2nd DRAFT

Report to Pacific Aquaculture Caucus / National Aquaculture Association

Session:
"Farming Ocean Carnivores: The Science, Economics and Politics of Rapidly Expanding Aquaculture"

At the 171st National Meeting of the
American Association for the Advancement of Science
(Theme: The Nexus: Where Science Meets Society)

Omni Shoreman Hotel
Washington, D.C.

February 18, 2005

By Hugh Mitchell, MS, DVM
Aquatic NW Veterinary Services

This February, the association that publishes "Science": the American Association for the Advancement of Science (AAAS) held their 171st National Meeting in Washington, D.C. The theme of the meeting was: "The Nexus: Where Science Meets Society". One session caught the attention of the National Aquaculture Association and the Pacific Aquaculture Caucus: "*Feeding Ocean Carnivores: The Science, Economics and Politics of Rapidly Expanding Aquaculture*", and this author was sent as a representative to attend and report back to the membership.

The session was organized by two prominent and respected environmentalists, who were also speakers. Jane Lubchenco is a renowned marine ecologist from Oregon State University, and is well-known for her talks and writings on global warming and the challenges of human-dominated ecosystems. She often gives strong examples of how destroying our ecosystems will rob us of potential medicines, and put various regions under varying degrees of economic hardship, illustrating that conservation is in everyone's interest. She has received several awards and fellowships for her work, including the Heinz Award and the PEW Fellowship. Rebecca Goldburg is from Environmental Defense (previously: Environmental Defense Fund), whose mission includes: "protecting the rights of all people … and the solutions we advocate will be based on science … that win lasting economic and social support because they are nonpartisan, cost-effective and fair." Their website lists farmed salmon as an "eco-worst" seafood choice. They currently have about $54 million in assets.

I attended expecting a somewhat "stacked" and biased seminar, with much the same rhetoric and pseudoscientific musings that we have heard against salmon farming. However, I was very encouraged to hear more of a balanced perspective voiced, with a realization, when compared to aquaculture, that commercial fisheries was not always the eco-friendly source of seafood as it was currently trying to portray itself to the lay-public and environmentalists.

(Program summary and abstracts in Appendices).

Dr. Lubchenco introduced the session with comments of how aquaculture "exploded" in the 1980's and "neglected conservation". She mentioned that marine carnivore farming had increased 9% since the 1990's, providing for concerns such as: waste pollution, space conflict, and escapee's. She said that the raising of carnivores offshore still provided for several environmental challenges, including: feed, escapees, waste, diseases, pollution, and industrial scale-up, with the big question: "Could it still be sustainable?".
My concern was that there was never a mention or critique at how existing regulators and legislation did or did not work at mitigating her stated concerns. There was only a general assumption that they were entirely ineffective. Also, there is an implied assumption that only carnivores are an environmental threat. Feeding animals for food, is really little more than moving carbon around. Moving plant carbon versus animal carbon is no guarantee of a smaller environmental footprint. Row crops farming have been shown to have significant environmental impacts in the past.

Paul Sandifer, of NOAA, spoke on the U.S. Commission on Ocean Policy's recommendations for a national policy framework for marine aquaculture, which would be the basis for drafting legislation. He outlined 6 elements: 1) Application of the precautionary approach to the ecosystem; 2) Incorporation into a national plan for managing, developing, and conserving the US EEZ; 3) Designating NOAA as the lead federal agency for marine aquaculture; 4) development of an interagency and state permitting and regulatory program; 5) Increased R&D (including alternatives for fish meal and fish oil in the diets); and 6) Global compliance with UN's Code of Conduct for Responsible Fisheries. The conclusion was: "Careful development of marine aquaculture was in the best interest of the country. "
The question was asked as to whether the adequacy of existing state and regional regulations had been taken into account in formulating this Policy. The answer was: "Not really ".

Dr. Albert Tacon 's talk was entitled: "Ecological Mathematics of Fish Production: can we feed the world on carnivores". His short answer at the start was: "Yes". He stated that in developed countries, 60% of the cultured fish are carnivores (taking 42.1 % of the fish meal production), versus 5% in developing countries. Also, 2.5 million metric tons (mMT) of farmed marine and brackish carnivorous fish produced in 2002 necessitated the consumption of 1.62 mMT of fish meal, or 6.48 to 8.1 mMT of pelagic fish (excluding trash fish). His conclusions were that the industry has to reduce its dependency on fish meal sources, and that it is positive that the reduction of fish meal use is economically driven. What was left out of his talk was: the sustainability of the fish meal fisheries; an ecological comparison of the effectiveness /efficiency of where the other 57.9% of the fish meal goes (one could make the argument that feeding fish to fish is the best use of fish meal as it preserves biological capital); and a comparison of the relative efficiency of the wild fisheries carnivores in converting wild forage. The latter point is too often glossed over in the whole discussion.

Dr. Ian Fleming of Memorial University gave the most alarmist discussion: "Fugitive fish: risk associated with fish farm escapees". He stated that the risk was proportional to the probability of escape, the magnitude, the frequency, and the impact, and reviewed two whole river release experiment studies (Iusa in Norway and Srahrevagh in Ireland). In River Iusa, there was a reported 31 to 32% depression in smolt production, with a 28% reduction in breeding success, a 70% reduction in juvenile survival, and a 16% reduction in lifetime fitness. In the Srahrevagh River, there was an overall depression in population fitness. His conclusions were: impacts are greater within versus without native range of farmed species; there is ecological displacement; there is reduced population productivity; and risks increase with increasing escapees. He thought that in the Pacific, outside of their native range, Atlantic salmon were poor colonizers which failed to establish self-sustaining populations. These two whole-river studies should be examined for their scientific soundness as assessment of genetic fitness, together with the correlation versus causation dilemma, can be extremely difficult to sort out. Although many geneticists are If genetic pollution is a real effect, as many geneticists

Daniel Benetti (University of Miami, Rosenstiel School of Marine and Atmospheric Science) provided the most pro-aquaculture talk of the entire session: "Can aquaculture of carnivorous fish be sustainable: case studies from the Caribbean". He described two Ocean Spar cages off Puerto Rico and the Bahamas with Cobia (*Rachycentron canadum*), heralding feed conversion as being 2,2 to 3.7 more efficient that native wild Cobia, and extensive environmental assessments of the water quality and benthos surrounding the pens (ammonia, nitrite, nitrate, chlorophyll, sediment organic content, etc.) showing no significant difference from control sites. This was greeted with much skepticism from several members of the audience. The results shouldn't be surprising, however, to anyone who has a basic understanding of tropical oceanography, where the permanent thermocline provides for a nutrient-starved desert. Any added nitrogen is rapidly processed. However, there is also an argument to be made for what is the potential impact of the output from a large production facility? The nutrient-starved ecosystem of the tropical ocean behooves aquaculturists to put into place stringent monitoring programs.

Dr. Thierry Chopin of the University of New Brunswick (Canada) heralded integrated multi-trophic aquaculture in: "Integrating for sustainability: benefits of fish, seaweed and shellfish farming". He pointed out that Atlantic salmon farming was 98.9% of the farmgate value of aquaculture in New Brunswick, and that aquaculture as a whole was 80% meat and 20% plants, versus agriculture which was 80% plants and 20% meat. He described his own experiments with salmon-mussel-kelp polyculture, and mentioned that these types of projects were also being conducted in Chile, Israel, South Africa and Costa Rica.

Dr. Rosamond Naylor from Stanford spoke on: "Transforming the Oceans: Economic Change in Fishing and Farming". Much of her views are summarized in her most recent collaboration with R. Goldburg, which was available at the session, and is attached to the appendices of this report ("Future Seascaped, fishing, and fish farming"(2005), Front Ecol Environ 3(1): 21-28). This paper is surprisingly more moderate than previous writings by these authors, and acknowledges a deeper understanding of some of the issues. Her talk was not nearly as comprehensive as her abstract promised, and asked more questions ("Precautionary Principle") than it answered. Her basic questions were: Does aquaculture take the pressure off of wild stocks, and who wins and who loses? She acknowledged that Alaska salmon fisheries was used to no competition and that farming was causing a redistribution of income, which was precipitating all sorts of political issues, including subsidization. She pointed out the anti-dumping initiatives, especially with the domestic shrimp fishery and "foreign" farmed shrimp product. She voiced concerns that the global aquaculture industry was consolidating, mirroring what was happening in other foodstuffs, which were integrating into major global chains. She posed the questions on offshore aquaculture : Who gets the leases (just corporations)? What are the technological, ecological or political solutions? What will be the actual added employment? How will there be a distribution of income between farmers and fishermen? She ended with a statement that Alaskan fisheries were highly subsidized, and acknowledged that "aquaculture is less subsidized than fisheries".

Rebecca Goldberg from the EDF was the final speaker and talked on: “Environmental Policies and Controversies Concerning Marine Aquaculture”. She stated that here concerns about offshore aquaculture stem from the “problems with salmon farming”. She did make some statements which show an evolution in her thinking, however, based upon previous lectures and writings. While she repeated the net loss of fish argument (3 parts fish from meal producing 1 part carnivorous farmed fish) she did acknowledge that it was “more efficient to farm than fishing” but this “makes sense only if aquaculture substitutes for fishing”. Right now, this isn’t the case and marine aquaculture must reduce fish meal use. She brought up that perpetuated myth that farmed fish have more contaminants (This is a conservation issue?). She then showed some scientific acknowledgement that the nitrogen discharge from a salmon farm was small compared to the nitrogen fluxes in the ocean, only to fall back into non-science by stating: “but it still is a really big number and too large to ignore in offshore aquaculture”. In other words, it really isn’t significant but we better pay attention to it. She also stated that the impact of escapees of marine finfish that might be farmed offshore may be different than escapees of anadromous salmon, and this should be studied.
Her conclusions were again guided by the precautionary principle (i.e.: prove the negative before anything is allowed to proceed): offshore aquaculture could have significant environmental impacts; there are R&D challenges to making offshore aquaculture environmentally sustainable; cumulative environmental impact of offshore aquaculture “success” should be evaluated by NOAA; and legislation should require that offshore aquaculture facilities should meet a high environmental standard before receiving permits.

The panel discussion afterwards, did not add much extra to the proceedings. A prime concern of Goldberg and Naylor was that you had supplementation, instead of substitution by aquaculture of the fisheries, and that this was detrimental to the oceans ecosystems. Naylor stated: “ A lot of economic interest in the wild fisheries and there are political interests that keep the two <aquaculture and fisheries> in play”. Goldberg stated that “Fish 2020” predicted that fish prices would continue to rise no matter what, inferring that the supplementation with the growth of both fisheries and aquaculture would have strong incentive to continue.
Mike Rubino of NOAA put out a general question for the audience: “How does NOAA proceed with offshore aquaculture policy?”. Some of the comments back included: a criticism of NOAA being a promoter and a regulator; the need for information on offshore aquaculture; aquaculture shouldn’t be promoted with the history of agriculture and fisheries; and GMO’s should be kept out of aquaculture.

In conclusion, the session seemed to be less antagonistic towards marine aquaculture than anticipated. There seems to be an evolving realization amongst key environmentalists that: marine aquaculture is inevitable; it is good to have it in our own waters, under our own purview, and that it may be a more efficient way of producing our seafood than the fisheries (economically and ecologically). On the other hand, it should be made to be sustainable (not ever defined by anyone at the session) and its operations (preferably non-multinational corporations) should be under close scrutiny by the regulatory authorities, always airing on the side of caution when environmental impacts are in doubt.

APPENDIX 1

TRACK: Oceans and Coastlines

TITLE: Farming Ocean Carnivores: The Science, Economics and Politics of Rapidly Expanding Fish Aquaculture

DATE: Friday, February 18, 2005

TIME: 8:30 a.m. - 11:30 a.m.

ORGANIZERS: Jane Lubchenco, Oregon State University; Rebecca Goldburg, Environmental Defense

PARTICIPANTS: ** = invited, not yet confirmed.*

Jane Lubchenco (Speaker), Oregon State University
Feeding a Growing Appetite: The Promise and Challenge of Farming Carnivorous Fish

Paul Sandifer (Speaker), National Oceanic and Atmospheric Administration
A Policy Framework for the Farming of U.S. Ocean Waters

Albert Tacon (Speaker), University of Hawaii at Manoa
Ecological Mathematics of Fish Production: Can We Feed the World on Carnivores?

Ian Fleming (Speaker), Memorial University of Newfoundland
Fugitive Fish: Risk Associated with Farmed Fish Escapes

Daniel Benetti (Speaker), University of Miami, Rosenstiel School of Marine and Atmospheric Science
Can Offshore Aquaculture of Carnivorous Fish be Sustainable? Case Studies from the Caribbean

Thierry Chopin (Speaker), University of New Brunswick
Integrating for Sustainability: Benefits of Fish/Seaweed/Shellfish Farming

Rosamond Naylor (Speaker), Stanford University
Transforming the Oceans: Economic Change in Fisheries and Farming

Rebecca Goldburg (Speaker), Environmental Defense
Environmental Policies and Controversies Concerning Marine Aquaculture

AVAILABLE ABSTRACTS:

SYNOPSIS:

The depletion of fisheries around the globe has created an impetus to expand seafood production through aquaculture, or fish farming. Between 1991 and 2001 global production of farmed fish more than doubled in weight and value. This spectacular increase has prompted aquaculturists, governments, and scientists to explore farming a wider variety of fish and in new areas of the ocean. New species beginning to be farmed include Atlantic cod, Atlantic halibut, cobia, and mutton snapper -- high-end species with enormous economic potential. The recent U.S. Commission on Ocean Policy recommended expansion of marine aquaculture in the U.S. EEZ (3-200 nm offshore), and the National Oceanic and Atmospheric Administration has drafted legislation to expand the agency's role in regulating and promoting offshore aquaculture. This anticipated push to increase production raises a number of scientific issues, from the technical feasibility of farming offshore, to the ecological mathematics of farming carnivores, to associated economic impacts. This session will address new research on the sustainability of this growth: What progress has been made in rearing finfish offshore? What are the potential ecological impacts of leasing ocean systems for farming? Will integrated multi-trophic aquaculture be a practice providing a balanced ecosystem approach? Will aquaculture help protect wild fish by replacing capture fisheries in the marketplace? What policies need to be in place to ensure a sustainable framework for farming the EEZ? Speakers will address these issues from a variety of perspectives, emphasizing how science can contribute to shaping the future of farming in the sea.

ABSTRACTS:

Title:
Can offshore aquaculture of carnivorous fish be sustainable? Case studies from the Caribbean.

Presenter:
Daniel Benetti

Authors:
Daniel D. Benetti, Larry Brand, James Collins; University of Miami at RSMAS
Antonio Benetti, Universidade Federal do Rio Grande do Sul at IPH
Brian O'Hanlon, Snapperfarm, Inc.
Andy Danylchuk, Cape Eleuthera Research Institute

Abstract:

User conflicts and pollution concerns suggest that major environmental benefits are to be gained by moving cage aquaculture operations further offshore. The U.S. is paving the technological road to sustainable development of offshore aquaculture through university-industry-government partnerships. Emerging technology is being used to demonstrate the environmental sustainability and economic viability of raising hatchery-reared cobia (Rachycentron canadum) in collaboration with the private sector (Snapperfarm, Inc. and AquaSense LLC) using submerged cages in exposed sites in Puerto Rico (US) and the Bahamas.

Sampling stations were set up at different distances and directions from the fish cages. Possible eutrophication of the local environment was evaluated monthly by measuring dissolved nitrogen and phosphorus, phytoplankton biomass, epiphyte growth potential, sinking flux of organic matter into sediment traps, organic content of the sediments, and benthic microalgal biomass. In all cases, no significant differences were found as a function of distance from the cages or relative to upstream-downstream direction. Environmental data from Puerto Rico and the Bahamas indicate that the current regime and resulting dilution of nutrients from the submerged cages do not lead to a significant change in the ecosystem near the cages.

Cobia exhibit extraordinary growth (4-6 kg/12 months), yielding 1 kg of fish biomass when fed 1.8 kg of pellets containing 50% fish meal (FCR = 1.8). Taking into account that energy loss between trophic levels in nature results in an ecological efficiency of only around 10%, our data shows that using fish meal to produce high-value fish for human consumption in aquaculture can be 3.7 times more efficient than this transformation in nature. Results suggest that growing cobia in exposed sites with adequate depth and currents can produce high yields of seafood for human consumption with low environmental impact.

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Title:
Integrating for sustainability: benefits of fish/seaweed/shellfish farming

Presenter:
Thierry Chopin

Authors:
Thierry Chopin, Bruce MacDonald; University of New Brunswick, Canada
Shawn Robinson, Katsuji Haya, Frederick Page; Department of Fisheries and Oceans, Canada
Neil Ridler, University of New Brunswick, Canada
Patrick Fitzgerald, Heritage Salmon Company Inc., Canada
Sharon Boyne-Travis, Canadian Food Inspection Agency, Canada

Abstract:

Integrated multi-trophic aquaculture holds great potential for improving the sustainability of aquaculture. Based on an age-old, common sense, farming practice, the by-products (wastes) from one species become inputs for another: fed aquaculture (fish or shrimp) is combined with extractive inorganic aquaculture (seaweed) and extractive organic aquaculture (shellfish). With the support of AquaNet, the Network of Centres of Excellence in Aquaculture in Canada, we are developing such a system at an industrial pilot scale by co-cultivating salmon (Salmo salar), kelp (Laminaria saccharina) and blue mussel (Mytilus edulis) at three aquaculture sites in the Bay of Fundy, Canada.
After three years of research, our findings support the establishment of integrated multi-trophic aquaculture

systems for environmental sustainability (bioremediation), economic diversification (from fish filets to bioactive compounds) and social acceptability (better management practices). Innovative kelp culture techniques have been developed and improved both in the laboratory and at the aquaculture sites. Increased growth rates of kelps and mussels cultured in proximity to fish farms, compared to reference sites, reflect the increase in food availability and energy. Nutrient, biomass and oxygen levels are being monitored to model the bioremediation potential of an integrated multi-trophic aquaculture site. None of the therapeutants used in salmon aquaculture have been detected in kelps and mussels collected from the integrated sites over the three years of the study. A taste test at market size conducted on site grown versus reference mussels showed no discernable difference. A survey of aquaculture attitudes found that the general public is more negative towards current monoculture practices and, although relatively unfamiliar with the concept, feels positive that integration would be successful. We are now in the process of scaling-up experimental systems and working on an appropriate food safety regulatory and policy framework that will allow the development of commercial scale integrated operations.

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Title:
Transforming the Oceans: Economic Change in Fisheries and Farming

Presenter:
Rosamond Naylor

Authors:
Rosamond Naylor, Stanford University

Abstract:

Aquaculture is frequently cited as means to increase seafood supply in a world where greater quantities of fish cannot be captured from the oceans. Between 1992 and 2002 global production of farmed finfish and shellfish ("fish") almost tripled in weight and nearly doubled in value, and today roughly 40% of all fish directly consumed by humans worldwide are farmed. Until recently, most aquaculture production has been of freshwater fish, such as carp and tilapia, in Asia. However, marine aquaculture, particularly production of salmon and shrimp, has been growing dramatically and new marine species, such at Atlantic cod, Atlantic halibut, and bluefin tuna are rapidly coming on line. This talk will focus on the economics of farming carnivorous fish in the oceans. Data will be presented on industry structure, economic gains, and projected economic growth in marine aquaculture. Recent experience from the salmon and shrimp sectors will be used to illustrate the extent to which aquaculture is supplanting wild fish capture on global and regional scales, and the impact that aquaculture growth is having on local fishing communities. The external costs of aquaculture and fishing activities—those costs not born directly by producers—will also be discussed in relation to consumer demand and prices. Policy measures to reduce the economic distortions in carnivorous fish production caused by subsidy programs and environmental externalities will be highlighted.

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Title:
A Policy Framework for the Farming of U.S. Ocean Waters

Presenter:
Paul Sandifer

Authors:
Paul A. Sandifer, National Oceanic and Atmospheric Administration, Hollings Marine Laboratory

Abstract:

On September 20, 2004, the US Commission on Ocean Policy (USCOP) presented the first comprehensive assessment of US ocean policy since the Stratton Commission's seminal report in 1969. Because of its potential to help supply the expanding US seafood market while decreasing reliance on imports and wild

fishery stocks, aquaculture was among the many activities the USCOP considered. Taking into account environmental and economic issues plus recent advances in U.S. rearing technologies, the Commission concluded that an environmentally and economically sustainable marine aquaculture industry could develop in US waters if it received appropriate policy and technical support.
The USCOP recommended a national policy framework for marine aquaculture composed of the following elements: (1) Incorporation of offshore marine aquaculture within a national plan for managing, developing, and conserving the US EEZ. (2) Application of a precautionary, ecosystem-based approach to its development. (3) Designation of NOAA as lead federal agency for marine aquaculture. (4) Development by NOAA of a comprehensive interagency permitting and regulatory program for marine aquaculture that would provide for environmental protection, coordination with states, participation by a variety of stakeholders, use of best management practices, and establishment of environmental performance guarantees and user fees. (5) Expansion of R&D, training, extension and technology transfer in support of marine aquaculture. (6) Encouragement of worldwide compliance with the aquaculture provisions of the UN's international Code of Conduct for Responsible Fisheries.
NOAA is drafting legislation that would provide the agency authority to implement several of the USCOP's recommendations, including the issuance of site and operating permits for offshore aquaculture, conditioned with necessary environmental safeguards. If enacted by the Congress, this legislation would begin a new era in the development of sustainable seafood production and open a new and challenging frontier for US business.

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Title:
Fugitive fish: risk associated with farmed fish escapes.

Presenter:
Ian Fleming

Authors:
Ian A. Fleming, Memorial University of Newfoundland

Abstract:

Escapes are well known to accompany the open netpen farming of fish in marine environments. This is exemplified by the farming of salmon; the most widely farmed marine finfish for commercial markets, with escapes reported in all salmon aquaculture regions. As such, salmon provide amongst the best models for assessing biological risk associated with farmed fish escapes. Their escape into the wild can result in interbreeding and competition with wild salmon and can facilitate the spread of pathogens, thereby impacting wild populations negatively. Such impacts are exemplified by two recent whole river experiments that documented evidence of an immediate depression in wild population productivity (in one case >30%), as well as a longer-term depression in fitness caused by interbreeding. Here, I show that risk is large when salmon are farmed in their native range, when large numbers of salmon are farmed relative to the size of wild populations, and when exotic pathogens are introduced. An understanding of such risk is critical in designing aquaculture policy and developing management options not only for the farming of salmon, but also other marine finfish.

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Title:
Environmental Policies and Controversies Concerning Marine Aquaculture

Presenter:
Rebecca Goldburg

Authors:
Rebecca Goldburg, Environmental Defense

Abstract:

The global fish catch will not significantly increase, and there is wide agreement that aquaculture must grow as an alternative source of seafood. Both the recent reports of the US Commission on Ocean Policy (2004) and the Pew Oceans Commission (2003) highlight marine aquaculture development, although their recommendations differ. The National Oceanic and Atmospheric Administration (NOAA) has drafted legislation to pursue the development of offshore aquaculture in the United States exclusive economic zone. To date, salmon are the primary type of marine finfish farmed in North America, but NOAA and others are pursuing a number of marine finfish species for commercial production. Many people now view salmon farming in marine waters as environmentally harmful. Depending on how they are raised, farming of new species of marine fish could amplify some of the environmental impacts of salmon farming, such as use of wild fish as feed inputs, the numbers of escaped farmed fish that interact with wild fish, and impacts from farm wastes. I quantify some of these potential impacts. New policies for marine aquaculture must consider the potential cumulative effects of fish farming, and they must integrate fishing, aquaculture, and conservation objectives.

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Title:
Ecological mathematics of fish production: can we feed the world on carnivores?

Presenter:
Albert Tacon

Authors:
Albert G.J. Tacon, University of Hawaii at Manoa,

Abstract:

Capture fisheries has been feeding the world on carnivores since mankind first started hunting or fishing the oceans. In fact over-fishing for high value carnivorous fish species has been such that the catch has now moved down the food chain toward smaller and shorter-lived species. With over one third of the total fish catch destined for reduction into non-food uses and per caput food supply from capture fisheries decreasing, the sector currently supplies less than 1% of our total calorie intake (despite the fact that over 71% of our planet's surface is covered by ocean).

Aquaculture by contrast is seen as the coming blue revolution, with per capita supply of farmed aquatic produce steadily increasing. However, like capture fisheries, emphasis within developed countries has been placed toward the culture of high value carnivores (60% of total fish production within these countries), compared with only 5% within developing countries. Globally over 80% of cultured marine-brackishwater fish are carnivores, compared with 5% for cultured freshwater fish, and 0% for farmed livestock.

At present the culture of carnivorous fish species is totally dependent upon capture fisheries for sourcing feed inputs, either in the form of fishmeal and fish oil, or lower priced trash fish. Thus, the global production of 2.5 million metric tons (mmt) of farmed marine and brackishwater carnivorous fish in 2002 necessitated the consumption of 1.20 mmt of fishmeal and 0.42 mmt of fish oil or the equivalent of 8.1 mmt of pelagics (the data excluding the use of trash fish as feed, estimated at over 4 mmt in mainland China alone).

Although alternative non-food grade feeding stuffs can be used within feeds for the production of marine-brackishwater carnivorous fish species, the long term sustainability of meeting the world's pressing food needs through the intensive farming of obligate carnivores is questionable.

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Title:
Feeding a Growing Appetite: The Promise & Challenge of Farming Ocean Carnivores

Presenter:
Jane Lubchenco

Authors:
Jane Lubchenco, Oregon State University

Abstract:

Depletion of global fisheries coupled with increased consumer demand for seafood has led to an explosion in aquaculture around the world. In the past 20 years aquaculture has grown 4-fold and now makes up 1/3 of the global seafood supply. By 2030 aquaculture may comprise up to 50% of the world's total fish requirements and require an additional 40 million metric tons to meet demand. One of the fastest growing sectors is the farming of marine carnivorous fish and shellfish. The U.S. is one of the main market drivers for increased demand for carnivores. Because the U.S. currently imports 78% of its seafood (mostly fish and shrimp), there is significant interest in identifying new opportunities for farming ocean carnivores in U. S. waters. Paralleling this opportunity are increasing concerns about health, environmental, social and economic impacts of aquaculture. Some of the challenges to expansion of the farming of ocean carnivores include: (1) Feeds: can high quality carnivorous species be raised without continuing to deplete populations of wild fish that are currently caught to provide fishmeal? Can feeds be improved to minimize compounds with human health consequences? (2) Escapes: If some escapes are inevitable, should farming be limited to native species? (3) Waste: Are there limits to the scale of farming that can be done without significant pollution? How might large-scale operations be designed to minimize impacts? (4) Polyculture: Can integrated polyculture systems ameliorate the waste problems of single-species farming? (5) Scale: What ecosystem services are lost when large areas of the ocean are converted to aquaculture? What are the associated trade-offs and limits? (6) Impacts on fishing sector: What are the economic and social consequences associated with scaling up production of carnivorous fish? These challenges are immediately relevant to the formulation of new policies to guide expansion of aquaculture.