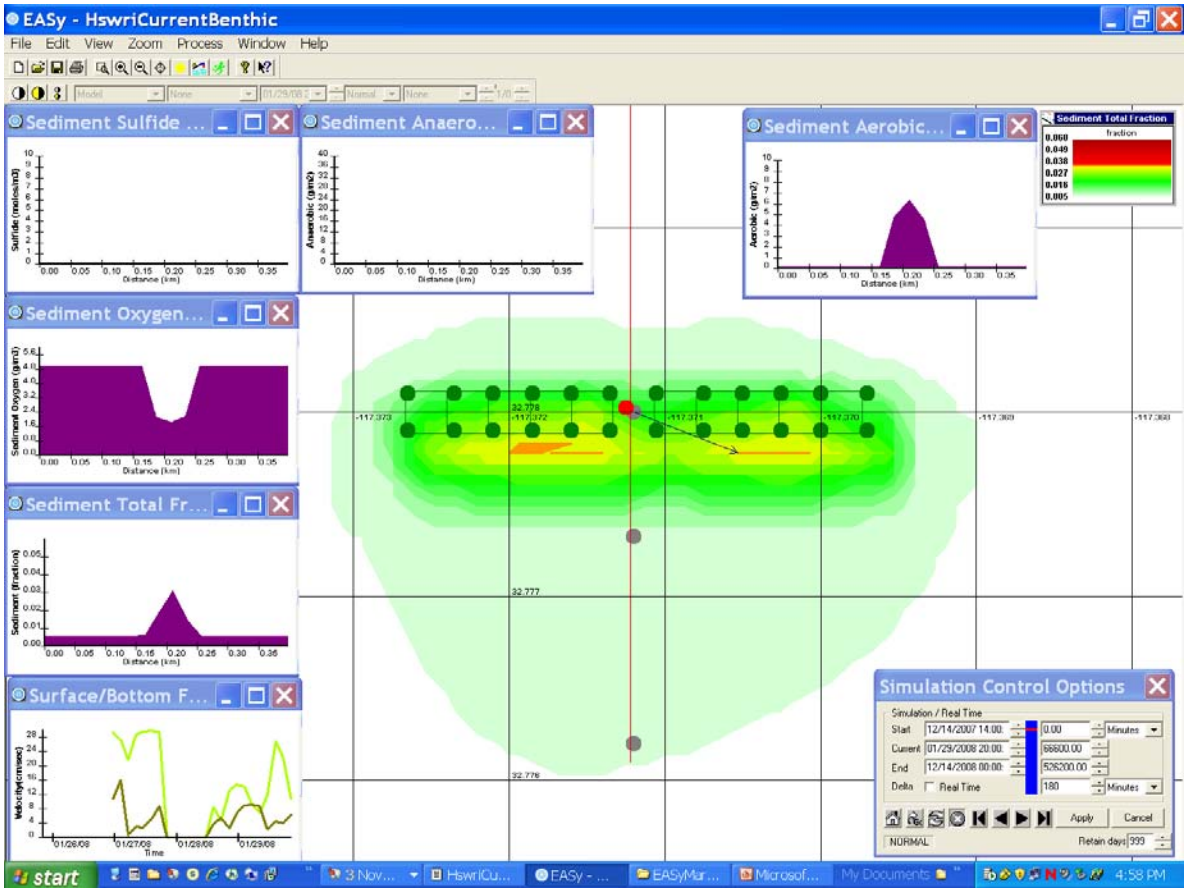

Figure 5. Example of graphical output from the simulation model at 46 days run time showing selected benthic effects components of the output only.

In the lower right corner is the simulation control panel which provides the means, sets the start and end times of the simulation as well as the time step at which the results of calculations are rendered on the computer screen.

Now, a description of the X-Y plots clustered around main image of Figure 5. The lower left corner has a graph showing the speed of currents at the surface and in the suspended layer above the bottom for the previous 3.5 days. The remaining graphs provide values on several key variables along the red transect line that runs through the center of the base map as follows. (These are just a few of the ~50 such graphs available to examine vertical profiles or cross sectional transects). Moving from bottom to top and then from left to right, these are the:

- Total organic carbon fraction in sediments along the transect reached a maximum value of 3% immediately south of the cages at this point in the simulation,
- Sediment oxygen concentration, which reaches a minimum value of 1.8 g O_2 m^{-3} (same units as mg/L) and is a mirror image of the distribution of organic carbon,
- Hydrogen sulfide concentration in the sediment layer, which is in moles H_2S m^{-3} and negligible,
- Biomass of anaerobic organisms in the sediment layer, which is in g C m^{-2} and negligible.
- Biomass of aerobic organisms in the sediment layer, which peaks at 6 g C m^{-2} and is a mirror image of the distribution of organic carbon.

Finally, the base map (main image) shows a vector that indicates the velocity of the current in the suspended layer, three gray dots that are sites we have selected to store the results of computations at each time step for the entire simulation. The red dot is a site we have selected to obtain a vertical profile of parameter values in the water column. One can also double click on any cage to obtain information of stock density, fish size, feed rates, growth rates, and rates of waste production.

Surface and bottom velocities over the past few days of the run and at the current time are shown in the lower left corner of Figure 5. The conditions at this time step are near the upper end of the impact of waste deposition by the demonstration farm. Examination of the complete time series clearly indicates the dynamic and erratic nature of waste deposition in waters of varying current velocities. If the mean current velocities are close to threshold levels of deposition and erosion (as is the case for comparison farm), small changes in current cause rapid, frequent, and dramatic changes in local rates of waste deposition. Thus, Deposition and erosion of wastes near a fish farm change rapidly with relatively small changes in velocity.

As previously explained, simulation of the demonstration fish farm is identical to that of the comparison farm with three exceptions. The current velocities throughout the water column are 25% higher thus matching the Doppler current meter record that was recorded in the winter of 2007-2008 at the proposed site. The depth of the water column was increased from 25 to 91 meters in order to match the proposed offshore site. And the spacing of the cages was increased by greater than three times. These changes profoundly change the fate of particulate organic wastes produced by the farm as well as the effects on water column parameters such as dissolved oxygen and nitrogen concentrations, discussed later in this report.

Figures 6-7 are snapshots taken at different times on day 17 of the simulation. The color scale in the legend of the comparison farm has been reduced by 10-fold order to visualize the TOC footprint of the farm.

In Figure 6, the base map shows the spatial distribution of TOC in the vicinity of the farms. This deposition event was initiated by a drop in bottom current velocity within the suspension layer to a rate below the threshold of deposition for waste feed for certain and at times for waste feces. As indicated in the plot of current velocity (mid right plot) the bottom current decreased to a relatively slow range periodically for several days prior to the snapshot. This event is best considered a dusting of the sediments around the farm since the amount of organic material deposited is extremely small; so small in fact that we were forced to increase the sensitivity of the legend color palette 30-fold in order obtain sufficient contrast to visualize this weak footprint. As indicated by the color legend (upper

right), the ambient concentration of TOC was set at 0.006 g carbon per g sediment (0.6% by dry weight), which is the same as that of the comparison farm simulation. Yet the peak concentration of TOC within the footprint is only about 0.0063 g carbon per g sediment dry wt. (= 0.63%, lower left plot). This difference is probably undetectable by the most accurate sampling and analytical techniques.

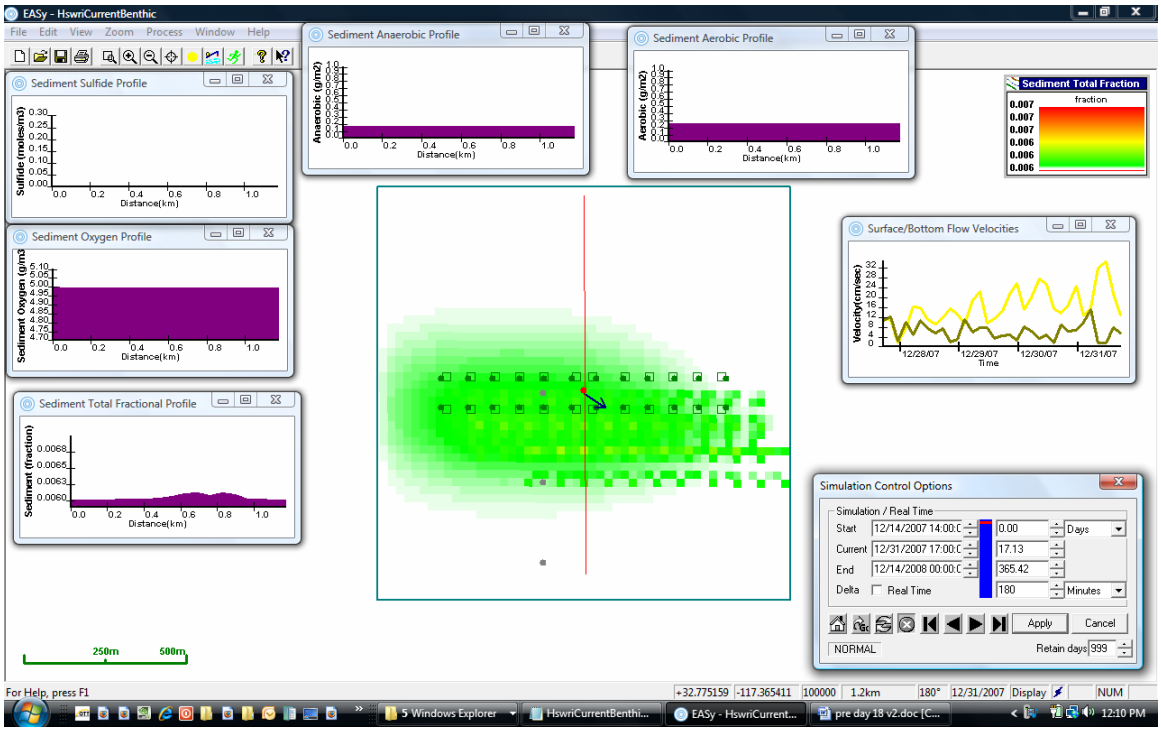

Figure 6. Demonstration of a fish farm simulation at day 17

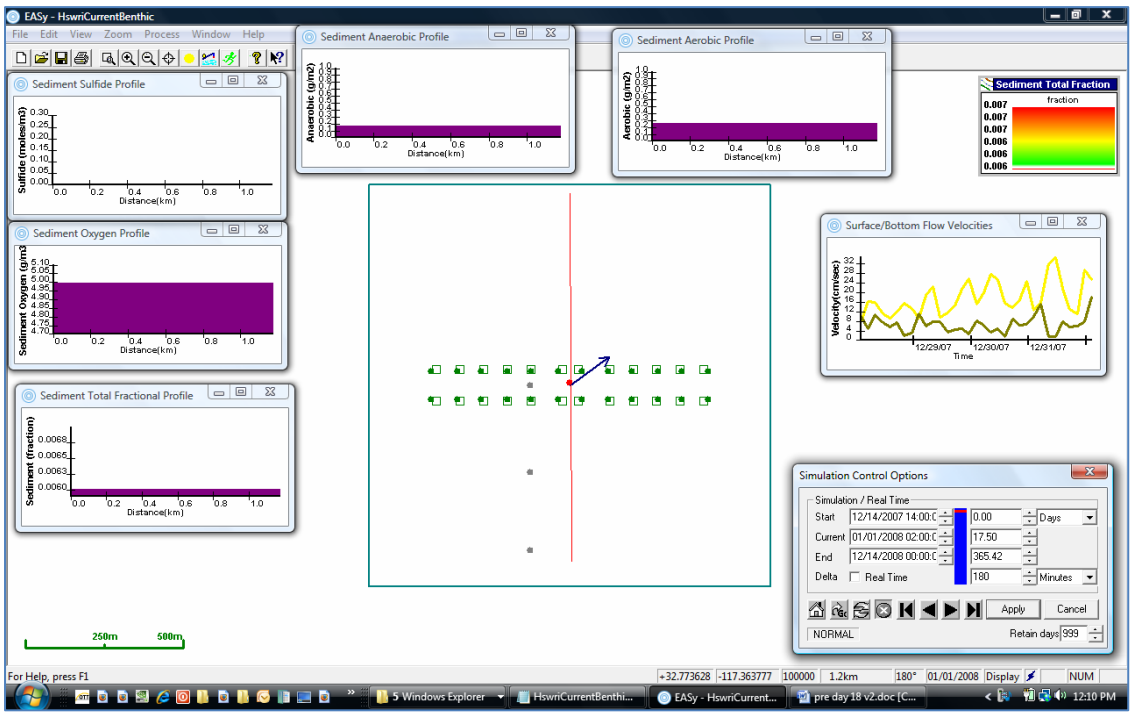

Figure 7. Snapshot of conditions 9 hours after those shown in figure 6

This sedimentation event did not perturb the virtual benthic community. The concentration of oxygen in the sediments remained high, 5.0 g O_2 m^{-3}, similar to O_2 concentration in the suspension layer

(water column above immediately Figure 7. Demonstration farm simulation at day 17.5 (9 hours after previous figure).above the bottom) and the hydrogen sulfide concentration of hydrogen is negligible (upper left plot). The biomass of aerobic organisms (mid right plot) is low, 0.25 g carbon m^{-2}, and the biomass of anaerobes (mid left plot) remained low because of oxygen inhibition.

The two figures illustrate the transient "dusting" of the bottom with TOC. Figure 7 shows that the dusting has been completely removed by increased bottom shear 9 hours after deposition. This pattern of dusting of the sediments with farm waste during low current velocities and sweeping of the waste during high velocities is found throughout the time series. Our simulation of the demonstration farm indicates that the impact of the farm will be restricted to a small increase in the biomass of the aerobic organisms and possibly some minor increases of infauna diversity and biomass associated with the "halo effect" first described by Pearson and Rosenberg (1978).

Conclusion: The much lower rates of waste deposition at the demonstration fish (fig 6 and 7) farm relative to the comparison farm (fig.5) are the result of the additional time required for the waste particles to reach the sediment. This additional time to fall through the water column insures greater dispersion (dilution of the waste) at the time of deposition. In addition the frequency of erosion and dispersion events was higher at the demonstration site because the currents at near the bottom were roughly 25% greater at the demonstration site. Finally, the rates of deposition are sufficiently low that the benthic community will provide a carrying capacity sufficient to remineralize the additional deposition of labile carbon.

Although the impact of the comparison farm approaches the limits of the standards set by the State of Washington (a leader in regulation), the demonstration offshore farm far exceeds any standards utilized in any jurisdiction worldwide for fish farm regulation. These results are not unexpected given the strong currents and relatively great depth at the demonstration site. Just as importantly, the currents are not excessively strong, which means that the fish farm can be operated and maintained correctly and the risk of structural failure should be less than in other environments where mean current velocity exceeds 30 cm s^{-1} for prolonged periods (Rensel et al. 2007).

While we predict that it will be difficult to detect the presence of the demonstration farm from changes in sediment chemistry, it may be possible to detect small changes in benthic infauna. Weston (1991) showed that invertebrate infauna respond more quickly and measurably than sediment chemistry measures. In the present case, because the loading to the sediments will be far below 1 gm carbon/ m^2 per day (a commonly accepted threshold of loading that begins to result in adverse effects), the organic deposition by the demonstration farm should be positive, providing increased organic food supply and resulting in enhancement of the biota both in species diversity and biomass..

In Summary

- Benthic effects at the HSWRI Farm were <10x the nearshore comparison fish farm site due to moderately strong currents, great depth and pen spacing.
- Both the theoretical nearshore and proposed offshore site will exceed standards of the State of Washington (a leader in regulation progress and rigorousness)
- The HSWRI offshore demonstration site far exceeds any standards utilized in any jurisdiction worldwide for fish farm regulation and performance.
- Water column effects: transitory, minor decreases of dissolved oxygen and increases of dissolved inorganic nitrogen within the cages and immediately downstream.
- The organisms at greatest risk to changes in water quality in any net-pen fish farm operation are the farmed fish themselves, not wild fishes or invertebrates.
- The Southern California Bight offers large areas for offshore fish farms. It has a total area of 3,200 km^2 with depth of 40 and 100 meters.

REACTION PANEL 1: SCIENTISTS AND ENVIRONMENTALISTS RESPOND WITH ADVICE ON IDENTIFYING ZONES, INCREASING OPPORTUNITIES AND DECREASING THE RISKS OF SITING, AND OTHER ISSUES ASSOCIATED WITH OFFSHORE AQUACULTURE IN THE SOUTHERN CALIFORNIA BIGHT

Jerry R. Schubel, Moderator

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William Eichbaum
Vice President, Marine Portfolio, World Wildlife Fund

The World Wildlife Fund (WWF) has been very active in the aquaculture area for more than a decade. We do a series of aquaculture based dialogs[17] that are designed to ultimately produce standards for aquaculture products that hopefully would become the basis for a process of certification. WWF is currently working on about nine different products and I believe the first of the standards will come out in early 2009.

I am working on the problem of restoring native oysters to Chesapeake Bay. We are looking at aquaculture be a big part of the process. Dealing with cultural traditions, the infrastructure changes we've talked about, and the attitudinal issues—these are quite severe in Chesapeake Bay as they are in many nearshore areas.

As I listened today, what was I learning? What was I stimulated by? What was I troubled by? I have come up with some ideas and I hope you will forgive me if they are unduly provocative, or naïve, or perhaps not very helpful. I haven't had the time to turn them into helpful, highly sophisticated statements. But they are issues that have come to my mind as I listened today.

Some Framing Points: Some Concerns

1. When I come to California, I always think that I am coming to a place that has one of the largest economies in the world. I think that those of you in California who are thinking about building this offshore aquaculture industry need to think about how do you do this from the perspective of being one of the largest and most robust global economies.

2. How many here have read *The Omnivore's Dilemma*? (See Pollan 2006) It is an interesting and provocative description and analysis of the food supply business, primarily in the United States. It ranges across three or four different models beginning with the factory production of beef consumed in McDonald's hamburgers and ends with the author shooting a wild boar south of San Francisco and serving it with other food that he gathered in the Berkeley area. In between there are several other models.

I think one of the things that those of you who are interested in aquaculture and in high seas based aquaculture need to think about is what sort of model do you want this industry to look like? What do you want people to think about aquaculture products when they have a choice to make in a restaurant between wild and foreign aquaculture products? Some of those models are not particularly attractive such as beef lots in Kansas. Also some of them are very impractical such as shooting wild boar regularly south of San Francisco.

So what is the model in terms of where it fits in an economy, where it fits the global economy? That is what's important. And that brings me to another over-arching issue that is very important to us at WWF.

Think Globally before Acting Locally

We work around the world on aquaculture issues and on marine conservation issues. Our work takes us not only into the biodiversity of the sea, but also into the lives of people who live around the world,

17. http://www.worldwildlife.org/what/globalmarkets/aquaculture/item5218.html.

people who are very intimately dependent on the bounty of the sea for not only their basic food, but what may be their only opportunity to move into a cash economy. The question becomes what is the right balance between what California might be able to afford to get for itself and what the people in much of the world need to be able to rely on the ocean for? I think this is an important and relevant question when we talk about aquaculture, particularly when we talk about carnivorous fish in the open ocean and we talk about fish meal and fish oil which I will come back to.

What is the way the use of the protein of the sea going to look like not in five years when we are perhaps doing one large experiment, but in 20 years when there may or may not be an industry in the ocean waters off of California?

Having laid out a few concerns that I feel are important, I want to touch on some specific issues.

Ocean Governance
A number of discussions this morning included the issue of governance. I am truly persuaded that unless the United States gets its ocean governance system fixed, we probably aren't going to see widespread high seas aquaculture in this country. The conflicts over use are just too great and in too many areas for that to happen. And that's true not just for aquaculture. It is true for a number of uses today, particularly for energy from marine resources being used themselves or the winds over the sea. being harvested. So ocean governance in my mind is going to be a critical component; however, I don't believe that however artful, willful, and creative the lawyers and politicians in California are, that they will be able to range out through the whole EEZ because of the failure of the federal government to play a role there.

Ecosystem-based Management
A second point—I was quite surprised that in response to my question this morning the observation was made that ecosystem-based management can't work, or isn't going to happen, or whatever the comment was that I am paraphrasing (Bartley, page 26 snf 88). If we can't get to effective ecosystem-based management in our marine environment, we aren't going to have aquaculture in the high seas. The two have to go together. I think it is useful to reflect on whether or not you necessarily have to have ecosystem-based management, although I would argue as I did in my first point that we should have an integrated and woven together theory of governing the ocean, I think that even if you have sort of single topic management regimes, as we do in fisheries regimes generally, it can be done on an ecosystem basis. It's harder, but it can be one. I don't think we should give up on ecosystem-based management even if it is sort of "wonky". Certainly no one in the public knows what you are talking about. It's hard. The government structures don't allow for it. We don't have the science. But if there is one place we do have the science to do ecosystem- based management, it is here is the waters of California. It would be a tragedy if that resource of scientific knowledge weren't used.

The Forage Fish Question
Coming back to the fish meal/fish oil forage fish question. The issue there in my mind is not so much efficiency, although that is an issue. The issue that did come up later in our discussion is whether we want to use every single last element of the trophic levels of life in the sea to feed human demand, or do we want to leave something there for the biodiversity that we currently see. That's really the issue about forage fish, and also perhaps related to opportunities for the poor people of the world.

Climate Change
A topic that I am very surprised did not come up at all, words that I have not heard once—climate change. What might happen to life in the marine environment, and particularly if it happens here? This is probably not very relative when discussion is about something that will occur in the middle of this century. Certainly what you will be designing over the next five to ten years will not be relevant. I do think, however, that people have to take a much more serious look at what the potential impacts of climate change in the marine environment could be and consider them. I have not given up on

mitigation but I think the reality is that we are going to face changes that are unanticipated and profound, and they will be fairly quick, especially in the marine world.

Conclusion
So having said all of that, where does that leave me? It leaves me with some questions about whether all elements are in place to adequately test the hypothesis laid out at the start of the forum. I do believe that it is probably useful to start to think about what the careful design of an experiment and scale would be while recognizing that an experiment and scale are not the same thing as building an industry unless the issues I have raised, and that I'm sure others have thoroughly examined, are addressed.

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Mark Drawbridge
Senior Research Scientist, Hubbs Sea World Research Institute
President, California Aquaculture Association

I am here wearing two hats. One is that of research biologist at Hubbs Sea World Research Institute. You have heard about the work we have done in the past and are proposing to do. I can reference, and I would like to, some of that work that has gone on. My other hat is that of the current president of the California Aquaculture Association.

As has been discussed today, marine aquaculture in California is very small. It is mostly shellfish. There are a few abalone farmers who are interested in experimenting with finfish species as an add-on to their current operations. But in general the California industry is very small.

Yes, from my perspective and looking at what I hear at quarterly board meetings and other meetings, the aquaculture industry in California has some real challenges. We've talked about fresh water use and many people are now looking at the marine environment.

On a small scale with cages for white seabass NPS permits are not requires because the cages are so small. But through that process and working in this case with the regional boards, over time we have developed monitoring programs tapping into the expertise of consultants such as Jack Rensel and Ken Brooks from Washington State. Again, no re-inventing the wheel, but in this case, tapping into what has already been done in salmon culture. Bringing that expertise to the table has been very helpful.

Our plan for our offshore aquaculture project might not have been immediately obvious. A project we proposed five or six years ago has been mentioned. When we proposed it, we did not have the luxury of having the AquaModel. What we did was fill out an NPS application; put together a proposed environmental modeling scheme for both the water and the benthos based primarily on what was know for salmon. We never quite got to the point of sitting down with the EPA to flush out what they liked and didn't like about that particular approach. In this case partnering with Jack (Rensel) and Dale (Kiefer) we have an opportunity to model the impacts ahead of time using the AquaModel. Of course, there will be an ongoing monitoring program associated with the project in which we will get needed validation information. Jack alluded to the model taking some of the mystery out of that particular part of the equation. I understand that, based on our previous discussion that is only a piece of the pie. But it is certainly helpful if you are going through the permit process to knock down as many of the issues as you can.

Let me make some observations in reference to some of the comments that have been made.
We have a project going on now in Mexico in which we are learning a great deal. This is a cage demonstration project we would rather be doing in California. In this case we are testing species that have never been cultured before in Pacific coastal waters, California yellowtail and striped bass. We

are also testing different cage designs. Again, things that have never been done before to address some of the concerns and questions. We have a fixed, floating, gravity-style cage being tested side-by-side with a submersible cage trying to evaluate both the performance of the fish and the operation of the cages—what they require in terms of maintenance, how they hold up in storms, what's required to clean them, etc. We have the regulatory structure in place where agencies are identified to regulate and monitor these cages. It's not like the NPS permit for example. You have to renew the permit every five years. Through experience with our hatcheries we have found that every five years when we go to NPS to renew, NPS has changed something, sometimes it has been more onerous for us, sometimes it has been less. Through working with the agency, we have developed a good relationship and from that perspective, it all makes sense.

In context of our discussion here, and any demonstration project out there, this one happens to be small scale. It is designed to answer the concerns of people. The best way to do it is get some fish in and some data out.

Something else that is going on, as mentioned, earlier is development of the PEIR for coastal waters. From the perspective of the California Aquaculture Association, we look at the PEIR very optimistically and are anticipating its availability. It will be extremely valuable. With the project that I have just described, we have to go through all the same exercise on our own. How nice it would be to have a more comprehensive document that deals with 80-85% of what we have to do!

The regulations for permits exist. Standards have to be set. There are some from the salmon industry but I don't know how much can be brought over into an offshore environment.

The thing that is obvious to me, and obvious to most of you, is that net finfish farms are in a set location. You can measure what is going on in and around them. It is not like something free wheeling out there in the environment. The checks and balances should be in place for those types of things.

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George Leonard

Director of the Aquaculture Program, The Ocean Conservancy

The Ocean Conservancy is a national organization headquartered in Washington, D.C. with offices around the country including one in California. We like to think of ourselves as science based and also solutions oriented. I work in the policy arena, largely on fisheries. My predecessor at the Ocean Conservancy, Tim Eichenberg, had an integral role in the development of California's SB201 so we have some institutional history here in California in respect to the issue of offshore aquaculture.

A few comments starting from the broad and going to the narrow.

First, I think there is some real value in the analogy of farming the ocean as we farm the land, particularly, thinking about the details of that analogy. Think about how poorly we have done on land and then think about the analogy in ocean systems and how we cannot follow the same trajectory.

In many respects this is all going to turn into a discussion about specific geographic areas and no one has a social license to operate in public trust resource areas. You need to work with the public to gain insights into that. In many respects Neil Sims has done a very good job in Hawaii. We need to reach out to the community and have a discussion with the public. My sense is the discussions here would be quite different if there were different people in the room. That is something that should not be underestimated.

The other issue we need to think about is how you integrate the concept of aquaculture into the concept of ocean protection generally. The idea of ocean protection, marine reserves, marine

protected areas—specifically thinking about areas in which there will not be aquaculture as much as we think about areas in which there might be aquaculture. We need to make sure both are addressed.

With respect to California specifically. The Ocean Conservancy's position has been that we need strong national standards for the development of aquaculture in offshore waters. We actually think that there is a real opportunity here for California to take the lead. California has often been at the forefront of many environmental issues and we don't see why this can't also be the case with aquaculture.

We believe that the terms of the liability and environment provisions in SB201 bill have set a good national standard. While we think it might be a good model, we need to think through what the problems are. We should embrace high environmental standards: we shouldn't shrink away from them. There is an opportunity for California to lead.

In that context, it is important to lead with new models, new thinking, and new ideas. Certainly there is great work being done at Hubbs but I think we need to work at getting new ideas and putting them to work—multi-trophic aquaculture, new ideas about sustainable feeds, taking into consideration how you minimize those feeds, dealing with the ecological footprint of feeds—all are going to be critical in setting that new model, in setting that new bar.

I am very concerned and worry about an expansion of traditional technology, using a traditional infrastructure in a place where 20-30 years from now you will find it very difficult to slow down the institutional inertia behind that existing infrastructure. So let's be creative and visionary now, rather than setting up an infrastructure that will hold down creativity later on farther down the line.

About the California standards. One of the things we like about them is that they are performance based and define the kinds of environmental performance we want to see. I think that allows industry to get within that rather than being prescriptive about best management practice.

My final point, getting a little narrower talking about the model. I think there are some fascinating opportunities to understand the detail, the interrelationship between hydrodynamic oceanography and the global effects of aquaculture. But I think it is also the case that models done at the farm level are not the same as Bill (Eichbaum) suggested as the consequences of developing a large scale industry. We need to be careful that if we feel very comfortable about individual sites that we understand that should not necessarily cause us lots of comfort about an entire industry 20-30 years from now.

I would suggest that we bring ourselves back to thinking not only about what we want to do on a small scale, but also make sure we are setting a long term vision that works for the public, for fishermen, and for seafood consumers as well.

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Neil Sims
President, Kona Blue Farms, LLC
President, Ocean Stewards Institute

I want to go through the Kona Blue experience about availability, achievability, and value of sustainable open ocean aquaculture because much of it is germane to our panel discussion. Then I will respond to a review of Kona Blue and Kona Kampachi® and, lastly, list seven take home messages.

Kona Blue's mission is to expand the environmentally sound production of the ocean's finest fish. The company

- Pioneers and promotes sustainable aquaculture,

- Produces and sells nutritious marine fish; and
- Builds Kona Blue as the world's leading brand of premium farmed fish.

Why the open ocean? There are minimal conflicts with other user groups. Because the water is deeper, there are minimal environmental impacts. As a result of improved water quality, the product is high quality and healthy. All of these lead to the opportunity to culture superb products in pristine waters.

Kona Blue is located on the lee side of the island of Hawaii on the Kona coast. We are protected from the prevailing winds by Keahole Point. The site attributes are:
- 200-220 ft of water, beyond diving range
- 2600 ft offshore
- Outside of fishing grounds and clear of fringing reef
- Sandy bottom
- Strong currents

We have eight submersible SeaStation™ cages in which the grid design allows the stations to be raised to half-emerged. The top of the cage is usually submerged about 30 ft below the surface in the silent world. So far over one million fish have been stocked in these offshore cages.

Third parties conduct all ongoing monitoring of:
- Fish health
- Water quality
- An adjacent coral reef ecosystem (fishes and benthos) and,
- Marine mammal interaction

To date there have been no significant environmental impacts; indeed, there has been no measurable impact outside the immediate footprint. We have seen some periodic seasonal carbon enrichment underneath the cages but once the currents pick up, it is quickly assimilated.

The finfish species we are growing is a relative of California yellowtail. Kona Kampachi® (*Seriola tivoliana*). It is a native deep water species. We are getting 50,000-60,000 fish every three months out of the hatchery. Growth rate is excellent, 2.2 kg offshore in 12 months with a highly efficient feed conversion rate. In the pen trials, it can get as low as 1:1 dry pellet per wet fish. Offshore due to inefficiencies of feeding offshore, it is 1.8-2.0 to 1. It is a great sashimi fish. There is no existing commercial fishery and the species is amenable to hatchery culture. We are harvesting 25,000 pounds a week and getting excellent reviews from restaurateurs across the country.

We are able to tell our customers that:
- The fish diet is controlled from hatch to harvest.
- Ranching is not what we are trying to do here.
- There is no risk of internal parasites or cigriatera such as is found in wild kahiala.
- There is no detection of mercury at sensitivity levels of 50 times the FDA's allowable limits.
- Fat levels of over 30% dry weight make Kona Kampachi® great for providing heart-healthy omega-3 fatty acids.

The take-home messages

1, Permitting: **Sweat equity**

Permitting is vulnerable to vagaries. Our August 2007 expansion plans were to expand the eight existing 3,000m^3 net pens. Our plans met with opposition. You are going to find people who will object to what you are doing.

a. A protracted permit process from 1997 when Hawaii's ocean leasing legislation was revised until 2005 when the first cage was developed included public meetings with

the Kona community, filing, and issuance of permit applications in between. The community was included in early discussions and throughout the permit process.

b. Met extensively with shoreline conservation, cultural, and recreational interests.

c. Placed draft EIA and public comments on our website.

d. Took a consultative, conciliatory approach to decision making.

2. Site selection: **To and fro trips**

A round trip to and from the farm site to Honokohau Harbor. a distance of 5.5 nm, takes 84 minutes at a speed of 8 knots. So proximity to a commercial harbor is an advantage. The crew is being paid during that 84 minutes and this happens every time you want to take fish out or bring them back, or take feed and equipment out.

3. Site selection: **Go deep.**

It gives me a lot of peace of mind to know not just how we impact the benthos, but also being that deep you know that the chances of any feedback loop with the benthos attacking your fish is reduced to a minimum.

4. Hatchery: **What hatchery?**

There have been some attempts to do open ocean aquaculture without an associated hatchery, involved in the business plan. If you are going to do offshore aquaculture, you have to have a hatchery. It is essential to the ability to produce the fish and it also the key to sustainability, scalability, and quality. What you present to the investors as sustainable gives you a premium and, scalable allows you to expand your operation. You are not dependent as they are in Ensenada on whether the fish show up as juveniles to be captured for the grow-out. Quality also seems to be better.

5. Monitoring: **Go green or go home.**

As an industry and as individual companies we must embrace the idea of monitoring. We have to be able to hold ourselves up as doing this in an environmentally sound manner or we are not going to be allowed to start or expand. If we are not able to expand, then really what are we doing? We monitor the effluent site immediately down-current of the cage with highest biomass one hour after feeding with a control site up-current of the cage.

The critical validation of environmentally sound aquaculture includes no discernible impact in turbidity at the cage in the surface water, mid-water, and bottom water. We have these data on our website and when people ask what's the impact on water quality, on the benthos, we can refer them to the data at http://www.kona-blue.com/emonitoring.php, and we have third party validation.

6. Market: **Build your brand.**

I would like to think we have been successful[18]. If you are going to get out into the open ocean in deep water, it is breathtakingly expensive. The number that has been talked about by Don (Kent) is about right. That's what we should be thinking about. You have to have your customers willing to pay for that. To do so you have to build your brand and you have to be able to build your brand in a rational way to differentiate yourself in the market place. We work very hard at this.[18]

7. Ocean stewards: **Divided we fall!**

If we do this individually we really aren't going to have an impact so why are we doing it? The Ocean Stewards[19] is a trade organization advocating for the emerging open ocean aquaculture industry and it has been doing so for several years.

Our mission is:

> *To represent and work toward the best use and management of the open oceans, meeting the increased demand for healthful seafood, through appropriate balancing of the expansion of environmentally sound open ocean aquaculture, with protection of open ocean resources and habitats.*

Deeply rooted in the message is the concept of sustainability, not only that we should grow more fish, but that we should grow more fish better. It is embedded very consciously in our mission statement.

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18. http://www.kona-blue.com/faq.php
19. http://www.oceanstewards.org/

We are geographically broad throughout the Americas. We are also working very hard to integrate new chapters of the ocean stewards back through the investment community, insurance companies, feed companies, soybean industry—all the way through to restaurateurs, distributors, and retailers.

Third party Validation of 'Sustainable' Open Ocean Fish Farming. We were very proud to achieve this ranking in the yellow column of the Monterey Bay Aquarium's Seafood Watch Program's guide—"US farmed yellowtail – i.e., Kona Kampachi® a good alternative." It is said that the NGO's just want to stop aquaculture. They are not looking for solutions. They do not want to help us get better at it. I think this is ample testimony that in the United States, the more rational NGO's do want to work for solutions.

Our goals for 2008 included:

First major goal
To promote offshore aquaculture through appropriate standards and validation of operations that set high standards.

- Sustainability standards forum—a further dialog process concerning what the ocean stewards do. We are working closely with WWF to progress toward sustainability standards so we can have third party validation on an individual farm basis. While it is not certification, I think it is something that we should move toward, something that is akin to the individual farm certification that you see in organic standards.
- Promote a higher profile for Ocean Stewards and open ocean fish farming as a sustainable industry. We are going to encourage others to aspire toward better production systems.
- WWF, Monterey Bay Aquarium, and some of the other more progressive NGOs are joining us. We hope to have an announcement soon about the dialog for the two we are initially going to focus on, *seriola* and cobia[20]. These are the two species we have been moving forward with in the U.S. and open ocean aquaculture.

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Second major goal
To represent ourselves, the industry, as doing aquaculture in the open ocean in an environmentally friendly and sustainable way.

Third major goal
To bring U.S. permitting efforts closer to fruition:

- Offshore aquaculture legislation: Hopefully we will be going back to the new administration with representatives of the NGO community side-by-side with us to argue the case about the need for unified standards.
- We are actively supporting the
  - Fisheries Management Plan (FMP) for the Gulf of Mexico. and
  - MMS rulemaking process which I think is a helpful step in the right direction provided that NOAA and EPA have full regulatory oversight of it.
- Advocating additional research funding both for wild fisheries and for aquaculture to ensure a safe, secure supply of seafood for the nation. We need more research for feeds, engineering, etc

To come back to "Advisability, Achievability, and Values?" Why do this in southern California? I think we have a responsibility to do this on a number of levels.

- Leadership: We need to harness California's indomitable, entrepreneurial spirit.
- If not us, then who? If not here, then when and where?

The value of this? We have a moral responsibility. People have to be eating more seafood. In 2006 the seminal article written in by Mozaffarian and Rimm (See Mozaffarian and Rimm 2006) pointed out

20. www.worldwildlife.org/seriolacobiadialogue

that with a modest increase in seafood, the consumption of oily fish, there was a 35% reduction in mortality from heart disease and a 17% reduction in mortality across the board***. It is an imperative that we do this.***

I think I've answered the questions, "Why in Southern California?"

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Robert Stickney
Director, Texas Sea Grant Program
Professor, Biological Section, Department of Oceanography, College of Geosciences,
Texas A&M University

I have been involved with the Gulf of Mexico aquaculture and what was called the aquaculture amendment which has now changed to a full fledged management plan. Wayne Swingle, executive director of the Gulf of Mexico Fishery Management Council, appointed me to an ad hoc committee that was to look at the proposed amendment. The first draft was 200 plus pages, most of which repeated every 10 pages. The committee sent it back to council and the members worked on the amendment for another 12-18 months. At a second ad hoc committee meeting we ironed out some of the options that were being proposed and recommended what the options might be. Public hearings followed.

I think the council got tired of waiting for the federal government to act and decided to put something together the council thought would work. They went to NOAA legal where the document disappeared for several months. Now the council is trying to develop the regulatory process. It is the same issue over and over again. This permitting and regulatory process was one of the main reasons progress was held up. You don't get much interest until you have a regulatory environment that people can understand.

I think it was in 2005 that I was asked by the president of the American Fisheries Society to chair a committee to look at who might be interested in going into open ocean aquaculture. Mark Drawbridge was one of the members of that committee. We went out and surveyed everyone we could think of asking: "Are you interested in getting into open ocean aquaculture?" ***The response was either no response or "Are you nuts?"*** What we got back was that without a predictable regulatory environment, we are not even thinking about it until we know what the rules are. I think that is one of the take home messages we've had at this meeting. You have to put together something that people can understand.

One of the other things the committee discussed that hasn't come up here is that there has been the feasibility of developing aquaculture parks. Put all the farms together. Pack them all in. That is the best way that I can think of to create an environmental problem.

Most people I have talked to about the Gulf of Mexico plan, that I hope will get underway next year, assuming that someone has applied, don't support aquaculture parks but rather favor distribution of farms. There has been some work done on mapping of where aquaculture might be appropriate in the Gulf and in some other places. If you look at any open ocean area, there are sea lanes, commercial fisheries, and, in our case, the Gulf of Mexico has 15,000 oil platforms, all of which survived the last storms without any big spills. Also there are military no entry zones. It really limits the available space down from 8,000 km^2 to quite a bit less although it does give you some areas that look like they could be used.

I do think a demonstration project needs to be done. I applaud Hubbs' efforts but I think in the long run a commercial scale project has to be put in place to really prove the concept. Someone needs the chance to go out there and not only set up a commercial scale operation, but also be allowed to use

the adaptive management approach. If you do find the operation is causing a problem give the person a chance to rectify the problem and move on. If the approach is used that if we find anything we don't like, we are going to shut you down, that's the end of the permit and that will not go anywhere. If you look hard enough, there is going to be some kind of measurable effect and how that is dealt with has to be considered. I really like the adaptive management approach and I think it is one that needs to be included.

The comment this morning about winning a lottery was an appropriate one. If you are going to grant the first permit and you look at the applicants and decide which one has the best merit, then give someone a chance to go out there and either prove the concept or prove that there is no way they can make it environmentally, or most probably economically. I wouldn't grant eight or ten permits right out of the box.

One other thing that hasn't been mentioned is good seafood safety security. We have seen issues about toys, food, and pet food imported from China. Certainly the United States is vulnerable to food security issues too. That is something to think about, particularly in the world we live in today.

Post Forum: Action by Gulf of Mexico Fishery Management Council January 27, 2009 reported by SunHerald

"Following a long afternoon of public comments, the Gulf of Mexico Fishery Management Council voted 11-5 in favor of a fishery management plan that could see fish raised in deep-water pens in federal waters as far as 200 miles out in the Gulf. The plan, which opponents say will almost certainly face legal challenges, allows pen-raising of many of the same species now caught in the wild and will apply to federal waters off the coasts of Mississippi, Louisiana, Texas, Florida, and Alabama. The plan has been six years in the making and grew from policies by the former Bush administration.

It now goes to the Department of Commerce in Washington for review, and for implementation of regulations governing the new industry. Thus, the Gulf will become the first federally-regulated deep waters in American history to see fish raised in pens, nets or cages for commercial harvest."

COMMENTS AND QUESTIONS

Weaver to Eichbaum: This carbon business CO_2 is a real mess. I think it is probably good to note that all the life cycle analyses I have read so far including presentations, publications, and sometimes reviews that have not yet been published, seem to indicate that farmed fish are far superior to wild caught in regard to protein conversion and carbon footprint. That's the way the numbers are coming out and that includes fish and fish meal.

You used the term carnivorous fish. What is the difference in terms of the dietary requirements of a carnivorous fish and a vegetarian fish? Please note that there have been publications showing that with a zero fish meal diet, for example, rainbow trout (which is a carnivore), you get the same growth rate, the same FCR—food conversion ratio—efficiency, the same flesh quality as you get with a fish meal diet. The only difference is that the zero fish diet is more acceptable in that the fish are eating some of the same ingredients as chickens are fed and grain producers are happy.

I also want to point out that aquaculture as we know it is growing at a rate of two percent a year worldwide, not in the U.S., but worldwide. Right now something like 25 percent of the world's fish meal supply is going into aquaculture. Basically that means that in seven years, it will be 100 percent. The problem is clearly going to take care of itself.

Eichbaum: I suspect that I probably agree with you on most of what you have said and certainly the fact that the problem will take care of itself eventually is true. My only concern is that we just not allow that to happen at the rate at which natural forces whether economic or man-made, or biological cause it to happen. Instead, we should positively intervene so as to accelerate the rate at which some of

these issues are dealt with. I also think it has to be thought of in the context of what is California's responsibility in thinking about these issues in a global context, the context we are in today?

I wouldn't want to argue with any one of your specific points, and I think that in some ways your overall conclusion is not too different from the conclusion I arrived at. I wasn't making an argument one way or the other against ocean aquaculture. I was just raising a concern.

Leonard: I would also like to respond. There are two parts to the carbon footprint, CO_2 and ocean acidification. Correct me if I am wrong. One is what Bill (Eichbaum) talked about. I was able to see what you were getting at, the fact that with ocean acidification we are expecting the marine food webs to look radically different than they do now. This has huge implications for both a feed source for aquaculture and the assumptions about how fish are grown in existing sea water with existing nutrients and pH, all of which may eventually change.

Eichbaum: That was my climate point. I think Dallas (Weaver) was talking about other points I made. I do think the climate part is an important one and it is not just one of acidification. It is also currents. What is this environment going to look like?

Leonard: I want to make a comment on the forage fish issue. I think it is important to recognize, to understand, to think about the relationship between aquaculture and captive fisheries and act proactively. Is it likely that all aquaculture will move away from the use of wild caught fish, something I would like to see happen? Probably not! I would like to at least reduce the use of forage fish for feed. Has anyone called for a stop, a ban on global forage fisheries? Probably not! Something in the management of foreign fisheries that would be useful to surface is a truly ecosystem-based management system for forage fish. It explicitly would take into consideration the needs of other predators within the ecosystem and I think that alone would help the sustainability side of the feed ingredients issue surfacing. There are a host of issues you can talk about in regard to forage fish.

Finally I think forage fish is not a buzz word; in fact, it is an important word in respect to the location fish have within the trophic web and their importance relative to other fish, marine mammals, or birds above them.

Sims: A comment on the use of the term 'carnivorous fish' and the difference between so-called carnivores and herbivores. Carnivores are carbohydrate-intolerant. They cannot eat, digest, and assimilate the carbohydrates that are in the water of the diets of herbivores because of their G.I. tract. They do perfectly fine on vegetable matter as long as they have the right amino acid balance and the right fatty acid balance. I think the term carbohydrate-intolerant is one you should all become familiar with and one that we should all use. When someone says "carnivorous fish", your response should be "No! no! carbohydrate-intolerant fish."

We are working very hard at this with Kona Kampachi®. Originally we were feeding them 8-0 percent fish meal and fish oil but we have recently made a diet change to our organic diet. We are now feeding a total of 20 percent fish meal and fish oil and if we are able to keep our FCRs at 1.8. This should be under 1:1 in terms of a wet fish in to wet fish out ratio. That is ecological efficiency. We will actually be a net marine protein oil producer!

What is needed here is the engine of an industry to drive toward solutions. If we all sit back on our hands and wait for the academics to come up with solutions to this, it isn't going to happen.

Hedgecock: The issue of forage fish fisheries has been around for a long time. And the industry has been stable for decades. We just have not caught up with aquaculture.

Eichbaum: There are demands being made on—I won't call them forage fish, it seems to be an offensive term. Take krill as an example of the issue. The increased demand for use of krill as feed has resulted in journeys to Antarctica to fish the krill resources there. This is a demand that did not exist previously.

I agree with you. I was struck by one of the graphs shown today that showed a pretty flat yellow line. Where it is going has changed.

Post Forum Comment: The US National Marine Fisheries Service is considering a ban on krill fishing in the EEZ off the Pacific coasts of California, Oregon and Washington. There is a current ban on krill harvesting in the state waters of California, Oregon, and Washington.

Drawbridge: A quick comment on California Sea Grant in terms of what California's responsibility is in regard to this particular question. Two of the nation's leaders in the field, Rick Barrow and Ron Hardy, and HSRSI were just awarded a grant for a three year project to look at this. We will be working with white seabass and California yellowtail, two of the top five species identified for aquaculture in this region. The industry is concerned about it. It is written into SB201 and California Sea Grant recognizes it as a top priority issue.

Sims: On the discussion about ecosystem-based management and the need for marine reserves to protect wild fish stocks. I think we all ought to look very closely at the potential to integrate offshore aquaculture and marine reserves. I have seen many examples in which they are complimentary. In the Philippines the best instances of pristine coral reefs are right under pearl farms because there is a guard with a spotlight and machine gun sitting on top of the pearl farm to protect it. That means there is no dynamite fishing on the reef, a practice that is destroying coral reefs.

A fish farm provides structure which is the main constraint in the open ocean for diversity and productivity. So just by virtue of having your cages in a reserve, you are going to promote a higher biomass of the reserve's wild fishes. Certainly it is not the answer to pristine preservation of the marine environment. You still need to have vast areas of the ocean that are preserved where you want to have protected areas to allow your wild fish stocks to increase. However, I think there is compatibility between open ocean aquaculture and marine protected areas.

King to Sims: The analogy I often is use is that of the automobile. We are somewhere between where Mr. Binns pushed that horseless carriage out of the garage and the Model T. Where we want to get to the Prius. A term used by the organic community is continuous improvement. If we are lucky, for the rest of our lives we are going to be continuously improving this model.

King to Sims: We had a great presentation of your amazing Kona Blue operation. There are programs operating in Maine and Washington State and I believe good ones in Japan. What are we really telling California? It seems to me that there are models out there.

Sims: There are certainly ways to improve the efficiencies of our operation. In terms of being an example of what we might be able to do in terms of producing a great product in an environmentally sound way. Look at Kona Blue and Kampachi®. Mark (Drawbridge), anyone who starts to scream and holler, put them on a plane and have him sent out to Kona. We will put a mask and snorkel on the individual and show the protester our operation.

Sam, I would take exception to the broad examples you used of good operations. I think there are problems and questionable practices in some of them. You mentioned Japan. The hamachi culture there is dependent on catching fingerlings and growing them out. This means even though farmed, they are being taken from the wild stock. The impacts of taking these wild fish out of circulation are starting to show. Hamachi taken from the wild and grown-out in cages never bred in the wild and wild

stocks need the breeders for sustainability. Wild hamachi is in decline. The Japanese farmers also tend to stock the fish in high-density cages, a potential risk for disease.

Eichbaum: That is part of a point I was trying to make with some of my comments. There are those very site specific, often quite small, isolated, and not very intense examples of success. But if you want to move to scale for the industry, you have to go beyond these examples and that is the reason why I sort of stressed the need for having a vision of what California wants the industry to be doing. I don't agree that the answer is really a choice you can make. You have to have a vision.

On the governance issue. You can get a site out there—maybe—but when you try to add 20, which is what we as an industry will require, this is when you will get the conflicts, the backlash, and the increased level of environmental uncertainty. We don't really have the major issues in place, sort of a structure in which to play, the tools to deal with all this. I think having these will help an industry grow in scale in a way that will be acceptable to a broad swath of the public. That is my observation.

Schubel: I agree with you.

Drawbridge: Looking at what we have proposed for our farm as an example, I think that if we could place the demonstration project out there, stock it with fish, and operate it as is planned, then it is phased in terms of scale and production. There are safeguards in place that have not necessarily been fully defined yet but they can be in terms of maximum permissible discharges (MPDS) permits that could provide a review of the project. These permits have a five year limit. If an operation does not meet certain criteria, it needs to be modified. A project can be conditioned.

I want to address the concern being voiced that the industry is just going to spiral out of control and all of a sudden, within a two or three year periods, there will be 20 farms. We are just on the front end trying to demonstrate some real basic stuff and we can't get off the ground. That makes it difficult to answer the question what is the big picture for California. How do you map the Southern California Bight in terms of where farms are, how many there are, and what they are growing? That is probably a 10 year project.

Leonard: Sam (King), I just want to try to address your question. One of the things we have not spent much time talking about today nor have we had a formal presentation on the issue, is the nature of the environment and the risks of offshore aquaculture. We have talked a little about the subject and had some detailed information on the benthic issues. But I think some of the reasons why this is so controversial is that there is a large, a very large, body of scientific literature that has identified a host of issues based on what has emerged from the salmon farming industry. The industry has been very controversial. People get extremely upset about it and there are a lot of personal issues that come with it. Statements have been made that people are lying and making up data. It is not a pretty picture. I would suggest that there is enough evidence to suggest that there are legitimate environmental risks and that many of them are not the sediment-benthic impact. There is an issue associated with wild fish and disease impacts which I think is one of the biggest challenges and largely driven by issues of scale and how metadynamics might interact with disease problems. I think the package of issues is something that worries a lot of folks, certainly a lot of environmental folks. It also worries the fishing industry because of the potential impact on fish stocks. And I think there is worry about competition in the marketplace and otherwise with the fishing community.

These are real issues that are very much separate from where you can put your cages in the water to grow out fish and make money out of the operation. If we really want to be honest about this and we really want to develop something we can live with, then we have to deal with all of the issues and we have to be thoughtful when doing so. We have to be precautionary, risk adverse, and figure out what our level of tolerance is if we want to find ourselves in a place where we feel good about what we have done.

SUMMARY AND WRAPUP FOR THE DAY

Sam King

President and CEO, Kings Seafood Company

We are going to find our fish no matter what. California has the opportunity to be one of the suppliers but will the opportunity be seized here to provide the food and the jobs? Those who want to develop the aquaculture industry in this state are faced with a real hassle in order to do so. How much will the investor, the entrepreneur be willing to go through? If they keep hitting a wall, they will go elsewhere as has already been done by Hubbs with an operation in Mexico.

We need to make a decision to do aquaculture in California realizing there are risks accompanying the opportunities or we need to decide not to do it.

RECAP OF DAY 1 AND A POSSIBLE WAY FORWARD: SETTING THE STAGE

JERRY R. SCHUBEL

Two points about discussion/conservation that are very important to us at the Aquarium of the Pacific:
1. How to have a conversation, a discussion about something that is very important and at the same time very controversial such as offshore aquaculture or global climate change, and
2. How to have a discussion that involves all the stakeholders but still have appropriate respect for the experts.

Everyone has an obligation to think about what kind of world we want to live in; what kind of uses we want for our ocean; and so on. These are not scientific questions. They are not questions for which respect for what the experts tell us should necessarily be a factor. But when we talk about different kinds of feed, siting, types of cages, and/or benthic impacts, we ought to pay more attention to our experts so we can change our lives and live in the kind of world we want to life in.

Finding the balance is always a difficult challenge. Our aquarium has 1.5 million visitors a year. We have an additional large number who visit our website. And we constantly struggle with bringing critically important and controversial issues to the public. Recently the American Society of Limnology and Oceanography asked if we could help them figure out how to connect that professional society and its scientists to the public through aquariums and science centers.

Let me offer a few thoughts about what I heard yesterday together with some personal observations.

It is important that we recognize that we are going to be living in a different world by 2050. Like the rest of the world, California will have changed dramatically. A few ways in which our state will change that will have an impact on fresh water aquaculture.

- Potable water will become increasingly scarce
- Global climate change will markedly impact the state. Biodiversity of our coastal ocean will change due to increasing temperatures. Sea level will be higher and will impact the coast and alter our uses of it.
- Snowpack, our major fresh water reservoir, will be diminished. The northern part of the state will probably receive more rain instead of snow while the southern part will have even less precipitation than it has now.
- Currently there are pumping restrictions in the Delta to protect Delta smelt, longfin smelt, and salmon. Restrictions will in all likelihood increase to protect more threatened and endangered species. As a result of current restrictions, Southern California is losing 30 percent of the water we would normally get from the Delta and we don't have any obvious way to make it up. In large measure we have already done and are doing a good job with conservation so conservation can't do it.. Measures that may need to be taken are
    1. elimination, or at least reduction, of Inappropriate agriculture such as cotton and rice, and
    2. identification of new sources of fresh water through capturing stormwater runoff and municipal waste water runoff, and ocean desalination.
- Fresh water aquaculture may be more problematic.

What kind of future do we want to design for humans and the creatures with which we share the planet?

This really is a design problem from my perspective. Yes, some of the factors that will impact California are out of our control, but many are not. To design a future for the California we want, we

need a big, bold, more encompassing long-term vision. As was said earlier in this meeting, we need to look at the future's entire food supply and examine where an appropriately configured and sustainable offshore aquaculture could fit together with conserving and restoring habitat and managing wild fisheries. Wild fisheries in California have plateaued at about 170,000mt/yr. We do need to continue to manage our fisheries and restore essential fishery habitat, but we are probably not going to see a significant increase in wild fisheries tonnage.

As we heard yesterday there are factors that favor development of a sustainable offshore finfish aquaculture industry in the Southern California Bight.

- Favorable oceanographic conditions with good currents and water exchange, appropriate depth, and few major storms.
- Adequate space in the bight that is close to shore, markets, and land-based processing facilities, which could reduce the carbon footprint of transportation back and forth from offshore farms
  One estimate was that there could be 40 farms of 0,5mi^2 each producing, 2,500 mt/year that would occupy an aggregate of 20 mi^2, an area that is only about 0.1 percent of Southern California fish blocks.
- A wonderful breadth and depth of relevant scientific and technical expertise in California
- Large demand and a growing market. The market will increase both because of the healthfulness of seafood and population growth. It is predicted that there will be an increase of six to seven million people in Los Angeles County alone in 25 years.
- Increasing demand for locally-grown food products
- A legislative mandate to promote development of aquaculture
- Strong environmental laws and a strong ocean ethic that can be advantageous under the right circumstances
- Desire to reduce carbon footprint, fish food miles, etc.; part of a strong California environmental ethic
- Feasibility of multi-trophic aquaculture which can have advantages by reducing contaminants, enhancing water quality, and reducing the economic risk because of the addition of different crops

We heard some of the challenges to developing a sustainable offshore aquaculture industry in the Southern California Bight.

- A complicated regulatory environment with significant unpredictability. The uncertainty makes it difficult to get investors.
- The cost of launching a project given the uncertainty and the difficulty of getting investors. A demonstration project could cost $15-50 million.
- Competition for space in one of the most heavily developed and urbanized coastal areas in the world.
- Issues of 'scaling up' one or more demonstration projects to an industry. The issues are significant. What would a fully developed offshore aquaculture industry look like and what would the impacts, costs, and/or the benefits be?
- Development of offshore aquaculture would need to be done in the context of ecosystem-based management and adaptive management.
- Lack of support among many environmental groups
- Lack of public support. We need to have much more public outreach and it has to be more effective. Just having public meetings is not really the answer. We need to not only use the expertise of Sea Grant and graduate students as Jim Fawcett suggested, but perhaps also people such as Larry Susskind whom I mentioned previously. He has written a book on dealing with an angry public and he could be helpful.
- Lack of a constituency. Examples given of effective constituencies were the California associations of the wine and milk industries. More effective outreach that includes all stakeholders is needed.

- Impacts of adverse publicity. There are numerous examples of aquaculture 'gone bad'. They are well-publicized by the media and latched onto by NGOs, e.g., salmon farming in Chile. Successes such as Kona Blue's Kona Kampachi® project are seldom publicized

Then there are the questions; Why Southern California? Why not somewhere else?
One of you said I asked the wrong question. You said I should have asked *Why **not** Southern California* instead of *Why Southern California*.

- It is a moral issue according to some of you. With food shortages predicted in the future, farming of fish may be a necessity.
- Jobs are being lost offshore. It might make jobs available that can be well paying. The skills and knowledge of people in the wild fisheries industry could be utilized. At some point we have to focus on things we are good at.
- It would provide a safe, stable, secure, sustainable supply of healthful seafood. When you purchase imports, you have no assurance about any of these factors.
- It would contribute to reduction of the trade deficit.
- It would contribute to both the national and state economies.
- It would make transparent the conditions under which the fish were grown (a matter of health security), the environmental impacts, and the conditions under which the work force (the socio-economic factor) worked and the benefits provided them.
- It would create a new vision and model for what sustainable offshore aquaculture can be; would be complimentary to the 'California-Grown' label for agricultural products; and could help public buy-in of offshore aquaculture. California has the largest agriculture industry in the world, ahead of Texas by a factor of two.
- Other states and countries are benefiting from our technological expertise in marine aquaculture; we are not.
- With a little imagination aquaculture sites might be combined with some of the MPAs California is developing in a network along its 1,100 miles of coast as has been done in the Central Coast with kelp harvesting by abalone farms.
- If promoted, maybe and just maybe, if done properly, it would help us preserve the working waterfront and could help conserve wild fish stocks.

Reducing the Risks: Some Suggestions
- Site farms using ecosystem-based management and sophisticated models such as the AquaModel we heard about yesterday. It was asked whether there are any good examples where we have done ecosystem-based management. It is a very short list but I think it must be done.
- Expand cautiously. We need to be careful and move forward appropriately.
- Grow only native species or species such as striped bass that have become naturalized.
- Enforce strict standards.
- Monitor for compliance with the standards.
- Use adaptive management, erring on the side of caution.
- Create a fishery trust fund to support research in both wild fisheries and aquaculture.

There are some economic questions.
Can locally grown aquaculture products compete with imports? What will farmed fish do economically to demand for wild caught fish? Can an offshore aquaculture industry in California be a sustainable enterprise?

Lingering questions/issues on which the public may need help getting answers
If we are going to have a supportive public, we have to be able to answer these questions in ways that the public understands and can acquire the information needed to evaluate the 'other side'.
- Forage fish as feed. What is the problem/issue? How significant is it?

- The larger feed issues. Are fish feeds really on a trajectory to sustainability? What are the implications?
- The fish defecation issue. When fish defecate in the ocean, it's not the same as human fecal material entering the ocean. The public needs education to understand the difference. When fish scientists stand up in a public meeting and equate fish excrement to human excrement, you know they don't believe that as scientists. So somehow we have to make our scientists more accountable for the kinds of statements they make.

A Beginning of the Day Message
We don't know everything, but we know a lot, and it's time to begin to carefully design an offshore aquaculture demonstration project and implement it. We need to set high standards, to monitor, to enforce, etc.

A Beginning of the Day Question
Would the HSWRI *Pacific Ocean Fish* demonstration project be a good place to start to acquire the necessary data, information, public confidence, etc.?

REACTION PANEL 2: RESPONSE BY STATE AND FEDERAL POLICY MAKERS AND BUSINESS LEADERS WITH SPECIFIC ADVICE ON HOW TO DECREASE THE RISKS AND INCREASE THE OPPORTUNITIES OF AN OFFSHORE FINFISH AQUACULTURE DEMONSTRATION PROJECT IN THE SOUTHERN CALIFORNIA BIGHT *Robert Stickney, Moderator*

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Michael Rubino
Manager, NOAA Aquaculture Program

The question before us is how to decrease risks and increase opportunities.

Decreasing Risks and the Regulatory Process
First, in terms of decreasing risks we have laws and regulations. We already have a process at the state and federal levels for aquaculture projects. It is a review process. It is extremely well designed as a result of more than 30 years of experience in hatchery aquaculture. At the federal level there are the Corps of Engineers, EPA, Coast Guard, and NOAA Fisheries in terms of reviewing projects and in terms of essential fish habitat, invasive species, and protection of marine mammals. There are also some similar agencies at the state level.

The environmental standards are very much the same around the world. California may not have much experience in finfish farming but you can look to Washington State, Maine, Florida, Hawaii, Norway, Australia, and New Zealand for information and guidance. And NOAA looked at all of those places. They are becoming very similar in their approaches. Their standards are quite robust and can be adapted to moving further offshore—everything from siting, to species selection, to feeding, to environmental impacts, to monitoring, and to reporting. We also have public review through the ERIS process. Through all of this, it seems to me that the design to identify and flush out bad projects and thereby decrease risks exists. Design also exists for monitoring and reporting to identify cases of bad practices or issues as they come up.

On the other hand we have heard that from a business perspective, this regulatory review process in the United States is risky, complicated, uncertain, and costly. Most of us in the business have heard about one-stop permit shopping. That is really what is necessary. It can be done. I think there are elements of it here even in the absence of federal legislation. If the state of California and the Corps of Engineers worked together, you could have one-stop permit shopping for some of these California projects you are talking about.

There are some models available. In the late 90's the New England Fishery Management Council essentially set up a system for one-stop permit shopping for offshore aquaculture. The council's focus was scallop farming. The plan was to set up a system in which the state and federal agencies would meet with the permit applicant and discuss all the issues before the actual application was submitted. The proposal was not confirmed for a variety of reasons.

Security and Liability
The private sector is also asking for security of tenure so the rules and the goal posts cannot be changed every few years. I think the federal system is already set up to provide security.

One lingering issue that will have to be faced in California and at the federal level is the question of liability. You cannot have unlimited environmental liability. The permit review process is designed to send back, to eliminate projects with most of the risks. It is as if we are collectively taking a risk and assuming those risks by permitting projects. Some smart lawyers are going to have to define the limits

of the environmental liability box, if that is something you want to include and have it at such a level that it can be bonded.

Economics
I disagree with those who say it is less expensive to do aquaculture in other countries. The economists who worked on this offshore aquaculture support demonstrated quite well that if you can do it in Norway with their regulatory structures, at their high cost of labor and land, you should be able to do it in the United States. About 50-60 percent of your cost is feed and 20 percent is hatchery. That is the same the world over. You are talking about the last 20 to 30 percent. If you are processing a product in quantity, perhaps it is cheaper to do it with low labor costs, but if your product is one that is whole, fresh, close to market, niche market live, the shorter transportation is an advantage.

Research and Development
While there currently are NOAA programs and fisheries funding programs that can be used, we need more funding of research and development not just for pilot demonstration projects, but also to build the infrastructure around the industry such as at the university level in terms of how to handle health issues and concerns. It also helps as issues come up in terms of adaptive management, in terms of innovation in becoming even better at what could be called 'eco-efficiency' or 'eco-effectiveness', ecosystem-based management, and integrated multi-trophic aquaculture—these are areas that the industry is currently addressing and in which it should continue to move toward.

Risk Insurance
On the economic side one way to reduce risk and increase opportunities is to have risk insurance. Aquaculture in this country does not get the advantages given to the beef, chicken, pork, and milk industries. If you go to Norway or the European Union or if you are growing agricultural crops, you can get crop insurance. This is something I think the USDA is working on.

Stakeholder Involvement
Then there is the point of getting local communities involved from fishermen, waterfront, and restaurants to markets. We need to make these projects their projects. That will both help sell the product and help sort out conflicts of issues in the marine environment. It will help environmental, economic, and social sustainability of these aquaculture projects.

Building in Failure
Lastly, I would encourage you to have more than one company or group of people to do projects. You have to be able to build in capacity to be able to tolerate some failure. The venture capital approach idea is really what you are looking at. It will be a period of 10 years or more of experimentation if you go to federal waters for open ocean offshore aquaculture. If there are only one or two projects out there, with Murphy's Law operating, there will be things that happen that have nothing to do with does it really work or not. With 10 or more projects perhaps two or three would do well, three or four fail, and a couple would be in between. You will learn a lot in the process.

Conclusion
Put risk in perspective. As has been said, we know a lot about aquaculture. Relative to other marine and human uses and their impacts on the marine environment, the risks of aquaculture are quite well known. And they are small. If we spend 10 years in build up going from no projects to say 10-20 projects, we will have to step back, reassess, and look at it again.

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Benedict Posadas
Associate Extension & Research Professor of Economics, Mississippi State University

I was asked me to comment on the economic viability of offshore aquaculture in Southern California. For the past five years my work has been devoted to other efforts, especially after Katrina, but this was a challenge and one I assume not without risk. While my experience with Southern California is limited, I took the challenge based on my experiences between 2000 and 2005 looking at aquaculture in the Gulf of Mexico. The model I am presenting is the one I prepared last week and is my first in terms of economic viability in this part of the U.S. It does not include yesterday's discussion. My presentation will cover U.S. marine aquaculture, preferred aquaculture species, economic model of Commercial Offshore Aquaculture Production System (COAPS.), risk analysis, and potential economic benefits. The graphics used in the presentation can be accessed at www.msstate.edu/dept/crec/publish/posadas-sep2008-longbeach-handout.pdf

Risks and Uncertainties

The term 'risks' as used in this presentation is defined as the probability that an investment's actual return will be different than expected due to uncertainties in the following

1. biological performance of the production system,
2. physical environment surrounding the production system,
3. markets of its fish products, and
4. markets of inputs used in production.

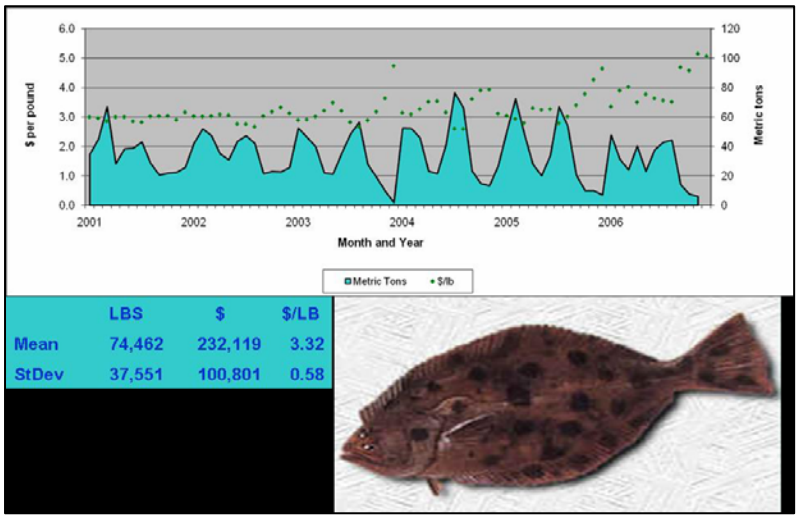
These are some specific risks and uncertainties associated with an offshore project that need to be addressed in doing an economic model. Highly variable, and mostly beyond the control of the farmer, are the fish market ex-vessel prices and the input market costs. The fingerling cost can be reduced if the project is able to eliminate the middle man and develop its own hatchery such as is the case with HSWRI. For additional information: (Posadas 2008)

Biological	**Environmental**
Harvest sizes	Temperature changes
Growth rates	Natural disasters
Survival rates	Predators
Disease	

Fish Market Prices	**Input Markets Costs**	
Whole fish	**Fingerlings**	**Processing**
Live fish	**Feed**	**Storage**
Headed and gutted fish	**Fuel**	**Transport**
Steak	**Insurance**	
Fillet	**Labor**	

U.S. Marine Aquaculture

The largest single sector of the U.S. marine aquaculture industry is molluscan shellfish culture (oysters, clams, mussels), which accounts for about two-thirds of total U.S. marine aquaculture production, followed by salmon (about 25 percent) and shrimp (about 10 percent). Recent advances in offshore aquaculture technology have resulted in several commercial finfish and shellfish operations in more exposed, open-ocean locations in state waters in Hawaii, New Hampshire, and Puerto Rico. The data for figures, 1, 2, and 3 are based on NOAA statistics for 2001 for all of the U.S. for monthly landings and ex-vessel prices for the commodity in 2001.

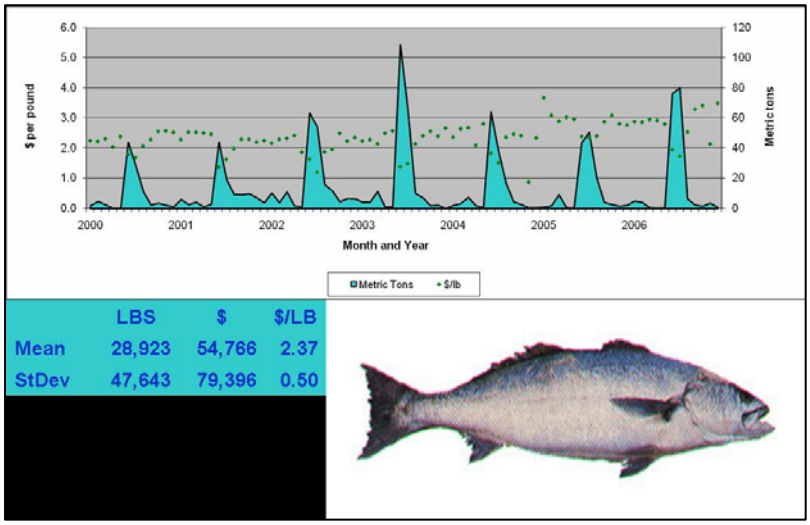


	LBS	$	$/LB
Mean	74,462	232,119	3.32
StDev	37,551	100,801	0.58

The left Y axis is $/lb and the right metric tons. Each month about 74,000 pounds are landed with a value of about a quarter million dollars with a mean ex-vessel price of $3.32/lb. The standard deviation of $0.50/lb carries with it a risk of failure.

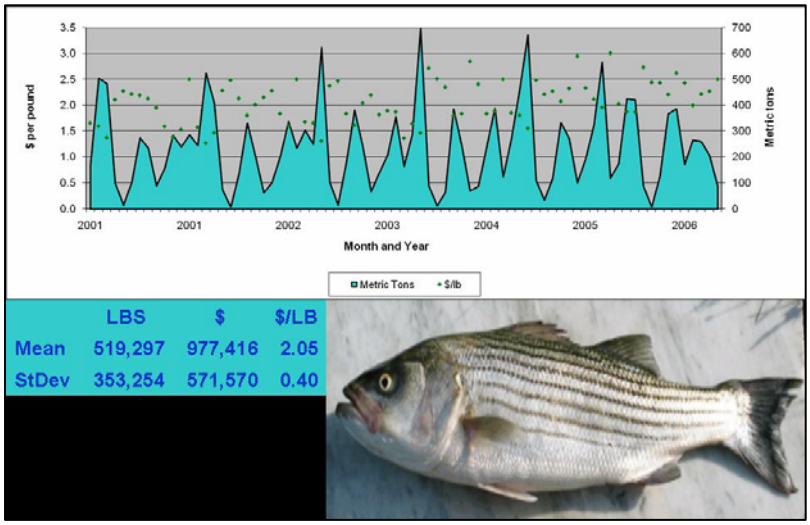
Figure 1. U.S. Commercial Landings for California halibut (California flounder), *Paralichthys californicus*

Erratic landings with a risk factor similar to that of halibut.



	LBS	$	$/LB
Mean	28,923	54,766	2.37
StDev	47,643	79,396	0.50

Figure 2. U. S. Commercial Landings for white seabass (white weakfish), *Atractoscion nobilis*

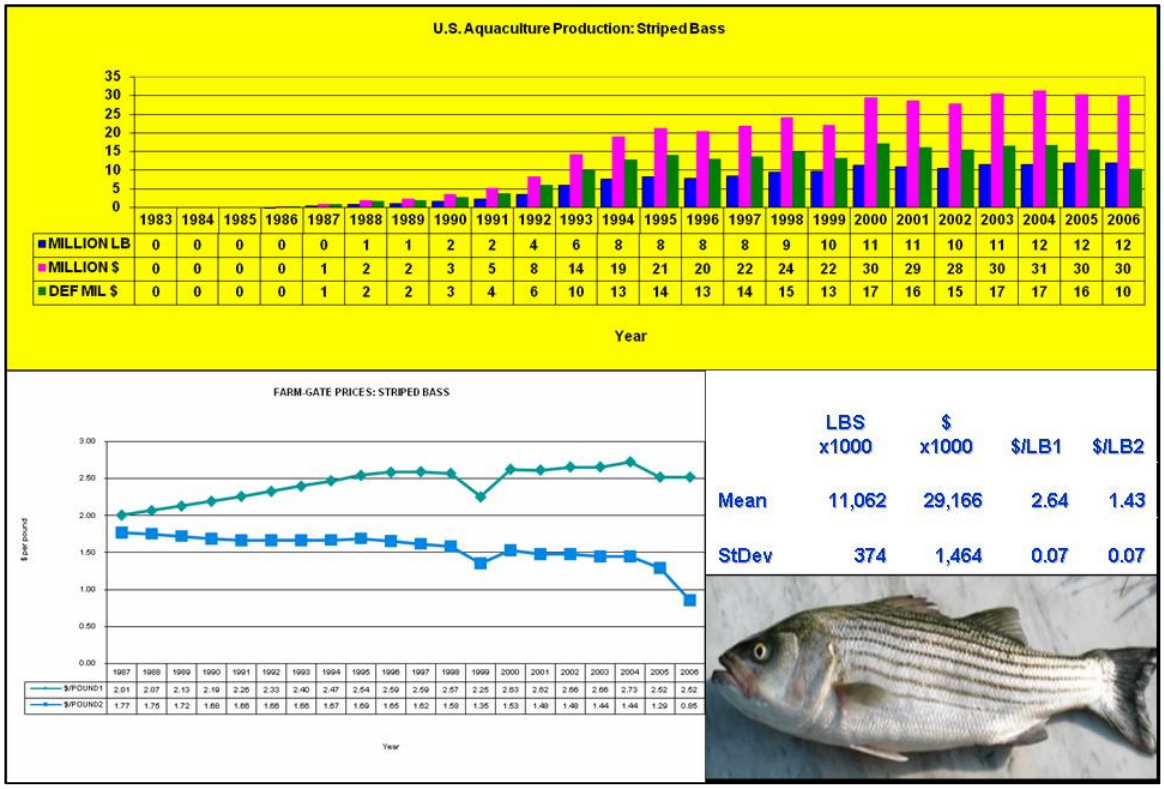


	LBS	$	$/LB
Mean	519,297	977,416	2.05
StDev	353,254	571,570	0.40

The landings and ex-vessel prices are also variable for wild caught striped bass as shown in Figure 3. While more fish are landed, the prices are lower and, while the deviation is lower per pound than for the other two species, there is still a considerable risk.

Figure 3. U.S. Commercial Landings of striped bass (rock or rockfish), *Morone saxatilis*

Turning now to aquaculture of striped bass, the supply is more stable, and while the ex-vessel price per pound is lower than for wild caught, the risk is far less than for wild caught as shown by the deviation of only seven cents per pound over the past five years.



	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
MILLION LB	0	0	0	0	0	1	1	2	2	4	6	8	8	8	8	9	10	11	11	10	11	12	12	12
MILLION $	0	0	0	0	1	2	2	3	5	8	14	19	21	20	22	24	22	30	29	28	30	31	30	30
DEF MIL $	0	0	0	0	1	2	2	3	4	6	10	13	14	13	14	15	13	17	16	15	17	17	16	10

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
$/POUND1	2.01	2.07	2.13	2.19	2.26	2.33	2.40	2.47	2.54	2.59	2.59	2.57	2.25	2.53	2.62	2.66	2.66	2.73	2.52	2.52
$/POUND2	1.77	1.75	1.72	1.68	1.66	1.66	1.66	1.67	1.69	1.65	1.62	1.59	1.35	1.53	1.48	1.48	1.44	1.44	1.29	0.85

Figure 4. U.S. Striped bass aquaculture

A Hypothetical Model for Offshore Aquaculture in Southern California

While I had a model, there are few data available for offshore aquaculture in Southern California such as support services and the needs and essential services of processing, financing, insurance, personnel training, etc. I was able to borrow some data on white seabass from Mark Drawbridge and to find some in publications; unfortunately, the information was for hatcheries either onshore or nearshore. For ex-vessel price data I relied on NOAA Fisheries and the Urner Barry community marketing reporting service. I borrowed the model and some data from the reports of the studies done in the in the Gulf of Mexico in 2005, one of which was about 40 km offshore (See Posadas 2005). The steps in the process were:

- Develop hypothetical model for Southern California
  - Estimate investment requirements
  - Estimate annual costs and returns
  - Develop annual cash flows
- Evaluate the economic and financial feasibility using NPV (Net Present Value)[21] & IRR (Initial Rate of Return)[22] methods
  - Use base model scenarios
  - Incorporate risks and uncertainties using Simulation and Econometrics to Analyze Risk © (SIMETAR)[23]

21. http://en.wikipedia.org/wiki/Net_present_value
22. http://invest-faq.com/articles/analy-int-rate-return.html
23. http://www.simetar.com/aboutus.aspx

- COAPS (**Commercial Offshore Aquaculture Production System)**
  - Gulf of Mexico Offshore Aquaculture Consortium[24]
  - Hubbs-SeaWorld Research Institute

- Offshore cage design & operation
  - Ocean Spar SeaStation™ (OSSS)[25] and other manufacturers

- U.S. commercial ex-vessel and wholesale prices
  - NOAA Fisheries
  - Urner Barry[26]
  - Market discovery

Initial Fixed Investment Required for Twelve 3,000m^3 OSSS Cages.

Item	Qty	Total Cost	Cost per m3
Land (can be leased)	2 acres	100,000	2.78
nnn Permit (unknown)	1 farm	0	0
Office building (can be rented)	2000 ft2	400,000	11.11
Service vehicle	1	50,000	1.39
Fish transport vehicle (can be contracted)	0	0	0
Fingerling transport system	1	11,844	0.33
Monitoring equipment (can be contracted)	0	0	0
Cages, mooring & feed distribution systems	12	1,800,000	50.00
Aquaculture service vehicle (still at design stage)	0	0	0
Net cleaners	12	120,000	3.33
Service boats (>50ft), engines and cranes	2	200,000	5.56
Miscellaneous items	0	0	0
Total investment		2,681,844	74.50

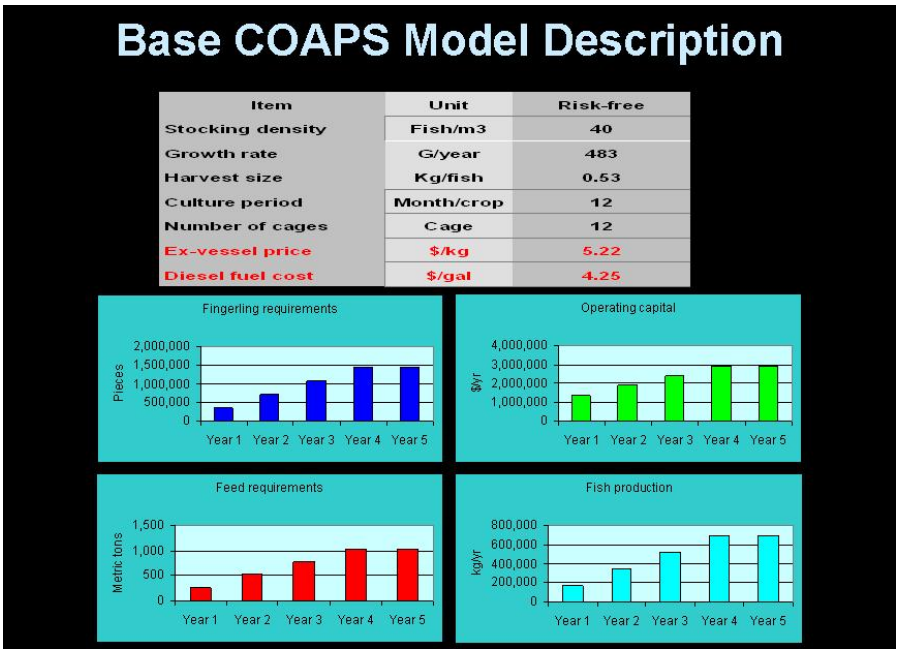
The total investment required for a pod of 12 cages is about $2.7 million dollars with a cost per cubic meter of $2.78. The land cost of $50,000/acre and the cost per cubic meter would probably be higher in Southern California. At this time the permitting cost is unknown; however, it would appear to be high due to the requirements stated in SB201.

Previous presentations and discussions at this forum have centered on grow-out facilities. A hatchery is a requirement for an offshore project. How and where will it be sited to service the offshore operation? How are you going to transport feed, equipment, personnel, fingerlings, the product, etc.? Where will the marketing department be located? How far away from the site will the infrastructure be? To estimate the economics required for a project sited in Southern California, you need to include the cost of a service vehicle. The Gulf of Mexico consortium included in its model an aquaculture

24. http://www.masgc.org/oac/index.htm
25. http://www.oceanspar.com/seastation.htm
26. http://www.urnerbarry.com

service vehicle (ASV) to be built at an estimated cost of $1.5-2.5 million dollars, depending on the size of the vessel. Build out did not happen.

COAPS Modeling



Item	Unit	Risk-free
Stocking density	Fish/m3	40
Growth rate	G/year	483
Harvest size	Kg/fish	0.53
Culture period	Month/crop	12
Number of cages	Cage	12
Ex-vessel price	$/kg	5.22
Diesel fuel cost	$/gal	4.25

Figure 5. The COAPS model is based on present day expectations of technology, mitigation of offshore grow-out, biology of the suitable species, recommended usage and costs of inputs, and established ex-vessel prices. The price and fuel costs are subject to change and constitute a risk the enterprise will face.

The stocking density of 40 fish/m^3 is based on recommendations made in the Gulf study for the maximum biomass market-size fish per cubic meter. Conclusions are derived for each of five years for fingerlings, metric tons of feed, needed operating capital, and production based on input item, unit, and risk.

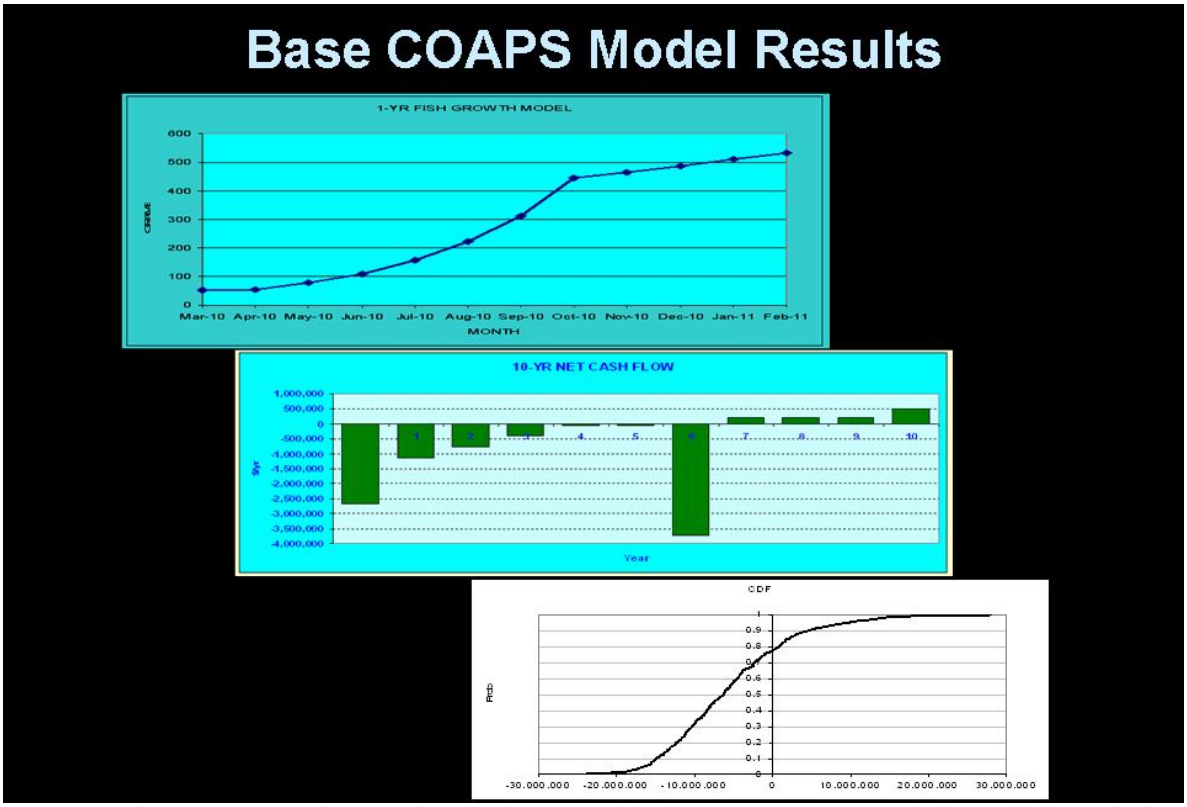


Figure 6. Based on a 12 month growth rate (top graph), the 10 year net cash flow, (the net balance of the amounts of cash being received and paid), for the first six years is negative, becoming markedly so in Year 6. The reason for this is the assumption that the life span of the offshore facility is 5 years &

replacement is then necessary. A positive NCF of about $200,000 occurs in Year 7. So what is the projection for chance to fail based on the Figure 6 scenario? ***About 78 percent***.

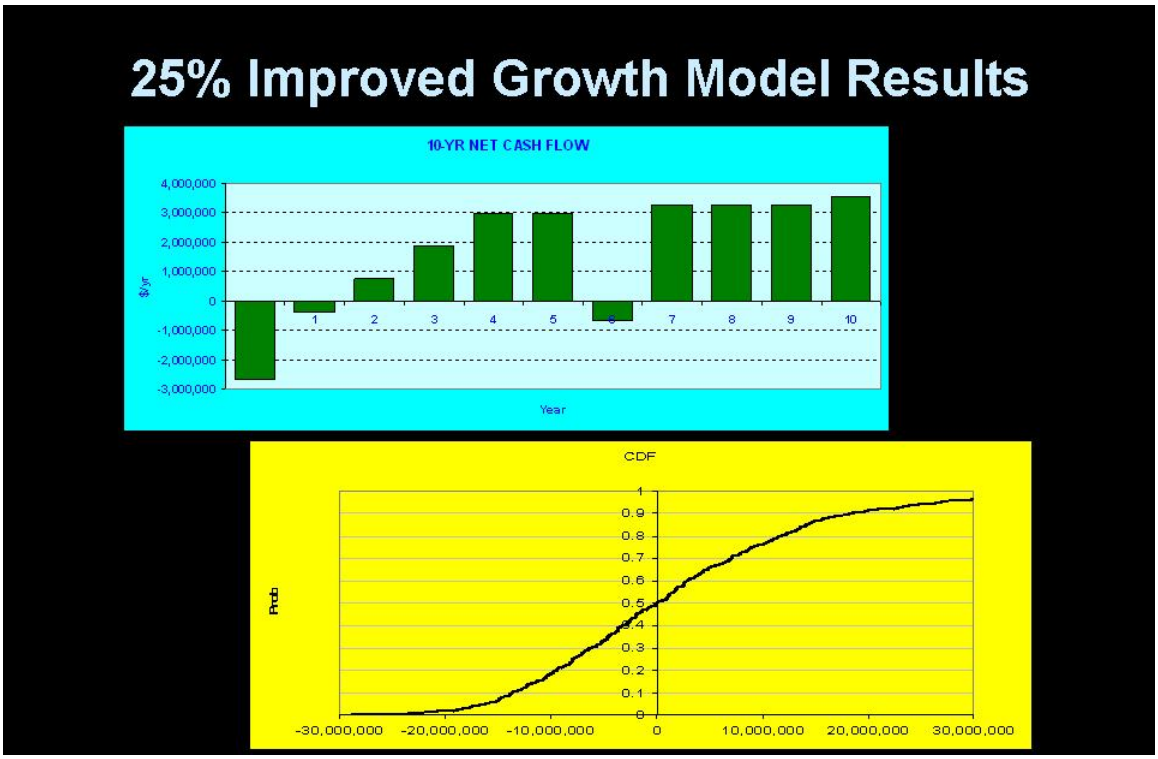


Figure 7. But what is the projection if you improve the growth rate? The net cash flow becomes positive in Year 2, is only about $500, 000 below the line in Year 6, the year of replacement, and brings in $3 million in Year 7 in contrast to the base model figure of about $200,000. So what is the projection for chance to fail based on this scenario? ***About 50 percent.***

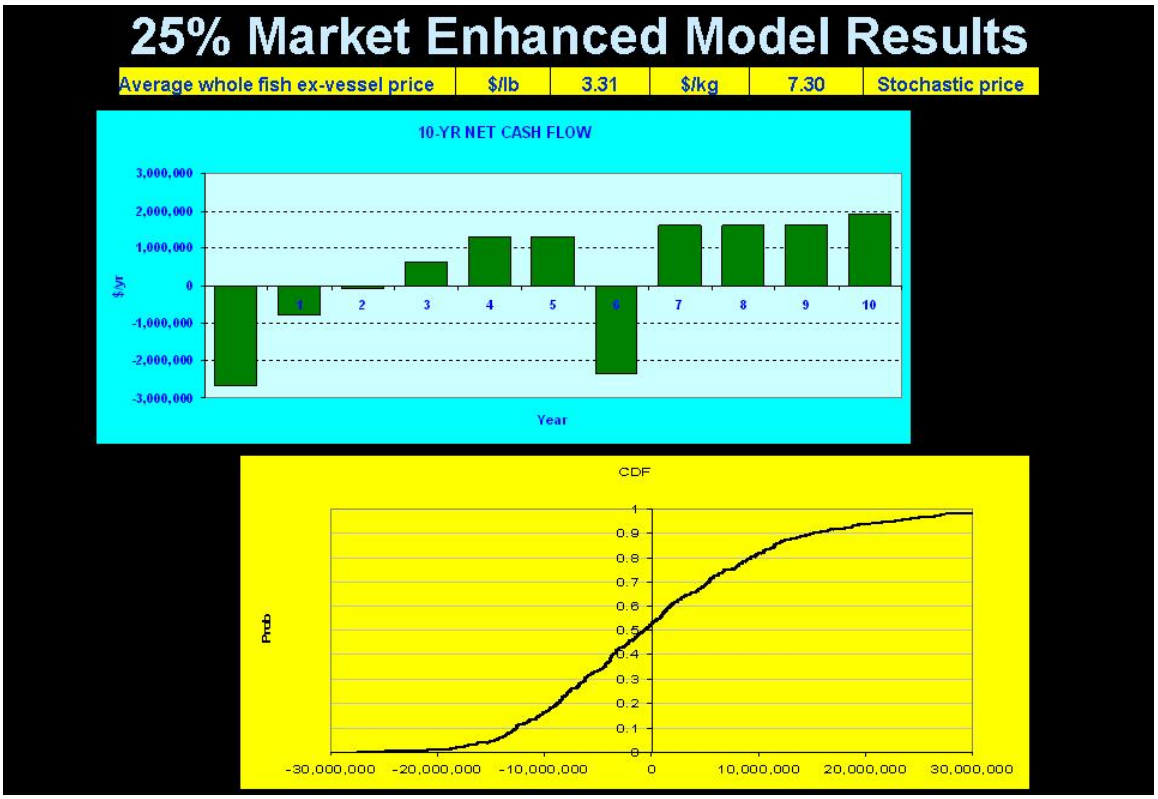


Figure 8. When the market is enhanced 25%, the chance of failure is slightly greater than when the growth rate is improved.

Potential Annual Economic Benefits Based on the Simulation for a Southern California Site

Gross receipts per 12 cage farm	$3.6 million
Output created	8.3 million
Value added created	3.8 million
Employment generated	126 jobs
Labor income earned	$3.4 million
Indirect taxes collected	$0.27 million

Current COAPS model implications

COAPS modeling was based on experimental or recommended management practices. Economic viability of COAPS depends on the continuation of:

Better fish (higher prices),
Faster growing fish (~w lbs/year), and
Lower costs of production.

Conclusion

To make it, you need to produce a better fish that can be sold at a better ex-vessel price than is now being paid based on landings data.

It should be pointed out that the COAPS model is specific to a site and a species. When the site and/or the species change, a new simulation must be done.

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Drew Bohan

Executive Policy Officer, California Ocean Protection Council

On behalf of Governor Schwarzenegger and Secretary Chrisman, I want to thank Jerry Schubel for setting up this forum. This is the second time this week that I have spoken at a meeting, the first time was at the American Water Works Association. One parallel between that meeting and this forum is that for the second time in a week, I know the least of anyone in the room about the subject.

The California Ocean Protection Council

I am the California Ocean Protection Council (OPC) policy person. A few words about the council. It was established pursuant to the requirements of the California Ocean Protection Act passed in 2004. Membership consists of the secretary of resources, lieutenant governor and state lands commission chair alternating yearly, state controller, secretary for environmental protection, two public members appointed by the governor, and two non-voting members also appointed by the governor, one from the Assembly and one from the Senate.

The council is tasked with these responsibilities.

- Coordinate activities of ocean-related state agencies to improve the effectiveness of state efforts to protect ocean resources within existing fiscal limitations.
- Establish policies to coordinate the collection and sharing of scientific data related to coast and ocean resources between agencies.
- Identify and recommend changes in law to the Legislature.
- Identify and recommend changes in federal law and policy to the Governor and Legislature.

The OPC does not make laws or pass regulations. It cannot stop aquaculture from happening nor can it make it happen, but it does take positions that can prove to be very influential. We frequently get calls requesting that we get behind something with the caller stating that our position might move something forward. On the flip side our position may be able to slow down a contentious issue. That is where we could play a role in aquaculture in California—taking a position. It is my job to get advice from my bosses about the position they want to take.

In regard to aquaculture, the OPC funded the PEIR intended to set up a framework for California to be involved in offshore finfish aquaculture. My basic understanding is that the PEIR is a tradeoff. On one hand it provides some regulatory certainty and a clear path for those who would like to do aquaculture in California. On the other hand it establishes some very clear, potentially troublesome performance standards to make sure the concerns that have been discussed here are addressed.

My Perspective on the State's Position on Aquaculture
From my perspective Steve Weisberg keyed up the issue quite well yesterday. What are the important reasons why the state should get behind aquaculture? What are the reasons why aquaculture is good for the state? Does the industry have the potential to help or harm the ocean? Again I am not an expert. I don't know the answers but I can share my perspective resulting from preparatory reading and attending this forum.

It seems to me that you have many ideas for responses to Steve's questions; however, I don't think most of them are relevant to the questions I would ask you. To what extent are you willing to improve California's economy, provide jobs, and feed hungry people—all very valuable endeavors, but not from the OPC's perspective or its mission, its charge!

Sustainability of fish jumped out at me, a compelling reason to support this. My sense was that the problems you talked about involved fecal and other wastes, escapement, and introduction of non-native species. All seemed to be manageable problems; however, they aren't show-stoppers. Aquaculture isn't like nuclear power with nuclear waste that some people are arguing that we just can't manage the material properly so we shouldn't engage in this form of energy. Aquaculture doesn't seem anything like that from what I have heard.

It seems to me that the tougher issues are protecting wild fish and sustainability. Those two jumped out at me as things that might seem to be compelling reasons for the OPC to support offshore aquaculture. It seems to me that the toughest issue being faced is the sustainability one. The word sustainability is floated out by many people and it was used frequently yesterday. I ask you collectively, what is your frame of reference when you state that long term this is a sustainable industry?

Life cycle cost analysis has been mentioned. I would be interested to see what life cycle cost analysis suggests about aquaculture. Again the important question is relative to what?

I lived in Palau in the south Pacific for six years where there was a large wild tuna offshore harvest. The catch was shipped somewhere to be processed and came back to our stores in cans. We did look at aquaculture then with the view that if we grew something locally that the islanders ate, then maybe we would be doing a good job and in the last analysis would probably have a winner. Today, when sustainability is on the table, there is discussion about the cost of gas and increasing emphasis and conversations about green house gases and carbon footprints. I would pose this challenge. How do you measure sustainability by these kinds of things—green house gases, carbon footprints, long term sustainability for future generations, and those kinds of impacts? It might not matter in your term, but it might in the long term if you are talking about what the inputs are to extract the type of proteins you want assigned a higher value. Business arguments were made yesterday why offshore aquaculture is doable and sensible. I would put the challenges back. I don't pretend to know the answer.

How do you address the questions I posed if this is a long term model for feeding people? I have strayed a bit from what the Ocean Protection Council does but I thought I would issue the challenge.

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James Fawcett
Director, Marine Science & Policy Outreach, Sea Grant Program,
Wrigley Institute for Environmental Studies
University of Southern California

I am a social scientist. I don't deal primarily with aquaculture: I do deal with fisheries. I am an urbanist who studies coastal zone management and the marine transportation industry. I know something about seaports. I teach in the public policy program at the University of Southern California so I am interested in the public side of issues such as aquaculture, particularly some of the landing issues, the **onshore** impacts of **offshore** aquaculture.

Some Factors Influencing the Shoreside Impacts of Offshore Aquaculture

1. Species cultured
2. Capacity of offshore facility
3. Space for the hatchery, the staging of juveniles prior to introduction to an offshore facility
4. Volume of catch at harvest
5. Method of processing
6. Location of processing
7. Type of equipment staging required for the offshore facility
8. Type and number of vessels required for support
9. Size of feed storage required
10. Shoreside laboratory and office space required
11. Availability of space at a shoreside port or harbor
12. Availability of transport access to market
13. Capacity of regional labor market

The issues I want to talk about are generic. While they are not specific to Southern California, I think they are issues to which the offshore aquaculture industry needs to pay attention.

Conversion of Port Land to Uses Other than Fisheries

In the past few years I have done studies on the incorporation of work planning in state coastal management programs. In California we honor seaports and coastal dependent industries and they are incorporated into our coastal management program. In the United States such action is relatively uncommon. Very often, especially in smaller states, seaports and seaport planning are exempted from the state's coastal management regime. When that happens, the ports are left very much on their own devices to put the land to whatever wishes they want to. Fishing is not exactly a high priority in any of these ports. Moving cargo has a much higher usage priority and it generates a great deal more money so the fishing industry comes up short in many of these places, But not in California. Four southern ports have work plans that are incorporated into the stakeholder management plan—the Ports of Hueneme, Los Angeles, Long Beach, and San Diego.

When port land gets converted away from fishing to unrelated uses, it does not come back. Once converted to condominiums or other not-close-to-the-intended-use of the land, it will not be returned to use for fishing. There is an interesting example in the Port of Los Angeles where the redevelopment agency is building high rise condominiums two blocks from the waterfront. Such development will undoubtedly cause the port problems but, unfortunately, the port has no control over what that land is used for.

The offshore aquaculture industry, and indeed the seafood industry, needs to advocate to move port planning into the costal management regime as is done in California so as to protect itself. If the industry does not do this, then conversions such as those taking place today will likely continue in the future because of the value of land adjacent to the waterfront.

The advantage we have in California is that fishing is a protected industry under the state constitution. Therefore we are protected in two different ways and I think that places us in a somewhat unique position.

What is the fishing industry situation locally? About 59 of the 4,300 acres that make up the Port of Los Angeles are currently reserved for fishing. A fish market occupies 1.9 acres of the 59. Fish Harbor, as shown on the photo of the Ports of Los Angeles and Long Beach, is where the old tuna canneries were formerly located. At one point the canneries had 10,000 employees. But the employment figure has changed markedly. It is a great deal smaller than it was 25 years ago. Today Fish Harbor is the berthing place for what remains of our commercial fishing fleet.

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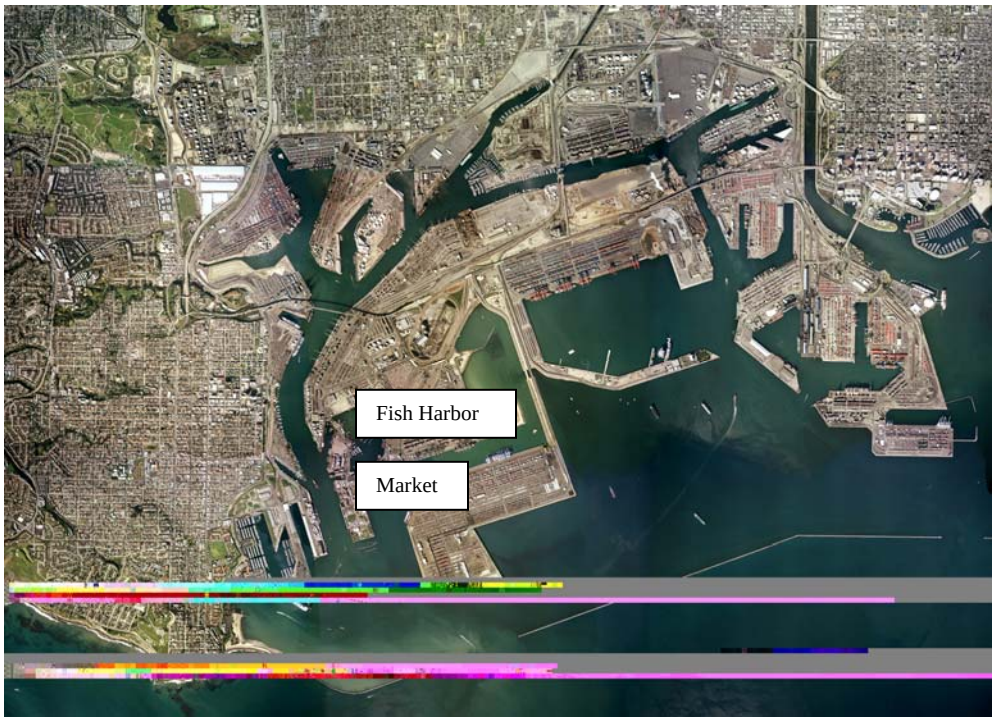
Ports of Los Angeles and Long Beach--2007



Impact of Offshore Aquaculture on the Local and Regional Labor Markets

The Los Angeles Economic Development Council has stated that based on estimates of the direct and indirect employment impact of a **fishing** operation on the Southern California regional economy, indirect employment would be 150 percent of direct. Indirect includes:

- upstream: supply aquaculture operations with direct inputs;
- downstream: distribution chain from aquaculture operations to the consumer;
- induced: industries supported by household spending from
  - aquaculture operations (employees of the operation), and
  - employees of the industries who are upstream and downstream suppliers to the aquaculture operation.

This 150 percent figure is based on estimates. I looked at the NOAA offshore aquaculture economic reports that Mike Rubino referred to and tried to come up with some sense of this industry's employment impacts. Lucky Jim, the numbers are all over the map and the people at NOAA know a lot more about this than I do. For example, Los Angeles County has 10 million residents. The current impact of the fishing industry on the employment rate in the county is miniscule. The North American Industrial Classification System currently counts 111 employees in commercial fishing in L.A. County. The Los Angeles Development Association **estimates** that there are probably 500 people involved in

the commercial fishing industry in Southern California, most in warehousing, moving products around the warehouses in the Fish Harbor area.

So I think hanging your hats on the employment opportunities that the industry is likely to produce may be like hanging your hat on a weak peg. You know more about this than I do but I was amazed at the really small number of people currently involved in this industry when commercial fish landings in Southern California are still quite substantial—at least in the wet fish industry. This is a problem that needs to be resolved but I don't think that the employment impact is politically an effective argument for proposal as a benefit of the offshore aquaculture industry.

Community Involvement and Opposition

An area that I have spent a great deal of time working on is community involvement and opposition on projects ranging from oil terminals to LNG terminals to development projects along the coast. One thing I have found from looking at this phenomenon for about 30 years is that when the public does not understand something, it is opposed. If the public is unaware of the impact of whatever is being proposed, it is opposed to it. There are many people out there who take advantage of perceived public ignorance. Then there is also a whole range of people from one side of the political sector to the other who have a voice.

One of the things we tend to forget is that some of the economic issues are legitimate environmental issues. When we are talking about environmental groups, we tend to deemphasize it. I think it is important to bring the full spectrum of both the advantages and disadvantages of whatever is being proposed to the public. The public certainly has a right to be involved when we are taking about public goods, offshore waters, and use of public lands. The public and its collective representatives have every right to be involved and indeed they are. In the case of offshore aquaculture, since this industry is fundamentally the moving party, it is your responsibility to bring the issues to the public.

I am reminded of the California Wine Association, founded in 1894 and a strong proponent of California wines. It works. If you criss-cross the country, you find that California wines are well known and popular. This is not because of the quality but because of the demand that the California Wine Association has generated. What has happened in the aquaculture industry? Do I see TV ads pushing aquaculture such as those I see pushing California milk and cheese or advocating for the industry? Do I see publications? No! In order to change public perception about the industry, I think it is going to be your responsibility to make a good case for doing offshore aquaculture in the Southern California Bight.

In terms of practical applications, there has been a great deal of discussion here about making certain that the public has good information when a project comes up for review. **That is a mistake. That is way too late to try to educate the public.** The public needs to be educated **before** the project is even on the drawing board. Why? Because then the public understands what is going on in the industry. There is an opportunity to bring out information without the threat of an incipient project. I think it is very important to do this long before a project has reached the design stage.

Mention has been made of Larry Suskin, one of the founders of the Harvard Negotiation Project (http://www.pon.harvard.edu/hnp). He and his people do great work but basically they work when a problem has become crystallized. When we are sort of in the inchoate environment here where you can even talk among yourselves and find there are different points of view concerning what the industry is all about, it is too early to get someone like Suskin involved. Public education should happen first to at least surface what the business's parameters are just so the public has an idea what you are talking about.

Don't wait until you need friends. Win them long before there is a need. When there is a need, it is too late. Listen to what your opponents are saying as well as what the general public says about the

project. Then modify your project accordingly. I don't mean modify it based on every complaint, just be willing to modify and do so when the suggestion has been well thought out. Yesterday we heard that Kona Blue would like to have had a larger operation than the current one; however, the comments from the community were listened to and the project modified accordingly. That is standard developer operation in land projects. The aquaculture industry needs to do the same. When it comes to this industry, the public needs to feel that it has a voice, its voice is a valid one, and it is heard.

Summary
I think there are three large issues for the offshore aquaculture to be concerned about: land conversion, employment, and probably the most important of the three, dealing with the public. Every project is that way.

Moderator's Comment
As a social scientist, I do a fair amount of work dealing with controversial issues as well. I strongly concur with your point about involving the public and the other issues as well.

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Sam King
President, King's Seafood Company

Twenty years ago we were offered a location in Santa Monica for a restaurant. We did a market analysis about the restaurants in the area and came up with the idea that a seafood restaurant would very well fill a niche since there were none in the area that served oceanic seafood. Further research revealed that there were not many seafood restaurants in all of Southern California. This really shocked me because California has such a wonderful coastline. Additionally we discovered that this area was very much different from the rest of the coastal United States. We had to journey country-wide to places such as Seattle, Boston, and New Orleans to really learn about seafood and the seafood restaurant industry.

Jim Fawcett mentioned wet fish landings in Southern California and that data is all over the map. I would like to know what the statistics really are. If you were to walk the wharf in San Pedro, you would not see a single fishery existing. They are just not there.

An Analysis of a Typical King's Seafood Restaurant Menu
I went over the seafood products on yesterday's menu at King's Seafood Restaurant. The items that required long distance transportation impacting the carbon footprint included:

- wild caught international
  - mahi mahi from Ecuador
  - Pacific swordfish, probably from east of Hawaii. This is a seasonal fish and the California season will start soon. What we are serving now came from a long way away.
  - dolphin tuna probably from east of Hawaii
  - Pacific albacore tuna probably from Fiji
  - jumbo shrimp from Guaymas, Mexico
- farmed international
  - catfish from New Zealand
  - tilapia from Costa Rica
  - Chilean salmon

I might argue that getting seafood products from these places is expensive, has a negative impact on the trade deficient, and has quite a negative impact on the carbon footprint.

Closer to home and without a negative impact on the trade deficit but still with an impact on the carbon footprint:

- wild caught United States
  - Coho (silver) salmon from Alaska fisheries
  - halibut from Alaska.
  - ono from Alaska
  - wahoo from Alaska
  - thresher shark from Hawaii's Big Island
  - eastern jumbo sea scallops from east coast fisheries
- farmed United States
  - rainbow trout from Idaho
- local wild caught
  - California halibut, closer to home but still 120 miles away from my distributor and a seasonal fish
  - white seabass, also seasonal. When legally harvested Chilean seabass is available, I am proud to serve it but it is only available seasonally for only a very short time.

In summary there were only two locally caught seafood products on our menu. Think about the carbon footprint model and the trade deficit impact. I don't have to tell you that something that is locally grown here presents an opportunity to change negative impacts to positive ones.

The Distribution Chain.
A point about the chain. I listed about 17 seafood products, only two of which were locally harvested. If we were able to control the seafood value chain with availability of farmed fish raised off the California coast, we would have the ability to eliminate one or two steps on that ladder in regards to increasing costs. So I think the opportunity for aquaculture in this model is incredible.

From our perspective we do not have a huge fishery in Southern California. We have calamari, sea urchins, and sardines but other than those items, I do not see much coming from local fisheries. Taking another look at our menu, we probably carry 45-50 different seafood species and, depending on the season, there might be three or four that are local. That's reality. I mentioned swordfish and seabass – both are seasonal. Pacific lobster, again low production and also seasonal.

I see the role of aquaculture in Southern California as an obvious one.

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Devin Bartley
State Aquaculture Coordinator, California Fish and Game

The Ecosystem Approach: a Clarification
I would like to clarify something I said yesterday that may have been misunderstood. (See page 26 of the report) Last evening I was asked why I did not think that the ecosystem management approach would work. I do think it will work. Apparently my comment yesterday was:

"*I would like to say a few words about the ecosystem approach. It is impossible*".

What I meant was that it is such a complicated subject, that you can't deal with it in a few words. I firmly believe that when we look at offshore aquaculture and aquaculture development in general, we have to look at the ecosystem and that ecosystem must include people. I know that many ask what exactly does ecosystem approach mean. It's unworkable. It's complicated. But I think we forget the progress we have made moving from single species management or just focusing on a single species or a single production unit to considering things we have heard during this panel discussion. Jim Fawcett's points about work development and developing stakeholders, identifying negative impacts and current flaws, for example. We have come a long way in broadening our vision of the products we are looking at.

Moving Ahead
As the last speaker much of what I would have said has been said, especially by Mike Rubino. I think it is time to start with experimentation so innovation can begin. I think we have to start with the aid of the models we heard about yesterday. I think we ought to embrace the NGOs. There are the 'ENGOs', the environmental NGOs, and the 'INGOs', the industrial NGOs. We have to bring both aboard.

Information Base
I believe that if we want to reduce risk, we have to increase our information base. This will be the best way to address the uncertainties and the economic and ecologic impacts that are associated with offshore aquaculture development. We need information on production and impacts and these will form the terms of leases that the state and federal governments will award for offshore aquaculture ventures.

The PEIR
We have heard a lot about standards. They are very necessary, in fact, extremely necessary. I do not think the PEIR will define standards but will instead define ways to establish standards for a given aquaculture facility in a given area with a given species.

The Precautionary Principle
We have also heard a little about adaptive management and the precautionary principle. I think they are similar. The precautionary principle has been inflammatory for some people so many like to stay away from the words.. When I was working in agriculture, because the name is just bandied about, we defined what we meant by the precautionary principle. Everyone has his/her idea or sort of an idea about what it means. A key element of what we think it means is to establish target and limit points. These points are what you want to aim for such as a certain quantity of product, a certain economic return. Limits reference points for fisheries would be something such as maximum sustainability yields, changes in benthic biodiversity, certain number of escapees each year, and/or changes in gene frequencies.

It was said at this conference that the precautionary principle is an excuse for not doing anything. I would disagree. Once you start thinking about it, you can develop reference points that actually guide and inform you about your operations. We can have monitoring but we don't know how we should react—in essence where the red and green flags are.

The other point about the precautionary principle is that limits are defined upfront so the farm operator knows what he is getting into. You can have this many escapes before you are shut down. If a change in your gene frequency is observed, you will have to start farming sterile fish. If you operate for this length of time and there are no negative impacts, you can expand. All of these let the stakeholder know what the rules of the game are in advance of jumping into the game. I think the PEIR will be a very good first step in facilitating this whole process. It is going to lay out a framework for what species can be grown, what sitings can be had, and what the management practices are.

Some of us at a meeting in Oregon last week asked the industry what kind of effort is needed from us. Can we subsidize research? Can we give you graduate students? The response was:

> *Give us the permits! Let us get on with it without having to go through regulatory gymnastics that not only California, but many other states are asking us to do.*

So if the PEIR could provide decisions in a farm sense—how to farm native species, how to use best management practices, where siting areas will be, how monitoring will be done— it would be sort of like one-stop shopping. It will really help fish farmers get over impunities and very significant hurdles

so we can start collecting real data with real farming systems linked to adaptive management or the precautionary principle approach, changing things as we go along.

A colleague from Washington State said that it took 10 years to develop operations there. That is important to know. We are not going to solve this overnight.

California's Aquaculture Development Committee
There are many compelling reasons to establish fish farming in California. The compelling reasons not to are the regulatory obstacles. I hope we can address them—It is part of my job to do so. California does have an aquaculture development committee which was mandated in the California Aquaculture Promotion Act of 1995[27]. It is composed of representatives of the industry, and various public agencies. Mark Drawbridge was recently appointed to the committee. I am quite sure we will be expanding the group's membership to include the environmental and industrial NGOs.

Aquaculture and a Level Playing Field
In closing and going back to the ecosystem approach which is a really broad approach. It would be nice if aquaculture had a level playing field but when you look at the economic returns from agriculture, water diversion, transportation, and ports development, you can see that aquaculture is a very poor relative. I think a level playing field is very important. It is not an easy thing to achieve and it is not going to happen overnight.

Grazing of livestock is an acceptable activity in a protected wilderness area but oyster farming is not acceptable. This makes no sense to me. Many developers in the San Francisco Bay area have and are getting exceptions from water quality discharge requirements while we are wondering what happened to our salmon. The fact is that so many industries discharge into San Francisco Bay. as a result of these exceptions to the water quality standards, San Francisco Bay is filthy. Is it any wonder that salmon don't want to come back to spawn?

Conclusion
I think there are real possibilities for offshore aquaculture in California and there are also real challenges. I hope I am up to the task.

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Comments from the Moderator

We heard about risks from different perspectives. Benedict Posadas talked about economics and the use of economic modeling to determine risk levels.

Michael Rubino, Devin Bartley, and Drew Bohan all talked about policy issues, a subject strongly and frequently mentioned yesterday. One of the most awesome tasks we face in promoting development of offshore aquaculture in the absence of policy is the permitting process issue, the difficulties in getting permits, and the possibility of being out-bid for a lease. The inability to get a permit is probably the first order of risk.

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27. Fish and Game Code Section 15700. The director shall appoint an Aquaculture Development Committee consisting of the following persons (a) At least 12 members representing all sectors of the fresh and salt water aquaculture industry. (b) One member representing the department, two members from and chosen by the University of California, one with expertise in aquaculture science and one with expertise in outreach to the fisheries community, and one member each from and chosen by the Department of Food and Agriculture, the California Coastal Commission, the State Lands Commission, the State Water Resources Control Board, the State Department of Health Services, and the Joint Legislative Committee on Fisheries and Aquaculture. The member of the committee appointed by the Joint Legislative Committee on Fisheries and Aquaculture shall meet and, except as otherwise provided incompatible with his or her position as a Member of the Legislature.

Jim Fawcett made the point that we need to address the political domain. Michael, Drew, and Devin all talked about this as well. We need to think about the political opposition and we need to engage the public early on, addressing concerns about issues upfront so that the permitting and policy processes can move ahead in a more rational manner.

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QUESTIONS AND COMMENTS

SCHUBEL: Devin (Bartley), I do believe that when you establish reference points up front as you said, you need to make them clear; otherwise, people will not know what the target is. So long as up front you set them very conservatively to protect the environment, they should then work.

Weaver: What is meant by sustainability and the real question for how long a period? If you make the assumption that humans will continue to like to eat meat and if you start looking at the population growth predicted for the next 50 years, we just have to look at the physiological limitations of the animals. Fish, unlike chickens, don't have to stand up and they don't have to stay warm. These two impacts are why fish in general have much better food conversion efficiency than you can ever get with a terrestrial animal. This is a fundamental property that you can't get around. So when you look at long term sustainability, you are a lot better off shifting to any of these cold-blooded animals just to avoid the energy loss. Because even on the economic model presented previously, so much of that is really based on concepts from terrestrial agriculture that don't quite apply. For example, if a metabolic rate is half as much and a fish is growing at half the speed, and if you are talking about metabolism, not the number of fish, the annual economics are very small. That is different than it is with chickens.

González: What is the "foot print cost" of producing animal protein through raising cattle vs. fish aquaculture? Consider the same question but specifically for California where fresh water is a scarce resource. Just imagine the amount of water needed to produce a kg of meat from cattle; the water you need to produce its food and the water it drinks to the time it is slaughtered. I am sure someone has made these calculations already. Now, think about all the excess nutrients produced by raising cattle (fertilizers for pasture and what it is excreted by the animal during its life); where does it end? I am sure, a good part ends in the ocean. This does not mean that people are going to stop eating meat but the more fish is available, the more likely it would be consumed instead of meat.

I consider producing food a strategic industry. Can you think of another strategic industry that could offer less environmental risk to the ocean? In the case of aquaculture, all the risks are identified, almost all are reversible (except perhaps problems with invasive or exotic species), and all have a way to be minimized or eliminated.

ASSEMBLING THE PIECES: POINT/COUNTERPOINT

Jerry Schubel, Moderator

THE POINT: DENNIS HEDGECOCK
Paxton H. Offield Professor of Fisheries Ecology
University of Southern California

At the onset of this forum we were challenged to develop the case to reject the hypothesis that:

> *Southern California could support an offshore finfish aquaculture industry that could become a $1 billion/year industry with only a very small percentage of State waters or the EEZ in the Southern California Bight dedicated to this purpose. A properly constructed and managed industry would provide a safe, secure, stable supply of healthful seafood to the region, would help relieve pressure on wild fish stocks, and would help conserve the remaining working waterfront—all without unacceptable adverse impacts on the environment and other uses of the ocean.*

In my opinion, we have heard absolutely nothing during this meeting that would cause us to reject that hypothesis. I think the environmental problems are essentially completely removed with the model that Dale (Keifer) and Jack (Rensel) presented. That seems to be a non-issue. I think the biological problems that have been raised are the typical laundry list that is generally put forward. The risks from these things are extremely small. There is no reason not to move forward with a cautious approach to checking out the potential for aquaculture in the Southern California Bight on a large scale.

Jerry's summary of the advantages was very thorough and I don't think I need to repeat them. There has been no reason put forward at this meeting that I can see that would cause us to reject the hypothesis. **We should go for it**. We should take the next step whatever that might be.

Selling the Public

A second point I would put forth is also based on what we have heard during this forum. It is clear that we have not sold the idea of offshore aquaculture completely to everyone. There is a great deal of selling still to be done to let the public know:

- What aquaculture is
- What it is about
- What its scope is
- What the potential impacts could be, they are quite minimal, and the risks are quite low

We are not talking about nuclear energy or LNG plants—nothing like that. We need to help the public understand that the culture of aquatic organisms will not be harmful if done reasonably and responsibly.

Clearly there is a great deal to do in the realm of public education. I think a number of us should get together and work with and support the Aquarium of the Pacific and other institutions capable of reaching the public and discussing these issues in a broad context.

Looking Ahead: Going Deeper

Finally from my point of view something is missing from the discussions here. We are so focused on the immediate steps that I think we have somewhat lost sight of what the future potential could be. We talked a lot about the scaling problem but from the information given to us by Don (Kent), Jack (Rensel), and Dale (Kiefer) about the areas where you are within water depths of 100-150 feet, my conclusion would be that the potential areas are actually quite small and a few of them are off the

table immediately. Siting isn't going to fly in San Pedro or Santa Monica Bays for example. But if we could develop the technology for deeper moorings and move a little bit farther offshore, we would be expanding into a potentially much larger area. This is an engineering problem that I think is solvable. By using submersible cages farther offshore, we would be eliminating many of the concerns people have. If we could go to offshore areas that are anoxic, we would not be competing with fishing or trawling which don't happen far offshore. I think if we have a slightly longer time frame perspective on offshore aquaculture, opportunities are going to increase as technology develops.

In the same vein, I think we should take the long term view and start talking about domesticating some of these species and improving growth rates. The economic modeling that we saw today showed that there is nothing like improving growth rate to improve your bottom line. That is what has driven agriculture for the past 10,000 years.

Domesticating Aquatic Species
There is an enormous opportunity for domesticating aquatic species. That puts us then into the realm of being more concerned about the wild-farmed interactions but there are technologies to deal with that as well.

In Conclusion
So I think as we look down the road, there are opportunities to expand even more than there are at present. As we have heard at this forum, the opportunities are already considerable and enough to get started. That's my point.

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THE COUNTER POINT: WILLIAM EICHBAUM
Vice-president, Marine Portfolio World Wildlife Fund

As a counterpoint, I think we have really had a very thorough discussion in this day and a half and Jerry. I want to thank you for inviting me to be here and participate. I've learned a lot. I ended my remarks yesterday saying that in my view, an experiment at scale was not the same as building an industry. It is clear that the hypothesis and objective of many is to try to build an industry here in Southern California. I want to address that in sort of a counter point way.

Is an unaware public an opposed public?
One of the quotes from this morning was that a public unaware is a public opposed. That is true, but on the issue of aquaculture, it may not be that it is a public unaware but a public inclined to be opposed because they have heard about some of the negative experiments or experiences that have occurred and these have influenced the public's immediate reactions.
I am mindful of a debate on nuclear power that I had in the early '70s with the first regional administrator of Region 3 of the EPA. He made the analogy that if the first thing that humankind had done with electricity was to operate an electric chair instead of a light bulb, our whole social attitude toward electricity might be quite different. The analogy being that if the first thing we had done with nuclear power had been constructive rather than to blow up some Japanese towns and cities, we might have had a different attitude toward nuclear power.

I don't think the situation of aquaculture is quite that bad but I do think it is not merely a public unaware. I think it is a public inclined to be somewhat negative and I think that in order to build an industry, that attitude has to be overcome. So it is worth thinking about where does that negativity come from? I suggest it is at sort of a gut level response. It comes from some of the stories the public has heard about things that have happened elsewhere with aquaculture. I think that there is a range of negative reactions from the fairly specific to the general underlying that.

Other Issues
I want to talk a little more about some general issues because I think there is a series of conditions we have discussed in this forum about the specific project that is before you that deal fairly well with many of the specific issues. But if it is the precursor to building an industry, maybe there are some more general issues. I think a lot boils down to the word 'competition'. I think there is a range of conflicts that arises out of competition that people are either subconsciously or quite consciously aware of.

The Word 'Competition'
The first of those is what I would call the competition for ocean space. I am not arguing that the proposals, or the options, or the numbers that have been discussed here for Southern California setup a real competition, but I think there is a perception that the variety of uses of ocean space are in competition with each other and that aquaculture could be a very important player in a negative way for those who want to do other things with ocean space.

There is also the concern about competition with wild fisheries and I think the industry, and the food industry as a whole, need to figure out how to get a better handle on this concern and a better discussion going on about it. I have this debate every day in my office where we work very actively with the wild salmon fishery in Alaska collaboratively. Every time we send out a report about the positive values of salmon aquaculture and moving it along to sustainability or meeting criteria, earthquakes occur outside our office in Anchorage generated by Alaska's wild salmon fishery. So somehow that competition is there. It does not produce any positive results and I think discussion needs to be improved.

I think there is a sense that at the end of the day that marine resources are in decline and there is competition for those living resources whether it is by recreational fishermen or other interests. That sets up an area of conflict that gets articulated in many different ways.

Conclusion
If there is going to be movement from an experiment to an industry, some of these larger scale failures of communication and understanding, and maybe realities, need to be addressed. That is why I have raised some of the issues I brought up yesterday, particularly ocean governance issues.

My final thought is that as any project here may move forward, it would be important not to just talk about the project, but to talk with these different communities about the larger implications so that the kind of conversation, the kind of education, the kind of effort to share values and expectations and opportunities for the middle of the century can be really understood and explored.

QUESTIONS AND COMMENTS

Rensel: A little counterpoint to what Bill Eichbaum said. Public polling by independent firms in the Pacific Northwest actually shows that the public is not opposed to aquaculture in that area. Despite all the misinformation, the public is actually relatively favorably disposed to aquaculture and I would submit the supposition that it is a vocal minority that is responsible for the bad press. Let's be fair! Some of the things they talk about have occurred in the past. In my opinion they do not really reflect the current state of affairs.

Leonard: Three things. Bill (Eichbaum), I appreciate your comments. I would agree with almost all of them. I don't know if these are ideas, advice, or what.

The first would be the competition issue from the aquaculture side. Looking for species that inherently do not compete with wild fish or fishermen, and fish that are currently in the market is perhaps a way

to move forward. Again, I think using Neil's (Sims) project as an example, there is no wild fishery for yellowtail in Hawaii. The absence would seem to take that issue off the table.

I would be very explicit about not bad-mouthing fishermen. I have been shocked at how antagonistic some in the aquaculture community are toward fishermen. I have said this before; I don't think it is helpful.

I think we need to work in a way in which fish are viewed as the equivalent of the concept the "rising tide lifts all boats." Maybe it is marketing, maybe market differentiation, I am not sure. But allowing it to play out as a sort of negative market consequence as happened with wild salmon and farmed salmon a decade ago is not going to be very helpful.

The other idea in getting public support for the integration of aquaculture into conservation, is it crazy to ask the aquaculture industry to support development of marine protected areas and marine reserves in their quest to expand an industry into a public resource? It is just a concept.

Weaver to Eichbaum: The competition thing. That happens to be a driving force and it is the ENGOs themselves who have pushed many of these images in certain directions, particularly I think, in the case of shrimp. There was competition between shrimp farmers and commercial shrimpers and the ENGOs deliberately targeted aquaculture while they totally ignored bottom trawling, which unquestionably is the most destructive fishery practice in terms of what it actually does to the ecology. Everyone knows this is because the ENGOs specifically went after aquaculture. So part of our image problem seems to be a result of activities by your organization.

Eichbaum: It is not our organization and I think you are wrong. In terms of wild caught fisheries, the environmental community is probably as concerned about bottom trawling and bringing it under control as it is about anything in the wild fishery area. You are just wrong! And I think that as far as the farming of shrimp goes, the record of the early '90s is quite negative in many places. As a result of the focus on that, and the effort to create standards, work that Jason Clay really started back in the '90s, there have been many changes that have been quite beneficial for the farmed shrimp industry.

Weaver to Eichbaum: Except Jason Clay mentioned at a meeting when you originally made a decision as to whether to go after aquaculture or go after bottom trawling, you made a decision that going after aquaculture would be fairly easy. The decision was made based on the fact that going after bottom trawlers at the time was politically impossible. So basically you get a lot more fund raising bucks by going after a non-existent industry that couldn't fight back and bottom trawling could.

Eichbaum: This is the kind of conversation that I think is not very helpful. To take a public policy discussion, to take an environmental discussion, and to take an economic discussion and suggest that environmental organizations makes choices in order to raise money—I resent that.

Santerre to Eichbaum: You mentioned three items on competition for ocean space. Then you brought up the subject of competition between wild Alaskan salmon and farmed salmon. That is just an economic discussion. I am not sure why it is a concern to WWF. It is basically healthy competition when you can produce fish a great deal cheaper than you can capture them. I don't know how that gets into an environmental discussion.

The third item you brought up was resources decline. I think people on all sides of this issue realize and agree that resources are in decline. Yet you did not talk about not taking action, the impact of not having more aquaculture producing the food that health professionals are telling consumers they should eat. The number of consumers is going to increase and the demand for nutritious seafood is going to increase concurrently. As a result, more pressure will be put on wild fisheries. Taking no action will have a significant environmental impact. I was surprised that wasn't one of your three points.

Eichbaum: Right. Well, my assigned role in this point-counterpoint discussion was to be the negative voice and attack any vulnerabilities of aquaculture—real and perceived. This sort of narrowed the box.

On your point about competition between wild and aquaculture fisheries, I guess I agree that it may be an economic issue. But I also think it does have environmental implications and it certainly has public policy implications. As I said, we actually work with both sides of that equation.

Our thought is that it would be easier to make progress on many issues across the spectrum of competition if there were some ability to have a conversation between both sectors about the issue we have talked about--what the future of supplying people with protein from the sea is going to be. I don't think it is going to be only wild caught fisheries or only aquaculture. It is going to be a mix of the two. I don't think we should answer the question of what the mix will be based solely on economic competition. I think we ought to make some public policy choices and I think it is responsible for WWF to be part of that discussion in addition to anyone else who has an interest in the issue.

Hedgecock: If we bring the discussion back to the local Southern California Bight, essentially there isn't a fishery here. What Sam (King) is telling us is that there isn't any commercial fishing industry locally that makes these seafood resources available to us. Perhaps Mark Helvey can address this.

Helvey: Sam King was talking about swordfish season arriving. Actually the season started last August 15th but because of regulatory procedures and the sustainable climate we live in, which is a good climate, the catch is kept under control. Swordfish won't really be seen on the market until November 15th. The fish are out there. It is just that we have to protect the other organisms that co-exist with them. So it is the regulatory framework within which we operate that controls availability and it is going to continue.

Hedgecock: What about species that have been under discussion here? No one has talked about culturing swordfish but amberjack, yellowtail, sea bass, and other species have been discussed.

Helvey: A lot of that involves species that are migratory and, again it is going to depend on ocean conditions and what the fish are feeding on. It is very cyclical.

Hedgecock: So an aquaculture product that would be available at the times of the year when there are no landings would not be competing with anything.

Helvey: You would not think so.

Drawbridge: Using white seabass as an example in regard to competition and year-round availability. As Sam King mentioned, as a wild product the species is available only a few months of the year, In my opinion, the wild product legal size is 28 inches, about the minimum length for a five pound fish. The farmed product would be much smaller but it would be available year-round. So it depends on how you are going to balance this, but I think it can be balanced. Using white seabass as an example, there would be a market for both the wild product and the farmed product.

Sims: First, an answer to Gorge Leonard's question about supporting marine reserves. Absolutely! I think the open ocean aquaculture community would roundly support the push for more protected areas because most of us come from a vision of passionate concern about the ocean environment. And I think shoulder to shoulder, if we could make the argument that as we increase the amount of protected areas, there is going to be a reduction in the availability of wild fish stock. How are we going to meet that short fall? I have an idea. How about having open ocean aquaculture? I think that is a compelling argument.

I would like to address the proposition that Jim (Fawcett) put forward that we need to educate the public first before we put a project forward. I don't think that will work. I think we all recognize we are

losing this debate. A couple of buzz words will help remind you how badly we are losing this debate. Think about the analogy between 'fish poop' and sewage. What do the two words 'sea lice' bring to mind? And then 'tigers of the sea', a beautiful buzz word phrase. It sticks in people's minds. We are losing this debate roundly. I don't think we can change that dynamic unless we propose here that this project—the one we propose--is the way that we change the debate because it is so different from that history.

Over the past day and a half we have put forth compelling arguments why this should move forward. How do we get that out into the public arena? The best thing we could do would be to have an article on the front page of the Los Angeles Times. So what would the response be if you went to the environmental editor of the paper and said: Why don't you do an article about how good open ocean aquaculture is? He is going to say: "Well, I need a conflict. Where's the conflict? I don't have a story unless there is a conflict." I know this would happen because I have gone to editors time and time again and gotten such a response. So put forth a proposal and bingo, you've got a conflict. You will have a forum for discussion of these issues that journalists are going to want to write about and people are going to want to talk about, and this will happen not just in a room where we talk among ourselves. It will be a lively open discussion.

I think we have the strength of logic and science on our side. Let's shine a light in here. Let's get that ignorance and superstition out of the way so we can move forward.

Z. Grader: I agree with George (Leonard). If you are going to engage the community, you don't do it by bashing. There is a lot of bashing of the commercial fishing community by the aquaculture industry. Today I have heard some of those mischaracterizations of the concerns of commercial fishermen about certain aquaculture operations, mainly salmon, where there are genuine problems that don't have anything to do with competition.

I think the first thing you have to do is to start doing outreach and you don't do that by bashing. There is also a fair amount of bashing of environmental groups by the aquaculture industry. It has to get over that. You can't just go in like the local chamber of commerce complaining about regulations. We are in a regulatory environment. You have to engage the community and you have to be realistic in what you are proposing and what you can provide. Don't say you are going to feed the world with amberjack. You are not. You have to make your case here. I think you can.

Eichbaum: I want to comment on Neil's (Sims) point. If this project is going to go forward, it needs to address not just the specifics of the project, but also the larger contextual issues in which an industry could get built. And the entire community needs to be involved in the educational process.

Bartley: Consumers are hesitant. Who is benefiting, the consumer or the producer? A comment on the roots of this opportunity to change the attitude in which consumers are reluctant to accept certain types of development. Consider the case of Monsanto which misplayed its hand. Monsanto makes genetically engineered products that are advertised for industry. Roche, a pharmaceutical company, makes a genetically modified product, a vaccine, which is presented as a benefit to the consumer. In describing what **we** are doing, we need to be accurate and transparent.

I previously mentioned the value of partnerships with different organizations. WWF is an extremely good example of an organization that does this. WWF, the World Bank, the government of Thailand and FAO got together to discuss the shrimp problem and developed a list of guidelines. If WWF had tried to do that independently, the product would have been criticized. California should use WWF's approach as a guide.

Schubel: Another reason why I think WWF is successful is that it does not just address the enviroment. Often the people who live in the areas where WWF is working are factored into the equation.

Another point I think we need to underscore is the importance of framing issues properly. The word framing is often misued as spin. That is not what framing means. We do not frame most of our issues broadly enough and long term enough. I think that is one of our problems here.

Helvey: An important point about public outreach and its application to potential aquaculture programs has been brought up several times in this forum. What is missing from this debate is fishermen. If we are to contemplate next steps, the kind of public outreach required to be successful in what we are discussing needs to include commercial and recreational fishermen, the environmental community, and industrial aquaculturists.

Ito: Where I have been working in Mexico there is little conflict in the form of competition between the commercial fishermen and the aquaculture industry harvesting the species we have discussed here. In Ensenada the species harvested is sardines and the conflict is between the fishermen and the sardine processors on land. Sardines formerly sold for $40 a metric ton**.** Fishing boats remained at the docks and boat leases were bought up. Once the grow-out aquaculture tuna industry started and sardines were sought after for forage, the wild sardine fishery flourished once more, the price of sardines tripled, and commercial fishermen supported the tuna aquaculture industry. On the other hand, however, the producers who process sardines for human consumption resent the competition.

We will need commercial fisherman to develop the aquaculture industry we are discussing. We absolutely need to involve them. They are a dying breed.

Bush: I am associated with The Cultured Abalone, a land-based abalone farm dependent on the ocean for kelp. We have a lease that enables us to harvest kelp, the forage for the abalone. We are advocates of kelp protection on which our industry is dependent and we took an advocacy position when marine protected areas were being designated in the California central coast MPA project. Marine reserves, areas where no extraction is permitted, were being designated that have kelp forests in the middle of them. In spite of the fact that we were designated as stakeholders, we had to fight tooth and nail to keep this from happening. I mention this because we are now involved in the South Coast Project. We are doing this transparently to demonstrate our values as stewards of kelp in areas that are not designated as MPAs. There has to be a mutual realization about dependence on sharing of natural subsidy resources.

Schubel: As you (Bush) pointed out, the process of designating marine protected areas off California's south coast has started. The Aquarium of the Pacific is in a collaborative partnership to educate the public about how it can get involved in the designation process. We could work together and have the kind of conversation you are talking about with fishermen, environmental groups, and the industry. That could be a good start. We would be interested in talking to any of you who would be willing to structure what might be a useful dialogue.

King: What we find from our customer base is confusion, not opinion. The public is telling us it is eating more salmon than ever before, wild and farmed, two million pounds. Supply does not appear to be a problem and the public is confused. Salmon is available at Costco and Wal-Mart. The public is more influenced by price than by source.

Bowman: Honesty, candor, openness. Trust is an issue. The public is smart enough to see this is a money making opportunity and to see there are problems. The public is influenced by environmental concerns. What would help is to deal with these problems in a transparent way. Treat the community as smart. Your industry has problems and the public can see that.

Sims: I spoke earlier about the industry needing to drive innovation. Here in the U.S. entrepreneurial ingenuity is a great force that can be harvested to correct these kinds of problems. The profit motive is what will drive this and that is not necessarily a bad thing. It can be harnessed for good.

Schubel: Honesty, candor, transparency—all cut both ways in terms of how the science is used to support or attack aquaculture The industry needs one set of facts. Interpretations can vary.

Leonard to Hedgecock: You said that the environmental issues of aquaculture were manageable, quite small, and in some cases trivial. My question is how does that measure up to the large volume of science that supports your statement and the many controversial studies that have been published in marine high profile journals and have not been retracted? There is a gap somewhere between the science that many of the risks are quite small and the conclusions of the respondents that there are impacts on the environment.

Hedgecock: Sorry, I wasn't speaking about all of aquaculture, only what we brought to the table here about a demonstration finfish aquaculture project in the Southern California Bight. One of the main issues has been the input of nutrients into the environment by fish farms. The model clearly shows that the impact is trivial. I was reflecting on this area and this project. Are we in disagreement about that?

Leonard: No. At the same time we are talking about developing an industry that will discharge into the coastal system. Recently there was an article published in *Science* that showed a dramatic and exponential increase in the number of dead zones around the world. It wasn't aquaculture or aquaculture runoff or any of those things.

Schubel: This is a good example where innovative integrated multi-trophic aquaculture could play a role, using seaweed, kelp, to take-up nutrients and harvesting the kelp for food and other uses. There has even been a proposal to harvest it for natural gas. So there are ways to solve the problem if there is one.

Post Forum Comment: October 2008 announcement by GreenFuel Technologies:
http://current.com/items/89447987/first_commercial_algae_plant_to_genereate_power_and_clean_smoke_stack.htm

I want to come back to the question of manageable, quite small, trivial impact. If you look at the media and the literature, there have been some horror stories about aquaculture gone badly--some salmon farms in Chile for example. The science makes it quite clear that the impacts have been very bad. These farms were badly sited, too many of them, too close together, in areas where the circulation is inhibited, the residence time too long, too many fish in each cage, etc. The list of impacts and mistakes is a long one.

I think that what I heard people say yesterday is that if you site farms properly, manage them properly, and feed properly so no excess feed goes to the bottom as happened in the Gulf of Maine, then you can control the environmental impact so it is very small, even trivial.

Yarish: The proposals that have been put forth are all mono-specific. A multi-trophic approach to aquaculture offers economics, diversification, and ecological services. I want to caution that the ecological process needs to be addressed from the start. Farms are doing a lot better in being managed. Norway aquaculture farm employees are fisherman. Fishermen have got to come around to how aquaculture can be a help to them.

Santerre: One of the things that I am troubled by is the push for zero impact of food production for aquaculture. Aquaculture is one of the biggest polluters there is on the planet. There will be an impact. Zero impact is just not achievable or plausible. The industry will discharge into the ocean so how do you have an industry that influences a declining ocean? A reasonable impact needs to be considered so aquaculture can move ahead if we are to meet the global demand for seafood.

Another point is the carbon footprint. We know that about 90 percent of the grain produced is eaten by animals that are in turn eaten by humans. If we could just eat the grains, it would be better for the

planet. Of course, that isn't going to happen. A common sense approach to some of this discussion, especially zero impact.

Yarish: The Norwegian model may not be a multi-trophic approach but what the Norwegians have done is look very, very carefully at habitats as a whole. They look at how their farms affect the immediate area and take that into consideration and once that is done, you have a bare box. They have some beautiful models that actually look at the acquisition of nutrients in the kelp beds.

Another point. Some of my co-workers did some work with a group in Maine that had heard about MTAC but knew nothing about it. After we showed them how to do it, they now have a business plan to harvest mussels using MTAC. Even if they can't sell the seaweed component, they looked at the environmental aspects of the entire operation and are going in the direction of MTAC.

Weaver: Keep in mind that aquaculturists have a strong self-interest in keeping the environment healthy, avoiding self-pollution, pathogens, etc. It has to do with understanding and all of these self-interests are moving in the same in protecting the environment. The natural evolution of aquaculture is to improve environmental issues, often through self interest. That is what aquaculturists are really depending on.

A good model to look at is the evolution of shrimp farming. The natural evolution of newer technologies is to protect the environment. Mangroves proved to be unsuitable for shrimp farms so the industry abandoned the mangroves and moved to salt flats behind mangroves. Some have planted mangroves for protection purposes and most recently, have started to manage the water supply so they are literally not discharging, zero discharge. This is all based on their own personal self-interest. It has nothing to do with being driven by the NGOs.

Schubel: But earlier shrimp farming did take a huge environmental toll and I think what we have heard here in the last day and a half is that we would like to avoid having negative impacts on the environment and shorten the time to get to the kind of technology that is at least environmentally benign.
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Tze: The 'Osborn Effect', the error of the computer industry in the 1980s in announcing a new model too soon, applies to IMTA. Multi-trophic aquaculture is next generation. It is not ready for prime time. At the moment monoculture is the solution. Let's not distract the public with far-out ideas.(http://en.wikipedia.org/wiki/Osborne_effect)

Sims: I agree. This is hard; it is hard to add additional species to the system

Yarish: I understand the economics, but I do know that there are fouling issues that need to be addressed upfront; not plan for today but for industry and that needs to be included and available.

Z. Grader: As I see it the purpose of this forum is to determine if there is a way to have some sort of aquaculture in Southern California. If there is a possibility of sustainable aquaculture in Southern California, then it is probably about ready to find out. I think there is a promise that it is nearly ready to work. Do the outreach. Now is the time to get the names of the local people in the fishing community, the names of the NGO leaders, specifically NDRC and Coastkeeper. Coastkeeper wants to work on the problems of water quality.

Don't get into salmon issues. I don't know them well enough to debate and if I did, it would take hours.

Shubel to Grader: That is a very important comment. If we decide we would like to have a dialog as part of the MLPA project bringing together environmentalists, fisheries people, aquaculturists, etc., would you be willing to help us structure and orchestrate the conversation?

Z. Grader: It is something to talk about.

Rensel: In regard to integrated multi-trophic aquaculture, it is going on now. Adapt it locally.

CONCLUDING REMARKS

Jerry R. Schubel

Over the last day and a half we have had a good conversation with each other. Clearly we did not always agree, bit none-the-less, it was a good conversation. Wendell Berry is a farmer in Kentucky and probably one of the world's best known living essayists. His book *The Age of Ignorance* (See Barry 2005) contains a wonderful essay on conversation. He makes the arguments that if you have a conversation, it means that some of the time you are talking and some of the time you are listening. That often is not the case in public meetings. I think we have all done a good job at this forum in having a good conversation.

It is now time to bring the forum to a close. I think the statement that Zeke Grader made is a very important one. It appears that if we interpret and summarize what we have said and discussed here well, we can indeed make the case for doing an experimental demonstration project. I agree with Dennis Hedgecock who said that in terms of the hypothesis we did not hear anything that would disprove the hypothesis. Remember in science you cannot prove a hypothesis: you can only disprove it.

There were some caveats. There were some weak points and we need to focus on them to achieve what we all want—a healthy ocean, a sustainable fishing industry, and an adequate protein supply for a growing world population among other things.

I want to thank all of you for your time, your ideas, and your conversation over the last day and a half.

CONCLUDING REMARKS

Sam King

I want to thank Jerry for the last day and a half. An aquarium is not necessarily the right background for a conversation such as we have had, but I want to thank him for having the foresight to bring this group together.

FINDINGS, CONCLUSIONS, RECOMMENDATIONS

FINDINGS

Although no formal votes were taken, at certain times throughout the forum straw polls were taken to assess the level of support for certain conclusions and recommendations. All the findings that follow had very strong support of the participants.

FAVORABLE CONDITIONS IN THE SOUTHERN CALIFORNIA BIGHT AND IN CALIFORNIA

- Ooceanographic conditions in the Southern California Bight make it one of the most favorable coastal areas of the entire nation for development of a sustainable offshore aquaculture industry.
- Favorable conditions include: good circulation, relatively deep water close to shore, and few severe storms.
- A critical mass of the necessary shore-based fisheries support infrastructure still exists.
- There is a high level of scientific and technical expertise in fisheries and aquaculture within the region.
- "California ocean ethic" could be very advantageous to developing a sustainable offshore aquaculture industry that would complement the "California-Grown" label for agricultural products, and that could serve as a model for the rest of the state, the nation, and the world.
- The Southern California Bight is within a 36 hour truck delivery of products to a market of approximately 50 million people.

IMPEDIMENTS AND CHALLENGES TO DEVELOPING OFFSHORE AQUACULTURE IN THE SOUTHERN CALIFORNIA BIGHT

Perhaps the two biggest impediments to development of an offshore aquaculture industry anywhere in California are lack of a strong constituency, either from industry or the public, and the existing regulatory framework that involves both state and federal agencies discourages investment in offshore aquaculture development because of its complexity, uncertainty, and unpredictability.

In California, the Sustainable Oceans Act (SB201) provides a comprehensive framework for the state to manage marine finfish aquaculture in state waters in an environmentally sustainable manner. In the absence of a coordinated regulatory framework for federal waters, and assuming there are no conflicts with federal legislation and regulations, California could argue that the state would have authority to register and regulate an offshore facility in federal waters with existing legislation, policies and regulations, recognizing that other federal laws also would apply.

Before venture capitalists and aquaculture entrepreneurs will make significant investments in offshore aquaculture in California waters, there will need to be some assurances that if standards and criteria are met, they can have confidence that their leases can be extended in both time and space. At present, this is not the case.

A thoughtful and systematic analysis should be carried out to explore and evaluate how a few demonstration farms might evolve into a full-fledged industry—what that industry might look like when mature including: the number and location of farms, how it could be integrated with other uses of the coastal ocean to minimize conflicts, environmental and economic impacts, etc.

Competition—real and perceived—needs to be dealt with. Competition with wild fisheries can be minimized by having aquaculture in Southern California concentrate on those species for which there is no viable commercial fishery or where availability is limited seasonally. Competition for ocean space is more challenging in the Southern California Bight which is a prototypical example of an urban ocean with multiple and conflicting uses. Movement of farms farther offshore and into deeper water would reduce conflicts with surface activities. Space-based allocation of uses could decrease competition for space by assigning societal important uses to appropriate locations. A viable and

sustainable offshore aquaculture industry would require less than 1% of state waters within the Southern California Bight and less than 0.1% of the contiguous EEZ waters.

RECOMMENDATIONS

There was unanimous agreement that it is time to design and carry out one or more demonstration projects in the Southern California Bight to test the concept of offshore aquaculture using the following approach:

The site(s) should be selected using the best tools available, such as the AquaModel. High environmental performance standards should be set and the operation should be monitored rigorously for compliance with those standards.

The scale of the projects should be large enough that concerns such as those associated with water quality and benthic impacts can be evaluated at appropriate confidence levels.

The species selected should be native to the region, or those that have established self-reproducing populations. Examples include: white sea bass, California yellowtail, California halibut, and striped bass.

The project should be based on the precautionary principle and adaptive management.

The entrepreneurs should be given the opportunity to learn from their operations and to incorporate those lessons into revised business practices consistent with achieving high environmental standards.

If offshore aquaculture is to become a successful industry in Southern California, it needs a constituency. This will come only through a sustained program of public education and outreach that is accurate and balanced and based on the best scientific data and information. On-going conversations are needed among the various constituencies to explore issues—real and perceived—and to elevate these conversations above the level of 'bashing'. The conversation needs to encompass what the supplying of people with protein from the sea will be in the future, the mixture of wild-caught and farm-grown. This conversation would benefit by being embedded in a larger discussion of the total food supply for the future.

CONCLUSIONS

The potential for development of a sustainable offshore aquaculture industry in the Southern California Bight is high based on existing data, information, and knowledge. Nothing said during this forum would violate the original hypothesis:

> *Southern California could support an offshore finfish aquaculture industry that could become a $1 billion/year industry with only a very small percentage of State waters or Federal waters (the EEZ) in the Southern California Bight dedicated to this purpose. A properly constructed and managed industry would provide a safe, secure, stable supply of healthful seafood to the region, would relieve pressure on wild fish stocks, and would help conserve the remaining working waterfront—all without unacceptable adverse impacts on the environment and other uses of the ocean.*

The economic value may be overly optimistic and a number of areas continue to be of concern, but the very strong consensus was that perceptions will be changed only through successful demonstration projects of appropriate scale, managed adaptively, and with certain safeguards built in.

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APPENDIX B

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APPENDIX C. PRESENTER BIOGRAPHIES

CONNER BAILEY is a professor of rural sociology at Auburn University. His work focuses on the connection between natural resources and community development. Dr. Bailey has extensive international experience in marine capture fisheries and coastal aquaculture. Prior to joining the faculty at Auburn, he worked in the Marine Policy Center at Woods Hole Oceanographic Institution and at the International Center for Living Aquatic Resources Management. He has also taught fisheries resource management and development at the College of Fisheries, University of Tromsø, Norway. He holds a PhD in developmental sociology from Cornell University.

DEVIN BARTLEY is the California aquaculture coordinator, California Department of Fish and Game (DFG). He joined the DFG after 17 years with the Food and Agriculture Organization of the United Nations (FAO) in Rome, While at FAO, he worked on genetic resource management, alien species, and inland fisheries. Now back in California. Dr Bartley is involved with increasing the level of awareness on aquaculture in the general public and regulatory agencies, and with developing informed policies on aquaculture development and management. He received his Phd from the University of California Davis.

DREW BOHAN is the executive policy officer for the California Ocean Protection Council (OPC). The OPC is dedicated to protecting California's coast and ocean by improving the way the state manages these resources. Prior to joining the OPC, Bohan served as a deputy cabinet secretary for Governor Arnold Schwarzenegger and as assistant secretary for policy at the California Environmental Protection Agency. His non-government positions have included Executive Director of Santa Barbara Channelkeeper and litigation associate for the San Francisco law firm Heller, Ehrman, White and McAuliffe. Bohan received his law degree from Golden Gate University in San Francisco.

MARK DRAWBRIDGE is the senior research scientist and director of aquaculture at Hubbs-SeaWorld Research Institute. He is the current president of the California Aquaculture Association. He serves as an adjunct faculty member at the University of San Diego. He is a member of the Western Regional Aquaculture Center's technical committee and Vice Chair of the California Farm Bureau Federation Commodity Advisory Committee for Aquaculture. He received a B.S from Gettysburg College and an M.S. from San Diego State University.

WILLIAM EICHBAUM is vice president and managing director of the World Wildlife Fund's Marine Program. He has packed a dozen lifetimes' worth of accomplishments into his career as an environmental advocate. In the 1970s, he helped organize the first Earth Day. In the 1980s, he played a key role in the creation of the Chesapeake Bay Program. Before joining WWF in 1989, he served as Massachusetts' Undersecretary of Environmental Affairs. While working on environmental affairs for the state of Maryland, he spearheaded legislation for the Clean Water Act authorizing the creation of a national estuary restoration program. Now, as WWF's ultimate advocate for the sea, he is working to end destructive fishing practices, reduce pollution, and establish a network of effectively managed, ecologically representative marine protected areas covering at least 10% of the world's seas.

JAMES FAWCETT is the director of marine science and policy outreach for the Sea Grant Program at the University of Southern California, an element of the USC Wrigley Institute for Environmental Studies. Concurrently, Dr Fawcett is the Marine Transportation and Seaport Specialist with the program. He also holds an appointment as an adjunct associate professor of public policy in USC's School of Policy, Planning and Development. He holds a Ph.D. in urban planning from USC.

JOHN FORSTER is the president of Rensel Aquatic Science Consultants Associates. He worked on shrimp aquaculture for the UK government from 1965 to 1973 and then joined BOC Ltd. for whom he ran a commercial trout farm and the international technical services division. He moved to the

United States in 1984 to set up Stolt Sea Farm's west coast salmon and sturgeon farming operations. In 1994 he started his own consulting firm and founded Columbia River Fish Farms, LLC. He has been a contributor to phytoplankton studies worldwide including harmful algae, effects on fish and shellfish, and mitigation means. Dr. Forster holds a PhD in Fisheries and Oceanography.

DENNIA HEDGECOCK is the Paxson H. Offield Professor of Fisheries Ecology at the University of Southern California, Department of Biological Sciences, where he serves as head of the Marine Environmental Biology Section and graduate program. Dr. Hitchcock has published over 110 scholarly articles on the population, quantitative, evolutionary and conservation genetics of marine fish and shellfish, primarily Pacific oysters, white seabass, and Pacific salmon. He obtained his PhD in biological oceanography from Scripps Institute of Oceanography.

MARK HELVEY is the assistant regional administrator for Sustainable Fisheries with NOAA's National Marine Fisheries Service (NMFS), Southwest Region. His principal area of responsibility is the conservation and management of fishery resources. Prior to joining NMFS, Mr. Helvey was a research associate at Occidental College in Los Angeles, California. He holds B.S. and M.S. degrees from the University of California, Santa Barbara and the University of Arizona, respectively, and an MBA from California State University, Long Beach.

BURTON JONES is a Research Associate Professor in the Marine Environmental Biology section of the Biology Department at the University of Southern California. Dr. Jones research interests include bio-optical oceanography, physical-biological interactions, coastal processes, and coastal ocean observing systems. He has been involved in studying the dynamics of physical/bio-optical interactions in a variety of environments that include coastal California. Recently, as part of the Southern California Coastal Ocean Observing System (SCCOOS) and research in harmful algal bloom monitoring, Dr. Jones has been involved in implementing a coastal observing system that includes both fixed sites and autonomous vehicles. This includes participation in the development of an intelligent network of fixed and mobile nodes capable of adaptive mapping and sampling strategies. He holds a PhD in biological oceanography from Duke University.

DON KENT has led Hubbs-SeaWorld Research Institute as president since 1998. He joined the Institute in 1977 as a graduate student working on the growth characteristics of striped bass. He has participated on numerous Institute research programs including minimizing interactions between fisheries operations and protected species, and the development of marine finfish aquaculture. In 1983 he worked with the recreational fishing community, the California Legislature to initiate the Ocean Resources Enhancement and Hatchery Program (OREHP). As principal investigator, Dr. Kent was responsible for the planning and construction of the Leon Raymond Hubbard, Jr. Marine Fish Hatchery in Carlsbad, California, which was dedicated in 1995. In recognition of his contributions to sustainable fisheries management, NOAA presented him with its Stewardship and Sustainability Award in 2007.

DALE KEIFER IS a professor in the Department of Biological Sciences at the University of Southern California, Dr Kiefer is also Chief Scientist of System Science Applications, a marine consulting and software development company. He has published 75 papers and 16 reports in bio-optical oceanography, phytoplankton ecology and physiology, and fisheries information systems. He holds patents for a wave-dampening in swimming pools and the natural Fluor meter, which provides instantaneous estimates of aquatic photosynthesis. Currently, he is working in three areas of oceanographic research and engineering. He developed AquaModel, which simulates the transport and fate of waste products produced by fish farms, with Dr. Rensel and Frank O'Brien He is also working with the Pfleger Institute of Environmental Research and NASA's Jet Propulsion Laboratory to develop tools to track electronically tagged pelagic fish and sharks and to analyze recruitment in marine fish populations. In collaboration with fisherman and marine scientists from Alaska he is developing an ecosystem-based model for the restoration of the Prince William Sound herring population. De. Keifer holds a PhD in oceanoGraphy from Scripps.

SAM KING is the President and Chief Executive Officer of Kings Seafood Company, Inc. Kings was formed in November 1983 as the University Restaurant Group. From that time, King, his cousin and partner, Jeff King, and his management team have developed and operated restaurants. These include five signature restaurants -- 555 East Steakhouse, Ocean Avenue Seafood, i Cugini, Water Grill, and Lou & Mickey's. In 1994, the team created the King's Fish House concept which presently has 12 restaurants in southern California, Arizona, and Nevada. Sam serves on various boards that include the Aquarium of the Pacific and the Wrigley Institute of Marine Science at University of Southern California.

GEORGE LEONARD is director of aquaculture for Ocean Conservancy. Dr. Leonard's goal is to ensure that U.S. aquaculture develops under strong environmental standards. His work is currently focused on legislative activities surrounding the development of open ocean aquaculture in state and federal waters. Prior to this appointment, Dr/ Leonard was the Senior Science Manager for Monterey Bay Aquarium's Seafood Watch program where he was responsible for overseeing the research and analysis of capture fisheries and aquaculture practices related to the development of sustainability recommendations for the public and businesses. Before joining Seafood Watch in early 2002, he was the Program Manager for COMPASS (the Communication Partnership for Science and the Sea) where he helped communicate emerging marine conservation science to policymakers, NGOs and resource managers. His PhD is in ecology and evolutionary biology from Brown University.

FRANK O'BRIEN is a highly experienced modeler and software engineer. Mr. O'Brien has extensive experience in every phase of software development including management and business development, requirements analysis, algorithm development, and prototyping. He was the architect and lead developer of EASy GIS software, a dynamic 3D oceanographic GIS system, its NetViewer, and with the assistance of other team members developed the Mariculture module. His experience includes programming for the development of a series of information systems in support of mariculture environmental analysis, fisheries management, fish tracking, marine biogeographics, hydro-optical water analysis, water quality studies, and coastal area management projects including the Gulf of Maine Biogeographic Information System (Sloan/NOPP), NOAA-NESDIS Sea Nettles, Santa Monica Bay Virtual Ocean (SMBRP).

BENEDICT POSADAS an associate professor of economics at Mississippi State University. His current interests and responsibilities are to establish and maintain partnerships, secure funding and conduct economic research on these coastal-related issues: economic recovery, sustainable economic development, horticulture production and distribution, nursery mechanization and automation and to develop and maintain educational programs based on research results addressing the coastal issues relating to natural disaster economics, fisheries economics, aquaculture economics, and environmental valuation. Dr. Posadas is also responsible for the development and maintenance of the website of the Coastal Research and Extension Center, Mississippi Sea Grant Extension Program, Center for Urban Rural Interface Studies. He is the principal author on numerous papers related to aspect of aquaculture including catfish, oysters, prawns, tilapia, coastal herring and crawfish. His research has included cage culturing, closed systems, and the economics of aquaculture.

J. E. "JACK" RENSEL is the president of Rensel Aquatic Science Consultants Associates and principal investigator at Senior Scientist at System Science Applications He specializes in aquaculture effects and modeling studies that stem from his work with benthic and pelagic food-web studies in the Pacific Northwest and throughout several continents. He is known for his work with harmful algal bloom dynamics and their effects on fish. Dr. Rensel's work includes numerous net-pen siting studies, development of regulatory performance standards, fish bioenergetics and many forms of research and monitoring related to fish and shellfish aquaculture. He is a consultant to fish farming corporations, domestic and foreign governments, universities and environmental organizations. He holds a PhD in Fisheries and Oceanography.

MICHAEL RUBINO is the manager of the National Oceanic and Atmospheric Administration's Aquaculture Program. He joined NOAA in late 2004 to lead NOAA's renewed commitment to marine aquaculture. Most recently, Dr. Rubino was the manager of New Funds Development for the World Bank's Carbon Finance Group. In the 1990s, Dr. Rubino was at the International Finance Corporation, a private sector affiliate of the World Bank, where he developed renewable energy and biodiversity investment funds. Earlier he was the CEO of Bluewaters, Inc., an aquaculture R&D company, and a partner in Palmetto Aquaculture, a shrimp farm in South Carolina. Dr. Rubino also served as vice-chairman of the State of Maryland's Aquaculture Advisory Committee. He holds a Ph.D. in Natural Resources from the University of Michigan.

CHARLES SANTERRE is a professor of food toxicology in the Department of Foods and Nutrition at Purdue University. Dr. Santerre was the National Spokesperson for the Institute of Food Technologists and has served as Chairperson for the Toxicology and Safety Evaluation Division. He received a B.S. degree in Human Nutrition and a Ph.D. degree in Environmental Toxicology and Food Science, both from Michigan State University.

STEPHANIE SHOWALTER is the director of the National Sea Grant Law Center at the University of Mississippi. Ms. Showalter oversees a variety of legal education, research, and outreach activities, including providing legal research services to Sea Grant constituents on ocean and coastal law issues. Ms. Showalter holds adjunct positions at the University of Mississippi School of Law and the University of Southern Mississippi teaching such courses as Ocean and Coastal Law and Wetlands Law and Regulation. Ms. Showalter's research on natural resources, marine and environmental law issues has been published in a variety of publications. Ms. Showalter's duties also providing assistance to organizations and governmental agencies with interpretation of statutes, regulations, and case law. Ms. Showalter is licensed to practice law in Pennsylvania and Mississippi. She received a B.A. in History from Penn State University and a joint J.D./Masters of Studies in Environmental Law degree from Vermont Law School.

JERRY R. SCHUBEL is president and CEO of the Aquarium of the Pacific.. He also directs the Aquarium's Marine Conservation Research Institute. He was dean and director of the Stony Brook University's Marine Sciences Research Center from 1974 to 1994 and for three of those years served as provost at the University. He has served on numerous National Research Council commissions, committees, and boards and chaired the Marine Board. He is past chair of the National Sea Grant Review Panel and has served on the National Science Foundation's Education and Human Resources Advisory Council, and US EPA's Science Advisory Board. He is a member of the Marine Board, chairs the Ocean Research and Resources Advisory Panel, and is a member of the Science Advisory Team for the California Ocean Protection Council. He is president emeritus of the New England Aquarium. He and Sam King co-founded the Sustainable Seafood Forum. Dr Schubel is on the standards committee of the Global Aquaculture Alliance.

NEIL SIMS is the co-founder and president of Kona Blue Water Farms, LLC, and founding president of Ocean Stewards Institute. Kona Blue is the first integrated marine fish hatchery and open ocean fish farm, off the Big Island of Hawaii. The company presently produces about 25,000 lbs per week of sashimi-grade sustainable Kona Kampachi® in its offshore farm site. He is the founder and president of the Ocean Stewards, a trade association that provides a united voice for championing offshore aquaculture in the Americas. The Ocean Stewards are deeply committed to environmentally sound development of the open oceans, and rational expansion of offshore fish farming.

ROBERT STICKNEY is the Director of the Texas Sea Grant College Program and Professor of Oceanography at Texas A&M University. Dr. Stickney has been involved with aquaculture throughout his professional career. He has experience with the industry aquaculture in about 20 countries and has worked with freshwater and marine finfishes ranging from catfish and tilapia to salmon and Pacific halibut. He is the author of numerous books, book chapters and refereed publications and is currently

Editor-in-Chief of the journal *Reviews in Fisheries Science* and World Aquaculture (the magazine of the World Aquaculture Society). . He received his Ph.D. in Oceanography at Florida State University.

DAVID TZE co-founded and manages Aquacopia, the first aquaculture venture capital fund. Broadly, he has applied pioneering strategies and technology to developing sectors within established industries. He was strategy vice president of NetworkOil, an equipment marketplace for the oil industry, spearheaded tech consultancy Concrete, and co-founded Cache Networks, a novel digital television platform. Tze serves on the boards of Snapperfarm, Oberon, Ocean Farm Technologies, and The Ocean Stewards Institute. He has a bachelor's degree in economics from Princeton University

DALLAS WEAVER is president and owner of Scientific Hatcheries, Inc. He has been designing and building closed aquaculture systems since 1973 with the intent of creating the technology necessary to build a business that can compete with existing Asian tropical fish producers. This business produced over 20,000,000 fish per year for the research and pet markets in highly automated recycle systems (both fresh water and marine). Dr. Weaver has been conducting research on water treatment systems for industry and aquaculture. In his semi-retirement, he is pursing an interest in suspended solids (SS) pollution from bottom trawling activities. This work is being done in conjunction with United Anglers of So. California. Dr. Weaver holds a bachelor's degree in engineering and a PhD in Applied Science.

CHARLES YARISH is a Professor of Ecology and Marine Sciences at the University of Connecticut He developed an internationally known laboratory for seaweed research and has been a leader in the development of integrated multi-trophic aquaculture (IMTA). In 2008 Dr Yarish was elected to the Connecticut Academy of Science & Engineering. He has published extensively including two co-edited books. He has served with many organizations including the International Executive Service Corps' Aquacultural Project (Kenya), member of the Organizing Committee & the Executive Secretariat for the Vth International Phycological Congress, Qingdao, China and The Advisory Board of the Institute of BioSciences (Halifax), National Research Council of CanadaDr. Yarish received the 1992 Marinalg Award's First Prize at the XIVth International Seaweed Symposium, Brittany, France for his work in East Africa (Kenya) judged to be the most useful to the economic development of the world seaweed industry. He has assisted the Office of Oceanic and Atmospheric Research, NOAA, U.S. Department of Commerce on matters dealing with aquaculture in the People's Republic of China, South Korea and Japan.

APPENDIX D. SUSTAINABLE OCEANS ACT (SB201)

CHAPTER 36
FILED WITH SECRETARY OF STATE MAY 26, 2006
APPROVED BY GOVERNOR MAY 26, 2006

INTRODUCED BY Senator Simitian
(Principal coauthors Senator Maldonado and Assembly Member Parra)
(Coauthor: Senator Denham)
(Coauthors: Assembly Members Baca, Berg, Bermudez, Pavley, and Saldana)
FEBRUARY 10, 2005

An act to amend Sections 15400, 15405, 15406, 15406.5, and 15409 of, and to add Sections 54.5 and 15008 to, the Fish and Game Code, and to amend Section 30411 of the Public Resources Code, relating to aquaculture.

LEGISLATIVE COUNSEL'S DIGEST

SB 201, Simitian Marine finfish aquaculture: leases.

(1) Existing law authorizes the Fish and Game Commission to lease state water bottoms to any person for aquaculture, and authorizes the commission to adopt regulations governing the terms of the leases. Existing law prohibits state water bottoms from being leased, unless the commission determines that the lease is in the public interest.

This bill would prohibit a person from engaging in marine finfish aquaculture, as defined, in state waters without a lease from the commission. The bill would require leases and regulations adopted by the commission for marine finfish aquaculture to meet certain standards. The bill would establish maximum initial and renewal terms for those leases.

(2) Existing law requires the restoration of an aquaculture lease site upon the termination of the lease.

The bill would require the commission to require financial assurances of each lessee to ensure that restoration is performed, and would make marine finfish aquaculture lessees responsible for damage caused by their operations, as determined by the commission.

(3) The California Coastal Act requires the Department of Fish and Game, in consultation with the Aquaculture Development Committee, to prepare programmatic environmental impact reports for existing and potential commercial aquaculture operations in both coastal and inland areas of the state if certain conditions are met.

This bill would delete that requirement from the act, and, instead, modify provisions relating to aquaculture to include that requirement. The bill would further require that if a final programmatic environmental impact report is prepared pursuant to that requirement for coastal marine finfish aquaculture projects approved by the commission, the report provide a framework for managing marine finfish aquaculture in a sustainable manner that adequately considers specified environmental factors.

(4) The provisions of the bill would be known as the Sustainable Oceans Act.

(5) Because this bill creates a new crime, it would impose a state-mandated local program.

(6) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act or a specified reason.

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. This bill shall be known, and may be cited, as the Sustainable Oceans Act.

SEC. 2. Section 54.5 is added to the Fish and Game Code, to read:

54.5. "Marine finfish aquaculture" means the propagation,cultivation, or maintenance of finfish species in the waters of the Pacific Ocean that are regulated by this state.

SEC. 3. Section 15008 is added to the Fish and Game Code, to read:

15008. (a) The department shall, in consultation with the Aquaculture Development Committee, prepare programmatic environmental impact reports for existing and potential commercial aquaculture operations in both coastal and inland areas of the state if both of the following conditions are met:

(1) Funds are appropriated to the department for this purpose.

(2) Matching funds are provided by the aquaculture industry. For the purpose of this section, "matching funds" include, but are not limited to, any funds expended by the aquaculture industry before January 1, 2006, for the preparation of a programmatic environmental impact report.

(b) If the final programmatic environmental impact report is prepared pursuant to subdivision (a) for coastal marine finfish aquaculture projects and approved by the commission under the California Environmental Quality Act set forth in Division 13 (commencing with Section 21000) of the Public Resources Code, the report shall provide a framework for managing marine finfish aquaculture in an environmentally sustainable manner that, at a minimum, adequately considers all of the following factors:

(1) Appropriate areas for siting marine finfish aquaculture operations to avoid adverse impacts, and minimize any unavoidable impacts, on user groups, public trust values, and the marine environment.

(2) The effects on sensitive ocean and coastal habitats.

(3) The effects on marine ecosystems, commercial and recreational fishing, and other important ocean uses.

(4) The effects on other plant and animal species, especially species protected or recovering under state and federal law.

(5) The effects of the use of chemical and biological products and pollutants and nutrient wastes on human health and the marine environment.

(6) The effects of interactions with marine mammals and birds.

(7) The cumulative effects of a number of similar finfish aquaculture projects on the ability of the marine environment to support ecologically significant flora and fauna.

(8) The effects of feed, fish meal, and fish oil on marine ecosystems.

(9) The effects of escaped fish on wild fish stocks and the marine environment.

(10) The design of facilities and farming practices so as to avoid adverse environmental impacts, and to minimize any unavoidable impacts.

SEC. 4. Section 15400 of the Fish and Game Code is amended to read:

15400. (a) Except as prohibited by Section 15007, the commission may lease state water bottoms or the water column to any person for aquaculture, including, but not limited to, marine finfish aquaculture. Upon appropriation of funds for that purpose, or if funds are otherwise available, the commission shall adopt regulations governing the terms of the leases, after consulting with affected stakeholders in a public process. No state leases shall be issued, unless the commission determines that the lease is in the public interest in a public hearing conducted in a fair and transparent manner, with notice and comment, in accordance with commission procedures. Leases issued, and regulations adopted, pursuant to this section shall not be construed to be fishery management plans.

(b) A person shall not engage in marine finfish aquaculture in ocean waters within the jurisdiction of the state without a lease from the commission. Leases and regulations adopted by the commission for marine finfish aquaculture shall meet, but are not limited to, all of the following standards:

(1) The lease site is considered appropriate for marine finfish aquaculture in the programmatic environmental impact report if prepared and approved by the commission pursuant to Section 15008.

(2) A lease shall not unreasonably interfere with fishing or other uses or public trust values, unreasonably disrupt wildlife and marine habitats, or unreasonably harm the ability of the marine environment to support ecologically significant flora and fauna. A lease shall not have significant adverse cumulative impacts.

(3) To reduce adverse effects on global ocean ecosystems, the use of fish meal and fish oil shall be minimized. Where feasible, alternatives to fish meal and fish oil, or fish meal and fish oil made from seafood harvesting byproducts, shall be utilized, taking into account factors that include, but need not be limited to, the nutritional needs of the fish being raised and the availability of alternative ingredients.

(4) Lessees shall establish best management practices, approved by the commission, for each lease site. Approved best management practices shall include a regular monitoring, reporting, and site inspection program that requires at least annual monitoring of lease sites to ensure that the operations are in compliance with best management practices related to fish disease, escapement, and environmental stewardship, and that operations are meeting the requirements of this section. The commission may remove fish stocks, lose facilities, or terminate the lease if it finds that the lessee is not in compliance with best management practices, that the lessee's activities have damaged or are damaging the marine environment, or that the lessee is not in compliance with this section. The commission shall take immediate remedial action to avoid or eliminate significant damage, or the threat of significant damage, to the marine environment.

(5) Before issuance of the lease, the lessee shall provide baseline benthic habitat and community assessments of the proposed lease site to the applicable regional water quality control board or the State Water Resources Control Board, and shall monitor the benthic habitat and community during the operation of the lease in a manner determined by the regional board or the State Water Resources Control Board. The regional board and the State Water Resources Control Board may establish and impose reasonable permit fees to pay for the costs of administering and conducting the assessment and monitoring program.

(6) Finfish numbers and density shall be limited to what can be safely raised while protecting the marine environment, as specified by the terms of the lease, subject to review and amendment by the commission.

(7) The use of all drugs, chemicals, and antibiotics, and amounts used and applied, shall be minimized. All drugs, therapeutic substances, and antibiotics shall be used and applied only as approved by the United States Food and Drug Administration for marine finfish aquaculture. The lessee shall report that use and application to the commission on a regular schedule, as determined by the commission, but no less than annually, that shall be included in the terms of the lease. The commission shall review those reports on a regular basis and at least annually.

(8) The commission shall require all farmed fish to be marked, tagged, or otherwise identified as belonging to the lessee in a manner determined appropriate by the commission, unless the commission determines that identifying farmed fish is unnecessary for protecting wild fish stocks, the marine environment, or other ocean uses.

(9) All facilities and operations shall be designed to prevent the escape of farmed fish into the marine environment and to withstand severe weather conditions and marine accidents. The lessee shall maintain records on all escapes in a manner determined by the commission. In the event of more than de minimis escapement, the number of escaped fish and the circumstances surrounding the incident shall be reported immediately to the commission, and the lessee shall be responsible for damages to the marine environment caused by those escaped fish, as determined by the commission.

(10) The lessee shall, at a minimum, meet all applicable requirements imposed by the State Water Resources Control Board and the regional water quality control boards, and shall prevent discharges to the maximum extent possible. Monitoring and testing of water quality shall be required on a regular basis as deemed appropriate by the State Water Resources Control Board or the regional water quality control boards. All inspection and monitoring reports and other records, and all data on the discharge of chemical and biological pollutants shall be kept on file and available for public review.

(c) If a restoration or enhancement plan is submitted to, and approved by, the commission, and that plan, among other things, provides for monitoring and protecting the benthic habitat, the prevention of pollution, and the prevention of adverse impacts on wild fish stocks from disease, parasites, and genetic alterations, subdivision (b) shall not apply to any of the following:

(1) Artificial propagation, rearing, and stocking projects for the purpose of recovery, restoration, or enhancement of native fish stocks carried out under either of the following:

(A) A scientific collecting or research permit issued by the department.

(B) The California Ocean Resources Enhancement and Hatchery Program, as set forth in Article 8 (commencing with Section 6590) of Chapter 5 of Part 1 of Division 6, for the enhancement of white seabass.

(2) Nonprofit hatcheries and nonprofit artificial propagation projects operated by, or on behalf of, licensed commercial or sport fishermen and fisherwomen for the purpose of recovery, restoration, or enhancement of California's native marine fish populations, pursuant to Chapter 8 (commencing with Section 6900) of Part 1 of Division 6.

(d) Nothing in this section shall be construed to limit or expand the application of any other state law or regulation pertaining to marine finfish aquaculture conducted within the ocean waters under the jurisdiction of this state.

SEC. 5. Section 15405 of the Fish and Game Code is amended to read:

15405. (a) Except as specified in subdivision (b), no initial term of a state water bottom lease shall exceed 25 years.

(b) The initial term of a state water bottom lease for marine finfish aquaculture shall not exceed 10 years.

SEC. 6. Section 15406 of the Fish and Game Code is amended to read:

15406. (a) Each state water bottom lease shall specify a period prior to expiration when renewal of the lease may be requested by the lessee. If during this period the lessee is still actively engaged in aquaculture, as determined by the commission, the lessee shall have a prior right to renew the lease on terms agreed upon between the commission and the lessee. If terms are not agreed upon, the commission shall advertise for bids on the lease. If a request for renewal is not made by the lessee, the commission shall advertise for bids on the lease. The commission shall consider bids only from aquaculturists registered pursuant to Section 15101.

(b) Notwithstanding subdivision (a), with respect to any lease of state water bottoms in effect on January 1, 1983, the lessee shall have a prior right to renew the lease. If the lessee does not renew the lease, the commission shall advertise for bids on the lease. The commission shall consider bids only from aquaculturists registered pursuant to Section 15101.

(c) Except as specified in subdivision (d), a lease may be renewed for additional periods not to exceed 25 years each.

(d) A lease for marine finfish aquaculture may be renewed for additional periods not to exceed five years each.

SEC. 7. Section 15406.5 of the Fish and Game Code is amended to read:

15406.5. (a) Except as specified in subdivision (b), the commission shall award water bottom leases to the highest responsible bidder, if the bid meets or exceeds the minimum annual rent established by the commission, which shall not be less than two dollars ($2) per acre, for all species cultivated, unless the acreage applied for is 10 acres or less, in which case the minimum acceptable rent shall be ten dollars ($10) per acre. The annual rent for any lease in effect on January 1, 1983, for the cultivation of oysters shall be one dollar ($1) per acre

until the expiration thereof. The commission may reject any or all bids for the lease of state water bottoms if it deems the rejection to be in the public interest.

(b) Fees for marine finfish aquaculture leases shall, at a minimum, be sufficient to pay for the costs of administering the marine finfish leasing program, and for monitoring and enforcing the terms of the leases.

SEC. 8. Section 15409 of the Fish and Game Code is amended to read:

15409. (a) Upon termination of a lease, for any reason, all structures shall be removed at the lessee's expense from the leasehold, and the area shall be restored to its original condition. If the lessee fails to remove the structures, the state may remove them and the lessee shall pay the removal costs incurred.

(b) The commission shall require financial assurances of each marine finfish aquaculture lessee to ensure that restoration is performed to the satisfaction of the commission. Financial assurances may take the form of surety bonds executed by an admitted surety insurer, irrevocable letters of credit, trust funds, or other forms of financial assurances specified by the commission, as it determines are available and adequate to ensure the lease site is restored pursuant to this section.

(c) Marine finfish aquaculture lessees shall be responsible for any damages caused by their operations, as determined by the commission, including, but not limited to, reimbursement for any costs for natural resource damage assessment.

(d) Nothing in this section limits the state in pursuing additional remedies authorized by law.

SEC. 9. Section 30411 of the Public Resources Code is amended to read:

30411. (a) The Department of Fish and Game and the Fish and Game Commission are the principal state agencies responsible for the establishment and control of wildlife and fishery management programs and the commission shall not establish or impose any controls with respect thereto that duplicate or exceed regulatory controls established by these agencies pursuant to specific statutory requirements or authorization.

(b) The Department of Fish and Game, in consultation with the commission and the Department of Boating and Waterways, may study degraded wetlands and identify those which can most feasibly be restored in conjunction with development of a boating facility as provided in subdivision (a) of Section 30233. Any study conducted under this subdivision shall include consideration of all of the following:

(1) Whether the wetland is so severely degraded and its natural processes so substantially impaired that it is not capable of recovering and maintaining a high level of biological productivity without major restoration activities.

(2) Whether a substantial portion of the degraded wetland, but in no event less than 75 percent, can be restored and maintained as a highly productive wetland in conjunction with a boating facilities project.

(3) Whether restoration of the wetland's natural values, including its biological productivity and wildlife habitat features, can most feasibly be achieved and maintained in conjunction with a boating facility or whether there are other feasible ways to achieve these values.

(c) The Legislature finds and declares that salt water or brackish water aquaculture is a coastal-dependent use which should be encouraged to augment food supplies and to further the policies set forth in Chapter 4 (commencing with Section 825) of Division 1. The Department of Fish and Game may identify coastal sites it determines to be appropriate for aquaculture facilities. If the department identifies these sites, it shall transmit information identifying the sites to the commission and the relevant local government agency. The commission, and where appropriate, local governments, shall, consistent with the coastal planning requirements of this division, provide for as many coastal sites identified by the Department of Fish and Game for any uses that are consistent with the policies of Chapter 3 (commencing with Section 30200) of this division.

(d) Any agency of the state owning or managing land in the coastal zone for public purposes shall be an active participant in the selection of suitable sites for aquaculture facilities and shall make the land available for use in

aquaculture when feasible and consistent with other policies of this division and other provisions of law.

SEC. 10. No reimbursement is required by this act pursuant to Section 6 of

Article XIII B of the California Constitution because the only costs that may be incurred by a local agency or school district will be incurred because this act creates a new crime or infraction, eliminates a crime or infraction, or changes the penalty for a crime or infraction, within the meaning of Section 17556 of the Government Code, or changes the definition of a crime within the meaning of Section 6 of Article XIII B of the California Constitution.

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