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DRAFT POLICY AND GUIDELINES FOR FIN FISH FARMING, MARINE AQUACULTURE EXPERIMENTS AND PILOT PROJECTS IN SA

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INTRODUCTION

The development of marine aquaculture in South Africa is faced with a particularly difficult set of challenges. The country has a high-energy coastline with a limited number of protected sites, coastal real estate is at a premium, and marine aquaculture is not a traditional economic activity. However these challenges are not unique to South Africa and it should be noted that, despite similar constraints, other countries such as Australia have developed successful aquaculture industries. South Africa can achieve the same success by developing appropriate local technology or adapting technology from abroad.

Counting in its favour, South Africa possesses a wealth of indigenous and endemic marine species, some of which have been identified as potential candidates for farming, and a range of unpolluted marine environments. There is a well-developed scientific fraternity and research capacity, and the local marine aquaculture industry has proven itself to be highly innovative. With the appropriate interventions and support, there is a good chance that technological solutions can be pioneered that will overcome the challenges to develop a strong and healthy aquaculture industry.

The development of aquaculture technology requires intensive and sustained capital. Most aquaculture businesses are SMME's, and therefore cannot afford to invest in research projects on the scale required. In all countries where aquaculture has experienced rapid growth in the recent past, governments have provided financial assistance, management and the appropriate institutional environment to drive technology and research. Similar interventions are necessary for aquaculture success in South Africa too.

Finfish farming

The introduction of finfish (Class Teleostei) represents an exiting new development in the marine aquaculture industry in South Africa. Cultured marine fish offer the industry access to a wider seafood market, but at the same time finfish farming at sea ushers in a number of challenges and environmental concerns not associated with traditional shellfish farming. The need to feed fish on a high protein diet and the mobility of fish intensifies risks of pollution and disease transfer to wild stocks.

South Africa has the option of farming foreign species which have been farmed with great success overseas but which may have saturated the market, or it could concentrate on developing indigenous products and attempt to establish these on local and international markets.

Marine fin-fish-farming strategies

Distinction is made between the following types of farming operations:

1. Land-based farms that use artificial seawater. These farms are totally isolated from the sea.
2. Land-based farms that rely on a pumped exchange of sea water between the farm and the sea or estuary. These facilities may recycle sea-water and have the option of isolating the farm from the sea for limited periods. Incoming and outgoing water can be screened.
3. Sea-based farms in which fish are penned in *floating cages* made of netting and anchored in the shallow coastal zone. Sophisticated designs may include cages with single point moorings that allow the cage to move over a circular area to reduce localised concentration of organic waste in the sediments.
4. Sea-based farms in which fish are penned in *submerged cages* made of netting and anchored in deep water away from the coastal zone. Surface buoys mark the position of the cages, which are hauled to the surface for stocking, slaughtering and monitoring.
5. Sea-based farms in which fish are penned in *submerged cages* in deep but mid-water away from the coastal zone. Surface buoys mark the position of the cages. Cages are hauled to the surface for stocking, slaughtering and monitoring.

There are costs and benefits associated with each type of farm, and these need to be considered carefully with reference to environmental impacts, costs and production. As a rule, the land-based options are encouraged above sea-based cages. Land-based operations offer total or controlled isolation from the sea, which carries the following advantages:

- Effluents that contain high organic loads, and pharmaceuticals can be kept from the ocean.

- Contact between wild and farmed fish is avoided, thereby eliminating risks of disease spread and genetic contamination.
- Interactions with marine mammals and large piscivorous predators are avoided.

The most important choice of operation is between land- and sea-based farms. Although land-based farms will still need to undergo environmental impact assessments, their impacts are small in comparison to sea-based farms. Naturally, the costs of land-based operations are greater than sea-based cages. To a very large extent these higher costs reflect the rental of coastal land and the need to rid the impoundments of waste products and maintain homeostatic environments. The cost of coastal land is generally high for pump-ashore facilities. Cheaper inland sites are to be balanced against the costs of artificial sea-water. The greater degree of control offered by the latter is an advantage that will count heavily in favour of applications to farm alien species, and endemic species that are at risk from disease and genetic contamination. When free from the constraint of sea water supply, farms can be established close to inland markets, thereby reducing refrigerated transport costs.

An exception to the high cost of coastal land is the Northern Cape where some diamond mines are nearing the end of their productive lifespan. These operations will leave infrastructure that in some cases, could be converted for marine aquaculture operations. In addition, several abalone farms have expressed interest in using abalone effluent water as a growth medium for fish culture, and some farms have conducted successful preliminary trials in this regard.

Sea-based farming is cheaper, partly because they use common-property resources and rely on the ocean to flush waste products. The negative press accorded to finfish farming is almost entirely due to environmental and health impacts of sea-based farms. The bulk of these guidelines address the consequences of farming finfish at sea, specifically the need to prevent pollution, protect wild fauna and protect the commonage rights of citizens to the sea. It is largely for these reasons that sea-based farms are to be contained in nodes.

Apart from the environmental impacts, South Africa does not offer an ideal environment for sea-based finfish farming, due to exposure to heavy seas, and high-nutrient waters that cause heavy biofouling of immersed structures. Technology can overcome at least some of these problems. Several companies have developed cages that can withstand extreme conditions (e.g.: Farmocean, Dunlop, Bridgestone, Oceanspar, Polar Circle, Net Systems), however the vital ancillary activities such as feeding, net maintenance, fish harvesting etc., have not been appropriately resolved. Experience thus far shows that there are large risks and high costs associated with farming in the high seas environment.

The submerged cage options may offer a better alternative, deep water is calmer and less productive (i.e. less biofouling). Open ocean cages have been tested in a number of countries including Ireland, Norway, Spain, Portugal, Hawaii, Libya, China, and Australia. One disadvantage is that the farms are remote from land-based supplies. It is expected that South Africa will need to experiment with submerged cages.

Until appropriate cage culture technology is tested, finfish culture operations in South Africa will remain largely land-based. The high price of coastal real estate in many areas, unfortunately make pump-ashore facilities expensive to develop.

ENVIRONMENTAL IMPACTS OF FISH-FARMING

Fish farming has received bad publicity overseas in recent years, where poorly regulated and poorly managed operations have had a number of environmental impacts. The following list of impacts does not apply to every case, and the severity can vary widely. It will be evident that most of the impacts are associated with sea-based cages.

1. Pollution

1.1 Feed waste and fish feaces

Unlike shellfish farming, which depends on the natural supply of nutrients, fish farms are sustained by exogenous sources of protein and carbohydrate. Approximately 80% of the carbon and 45% of the nitrogen in the feed is retained in fish production: the balance is either wasted or excreted. The waste causes nutrient enrichment in the water and sediment, where it could lead to a number of well-described effects, including anoxia, increased bacterial counts, phytoplankton blooms and benthic community changes. Eutrophication can be reduced in sea-based operations by limiting the size of the farm, choosing well-flushed sites, rotating cages, and using feed with greater assimilation efficiencies.

1.2 Anti-fouling chemicals

The installation of any structure in the coastal zone provides a substrate for sessile invertebrates and algae. Toxic chemicals known as anti-foulants are used to prevent settlement. Anti-foulants are routinely used on ships and small craft, but its application on stationary farm structures could compromise the quality of the farmed product, and poison naturally settled plant and animal populations.

1.3 Medication, antibiotics and anti-parasite chemicals

Chemicals used as therapeutants to combat disease and build up resistance in fish that may be infected are sometimes passed on to the environment. The use of antibiotics is problematic in that it could lead to development of resistant strains of bacteria. Anti-parasite chemicals are generally toxic to invertebrates, impacting on adjacent benthic communities and shellfish farms.

2. Escaped fish interbreed and weaken wild stocks

Farmed fish frequently escape from sea-based farms and interact with their wild conspecifics. Problems arise if the farmed fish are drawn from a different genetic stock, or are artificially selected. Competition for resources and mates between farmed and wild stocks reduce the vigour of wild populations, particularly where wild stocks have been reduced by over-fishing. The risk can be mitigated if farms are limited to species that are not depleted in the wild, by keeping fish in land-based impoundments, and by using the appropriate genetic strains for each area.

3. Farms increase infection rates among wild fish

It is a general tenet of epidemiology that the density of hosts is positively related to parasite infections. This is nowhere more apparent than in cage aquaculture. Cages also prevent fish from exercising natural parasite-shedding behaviour. Wild fish attend sea-based cages, where they may become infected by parasites and diseases. The increased parasite load may reduce the spawning capacity of wild stocks.

4. Interaction with piscivorous predators

Wild populations of seals, birds and sharks will attempt to prey on fish in cages held at sea. Their efforts could damage nets, causing escapement. Problem animals are difficult to chase away, and farmers are usually tempted to dispatch such animals by lethal means. Passive dispersal is rarely successful. South Africa has strong populations of piscivorous predators.

5. Entanglement of cetaceans

Whales may entangle themselves in ropes that secure cages. In the south-western Cape the number of southern right whales is increasing at 7% p.a. Mother-calf pairs frequent shallow protected bays where cages could pose a risk of entanglement.

6. Social and economic conflicts

Fish farms need to exclude other users from the coastal zone for security reasons, and so reduce options for fishermen and recreational users of the coastal zone and may damage tourism. Whereas land-based farms are developed on private property, sea-based farms may use communal space for private gain. In South Africa, potential offshore sites for marine aquaculture are reduced to a few protected sites, which are generally in high demand for other, established purposes.

GUIDELINES FOR MARINE AQUACULTURE VENTURES, EXPERIMENTS AND PILOT PROJECTS

A number of guidelines are presented below which broadly aim to steer the industry away from the environmental problems identified above and at the same time introduce a regulated environment in which aquaculture can develop in South Africa. These guidelines are informed by science and usually have their foundation in law or policy. These guidelines reflect a policy that will be adopted by DEA&T, and it is articulated here in a manner that can serve to inform the industry. Clearly not every eventuality can be considered. Many *ad hoc* application will have to be considered. These guidelines will be used by DEA&T in assessing aquaculture permit applications, but do not exempt the farmers or applicants from laws or obligations that may apply.

Guideline 1 – Selection of appropriate species

Whereas many species may have commercial potential, it is necessary to restrict the farming of certain species to land based, or perhaps offshore sites. In some cases, a species might not be permitted for aquaculture in South Africa. These are principally alien (ivasive) species, which may be barred from the country altogether.

The Biodiversity Act provides mechanism for regulating the movement, possession and culture of species. Alien species regulation is aimed at preventing invasions of alien species, which may cause expensive and irreversible damage. As a rule, alien (invasive) species will not be permitted in sea-based cages. The risk of escape is great, and the release of alien species should be avoided at all costs. The Biodiversity Act lists a number of restricted activities (including culture and propagation) that apply to alien species, which includes any animal or plant outside its natural range.

Farmers are encouraged to consider endemic species, and specifically those genetic strains that are native to the area of the farm, to minimize risks associated with escapement. With land-based operations almost any endemic species can be chosen, but some restriction in sea-based cages is required. The two great concerns are the escapement of farm-bred fish and the cultivation of fish parasites, both of which could jeopardize wild stocks, particularly those that have been heavily impacted by other causes. For this reason, protected and threatened species, as listed in terms of regulation 56 of the Biodiversity Act will only be considered in sea-based cages after a risk assessment is undertaken and is favourable. Suitable technology will have to be investigated to ensure that the animals do not mate with the wild stocks in case of escapement.

A further consideration is the domestication of the species. Those species for which there is no reliable method of rearing young from captive broodstock are obviously not suitable for fish farming. Some of the most devastating impacts of fish farming have arisen where farmers source their stock from natural recruitment.

Guideline 2 Site selection

Location is the most important element in selecting a site for aquaculture. Fish farms should be located in accordance with national plans and other legal frameworks at sites suitable for maintaining fish in optimal health and achievement of economic sustainability whilst minimizing damage to the natural environment and marine living resources and recognizing the rights of other coastal or offshore resource users.

There are many examples internationally where unplanned and inappropriate placement of marine farms has led to production failures, environmental degradation, resource user conflict and social inequity. Such impacts has far-reaching implications and can contribute towards a negative perception of the aquaculture sector as a whole. Adverse impacts of aquaculture activities on coastal habitats, spread of disease, impact of farm effluent can be minimized and farm production enhanced by well-conceived site selection. Aquaculture operations are highly diverse with very different requirements when it comes to site-specific characteristics. Good water quality is a key factor.

When deciding on locations for aquaculture operations farm or project level assessments more often than not reveal little of major concern. However, many small-scale projects may have serious environmental consequences, particularly if concentrated in an area. Cumulative and additive effects of aquaculture need to be taken into account. Addressing these concerns will require some form of integration of planning and management for other sectors that place demands on the marine resource. The total accumulating effects should be addressed through sectoral environmental assessments on a regional or sub-regional basis. These initiatives should be form part of a more comprehensive assessment that accommodates other relevant sectors and activities. Such a process is fundamental to establishing particular nodes for various marine aquaculture activities. The approach of zoning or pre-allocating areas for aquaculture is probably the most effective means of avoiding conflict with other resource uses.

The following guidelines are proposed to assist regulatory authorities and aqua-farmers in deciding upon the suitability of a particular area for a given fish farming activity or for use in situations where there is not a coastal zone management plan in place or equivalent zoning process to pre-allocate areas to aquaculture.

Recommendations

- Sites should possess the appropriate biophysical attributes for the species under consideration and the planned mode of farming. Good water quality is essential for maintaining health and production on farms. Several key variables such as temperature, dissolved oxygen and salinity need to be considered. In this regard both the mean and temporal and spatial variation about the mean are relevant. Farms should be sited an adequate distance from natural and anthropogenic sources of pollution that may affect production and marketability (public health). In addition, the site should have suitable physical attributes of depth, currents, wave fetch, mixing and bottom characteristics of bathymetry and substratum. While well-flushed areas are desired some degree of protection from current and wave exposure is necessary to avoid damage and loss of stock. Bottom substratum is important in deciding on mooring type and placement. Areas with marked depressions in the sea floor should be avoided as these may act as traps for organic wastes emanating from the farms. Good husbandry requires rotation of stock amongst sites. Adequate space for each site to lie fallow for a period must be accommodated.

- hydrology(temperature, salinity, dissolved oxygen, stability in important biochemical variables, depth, space for fallowing, substratum for mooring, good water quality, inclination and pump head).
- Available infrastructure and services should be adequate to provide the support necessary for a viable operation. These include sea and land transport, equipment manufacture and maintenance, feed supply, underwater inspection, processing establishments, labour force etc. A sufficient concentration of farms may be required to sustain a locally based support service, particularly in remote areas. Such farms should operate under some form of management agreement to allow efficient use of infrastructure and resources. Expansion of farming effort to achieve economies of scale will require appropriate siting to encourage corresponding growth in support industries.
- Farms should not be incompatible with the conservation, recreation and amenity value of the area. Farms may not be sited in marine protected areas and should avoid interaction with migratory birds and bird sanctuaries. Fish farms should not be allowed in or near sensitive areas such as wetlands and mangroves. Placing farms in recreational areas may result in a loss or reduction in the recreational value. Often issues such as the perception of remoteness and expected social experience are implicated in this regard. More direct concerns such as navigation for recreational boaters, general recreation areas (e.g. beaches, bays, dive sites etc.), and effects on wild stocks exploited by sports-fishermen need to be taken into account. Public consultation forms a crucial component of avoiding such resource use conflicts.
- Farms should be sited so as to avoid conflict with local commercial uses of the area such as fishing (including shellfish harvesting), whale watching tours, diving, existing or planned aquaculture ventures etc. Farm lease boundaries should provide navigational corridors for access by other users. Individual farms should be positioned sufficiently apart to minimize the risk of disease spread and advection of potentially toxic chemicals and wastes from one to the other. Filter feeding shellfish that could accumulate antibiotics and other pollutants originating from fish farms, may pose a public health risk if consumed.
- Due consideration should be given to the incidence and severity of blooms of harmful algae when deciding on where best to site farms. Blooms of naturally occurring fish-killing phytoplankton can result in catastrophic mortalities on fish farms. Captive fish are

particularly susceptible as they cannot avoid blooms. The primary mode of action of fish killing species appears to be disruption of gill function through mechanical damage, action of toxins or depletion of environmental oxygen levels. Such effects would be exacerbated by other factors leading to reduced oxygen levels at the site. Species known to cause fish-kills have been detected around the South African coastline.

- Locate farms at sites with a high intrinsic capability to assimilate and disperse organic wastes produced. Accumulation of solid organic wastes produced from farm operations will have benthic impacts ranging from the immediate vicinity to some distance from the source. Local impacts can affect the viability of the farm itself while further away other uses may be impacted. Dissolved wastes may in turn promote localized growth of nuisance species such as fouling organisms and harmful phytoplankton. A compromise must be reached between structural integrity and the need for rapid flushing. Average current speeds should facilitate removal of wastes and as a rule of thumb should exceed 10cm/sec at the surface. Sites should also not be subject to heavy natural organic deposition and hence oxygen demand. Typically such sites are characterized by bottom sediments with a small silt and clay composition.
- Farms should be sited to minimize interaction with top fish-predators such as sharks, seals and birds. Besides stock loss through predation and escapement from damaged nets, stress and harassment of farmed fish by predators can lead to lower product quality and value. Consideration should also be given to potential entanglement of marine mammals that could lead to injury or mortality.
- Locate farms at an appropriate distance from sensitive fish habitats such as spawning grounds, nursery areas, feeding areas and migration routes.
- Land-based farms should not be under significant threat of extensive damage by floods (locate above the 1:50 year flood level).
- Pump-ashore farms should strive for a low head height for pumping water. The best site has a low inclination away from the water source, which facilitates gravity drainage and the capability to cascade water from tank to tank.

Guideline 3 Stocking density

The total mass and density of fish at a given site will be regulated. Many of the environmental impacts of fish farming are scale-dependent. Keeping farms small could reduce pollution below detectable limits, and prevent frequent outbreaks of diseases and parasites. Opposing this is the positive economy of scale.

In determining the appropriate size of a farm, DEAT will be advised by biogeochemical mass-flow models of farm effluent at various scales. Important limits are the onset of anoxia, critical bacterial counts, and increases in primary production.

Suitable data to determine health limits to stocking might be rare, particularly for indigenous species, which will lead to precautionary limits. A rule of thumb to be followed is that the amount of farmed fish at any site is kept within the environmental carrying capacity/density of the area. Catch statistics and fishery models should indicate the size of naturally occurring populations in most situations. The rationale here is that the consequences escapement and diseases are reduced by a low ratio of farmed to wild fish.

Further refinements to stocking densities should be pursued by way of experiments with parasite loading. Limits to infection rates will be set, but these will vary between host and parasites species.

Guideline 4 Pollution control

As with agriculture, many aquaculture practices produce waste products, both dissolved and particulate, that can have devastating effects on the receiving environment. If not properly managed local degradation of environmental quality can affect the viability of the farming operation whereas far-field effects could impact on other seawater or land resource users. Particulate wastes from fish and uneaten feed that settle to the sea-bed cause organic enrichment resulting in changes in the community structure of the bottom fauna as well as physical and chemical changes to the sediment. Sediments may turn anoxic leading to production of toxic hydrogen sulfide and oxygen depletion of bottom waters. Soluble fish excretory products can lead to localized nutrient enrichment and possible eutrophication.

Recommendations

- Adhere to environmental management plans and monitoring requirements. Ensure that effluent or receiving water body conforms to national or other relevant water quality guidelines.
- Promote efficient use of formulated feeds by use of quality products of high conversion ratios and minimization of feed wastage. Control of feeds and feeding is of critical importance in maintaining a cost-effective and environmentally sound operation. Feeds constitute a major if not the major operational cost to a farmer. Wasted feed is a major contributor to nutrient and particulate organic matter input to the environment and can result in degradation of water quality and related complications. The use of trash fish and moist pellets (as opposed to dry feed) is undesirable as the uneaten or inedible particles have greater potential to pollute the local environment. There is increasing concern over the use of fish meal from a dwindling resource in fish diets – a process that is also wasteful in terms of protein conversion. Where possible feeds with a low fish meal content should be employed to lessen aquaculture's pressure on wild fisheries.
- In contained systems such as tanks and ponds wastes should be collected and treated in some manner to minimize impacts on the environment. Strive to reduce particle loads through incorporation of sedimentation ponds in water inlet and outlet designs.
- Integrated culture of different species should be explored wherever possible. Cultivation of different life-forms in effluent or surrounding water can significantly reduce nutrient or particulate loads. The practice has the added benefit of providing a secondary crop.
- Follow a rotational plan that allows fallowing of sites for a period of time. The duration for of fallowing will vary between sites according to stocking densities and biophysical attributes. Impacted sites should lie fallow for a sufficient period to allow sediments to return to their natural state.
- The visual effects of aquaculture are often viewed as negative particularly when the farm structures are dominant. Surveys in Canada have shown that the perception of fish farms were influenced by the visual prominence of the structure in the environment. Aquaculture and tourism can coexist provided farms are sited and designed to blend in with the local surroundings. Subdued colours and non-reflective materials should be used wherever possible and spacing of individual units should conform to the coastline.

- Dead fish and farm debris such as nets and ropes should be removed frequently from enclosures and disposed of in an appropriate manner on land.

Guideline 5 Fish Health

A proactive policy of prevention should be adopted in the management of fish health, which is typically dependent on the quality of the environment in which the fish live. The most important step in controlling infectious disease is to provide an environment that minimizes stress [which can be defined in fish as the alteration of one or more physiological variables to the point that survival may be impaired in the long-term]. Health management plans should therefore aim at reducing stress at all phases of the culture cycle by thorough preparation of the farms before stocking, and maintenance of optimal environmental conditions through management of stocking densities, aeration, feeding and water exchange. Attempting to limit the introduction of diseases through use of disease free stocks, routine monitoring and recording of fish health to detect any developing problems, and maintenance of biosecurity in quarantining and treating any farm components are other critical elements of a health management plan.

An active surveillance programme to identify the distribution and frequency of existing disease, pathogens and parasites in both farmed and wild fish stocks should be a priority. Information is lacking concerning fish diseases in the marine environment. There is thus a need for diseases to be identified, in order to define what diseases should be reportable to managing agencies. Until that information is available, all disease events on farms should be reported as a condition of the aquaculture permit. It is essential that a comprehensive fish health database be developed, linking all relevant disease, pathogen and parasite information from industry and management agencies, to assist in adequately managing the risks associated with this industry. For aquaculture operations to remain as free as possible of pests and disease it is important to ensure that stocks are healthy before and after introduction to a site. Concerns relating to fish health and the movement of live fish relate to the possibility of transferring or importing an “exotic” disease or disease-causing agent. To minimize the risk of potential disease from the import or transfer of fish, the International Council for the Exploration of the Seas (ICES) code of practice respecting fish introductions and transfers should be followed.

Fish health management therefore needs to be addressed through specific disease prevention and management protocols, minimum health record requirements, outbreak management protocols, drug use standards, and disease reporting requirements.

Recommendations:

- Stock health management plans focusing on disease prevention rather than treatment must be established and implemented to ensure that the conditions in which fish are held are optimized for the reduction of stress.
- Fish should be inspected frequently to ensure that significant behavioural and physical changes are discovered and acted upon immediately. If disease presence is suspected proper diagnosis must be sought.
- The introduction of diseases must be avoided by ensuring that fish brought into an aquaculture system are of good health and certified origin. Adequate management strategies should be implemented to avoid spreading fish diseases within and between farms and into the ecosystem where wild fish may be affected. The importation and transfer of live fish must be authorized by permit stating that the fish come from a source that has been inspected and found to be free of any disease, and records must be maintained to track all imports and stock movement. Imported fish should also be held under quarantine in an approved facility and if a disease of concern is detected during the quarantine period, all stocks should be destroyed and the facility disinfected.
- Veterinarian services are required for assessing the importance of disease, and designing prevention and control programmes. Diseases of importance to the viability of the industry, and the health and welfare of animals and the public need to be identified. For this reason farm health records and disease control practices and procedures need to be continually reviewed.
- Only approved therapeutic agents should be used and the use of all drugs, pesticides and hormones must be prescribed by a registered veterinarian. Prescribed dosages and where appropriate, withdrawal times, must be observed in order to avoid the accumulation of residues in the flesh. Records of administered drugs must be kept and should include: the name of the permit holder, the location of the farm, the species being cultured, the name of the prescribing veterinarian, the drugs used, the procedure for administering, the treatment schedule, and the

name of the person responsible for administering the treatment. A drug free period before harvesting should also be specified by the veterinarian.

- If measures taken by farmers prove inadequate in managing disease outbreaks, fish may be quarantined, seized and/or disposed of. Dead or dying fish require prompt removal from the growing area regardless of the reason for mortalities; in away that does not affect the welfare and health of the remaining stock or environment.

Guideline 6 Food Safety

Increasing focus is being placed on the safety of foods being sold on world markets. The need to ensure food safety and the quality of fish products, whilst reducing the risks to human health and ecosystems from chemical use is growing. Increasing calls for traceability of food products are also affecting the food production industry such that consumers can be assured that the product has been produced without the use of transgenic technologies, without addition of undesirable or harmful chemicals or additives, and that the environments and ecosystems affected by the production facilities have not been compromised in any way.

Most food safety issues are not specific to aquaculture or fish farming as all foods can transmit disease. Diseases found on fish farms are typically not known to have human health significance. People are rather affected by pathogens associated with the handling and preparation of fish. The hazards associated with finfish can therefore be grouped into pre-harvest contamination, and contamination following harvesting and processing. Pre-harvest contamination mainly involves biological hazards: bacteria, parasites, biotoxins from toxic algae and, to a lesser extent, chemical hazards. At least ten genera of bacterial pathogens have been implicated in seafood-borne diseases some of which are naturally present in the aquatic environment while others are introduced often with human or animal faeces. A few bacteria associated with faecal contamination of seafood pose a large-scale health threat particularly when culture systems are close to centers of human population. A large number of fish species can serve as sources of parasitic infections some of which affect humans. Biotoxins are one of the most important biological hazards, and ciguatera poisoning constitutes the main hazard. Potential hazards due to chemical contaminants in fish and fish products include heavy metals, fertilizers, pesticides, disinfectants, drug residues and antifouling agents. Other human pathogens typically contaminate fish during post-harvest handling and the allergy producing substance histamine will develop in fish where large amounts of free histidine and bacteria are present.

Responsible use of feed additives, including antibiotics and growth promotants, requires particular care in adjusting the quantities and rates of delivery to obtain the desired effects with minimum wastage, as well as paying close attention to withdrawal periods to ensure products free of contaminants. A primary concern with the use of drugs as additives to fish feed is the possibility that wild fish, shellfish and other marine resources that consume waste feed may accumulate drug residues.

Recommendations:

- Reducing the number of seafood related sickness outbreaks requires continued and coordinated efforts by several agencies, including those involved with water quality, disease surveillance, consumer education, and seafood harvesting, processing, and marketing. The selling of tainted, decomposed or unwholesome fish for human consumption is also prohibited.
- Safe, effective and minimal use of therapeutants must be ensured by administration only with veterinary prescription and supervision.
- Contamination of products with human pathogens, parasites, heavy metals, antibiotics and other substances must be avoided. Products destined for human consumption need therefore to be inspected for antibiotic residues, toxic materials and other additives and contaminants.
- Quality control systems need to be applied to produce safe high quality fish farm products and measures for sanitary harvest, handling and transport of fish need to be implemented.
- Strategies for food safety and quality include the application of HACCP [Hazard Analysis and Critical Control Point]. Where appropriate, the finfish sector should institute farm management programmes based on the principles of the HACCP system, which should be applied at all stages from production, collection and transport, to the consumption of food.

Guideline 7 Social Responsibility

Aquaculture has an important role to play in bridging the gap between the supply and demand of affordable food of high quality. Aquaculture operators must be aware of the social contribution required of their farming activities and assure their integration in local community development and planning. Fish farms should therefore be developed and operated in a socially responsible manner that benefits the farm, the local communities and the country, and contributes effectively to rural development and poverty alleviation in coastal areas.

Recommendations:

- Conflict within local communities owing to the development and operation of fish farms should be minimized by ensuring that the benefits derived from fish farming are shared equitably.
- Risks to those engaged in fish farming should be minimized through training and extension in responsible fish farming practices.
- The welfare of fish farm employees should be ensured by providing a safe and stable working environment.

Comments to be submitted to the Department by 31 January 2007

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