Queensland Government

Department of
Primary Industries and Fisheries

Reference: 04/16515

3 November 2004

Mr Kevin Smyth
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Dear Mr ~~Smyth~~ Kevin

Proposed prawn farm at Guthalungra – assessment of impacts on seagrasses in Abbot Bay

I refer to the discussions that you and Dr Trevor Anderson had with Rob Coles, Phil Hales and Michael Heidenreich of the Department of Primary Industries and Fisheries (DPI&F) at the Northern Fisheries Centre in Cairns on 7 October 2004. The meeting was held in response to your request to gain a clearer indication of how the proposed prawn farm might affect seagrasses in Abbot Bay and how Pacific Reef Fisheries (Australia) Pty Ltd (PRF) might respond to various agencies' comments and questions on the Environmental Impact Statement to progress with the proposal.

It is not possible to determine with statistical validity the impacts that the proposed development would have on seagrasses in Abbot Bay without a lengthy and prohibitively intensive and expensive study. This is due to the large number of variables that would have to be quantified and the natural variations that occur in this marine environment. As a consequence, a risk management approach needs to be undertaken in assessing the likely impacts of discharge from your prawn farm proposal.

Taking this approach, it is the opinion of this department that effluent from the proposed Guthalungra prawn farm may have an effect on the seagrass ecology of Abbot Bay, but that it is unlikely to be measurable or significant. This opinion is based on our knowledge of seagrass ecology, the dynamics of Abbot Bay, and our review of published research on the impacts of prawn farm effluent in Australia.

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It is the opinion of this department that if there are impacts, they are likely to be changes in seagrass distribution and epiphyte loads due to changes in light and nitrogen levels in the water column, although the spatial impact is likely to be small in relation to the distribution of seagrasses throughout Abbot Bay.

As requested, I have attached an appendix of answers to the specific questions you raised during the meeting of 7 October 2004, which elaborates on the opinions above and may be useful in your discussions with other agencies.

If you require any further information regarding this matter, please do not hesitate to contact Phil Hales on telephone 07 4035 0144 or email phil.hales@dpi.qld.gov.au.

Yours sincerely

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Att

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Attention: Mr Phil Hales

Appendix A

Questions asked during meeting of 7 October 2004 at Northern Fisheries Centre between Pacific Reef Fisheries (Australia) Pty Ltd and Department of Primary Industries and Fisheries Staff

What further studies might Pacific Reef Fisheries (PRF) undertake and how might the company address comments made by several agencies, including Department of Primary Industries and Fisheries (DPI&F), regarding possible impacts of the proposal on seagrasses in Abbot Bay?

The department is of the opinion that PRF has undertaken a satisfactory survey to document the distribution and composition of the seagrass meadows in the shallower waters of Abbot Bay in the vicinity of the proposed intake and discharge facilities. Given the relatively clear waters of Abbot Bay, it is possible that the distribution of seagrasses of the genus *Halophila* may extend into the deeper waters of the Bay. However, the department does not consider that a deep water survey of seagrasses is warranted due to the costs involved and the limited benefits such a survey would provide in the assessment of the proposal.

Seagrass distribution, speciation and productivity will vary significantly throughout the year and between years due to the natural and anthropological influences on the Bay. It is extremely difficult to differentiate the effects of these various influences without a very extensive and very expensive study over considerable years prior to and post the commencement of discharge into the Bay. Such a study would be outside the timeframes in which to assess this proposal and would be an unfair burden in terms of the costs of such a study on a single proposal, the results of which may then be used to assess future proposals. PRF should concentrate efforts on a risk assessment using the most likely factors to influence seagrass distribution, speciation and productivity.

It is the DPI&F's opinion, based on knowledge of seagrass ecology, the natural environment of Abbot Bay, and published papers looking at the impacts of prawn farm effluents, that the two most likely negative influences on distribution and productivity of seagrasses would be the potential for accumulation of nutrients in the sediments and changes to the availability of light on the seabed due to increases in suspended solids.

Based on the findings of Burford *et al.* (*Marine Pollution Bulletin* **46** 2003, 1456-1469) that the impact of prawn farm effluent is predominantly on the water column and not sediment processes, and our knowledge that effluent discharge will occur for only part of the year and vary considerably in quantity and quality, it is unlikely that nutrients will accumulate to a significant level in the sediments.

Suspended solids in prawn farm effluent would be the main influence on light levels and this will largely be related to chlorophyll 'a' levels, given the proposed degree of settlement of the effluent prior to discharge. Modelling undertaken for the Environmental Impact Statement (EIS) used a value of 0.03 milligrams per litre chlorophyll 'a' in the effluent discharged to the Bay. Even without dilution and diffusion of the effluent, chlorophyll 'a' levels of 0.03 milligrams per litre are unlikely to reduce light levels to the degree (seventy – ninety per cent) that would threaten the survival of the seagrass species identified in the Bay (see species requirements below). Based on the work done by Dubinsky and Berman (*Limnology & Oceanography* **26** 1981, 655), chlorophyll levels of 0.03 milligrams per litre (thirty milligrams per cubic meter) that were modelled at the point of discharge would absorb less than forty percent of available light. Levels of 0.015 milligrams per litre would absorb less than twenty per cent surface light. While this does not take into account the turbidity effects due to natural weather events, these events are likely to involve wave and current movements which will assist in the dilution and diffusion of the effluent and hence disperse the effects of the effluent on light transmission.

Although nutrients in the discharge may facilitate algal growth, the department is of the opinion that the diffusion and dilution of the effluent as modelled are unlikely to facilitate algal blooms to a density at which seabed light levels will be significantly affected (reduction in light transmission to thirty per cent of surface light or ~100 – 200 milligrams per litre cubic meter chlorophyll 'a', based on Dubinsky and Berman).

The department is of the opinion that further investigation of the effects of the effluent on light transmission is not necessary. If further tests of light transmission need to be undertaken, a Secchi disc may be useful to map critical levels of natural light reaching the seabed in Abbot Bay. The depth at which the Secchi disc disappears from view equals eighteen per cent of incident light (Caruthers *et al.* in *Global Seagrass Research Methods*, Short and Coles (eds.) 2001) which is roughly equivalent to the critical light levels for the species found in the Bay. If the Secchi disc is clearly in view on the seabed, light transmission is unlikely to be a critical factor in seagrass presence.

Further comments on these two influences are made below in reference to the species of seagrass found in Abbot Bay.

In summary, the department is of the opinion that no further investigations into the affects of the effluent on seagrasses is required although regular monitoring to confirm the that light transmission remains unchanged would be appropriate. This monitoring would enable alternate management of discharge to avoid permanent disturbance to seagrass.

What is the nature of the seagrass meadows in Abbot Bay and what is the significance of the species composition and density?

Seagrasses of eastern Australia are important for stabilising coastal sediments, providing food and shelter for diverse organisms, as a nursery ground for prawns and fishes of commercial importance, and for nutrient trapping and recycling. The marine mammal, *Dugong dugon*, and the green sea turtle, *Chelonia mydas*, feed directly on seagrasses, particularly the species, and densities found in Abbot Bay. Both animals are used by indigenous Australian communities for food and ceremonial purposes.

Queensland has approximately fifteen species of seagrass and around 6000 square kilometres has been mapped in coastal (less than fifteen meters deep) waters.

The three (3) species found in Abbot Bay in the survey are *Halophila ovalis*, *H. spinulosa* and *Halodule uninervis*. All are known to be of importance to fisheries productivity and food for dugong. All are common in tropical coastal waters. In this region density is likely to be variable and seasonal and may reflect grazing pressures and/or the influence of past events such as storms and cyclones. All three species flower and fruit at this latitude and would be expected to recover quickly from small and short-term impacts. Species in the genus *Halophila* can be found from intertidal areas down to sixty metres depth. *Halodule* are mostly found in intertidal or shallow sub-tidal waters.

The Abbot Bay location differs from other seagrass sites where prawn farms have been located and effluent discharged in that it is relatively more exposed to the south east trade winds and not at a site where it would be expected to find the extensive meadows that are more common in the sheltered bays of north east Queensland.

What is affecting the species composition, density and distribution of seagrasses – physical, nitrogen, phosphorous, light?

A number of general parameters are critical to whether seagrass will occur along any stretch of coastline. These include physical parameters that regulate the physiological activity of seagrasses (temperature, salinity, waves, currents, depth, substrate and day length), natural phenomena that limit the photosynthetic activity of the plants (light, nutrients, epiphytes, grazing and diseases), and anthropogenic inputs that inhibit the access to available plant resources (nutrient and sediment loading). Various combinations of these parameters will permit, encourage, establish or eliminate seagrass from a specific location.

The depth range of seagrass is most likely to be controlled at its deepest edge by the availability of light for photosynthesis. Exposure at low tide, wave action, and associated turbidity and low salinity from fresh water inflow, determine seagrass species survival and distribution at the shallow edge. Seagrasses survive in the intertidal zone, especially in sites sheltered from wave action or where there is entrapment of water at low tide (for example reef platforms and tide pools) protecting the seagrasses from over-exposure to heat or desiccation at low tide.

In northern Abbot Bay, the existing distribution of seagrasses is likely to have resulted from a combination of light availability, grazing, weather exposure and possibly limitations to the amount of sediment nutrients available to the plants. It would also be expected that the freshwater flows from the Elliot River would have negative, although temporary impacts on seagrass distribution in the area due to short-term changes in light and nutrient availability and salinity.

It would require extensive experimentation over considerable time to develop an effective model that would adequately describe the relative influence of these factors on the distribution of seagrass, amount of seagrass biomass and the species composition. Given the exposure to physical changes and proximity to the Elliot River mouth, it is likely that significant changes in distribution and density of seagrasses would likely occur in this area during the year and between years due to environmental and land-use factors.

The two factors significant to seagrass distribution and productivity that the prawn farm effluent discharge are most likely to influence are nutrient availability and light penetration. I note the advice that your water quality monitoring indicates that ambient nutrient levels in Abbot Bay are significantly above the Australia and New Zealand Environmental and Conservation Council (ANZECC) guidelines. This would suggest that nutrients, particularly phosphorous, are unlikely to be limiting seagrass growth and distribution. Nutrients could limit seagrass growth and distribution in the long-term if there is the potential for nutrients to promote algal development and dominate the seabed ecology. Other important factors to consider in this assessment are the varying volumes and timing of discharge during the year in relation to the seagrass growth cycle, and seasonal weather patterns that may affect sediment movement and hence nutrient storage.

The algae and other suspended matter in prawn farm effluent have the potential to reduce the transmission of light to the seabed and disrupt photosynthesis. The three species present in the area are tolerant of low light situations and require approximately ten – thirty per cent of surface light to grow. These species do not, however, tolerate levels lower than ten per cent for more than short periods of time. As discussed previously, it is our opinion that the effluent will not have a significant affect on light levels.

Prawn farm effluent may also influence salinity and temperature levels, particularly during the drier months of the year. Efforts should be made to ensure the diffuser design maximises mixing and dilution, and reduces the likelihood of warmer, more saline and hence denser effluent water remaining on the seabed. The discharge location should also be located where currents and wave action optimise mixing, without driving effluent onto the foreshore. Where possible, discharge should be undertaken on an ebbing tide after high water.

How to accurately and cost effectively predict how the prawn farm effluent might affect seagrasses?

The EIS identifies a proportion of the seagrass meadow will be in an area where discharge concentrations exceed the ANZECC guidelines for nitrogen and phosphorus and levels of chlorophyll 'a'. This area is relatively small compared with the area of seagrass in Abbot Bay but could still involve a substantial area of seagrass – some eighteen hectares.

The EIS correctly notes that the species of seagrass in Abbot Bay are likely to have a high leaf turnover and are less likely to be effected by epiphyte growth as a result of increased nutrient input than the relatively slower growing temperate species.

Each combination of site dynamics, hydrology and seagrass species and distribution is unique and it is difficult to predict with accuracy either a short- or long-term impact of the planned effluent discharge. Recent scientific papers note "*there remains a lack of ecological meaningful information about the impacts of effluent*" (Jones *et al.*, *Estuarine Coastal and Shelf Science* 2001 **53**, 91-109). These authors also note that the capacity of the system to assimilate added nutrients may not be a sufficient measure to determine impacts on the ecosystem. Burford *et al.* (*Marine Pollution Bulletin* **46** 2003, 1456-1469) also note that while the potential adverse impacts of prawn farm effluent are widely referred to, these are poorly documented in scientific studies. These authors looked at the effluent from two Queensland farms at Port Douglas and Hinchinbrook. Both sites are different from Abbot Bay in that their seagrasses are mostly intertidal. They suggest monitoring ecological processes, not water quality parameters. Their conclusions were that the predominant impacts occur in the water column processes and not in sediment processes. This would suggest that nutrient accumulation in the sediments of Abbot Bay from the prawn farm effluent is unlikely to be significant, particularly given the dilution potential with the prevailing winds and currents, and that discharge will occur for only part of the year.

From these studies DPI&F can infer that it is possible that some seagrass (*Halophila spp.)* may possibly be lost at the deeper edge if there is a significant loss of light passing through a water column due to localised, increased algal concentrations. Increased nutrients are likely to stimulate algal growth leading to a more complex plant community in areas where nutrient levels remain higher than ambient for significant periods of time. Seagrasses may be reduced in density or be lost if this algal community is sufficient to reduce the amount of light reaching the seagrasses. However, as stated previously, the species present in the Bay have a high leaf turnover and are less affected by epiphyte growth. Water column nutrients are likely to favour the growth of epiphytic and macro-algae over seagrasses. The effect of this sort of change and the areas involved would be likely to have a negligible and unmeasurable ecological effect.

Based on the available information, the above prediction of the potential effects on the seagrass meadows has been made. A complex modelling exercise would provide further insight but would require seasonal and annual input parameters for baseline data, requiring several years of research in the field and laboratory prior to farm operation. While that may be desirable, it is not justified by the level of impacts likely to occur.

How to accurately and cost effectively monitor how the prawn farm effluent might affect seagrasses?

Changes in the seagrass meadows adjacent to the prawn farm are likely to occur over a period of years and against a background of possibly high natural variation and climatic events and existing land uses. Sampling regimes would need to be tailored to the site to enable sufficient statistical power to separate changes due to the farm from those occurring naturally. While there are numerous designs available for this purpose, all would be costly given the level and type of sampling required. This raises an unresolved issue as to how this cost should be borne.

From a fisheries point of view, it would be useful to monitor changes in benthic and pelagic fauna as well as plant communities. This is a long-term monitoring task that could be incorporated into existing fisheries long-term monitoring programs and this option would be worth exploring, however, would be dependent on adequate long-term funding.

As per our original advice on the EIS however, it would be desirable for the proponent to give priority to finding and funding ways of reducing the effluent volume and nutrient concentrations leaving the farm rather than on monitoring their effects.