Environmental Code of Practice for Australian Prawn Farmers

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Introduction

The potential for environmental impacts to result from prawn farming has received increased attention internationally over recent years. The Australian prawn farming industry through their national body, the Australian Prawn Farmers Association, formulated this Code of Practice in recognition of the industry's need to become recognised as an environmentally sustainable industry.

Specifically the document aims to:

- Provide realistic objectives;
- Be flexible;
- Be relevant to Australian prawn farmers;
- Provide a mechanism for environmental self regulation;
- Be practical;
- Focus on outcomes;
- Provide options for management;
- Fall within the legal requirements of Queensland's Environmental Protection Act 1994.

It is the objective of the Australian Prawn Farmers Association to pursue Ministerial approval for this Code of Practice in Queensland and similar recognition in the Northern Territory and New South Wales. Resulting in clarity and consistency across the industry when observing obligations of the General Environmental Duty.

What is a Code of Practice

A Code of Practice provides a self imposed set of rules for the carrying out of a specific activity. It is the responsibility of the proponent of a Code of Practice to define the intended purpose and to specify the particular operational practices to be adopted.

A Code of Practice may become a legal document (particularly in Queensland), and may be called up to prescribe appropriate legal practices.

In Queensland, every person has a general environmental duty to take all reasonable and practicable measures to prevent or minimise environmental harm. Other States and Territories have similar in principle requirements to the general environmental duty.

Environmental harm is unlawful unless it is authorised under an environmental authority, Environmental Protection Policy, an Environmental Management Program, a license, an approval, an Environmental Protection Order or an emergency direction.

An approved Code of Practice has particular value as a defence to a charge of causing unlawful environmental harm.

Need for a Code of Practice

The only sound approach to the development of the Australian prawn farming industry is through maintaining the integrity of the environment so as to enable the industry to be sustainable. In general, Australian prawn farms are sparsely located, with few regions containing a proliferation of prawn farming activities. This low concentration of development places the Australian prawn farming industry in a position to implement an environmentally responsible approach to both future developments and existing operations.

It is believed that through this Code of Practice the Australian prawn farming industry will be able to make substantial

progress toward both the economic and environmental sustainability of the industry, while ensuring that prawn farmers meet their General Environmental Duty.

At present prawn farm wastes are managed through "end of pipe" regulation. This Code of Practice attempts to move members of the Australian prawn farming industry toward ecologically sustainable production by recommending management practices that minimise contaminant levels in discharge waters and subsequently improve profitability. The final result of improvements in management techniques is to replace "end of pipe" regulation with sustainable management practices.

What this Code of Practice means

Compliance with this *Environmental Code of Practice for Australian Prawn Farmers* will ensure that all Australian prawn farms minimise the potential environmental impacts of Australian prawn farming both now and in the future.

The Code of Practice has been prepared to address the potential environmental impacts associated with prawn farming in Australia and to provide suitable Best Practice Environmental Management for members of the Australian prawn farming industry.

It is outside of the scope of this Code of Practice, to address in detail all the techniques used by the Australian prawn farming industry in producing prawns. This document has focused on issues of environmental significance and has listed on-farm management techniques which may apply to minimising environmental impacts.

The Environmental Protection Act 1994 allows the Minister for the Environment to approve this Code of Practice, which states ways for prawn farmers to achieve compliance with the General Environmental Duty and so be within the law as a way of managing activities that cause or are likely to cause environmental harm. An approved Code of Practice is not a regulation under the Environmental Protection Act 1994 however it does have legal standing.

By following this *Environmental Code of Practice for Australian Prawn Farmers*, prawn farmers will be able to show "due diligence" and meet the legal requirements of the General Environmental Duty.

No penalties can be directly imposed on a prawn farmer for failing to follow advice in a Code of Practice approved by the Minister. Likewise, for those failing to follow the Code of Practice no protection can be afforded either.

This *Environmental Code of Practice for Australian Prawn Farmers* does not remove the legal requirements that prawn farmers have under their Environmental Authority and associated conditions. After approval by the Minister, future Environmental Authorities may include compliance with the Code of Practice as a condition.

How to Comply with this Code of Practice

In order to comply with this Code of Practice, a prawn farmer must comply with the requirements appearing as boxed text in this Code of Practice.

It should, however, be noted that nothing in this Code exempts or varies the requirement of a prawn farmer to comply

with any valid condition imposed on an environmental authority issued under the Environmental Protection Act 1994 with respect to their farm or facility.

Ecologically Sustainable Development

The concept of Ecologically Sustainable Development has evolved from the World Commission on Environment and Development's report, *Our Common Future* (1987). It can be generally defined as conserving and enhancing the community's resources such that, our total quality of life, both now and in the future, is secured.

The *Environmental Code of Practice for Australian Prawn Farmers* supports the principles of Ecologically Sustainable Development and the Precautionary Principle.

Consistent with the three operational interpretations of the Precautionary Principle (Young 1993), it is suggested that as confidence with an activity increases, a transition must be made to require only the use of best available technology when this does not entail excessive cost.

The management practices set out in this Code of Practice provide a responsible approach to environmental management while ensuring that prawn farms will continue to be economically viable.

Specifically the *Environmental Code of Practice for Australian Prawn Farmers* endorses the following objective:

To protect Australia's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

Industry Commitment and Environmental Policy

Management of the Australian prawn farming industry recognises that protection of the environment is a requirement of all businesses to ensure long term benefit to all stakeholders. The Australian prawn farming industry is committed to the development and operation of an environmentally sustainable prawn farming industry.

This Code of Practice supports a commitment to environmental management, which recognises that only the financial success of the operation can ensure the provision of adequate resources to manage environmental issues. It recognises that to maintain such a commitment will require Australian prawn farmers to carry the burden of some cost.

Participants in the Australian prawn farming industry are encouraged to:

- support industry research into environmental issues;
- achieve and where practicable, go beyond compliance with all legislation and license conditions;
- ensure that products are produced, packaged, delivered, disposed of and recycled in an environmentally responsible manner;
- minimise use of raw materials and energy;
- design their production systems to minimise adverse environmental impacts;

- take into consideration environmental impacts of new projects at the planning stage;
- provide management and employees with appropriate levels of environmental training and education;
- require employees to accept environmental responsibilities as a part of their job description;
- conduct environmental reviews at appropriate intervals.

Compliance with this Code of Practice is not only likely to reduce the potential environmental impacts of prawn farming, it is likely to improve the profitability of existing and new farms through reduced operating costs.

Industry Description

Prawn farming in Australia involves the saltwater culture of Penaeid prawns in artificial environments. In general this involves the intensive culture of prawns in earthen ponds. Farmers manage the pond environment for maximum survival and growth rates, through a balance of aeration, feed and water quality management. As a result of water quality management there is a need for farmers to discharge prawn pond effluent into the surrounding environment.

Australian farmed prawn production has increased from 233 tonnes in 1988/89 to 1450 tonnes in 1994/95, with a farm gate value of approximately $30 million. This increase is based on an increase in farm numbers and increased productivity from existing farms.

Currently the majority of this product is *Penaeus monodon* and is targeted at the domestic market. Approximately 160 tonnes of *Penaeus japonicus* was exported to Japanese markets in 1995 (Kitada, 1996).

Australian producers are beginning to target their product at the world farmed prawn market as the traditional producers (such as South-East Asia) decrease production due to poor resource management strategies and the associated environmental degradation.

Australia has the ideal opportunity through this Code of Practice, coupled with quality operational and resource management strategies, to maintain the high quality of the existing environment.

Expected Environmental Outcomes

Australian prawn farmers must undertake reasonable and practicable management practices set out in this code necessary to meet the expected environmental outcomes.

In determining if a practice is reasonable and practicable, consideration must be given to the following;

- the current state of technology in the industry;
- the financial considerations of the action;
- the likelihood of successful outcomes from the action;
- the nature of the harm or potential harm; and,
- the sensitivity of the receiving environment.

Outcomes

New and existing prawn farmers must achieve the following in order to comply

with their legal responsibilities to protect the environment. Compliance may be demonstrated if all these Expected Environmental Outcomes can be shown to have been met.

1. Adopt measures to minimise the clearing of native vegetation and associated fauna habitats, external to pond development areas, as relevant to the sensitivity of the environment.
2. Measures must be adopted to ensure that a prawn farm operation does not lead to irreversible or long term impacts to the biological integrity of mangrove and other aquatic ecosystems.
3. Measures must be adopted to ensure that the discharge of prawn farm effluent does not result in an irreversible or long term increase in:
   - nutrients;
   - phytoplankton levels;
   - suspended solids;

   outside of the initial mixing zone. Likewise, measures must be adopted to ensure that, where the water quality objectives for the receiving waters are exceeded within the initial mixing zone, the size of the initial mixing zone is minimised so that environmental values, especially biological integrity and suitability for recreational use are not adversely affected. Ultimately the industry aims to achieve nil tangible impact to water quality in accordance with ANZECC guidelines.[1]
4. Measures must be adopted to ensure that a prawn farm operation does not lead to significant deterioration in groundwater quality, through unacceptable increases in groundwater salinity.
5. Measures must be adopted to minimise impacts on noise levels at noise sensitive locations at sensitive times.
6. Measures must be adopted to minimise the impacts of odours at sensitive places.
7. Measures must be adopted to minimise impacts on the environment from storage and use of pond sediments.

The Expected Environmental Outcomes will be achieved if producers adopt the appropriate management practices outlined in this Code of Practice.

Performance Indicators

Performance indicators are necessary to measure the level of change in a variable and relate the measurement to a level of change that may be considered a significant environmental impact.

It is not possible to recommend a uniform set of performance indicators for the entire industry due to the variation in natural habitats between farm locations. ANZECC (1992) advises that individual acceptable water quality parameters for receiving waters must be determined on a site specific basis. The measurable parameters for all environmental values must be determined in a holistic manner and must take into account the varying natural community structures within different receiving environments.

The final site specific performance indicators must be determined by Administering Authorities in consultation with prawn farm operators after considering:

[1] Refer to Schedule 1 for detailed water quality objectives.

- Natural background levels;
- Environmental values of the receiving environment;
- Assimilative capacity of the receiving environment.

In Queensland these requirements are determined by the Environmental Protection (Water) Policy.

Potential Environmental Impacts

Recent observations by Boyd (1996) have indicated that Australian prawn farmers are amongst the most environmentally sustainable in the world. Accurate levels of environmental impacts related to prawn farming in Australia have not yet been adequately defined, although anecdotal reports and preliminary research (Trott 1996), suggest that adverse impacts to water quality and indirect impacts to aquatic flora and fauna, by well planned and managed prawn farms, are yet to be demonstrated.

Water Quality

The discharge of prawn farm effluent has the potential to create significant changes to the quality of the receiving waters. The major concerns in regard to the discharge of prawn farm effluent relate to the discharge of:

- dissolved metabolic wastes from prawn activity and the biological breakdown of waste feed particles and prawn faecal matter;
- particulate nitrogen and phosphorous, originating primarily from organic matter as prawn faecal matter, algal cells, waste feed particles and soil particles. At some times, significant levels originate from farm intake water sources;
- suspended solids from particulate organic matter and erosion of pond floor, walls and discharge channels. At some times, significant levels originate from farm intake water sources;
- excess phytoplankton.

The possible impacts of prawn farm effluent on water quality include:

- creation of eutrophic zones within the receiving waters;
- increased fluctuation of diurnal dissolved oxygen levels;
- creation of visible plumes;
- accumulation of nutrients within the receiving waters.

Aquatic Flora & Fauna

The direct impacts to aquatic flora and fauna generally relate to the clearing of mangroves and disturbance of wetland areas during the construction phase of development.

Further potential impacts are related to changes to the tidal prism and creek flow rates caused by the pumping or discharge of water and the subsequent alienation of wetland areas or changes to stream morphology.

The indirect impacts to aquatic flora and fauna by prawn farms, relate to the potential changes to water quality within the receiving environment. Potential impacts include; changes to benthic faunal communities, changes in the level of epiphytic growth and speciation within mangrove communities, shading and smothering of seagrasses from phytoplankton and suspended solids and increased populations of macroalgae.

Aquatic flora and fauna are potentially affected by the disturbance of acid sulphate soils during construction of prawn farms and the subsequent entrance to the ecosystem of acid leachate, possibly resulting in low pH levels within waterways which may be detrimental to the structure of marine communities.

Terrestrial Flora & Fauna

Terrestrial fauna and flora may be directly affected by clearing of vegetation and native habitats associated with the construction and subsequent operation of prawn farms.

The clearing of native terrestrial flora has the potential to significantly impact on the biodiversity of a region, specifically in relation to the removal of habitats occupied by threatened or endangered species. The removal of coastal wetlands has the potential to impact on migratory birds which may be specifically protected under international conventions.

Prawn farming requires the storage of artificial feeds which has the potential to attract pest species.

The construction of open expanses of water and the culture of prawns has the potential to provide a food source for predatory bird species.

Tidal Hydrology

The intake and discharge of seawater for a prawn farm has the potential to impact on estuaries and creeks through an increase in the tidal flow and subsequently the tidal prisms of the estuaries and creeks. Significant changes have the ability to impact on stream bank stability, which in turn may indirectly impact on the aquatic flora and fauna of the affected estuaries.

Groundwater

Prawn farm developments have the potential to provide a conduit for salt water to enter groundwater supplies, leading to salinisation of groundwater supplies and the possible degradation of groundwater suitable for irrigation and other established uses.

Odour

Where prawn farms are constructed near other rural users or have had residential development encroach on previously rural areas, there is the potential for odours to create a nuisance. Impacts are likely to result principally from the disturbance of pond sediment immediately after pond draining. The level of impacts will vary depending on background odours, wind directions, distances to sensitive places and buffers.

Noise

Where prawn farms are constructed near other rural users or have had residential development encroach on previously rural areas, there is the potential for operational noise to create a nuisance. Impacts are likely to result principally from aeration devices, pump operation and feeding operations. The level of impacts will vary depending on background noise levels, the type of noise, distances to sensitive places and buffers.

Appropriate Management Practices

These Appropriate Management Practices have been determined using Best Practice Environmental Management.

The Best Practice Environmental Management of an activity is the management of the activity to achieve an ongoing minimisation of the activity's environmental harm through cost-effective measures assessed against the measures currently used nationally and internationally for the activity (EPA 1994).

In deciding the Best Practice Environmental Management of an activity, regard must be had to the following measures:

- Strategic planning by the person carrying out, or proposing to carry out, the activity;
- Administrative systems put into effect by the person;
- Public consultation carried out by the person;
- Product and process design;
- Waste prevention, treatment and disposal.

Site Selection

Site selection and evaluation must ensure that the proposed site will be capable of operating in an economically viable and environmentally responsible manner and in accordance with this Code of Practice.

In evaluating potential prawn farm sites, developers must identify the features of the site and its environment listed in this section. Evaluations must take into account the objectives and the likely environmental risks of the proposed project.

The following list although not exhaustive, identifies the major issues that must be considered, utilising appropriate expertise, when evaluating a potential prawn farm site[2].

- Capacity of the receiving environment to dilute and assimilate the discharge waters;
- Environmental value of the site and the region;
- The potential impacts of the development on environmental values and biodiversity;
- Access to marine or estuarine waters;
- Water quality and tidal hydrology;
- Existing flora and fauna, both on and surrounding the site;
- Soil types, including clay content, erosion potential, and acid sulphate soil;
- Topography and flood levels;
- Freshwater influences;
- Neighbouring land uses;
- Existing water users;
- The proximity of Marine Parks, Fish Habitat Areas, Erosion Prone Areas, Coastal Control Districts, National Parks, Ramsar sites, Recreational Area Management Areas and World Heritage Property;
- Regulatory requirements of the development, site and region;
- Historical land uses.

[2] See also Chapter 1 Chanratchakool et al (1998)

Farm Design and Planning

The planning stage of any prawn farm development (new or expanding), is crucial not only for financial success, but also as an opportunity to design the development in a way which will not cause undue influences on the environment[3].

New prawn farms and any expansion of existing farms, must be designed and planned in accordance with the checklist below to minimise the risk of harm to the environment.

The planning and design of proposed prawn farms must incorporate the following, utilising appropriate expertise;

- Identification of features of the farm and its environment which are important aspects of ecological value;
- Vegetated buffer zones and where necessary habitat corridors;
- Intake points must be located to create access to high quality water, while recognising the need to minimise disturbance and potential impacts to marine vegetation;
- Pond wall batters must be constructed from suitable material and designed with optimal batter angles to prevent slump and erosion;
- Consideration of prevailing wind direction in order to reduce wave setup and associated bank erosion;
- Identify acid sulphate soils and provide appropriate management actions;
- Ponds must be completely drainable;
- Pond drainage may be through a monk gate, stand pipe or centre drain system;
- In the event of a prawn farm utilising a centre drain system, pond discharge water must be retained for an appropriate time to reduce the suspended solid loading, prior to release into the receiving waters.
- Farm design must incorporate a settlement pond of appropriate size or other design features that will assist in reducing the level of suspended solids in discharge waters;
- Discharge points must be located to create access to tidal waterways that will maximise the advection and dispersion of discharge waters and minimise impacts to tidal hydraulics, while recognising the need to minimise disturbance and potential impacts to marine vegetation;
- Farm size must be limited according to the advection, dispersion and assimilative capacities of the receiving environment, to ensure that unacceptable pressure is not placed on these systems;
- Farm design must minimise disturbance to mangrove communities, saltpans or other tidally influenced zones;
- Areas of significant vegetation must be preserved, wherever and whenever possible, provided that the economic and productive efficiencies of the operation are not compromised.

The final design must ensure that the proposed farm will operate in an environmentally sustainable manner and in accordance with other sections of this Code of Practice.

[3] See also Chapter 2 Chanratchakool et al (1998)

Construction

Correct construction of the farm is likely to lead to increased profitability through savings in maintenance and unexpected construction failures.

Prawn farms must be constructed in such a way as to minimise the risk of harm to surrounding areas. The construction plans must demonstrate the following issues have been considered: earthworks and erosion control; acid sulphate soils; groundwater; and vegetation clearing.

Where reasonable and practicable, the following practices must be complied with when constructing a new prawn farm.

Earthworks and Erosion Control[4]

- Earthworks must be minimised during any recognised wet season;
- The area disturbed must be limited to the immediate construction area;
- Appropriate methods (such as perimeter bunds), must be used to prevent overland flow from entering the construction site;
- Appropriate methods must be used to reduce erosion of topsoil from within the development site;
- Appropriate methods must be used to reduce siltation of waterways (eg by using straw bales, silt fences or sediment traps);
- Stripped top soil must be stored within a bunded area;
- Downstream conditions must be checked for possible erosion and/or flooding due to concentrated flows;
- Top soil must be placed over pond walls and suitable vegetation must be encouraged to grow on the pond walls and batters, or other erosion protection methods must be used.

Acid Sulphate Soils

- The excavation and disturbance of known acid sulphate soils must be minimised;
- If disturbed, acid sulphate soils must be managed, in accordance with recognised guidelines[5];
- Areas where acid sulphate soils have been disturbed and exposed must be rehabilitated.

Groundwater

- Ponds must be constructed from material capable of retaining water;
- Pond walls and floors must be constructed to minimise hydraulic conductivity.

Vegetation Clearing

- Boundaries of the construction area must be clearly marked prior to the commencement of vegetation clearance;
- Roads for construction access must be constructed to minimise vegetation clearance;
- Marine plants are only to be removed under appropriate approvals from the Administering Authority;
- Clearing and disposal of cleared vegetation shall be in accordance with the Administering Authority requirements.

Pond Management

Feed Management

Feeding methods and products vary considerably according to the species cultured, prawn weight, operating

[4] See also EGQCS, 1996.

[5] See references for acceptable guidelines.

environment and operator preference. Food types and feeding methods are significant contributors to production efficiency, profitability and nutrients within discharge water. An improved level of feed management has the potential to significantly contribute to waste minimisation and farm profitability. [6]

Feed management: Feeding strategies must be planned and managed to optimise Food Conversion Rates, productivity and minimise the associated nutrient levels in discharge water.

In accordance with this Code of Practice and the objective of minimising the level of waste products in discharge waters, prawn farmers must:

- Only use artificial feed derived from a certified source;
- Monitor the amount of feed eaten by prawns on a regular basis;
- Calculate feed requirements according to the results of daily feed monitoring;
- Conduct biomass calculations at appropriate intervals;
- Use a feed with the least amount of dust/fines possible;
- Maintain the quality of feeds by storing in cool dry areas;
- Store feed in a manner that will not attract pest species;
- Ensure feeds are not stored for extended periods;
- Use a quality feed with a suitable water stability;
- Use a feed with a level of phosphorous below 2%;
- Use a feed which provides an optimal protein/energy balance;
- Use a feed which has a high percentage of digestible ingredients.

Stocking Densities

Stocking densities of prawn farms will vary between and within farms. The stocking density of ponds will contribute significantly to production efficiency, profitability and nutrients within discharge water.[7]

Stocking Densities: Stocking densities must be planned and managed to optimise production, minimise the pressure placed on water quality within the ponds and minimise associated wastes.

Prawn farmers must consider the following when calculating stocking densities:

- Aeration capacity;
- Water exchange capacity;
- Feed quality;
- Impacts of increased metabolic wastes;
- Disease implications.

Aeration

Appropriate use of aeration has the potential to increase productivity and reduce waste products within the discharge waters.[8]

Aeration: Prawn farmers must plan to optimise their aeration rates in accordance with pond biomass levels and phytoplankton levels.

[6] See also chapter 6 Chanratchakool et al (1998)

[7] See also chapter 5 Chanratchakool et al (1998)

[8] See also chapter 7 Chanratchakool et al (1998)

Aeration devices must:

- Maintain pond floors in an aerobic state;
- Not promote pond wall and floor erosion;
- Promote pond water circulation and reduce stratification.

Water Exchange

The level of water exchange on prawn farms varies depending on climate, phytoplankton levels, pond biomass, management techniques and species cultured. The appropriate use of water exchanges has the potential to increase productivity and reduce waste products within the discharge waters[9].

Water exchange: Prawn farmers must plan to optimise their water exchange rates in accordance with other appropriate complimentary management techniques.

Water exchange strategies must be determined in accordance with:

- Species being farmed;
- Incoming water quality;
- Stocking densities;
- Feed management strategies;
- Ability to recirculate water;
- Pond aeration techniques.

Escape Prevention

There are various methods employed within the Australian prawn farming industry to ensure that cultured animals are not released into the environment.

Escape prevention: Prawn farmers must take all reasonable and practicable measures to ensure that no animals (endemic or non-endemic) are released into the environment from a prawn farm.

Stock containment practices could include any or all of the following:

- Screening of pond discharge structures in accordance with prawn size;
- Exchanging pond water at times when animals are known to be inactive;
- Screening farm discharge structures with an appropriate sized mesh.

Harvesting

The various harvesting methods employed throughout the Australian prawn farming industry have the potential to impact on the environment indirectly in varying degrees.

Harvesting: Prawn farmers must utilise a harvesting method which minimises the suspended solid and nutrient loading of discharge waters.

Harvesting practices may include:

- Net and trap harvesting;
- Trawl harvesting;
- Drain harvesting.

In the event of a prawn farm utilising trawl or drain harvesting methods, pond discharge water must be managed in a manner to reduce the suspended solid loading, prior to release into the receiving waters.

[9] See also chapter 7 Chanratchakool et al (1998)

Operational Erosion Control

In accordance with this Code of Practice prawn farmers must manage operational erosion in such a way as to minimise the risk of harm to surrounding areas. Increased operational erosion control is likely to result in marked decreases in the levels of suspended solids and particulate phosphorus within discharge waters. Additionally, suitable advanced erosion control practices are likely to lead to increases in profitability through a reduction in the maintenance costs associated with pond wall erosion[10].

Prawn farmers must plan and implement appropriate operational erosion control methods which minimise suspended solid loading in discharge waters.

Where necessary the following practices must be complied with:

Pond Wall and Floor Erosion Control

- Aerators must be located so as not to promote pond bank erosion;
- Pond walls must be of a suitable batter angle to reduce scouring and erosion;
- Vegetation must be encouraged to grow on pond batters, above the water line;
- Where necessary, protect pond walls from erosion below the water line;
- Walls exposed to prevailing winds and the corresponding waves must be adequately protected from erosion;
- Final pond draining must take place in a manner that minimises the erosion of pond floors and the subsequent removal of sediment with pond discharge water;
- Farmers must monitor the volume of sediment in each pond at the end of each crop, (this will provide a performance indicator for management changes).

Discharge Channel Erosion Control

- Pond discharge structures must be designed in such a manner as to minimise the level of erosion resulting from the discharge of pond waters, with special emphasis on protecting drain walls from direct water impact and associated erosion;
- Channel walls must be constructed from a suitable material and be of a suitable batter angle to reduce scouring and erosion;
- Vegetation must be encouraged to grow on channel batters, above the water line;
- Where necessary, protect channel walls from erosion below the water line;
- Discharge channels must be constructed in such a way as to minimise discharge water velocity.

Farm Discharge Point Erosion Control

- Farm discharge structures must be designed in such a manner as to minimise the level of erosion resulting from the discharge of waters;
- Discharge to waterways must be minimised or avoided at times when unacceptable erosion of creek or stream banks is likely to occur;
- Farm discharge points must be suitably protected against scouring.

[10] See also chapter 3 Chanratchakool et al (1998)

Pond Effluent Management

Prior to the release of pond discharge waters, waste minimisation must be practiced. Farmers must apply suitable management to pond effluent prior to its release. The effect of appropriate management will be to reduce the level of suspended solids, particulate nitrogen and particulate phosphorus within discharge waters. In addition, some advanced techniques are likely to lead to decreases in the levels of dissolved nitrogen, dissolved phosphorous and chlorophyll 'a' within the discharge waters[11].

Prawn farmers must plan and implement pond effluent management procedures which minimise the suspended solid and nutrient levels of discharge waters.

The following are appropriate ways of minimising suspended solids and nutrient levels in discharge waters:

- Installation and use of an appropriately designed settlement pond;
- Reduction of discharge water velocity in discharge drains;
- Protection of pond discharge points from erosion;
- Installation of pond/farm recirculation systems;
- Retain pond discharge water for a suitable period after final pond draining;
- Use biological filtration/treatment mechanisms, such as bacteria, artificial wetlands, macroalgae and bivalves;
- Use of other recognised water treatment systems.

[11] See also chapter 3 Chanratchakool et al (1998)

Sediment Management

The biological activity, aeration and feeding practices involved in prawn farming results in the accumulation of sediments within the production ponds. In some cases these sediments are removed at the end of each production cycle. The storage of these sediments has the potential to impact on the environment through erosion of sediment and the associated leaching of nutrients and salts into waterways and groundwater supplies.

The minimisation of these wastes will substantially promote environmental sustainability. Additionally, suitable sediment management practices are likely to lead to increases in profitability through a reduction in the maintenance costs associated with the removal and storage of these sediments. Prawn farmers must manage the production of sediment and must also manage the sediment once it has been removed from ponds and channels. Sediment production must be minimised using appropriate operational erosion control, feed management and stocking density techniques.

On removal of sediment from ponds, prawn farmers must store or dispose of the sediment in accordance with the practices set out in this Code so that any potential environmental impacts from erosion or leachate.

On removal from ponds, sediment must be stored in a designated disposal area or spread as top soil in appropriate crop or pasture areas. These areas must have the following properties:

- If sediment is stockpiled for extended periods, the floor of the designated storage area must be compacted sufficiently to minimise nutrients leaching into groundwater;
- Methods (such as perimeter bunds), must be used to prevent overland flow from entering the designated storage area (or crop/pasture area) and resulting in unacceptable levels of sediment/top soil erosion;
- Methods must be used to reduce erosion of the sediment from within the storage area (or crop/pasture area) and subsequent siltation of waterways (such as using cropping, hay bales or sediment traps).

Noise

Prawn farm noise sources are principally aeration, feeding and pumping. The majority of prawn farms are constructed in areas where there are no noise sensitive locations. In some instances, where prawn farms are constructed near other rural users or have had residential development encroach on previously rural areas, noise emissions need to be managed.

Prawn farmers must minimise the impact of noise on sensitive places at sensitive times.

In managing noise emissions from a prawn farm, where that noise creates or is likely to create a nuisance at a sensitive place at sensitive times, prawn farm operators must incorporate appropriate noise reduction techniques. Such techniques may include:

- Incorporating at the planning stage, maximum distances between noise sources and sensitive places;
- Construction of vegetated buffer zones;
- Construction or use of appropriate noise barriers or noise attenuators;
- Alteration to the number or type of aeration mechanisms used;
- Consultation with local governments and developers to ensure adequate buffer zones are provided.[12]

Odours

Prawn farm odours are principally related to the draining of ponds and disturbance of damp or wet pond sediment. The majority of prawn farms are constructed in areas where there are no odour sensitive locations. In some instances, where prawn farms are constructed near other rural users or have had residential development encroach on previously rural areas, odours may need to be managed.

Prawn farmers must take all reasonable and practicable measures, to minimise the impact of odours on sensitive places .

In managing prawn farm odour sources, prawn farmers, where reasonable and practicable, must:

- Minimise the amount of sediment to be disturbed;
- Allow pond sediment to dry sufficiently prior to disturbance;
- Not disturb sediments that are likely to be odorous when wind direction and strength will carry the odour to sensitive places;
- Consultation with local governments and developers to ensure adequate buffer zones are provided.[13]

[12] See Planning Guidelines - Separating Agricultural and Residential Land Uses.
[13] See Planning Guidelines - Separating Agricultural and Residential Land Uses.

Chemical Use

A variety of chemicals may be used in the Australian prawn farming industry to treat and/or control various diseases, fungi and parasites or to facilitate production. Use of chemicals necessarily involves user responsibility for any or all methods of safe handling.

Prawn farmers must ensure that chemicals are not discharged, in concentrations which are likely to cause unacceptable changes, into the receiving environment.

Chemicals and their containers must be stored, used and disposed of in accordance with manufacturers instruction, MSDS and local, State and federal requirements and legislation.

Prawn farmers must ensure that all chemicals stored and used within the prawn farm are stored, used and containers disposed of, in accordance with:

- The manufacturer's instructions as contained within labels and other supplementary documents;
- Their Material Safety Data Sheet;
- Local Authority requirements;
- Administering Authority requirements;
- Relevant Local, State or Federal legislation.

Farmers must seek advice from relevant government departments, before using any chemicals if the farmer is unsure of their suitability. The use of unlabelled or inappropriately labelled chemicals, lacking adequate advice on correct use, dosage, withholding periods and residue levels may result in:

- Reduced efficiency and safety of the treatment for target species;
- Chemical residues within prawns;
- Reduced safety to consumers of food from treated species;
- Reduced safety to operators;
- Market refusal to accept products;
- Production of chemical resistant strains of pathogens;
- Adverse environmental impacts to flora and fauna.

Environmental Contingency Plans

Due to the difference in management techniques and site variability in the Australian prawn farming industry, the development of an industry contingency plan is not possible.

Each prawn farm location must develop in consultation with Administering Authorities, a satisfactory, site specific environmental contingency plan.

Contingency plans are needed to provide management actions in the event of environmental breaches occurring.

As an example an environmental contingency plan may take into account the following:

- There may be contamination of pond water in excess of normal management expectations (eg. spillage of a contaminating substance or failure of erosion control mechanisms);
- The contingency plan must be initiated to ensure that there is no or limited effect on the quality of discharge waters;
- Remedial measures may be required to minimise the discharge of pond waters;

- Management techniques must be reviewed in the area specific to the contamination;
- Specific procedures must be implemented until the breach is resolved and normal operating procedures are restored;
- Monitoring of discharge effluent must be more frequent than normal should a contingency plan be initiated;
- On the implementation of a contingency plan, the Administering Authority must be notified as soon as practicable by the management of the operation, where the contamination is likely to be released into the receiving waters.

Predator Management

A range of predators have the potential to impact on prawn farming operations. The management of predators will vary considerably depending on the species, region and operator preference. The appropriate management of predators is likely to increase profitability and minimise the potential environmental impacts to predator species.

Predators management techniques must be planned and implemented to minimise impacts to native fauna species while protecting the economic viability of the prawn farm.

In order to appropriately manage predators, prawn farmers must utilise one or more of the following practices as appropriate:

Eels, Finfish and Crustaceans

- Screening of pond intake and discharge structures with appropriately sized mesh;
- Appropriate chemical treatment of pond water.

Avifauna

- Overhead netting of ponds;
- Installation of waterline nets;
- Installation of overhead wires;
- Use of repellent sound emissions;
- Use of repellent light emissions;
- Culling of target species, under an appropriate permit as issued by the Administering Authority;
- Increased personnel around ponds at peak feeding times for birds;
- Installation of predatory images or models.

Disease Management

Disease and health management requires a holistic management approach inclusive of, water quality management, hygiene, feed management, aeration, bird control and post larval health.[14]

Members of the Australian prawn farming industry must develop plans to ensure that, in the event of a disease outbreak, the threat of disease spread within a farm and spread from a farm is minimised. Disease management under this plan must be in accordance with any Prawn Health Management Guidelines adopted by the APFA.

Prawn farm managers must implement an appropriate disease management strategy in accordance with the Prawn Health Management Guidelines.[15] Compliance with these guidelines will benefit farmers through providing a set of standard procedures in

[14] See also chapter 10 Chanratchakool et al (1998)

[15] To be developed by the APFA in consultation with Administering Authorities.

the event of a disease outbreak and subsequently minimising losses from disease and by contributing to the long term sustainability of the industry.

Prawn Feed Packaging

Currently the feed used in prawn farming is transported in paper or plastic bags. A reduction in the level of feed packaging will reduce the costs associated with the storage and disposal of this packaging.

Reduction of this waste is a direct consequence of a reduction in the food conversion rate (FCR) of the production cycle. As prawn farmers reduce their FCR, they will proportionally reduce this type of packaging.

It is an unrealistic objective to strive for a disproportionate reduction in this packaging. Other forms of reduction such as larger bags and changes to packaging materials create other problems such as with workplace health and safety (heavy bags and related worker injuries), feed contamination and moisture absorption.

Negotiations must be undertaken at an industry level, with feed manufacturers to ensure that packaging is of a recyclable nature.

Prawn farmers must, where reasonable and practicable, progress toward reducing the amount of non-recyclable packaging materials used in prawn feed storage and transportation.

Prawn farm managers must, where reasonable and practicable:

- Reduce the FCR for production;
- Monitor and liaise with feed suppliers to ensure packaging is minimised and is of a recyclable nature;
- Recycle packaging material;
- Determine sources of excess packaging and implement remedial management actions as necessary.

General Domestic and Office Wastes

This waste stream is generally minor in its nature and is limited to office waste paper, domestic garbage and lunchroom wastes. The Australian prawn farming industry must reduce as practicable the amount of wastes generated from office and lunchroom activities.

Energy Use

The Australian prawn farming industry recognises that large amounts of energy are regularly required to ensure that production levels are maintained and to assist in maintaining environmental management practices.

As commercial operations, the use of excessive energy during the production cycle is not in line with the financial objectives of prawn farmers. Improved energy management will benefit farmers directly through reduced operating costs. This Code of Practice promotes responsible energy management and prawn farmers must:

- Promote daily awareness of energy use patterns;
- Monitor annual and quarterly energy expenditure;
- Isolate and remedy energy waste actions;
- Minimise unnecessary vehicle usage;

- Maintain electrical equipment for optimal performance.

Training

Training employees is a vital part of ensuring that an organisation maintains a suitable level of compliance with this Code of Practice. Staff must be aware of the requirements of the Code of Practice , in varying levels of detail, depending on their duties.

Training programs must contain common elements such as familiarisation with the company environmental policy, the Code of Practice, commitment to waste prevention and raw materials conservation. Employees must be encouraged to suggest new ideas which are in line with compliance with the Code of Practice.

Environmental Monitoring

An environmental monitoring program may be required by Administering Authorities as a condition of license, to quantify the extent and nature of any environmental changes attributable to a prawn farming operation. The environmental monitoring program must aim to differentiate such environmental changes from naturally occurring environmental fluctuations.

Where an environmental monitoring program is not provided for in licence conditions, prawn farmers must implement an appropriate environmental monitoring program to quantify changes in the receiving environment attributable to the prawn farming operation.

The design of appropriate monitoring programs must consider the following:

Environmental Authority

Frequently a licence or other authority will include specific monitoring requirements in its conditions. The conditions might address issues such as frequency, techniques and performance indicators, and must be included in the final monitoring program.

Cost Effectiveness

A monitoring program must aim to be cost effective. The level of change to be detected needs to be balanced against the costs associated with monitoring and the environmental values of the receiving environment.

Performance Indicators

It is not possible to recommend a uniform set of performance indicators for the entire industry due to the high variability in receiving environments. ANZECC (1992) advises that individual acceptable water quality parameters for receiving waters must be determined on a site specific basis.

Natural Variability

It is important to have a clear understanding of both acceptable levels of environmental change and levels of natural variability, to ensure that the monitoring program can determine environmental impacts as required by the Administering Authority. A monitoring program must be designed with a stated hypothesis and address this with collection of data regarding appropriate parameters at an adequate temporal and spatial frequency.

Monitoring Frequency

The frequency of data collection needs to take into account the magnitude and time

scale of potential impacts. Environmental impacts resulting from a prawn farming operation are most likely to be from discharge of large volumes of waters which contain concentrations of suspended solids, phytoplankton and nutrients. Potentially influenced communities are likely to respond slowly and changes will occur gradually.

In this regard, monitoring frequency can be less frequent than if potential impacts and associated responses were both quick and extreme.

Control Sites

The inclusion of control sites is required to detect any wide-spread natural influences that are unrelated to the aquaculture operation but nevertheless may result in significant changes to communities and/or variables being measured.

Baseline Data

It will be important for the monitoring program to incorporate a baseline data collection phase to provide a set of background data to assess natural variability and the spatial and temporal scale at which monitoring would be most appropriate. Administering Authorities could use this information to determine a threshold for the cost effective, detectable level of change in a monitoring program.

Sampling Techniques

Sampling techniques and monitoring of environmental parameters must be in accordance with appropriate and recognised scientific methodology. Specifically the techniques utilised when taking environmental water samples must be in accordance with the most recent edition of the *Water quality sampling manual* published or endorsed by the Administering Authority.

Environmental Complaints

Complaints in regard to environmental issues of prawn farms may take two forms:

1. Receipt of a formal complaint from Administering Authorities;
2. Receipt of a written complaint from a third party.

Complaints will be recognised by prawn farmers under this Code of Practice on the basis that the complaint:

- is in a formal or written manner;
- notes the specific incident;
- notes the specific concern or potential impact of the alleged incident;
- notes the place of the alleged incident;
- notes the date and time of the alleged incident.

On receipt of a complaint made in the appropriate form, the prawn farmer will notify the Administering Authority in writing as soon as practicable of the complaint and will implement an internal investigation. Such an investigation will include, a review of the relevant environmental records, communications with the responsible employee(s) and any other actions the prawn farm management deems as necessary.

The Administering Authority will be informed in writing of the outcome of the investigation within thirty days of completion of the investigation.

In the event that any single incident is substantiated by the investigation, the prawn farmer must undertake a review of

operating procedures to ensure that the incident is not repeated. If the incident identified is a continuing breach, the farm contingency plans must be implemented.

Environmental Records and Auditing

Under this Code of Practice, prawn farmers must undertake to keep all records required to provide a substantial base of information for the collation of environmental data relevant to the aquaculture operation. Such records must include:

- Time and date of monitoring activities;
- Laboratory water quality results in line with monitoring requirements;
  - original analysis report;
  - collated data;
- In situ water quality measurement results in line with monitoring requirements;
- Approximate discharge volumes for each day (± 5%);
- Pond sediment volumes, as removed from ponds after draining;
- Rainfall records;
- Records of major rain events and visual observations of surrounding waterways;
- Correspondence with Administering Authorities;
- Relevant correspondence with interest groups and community organisations;
- Written complaints received by the company;
- A copy of relevant licenses and approvals;
- Environmental Audit and Review reports and annual returns;
- Sources, dates and details of post-larvae delivery;
- Dates, volumes and types of chemicals used on the farm;
- Names and addresses of consultants and contractors engaged in environmental matters.

Under this Code of Practice, prawn farmers must conduct an annual review of their environmental records and management systems. The review shall comprise an internal review to confirm that the proposed actions are appropriate. The results of the review are to be forwarded to the Administering Authority if required and as appropriate.

Site Rehabilitation

This Code of Practice provides for the rehabilitation of prawn farm sites on termination of prawn farming activities.

Where a prawn farmer chooses to terminate the operation of a prawn farm and not continue with a similar use, the prawn farm site must be rehabilitated in accordance with any requirements set by an Administering Authority or alternatively, to the extent that no further impacts to the environment result from the development site.

Site rehabilitation must include one or more of the following actions:

- Restoration of topography;
- Burying of pond sediments;
- Revegetation of site;
- Closure of farm intake and discharge channels;
- Restoration of Crown Land.

Code of Practice Review

This Code of Practice must be reviewed by the Australian prawn farming industry on an annual basis. New technology must be

incorporated where appropriate, based on its efficiency and effectiveness to minimise the environmental impacts of prawn farming. An additional review of the entire document must be completed no later than every five years.

In conjunction with this Code of Practice, a series of procedural guidelines must be developed to deal with specific issues which require substantial detail, such as health and disease management. Similar procedural guidelines should be developed for each step of the prawn farming process.

Review is the responsibility of the Australian Prawn Farmers Association which should conduct the review in consultation with Administering Authorities.

This Code of Practice has been reviewed by the APFA at the following times:

- December 1996
- July 1997
- September 1998
- May 2000
- July 2001

Consultation

A draft of this Code was released for public consultation by the Queensland Minister for Environment, the Hon. Rod Welford in May 2000. The Code was subsequently reviewed by the Queensland Environment Protection Authority taking into account comments made by the community during public consultation. The Association has considered those comments and recommendations from the Environment Protection Agency and incorporated them into the Code in July 2001.

The following Administering Authorities and interest groups have or have been offered an opportunity to contribute to the development of this Code of Practice:

- Australian Seafood Industry Council
- Great Barrier Reef Marine Park Authority
- Mackay Conservation Group
- North Queensland Conservation Council
- Northern Territory Department of Primary Industry & Fisheries
- Northern Territory Department of Lands, Planning and Environment
- NSW Environment Protection Agency
- NSW Fisheries
- Queensland Commercial Fisherman's Organisation
- Queensland Conservation Council
- Queensland Department of Environment
- Queensland Department of Primary Industries
- Sunfish

To date the following Administering Authorities and interest groups have participated and contributed to the development of this Code of Practice:

- Australian Prawn Farmers Association
- Australian Seafood Industry Council
- Great Barrier Reef Marine Park Authority
- North Queensland Conservation Council
- Northern Territory Department of Primary Industry & Fisheries
- Northern Territory Department of Lands, Planning and Environment
- NSW Environment Protection Agency
- NSW Fisheries
- Queensland Environment Protection Agency
- Queensland Department of Primary Industries

Relevant Environmental Legislation

Prior to developing or operating a prawn farm it is the responsibility of the prawn farmer to ensure that all necessary regulations have been satisfied. It is not within the scope of this Code of Practice to provide a detailed list of all regulatory mechanisms which have the potential to impact on prawn farm developments. Individual prawn farmers must ensure that they seek appropriate legal advice in regard to their responsibilities.

Relevant Environmental Legislation (Commonwealth)

Great Barrier Reef Marine Park Act (1975)

The Great Barrier Reef Marine Park Act (1975), provides for the protection, wise use, understanding and enjoyment of the Great Barrier Reef in perpetuity through the care and development of the Great Barrier Reef Marine Park. When assessing the impacts of proposed prawn farms, the likely impacts to the Great Barrier Reef need to be assessed.

World Heritage Properties Conservation Act (1983)

The Commonwealth World Heritage Properties Conservation Act (1983), protects registered property and areas against any activity that is "*likely to damage or destroy*" an area of World Heritage Property. When assessing the impacts of proposed prawn farms, the likely impacts to World Heritage Areas need to be assessed.

International Treaties and Conventions

The Federal and Queensland Governments have agreed to and become involved in, a number of environment based treaties and conventions, including Ramsar, CAMBA and JAMBA. These treaties and conventions have the objective of protecting various world environmental values such as bird migration and wetlands preservation.

Relevant Environmental Legislation (Qld.)

Environmental Protection Act 1994

The Environmental Protection Act 1994 requires that a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm.

Further, the Environmental Protection Act 1994 provides that as aquaculture is an Environmentally Relevant Activity, persons undertaking this activity are required to be licensed. Conditions affecting how the activity is to be conducted may be placed on this licence and must be complied with.

Fisheries Act 1994

Aquaculture licenses are required by all persons conducting aquaculture activities where the product is for sale. The Fisheries Act 1994 restricts the clearing or removal of marine plants and works within declared Fish Habitat areas. It also provides the DPI with options in regards to disease management.

Integrated Planning Act 1997

The purpose if the Integrated Planning Act is to achieve ecologically sustainability through coordinating and integrating planning at the local, regional and State

levels, by managing the process by which development occurs and through managing the effects of development on the environment.

This Act incorporates the Integrated Development Assessment System (IDAS) which is a system designed to provide a single administrative framework for the assessment and approval of all development.

Under the IDAS assessment system, applicants are required to provide sufficient detail for assessment and undertake public notification.

Local Authority Town Planning Schemes, Local-Laws and Regulations

Some Local Authorities require that developments within their jurisdiction seek town planning approval or general approval for specified earthworks, clearing areas under Vegetation Protection Orders and building construction.

Local Strategic Plans may guide development in a region or local government area and may limit the number or type of developments in an area.

Water Resources Act 1989

The Water Resources Act 1989, requires that permits be obtained prior to altering riverine environments or drawing from groundwater supplies.

Nature Conservation Act 1992

The Nature Conservation Act 1992, requires that permits may be required for activities within in areas prescribed in Nature Conservation Plans, defined as critical habitats or covered by a Conservation Order.

Beach Protection Act

This Act provides for the protection and management of coastal zones, in particular the management of Erosion Prone Areas which are defined as the area below the Highest Astronomical Tide or 40 metres landward of Mean High Water Springs, whichever is the greater.

Marine Parks Act 1982

The Marine Parks Act 1982, provides for the protection of declared marine areas as Marine Parks. Under the various Marine Park Orders, declared marine areas are protected from certain activities in order to provide conservation of the area.

Coastal Protection & Management Act 1995

This Act provides for the protection, conservation, rehabilitation and management of the coast and requires that any use of the coastal resources is undertaken in an ecologically sustainable manner.

This Act also provides for an extension of the effect of Section 86 of the Harbours Act 1955, which stipulates that approval is required prior to construction, for other than private use, of any structure on tidal lands or waters.

Relevant Environmental Legislation (N.S.W.)

NSW Fisheries Management Act 1994

Provides for the issue of aquaculture permits and licenses and the development of new types of aquaculture. It provides for contributions to aquaculture research and promotes environmental responsibility in the industry and is responsible for the protection of marine habitats.

National Parks and Wildlife Act 1974

This Act provides for the protection of sites of archaeological and cultural importance and for the protection of terrestrial fauna and flora.

Threatened Species Conservation Act 1995

The Threatened Species Conservation Act 1995, provides for the protection and conservation of threatened species and ensures that potential impacts to threatened species are considered as a part of any development.

Environmental Planning and Assessment Act 1979

This Act determines whether an aquaculture development requires Consent of a local council or if another government department is to be the determining authority. This Act also determines whether an Environmental Impact Statement is required for a designated development and integrates the Threatened Species Conservation Act 1995.

Local Government Act 1993

The Local Government Act 1993, requires that development applications consider Local Environment Plans and State Environmental Planning Policies for wetlands and other protected habitats.

Protection of the Environment Operations Act 1997

The POEO Act is now the principal statute in NSW regulating environmental protection. It is a comprehensive piece of legislation which replaces the *Clean Waters Act 1970* and six other statutes with the aim of consolidating, streamlining and strengthening the environmental regulatory regimes which deal with air and water pollution, noise control and the licensing system. The POEO Act also provides a framework for the making of regulations with respect to a wide range of matters related to the prevention, control, abatement or mitigation of pollution. The Act has a Schedule that lists all the activities that must have a license. The listing sets threshold criteria which specify the minimum 'size' of an activity that requires an environmental protection license from the NSW Environment Protection Authority.

Crown Lands Act 1989

Under the Crown Lands Act 1989, approval is required prior to construction, , of any structure on Crown Land.

Rivers and Foreshores Act 1948

This Act provides for the protection of river banks and the prevention of erosion.

Water Act 1912

The Water Act 1912 provides for protection of groundwater from saltwater intrusion and the regulation of developments on flood plains.

Relevant Environmental Legislation (N.T.)

Northern Territory of Australia Fisheries Act

Aquaculture licenses are required by all persons conducting aquaculture activities in the Northern territory. The Fisheries Act also restricts the clearing or removal of marine plants.

Soil Conservation and Land Utilisation Act 1992

This Act makes provision for the prevention of soil erosion and for the conservation and reclamation of soil, however, the current Act is being reviewed in order that all land resources conservation issues are addressed.

Planning Act 1993

The Planning Act 1993 requires that public notification of a proposal relating to a prawn farm. Section 51 of the Act specifies the matters to be considered by the Administering Authority when considering development proposals.

Darwin Regional Structure Plan 1990

The Darwin Regional Structure Plan 1990, outlines aquaculture development opportunities for the Darwin Region and location requirements.

Environmental Assessment Act

This Act requires that the environmental impacts associated with prawn farming in the Northern Territory are fully considered.

Water Act

The Water Act provides regulations in relation to all aspects of water works, including; damming of water courses, installation of bores and discharge of waste waters.

Port Authority Act

The Port Authority Act, provides for regulation of construction within tidal waters in the Darwin region.

Territory Parks and Wildlife Conservation Act 1993

This Act provides for the protection and conservation of native fauna and flora within the Northern Territory and for the establishment and protection of marine parks.

Definitions

Acid Sulphate Soils	- Soils which contain pyrite and have the potential to produce acid leachate when oxidised.
Administering Authority	- Government agency responsible for the administration and approval of aquaculture developments.
Aeration	- the process of adding oxygen to the pond water.
CAMBA	- China - Australia Migratory Bird Agreement
Certified Source	- A supplier or manufacturer of product which has been certified as environmentally appropriate by the Australian Prawn Farmers Association.
Chemical	- A chemical, drug, antibiotic or disinfectant.
Chlorophyll-a	- A green pigment used as a measure of phytoplankton levels in a water sample.
Dissolved Nitrogen	- Typically nitrate, nitrite and ammonia.
Dissolved Phosphorous	- Typically Ortho-phosphates.
DPI	- Queensland Department of Primary Industries or equivalent agency in other states (eg. NSW Fisheries)
Effluent	- Prawn farm discharge water; primarily seawater with an additional load of nutrients, suspended solids and phytoplankton.
Environmental Authority	- A license, permit or other authority that is issued under law, allowing the conduct of an Environmentally Relevant Activity.
Environmentally Relevant Activity	- Any activity which has the potential to release a contaminant into the receiving environment when the activity is carried out. This is a specific term in the *Environmental Protection Act 1994* (Qld) but the concept applies equally to all other States and Territories.
Exotic diseases	- Diseases that are not known to be endemic to Australian waters.
Farm Discharge Point	- Point at which water is released from a prawn farm into the external environment.
Feed	- Artificial pellets or crumbles manufactured for prawn diets.
Fish Habitat Zones	- An area of water protected by legislation for its value as a fishery habitat.
Food Conversion Rate	- Mass of feed used related to mass of prawns produced.
General Environmental Duty	- A person's duty not to carry out any activity that causes or is likely to cause, environmental harm, unless the person takes all reasonable and practicable measures to prevent or minimise the harm.
Groundwater	- Water occurring beneath the natural ground level.
Initial Mixing Zone	- The part of the receiving water where the waste water is diluted before it reaches the same density as the receiving water.

JAMBA	- Japan - Australia Migratory Bird Agreement
Marine Parks	- An area of water protected by legislation for its environmental values. Includes State and Federal Marine Parks.
Noise Sensitive Location	- A place defined as a “noise sensitive place” by the Environmental Protection (Interim) Regulation 1995.
Nutrients	- The mix of phosphorous and nitrogen contained within discharge waters.
Particulate Nitrogen	- Typically nitrogen found in organic matter.
Particulate Phosphorous	- Typically phosphorous bound to inorganic suspended solids and some organic matter.
Pathogens	- Causative organisms of disease.
Performance Indicator	- A predetermined environmental objective which is used as an indicator of the impacts or potential impacts of a prawn farm.
Pond discharge structures	- Point and structure at which water is released from a prawn production pond into a discharge channel.
Pond recirculation systems	- A system which will allow for partial or total reuse of pond discharge water within a single prawn farm.
Prawn	- Any marine prawn or shrimp species (typically Penaeid or Metapenaeid) which is commonly known as a prawn or shrimp.
Prawn farm	- An artificial pond environment for farming prawns.
Prawn farming	- Managing the pond environment of a prawn farm for maximum survival and growth rates of prawns, through a balance of aeration, feed and water quality management.
Prawn farmer	- A person or organisation that manages the pond environment of a prawn farm and holds a license under the necessary legislation (in Queensland the *Environmental Protection Act* and/or the *Fisheries Act*) to carry out the activity.
Ramsar	- Convention on Wetlands of International Importance (Ramsar Convention).
Reasonable and Practicable	- Where consideration has been given to the following: • the current state of technology in the industry • the financial considerations of the action • the likelihood of successful outcomes from the action • the nature of the harm or potential harm • the sensitivity of the receiving environment
Sensitive Place	- a dwelling, mobile home or caravan park, residential marina, nursing home or other residential place; or - a motel, hotel or hostel; or - a childcare centre, kindergarten, school, university or other educational institution; or - a medical centre or hospital; or - a conservation area; or - open space used by the public as of right for passive recreation; or

	- as otherwise defined in the QDEH Environmental Protection (Noise) Policy and/or QDEH Environmental Protection (Air) Policy.
Sensitive Time	Between 7 pm and 7 am or otherwise defined in the QDEH Environmental Protection (Noise) Policy
Settlement Pond	- A pond of sufficient size to retain all pond discharge water for sufficient time to allow for some or all settleable particles to settle.
Stocking densities	- Number of prawns stocked on a square metre basis.
Suspended Solids	- A measure of the filterable particulate matter in a water sample.
Unacceptable (Increase/Change)	- Changes in the parameter under consideration, which would be regarded as incompatible with the concept of ecologically sustainable development.
Work Place Health and Safety regulations	- Any state or federal regulations which seek to protect the health and safety of workers.
World Heritage Property	- Areas as defined by the World Heritage Register.

Specialist References

Site Selection, Farm Design, Planning and Construction

Boyd C.E (1998) Soils in pond aquaculture. Aquaculture Asia magazine Jan - March 1998 pp 6 - 10

Chanratchakool, P, Turnbull, J. F, Funge-Smith, S. J, MacRae, I. H. & Limsuwan, C. (1998) *Health Management in Shrimp Ponds*. Aquatic Animal Health Research Institute, Dept of Fisheries, Kasetart University Campus, Bangkok.

Department of Natural Resources (1997) Planning Guidelines - Separating Agricultural and Residential Land Uses.

EGQCS (1996) *Soil Erosion and Sediment Control, Engineering Guidelines for Queensland Construction Sites 1996*, Institute of Engineers.

NSW EPA (1995) *Assessing and Managing Acid Sulphate Soils*, Environmental Guidelines Environmental Protection Agency 95/41.

QASSIT (1997) Sampling and Analysis Procedures for Lowland Acid Sulphate (ASS) in Queensland. Queensland Acid Sulphate Investigation Team, Department of Natural Resources.

Pond and Farm Management

Beveridge, M.C.M., Phillips, M.J. & Clarke, R.M. (1991) A quantitative and qualitative assessment of wastes from aquatic animal production. pp 506 - 553. In D.E. Bruce & J.R. Tomasso (Ed). *Advances in Aquaculture. Volume 3*. World Aquaculture Society, Baton Rouge, Louisiana USA.

Boyd C.E (1998) Pond water aeration systems. Journal Aquaculture Engineering 18 (1998) pp 9 - 40

Boyd C.E. (1995) Chemistry and efficacy of amendments used to treat water and soil quality imbalances in shrimp ponds, pp 183-199. In Browdy, C.L. & Hopkins, J.S (eds) *Swimming Through Troubled Waters* - proceedings of the Special Session on Shrimp Farming at Aquaculture '95. Published by World Aquaculture Society.

Boyd, C.E, Tanner, M.E, Madkour, M & Kasuda, K. (1994) Chemical Characteristics of Bottom Soils from Freshwater and Brackish Water Aquaculture Ponds. Journal of World Aquaculture Society 25 (4) pp 517-534.

Boyd, C.E. & Pippopimyo, S. (1994) Factors affecting respiration in dry pond bottom soils. Aquaculture Journal 120, pp 283-293.

Chanratchakool, P, Turnbull, J. F, Funge-Smith, S. J, MacRae, I. H. & Limsuwan, C. (1998) *Health Management in Shrimp Ponds*. Aquatic Animal Health Research Institute, Dept of Fisheries, Kasetart University Campus, Bangkok.

Chien Y.H. & Liao I.C. (1995) Integrated approach to prawn growout system design pp 167-182. In Browdy, C.L. & Hopkins, J.S (eds) *Swimming Through Troubled Waters* - proceedings of the Special Session on Shrimp Farming at Aquaculture '95. Published by World Aquaculture Society.

Hopkins, J.S, Hamilton, R.D, Browdy, C.L & Stokes, A.D. (1993) Effect of Water Exchange Rate on Production, Water Quality, Effluent Characteristics and Nitrogen Budgets of Intensive Shrimp Ponds. Journal World Aquaculture Society. 24 (3) pp 304-320

Jory D.E. (1995) Feed management practises for a healthy pond environment, pp 118-143. In Browdy, C.L. & Hopkins, J.S (eds) *Swimming Through Troubled Waters* - proceedings of the Special Session on Shrimp Farming at Aquaculture '95. Published by World Aquaculture Society.

Kiyoshi, M & Boyd, C.E. (1994) Effects of Aeration, Alum Treatment, Liming, and Organic Matter Application on Phosphorus Exchange between Soil and Water in Aquaculture Ponds at Auburn, Alabama. Journal of the World Aquaculture Society 25 (3) pp 405-416

New, M.B. (1995) Feed management and Nutrition for Sustainable Aquaculture. Paper presented at PACON 1995 meeting Hawaii.

Smith, P.T & Masters, S.J. (1995) Origin of reduced sulfur compounds in pond sediment. *Proceedings of Sustainable Aquaculture 95*, pp 225-260 PACON International.

Smith, P.T. (1995) The effect of drying on the chemistry and bacteriology of shrimp pond sediment. Fourth Fisheries Forum, Beijing 1995.

Smith, P.T. (1996) Physical and chemical characteristics of sediments from prawn farms and mangrove habitats on the Clarence River, Australia.. *Aquaculture Journal 1361*

Effluent and Waste Management

Chanratchakool, P, Turnbull, J. F, Funge-Smith, S. J, MacRae, I. H. & Limsuwan, C. (1998) *Health Management in Shrimp Ponds*. Aquatic Animal Health Research Institute, Dept of Fisheries, Kasetart University Campus, Bangkok.

Boyd C.E. (1995) *Effluent and Solid Waste Management in Pond Aquaculture*. Presented at 3rd Equadorian Aquaculture Conference, November 1995.

Boyd, C.E. (1995) Effluent and Solid Waste Management in Pond Aquaculture. Personal manuscript which evaluates the results of large study on *Aquaculture Sustainability and the Environment* conducted by Network of Asian Centres for Aquaculture (NACA) and Asian Development Bank (ADB).

Boyd, C.E. (1995) Regional Review of Environmental Issues and Aquaculture Sustainablity. Draft manuscript prepared for NACA which reviews the country reports, S.E. Asia, on *Aquaculture Sustainability and the Environment.*

Endander, M & Hasselstrom, M (1994) An Experimental Wastewater Treatment System for a Shrimp Farm in Malaysia. INFOFISH International 4/94 pp 56-61

Flaherty, M & Karmjanakesorn, C. (1995) Marine Shrimp Aquaculture and Natural Resource Degradation in Thailand. Environmental Management Vol. 19 No.1 pp 27-37.

Funge-Smith, S.J. & Briggs, M.R.P. (1994) Institute of Aquaculture, University of Stirling, Scotland. UK Appendices of Final Report to the Overseas Development Administration - *Development of Strategies for Sustainable Shrimp Farming in Thailand.*

Funge-Smith, S.J. & Briggs, M.R.P. (in prep) The organic composition of soil and accumulated sediments in intensive marine shrimp ponds in Thailand. Institute of Aquaculture, University of Stirling, Scotland. UK

Funge-Smith, S.J. & Briggs, M.R.P. (in prep) The origin and fate of solids and suspended solids in intensive marine shrimp ponds in Thailand. Institute of Aquaculture, University of Stirling, Scotland. UK

Funge-Smith, S.J. & Briggs, M.R.P. (in prep) Water quality and nutrient discharge of intensive marine shrimp ponds in Thailand and their relationship to pond productivity. Institute of Aquaculture, University of Stirling, Scotland. UK

Gavine, F.M, Phillips, M.J. & Kenway, M. (1995) The integration of treatment systems to reduce environmental impacts of effluent from coastal shrimp ponds in Thailand - biological and physical constraints. (In press)

Hopkins, J.S., Sandifer, J.S. & Browdy, C.L. (1995) A review of water management regimes which abate the environmental impacts of shrimp farming, pp 157-166. In Browdy, C.L. & Hopkins, J.S (eds) *Swimming Through Troubled Waters* - proceedings of the Special Session on Shrimp Farming at Aquaculture '95. Published by World Aquaculture Society.

Macintosh D.J. & Phillips, M.J. Environmental Issues in Shrimp Farming. (source of reference and year unknown) pp 118-144

Pruder, G.D. (1990) Effluent Treatment Processes Literature Study. Project II *Aquaculture Effluent Discharge Program Year 1 Final Report* prepared for Centre for Tropical and Subtropical Aquaculture Hawaii. pp 55-66

Robertson, A.I. & M.J. Phillips. (1995) Mangroves as Filter of Shrimp Pond Effluent: predictions and biogeochemical research needs. Hydrobiologia 295 pp 311-321

Smith, P.T. (1995) Characterisation of the effluent from prawn ponds on the Clarence River, Australia. *Proceedings of Sustainable Aquaculture 95*, pp 327-338. PACON International.

Smith, P.T. (1995) NSW Prawn Farming Pollution Reduction Program Report. Individual reports done as EPA license condition for NSW prawn farms.

Trott, L (1996) Presentation at the APFA Conference Cairns Qld July 1996.

Wang, J.K. (1990) Alternative Effluent Treatment Processes. Project II *Aquaculture Effluent Discharge Program Year 1 Final Report* prepared for Centre for Tropical and Subtropical Aquaculture Hawaii. pp 97-105

Ziemayan, D (1990) Characterisation of Aquaculture Effluent and Environmental Assessment for Effluent from Hawaiian Aquaculture Facilities. Project I *Aquaculture Effluent Discharge Program Year 1 Final Report* prepared for Centre for Tropical and Subtropical Aquaculture Hawaii. pp 2-53

Disease Management

Chanratchakool, P, Turnbull, J. F, Funge-Smith, S. J, MacRae, I. H. & Limsuwan, C. (1998) *Health Management in Shrimp Ponds*. Aquatic Animal Health Research Institute, Dept of Fisheries, Kasetart University Campus, Bangkok.

Bell A.B. & Lightner D.V. (1992) *Shrimp Facility Clean-Up & Restocking Procedures*. College of Agriculture, The University of Arizona.

General References and Further Reading

Chanratchakool, P, Turnbull, J. F, Funge-Smith, S. J, MacRae, I. H. & Limsuwan, C. (1998) *Health Management in Shrimp Ponds*. Aquatic Animal Health Research Institute, Dept of Fisheries, Kasetart University Campus, Bangkok.

ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters*. National Water Quality Management Strategy.

ANZECC & ARMCANZ (1999) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy. Public Comment Draft, Prepared under the auspices of: Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. July 1999.

Briggs, M.R.P. & Funge-Smith, S.J. (in prep) A nutrient budget of some intensive marine shrimp ponds in Thailand. Institute of Aquaculture, University of Stirling, Scotland. UK

EPA (1994) Environmental Protection Act 1994.

Hajek, B.F. & Boyd, C.E. (1994) Rating Soil and Water Information for Aquaculture. Journal Aquaculture Engineering 13 pp 115-128.

Kitada (1996) Report and presentation to Kuruma prawn farmers, March 1996.

Kwei Lin C. & Beveridge M.C.M. (1993) Shrimp Culture and the Environment: Lessons from the World's most rapidly expanding warmwater aquaculture sector. *In* Pullin R.S.V. Rosenthal H. & MacLean J.L. (eds) *Environment and Aquaculture in Developing Countries*. ICLARM Conference Proceedings.

Lobegeiger R (1995) *Aquaculture Production Survey, Queensland 1994/95. Report to Farmers*. Aquaculture Information Series. QDPI.

Our Common Future (1987) Report by the World Commission on Environment and Development.

Phillips, M.J, Beveridge, M.C.M. & Clarke, R.M. (1991) Impact of Aquaculture on Water Resources. pp 568-591 In D.E. Bruce & J.R. Tomasso (Ed). *Advances in Aquaculture. Volume 3.* World Aquaculture Society, Baton Rouge, Louisiana USA.

Phillips, M.J, Kwei-lin, G. & Beveridge, M.C.M. (1993) Shrimp Culture and the Environment. Lessons from the worlds management rapidly expanding warmwater aquaculture sector. Environment and aquaculture in developing countries ICLARM. ICLARM conference proceedings 3 pp 171-197

Pillay, T.V.R. (1992) Aquaculture and the Environment. Oxford Fishing News Books.

Young, M.D. (1993) For Our Children's Children: Some Practical Implications of Inter-Generational Equity and the Precautionary Principle. Resource Assessment Commission, Occasional Publication Number 6, November 1993.

Water Quality Sampling Manual 2nd Ed (1995) Department of Environment. and Heritage

A Review of Prawn Farm Effluent Treatment and Management (August 1997) by Queensland Department of Environment SE Region

Schedule 1 - Detailed Water Quality Objectives

This Code of Practice recognises that it is not possible to recommend a uniform set of water quality performance indicators for all prawn farms and that individual water quality parameters for receiving waters must be determined on a site specific basis.

This schedule defines the long term objectives of the industry in relation to water quality impacts outside of the initial mixing zone.

The Australian prawn farming industry, through it's national body the Australian Prawn Farmers Association, supports the long term objective of a nil tangible impact to water quality outside of the initial mixing zone, as a result of prawn farming operations.

Low risk trigger values defined by ANZECC & ARMCANZ (1999) can be determined based on the distribution of existing stressors from similar well functioning ecosystems. Guideline trigger values are set by the statistical thresholds of the stressor in the natural distribution of data from local or regional reference ecosystems.

Where reference data are non-normally distributed, the water quality objectives of the APFA are to ensure that the statistical mean for water quality stressors remains within an acceptable range post operation. Based on ANZECC & ARMCANZ (1999) these levels would be between the 20^{th} and 80^{th} percentile. Where data are normally distributed, these levels would be determined by the mean $\pm$ the statistical standard deviation for the reference data.

It is important to note that stressors occur naturally and vary widely in aquatic ecosystems and it is thus difficult to provide meaningful guidelines for specific trigger levels unless such data are derived from the site or region in question.

Where no local or regional reference data are available, interim trigger levels, as defined by ANZECC & ARMCANZ (1999), can be used as an objective for environmental performance. The following table as modified from ANZECC & ARMCANZ (1999) provides interim trigger levels for assessing possible risk of adverse affects due to nutrients for the two ecosystems relevant to prawn farming operations.

Receiving Environment Type	**Trigger Levels**		
	Chlorophyll a (µg/L)	**Total Nitrogen** (µg/L)	**Total Phosphorous** (µg/L)
Estuaries	2	80	45
Coastal & Marine	0.3	350	55