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NOAA Aquaculture Program
Alternative Feeds Initiative
1315 East-West Highway
Room 13117
Silver Spring, MD 20901

Submitted via email to noaa.aquaculture@noaa.gov and via fax to (301) 713-9108

RE: Alternative Feeds Initiative

Please accept these comments on behalf of Food & Water Watch[1] regarding aquaculture feed ingredients, as NOAA and USDA begin their Aquaculture Feeds Initiative. First, given the precarious state of world fish stocks, we feel strongly that aquaculture operations must reduce their dependence on fishmeal and fish oil from wild caught sources. Additionally, as scientists and industry investigate alternatives to traditional feeds that include wild fish, it is important to take into consideration the potential environmental, socioeconomic, and human health impacts of the source and use of various ingredients.

Food & Water Watch recommends that the federal government focus its research efforts on the following questions:

- How can the human food safety and fish health risks of the use of fish and terrestrial animal by-products in feed be minimized?
- What are the environmental, human health, and socioeconomic effects from use of different feed ingredients from various sources?
- What are the environmental impacts (effluent levels) from fish consumption of different feed formulations? How can the digestibility of aquaculture feed be improved to reduce nitrogen and phosphorous emissions from aquaculture facilities?
- What are the physiological effects of the consumption of different feed ingredients to various fish species?
- How can the nutritional value of fish, for example levels of omega-3 fatty acids, be maintained without the use of fishmeal or fish oil?
- How will NOAA and USDA coordinate with FDA Center for Veterinary Medicine Division of Animal Feeds to ensure the safety of aquaculture feeds?

Food & Water Watch recommends that the federal government not focus its research efforts on the following areas because of negative environmental impacts:

- Genetically modified feed ingredients
- Krill meal and oil

[1] Food & Water Watch is a nonprofit consumer advocacy organization, which works to ensure clean water and safe food.

- Bycatch utilization

Until safe, nutritionally appropriate, sustainable feed ingredients are found to eliminate the net loss of marine protein from wild reduction fisheries, Food & Water Watch urges NOAA and USDA to not promote the commercial aquaculture of carnivorous fish species.

Fishmeal and Fish Oil

One-third of the global fish catch becomes fishmeal or fish oil. Many industrial fishing fleets take fish from the ocean faster than the fish reproduce. For example, from 1988-2003, over-fishing eliminated 99 percent of the South American pilchard, commonly turned into fishmeal.[1] Additionally, out of the top fish species destined for reduction into fishmeal and fish oil, Atlantic herring, Atlantic horse mackerel, blue whiting, capelin, chub mackerel, Japanese anchovy, Peruvian anchovy, and sandeels are all fully exploited or overexploited.[2] Removing these fish from the ocean to fatten farmed fish reduces food for penguins, whales, and other ocean mammals, and larger predatory fish, disrupting normal ecosystem function.

Aquaculture operations use about half of the world's fishmeal and more than 80 percent of the fish oil.[3] In 2003 alone, fish farms consumed about 18 million tons of fish (equivalent to more than 160 billion herring) in the form of fishmeal and oil.[4]

Alternative Protein and Lipid Sources

A wide variety of potential feed ingredients are being tested as potential replacements for fishmeal and fish oil. Our purpose is not to provide a complete list of ingredients, nor is it to compare their merits in terms of fish nutrition. Rather, we highlight concerns about a few potential ingredients to illustrate the range of food safety, environmental, and socioeconomic issues that should be considered and evaluated.

<u>How can human food safety and fish health risks from use of fish and terrestrial animal by-products in feed be minimized?</u>

Mercury

The use of fishmeal and fish oil in aquaculture feed has been linked to mercury concentrations in farmed fish. Studies on cod and salmon show that 20 to 40 percent of the mercury in fish feed accumulates in the edible fillet of farmed fish.[5,6] Feed ingredients from marine sources are a major contributor of mercury to fish feed.[7,8] Although a legal limit for mercury in feed has been established, FDA testing of feed for mercury is very limited.[9] The FDA work-plan for 2007 was to test only 20 feed samples for mercury.[10] Researchers in the United States and Canada tested a variety of commercial fish feeds from 1998-2005, and found levels of mercury with a mean Hg concentration of 51 ppb (ranging from 7 to 90 ppb).[11,12,13]

The use of fisheries by-products will also carry the risk of contributing to increased mercury levels in farmed fish fillets. Fish that are higher on the food chain may actually have higher concentrations of mercury. Therefore, NOAA and USDA should work with

FDA's Center for Veterinary Medicine to investigate ways to increase testing of aquaculture feed for mercury and other contaminants.

Pathogen Concerns

In the United States, terrestrial animal feed is frequently contaminated by pathogens, including *Salmonella* and *E. coli*.[14] In some cases, these pathogens can be transferred to the animal and subsequently to the human consumer.[15] Studies have found *Salmonella enterica* in up to 56 percent of animal feed samples tested and *E. coli* in up to 48.2 percent of feed samples.[16] One source of pathogens in feed is the use of contaminated ingredients that have been condemned or are otherwise unfit for the human food supply to make the feed, particularly of animal or fish origin.

For example, in 1970, an outbreak of *Salmonella enterica* serotype Agona infection was linked to the use of contaminated Peruvian fishmeal in chicken feed.[17] Before 1970, only two human infections of this strain of salmonella had been reported in the United States.[18] However from 1970 to 2000, close to 30,000 *Salmonella enterica* serotype Agona infections were reported. [19] Due to the high rate of unreported infections from *Salmonella*, it is estimated that more than 1 million illnesses have occurred in humans since the pathogen was introduced. [20]

The potential for development of antibiotic-resistant bacteria creates an additional level of concern. Animal agriculture's common use of antibiotics at sub-therapeutic levels leads to the development of pathogens that are resistant to one or more antibiotics. These pathogens can survive the rendering process and remain in the animal by-products that are used in feeds. For example, scientists have found bacteria that are resistant to gentamycin, stereptomycin, ampicillin, and amoxicillin in animal feeds, all of which are used in human medicine.[21] One study of poultry, cattle, and fish by-products found antibiotic-resistant bacteria in 85 percent of the samples.[22] Samples of poultry meal, bone meal, and cattle meat meal were most likely to have bacteria that were resistant to five or more antibiotics.[23] When humans become infected with antibiotic-resistant bacteria, their illnesses are more difficult to treat.

In addition to the food safety risks, the use of fish by-products opens up the possibility that fish viruses, bacteria, fungi, and parasites could be transmitted through aquaculture feed. The European Commission Scientific Committee on Animal Health and Animal Welfare reviewed the risks of using fish by-products in aquaculture feed and recommended that farmed finfish by-products should not be fed to farmed finfish and farmed invertebrate by-products should not be fed to farmed invertebrates.[24]

The current methods used to process fish and animal by-products for feed have proven to be insufficient to guarantee food safety of farmed animals. More research is needed on what processing methods are effective at inactivating various pathogens that can infect humans and fish. NOAA and the USDA should coordinate this research with the Animal Feeds Division at FDA's CVM.

Arsenic

Arsenic is used in poultry feed to prevent infection, stimulate growth, and improve pigmentation.[25] The arsenic additive roxarsone is fed to about 70 percent of broiler chickens in the United States.[26] At low levels, arsenic can cause cancer and contribute to heart disease, diabetes, and reduced brain function.[27]

Most of the arsenic fed to chickens is excreted. Poultry litter (waste) has been found to contain up to 48 ppm arsenic due to the excreted waste and spilled feed containing arsenical additives.[28] Another study found an average arsenic concentration of 0.39 ppm in chicken liver.[29]

There have been suggestions to utilize poultry litter and other poultry by-products as a food source for aquacultured fish. If fish consume arsenic laced feed, they may bioaccumulate the compound.[30] This process has been shown for cattle; when cows consume feed with poultry litter, they have higher levels of arsenic in their muscles.[31]

Research is needed to determine the extent of bioaccumulation of arsenic in edible fillets of fish that consume feeds that include different conventional poultry by-product ingredients.

<u>What are the environmental, human health, and socioeconomic effects of sourcing different feed ingredients?</u>

As NOAA and USDA look into different ingredients for use in aquaculture feed, they should consider the effects of the production of ingredients so that the change in ingredients does not simply trade one potential harm (overexploitation of prey species) for others. Soy, corn, and palm oil production have all been associated with significant environmental, human health, and socioeconomic effects that should not be ignored.

Soy

The American Soybean Association and the U.S. Soybean Export Council have been promoting the use of soybean meal in aquaculture around the world for over a decade.[32] Now, the soybean industry is turning to the United States aquaculture industry as a potential market, and has funded research on soy inclusion in feed at Virginia Tech, the University of New Hampshire, and Kona Blue Water Farms in Hawaii.[33]

However, although there is arguably more industry support for the use of soy than any other ingredient, this does not mean that soy is necessarily the best choice in terms of sustainability or fish nutrition. In the United States, fertilizer run-off from soybean farms has contributed to a “dead zone” in the Gulf of Mexico that is almost the size of New Jersey.[34] No marine life can survive in this zone, and this is problematic for both wild fish and the Gulf coast industries that depend on them.

In Brazil, Argentina, and Paraguay, tropical rainforests and savannahs have been destroyed to make room for soy production. According to the World Wildlife Foundation, increased soybean production in South America could destroy 22 million hectares of

these vital ecosystems.[35] Also, the heavy use of toxic herbicide on soy crops has destroyed crops on subsistence farms, polluted ground water, and caused illnesses, especially among Brazilian children.[36]

Corn

Corn gluten meal has also been proposed for use in aquaculture feed. Unfortunately, corn is also an intensively produced crop with significant negative environmental impacts. Corn production consumes more than 40 percent of all commercial fertilizers used on crops in the United States, including 10 billion pounds of nitrogen fertilizer per year.[37,38] In addition to contributing to the Gulf of Mexico "dead zone" described above, nitrogen fertilizer can also leach into drinking water sources, contaminating the water with excess nitrate and causing human heath problems including cancers and birth defects.[39]

Additionally, corn is produced with large quantities of herbicides and pesticides. In fact, corn herbicides are the most prevalent (both in terms of frequency and concentration) agricultural pesticides present in surface and drinking waters throughout the United States.[40] About 75 percent of corn in the United States is treated with the herbicide atrazine, which is banned in the European Union. [41] The chemical has been shown to potentially cause cancer and may disrupt endocrinal development.[42,43] Other herbicides and insecticides used in corn production, such as carbofuran, methomyl, methyl parathion, and terbufos are known to be highly toxic to birds, mammals, and fish.[44]

Palm Oil

Researchers have investigated the use of palm oil to meet lipid requirements of fish. However, palm oil production has been associated with significant environmental destruction in Malaysia and Indonesia, where the majority of palm oil is produced.[45] Large tracts of tropical rainforest have been cleared, sometimes with fire, to make way for palm plantations.[46] In Malaysia, oil palm production was responsible for an estimated 87 percent of deforestation from 1985 to 2000.[47] The Sumatran tiger, Sumatran and Bornean orangutans, Asian elephant, and Sumatran rhinoceros are all endangered species that once thrived in these rainforests.[48] Additionally, the draining and burning of peatland has created enough carbon emissions to put Indonesia as the third leading contributor to climate change.[49]

Palm oil production has also had significant negative effects on workers and local people. Heavy use of pesticide puts at risk the health of plantation workers, the majority of whom are women. [50] The dumping of palm oil mill effluent pollutes drinking water, and has lead to declines of fish stocks in rivers and lakes. [51]

<u>What are the environmental impacts of fish consumption of different feed formulations?</u>

The digestibility of feed ingredients affects the volume and composition of effluents that are emitted from aquaculture operations. Less digestible ingredients lead to greater phosphorous and nitrogen emissions, which can negatively impact the aquatic

environment.[52,53] More research is needed on methods to improve the digestibility of feed ingredients to minimize effluent emissions.

What are the physiological effects of the consumption of different feed ingredients to various fish species?

As researchers investigate new feed ingredients, it is important to look at the nutritional needs of fish species and the physiological effects from consuming different diets. For example, salmonids have exhibited intestinal inflammation from soy consumption, leading to increased susceptibility to the fish pathogen furunculosis.[54]

A study of gilthead sea bream found that replacement of fishmeal with plant protein ingredients affected the immune system of fish, and recommended further study on the issue, looking at specific immune indicators and pathogens.[55] Additionally, a study of Atlantic cod confirmed that fish diet affects the microorganisms in the digestive tracts of fish, which has implications for fish health.[56] The authors note, "Furthermore, the effect of dietary components such as fishmeal, standard soybean meal, and BPSBM on the gut microbiota is important to investigate as the GI tract is one of the major routes of infection in fish."[57]

The case of beef production in the United States illustrates how animal feed ingredients can have unintended consequences for both animal health and food safety. Cattle and other ruminants, with pH-neutral rumens, are biologically suited to eat grass. However, they are often fed a finishing diet of corn and soybeans for a few months prior to slaughter. This grain-based diet turns the digestive tract acidic, and can cause the serious health problems of acidosis and feedlot bloat.[58] Scientists also point to human health risks associated with this grain-based diet. When *E. coli* develops in an acidic digestive system, it is more likely to survive in the acidic digestive system of a human. [59] A researcher from Cornell University found that cattle fed hay for the five days before slaughter had dramatically lower levels of acid-resistant *E. coli* in their feces than cattle fed corn or soybeans.[60]

More research is needed on the ways in which different food ingredients affect the health and disease susceptibility of different fish species.

Some potential ingredients should not be used in aquaculture feed because of unacceptable ecosystem impacts or unresolved questions. We therefore urge the federal government to not devote research funds to the investigation of the following as feed ingredients:

Genetically Modified Feed Ingredients

Genetic modification of feed ingredients to enhance aquaculture production, whether to add carp growth hormone, omega-3 fatty acids, or pathogen antigens, is another option being considered by feed producers. Additionally, a significant percentage of soy, corn, and other crops have been genetically modified to enhance crop production. However,

questions remain unanswered regarding the health and environmental impacts of genetic engineering.

The negative environmental impacts of genetically modified crops include the genetic contamination of nearby plants and native species and effects on insect and small animal species.[61] Also, herbicide-resistant weeds have developed around crops modified with herbicide resistance, increasing the need for application of additional herbicides.[62] A four-year study comparing genetically modified canola to its conventionally bred equivalent found fewer seeds, bees, and butterflies in the field with genetically modified crop.[63]

Until genetically modified crops can be proven to be safe for consumers and the environment, the federal government should not fund research on the use of genetically modified ingredients in aquaculture feed.

Krill

An important prey species for marine mammals and seabirds, krill are a vital base of the Antarctic aquatic ecosystem. Unfortunately, advances in fishing technologies and ineffective fishery management, coupled with climate change, are threatening krill populations.[64,65,66] Also, krill fishing is geographically concentrated near breeding grounds of penguins, placing vulnerable and near threatened species at risk.[67]

The aquaculture industry must not simply substitute its reliance on small pelagics with a reliance on krill, and the federal government should not fund research into the use of krill meal and oil as ingredients in aquaculture feed.

Bycatch

Bycatch, the catch of unintended or unwanted marine species when fishing, is a significant problem that should continue to be addressed through advances in technology and management. However, creating a market for the use of bycatch in aquaculture feed could increase the problem. If bycatch had commercial value, then fishermen would have the incentive to intentionally catch non-target species that could be sold to processors as "bycatch," and the overall take of these species could increase. Also, much bycatch goes back into the ocean. Though frequently dead or dying, this bycatch ends up as food for marine species. The federal government should not fund research on the use of bycatch in aquaculture feed.

Conclusions

Food & Water Watch appreciates that NOAA and the USDA are taking an interest in exploring alternative feed sources, as this affects the future of aquatic ecosystems throughout the world. Until commercially viable alternatives to fish meal and oil from wild caught sources are found, the aquaculture of carnivorous finfish will continue to be unsustainable. Therefore, we recommend that until safe, nutritionally appropriate, sustainable feed ingredients are found to eliminate the net loss of marine protein from reduction fisheries, NOAA and USDA should not promote the commercial aquaculture of carnivorous fish species.

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We look forward to the opportunity to continue working with NOAA and USDA on the Alternative Feeds Initiative. If you have any questions, please feel free to contact Lisa Reinhalter at lreinhalter@fwwatch.org or Marianne Cufone at mcufone@fwwatch.org.

Sincerely,

Lisa Reinhalter, Policy Analyst

Marianne Cufone, Director, Fish Program

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