

February 29, 2008

Re: Alternative Feeds Initiative

Thank you for the opportunity to comment on the NOAA-USDA Alternative Feeds Initiative. We are a group of scientists, conservation organizations, aquaculture producers, feed research and development specialists, and private equity firms who share a common concern that the expansion of aquaculture may threaten wild fish populations and associated ecosystems unless steps are taken to reduce the industry's reliance on marine resources for feed ingredients. We are pleased that NOAA is taking a leadership role toward protecting reduction fisheries and lessening the ecological impact of aquaculture.

As is noted in the call for comments, the wild fish populations traditionally used to supply cultured fish with fishmeal and fish oil are under increasing commercial fishing pressure. There is a pressing need to transition away from aquaculture feeds sourced from targeted reduction fisheries and to find more sustainable sources of fish nutrition, as well as to use fishmeal and fish oil more efficiently.

Research Priorities

We recommend the establishment of a competitive grants program for developing sustainable, alternative fish diets. Research in this area needs to move beyond black-box feeding trials on well-studied species (e.g., feed fish different feeds and measure differences in growth) to understanding the nutritional requirements of different fish species and how nutrients and dietary components in a variety of feeds meet those requirements. The development of alternative feeds would benefit from a greater knowledge base in areas including fish nutritional requirements, the characteristics and suitability of various feed ingredients, the environmental impacts of various feed sources, the development of cost-effective ingredients, and the development, evaluation and transfer of effective processing technology to the commercial production of ingredients and feeds. Funding to update the National Research Council's report concerning feed ingredients and resources, fish nutrition, and environmental impacts would improve the industry's ability to target feed inputs and formulations to specific species.

We recommend that the federal government focus its research on the following alternative sources of protein and lipids:

Seafood processing byproducts exist in large quantities (as over 30% of seafood processed is inedible) and are some of the best nutritional substitutes for forage fish, with high levels of long-chain omega-3 oils, including EPA and DHA. Byproducts should be sourced from environmentally-responsible aquaculture operations or from fisheries sustainably managed within an ecosystem context.

- Analysis of the supply chain, including transportation, incorporation into feed mill operations, and traceability of fish species and origin through the feed manufacturing process, is needed to understand the economic feasibility and challenges of incorporating seafood processing byproducts into aquaculture feeds.
- The current use of these seafood byproducts should be evaluated and the socioeconomic and environmental effects of diverting them into aquaculture feed assessed.

- Additional research is needed on contaminant levels (e.g. PCBs and methylmercury) in fish byproducts and the potential bioaccumulation of contaminants in farmed fish as a consequence of their inclusion in the diet. Ways to minimize the levels of contaminants in aquafeeds should be studied.
- Research should be conducted to assess the risk of prions and other disease transmission associated with feeding scraps from one species back to the same species and as well as feeding these scraps to other species of fish. Thus far, there has been no evidence of this mechanism of disease transmission in fish, but this observation requires factual support.

Terrestrial plants are currently the most widely used replacement for fishmeal and fish oil; however, they still require further research and development. Terrestrial plants are presently an incomplete feed ingredient for fish, lacking significant quantities of certain essential amino acids and key long-chain (C20 and C22) omega-3 oils. They also contain anti-nutritional factors that are detrimental to fish growth and nutrient utilization.

- Research is needed into forms of plant meals and oils that are more nutritionally beneficial and readily utilized by the fish. For instance, soy protein concentrate has a higher level of protein and lower level of undesirable components, as compared with soybean meal. The more digestible the feed is, the less is excreted by the fish, thereby reducing water pollution from aquaculture operations. Nutrient interactions are quite complex, and further research and development is required to understand and overcome the limitations of common plant protein ingredients.
- The environmental impacts of farming these crops for aquaculture, such as deforestation, soil erosion, fossil fuel consumption, and pesticide contamination, must be carefully evaluated and weighed against traditional and other alternative sources of nutrition for cultured fish.
- As biofuels production increases, opportunities exist to recover and utilize protein from the grain and oilseed co-products of biofuel manufacturing processes. Investments and novel approaches in this area should be encouraged to explore and develop products for use in aquafeeds that are of higher nutritive value than those currently produced.

Animal byproducts are available in great quantities; approximately 9 million metric tons of animal proteins and fats are produced each year in the U.S. and Canada alone. They also are cost-effective, have high nutritive value, and complement very well some plant protein ingredients. However, there are a range of issues that must be addressed before animal byproducts are promoted broadly for use in fish feeds.

- The risk of disease transmission must be thoroughly studied, particularly since transmissible spongiform encephalitis (TSE) and other threatening diseases are known to exist in mammalian livestock. While naturally-occurring TSE has not been identified in pigs or poultry up to this point, it is an issue of considerable concern to consumers.
- There is significant public concern about feeding the unwanted parts of animals to other animals, and potentially among a section of the public – including people who eat fish but not meat from terrestrial animals – about feeding mammals or poultry to fish. These concerns and perceptions must be understood more thoroughly and be adequately addressed.

- Overall, it must be determined whether the ecological benefits outweigh the risks of using various types of animal byproducts as feed.

Single-cell proteins and oils, such as from bacteria, microalgae, protists, and yeasts, are being explored as sources of protein and omega-3 oils for aquaculture feeds, with early trials using microalgae yielding up to 50% long-chain omega-3 oil content.

- A vast number of unicellular species could potentially be used to produce proteins and oils for the aquaculture industry, and research should be supported to find the best-suited organisms for this purpose. In addition, a better understanding is needed of the extent to which single-cell proteins and oils can be substituted in aquafeeds and of the effect of substitution on fish nutrition and flesh quality.
- Analyses of the effects of the production techniques on the environment – for example, energy use and effluent discharge – are needed.
- For single-cell proteins and oils to become widely practicable, costs need to be reduced, either through economies of scale or through an incentive for having a low environmental impact, if this is deemed to be the case. Economic studies and process engineering should be performed to explore the conditions necessary to make single-cell processes more economical.

Marine and terrestrial invertebrates, such as polychaete worms and terrestrial insects, are being pursued as sources of protein, and in some cases, omega-3 oils for fish feed. These invertebrates are similar to those consumed by many fish species in nature.

- The development of production systems for these animals is in its infancy, and considerable research is needed to develop efficient, economically viable production methods.
- At least in some cases, polychaete worms are now being fed fisheries products. The development of alternative diets for these animals is essential if they are to be an ecologically desirable ingredient for fish feeds.

Feed Sources Not Recommended at this Time

While forage fish are presently the primary marine resource used for aquaculture feed, there is a growing interest in other marine organisms as potentially viable feed ingredients. Most notably, krill and bycatch of non-targeted species are increasingly being utilized, in whole or in part, as aquafeed. Because of the potentially severe impacts on ecosystem function and human food security, we cannot recommend the use of krill or bycatch as alternative sources of proteins and oils unless and until research demonstrates that the use of these species will not negatively impact the ecosystem.

Very little is known about krill populations and how they respond to fishing pressure or impending climate change in the ocean. Research in these areas would improve our understanding of the ecosystem impact of their use in aquafeeds. Krill are a vital species in the marine food web, providing a main source of food for penguins, seabirds, seals, whales, fish, squid, and other animals. Extreme caution is required in fishing krill, which is regulated by CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) in the Southern Ocean, because of their key role in the ecosystem. Overfishing of krill, particularly concentrated fishing efforts in localized regions, could severely undermine the food web and

devastate marine life. As such, increasing fishing pressure for krill is worrisome and should not be encouraged.

Some species of bycatch, or fish caught incidentally while targeting other species, are of too little value to be sold commercially. The use of these fish in aquafeeds has been proposed, but many of these fish are caught in developing nations, where they are often used for sustenance locally. For instance, women in Indonesia make these fish into fish balls for local consumption. Should aquaculture deprive the poor of this important source of protein, it will likely have consequences for food security and poverty alleviation. Trends are troubling, as the price of these fish has recently doubled in Vietnam due to increasing demand from the growing aquaculture sector there. Creating a market for bycatch as an aquafeed substitute would run counter to ecosystem protection, and thus, the use of bycatch should be avoided.

Efficient Use of Fishmeal and Fish Oil

In the short-term, the aquaculture industry is likely to remain at least partially dependent on fish-based feeds. To minimize the impact on wild fish stocks, research and regulation is needed so that fish-based feed inputs are used strategically and only in essential life stages. For instance, nutritionally adequate substitutes for fishmeal and fish oil may not be available for juvenile fish, but research should be done to determine how soon the fry of various aquaculture species can be weaned onto alternative diets. After that point, fish-based inputs may be able to be eliminated from the diet or restricted to use in finishing diets to improve product quality for consumers. At present, inclusion rates of fishmeal and fish oil in many feed mixes are in excess of nutritional requirements. For example, typical salmon feeds include 20% fish oil or more when salmonids only require 1-2% long-chain omega-3 oils for basic health, and perhaps twice that for optimum human health benefits.

Sustainable sourcing and traceability of fish inputs are also essential components to ensuring the sustainable use of wild fish stocks. Only by conveying through the supply chain the origin and nature (e.g., species) of the fish used in a bag of feed can farmers and consumers be assured that unsustainable fisheries are not being utilized in the feed. At a minimum, country-of-origin labeling is needed on feeds and feed ingredients, as is currently required for fish sold at retail outlets. However, more detailed information, such as species and inclusion rates, should be available to aquaculture producers. Research should be supported to investigate the feasibility and optimal design of traceability and country-of-origin labeling schemes for fish feeds and feed ingredients.

Finally, other current users of fishmeal and fish oil (e.g., livestock production) should be examined, and the phasing out of fishmeal and fish oil use in those industries should be encouraged.

Opportunities and Obstacles to Alternative Diets

The open ocean aquaculture bills currently in Congress provide an important opportunity to encourage the nascent U.S. fish farming industry to incorporate alternative feeds. For example, language should be included in these bills calling for the use of best available technology to minimize the use of fishmeal and oil from reduction fisheries in feeds and encouraging the

development of sustainable, alternative feed sources through research, funding, and market-based incentives.

At present, the cost of many of these more sustainable options is too high to be economically viable. Incentives are needed to bring the cost down before alternatives will be widely adopted by the industry. We encourage NOAA to carefully consider appropriate incentives that are structured to encourage the development and use of environmentally responsible feeds while avoiding over-capitalization in the aquaculture industry.

Maintaining Nutritional Benefits to Consumers of Farmed Fish

Over a fish's lifetime, most of the oil it ingests is metabolized for energy, and only a small portion is stored as body fat. Fish can be grown largely on alternative sources of protein and oils and then "finished" on fishmeal and/or fish oil to boost the flavor of the flesh and long-chain omega-3 oil content before harvest and sale. Placing salmon on a finishing diet high in fishmeal and fish oil for a final period of up to three months following a vegetarian diet reduces the total amount of fish oil used over the fish's lifetime by up to 85%. This time period is sufficient to restore the traditional salmon flavor as well as achieve a suitably high content of omega-3 oils beneficial to human health while greatly reducing the total amount of fish oil used.

Another potential technology for producing omega-3 oils is the genetic engineering of terrestrial crops using genes derived from unicellular algae. Several groups are currently conducting research to produce such genetically engineered plants, which have the potential to confer the human health benefits of omega-3 oils without the negative environmental impact of depleting wild fisheries. However, genetic engineering may raise other concerns, such as the risks to ecosystems and human health and, as noted by some groups, the inadequate state of U.S. federal regulation of genetically engineered crops. These concerns will need to be carefully assessed before genetically engineered land plants containing long-chain omega-3 oils are introduced as feed ingredients. At present, technological challenges supersede these concerns; advancements in the science are still needed to achieve high levels of the long-chain omega-3 oils and enhance their yield in land plant oils. When the technology has matured and a more complete understanding of the potential effects of these genetically modified crops has been achieved, it is possible that genetically modified crops with suitable protein and, in particular, oil quality may be of great benefit to both the aquaculture industry and consumer health.

Thank you again for the opportunity to comment. We welcome the opportunity to work with NOAA and the USDA in providing additional feedback on this important topic.

Sincerely,

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