Appendix 6: Risk assessment methods for proposed expansion of marine aquaculture in Macquarie Harbour in relation to matters of national environmental significance

Purpose

To develop a risk assessment and risk management framework for the expansion of marine aquaculture in Macquarie Harbour in relation to Matters of National Environmental Significance (MNES).[1]

Scope

For the purposes of this assessment the project area has been defined as the indicative project area described in Part 2 of the associated referral. This area has been further buffered to include the Gordon River Catchment, associated areas of the Tasmanian Wilderness World Heritage Area and Southwest Conservation Area, and the coastline and adjacent marine environment outside Macquarie Harbour as a conservative approach to the risk assessment process.

The assessment focussed on those actions associated with the marine aquaculture operation. Where possible (i.e. where there are consequential flow-on effects to existing shore facilities) terrestrial matters were also considered. If there is land-based expansion in the future this will require further risk assessment for possible significant impact. The activities that were considered as part of the assessment are contained in Appendix 1.

Methodology

The risk assessment and management methodology is derived from *Ecological Risk Management Framework for the Irrigation Industry* (Hart *et al*, 2005) with additional reference to reports prepared using this methodology. Where necessary, further refinement of methodology has been derived from risk assessment frameworks that have been developed for risk analyses in other relevant fields (e.g. risk assessment for wetlands (Kellett *et al*, 2005; reducing bias in probability analysis, Hillson and Hulett, 2004).

The Risk Assessment considered:
(a) What MNES exist within the proposed project area?
(b) What hazards/risks *associated with the project* may impact on the MNES? (Including direct and indirect impacts, cumulative impacts, and impacts over the short, medium and/or long term).

In undertaking this analysis the following were considered:

- The hazard
- The MNES
- The probability of the hazard impacting on MNES
- The consequence of that impact
- Timeframes of impact
- How all these have been determined

The risk assessment was then divided into two parts:

A. Semi-qualitative risk assessment pre-mitigation, and
B. Semi-qualitative risk assessment following mitigation.

PART A –SEMI-QUALITATIVE RISK ASSESSMENT PRE-MITIGATION

[1] This risk assessment has allowed risks to be identified. Further interpretation has occurred in order to determine whether or not significant impacts are likely.

In Part A, the risk assessment process consisted of 5 phases:

1) Identification of all foreseeable actions[2] to be undertaken as part of the project, and the potential hazards – direct and indirect – that may be created as a result of these actions.
2) Identification of MNES in the project area and within a relevant buffer zone[3] using the Commonwealth Government's on-line Environmental Reporting Tool.
3) Refinement of MNES distribution using all available data sources.
4) Preliminary semi-qualitative assessment of MNES using Significant Impact Criteria (Commonwealth of Australia 2009).
5) Detailed semi-qualitative risk assessment (i.e. taking into account all known data and further analysing this using expert opinion) of all MNES considered to be potentially at risk of significant impact.

It should be noted that the assessment is of risk *prior* to the adoption of any risk mitigation measures. The assessed level of risk does not, therefore, reflect the influence of mitigation strategies on overall risk.

1. Identification of Hazards and Construction of a Hazard – Effects Relationship Table

The risk assessment considered the expansion of marine farming of salmonids in Macquarie Harbour on Tasmania's West Coast. Marine aquaculture potentially involves a number of related activities, including both on-shore and in-water components. Different enterprises employ different methods, and these will be influenced by a range of factors including feasibility, cost, local conditions, distance to markets etc. Furthermore, innovation may result in the adoption of a range of new technologies which may change the way in which activities are undertaken (and therefore the impact those activities may have on the environment).

For the purposes of the assessment it was necessary to consider a "model" marine farming enterprise. This was done through consultation with DPIPWE's marine farming specialists and industry. A preliminary meeting with staff from the Marine Farming Branch (DPIPWE) and an industry representative identified the actions to be undertaken as part of the proposal. This discussion was also informed by reference to *EPBC Act Policy Statement 2.2: Offshore Aquaculture* (Commonwealth of Australia, 2006).

Identification of key ecological effects that could result from the project (including both construction and operation phases) was undertaken by literature review and seeking further expert opinion. The resulting hazard-effect table, which sets out all the major hazards that may cause adverse effects on MNES. This matrix includes hazards that may have both direct and indirect impacts on the value in the short, medium and long-term.

It is acknowledged that not all of the activities considered in the assessment will necessary be undertaken by all (or any) of the operators in Macquarie Harbour. Nevertheless, it is important to undertake the assessment by considering all of those activities that are currently undertaken in this kind of marine aquaculture. That is, the assessment considers a "typical" marine farming operation as well as considering any activities likely to be particular to operations in Macquarie Harbour.

The assessment also acknowledges that industry routinely adopts mitigation measures to maximise productivity and minimise environmental harm. These actions are included in the risk assessment for each MNES, which also acknowledges that some mitigation measures are potentially capable of having a negative impact on such values as threatened fauna (for example, the use of antibiotics to reduce the impact of bacterial disease in farmed fish may impact on wild fish species).

[2] This refers to all actions that would be permitted in the amendment to the plan and foreseeable actions that are consequent on that amendment.

[3] For the purposes of this assessment the "relevant buffer zone" has been defined as (a) the Gordon River catchment subject to tidal influence. That is, that part of the river system that could possibly be impacted – directly or indirectly – by changes in Macquarie Harbour through the movement of such things as nutrients and sediment, and (b) the coastal zone (including marine ecosystems) outside the Macquarie Harbour Heads, where indirect impacts are possible.

It should be noted that the assessment distinguished between those mitigation measures that are common practice in marine farming, and those that may be required to mitigate specific threats to MNES. The assessment in Part A is of risk *prior* to the adoption of specific risk mitigation measures relating to MNES. The assessed pre-mitigation level of risk (LOW, MEDIUM or HIGH) identifies those activities with the potential to impact on MNES, and therefore prioritises those activities for which mitigation may be required.

The combination of likelihood and consequence that results in a threat assessment of MEDIUM or HIGH indicates that mitigation measures will be needed to reduce the risk of significant impact on MNES.

2. Identification of Matters of National Environmental Significance

An initial search using the Commonwealth Government's on-line Environmental Reporting Tool yielded a list of MNES that included a World Heritage Area and Heritage Places, endangered and vulnerable species, and listed migratory species. As a precautionary measure, marine species listed under the EPBC were also considered to ensure that components of the Commonwealth Marine Area off the west coast of Tasmania were not likely to be indirectly impacted by the proposal.

3. Refinement of distribution data

The derived list of MNES individual species and ecological communities was further refined by interrogating all available distribution data sources. This was undertaken as the coarseness of the initial data search resulted in a number of species being included that are not known to exist within the project area or buffer (for example the Tasmanian Giant Freshwater Crayfish, which has not been recorded from within 100km of the project area).

The following available data sources were used for this process:

Listed threatened ecological communities:

- Tasmanian Government's Natural Values Atlas (www.naturalvaluesatlas.dpiw.tas.gov.au);

Listed threatened species:

- Tasmanian Government's Natural Values Atlas (www.naturalvaluesatlas.dpiw.tas.gov.au);
- Conservation and Listing Advice;
- Commonwealth Government's Species Profile and Threats Database (SPRAT);
- Recovery Plans (Commonwealth and State);
- Threatened Species Modelled Extents developed by the Tasmanian Forest Practices Authority (FPA, 2008) for swift parrot;
- Threatened Fauna Handbook (Bryant and Jackson, 1999);
- Forest Practices Authority on-line fauna information (http://www.fpa.tas.gov.au/index.php?id=82).

Listed migratory species, Listed Marine Species and Whales and Other Cetaceans:

- Tasmanian Government's Natural Values Atlas (www.naturalvaluesatlas.dpiw.tas.gov.au);

In addition, expert advice was sought for those species whose distribution appeared to be poorly known, or for which there were no recent records.

4. Semi-qualitative risk assessment of MNES

The identified MNES were subjected to preliminary quantitative and semi-qualitative risk analyses based on the likelihood of the MNES being impacted in any significant way by the project. This process involved desktop analysis of distribution data and known hazards, as well as expert opinion.

Significance was determined by application of the criteria contained in *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Commonwealth of Australia, 2009).

Preliminary assessments considered both direct and indirect impacts, over short, medium and long time frames.

A precautionary approach was taken where gaps in relevant knowledge were identified. That is, if the distribution of a species was considered to be poorly understood it was assumed that the potential impact may be significant and therefore more detailed risk analysis was required. In this way the preliminary analysis included an estimation of confidence, and any matter where the confidence was not considered good was referred for further risk analysis.

The purpose of this assessment phase was to determine which MNES required more detailed risk assessment, and which would not be susceptible to significant impact as a result of the proposal.

5. Detailed semi-qualitative risk assessment

All values not excluded by the initial risk analysis were then subjected to a semi-qualitative risk assessment using the matrix recommended by Hart *et al* 2005, and based on *Environmental Risk Management: Principles and Practice*, (Standards Australia/Standards New Zealand, 2006) – Figure A6.1.

Likelihood		Consequence				
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost Certain	(5)	5	10	15	20	25
Likely	(4)	4	8	12	16	20
Moderately likely	(3)	3	6	9	12	15
Unlikely	(2)	2	4	6	8	10
Rare	(1)	1	2	3	4	5

Figure A6.1: Categories of risk for qualitative assessment. Likelihood and consequence are scored subjectively. Risk ratings are scored and categorized as High (dark shading), Medium (light shading) and Low (no shading) (after Hart *et al*, 2005).

The semi-qualitative rather than a quantitative risk analysis method was adopted because the purpose of the analysis is to determine risk to MNES based on EPBC Act principles. That is, it is designed to determine whether the reaching of a risk threshold (with a "significant impact") is likely to occur.

Application of the matrix involved answering the following questions:

1. How likely is it that the hazard(s) identified from the hazard-effect relationship analysis undertaken as part of the problem formulation (scoping) phase will impact on the identified value? [likelihood or probability]

2. How significant will this impact be? [consequence].

It should be noted that "significance" in this context was determined by the criteria identified in Commonwealth of Australia, 2009; it does not relate simply to whether the hazard/impact will result in the elimination of the value from the area.

While this process provides a score by which values and threats may be ranked, it relies on expert opinion, and is therefore subject to a number of assumptions and constraints. The first significant

assumption is that the expertise available to apply the matrix is sufficient to provide a valid result. Lack of available expertise is a significant constraint; however, in the case of this analysis there was recognised (peer-supported) expertise available for each of the values being analysed, with population and other data available to support each individual assessment.

PART B –SEMI-QUALITATIVE RISK ASSESSMENT POST-MITIGATION

In order to determine residual risk mitigation measures were applied to each action identified in Part A as posing a MEDIUM or greater risk of a significant impact on MNES. Those assessed as LOW risk have not been considered further (although it is recognised that the mitigation measures proposed will further reduce risks across a range of species and other values).

APPENDIX 1: Hazard-Effect Table used in the Risk Assessment Process

The Hazard-Effect Table identifies the **Hazard** (the action that may have an impact on an ecological value), the **Impact** (the result – both direct and indirect – of that action) and the **Risk** (the potential consequence for ecological values).

Phase	Hazard	Impact	Risk
Construction – On-Shore	**On-shore facilities – road access**	Soil and vegetation removal Direct mortality Soil dumping Introduction of weeds, diseases Noise/disturbance Vehicle and machinery movement	Loss of individuals Fragmentation of communities Loss of breeding/feeding/resting habitat (fauna) Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduce potential for genetic diversity Interruption to breeding (fauna)
	On-shore facilities – sheds etc	Soil and vegetation removal Direct mortality Soil dumping Introduction of weeds, diseases Noise/disturbance Vehicle and machinery movement Visual amenity impacts	Loss of individuals (flora and fauna) Fragmentation of communities Loss of breeding/feeding/resting habitat (fauna) Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduced potential for genetic diversity Interruption to breeding (fauna) Loss of heritage values
	Laydown areas	Physical damage to vegetation Direct mortality Introduction of weeds, diseases Noise/disturbance Vehicle and machinery movement Soil compaction	Loss of individuals (flora and fauna) Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduced potential for genetic diversity Interruption to breeding (fauna)
	Pumping/treatment/waste disposal stations	Soil and vegetation removal Soil dumping Introduction of weeds, diseases Noise/disturbance Vehicle and machinery movement	Loss of individuals (flora and fauna) Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduced potential for genetic diversity Interruption to breeding and migration (fauna)
	Soil disposal	Physical damage to vegetation Direct mortality Introduction of weeds, diseases Noise/disturbance Vehicle and machinery movement	Loss of individuals (flora and fauna) Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Interruption to breeding (fauna)
	Storage (construction materials/machinery)	Physical damage to vegetation	Loss of individuals (flora and fauna) Increased competition or disease,

		Introduction of weeds, diseases Noise/disturbance Vehicle and machinery movement	leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduced potential for genetic diversity Interruption to breeding (fauna)
	Bank stabilisation	Direct mortality Soil and vegetation removal Soil dumping Introduction of weeds, diseases Noise/disturbance Vehicle and machinery movement Soil compaction	Loss of individuals (flora and fauna) Loss of habitat Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduced potential for genetic diversity Interruption to breeding (fauna)
	Boat moorings/wharf structure	Direct mortality Introduction of pests, diseases Noise/disturbance Vehicle and machinery movement Physical/structural disturbance of substrates and fauna. Increased sedimentation	Loss of individuals (flora and fauna) Loss of habitat Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduced potential for genetic diversity Interruption to breeding (fauna)
	Dredging	Direct mortality Introduction of pests, diseases Noise/disturbance Vehicle and machinery movement Physical/structural disturbance of substrates and fauna. Increased sedimentation	Loss of individuals (flora and fauna) Loss of habitat Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduced potential for genetic diversity Interruption to breeding (fauna)
Construction – Marine	**Cage deployment - moorings**	Direct mortality Introduction of pests, diseases Noise/disturbance Vehicle and machinery movement Physical/structural disturbance of substrates and fauna. Increased sedimentation.	Loss of individuals (flora and fauna) Loss of habitat Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduced potential for genetic diversity Interruption to breeding (fauna)
	Cage deployment – cages, support barges	Direct mortality Introduction of pests, diseases Noise/disturbance Vehicle and machinery movement	Loss of individuals (flora and fauna) Loss of habitat Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna)

		Physical/structural disturbance of substrates and fauna. Increased sedimentation. Visual impact	Reduced potential for genetic diversity Interruption to breeding (fauna) Loss of heritage values
	Vessel activity	Oil spill Noise	Loss of habitat Interruption to breeding (fauna) Loss of heritage values
	Mitigation / Rehabilitation measures	Introduction of weeds, pests, diseases Noise/disturbance Vehicle and machinery movement Soil compaction	Increased competition or disease, leading to mortality (flora and fauna) Interruption to breeding (fauna) Recruitment prevented or reduced (flora and fauna)
Operation – Land	**Transport**	Noise, collision	Interruption to breeding (fauna) Mortality
	Lighting	Disruption of movement, including bird-strike	Direct mortality Interruption to breeding (fauna)
	Extended hours / industrial activity	Noise	Interruption to breeding (fauna)
	Vessel movement	Oil spill Noise	Loss of habitat Interruption to breeding (fauna) Loss of heritage values
	Water usage	Water level fluctuation Changed flow regime Changed nutrient levels Increased sedimentation	Loss of individuals (flora and fauna) Habitat loss Diminished breeding capacity Reduced food availability
	Erosion	Changed nutrient levels Increased sedimentation Soil and vegetation removal	Loss of individuals (flora and fauna) Habitat loss Diminished breeding capacity Reduced food availability
	Dredging (adjacent to land based ops and not associated with farm operation)	Direct mortality Introduction of pests, diseases Noise/disturbance Vehicle and machinery movement Physical/structural disturbance of substrates and fauna. Increased sedimentation	Loss of individuals (flora and fauna) Loss of habitat Increased competition or disease, leading to mortality (flora and fauna) Recruitment prevented or reduced (flora and fauna) Reduced potential for genetic diversity Interruption to breeding (fauna)
Operation - Marine	**Pest species transfer – material introduction and stocking**	Introduction of, pests, diseases	Loss of individuals Interruption to or reduced capacity for breeding

			Habitat loss Reduced food availability
	Lighting (above and below)	Direct mortality (birdstrike) Disruption of movement, Visual impact	Loss of individuals Interruption to breeding (fauna) Loss of heritage values
	Energy generation	Noise Pollution	Loss of heritage values Interruption to breeding (fauna)
	Cages, barges		Loss of heritage values
	Wildlife interaction control nets	Direct mortality (entanglement)	Loss of individuals Interruption to breeding (fauna) Loss of heritage values
	Wildlife interaction control sound	Noise	Loss of individuals Interruption to breeding (fauna) Loss of heritage values
	Moorings	Increased sedimentation	Habitat disruption
	Farming		
	Feeding	Direct mortality Eutrophication Benthic smothering Increase in nuisance species	Loss of individuals (fauna) Reduced potential for genetic diversity Interruption to reproduction
	1. Metabolic waste (particulate) / waste feed	Benthic smothering Increase in nuisance species	Loss of individuals (fauna) Reduced potential for genetic diversity Interruption to reproduction Habitat alteration
	2. Metabolic waste (soluble)	Changes in water chemistry	Habitat alteration Changes to food availability
	Therapeutics and chemicals	Changes in water chemistry Genetic impacts Increased disease risk	Habitat alteration Changes to food availability Changes to species Loss of individuals
	Anti-fouling	Direct mortality Changes in water chemistry Genetic impacts	Loss of individuals Increased disease risk Changes to food availability
	Waste materials – fish mortality (bio),	Changes in predator behavior Entrapment (pits) Changes in water chemistry	Interruption to breeding cycles / behaviours Increased disease risk Changes to food availability
	Waste materials – waste-water, rubbish	Changes in water chemistry Entanglement Visual impact	Loss of individuals (fauna) Loss of heritage values Increased disease risk Changes to food availability
Land Use Change	**Escapees - predation**	Predation risk	Loss of individuals (fauna) Loss of heritage values

	Escapees – establishment of wild population	Predation risk	Loss of individuals (fauna) Loss of heritage values
	Escapees – fish down & recreational (netting)	Noise Pollution Entanglement	Loss of individuals (fauna) Interruption to breeding (fauna) Loss of heritage values
	Changing nets, grading, sorting, harvesting, maintenance	Noise Pollution	Loss of individuals Interruption to breeding (fauna) Loss of heritage values
	Increased recreation (boating, on-shore)	Noise Pollution Direct mortality	Loss of individuals Interruption to breeding (fauna) Loss of heritage values
	Environmental monitoring in both Harbour and WHA	Noise Introduction of pests etc	Loss of individuals Interruption to breeding (fauna) Loss of heritage values
	Shoreline cleanups	Noise Introduction of pests etc	Loss of individuals Interruption to breeding (fauna) Loss of heritage values