

**FINFISH AQUACULTURE IN
WESTERN AUSTRALIA:
FINAL ESD MANAGEMENT REPORT
FOR MARINE FINFISH AQUACULTURE**

FISHERIES MANAGEMENT PAPER NO. 233

Published by
Department of Fisheries
168 St. Georges Terrace
Perth WA 6000

June 2009
ISSN 0819-4327

Finfish Aquaculture in Western Australia:
*Final ESD Management Report
for Marine Finfish Aquaculture*

June 2009

Project Manager and author: Fiona vom Berg

Fisheries Management Paper No. 233

ISSN 0819-4327



Government of **Western Australia**
Department of **Fisheries**

CONTENTS

DISCLAIMER.....	1
ACKNOWLEDGEMENTS	1
GLOSSARY.....	2
1.0 INTRODUCTION.....	3
2.0 ENVIRONMENTAL ASSESSMENT & LICENSING	4
2.1 Current Assessment Processes	5
2.1.1 Department of Fisheries	6
2.1.2 Department of Environment and Conservation.....	6
2.2 Moving Forward	6
2.3 The Memorandum of Understanding.....	7
3.0 THE ESD FRAMEWORK.....	9
3.1 Issues Identification	9
3.1.1 What is the ESD framework?.....	9
3.1.2 How does the ESD framework operate?	9
3.2 Management Report.....	10
3.3 Codes of Practice	10
3.4 Management and Environmental Monitoring Plan (MEMP)	10
4.0 FINFISH AQUACULTURE IN WA	11
4.1 Cage Culture	11
4.2 Diet.....	11
5.0 OUTLINE OF REPORTING PROCESS.....	12
5.1 Overview.....	12
5.2 Issues Identification (Component Trees)	12
5.3 Risk Assessment/Prioritization Process.....	14
5.4 Component Reports	16
5.5 Regional/Catchment Areas for Level 2 Assessments	17
5.5.1 IMCRA Regionalization.....	17
6.0 MANAGEMENT REPORTS	19
6.1 Impacts on the General Environment (Whole of Industry)	19
6.1.1 Wild Stock of Cultured Species	20
6.1.2 Cultured Stock/Business (Husbandry)	27
6.1.3 Other Species/Communities/Processes	31
6.2 Impact of the Industry on the Region (Cumulative Impacts)	45
6.2.1 Water Use	46
6.2.2 Ecological Community Structure and Biodiversity	53
6.2.3 Physical Structures, Construction and Tenure.....	76
6.2.4 Production	88

6.3 Impacts from Individual Facilities on Environmental Wellbeing	95
6.3.1 Site Selection.....	96
6.3.2 Operation.....	115
7.0 APPENDIX	161
8.0 REFERENCES.....	162

DISCLAIMER

The information in this document is derived from sources believed to be reliable and accurate at the time of release. The publisher disclaims any responsibility or duty of care towards any person for loss or damage suffered from any use of this publication for whatever purpose and in whatever manner. While considerable care has been taken in producing this publication, the publisher accepts no responsibility for errors or omissions. The information is provided solely on the basis that readers will be responsible for making their own assessment of the matters contained or discussed herein and are advised to verify all relevant representations, statements, information and advice. No person should rely solely on this publication for the purpose of making business or investment decisions.

© Department of Fisheries

ACKNOWLEDGEMENTS

A number of government officers contributed to the development of this project and subsequent Management Report.

- Peter Skitmore Department of Environment and Conservation
- Steve Nel Department of Fisheries

The author would also like to thank the following people for providing thoughts, ideas and constructive comment during the development of this report.

- Stephanie Turner Department of Fisheries
- Victoria Weir Department of Fisheries
- Greg Jenkins Challenger TAFE
- Guy Westbrook Marine Produce Australia Pty Ltd
- Erica Starling Indian Ocean Fresh Australia Pty Ltd
- Dan Machin Aquaculture Council of WA
- Cameron Sim Department of Environment and Conservation
- Carissa Aitken Department of Environment and Conservation
- Kevin Crane Department of Environment and Conservation
- Fran Stanley Department of Environment and Conservation
- Rae Burrows Department of Fisheries

GLOSSARY

ACWA	Aquaculture Council of Western Australia
ADC	Aquaculture Development Council
APVMA	Australian Pesticides and Veterinary Medicines Authority
Aquafin CRC	Aquafin Cooperative Research Centre
BAM Act	<i>Biosecurity and Agriculture Management Act 2007</i>
BAMB	Biosecurity and Agriculture Management Bill
CALM	Department of Conservation and Land Management
DEC	Department of Environment and Conservation
DIA	Department of Indigenous Affairs
DoW	Department of Water
DPI	Department of Planning and Infrastructure
EBFM	Ecosystem-Based Fisheries Management
ESD	Ecological Sustainable Development
EMP	Environmental Monitoring Program
MEMP	Management and Environmental Monitoring Plan
EPA	Environment Protection Authority
EP Act	<i>Environment Protection Act 1986</i>
EPBC Act	<i>Environmental Protection and Biodiversity Conservation Act 1999</i>
ERA	Ecological Risk Assessment
FRDC	Fisheries Research and Development Corporation
FRMA	<i>Fish Resources Management Act 1994</i>
FRMR	<i>Fish Resources Management Regulations 1995</i>
GMO	Genetically modified organism
IDCA	Inter-Departmental Committee of Aquaculture
IFM	Integrated Fisheries Management
NAC	National Aquaculture Council
PIRSA	Primary Industries and Resources of South Australia
RAMSAR	<i>The Conservation of Wetlands of International Importance, especially as Waterfowl Habitat, signed at Ramsar Iran, in 1971</i>
SARDI	South Australia Research and Development Institute
SBT	Southern bluefin tuna
SWQMS	State Water Quality Management Strategy
WAPC	Western Australian Planning Commission
WQ	Water quality
WQPN	Water Quality Protection Note

1.0 INTRODUCTION

Aquaculture is one of the faster growing industries in Australia, having grown in value by over 13 per cent over the past 10 years. It is currently valued at \$743 million with an industry vision to achieve \$2.5 billion in sales by 2010. In Western Australia the industry is still in its infancy, with a total of 457 aquaculture licensees across the State producing a variety of species from finfish (barramundi, silver perch, rainbow trout, pink snapper and black bream), to marron and yabbies, black pearls, mussels and ornamental fish. Not counting marine algae production, the farm gate value of aquaculture production in 2007/08 was over \$9.4 million. Grow-out weight of finfish alone was over 400 tonnes.

It has been recognized that there are a number of potential impediments to achieving continued growth of this industry. These include the need for increased investment, an expansion in markets and ensuring environmental sustainability. One of the most important however, is meeting the growing expectations of the community that all aquaculture sectors can clearly demonstrate that they are operating within the principles of Ecologically Sustainable Development (ESD).

Western Australia's Department of Fisheries is responsible for the management of aquaculture in the State and is committed to implementing ESD. These principles are contained within the objectives of the *Fish Resources Management Act 1994* and the agency is keen to demonstrate both to the Government and the broader community that these principles are being achieved. The Department developed a policy statement in 2002, *Policy for the Implementation of Ecologically Sustainable Development for Fisheries and Aquaculture within Western Australia* (Fletcher 2002) to provide direction to the agency on incorporating ESD within fisheries and aquaculture management.

Using the ESD Framework for Aquaculture, which was generated by the Fisheries Research and Development Council (FRDC) subprogram in conjunction with the Aquaculture Committee of the Australian Fisheries Managers Forum and the National Aquaculture Council (the national peak industry representative body), the marine and land-based finfish aquaculture sector is being run through this process, to be followed by the prawn aquaculture sector.

This ESD report provides a comprehensive overview of the information pertaining to the finfish aquaculture sector. A major element is the explicit determination of the operational objectives, performance measures and indicators that will be used to assess performance against environmental management requirements. Most importantly, this report includes appropriately detailed justifications for the levels chosen and the methods used. Therefore, the Department of Fisheries' annual *State of the Fisheries* publication reports on the evaluation of performance of the finfish aquaculture sector against these sets of "agreed" objectives/performance measures.

As stated in the Department's ESD policy "*Policy for the Implementation of Ecologically Sustainable Development for Fisheries and Aquaculture within Western Australia*" (Fletcher 2002), it is expected that the ESD report, and therefore the objectives and performance measures, will be reviewed every five years to ensure that they remain relevant and appropriate with current scientific protocols, social attitudes and prevailing environmental conditions.

2.0 ENVIRONMENTAL ASSESSMENT & LICENSING

All applications for aquaculture licences in Western Australia are issued pursuant to Sections 96 and 97 of the *Fish Resources Management Act 1994*. Ministerial Policy Guideline No. 8 sets out the assessment process for aquaculture proposals in the aquatic environment within WA. The Department of Fisheries refers specific types of aquaculture licence applications or those in sensitive locations, to the Environmental Protection Authority for environmental impact assessment under Part IV of the *Environmental Protection Act 1986*. The Department for Environment and Conservation also regulates certain types of aquaculture facilities which discharge waste to the environment under Part V of the *Environmental Protection Act 1986*.

There are instances of duplication and overlap in the assessment of government regulatory control in relation to aquaculture premises. The Department of Fisheries, the Department of Environment and Conservation, the Aquaculture Council of Western Australia (ACWA) and licensees raised concerns regarding this duplication in the light of there being no perceived benefits. It was agreed that the burden on licensees and the wasteful nature of government resources needed to be addressed.

The former Department of Environment initiated a review of the environmental licensing and works approval regime, as part of the Prescribed Premises Review, in late 2005 to:

1. Review the triggers point for licensing (amend the activities that would be ‘prescribed’), with a view of reducing the number of licenses for aquaculture activities.
2. Reduce the duplication of management of certain issues (e.g. remove the case where one issue, say, dust management, is managed and licensed by three decision-making authorities).
3. Review of environmental licence conditions with a view to remove conditions that are not necessary/useful/meaningful.

The results of this review were that aquaculture activities in general are low risk and that the prescribed premises should be amended to totally preclude aquaculture activities from the requirement to be environmentally licensed.

On the basis that aquaculture activities in Western Australia, licensed since 1996, have proven to be a low environmental risk, the current proposal is to:

1. Remove all aquaculture facilities from the prescribed premises list, resulting in there being no requirement for environmental licences and works approvals.
2. Ensure that an appropriate environmental management regime remains within the aquaculture industry, so a Memorandum of Understanding will be established between the Department of Environment and Conservation and the Department of Fisheries. The elements of the memorandum are proposed to cover: requests to the Department of Environment and Conservation for advice; provision of aquaculture licensing information; independent monitoring/auditing; annual reporting of monitoring; and Codes of Practice.

The Memorandum of Understanding between the Department of Environment and Conservation and the Department of Fisheries will ensure that appropriate environmental regulation, management and reporting of the aquaculture industry persist for currently prescribed premises under the *Environmental Protection Regulation 1987* following the removal of the requirement for environmental licences and works approval by the Department of Environment and Conservation.

The Minister for Environment formally agreed to this proposal in early 2006.

2.1 Current Assessment Processes

Aquaculture is an industry currently regulated by two departments and local authorities within Western Australia. Within the Department of Environment and Conservation, premises are licensed under Part V of the *Environment Protection Act 1986*. They fall under Category 3 or 4 of the prescribed premises list under the *Environmental Protection Regulations 1987*.

Category 3: Aquaculture (ponds or tanks)

Premises on which -

- (a) marine, estuarine or freshwater fish or prawns are propagated or reared; and
- (b) supplementary feeding occurs,

in ponds or tanks that discharge waste into waters or onto land (biomass of 1,000 kg or more).

Category 4: Aquaculture (natural waters)

Premises on which –

- (a) marine, estuarine or freshwater fish or prawns are propagated or reared; and
- (b) supplementary feeding occurs,

in enclosures in naturally occurring water.

Currently the Department of Environment and Conservation administers 14 licences (11 x Category 3, 3 x Category 4) and 6 works approvals (all Category 3). The Department of Environment and Conservation works approval and licensing process is concerned primarily with pollution prevention and the management of discharges and emissions. In the case of aquaculture, this is primarily the discharge of nutrients.

Aquaculture also requires a licence from Department of Fisheries and in the case of land-based aquaculture on freehold land, requires planning approval from the relevant local government authority.

Large or environmentally significant aquaculture proposals¹ are assessed by the Environment Protection Authority under the provision of Part IV of the *Environment Protection Act 1986*.

¹The Environment Protection Authority considers that environmental significance is a function of:

- the extent and consequence of impacts on biophysical aspects;
- the environmental values of the area affected;
- the extent of emissions and their potential to unreasonably interfere with the health, welfare, convenience, comfort or amenity of people the potential for biophysical impacts of the proposal to significantly and adversely change people's social surrounding;
- the extent and rigour to which potential impacts have been investigated and described in the referral, and the confidence in the reliability of predicted impacts;
- the extent to which the proposal implements the principles of sustainability;
- the ability of decision-making authorities to place conditions on the proposal so ensure required environmental outcomes are achieved; and
- the likely level of public interest, and the extent to which the proponent has consulted with interested and affected people and responded to issues raised.

Environmental Guidance for Planning Development Draft Guidance Statement No. 33 (Environmental Protection Authority June 2005)

2.1.1 Department of Fisheries

Within the framework that has been established by the Fish Resources Management Act 1994, Ministerial Policy Guidelines are issued under Section 246 for the assistance of the Chief Executive Officer in decision-making and for the information of the fishing and aquaculture industry, and the wider community.

Policy guidelines set out matters that the Minister responsible for the administration of the Act considers to be of importance in respect of the performance by the Chief Executive Officer of this function under the Act.

In December 1997, the Minister published Ministerial Policy Guideline No. 8, which sets out in detail the extensive public consultation process to be used in considering and assessing applications in coastal waters, together with key matters to be considered as part of the decision-making process. This Ministerial Policy Guideline has been used since that time and is set for review in 2009.

Proposals can also be referred to the Environmental Protection Authority for environmental impact assessment, which can be either an informal or formal process under the *Environmental Protection Act 1986*. This process will not be altered by the licence changes proposed through the Memorandum of Understanding.

2.1.2 Department of Environment and Conservation

When the prescribed premises list was initially developed under the *Environmental Regulations 1987*, the knowledge base and experience in the aquaculture industry in WA was limited and its licensing requirements were influenced by experiences elsewhere.

Since 1996, with the increased development of the aquaculture industry and 12-years experience in licensing various premises, the environmental implications of this industry have been clarified.

Since 1996, a wider variety of statutory provisions became available to the Department of Environment and Conservation under the *Environment Protection Act 1986*. These include Environmental Harm, Unauthorized Discharge Regulations and wider provisions for Environmental Protection Notices. As such, the need to use licences as the preferred tool to manage aquaculture activities is no longer essential.

2.2 Moving Forward

It is now a widely held view that the majority of aquaculture activities have been managed by operators such that unacceptable environmental outputs have not been observed. Complaints to the Department of Environment and Conservation about aquaculture are few and have not been focussed on water quality issues. The major areas of complaint about aquaculture activities relate to:

- stream flow;
- water allocation;
- stream bed and bank disturbance;
- vegetation loss; and
- wetlands

Monitoring of emissions from aquaculture projects has not shown nutrients or other waste components constitute a problem.

As mentioned previously, Part V of the *Environment Protection Act 1986* deals primarily with pollution prevention, managing emissions and discharges into our environment, by issuing Works Approvals for the construction of premises, and licences for the operation. Within these instruments, conditions are set, allowing particular activities or emissions to take place, or design and operations specifications that must be adhered to. The major issues mentioned above, are not, and cannot be addressed under Part IV processes of the *Environment Protection Act 1986*.

From the Keating and Welker reviews, the issue of duplication and overlap were acknowledged as a major problem throughout government departments. Currently, within the aquaculture industry, the Department of Fisheries and the Department of Environment and Conservation both have major involvement in licensing requirements. It is a complex process to begin construction and operations of an aquaculture facility, obtaining approvals from these government departments along with local government authorities and often one step cannot continue before approval from another is completed. This creates significant problems for operators in this industry and reflects badly on Government.

Often, both departments manage the same issues and this overlap creates inefficient use of resources and time by officers, unnecessary confusion to proponents, and inhibits transparency.

The Department of Fisheries currently have about 130 licenses, some of which with the current arrangements could potentially require Part V licensing. The proposal will therefore reduce the number of licences needing Department of Environment and Conservation approval. This, together with the reduction of licences, will ensure that Department of Environment and Conservation resources will be allocated to more significant and urgent environmental issues.

Specific issues relating to water resources and vegetation clearing could also be managed under existing Acts and Regulation, such as water allocation under *Rights in Water and Irrigation Act 1914* (RIWI Act) and native vegetation protection under the *Environment Protection Act 1986*.

The process of implementing a Memorandum of Understanding and removing the requirement of Part V to licence aquaculture premises will reform the regulatory control of the industry. There will be a more transparent, robust and defined responsibility between agencies and above all, the environmental risks associated with this activity should not be increased.

2.3 The Memorandum of Understanding

It is proposed that the future management of aquaculture premises be undertaken solely via Department of Fisheries licences and that a Memorandum of Understanding between Department of Fisheries and the Department of Environment and Conservation be developed to ensure the environmental interest previously managed by the Department of Environment and Conservation are addressed via the Department of Fisheries' regulatory role.

The requirements to be included in the Memorandum of Understanding are as follows:

- a) Environmentally-significant, large-scale or contentious aquaculture projects will continue to be assessed and managed under Part IV of the *Environment Protection Act 1986* by the Environment Protection Authority. The use of Part V as well as Part IV for such projects will not add value and is duplicating regulation.
- b) The Department of Environment and Conservation will ensure its environmental protection interests and responsibilities are met via the Memorandum of Understanding with the Department of Fisheries. This memorandum will have input from industry groups and the general public.

- c) Current Department of Environment and Conservation and Department of Fisheries' guidelines will continue to be utilised and referred to in the management process (i.e. Ministerial Policy Guideline No. 8).
- d) The Department of Fisheries will provide monitoring and reporting of any significant industry issues and problems on a periodic basis (i.e. on a six-month or a 12-month period) to the Department of Environment and Conservation.
- e) Such results will be provided in a publicly available form (i.e. electronically web-based PDF document) for relevant groups and members of the general public to access.
- f) If environmental harm does occur in a specific instance, this will be managed by the Department of Environment and Conservation under existing statutory provisions of the *Environment Protection Act 1986*.
- g) The Department of Fisheries will continue to issue its own licences covering relevant matters in accordance with the *Fish Resources Management Act 1994* and the Memorandum of Understanding.
- h) Before Department of Fisheries issues any licences, it will continue to seek input from the Department of Environment and Conservation under the Ministerial Policy Guideline No. 8 consultation processes. This will enable any key environmental matter to be addressed.
- i) There will be periodic review of the operation of the Memorandum of Understanding and the environmental outcomes achieved.
- j) The Department of Fisheries will ensure that periodic independent monitoring and inspections of aquaculture facilities are undertaken to ensure environmental standards are being maintained. This will be required as part of the Department of Fisheries licence conditions. Results of such monitoring and inspections will be provided to the Department of Environment and Conservation and interested stakeholders.

3.0 THE ESD FRAMEWORK

3.1 Issues Identification

Until recently, there were no methods available to implement Ecologically Sustainable Development (ESD) in a full and practical manner. During the past four years, work within the Fisheries Research and Development Council subprogram on ESD Reporting and Assessment has been underway to develop a series of national ESD frameworks to enable all Australian fisheries and aquaculture sectors to demonstrate that they are operating utilizing ESD principles (Fletcher *et al.* 2004).

3.1.1 What is the ESD framework?

The ESD framework for aquaculture has similarities to the ESD framework developed for wild capture fisheries. Both frameworks help to identify the relevant environmental, social/economic and governance issues; assist with determining the appropriate level of management response using risk assessment techniques; and provide a reporting structure to document outcomes. For aquaculture, they are structured into three different spatial levels:

- ‘whole of industry’ issues;
- catchment/regional issues; and
- within facility issues.

This hierarchical approach is designed to show the linkages between what is required at the operator level and the outcomes wanted by government/community at the regional and whole of industry scales.

The guide can be used to facilitate the development of reports/assessments at the ‘whole of industry’ level, at a regional level or as the basis for an Environmental Management System at the facility level. Thus, it can be used at whatever level is appropriate depending upon the questions being asked and who is asking them.

Given that most aquaculture operations are assessed/approved at an individual facility level and a large number of government agencies are usually involved in the assessment of aquaculture, the ESD framework for aquaculture can also function as a set of guidelines for coordinating processes and ensuring due diligence, not just as a method for the generation of a single report on an industry.

Finally, the ESD framework has not been developed to add more steps to the process of approvals for aquaculture leases/licenses. Instead, it is designed to help minimize overlaps, redundancies and omissions in the current procedures to improve the efficiency and effectiveness of the outcomes for both industry participants and the wider community.

3.1.2 How does the ESD framework operate?

There are five key elements used in the process to complete an ESD report for an aquaculture sector:

- a) identifying the issues relevant to the industry/sector/individual;
- b) prioritising these issues;
- c) completing suitably detailed reports/management strategies for each issue (dependent upon their priority, complexity and the scope of the requirements – ie whole of industry, a region or even just a single operator);

- d) compile summary background material on the industry (where relevant), the major species affected and the environments that the industry operates within (this enables the reader to put the material presented within any report into an appropriate context); and.
- e) using the generated material to assist individuals or industry (e.g. for use in generating Environmental Management Systems or Code of Practices) or by agencies as the basis for demonstrating they are achieving appropriate outcomes for government (e.g. Reports to Parliament).

This framework report forms Publication No. 6 of the FRDC - ESD Reporting and Assessment Subprogram and can be downloaded from the web at: <http://www.aqua-esd.com>

In 2006, the Department of Fisheries organised a workshop for each species currently listed as being Category 3 or Category 4, namely marine and land-based finfish, as well as prawn aquaculture. Attendees at the workshop represented relevant government agencies (Department of Fisheries, Department of Environment, Department of Water), industry players and interest groups (Conservation Council). The workshops identified the issues specific to each sector and classified the risks for those issues. Justification for the risk value and ranking were provided for each issue identified: the level of information provided appropriate to the perceived risk. These reports are available as Fisheries Management Papers No. 229 and No. 230.

3.2 Management Report

This management report (Fisheries Management Paper No. 233) incorporates input from workshop participants as well as other officers from within the Department of Environment and Conservation and the Department of Fisheries. This document provides the basis for all further work, such as licence conditions, the Code of Practice and the Management and Environmental Monitoring Plan. This report formed the basis for discussion at the workshop held in December 2008 and includes comments from participants.

3.3 Codes of Practice

The Department of Fisheries supports the development of Codes of Practice for industry sectors and will support these codes through licensing conditions and/or regulations where possible. In order to maintain best practice, the Department of Fisheries will develop Code of Practices in accordance with the ESD Framework, in agreement with the Department of Environment and Conservation and the Aquaculture Council of Western Australia.

The 'outputs' developed at the facility level have been used to develop a Code of Practice for marine finfish aquaculture in WA. This document will be available for public comment.

3.4 Management and Environmental Monitoring Plan (MEMP)

Issues that have been identified as being of medium-to-high risk have been taken forward into the sector-specific Management and Environmental Monitoring Plan. These plans will be developed in collaboration with the Department of Environment and Conservation and will be enforced through Department of Fisheries' licence conditions. Annual reporting to the Department of Fisheries will be independently audited, with the reports being forwarded to the Department of Environment and Conservation for review.

Audit reports will be available for public review and form the basis for aquaculture input into the Ecosystems Based Fisheries Management framework.

The generic Management and Environmental Monitoring Plan will also be available for public comment.

4.0 FINFISH AQUACULTURE IN WA

The species being farmed in the marine environment currently in WA are barramundi, mulloway and yellowtail kingfish, although more are authorized through various aquaculture licenses.

There are a number of general reviews on the environmental impacts of marine finfish aquaculture and although these reviews draw upon experience from countries other than Australia, many of the issues discussed in these papers are relevant to Western Australian aquaculture.

4.1 Cage Culture

The grow-out method being considered in this report is cage culture in marine and/or estuarine waters. Relatively few companies are using this technique, primarily because of the difficulties in obtaining government approval to establish fish farms in public waters. Cage culture in estuarine or marine waters has advantages over other systems, particularly where large-scale production is envisaged. There are, however, challenges with bio-fouling of cages and to a lesser extent, predators, which can cause holes in the cage and hence the escape of stock. Predator nets around the cages are recommended.

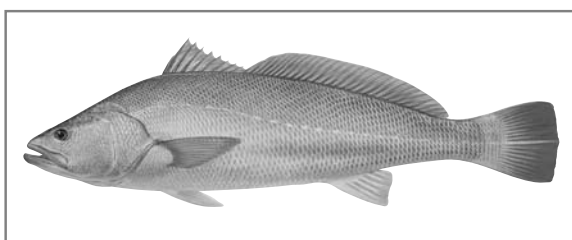
4.2 Diet

In Australia, farmed finfish are reared on dry, pelleted diets, in contrast to South-East Asia where they are usually reared on 'trash' fish or in association with a foraging species such as *Tilapia* spp. Weaning fry from live feed to dry crumbles can be commenced with fry as small as 10 mm total length, but much better survival and quicker adaptation onto the dry diets is obtained if weaning is delayed until the fry are at least 15 to 20 mm total length.

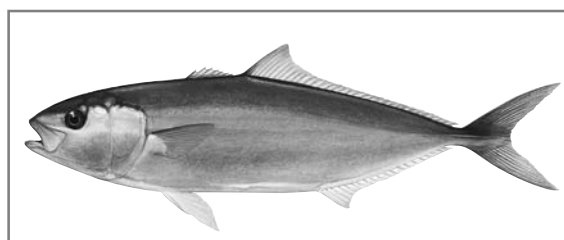
Finfish are reared on progressively larger pellets as they grow from fingerling to market size. Most species are happy to feed from the water surface. Diets produced by Australian fish feed manufacturers give good food conversion ratios of around 1.0 to 1.8:1, depending on feed type and size of fish harvested.

Although this information is provided for these three species, the types of culture methods and diets are comparable across the other species.

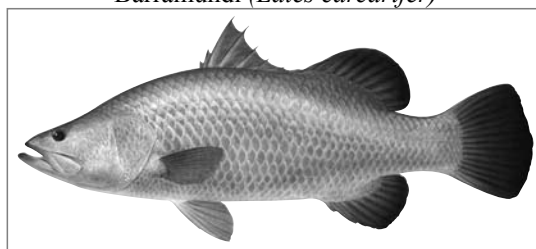
Mulloway (*Argyrosomus hololepidotus*);



Yellowtail kingfish (*Seriola lalandi*)



Barramundi (*Lates carcarifer*)



(Illustrations © R.Swainston/www.anima.net.au)

5.0 OUTLINE OF REPORTING PROCESS

5.1 Overview

There are four steps involved in completing the ESD report for the marine finfish aquaculture industry, based upon using the National ESD Reporting Framework, which is outlined in detail in the WA ESD policy paper (Fletcher 2002) and the “How to Guide” (Fletcher et. al., 2004) located on the website (www.fisheries-esd.com).

The issues to be addressed for this industry were determined at a stakeholder workshop (see Fisheries Management Paper No. 229). This process was facilitated by adapting the set of Generic ESD Component Trees into a set of trees specific to the aquaculture industry.

A risk assessment/prioritization process was completed that objectively determined which of these identified issues was of sufficient significance to warrant specific management actions and the development of a management report. The justifications for assigning low priority or low risk were also recorded.

An assessment of the performance for each of the issues of sufficient risk to require specific management actions need to be completed, using a standard set of report headings where operational objectives, indicators and performance measures, management responses etc are specified.

An overview assessment of the industry is then completed including the development of a Code of Practice and Management and Environmental Monitoring Plans for activities that will need to comply with acceptable levels of performance to continue or, where necessary, improve the performance of the industry.

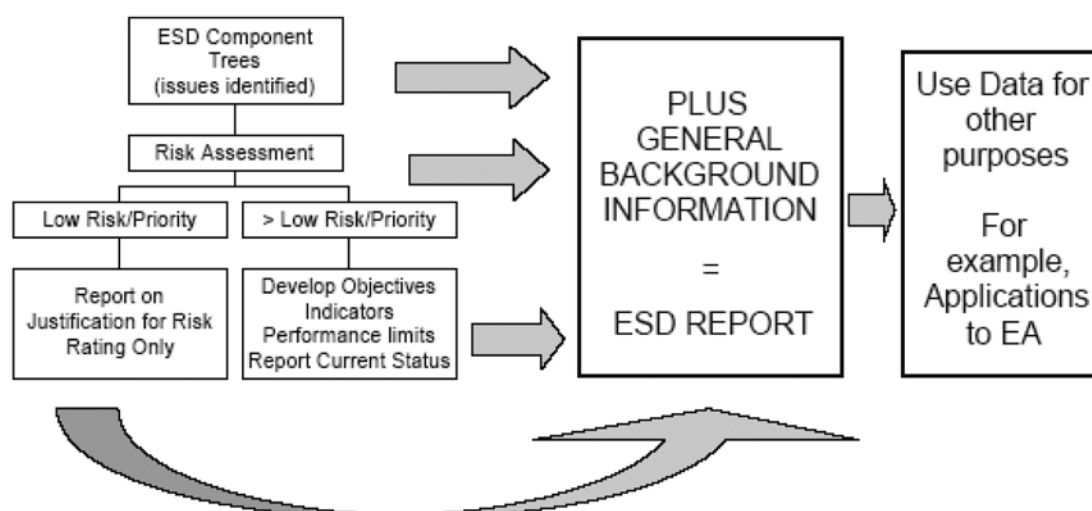


Figure 1 Summary of the ESD reporting framework process

5.2 Issues Identification (Component Trees)

The National ESD Reporting Framework has eight major components, which fall into three categories of the ‘Contributions to ecological wellbeing’, ‘Contributions to human wellbeing’ and the ‘Ability to achieve the objectives’. Each of the major components is broken down into more specific sub-components for which ultimately operational objectives can be developed.

Contributions to Ecological Wellbeing

1. Impacts on the General Environment (Whole of Industry)

Are there issues that need to be dealt with at the ‘whole of industry’ level?

2. Impacts within Catchment/Region

This deals with the cumulative impacts that may occur from multiple facilities in the one region/catchment

3. Impacts within Facility

What issues need to be addressed within each facility?

Contribution to Human Wellbeing

4. Indigenous Wellbeing

How does the industry sector affect indigenous communities in the area where the industry operates?

5. Community Wellbeing

Are there local (including the industry itself) or regional communities that are dependent on the industry and/or are they supportive or negative about its operation?

6. National Wellbeing

How does the industry/sector contribute to national issues such as employment rates, supply of fish, economic returns, reductions in trade deficit etc?

Ability to Achieve

7. Governance

Are the management processes and arrangements for the industry appropriate and efficient to enable the other elements to achieve an adequate level of performance?

8. Impacts of the Environment

Are there issues that may reduce or improve performance of the industry/sector that are outside of the direct control of the management agency/industry?

To maximize the consistency of the approach amongst different sectors, common issues within each of the components were identified within each of the major component areas and arranged into a series of “generic” component trees (see Fletcher (2004) and the www.fisheries-esd.com web site for a full description). These generic trees were used as the starting point for identifying the issues. These trees were subsequently adapted into trees specific to the finfish aquaculture industry during an open consultative process involving all stakeholder groups. This was achieved by expanding (splitting) or contracting (removing/lumping) the number of sub-components as required.

The trees for the marine finfish aquaculture industry were developed at a workshop held in April 2006. The stakeholders present during this meeting covered the aquaculture licensees, environmental groups, Department of Environment and Conservation, Department of Water, Department of Fisheries staff and industry representatives (see Fisheries Management Paper No. 229).

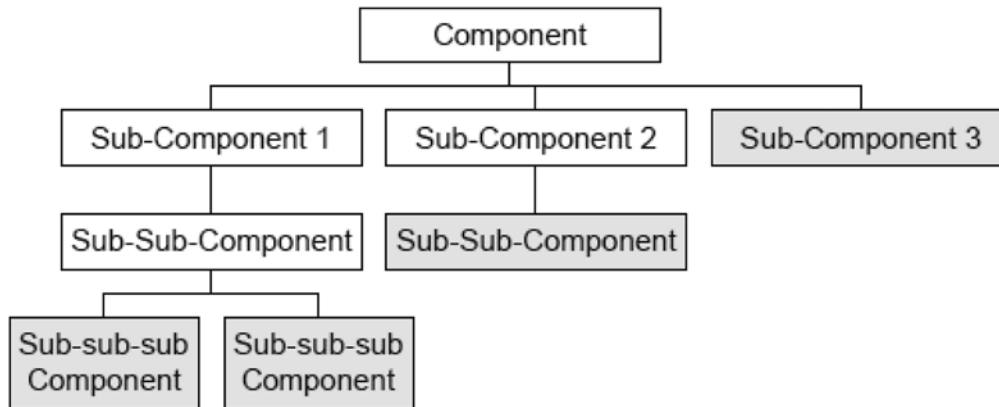


Figure 2 Example of component tree structure

5.3 Risk Assessment/Prioritization Process

After the components/issues were identified, a process to prioritize each of these was completed using a formal risk assessment process. The risk assessment framework that was applied at the workshop was consistent with the Australian Standard AS/NZS 4360:1999 Risk Management, concentrating on the risk assessment components. The general risk assessment process is well documented, but in summary it considers the range of potential consequences of an issue/activity and how likely those consequences are to occur. The combination of the level of consequence and the likelihood is used to produce an estimated level of risk associated with the particular hazardous event/issue in question.

The group at the workshop in 2006 made a realistic estimate of the consequence level for each issue. This level was from '0' to '5', with '0' being negligible and '5' being catastrophic/irreversible. This assessment was based upon the combined judgment of the participants at the workshop, who collectively had considerable expertise in the areas examined. The level of consequence was determined at the appropriate scale for the issue.

In assigning a likelihood level it was important to remember that the likelihood of that consequence occurring was assessed and *not* the likelihood of that particular activity occurring. The consequence and likelihood levels were determined for issues using the tables outlined in the framework (Tables 1 and 2). During the workshop, participants were asked to score the consequence and likelihood on the basis of what they expected over the next five years, not just on the current situation. The risk value and ranking for each issue were then determined using the risk matrix (Table 3).

From these two figures (consequence and likelihood), the overall risk value, which is the mathematical product of the consequence and likelihood levels (Risk = Consequence x Likelihood), was calculated. Finally, each issue was assigned a Risk Ranking within one of five categories: Extreme, High, Moderate, Low and Negligible based on the risk value (Table 4).

In general, only the issues of sufficient risk (Moderate, High and Extreme), i.e. those that require specific management actions, need to have a full performance report completed. Nonetheless, the rationale for classifying issues as low risk or even negligible were also documented and form part of the ESD report. This allows all stakeholders and interested parties to see why issues were accorded these ratings.

Table 1 The Consequence Table for use in Ecological Risk Assessments (ERA) related to aquaculture (from Fletcher *et al.* 2004). While this is the table used in the workshop, participants were asked to assess the situation over the next five years, and thus the wording should be read to reflect this time frame.

Level	Descriptor
Negligible (0)	Ecosystem: Interactions may be occurring but it is unlikely that there would be any change outside of natural variation.
Minor (1)	Ecosystem: None of the affected species play a keystone role – only minor changes in relative abundance of other constituents.
Moderate (2)	Ecosystem: Measurable changes to the ecosystem components without there being a major change in function (no loss of components).
Severe (3)	Ecosystem: Ecosystem function altered measurably and some function or components are locally missing/declining/increasing outside of historical range &/ or allowed/facilitated new species to appear. Recovery is measured in years.
Major (4)	Ecosystem: A major change to ecosystem structure and function (different dynamics now occur with different species/groups now the major components of the region). Recovery period is measured in years to decades.
Catastrophic (5)	Ecosystem: Total collapse of ecosystem processes. Long-term recovery period may be greater than decades.

Table 2 Likelihood Definitions (from Fletcher *et al.* 2004).

Level	Descriptor
Remote (1)	Never heard of, but not impossible
Rare (2)	May occur in exceptional circumstances
Unlikely (3)	Uncommon, but has been known to occur elsewhere
Possible (4)	Some evidence to suggest this is possible here
Occasional (5)	May occur
Likely (6)	It is expected to occur

Table 3 Risk Matrix – numbers in cells indicate risk value, the colours/shades indicate risk rankings (from Fletcher *et al.* 2004). Note that the risk level is calculated by multiplying the likelihood value by the consequence value.

		Consequence					
		Negligible	Minor	Moderate	Severe	Major	Catastrophic
Likelihood		0	1	2	3	4	5
Remote	1	0	1	2	3	4	5
Rare	2	0	2	4	6	8	10
Unlikely	3	0	3	6	9	12	15
Possible	4	0	4	8	12	16	20
Occasional	5	0	5	10	15	20	25
Likely	6	0	6	12	18	24	30

Table 4 Suggested risk rankings and outcomes (from Fletcher *et al.* 2004).

Risk Rankings	Risk Values	Likely Management Response	Likely Reporting Requirements
Negligible	0	Nil	Short Justification Only
Low	1 – 6	None specific	Full justification needed
Moderate	7 – 12	Specific management needed	Full performance report
High	13 – 18	Possible increases to management activities needed	Full performance report
Extreme	> 19	Likely additional management activities needed	Full performance report

It is important to note that the risk assessment involves the completion of reports that contain the completed justifications for the scores generated. Thus, the scores determined within the meeting on their own are insufficient.

5.4 Component Reports

Issues of sufficient risk or priority that require specific management actions have a full management report completed (which form Section 6 of this report). Nonetheless, the rationale for classifying issues as low risk/priority is also documented and form part of the report so that stakeholders can see where all the identified issues have finished.

For each of the lowest level sub-components (assessed as being of sufficient risk/priority to address), a detailed assessment of performance is generated. There was agreement previously upon a set of nine standard headings, each of which need to be addressed. In addition to this list is a further heading: 'Rationale for Inclusion'. This specific heading allows the issues raised within the risk assessment process to be explicitly recorded. A full description of each of these headings is located in the 'How to Guide' (Fletcher *et al.* 2004).

1. Rationale for Inclusion and Identification of Management Authority
2. Operational Objective (plus justification)
3. Indicator
4. Performance Measure/Limit (plus justification)
5. Data Requirements/Availability
6. Evaluation
7. Robustness
8. Fisheries Management Response
 - Current
 - Future
 - Actions if Performance Limit Exceeded
9. Comments and Action
10. External Drivers

For issues at the facility-level, where input into the deregulation process is required, this list has been modified to incorporate specific recommendations for the Code of Practice, licence conditions and the Management and Environmental Monitoring Plan. This list is as follows:

1. Rationale for Inclusion and Identification of Management Authority
2. Operational Objective (plus justification)
3. Indicator
4. Performance Measure
 - Code of Practice
 - Licence condition
 - Management and Environmental Monitoring Plan
5. Fisheries Management Response
 - Current
 - Future
 - Actions if Performance Limit Exceeded

The completion of the component reports was initiated at the stakeholder workshop in December 2008. Initial report development was undertaken prior to the workshop by Department of Fisheries' staff. The completed set of management measures was sent to all attendees for discussion and any problems/concerns incorporated into this final management report.

5.5 Regional/Catchment Areas for Level 2 Assessments

The ESD framework is structured into three different spatial levels:

- whole of industry issues;
- catchment/regional issues; and
- within facility issues.

This hierarchical approach is designed to show the linkages between what is required at the operator level and the outcomes wanted by government/community at the regional and whole of industry scales. In order to complete the Level 2 assessment, it is necessary to identify relevant regions and catchments. Using those developed through the Interim Marine and Coastal Regionalisation for Australia (IMCRA) process provides a system already developed using ecological criteria.

In 1996, under the auspices of the Australian New Zealand Environment and Conservation Council (ANZECC), the then Commonwealth Department of Environment and Heritage developed a system of ecosystem-based classification for marine and coastal areas of Australia. This system was called the "Interim Marine and Coastal Regionalisation for Australia", or IMCRA.

As the IMCRA report states:

"There is growing recognition of the importance and need to protect marine biodiversity for both conservation and economic reasons. Governments, the community and all users have a shared responsibility to ensure the long term viability of the biological diversity, marine system function and resource use of the estuaries, seas and oceans. Issues of resource conflict and overuse and the need for sustainable resource use and biodiversity conservation typically occur at local and regional scales. To address these issues there is a need for a regional planning framework which encompasses data and information on ecological patterns and processes."

5.5.1 IMCRA Regionalization

The scale and extent to which different human activities affect either biodiversity and/or ecological processes and the extent to which these human activities or impacts can be managed determines both the scale and nature of management and monitoring required, and hence defines the framework for ecosystem management. As such, biogeographical regions or bioregions provide the boundaries and framework for biodiversity or conservation management and the integrated, multiple-use management of other specific human activities or uses, such as fisheries, mining and tourism.

For WA, 17 meso-scale regions were identified, these being:

ABR	Abrolhos Islands	NIN	Ningaloo
CAB	Cambridge – Bonaparte	NWS	North West Shelf
CAN	Canning	OSS	Oceanic Shoals
CWC	Central West Coast	PIN	Pilbara (nearshore)
EMB	Eighty Mile Beach	PIO	Pilbara (offshore)
EUC	Eucla	SBY	Shark Bay
KIM	Kimberley	WSC	WA South Coast
KSD	King Sound	ZUY	Zuytdorp
LNE	Leeuwin – Naturaliste		

The IMCRA sets the scale of regions to between hundreds to thousands of kilometres. Those identified with a grey box have been considered suitable for a regional perspective or Level 2 assessments in this ESD process. (Figure 3)

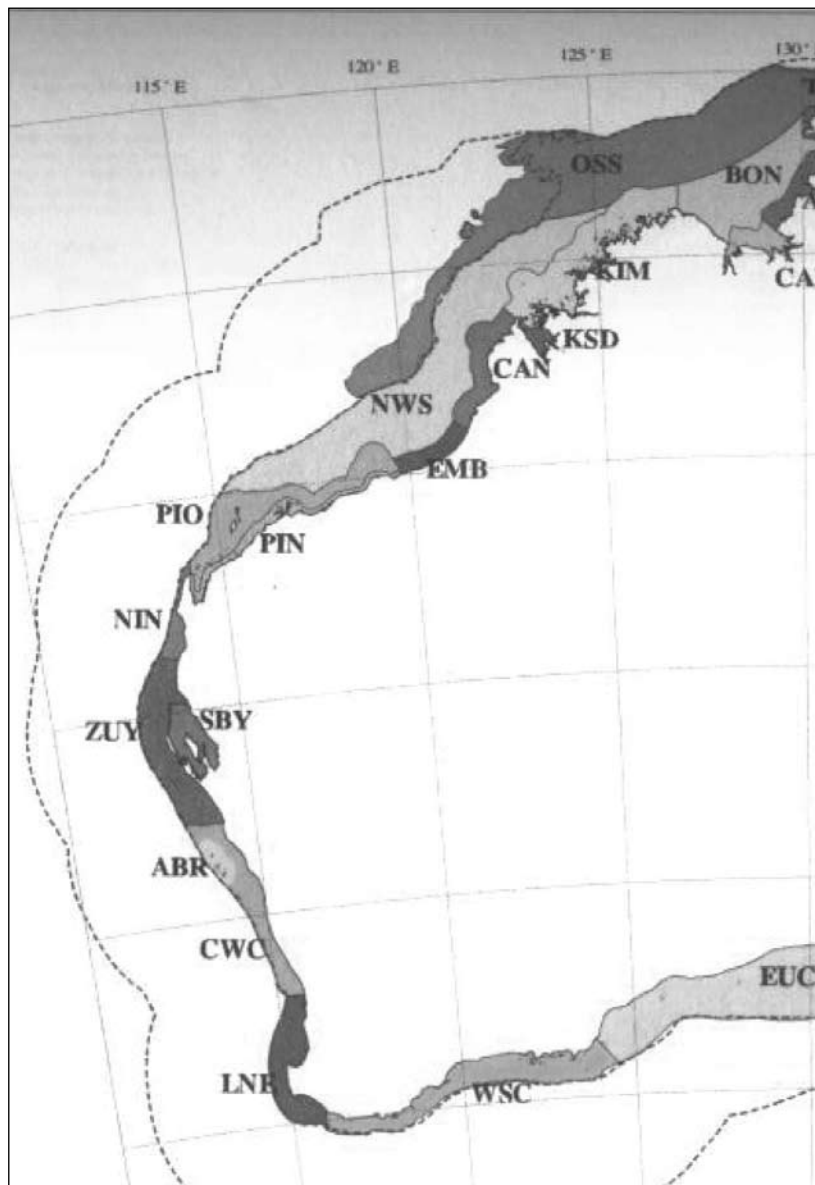


Figure 3 Interim Marine and Coastal Regionalization for Australia Version 3.3 (1998) – Meso-scale Regions

6.0 MANAGEMENT REPORTS

There is significant literature on site selection for sea cage culture – some of these considerations are:

- adequate shelter;
- moderate current (too strong creates problems with the set of nets, anchoring and may be excessive for the fish: too weak, and oxygen or metabolites may become limiting);
- adequate depth (to keep nets at a minimum distance from decaying organic matter and to ensure high water quality);
- ease of access for the operator;
- minimal security (poaching problems);
- minimal predator problems;
- minimal fouling;
- suitable salinity regime (dependent on the species);
- access to a reliable supply of reasonably priced inputs; and
- access to dealer distributor networks and markets; and
- distance from other operators (especially where disease is a problem)

These and other issues were identified in the risk assessment workshop and will be considered in more detail in the following sections, at the level of ‘whole of industry’, regional and individual facility.

The relevant management authorities have been identified as well as the identification of suitable indicators and performance measures, and current and future management responses.

6.1 Impacts on the General Environment (Whole of Industry)

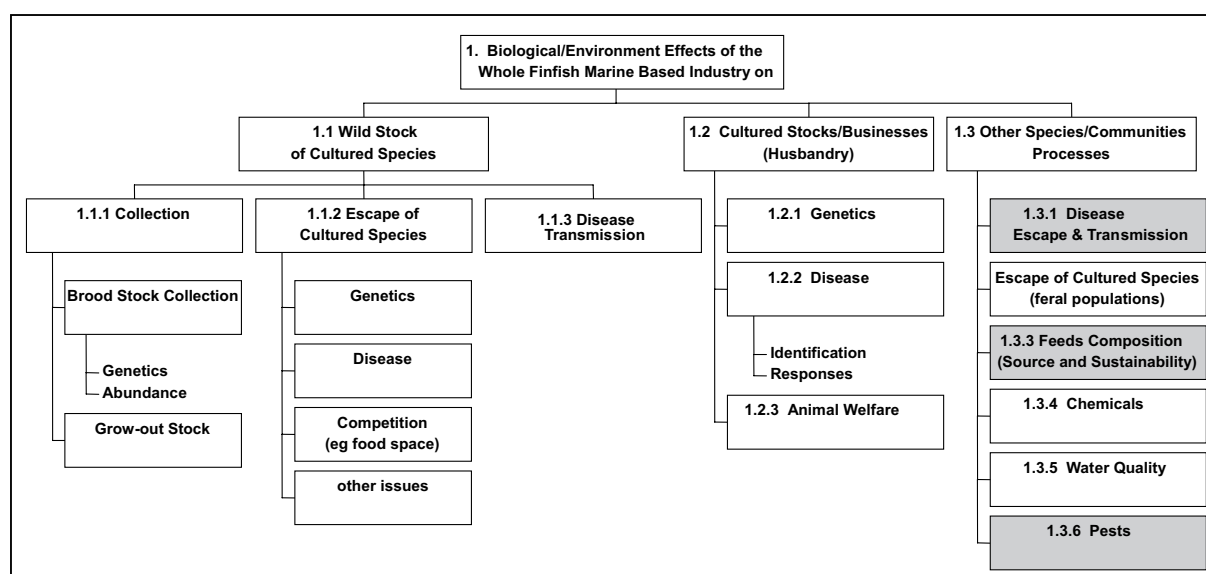


Figure 4 Component Tree 1 for Environmental Effects of the Whole Finfish Industry

A grey box indicates that the issue was considered high enough risk to warrant having a full report on management. The numbers for the following issues, reflect the numbers outlined in the various component trees.

6.1.1 Wild Stock of Cultured Species

6.1.1.1 Collection

- **Brood stock collection**

Rationale for Inclusion and Identification of Management Authority

The number of individuals that may be taken as brood stock for marine finfish aquaculture from wild stocks is determined on a case-by-case basis. The broad impact of this collection on spawning stocks is considered here.

ERA Risk Rating: Effects of the collection of brood stock on spawning stock size (C2 L1 LOW)

Given the size of the WA finfish aquaculture industry, both current and expected over the next five years, as well as the number of applications for Exemptions to collect brood stock, the consequence is considered to be moderate however the likelihood of this happening is remote. By maintaining the existing management arrangements, no additional response is needed.

The management authority is the Minister for Fisheries through Ministerial Exemption.

Operational Objective (plus justification)

Spawning stocks of wild populations are not impacted by the collection of aquaculture brood stock.

Justification

The Minister for Fisheries, as well as the broader community, will only support the granting of Exemptions authorizing the collection of individuals for use as brood stock by the aquaculture industry, if the numbers taken under Exemption do not impact on spawning stock levels.

In Western Australia, the current legislative framework allows for the granting of an Aquaculture Licence, which provides authority to conduct aquaculture activities for commercial purposes. An Aquaculture Licence however, does not confer any approval to collect fish from the wild for farming purposes. Aquaculturists can source brood stock by various methods: purchasing from commercial fishermen, other Aquaculture Licence holders or retail outlets, or by applying for a Ministerial Exemption.

A Ministerial Exemption is provided for under Section 7 of the Fish Resources Management Act 1994. A draft policy statement was developed by Department of Fisheries to set out the processes to be undertaken in applying for an Exemption. The policy also sets out suggested numbers and sizes of fishes that may be taken and the method by which they are taken. For marine, estuarine and freshwater finfish, the numbers will be determined on a case-by-case basis using methods such as line capture, fish traps, nets or electrofishing.

Fisheries Management Response

- *Current*

Maintain the current draft policy position including the limits on numbers, sizes and sexes collected.

Department of Fisheries officers are required to be present during brood stock collection to ensure compliance with Exemption conditions i.e. location and numbers.

- *Future*

Ecosystem-Based Fisheries Management is being implemented throughout the Department of Fisheries and broader changes to stocks will be identified when cumulative assessments across all sectors are undertaken.

If it can be shown that the collection of aquaculture brood stock is having an impact on spawning stock sizes, it may be necessary to restrict brood stock collection numbers, limiting either the number of Exemptions issued or the number of individuals collected under each Exemption.

It may also be beneficial to encourage local hatcheries culturing more diverse stocks.

- *Actions if Performance Limit exceeded*

There may be a need to limit any further collection of certain species if the spawning stocks fall below a critical stock size. These measures may also relate to commercial fishers or simply require aquaculture brood stock collectors buy all stocks from a commercial licensed fisher.

Comments and Action

The Department of Fisheries should finalize the *Brood stock Policy* and *Hatchery Policy*.

Additional monitoring of the wild stocks for target aquaculture species. This could be in support of commercial fisheries research if the species is also targeted by that sector.

Research into closing the life cycles for specific aquaculture species should be considered if investment can support the infrastructure necessary to grow out any fingerlings produced.

• Grow-out stock

Rationale for Inclusion and Identification of Management Authority

Any species determined to be suitable for grow out of wild caught stock in the future, would firstly need to demonstrate that stocking levels can sustain this activity, i.e. be in line with the principles of Integrated Fisheries Management (IFM).

ERA Risk Rating: Effects of harvesting wild stocks for grow out (C3 L2 LOW)

A consequence ranking of severe has been selected if considering grow-out of pink snapper under the current circumstances. Authorization to grow-out wild caught species is not being considered by Department of Fisheries or industry at present, however this may change in future years, hence the likelihood rating of rare at this point in time.

The management authority is the Department of Fisheries through aquaculture licences with the Commonwealth Department of Agriculture and Food, Fisheries and Forestry and the Australian Fisheries Management Authority assisting in the determination of any southern bluefin tuna (SBT) quota.

Operational Objective (plus justification)

Any collecting of fish for grow-out has no long term impact on wild stock numbers.

Justification

In WA, most fish are either grown out from hatchery stock or brood stock. South Australia is the only state currently growing-out wild caught southern bluefin tuna and with the quota system in place for this species, this is unlikely to occur in WA within the next five years. There are

issues regarding the stocks of this species in the wild. The Australian government is a member of the Convention for the Conservation of Southern Bluefin Tuna (CCSBT) and participates in discussions setting quotas to CCSBT member nations. Whether this quota will be lowered from its current level in future years is unclear.

Pink snapper could be a species suitable for grow-out. However, the stocks are at such a low level due to other fishing pressures that the Department of Fisheries is not considering authorizing its grow-out.

Fisheries Management Response

- Current

If the grow-out of certain species is granted, limits should be placed in line with IFM principles. If necessary, commercial catches may be lowered to assist in the recovery of stocks.

Maintain current policy regarding Ministerial Exemptions for aquaculture brood stock collections – especially for species that may also be targeted for grow out.

- Future

Consider the need to apply restrictions on the granting of any new Exemptions if collecting certain species for grow-out.

Any grow-out of southern bluefin tuna would need to demonstrate that quota has been purchased.

It is contrary to provisions of the *Fish Resources Management Act 1994* to deliberately release stocks from aquaculture facilities into the wild to restock declining wild stock due to potential disease concerns. Fisheries Management Paper No. 162 provides a general policy position around the reseedling of wild gastropods and bivalves in WA and the appropriateness of using aquaculture product.

- Actions if Performance Limit exceeded

If collection for the grow-out of finfish stocks result in a wild stock decline, then it may be necessary to limit any further licences authorizing this activity.

6.1.1.2 Escape of cultured species

• Genetics

Rationale for Inclusion and Identification of Management Authority

Some operators purchase fingerlings from South Australia or the Northern Territory, increasing the risk of escapes intermixing with wild stocks and resulting in changes to genetic strains. This risk could be removed by clarifying whether separate genetic stocks exist for certain species of interest.

ERA Risk Rating: Risks of genetic impacts on wild stock due to escapes of cultured stock (C2 L2 LOW)

The consequence value has been set at moderate in light of imposing licence conditions and the level of importation of interstate stocks. The likelihood of any changes occurring to the genetic structure of wild stocks is considered to be rare due to the current size of the industry in WA and the existing arrangements to respond to large fish escape events.

The management authority is the Department of Fisheries by way of the aquaculture licence.

Operational Objective (plus justification)

Aquaculture farms are managed to minimize impacts on the genetic integrity of wild stocks due to escapes.

Justification

The size of the WA finfish aquaculture industry is relatively small with most farm stock purchased from approved hatcheries or from wild caught brood stock. There is an opportunity for WA to develop a larger barramundi hatchery industry to minimize risks due to the importation of genetically different stock.

Under licence conditions, licensees are required to notify the Department of Fisheries of any large fish escapes within 24 hours. Associated aquaculture licence conditions require:

- *the net to be of a certain mesh size and quality to provide a complete barrier in order to retain 100 per cent of fish stocked;*
- *the mesh to be of a specified size depending on the size of the fish to be contained; and*
- *the mesh does not contain holes or openings greater than 1.5 times the size of the mesh.*

These conditions are not imposed to all sea cage finfish aquaculture, however the Department of Fisheries is currently reviewing all licence condition on a species-by-species basis. Once this review is complete, there will be a consistent approach to the application of these conditions.

Fisheries Management Response

- Current

Maintain the current licence conditions requiring the reporting of any escape events. Conditions are placed on licenses if it is considered necessary to limit the brood stock collection locations for genetic-related issues such as distinct genetic strains.

Maintain the Department of Fisheries *Emergency/Incident Management Plan* (2002) which is designed to:

- enable the Department to respond to emergencies of any nature in a consistent and effective manner; and
- be expanded and adapted to suit specific emergencies, including the establishment of sub-plans which all have a consistent initial approach.

- Future

Any future legislative changes resulting from the enacting of the *Biosecurity and Agricultural Management Act* may provide more stringent controls on the importation of certain fish species. It could provide the impetus for the Department to encourage the development of locally-sourced hatchery product for finfish species.

There is a need to develop protocols for the movement of fish between and within regions in light of genetic concerns. If genetically modified organisms are eventually utilized, the Department of Fisheries will need to reconsider any protocols for translocation of fish and escape events.

- Actions if Performance Limit exceeded

Authorize only regionally endemic stocks on farms and limit any further translocation of non-native stock into a region.

- **Disease**

Rationale for Inclusion and Identification of Management Authority

Protocols are needed at the ‘whole of industry’ level to minimize the risk of disease transmission to the wild stock from any escapes of cultured stocks from aquaculture facilities.

ERA Risk Rating: Effects of disease transmission to wild stocks due to escapes (C3 L1 LOW)

This could become an issue due to the time required to identify any disease and gain approval for treatment with chemicals. Disease transmission is a remote possibility since stocking levels are low, importation of certain fingerlings requires health certification and translocations must have prior approval.

The management authority is the Department of Fisheries under the *Fish Resources Management Act 1994*.

Operational Objective (plus justification)

Protocols are in place to limit disease transferrals due to escapes from aquaculture farms.

Justification

Existing regulations (Fish Resources Management Regulations 1995, Regulation 69) require all aquaculture operators notify the Department within 24 hours of becoming aware or suspecting, that any fish at the place where aquaculture is carried out may be affected by diseases as specified. This allows for the treatment or euthanizing of infected stock to minimize any further spread of the disease to wild stock.

Mainly due to its isolation, Australia has maintained freedom from imported, infectious diseases. The surveillance and reporting program needs to focus on the fact that Australia will increasingly be called upon to substantiate freedom from major diseases in order to support its export certification and quarantine import policy. The best way to achieve this is through facility level implementation programs, organised at the industry level (state wide).

In Australia, each State and Territory has operational responsibility for the surveillance, monitoring, control and eradication of aquatic animal diseases, whether the diseases are endemic or exotic. In addition, Australia has international obligations, including reporting to the global organisation for animal health Office International des Epizooties (OIE). Each State and Territory government is responsible for gathering the information regarding notifiable aquatic animal diseases.

Fisheries Management Response

- *Current*

Maintain the *Fish Resources Management Act 1994* and the *Fish Resources Management Regulations 1995* reporting requirements for both escape events and disease identification. Once an escape event or disease outbreak is identified, the Department of Fisheries response is to implement the *Emergency/Incident Response Plan (2002)*.

The provision of annual Management and Environmental Monitoring Plan reports will be enforced as a licence condition and the assessment of these reports by the Department will continue.

Health certification is required for some translocations, including hatchery to grow out.

- *Future*

The *Biosecurity and Agriculture Management Act 2007* and its proposed regulations may provide more rigid guidelines for the movement of fish and equipment.

Consider the use of chemicals in instances where use is justified. If chemicals are used, there should be a strict monitoring program implemented to identify any effects on the environment.

- *Actions if Performance Limit exceeded*

The implementation of more rigorous health testing of farm stocks would guarantee diseases are detected early and ensure there is adequate time for a more rigorous, considered response.

Standardize any disease mitigation strategies and specify required escape minimization measures to be used by all operators irrespective of species, location or size of farm.

Comments and Action

It will be difficult to determine exactly from where any disease identified in wild stocks has originated from and have confidence that an individual farm can be identified as the sole source.

External Drivers

Diseases could be introduced via international shipping traffic or through lapses in health certifications. Uninformed members of the public could inadvertently bring in diseased fish to WA or marine pests attached to recreational boats.

- **Competition**

Rationale for Inclusion and Identification of Management Authority

The escape of cultured animals could cause problems to wild stocks if their presence leads to an increase in competition for resources. We do not know the impacts and it is possible that escapees may have an impact on the food chain, if the numbers are great.

ERA Risk Rating: Effects of increasing competition for food with wild stocks due to escapes of cultured stock (C1 L3 LOW)

Given the apparent poor feeding ability of escaped fish reported through research papers, it is considered that the current consequence of escapees for competition on the wild stock is likely to be minor, and that over the next five years might be moderate rather than severe. If the absolute number of escapees increases substantially, then a severe ranking may be appropriate.

The management authority is the Department of Fisheries via the *Fish Resources Management Regulations 1995* and licence conditions.

Operational Objective (plus justification)

Aquaculture farms avoid impacting on wild stocks due to escapes.

Justification

Direct comparisons are difficult to make due to the differing husbandry practices used between the hemispheres. In the northern hemisphere several generations of Atlantic salmon are bred and cultured, whereas in Australia, for all native sea cage finfish species, only the first generation is cultured and therefore there is no artificial selection occurring nor is there any use of genetically

modified organisms. There would be little risk of 'genetically superior' escaped fish that are better at competing for resources than the wild stock. Given this, competition would only be a concern if behavioural differences between wild and cultured fish led to a cultured stock that actively competed with the wild stock.

If stocks of major feed species remain at levels that allow wild stocks to feed naturally, this demonstrates sustainability of the ecosystem irrespective of whether escapes of cultured stocks occur or not.

Interactions between wild and cultured fish have been predominantly studied on salmon populations in the northern hemisphere. In the Northeast Atlantic, gut analyses were performed and it was found that there was no difference in condition, number and weight proportions of prey in the diet between wild and escaped cultured salmon. This suggests that an increase in the numbers of escaped salmon may result in increased competition for food for the wild stock in that region. It is questionable whether the same result would be obtained in WA as the level of aquacultured fish is considerably lower than that of salmon in the northern hemisphere.

Research on escaped Yellowtail kingfish in South Australia suggests that escapees do not feed well and remain around aquaculture facilities searching for pellets rather than actively forage.

Fisheries Management Response

- Current

Utilize appropriate cage structures to minimize possibility of escapes.

- Future

Research into impacts on food chain from escapes may be required if the industry grows substantially over the next five years and large escape events occur on a regular basis.

- Actions if Performance Limit exceeded

It could require the utilization of specific cage structures to ensure no large escape events occur.

6.1.1.3 Disease transmission

Rationale for Inclusion and Identification of Management Authority

The deliberate release of cultured individuals could increase the risk of disease introductions to any remnant stocks.

ERA Risk Rating: Effects of release of cultured individuals on disease introduction to remnant stocks (C3 L1 LOW)

Departmental policy prohibits the intentional release of fish (without approval) and any accidental escapes must be reported under the *Fish Resources Management Regulations 1995*. Response procedures are managed through the *Emergency/Incident Management Plan*. Since these protocols are already in place, it is considered that consequence values could be severe however the likelihood of this occurring at present is remote.

The management authority is the Department of Fisheries by way of the *Fish Resources Management Act 1994* and the *Fish Resources Management Regulations 1995*.

Operational Objective (plus justification)

Aquaculture stocks will not be released without approval in order to minimize the risk of disease transferral.

Justification

There have been no documented cases of the direct transfer of native or exotic diseases from sea cage cultured fish to wild stock in Australia. That is not to say there have been no disease issues, more that research has yet to be undertaken into this issue. Throughout the rest of the world there have been incidents where exotic diseases have been introduced to wild fish from translocated farmed fish, which have had serious consequences on local fish populations. In contrast, there have been no documented cases of direct disease transfer from farmed fish to wild fish of pathogens that are native to the region.

There are restrictions and regulations in place that limit the importation and translocation of fish into and around WA, thereby reducing the risk of exotic disease introductions. These restrictions may become more rigorous once the Biosecurity and Agriculture Management Act 2007 and its associated regulations are enacted.

Fisheries Management Response

- Current

Regulations already exist requiring health certification and translocation approvals for certain fish species. The deliberate release of aquaculture stock without approval is currently restricted.

- Future

More stringent requirements under health certifications during translocation or importation (under the *Biosecurity and Agriculture Management Act 2007*) of all fingerlings.

- Actions if Performance Limit exceeded

Should any aquaculture licensee deliberately release fish on an ongoing basis, the Chief Executive Officer could either prosecute under the *Fish Resources Management Act 1994* or terminate the licence.

6.1.2 Cultured Stock/Business (Husbandry)

6.1.2.1 Genetics

Rationale for Inclusion and Identification of Management Authority

Protocols are necessary to ensure the genetic integrity of captive brood stock is maintained at appropriate levels. This incorporates industry-wide agreement on the use of genetically modified organisms and selective breeding programs.

ERA Risk Rating: Effects of genetically modified brood stock (C3 L1 LOW)

For genetically modified organisms with similar likelihood of escapes as non-modified stock, consequences are unknown but precautionary principles would suggest they might be considered as severe, giving an overall inherent risk as moderate. There has been preliminary discussion held regarding the use of genetically modified organisms within the WA aquaculture industry

and it is not currently being considered. In light of these comments, the likelihood of genetically modified organisms being used has been lowered to remote, with an overall rating of low.

The management authority is the Department of Fisheries via the aquaculture licence.

Operational Objective (plus justification)

Use of genetically modified organisms in aquaculture will not effect the broader environment.

Justification

The Australian Government enacted the Gene Technology Act 2000 and supporting Gene Technology Regulations 2001, which underpins Australia's nationally consistent regulatory system for gene technology. Its objective is to protect the health and safety of people and the environment. The Act does this by identifying risks posed by or as a result of gene technology, and managing those risks by regulating certain dealings with genetically modified organisms.

Aquaculture organisms can fall into one of three categories:

- *non-genetically altered organisms (NGAOs) – produced in a hatchery either from brood stock or farmed brood stock without a scientifically-based breeding program*
- *genetically improved organisms (GIOs) – these might be produced either through a traditional selective breeding program or through ploidy manipulations.*
- *genetically modified organisms (GMOs) – these are organisms produced by the application of gene technology.*

Aquatic genetically improved organisms are generally bred for traits such as faster growth rate or traits desired by consumers. Selection programs work with existing genetic variation, selecting those combinations that give improved results. Hence the wild population will have the same genetic structure.

In Australia, for all native marine finfish species, there is no artificial selection occurring nor is there any use of genetically modified organisms) at this point in time. WA should develop a policy to guide any use of genetically modified organisms in support of the national direction once this becomes an issue.

Fisheries Management Response

- Current

There is no use of genetically modified organisms in the WA aquaculture industry at present. Selective breeding issues should be considered when they arise.

- Future

Develop a policy and associated protocol to guide the use of genetically modified organisms and selective breeding programs in WA. This may require trialing the grow-out of genetically modified organisms in land-based facilities prior to authorizing their farming in marine waters.

Importation of fingerlings from overseas may inadvertently include genetically modified organism if rigorous documentation is not required. It may be necessary to consider extended translocation and health certification if the use of genetically modified organisms is approved.

- Actions if Performance Limit exceeded

Prohibit further use of genetically modified organisms if required. Selective breeding programs

may continue, however stock containment may require stricter measures to ensure no cross-contamination if escapes occur.

6.1.2.2 Disease

Rationale for Inclusion and Identification of Management Authority

Disease monitoring, surveillance and risk minimization programs should be applied across the industry to assist in the identification of new diseases and mechanisms for dealing with severe disease outbreaks.

ERA Risk Rating: Disease monitoring of cultured stock (C2 L3 LOW)

The consequence of not having a surveillance program could be moderate if the industry were to grow at its current rate over the next five years. The likelihood of not having an industry-wide surveillance program is possible, as the Department of Fisheries' Fish Health Unit is not funded to provide any extension services.

The management authority is the Department of Fisheries under the *Fish Resources Management Regulations 1995* and via licenses.

Operational Objective (plus justification)

A consistent approach to disease management will operate across the industry.

Justification

In Western Australia there is no industry-wide disease monitoring program for the marine environment, however the Department has been monitoring the State trout hatchery since 1995. All importations or translocation of fingerlings into WA requires health certification - this service is provided by the Department's Fish Health Unit.

The Fish Health Unit provides diagnostic services to deal with any disease outbreaks or research into identified fish diseases. The Fish Kill Program, which has operated for 10 years, investigates all fish kills in the wild, irrespective of whether they are associated with aquaculture or not.

The Fish Resources Management Regulations 1995 requires that all aquaculture operators notify Department of Fisheries as soon as they are aware that disease may be affecting stock. At present this is the only mechanism for detecting and reporting disease outbreaks. There are no sector-wide surveillance programs implemented by Department of Fisheries and due to this lack of any consistent protocol, a slightly higher risk value would be expected. The agency has an Emergency Response Plan that operates effectively.

Members of the finfish aquaculture industry must ensure that the risk of disease outbreak is minimized and that, in the event of a disease outbreak, Department of Fisheries is informed. It should ensure the threat of disease spreading within the facility or from the facility is minimized. Guidance on a whole-of-industry protocol will be developed and implemented through the Code of Practice and this will ensure a consistent approach that can be reviewed and updated on a regular basis.

Codes of Practice are voluntary however the driver behind the implementation of this issue is currently the Fish Resources Management Act 1994. Regulations under the Biosecurity and Agriculture Management Act 2007 may include the provision to make known diseases notifiable, with consequent responses. It is unclear at present what form these provisions will take. Having industry input into determining the best way to deal with disease management will ensure a greater uptake of any guidance provided.

Fisheries Management Response

- Current

In Western Australia there is no industry-wide disease monitoring program, however the importation or translocation of fingerlings generally requires health certification. The Department has a Fish Health Unit, which deals with any reported disease outbreaks and undertakes research into fish diseases. There are no proactive monitoring activities.

- Future

Develop the Code of Practice to provide guidance on disease management protocols that can be implemented on individual farms. Review and update as required (or every five years).

- Actions if Performance Limit exceeded

Implementation of more rigid and strict disease management measures could be required if disease continues to be of concern across the State. More focus should be placed on individual facilities to ensure they have appropriate strategies in place to deal with disease outbreaks and this will demonstrate a 'whole of industry' protocol.

External Drivers

Actions by individuals outside of the aquaculture industry could impact on operators if education programs do not provide the appropriate information on disease management, mitigation or treatment options.

6.1.2.3 Animal welfare

Rationale for Inclusion and Identification of Management Authority

There is a need to deal appropriately with animal welfare issues associated with finfish aquaculture. Current protocols exist at a national level.

ERA Risk Rating: Animal welfare issues and protocols (C1 L3 LOW)

The National Aquaculture Council developed a protocol supported at the state-level by an Aquaculture Council of WA protocol. The consequences are minor as management is still provided through other mechanisms, albeit not sector specific.

The primary management authority is the Department of Fisheries under the *Fish Resources Management Act 1994*.

Operational Objective (plus justification)

Aquaculture stocks will be farmed in line with animal welfare protocols.

Justification

There are moves at an international level to ensure any slaughtering of aquaculture products is done in the quickest and most humane way. Australia is providing comment into these international level discussions and WA may be obliged to consider any outcomes.

All matters relating to the welfare of fish in WA are prescribed under the Fish Resources Management Act 1994 with the Department of Fisheries having sole responsibility for fish welfare. At the national level via the Australian Animal Welfare Strategy, the Aquatic Animal Welfare Working

Group has been established to progress the harmonization of welfare legislation.

Through the Fish Resources Management Act 1994 (section 258 (va)) regulations can be developed to prevent cruelty to fish and provide for the welfare, safety and health of fish. New guidance will be provided to licensees through the Code of Practice for finfish aquaculture.

Fisheries Management Response

- Current

Stocking densities in WA farms are generally low, which alleviates the possibility of density-dependent animal management concerns.

- Future

Ensure the National Aquaculture Council and the Aquaculture of Western Australia-developed protocols are included in the Code of Practice. Operational actions can then result in appropriate behaviour by licensees.

Review the legislative arrangements as required.

- Actions if Performance Limit exceeded

Recommend action be taken by the Department of Fisheries against individual licensees if protocols do not lead to appropriate operational practices.

Comments and Action

There is a need to consider decommissioning of sites and any stocks that may be abandoned if an operator goes bankrupt. Licence conditions are being reviewed and, together with the *Fish Resources Management Act 1994* amendments being progressed, will allow for conditions being operational past the termination or cancellation of any licence.

External Drivers

There are moves on an international level to ensure any slaughtering of aquaculture products is done in the quickest and most humane way. Australia is providing comment into these international level discussions and WA may be obliged to implement any outcomes.

6.1.3 Other Species/Communities/Processes

6.1.3.1 *Disease escape and transmission*

Rationale for Inclusion and Identification of Management Authority

Disease could be passed on to other fauna from cultured stocks, through the passage of pathogens through the water column, intermediary hosts or from escapes.

ERA Risk Rating: Effects of disease from cultured stocks passing to wild stocks (C3 L3 MODERATE)

Diseases could potentially be transmitted to other animals by escaped fish, through direct interaction with the cultured fish in the sea cages, or indirectly through the water column. Disease transmission between the cultured stock and either the wild stock of that species or other species in the environment could occur.

The management authority is the Department of Fisheries under the *Fish Resources Management Regulations 1995* via licences.

Operational Objective (plus justification)

Diseases emanating from aquaculture farms will not affect wild stocks.

Justification

When large numbers of fish are confined to a relatively small area, as occurs in sea cage farming, factors such as overcrowding, increased stress and reduced water quality can produce conditions suitable for the spread of disease and parasites in the cultured fish. It is possible for wild stocks and other species of fish to interact with the cultured stock either through the sea cages or when fish escape and this could potentially lead to the transfer of disease between them. The transmission of disease from the cultured stock to the wild stock and other species could have potentially significant consequences. To date there have been no investigations into disease transmission between wild and cultured fish in Australia. A great deal of research has been conducted in the northern hemisphere and although there is much debate in the literature, there is insufficient evidence to conclude whether or not observed increases in disease in the wild stocks are due to disease transfer from escaped cultured fish (De Jong and Tanner 2004).

There are numerous groups of disease-causing organisms found in farmed fish worldwide. There are very few pathogens identified for yellowtail kingfish in Australia. A lot more information is known about the salmonid pathogens in Australia as these species have been cultured for several decades in Tasmania. Several more pathogens have been identified throughout the world especially in Japan where close relatives of the yellowtail kingfish are cultured and in countries such as Canada and Norway where Atlantic salmon are cultured. To date, there is no documented evidence that these pathogens have been transmitted to, or spread by cultured fish to wild fish or have caused an increase in disease in wild fish.

Given the contentious nature of this issue in the northern hemisphere, where it is possible that the salmon aquaculture industry is having detrimental effects on wild salmon stocks as a result of disease, the moderate risk ranking is based on an unlikely likelihood but severe consequence. It should be realised, however, that any effect of aquaculture is just one of a long list of possible causes for the decline of wild salmon stocks in the northern hemisphere and the negative effects of aquaculture probably occurred because stocks are already stressed from other forms of disturbance and pollution. The moderate risk ranking reflects the fact that we simply do not know but it is entirely possible that aquaculture has little if any effect. Under current policies, the risk of introducing new diseases is probably low but it is essential that current practises relating to import and translocation of stock continue, otherwise this ranking could increase.

Indicator

- Number of farms reporting diseases across the State.

Performance Measure / Limit (plus justification)

- The number of major mortality events in wild stocks that can be attributed to aquaculture operations is zero.

Justification

Throughout the rest of the world, there have been incidents where exotic diseases have been introduced to wild fish from translocated farmed fish, resulting in serious consequences for local

fish populations. In contrast, there have been no documented cases of direct disease transfer from farmed fish to wild fish of pathogens that are native to the region. Indirect correlations suggest that there is a link between the increase of the incidence of disease in wild stock and the occurrence of aquaculture but correlations of this type do not provide evidence of a causal link. The difficulty of identifying direct pathogen transfer between the cultured stock and wild stock stems from the difficulty in determining the origin of the pathogen in wild stock and establishing any links with disease in cultured fish.

For pathogens already present in an area, there is no definitive evidence that marine aquaculture has caused an increase of those diseases that are “native” in the wild stocks. Several studies in the northern hemisphere have correlated high sea lice infection rates in wild stock, with areas of intense aquaculture. For example, Norway found that a population of Arctic char and sea trout, in an area where aquaculture of the closely related Atlantic salmon occurs, had higher salmon lice infestations compared to populations that were located in an aquaculture free area. However, this type of correlative relationship does not take into account that disease or parasite load can be dependant on the local environmental conditions and therefore does not provide evidence of causal linkage between aquaculture and disease prevalence in wild fish. Another study used a more appropriate method by comparing parasite loads in the wild fish in the same area during times of fallowing and times of aquaculture production. They found a weak relationship between lice abundance on wild salmonids and the stage of production of fish farms. Infestations of sea lice in the wild fish were higher during periods of farming compared to the fallowing period. However, there was no statistically significant correlation between the lice abundance on the wild and farmed fish indicating that other factors may have a greater influence on lice abundance.

Several models have been developed to estimate and quantify the parasitic populations in cultured and wild fish. However, they do not estimate or infer anything about transmission between the two stocks. The difficulty with developing such a model stems from the large number of variables that influence transmission and the lack of accurate data. These variables include wild and cultured host ecology, parasite infection dynamics, larvae, hydrodynamics, temperature and salinity.

The Department of Fisheries developed the “Emergency/Incident Management Plan” in July 2002, which is designed to:

- enable the Department to respond to emergencies of any nature in a consistent and effective manner; and*
- be expanded and adapted to suit specific emergencies, including the establishment of sub-plans which all have a consistent initial approach.*

The plan provides a framework for the administration of all incidents in which the Department is involved as either a primary or secondary responder. It includes fish kills, disease outbreaks, feral pest incursions, pollution, algal blooms and other emergencies, and deals with both commercial and non-commercial fish species.

Currently there are no mechanisms to compensate aquaculture licensees should they be required to cull stock for disease management reasons. The Australian Government utilizes arrangements for the terrestrial agriculture sector, providing for compensation under specific circumstances. This could be reviewed to determine whether it is suitable as a template for developing aquaculture arrangements.

Data Requirements/Availability

Data on catch rates and stock assessments from commercial fisheries will likely provide the only data for broader wild stocks. Currently in WA there is no commercial aquaculture production of any marine species specifically targeted by a commercial fishery but species such as mahi mahi, yellowtail kingfish, mulloway, pink snapper, southern bluefin tuna, various emperor species, estuary cod and baldchin groper have/are being considered for future aquaculture ventures.

Translocation policies provide some insurance against the introduction of disease via the importation of fingerlings from interstate or other regions. Assessment of applications incorporates input from the Department of Fisheries' Principal Fish Pathologist and Translocation Officer, where a risk assessment is sometimes conducted. Fingerlings should be free of any signs of clinical disease prior to being certified for release into an aquaculture facility.

There is no expectation that any financial burden would be placed on aquaculture licensees to collect data about impacts on commercial fish species.

Evaluation

The behaviour of escaped fish could potentially play an important role in the transmission of disease to wild stock. There is very little known about the behaviour of escaped fish, except in South Australia where yellowtail kingfish escapees often stay close to farms for several days enabling their recapture. It is not known whether escaped fish form self-sustaining populations or integrate with wild schools thereby increasing the chances of disease transfer.

Robustness

This would be low since it is difficult to detect, monitor and measure diseases in the wild until fish health declines to a stage where major mortalities occur.

Fisheries Management Response

- Current

Health certification for all fish transferred from hatcheries to open sea cages should be undertaken, however this may not be feasible in all instances. This certification ensures that fingerlings are disease-free upon entering open ocean facilities and ensuring there is no transferring of pathogens or parasites across regional / state boundaries.

The state-wide *Translocation Policy* provides a framework for assessing the risk from transferring fish between states/regions and this will continue to be used. This policy has been assisted through the enacting of the *Biosecurity and Agriculture Management Act* in 2007.

Any use of chemicals requires the application and approval through the Australian Pesticides and Veterinary Medicines Authority and this system is unlikely to change, even under any new regime brought about by the *Biosecurity and Agriculture Management Act 2007*. There is some chemical usage² in WA's sea cage finfish aquaculture industry, with chemical application occurring mainly within land-based hatcheries.

- Future

If disease outbreaks occur within facilities or on a regional basis, there may be a requirement to reconsider stocking densities. Consequences may also require more often and rigorous health checks and/or Management and Environmental Monitoring Plans.

² Chemicals in this context means those chemicals requiring veterinary approval.

Research into the health and abundance of wild stocks would provide some useful data and consider whether diseases are actually transferring into aquaculture facilities. Information suggests that this type of research can be difficult and costly to undertake depending on the issue.

Longer quarantine periods for any newly introduced fingerlings could be investigated together with the use of freshwater baths or formalin dips.

A process should be developed outlining the action required once a disease has been detected.

- *Actions if Performance Limit exceeded*

Implement *Emergency/Incident Response Plan* and cull all affected organisms. There may be a closure of any further translocation from a certain state or hatchery until the disease vector has been determined.

Comments and Action

A PhD student from the University of Adelaide was researching parasite transmission between wild and cultured yellowtail kingfish in South Australia. The transmission of other diseases between the wild and cultured stocks needs further research as does the behaviour and ecology of the escaped fish.

There is no direct data available on this issue however the reporting of farm mortality events and disease outbreaks across a region could be investigated to see if there is any causal link to mortality events in wild stocks. Consideration of the importation of disease through feed is also of concern. The pilchard deaths in South Australia during 1995 and again in 1998/99 were a result of the spread of a Herpes virus throughout the wild populations and had serious consequences on the stock. Understanding of the pathogen has increased significantly since the first outbreak but there are still important knowledge gaps, such as the source of the virus.

External Drivers

Apart from the disease transmission issues, environmental factors such as variations in the Leeuwin Current are likely to affect the distribution, biology and recruitment of species. How these natural variations will affect disease pathogens, positively and negatively, is unknown.

6.1.3.2 *Escape of cultured species (feral populations)*

Rationale for Inclusion and Identification of Management Authority

The aquaculture of species not native to an area or state (i.e. outside of their natural range) has the potential for escapes to establish exotic populations.

ERA Risk Rating: Effects on environment due to the culturing of exotic species (C3 L1 LOW)

Bearing in mind current policy, the consequence would be severe however the likelihood of any non-native species being aquacultured in the marine environment is remote.

The management authority is the Department of Fisheries under the *Fish Resources Management Act 1994*.

Operational Objective (plus justification)

The aquaculturing of exotic species in sea cages will be restricted.

Justification

The Department of Fisheries limits sea cage aquaculture of non-native marine finfish and requires this type of aquaculture to be undertaken within a closed, land-based system. This policy is designed to minimize any likely introduction, through escapes, of exotic species into the WA marine environment.

Fisheries Management Response

- Current

Current policies do not allow for the aquaculturing of exotic species in open sea cages.

- Future

Should new technology be proven to remove any possibility of escape events, there may be some consideration for allowing the aquaculturing of exotic species in certain areas, excluding sensitive habitats. There would be stricter monitoring and reporting requirements to ensure suitable transparency of the management decision to the public.

- Actions if Performance Limit exceeded

Any applications for licences that are granted for exotic species would still need a translocation approval and health certification prior to bringing any fish into WA. Any fish brought in without this approval is destroyed.

6.1.3.3 Feeds composition (source and sustainability)

Rationale for Inclusion and Identification of Management Authority

The finfish industry uses feeds imported from overseas as well as interstate. The source of the ingredients in these feeds needs to be sustainable.

ERA Risk Rating: Impacts on feed composition and their sustainability (C2 L4 MODERATE)

Given the small amount of fish farmed in WA, the risk the State's industry imposes to baitfish stocks is low, however when we consider the aquaculture industry across Australia as a whole, the risk may be moderate. Demand from aquaculture is likely to be contributing to overfishing of a number of wildfish stocks. Of greater risk is the impact that relying on baitfish fisheries could have on the aquaculture industry, as prices are likely to increase as demand continues to increase.

There is no direct management authority and the issue is a commercial decision between feed producers and aquaculturists. The Code of Practice can guide operators in the purchasing of any feeds.

Operational Objective (plus justification)

A sustainable, high quality feed will be used by the WA finfish aquaculture industry.

Justification

Currently sea cage finfish aquaculture (except for tuna) uses mainly pelletized feed, which consists predominantly of fishmeal and fish oil that are obtained from overseas baitfish wild capture fisheries. One of the major concerns for those opposed to the aquaculture of carnivorous fish is that more baitfish by weight is required for feed than what is produced by weight as the final product. For example, for every 3.16 kilograms of baitfish used, only 1kg of

salmon is produced. These feed conversion ratios are improving however a lot is dependent on specific farm management practices. The indirect use of baitfish is one of the weaknesses in the argument that aquaculture will help relieve the pressure on wild capture fisheries. Most of the world's baitfish fisheries are fully exploited, overexploited or depleted and if aquaculture keeps expanding then supply may fall short of demand. While these fisheries should be managed for sustainability by the relevant fisheries authorities, history shows that this is often not achieved and increased demand for product could lead to further problems with overfishing.

Baitfish are primarily small pelagic fish and the main wild capture species utilised for global supplies of fish meal are anchoveta, Chilean jack mackerel, chub mackerel, Japanese anchovy, round sardinella, Atlantic mackerel and European mackerel. Six of these species are found in the top 10 of capture fisheries in terms of production. Several management strategies and regulations have been put into place by government agencies around the world in order to improve the sustainability of these baitfish fisheries. The main fishmeal producing countries in order of decreasing output are Peru, Chile, China, Thailand, Japan, USA, Denmark, Iceland and Norway. Worldwide, one-third of the fish used to make fishmeal are used for aquaculture, while the remaining two-thirds are used for fishmeal to feed poultry, pigs and other animals.

The over-exploitation of these pelagic fish species may have severe consequences for the food chain by reducing the available food for larger predatory fish. For example, in the North Sea, overfishing of sandeel, Norway pout and capelin has been associated with a decrease in stocks of certain fish such as cod, as well as changes in the distribution, population dynamics, and reproductive success of seal and seabird colonies. In the Peruvian upwelling system, a strong interaction between anchoveta and seabird and mammal populations has been observed. In Australia, pilchards (*Sardinops neopilchardus*) and jack mackerel (*Trachurus declivis*) are harvested for marine finfish food and both species are known keystone prey for a number of vertebrates including penguins, gannets, Australian fur seals, short-beaked common dolphins and Indo-Pacific dolphins.

The amount of baitfish captured varies greatly between years and there is some evidence that the global catch is declining, although some fisheries, such as pilchards in WA, are still classified as underexploited. At present, Western Australian aquaculture is highly dependent on the import of fishmeal and fish oil for feed. Fishmeal and oil prices have risen over the past few decades and will probably continue to rise as stocks become limited and demand increases. Due to the fluctuating food source, the industry has recognised the need for fishmeal and fish oil replacements in the diet. Carnivorous fish can use plant-based protein and oils just as well as fish based proteins and oils. There are some product quality issues with the use of alternatives to fish oils but the fish's health and growth are not affected.

Indicator

- A sustainable, high quality feed will be used by the WA finfish aquaculture industry.
- Level of alternative sources of proteins/lipids in fish feed.

Performance Measure/Limit (plus justification)

- Fish feeds used across the industry in WA are predominantly from sustainable sources.
- Level of alternative source of protein / lipids in fish feed increases over time.

Justification

There is currently extensive research into fishmeal partial replacements for feeds both in Australia and overseas. Worldwide, a wide variety of fishmeal replacements have been evaluated

although very few of them show any potential for inclusion in a carnivorous fish diet. The main problem with the use of some of these products is their limited availability, varying quality and prices. The replacement of fishmeal with meat meal has become highly controversial in recent years because major problems arose when livestock were fed meat meal contaminated with Bovine Spongiform Encephalopathy (BSE).

The Department of Fisheries has been undertaking research into replacements for over ten years. Most of the assessment has been focussed on meat meals and lupin meals. Research has been able to replace 66 per cent of the fishmeal in trout diets with lupin protein concentrates and 100 per cent of the added oils in snapper diets with canola oil. Commercially, most diets now use less than 30 per cent fishmeal but going any lower has issues with palatability of the diet to the fish and also is generally not cost-effective in terms of the formulation cost. Even with the fishmeal prices doubling over recent time, lupin replacements are a cost effective protein source for use in feeds but this still drives the feed prices up.

The FAO state that although aquaculture's contribution to total world fisheries landings has increased ten-fold over the past century, from 0.64 million tonnes or 3.2 percent of total fisheries landings in 1950 to 54.78 million tonnes or 37.4 percent of total fisheries landing in 2003, the finfish and crustacean aquaculture sectors are still highly dependent upon marine capture fisheries for sourcing key dietary nutrient inputs, including fishmeal, fish oil and low value trash fish. This dependency is particularly strong within aquafeeds for farmed carnivorous finfish species and marine shrimp.

Disposition of total global fish and shellfish catch in 2003 was 91.51 million tonnes, of which 63.23 million tonnes (69.1 percent) were used for direct human consumption and 28.28 million tonnes (30.9 percent) for reduction into meals and oils and other non-food purposes (23.4 percent for reduction into fishmeals and fish oils, and 7.5 percent for other miscellaneous purposes). The above estimate refers to only whole fish destined for reduction, and so excludes other fish scraps and processing wastes. In 2002, total quantity of whole fish and trimmings reduced into meals and oils was estimated as 33 million tonnes (27.4 million tonnes of whole fish caught by dedicated fishing fleets and 5.6 million tonnes of trimmings and rejects from food fish).

Although production of fishmeal and fish oil has remained relatively static over the years, there has been considerable uncertainty on the future availability and use of these finite commodities due to the combination of a number of factors such as a) increasing concern of consumers for feed and food safety, b) sustainable use of available fishery resources and c) strong global demand for fishmeal and fish oil, that supply cannot keep pace with demand and that the prices of these finite commodities will increase in the long run. Further, the use of trash fish as direct feeding in aquaculture is unlikely to be sustainable - apart from the obvious biosecurity/disease risks and potential environmental/polluting effect of using non-processed low value fish products as aquaculture feed, there are increasing concerns that the increasing demand for these products by the domestic aquaculture sector may result in increased fishing pressure on available fish stocks, driving up the cost of 'trash fish' and placing this resource out of the economic reach of the poor, who use "trash fish" for direct human.

Data Requirements/Availability

Information outlining sources of fishmeal need to be included on packaging.

Evaluation

The issue of fishmeal processes influencing feed prices and consequently affecting aquaculture profitability is still a key issue that needs addressing. By improving resource base availability for

feed companies to use alternatives it will help reduce feed price pressure and therefore improve profitability for the industry. There aren't many aquacultured ingredients used in feeds and certainly nothing that is making any inroads into addressing the protein supply issue. A more prudent approach is to rely on the production of agricultural products/by-products for use in feeds.

Robustness

Robustness will be high as the indicators will be a direct measure of the availability of feeds. The cost of feeds will also be a direct reflection of the availability of key ingredients.

Fisheries Management Response

- Current

Research into alternative sources of lipids / proteins for use in fish feeds should continue and be extended to consider new and innovative sources such as microalgae.

Planting alternative crops to supply lipids is considered to be best approach. The cost per tonne paid to farmers would need to increase to encourage the planting of the right lupin crop.

- Future

Continue research into alternative sources of lipids / proteins for use in fish feeds

Ensure any species imported for use in an aquaculture feed, is included on the species lists for the *Biosecurity and Agriculture Management Regulations*. Any new species will need to be assessed and added to the regulations as required.

Other issues that the industry needs to consider are:

- the use of fishery waste products and aquaculture by-product processing products in feeds
- the use of genetically modified organisms in the food chain
- product quality issues, such as maintaining the omega-3 levels at to maintain product quality
- environmental impacts associated with feed design and management

- Actions if Performance Limit exceeded

Mandatory use of agricultural sources for lipids in fish feeds could be considered if fish stocks continue to decline or biosecurity risks of imported feed increase.

Additional research and funding into aquaculturing of fish for use of fish feeds could be considered.

Comments and Action

It should be realised that the fish feed species are targeted by sectors apart from aquaculture and should aquaculture discontinue the use of fish for supplying fish meal/oil, there would still be considerable demand for these species.

The other major risk associated with feed is contamination. While there is recent, although controversial, evidence that cultured fish have high contaminant levels due to contaminated feed, in Australia the National Residue Survey Group regularly tests for contamination to ensure there are no problems. There is currently no testing program for imported feed however, so there is some risk of contamination occurring and leaving farmers with unmarketable product.

External Drivers

If other countries expand or commence aquaculture, then there will be more competition for feed and prices will increase. The WA aquaculture industry needs a back-up strategy for sourcing and supply of feed. Most suppliers of fishmeal do not like to supply smaller operators. They prefer to supply larger amounts to the bigger industries. WA operators may lack leverage to influence fish feed producers due to their small feed requirements.

In certain instances, there may be public health issues with the ingredients used and testing should be carried out on imported pellets to monitor toxin levels in fishmeals – farmers should therefore be selective as to where they purchase feed.

The FAO *Code of Conduct for Responsible Fisheries* says ‘States should encourage the use of fish for human consumption and promote consumption of fish whenever appropriate’, and ‘discourage the use of foodfish fit for human consumption for animal feeding’. The FAO also recommends, in line with the *Rome Declaration on World Food Security* and the *World Food Summit Plan of Action*, that aquaculture activities do no harm to the existing food supplies of the poor, but rather help by providing much needed affordable aquatic food produce and employment opportunities within both inland and coastal rural communities.

6.1.3.4 Chemicals

Rationale for Inclusion and Identification of Management Authority

If chemicals are being used by the aquaculture industry, a ‘whole of industry’ approach to their use is required.

ERA Risk Rating: Protocols for chemical use in industry (C3 L2 LOW)

The consequences of any inappropriate use of chemicals due to the lack of an industry-wide protocols could be severe due to the low level of relevant research and understanding of local impacts, however, with the current protocols and approvals processes, the likelihood of anything happening is rare.

The primary management authority is the Australian Pesticides and Veterinary Medicines Authority by way of applications for chemical usage.

Operational Objective (plus justification)

Chemical use by the aquaculture industry will be in line with industry-wide protocols.

Justification

The Australian Pesticides and Veterinary Medicines Authority manages the registering and use of chemicals in Australia and use is not permitted without prior approval. This protocol manages the industry as a whole, so there is some level of industry-wide approach already in operation. The use of chemicals, however, is still determined on an individual basis rather than having some predetermined response to known or expected disease outbreaks.

A lot of work has been done in Scotland into the use of chemicals and the resultant impacts to the environment. Intensive production of farmed salmon has been associated with both disease and parasite problems that have caused major losses to the industry. The use of antibiotics and chemotherapeutants used to be widespread.

Extreme disease problems in the early 1990s led to very high levels of antibiotic use in fish feed,

causing increasing levels of antibiotic resistance in the bacteria. Once in the marine environment, these antibiotics are still active and can cause resistance within other non-target bacteria species, with implications for human health. They are also persistent, with little or no degradation occurring in the sediments where they may persist for months or even years. Antibiotics also suppress the decay of organic matter, thus affecting seabed recovery under cages. The development of increasingly effective vaccines has now reduced the levels of antibiotic use.

Sea lice can also present major problems for the industry. These parasites are treated mainly using chemotherapeutants, which are either poured into the enclosed fish cage and then released after the treatment, or incorporated into the salmon feed. Sea lice treatments are, by their very nature, biocidal and have raised considerable concern over their impacts on other non-target species and the ecology of the marine environment. Resistance to treatments has also been encountered in sea lice.

Fisheries Management Response

- Current

Maintain the registration/assessment of any chemical use through the Australian Pesticides and Veterinary Medicines Authority. Any chemicals that are approved must be reported through the Management and Environmental Monitoring Plan annual reports.

- Future

Once the Code of Practice has been developed, there is a need to advise industry that this has been done and recommend it is utilized.

Research is required to understand impacts for WA species and environments. If use is required in future years, need to consider research on target species impacts, other species, broader ecosystem as well as any longterm retention in sediments etc.

- Actions if Performance Limit exceeded

If protocols prove to be ineffective, then a review will be required. This may be in response to breaches of the protocol (i.e. using chemicals without approval), the application process being overly onerous or changes to the process by the Australian Pesticides and Veterinary Medicines Authority.

The Commonwealth Productivity Commission is reviewing the registration process of all chemicals, which may result in different process being implemented in the next few years. The WA Department of Health and the Department of Agriculture and Food are both reviewing the use of pesticides and chemicals in this State, through two separate processes. The Department of Fisheries will ensure that any recommendations coming out of these two processes are complimentary and do not encumber industry with protocols that limit their ability to use chemicals to manage disease outbreaks.

6.1.3.5 Water quality

Rationale for Inclusion and Identification of Management Authority

Common standards for water quality have been developed and must be used by industry. These are generally in respect to environmental and social values.

ERA Risk Rating: Impacts of applying common standards for water quality (C1 L2 LOW)

In light of the current operational protocols and policies, the consequences of not having common standards would be minor, with a likelihood of anything of consequence happening, being rare.

The primary management authority lies in the Department of Environment and Conservation, however implementation will be through the Department of Fisheries via aquaculture licences.

Operational Objective (plus justification)

Aquaculture is managed under consistent and appropriate water quality standards.

Justification

Four environmental values have been identified as relevant to the coastal waters of WA. Six Environmental Quality Objectives or management goals have been developed to protect these environmental values. The environmental values and their associated Environmental Quality Objectives are:

Ecosystem health

EQO 1 Maintenance of ecosystem integrity (naturally diverse and healthy ecosystems)

Fishing and Aquaculture

EQO 2 Maintenance of aquatic life for human consumption (seafood safe to eat)

Recreation and Aesthetics

EQO 3 Maintenance of primary contact recreation values (waters safe for swimming)

EQO 4 Maintenance of secondary contact recreation values (waters safe for boating)

EQO 5 Maintenance of aesthetic values (pleasant, attractive environment)

Industrial water supply

EQO 6 Maintenance of industrial water supply (water suitable for industry use)

Ecosystem health recognises that people value the natural ecosystem for its own sake. This value signals a desire to maintain the essential natural structure and function of any ecosystem. EQO 1 has four levels of protection, these being maximum, high, moderate and low. These levels represent the minimum acceptable level of environmental quality to be achieved through management of the waters. They do not describe the current or preferred environmental condition. The Environment Protection Authority and the Department of Environment and Conservation have determined the limit of acceptable change for each of these protection levels. These are summarized as follows:

Maximum	no contaminants (pristine)	no detectable change from natural variation
High	very low levels of contaminants	no detectable change from natural variation
Moderate	elevated levels of contaminants	moderate changes from natural variation
Low	high levels of contaminants	large changes from natural variation

Fishing and aquaculture values relate to ensuring the environmental quality is suitable for the gathering and farming of seafood for human consumption. The intent is to ensure seafood

collected or grown in waters where this environmental value is protected would not have levels of contaminants in the flesh that would exceed the Australian Food Standards.

The Department for Environment and Conservation and the Department of Water are providing input into the development of plans, which will be managed by the various natural resource management groups. The reports have been completed for Cockburn Sound and the Pilbara Coast.

Fisheries Management Response

- Current

Utilize the water quality criteria developed for Cockburn Sound and the Pilbara coast.

- Future

Work with regional natural resource management groups, the Department of Environment and Conservation and the Department of Water in the development of future water quality criteria and determination of environmental values to include aquaculture as a valid user.

6.1.3.6 Pests

Rationale for Inclusion and Identification of Management Authority

Protocols need to be developed regarding the transportation of equipment in order to limit the possible introduction of marine pests. The impact of these species could have devastating consequences on the environment and financial viability of the industry.

ERA Risk Rating: Protocols to limit impacts from transportation of equipment (C2 L4 MODERATE)

Marine pests have the potential to cause significant long-term economic, ecological and health consequences for the sea and the creatures who live in it. They can have a harmful effect on the biodiversity and health of marine ecosystems, and the industries and amenities that depend on them. There are currently about 250 introduced marine species in Australia. Already 92 of these can be found in WA.

The management authority is the Department of Fisheries. The WA Government is reconsidering arrangements using regulations under the *Biosecurity and Agriculture Management Act 2007*. The use of voluntary guidelines developed by the National Introduced Marine Pests Coordination Group supports this management framework.

Operational Objective (plus justification)

Aquaculture will not increase the risks due to introduced marine pests.

Justification

Aquaculture activities in some Australian states have resulted in the deliberate introduction of non-native aquatic plants and animals so that they can be cultured for food. When an aquaculture species is being transported from one place to another, other animals and plants may be introduced unintentionally via the transport water or packaging, or may attach themselves to the aquaculture species. These unintended introductions are classified as marine pests, rather than a disease.

Indicator

- No new incursions in the State due to aquaculture operations.

Performance Measure / Limit (plus justification)

- WA continues to be a member of the National Consultative Committee on Introduced Marine Pest Emergencies.
- The Department of Fisheries maintains its *Emergency Incidence Response Plan*.
- Compliance and education activities are used to inform industry of any legislative requirements.

Justification

The management of introduced marine pests has two components: controlling existing invasions and preventing the introduction of new exotic species. State, Territory and Commonwealth agencies are working with industry and the community to prevent further pest introductions, to reduce the impacts and further spread of existing introduced marine pests and to develop options for their eradication.

Data Requirements/Availability

Management and Environmental Monitoring Plan results each year could include a video of the seabed, which is used to identify any marine pest that may be transported into a site via equipment.

Monitoring, if marine pests within ports and other high use areas are found, is being conducted by the Department of Fisheries as part of various federal initiatives.

Evaluation

Translocation of marine pests around the state should hopefully be limited by the use of the Department of Fisheries' translocation policy and assessment process. Transportation of equipment may be addressed by the new *Biosecurity and Agriculture Management Act 2007* and associated regulations through the 'potential carrier' management arrangements.

Robustness

Robustness will be high as the indicator is a direct measure of the ability to monitor for marine pests and limit incursions.

Fisheries Management Response

- Current

Maintain use of the Department of Fisheries' translocation policy and progress the development of the *Biosecurity and Agriculture Management Act 2007* and associated regulations.

Maintain the Department of Fisheries' *Emergency/Incident Management Plan*

Implement national guidelines on managing marine pests.

- Future

Incorporate guidance from legislation into the Code of Practice and advise industry.

Link with research into vectors for marine pest incursions and their management

- *Actions if Performance Limit exceeded*

Implement stricter guidelines for aquaculture equipment movements if necessary.

External Drivers

Shipping traffic into and around WA is of great concern when considering marine pests and their management. Ballast water will be managed through the *Biosecurity and Agriculture Management Act 2007* and associated regulations in coordination with any national guidelines.

6.2 Impact of the Industry on the Region (Cumulative Impacts)

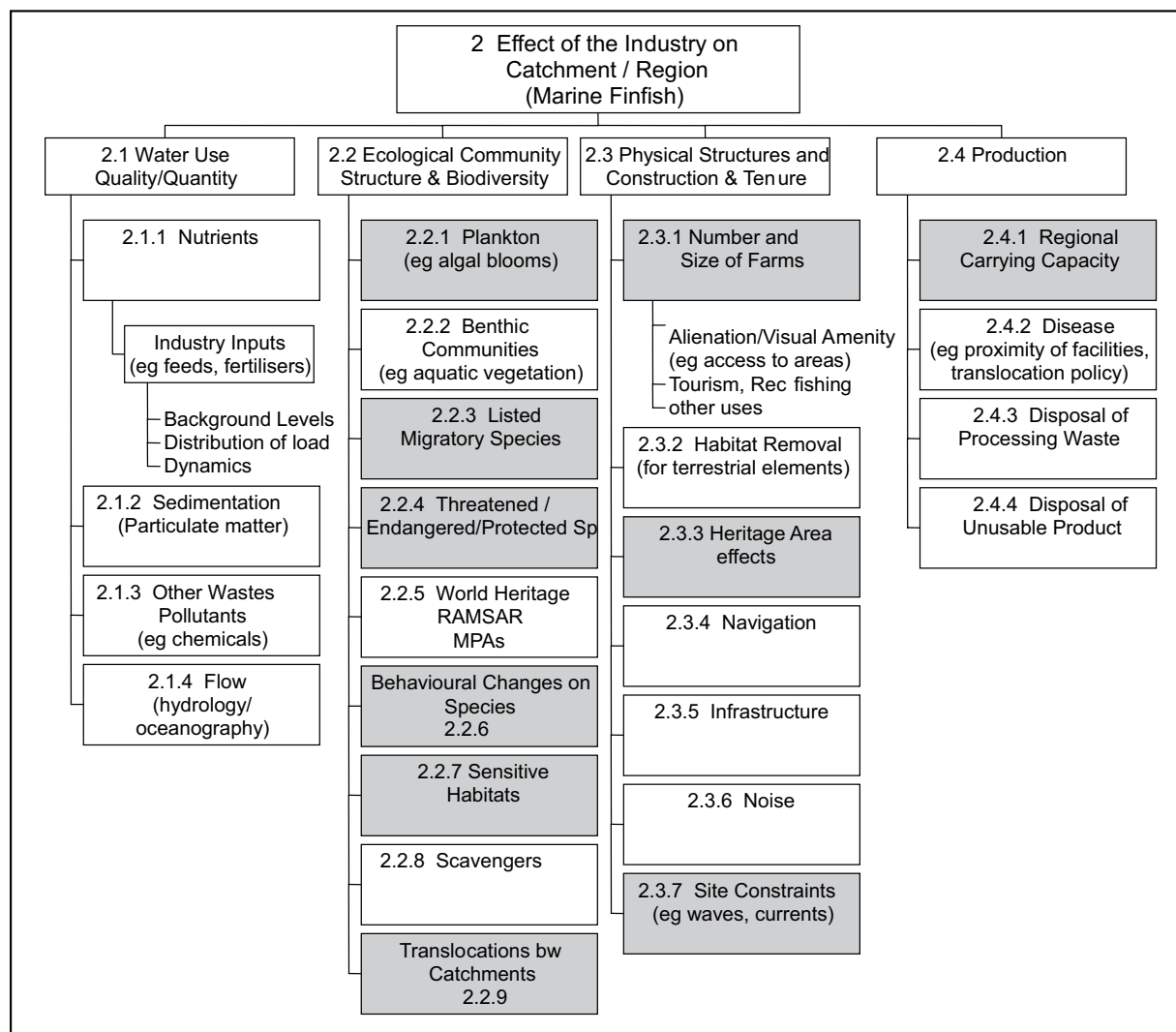


Figure 5 Component Tree 2 - Environmental Impacts of Sea cage Finfish Aquaculture Industry on the Region

Integrated Marine and Coastal Regionalisation of Australia (IMCRA) regions considered for the Ecological Risk Assessment (ERA) in this report are:

KSD	King Sound	CWC	Central West Coast
SBY	Shark Bay	LNE	Leeuwin-Naturaliste
ABR	Abrolhos Islands	WSC	WA South Coast

6.2.1 Water Use

6.2.1.1 Nutrients

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	0	1	1	Low
SBY	2	2	4	
ABR	2	2	4	
CWC	1	1	1	
LNE	1	1	1	
WSC	2	1	2	

ERA Risk Rating: Effect on region due to release of nutrients

Rationale for Inclusion and Identification of Management Authority

Production by aquaculture facilities releases nutrients into the broader environment, so setting maximum or total regional levels allowable (e.g. total dissolved solids per day/week/year) may be required.

In WA, regional water quality criteria are being developed through the State Water Quality Management Strategy which provides the implementation framework for determining environmental values for water quality, broad environmental quality objectives (EQO) for each environmental value and environmental quality criteria (EQC) or benchmarks, to determine if a standard has been breached. At current stocking levels and at levels likely to be achieved over the next few years, this issue is a low risk at the region level. While there is disagreement over the regional impact of tuna farming in South Australia, there is probably little regional impact of other forms of sea cage finfish farming at this stage. The risk would be low but with expansion it could become moderate.

The primary management authority is the Department of Environment and Conservation, however implementation of the legislative obligations under the *Environment Protection Act 1986* will be imposed by the Department of Fisheries by way of aquaculture licences, under a Memorandum of Understanding. The Department of Fisheries can use the *Fish Resources Management Act 1994* to manage environmental impacts resulting from the aquaculture operation, if the operation could result in an impact on fish or fish habitat.

Operational Objective (plus justification)

No detectable change in regional nutrient levels that can be attributed to aquaculture.

Justification

Work undertaken in Victoria, reviewed appropriate methods for environmental monitoring of marine aquaculture and these methods may be applicable to other Australian waters. They separated the possible indicators of environmental change into three main categories; (1) impacts on sediment quality, (2) impacts on water quality and (3) biological impacts. It is usually the biological variables that are of interest because changes in the chemical variables may not be enough to cause biological changes due to the varying assimilation at different sites. So, although a change in the chemical variable may be detected, due to the high assimilation of nutrients in that particular area, a biological change may not be detected.

The waters off the west coast of WA are nutrient poor and major upwellings do not occur. The Leeuwin Current originates in the open ocean north of North West Cape and flows southwards along the west coast of WA, along the outer continental shelf. It is strongest in winter, raising sea surface temperatures significantly higher than they otherwise would be. The Leeuwin Current is nutrient poor, raising the question of how such a biologically productive region exists in the middle of a sea where the necessary nutrients for plant production are in such low supply.

Within the context of this report, we need to consider the regions identified and the risk of nutrient enrichment from aquaculture. Item 6.2.2.7 (sensitive habitats) contains descriptions of the environments themselves i.e. the type of habitats that may be affected by nutrients and will not be repeated here. In the context of nutrient enrichment for aquaculture however, we need to consider other constraints.

Water can be turbid for two reasons – due to suspended sediment particles or tannins. In both cases this can lead to a decreased response to nutrients, as the nutrient molecules may be in equilibrium with the sediment particles. These sediment particles (i.e. clay) can sometimes bind with the nutrients settling them out thereby lowering the possibility of an algal bloom. In both instances any response to increased nutrients, is likely to be less as sunlight is unable to penetrate any depth into the water column. This is the case in King Sound where muddy waters are caused by the sediment loads reaching the coast and the extreme tidal fluctuations.

If we compare this to clear waters i.e. such as Shark Bay and the South Coast, the response is likely to be different. The waters of these areas are clear, evident by the seagrass meadows and algal communities found in both. A different response is also likely as a result of the different flushing rates experienced. Nutrients in waters such as Shark Bay are likely to lead to an increased epiphyte load on the seagrass fronds, decreasing the amount of light reaching the plant, resulting in eventual death if the epiphytic growth persists. The lower flushing rates in Shark Bay may mean any nutrients in these waters are not flushed as quickly and could build up over time. Along the south coast, where ocean currents are significant, seagrass and algal communities are unlikely to be affected by nutrients to the same degree.

The Abrolhos Islands has coral ecosystems, which will respond differently to seagrass. There is very little information available to describe the impacts that could occur, so a cautious approach is recommended.

In Western Australia, the State Water Quality Management Strategy (2004) provides for the establishment of environmental values and environmental quality objectives as goals for environmental quality management. This strategy has as an objective, the protection of the environment from the effects of waste inputs and pollution. Thorough public consultation must be undertaken prior to the development of environmental values and environmental quality objectives prior to their submission to the Environment Protection Authority for review and endorsement. These values then guide environmental impact assessment and natural resources management.

Fisheries Management Response

- Current

The Department of Fisheries' Aquaculture Licence conditions require an Management and Environmental Monitoring Plan. These plans are being reviewed to implement a more robust data gathering exercise, including a more transparent reporting mechanism. The Department of Fisheries is also implementing the Ecosystem Based Fisheries Management framework and aquaculture Management and Environmental Monitoring Plans will contribute to this process.

- Future

Identifying zones suitable for aquaculture, incorporating water quality criteria, are needed.

Research into the impacts in tropical waters and over coral systems is being considered to determine any impacts observed due to the existing level of farming.

Research should consider what 'natural variation' is within each region, in order to determine when nutrient enrichment occurs.

- Actions if Performance Limit exceeded

Individual facilities will still be required to provide site-specific data. The Department of Environment and Conservation are interested in managing the individual facility, however regional assessment could become more important should the industry grow over the next five years in specific regions.

Comments and Action

Regional water quality must be based on the assumption that individual Management and Environmental Monitoring Plans are monitoring whether there are no impacts outside the license area, i.e. water quality guidelines are met at the license boundary. For areas of significance such as environmentally sensitive sites (e.g coral reefs and sea grass meadows) these should not be part of any license area.

In regions such as the Abrolhos, seasonal habitation can lead to nutrient increases, due to point source discharges of effluent. This may have direct deleterious effects on local coral calcification rates or indirectly through smothering by macroalgae proliferation.

External Drivers

Nutrients are also discharged into the marine environment from other sources, beyond the ability of Department of Fisheries to manage. Monitoring or regional assessment undertaken by the Department of Environment and Conservation needs to consider these outside influences.

6.2.1.2 Sedimentation (particulate matter)

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	1	1	1	Neg - Low
SBY	0	1	0	
ABR	0	1	0	
CWC	1	1	1	
LNE	0	1	0	
WSC	0	1	0	

ERA Risk Rating: Impact of sedimentation across the regions caused by release of material

Rationale for Inclusion and Identification of Management Authority

In Western Australia, regional water quality criteria, including sedimentation will be developed through the State Water Quality Management Strategy which provides the implementation framework for determining environmental values for water quality, broad environmental quality objectives (EQO) for each environmental value and environmental quality criteria (EQC) or benchmarks to determine if a standard has been breached. Major impacts are generally found within a localised area and are unlikely to pose a significant threat to the regional environment at current levels of farming in WA. As a result, the consequence would be expected to be negligible or minor depending on the region. The likelihood of these impacts occurring is remote.

The primary management authority is the Department of Environment and Conservation however implementation of the legislative obligations under the *Environmental Protection Act 1986* will be imposed by the Department of Fisheries by way of aquaculture licences, under a Memorandum of Understanding. The Department of Fisheries can use the *Fish Resources Management Act 1994* to manage environmental impacts resulting from the aquaculture operation, if the operation could result in an impact on fish or fish habitat. Operators can use fallowing within the licensed area if necessary as a practice to minimize benthic habitat impacts.

Operational Objective (plus justification)

No detectable change, at a regional scale, in sedimentation that can be attributed to aquaculture.

Justification

Many studies have shown that benthic infauna is a reliable indicator of near-field environmental change caused by increases in nutrients and sedimentation and as such, infauna sampling has become a common tool in environmental monitoring programs worldwide. In South Australia, all license holders are required to submit an Environmental Monitoring Program report annually in accordance with the monitoring protocol outline by Primary Industry and Resources of South Australia (PIRSA) Aquaculture. This Environmental Monitoring Program is based on the statistically rigorous Environmental Monitoring Program required for the tuna farming industry. It quantitatively addresses changes to the benthic infauna at potentially impacted lease sites relative to replicated control sites. In addition, a qualitative assessment of the epibenthic flora and fauna is made using underwater video.

Management of individual sites through analysis of Management and Environmental Monitoring Plan results will ensure any sedimentation impacts remain on site, below trigger levels and not result in region-wide changes. These parameters will be dealt with in more detail in the individual facility section.

Fisheries Management Response

- *Current*

The Department of Fisheries imposes licence conditions requiring environmental monitoring at the facility level. This data is currently not assessed across the region, however the level of aquaculture development within any region is unlikely to be producing any regional level impact.

The Department of Environment and Conservation is developing environmental values and criteria for each region however this program will not be completed for some years.

- *Future*

Completing the Department of Environment and Conservation program for determining environmental values etc will provide some level against which to assess various facility Management and Environmental Monitoring Plans.

The Aquafin Cooperative Research Centre has finalised a project for the “*Development of regional environmental sustainability assessments for tuna sea cage aquaculture*”. The findings from this project should be considered for understanding and detecting sedimentation impacts under marine finfish cages.

- *Actions if Performance Limit exceeded*

Focus should be on facilities minimizing their individual level of sedimentation as determined through their Management and Environmental Monitoring Plans. More rigorous testing and changes to operational procedures to lower sedimentation to an acceptable level are required.

6.2.1.3 Other wastes/pollutants (chemicals)

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	2	1	2	Low
SBY	3	1	3	
ABR	3	1	3	
CWC	1	1	1	
LNE	1	1	1	
WSC	3	1	3	

ERA Risk Rating: Effects of other pollutants, such as chemicals on the region

Rationale for Inclusion and Identification of Management Authority

In WA, approval must be sought for the use of any chemicals on a case-by-case basis. There are industry-wide protocols guiding the use of chemicals, however, the actual level of chemical usage is low at present.

The primary management authorities are the Department of Agriculture and Food as well as the APVMA in respect to the registration of chemicals and subsequent authorization of their use. The Department of Agriculture and Food developed a Code of Practice for the use of agricultural and veterinary chemicals in WA (3rd Edition) (2005).

Other management authorities are the Department of Environment and Conservation and Department of Fisheries. Obligations under the *Fish Resources Management Act 1994* will be imposed by the Department of Fisheries via aquaculture licences to manage environmental impacts resulting from the aquaculture operation, if the operation could result in an impact on fish or fish habitat. The implementation of these secondary legislative obligations is through the Department of Fisheries via licence conditions and any Code of Practice.

Operational Objective (plus justification)

No regional level impacts due to the use of chemicals by aquaculture.

Justification

Intensive aquaculture in other parts of the world is dependent on the use of medicines and chemicals to control the biological environment within the culture system. A wide range of chemicals are used including antibiotics, anti-parasitics, fungicides, herbicides and disinfectants. The degree of environmental damage from these compounds will depend on their toxicity to local species, their distribution in the environment and their half-life in that environment. Usually, those organisms closely related taxonomically to the target organisms for any treatment will be most at risk. For example, chemicals used to kill crustacean parasites such as sea lice are likely to pose most risk to wild crustaceans but the exact effects will depend on the mode of action of the medicine. The more persistent the chemical is in the environment, the greater the ecological effect.

Anti-bacterials may be found in non-target organisms around farms but the amounts found vary between species possibly due to their feeding habitats. Studies overseas into the residues and bacterial resistance in sediments beneath a sea cage holding salmon, showed impact confined to an area of the sediment smaller than the area of the cage block itself. Elevated frequencies of resistance were detected in samples from a wider area than the cage but there was no correlation between the concentration of the antibacterial and the frequency of resistance.

The use of large amounts of chemicals in aquaculture is usually a sign of crisis or poor husbandry. Where such operations discharge significant amounts of hazardous chemicals to the aquatic environment, it is likely that the operation is unstable and may be unsustainable, as stressed animals are more likely to succumb to disease.

Fisheries Management Response

- *Current*

Application and approval processes should be maintained until a more robust protocol is developed and supported by appropriate legislation.

- *Actions if Performance Limit exceeded*

Limit the use of certain chemicals in specific areas if long-term impacts are detected and can be attributed to a specific aquaculture operation.

6.2.1.4 Flow (hydrology/oceanography)

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	0	2	0	Neg --Low
SBY	1	4	4	
ABR	0	2	0	
CWC	0	1	0	
LNE	0	1	0	
WSC	0	1	0	

ERA Risk Rating: Impact on water flow across the region

Rationale for Inclusion and Identification of Management Authority

Siting aquaculture facilities in appropriate locations in respect to hydrology can lessen or prevent many of the environmental impacts of aquaculture.

On the basis of current policy and the number of operational farms, the consequences could range between negligible or minor in areas such as Shark Bay due to the sensitive environmental habitats and lower tidal flushing. The likelihood is considered to be remote to possible.

The management authority is the Department of Fisheries, using information obtained through aquaculture licence applications and their assessment. Ongoing management is directed by results of data gathered through the licence-specific Management and Environmental Monitoring Plans.

Operational Objective (plus justification)

Regional water circulation will not be restricted by the placement of aquaculture facilities.

Justification

Flushing time is a key characteristic for aquaculture and it is a measure of the time required for the volume of water in a given area to be completely replaced. A higher flushing time means that the waters are replaced more often, reducing the chance of nutrients or other build-up from aquaculture to occur.

Siting is crucial in sea cage farming, which relies on natural tides or currents to flush wastes that settle below farms. High rates of erosion of bottom sediments, as well as high water flows, are most desirable. Farms must be well spaced to reduce the potential for the spread of disease between farms, as well as reduce any cumulative effects of waste production. Having a minimum distance between farms will also ensure tidal flows and currents are not interrupted significantly.

Knowing wave heights, tides and currents, as well as flushing rates, for all regions where aquaculture is likely to be located are required. The regions in WA that need consideration include area such as King Sound, previously described as having large tidal fluctuations, and the Abrolhos Islands.

Fisheries Management Response

- *Current*

Maintain the rigorous Ministerial Policy Guideline No. 8 assessment processes to minimize likelihood of any water circulation interruptions.

- *Future*

Consider regional strategic planning to identify zones where more aquaculture development could feasibly be located.

If any lowering of flushing rates is detected, instigate appropriate farm management response such as moving cages further apart or lowering stocking densities.

- *Actions if Performance Limit exceeded*

Move farms into alternative areas if water circulation is lowered to the detriment of the surrounding habitat.

6.2.2 Ecological Community Structure and Biodiversity

6.2.2.1 Plankton (algal blooms)

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	0	1	0	Neg - Mod
SBY	3	4	12	
ABR	2	2	4	
CWC	0	1	0	
LNE	1	4	4	
WSC	2	2	4	

ERA Risk Rating: Increased frequency/intensity/composition of plankton blooms

Rationale for Inclusion and Identification of Management Authority

An increase in nutrients, which normally limits primary productivity in the aquatic environment, can cause an increase in algal growth. Increased algal growth can lead to eutrophication or increases in frequency and magnitude of toxic and non-toxic algal blooms.

There is no data to suggest sea cage finfish aquaculture would have a direct impact on phytoplankton composition and abundance in Western Australia. Given that there are suggestions that severe problems have occurred elsewhere, the consequence could be severe but the likelihood is rare or possible.

The primary management authority is the Department of Environment and Conservation, however implementation of the legislative obligations under the *Environment Protection Act 1986* will be imposed by the Department of Fisheries via aquaculture licences, under a Memorandum of Understanding. The Department of Fisheries can use the *Fish Resources Management Act 1994* to manage environmental impacts resulting from the aquaculture operation, if the operation could result in an impact on fish or fish habitat.

Operational Objective (plus justification)

Phytoplankton bloom frequency, intensity and composition as a result of aquaculture will remain within acceptable levels.

Justification

It is necessary to put some context on the sites where sea cage aquaculture is likely to occur and the impact of nitrogenous compounds being released and causing plankton blooms. Generally, finfish farms are located in areas where the currents are at least one to two knots. Research undertaken in the USA in 2000 found that at temperatures of 10 - 15° C, it takes one to two days for an algal cell to divide, even if all its photosynthetic needs are met. An algal bloom may result in cell densities increasing from a few thousand cells per millilitre to perhaps a million. This requires eight or nine cell generations, or a minimum of 8 - 16 days. In open bodies of water, moving with a net speed of even 2 cm/sec, a phytoplankton population would move 14 km from the location at which nutrients were added during creation of the bloom. Therefore, it appears reasonable to conclude that, within a single algal cell division (one to two days), the water passing through the farm would have travelled at least 1.7 km. It is difficult to conclude that the nutrient additions from the farm, generally undetectable at 50 m downstream, would have any effect at all on primary production even if the water body were nutrient limited. This would seem to be supported by the development of plankton blooms in WA, which generally form during high temperatures with long spells of calm weather when the waters are not moving at a great speed or distance.

Indicator

- Aquaculture is managed to avoid unacceptable frequency, intensity and composition of phytoplankton blooms.

Performance Measure / Limit (plus justification)

- There are no toxic phytoplankton blooms as a result of aquaculture.
- There is no increased intensity or frequency of phytoplankton blooms as a result of aquaculture.

Justification

Buschmann et al. (2007) state that organisms forming the planktonic food web are key factors in the assimilation of excess nutrients in the water column. The main group of organisms are:

- *phytoplankton, microscopic photosynthetic algae and cyanobacteria. The main taxonomic groups are picocyanobacteria, diatoms, dinoflagellates and a diverse group of small eukaryotic flagellates. Sizes typically vary between 2 – 100 µm: colonies may be larger.*
- *heterotrophic bacteria, small organisms (<1 µm) consuming dissolved organic compounds but also inorganic nutrients like the phytoplankton;*
- *heterotrophic nanoflagellates (HNF), small (4 – 8 µm) protozoan grazers that feed on picocyanobacteria and bacteria;*
- *microzooplankton, often dominated by ciliates in north-eastern Atlantic waters (5 – 50µm), protozoan grazers that feed on small phytoplankton mainly; and less important also HNF, the smallest individuals (5 – 10 µm) may feed on bacteria; and*
- *mesozooplankton, larger individuals (>200 µm but also smaller) often dominated by crustacean zooplankton like copepods in NE Atlantic waters.*

Ammonia, which is the principal excretion product from all aquatic animals and the most common limiting nutrient for phytoplankton, is not easily found persisting in high concentrations in water masses around and downstream of cages.

Studies on salmon farms looked at small increases in dissolved nitrogen within and on the perimeter of the lease. In all of these instances, the quantity of dissolved nitrogen added by even several farms had no measurable effect on phytoplankton production. Studies of a Scottish loch with very restricted water exchange to the open sea and a large salmon farm also concluded that there were no measurable effects on phytoplankton density.

Studies on the Pacific Northwest examined phytoplankton production and blooms of noxious phytoplankton. They concluded that nitrogen levels and phytoplankton production at salmon farms were determined by ambient conditions and that salmon farms had little or no effect on ambient levels of either nutrients or phytoplankton density.

These studies strongly support the theory that, with the exception of a few shallow, very poorly flushed embayments, the potential for sea cage enhancement of phytoplankton populations is remote or non-existent. Since specific data is unavailable for regions in WA, being able to strongly conclude that the same stands for WA environments is not possible at this point in time. Therefore, monitoring programs should gather this data for five years to consider the results gained from existing farms, then make a determination on the long term need for an indicator.

In line with the State Water Quality Management Strategy, detectable change beyond natural variation is nominally defined by the median of a test site parameter being outside certain percentiles of the measured distribution of that parameter from a suitable reference site.

This issue will be dealt with in more detail in the individual facility section.

Fisheries Management Response

- Current

Phytoplankton monitoring forms part of the Management and Environmental Monitoring Plan attached to some aquaculture licences. The Department of Fisheries will be applying this plan to all finfish aquaculture licences.

- Future

Determine ambient plankton level for regions where information is not currently available.

- Actions if Performance Limit exceeded

Should management practices be inadequate to limit plankton blooms, there may be a need to reconsider the nutrient discharge levels emanating from each facility and assess them against the current biomass or farm management practices.

6.2.2.2 Benthic communities (aquatic vegetation)

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	0	1	0	Neg -Low
SBY	2	2	4	
ABR	1	2	2	
CWC	1	1	1	
LNE	1	1	1	
WSC	2	1	2	

ERA Risk Rating: changes to benthic communities due to sedimentation and shading

Rationale for Inclusion and Identification of Management Authority

Aquaculture has often been seen as the cause behind many of the changes to benthic habitats on a broad scale in other parts of the world. However, it is rare to be able to demonstrate any linkage between the nutrients produced from farming and a biological response, although many such linkages have been claimed. Beyond looking at purely local enrichments, it is normally not feasible to attribute wider-scale effects to nutrients from farms.

The primary management authority is the Department of Fisheries, except for areas within Marine Parks where the primary management authority is the Department of Environment and Conservation. The Department of Fisheries uses the *Fish Resources Management Act 1994* to manage environmental impacts resulting from the aquaculture operation, if the operation could result in an impact on fish or fish habitat.

Operational Objective (plus justification)

No changes to benthic communities, at a regional level, as a result of aquaculture.

Justification

Benthic flora may be affected by sedimentation from cage farms. Meadows of the seagrass Posidonia spp. cover vast areas in shallow regions of the world's oceans. They are regarded as the cornerstone of the littoral ecosystem, providing a wide variety of niches accounting for the high diversity of these areas. Seagrass meadows are feeding grounds for many significant faunal species. Nutrient inputs from sea cage farms have been observed to result in an increase in leaf length and increased biomass of epiphytes (algae growing on the seagrass) and fish but with decreased meadow density and total disappearance of Posidonia directly beneath the cages themselves.

The Environmental Protection Authority developed Guidance Statement No. 29 - Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment (2004) and the subservient Draft Guidance Statement No. 22 - Seagrass Habitat Protection (1998). These statements provide non-statutory advice to proponents about the minimum requirements for environmental management which the Environment Protection Authority would generally expect to be met during environmental impact assessment processes and specifically reflect Environment Protection Authority position on developments over seagrass habitat.

Around Australia, little work has been done to determine the regional impacts of aquaculture, however the Aquafin Cooperative Research Centre recently completed a project to consider the

regional assessment of tuna aquaculture in SA. In Western Australia no data is available, so studying the results from the Cooperative Research Centre will assist in putting in place mechanisms to monitor any regional impacts on benthic habitats. The Department of Fisheries implements a policy position to limit individual aquaculture proposals directly over seagrass habitats.

Fisheries Management Response

- *Current*

Assessment under Ministerial Policy Guideline No. 8 ensures management agencies are given the opportunity to comment on all marine aquaculture applications. The Environment Protection Authority assesses large-scale proposals independently.

- *Future*

Consider revising the criteria and trigger values for parameters being monitored if benthic habitat impacts are found to be impacting the environment as part of the Management and Environmental Monitoring Plan.

Participate in future discussions with the Department of Environment and Conservation during any determinations of environmental values for regions not covered by strategies.

- *Actions if Performance Limit exceeded*

Apply more rigorous Management and Environmental Monitoring Plans to individual licenses if benthic habitats are impacted at the facility level to ensure broader regional level impacts will be avoided.

6.2.2.3 Listed migratory species

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	4	4	16	Mod
SBY	4	4	16	
ABR	3	4	12	
CWC	3	3	9	
LNE	3	3	9	
WSC	4	2	8	

ERA Risk Rating: Changes to migratory species in the area

Rationale for Inclusion and Identification of Management Authority

Migratory species traverse the same waters used by aquaculturists for finfish farming. There is a need to consider whether protocols are required to guide the siting and operation of facilities in any region to ensure impacts on these species are minimized and/or ecologically insignificant.

Under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), migratory species protected under international agreements are considered to be ‘matters of national environmental significance’. Referrals to the Commonwealth Minister for the Environment are required if an action (in this case aquaculture) has, will have, or is likely to

have, a significant impact on a matter of national environmental significance.

The finfish farming industry in WA is still rather small and any new proponent should be reminded of the need to undertake the self-assessment against the EPBC Act.

The primary management authority is the Commonwealth Department for the Environment, Water, Heritage and the Arts (DEWHA). The state level management authority is the Department of Environment and Conservation.

Operational Objective (plus justification)

Aquaculture is operated to minimize interactions with listed migratory species.

Justification

At the commencement of the EPBC Act, the National List of Migratory Species consisted of those species listed under the following International Conventions:

- *Japan-Australia Migratory Bird Agreement (JAMBA)*
- *China-Australia Migratory Bird Agreement (CAMBA)*
- *Convention on the Conservation of Migratory Species of Wild Animals - (Bonn Convention)*

Under the EPBC Act, a 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted and upon the intensity, direction, magnitude and geographic extent of the impacts.

Some listed migratory species are also listed as threatened species and different criteria for determining whether significant impacts will occur, apply for both. The criteria for migratory species include the following:

- *substantially modify (including fragmenting, altering flow regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;*
- *result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or*
- *seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.*

Indicator

- Interactions between aquaculture and listed migratory species are at acceptable levels.

Performance Measure/Limit (plus justification)

- The number of interactions between aquaculture operations and listed migratory species across a region does not exceed two per year.

Justification

Proponents are required to consider all adverse impacts that may result from their actions, including indirect and offsite impact from supplemental feeding, waste material or chemicals that fall, are washed or discharged into the marine environment. These are in relation to:

- *site selection and the location of buildings or activities on the selected site;*
- *the timing of the action or its component activities; and*
- *the design of any buildings or other structure or infrastructure.*

Human activity at aquaculture facilities can affect wildlife. Where fish farms are sited in remote areas, wildlife may be affected by human disturbance resulting from routine farming activities in a way that animals would not be in places where they have become used to regular human activity. Regions such as King Sound are known to provide important wading bird habitat, especially at, and north of, Roebuck Bay. Tidal mudflats are significant feeding areas and although sea cage aquaculture does not directly impact of these areas, adjacent activities may disturb sites used for roosting.

The whale shark inhabits the world's tropical and warm-temperate oceans and while thought to be primarily pelagic, seasonal feeding aggregations of the sharks occur at several coastal sites such as Ningaloo Reef. Its range is restricted to about $\pm 30^\circ$ Latitude where it is found to a depth of 700 m. The whale shark is solitary and rarely seen in groups unless feeding at locations with an abundance of food. The whale shark is targeted by artisanal and commercial fishers principally in several areas where they seasonally aggregate. The population is unknown and the species is considered vulnerable by the International Union for Conservation of Nature. Whale sharks are filter feeders - one of only three known filter feeding shark species. It feeds on phytoplankton, macro-algae, plankton, krill and small nektonic life, such as small squid or vertebrates.

Southern right whales inhabit the world's southern oceans. During the warmer months of the year they feed on small crustaceans in nutrient rich sub-Antarctic waters. When the days become cooler the whales migrate northward to warmer waters. They spend the winter months calving, mating or nursing their young before returning south in spring to feed again. All regions being considered for sea cage aquaculture need to consider whale interactions.

In Australia, dugongs swim in the shallow coastal waters of northern Australia from the Queensland/New South Wales border in the east to Shark Bay on the Western Australian coast. They are also found in other parts of the Indian and Pacific Oceans in warm shallow seas where seagrass is found. Dugongs are protected under the EPBC Act, which lists dugong as a marine and migratory species.

Data Requirements/Availability

Site-specific Management and Environmental Monitoring Plan reports will include reporting on all interactions between sea cages and listed migratory species, both marine mammal and avian species. These will be analyzed for a regional context

Evaluation

Marine mammals that will need to be considered as the industry grows are whales and sea lions. At present, there are insufficient levels of development to constitute any threat to these species. 'Acoustic harassment devices' have been used in other countries such as Canada, but are not being considered in here due to costs and the unknown, long term impact this sound may have.

The use of certain feeds and feeding techniques can lower the likelihood of interactions. Pellet feeds are not as attractive to birds, as opposed to trash fish. Whales are unlikely to be attracted by feeds, rather the animal being inquisitive and getting entangled in anchor ropes and cage netting. However, they are animals acutely aware of their surroundings.

Robustness

The indicators will provide a highly robust measure of any changes to listed migratory species since all operators will be required to report to both the Commonwealth and State agencies on any interactions.

Fisheries Management Response

- *Current*

Develop protocols for applicants and operators on the obligations under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) regarding identification and reporting of interactions with listed migratory species.

Ensure all applicants for large-scale facilities are aware of the need for self-referrals of proposals that may trigger the EPBC Act. Make necessary changes to the Department of Fisheries' Aquaculture Licence Application Form to prompt the appropriate action.

IncludereportingofinteractionswithoperatingfarmsthroughtheManagementandEnvironmental Monitoring Plan. This ensures that the information collected by the proponent is reported to either the Commonwealth's Department of Environment, Water, Heritage and the Arts or the State's Department of Environment and Conservation. The Department of Environment and Conservation manages whale interactions under the *Wildlife Conservation Act* and information required by proponents is available from this agency. Should any entanglements occur, the Department of Environment and Conservation response teams attend as necessary.

- *Future*

Develop protocols for dealing with marine animal interactions relevant to each region and make them industry-specific.

- *Actions if Performance Limit exceeded*

Instigate stricter reporting for all regions with significant levels of interactions with listed migratory species or use of appropriate deterrent devices on sea cages.

6.2.2.4 *Threatened/endangered/protected species*

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	0	1	0	Neg - Mod
SBY	2	4	8	
ABR	1	3	3	
CWC	1	3	3	
LNE	1	4	4	
WSC	3	3	9	

ERA Risk Rating: Interactions between threatened species and facilities

Rationale for Inclusion and Identification of Management Authority

Threatened, endangered and protected species are found in most areas where aquaculture farms

wish to be located. There is a need to develop protocols to be employed by all facilities to minimize or the effect of these interactions should they occur. Interaction in the context of this document means the influence aquaculture has on these species.

Under the *Environmental Protection and Biodiversity Conservation Act 1999*, threatened/endangered/protected species protected under international agreements are considered to be 'matters of national environmental significance'. Referrals to the Commonwealth Minister for the Environment are required if an action (in this case aquaculture) has, will have, or is likely to have, a significant impact on a matter of national environmental significance.

The primary management authority is the Commonwealth's Department for the Environment, Water, Heritage and the Arts (DEWHA). The state level management authority is the Department of Environment and Conservation.

Operational Objective (plus justification)

Aquaculture operates in a manner that minimizes interactions with threatened species.

Justification

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted and upon the intensity, direction, magnitude and geographic extent of the impacts. An action is likely to have a significant impact on a critically endangered / endangered / vulnerable species if there is a chance or possibility that it will:

- *lead to a long term decrease in the size of a population;*
- *reduce the area of occupancy of the species;*
- *fragment an existing population into two or more populations;*
- *adversely affect habitat critical to the survival of a species;*
- *disrupt the breeding cycle of a population;*
- *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*
- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat;*
- *introduce disease that may cause the species to decline; or*
- *interfere with the recovery of the species.*

The Aquaculture Council of WA in conjunction with the Department of Environment and Conservation and SeaNet Environmental Extension Service developed a Code of Practice for Whale Interactions in 2006.

Indicator

- Interactions between aquaculture and threatened species are at acceptable levels.

Performance Measure/Limit (plus justification)

- The number of interactions between aquaculture and threatened species across a region does not exceed two per year.

Justification

A number of dolphin species are found in Western Australia. There are some anecdotal observations of behavioural changes in dolphins around farms in South Australia but these have not been quantified. The potential impacts of aquaculture on dolphins can be either direct, by intentional killing and incidental capture, or indirect, through competition for food and changes in the habitat. Dolphins can be attracted to farms due to the increase of fish around the farms that are feeding on the excess feed. Dolphins can also become entangled in the sea cage nets or anti-predator nets, although it is unknown why they become entangled even though they are aware of the nets. It is thought that they become distracted while feeding.

From the results of various studies undertaken in South Australia, several recommendations were made, including the removal of anti-predator nets, minimization of food wastage, use of pellet feed, appropriate siting of farms, prompt removal of dead fish, gear maintenance and constant vigilance. Several methods that are not recommended were also listed, including the use of acoustic devices, trapping and relocation, and chasing. Dolphins are a protected species and therefore it is illegal to kill them. Farmers must attempt to safely release any trapped or entangled animals and guidance through any Code of Practice if appropriate.

*The Great white shark, *Carcharodon carcharias*, is one of the protected species of shark in Western Australia, along with the whale shark, the grey nurse shark and the northern river shark, and is found in almost all the aquaculture regions. There is currently no published information on the interactions between sharks and aquaculture in Australia or worldwide. In South Australia, most of the interactions between sharks and sea cages are with bronze whaler sharks. Bronze whaler sharks are not a protected species and are usually killed if they enter the seacages. Farmers are not permitted to kill great white sharks and must attempt their safe release.*

Fish farming represents an opportunistic source of food for seals and sea lions and the potential for interactions exists wherever seals encounter fish farms. These interactions continue to cause substantial losses to salmon farmers and governments have been called upon to mitigate the problem in various states of Australia and countries around the globe.

*Both the Australian sea lion (*Neophoca cinerea*) and New Zealand fur seal (*Arctocephalus forsteri*) are known to occur along the south coast of WA. Breeding and haul-out sites exist on several islands of the Recherche Archipelago. The New Zealand fur seal is a more proficient 'scrambler' than the Australian species and may pose a greater risk of interactions if they have an opportunity for above-water access to the fish being cultured.*

There is currently no sea cage aquaculture along the south coast however there exists significant potential for future aquaculture assuming suitable farming technology is used to mitigate any impacts due to interactions with threatened species.

Data Requirements/Availability

Management and Environmental Monitoring Plan results will provide data on the number of interactions each year. This data will guide the development and review of the Code of Practice and information provided to proponents and applicants.

Evaluation

The size of the industry in WA is small and together with the low feeding rates has not resulted in any interactions to date (at least those reported). Drivers that may lead to increases in interactions are: increases in stocking densities within cages; the number of farms in any region; feeds and feeding methods employed; and poor farm management.

Robustness

The indicators provide a robust measure of the objective since they state whether the tools are there and being employed in order to limit impacts on these species.

Fisheries Management Response

- *Current*

Environmental Protection and Biodiversity Conservation Act 1999 referrals are mandatory but for self-referral only.

State-level reporting is by way of the Department of Fisheries aquaculture licence conditions – requirement for a Management and Environmental Monitoring Plan for all marine aquaculture facilities. Reporting under the *Conservation and Land Management Act* still applies.

- *Future*

It may be necessary to consider mandatory referrals for all sea cage applications if interactions with threatened/endangered/protected species increase to an unacceptable level.

- *Actions if Performance Limit exceeded*

Require more stringent licence conditions to lower risk of impacts – such as decreases in stocking density, removal of some cages to lower regional biomass levels, changes to feeds and/or feeding methods, and incorporation of any changes in cage technology.

Comments and Action

The list of threatened/endangered/protected species will continue to grow, due not so much to aquaculture operations but all anthropogenic activities and climate change. There will be a need to ensure operators and applicants are aware of the revised lists. The Department of Fisheries will also need to review the Management and Environmental Monitoring Plan to include additional species if and when required.

6.2.2.5 *World Heritage Area/RAMSAR/Marine Protected Areas*

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	0	1	0	Neg - Low
SBY	2	3	6	
ABR	1	3	3	
CWC	0	1	0	
LNE	0	1	0	
WSC	1	1	1	

ERA Risk Rating: Effects of aquaculture of RAMSAR/Marine Protected Areas (MPAs)/ World Heritage Area (WHA)

Rationale for Inclusion and Identification of Management Authority

These zones are present in all regions of Western Australia and arrangements are required to ensure aquaculture operators comply with objectives set down for these areas. Some areas managed under the *Environment Protection and Biodiversity Conservation Act 1999* require development referrals.

The primary management authority differs depending on the area in question. For those areas under Commonwealth jurisdiction, the Department of the Environment, Water, Heritage and the Arts (DEWHA) is the responsible agency. For areas under state jurisdiction, the Department of Environment and Conservation has management responsibility. RAMSAR refers to areas identified in relation to the *Conservation of Wetlands of International Importance, especially as Waterfowl Habitat*, signed at Ramsar Iran, in 1971.

Operational Objective (plus justification)

Aquaculture avoids impacting on RAMSAR, MPA or WHA sites.

Justification

The assessment process used by Department of Fisheries requires all applications for sites in waters vested in other authorities, such as the Department of Environment and Conservation and the Department of Environment, Water, Heritage and the Arts (DEWHA) be referred for comment. Any issues relating to the number of aquaculture sites operating within a marine managed area or cumulative impacts from the operations are dealt with at this stage.

Sections 92 (5) & (6) of the Fish Resources Management Act 1994 state that:

(5) An aquaculture licence must not be issued in relation to —

(a) an area of a marine park other than one from which aquaculture is excluded under section 13B of the Conservation and Land Management Act 1984; or

(b) an area of a marine management area,

unless the Minister to whom the administration of the Conservation and Land Management Act 1984 is for the time being committed by the Governor approves the granting of the licence.

(6) Subsections (4) and (5) do not affect the validity of—

(a) a licence issued before the commencement of section 50 of the Acts Amendment (Marine Reserves) Act 1997 ; or

(b) a licence issued in relation to an area which is affected, after the issue of the licence, by a reservation under section 13 of the Conservation and Land Management Act 1984, or by a notice under section 62 of that Act.

Ministerial Policy Guideline No. 8 requires all applications in coastal waters be referred to relevant authorities, the Department of Environment and Conservation being one such authority. The Department of Fisheries is required to obtain all necessary approvals prior to finalizing its assessment of applications. Therefore, any application within a Marine Protected Area will be considered by the Department of Environment and Conservation against objectives stated within the relevant Management Plan. Licence renewals assume that unless Marine Protected Area objectives have changed through a review of a Management Plan, a renewal must be granted.

Applications within World Heritage Areas must be referred to the Department of Environment,

Water, Heritage and the Arts under Ministerial Policy Guideline No. 8 for any necessary approval. The Department of Environment and Conservation also has roles and responsibilities at the state level to assess proposals where Conservation and Land Management estates sit in conjunction with Commonwealth estates.

RAMSAR sites are protected under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act), and are considered to be ‘matters of national environmental significance’. Referrals to the Commonwealth Minister for the Environment are required if an action (in this case aquaculture) has, will have, or is likely to have, a significant impact on a matter of national environmental significance.

Fisheries Management Response

- *Current*

Ministerial Policy Guideline No. 8 processes require referral to the appropriate management authority and approval from this authority. The Department of Fisheries will only grant a licence with this approval. Licences for facilities in these areas will include an Management and Environmental Monitoring Plan and depending on the issue, incorporate more rigorous testing requirements and appropriate trigger values.

- *Future*

The Commonwealth is reviewing the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) during 2009 with the terms of reference including environmental impact assessment processes and clarity for proponents regarding the decision to self-refer. The Department of Fisheries is requesting clearer definitions for terminology used in the Act, as well as any guidance statements.

- *Actions if Performance Limit exceeded*

Formal notification to applicants of obligations under the EPBC Act and the referral of all applications for assessment.

6.2.2.6 Behavioural changes on species

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	1	1	1	Low - Mod
SBY	2	4	8	
ABR	1	3	3	
CWC	1	4	4	
LNE	1	4	4	
WSC	1	2	2	

ERA Risk Rating: Effects of aquaculture on individual species behaviour

Rationale for Inclusion and Identification of Management Authority

The locating of facilities has the potential to change the behaviour of species due to noise, additional feed and as a result of structures placed in the water. There may be a need to develop

protocols to ensure regional level impacts do not occur to certain species however this may be best achieved at the individual facility level. The main interactions are likely to be with avian, crocodile and shark species.

It could be argued that studies in other parts of the world on bird interactions with aquaculture are irrelevant to assessing the interactions in WA because these studies have focused on land-based aquaculture, where mostly small fish are cultured and sick or dying fish are taken by predatory or scavenging birds. Given the low level of aquaculture activity in the various regions likely to have an impact on the behaviour of species, the consequences are considered to be minor or moderate if located in Shark Bay, where a higher number of protected species occur. The likelihood of these consequences occurring ranges from remote to possible, again in Shark Bay

The primary management authority is the Department of Environment and Conservation for certain protected species under the *Wildlife Conservation Act 1950*, which provides for the conservation and protection of wildlife.

Operational Objective (plus justification)

Aquaculture minimizes changes to the behaviour of individual species.

Justification

*Some regions have significant numbers of important species, such as dugongs, dolphins, stingrays, whales and migratory birds. Research on this issue is scarce, however work has been undertaken to investigate the interactions between seabirds and southern bluefin tuna aquaculture farms in Port Lincoln. Short-tailed shearwaters (*Puffinus tenuirostris*) were observed to eat a very small proportion of the total feed taken by seabirds at farms that use either baitfish or pellets, and were observed in very low numbers within the sea cages (average two) compared to the larger number observed outside the sea cages (average 60 to 70). The southern giant petrel (*Macronectes giganteus*) was found to visit aquaculture leases however they were not observed to eat the feed.*

In South Australia, the main sea cage finfish species cultured are southern bluefin tuna, yellowtail kingfish and Atlantic salmon, with these species being large predatory fish and unlikely to be preyed or scavenged upon by the seabirds. In this case, the most common source of interaction is the consumption of feed. To counteract this, cages are covered by bird netting to prevent access by scavengers and predators. This measure is also implemented in WA.

Indicator

- Interactions between aquaculture and individual species are at acceptable levels.

Performance Measure/Limit (plus justification)

- The number of interactions between aquaculture facilities and individual species, across a region, does not exceed two per year.

Justification

Seabirds present on tuna farms have shown a general preference for baitfish over pellets when both types of feed were available at the same time. In addition, it has been found that seabirds do not consume any feed when it was distributed in the sea cage as frozen blocks. The seabirds ate a high proportion of feed when baitfish were dispensed pneumatically or by shovelling. Behavioural changes were seen in the seagulls that foraged at the farms. Although the gulls are

not migratory, this suggests that behavioural changes may also occur in migratory birds.

Sea lions are known to interact with salmon farms in many parts of the world. There is currently no sea cage aquaculture along the south coast of WA, however there exists significant potential for future aquaculture, assuming suitable farming technology is used to mitigate any behavioural changes to these species.

In order to gain a better understanding of any behavioural changes that might be expected on great white sharks, there needs to be a monitoring and mandatory reporting program. The license conditions for sea cage finfish farms requires any interactions with large marine vertebrates (including sharks) to be reported, as well as in the annual environmental monitoring reports. However, due to the young age of the industry, it is not yet clear if these procedures are effective, or what the results of this monitoring show. More information on the ecology, biology and population status of the great white shark is also required in order to assess and manage the impacts of sea cage finfish aquaculture on their behaviour.

Data Requirements/Availability

Minimal data relevant to WA species and regions is available outside of anecdotal information gathered through the existing Management and Environmental Monitoring Plan.

Robustness

This is a set of indicators that only provides a low, indirect measure against the objective. Protocols can be developed to allow operators to determine whether they are providing appropriate information on any behavioural changes to species.

Fisheries Management Response

- Current

Mandatory monitoring and reporting of any interaction between aquaculture facilities and species covered under legislation operates. Department of Fisheries imposes this requirement by way of aquaculture licences however the responsibility for reporting resides with the Department of Environment and Conservation. Protocols should be developed in consultation with industry, for managing and minimizing any interactions with individual species – these will be maintained via reporting within the MEMP of any breaches.

- Future

May need to consider mandatory reporting under the *Environmental Protection and Biodiversity Conservation Act 1999* if the Commonwealth changes the reporting system, such as being proposed through the Memorandum of Understanding between the Department of Environment, Water, Heritage and the Arts (DEWHA) and the WA government.

- Actions if Performance Limit exceeded

The Department of Environment and Conservation may need to consider stricter applications of larger penalties if breaches continue to occur i.e. behavioural changes are identified and operators fail to rectify / mitigate the cause of any concern.

External Drivers

This is not directly within the legislative responsibility of Department of Fisheries, however the implementation will be achieved through a Department of Fisheries licence condition requiring

Management and Environmental Monitoring Plan reporting and operational techniques. There will need to be agreement on any protocols developed to detect and take action against those who fail to comply with any direction. This topic should be reconsidered once reporting from existing farms is analyzed or for farms that reach a commercial scale.

6.2.2.7 Sensitive habitats

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	1	3	3	Low - Mod
SBY	3	4	12	
ABR	3	4	12	
CWC	2	2	4	
LNE	1	1	1	
WSC	3	2	6	

ERA Risk Rating: Effects on sensitive habitats by aquaculture

Rationale for Inclusion and Identification of Management Authority

The inappropriate locating of aquaculture facilities could cause significant impact upon sensitive habitats found around WA's coastline. Sensitive habitats are considered to be those habitats identified in the Environment Protection Authority Guidance Statement No. 29 *Benthic Primary Producers Habitat Protection* and include seagrass, coral, mangrove, intertidal mudflats, macroalgal habitats and their associated biological communities.

The primary management authority is the Department of Fisheries, except for areas within Marine Parks where the primary management authority is the Department of Environment and Conservation. The Department of Fisheries uses the *Fish Resources Management Act 1994* to manage environmental impacts resulting from the aquaculture operation, if the operation could result in an impact on fish or fish habitat.

Operational Objective (plus justification)

To minimize the regional impact of aquaculture on sensitive habitats.

Justification

Planning activities for aquaculture have identified certain areas as suitable, however desktop studies will determine whether the regions include any Marine Protected Areas or sensitive habitats. Considering each region separately will identify some of the more important areas.

The seabed in King Sound is predominately sandy, with little likelihood of significant benthic habitat resulting from the natural turbidity of the water. Due to the minimal sensitive habitats that could be affected by aquaculture development, the consequences are considered to be minor. The Kimberley Aquaculture Plan sets out the zones considered as suitable for aquaculture and King Sound has been identified as one of those where finfish aquaculture could occur.

*Approximately 4,000 km² of the Shark Bay marine environment consists of seagrass meadows, which is the largest reported area of this kind in the world. Seagrass is an important component in maintaining the structure and productivity of this unique area. *Amphibolis antarctica* is the*

dominant species in an assemblage of 12 different seagrass species. The meadows are an essential link in the food web of Shark Bay, providing a high productivity biomass as well as being a source of nutrients and a habitat and nursery for both fish and invertebrates.

The diverse range of ecosystems in the bay mean that the consequences could be severe. Hence, this region requires considerably more management and stricter conditions on any aquaculture activities that operate in these waters. The current Aquaculture Management Plan for Shark Bay sets out the recommendations to appropriately manage aquaculture in this region. The Marine Park Management Plan was due for review by the Department of Environment and Conservation in 2008.

The Abrolhos Islands are located near the northern end of the west coast overlap zone, where tropical marine species dominate but significant numbers of temperate species occur. The marine system contains a considerable development of high latitude coral reefs, the southernmost in the Indian Ocean, but also has extensive growths of temperate macroalgae such as kelp. The combination of tropical, temperate and WA marine species makes the Abrolhos Islands a unique area, with considerable scientific value.

The Central West Coast region runs from Kalbarri to Perth and incorporates a diverse, moderate energy coastline. The marine fauna is diverse and plentiful with the single, most profound effect on this fauna being the Leeuwin Current. Interest in aquaculture in this area is low at present, which means that consequences are considered to be less than if the industry were larger.

The Leeuwin - Naturaliste region extends from Perth to Black Head on the south coast. This is a high energy, heavy swell coastal area with cold inshore currents running counter to the warm offshore Leeuwin Current. The marine fauna and flora species are diverse with strong affinities to the southern Australian regions, sharing similar habitats to the South Coast. Current interest in aquaculture in this region is minimal, with most activity by tertiary institutions.

The affinities of the WA South Coast marine and estuarine flora and fauna are shared strongly with the South Australian region but with a significant local endemic element. Extensive seagrass meadows are a feature of many sheltered bays and inlets. Kelps dominate rocky substrates in the sublittoral zone, along with a rich rocky shore intertidal fauna. There is potential for aquaculture in this region in the future.

Indicator

- The cumulative use by aquaculture in areas considered to be sensitive habitats is within acceptable levels.

Performance Measure/Limit (plus justification)

- Area of sensitive habitats that is occupied by aquaculture per region is not greater than two per cent.

Justification

Processes to assess any licences for sea cage operations progress through the Ministerial Policy Guideline No. 8 processes, irrespective of whether they are located over sensitive habitats. Generally speaking, the Department of Fisheries implements a policy of not approving aquaculture over seagrass and considers whether to approve, or not, any applications over other habitats such as corals. Any licenses that are approved will be required to operate under a strict environmental management regime, including a more onerous Management and Environmental Monitoring Plan.

More detail on this is provided under section 6.2.2.2.

Data Requirements/Availability

Management and Environmental Monitoring Plan results will provide some information from existing sites which are licensed to operate over sensitive habitats. The Department of Environment and Conservation undertake monitoring of conservation estates, as well as against Natural Resource Management Strategy targets.

There is a need to consider developing management zones as a basis for a strategic assessment of aquaculture near, or over, sensitive habitats.

Evaluation

There is a need to determine whether cumulative impacts to sensitive habitats can occur when aquaculture farms are approved within a region but not necessarily directly over sensitive habitats. Buffer distances between farms and habitats may need to be considered if the industry grows over the next 5 years. This information may lead on from Management and Environmental Monitoring Plan results gathered over time, but programs need to be designed to allow for this type of analysis.

Robustness

This will be a highly robust measure as the Management and Environmental Monitoring Plan will be able to detect any impacts on sensitive habitats on an annual basis for each site – this can then be correlated across a region.

Fisheries Management Response

- Current

Management of the marine environment is undertaken under the objectives of the *Fish Resources Management Act 1994*.

Ministerial Policy Guideline No. 8 assessment includes referrals to the Department of Environment and Conservation for assessment against objectives of any conservation estate Management Plans, as well as guidance regarding environmental values for regions.

- Future

The Code of Practice should provide guidance on use of ‘best practice’ technologies.

Research is needed into regional carrying capacities and impacts on sensitive habitats from aquaculture of certain species, using specific feeds, etc.

Strategic assessment of regions is required, with early identification of areas not suitable for sea cages within regional planning strategies.

- Actions if Performance Limit exceeded

No further sites will be approved over sensitive habitats irrespective of species or farming technologies utilized.

A more rigorous Management and Environmental Monitoring Plan, including mandatory use of particular technologies.

6.2.2.8 Scavengers

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	1	1	1	Low
SBY	1	2	2	
ABR	1	1	1	
CWC	1	1	1	
LNE	2	3	6	
WSC	1	2	2	

ERA Risk Rating: Effects on level of scavenger abundance

Rationale for Inclusion and Identification of Management Authority

Some aquaculture operations result in increases in scavenger abundance and/or densities. There may be a need to consider whether protocols should be developed to identify and monitor the numbers of indicator species from a regional perspective.

The primary management authority is the Department of Fisheries through aquaculture licences and assessment processes.

Operational Objective (plus justification)

Aquaculture is managed to avoid increases in scavenger species abundance.

Justification

Considerable research has demonstrated that organic enrichment of sediments is one of the most significant impacts from sea cage culture. Changes to the geochemical processes and benthic infaunal communities indicate that farm management practices can lessen the long-term damage. Some increase in the number of invertebrate scavengers (eg. ascidians, polychaetes, gastropods) can occur underneath cages, even with good farm practises. Monitoring programs can detect these changes and a fallowing regime is the most commonly used mechanism to assist in sediment recovery.

Other scavenger species more normally associated with aquaculture (i.e. seagulls) have different impacts. Seagulls are controlled as a consequence of the perceived risk of transferring pathogens through excreta into the food chain. Methods used in South Australia to control sea gull numbers involved 'pricking' the eggs to limit their viability. This method does not require particular scientific expertise, is done on a yearly basis and is a cheap and efficient way to lower seagull numbers. In conjunction with different feeds and feeding techniques, the industry is assisting in controlling bird numbers.

Fisheries Management Response

- *Current*

The Management and Environmental Monitoring Plan will provide information on scavenger species to be monitored and actions to take if an increase in species number or abundance occurs.

The Code of Practice should identify techniques to minimize these impacts occurring.

Minimizing the use of trash fish in favour of pellets or requiring bird netting on cages can be implemented if necessary to limit the ability of seagulls to access waste feed.

- *Future*

Field surveys may be required for a region if scavenger populations expand to the detriment on other species. Depending on the scale of farming within a region and the results on scavenger species surveys, no further responses may be required.

- *Actions if Performance Limit exceeded*

Mandatory mitigation measures may be required for all facilities in a region if numbers get beyond a critical mass.

External Drivers

Other anthropogenic activities, such as rubbish tips, may lead to increases in scavenger numbers, depending on the region. The ability for the Department of Fisheries to influence these drivers is questionable.

6.2.2.9 Translocation between catchments

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	2	2	4	Low - Mod
SBY	3	3	9	
ABR	2	2	4	
CWC	1	2	2	
LNE	1	2	2	
WSC	3	3	9	

ERA Risk Rating: Translocation policies for stock movements

Rationale for Inclusion and Identification of Management Authority

There are two main risks associated with the translocation of fish from overseas, interstate and between regions for the purpose of aquaculture. These risks are the introduction of exotic disease and the introduction and establishment of exotic organisms. The introduction of exotic organisms can be broken down further into two components: establishment of feral population of exotic cultured animals and the introduction of exotic plants and animals that may have inadvertently been translocated with the cultured fish. The possibility of the introduction of exotic plants and animals remains a risk to both the industry and the environment

The primary management authority is the Department of Fisheries under an existing Memorandum of Understanding with the Environment Protection Authority. New legislative instruments currently being considered may manage translocation within and around WA.

Operational Objective (plus justification)

Translocation policies manage all movements of aquaculture stock between regions.

Justification

Translocation includes the movement of organisms beyond their natural range and/or to areas within their natural range that have genetic stocks and/or populations that are distinct from those in the source area. There are three levels of policies – international, national and state. On an international level, the International Council for the Exploration of the Seas (ICES) have developed standard Codes of Practice to minimize the adverse effects of translocation of aquatic organisms. Nationally, the Ministerial Council of Forestry, Fisheries and Aquaculture developed a policy in 1999, after the Department of Fisheries had signed a Memorandum of Understanding between it and the Environmental Protection Authority in 1997. This state policy deals with the translocation of non-endemic species into or within WA. With the enacting of the Biosecurity and Agriculture Management Act and associated regulations, this Memorandum of Understanding will fall away.

While there have been no documented introductions of exotic animals or plants due to aquaculture in Western Australia, such introductions have been common elsewhere in the world. While the majority of such introductions occurred prior to the implementation of today's stringent protocols to prevent such occurrences, there is still a risk of similar introductions happening today. These historical introductions emphasise the importance of taking extreme care when translocating stock long distances.

Indicator

- No introductions of exotic species from aquaculture in WA.

Performance Measure/Limit (plus justification)

- Translocation is in accordance with the Memorandum of Understanding with the Environment Protection Authority.

Justification

Currently, the Department of Fisheries' translocation policies manage the importation and translocation of fish into and around Western Australia. Authorizations from the Department are required for the import or translocation of certain fish, with a veterinarian certifying the stock.

For barramundi, the process for assessing the risk of translocation is outlined in Fisheries Management Paper No 159. The issues to be considered each time translocation approval is sought are the potential for any translocated barramundi to:

- *introduce disease;*
- *impact on the natural environment and the biodiversity of native species; and*
- *impact on the genetic diversity of existing stocks.*

The risk assessment includes a number of criteria:

- *the location of the proposed farm or water body to be stocked;*
- *the culture system to be used;*
- *the source of the barramundi to be utilized;*
- *the conditions that may be applied, including disease testing requirements; and*
- *the long-term security of the aquaculture system.*

For cage farming in open water bodies for areas within the natural range of barramundi, the criteria are - that stock must be certified disease-free; commercial aquaculture is permitted

subject to an aquaculture licence and conditions; licence conditions will be imposed that dictate a Code of Practice and gear requirements to minimize risk of escapes; and an inspection will be required to confirm gear requirements and site location. Stock are then able to be imported from any farm in Australia.

The Western Australian government is in the process of developing the legislative framework to manage the movement of organisms into and out of WA. Non-indigenous marine organisms (including plants, animals and plant and animal diseases) may be introduced or translocated by a variety of vectors, including ballast water, biofouling of vessels and equipment, aquaculture operations and aquarium imports. Introduced marine organisms represent major threats to native biodiversity and ecosystem integrity and may cause significant long-term social, cultural and economic impacts. The introduction of non-indigenous marine species and diseases to new environments has been identified as one of the greatest threats to the world's oceans.

Western Australia has developed new biosecurity legislation in the form of the Biosecurity and Agriculture Management Act 2007, which was passed by Parliament in September 2007. The Act came into force in stages during 2008, however the relevant subsidiary legislation and administrative arrangements are not yet completed. Some of these provisions will apply to the collection, translocation and grow-out of finfish, but exact details will be dependent on the final wording of the relevant subsidiary legislation.

The biosecurity provisions of the Act are aimed at preventing plant and animal pests and diseases from entering Western Australia (border security) and at managing those that are found in Western Australia to minimize their spread and impact (biosecurity within WA). The new Act will be Western Australia's primary biosecurity legislation and the primary regulatory framework to manage plant and animal pests and diseases that may affect the environment, industry and the economy or public safety and amenity. Within Western Australia, the Department of Fisheries has been appointed as the lead Agency for the management of biosecurity, pest animals and plants as well as animal and plant diseases, for fish (as defined under the Fish Resources Management Act 1994 and including pearl oysters) and the aquatic environment (i.e. all marine and other waters and the seabed within the limits of the State). These new responsibilities for aquatic biosecurity compliment already existing biosecurity programs undertaken by the Department that support the management of non-endemic species for aquaculture, commercial and recreational fishing stock enhancement, the aquarium industry, and educational, as well as research and development, purposes.

Prevention of new incursions by the management of vectors to minimize the risk of introduction and translocation is by far the best approach when it comes to managing non-indigenous marine organisms and better enables protection of Western Australia's marine environment and industries dependent on marine resources. Stopping plant and animal pests and diseases being introduced to Western Australia and also being translocated from one location to another within Western Australia is far more effective than trying to deal with them after they have established. By the time a new invasive organism is detected, the chances of successful eradication are low, and efforts must then focus on containment and management with considerable social, economic and ecological cost. It is therefore important that appropriate biosecurity management strategies and protocols are developed and implemented.

Australian Government, State and Northern Territory government agencies, as well as marine industries, scientists, and conservation agencies, are working to develop a National System for the Prevention and Management of Marine Pest Incursions. 'Best practice' guidelines are being developed to minimize biofouling and reduce the risk of marine pests being introduced into or translocated within, Australia for all marine sectors, including: commercial fishing,

aquaculture, recreational vessels, international yachts, commercial trading and non-trading vessels, vessels associated with the petroleum industry, illegal entry vessels and foreign fishing vessels, as well as ports, marinas and slipways. Commonwealth and State legislation is also being developed that will ensure that the discharge of internationally-sourced and domestic-sourced ballast water is subject to agreed measures to minimize the risk of introducing or translocating marine pests through ballast water.

When the Biosecurity and Agriculture Management Act 2007 and its associated regulations are enacted, they will govern the movement of finfish around Western Australia. Any proponent will need to refer to this document to determine its affect on their business.

Under the current policy, translocation of native species is likely to represent a low to moderate risk, depending on the region. A slightly higher risk would be associated with the inter-state translocation of barramundi for example, and it is important to maintain careful control over this process. If disease outbreaks occur in the areas these translocations originate from, the risk could become high.

Data Requirements/Availability

The number of translocation applications assessed will be known and information on species, locations, numbers and health issues recorded.

Evaluation

There will be a changeover in legislative requirements once the *Biosecurity and Agriculture Management Act 2007* comes into play, but until that time the existing translocation policy will provide the mechanisms to manage translocations. There may be a change in the data and/or reporting requirements, but the timing for this is still unclear.

Robustness

This will be a highly-robust measure of the objective, as the indicator is a direct measure of regional stock movements.

Fisheries Management Response

- Current

The Department of Fisheries' translocation policy is providing a robust framework to limit the likely importation of disease or other exotic organisms. The agency is known to take a cautious approach to this issue and maintaining this policy is recommended.

All brood stock collections, managed through Ministerial Exemption, also provide a case-by-case risk assessment of disease issues.

- Future

The *Biosecurity and Agriculture Management Act* and regulations may come into force and provide more direction on this issue. There may be a need to develop additional policies for other species depending on the direction the industry takes over the next five years.

- Actions if Performance Limit exceeded

Limit any further importation of fingerlings if disease becomes a higher risk in the hatchery. If need be, restrict regional translocations in order to minimize any disease transfer.

Comments and Action

It has been suggested that the risk of translocating native fish within their distributional range poses a greater threat than translocating exotic species, because the disease can spread to native populations that are known to be susceptible to the disease but may not have been exposed to the pathogen before.

6.2.3 Physical Structures, Construction and Tenure

6.2.3.1 Number and size of farms

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	1	2	2	Low - Mod
SBY	2	4	8	
ABR	2	4	8	
CWC	1	3	3	
LNE	1	2	2	
WSC	1	1	1	

ERA Risk Rating: Total number and size of farms across the region

Rationale for Inclusion and Identification of Management Authority

In order to ensure farms can operate within environmentally-sustainable limits, there is a need to consider limitations on the number and size of farms that can operate within a region. This issue relates to the carrying capacity of waters including other users, visual amenity and access.

Applying the principles of sustainable development to aquaculture projects presents many challenges to policy developers. Social and cultural considerations, conflicts with other more traditional uses of coastal waters, environmental concerns and existing legal and regulatory structures present obstacles to development of the industry. Diversity within the industry and the resources it requires, the locations in which it is practised and the need for private and public support add to the complexity of the situation.

Effective management of aquaculture in a sustainable fashion requires the involvement and cooperation of government, academia, the private sector, investors, communities and the public at large. Marine aquaculture should be looked on as an important component of extending protein supplies, providing economic development opportunities and jobs, and offering communities the ability to diversify.

The primary authority is the Department of Fisheries with the assessment of proposals on a case-by-case basis. There is a need for more strategic planning initiatives in this area.

Operational Objective (plus justification)

The number and size of aquaculture facilities is within the carrying capacity of the region.

Justification

The major challenges facing growth and development of the industry on a world-wide scale include: increasing competition for limited resources; environmental degradation of resources used or needed; lack of recognition of aquaculture as a legitimate resources user; lack of

legal and institutional support; over-regulation; and harmful publicity due to environmental degradation and social conflicts in isolated situations.

The difficulty however is more to do with the lack of recognition for aquaculture to be considered a valid user of the region's resources. Pressures for development are different across the regions however the Department of Fisheries has a role in ensuring aquaculture is considered as a justifiable user during the consultation for development of any regional planning strategies. Should this not occur, it will limit the industry's ability to have areas identified and set aside as being suitable for future aquaculture production.

Indicator

- The number and size of aquaculture facilities is within the regional carrying capacity.

Performance Measure/Limit (plus justification)

- No region is negatively impacted by an exceedance of its carrying capacity.

Justification

The coastal zones of most countries are facing increasing population pressures, industrial and residential development, and additional demands for the use of natural resources. The Food and Agriculture Organization (FAO) suggest five criteria for use by governments and planning agencies for locating aquaculture operations in suitable locations. Their Code of Conduct suggests that aquaculture be established in areas suitable for sustainable production and income generation; where economically and socially appropriate; to prevent or at least minimize conflicts with resource users; where it does not create undue externalities; and with respect to nature reserves, protected areas and critical and sensitive habitats.

The reality is that when no effort is made to strategically plan aquaculture site selection, the decision of where to locate and the assumption of associated risk are left to the private operator. This has the potential to create a highly charged situation, pitting the individual aquaculturist and aquaculture as a whole against other coastal users.

Policy makers should commence the process of designating sites for use, taking into consideration such factors as navigational rights, the potential for user conflict and minimization of environmental impacts. Local participation and education throughout the development process are important elements of ensuring future compliance.

Data Requirements/Availability

Regional carrying capacities need to be determined for all regions, as do Ecologically Sustainable Development (ESD) objectives. Some of this information has been gathered through the drafting of the natural resources management strategies across the State, however very little information regarding the appropriate level of aquaculture development that will be acceptable is available. The Western Australian Marine Science Institution (WAMSI) has funded a pilot project to develop Ecosystem-Based Fisheries Management for the west coast of WA, which will include social and economic considerations. This project will provide direction on how the issue can be considered from an aquaculture perspective.

Evaluation

Sustainable communities seek a balance among social values, market values and ecological values, as ideally, aquaculture development should be planned to improve upon the situation in these areas.

Robustness

As the data on regional ESD values is not available at present, the indicator identified will only provide a low measure of the objectives success. This will change to a high robust indicator once the WAMSI project is complete and monitoring plans reflect criteria to measure change.

Fisheries Management Response

- *Current*

Ministerial Policy Guideline No. 8 assessment processes ensure that all decision-makers and interested parties have the opportunity to comment on new proposals. Due to the lack of marine areas suitably zoned for aquaculture, each application must consider the full breadth of issues. This results in lengthy and costly research being undertaken by the proponent with no guaranteed approval at the end.

- *Future*

Social and economic data is lacking across most of the state and should be a key consideration for future research. The Aquaculture Development Council is funding a project to consider regional assessment requirements in collaboration with the Department of Fisheries/Department of Environment and Conservation/Environment Protection Authority. This project should provide results by the end of 2010.

- *Actions if Performance Limit exceeded*

Undertake regional carrying capacity assessment to determine number and size of aquaculture facilities that would be acceptable within a region. This may resolve concerns of stakeholders such as recreational or commercial fishers, boat and yacht owners, divers and others.

6.2.3.2 *Habitat removal (for terrestrial elements)*

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	2	3	6	Low
SBY	2	2	4	
ABR	2	2	4	
CWC	1	4	4	
LNE	0	2	0	
WSC	2	2	4	

ERA Risk Rating: Impact on regional amount of native terrestrial vegetation acceptably removed

Rationale for Inclusion and Identification of Management Authority

In most situations, sea cage aquaculture will require land facilities to provide storage of feeds, equipment maintenance areas, office space and post harvest operations. In some instances native terrestrial vegetation will be removed. There is a need to consider the maximum area of vegetation can acceptably be removed across the region. There is also a need to consider whether the removal will affect sensitive habitats. At the regional level the impact will be localised,

although the damage could still be long-term. A moderate risk is probably more appropriate at the individual facility level.

The primary management authority is the Department for Environment and Conservation and assessment is by way of the Native Vegetation Clearance Permit application to the Environment Protection Authority.

Operational Objective (plus justification)

Native vegetation removed for land-based facilities will be in line with regional policies.

Justification

It is widely agreed that habitat loss is one of the major causes of decreases in biodiversity and because of this, 'land clearance' is a listed key threatening process under the Commonwealth's Environmental Protection and Biodiversity Conservation Act 1999. Habitat destruction and fragmentation have had severe consequences for native terrestrial flora and fauna, while removal of coastal vegetation has resulted in sand drift and erosion of dunes due to the loss of vegetation acting as wind barriers. The removal of vegetation for any purpose, not just for sea cage finfish aquaculture, may have dire consequences.

Various position and guidance statements have been developed by the Environment Protection Authority, these being Guidance Statement No. 1 – Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline, Guidance Statement No. 49 – Development of Proposals in Shark Bay World Heritage Property, and Position Statement No. 2 – Environmental Protection of Native Vegetation in WA. These documents provide the basis for the direction given by the Environment Protection Authority to proponents regarding any likelihood for vegetation removal in each case.

Specific scientific research on the removal of terrestrial vegetation for support facilities for the sea cage finfish aquaculture industry is not required. Instead this issue requires continual assessment and management.

Fisheries Management Response

- Current

The Department of Environment and Conservation maintains the assessment of Native Vegetation Clearance Permits.

- Future

Ensure the Department of Environment and Conservation undertakes regional assessments of remaining native vegetation.

- Actions if Performance Limit exceeded

If excessive removal of vegetation occurs over and above that approved, the Environment Protection Authority can take action for causing environmental harm.

Comments and Action

The Department of Fisheries and local governments should consider promoting the use of shared facilities and/or access where possible. This would significantly reduce the pressure for vegetation removal.

Encouraging proponents to identify sites for facilities that are located away from sensitive

habitats or densely vegetated areas would give a better public perception of the environmental credentials of the industry.

The repair and maintenance of sea cage nets will be required and this should occur as close as practicable to the coast but not result in impacts on dunes or removal of coastal vegetation.

External Drivers

Applications for removal of vegetation for other uses will continue to put pressure across the region. External pressures such as climate change will be outside of the Department of Fisheries and aquaculture operators' sphere of influence.

6.2.3.3 Heritage area effects

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	2	4	8	Neg - Mod
SBY	2	4	8	
ABR	1	2	2	
CWC	1	2	2	
LNE	0	1	0	
WSC	1	1	1	

ERA Risk Rating: Effects of aquaculture of heritage areas

Rationale for Inclusion and Identification of Management Authority

Areas of heritage value can be impacted upon either directly or indirectly through the construction of aquaculture facilities and there is a need to consider processes that can limit this occurring. These sites can be both Indigenous and European heritage and include buildings, historic sites and places of indigenous significance.

The primary management authorities are the Department for Indigenous Affairs and the Department of Environment and Conservation.

Operational Objective (plus justification)

Aquaculture will not impact on regional heritage values.

Justification

Many major sites of Indigenous heritage value have previously been identified through regional coastal plans, however coastal sites may contain unknown burials which require additional surveys to locate. The Department of Indigenous Affairs require applicants to research the databases and many in remote locations will need to complete a heritage survey prior to construction. The best way to ensure all groups have the opportunity to comment is to have broad community consultation during the initial planning phase.

Development in regions in the north of the State, such as the Kimberley and Pilbara, are more likely to impinge upon Indigenous and European heritage issues, with European heritage affecting regions such as the Abrolhos Islands and South Coast to a lesser degree.

The Department of Fisheries is considering the drafting of a Kimberley Aquatic Management

Plan which may identify sites suitable for aquaculture, amongst other things. This plan could include provisions for highlighting where future heritage surveys may be required.

Indicator

- Aquaculture operations are managed to limit impacts on heritage values

Performance Measure/Limit (plus justification)

- No heritage values are affected by the construction of aquaculture facilities.

Justification

Many Indigenous groups around the world indicate that their interests are rarely addressed by current planning and decision-making processes. This may not be the case in WA, as the government is conscious of the need to consult with all interest groups. Ensuring the full involvement of these groups can assist in the identification of heritage values in the initial planning stages so that sites used for aquaculture facilities are aware of, and can avoid where possible, significant heritage values.

The cost of heritage surveys can be considerable and many prospective proponents are constrained in completing this work, not so much out of a lack of concern but a lack of financial resources. How this can be resolved is difficult to say. One option is for planning agencies, working at all levels of government, to include these costs in their budgets to enable the identification and delineation of areas that should be excluded from various activities at the early stages of zoning.

Data Requirements/Availability

Heritage Survey Reports are available through the Department of Indigenous Affairs and, together with databases, provide a comprehensive picture of heritage values for the region. These surveys could be considered across regions as the industry expands.

Robustness

Robustness will be medium, as not all regions have had heritage assessments and many proponents are financial constrained in undertaking this work.

Fisheries Management Response

- Current

Maintain the use of the *Aboriginal Heritage Act 1972* and *Environmental Protection Act 1986*. These acts provide the power to consider aspects of Aboriginal heritage. The main focus of the *Aboriginal Heritage Act 1972* is the protection of sites with social and heritage significant. The primary focus of the *Environmental Protection Act 1986* is to consider proposals with the potential to have an environmental impact.

Maintain use of Environment Protection Authority's Draft Guidance Statement No. 41 - *Assessment of Aboriginal Heritage* through referrals under the Ministerial Policy Guideline No. 8 process for assessment for all Aquaculture Licence applications.

- Future

Consider alternative measure for the identification of heritage sites through broader planning initiatives.

- *Actions if Performance Limit exceeded*

The Department of Indigenous Affairs can take legal action against any operator should they disturb a heritage site.

6.2.3.4 *Navigation*

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	1	1	1	Low
SBY	1	2	2	
ABR	1	1	1	
CWC	1	2	2	
LNE	1	1	1	
WSC	1	2	2	

ERA Risk Rating: Effect of aquaculture on navigational hazards

Rationale for Inclusion and Identification of Management Authority

Aquaculture infrastructure has the potential to be a navigational hazard to boating. There are also potential benefits to other users by the placement of appropriate marking and lighting on sites.

The primary management authority is the Department of Planning and Infrastructure (Marine Safety) however the Department of Fisheries imposes recommendations through aquaculture licence conditions. The compliance function operates through a Service Delivery Agreement.

Operational Objective (plus justification)

Aquaculture will be managed to avoid any regional navigational hazard.

Justification

The Department of Fisheries works closely with the Department of Planning and Infrastructure (Marine Safety) to ensure that each aquaculture application is assessed against international standards appropriate to navigational channel, boating and shipping movements. If approved, sites are required to install appropriate lighting and marking, and maintain it in a good working order.

The document Guidance Statement for Determining Categories of Marking and Lighting of Pearling and Aquaculture Licences/Leases (2009) provides a central reference point for marking and lighting of aquaculture lease/licence areas in Western Australian coastal waters in order to:

- *promote public safety through delineation of areas containing pearling and aquaculture infrastructure;*
- *provide uniform lighting and marking standards for pearling and aquaculture sites containing infrastructure and in some cases direction indicators; and*
- *protect in-water property located within the lease/licence area.*

For the purpose of marking and lighting, aquaculture lease/licence sites are classified into four categories according to the following parameters:

- *density of other traffic utilising the waters adjacent to and through the lease/licence site;*
- *possible obstruction to other vessels navigating over the surface of such waters;*
- *possible obstruction to other vessels requiring to anchor in such waters;*
- *depth of water within and adjacent to the lease/licence site;*
- *remoteness of the lease/licence site; and*
- *the need to mark the lease/licence site to ensure safety of navigation.*

The category assigned is recommended by the Department of Planning and Infrastructure in consultation with the lease/licence holder. The agreed marking and lighting is then imposed via aquaculture licence conditions.

Fisheries Management Response

- Current

Maintain current Ministerial Policy Guideline No. 8 referral to the Department of Planning and Infrastructure for direction on appropriate marking and lighting.

Maintain the license conditions requiring installation of appropriate marking and lighting and ensure all lights are maintained in a good working order.

The Department of Planning and Infrastructure (Marine Safety) map the locations of all navigational aids and all aquaculture operators must notify the agency when lights or markers are installed. In areas of heavy shipping or boating traffic, permanent markers are required.

- Future

Consider any impacts from inappropriate location of larger sites in areas of heavy traffic.

Ensure the use of appropriate and suitable apparatus for the site is imposed taking into consideration the local oceanographic conditions – this is a license condition.

- Actions if Performance Limit exceeded

Infringements notices can be issued and licences cancelled if conditions continue to be breached.

Comments and Action

The Department of Planning and Infrastructure will need to reassess the appropriate category of those sites located in areas where boating traffic increases over time. There is a duty of care to ensure appropriate navigational safety is maintained while acknowledging changes in commercial and recreational boat usage.

6.2.3.5 Infrastructure

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	1	4	4	Low
SBY	2	2	4	
ABR	2	3	6	
CWC	1	2	2	
LNE	1	1	1	
WSC	2	3	6	

ERA Risk Rating: Regional levels of supporting infrastructure

Rationale for Inclusion and Identification of Management Authority

There are numerous constraints to the growth of the aquaculture industry in WA, the largest being the provision of supporting infrastructure such as roads, power, moorings, wharves and water. The provision of these would also benefit the broader community.

There is no primary management authority apart from the Western Australian Planning Commission identifying where future needs may arise with each being the responsibility of a separate agency.

Operational Objective (plus justification)

The provision of supporting infrastructure for aquaculture is reviewed for each region.

Justification

The location of any terrestrial facility will be heavily influenced by the availability of supporting infrastructure, such as roads, power and water. In regions such as King Sound and the Abrolhos the provision of this infrastructure is dependant on cost, much of which will be borne by the proponent. Future planning for regional infrastructure should include any requirements for aquaculture if possible.

Not having additional infrastructure may limit growth of many smaller players as they need to commit more funds into providing wharves, access roads etc rather than into the aquaculture operation itself.

In areas such as Shark Bay and King Sound there may be restrictions on the amount of land available to construct further infrastructure due to loss of vegetation, heritage areas or retention of wilderness areas.

Fisheries Management Response

- Current

Maintain the involvement of the Department of Fisheries in all appropriate planning initiatives.

- Future

Participate in planning and research opportunities as they become available.

External Drivers

There are numerous agencies involved in resolving any issues, which makes it difficult to determine when and if anything may occur. Financial constraints are the major concern for each agency and priorities drive the construction of any new infrastructure.

6.2.3.6 Noise

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	0	1	0	Neg
SBY	0	3	0	
ABR	0	2	0	
CWC	0	1	0	
LNE	0	1	0	
WSC	0	1	0	

ERA Risk Rating: Effects on regional noise levels from aquaculture

Rationale for Inclusion and Identification of Management Authority

Noise may be detected by various mammals (i.e. dugongs and whales) within Shark Bay or the Abrolhos Islands but any impacts will be short term and far less than the level of disturbance caused by seismic activity or recreational boats for instance.

The primary management authority is the Department of Environment and Conservation through the Environment Protection (Noise) Regulations.

Operational Objective (plus justification)

Aquaculture will operate to avoid unacceptable regional noise levels.

Justification

Noise should not be an issue for the marine component however there may be some issues relating to land-based operations. Any noise issues for sea cage culture are likely to be caused by boating activities during feeding and harvesting or net changeover.

Fisheries Management Response

- Current

No management is required at present, as aquaculture operations are small and insignificant at the regional scale.

- Future

Undertake some form of noise monitoring if necessary.

- Actions if Performance Limit exceeded

Require operational changes to minimize noise impacts

6.2.3.7 Site constraints (waves, currents)

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	2	4	8	Low - Mod
SBY	3	4	12	
ABR	2	3	6	
CWC	1	3	3	
LNE	1	2	2	
WSC	3	4	12	

ERA Risk Rating: Constraints to placement of aquaculture facilities

Rationale for Inclusion and Identification of Management Authority

The success of any marine finfish aquaculture operation is largely dependant on the location of the site. The economic return from the sale of product will be maximized if the quality of the fish is high. Choosing the most appropriate site based on waves, currents and water depth can remove the main constraint to achieving a sustainable venture.

This issue will be more appropriately considered at a facility level rather than regionally. There is no primary management authority however direction to proponents wishing to select the most appropriate site could be provided in the Code of Practice.

Operational Objective (plus justification)

Constraints to aquaculture will be considered when assessing aquaculture applications.

Justification

Many of the unacceptable impacts to the regional environment can be informed by consideration of site and farming characteristics. The GESAMP (2008) report suggests that the potential impact of dissolved nutrients from fish farming on kelp can conceptually be modelled for site characteristics. Regional hydrodynamic models based on actual seasonal measurements provide a clear indicator of the likely zone of impact and whether the site is suitable to assimilate the expected nutrient loads.

Indicator

- Constraints influence the siting of aquaculture within a region.

Performance Measure/Limit (plus justification)

- All aquaculture approvals are considered recognizing the regional constraints.

Justification

Most finfish species require a current of between one to two knots to maintain flushing through cages. Water flows are important to maintaining optimal oxygen levels in the cages as well as assimilate waste products produced i.e. dissolved nitrogen. Balancing this flushing against protection from storm wind and waves is usually overcome by placing sea cages in the lee of islands or in bays. Offshore sites can be used but this requires the use of more robust cages structures and anchors.

Recent reports (Buschmann et al. 2007) show that the most important driver of impacts on pelagic nutrients, water quality and pelagic environments is hydrodynamics, with only stagnant site exhibiting increased phytoplankton biomass locally. The report states that greater understanding of the impacts of open water salmon cage aquaculture will be achieved by the improved development and widespread use of advanced three dimensional hydrodynamic modeling to estimate the mean volumetric loading rates of limiting nutrients to follow the spread and fate of excess inorganic nutrients from salmon farms. Hydrodynamic modeling is particularly important regionally and especially in areas with more than one farm in the same body of water.

The density of farms (i.e. number, size, proximity) should incorporate advanced three dimensional hydrodynamic modeling to scientifically determine site selection, with better determination of nutrient flux to ensure the natural assimilative capacity of the water column is neither exceeded nor changed so significantly that essential pelagic ecosystem functions are compromised.

The Aquaculture Development Council in collaboration with Department of Fisheries/ Department of Environment and Conservation/Environment Protection Authority and industry are commencing a project to evaluate a regional model that will include limitations to operations based on sites selected. Results should be available by the end of 2010.

Data Requirements/Availability

Many agencies in Western Australia have undertaken marine research for policy and planning activities. Some minor regionally-specific studies have been carried out in support of the Department of Fisheries' aquaculture development plans. Previous studies by the Department of Environment and Conservation for the marine planning processes are also available. The Department of Environment and Conservation has completed regional assessments for areas such as Cockburn Sound and the Pilbara coast. The Department of Industry and Resources, as well as numerous industry bodies, have considered oceanographic studies as part of the planning processes for large-scale proposals.

Using these and others as they become available will assist proponents in understanding the constraints to development in the marine environment. The National Oceans Office has commenced regional marine planning in WA, which will provide additional expertise and research results.

Robustness

This will have a medium robustness, as the number of regional reports able to provide this type of data is still small.

Fisheries Management Response

- Current

Maintain the Ministerial Policy Guideline No. 8 assessment process, incorporating information on site characteristics. Environment Protection Authority assessments of large scale proposals, or proposals in sensitive areas, are undertaken on a case-by-case basis.

Impose conditions requiring an Management and Environmental Monitoring Plan to Aquaculture Licences.

- Future

Review the application form to ensure the provision of suitable physical and biogeographical information is provided by all proponents

Selective research into the determination of zones by government will assist proponents.

6.2.4 Production

6.2.4.1 Regional carrying capacity

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	1	3	3	Low - Mod
SBY	2	4	8	
ABR	2	2	4	
CWC	1	2	2	
LNE	3	4	12	
WSC	1	2	2	

ERA Risk Rating: Regional carrying capacity

Rationale for Inclusion and Identification of Management Authority

The productivity and state of a site or region may be affected if sea cages are overstocked or if there is too high a biomass in an area. If fish production levels are too high, then excessive amounts of nutrients, in the form of waste and uneaten feed, will enter the surrounding environment. This may result in an increase in primary production, eventually leading to eutrophication and algal blooms.

Environmental capacity, carrying capacity or assimilative capacity is a property of the environment and its ability to accommodate a particular activity or rate of an activity without unacceptable change. Carrying capacity measures the resilience of the natural environment in the face of impact from human activities and must be measured against some established standard of environmental quality. Understanding and measuring carrying capacity allows for the determination of the scale of activity (using a specified technology) which can be accommodated without threat to an environmental standard. With the increasing emphasis on Ecologically Sustainable Development, the carrying capacity of a region is more commonly defined in terms of the maximum level of fish production that does not cause significant changes in the ecosystem.

The primary management authority is the Department of Fisheries in the context of determining the carrying capacity for aquaculture. Responsibility is exercised by imposing specific licence conditions and the annual review of Management and Environmental Monitoring Plan results. The Environment Protection Authority also assesses those applications undergoing an Environmental Impact Assessment using Guidance Statement No.29.

Operational Objective (plus justification)

Aquaculture operates within the region's carrying capacity.

Justification

Carrying capacity for the production of sea cage finfish can be estimated using a mass balance model. These models are based on the assumption that the concentration of a nutrient in an area

is determined by the nutrient loading. The carrying capacity of a region is calculated from the difference between the initial nutrient values of the body of water prior to use (by aquaculture) and the final nutrient levels after use. A maximum allowable nutrient level (dissolved inorganic nitrogen) can be set for the model based on the 1992 Australian and New Zealand Environment and Conservation Council water quality guidelines for embayments and coastal regions. In addition, the model can be run using maximum phytoplankton (as chlorophyll a) levels recommended by the ANZECC (1992) guidelines. The model should be conservative in that when calculating the carrying capacity based on either species of nitrogen, it is assumed that all waste nitrogen was released by that species.

Several factors including nutrient loading, the volume of the region, the nitrogen content of the fish food, the feed conversion rate, the flushing rate and the fraction of nutrients lost to the sediments are taken into consideration in any mass balance model. Using these factors the final nutrient levels in the water column after aquaculture production can be estimated from the nutrient loadings entering the system. From this the tonnage of fish that would produce the maximum allowable nutrient levels can be calculated.

The limiting factor with the use of these models is that they are calculated using either generic values or values for only one species of fish for the feed conversion ratio and feed nitrogen content. If a wet diet consisting of baitfish is used then they suggest that the carrying capacity would be substantially lower. The differences in these values may result in different carrying capacity values. In addition, the problem with this model is that it does not account for different species of fish, with different feed conversion ratio and feed content, being cultured in the same region. The carrying capacity needs to be constantly reassessed with the changing composition of farmed species and as new information and data becomes available.

The Aquaculture Development Council in conjunction with the Department of Fisheries is commencing a project in 2009 to determine the carrying capacity in four regions based on various models and fish species. When this project is complete in 2010, regulators will have a better understanding of the ways to determine regional carrying capacities and monitoring programs to ensure maintenance of specific environmental criteria.

Indicator

- Aquaculture is approved considering the regional carrying capacity.

Performance Measure/Limit (plus justification)

- The total aquaculture biomass within a region is below the maximum regional carrying capacity.

Justification

In the case of aquaculture, carrying capacity in relation to a specified area (e.g. a bay) might be interpreted as the:

- *rate at which nutrients can be added without triggering eutrophication;*
- *rate of organic flux to the benthos without major disruption to natural benthic processes;*
or
- *rate of dissolved oxygen depletion that can be accommodated without causing mortality of the indigenous biota.*

If carrying capacity can be determined, this opens the door to controls on effects, rather than

activity – a key principle. There arises the possibility of allocating a share of carrying capacity or a share of something it affects to a particular group. This is likely to offer an incentive to producers to modify technology or management so that production may be increased without exceeding the target. This contrasts with the use of area or production limits, which are directly restrictive and offer no incentives.

In order for individuals to be able to make a judgment as to whether ventures will be considered within a region, research on the carrying capacity needs to be done and be available. Many of the models used to do this are complex, requiring considerable expertise, so providing this type of resource (available as a downloadable computer model) will require some refinement. The Department of Fisheries utilizes information provided by proponents during the assessment of applications to determine maximum biomass for a site in order to maintain environmental sustainability.

Data Requirements/Availability

Management and Environmental Monitoring Plan results from each facility can be analyzed to present a regional perspective on carrying capacity.

University research offers a low cost way of gathering data – this may be through post-graduate studies or specific consultancies.

Evaluation

A project funded by the Fisheries Research Development Corporation and PIRSA Aquaculture and undertaken by SARDI Aquatic Sciences together with the University of Adelaide refined and validated some carrying capacity models. The models may prove useful in WA for determining carrying capacities and however its usefulness may be limited due to the broader range of habitats in WA and the species.

Any risk can be mitigated by taking a staged approach to increasing stocking levels and using the carrying capacity models discussed above in an adaptive management framework to first predict the likely change in the environment with any given increase and to allow for validation and refinement of the model.

Robustness

These measures will provide a medium robustness since monitoring of farm stocking densities in the various regions will improve the understanding of assimilative capacities over time.

Fisheries Management Response

- Current

Little has been done in determining carrying capacity in WA since the industry is still small.

- Future

It is necessary to complete regional carrying capacity models for zones where activity will be focused.

- Actions if Performance Limit exceeded

It is necessary to undertake more targeted research if results indicate an adverse environmental impact is occurring in a region due to exceeding the carrying capacity. The difficulty will

be determining when this impact may ‘flip’ the ecosystem, resulting in long-term serious environmental damage.

Comments and Action

The most widely accepted indicator of ecosystem change used to calculate carrying capacities is water quality. WA is moving towards carrying capacities calculated by determining the maximum level of fish production possible without exceeding the water quality for a region.

6.2.4.2 Disease (proximity of facilities, translocation policy)

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	0	1	0	Neg -Low
SBY	1	2	2	
ABR	0	1	0	
CWC	0	1	0	
LNE	1	3	3	
WSC	1	1	1	

ERA Risk Rating: Regional effects due to proximity between farms

Rationale for Inclusion and Identification of Management Authority

Protocols are needed for the industry as a whole that outline regional strategies to minimize the risk of disease transmission whether in terms of where sites are located and their proximity to each other, the movement of stock within the regions or the introduction of stock from outside the region.

The primary management authority is the Department of Fisheries using the *Fish Resources Management Act 1994*. Supporting this is the Department’s draft policy being developed for determining suitable buffers between various aquaculture sites.

Operational Objective (plus justification)

Aquaculture operates to avoid broad scale impacts from disease.

Justification

It is possible to calculate the probability that one sea cage will succumb to a disease outbreak from another farm with two major factors being evaluated, namely exposure and susceptibility. The exposure that one farm receives from an infected farm site depends on the source strength (the prevalence of disease at the infected site), the degree of dilution of infectious organisms and the virulence of the disease vectors. In calculating the contagion from one farm to another, involves a lot of physical oceanography, both to calculate the dispersion of the disease agents and to estimate how long it takes them to arrive, since virulence may decrease over time.

Wild populations tend to receive higher exposure to diseases present in fish farms, since they can swim very close to the site and often feed in the immediate vicinity of fish farms. Their susceptibility is much lower however since their exposure is often transitory and any infected individual may not remain in contact with the large population.

These situations are highly complex however it is unlikely modeling will be able to answer

questions about disease propagation with sufficient precision to be useful. Attempting to implement a buffer distance for normal conditions where water movement may be less than 0.5 knots, when storm conditions could increase this significantly, is problematic. Since disease propagation does not require continual exposure, a model based on the most common conditions is unlikely to give an adequate margin of safety.

The Department of Fisheries is considering the appropriate buffer distance to be required between sites farming various species and will incorporate a conservative figure to attempt to minimize disease transmission. Should this prove to be insufficient, this figure may need to be reassessed.

Fisheries Management Response

- *Current*

The Department of Fisheries does not have a formal buffer policy for aquaculture and currently makes a case-by-case assessment of the likelihood of any disease transmission. *Fish Resources Management Act 1994* requirements for reporting of any disease outbreak currently exist.

Continue to use Environment Protection Authority’s Guidance Statement No. 3 *Separation Distance between Industrial and Sensitive Land Uses* (2005) for those facilities such as seafood processing activities, which are associated with marine-based finfish aquaculture.

- *Future*

Finalize the buffer policy and if necessary review the buffer distance if unacceptable levels of disease transmission between farms occur.

- *Actions if Performance Limit exceeded*

Increase the buffer distances between species if required to focus on problem areas.

6.2.4.3 Disposal of processing waste

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	2	1	2	Low
SBY	3	1	3	
ABR	2	1	2	
CWC	1	1	1	
LNE	3	1	3	
WSC	1	1	1	

ERA Risk Rating: Effects of processing product in water

Rationale for Inclusion and Identification of Management Authority

Harvesting and processing of product occurs on site with the by-products then requiring disposal. It is important to identify the type of wastes that need to be disposed of, the legislative restrictions that apply and options that need to be developed.

The primary management authority is the Department of Environment and Conservation by

way of its role in the management of waste discharges into the marine environment under the *Environment Protection Act 1986* and its associated regulations.

The Department of Fisheries has a minor role under the *Fish Resources Management Act 1994*, however the existing regulatory regime does not provide any direct conditions.

Operational Objective (plus justification)

Aquaculture will avoid regional impacts resulting from the release of processing wastes.

Justification

Heavy dumping of offal can have local impacts such as lowering of aesthetics or attracting the attention of scavengers, which in the case of sharks and crocodiles may be a significant risk.

The areas in WA where marine finfish aquaculture occurs each have different reasons for wanting to ensure wastes are not discharged into the marine environment. Shark Bay has a higher requirement due to the limited flushing that occurs within the bay. The Leeuwin – Naturaliste region is of high concern because of the other users already discharging wastes into the water and the likelihood of exceeding any regional carrying capacity. The other regions however, have much greater flushing rates and any discharges would be dispersed relatively quickly.

Current fisheries management arrangements do not include any regulatory requirements in regards to aquaculture operators dealing with any harvesting or processing wastes. There are regulations however governing this activity under the Environment Protection Act 1986. Levels of aquaculture in any one region are insignificant but should this change or monitoring results show that existing operations are having unacceptable impacts on the environment through waster discharge, then aquaculture licence conditions could be imposed.

Codes of Practice are an appropriate way to guide existing operators.

Fisheries Management Response

- *Current*

The Department of Fisheries uses Regulation 62 (*Fish Resources Management Regulations 1995*) to manage the dumping of wastes into waters in the Abrolhos but only for commercial fisheries. Section 255 (*Fish Resources Management Regulations 1995*) could be used in certain circumstances if a single facility was polluting waters but this section has not been used in this context to date.

Maintain local government health regulations that limit the disposal of waste into waters.

The Department of Environment and Conservation continues to implement the *Environmental Protection Act 1986* and associated regulations dealing with pollution and unauthorized discharges

- *Future*

Develop a Code of Practice outlining land-based locations for disposal of wastes.

- *Actions if Performance Limit exceeded*

Action can be implemented by other authorities if breaches occur that are not appropriately dealt with under existing arrangement. This can include prosecution under environmental legislation or issuing of an Environmental Protection Notice.

6.2.4.4 Disposal of unusable product

ERA Risk Rating				
Reg	C	L	Rr	R
KSD	1	1	1	Low
SBY	1	1	1	
ABR	1	1	1	
CWC	1	1	1	
LNE	1	1	1	
WSC	1	1	1	

ERA Risk Rating: Ability to dispose of unmarketable product

Rationale for Inclusion and Identification of Management Authority

There will be times when operators need to dispose of unmarketable product or mortalities. The provision of information to operators within each region as to where this waste product can be disposed of needs to be considered.

The primary management authorities are local councils through by-laws and they provide suitable facilities that will accept this form of waste product. The Department of Environment and Conservation has management responsibility through the *Environment Protection Act 1986*. The Department of Fisheries could also outline appropriate methods through the Code of Practice.

Operational Objective (plus justification)

Aquaculture will appropriately dispose of all unusable product.

Justification

The WA finfish aquaculture sector is small at present and produces low levels of unusable product. Any unusable product is likely to be a result of disease and management practices recommend that all mortalities be collected from the cages on a daily or weekly basis. The mortalities are required, under local government health regulations, to be disposed of in land-based facilities, similar to processing wastes.

Arrangements with local government for normal and worst-case disposal requirements should be agreed in advance of them being required, i.e. each facility should be required to have an agreed worst-case disposal arrangement. If waste disposal at each facility is properly provided for, regional issues in this operational area should not arise.

Fisheries Management Response

- Current

Limited provision of advice or assistance at present occurs apart from requesting suitable disposal sites.

Maintain current protocols on disposal in land-based facilities that are managed by local government councils. Continue to abide by Local Government regulations and bylaws.

- *Future*

Code of Practice outlines facilities within each region that will accept aquaculture wastes.

- *Actions if Performance Limit exceeded*

Local government can take action against any operator that continues to dispose of waste inappropriately.

6.3 Impacts from Individual Facilities on Environmental Wellbeing

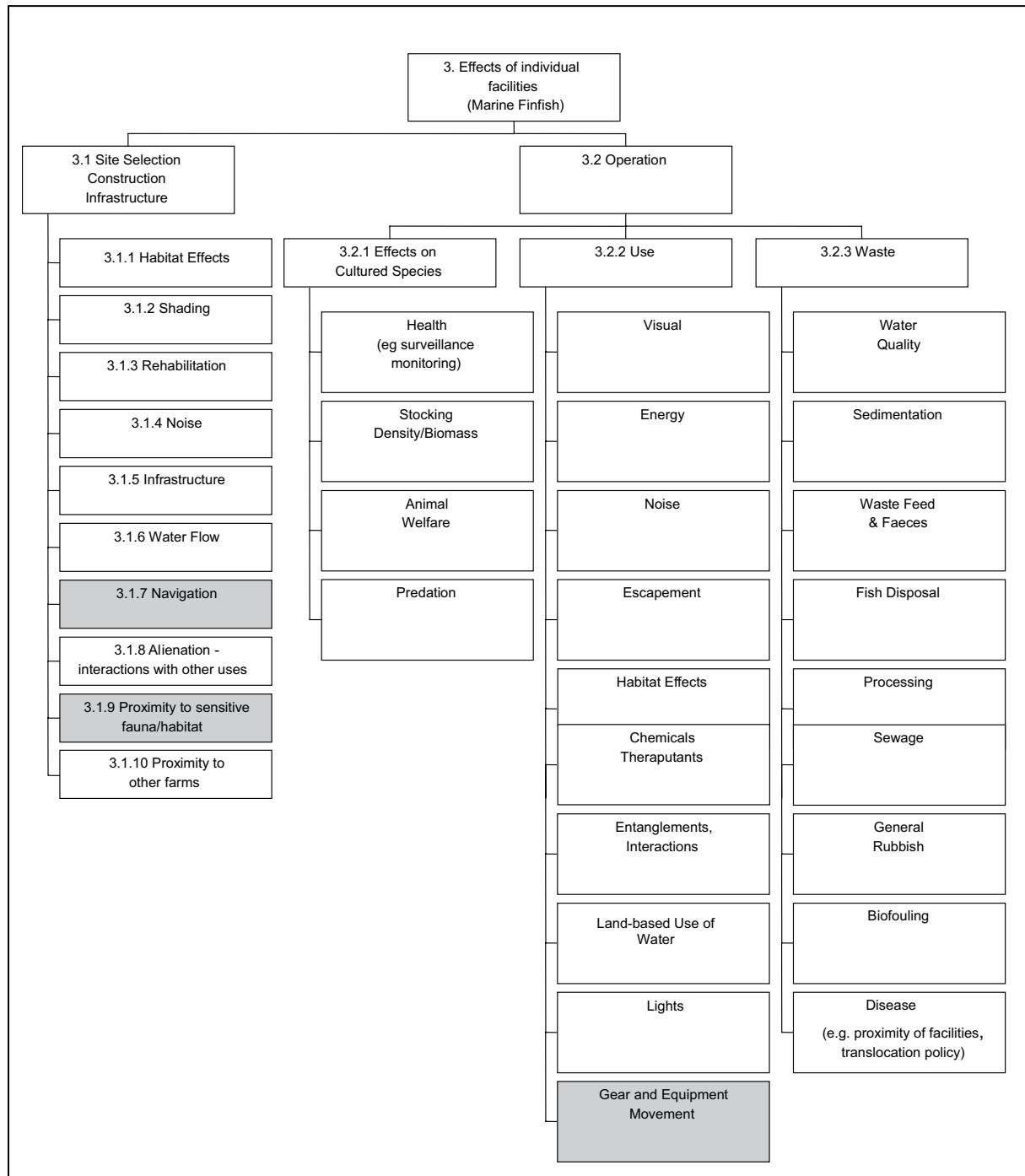


Figure 6 Component Tree 3 - Environmental Impacts from Individual Marine Finfish Aquaculture Facilities

The Department of Fisheries is responsible for the granting of a licence authorizing aquaculture in a specific location. This licence manages the operation of the aquaculture facility through licence conditions, but does not cover any activity during the construction phase. Construction activities are currently managed by the Department of Environment and Conservation under a Works Approval. Under the proposed arrangements, the Department of Environment and Conservation will remove requirements for an Environmental Licence and Works Approval, allowing Department of Fisheries to manage the ongoing operations through licence conditions, the Management and Environmental Monitoring Plan and the Code of Practice. Performance measures have been used as a guide to develop Codes of Practice and licence conditions, which have undergone further refinement and consultation.

6.3.1 Site Selection

6.3.1.1 Habitat effects

Rationale for Inclusion and Identification of Management Authority

Areas of habitat will be affected by the construction and operations of an aquaculture facility, however any direct impacts must remain within the area approved by the management authority and not affect surrounding areas. The information to be included in any application is considered here. Consideration of the amount of habitat to be effected by the operation must be included against the total allowable for the region.

ERA Risk Rating: Effects on surrounding habitat due to development (C1 L2 LOW)

Operational Objective (plus justification)

Aquaculture operations are appropriately located to avoid impacts to habitats adjacent to the site.

Justification

All proponents must outline the proposed operation and how farming practices will minimize any environmental impacts both on the site and adjacent areas. There needs to be consideration of the various physical constraints such as: water flow and depth; stocking densities and feed application rates; level of nutrient release and deposition of faeces; and the affect these will have on the habitat within and adjacent to the site. Applications should also include descriptions of the infrastructure to be used (i.e. anchors and cages) to ensure that regulators are able to assess whether these are the most appropriate for the location and can operate with minimal effects on benthic habitats.

Each proponent applying for marine finfish aquaculture will be required to provide in their application information on the habitat types over which they are proposing to site their cages. Generally speaking, a benthic habitat map would provide this data, however video footage may be suitable. This may be a more cost-effective approach to be considered in future for all applications. The Department of Fisheries is commencing a research project which will assist the agency to test a decision support tool for determining carrying capacity. This project will run for two years and end in 2010.

By ensuring proponents provide the necessary detail in their applications on the proposed operations and their environmental impacts, it is likely that they will more fully understand the management practices that will be required of them. Each site must be constructed and

managed to certain standards to ensure that regional values are maintained and this can only be achieved through a greater understanding of each sites direct influence over habitats and how this relates to the total impact across the region.

Indicator

- Site-specific information necessary to assess aquaculture applications is provided.
- Operations will be monitored to avoid medium to long term impacts to habitats.

Performance Measures

(Code of Practice/Licence Condition/Management and Environmental Monitoring Plan

Code of Practice	Proponents must ensure that appropriate information is provided as part of any application. Such a document will be tailored to the particular sensitivities of the location and may typically include the following details: <ul style="list-style-type: none"> • How the proposal complies with the Code of Practice; • A draft Management and Environmental Monitoring Plan; • The equipment to be used, including statements of its suitability for the conditions of the particular locations and how the equipment has been designed to reduce impacts on the environment; • The farmers procedures for routine operations; and • To address other site-specific issues regarding impacts on habitats.
Code of Practice	All new equipment should be installed in accordance with manufacturer's instructions, where these are available. Farmers should consider the potential benefits of having suppliers supervise the installation of cages and ancillary equipment.
Code of Practice	Moorings should be of a type compatible with the cage installations deployed on site. These should be designed, constructed and deployed to withstand stresses imposed by local tidal and/or water movement. Moorings should be consistent with the type of seabed at the site.
Code of Practice	Moorings should be designed and installed with a suitable mooring specialist and every component should be inspected according to a regular and recorded plan. The overall mooring specifications should be verified by a mooring engineering analysis performed by a third party taking into account local conditions.
Code of Practice	Environmental monitoring shall be carried out to ensure that surrounding habitat is not prejudiced. The parameters measured and the monitoring interval will depend on the system, species, stage of development and time of year.
Code of Practice	Should any parameters depart from the acceptable range, steps shall be taken to identify the problem and affect a remedy as soon as possible.
Code of Practice	Farmers should be familiar with water quality parameters for their stock and be able to recognize visual indicators of poor water and behavioural indicators of poor water quality.
Code of Practice	To assist site selection, the sediments provide a good indication of the dynamic nature of the site – coarse sediments tend to be associated with more dynamic sites and are usually better oxygenated.
Licence Condition	Licencees must prepare and implement an agreed Management and Environmental Monitoring Plan (MEMP). The licensee will use the Department of Fisheries' Finfish Aquaculture MEMP template or develop an MEMP of a comparable standard to be signed off by the Department of Fisheries/ Department and Environment and Conservation/Environment Protection Authority, as necessary. This plan must be finalized prior to any stock being placed on the site.

Licence Condition	Before 31 July of each year, the licensee must submit the MEMP report, which includes a copy of all results to July 1 of that year, to the designated Department of Fisheries' regional office and copied to the Chief Executive Officer of the Department of Fisheries.
Management & Environmental Monitoring Plan	The MEMP will identify the potential risks, detail the environmental values against which the risks will be compared and outline appropriate management strategies. A component of the monitoring program for water quality, sediment quality, primary producer health and benthic impacts (chemical and fauna) will be set out.
Management & Environmental Monitoring Plan	Water and sediment quality will be evaluated by comparing concentrations of nutrients with Environmental Quality Standards. Certain standards will be tentative where a detailed data set is not available and others will be based on previous studies.
Management & Environmental Monitoring Plan	Proponents will designate the location of the 'impact' site and the corresponding 'control' sites, of which there should be at least three. These will be agreed to in writing by the Department of Fisheries.

Fisheries Management Response

- *Current*

The Aquaculture Licence Applications Form currently asks for some detail on the area over which the operations will be located and the operations to be undertaken.

- *Future*

Revise the Aquaculture Licence Application Form to require that the proponent identify habitats within and adjacent to all facility locations and management strategies to avoid medium-to-long term impacts to habitats where appropriate. Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

Develop an agreed standard Management and Environmental Monitoring Plan for marine finfish aquaculture.

The Department of Fisheries will work with proponents during the development of applications to ensure a consistent standard. Once the application has been completed, the Department of Fisheries will determine whether a referral to the Environment Protection Authority is required.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

Any breaches of the Management and Environmental Monitoring Plan will trigger appropriate agency responses – these may be by the Department of Fisheries or the Department of Environment and Conservation, if the breaches are serious enough to trigger a response under the *Environment Protection Act 1986*.

6.3.1.2 *Shading*

Rationale for Inclusion and Identification of Management Authority

The installation of aquaculture infrastructure can result in the shading of some habitats, such

as seagrass from cages. Shading can be caused by a decrease in the intensity of light reaching the bottom, due to the presence of the cage itself or by an increase in epiphytic growth on the seagrass fronds caused by nutrient enrichment.

ERA Risk Rating: Effects of any shading due to facility (C1 L2 LOW)

The primary management authority is the Department of Fisheries, with day-to-day management through aquaculture licence conditions. If the site is located within a marine management area, then the Department of Environment and Conservation is the primary management authority.

Operational Objective (plus justification)

Infrastructure will avoid impact on benthic communities caused by shading.

Justification

Many studies into the impacts on seagrass from sea cages have been completed, ranging from nutrient enrichment, deposition, scouring by infrastructure and shading. Shading can be caused by a decrease in the intensity of light reaching the bottom due to the presence of the cage itself or by an increase in epiphytic growth on the seagrass fronds caused by nutrient enrichment. Either way, if the time period over which the shading occurs is extended i.e. more than three to four months, the seagrass can die due to an inability to photosynthesize.

Shading is unlikely to be the major reason behind aquaculture not located over significant benthic habitats, but provides additional cause to locate aquaculture over sandy habitats. This risk also deals with impacts during the construction phase however impacts due to shading over this short period should be below the threshold for any permanent loss.

Proponents should provide biological characterization information across the site. They should outline the potential risks that may result in effects on benthic communities and both proactive and reactive management responses to limit the impacts from these risks. In this case identifying an appropriate site should remove any risk caused by shading.

Indicator

- Benthic habitats impacted during aquaculture construction.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Installation of infrastructure should be undertaken using methods to minimize any impacts on benthic habitats, including the placement of cage anchors away from seagrass or coral. Mooring of boats during construction and operation should avoid impacting on these habitats.
Code of Practice	Proponents should locate aquaculture in areas with minimal coverage of benthic communities in order to minimize habitat impacts resulting from operations. Contact with the Department of Fisheries at the early stages of site selection, will avoid the need to reposition the farm.
Licence Condition	Licenses must implement and maintain an agreed Management and Environmental Monitoring Plan. The licensee will use the Department of Fisheries' Finfish Aquaculture Management and Environmental Monitoring Plan (MEMP) template or develop an MEMP of a comparable standard to be signed off by the Department of Fisheries/Department of Environment and Conservation/Environment Protection Authority, as necessary. This plan must be finalized prior to any stock being placed on the site.

Licence Condition	Before 31 July of each year, the licensee must submit the MEMP report, which includes a copy of all results to July 1 of that year, to the designated Department of Fisheries' regional office and copied to the Chief Executive Officer of the Department of Fisheries.
Management & Environmental Monitoring Plan	The MEMP will identify the potential risks, detail the environmental values against which the risks will be compared and outline appropriate management strategies. A component of the monitoring program for benthic impacts will be set out.

Fisheries Management Response

- *Current*

Department of Fisheries policy limits the granting of a licence for finfish aquaculture over seagrass. This lessens the possibility of shading leading to loss of seagrass habitat. For those sites where aquaculture has already been approved over seagrass, a more rigorous Management and Environmental Monitoring Plan is imposed through licence conditions.

- *Future*

If the policy changes to allow sites to be approved over seagrass, there will be a need to review the Management and Environmental Monitoring Plan to ensure that the plan measures impacts due to shading. Coral communities are also important benthic habitats, however implementing appropriate regulatory responses is more difficult due to the lack of data on impacts. The Department's environmental project will provide a clearer position on expected impacts and suitable management responses.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

For sites approved over seagrass, if shading (due to structures) results in a loss of seagrass, the cages should be fallowed more often to allow the seagrass to recover. If nutrient enrichment leads to epiphyte growth, then changes to the stocking density, feeding regimes or cage placement may be required to decrease nutrients entering the system and increase the dispersion of any wastes. Ultimately, the site may need to be relocated if impacts cannot be managed.

6.3.1.3 Rehabilitation

Rationale for Inclusion and Identification of Management Authority

Processes need to be in place in the event that the site ceases to operate as an aquaculture facility and needs rehabilitation.

ERA Risk Rating: Site rehabilitation (C1 L3 LOW)

The Department of Fisheries is currently amending the *Fish Resources Management Act 1994* to give the Chief Executive Officer the power to require a bond or bank guarantee on a licence, to cover the cost of any site rehabilitation should the operator go bankrupt and the site needs decommissioning. In the meantime, Section 195 of the *Fish Resources Management Act 1994* provides powers to Fisheries Officers to seize abandoned gear at sea, including aquaculture gear.

Operational Objective (plus justification)

Operators implement the Rehabilitation Plan in the event that the site is decommissioned.

Justification

Ultimately, it is the responsibility of the licensee to ensure all aquaculture equipment is removed from the site at the expiration of the licensee as well as restore the site to its original environmental condition, or as near as practicable. It is reasonable to expect that there should not be any use of public money to meet the costs for rectification of an operator's actions. However, if the licensee is no longer financially viable at the expiration of the licence, there needs to be a mechanism for the State to recover the cost of any remedial works it undertakes.

Currently, aquaculture licenses do not have any power past their cancellation or termination in requiring the rehabilitation of the site if the operator goes bankrupt. This is being rectified through amendments to the Fish Resources Management Act 1994 (FRMA) giving power to the Chief Executive Officer (of the Department of Fisheries) to attach a bond to a licence requiring the payment of a bond or bank guarantee to cover the cost of site rehabilitation, amongst other things. The Department will clean-up the site and recoup costs incurred through legal means, if necessary. Costs can also be recouped through the sale of seized aquaculture gear if the site is abandoned (FRMA section 195). The preferred option however, is for the operator to have a Rehabilitation Plan in place dealing with issues such as removal of cage infrastructure (anchors, stock) and environmental restitution of the seabed. In many instances however the only way for the seabed to be rehabilitated will be by allowing enough time for the assimilation of any sedimentary nutrient loading.

Indicator

- Aquaculture licensees have a rehabilitation plan for their site.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Operators should detail in the application how the site is to be rehabilitated and give consideration to equipment choice based on ease of decommissioning and rehabilitation.
Code of Practice	Licenses should develop a rehabilitation plan for their site within two years of approval, outlining actions that will be taken should decommissioning be required. This plan will be signed off by the Chief Executive Officer of the Department of Fisheries. <i>Items to be covered in the rehabilitation plan will be drafted in consultation with industry and incorporate input from local government and any relevant port authority.</i>

Fisheries Management Response

- *Current*

Aquaculture Licenses have no life beyond their cancellation or termination, however this is being changed through the *Fish Resources Management Act 1994* amendments. Costs incurred by the Department of Fisheries in cleaning up the site can be recouped through legal means.

- *Future*

Revise the Application Form to include the requirement for a rehabilitation plan. Provide guidance on how to draft this plan through the Code of Practice.

The *Fish Resources Management Act 1994* will give power to the Chief Executive Officer to require the payment of a bond against a licence to cover the cost of any rehabilitation in the event the operator goes bankrupt.

- *Actions if Performance Limit exceeded*

Once the Application Form is changed, any application lodged without the plan will be returned to the proponent for completion.

Any sites abandoned without a rehabilitation plan will be cleaned up by the Department of Fisheries, with costs being recouped via legal channels.

6.3.1.4 Noise

Rationale for Inclusion and Identification of Management Authority

Noise could be of concern during construction and operation of an aquaculture facility, however this is generally not a concern with marine sea cage farming. Any noise will likely emanate from the large boats used to install anchors or cages and during feeding.

ERA Risk Rating: Noise resulting from facility (C1 L2 LOW)

The primary management authority is the Department of Environment and Conservation under the *Environment Protection (Noise) Regulations*.

Operational Objective (plus justification)

Noise emissions are within acceptable levels.

Justification

Noise during construction can originate from the installation of anchors, being mechanical in nature but short term, and therefore unlikely to affect adjacent users.

Noise sources from finfish farms on an ongoing basis are principally from automatic feeding machines, boats and harvesting operations. Finfish farms are located offshore where there are no noise sensitive zones. Land-based operations may have higher noise emissions such as air conditioners, machinery used for moving harvested product, and generators. If these operations are located close to other rural users, noise emissions may need to be managed.

In managing noise emissions from a finfish farm or support land-based facilities, farm operators must incorporate appropriate noise reduction techniques, which may include:

- *incorporating at the planning stage maximum distances between noise sources and sensitive places;*
- *construction of vegetated buffer zones for land-based support facilities;*
- *construction or use of appropriate noise barriers or noise attenuators; and*
- *consultation with local governments and developers to ensure adequate buffer zones are provided.*

Indicator

- Noise levels are within *Environment Protection (Noise) Regulations* thresholds.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Licences should ensure that equipment that creates noise (e.g. air blowers, generators) is suitably muffled so as to prevent unacceptable disturbance to wildlife or humans. Local Government Environmental Health officers can be consulted for advice.
Code of Practice	Service infrastructure such as land-based facilities, are covered by regulations however vessels accessing the marine based site are not. It is recommended that applicants contact the Department of Planning and Infrastructure (Marine Safety) for advice regarding minimising noise emanating from vessels accessing site.

Fisheries Management Response

- *Current*

The Department of Fisheries does not have any jurisdiction in the management of noise emissions - this remains with the Department of Environment and Conservation/Environment Protection Authority.

- *Future*

Guidance on managing noise emissions during construction will be included in the Code of Practice.

Assist Local Government in developing guidelines on managing noise emissions.

- *Actions if Performance Limit exceeded*

The Department of Environment and Conservation/Environment Protection Authority will continue to take action for any breaches of the Noise Regulations.

6.3.1.5 *Infrastructure*

Rationale for Inclusion and Identification of Management Authority

For large and intensive cage culture developments, the availability of sufficient land to construct an office, feed store, laboratory, manager's house, etc, close to fish cages may be an important consideration in site selection. Services are also important. Fresh water, three-phase electricity, telephone and postal services, sewerage, road and rail services and veterinary assistance must all be assessed prior to leasing or purchasing a site. Proponents need to consider all these infrastructure requirements in any new proposal.

Infrastructure to be located on any marine site needs to be suitable for the purpose intended and comply with existing regulatory requirements. This includes appropriate surveys for boats to be used for accommodation or feed storage as well as cages and nets being selected taking into consideration the local environment.

ERA Risk Rating: Infrastructure requirements (C1 L6 LOW)

There is no single primary management authority, with each being the responsibility of a separate service provider. Local authority is the regulatory authority for these. DPI may be involved if a land lease is required.

The Department of Planning and Infrastructure (Marine Safety) will need to be consulted for any boats and barges intended to be moored on site – the Australian Maritime Safety Authority may also need consultation if the site is within their care, control and management.

Operational Objective (plus justification)

Engineering of infrastructure is appropriate for the site.

Justification

Western Australia has a vast coastline and many areas do not have the necessary service connections or infrastructure such as wharves and roads. The ability for Local Governments or smaller regional service providers to connect new areas to networks is limited by financial constraints. One way around this is to promote the use of joint facilities such as Aquaculture Parks.

Prioritization of any new service networks will be outside of the Department of Fisheries ability to direct however government-wide priorities can be influenced by agency comment. Budgetary constraints have restricted spending on infrastructure for the aquaculture industry as the State's focus has been on mining and energy sectors. The Department of Fisheries can assist in the future prioritization of new networks by being part of regional planning activities and identifying areas suitable for aquaculture operations.

Proponents will be advised to check all available information sources through local government and regional development agencies. Setting up a new aquaculture farm is costly enough without needing to consider whether the required infrastructure and services are available.

Infrastructure placed on the site should also be assessed as being suitable for the purpose for which it will be used.

Indicator

- Engineering of the infrastructure and aquaculture apparatus are suitable for the purpose and the site.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Relevant sources to assist in identifying existing and proposed infrastructure should be sought. These details may include other government departments as well as funding programs to assist in construction of new facilities.
Code of Practice	All cages should be manufactured to meet or exceed on-site operational requirements.
Code of Practice	All equipment should be installed in accordance with manufacturer's instructions. Farmers should consider the potential benefits of having suppliers supervise the installation of cages and ancillary equipment.
Code of Practice	Moorings should be of a type compatible with the cage installations deployed on site. These should be designed, constructed and deployed such that the loads and stresses imposed by tidal and/or water surface movement are spread evenly, and the cage installation is allowed to move and flex satisfactorily. Moorings should be consistent with the type of seabed at the site.
Code of Practice	Moorings should be designed and installed in consultation with the cage and moorings manufacturer and every component should be inspected according to a regular and recorded plan.
Licence Condition	All aquaculture apparatus must be purpose-built and suitable for the application for which it will be used.
Licence Condition	The type of anchor approved for this site is _____ and the licensee will install it in such a manner that the anchor does not move under the normal range of conditions experienced in that area.

Licence Condition	All cages for holding fish must be physically marked with an individual number.
Licence Condition	(<i>For barramundi</i>) The proponent must ensure that the main cage is: <ul style="list-style-type: none"> • constructed of net of a mesh size, type and quality that will reliably provide a complete barrier that will retain 100 per cent of the fish stocked in the cage; • of a mesh size between 2.5 - 22.5 cm stretched mesh size, depending on the size of the fish to be contained; • does not contain holes or openings greater than 1.5 times the size of the net mesh; • constructed so that the cage netting extends no less than 50 cm above the water line, or is secured by overhead netting to prevent fish escape by jumping; and is • fitted with predator exclusion or reduction devices.
Licence Condition	(<i>For barramundi</i>) The proponent must ensure that netting installed to deter predators is: <ul style="list-style-type: none"> • constructed of a mesh that uses cord greater than 2 mm in diameter; • of a mesh size between 2.5 - 22.5 cm stretched mesh size, depending on the size of the fish to be contained; • constructed so that the cage netting extends no less than 50 cm above the water line, or is secured by overhead netting to prevent fish escape by jumping; • does not contain holes or openings greater than 1.5 times the size of the net mesh; and • hung from the main cage a minimum distance of 30 cm.

Fisheries Management Response

- *Current*

The Department of Fisheries has a role in identifying information sources and, wherever possible, to direct proponents to appropriate facilities, such as aquaculture parks.

- *Future*

Include information in the Code of Practice for proponents identifying where information on regional and site-specific infrastructure/services can be located.

- *Actions if Performance Limit exceeded*

This is a farm management decision – if certain types of infrastructure regularly fail, the Department of Fisheries should work with the farmer to consider more appropriate technologies.

6.3.1.6 Water flow

Rationale for Inclusion and Identification of Management Authority

Applicants should provide information on the position of the aquaculture facility in relation to the surrounding water flows including current strength and tidal flushing rates.

ERA Risk Rating: Regional water flows (C0 L1 NEGLIGIBLE)

The primary management authority is the Department of Fisheries. All applications are referred to decision-making bodies under the Ministerial Policy Guideline No. 8 process. Ensuring 'input' is provided by these agencies will ensure the correct siting of facilities.

Operational Objective (plus justification)

Aquaculture facilities are appropriately sited and operated.

Justification

Good water exchange through cages is essential both for the replenishment of oxygen and removal of waste metabolites. Currents influence fish behavior, affecting social hierarchies, growth and growth disparities among stock and ultimately flesh quality. Few structures can withstand the impact of the open sea: winds tear at structures projecting above the water while waves attack objects on the surface. Shelter from these forces and waves in particular is therefore a prime consideration in site selection.

The provision of hydrodynamic data is essential to adequately assess the likely impact of the placement of a finfish farm. The data can be used to model dispersion around the site and identify the area of maximum impact. This can be calculated from current speeds and surrounding bathymetry. The higher the range of current speeds the greater the dispersion. Thus the hydrodynamic data can be used in predictive modelling of the impact of faeces, waste food, chemical use and subsequently advise on the maximum biomass at the site.

Bathymetric charts of the licence area and up to 1 km surrounding the farm are required. Current velocities at three depths (depending on total depth) for two 30 day period should be taken, most suitably collected using an Acoustic Doppler Current Profiler (ADCP). These periods should cover summer/winter or wet/dry seasons. The activity of the mid-depth and bottom waters is more important than that at the surface in considering the dispersal and re-suspension of particulate matter and so a complete record of the current profile is essential. This data should be accompanied by simultaneous wind measurements.

Although the relationship between cage culture, sedimentation of wastes, water quality and disease remains poorly understood, it is best to hold fish at least some distance above sediments to maintain adequate water flow through the cage. The Scottish Environment Protection Authority recommended in the Regulation and monitoring of marine cage fish farming in Scotland – a manual of procedures (1998) that there should be at least twice the proposed net depth of water at the site i.e. the depth from the base of the net to the sea bed is not less than the depth from the water surface to the base of the net. Experience there has shown that a depth of over 20 metres can be better in some areas for the dispersion of organic wastes. However, it should be noted that in some shallow areas current speeds increase relative to deeper areas, thus dispersing the wastes.

Two main components should be reviewed, the mean current speed and the 'zero' or quiescent period. The Scottish Environment Protection Authority has classified mean current speeds as:

- Greater than 10 cm/s = strongly flushed*
- Between 5 and 10 cm/s = moderately flushed*
- Between 3 and less than 5 cm/s = weakly flushed*
- Less than 3 cm/s = quiescent*

In other areas wind and wave induced currents may have significant effects in dispersing the wastes.

Sites proposed over deep basins raise other issues, such as accumulations of organic materials and de-oxygenation of bottom water. These therefore required particularly close consideration.

Indicator

- Hydrodynamic data, including bathymetric charts, are considered against the site plan so as to minimize changes to water flow while meeting operational requirements.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	The location of cages should allow an adequate flow of clean water through the nets but should be protected from exposure to extreme conditions that may harm fish or risk damage to the nets.
Code of Practice	Depending on cage design, the site should be sheltered and not overly exposed to prevailing winds or large wave action. Exposed sites (such as those offshore) require cages that are suitably specified for site conditions (such as maximum expected wave height and period).
Code of Practice	Depending on the depth of the cage, at least two to four metres clearance between the bottom of the cage and the sea floor at low tide should be maintained.
Code of Practice	Water current should be sufficient to flush away wastes from beneath the cage to minimize localized fouling. In instances where this is not possible, fallowing regimes will be required.
Code of Practice	The type and amount of hydrodynamic data needed for a site will vary depending on the local and regional annual variation in conditions. Sufficient data needs to be collected to feed into plume effect models to obtain suitable predictive forecasts.

Fisheries Management Response

- *Current*

The Department of Fisheries currently assesses information provided by prospective farmers however guidance will assist them in selecting most appropriate sites.

- *Future*

Include specific direction on the level of information required through the Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters.

6.3.1.7 *Navigation*

Rationale for Inclusion and Identification of Management Authority

Marine finfish aquaculture can comprise the installation of sea cages in areas that pose an increased navigational hazard to the unwary. These facilities are therefore required to install marking and lighting to give greater certainty to boating and shipping traffic. Effects of marine sea cages on navigation and safety include whether the farm is in or near a favoured navigation route and whether there is a risk of vessels running into the farm, particularly at night. The farm may also incorporate a mooring site for vessels, particularly for situations of adverse weather.

Aquaculture licenses are not exclusive therefore other marine users are allowed to navigate/ access the site and therefore providing a navigable pathway through the site is recommended for the safety of the other users and to prevent equipment losses.

ERA Risk Rating: Navigational hazards (C4 L4 MODERATE)

The primary management authority is the Department of Fisheries following recommendations from the Department of Planning and Infrastructure (Marine Safety). These recommendations by DPI are imposed via the aquaculture licence conditions.

Operational Objective (plus justification)

Navigational safety will not be compromised by aquaculture operations.

Justification

Marking and lighting of aquaculture sites in Western Australian coastal waters is required in order to:

- *Promote public safety through delineation of areas containing aquaculture infrastructure;*
- *Provide uniform lighting and marking standards for aquaculture sites containing infrastructure and in some cases direction indicators; and*

Protect in-water property located within the licence area.

For the purpose of marking and lighting, aquaculture licence sites are classified into four categories according to the following parameters:

- *Density of other traffic utilising the waters adjacent to and through the licence site;*
- *Possible obstruction to other vessels navigating over the surface of such waters;*
- *Possible obstruction to other vessels requiring to anchor in such waters;*
- *Depth of water within and adjacent to the licence site;*
- *Remoteness of the licence site; and*
- *The need to mark the licence site to ensure safety of navigation.*

The category assigned to each licence area is selected by the proponent for consideration by the Department of Planning and Infrastructure (Marine Safety). Their recommendation is forwarded to the Department of Fisheries for deliberation. The final marking and lighting category is then imposed via the Aquaculture Licence.

Aquaculture sites have been divided into four categories based on certain parameters. Each category has different marking and lighting requirements. The categories are summarised as follows:

- *Category One - this is the standard for marking all aquaculture licence sites unless an allowance has been made under another category;*
- *Category Two - this category is to be considered as the standard for marking licence sites which may require less critical marking than those under Category One. This could apply in areas with lower traffic density which have a lower likelihood of other craft navigating in the waters adjacent to the site;*
- *Category Three - this category is to be considered for marking licence sites that are located in inshore areas, in shallow waters where only small craft may navigate or in the tidal zone of littoral or reef areas. Individual applications for Category Three licence sites will be separately assessed for their marking and lighting requirements; and*
- *Category Four - this category is to be considered for marking licence sites that are located in very remote locations, subject to very low traffic density, often in unsurveyed or inadequately surveyed waters from Northwest Cape to the Western Australia/Northern Territory border including the waters of Exmouth Gulf. Individual applications for a Category Four licence sites may be separately assessed for their marking and lighting requirements.*

The Department of Planning and Infrastructure's Marine Safety Unit must be advised in writing two weeks prior to the anticipated establishment of any navigational aids. The licensee must also

advise the Marine Safety Unit upon completion of installation of a marking of an area so that the Department of Planning and Infrastructure can include any newly marked or modified areas on their navigation charts for use by relevant agencies, and other boat users and organisations.

Indicator

- Aquaculture operators install and maintain marking and lighting as specified.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Sites in tidal waters must be marked and lit in accordance with requirements determined, in principle, by the Department of Planning and Infrastructure in consultation, as appropriate, with any local Port Authority.
Licence Condition	The site shall be marked in accordance with the requirements of the Department of Fisheries document ' <i>Standardised Lease and Licensed Site Marking: Incorporating prescriptive requirements for pearling and aquaculture lease/licence sites</i> ' (2008), or as otherwise approved by the Chief Executive Officer of the Department of Fisheries.
Licence Condition	The marking and lighting will be installed as soon as aquaculture apparatus are placed in the water and are to be maintained in good working order from that point on. The Department of Planning and Infrastructure (Marine Safety) must be notified in writing, as soon as marking and lighting is placed in the water.
Licence Condition	The category of lighting, as set down in the document ' <i>Standardised Lease and Licensed Site Marking: Incorporating prescriptive requirements for pearling and aquaculture lease/licence sites</i> ' (2008), to be installed and maintained by the licensee on the site is _____. Or, Lighting, to be installed and maintained by the licensee on the site is _____. (for Port Authority waters only)

Fisheries Management Response

- *Current*

Protocols exist between Department of Fisheries and the Department of Planning and Infrastructure regarding the referral of applications for comment under the Ministerial Policy Guideline No 8 process and determination of suitable navigational aids.

- *Future*

Maintain current protocols.

Direct applicants to complete the *Guidance Statement for Determining Categories of Marking and Lighting of Pearling and Aquaculture Licences/Leases (2009)*.

- *Actions if Performance Limit exceeded*

Action can be taken by Department of Fisheries for failure to install and maintain marking and lighting. These range from prosecution for breaching a licence condition to eventual cancellation of the aquaculture licence. In instances where the proponent fails to respond to a notice to repair marking and lighting, the Department of Fisheries may undertake the maintenance work and recoup these costs from the proponent.

6.3.1.8 Alienation – interaction with other users

Rationale for Inclusion and Identification of Management Authority

The operation of marine sea cages can alienate other groups such as indigenous, recreational and commercial fishers, and boating from accessing waters. The diverse information relating to natural and human resources, coupled with the assessment and comparison of different development or technological alternatives, should provide a sound basis for the identification of sites which are particularly suited (or unsuited) to aquaculture development. Criteria for the identification or designation of such sites might include existing uses, land-use capability, conservation values, demographic and social characteristics and trends, hydrographic and physiographic features.

The applicant will be required to provide information on how their proposal may alienate other users. It is recommended applicants contact all potentially affected parties early on in the process and attempt to resolve conflicts prior to lodging any application.

ERA Risk Rating: Alienation of other groups (C1 L3 LOW)

The primary management authority is the Department of Fisheries with other government agencies playing a major role in commenting on the proposal. Ministerial Policy Guideline No. 8 sets out the process for assessing aquaculture application in coastal waters of WA.

Operational Objective (plus justification)

Aquaculture will be located to accommodate other users as far as reasonable.

Justification

Among the user conflicts that arise, particularly in developed nations, are those that develop between marine aquaculturists and users such as recreational fisherman and boaters, commercial fishermen, environmentalists and those who object to marine aquaculture on the basis of aesthetics. There can be disruption of rural/coastal communities when a new industry comes on the scene that does not appreciate the local culture and traditions.

One of the recently developed tools used for planning in the marine environment, is called Integrated Coastal Management. This concept came about due to the widespread acceptance of the fact that short-term, narrow sectoral development planning in the coastal zone should be replaced by a more strategic, long term and holistic approach. Integrated Coastal Management provides a mechanism for guiding development in an ecologically sustainable fashion by strengthening and harmonizing sectoral management.

The primary purpose of Integrated Coastal Management is to achieve the following sustainable development goals:

- ensuring the rational use of natural resources;*
- minimizing conflicts over use;*
- protecting and preserving the functional integrity of coastal ecosystems; and*
- equitable distribution of the economic benefits derived.*

The Department of Fisheries uses Ministerial Policy Guideline No. 8 to establish the principles against which the Chief Executive Officer will assess aquaculture applications in coastal waters of WA. Ministerial Policy Guideline No. 8 outlines the referral authorities whose approval is required for the activities to be conducted, those that must be consulted with and representative community and interest groups that may be directly affected by the proposal.

Although some of the social problems can only be addressed at the individual farm level, most are cumulative – insignificant when an individual farm is considered but potentially highly significant in relation to the whole sector. They are also additive, in the sense that they may add to the many other development pressures in the region.

Indicator

- New proponents recognise existing users and undertake consultation procedures.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Proponents should consult with existing user groups and regulatory bodies prior to finalising their aquaculture licence application, to identify the main conflicts and areas of interest as early as possible. Where possible, these conflicts should be resolved at an early stage.
-------------------------	---

Fisheries Management Response

- Current

Processes/referrals outlined in the Ministerial Policy Guideline No. 8 provide an open and robust mechanism for assessing aquaculture applications.

- Future

The Department of Fisheries is investigating the Ecosystem-based Fisheries Management framework which will include social and economic assessments. As this framework is developed, aquaculture can assist in gathering the necessary data.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

6.3.1.9 Proximity to sensitive fauna and their associated habitat

Rationale for Inclusion and Identification of Management Authority

The applicant needs to consider whether the proposal is sited close to an area where there is sensitive fauna and habitat associated with the fauna (i.e. dugongs and seagrass). Proponents will need to include within the application an outline of the species and ecological communities found where the proposed sea cages will be located. This data will be more rigorously assessed for sites located within or close to a Marine Conservation Reserve.

ERA Risk Rating: Proximity to sensitive habitats (C2 L4 MODERATE)

The primary management authority is the Department for Fisheries, which incorporates comments received during the referral process from the Department for Environment and Conservation. The Department of Fisheries imposes recommendations from the Department of Environment and Conservation/Environment Protection Authority through licence conditions (including the Management and Environmental Monitoring Plan).

Operational Objective (plus justification)

Sensitive fauna and their habitats will not be adversely impacted by aquaculture operations.

Justification

The Department of Fisheries is working together with the Department of Environment and Conservation to agree on a list of criteria for information that must be submitted with any application. This criteria incorporates identification of sensitive habitats either within or adjacent to the proposed site. Appropriate data collection methods include use of hyper spectral surveys, video tows or existing mapping sources. Once these habitats have been identified, correlation against the proposed activity will determine whether buffers are adequate.

Suitable buffer distances can be determined using results from Management and Environmental Monitoring Plans from comparable operations to set minimum distances to whale and dugong areas, sea lion haul out and breeding sites, as well as coral, seagrass and diverse algal communities if required. Information from interstate and overseas may also provide additional guidance for assessing potential impacts.

Information on the presence of sensitive fauna and flora is not available for a vast portion of the state, so proponents will need to undertake searches of databases, literature and make contact with relevant government agencies to clarify whether the site they are considering may be located in close proximity in their species of interest.

In some regions, avoiding seagrass and corals will not be possible, so in this case if the operation proposed still retains other benefits, then it could be considered with appropriate restrictions. These may be a change of species being farmed, use of different feeding regimes, lowering of the maximum stocking density or greater distances between each sea cage with longer fallowing times.

Management and Environmental Monitoring Plans are requirements of the licence conditions attached to all marine finfish licences. These reports must be received annually to allow the government and other interested persons, the opportunity to determine whether management arrangements are providing the necessary controls. These reports assist in determining buffer distances between aquaculture farms and sensitive habitats, using regionally specific data.

In Western Australia, the Department of Environment and Conservation has various statements requiring the consideration of impacts to sensitive fauna and flora. These are Environment Protection Authority Guidance Statements No. 1 – Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline, No. 49 – Development of Proposals in Shark Bay World Heritage Property, and Draft Environment Protection Authority Guidance Statement No. 33 – Planning and Development as well as Position Statement No. 2 – Environmental Protection of Native Vegetation in WA. Continuing to utilise these papers, will guide decisions on protecting these habitats while allowing development to an acceptable level. Applicants should consider these documents during the application development phase to mitigate impacts as much as possible.

The Environment Protection and Biodiversity Conservation Act 1999 should also be referred to during the application development stage.

Indicator

- Aquaculture minimizes or does not result in impacts to sensitive fauna and their habitats.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Proponents must ensure that appropriate information is provided as part of any application. Such a document will be tailored to the particular sensitivities of the location and may typically include: <ul style="list-style-type: none"> • Details of the benthic habitats within and adjacent to the proposed site; • Details of the sensitive species found associated with these habitats; and • Data, where available, on likely sensitive, potential interactions and management responses.
Code of Practice	Utilising lists of state and commonwealth listed species will assist in determining the sensitive fauna and habitats, to mitigate impacts from the proposal as much as possible. The lists set down the Department of Environment and Conservation's position for assessment of large-scale operations or those adjacent to sensitive habitats.
Code of Practice	Proponents should incorporate specific monitoring criteria and a management response in the Management and Environmental Monitoring Plan to ensure the activity does not result in unacceptable impacts to the environment.
Code of Practice	In managing the seabed and associated habitats, licensees must work in accordance with their licence conditions and monitoring protocols. These may include: <ul style="list-style-type: none"> • Abiding by any biomass and/or feed limitations; and • Routine water quality and sediment monitoring as stated in the Management & Environmental Monitoring Plan.
Code of Practice	Individual licensees may wish to adopt a recognised and independently audited Environment Management System.
Licence Condition	Licensees will prepare and implement an agreed Management and Environmental Monitoring Plan. The licensee will use the Department of Fisheries Finfish Aquaculture MEMP template or develop an Management and Environmental Monitoring Plan of a comparable standard to be signed off by the Department of Fisheries/Department of Environment and Conservation/ Environment Protection Authority, as necessary. This plan must be finalized prior to any stock being placed on the site.
Licence Condition	Before 31 July of each year, the licensee must submit the Management and Environmental Monitoring Plan report, which includes a copy of all results to July 1 of that year, to the designated Department of Fisheries Regional office and copied to the Chief Executive Officer of the Department of Fisheries.
Management & Environmental Monitoring Plan	The Management and Environmental Monitoring Plan will identify the potential risks, detail the environmental values against which the risks will be compared and outline appropriate management strategies. A relevant component for the monitoring and management of sensitive habitats and fauna will be set out.

Fisheries Management Response

- *Current*

The industry is still very small in WA, however the Department of Fisheries is considering proximity issues in respect to aquaculture. Referrals to the Department of Environment and Conservation under Ministerial Policy Guideline No. 8 can identify potential impacts to sensitive habitats and/or fauna. Proponents are encouraged to consider appropriate proactive and reactive management responses that will limit these impacts.

- *Future*

If current management controls fail to limit these impacts, then there may be a need to develop buffer distances from aquaculture facilities to sensitive fauna and flora, and include them as information in the Code of Practice.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

Until the sector grows and there is a need to consider proximity issues, there is no action to be taken.

6.3.1.10 Proximity to other farms

Rationale for Inclusion and Identification of Management Authority

When the marine finfish sector grows, there will be a need for strategic planning or zoning of aquaculture. These moves must consider proximity issues related to minimizing disease transfer, alienation of large areas of waters and is linked to regional carrying capacity. In the mean time, applicants must do this on a case-by-case basis.

ERA Risk Rating: Proximity to other farms (C1 L2 LOW)

The primary management authority is the Department of Fisheries. Other agencies provide comment through the assessment processes by highlighting any issues in this area.

Operational Objective (plus justification)

Reduce adverse environmental impacts due to the proximity between farms.

Justification

The locating of farms in close proximity to each other has risks and benefits. These can be summarized as follows:

- *Changes in circulation patterns due to the drag created by the nets and fish. If too many of these cages are placed too close together, the flushing capacity of the bay can change dramatically. Lower flushing means a lower potential to assimilate waste materials and assist in fallowing of sites that have been vacated from previous farming seasons.*
- *An increased likelihood of disease transmission however this will depend on the pathogen in question and its viability within the water column.*
- *The impact these farms may have on the migratory routes of certain species should they be too close together.*
- *Alienation of water to be of more concern and decisions need to be made considering the environmental impact that could result based on social issues.*

There is no strategic planning process in place in WA with applications assessed on a case-by-case basis. The Aquaculture Development Council is funding a project to identify processes and work required to designate zones for aquaculture. Once the project is complete, a Departmental policy can be developed, if considered appropriate.

Until then, proponents need to provide information on existing aquaculture development in the region. The proponent should discuss the proposal with regional groups regarding any conflicts that may result. The proponent may also need to research and where possible monitor whether any migratory species traverse the site (including species, frequency of sightings). The decision-making agencies must then consider this information during assessment and negotiate changes to the proposal if required.

Indicator

- Aquaculture licenses reduce adverse impacts on surrounding environments.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	It is important than finfish aquaculture operates within the capacity of the receiving environment and minimizes interaction between farm and wild fauna. Applicants considering applying for a new or varied authorisation should make early contact with regulatory bodies to identify areas of interest and where possible, resolve conflicts at an early stage.
-------------------------	---

Fisheries Management Response

- *Current*

The Department of Fisheries has not implemented any policy in this area, however the industry is not currently of a large commercial size. It has been recognized that requiring proponents to undertake broad scale planning exercises is inhibiting development and should be a role taken over by the Government. The Aquaculture Development Council has a project which is considering the protocols and information requirements to set aside areas zoned for aquaculture.

- *Future*

Develop a policy framework for determining areas suitable for zoning of aquaculture and commence planning activities to formalize these zones.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

6.3.2 Operation

6.3.2.1 *Effects on cultured species*

• **Health (surveillance monitoring)**

Rationale for Inclusion and Identification of Management Authority

On the assumption that industry-wide protocols have been developed, a facility-level Health Management Plan will then focus on all the critical control points along the production pathway where there are cost-effective opportunities to reduce risk of disease-related losses. The plan should focus on disease prevention rather than disease treatment.

ERA Risk Rating: Health of cultivated stock (C1 L2 LOW)

The primary management authority is the Department of Fisheries through the *Fish Resources Management Act 1994* and aquaculture licences. Operators are required to notify the Department of Fisheries of any disease outbreak. To support this, the operator should develop plans to guide operational activities.

Operational Objective (plus justification)

Licenses are responsible for minimizing and managing disease outbreaks in their facility.

Justification

The best approach is to maximize the ability to detect disease outbreaks within the farm, both from a commercial basis as well as environmental. Knowing the exact health status of each stock class will improve disease management and this should be part of the ongoing practices after the introduction of certified disease-free fingerlings into cages.

In 1998, Aquavetplan: Australia's National Strategic Plan for Aquatic Animal Health 1998 - 2003 was developed to respond to the recommendations made by a national taskforce. This plan was developed jointly by Government and the private sector and provides a strategic, national approach to dealing with aquatic animal disease. This program has been established to specifically address Australia's preparedness and response capability in the event of an outbreak of a disease. This plan provides general guidance on what operators must consider or undertake in order to manage disease in their facility.

Disease Management Plans set out the disease control principles for use in aquatic veterinary emergency incidents caused by the suspicion or confirmation of certain diseases in Australia. The Department of Agriculture and Food, Fisheries and Forestry through the Office of the Chief Veterinary Officer have developed these plans and they operate at a higher level.

Farm-based Health Management Plans comprise steps and control measures that are done daily, weekly, monthly and annually by staff, to reduce to acceptable levels the risks of disease-related losses on the farm. Risks are not eliminated – in most cases some disease losses will still occur but the cost of these losses will not justify increased expenditure on the program.

The key focus areas of the plan are:

- seasonal factors and stock planning;*
- cage preparation;*
- water quality management;*
- feed management;*
- fish health monitoring;*
- farm record keeping;*
- dealing with disease outbreaks; and*
- treatments and use of chemicals.*

Indicator

- A Health Management Plan is developed and implemented for each site.
- Plan reviews occur on a regular basis incorporating Management and Environmental Monitoring Plan results where relevant.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	In order to ensure that fish farm operators are operating to the highest possible standards of welfare, all licensees should compile a written Health Management Plan and update it regularly. The plan should consider the following: <ul style="list-style-type: none"> • seasonal factors and stock planning; • cage preparation; • water quality management; • feed management; • fish health monitoring; • farm record keeping; • dealing with disease outbreaks; and • treatments and use of chemicals.
Code of Practice	Each farm should identify a specialist experienced in fish disease and medicine usage who is available to advise at short notice in case of disease outbreaks.
Code of Practice	Licensees should consult the <i>Aquavetplan</i> for information specific to each major disease specific to licensed species and incorporate this into the Disease Management Plans.
Code of Practice	Any person undertaking aquaculture is required to notify the Department of Fisheries of the presence of suspicion of any notifiable disease within 24 hours of becoming aware of any disease or condition that the person cannot identify or within 14 days, if the disease is identified but has not been eradicated.
Code of Practice	Mortalities should be removed, counted and recorded, and should where possible be identified by cause. Mortalities should be removed in accordance with the Health Management Plan.
Code of Practice	Mortalities should be handled and disposed of in a manner that minimizes the risk of disease transmission by exercising good hygiene procedures for themselves, their clothes and their operational equipment.
Code of Practice	Licensees should reduce the risk to fish health associated with birds and other predators by adherence to appropriate predator control measures, ensuring secure storage of mortalities and good feeding practice that minimizes waste.
Licence Condition	Licensees must notify the Principal Fish Pathologist of the Department of Fisheries within 24 hours of becoming aware of any disease or condition that the person cannot identify.
Licence Condition	Licensees must notify the Principal Fish Pathologist of the Department of Fisheries within 14 days of any disease outbreak that has been identified but not eradicated.
Licence Condition	Licensee must develop a Biosecurity Plan.
Management & Environmental Monitoring Plan	The Management and Environmental Monitoring Plan will include reporting on disease outbreaks over the previous year and actions taken. It should incorporate sections on: <ul style="list-style-type: none"> • fish health during the year; • specific disease outbreaks; and • treatments and use of chemicals.

Fisheries Management Response

- *Current*

The Department of Fisheries requires operators to notify the agency of any disease outbreak. This is imposed via regulations (the *Fish Resources Management Regulations 1995*).

- *Future*

Advise operators to develop a Health Management Plan. Guidance on development of such plans will be through the Code of Practice.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

Action will be taken if licensees do not report disease outbreaks as required under the *Fish Resources Management Regulations 1995* since this breaches licence conditions.

• **Stocking density/biomass**

Rationale for Inclusion and Identification of Management Authority

Determining an appropriate stocking density for both the species being farmed as well as the surrounding environment is fundamental to running a profitable, sustainable business.

ERA Risk Rating: Stocking density / biomass (C1 L2 LOW)

The primary management authority is the Department of Fisheries through aquaculture licensing and conditions, however specific limitations are not imposed – this is considered a management decision.

Operational Objective (plus justification)

Stocking densities optimize production, whilst minimizing impacts to surrounding areas.

Justification

Intensive fish farming requires high stocking densities and feeding rates, and produces a constant stream of organic waste. As farming of this kind generally occurs in sheltered water, the resulting enrichment of the sea floor in the immediate vicinity of the cage may result. This waste is of particular concern to the industry, which recognises the need to maintain a healthy environment for the fish thus ensuring productivity and commercial viability of the farm. There is further concern in the wider community that degradation of the local environment be minimized and farms should be closely monitored to determine the extent of impacts associated with the operations.

A suitable biomass depends on the species being farmed and the location of the cages. Stocking densities for salmon in Scotland used to be 25 – 30 kg/m³ however this was reduced to 15 kg/m³ in order to control disease and improve fish health. The stocking density for snapper grown in New South Wales ranges between 6 – 10 kg/m³. South Australia has a limit of 4 kg/m³ for southern bluefin tuna. Barramundi farming in Cone Bay WA has stocking densities ranging from 15 – 40 kg/m³. Land-based barramundi farming in Australia can be between 40 - 100 kg/m³. The differing feed conversion ratio for individual species is reflected in the large variation of cage biomass, as is the type of feed used and the environment over which the cages are placed.

As a general rule, stocking density should be adjusted in line with the biological and behavioural needs of fish with regard to the prevailing environmental conditions in addition to health and welfare, according to current biological understanding. The farming system used, in particular the feeding technology and the ability to maintain water quality, should also be an important

factor in determining stocking density. Stocking density should be based on a range of variables, of which water quality parameters are the most important. For marine salmon, the Scottish Code of Good Practice (2003) recommends that fish welfare indicators such as condition factor and fin condition should also be taken into account.

Indicator

- Stocking density is based on the fish species and the prevailing environmental conditions.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Stocking density should be monitored in relation to health, fish behaviour and water quality to ensure that fish welfare is not compromised, with immediate attention being given to any problems that arise.
Management & Environmental Monitoring Plan	The Management and Environmental Monitoring Plan will include criteria to monitor water and sediment quality, which provides early warnings of potential environmental impacts that could lead to a deterioration of fish health due to over-stocking. These include: chlorophyll a, dissolved oxygen (water column and bottom), nitrogen and phosphorous, total suspended solids and sediment redox.

Fisheries Management Response

- *Current*

The Department of Fisheries does not directly manage stocking densities, however encourages operators to maintain suitable stocking densities that do not impact on the environment.

- *Future*

Continue to assess the Management and Environmental Monitoring Plan results, detecting any impacts on the environment that may be a consequence of overstocking.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

If Management and Environmental Monitoring Plan results show that the environment is being impacted due to overstocking, then the Department of Fisheries may need to impose cage specific biomass limits.

• **Animal welfare**

Rationale for Inclusion and Identification of Management Authority

Understanding responsibilities in regard to animal welfare needs to be incorporated into the husbandry techniques used within any aquaculture facility.

ERA Risk Rating: (C0 L1 NEGLIGIBLE)

The primary management authority is the Department of Fisheries under the *Fish Resources Management Act 1994*.

Operational Objective (plus justification)

Aquaculture licensees operate in accordance with animal welfare principles.

Justification

Within Australia a number of documents have been produced that incorporate welfare issues, either as general principles of humane treatment detailing handling and killing of animals for food purposes. The benefits to the producer are greater acceptance in the market place and increased overall health and productivity of the animals being cultured. The physiological changes associated with chronic stress render the animal more susceptible to diseases, with implications ranging from increased chemical usage to depression of growth rates. Stress itself may also result in poorer feed use by the animals, thus producing poor feed conversion efficiency (National Aquaculture Council undated).

Consideration of animal welfare parameters both during growout and especially at the time of harvest can produce tangible improvements in quality of the final product. High levels of stress pre-harvest result in a greater depletion of muscle energy reserves and a more intense rigor mortis, a shorter time after death. Careful control of crowding combined with a method of harvest that minimizes time out of water and time to complete stunning, will result in associated improvement in flesh quality, processing performance and shelf life.

Indicator

- Licensees operate in accordance with animal welfare protocols.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Licensees should be aware of the National Aquaculture Council's <i>Aquatic Animal Welfare Guideline</i> .
Code of Practice	All equipment defects should be immediately rectified, or if not possible, measures taken to safeguard welfare.
Code of Practice	Removal from water and handling of live fish should only be carried out when absolutely necessary. Use of an approved anaesthetic will reduce stress to the fish during times where handling is required.
Code of Practice	Different species have different tolerance to time out of water but the time should not be so long as to produce signs of distress. Even for tolerant species, times should be reduced when the air temperature is particularly high or low. In all cases, fish should be kept wet unless drying is required to avoid contamination of gametes during stripping.
Code of Practice	Where pumps, pipes and grading equipment are used, these should be designed and correctly set up for the purpose and should not injure or unnecessarily stress the fish.
Code of Practice	Fish should be transported in a way that minimizes any possible impact on their welfare.
Code of Practice	Slaughter methods for fish for market should be appropriate to the species and result in rapid and irreversible loss of consciousness.

Fisheries Management Response

- *Current*

Fisheries and Marine Officers can enter any property to check on whether appropriate animal welfare protocols are being observed.

- *Future*

Aquaculture operators should comply with the Code of Practice and the National Aquaculture Council's *Aquatic Animal Welfare Guidelines*.

- **Predation**

Rationale for Inclusion and Identification of Management Authority

Fish farms in marine environments are exposed to a variety of predatory wildlife, which can cause considerable loss of fish. Effective control is site specific with reporting subject to legislation.

Predators such as birds, seals and sharks have the potential to be a problem around aquaculture facilities. If these predators are protected species, this may require a different management response.

ERA Risk Rating: (C1 L4 LOW)

The primary management authority is the Department of Fisheries through aquaculture license conditions and the Management and Environmental Monitoring Plan based on recommendations from the Department of Environment and Conservation. The legislative power resides in the *Wildlife Conservation Act* through the Department of Environment and Conservation.

Operational Objective (plus justification)

Predator management techniques must be planned and managed to minimize impacts on native fauna species while protecting the economic viability of the fish farm.

Justification

It is imperative for all finfish aquaculture operators to acknowledge that they share the waters with existing wild life. Marine animals, seals or birds should not be allowed to “gain reward” from the farming operation. The availability of food is a potent reinforcement for wild animals and will quickly lead to development of negative interactions between these animals and the operational activities of the fish farm. These can include predation of farmed fish, aggressive behaviour from animals to staff, alteration in natural behavior and reproductive outcomes.

Licensees should establish and implement a Wildlife Interaction Avoidance Strategy through their MEMP. This will ensure that staff are fully trained in the correct manner to interact with wildlife and are held accountable for their interactions with wildlife present in the area.

As part of this strategy, a monitoring and reporting policy should document all interactions with marine mammals and birds. This will include a daily record of the number of sea lions, cetaceans, birds or other animals in the area of the sea pens and will report any interaction between animals and staff or animals and aquaculture equipment immediately to the farm manager. Reporting against the strategy objectives will be through the MEMP.

The use of appropriate technology such as the polar circle cage and also the steel System Farm type of enclosure can also be considered to lower threats caused by predation. Specifications to the manufacturer should include that “sea lion proofing” is required.

Operators should use industry best practice for selection and management of sea pens; this includes size and shape of cages, mesh selection, net tension and stocking densities. Correct management of these parameters has been shown to eliminate predation of caged fish and the negative interactions associated with these learnt behaviours.

Sea cages should include well maintained bird exclusion netting. This excludes birds that may

be predatory on small fish, but, equally important, excludes opportunistic feeding by birds on feeds supplied to the cultured fish, predominantly if bait fish are used. These birds can have undesirable sanitary and maintenance implications on cage infrastructure and can transmit diseases to the cultured fish.

It is vital that there is no encouragement of opportunistic feeding of wild birds because of the negative impacts this can have on natural behaviour and ecology.

Wherever there is livestock, there is inevitably a small percentage of dead stock. Licensees must dispose of all mortalities from operations in a timely and responsible manner; in accordance with licensing conditions. Dead fish should not remain in cage structures, thereby removing the scent trail that will attract predators including sharks.

Indicator

- Appropriate predator control methods are installed at all aquaculture facilities.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Adequate preventative measures should be incorporated into all farms at the planning stage and monitored/reviewed for effectiveness.
Code of Practice	Fish farm operators should ensure that proper procedures are adopted to reduce the impact of predators on farmed stock.
Code of Practice	Proper installation and maintenance of bird exclusion netting should be undertaken to limit predation by birds.
Code of Practice	The quantity of feed delivered to farm fish should be based on regular fish body weight measurements (to establish biomass) and observations of fish feeding behaviour to ensure minimal feed remains uneaten by farm fish, therefore reducing the waste feed available to wild finfish.
Code of Practice	Operators should exclude predators by deploying nets or other systems designed for that purpose.
Code of Practice	All rubbish is to be placed in dedicated waste bins, which should have secure lids and be secured to the vessel or work platform.
Licence Condition	Licensees must immediately report any interactions with sea lions, whales or other protected species in distress, including entangled or stranded animals, to the Department of Environment and Conservation's Wildcare Hotline on (08) 9474 9055 (24-hour emergency number), the Department of Environment and Conservation Duty Officer, in addition to the local Department of Environment and Conservation District Office.
Management & Environmental Monitoring Plan	Record behavioural observations (such as schooling, aggression or feeding), types and approximate numbers of predator species daily around aquaculture equipment, including specific observations during fish feeding.

Fisheries Management Response

- *Current*

Applicants provide the Department of Fisheries with information through the assessment process which enables the Department of Environment and Conservation to consider whether adequate management responses have been adopted. Reporting of interactions between seals, whales and turtles to Department of Environment and Conservation under the *Wildlife Conservation Act* currently exists, however this may not always be a result of predatory behaviour.

- *Future*

Depending on the level of increased predation on aquaculture facilities, the existing reporting requirement may be adequate to manage the impacts. Providing guidance through a Code of Practice will assist operators limit the opportunities which initiate predator interactions.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

6.3.2.2 Use

- **Visual**

Rationale for Inclusion and Identification of Management Authority

The dominant visual issue for marine-based sites is likely to be from activities occurring at a distance of less than one kilometre from the site. This will be reduced if appropriate cage infrastructure is used.

ERA Risk Rating: (C0 L3 NEGLIGIBLE)

The primary management authority is the Department of Fisheries through aquaculture licensing, however specific conditions are not imposed – this is considered a management decision.

Operational Objective (plus justification)

Licensees will consider the implications of any changes to visual amenity from their proposal.

Justification

With the exception of navigational safety aids, operators should select subdued colours for materials used for flotation and floating structures. The use of dark or muted colours for buoys, markers, netting and other equipment will reduce visual impact, although use of some brightly coloured buoys may be required in certain instances.

Indicator

- Licensees incorporate appropriate infrastructure to reduce visual impact.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Farms should seek to minimize impacting visual amenity by ensuring appropriate consultation with local stakeholders during project development.
Code of Practice	Local communities should be surveyed to determine existing resource use patterns and whether there are specific areas where the facility should not be located.

Fisheries Management Response

Current

There is no formal guidance on how to consider visual amenity impacts, with decisions to approve new applications reliant on information provided by the applicants or submitted by the public during the consultation phase.

Future

Applicants should be informed on how to consult with local communities to determine locations.

- **Energy**

Rationale for Inclusion and Identification of Management Authority

It is important for new facilities to consider future energy consumption and what is its energy efficiency rating. Marine-based sites use power for automated feeders, lighting and water pumps. Some operators utilise barges for hatcheries which will require the use of a generator to maintain water flow.

ERA Risk Rating: (C1 L1 LOW)

The primary management authority is the Department of Fisheries through aquaculture licensing, however specific conditions on energy usage are not imposed – this is considered an operational decision.

The aquaculture sector needs to manage its carbon use in order to remain competitive in overseas markets. Tools are required to enable the sector to assess its carbon footprint and to develop adaptation and market strategies in order to meet the carbon management and reporting objective.

Operational Objective (plus justification)

Operators will consider alternative energy sources in the design of new and existing facilities.

Justification

Western Australia is a vast state with a limited ability to provide additional power infrastructure. Marine aquaculture has small power needs with most energy requirements being for land-based support facilities. At present the need to consider alternative energy sources is small, however with the growing concerns about use of fossil fuels and the potential introductions of carbon trading schemes, aquaculture operators should investigate potential sources that are renewable. These alternative sources are currently based around solar or wind power but could be expanded in future years to include bio-fuels.

A large proportion of the cost in running vessels accessing the site is diesel and any rise in fuel costs can have significant implications on the profitability of all marine sectors. Operators could also consider the use of wind or solar energy to power cold storage for feed.

Indicator

- The use of alternative power sources is considered by operators.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Responsible energy management should involve licensees being daily aware of energy use and patterns and monitor annual and quarterly energy expenditure.
Code of Practice	Licensees should isolate and remedy energy waste actions and minimize unnecessary boat usage.
Code of Practice	Licensees are encouraged to use alternative power sources, including solar and wind power.
Code of Practice	Licensees should consider their carbon consumption when planning operations (inputs and outputs).

Fisheries Management Response

- Current

In an effort to measure, quantify and report in a way that consumers can understand, there has been some very crude attempts at quantifying the carbon impact caused via the production of goods or services. The most widely recognised of these attempts is “food-miles”, a concept relating to the distance food travels as a measure of its impact on the environment. However, this concept – which only includes the distance food travels – is misleading, as it does not consider total energy use or indeed any other factors that impact on the environment through the production of the food.

- Future

The Department of Fisheries recently commenced a project titled the ‘Carbon Management and Reporting Initiative’, which will involve a set of work package activities that will address how the Australian seafood industry can carbon-manage their enterprises competitively in the global marketplace.

The resultant tools, comprising case studies, policies, guidelines and indices, will assist fisheries managers, industry (primary production, processors, sellers) and goods and service providers to develop carbon-management adaptation and market strategies. In an adaptation strategy context, this will mean the development of strategies to measure, mitigate, monitor and report on carbon-management and provide the basis for the potential development of an aquatic-based carbon offset facility in the future.

• Noise

Rationale for Inclusion and Identification of Management Authority

It is important to consider whether the operation of the facility includes noisy machinery (e.g. pumps) or devices (e.g. bird scarers) and would such activities affect neighbours or sensitive fauna.

ERA Risk Rating: (C2 L3 LOW)

The primary management authority is the Department of Environment and Conservation, however specific conditions are not imposed. Ongoing observation of the *Environment Protection (Noise) Regulations* is required.

Operational Objective (plus justification)

Licensees operate in accordance with the *Environment Protection (Noise) Regulations*.

Justification

Noise often attracts attention and may lead to user conflicts. Efforts to improve the productivity and efficiency of aquaculture can lead to an increased reliance in motorized equipment, resulting in incidental noise generation. Some noise can travel considerable distance from the farm site, so, where possible, farmers should employ sound-suppression devices such as mufflers, baffles and barriers on operating equipment. Vessels should be maintained and equipment kept in good working order to minimize noise levels. Operating vehicles and boats at appropriate speed limits will also assist in noise reduction.

Indicator

- Aquaculture operators minimize noise emissions from operations.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Farmers should ensure that equipment that creates noise (e.g. air blowers, generators) is suitably muffled to prevent unacceptable disturbance to wildlife or humans. Local government should be consulted for advice if necessary.
Code of Practice	Operators should be aware of and observe the Noise Regulations under the <i>Environment Protection Act</i> .
Code of Practice	Operators should minimize noise disturbance to cetaceans, seals and turtles from operations. Although active deterrent devices such as 'Seal Crackers' can be effective, operators should avoid using them due to the impacts these devices can have on other marine species.
Code of Practice	Licensees should operate vehicles and boats at appropriate speed limits to assist in reducing noise emissions.

Fisheries Management Response

- *Current*

The Department of Fisheries does not have statutory responsibility in this area, however regulations under the *Environment Protection Act 1986* provide powers to the Department of Environment and Conservation irrespective of any specific licence condition attached under the *Fish Resources Management Act 1994*.

- *Future*

The Department of Fisheries will provide guidance through the Code of Practice, however legislative force remains under the *Environment Protection Act 1986*.

• **Escapement**

Rationale for Inclusion and Identification of Management Authority

The environmental risks associated with escapes differ depending on the type of system used, the species farmed, the scale and intensity of the operation, and the management practices employed. Primary risks are associated with the aquaculture of non-native species, which is not being considered in Western Australia.

ERA Risk Rating: (C1 L4 LOW)

The primary management authority is the Department of Fisheries through aquaculture license conditions and regulations.

Operational Objective (plus justification)

Aquaculture operations are managed to minimize the risk of escapes.

Justification

Finfish aquaculture systems in marine waters are comprised of cages which are prone to damage from storms, predators, human error or other causes (Marine Aquaculture Task Force 2007). Once damage has occurred, whether it is a small hole torn in a cage by a shark or damage caused by a collision with a boat, the organisms inside the cage are capable of escaping. These

escapes are costly for the farmer and it is generally in their best interest to protect, as much as possible, against escapes.

Another type of escape is the release of gametes into the environment. This type of escape can be associated with the aquaculture of shellfish and not finfish, as the fish are normally harvested prior to reaching maturity.

The escape of culture species may pose a variety of potential risks including pathogen transmission, interbreeding with conspecifics and introgression of alleles, competition for resources, predation, colonisation or disruption and damage to commercial and recreational industries, including aquaculture (Tucker and Hargreaves, 2008). For the species farmed in WA, these outcomes have neither occurred nor are likely to occur because:

- producers have a strong economic incentive to prevent escapes of culture animals;
- most pathogens are naturally occurring and ubiquitous;
- all species are culture in the native range; and
- State agencies have implemented legislation and policies to prevent, control, manage or mitigate potential impacts in this area.

Indicator

- Aquaculture licensees will minimize the likelihood of fish escapes.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Operators should have site-specific contingency plans that describe actions to be taken in the event of any escapes. Guidance on what needs to be done in the event of an escape is provided in the <i>Fish Resources Management Regulations 1995</i> . The use of any recapture nets requires authorisation of the Chief Executive Officer of the Department of Fisheries.
Code of Practice	Licensees must follow local, state and federal Regulations governing animals that may be imported, cultured or sold under authorisation.
Code of Practice	Operators should use best management practices to prevent escapes including obeying regulations, consider the effects of the sites (frequency of storm events, degree of exposure), minimize risks during fish transfers, use strong and durable materials for cage construction, and regularly inspect and adjust the infrastructure.
Licence Condition	Licensees must report all fish escapes to the Chief Executive Officer of the Department of Fisheries, as well as to the Department's regional office, within 24 hours.
Licence Condition	(<i>For barramundi</i>) The proponent must ensure that the main cage is: <ul style="list-style-type: none"> a) constructed of net of a mesh size, type and quality that will reliably provide a complete barrier that will retain 100 per cent of the fish stocked in the cage; b) of a mesh size between 2.5 - 22.5 cm stretched mesh size, depending on the size of the fish to be contained; c) does not contain holes or openings greater than 1.5 times the size of the net mesh; d) constructed so that the cage netting extends no less than 50 cm above the water line, or is secured by overhead netting to prevent fish escape by jumping; and is e) fitted with predator exclusion or reduction devices.

Licence Condition	<p>(For barramundi) The proponent must ensure that netting installed to deter predators is:</p> <ul style="list-style-type: none"> a) constructed of a mesh that uses cord greater than 2 mm in diameter; b) of a mesh size between 2.5 - 22.5 cm stretched mesh size, depending on the size of the fish to be contained; c) constructed so that the cage netting extends no less than 50 cm above the water line, or is secured by overhead netting to prevent fish escape by jumping; d) does not contain holes or openings greater than 1.5 times the size of the net mesh; and e) hung from the main cage a minimum distance of 30 cm.
--------------------------	---

Fisheries Management Response

- Current

Condition imposed on aquaculture licenses, requires the licensee to notify the Chief Executive Officer of the Department of Fisheries within 24 hours of becoming aware of any escape events.

- Future

Existing arrangements are managing this issue – should the industry fail to comply with these reporting requirement, there may be a need to increase any prosecution and/or fines.

- Actions if Performance Limit exceeded

Should licensees not report fish escapes to the Department of Fisheries, they are liable to be prosecuted for breach of a licence condition.

• Habitat effects

Rationale for Inclusion and Identification of Management Authority

This is the principle issue of interest to environmental regulators such as the Department of Environment and Conservation. Topics of interest include water and sediment quality, as well as benthic habitats (seagrass, corals and mangrove habitats as the key ecosystems).

ERA Risk Rating: (C2 L2 LOW)

The primary management authority is the Department of Fisheries through aquaculture licensing conditions and requirements are imposed on a site-specific basis to manage and monitor any likely impacts from the facility on adjacent habitats.

Operational Objective (plus justification)

Aquaculture facilities will avoid adverse impacts on habitats outside the licensed area.

Justification

Department of Environment and Conservation/Environmental Protection Authority policies require that the cause-effects pathways be identified during any environmental impact assessment. A better understanding of pressure-response relationships for key environmental receptors such as water, sediment and benthic habitats, enhances capabilities in completing environmental impact prediction, assessment and ongoing management/regulation. The characterisation must incorporate water and sediment quality, and the types, distribution and condition of benthic habitats.

It is acknowledged that nutrient related effects cannot be measured by concentrations in water or sediments and it is difficult to detect any change as a consequence of natural systems being highly variable. Therefore, the identification of the first/initial response that is detectable in the environment due to nutrient additions (in this case aquaculture waste) needs to be monitored.

The provision of scientific information to support the development of a practical early warning indicator of potential eutrophication has commenced in Western Australia. It is intended that indicators would be applied as an Environmental Quality Guideline (EQG) within the Environmental Quality Management Framework developed by the Department of Environment and Conservation. It is intended that the Environmental Quality Guideline would lie along a conceptual pathway that describes how key ecosystem attributes (eg. seagrass meadows and algal reefs) are affected by nutrient enrichment from aquaculture.

The intent of the Environmental Quality Guideline is to provide a basis to establish whether or not ambient conditions are such that there is the potential for habitat impacts to be stimulated relative to what would be expected under 'normal' conditions (i.e. utilising a reference vs impact site approach). If the Environmental Quality Guideline is not triggered then this would signal a low risk of a nutrient-related problem. If nutrients are found to be elevated, further investigations would be triggered to assess responses of key ecosystem attributes (e.g. algal-dominated reefs, seagrass meadows) that might be threatened further along the conceptual cause-effect pathway.

In this framework, exceeding the Environmental Quality Guideline is not intended to indicate an impact, rather it is intended to signal the 'potential' for an impact to be occurring. The further investigations triggered by the exceedance would be focussing on assessing environmental quality against an Environmental Quality Standard utilising a 'multiple lines of evidence' risk-based approach. Exceeding an Environmental Quality Standard would signify an unacceptable risk to the key ecosystem attribute and require the implementation of a management response.

From the licensees' perspective, they are required to establish and maintain an Management and Environmental Monitoring Plan which sets out the monitoring and management obligations in relation to the various Environmental Quality Standards. These form the criteria in the Management and Environmental Monitoring Plan against which the licensee must report each year.

Indicator

- Aquaculture licensees manage their operations to minimize impact on adjacent habitats.
- Aquaculture licensees will implement and report annually on the MEMP.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Licensees must manage the site to ensure no unacceptable impacts are detectable outside the licensed area. If any negative impacts are recorded, then appropriate management strategies must be implemented.
Code of Practice	Environmental monitoring must be carried out to ensure that surrounding habitats are not prejudiced. The parameters measured and the monitoring interval may be varied, depending on the system, species and stage of development.
Code of Practice	Licensees must operate the farm to minimize the impacts within the sites as much as possible.
Code of Practice	Should any parameters depart from the acceptable range, steps shall be taken to identify the problem and effect a remedy as soon as possible.

Licence Condition	Licensees will prepare and implement an agreed Management and Environmental Monitoring Plan. The licensee will use the Department of Fisheries Finfish Aquaculture Management and Environmental Monitoring Plan template or develop an Management and Environmental Monitoring Plan of a comparable standard to be signed off by the Department of Fisheries/ Department of Environment and Conservation/Environment Protection Authority, as necessary. This plan must be finalized prior to any stock being placed on the site.
Licence Condition	Before 31 July of each year, the licensee must submit the Management and Environmental Monitoring Plan report, which includes a copy of all results to July 1 of that year, to the designated Department of Fisheries' regional office and copied to the Chief Executive Officer of the Department of Fisheries.
Management & Environmental Monitoring Plan	The Management and Environmental Monitoring Plan will identify the potential risks, detail the environmental values against which the risks will be compared and outline appropriate management strategies. A component of the monitoring program for water quality, sediment quality, primary producer health and benthic impacts (chemical and fauna) will be set out.
Management & Environmental Monitoring Plan	Water and sediment quality will be evaluated by comparing concentrations of nutrients with Environmental Quality Standards. Certain standards will be tentative where a detailed data set is not available and others will be based on previous studies.
Management & Environmental Monitoring Plan	Proponents will designate the location of the 'impact' site and the corresponding 'control' sites, of which there should be at least three. These will be agreed to in writing by the Department of Fisheries.

Fisheries Management Response

- *Current*

An interim Management and Environmental Monitoring Plan has been developed and agreed to by both the Department Fisheries and the Department of Environment and Conservation. This incorporates monitoring activities to identify when trigger values for the Environmental Quality Standards are breached and appropriate management responses that will be taken by licensees.

The interim finfish Management and Environmental Monitoring Plan will be imposed on each license authorized for marine finfish species incorporating annual reporting, with the final Management and Environmental Monitoring Plan available after 2010.

- *Future*

The Department of Fisheries is commencing a major environmental project that will monitor existing finfish aquaculture operations to identify cause-effect pathways for key ecological receptors, characterize discharge characteristics for key aquaculture finfish species and synthesis assimilative capacity models. This project will ultimately identify parameters for monitoring impacts on key habitats that will be monitored as part of the finfish Management and Environmental Monitoring Plan after 2010.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

Breaches of Environmental Quality Standards and related trigger values in the first instance will require reporting to the Department of Fisheries, where an appropriate management response

will be discussed. Should the response not resolve the breach, then the site may need more radical responses, such as lowering stocking levels, moving the site or de-stocking totally.

The Department of Environment and Conservation can take formal action under the *Environment Protection Act 1986* should operators fail to remedy the breach, resulting in legal action being taken against operators.

- **Chemicals/therapeutants**

Rationale for Inclusion and Identification of Management Authority

A variety of chemicals may be used in the finfish aquaculture industry to treat and/or control various diseases, parasites or to facilitate production. Use of chemicals necessarily involves user responsibility for any or all methods of safe handling. Use is managed in accordance with industry-wide protocols and this ensures consideration is given to the ramifications on the environment.

ERA Risk Rating: (C2 L3 LOW)

The primary management authority is the Australian Pesticides and Veterinary Medicines Authority, with any aquaculture use protocols considered by the Department of Fisheries under the *Fish Resources Management Act 1994*. Use is not permitted without prior approval so in effect an industry-wide protocol already manages facility level usage. Licensees must be aware of and operate under this framework.

Operational Objective (plus justification)

No unacceptable changes to the receiving environment as a result of chemical and medicinal usage.

Justification

It has been suggested (Marine Aquaculture Task Force 2007) that the use of drugs or other chemicals to treat diseases should be considered in emergency situations and only after all other avenues have failed. There are environmental risks associated with the use of drugs, especially in open systems. It has been found that the use of large amounts of antibiotics in aquaculture, often in a prophylactic manner, has resulted in the emergence of antibiotic resistant bacteria in aquaculture environments; an increase of antibiotic resistance in fish pathogens; in the transfer of these resistance determinants to bacteria of land animals and to human pathogens; and an alteration of the bacterial flora both in the sediments and in the water column.

Vaccines offer a way for the aquaculture industry to prevent disease in stocks without the use of chemicals that ultimately end up in the marine environment. In addition to their role in preventing disease outbreaks and therefore the potential spread of disease, the use of vaccines in aquaculture could lead to reduced use of therapeutic chemicals.

Indicator

- Where required, all chemicals or therapeutants are approved prior to use.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	A veterinary health plan that outlines biosecurity protocols, preventative measures and treatments (for example vaccination, fungus control, lice control etc.) should be prepared. Where treatment is necessary it should be initiated without delay to ensure good welfare and medicine management.
Code of Practice	A veterinary prescription is required for all prescription-only medicines. In the case of in-feed medicines, this must be provided by a Medicated Feeding Stuff prescription.
Code of Practice	Accurate information should be provided to the attending veterinary surgeon so that correct dosages can be calculated for the fish concerned. Ensure that clear instructions for medication, dosage and administration are obtained and are communicated to the staff responsible for treatment.
Code of Practice	The recommended course of treatment at the correct dosage should always be completed. In the event of the inability to complete the course due to adverse weather conditions or where fish welfare would be compromised, treatment may be terminated. Where treatment is terminated early, this should be recorded, and advice sought from the veterinary surgeon.
Code of Practice	To ensure the end of medication is accurately determined, the feed bin or hopper should be cleaned to avoid contamination of non-medicated feed.
Code of Practice	All requirements for medicine withdrawal periods to the slaughter for fish for human consumption must be complied with. In general, the withdrawal period is specified on the Medicated Feeding Stuff prescription or advised by the veterinary surgeon.
Code of Practice	Extra-label use of drugs for aquatic animals in sea cages is prohibited, unless the drug is specifically approved for aquaculture use.
Code of Practice	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.
Code of Practice	Operators should be able to demonstrate that fish harvested for human consumption are free of unacceptable residues of all of the veterinary medicines and treatments used in their production
Licence Condition	Licencees will notify the Principal Fish Pathologist prior to any chemical and therapeutic drug usage.
Licence Condition	Licencees must record and report all instances of chemical and therapeutic drug usage.
Management & Environmental Monitoring Plan	<p>Details of all treatments used will be incorporated in the Management and Environmental Monitoring Plan. Each report will describe:</p> <ul style="list-style-type: none"> • the involvement of the nominated veterinary surgeon; • the justification for the use of the treatment; • the nature of the treatment used; • the circumstances under which fish are treated; • official controls on the use of treatment including any discharge into the environment, which must be covered under any Consent; and • any measures in place to prevent unacceptable residues of the treatment substance remaining when the fish are harvested.

Fisheries Management Response

- *Current*

All intended use of chemicals requires registration of the chemical by the Australian Pesticides and Veterinary Medicines Authority. This is being reviewed in 2009.

- *Future*

Should the industry face an increased risk of disease requiring the use of chemical and therapeutants, the regulators will firstly need to reconsider existing management arrangements.

- *Actions if Performance Limit exceeded*

Should existing arrangements prove insufficient to manage chemical usage, there may be a need to introduce specific regulation under the *Fish Resources Management Regulations 1995*, if appropriate.

• **Entanglements/interactions**

Rationale for Inclusion and Identification of Management Authority

Most interactions are likely to be predatory in nature, however entanglements of whales, seals, dolphins and turtles can be avoided if best farm management practices are implemented.

ERA Risk Rating: (C3 L1 LOW)

The primary management authority is the Department of Fisheries through aquaculture license conditions, however specific requirements are imposed through the Management and Environmental Monitoring Plan, such as reporting to the Department of Environment and Conservation any interactions with protected /listed species. If the operation is outside of state waters, then reporting on any interaction is to the relevant Commonwealth agency.

Operational Objective (plus justification)

Aquaculture will minimize the potential for entanglements and interactions with infrastructure.

Justification

Aquaculture facilities are attractive to predatory and scavenger species such as pinnipeds, dolphins, sharks, turtles and birds as a result of the concentration of potential food sources. Pinniped species around the world have similar behavioural patterns toward human intervention in their habitats and can over-integrate with human activities, becoming a danger to themselves. Some individuals have become 'rogue' animals around salmon aquaculture, such as in Tasmania, requiring relocation by the authorities to other rookeries.

Pinnipeds are known to eat fish through slack nets and to bite holes in nets creating avenues of escape and thus can adversely affect finfish aquaculture. Drowning after containment in or around cages is the main risk to pinnipeds with individuals becoming trapped in netting when it folds in response to current or wave action. Modern cage technology has significantly reduced this risk with cage walls being kept more rigid and taut. Cages structures have also removed the potential for hauling out onto walkways.

Shark and crocodile interactions are rare, however this may be due to a combination of under-reporting and the absence of farms within their habitats.

Whales are known to frequent the Western Australian coast during migration and although they do not have a predatory or scavenger interest in the farm, they do have the potential to become entangled within the infrastructure, particularly mooring ropes. Cages are unlikely to be of concern since they are large and easily seen, however ropes, if slack, can become entangled around the tail fluke.

Operators are required to develop and implement proactive and reactive management responses,

incorporating these strategies into the Management and Environmental Monitoring Plan. Operators should have set protocols for dealing with entanglements and/or interactions that can be easily implemented when required. Advice is available from the Department of Environment and Conservation on the correct handling or actions to be taken. As a basic practice, mortalities should be removed on a daily basis to limit the attraction of predators.

Other management practices that can be considered are to vary the timing of farm operations, use of predator nets or other barriers, use of acoustic deterrence devices and/or the introduction of more frequent periodic visits to site during the increase potential for entanglements i.e. whale migration time. Deterrent devices can include tape recordings of underwater boat noise played through hydrophones, propane cannons, and tape recording of animals that prey on the predator species. These types of devices are not currently used in WA.

Indicator

- Aquaculture incorporates management strategies to avoid entanglements and interactions with wildlife.

Performance Measures (Code of Practice/ Licence Condition/MEMP)

Code of Practice	If an animal is found entangled in aquaculture equipment, the operator will review the cause of the entanglement and farm practices will be adjusted accordingly so as to reduce the likelihood of further entanglements.
Code of Practice	Licensees should draft and implement a Wildlife Interaction Avoidance Strategy to minimize the causes and incidences of entanglements or interactions. Reference could be made to the Aquaculture Council of Western Australia's <i>Code of Practice for Whale Interactions</i> (2006).
Code of Practice	Feed regimes should limit the amount of waste feed and thereby lessen the attraction of predators to cages.
Code of Practice	Licensees should keep all infrastructure in good order and avoid unnecessarily loose nets and ropes. Bird and predator netting should be highly visible (i.e. of sufficient twine diameter and not monofilament) and of a mesh size that reduces the risk of entanglement.
Licence Condition	Immediately report any entanglement or interactions between the infrastructure and protection species to the Department of Environment and Conservation's Wildcare Hotline on (08) 9474 9055 (24-hour emergency number), the Department of Environment and Conservation's Duty Officer on (08) 9334 0224, in addition to the local Department of Environment and Conservation's district office.
Management & Environmental Monitoring Plan	Licensees must include a summary of each incident within the Management and Environmental Monitoring Plan as part of the annual report.

Fisheries Management Response

- *Current*

Licensees must report any interactions or entanglements. The *Wildlife Conservation Act 1950* provides legislative protection to certain species and any interactions between aquaculture infrastructure and these protected/listed species must be reported as soon as the operator is made aware. The Department of Environment and Conservation is responsible for the enforcement of this legislation and provides ongoing assistance in rescuing protected species around the state.

- *Future*

No further legislation or management is required in this area. Depending on the response by aquaculture licensees to reporting instances, this could be reconsidered.

- *Actions if Performance Limit exceeded*

Any non-reporting may result in prosecutions under the *Wildlife Conservation Act 1950*.

• **Land-based use of water**

Rationale for Inclusion and Identification of Management Authority

The need for support facilities on land will include access to freshwater - this may or may not be limited in supply.

ERA Risk Rating: (C1 L2 LOW)

The primary management authority is the Department of Water through water licensing.

Operational Objective (plus justification)

Aquaculture operations requiring land based support facilities have access to freshwater supplies.

Justification

Land-based support facilities for marine aquaculture are required for office space, storage of feeds and equipment, equipment wash-down as well as maintenance and washing down of cages and nets.

The Department of Water has some requirements for determining maximum allowable water use as certain regions may have stricter controls on the use and access to water. These assessments are made after formal applications are received and assessed by the Department on a case-by-case basis.

The use of bore water could be more appropriate in certain locations. Facilities need to be licensed to extract water from bores and assessments consider the draw-down on aquifers as well as impacts on groundwater tables.

Licensees must be aware of their responsibilities under any water licensing agreement and report water usage as required.

Indicator

- Aquaculture operations requiring access to freshwater maintain the necessary approvals.
- Licensee report water usage as required.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Licensees seeking access to freshwater must approach the Department of Water to obtain the necessary authorization for water quota.
Code of Practice	Licensees should minimize freshwater usage as certain regional areas may have restricted water resources.

Fisheries Management Response

- Current

Maintain the current Department of Water's assessment protocols for water licensing under the *Rights in Water and Irrigation Act 1914*.

- Future

Depending on future water requirements, there is no need to change existing arrangements.

- Actions if Performance Limit exceeded

Actions can be taken by the Department of Water if operators over-draw on their water allocation licence.

• Lights

Rationale for Inclusion and Identification of Management Authority

Lighting around marine finfish farms is primarily required for navigational purposes, but this is unlikely to be much of an issue in regards to impacting sensitive species. Some overseas aquaculture facilities are investigating the use of underwater lighting to increase growth rates of the fish but this is not being considered at present in WA.

ERA Risk Rating: (C0 L1 NEGLIGIBLE)

The primary management authority is the Department of Fisheries through aquaculture licensing conditions. Navigational lighting requirements are based on recommendations from the Department of Planning and Infrastructure (Marine Safety) but is covered under 6.3.1.7.

Operational Objective (plus justification)

Licensees install and use appropriate lights to minimize impacts on sensitive species.

Justification

Dr Col Limpus, an Australian sea turtle behavioural expert for the Queensland Environmental Protection Agency provided advice regarding the effect of navigation lighting on sea turtle behaviour. Dr Limpus concluded: "As long as there is intermittent light where the ON pulse is shorter than the OFF pulse (such as lights used to mark aquaculture sites), lights are not disruptive to turtle behaviour. This applies to green turtles, hawksbills, loggerheads and flatbacks". Dr Limpus went on to say that bright flashing lights have been used to mark pedestrian beach access tracks for the many thousands of tourists at the Mon Repos turtle rookery in Queensland for the past 20 years without any impact or effect on loggerhead turtle behaviour. In addition, a lighthouse navigation light on an important hawksbill nesting island in the Northern Territory was in 1992 converted from a bright rotating light to a very bright flashing pulse light, and the turtle hatchlings on the island were not disorientated by this. The colour of the light does not apparently make a difference either.

The issue of lights from vessels has been raised as an issue for birds and operators should consider keeping lighting levels as low as possible to minimize this risk.

It is difficult to make any statements on the use of such things as underwater lighting since no-one in Australia is using them and studies into their environmental impacts are lacking. Until lights are considered in this context, it is not possible to determine any performance measures.

Indicator

- Lights on aquaculture sites do not impact sensitive species.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	The use of surface and submerged lights on cages should be installed and/or shielded to direct the light only to where it is required.
Code of Practice	Optimum lighting patterns for fish welfare should be determined by practical experience, research outputs and specialist advice.
Code of Practice	Sudden changes to lighting levels should be avoided wherever possible.

Fisheries Management Response

- *Current*

There are no management arrangements currently dealing with lighting on aquaculture facilities.

- *Future*

Lights can be regulated via Section 49 of the *Environmental Protection Act 1986* as an 'unreasonable emission' of electromagnetic radiation, if required.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

Licenses installing inappropriate lights which impact sensitive species can be prosecuted.

• **Gear and equipment movement**

Rationale for Inclusion and Identification of Management Authority

Protocols to manage the movement of equipment between farms are needed and must reflect protocols developed at the whole-of-industry level.

Transportation of aquaculture equipment should operate under agreed guidelines to minimize any occurrence or possibility of transfer of marine pests. The view is that it is unlikely that this will be a big issue when transporting equipment between regions since policies are in place or being developed inline with the *Biosecurity and Agriculture Management Act 2007*. It is more of a concern for movement of equipment between states.

ERA Risk Rating: (C3 L4 MODERATE)

The primary management authority is the Department of Fisheries through its translocation policy, however this will fall away once the *Biosecurity and Agriculture Management Act 2007* and associated subsidiary legislation are enacted.

Operational Objective (plus justification)

Movement of aquaculture equipment in and around WA does not increase biosecurity risks.

Justification

Non-indigenous marine organisms (including plants, animals and plant and animal diseases) may be introduced or translocated by a variety of vectors, including ballast water, biofouling of vessels and equipment, aquaculture operations and aquarium imports. Introduced marine organisms represent major threats to native biodiversity and ecosystem integrity and may cause significant long-term social, cultural and economic impacts. The introduction of non-indigenous marine species and diseases to new environments has been identified as one of the greatest threats to the world's oceans.

Western Australia recently developed new biosecurity legislation in the form of the Biosecurity and Agriculture Management Act 2007, which was passed by Parliament in September 2007. The Act will come into force in stages through 2008, as the relevant subsidiary legislation is gazetted and administrative arrangements are completed. Some of these provisions will apply to the movement of aquaculture equipment within WA but exact details will be dependent on the final wording of the relevant subsidiary legislation.

The biosecurity provisions of the Biosecurity and Agriculture Management Act 2007 are aimed at preventing plant and animal pests and diseases from entering Western Australia (border security) and at managing those that are found in Western Australia to minimize their spread and impact (biosecurity within WA). The new Act will be Western Australia's primary biosecurity legislation and the primary regulatory framework to manage plant and animal pests and diseases that may affect the environment, industry and the economy or public safety and amenity.

Within Western Australia, the Department of Fisheries has been appointed as the lead agency for the management of biosecurity, pest animals and plants as well as animal and plant diseases, for fish (as defined under the Fish Resources Management Act 1994 and including pearl oysters) and the aquatic environment (i.e. all marine and other waters and the seabed within the limits of the State). These new responsibilities for aquatic biosecurity compliment already existing biosecurity programs undertaken by the Department that support the management of non-endemic species for aquaculture, commercial and recreational fishing stock enhancement, the aquarium industry, educational, as well as research and development purposes.

Prevention of new incursions by the management of vectors to minimize the risk of introduction and translocation is by far the best approach when it comes to managing non-indigenous marine organisms and better enables protection of Western Australia's marine environment and industries dependent on marine resources. Stopping plant and animal pests and diseases being introduced to Western Australia and also being translocated from one location to another within Western Australia is far more effective than trying to deal with them after they have established. By the time a new invasive organism is detected, the chances of successful eradication are low, and efforts must then focus on containment and management with considerable social, economic and ecological cost. It is therefore important that appropriate biosecurity management strategies and protocols are developed and implemented.

Australian Government, State and Northern Territory government agencies, as well as marine industries, scientists, and conservation agencies, are working to develop a National System for the Prevention and Management of Marine Pest Incursions. Best Practice Guidelines are being developed to minimize biofouling and reduce the risk of marine pests being introduced into or translocated within Australia for all marine sectors, including: commercial fishing, aquaculture, recreational vessels, international yachts, commercial trading and non-trading vessels, vessels associated with the petroleum industry, illegal entry vessels and foreign fishing vessels as well as ports, marinas and slipways. Commonwealth and State legislation is also

being developed that will ensure that the discharge of internationally-sourced and domestic-sourced ballast water is subject to agreed measures to minimize the risk of introducing or translocating marine pests through ballast water.

Once both the Biosecurity and Agriculture Management Act 2007 and its associated regulations are enacted, they will govern the movement of equipment and fish around Western Australia. Any proponent will need to be aware of how this legislation will affect their business.

Any licensing arrangements for imposing specific requirements as part of the Biosecurity and Agriculture Management Act 2007 cannot be imposed with the other prescribed licence conditions under the Fish Resources Management Act 1994 and must be imposed via a separate signed document. This will be developed once the legislation is finalised.

Indicator

- Aquaculture licensees operate within the provisions of existing biosecurity protocols.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Licensees must seek approval under the <i>Biosecurity and Agriculture Management Act 2007</i> for all movements of aquaculture equipment into and around WA. Movements within a region will be considered on a case-by-case basis, depending on the distance covered. This is not required for new cages, as the risk of translocating marine pests is not present.
Code of Practice	All current health and safety guidelines must be followed at all times, as disinfectant in higher concentrations can be dangerous to personnel.
Code of Practice	Surfaces and equipment should be thoroughly cleaned, with detergent if necessary, to remove any grease or fats prior to disinfection, as the presence of organic material during the disinfection process impairs the effect of the disinfectant. Much infectious material may be removed or inactivated at this important stage.
Code of Practice	All visible organic material should be removed, using detergent if necessary. These methods should comply with an agreed protocol based on manufacturers' instructions.
Code of Practice	Operators should minimize the risk of horizontal transmission of disease by avoiding simultaneous carriage of waste and fresh feed onboard vessels.
Code of Practice	Used nets should be transported in sealed containers. They should be tagged and logged on arrival at the designated dirty area of a net washing station to ensure they are kept separate from clean nets.
Code of Practice	Operators should consider the benefits of immersing nets in sodium hypochlorite solution at a concentration of 1,000 mg/l for six hours (or an alternative equally effective disinfectant at the appropriate concentration) then rinsed with fresh water. The sodium hypochlorite solution must be agitated to ensure an even concentration of hypochlorite. If nets are very heavily fouled the sodium hypochlorite concentration can be increased to ensure the presence of at least 5 mg/l active free chlorine after six hours.
Code of Practice	All removable items, including cage nets should be cleaned and disinfected according to the appropriate procedures. As a minimum, cages, barges, etc, should be scraped clean, using divers if necessary, and disinfected down to and including the waterline. The rest of the structure should be left to fallow for at least four weeks.

Code of Practice	Operators should consider removing all organic debris from diving suits and equipment with an appropriate detergent and rinsed in clean water. They should then be immersed in freshwater containing iodophor (minimum 100 mg/l free iodine) or an equally effective disinfectant for 20 minutes. Alternatively, gear should be heat treated by immersing equipment in clean freshwater so that the gear is maintained at a minimum of 55°C for at least five minutes.
Licence Condition	Licence conditions will be determined once the <i>Biosecurity and Agriculture Management Act 2007</i> and its associated regulations are finalised.

Fisheries Management Response

- *Current*

The management authority is the Department of Fisheries via translocation approvals. The WA Government is formalising regulations under the *Biosecurity and Agriculture Management Act 2007*. This direction supports voluntary guidelines developed by the National Introduced Marine Pests Coordinating Group.

- *Future*

Once both the *Biosecurity and Agriculture Management Act 2007* and its associated regulations are enacted, they will govern movement of equipment and fish around Western Australia.

- *Actions if Performance Limit exceeded*

Regulations will set down prosecution provisions once finalized.

6.3.2.3 Waste

- **Water quality**

Rationale for Inclusion and Identification of Management Authority

Any wastewater discharged into the marine environment from aquaculture operations must be of an acceptable level and in line with the State Water Quality Management Strategy. Proponents must demonstrate they will monitor and manage the water quality within their site to ensure impacts do not occur outside of the licensed area.

ERA Risk Rating: (C2 L3 LOW)

The primary management authority is the Department of Environment and Conservation however implementation is through the Department of Fisheries via licence conditions.

Operational Objective (plus justification)

Aquaculture licensees operate facilities in line with applicable water quality standards.

Justification

As mentioned in 1.3.5, four Environmental Values have been identified as relevant to the coastal waters of WA. Six Environmental Quality Objectives (EQOs) or management goals have been developed to protect these Environmental Values. Ecosystem Health recognises that people value the natural ecosystem for its own sake. This value signals a desire to maintain the essential natural structure and function of any ecosystem. EQO 1 (Maintenance of ecosystem integrity: naturally diverse and healthy ecosystems) has four levels of protection, these being maximum,

high, moderate and low. These levels represent the minimum acceptable level of environmental quality to be achieved through management of the waters but do not describe the current or preferred environmental condition. The Environment Protection Authority and the Department of Environment and Conservation have determined the limit of acceptable change for each of these protection levels. These are summarized as follows:

Maximum	no contaminants (pristine)	no detectable change from natural variation
High	very low levels of contaminants	no detectable change from natural variation
Moderate	elevated levels of contaminants	moderate changes from natural variation
Low	high levels of contaminants	large changes from natural variation

Within this framework, detectable change beyond natural variation is nominally defined by the median of a test site parameter being outside a certain percentile of the measured distribution of that parameter from a suitable reference site. Depending on whether the parameter has triggered the 20th/80th percentile, 10th/90th percentile, or 5th/95th percentile then the breach is either a level 1, 2 or 3 respectively. A specific management response is required to be taken by the licensee and is set down within the Management and Environmental Monitoring Plan.

Management of individual sites through analysis of Management and Environmental Monitoring Plan results will ensure any water quality impacts remain within the licensed area, below trigger levels and not result in region-wide changes.

Another potential source of wastewater is from harvesting operations conducted on site. Most operators undertake minimal processing on board harvest vessels, limiting activities to the actual euthanizing and storage of fish in ice slurries for transport to processing facilities or markets. Aquaculture licensees are only authorized for minimal processing, with any further processing considered to be 'secondary' in nature (i.e. value adding such as smoking, pickling) requiring a fish processors licence.

Indicator

- Aquaculture will have no detectable change in water quality outside the licensed area.

Performance Measures (Code of Practice/Licence condition/MEMP)

Code of Practice	Applicants must undertake a baseline data gathering exercise to inform both the application assessment process as well as provide the basis upon which the Management & Environmental Monitoring Plan will be compared.
Code of Practice	Baseline data should be collected over a six month period to take into consideration any seasonal variations and will include sample collections every four to six weeks over this period. Guidance on sample collection methods and protocols is provided on the Department of Fisheries website.
Code of Practice	Licensees will operate the facility using best practice techniques to minimize potential water quality impacts.
Code of Practice	Licensees should educate farm staff in appropriate methods to identify and mitigate water quality concerns.
Code of Practice	There is risk of spreading disease associated with the slaughter of farmed fish if appropriate precautions are not taken. Containment of fish and fish products, including blood is recommended at all on-site slaughtering operations and should be considered mandatory at sites with Marine Parks.
Code of Practice	Harvest bins should be leak proof and have well fitting lids strapped on tightly. To prevent spillage of blood and other wastewater in transit, the bins must not be over filled.

Code of Practice	All bins and harvest equipment should be cleaned with the wastewater being disposed of appropriately.
Code of Practice	If fish are to be carried in a well-boat, then oxygen supplies should be sufficient to last longer than the anticipated length of the journey.
Licence Condition	Licencees will prepare and implement an agreed Management and Environmental Monitoring Plan. The licensee will use the Department of Fisheries' Finfish Aquaculture Management & Environmental Monitoring Plan template or develop an Management & Environmental Monitoring Plan of a comparable standard to be signed off by the Department of Fisheries/ Department of Environment and Conservation/Environment Protection Authority, as necessary. This plan must be finalized prior to any stock being placed on the site.
Licence Condition	Before 31 July of each year, the licensee must submit the Management & Environmental Monitoring Plan report, which includes a copy of all results to July 1 of that year, to the designated Department of Fisheries' regional office and copied to the Chief Executive Officer of the Department of Fisheries.
Management & Environmental Monitoring Plan	<p>The Management and Environmental Monitoring Plan will identify the potential risks, detail the environmental values against which the risks will be compared and outline appropriate management strategies. The water quality monitoring program will be based on key water quality performance indicators for each site and require measurement, analysis and reporting. Parameters to be measured and analyzed may include (depending on the site):</p> <ul style="list-style-type: none"> • Electrical Conductivity • Turbidity/Secchi Depth • pH • Temperature • Dissolved Oxygen • Chlorophyll <i>a</i> • Total Nitrogen • Total Phosphorus • Filterable Reactive Phosphorus • Nitrate / Nitrite • Ammonium • Total Suspended Solids • Light attenuation coefficient • Phytoplankton biomass
Management & Environmental Monitoring Plan	Water and sediment quality will be evaluated by comparing concentrations of nutrients with Environmental Quality Standards. Certain standards will be tentative where a detailed data set is not available and others will be based on previous studies.
Management & Environmental Monitoring Plan	Proponents will designate the location of the 'Impact' site and the corresponding 'Control' sites, of which there should be at least three. These will be agreed to in writing by the Department of Fisheries.

Fisheries Management Response

- *Current*

Currently the Department of Environment and Conservation have broad responsibility for managing pollution and waste discharge under the *Environment Protection Act 1986*. The Department of Fisheries impose Management and Environmental Monitoring Plan requirements through licence conditions.

- *Future*

Without accurate data on factors like water currents, generation of waste, flushing dynamics and carbon accumulation for each aquaculture site, it is difficult to make any accurate predictions. Although this is ideal for reducing the risk of environmental impact, an underestimation of carrying capacities could unnecessarily hinder the growth of this industry and significant investment

opportunities could be lost. These factors therefore need to be investigated and quantified in order to develop more accurate models. The Department of Fisheries is undertaking a project to provide more WA-specific data in this area. These data should be available in 2011.

Specific direction on the level of information required should be included through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

If licensees fail to operate to maintain water quality to a point where it impacts the environment, then actions can be taken against the *Environment Protection Act* by the Department of Environment and Conservation.

• **Sedimentation**

Rationale for Inclusion and Identification of Management Authority

Marine finfish aquaculture will result in some sedimentation beneath the cages, however this risk is minimized by locating sites in areas where currents are able to flush the site and managing feed introductions. Assimilation of any nutrients in the sediment can be a management concern if practices such as fallowing are not employed.

ERA Risk Rating: (C2 L3 LOW)

The primary management authority is the Department of Environment and Conservation for pollution and waste discharge, however obligations under the *Fish Resources Management Act 1994* will be imposed by the Department of Fisheries via aquaculture licences. The Department of Fisheries can use the *Fish Resources Management Act 1994* to manage environmental impacts resulting from aquaculture operation, if the operation could result in an impact on fish or fish habitat.

Operational Objective (plus justification)

Licensees will operate facilities to avoid adverse impacts on the sediment outside of the licensed area.

Justification

The gross effects of sedimentation from intensive cage culture on the benthic environment essentially follow the pattern of impacts from other organic pollutant sources but on a more reduced spatial scale. As stated under 6.2.1.2, the recorded effects include reducing sediments; hypoxia in the water overlying the sediment; increased sulphate reduction; and marked changes in benthic faunal and meiofaunal assemblages in terms of species numbers, diversity, abundance and biomass.

Reports released by the British Ecological Society (Davenport et al. 2003) provide information on the potential impacts of enrichment from aquaculture on sediments. Communities of animals burrowing in sediments, which receive normal detrital inputs, are species rich, have a relatively low total abundance/species ratio and include a wide range of higher taxa, body sizes and functional types. As organic inputs increase, this diversity also initially increases as the enhanced food supply provides opportunities for the expansion of existing populations and the immigration of new species. However, deterioration of the physical and chemical conditions in the sediments progressively eliminates the larger, deeper burrowing and longer-lived forms favouring smaller, rapidly growing opportunist species.

With increasing inputs, the surface sediments become anoxic and only a small number of specialist taxa can survive, mainly small annelid and nematode worms, which may flourish in huge numbers. Where anaerobic processes occur close to the sediment surface, this can become covered in dense white mats of sulphide oxidising bacteria Beggiatoa sp. High flow rates, bringing a continuous supply of oxygen to the sediment surface, do allow the survival of infauna even when the sedimentary surface layer are anoxic but, where sediments suffer oxygen deficiency for even relatively short periods of a few hours e.g. caused by slack water, large sections of the benthic macrofauna are eliminated.

Similarly to water quality, the State Water Quality Management Strategy considers sediment changes through its determination of the Environmental Values that should be maintained and the level to which the ecosystem health should be protected. Depending on whether the parameter has triggered the 20th/80th percentile, 10th/90th percentile, or 5th/95th percentile then the breach is either a level 1, 2 or 3 respectively. A specific management response is required to be taken by the licensee and is set down with the Management and Environmental Monitoring Plan.

Management of individual sites through analysis of Management and Environmental Monitoring Plan results will ensure any sedimentation impacts remain on site, below trigger levels and do not result in region-wide changes.

Indicator

- Aquaculture will cause no detectable change in sediment quality outside of the licensed area.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Applicants must incorporate a baseline data gathering exercise to inform both the application assessment process as well as provide the basis upon which the Management & Environmental Monitoring Plan will be compared.
Code of Practice	Baseline data should be collected over a six month period to take into consideration any seasonal variations and will include sample collections every four to six weeks over this period. Guidance on sample collection methods and protocols is provided on the Department of Fisheries website.
Code of Practice	Licensees will operate the facility using best practice techniques to minimize potential sediment impacts.
Code of Practice	Licensees will educate farm staff in appropriate methods to identify and mitigate sedimentation concerns.
Licence Condition	Licensees will prepare and implement an agreed Management and Environmental Monitoring Plan. The licensee will use the Department of Fisheries' Finfish Aquaculture Management and Environmental Monitoring Plan template or develop an Management and Environmental Monitoring Plan of a comparable standard to be signed off by the Department of Fisheries/ Department of Environment and Conservation/Environment Protection Authority, as necessary. This plan must be finalized prior to any stock being placed on the site.
Licence Condition	Before 31 July of each year, the licensee must submit the Management and Environmental Monitoring Plan report, which includes a copy of all results to July 1 of that year, to the designated Department of Fisheries' regional office and copied to the Chief Executive Officer of the Department of Fisheries.

Management & Environmental Monitoring Plan	<p>The Management and Environmental Monitoring Plan will identify the potential risks, detail the environmental values against which the risks will be compared and outline appropriate management strategies. The sediment quality monitoring program will be based on key sediment quality performance indicators for each site and require measurement, analysis and reporting. Parameters to be measured and analyzed may include (depending on the site):</p> <ul style="list-style-type: none"> • Dry weight of the following: <ul style="list-style-type: none"> 1) Organic Matter (ORG) 2) Ash 3) Acid-Insoluble-Ash • Total Phosphorus • Total Kjeldhal Nitrogen • Heavy Metals (Cd, Pb, Hg, Cr, Zn) • Redox Discontinuity Level (RDL) • Benthic infauna (species and abundance)
Management & Environmental Monitoring Plan	<p>Water and sediment quality will be evaluated by comparing concentrations of nutrients with Environmental Quality Standards. Certain standards will be tentative where a detailed data set is not available and others will be based on previous studies.</p>
Management & Environmental Monitoring Plan	<p>Proponents will designate the location of the 'Impact' site and the corresponding 'Control' sites, and these will be determined on a case by case basis. These will be agreed to in writing by the Department of Fisheries.</p>

Fisheries Management Response

- *Current*

Maintain the requirement for an agreed Management and Environmental Monitoring Plan incorporating sediment monitoring against appropriate trigger values. This is imposed through aquaculture licence conditions.

- *Future*

Without accurate data on factors like water currents, generation of waste, flushing dynamics and carbon accumulation for each aquaculture site, it is difficult to make any accurate predictions. Where knowledge gaps exist, a precautionary approach should be taken. Although this is ideal for reducing the risk of environmental impact, an underestimation of carrying capacities could unnecessarily hinder the growth of this industry and significant investment opportunities could be lost. These factors therefore need to be investigated and quantified in order to develop more accurate models.

Specific direction should be included on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

If licensees breach trigger values then action will be taken to either reduce/remove stock to allow for fallowing.

• **Waste feed and faeces**

Rationale for Inclusion and Identification of Management Authority

Most feeds used in commercial aquaculture are manufactured to high quality standards and formulations are based on many years of research into the nutrient requirements of the cultured animals. Nevertheless, poor feeding practices can negate the benefits offered by these feeds. Incorporating feed practices that maximize the efficiency of feed use is considered here.

ERA Risk Rating: (C2 L3 LOW)

The primary management authority is the Department of Fisheries, however specific limitations are not imposed – this is considered a management decision. Indirectly, this is managed as part of water and sediment quality management.

Operational Objective (plus justification)

Licenseses will minimize the addition of waste feed as much as possible.

Justification

Water quality deteriorates when the waste load derived from feeding exceeds the capacity of the receiving environment to assimilate waste nutrients and organic matter. Impaired water quality stresses aquatic animals and reduces the efficiency of feed conversion and production. High stocking and feeding rates also lead to waste water with a greater pollution potential, although the impact of feeding rates on water quality depends on when and where measurements are taken.

A review into the impact of salmon feeds and the environment (Tacon 2005) stated that dietary substitution of fishmeal and/or fish oil with less digestible plant and animal protein and lipid sources will result in increased nutrient loading and potential loss in fish growth and feed efficiency. However, such negative impacts could be greatly reduced by selecting the use of highly digestible ingredient sources and/or through the use of enzyme treated plant protein and/or exogenous dietary feed enzymes.

Indicator

Nutrient wastes derived from fish farming will not impact the environment outside the licensed site.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Feed must be sourced from a reputable producer under strict quality control system protocols. Preferably feed should be sourced from an Australian supplier, however imported feed can be used, subject to appropriate quality controls.
Code of Practice	All farmers should have a written feed management plan, which might include (but not be limited to) guidance on the following points: <ul style="list-style-type: none">• feeding the correct feed size for the fish;• feeding the correct amount of feed to any fish stocks, in the proper manner and over the correct periods of the day;• regular monitoring of feed conversion efficiency (following sample weighing) and assessment of whether staff feeding protocols and guidelines are effective;• the use of feedback loop feeding systems should be considered, since these improve conversion efficiency, decrease environmental impact and generally ensure that finfish feed is used as efficiently as possible; and• to comply with worlds best practice, there should be regular monitoring of feed wastage using technology such as underwater cameras or sensors.
Code of Practice	Farmers should ensure that they use feeds that have been formulated specifically for the species, and the life stage of the species, to which they offer the feed.
Code of Practice	Farmers should regularly review the specifications and use of diets with their supplier to effect improvement in performance where possible.

Code of Practice	Farmers should only use feed suppliers who effect programs monitoring levels of undesirable substances in feed and ensure levels are within legislative limits. Monitoring schemes should be reviewed and revised to take into account substances in feed on relation to legislative limits. Suppliers should provide traceability for ingredients and diet breakdowns.
Licence Condition	Licensees will prepare and implement an agreed Management and Environmental Monitoring Plan. The licensee will use the Department of Fisheries' Finfish Aquaculture Management and Environmental Monitoring Plan template or develop an Management and Environmental Monitoring Plan of a comparable standard to be signed off by the Department of Fisheries/ Department of Environment and Conservation/Environment Protection Authority, as necessary. This plan must be finalized prior to any stock being placed on the site.
Licence Condition	Before 31 July of each year, the licensee must submit the Management and Environmental Monitoring Plan report, which includes a copy of all results to July 1 of that year, to the designated Department of Fisheries' regional office and copied to the Chief Executive Officer of the Department of Fisheries.
Management & Environmental Monitoring Plan	Water and sediment quality will be evaluated by comparing concentrations of nutrients with Environmental Quality Standards. Certain standards will be tentative where a detailed data set is not available and others will be based on previous studies.
Management & Environmental Monitoring Plan	Proponents will designate the location of the 'Impact' site and the corresponding 'Control' sites, of which there should be at least three. These will be agreed to in writing by the Department of Fisheries.

Fisheries Management Response

- *Current*

There is no specific management around the limitation of waste feed and faeces, however water and sediment quality monitoring indirectly manage this issue.

- *Future*

Depending on the ability of the Management and Environmental Monitoring Plan to monitor and manage all inputs, there may be a need to provide more specific guidance on maximum feed inputs. Countries such as Norway manage the aquaculture industry using this method and similar arrangements could be considered.

Include specific direction on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

If the Management and Environmental Monitoring Plan shows breaches on the triggers for water and sediment quality, all inputs must be considered as the cause. Any breach requires a management response or if significant, prosecution action may be taken.

• **Fish disposal**

Rationale for Inclusion and Identification of Management Authority

The need for appropriate removal and disposal of dead or moribund fish can ensure predator species are not attracted to the farm, as well as limit any risk of disease. Arrangements with local government for normal and worst-case disposal requirements should be agreed in advance of being required, i.e. each aquaculture facility should be required to have an agreed worst-

case disposal arrangement. As each facility is properly provided for, regional issues should not arise.

ERA Risk Rating: (C1 L3 LOW)

The primary management authority is the Department of Fisheries, however specific limitations are not imposed – this is considered a management decision. Direction on location of land-based disposal facilities is provided by local governments.

Operational Objective (plus justification)

Dead and moribund fish will be appropriately removed and disposed of.

Justification

Mortality of culture species in aquaculture is unpredictable and highly variable among cages and facilities. A facility may experience chronic mortality of a few fish per day or a catastrophic loss caused by infectious disease, acute environmental stress or structural failures. Depending on water temperature and species, dead fish either float or sink, with warm water fish typically floating and cold water fish sinking.

Tucker and Hargreaves (2008) state the consequences of dead fish – they may serve as a source of infectious agents that may spread to other cages or into receiving waters; decomposition degrades water quality inside cages and in effluents; and they may restrict water flow and lead to failure of structural units.

Prevention and minimization of mortalities through proper fish health surveillance and management are the best methods for managing mortalities. Reducing losses to infectious or environmental disease will reduce the need to remove and dispose of dead fish. Health management includes timely removal of dead and moribund fish, which can be a potential source of pathogens. Analysing mortality rates and trends for each rearing unit may identify developing fish health problems before they become severe and may provide diagnostic information that may help identify the cause. WA offers diagnostic services and treatment recommendation for disease problems to aquaculturists through the Department of Fisheries' fish health laboratories.

In the United States, pollution discharge legislation includes prohibited discharges such as any floating, suspended or submerged matter, including dead fish, in amounts causing nuisance or objectionable conditions or that may impair designated beneficial uses in the receiving water or prohibits discharge of fish mortalities, kill spawning, processing wastes and leachate from these materials to waters. Western Australia has similar regulations subsidiary to the Environmental Protection Act and the disposal of fish mortalities to the water is not permitted under the Litter Act 1979.

Disposal methods are site-specific and are governed by local and state regulations. Approved methods usually include rendering, composting, digestion, disposal in an approved sanitary landfill, decomposition under specific conditions, incineration, burial and burning. Mortalities may be used as fertilizer in some locations. Incineration, burial and burning of fish mortalities should only be used where all other options listed above are not feasible or practicable.

Indicator

Licenseses will regularly collect and dispose of dead and moribund fish.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Inspections (weather permitting) and removal of dead or moribund fish should take into account the need to; <ul style="list-style-type: none"> • minimize handling at inspection and dead fish removal to avoid stress to the live fish within the enclosure; • take prompt remedial action in accordance with the Veterinary Health Plan to deal with any health or welfare problems; and • keep full records of each inspection, to include the number of mortalities removed, and the likely cause of death as determined by a suitably competent person.
Code of Practice	Where problems are identified during an inspection, the farmer should act promptly to discover the cause and take remedial action, in consultation with a veterinary surgeon or fish health expert when appropriate.
Code of Practice	Licensees should proactively cull wounded or sick fish to reduce the attraction of predators wherever possible. Fish should be culled quickly to avoid blood loss. Fish that are culled should never be left open to access by predators.
Code of Practice	To minimize any transfer of disease, equipment used to remove dead or moribund fish should be disinfected between cages, by dipping into an approved food grade disinfectant. Equipment should also be disinfected after each use prior to storage.
Code of Practice	Mortalities should be recorded from each cage, recording fish weight, number or both. Mortalities can then be subtracted from estimated population totals to maintain an inventory for each cage and the facility.
Code of Practice	Licensees must not select any site for disposal of fish without gaining the necessary approval due to the possibility of disturbing Aboriginal heritage sites and/or artifacts.
Code of Practice	Licensees must collect all fish mortalities in sealed containers and return them to shore for reuse or disposal.

Fisheries Management Response

- *Current*

Local government by-laws govern the disposal of dead and moribund fish. Licensees should liaise with the respective local shire regarding requirements for disposal of fish.

Licensees must contact the Department of Indigenous Affairs prior to selecting any site for burial of fish due to the potential for disturbing an Aboriginal Heritage site and/or artifacts.

- *Future*

Existing legislation should be adequate to manage this issue as the risk of large numbers of dead fish is low due to current levels of aquaculture.

- *Actions if Performance Limit exceeded*

Local government can prosecute under local by-laws should any licensee not undertake disposal of fish as required.

Any disturbances to Aboriginal Heritage sites and/or artifacts carry heavy penalties, which are managed by the Department of Indigenous Affairs.

• **Processing**

Rationale for Inclusion and Identification of Management Authority

Processing of product (particularly filleting etc) can be undertaken onsite. Any waste should be disposed of off-site, using a licensed landfill. Guidelines for processing and disposal of waste should be developed and incorporated into a Code of Practice. Processing on board vessels is covered by fish processing licences using 'HACCP' (Hazard Access Critical Control Points) for food safety.

ERA Risk Rating: (C2 L3 LOW)

The primary management authority is the Department of Fisheries through aquaculture license conditions, however specific limitations are not imposed via the aquaculture licence when the processing involves practices such as smoking, gilling/gutting. Processing sites are individually licensed, as each has separate food and health issues.

Operational Objective (plus justification)

Disposal of processing waste will use approved methods and locations.

Justification

Harvesting and slaughtering operations are significant vectors and risks in the spread of aquatic disease. Water containing blood from diseased fish being slaughtered for disease-control purposes may contain especially high levels of virus and/or bacteria. Even on populations not exhibiting clinical disease, significant levels of the virus can be detected in blood samples collected directly from the fish. Blood-water can stress other animals on the site and act as a vector for pathogens and should not be discharged during these operations.

During harvesting, if fish are to be transported alive, fish should be moved directly into transport containers and then sealed with adequate life support to maintain animal welfare. In Scotland and Norway, well-boats used to transport salmon to slaughter have been implicated in the spread of infectious salmon anaemia.

If fish are to be transported dead, conducting stunning, slaughter and bleeding in a manner that contains bodily fluids and in particular prevents the spilling of blood or water with blood in it. Harvest procedures should be designed and implemented to reduce any associated discharges. Harvest and post-harvest vessel and equipment cleanup procedures should minimize any wastes discharged overboard.

On-site processing wastes, such as fish offal, blood-water and scales, should be collected and returned to shore for proper disposal. On-site processing is strongly discouraged as it may compromise biosecurity. If on-site processing must occur, all processing waste must be collected and transported to land in containers with tightly sealed, watertight lids.

Harvesting ops re gilling, gutting etc

Indicator

Licenses undertaking on-site processing should dispose of all waste in land-based facilities.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Where fish are gutted and cleaned prior to leaving the farm, processing wastes such as fish offal, blood-water and scales, must be collected and returned to shore for proper disposal.
Code of Practice	If on-site processing occurs, all processing waste must be collected and transported to land in containers with tightly-sealed, watertight lids.
Code of Practice	Purpose-built processing facilities are recommended – fish should be chilled and dispatched as rapidly as possible after harvesting to ensure the freshness of the product.
Code of Practice	Licenses must limit processing authorized as part of an Aquaculture licence to voiding, purging, packing and chilling aquaculture product for commercial sale. Any 'secondary' processing will require a separate authorization.

Fisheries Management Response

- *Current*

Primary processing authorized under an Aquaculture Licence includes voiding, purging, packing and chilling aquaculture product for commercial sale. Licence conditions could manage the processing activities allowed and could be varied by application. For any other processing, this would be termed 'fish processing' and is covered under the current definition of 'processing' in the *Fish Resources Management Act 1994*, requiring a separate authorization. It means 'to cut up, shell, skin, shuck, fillet, cook, freeze, can, preserve or otherwise treat'.

- *Future*

No further management response should be required under these existing arrangements. More clarity on the limitations of the Aquaculture Licence should be provided formally, either through legislative amendments or policy.

- *Actions if Performance Limit exceeded*

Licenses can be prosecuted under the *Fish Resources Management Act 1994* if they breach Aquaculture Licence conditions.

• **Sewage**

Rationale for Inclusion and Identification of Management Authority

The need to deal with sewage will depend on the activities authorized at the land-based facility and should not be an issue in respect to the offshore site.

ERA Risk Rating: (C1 L2 LOW)

The primary management authorities are the local government council (using local by-laws) or the Department of Health (via regulations) if a septic tank is used.

Operational Objective (plus justification)

Land-based operations will comply with legislative requirements for sewage disposal.

Justification

Sea cage operations may generate solid and liquid wastes. Control, containment and disposal of solid and liquid waste from farms presents unique challenges because of the proximity with

aquatic ecosystems. As with other marine farm operations, some may view it as tempting to dispose of wastes directly into the aquatic environment. This is a short-sighted and inappropriate perspective that can result in negative environmental impacts. Farmers need to be particularly vigilant in the control and appropriate disposal of solid and liquid wastes during farm operations.

Many sea-cage finfish farmers only use the land based support site for storage and locating of offices and the company may not be able to fund the provision of full water treatment – in this instance septic tanks may be the only option. Using joint facilities, if located in remote areas, could alleviate some of the issues surrounding the provision of suitable water treatment for individual operators.

Indicator

Licenseses comply with requirements for disposal of sewage at land-based facilities.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Licenseses must contact the local government council and/or Department of Health for guidance on appropriate mechanisms to deal with sewage waste from land-based operations.
Code of Practice	Licenseses should consider conducting a systematic review of farm operations and develop a waste management plan.
Code of Practice	Licenseses must collect all human waste in sanitary containers and return it to shore for proper disposal. Seal transport containers to prevent spillage and securely tie them down during transport. Farm support vessels of the appropriate size should have approved sanitation devices on board. All human waste must be disposed of according to applicable regulations.

Fisheries Management Response

- *Current*

The Department of Health and local governments currently manage the disposal of sewage from land-based facilities via regulations or local by-laws. The Department of Fisheries does not have responsibility for disposal of sewage.

- *Future*

Depending on the ability of current management arrangements to deal with sewage-related issues, this could be reviewed. Imposing aquaculture licence conditions to manage sewage disposal on land-based facilities is outside the objectives of the *Fish Resources Management Act 1994*.

- *Actions if Performance Limit exceeded*

Breaches of council by-laws or Department of Health regulations can be dealt with via issuing of infringement notices.

• **General rubbish**

Rationale for Inclusion and Identification of Management Authority

Protocols are needed for the management of general rubbish, both at the farm site and within the land-based support facility.

ERA Risk Rating: (C1 L2 LOW)

The primary management authority is the Department of Fisheries, however currently there is no specific licence condition imposed to manage this issue – this is considered a management decision. The *Fish Resources Management Act 1994* sets down powers in relation to polluting activities, but it is unclear whether this applies to rubbish.

Operational Objective (plus justification)

Aquaculture will manage and dispose of rubbish created through its operations responsibly.

Justification

Forms of solid waste from cage facilities include many sources. To manage, use and dispose of wastes generated during production activities effectively, licensees should conduct a systematic review of farm operations and develop a waste management plan. An effective plan will clearly identify all wastes generated on a site, identify their source and volume and classify them with respect to any risks associated with their collection and appropriate disposal.

Designing a waste management plan to minimize the generation of waste while recognising the practical challenges associated with marine operations will consider alternative practices to reduce the use of materials that generate solid waste. The use of packaging and material handling methods that reduce total packaging needs are strongly encouraged, and plans should encourage reduction, reuse, and recycling of waste materials.

Solid waste management plans should encourage reduction, reuse and recycling to waste materials. In cases where human or animal health may be compromised by reuse or recycling, use a containment and disposal method that ensures effective disposal while protecting human and animal health. As a minimum, facilities should address human waste, feed bags, net fouling organisms, scrap rope and netting, fish mortalities and old feed packaging materials.

Indicator

Aquaculture operations minimize, manage and dispose of all rubbish appropriately.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Licensees should collect all feed bags, packaging materials, waste rope and netting and return it to shore for proper disposal, using methods and facilities approved by appropriate regulatory authorities. Recycling of these materials is strongly encouraged.
Code of Practice	Licensees should collect and return to shore all old feed for proper disposal. Expired or spoiled feed can be composted or used as agricultural fertiliser at levels that are appropriate and do not result in nutrient overloads on application sites. If feed is to be composted or used as fertiliser, consultation with the appropriate management authorities to ensure environmental regulatory compliance.

Fisheries Management Response

- *Current*

Under the *Fish Resources Management Act 1994* (section 255) the Minister may prohibit a person from engaging in any activity if in the Minister's opinion, the activity is polluting or is likely to pollute the aquatic environment. This notice may apply generally or at specified time or circumstances and remains in force until specified or revoked.

- *Future*

It may be necessary to consider the penalties applied under the *Fish Resources Management Act 1994* and whether they should be applied to aquaculture. This will depend on the objectives of the *Fish Resources Management Act 1994* and whether it relates to general rubbish.

- *Actions if Performance Limit exceeded*

If someone contravenes a notice issued by the Minister, penalties exist for individuals and body corporates.

- **Biofouling**

Rationale for Inclusion and Identification of Management Authority

Biofouling removal from structures is a big problem, especially for marine-based facilities in tropical waters. There is a need to deal with the material when it is cleaned-off nets without placing restrictive barriers onto licensees in order to minimize environmental impacts.

ERA Risk Rating: (C2 L2 LOW)

The primary management authority is the Department of Fisheries through aquaculture licensing and conditions, however specific limitations are not imposed – this is considered a management decision.

Operational Objective (plus justification)

Biofouling will be managed to limit negative impacts on the environment and the facility.

Justification

Biofouling is the growth and accumulation of aquatic plants and animals on submerged surfaces such as nets, ropes, cage collars, buoys, boats and barge bottoms. Fouling decreases the open area of containment nets by increasing the diameter of netting twine. This results in a reduced open area and subsequent impedance of water flow, increasing hydrodynamic forces on the fouled net. Biofouling increases the weight of nets and associated tackle and reduces the useful life of nets and ropes from abrasion and chafing by fouling organisms such as shellfish and barnacles. The combined effects of fouling can put severe stress on moorings and cause damage to nets. In extreme cases, heavy biofouling loads may increase the risk of fish escapes caused by net or cage collar failure. Biofouling increases benthic deposition, increases pathogen and pest resident populations and increases fuel use for work vessels.

Dissolved oxygen to sustain fish in cages is derived from water flowing through the net. Biofouling reduces water exchange and therefore reduces dissolved oxygen supplies within the cage. As fouling increases and water flow decreases, dissolved oxygen concentrations may decline to levels that stress fish. Consequences of this may include poor feed conversion, increased disease susceptibility and in some cases suffocation and death.

Biofouling is primarily an operational issue however controlling it has implications for the environment impacts of sea cage aquaculture. Some biofouling control measures however may have adverse environmental impacts, such as use of certain chemicals to reduce fouling rates.

Fouling organisms dislodged during cleaning activities may accumulate beneath the cages, exacerbating the effect of benthic accumulations of organic matter from feeding. Biofouling control is a significant operational issue with environmental ramifications that should be

addressed through careful planning. Air-drying, mechanical removal and non-chemical procedures to control biofouling are the preferred methods however licensees are encouraged to consider this issue when choosing netting material.

Indicator

Licensees will implement biofouling control measures to avoid impacting the benthic environment outside the site.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	Licensees should develop an integrated biofouling management plan incorporating both chemical and non-chemical control methods. Effective biofouling control requires an understanding of the life cycles of fouling organisms so that control mechanisms can be used strategically to break the fouling organisms life cycle and prevent or reduce colonization levels. These plans may need to deal with multiple species therefore proposed management strategies should indicate how the strategy relates to the organisms life history and ecology. Maximum density thresholds for triggering biofouling organism control responses may be included.
Code of Practice	Licensees should coordinate biofouling control actions with any surrounding farmers to reduce the risk that poorly managed farms could act as a fouling organism reservoir.
Code of Practice	If the farm appears to be the predominant locus for a pest organism, licensees can reduce levels of infestation by removing the fouled equipment and allowing pest populations to return to baseline levels.
Code of Practice	Licensees should consider air-drying of nets as an effective non-chemical biofouling control method. Desiccation of nets or equipment hoisted out of the water will kill biofouling organisms but not remove them. Dead fouling organisms will decay and slough off over time if the nets or equipment are re-immersed in water. This should only be considered if fouling levels are not so high as to impact water quality or fish health by this process.
Code of Practice	Licensees should develop and implement a net cleaning and changing plan that includes a schedule for regular monitoring of fouling levels and a schedule for changing and cleaning nets. Nets should be changed or cleaned before fouling levels impact fish health and facility integrity.
Code of Practice	Net cleaning and changing should be conducted in a manner that does not frighten fish and maintains the volume of the net bag during the activity.
Code of Practice	Licensees should minimize discharging substances associated with <i>in situ</i> cleaning of biofouling. Pressure washing of nets and cage collars is strongly discouraged unless it is for disinfection and cleaning during site fallowing associated with a disease control program, in which case nets should be transported to shore in closed containers for cleaning and disinfection.
Code of Practice	Licensees should consider washing nets on land away from the farm site to reduce discharge of dislodged biofouling organisms, if appropriate. All wastes should be collected and disposed of in appropriate facilities.
Code of Practice	Where equipment is cleaned on site, chose those with high flushing rates. Ensure that cleaning activities are conducted so that biofouling material dislodged from one cage does not drift through other cages containing fish.

Fisheries Management Response

- Current

There are no specific regulatory requirements to manage biofouling however deposition of aquaculture wastes onto benthic habitats, irrespective of their origin (i.e. feed, faeces or biofouling), is monitored as part of the Management and Environmental Monitoring Plan. The requirement for an Management and Environmental Monitoring Plan is imposed via aquaculture licence conditions.

There are no specific limitations under the *Fish Resources Management Act 1994* for use of antifoulants, however the Department of Fisheries and the Department of Environment and Conservation discourage their use. This position should be maintained until some other more robust protocol is developed and supported by appropriate legislation.

- Future

Providing guidance through the Code of Practice will ensure licensees are aware of best management practices.

- Actions if Performance Limit exceeded

Use of unauthorized chemicals can be prosecuted by the Department of Agriculture and Food under existing legislation. Any impacts outside of the licensed site due to inappropriate biofouling control measures and identified through Management and Environmental Monitoring Plans can be managed through licence conditions in the first instance. Larger impacts can be managed through breaches under the *Environment Protection Act 1986*.

• Disease (proximity of facilities, translocation policy)

Rationale for Inclusion and Identification of Management Authority

There is a need to consider the transmission of diseases due to the proximity of neighbouring farms having regard to the 'whole of catchment' requirements.

ERA Risk Rating: (C3 L1 LOW)

The primary management authority is the Department of Fisheries using the *Fish Resources Management Act 1994*, through translocation approvals or via policy set down in Fisheries Management Paper No.159 specifically for barramundi.

Operational Objective (plus justification)

All movements of aquaculture stock into the State are undertaken in accordance with legislation.

Justification

Historically fish species which are non-endemic to Western Australia have been translocated for the purposes of domestic stocking of farm dams, recreational fishing and aquaculture. In the past, these fish species were only subject to disease-free certification and the requirement that they were sited/stocked within impounded waters in the State. However, in recent years, with an increase in scientific knowledge and environmental awareness, the need for a scientific decision-making process covering the translocation of non-endemic fish species into Western Australia has been identified.

As a result, a risk assessment process has been developed by the Department of Fisheries in conjunction with the Environment Protection Authority, resulting in the establishment of a Memorandum of Understanding between the two agencies. This process has developed from a need to provide the appropriate level of protection for the environment, while facilitating the environmentally sustainable development of commercial aquaculture and stock enhancement for recreational fishing.

Currently, the translocation of a fish species non-endemic to the State of Western Australia, or that particular area of the State, into or within Western Australia requires the prior written approval or written authority of the Executive Director, Department of Fisheries, in accordance with Regulation 176 of the Fish Resources Management Regulations 1995.

Written approval may be obtained through the translocation risk assessment process, which only applies to the translocation of non-endemic species for aquaculture and recreational fishing stock enhancement purposes. Further information and application packages may be obtained from the Department of Fisheries.

Transfer of diseases between aquaculture sites is a serious concern and must be considered when assessing the proximity of aquaculture sites to one another. Of major concern is the transfer of naturally occurring diseases into the aquaculture stock that are stressed or densely stocked. Offshore cage aquaculture in an open system and therefore there is no control over water flow and subsequent transfer of diseases through the water. If farms are in close proximity to one another, other vectors can transport disease including naturally occurring fish and birds. Additionally, when considering the impact of disease and its transfer, the choice of separation distance might seem large enough to reduce the transfer of disease however under severe environmental events, such as during large storms, high winds and cyclones, diseases can be transferred much further.

Subsequent analysis of disease that spread among fish farms in Norway has shown that hatcheries with two or more fish farms within a 10 km radius infected with furunculosis (a salmonid bacterial disease) were at a two times higher risk for having the disease compared to hatcheries with fewer than two infected farms within that distance. Likewise, another Norwegian study indicated that the risk for acquiring infectious salmon anaemia (a salmonid virus disease (ISA)) was increased on marine fish farms that were adjacent to an infected farm and a report from British Columbia (Canada) that furunculosis spread from one marine site to another 10km away.

Modelling of the spread of salmon anaemia in marine sea cage farms in Canada has also shown that there is a strong relationship between the distance and sites within 5 km. Reported outbreaks of ISA occurred at a farm in Burra that was within 5 km of a processing plant that had been discharging processing effluent and where infected carcasses had been ensiled. Research has also recommended that any aquaculture activities in Norway be separated by at least 5 km in areas where salmon anaemia (ISA) is a risk. Risk of transfer of ISA has also been reported to be increased if farms are within 500 m of each other as the virus may spread through the water.

Indicator

Licenses operate in accordance with translocation protocols and consider proximity issues when selecting farm sites.

Performance Measures (Code of Practice/Licence Condition/MEMP)

Code of Practice	<p>Licencees should consider measures to reduce the risk of disease due to proximity of another farm, such as:</p> <ul style="list-style-type: none"> • selection of species that have a higher tolerance to disease; • careful site selection; • only stock cages with healthy and appropriately sized fishes; • regular grading; • monitoring stock behaviour; • monitoring of water quality; • monitoring of feed quality and freshness; • cleaning and disinfection of equipment; • removal of mortalities and monitoring of mortality rates; • discouraging predators; • high-level husbandry skills should be maintained especially when handling or moving stock; and • appropriate stocking densities
Code of Practice	<p>Proponents should submit a Biosecurity Plan as part of their application, which must be approved by the appropriate person at the Department of Fisheries. Applicants should include detail regarding mitigation measures to be employed at the site.</p>
Code of Practice	<p>Licencees should use a Biosecurity Plan and protocols to prevent, control and eradicate diseases to preserve human, animal and environmental health.</p>
Licence Condition	<p>The barramundi to be farmed must only be sourced in accordance with the Department's translocation policy or as outlined in Fisheries Management Paper No. 159 if sourcing barramundi.</p>
Licence Condition	<p>In addition to the obligations for licence holders under Regulation 64 of the <i>Fish Resources Management Regulations 1995</i>, the proponent must make and maintain the following records:</p> <ul style="list-style-type: none"> • the numbers of fish stocked into each holding cage; • the movements of fish from one cage to another; • the numbers of fish culled and removed from the cages; and • the numbers of fish removed from the cages at the time of harvesting.
Licence Condition	<p>At all times the proponent must maintain the written records referred to in (9) in a secure place within the aquaculture facility, for a period of seven years.</p>
Licence Condition	<p>Criteria that must be considered prior to the movement of any barramundi stock. These are:</p> <ul style="list-style-type: none"> • It is highly preferable that barramundi stocks for the purposes of commercial and non-commercial aquaculture be sourced from stocks within the area in which the farm is located. • Barramundi brought into Western Australia from interstate shall be sourced from licensed hatcheries only (i.e. not from the wild) and shall be health-tested to the satisfaction of the Principal Fish Pathologist of the Department of Fisheries. • Health testing and certification shall be performed by government veterinary officers or other authorized officers in laboratories using methods approved by the Principal Fish Pathologist of the Department of Fisheries. • Testing standards shall meet with a 95 per cent degree of confidence that the imported population is free of the 'nominated' diseases. • 'Nominated' disease must include relevant 'notifiable' diseases, as listed under the <i>Enzootic Disease Regulations 1970</i>, and any other diseases nominated by the Principal Fish Pathologist of the Department of Fisheries for the particular populations to be imported. • All cost of importation, quarantine and disease testing will be borne by the proponent.

<p>Licence Condition</p>	<p>Testing protocol for juvenile barramundi are as follows:</p> <ul style="list-style-type: none"> • A sample of 150 fish shall be taken from a given batch of barramundi for disease testing prior to importation or movement between drainage basins. • Each batch of fish must be numbered and kept in isolation until the testing is completed. • The sample of 150 fish is subject to examination for signs of disease or pathogenic organisms using current diagnostic techniques as designated by the Principal Fish Pathologist of the Department of Fisheries. • Batches of fish that cannot be declared free from viral nervous necrosis (VNN), notifiable diseases or significant protozoan or metazoan infections will not be permitted to be imported into the State, or moved from drainage basin to drainage basin. • If testing proves negative, a health certificate can be issued. The certification is specific for the particular batch of fish tested from the specified hatchery or farm and remains current for two weeks. Should the certification expire prior to the fish being imported, the fish will be required to be re-tested.
<p>Licence Condition</p>	<p>Barramundi eyed ova may be imported into Western Australia subject to the following conditions:</p> <ul style="list-style-type: none"> • The proponent must be the holder of a current Aquaculture Licence and have obtained the written approval of the Chief Executive Officer of the Department of Fisheries prior to importation. • The consignment of eyed ova to be imported shall be accompanied by any required certification (such as disease certificates or translocation approvals) to enable inspection at the point of entry to proceed. • The eyed ova shall be transferred directly to an 'approved' quarantine facility and will remain in quarantine until the health testing on the resultant larvae has been completed to the satisfaction of the Principal Fish Pathologist of the Department of Fisheries. • Any imported packing materials and water are to be disinfected, destroyed by incineration or disposed of as directed by the Principal Fish Pathologist of the Department of Fisheries • Any unusually high mortalities (i.e. greater than five per cent) must be reported to the Principal Fish Pathologist and the Translocation Officer of the Department of Fisheries within 24 hours of occurrence. • All costs of testing and inspection are to be borne by proponent. • A sample of 150 fish, a minimum of 20 days old, shall be taken from the batch of barramundi for disease testing prior to release from quarantine. • The sample of 150 fish is subject to examination for signs of disease or pathogenic organisms using current diagnostic techniques as designated by the Principal Fish Pathologist of the Department of Fisheries. • Batches of fish that cannot be declared free from viral nervous necrosis (VNN), notifiable diseases or significant protozoan or metazoan infections will not be released from quarantine and may need to be destroyed. • If testing proves negative, a health certificate may be issued. The certification is specific for the particular batch of fish tested from the specified hatchery or farm and remains current for two weeks. Should the certification expire prior to the fish being imported, the fish will be required to be re-tested.
<p>Licence Condition</p>	<p>Sampling protocols that may be required for the disease testing of adult barramundi will be developed by the Principal Fish Pathologist on a 'case-by-case' basis.</p>

<p>Licence Condition</p>	<p>Quarantine Facility Requirements are:</p> <ul style="list-style-type: none"> • The quarantine facility shall be constructed in a location approved by local government authorities where required, and not be located in an area classified as flood-prone by the relevant State authority. • The facility is to be used only as a quarantine facility and must not contain any other fish unless these are never to be removed from the facility. • All tanks and other holding devices shall be permanently numbered and fitted with a recording chart which is kept up-to-date and indicates the total number of fish, losses through death, and any signs of disease. • The facility shall be lockable so as to prevent unauthorized entry, and have secure walls and sealed floors so as to hold the total volume of water. • The quarantine facility shall be constructed so that the fish can be readily accessed and inspected, and sufficient light must be supplied. • Any waste water from transport or the aquaculture operation shall be: <ul style="list-style-type: none"> a) disposed of on dry ground at least 100 metres from any waterway; or b) disposed of by discharge to a soak-well system that does not have the facility for surface water flow; or c) sterilised by treatment with chlorine to 50 parts per million for 10 minutes prior to discharge. • The facility shall contain a sink discharging to a sewer as in (6) above, or tubs or other devices to enable the washing and rinsing of hands or any other part of the body in contact with the fish or water with a quaternary ammonium compound or other approved general skin disinfectant. All persons entering the facility shall carry out such disinfection prior to leaving the facility. • Entry to the facility shall be restricted to the owner and designated employees thereof, and to officers of the Department of Fisheries.
---------------------------------	---

Fisheries Management Response

- *Current*

Regulations 176 and 177 of the *Fish Resources Management Regulations 1995* control fish and disease. Regulation 176 provides the power to require translocation approval to bring non-endemic fish into the State and move them around the State (outside of their natural range). Regulation 177 controls the notification of disease outbreaks and the actions required for their control.

- *Future*

For fish that are endemic of being moved within their natural range (i.e. from a hatchery to marine waters for grow-out) health certification will be required under the *Biosecurity and Agriculture Management Act 2007*.

There is a need to determine appropriate buffers between farm sites (taking into account differing species or types) to minimize possibility of disease transmission. The use of chemicals and residual chemicals in the water column will also influence any treatment of disease.

Specific direction should be included on the level of information required through the *Guidance Statement for Information Requirements for Aquaculture Licence Applications in Coastal Waters*.

- *Actions if Performance Limit exceeded*

Licencees not complying with translocation requirements can have their stock destroyed or be subject to prosecution if the breach is serious enough.

7.0 APPENDIX

Workshop Attendees:

Carissa	Aitken	Department of Environment and Conservation
Bill	Bairdsley	Department of Fisheries
Russell	Barnett	Aquaculture Development Council
Samantha	Bridgwood	Department of Fisheries
Rae	Burrows	Department of Fisheries
Kevin	Crane	Department of Environment and Conservation
Kerryn	Dayley	Department of Environment and Conservation
Phil	Dyer	Global Barramundi Pty Ltd
Robin	Green	Global Barramundi Pty Ltd
Michelle	Hanlon	Aquaculture Development Council
Isaac	Hatch	Department of Environment and Conservation
Janet	Howieson	Department of Fisheries
Greg	Jenkins	Aquaculture Development Council + Challenger TAFE
Maggie	Lilith	Aquaculture Development Council + Conservation Council
Dan	Machin	Aquaculture Council of WA
Steve	Nel	Department of Fisheries
Gavin	Partridge	Challenger TAFE
Daryn	Payne	WTN Nominees & Pelsaert (WA) Pty Ltd
Alan	Savage	Western Kingfish Ltd
Peter	Skitmore	Department of Environment and Conservation
Erica	Starling	WTN Nominees & Pelsaert (WA) Pty Ltd
Fiona	vom Berg	Department of Fisheries (Project Manager + Facilitator)
Victoria	Weir	Department of Fisheries
Guy	Westbrook	Marine Produce Australia

8.0 REFERENCES

- Beveridge, M. (2004) *“Cage Aquaculture”*. Blackwell Publishing Third Edition. 368pp.
- Black, K. (2001) *“Environmental Impacts of Aquaculture”*. Sheffield Academic Press Ltd. 211pp.
- Buschmann, A., Costa-Pierce, B., Cross, S., Iriarte, J.L., Olsen, Y. and Reid, G. (2007) *“Nutrient impacts of farmed Atlantic salmon (Salmo salar) on pelagic ecosystems and implications for carrying capacity”*. Final Report of the Technical Working Group on Nutrients and Carrying Capacity of the Salmon Aquaculture Dialogue. 68pp.
- Davenport, J., Black, K., Burnell, G., Cross, T., Culloty, S., Ekaratne, S., Furness, B., Mulcahy, M. and Thetmeyer, H. (2003) *“Aquaculture: the ecological issues”*. The British Ecological Society. 90pp.
- De Jong, S. and Tanner J.E. (2004) *“Report on the Environmental Risk Assessment Workshop September 23-24 2003 for Marine Finfish Aquaculture in South Australia”*. SARDI Aquatic Sciences Publication No. RD03/0044. SARDI Aquatic Sciences, Adelaide. 98pp.
- Department of Fisheries (2008) *“Final ESD Risk Assessment report for Sea-cage and Land-based Aquaculture”*. Fisheries Management Paper No. 229. 162pp.
- Department of Fisheries (2005) *“Access the Brood stock and Hatchery Production of Endemic and Non-Endemic Species for Aquaculture Purposes”*. A Draft Policy Paper. 25pp.
- Department of Fisheries (2004) *“Draft Aquaculture Plan for Shark Bay”*. Fisheries Management Paper No. 171. 130pp.
- Department of Fisheries (2002) *“Reseeding of Grazing Gastropods and Bivalves into the Marine Environment in Western Australia”*. Fisheries Management Paper No. 162. 32pp.
- Department of Fisheries (2002) *“Emergency / Incident Management Plan”*. 35pp.
- Donovan, D.J. (1999) *“Industry Environmental Codes of Best Practice for Freshwater Finfish Aquaculture”*. Prepared for the Department of Primary Industries and the Queensland Finfish Aquaculture Industry. 30pp.
- Environment Protection Authority (2003) *“Benthic Primary Producer Habitat Protection for Western Australia’s Marine Environment”*. Guidance Statement No. 29. Guidance for the Assessment of Environment Factors. 25pp.
- Fisheries Western Australia (2000) *“Aquaculture Plan for the Houtman Abrolhos Island”*. Fisheries Management Paper No. 137. 102pp.
- Fletcher, W.J. (2002) *“Policy for the implementation of Ecologically Sustainable Development for Fisheries and Aquaculture within Western Australia”*. Fisheries Management Paper 157. Department of Fisheries, Western Australia 70pp.
- Fletcher, W.J., Chesson, J., Fisher, M., Sainsbury, K.J., and Hundloe, T.J. (2004) *“National ESD Reporting Framework: The ‘How to’ Guide for Aquaculture”*. Version 1.1 FRDC, Canberra, Australia. 88pp.
- Food Standards Australia and New Zealand (undated) *“Fact Sheet – Antibiotics in the food supply”*. FSANZ website – 31 July 2006.
- Food Standards Australia and New Zealand. (undated) *“Fact Sheet – Malachite Green in aquacultured fish”*. FSANZ website – 31 July 2006.

- Fowler, N. (1996) *“Gascoyne Aquaculture Development Plan”*. Prepared on behalf of the Fisheries Department of Western Australia and the Gascoyne Development Commission. 174pp.
- Goldburg, R. and Triplett, T. (1997) *“Murky Waters: Environmental Effects of Aquaculture in the US”*. Environmental Defense Fund. 198pp.
- Government of Western Australia (2004) *“State Water Quality Management Strategy”*. No.6 Implementation Framework for Western Australia for the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and Water Quality Monitoring and Reporting (Guidelines Nos. 4 & 7: National Water Quality Management Strategy). 64pp.
- Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) (1997) *“Towards safe and effective use of chemical in coastal aquaculture”*. Food and Agriculture Organisation of the United Nations, Rome. 52pp.
- IMCRA Technical Group (1997) *“Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environment”*. Version 3.2. Environment Australia, Commonwealth Department of the Environment, Canberra. 120pp.
- Marine Aquaculture Taskforce (2007) *“Sustainable Marine Aquaculture: Fulfilling the promise; managing the risks”*. 128pp.
- Nel, S. (1996) *“Kimberley Aquaculture Development Plan”*. Prepared on behalf of the Fisheries Department of Western Australia and Kimberley Development Commission. 106pp.
- Ross, A. (1997) *“Leaping in the Dark – a review of the environmental impacts of marine salmon farming in Scotland and proposals for change”*. A report to Scottish Wildlife and Countryside Link. 92pp.
- Scottish Environment Protection Agency (1998) *“Regulation and Monitoring of Marine Cage Fish Farming in Scotland”*. A Procedures Manual.
- Scottish Executive (2003) *“A Code of Good Practice for Scottish Finfish Aquaculture”*. 112pp.
- Tacon, A.G.J. (2005) *“State of Information of Salmon Aquaculture Feed and the Environment”*. A report prepared for the WWF Salmon Aquaculture Dialogue. 81pp.
- Tucker, C.S. and Hargreaves, J.A. (2008) *“Environmental Best Management Practices for Aquaculture”*. U.S. Aquaculture Society Wiley Blackwell. 592pp.
- Ward, B. (2002) *“Policy Paper on GMOs and Genetically-Improved Organisms in the Aquaculture Industry”*. 3pp.

