Offshore AQUACULTURE *in the Pacific Northwest*

A white paper of a forum held at

OSU Hatfield Marine Science Center

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Edited by Chris Langdon, Oregon State University

Sea Grant Oregon

Contents

Cover photo: A ship checks the cages in an offshore mussel growing field. (© iStockphoto.com/Ziva_K)

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Executive Summary

Chris Langdon, Oregon State University

The United States faces a potential shortage of inexpensive, high-quality seafood in the near future. The absence of foreseeable increases in harvests from exploited capture fisheries, compounded by an unprecedented 39 percent predicted growth in global population in the next 40 years, will put severe pressure on seafood supplies and prices. In addition, the anticipated rapid growth and development of emerging countries will lead to increased demand for high-quality seafood as the dietary standards of these countries improve.

Global aquaculture is rapidly expanding to help fill the widening gap between seafood demand and supply from capture fisheries. United States aquaculture production accounts for only about 1.5 percent of total global production, and there has been little expansion over the past decade. The U.S. depends on imports to meet about 80 percent of its seafood demand, at an annual cost of $13 billion. Future availability of seafood for U.S. consumers is an issue worthy of immediate attention by policy makers and society.

The Pew Oceans Commission (2003) and the U.S. Commission on Ocean Policy (2004) both described opportunities and challenges associated with expansion of offshore aquaculture. In response, NOAA is facilitating development of marine aquaculture, including offshore aquaculture. In 2007 NOAA submitted to Congress the National Offshore Aquaculture Act, which, if enacted, would authorize the Commerce Secretary to issue offshore aquaculture permits in federal waters, after careful consideration of potential environmental effects and in consultation with adjacent coastal states. The act also would authorize the Commerce Secretary to establish research programs for all types of marine aquaculture, including shellfish farming and marine stock enhancement. Offshore aquaculture projects in state waters in the Northeast, the Southeast, the Caribbean, and Hawaii have already been established, and engineering, biological, and economic challenges are being addressed. However, no such projects have been established in the Pacific Northwest.

This forum, reviewed in this white paper, was an initial step in providing interested parties with information on current scientific, technical, economic, and social aspects of offshore aquaculture, in order to better evaluate its potential in this region. The forum was comprised of a mix of talks and breakout sessions. All the talks are available as PDF documents and streaming video from the forum's Web site, http://oregonstate.edu/conferences/aquaculture2008. A set of recommendations is provided for the future evaluation of offshore aquaculture in the Pacific Northwest.

The forum made two overarching recommendations:

1) Education and outreach on offshore aquaculture should be undertaken to benefit coastal communities.
2) Demonstration projects should be established to determine technical, biological, economic, and environmental aspects of offshore aquaculture.

Richard Langan

A 20-ton, floating container for supplying feed to offshore caged fish.

Acknowledgments

The forum was made possible with guidance provided by the forum's Advisory Committee. The committee consisted of Ed Backus, Ecotrust; Michael Banks, Coastal Oregon Marine Experimental Station (COMES) and the Cooperative Institute for Marine Resources Studies (CIMRS), Oregon State University (OSU); Peter Becker, Pacific Aquaculture Caucus; George Boehlert, Hatfield Marine Science Center (HMSC), OSU; Jeff Feldner, OSU Extension Service; Michael Harte, College of Ocean and Atmospheric Sciences (COAS), OSU; Onno Husing, Oregon Coastal Zone Management Association (OCZMA); John Meyer, Communication Partnership for Science and the Sea (COMPASS), OSU; Mike Rust, Northwest Fisheries Science Center, National Marine Fisheries Service (NMFS); and Gil Sylvia, COMES, OSU.

Invited speakers gave talks that formed a framework for deliberations that occurred during breakout and wrap-up sessions. The speakers were Jim Anderson, University of Rhode Island; Devin Bartley, California Department of Fish and Game; Randy Cates, Cates International Inc.; John Forster, John Forster Consulting Inc.; Rebecca Goldburg, Environmental Defense Fund; Cliff Goudey, Massachusetts Institute of Technology; Richard Langan, University of New Hampshire; Michael Morrissey, OSU; Michael Rubino, NOAA; Mike Rust, NMFS; and Gil Sylvia, OSU.

Carol Cole (COMES) coordinated many of the forum's activities. Justin Overdevest assembled materials for the forum's Web site and, along with Jessica Waddell (CIMRS), helped edit the white paper.

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Courtesy of NOAA

Installing a Sea Station cage (Ocean Spar).

Introduction

Chris Langdon, Oregon State University

Offshore aquaculture: a pathway for meeting future U.S. demand for seafood?

The demand for seafood is projected to increase, both as a consequence of global population growth and higher standards of living in developing countries. The global human population is projected to increase from about 6.7 billion in 2008 to 9.3 billion by 2050 (USAID 2008)—a 39 percent increase in about 40 years. This rapid expansion is unprecedented and will result in greater pressure on the earth's natural resources, including seafood.

Globally, 77 percent of wild stocks of fish are either fully or overexploited (FAO 2007). A similar situation has developed in the U.S., with an estimated 45 percent of fish stocks overfished, despite efforts to rebuild stocks under the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (Rosenberg et al. 2006). There is little likelihood that harvests of wild fisheries will meet future increased demands for seafood either in the U.S. or globally.

The United States is far from self-sufficient in meeting its demands for seafood; it currently imports about 80 percent of its needs from a wide range of countries, at an annual cost of $13 billion. In contrast, U.S. seafood exports are valued at only $4 billion (NMFS 2008). This seafood trade deficit will likely increase as the U.S. population grows by 44 percent in about 40 years, from a current population of 304 million to an estimated 438 million in 2050 (USAID 2008).

Clearly there is a need to develop additional sources of seafood for a rapidly growing human population, if current levels of per-capita consumption are to be maintained. Aquaculture offers one approach in meeting this projected future global demand. Global aquaculture is already the fastest-growing food-production sector (an 8.8 percent annual increase since 1970) and supplied 43 percent (42.7 million tones) of all globally consumed fish in 2004 (FAO 2007). In contrast, aquaculture production in the U.S. is small, representing only about 1.5 percent of total global production, and production has not grown over the past decade.

The state of aquaculture in the U.S.

The reasons for the slow growth of U.S. aquaculture production are numerous. They include non-supportive state and federal regulatory structures, lack of trained personnel, insufficient capital investment, demanding environmental requirements, high labor costs, and competition with other users of coastal waters. As a consequence, many U.S. and international companies have located their operations outside the U.S., mainly in developing countries. However, it should be noted that salmon aquaculture thrives in Norwegian and Scottish waters, indicating that successful aquaculture operations can be profitable in developed countries, even with high labor costs and strong environmental regulations, as long as there is a supportive regulatory and social framework.

The Pew Oceans Commission (2003) and the U.S. Commission on Ocean Policy (2004) both addressed opportunities and challenges associated with expansion of offshore aquaculture. In an effort to help stimulate growth of domestic aquaculture and to avoid direct competition with other users of coastal waters, NOAA, following recommendations of the U.S. Commission on Ocean Policy and direction of the U.S. Ocean Action Plan, has recently focused on developing a regulatory structure to support the development of offshore aquaculture in federal waters (the zone between 3 and 200 miles from the coast). In addition, NOAA and other federal and state agencies have supported demonstration projects to investigate the technical and economic feasibility of aquaculture of marine fish and shellfish species in the nearshore state waters of New Hampshire, Puerto Rico, Gulf Coast states, California, and Hawaii. Several private, commercial finfish farms have been established in nearshore waters of Hawaii and Puerto Rico; commercial mussel farms operate in state waters off the coast of New Hampshire and California; and commercial salmon farming has been practiced for more than three

decades in the nearshore waters of Maine and Washington State.

Aquaculture in the Pacific Northwest

The Pacific Northwest offers some unique opportunities for offshore aquaculture. Clean ocean waters will allow production of high-value, cold-water fish and shellfish species, while high wave and wind energy could provide offshore structures with sources of power. In addition, the region has a strong fishing community capable of participating in offshore operations.

West coast state policy and regulatory provisions for offshore aquaculture are in various stages of development. In Oregon, aquaculture operations are covered by Goal 19 of Oregon's Statewide Planning Goals, the Territorial Sea Plan (TSP), and the Coastal Management Plan. Furthermore, a House Joint Memorial was passed in 2005 that urged Oregon's Legislative Assembly to establish a regulatory system for open-ocean aquaculture that takes into account the concerns of fishing communities and potential environmental impacts. The state of Washington has already established policies and regulations for both shellfish and finfish aquaculture in nearshore waters, but not specifically for offshore aquaculture. Passed in 2006, the California Sustainable Oceans Act provides a complex framework for leasing and rigorous requirements for offshore aquaculture operations. The forum suggested that consistent and well-coordinated state and federal policies and regulations need to be developed (see section below on federal and state policies).

The forum

The purpose of the forum was to bring together a wide range of participants from state and federal agencies, the media, research institutions, and coastal and fishing communities, to discuss the risks and opportunities of offshore aquaculture in the Pacific Northwest (Appendix 1). This region previously had not held an informed discussion of this subject, despite progress made in other parts of the U.S.

The forum consisted of a series of presentations by scientists, economists, members of federal and state agencies, businesspeople, and a panel of west coast fishers (Appendix 2). Text and streaming videos of the talks and panel discussions are available on the forum's Web site, http://oregonstate.edu/conferences/aquaculture2008/.

Federal and state perspectives were provided by Michael Rubino (manager of NOAA's Aquaculture Program) and Devin Bartley (aquaculture coordinator, California). Michael Rubino described the goals of the National Offshore Aquaculture Act and various NOAA-funded, pilot aquaculture projects. Devin Bartley explained how California has developed a legislative framework for nearshore and offshore aquaculture as part of its Sustainable Oceans Act that could complement future federal policies and laws. John Forster (Forster Consulting) completed the talks of the first session by outlining technological, legislative, and social issues that need to be addressed to encourage investment by the business community.

The talks of the first session were followed by a panel of four west coast fishermen who provided the forum with perspectives of the fishing industry. They voiced their concerns about the potential economic impacts of aquaculture production on prices of wild-caught fish and about how offshore aquaculture would complement their current fishing activities. They also raised questions about the technological feasibility of offshore aquaculture in the stormy ocean conditions of the Pacific Northwest.

Engineering (Cliff Goudey, MIT), biological, and husbandry issues (Mike Rust, NMFS), as well as environmental issues (Rebecca Goldburg, Environmental Defense Fund), were addressed in the second session. Cliff Goudey discussed differences between the engineering requirements of nearshore and offshore cage structures and summarized various engineering approaches that could be evaluated. Mike Rust rated the potential of a wide range of native fish and shellfish species for offshore

aquaculture. His scoring was based on availability of seed for grow-out, feed requirements, growth rates to market size, market value, potential competition with existing fishery products, and existing aquaculture information available for each species. According to his scoring, mussels and scallops had the greatest potential for successful offshore aquaculture, while rockfish and greenling were the highest-ranking fish species. Last, Rebecca Goldburg emphasized the need to develop sustainable offshore aquaculture with a strong and transparent regulatory framework that addressed potential environmental impacts, such as pollution, diseases, and parasites, as well as the effects of cultured escapees on wild populations.

In the third session of the forum, Randy Cates (Cates International, Inc.) provided the forum with a businessman's perspective on developing and operating a profitable nearshore aquaculture farm in Hawaii. He concluded with the statement: "The debate on whether to farm fish is over; the debate now is how to do it right!"

Economic considerations of offshore aquaculture were addressed by Jim Anderson (University of Rhode Island) and Gil Sylvia (Oregon State University). Jim Anderson discussed economic factors that have caused the rapid growth of global aquaculture. He concluded that demonstration projects were needed to facilitate technical, environmental, and economic evaluation of this approach to producing seafood in the Pacific Northwest. Gil Sylvia focused on the potential social benefits and costs of offshore aquaculture for coastal communities and recommended further research and education to provide information for the development of appropriate policies and regulations.

Richard Langan

Aquaculture mussel lines.

Breakout sessions were held on six topics:

1) Why the Pacific Northwest?
2) Technical and scientific questions
3) Potential environmental impacts
4) Social needs and values
5) The fishing industry and other offshore interests
6) Federal and state policies

Session leaders were asked to summarize their findings and identify the most important next step(s) in evaluating the opportunities and risks of offshore aquaculture in the Pacific Northwest. A final wrap-up session brought all the forum participants together to determine common themes and recommendations for future action. The breakout and wrap-up session summaries are presented in this white paper, along with recommendations for future action.

Why the Pacific Northwest?

James Anderson, University of Rhode Island; and John Forster, John Forster Consulting Inc.

The group first sought to identify the advantages for offshore marine aquaculture offered by the Pacific Northwest. These were as follows:

Biophysical elements

- The water temperature provides the optimal range for salmonids, sablefish, halibut, various rockfish species, oysters, and mussels.
- A gently sloping shelf with a sandy bottom provides the ideal situation for mooring cages.
- Notwithstanding concerns about use of the space for commercial fishing, there is limited commercial shipping in the area.
- The coast is well studied; therefore, location siting of cage farms can be based on reliable oceanographic data.
- Naturally productive waters are well suited to shellfish production, although El Niño years may be a risk.

Inputs and services

- Strong PNW traditions in fisheries, maritime services, student training, and university research
- Extensive salmonid hatchery and farming experience (if expansion of salmonid farming is deemed acceptable)
- NOAA research on other local marine finfish species offers a good basis for starting with new species
- Local and regional feed and deepwater cage suppliers
- Large aquaculture service and supply capability in British Columbia
- Seafood processing and distribution systems are in place, which would benefit from the availability of farmed products

Market and social elements

- History of near-shore aquaculture, such as oysters, mussels, and salmon
- Strong, west coast seafood demand, which provides competitive logistical advantages compared to producers elsewhere
- West coast Asian ethnic demand for live fish offers a high-priced "way in" for startup projects
- Rockfish bycatch leading to closures of fisheries for other commercial species suggests an opportunity for an enhancement program and, therefore, for a marine fish hatchery that could serve such a program as well as supply marine species for commercial farming

Why *not* the Pacific Northwest?

Despite the advantages listed above, reasons why the Pacific Northwest may not be receptive to or suitable for marine aquaculture were identified as follows:

Stakeholder objections

- General, strongly motivated opposition from commercial fishermen and environmental NGOs versus weakly motivated potential support from seafood consumers, public sectors, and industry
- Sustained public relations campaign by these groups against floating finfish marine aquaculture has led to more general public concern
- Concern about the leasing of public waters for private commercial activity
- Perception that much of the PNW coastline is still pristine, leading to calls for protection of large areas as Marine Protected Areas

Physical conditions

- Numerous windy and stormy days will make operating offshore difficult.
- Currents were reported to be strong—up to two knots (this is not necessarily negative for aquaculture).
- Dead zones caused by upwelling of deep water with little dissolved oxygen may lead to large-scale fish mortalities, unless the locations of such upwelling are predictable and avoidable.

Next steps

- Establish a "demonstration" or "experimental" farm to answer questions, build local knowledge, and provide training.
- Create one or more aquaculture zones.

Technical and Scientific Issues

Mike Rust, Northwest Fisheries Science Center, NOAA; Richard Langan, University of New Hampshire; and Cliff Goudey, Massachusetts Institute of Technology

What information is needed about engineering, candidate species, husbandry, and other technical and scientific factors to assess the potential for successful, commercial, offshore culture of species from larvae to marketable size?

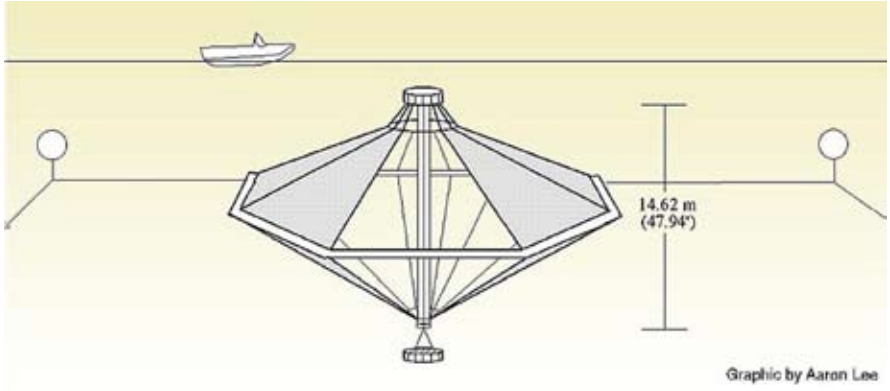
Similar to other breakout sessions, participants were asked to identify what is known and what additional technology or information is needed, and then select the top priority from the technology and information needs. It became apparent that without a clearer picture of where and under what conditions such an initiative was to occur, the known and critical unknowns could not be defined. This need is reflected as the highest priority emerging from the session.

Existing information, technology, and capabilities

- Oceanographic data: This issue actually straddled the known-unknown categories. There was a general opinion that oceanographic data are available and that abundant data are available for Puget Sound and the Straits of Juan de Fuca. However, no one in the group was able to confirm that there was either adequate data or a synthesis of oceanic conditions (waves, currents, temperature, oxygen profiles) for the Pacific Northwest shelf. Given that there are two strong ocean sciences universities in the region, the group assumed that data are available.
- Tools and capabilities are available to determine appropriate sites for cage culture, and appropriate mooring technologies can be selected, assuming that adequate oceanographic and benthic data are available.
- The number, location, and capabilities (for example, infrastructure) of harbors is known.
- Anchoring technology is available for depths up to 100 meters.
- There are proven cage technologies for finfish culture and submerged longline technologies for shellfish (mussel) culture.
- There is considerable knowledge about marine finfish husbandry (feeds, fish health), based on experience with salmon farming and other emerging species.
- There are large-scale hatcheries for salmonids and lab-scale hatcheries for other marine finfish.
- There is knowledge of and experience (in the U.S.) with operating offshore finfish and shellfish farms.
- Capabilities exist for acquisition and real-time transmission of many different types of data.

Information and technology needs

- Appropriate sites need to be identified based on use by other groups, current and planned activities (including energy development), environmental/biological sensitivities, and site-specific oceanographic and benthic data.
- The effect of climate change on the extent, frequency, and duration of hypoxic zones is not well understood.



Courtesy of NOAA

Diagram of one type of offshore cage used in aquaculture.

- The economics and logistics of a scale up to commercial production at open-ocean sites are not well known.
- The most-appropriate species for finfish culture need to be identified. A number of native species are promising; however, none has been evaluated in offshore cages and few have been evaluated in the lab.
- Capacity for large-scale hatchery production of marine finfish is lacking.
- Technology for remote monitoring and security are still in developmental stage and not yet available "off the shelf."
- Technologies for autonomous operations (for example, feeding, cleaning, and observing) are in an early stage of development and not yet available "off the shelf."
- Methods to determine fingerling quality are lacking.
- Species-appropriate cage designs may be needed to match local species (for example, wolfish).
- Affordable and practical technologies are needed for deepwater mooring or mobile systems operated at open-ocean depths.
- Potential synergies with ocean renewable power technologies are unknown.

Next step

- The identification of appropriate sites, based on user groups, current and planned activities, environmental and biological sensitivities, and site-specific oceanographic and benthic data, is needed before any meaningful progress can be made in other technological or biological aspects of marine aquaculture.

Richard Langan

Atlantic cod harvested from cages offshore of New Hampshire.

Environmental Impacts

George Leonard, Ocean Conservancy; Michael Kent, Oregon State University; and Michael Banks, Oregon State University

The environmental impacts of open-net pen aquaculture are both scientifically important and politically contentious. Much of what we know scientifically about the risks of open-ocean aquaculture emerges from an understanding of the risks of other open-net pen-farming systems, most notably farmed salmon in coastal habitats. However, it is difficult to make direct comparisons between farmed salmon and hatchery-supplemented, wild-caught salmon and any of a number of potential new species that may be grown in offshore habitats. Nonetheless, it is prudent to apply general insights that have emerged from other systems to new species and technologies that hold promise for offshore aquaculture.

Major risks

Five major environmental-impact risks are widely recognized as important. For each, our group identified what is known, what is unknown, and what needs to be done to address the issue. These five impact risks are

- genetic consequences of escaped fish,
- disease and pathogen amplification and retransmission,
- consequences of nutrient input,
- use of marine resources for feed, and
- interactions with wild animals.

Genetic consequences of escaped fish

There is general consensus that farming of nonnative species poses a greater environmental risk than farming of native species. However, we also know from experience with hatcheries used for stock enhancement that native species can be subjected to unintended selective pressures in hatcheries, and thus even aquaculture-reared native fish may pose some level of genetic risk to wild fish, should they escape. To address this concern, we need

- a better understanding of the genetic structure of likely candidate species for open ocean aquaculture,
- knowledge of the abundance and genetic structure of wild stocks of these same fish, and
- the development of sterile stocks to further reduce the risk of escaped fish.

Disease and pathogen amplification and retransmission

Disease issues in aquaculture center on two separate concepts. The first is the introduction of exotic pathogens through the culture of fish. This is reasonably easy to control with good biosecurity and husbandry techniques. The second, and more problematic, issue concerns the amplification of native pathogens, generally during outgrowing of fish in net-pen operations. The universality of retransmission from farmed fish to wild fish is unclear, but there is enough known to conclude that risk of retransmission is a legitimate concern with open-ocean aquaculture. It is also not known what level of disease at the farm level will put wild fish at risk. To address these concerns, we need

- comprehensive baseline data on disease in wild fish populations before farming begins,
- application of island biogeography models at the landscape level to new habitats (that is, treat cages as novel habitats) to better evaluate the nature and risk of disease transmission as the industry develops, and
- the development of a Pacific Northwest specific research agenda that addresses these issues.

Consequences of nutrient input

The effects of nutrient inputs from aquaculture on marine ecosystems are probably the best understood of the environmental concerns, at least at small scales. Existing models of nutrient dispersion (for example, DepoMode) are scientifically robust and readily available. In addition, data from other farming systems (for example, salmon farming) are also readily available. What is unclear is the fate of nitrogen and phosphorus in different systems and under different oceanographic and hydrographic conditions. In short, we have a poor understanding of when nutrient inputs can be viewed as food ("good") and when they should be viewed as waste ("bad"). It is difficult

to satisfactorily address these concerns in advance of aquaculture development; therefore, scaled and cumulative impacts of nutrient inputs will need to be closely monitored during development.

Use of marine resources for feed

It is understood that without substitutes for fishmeal and fish oil, limited supplies of these key ingredients will limit the ability of fed aquaculture to expand. It is also clear that without these substitutes, industry expansion poses a risk of further degradation of marine ecosystems and food webs through overfishing of small, pelagic fishes as well as population impacts on other species dependent on forage fish for food. We need to

- identify new protein sources for farmed fish, including those of marine origin; and
- identify, evaluate, and ameliorate the ecological consequences of using other marine and non-marine ingredients.

In short, we don't want to unintentionally create greater environmental impacts by moving to new ingredients. An additional tool to encourage increases in sustainability of traditional, marine-derived feed ingredients is exploration and support of eco-certification of forage fisheries and other market mechanisms to reward ecosystem-based fishery management.

Interactions with wild animals

We know that cages will act as fish-aggregating devices (FADs), and the *Field of Dreams* effect is almost guaranteed to occur: "If you build it, they will come." In this sense, pinnepeds and seabirds will be a problem for fish farmers in the Pacific Northwest.

Courtesy of NOAA

View from inside a Hawaii offshore aquaculture cage, with moi swimming near the surface.

Further, offshore aquaculture in the Pacific Northwest may put these animals at risk if not proactively addressed. It is unclear what specific effects new structures may have on associated marine animals and what consequences will result from aggregation (for example, collision, entanglement, and predation effects) of attracted animal communities. In advance of industry expansion, we need to

- identify species of concern where interactions are most likely to occur, including in the Pacific Northwest; and
- study the behavioral response of animals to structures, to determine what monitoring will be required.

Important caveat

Much of the breakout group's discussion centered on the need for monitoring the environmental impacts of open-ocean aquaculture as the industry expands. It is important to remember, however, that monitoring is not the same as ameliorating impacts. Monitoring (and the knowledge that emerges from it) is therefore necessary but not sufficient. Impacts must be known but they must also be reduced, minimized, or eliminated (where feasible) to meet the growing expectations of regulators, seafood businesses, and the seafood-consuming public for environmentally responsible seafood products.

Social Needs and Values

Ed Backus, Ecotrust; and Gil Sylvia, Oregon State University

The Social Needs and Values breakout committee identified five sets of core values representing the Pacific Northwest. These core values must be considered when evaluating the potential for offshore aquaculture development off the Pacific Northwest coast.

Core values

- Preserve and reinforce the structural vitality of coastal economies and communities.
- Maintain cultural values inherent in coastal communities, including those represented by the commercial fishing industry.
- Conserve marine ecosystems so they retain their integrity and continue to provide vital services.
- Support an equitable public process that fairly and transparently evaluates the offshore aquaculture industry and its ability to generate economic, social, and environmental benefits for Pacific Northwest communities.
- Establish and retain assets associated with aquaculture permits and rights that bring greater value to the industry and coastal communities.

Key issues

The committee also discussed key design issues that must be considered when evaluating the development of offshore aquaculture development. These included

- establishing a permitting process that is fair to potential applicants while allowing good public process;
- creating a functional and efficient multiple-use ocean-zoning approach supported by relevant research to meet local, regional, and national needs;
- conducting a community needs assessment to determine how communities could be impacted by offshore aquaculture development and permits;
- underwriting permits with private or public insurance to manage risks and liabilities;
- developing a cumulative-effects assessment to understand the marginal and total effects from multiple aquaculture operations together with other ocean uses;
- adopting an aquaculture code of practice that will act to minimize risks and costs from aquacultural operations and drive strategies for effective self-enforcement;
- establishing effective environmental and social standards to ensure that aquacultural operations are meeting environmental and social needs at least cost; and
- recognizing that as a new industrial sector, there will be a need for the regulatory process to adapt and learn as the industry develops.

Recommendations

The committee recommended that six steps be taken next to ensure the best decisions are made with respect to potential development of offshore aquaculture:

- Continue to promote a regular (or frequent) public dialogue on offshore aquaculture.
- Begin the development of a spatial zoning process that might accommodate offshore aquaculture.
- Support the development of legislative initiatives on establishing environmental and social standards.
- Continue to learn from aquaculture and other spatial-based ocean-development projects occurring in California, Oregon, and Washington.
- Make all information available to the public, using a variety of tools and methods.
- Develop a pilot commercial-scale project to evaluate technical, financial, and environmental viability.

Next steps

The committee highlighted two important concluding recommendations: (1) foster a community "bottom-up" process for evaluating offshore aquaculture with other ocean uses within a spatial planning system, and (2) establish early and continuous dialogue with coastal communities and the general public.

Fishing Industry and Other Offshore Interests

Kaety Hildenbrand, Oregon State University; and Jeff Feldner, Oregon State University

The fishing industry representatives and fishers who were involved in this breakout session were generally not supportive of offshore aquaculture activities of fish species in net pens. However, they are interested in being involved in the conversations around this topic. They are potentially interested in learning more about offshore shellfish aquaculture, such as mussel culture.

Studies have shown that aquaculture does affect the marketing and prices received for wild-caught fish. The impact to fishermen could be minimal or substantial, depending on the species that is grown, the time of year it is harvested, and the marketing strategies. To address this concern, we need to refer to existing studies and reports on market competition.

Offshore activities that could compete with aquaculture for space include commercial fishing, recreational fishing, wave energy, offshore wind farms, marine reserves, cable installation, military uses, dredging and dredging disposal, transit and navigation, cargo shipping, effluent disposal, sensitive ecological habitats or areas that have other protections placed on them (bird sanctuaries, rockfish conservation areas, etc.), and known migration routes for marine mammals or other species. Therefore, we need to address spatial criteria when siting offshore aquaculture facilities.

A regulatory framework is missing. Adequate guidelines such as the following need to be put in place before this type of aquaculture is tried:

Richard Langan

Deployment of an Aquapod (Ocean Farm Technologies) sea cage.

- permitting,
- environmental monitoring,
- socioeconomic studies,
- salvage, and
- response.

Jurisdictional issues also need to be considered and made clear.

Can offshore aquaculture facilities survive in the Pacific Northwest?

- Have adequate studies been done of the devices' short-term (winter storms) and long-term durability in similar weather and wave conditions?
- If they do not survive, who is responsible for the salvage of that equipment?

There are several social questions that need to be discussed, such as

- Is this a supplement to commercial fishing activities, or is it meant to replace commercial fishing?
- Would fishermen actually want to work these types of jobs?
- Would there be an investment made from the aquaculture developer into the coastal community as a whole?

Next step

Provide an unbiased outreach program to coastal communities, to give them an opportunity to learn about offshore aquaculture and engage in the discussion.

Federal and State Policies

Susan Bunsick, NOAA Aquaculture Program; Devin Bartley, California Department of Fish and Game; and Brian Fredieu, NOAA Aquaculture Program

Clear and well-developed federal and state policies and regulations are necessary for the aquaculture industry to advance the sustainable development of offshore aquaculture in the Pacific Northwest. This breakout session analyzed and discussed what policies should be recommended to improve or further develop federal and state legislation to responsibly foster aquaculture in the Pacific Northwest. The session consisted of a wide range of stakeholders, including representatives from environmental and industry-related NGOs, state government, federal government, commercial fishing interests, and aquaculturists.

What regulations and legislation are currently available?

The regulations discussed at the state level were the existing regulations for aquaculture in California and Oregon. Washington was reported to have a "good" regulatory framework, but details of this framework were not discussed.

California

Public Resources Code 826 provides that "it is in the interest of the people of the state that the practice of aquaculture be encouraged…" This provides a stepping stone for other California aquaculture legislation and regulations that comprise the California Fish and Game Code and the California Code of Regulations. These documents contain provisions from, *inter alia,* the Coastal Act, the Marine Life Protection Act, and the Sustainable Oceans Act (S.B. 201). The California Sustainable Oceans Act provides a rigorous framework for lease requirements of aquaculture facilities located in state waters. Approval and review of best management practices, baseline surveys, aquaculture fish product identification, and other testing must be sought from a variety of state and local agencies.

Oregon

Aquaculture operations are covered by Goal 19 of Oregon's Statewide Planning Goals, the Territorial Sea Plan (TSP), and also the Coastal Management Plan. The TSP Part II provides the standard for agencies to apply when reviewing proposals that affect Oregon's ocean resources. Together these plans provide implementation requirements and management measures for any actions likely to affect ocean resources or Oregon's territorial sea.

Federal

Federal authority for aquaculture spans across multiple agencies under multiple laws. The major legislation for U.S. aquaculture is the National Aquaculture Act of 1980. This act promotes private development in aquaculture and also establishes the Joint Subcommittee on Aquaculture, which is tasked to coordinate national aquaculture policy. Proposed legislation—the National Offshore Aquaculture Act of 2007 (S. 1609, H.R. 2010)—would establish the Department of Commerce as the lead federal agency for permitting of aquaculture in federal waters (3 to 200 miles offshore); however, no Congressional action is anticipated in 2008. Under current law, the key federal agencies involved in permitting of offshore aquaculture include the

- Army Corps of Engineers, for the permitting of activities affecting navigable waters under the Rivers and Harbors Act;
- Environmental Protection Agency (EPA), which issues National Pollutant Discharge Elimination System (NPDES) permits and reviews environmental effects of aquaculture under section 403(c) of the Clean Water Act;
- U.S. Fish and Wildlife Service, for consultations under the Endangered Species Act (ESA) to ensure that no project interferes with any species-recovery program;
- National Marine Fisheries Service (NMFS), for exempted fishing permits under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and for consultations under the ESA and MSA's essential fish-habitat provisions; and
- Minerals Management Service (MMS), for aquaculture as an alternative use of facilities on the Outer Continental Shelf, under proposed rules to implement the Energy Policy Act of 2005.

Richard Langan

Deployment of a JPS cage (JPS Industries).

For activities in federal waters that may impact state waters and coastal areas, there are provisions in the Coastal Zone Management Act that require state certification of activities to be consistent with the enforceable policies of approved state coastal-management programs. The Lacey Act, which prohibits illegal trade in fish and wildlife in violation of any wildlife-related state, federal, tribal, or foreign laws or regulations (16 U.S.C. §3372(a)), also addresses consistency with state laws and regulations.

What policies are needed?

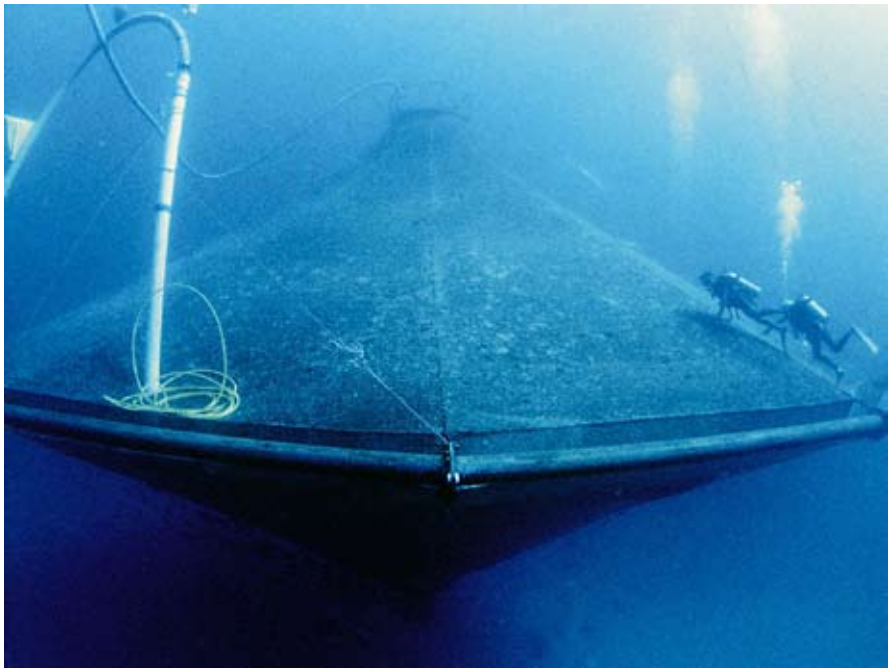
The current regulatory framework for offshore aquaculture is fragmentary and complicated, and it lacks clear lead responsibilities, especially with regard to how state and federal agencies work together. A variety of perspectives were offered on what is needed to develop a better regulatory structure to provide for the sustainable development of aquaculture. Key recommendations include

- the development of prescriptive siting and zone mapping for aquaculture operations. Though Oregon has the TSP and Ocean Resources Management Plan, those plans prioritize fisheries in terms of preferred use and renewable biological assets. TSP provides authority to establish zoning, but currently there is no aquaculture zoning in the state.
- resolution on how the permitting of aquaculture "worked" in federal waters, and—for agencies with overlapping ocean jurisdiction (for example, the Minerals Management Service and NOAA)—how conflicts in management are resolved. Because the answers either did not exist or could be answered only on a case-by-case basis, all group members agreed that an agency needed to be designated to take the lead on these issues. The majority of the stakeholders present agreed that NOAA was the natural choice to manage these operations. Resolution is needed on the issue of liability. Although California has a regulatory structure in place that gives authority to assess damages and liability, the state has not yet worked out how to assess damages.
- the creation of publicly funded demonstration projects or public-private partnerships. However, there may be a conflict if the same agencies that are funding projects are also in charge of regulating. Any public demonstration projects should be separate from the licensing, permitting, and regulating mechanisms. Mechanisms need to be developed to ensure transparency and accountability in the funding and oversight of demonstration projects.
- additional efforts to promote community involvement. Many of the stakeholders present acknowledged that, although there are mechanisms for stakeholder involvement in project planning, communities want to know that their interests are going to be considered. If you get community

support, the necessary political will to implement these aquaculture operations will develop. It was also noted that during the public-process portion of rule-making and policy development, there should be more transparency and clearer legal standards in resulting legislation. Scientific and other data must be made more available to the community so they have a better opportunity to comment. Historical access to traditional fishing grounds needs to be maintained. Aquaculture and other new ocean uses need to resolve spatial issues prior to development. Impacts must be analyzed as to whether these new ocean uses are cumulative in nature. Although legislation often includes a directive on reporting requirements for aquaculture, enforcement of such legislation should be improved to provide better information on the industry.

- a "standard" comprehensive coverage of environmental impacts, including mandates on and guidelines for evaluating the impacts of fish escapes, and concrete guidelines on the handling of diseased fish. This would guide the response from regulatory agencies that deal with these impacts.
- the establishment of an Ocean Policy Group for the Pacific Northwest to concentrate federal or state expertise on evaluating permitting and operation of aquaculture.

Courtesy of NOAA



Divers inspect an aquaculture cage.

Next step

The immediate next step is to establish a clear and streamlined state and federal permitting process for aquaculture operations. This process must include a clear, understandable regulatory process that is transparent and is based on accurate information, monitoring, and consideration of impacts. Clear standards and guidelines for environmental impacts, liability, and cost recovery should be established and included in the process. The overarching principle that guides these processes is adaptive management that incorporates scientific research into economically, socially, and environmentally sustainable action.

Recommendations for Future Action

Chris Langdon, Oregon State University

The following recommendations were made as a result of discussions during the breakout and wrap-up sessions:

1) *Core values of coastal communities:* Proposed development of offshore aquaculture must consider the core values of coastal communities, as listed by participants in the section on "Social Needs and Values." These include (a) maintaining the vitality and cultural values of coastal communities, (b) conserving marine ecosystems, (c) supporting a transparent evaluation process, and (d) ensuring that assets and interests of coastal communities are protected and, where possible, enhanced.
2) *Scientific, technical, and economic research needs*: There is a great deal we know based on previous research, pilot-scale demonstration projects, and business enterprises that have focused on nearshore and offshore aquaculture in the U.S. and abroad, including net-pen salmon culture. However, the unique conditions of the Pacific Northwest indicate that additional research and demonstration projects are needed to determine to what extent this knowledge can be applied to this region. The culturing of species that are not currently fished commercially should be prioritized, and there was broad forum support for evaluating offshore shellfish culture.
3) *Regulatory framework*: There is confusion about the regulatory framework at both state and federal levels. The absence of a Congressionally approved National Offshore Aquaculture Act adds further uncertainty. The regulatory framework should address the permitting process as well as environmental monitoring, salvage responsibilities, and socioeconomic factors.
4) *Coordination between state and federal agencies:* Improved coordination between state and federal agencies needs to occur to ensure the development of clear policies and regulations to guide the development of sustainable, environmentally friendly, socially beneficial, and economically viable offshore aquaculture in West Coast states that choose to foster this enterprise.
5) *Outreach and education:* There is a need for outreach and education for offshore aquaculture, to inform local coastal communities of potential risks and opportunities. Local coastal communities should be involved in decision-making processes.
6) *Resource conflicts:* The potential for conflict exists with currently established coastal industries and interests, especially the fishing industry. Development of offshore aquaculture should not compete with established industries, but rather complement them and provide additional sources of income and employment. Zones for aquaculture, fishing, offshore energy facilities, and other uses should be created to facilitate permitting of new enterprises and reduce competition for space.
7) *Environmental concerns:* Environmental concerns need to be addressed to ensure that offshore aquaculture activities are consistent with state and federal policies and laws to protect the marine environment. Development of a code of practice and standards would lessen uncertainty of environmental risks and costs for aquaculture operations.

Highest-priority next steps

Many participants in the wrap-up session identified two high-priority next steps to fully evaluate the potential costs and benefits of offshore aquaculture in the Pacific Northwest:

1) Establish an outreach and education program for coastal communities to facilitate informed discussion and support decision-making processes.
2) Establish demonstration projects to address key engineering, biological, environmental, economic, and social factors that will determine the success or failure of commercial offshore aquaculture.

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(Some of the references cited below can be downloaded as PDF files from the forum's Web site, http://oregonstate.edu/conferences/aquaculture2008/.)

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Richard Langan

Atlantic cod in sea cage off the coast of New Hampshire.

Appendix 1 – Forum Participants

First Name	Last Name	Affiliation
David	Allen	OPAC
James	Anderson	Department of Environmental and Resource Economics, URI
Holly M.	Arrigoni	Environmental Protection Agency
Jan	Auyong	Oregon State University
Brent	Bahrenburg	Washington State Community, Trade, and Economic Development
Michael	Banks	Cooperative Institute for Marine Resources Studies/COMES
Devin	Bartley	California Department of Fish and Game
Caroline	Bauman	Economic Development Alliance, Lincoln
Dale	Beasley	Columbia River Crab Fishermen's Association
Peter	Becker	Pacific Aquaculture Caucus Inc.
John	Bielka	Pacific Seafood
Jeffrey	Bishop	Oregon International Port of Coos Bay
George	Boehlert	OSU Hatfield Marine Science Center
Gregg	Bonacker	EWOS
Ben	Bowman	Food and Water Watch
Troy	Buell	Oregon Department of Fish and Wildlife
Susan	Bunsick	NOAA Aquaculture Program
Randy	Cates	Cates International, Inc.
Jingjie	Chu	University of Rhode Island
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Wayne	Hoffman	MidCoast Watersheds Council

Appendix 1 – Forum Participants *continued*

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Peter	Huhtala	Pacific Marine Conservation Council
Onno	Husing	Oregon Coastal Zone Management Association (OCZMA)
Robert	Iwamoto	DOC/NOAA/NMFS/NWFSC
Kym	Jacobson	NOAA Fisheries/NWFSC
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Lissa	Jones	American Fish Farms
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Paul	Klarin	DLCD/Oregon Coastal Management Program
Bruce	Koike	OCCC-Aquarium Science Program
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Dick	Van der Schaaf	The Nature Conservancy
Joanne	Verger	Senator, Oregon
Jennifer	Wagner	Congresswoman Darlene Hooley
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James	Wierson Sr.	Ocean Stewards; WAS; USAS
Diane	Windham	NOAA/NMFS
Graham	Young	Western Regional Aquaculture Center

Appendix 2 – Forum Program

Forum on Offshore Aquaculture in the Pacific Northwest
September 9–10, 2008 • OSU Hatfield Marine Science Center, Newport, Oregon

Sept. 9	SCHEDULE	INVITED SPEAKERS
9.00	**Welcome**	**Chris Langdon,** Oregon State University
9.15	**Keynote Speaker:** ***Realizing the vision for open ocean aquaculture***	**Richard Langan**, U. New Hampshire Open Ocean Aquaculture Project
	REGULATORY, BUSINESS, AND COMMUNITY PERSPECTIVES – moderator Michael Harte	
	The federal perspective: NOAA's role in developing U.S. marine aquaculture	**Michael Rubino,** Aquaculture Program manager, NOAA
10.30	COFFEE/TEA	
10.45	***Offshore aquaculture – California perspective***	**Devin Bartley,** aquaculture coordinator, CA
11.15	***Aquaculture industry perspectives***	**John Forster,** Forster Consulting Inc.
11.45	***Fishing industry perspectives***	**Panel discussion -** moderator **Kaety Hildenbrand,** Oregon Sea Grant Extension
12.30	LUNCH	
	TECHNICAL AND SCIENTIFIC ISSUES – moderator George Boehlert	
1.30	***Site and engineering issues***	**Cliff Goudey,** MIT
2.00	***Biological and husbandry issues***	**Mike Rust**, NWFSC NMFS
2.30	***Environmental issues***	**Rebecca Goldburg**, Environmental Defense Fund
3.00	COFFEE/TEA	
3.30	**BREAKOUT SESSIONS (concurrent):** 1) Why the Pacific Northwest? (Leaders: Anderson and Forster) 2) Technical and scientific questions (Leaders: Rust, Goudey, and Langan) 3) Potential environmental impacts (Leaders: Leonard, Kent, and Banks) 4) Social needs and values (Leaders: Backus and Sylvia; Barry Fisher Room) 5) The fishing industry and other offshore interests (Leaders: Feldner and Hildenbrand) 6) Federal and state policies (Leaders: Bunsick and Bartley)	
5.00	END	
7.00	RECEPTION AND DINNER – Oregon Coast Aquarium **8.45 pm Dinner speech:** ***Adding value to aquaculture*****. Michael Morrissey,** Food Innovation Center**,** Oregon State University.	
Sept. 10		
	SOCIAL AND ECONOMIC ASPECTS – moderator Peter Becker	
8.30	***Business case study***	**Randy Cates**, Cates Intl. Inc.
9.00	***Economic opportunities and strategies for developing offshore aquaculture in the Pacific Northwest***	**Jim Anderson,** University of Rhode Island; **Gil Sylvia,** Oregon State University
9.30	PHOTO OF ATTENDEES and COFFEE/TEA	
10.00	**WRAP-UP DISCUSSION** 1) Reports from session leaders 2) Next steps	**Jeff Feldner,** Oregon Sea Grant Extension; **Gil Sylvia**, Oregon State University
12.00	Final comments	**Chris Langdon,** Oregon State University

Appendix 3 – Forum Sponsors

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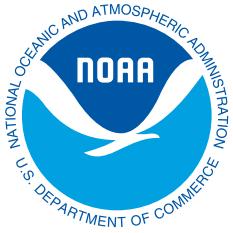

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