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WESTERN KINGFISH LTD

Western Kingfish Limited

Pilot Aquaculture Project

Environmental Monitoring and Management Plan

301012-00425

8-Jul-08

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PROJECT 301012-00425 - PILOT AQUACULTURE PROJECT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for internal review	A Branco	A Costen	N/A	22 May 08	N/A	
B	Issued for client review	A Branco	A Savage	A Costen	3 June 08		
0	Issued as final	A Branco	R Scoones	A Costen	2 July 08		
1	Issued for Use	A Branco	R Scoones	A Costen	8 July 08	A Savage	8 July 08

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1. INTRODUCTION

1.1 Background

The Western Kingfish Limited (WKL) aquaculture pilot project is a small-scale operation on 30 hectares of aquaculture licensed area located in the Hill River Special Purpose (Aquaculture) Zone of the Jurien Bay Marine Park (JBMP). The JBMP has significant social and ecological conservation value to the community of Western Australia. Following the pilot project, there are plans to expand the aquaculture operation in the Hill River Aquaculture Zone and also potentially in the Seaward Ledge Special Purpose (Aquaculture) Zone. This pilot project, which has approval to produce up to 200 tonnes of yellowtail kingfish (Seriola lalandi), seeks to determine the technical feasibility and environmental monitoring and management requirements of such a commercial scale operation.

The Jurien Bay Marine Park contains a combination of offshore reefs, islands and sheltered lagoons which are thought to be representative of the marine biodiversity of Western Australia's central west coast. The marine biota is contains a mix of temperate and tropical organisms due to the influence of the Leeuwin Current on the ecology of the region, including both non-reef-forming corals and seagrass meadows. The islands in the marine park are also ecologically important as seabird and sea lion breeding areas. Commercial fishing, recreation and marine nature-based tourism are also of considerable economic and employment benefit to the region.

This document comprises the Pilot Project Environmental Monitoring and Management Plan (EMMP) for WKL's pilot project to meet the Department of Environment and Conservation's (DEC) requirements for the pilot project. The EMMP aims to maintain the integrity of the JBMP through preservation of its social and ecological values. Following submission of a Framework EMMP and subsequent Interim EMMP, WKL recently received approval from the WA Department of Fisheries (DoF) to release 50,000 yellowtail kingfish fingerlings into sea pens located in the JBMP. This approval was granted on the condition that the Pilot Project EMMP be submitted and approved within two months of the initial stocking of sea pens (i.e. prior to 15 June 2008).

WKL has onshore and offshore facilities to support the aquaculture venture, including three aquaculture licences within the Hill River Aquaculture Zone. A proposal to move one of these aquaculture licence areas (Licence Area C; refer to Appendix C) to a location with less seagrass was recently approved by the DoF. The sea pens in the adjusted Licence Area C have now been stocked with fingerlings and commercial-scale operations are also likely to take place in this aquaculture licence area in the future.

Sea-based infrastructure for the pilot project in Licence Area C includes two sea pen systems. A single polar circle sea pen, based on a floating ring with nets of flexible nylon or other synthetic

materials as is used for Atlantic salmon aquaculture in Tasmania and in the yellowtail kingfish industry in South Australia, is currently being used for the early development work. Net changes are required because the nets become overgrown by fouling organisms (antifouling chemicals will not be used on sea pen netting), and to increase mesh size as the fish grow. Above the water there is a rail and netting to exclude sea lions and birds.

The second and principal sea pen system will use the System Farm® method which uses square, metal mesh sea pens which can be linked together to create a stable platform. The System Farm® module will consist of six 24 m ×24 m pen units for the proposed 200 tonne pilot project operation (Appendix A).

Both sea pen systems are moored to the seabed by anchors, chain and rope, and are relatively easy to move, even when stocked, meaning that they can be moved to a new location within the aquaculture licence area to allow fallowing of sites, even during a production run. Bird exclusion netting has been installed over both systems.

Fish will be fed an extruded, sinking, pelletised commercial feed, of which the major constituents are protein (~50%), lipids (~17%), carbohydrates (~15%), moisture (~8%) and ash (~10%). Yellowtail kingfish are fast growing fish and are anticipated to attain a market size of approximately 3-4 kg in between 15 and 18 months. A relatively low stocking density of 10-15 kg/m3 will be maintained for the pilot project.

1.2 Legislation

The WKL pilot project is located in the Hill River Special Purpose (Aquaculture) Zone, which is defined in the Jurien Bay Marine Park Management Plan 2005-2015 (CALM and MPRA 2005). The Special Purpose (Aquaculture) Zone is located in the Jurien Bay Marine Park which is vested in the Western Australian Marine Parks and Reserves Authority (MPRA); the DEC is responsible for its management.

Several Western Australian statutes apply to this pilot project, governing the general conduct of aquaculture activities and also the conduct of these activities in a marine park. The DoF governs the management and regulation of commercial fisheries, including aquaculture, in Western Australia under the Fish Resources Management Act 1994 (FRM Act), and has the authority to issue licences to carry out aquaculture in Western Australia in accordance with Ministerial Policy Guideline No. 8, Assessment of Applications for Authorisation for Aquaculture and Pearling in Coastal Waters of Western Australia (FMA, 1998). In reference to the issue of aquaculture licences in marine parks, the FRM Act prevails over the Conservation and Land Management Act 1984 (CALM Act) to allow aquaculture activities in certain zones within marine parks. However, aquaculture activities that may have a significant impact on a marine park are also subject to assessment under the Environmental Protection Act 1986. Additionally, the Wildlife Conservation Act 1950 provides for the protection of

flora and fauna in Western Australia and influences the way in which aquaculture activities must be carried out.

WKL currently holds an aquaculture licence (Licence No. 1335) in the Hill River Special Purpose Aquaculture Zone. The licence covers an area of 29.8 ha, comprising two 10 hectare areas and one 9.8 hectare area. Aquaculture projects in this zone must be assessed by relevant agencies and are subject to the provisions of the FRM Act. Aquaculture in this zone is subject to environmental impact assessment and is only permitted where it can be demonstrated that a project is compatible with the designated purpose of the zone.

1.3 Approvals

In June 2007, WKL submitted a proposal to carry out the pilot project in Jurien Bay Marine Park. Initially, and again upon appeal, the Environmental Protection Authority (EPA) treated this proposal as Not Assessed – Public Advice Given. The public advice indicated that an Environmental Monitoring and Management Plan (EMMP) should be developed in consultation with DEC and DoF. Additionally, the EPA indicated that the EMMP should reflect the intent of the Jurien Bay Marine Park Management Plan and the National Water Quality Management Strategy series[1].

In response to this advice, and as a condition of Aquaculture Licence 1335, WKL submitted a draft EMMP (Proposed Monitoring Program for Sea Cage operation in Jurien Bay Marine Park) to the DEC in July 2007. The DEC opined that the monitoring program was deficient and provided some general and specific comments in a letter dated 21 December 2007 on behalf of the DEC Parks and Conservation Services and in consultation with the Marine Parks and Reserves Authority.

On 12 February 2008, WKL submitted a Framework EMMP to DEC and DoF who agreed in principle to allow WKL to introduce fingerlings to the sea cages before the Pilot Project EMMP for the pilot project was completed and approved. An interim EMMP, designed to manage the project from the time of the first placement of fingerlings to the stage of 3 tonnes or two months, whichever would come first, was subsequently submitted to, and accepted by, DEC and DoF on 14 April 2008.

This document represents the final component of the environmental impact assessment for the pilot project, comprising the final Environmental Management and Monitoring Plan for the pilot project.

[1] The National Water Quality Management Strategy (NWQMS) has been jointly developed since 1992 by the Australian Government in cooperation with state and territory governments, currently under the Natural Resource Management Ministerial Council. Other ministerial councils have also been involved for some issues. The NWQMS is part of the Council of Australian Governments' (COAG) Water Reform Framework and is acknowledged in the National Water Initiative. The NWQMS is comprised of 21 papers, constituting three major elements: policies, process and guidelines.

This Pilot Project EMMP is designed to address the specific areas requested by DEC in their responses to the EMMP Framework and Interim EMMP. As specified in the aquaculture licence conditions, this document must be approved by DEC and DoF within 2 months of the commencement of operations (i.e. before 15 June 2008). Table 1 summarises the environmental licences, endorsement and authority required for the pilot project.

As this is a pilot project, the EMMP will undergo two initial reviews after monitoring has begun. After 3 months of monitoring are complete, the monitoring program will be reviewed by WKL, the DEC, and DoF, with advice provided by the MPRA. After 6 months of monitoring, the entire EMMP will be reviewed. Both of these scheduled reviews are intended to allow adaptation of the EMMP to the evolving operational procedures of the pilot project and to refine the monitoring program to be applicable to local environmental conditions once additional data are collected and modelling has begun.

Table 1: Environmental approvals required for pilot project

LEGISLATION	RESPONSIBLE AUTHORITY	ACTIVITY	LICENCE/ENDORSEMENT/AUTHORITY	STATUS
Fish Resources Management Act 1994 (FRM Act) (section 97)	Department of Fisheries	Aquaculture operations	Licence 1335 covers aquaculture activities conducted within the Hill River Special Purpose Aquaculture (SPA) Zone. The licence covers an area of 29.8ha, comprising two 10ha areas and one 9.8ha area.	Granted
Fish Resources Management Act 1994 (FRM Act) (sections 135 & 142)	Department of Fisheries	Change of location of aquaculture operations	Location of one part of Aquaculture Licence 1335 (Licence Area C) changed to an area with less seagrass.	Granted
Conservation and Land Management (CALM) Regulation 34	Department of Environment and Conservation (DEC)	Mooring sea pens	Lawful authority required for anchoring to the sea bed.	Granted
Fish Resources Management Act 1994 (FRM Act)	Department of Fisheries on advice from Department of Environment and Conservation (DEC) and Marine Parks and Reserves Authority (MPRA)	Stocking of sea pens with fingerlings	Endorsement of Environmental Monitoring and Management Program for the pilot project (required within 2 months of commencement of activity	Pending

1.4 The EMMP Process

This document supersedes the Framework EMMP and the Interim EMMP produced by WKL for the pilot project. The Pilot Project EMMP consolidates information from the two preceding plans with

additional proactive and reactive management strategies, and is intended for implementation and continuous development throughout the pilot project (Figure 1). The information and requirements in this document relate to specific environmental values, which are considered to be of significance in the context of the JBMP and its management plan.

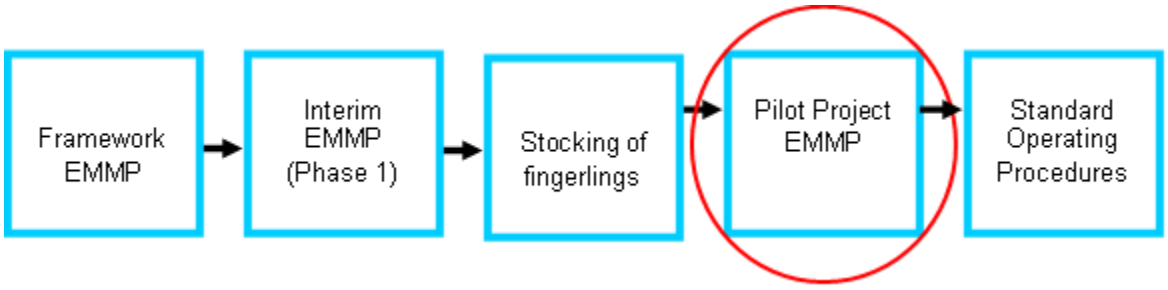

Figure 1: The EMMP Process for WKL aquaculture activities in JBMP

1.5 Scope of Pilot Project EMMP

This document describes the monitoring and management activities to be undertaken during the operation of the WKL pilot project to minimise the environmental effects that might derive from it. The monitoring and reporting components of this document will also assist in the production of informed decisions that can be built upon for the environmental monitoring and management of future project phases.

This is a living document and will be reviewed periodically and updated as relevant. It has been constructed to provide relevant information and practical, effective management strategies for the WKL staff involved in the operation of the project.

The Pilot Project EMMP provides detailed management strategies for each environmental value, which relate to various aspects of the operations. Standard operating procedures will be developed throughout the pilot project and finalised prior to commencement of further project phases.

This document addresses the following key environmental values:

- Water quality
- Sediment quality
- Benthic fauna
- Macroalgae
- Seagrass
- Cetaceans
- Turtles
- Sea lions
- Finfish
- Avifauna

For each environmental value, the following components are addressed:

Policy:	The guiding environmental management goal that applies to the value.
Objectives:	The aims that the management strategies have been designed to achieve.
Environmental Quality Standards:	Sets the benchmark by which the success of the management actions a judged.
Proactive Management Actions:	The procedures to be employed to ensure the relevant objectives are met.
Monitoring, Recording and Reporting:	The process of measuring actual performance, or how well the policy has been achieved. This component includes the format, timing and responsibility for reporting and auditing of the monitoring results.
Reactive Management Actions:	The action to be implemented in the case of non-compliance. Includes strategies and the person(s) responsible for the actions.

1.5.1 Supporting Documents

This EMMP also includes supporting documents, provided as appendices. These documents are designed to avoid replication within this EMMP. The purpose of each document is as follows:

Risk Assessment (Appendix B): the risk assessment identifies the impacts to ecological values that may result from the pilot project and identifies the risk of these impacts occurring (assessed by determining the likelihood and consequence of impacts) before management actions are applied.

Environmental Monitoring Program (Appendix C): this program identifies specific monitoring required for the environmental values of water quality, sediment quality, benthic fauna and primary producer habitat. Monitoring locations are provided along with monitoring methods, timing, recording and reporting requirements. Reactive management actions are also included and linked to specific trigger values.

Wildlife Interaction Avoidance Strategy (Appendix D): this strategy details requirements in relation to faunal environmental values, namely cetaceans and turtles, sea lions, finfish and seabirds. Proactive and reactive management actions are provided to prevent or mitigate interactions between aquaculture staff or equipment with wildlife. The main aim of the document is to avoid interaction, although this may not be totally achievable (i.e. can not completely avoid interactions such as wild finfish eating leftover feed etc.). Recording and reporting requirements are also detailed.

1.6 Emergency and Contingency Planning

An up to date emergency response plan will be developed and updated throughout the pilot project which provides guidance for handling emergencies. Specifically, emergencies such as net breaches and other fish escape events, non-secure drifting sea cages and petroleum product (fuel and oil) spills will be included. Emergency and contingency planning is beyond the scope of this report and will be developed throughout the pilot project operations.

1.7 WKL Environmental Policy and Objectives

WKL and its contractors will conduct all business in a manner consistent with their environmental policy, which is currently under development. WKL is committed to developing a sustainable aquaculture operation which can exist within the JBMP without compromising the environmental and social values of the park. To that end, Western Kingfish Limited will implement this environmental monitoring and management plan and develop it as necessary to provide assurance to itself and the relevant authorities that it is meeting the goals set out by the Jurien Bay Marine Park Management Plan.

The primary policy of this document is to maintain the integrity of the Jurien Bay Marine Park through preservation of its ecological and social values.

The primary objectives of this document are:

- to prevent any impacts to the Jurien Bay Marine Park
- to detect changes, trends and identify triggers for effective management responses through the implementation of a monitoring program
- to restrict the pilot project zone of impact to within the boundaries of the aquaculture licence boundary, and the zone of influence to within the aquaculture zone, by implementation of a set of management responses
- to protect water and sediment quality
- to protect benthic habitats
- to prevent any interactions between aquaculture personnel or equipment and wildlife
- to evaluate the effectiveness of proposed management responses
- to assess the impacts of the pilot project trial in a way that allows extrapolation to predict the likely effects from a larger scale aquaculture operation.

2. RESPONSIBILITIES

2.1 Staffing and Organisation

The key roles and responsible persons, with respect to environmental protection, are identified in Attachment C, the monitoring program description. Overall, the parties ultimately responsible for the environmental compliance of the project are the board of directors of Western Kingfish Limited: John Gillon (Chairman), Andrew Mitton (Director), Merv Collinson (Non-executive Director), and Alan Savage (Executive Director). The Environmental Manager, Alan Savage will act to ensure that the pilot project is managed in accordance with this plan, while the marine operations manager, will ensure the day-to-day operations are in compliance and that staff are all informed about and understand their responsibilities to the environment as described in this plan.

Every employee and contractor associated with this project will be made aware of their responsibility to preserve the marine environment and their obligations under this document. These persons will be required to have, or will be provided with the training necessary to acquire, the skills needed to meet those responsibilities. All staff will be expected to be familiar with the EMMP and understand what is expected of them in order to comply with it.

2.2 Induction and Training

All staff will be experienced with marine operations. All divers and vessel operators will be experienced and possess relevant current commercial-level certifications and all staff will be required to possess the level of skills and training relevant to their assigned duties, including their responsibility for the protection of the environment.

All staff will be briefed on the issues of environmental concern within the Jurien Bay Marine Park (JBMP), ensuring that they are aware of the environmental goals of this project and have the knowledge to undertake their duties in compliance with this EMMP.

WKL will conduct employee inductions, aimed at building a culture of environmental awareness,, understanding the conservation values of the Jurien Bay Marine Park and to educate all staff and contractors on this EMMP. A training register will be developed and maintained by the WKL Environmental Officer, which will list qualifications of all staff relevant to the aquaculture operations and list all staff inducted in the implementation of this EMMP. Staff will sign off in the training register to confirm they understand the requirements of the EMMP and their responsibilities in regard to the environment.

2.3 Consultation

Ongoing consultation will be undertaken between WKL and its contractors and the DEC, DoF and the Marine Parks and Reserves Authority regarding the implementation of the EMMP. This will include a quarterly and annual reporting schedule and provision of ongoing access to monitoring data. In addition, plans for public awareness campaigns for communicating with other regional stakeholders, including the general public, will be developed so that future aquaculture operations within the Jurien Bay Marine Park (JBMP) will not be compromised.

3. ENVIRONMENTAL IMPACTS

The pilot project is a low intensity operation, with low initial stocking densities and is not expected to have significant environmental impacts. However, due to the sensitive environment in which the project is being undertaken, it is important to consider potential environmental impacts.

Potential environmental concerns from cage aquaculture systems may include:

- eutrophication as a consequence of increased nutrient loadings (metabolic and uneaten feed wastes will either dissolve or settle on the sea beneath the cage)
- negative interactions of aquaculture personnel and equipment with wildlife
- the genetic or competitive effect escapees may have on wild populations
- the impact of disease transmissions on wild populations.

The pilot project may result in a variety of other environmental impacts, although proposed management strategies are expected to minimise or prevent such impacts. A risk assessment of potential impacts is provided in Appendix B, while impacts associated with each activity and environmental value are summarised in Table 2.

Table 2: Potential interactions between pilot project and environment

Project Activities	Water Quality	Sediment Quality	Seagrass Meadows	Macroalgae Communities	Benthic Fauna	Seabirds	Finfish	Sea Lions	Cetaceans	Turtles	Potential Interactions
Infrastructure Construction / Installation											
Vessel Traffic	x		x	x						x	noise, collisions, propeller damage to sea floor, petroleum product spill
Mooring Placement on Seabed		x	x	x	x						physical disturbance to substrate, area immediately surrounding final placement
Mooring Tackle Installation			x	x	x						physical disturbance to substrate, area immediately surrounding final placement
Sea Pen Frame Tow from Beach to Site										x	collisions with turtles or reef platforms
Net Installation on Sea Pen						x	x	x	x	x	entanglement of wildlife in loose netting before tension is applied
Other Sea Pen Infrastructure Installation (topside rails, bird netting, etc)						x		x			human interactions, collisions, entanglements

Project Activities	Water Quality	Sediment Quality	Seagrass Meadows	Macroalgae Communities	Benthic Fauna	Seabirds	Finfish	Sea Lions	Cetaceans	Turtles	Potential Interactions
Fish Introduction											
Transport of Fish from Hatchery to Sea						x	x	x	x	x	fish escape, attraction of wildlife, also see vessel traffic
Transfer of Fish from Transfer Barge to Sea Pen						x	x	x	x	x	fish escape
Operations											
Daily inspection of infrastructure								x	x	x	human interactions, see also vessel traffic
In water net and mooring inspection (snorkel or SCUBA)								x	x	x	behaviour changes, human interactions, see also vessel traffic
Removal of dead fish						x	x	x	x		behaviour changes, human interactions
Net Changes											escape, attraction of wildlife, also see vessel traffic
Feeding	x	x	x	x	x	x	x				attraction/supplemental feeding of sea birds, addition of excess feed to sediment, benthic fauna, and local fish populations

Project Activities	Water Quality	Sediment Quality	Seagrass Meadows	Macroalgae Communities	Benthic Fauna	Seabirds	Finfish	Sea Lions	Cetaceans	Turtles	Potential Interactions
Settling of Uneaten Foods		x	x	x	x						build up of organic matter below cages (potential to change sediment redox conditions, decrease bottom water oxygen) note: expected to be minimal
Fish Excretion	x		x	x	x		x				increased dissolved nutrient loads to water column (potential for increased light attenuation and decreased bottom water oxygen)
Fish Elimination	x	x	x	x	x						build up of organic matter below cages (potential to change sediment redox conditions, decrease bottom water oxygen)
Physical Presence of Stocked Sea Pen	x		x	x	x	x	x	x	x	x	shading, localised decrease in water movement, disease transmission (both ways), increased substrate/habitat for invertebrates, entanglement, behaviour changes (attraction of birds, sea lions, sharks, cetaceans, turtles, finfish), human interactions
Physical Presence of Mooring and Associated Tackle		x	x	x	x						physical disturbance to sediment and SAV (chain drag with tide/current/wind shifts)
Disease Treatment							x				incidental treatment of wild fish

Project Activities	Water Quality	Sediment Quality	Seagrass Meadows	Macroalgae Communities	Benthic Fauna	Seabirds	Finfish	Sea Lions	Cetaceans	Turtles	Potential Interactions
Harvesting						x	x	x	x	x	escape, attraction of wildlife, also see vessel traffic
General Maintenance						x	x	x	x	x	human interactions, also see vessel traffic
Decommissioning											
Detachment of Nets from Frame						x	x	x	x	x	entanglement of wildlife in loose netting before tension is applied
Tow of Sea Pen to Shore										x	collisions
Removal of Moorings and Associated Tackle			x	x	x						localised disturbance of substrate and SAV
Fallowing	x	x	x	x	x						improvement of water and sediment quality, increased habitat for SAV

4. ENVIRONMENTAL VALUES, MANAGEMENT STRATEGIES AND MONITORING

Preservation of the environmental and social values of the JBMP is a key objective of WKL and this operation will strive to prevent environmental effects. Management actions will be incorporated into every aspect of the operations which aim to minimise or entirely eliminate environmental effects. Where effects do exist, careful targeted monitoring will be combined with directed management strategies to identify effects, trigger appropriate management actions to reduce those effects, and further monitoring to assess the effectiveness of those management actions.

4.1 Environmental Values

The way in which we protect and manage our marine environment is based on an underlying set of values. These values will reflect the contemporary views that the community holds on the importance and place of the marine environment within society. The values will change through time and are influenced by a range of concerns including the economic and social well-being of present and future generations.

The community of Western Australia places a high value on the marine environment (EPA 2000). There is an expectation that people will be able to recreate in marine waters without suffering illness or infection; consume seafood in the knowledge that it is safe to do so; and enjoy the benefits of a healthy, abundant and diverse natural environment. The marine environment is regarded as a “commons” where there is common ownership. Accordingly the community expects that their asset will be protected both now and into the future. At the same time there is general acceptance of the need to accommodate other valid societal uses of the environment such as aquaculture, industrial and domestic treated wastewater discharge, shipping, mining, harbours and marinas, even though they can lower environmental quality and/or preclude certain social uses in localised areas.

The Jurien Bay Marine Park Management Plan (JBMPMP) is designed to preserve the ecological integrity of the area within the marine park because it is representative of the unique ecosystem of the central west coast. The JBMPMP outlines the environmental values that make up this ecosystem and must therefore be protected. The Management Plan also identifies the social values that are important in the region and are to be preserved in this multiple use park.

Western Kingfish Limited’s application is in an area zoned for aquaculture within a marine park. The intent will be to focus monitoring on these areas, and areas surrounding them to ensure that impacts are effectively contained within them, that the combined size of these areas is small and, most importantly, that the agreed and designated values and uses of the broader ecosystem are not compromised. Regardless of the zoning, it is important to consider that any activity permitted within the Jurien Bay Marine Park must not affect its ecological integrity or values.

4.2 Management Strategies

Specific proactive management strategies are provided for each environmental value. These strategies will be implemented during the pilot project, not only to minimise any potential impacts from the pilot project, but also to test the effectiveness of these strategies and develop them in preparation for future project stages.

Management responses linked to monitoring results are also critical for effective monitoring and management of the aquaculture pilot project. At this pilot project stage, preliminary management actions have been set. However, given the conservative nature of the trigger values, the higher level management actions are not likely to be appropriate given the scale of the impacts (or lack thereof) likely to result from exceedance. It is proposed that for the first 12 months of the pilot project, the more severe actions, such as adjusting husbandry practices or unplanned fallowing, will not be instituted (unless ecological impacts are detected outside the aquaculture licence area) until the triggers and management responses are reviewed in light of on-site data collection, mechanistic cause-effect links, and discussion among Western Kingfish Limited, DEC, and DoF. However, if triggers are exceeded at the boundary of the aquaculture zone or outside the aquaculture zone, the full set of management responses would be instituted in sequence and the causes of these impacts fully investigated.

The primary management responses are listed in Appendix C. More specific management actions, where required, are provided in the relevant sections of this report.

4.3 Monitoring

A detailed monitoring program for water quality, sediment quality, primary producer health and benthic impacts (chemical and faunal) is set out in Appendix C. This program details specific monitoring requirements for each relevant environmental value to monitor potential direct and indirect impacts to the environment as a whole and establish cause-effect pathways. The program also identifies specific monitoring sites, including impact and reference sites and details monitoring and analysis methods. Trigger values and subsequent management actions are also identified.

Trigger Values

The preliminary trigger values set out in the monitoring program are, at this point, quite conservative and based on arbitrary regulations (which are not based on cause-effect relationships) or on limited local baseline data. The aim of trigger values is to provide insight into potential environmental impacts prior to their actual occurrence. To this aim, the trigger values will be continually re-evaluated as part of this pilot project, and adjusted when necessary (with the approval of DEC and DoF) with the aim of identifying meaningful triggers which reflect the levels at which ecological impacts are likely to occur. As the trigger levels set for water and sediment quality conditions have been based on a dataset limited in temporal or spatial resolution and are conservative values, they are likely to be exceeded

during the preliminary phases of the aquaculture operation due to natural variation in environmental conditions. Once data are collected at appropriate reference and impact sites (with high temporal resolution and over a prolonged time frame) these triggers will be re-examined and adjusted. Furthermore, proposed management responses may also require re-evaluation. The Interim EMMP provides detail on how trigger levels were established.

Other environmental values of the marine park, such as marine fauna, are not easily managed in the same trigger-based manner as the water, sediment and benthic quality. Proactive management strategies have been established to protect these values. Management objectives and targets are also set out in this document, and been developed with reference to the management objectives and targets of the Jurien Bay Marine Park Management Plan (JBMPMP). Periodic monitoring in the form of daily logs to be analysed quarterly and included in quarterly reports will be undertaken to assess the ability of the proactive management activities to achieve the goals of the EMMP. Where impacts are observed, management actions similar to those proposed for the trigger-based plan will be enacted, as described in the relevant environmental value components of this document.

Routine Reporting

Reports will be submitted to DEC and DoF quarterly in a report card type summary format (see example template in Appendix C). These reports will include monitoring results from activities undertaken in compliance with the Environmental Monitoring Program as well as those required by the Wildlife Interaction Avoidance Strategy. Annual reports will be submitted summarising results, seasonal trends, and drawing conclusions assessing the effectiveness of the monitoring and management plan and discussing any proposed changes or other issues that arise. Ongoing access by government authorities to environmental monitoring data will also be provided. As part of this reporting structure, regular review of the existing management plan will be undertaken and recommendations for improvements or changes will be made.

Non-conformance and Corrective Action Reporting

Any time monitoring triggers are exceeded and reactive management actions implemented, or incidents occur with fauna, DEC, DoF, and MPRA will be notified by the Western Kingfish Environmental Officer. This will also trigger a sequence of management actions and investigations of the cause of the exceedance or incident, as described in the monitoring program. When inspection or operations auditing shows non-conformance with established procedures or standards, an internal process will take place to identify the cause of non-compliance, identify and implement corrective action, evaluate the results of the corrective action, and implement preventative measures. If these incidents impact on the environmental quality of the area, they will also be reported to DEC, DoF, and MPRA.

5. WATER QUALITY MANAGEMENT

Water quality in the Jurien Bay Marine Park is currently high, with no major threatening inputs across the marine park. The waters are nutrient-poor due to very low terrestrial freshwater inputs and a lack of significant offshore upwelling, although sporadic local upwelling is present in summer months as a result of the Capes Current (Holloway and Pattiaratchi 2002). The pelagic zone is characterised by very clear water and a low standing crop of phytoplankton (measured as chlorophyll a). Primary production is driven by benthic ecosystems, including macroalgae and perennial seagrass communities (CALM and MPRA 2005).

The then DoE (2005) conducted an analysis of background concentrations of selected toxicants in the coastal waters of the Jurien Bay Marine Park, and determined that coastal waters were generally of very high quality. Metals concentrations were low with localised elevations near Cervantes, and no organic chemicals were detected. The study recommended that the ANZECC and ARMCANZ 99% species protection trigger guidelines were appropriate for the marine waters, except for cobalt where the 95% trigger guideline was appropriate (2000).

5.1 Policy

- The pilot project will not significantly impact the water quality of the Jurien Bay Marine Park outside the aquaculture licence boundary.

5.2 Objectives

- To prevent the project from influencing water quality in the Jurien Bay Marine Park outside the aquaculture licence boundary
- To identify changes in water quality in the vicinity of the pilot project
- To identify the cause-effect pathway of any changes in water quality
- To appropriately manage identified impacts on water quality that result from the pilot project
- To gather site specific baseline data to inform monitoring and management of future project stages.

5.3 Environmental Quality Standards

- Monitoring, reporting and management undertaken as detailed in the Environmental Monitoring Program (Appendix C)
- Sufficient baseline data to perform impacts assessment and monitoring of future project stages.

5.4 Proactive Management Strategies

- The quantity of feed delivered to farm fish shall be regulated based on regular fish body weight measurements (to establish biomass) and observations of fish feeding behaviour to minimise metabolic and uneaten feed waste, therefore reducing potential impacts on water quality.
- All farm fish mortalities shall be removed daily to avoid decomposition and subsequent negative impacts on water quality.
- Fish stocking densities will be low to reduce the likelihood and severity of potential water quality impacts.
- No discharge of sewage (treated or otherwise) into the marine environment from the pilot project. Toilet facilities will be provided on board vessels (if practical for boat size) and pumped out for appropriate land-based disposal.
- Proper maintenance of equipment to reduce impact on water quality.
- Harvesting water transported to shore for proper disposal.

5.5 Monitoring, Recording and Reporting

- The monitoring program for water quality is detailed in the Environmental Monitoring Program (Appendix C).
- Each monitoring event will be recorded by the Environment Officer in a report card type summary format and report to DEC, DoF and MPRA (see example template in Appendix C).
- Daily records of fish feeding behaviour and weekly estimates of biomass will be kept. Weekly review of these records will be undertaken to regulate feed quantities as appropriate.
- Reports will be submitted to DEC and DoF quarterly and annually detailing the results of all monitoring undertaken in accordance with the Environmental Monitoring Program. Also included will be records of fish feed quantity in relation to fish and biomass feeding behaviour.

5.6 Reactive Management Strategies

- The reactive management strategies for water quality are detailed in the Environmental Monitoring Program (Appendix C).

6. SEDIMENT QUALITY

Although few studies have been conducted addressing sediment contaminants in the Jurien Bay Marine Park, sediment quality is assumed to be very high. There are few inputs of contaminants or nutrients to the area due to its location far from population centres, lack of large port facilities and low terrestrial runoff.

6.1 Policy

- The pilot project will not significantly impact the sediment quality of the Jurien Bay Marine Park outside of the aquaculture licence boundary.

6.2 Objectives

- To identify changes in sediment quality in the vicinity of the pilot project
- To identify the cause-effect pathway of any identified changes in sediment quality
- To appropriately manage identified impacts on sediment quality that result from the pilot project to contain them within the aquaculture licence boundary
- To gather site specific baseline data to inform monitoring of future project stages.

6.3 Environmental Quality Standards

- Monitoring, reporting and management undertaken as detailed in the Environmental Monitoring Program (Appendix C)
- Sufficient baseline data to inform monitoring of future project stages.

6.4 Proactive Management Strategies

- The quantity of feed delivered to farm fish shall be regulated based on regular fish body weight measurements (to establish biomass) and observations of fish feeding behaviour to minimise metabolic and uneaten feed waste, therefore reducing potential impacts on sediment quality.
- All farm fish mortalities shall be removed daily and disposed onshore to avoid decomposition and subsequent negative impacts on sediment quality.
- Fish stocking densities will be low (< 15 kg/m3) to reduce the likelihood and severity of potential sediment quality impacts.

6.5 Monitoring, Recording and Reporting

- The monitoring program for sediment quality is detailed in the Environmental Monitoring Program (Appendix C).
- Each monitoring event will be recorded by the Environment Officer in a report card type summary format (see example template in Appendix C).
- Daily records of fish feeding behaviour and weekly estimates of biomass will be kept. Weekly review of these records will be undertaken to regulate feed quantities as appropriate.
- Reports will be submitted to DEC and DoF quarterly and annually detailing the results of all monitoring undertaken in accordance with the Environmental Monitoring Program and records of fish feed quantity in relation to fish and biomass feeding behaviour.

6.6 Reactive Management Strategies

- The reactive management strategies for sediment quality are detailed in the Environmental Monitoring Program (Appendix C).

7. BENTHIC FAUNA

Marine invertebrate communities in the JBMP are diverse, found through all habitat types in the marine park and comprise a diversity of marine invertebrate communities, many of them endemic, such as crustacean, mollusc, sea star and brittle star species. A biological survey by the then Department of Conservation and Land Management (CALM) in 1997 identified 205 invertebrate species in JBMP, with a mixture of tropical and temperate biota. Many species were also found to be at their northern or southern distribution limits within the marine park. Sponge species are considered to be especially important, since they are likely to be endemic and also have the potential to contain important pharmaceutical substances (CALM and MPRA 2005).

The pilot project could impact on benthic fauna through the introduction of increased suspended solids, including from feed and metabolic waste, which increases turbidity, light attenuation and sedimentation,, abrasion, clogging of pores, respiratory and feeding organs, and even smothering and shading of benthic flora and fauna. In the aquaculture context, farm management criteria (i.e. cage size, stocking density/biomass, feed input and timing/duration of stocked/fallow period) are critical factors in determining the impact and recovery level of benthic fauna (Macleod and Forbes 2004).

7.1 Policy

- The pilot project will not result in an alteration to natural levels of benthic fauna abundance and species composition in the Jurien Bay Marine Park outside the aquaculture licence area.

7.2 Objectives

- No significant change to benthic fauna diversity or abundance outside the licence area as a consequence of the pilot project
- No change to benthic species composition or diversity in the general use or sanctuary zones as a consequence of the pilot project.

7.3 Environmental Quality Standards

- Monitoring, reporting and management undertaken as detailed in Appendix C
- No significant difference in benthic fauna diversity or abundance in the marine park before and after the pilot project
- No significant difference in the number of protected benthic fauna species in the marine park before and after the pilot project.

7.4 Proactive Management Strategies

- The quantity of feed delivered to farm fish shall be regulated based on regular fish body weight measurements (to establish biomass) and observations of fish feeding behaviour to minimise metabolic and uneaten food waste, therefore reducing potential impacts on benthic fauna.
- All farm fish mortalities shall be removed daily to avoid decomposition and subsequent negative impacts on benthic fauna.
- Fish stocking densities will be low (< 15 kg/m3) to reduce the likelihood and severity of potential benthic fauna impacts.

7.5 Monitoring, Recording and Reporting

- The monitoring program for benthic fauna is detailed in the Environmental Monitoring Program (Appendix C).
- Each monitoring event will be recorded by the Environment Officer in a report card type summary format (see example template in Appendix C).
- Daily records of fish feeding behaviour and weekly estimates of biomass will be kept. Weekly review of these records will be undertaken to regulate feed quantities as appropriate.
- Reports will be submitted to DEC and DoF quarterly (after each monitoring event) and annually detailing the results of all monitoring undertaken in accordance with the Environmental Monitoring Program and records of fish feed quantity in relation to fish biomass and feeding behaviour.

7.6 Reactive Management Strategies

- Any changes in abundance or species composition of benthic infauna from baseline levels (significant within error of measurement) outside the aquaculture license area will trigger Level 3 Management Actions, including potential ceasing of operations (refer to Appendix C).

8. MACROALGAE

Macroalgae are a key primary producer in the JBMP with at least 125 species present, the highest diversity occurring on intertidal reefs, both shallow and deep (>20 m) limestone reefs and platforms, and some species also present as epiphytes. Macroalgal communities in the JBMP are considered to be in very good condition with no major pressures present. Additionally, most algal communities are able to recover rapidly from human disturbance (CALM and MPRA 2005).

8.1 Policy

- The pilot project will not result in changes to macroalgae outside the aquaculture licence area.

8.2 Objectives

- To quantify the diversity and extent of macroalgae in the vicinity of the pilot project
- To prevent the loss of macroalgae abundance and diversity outside the aquaculture licence area.

8.3 Environmental Quality Standards

- Monitoring, reporting and management undertaken as detailed in Appendix C
- No loss of macroalgae abundance and diversity in the marine park as a consequence of the pilot project.

8.4 Proactive Management Strategies

- Staff will not collect or move detached macroalgae found in the water or on shore to minimise disruption to trophic linkages between benthic habitats.
- No anchoring will occur directly on or within swinging distance of seagrass beds or hard coral reefs in any circumstances, and wherever possible no anchoring within any other macroalgal community (note: work vessels will tie to cages rather than anchor).
- The quantity of feed delivered to farm fish shall be regulated based on regular fish body weight measurements (to establish biomass) and observations of fish feeding behaviour to minimise metabolic and uneaten food waste, therefore reducing potential impacts on macroalgal communities.
- All farm fish mortalities shall be removed daily to avoid decomposition and subsequent negative impacts on macroalgal communities.

- Fish stocking densities will be low (< 15 kg/m3) to reduce the likelihood and severity of potential macroalgal community impacts.

8.5 Monitoring, Recording and Reporting

- The monitoring program for macroalgae (benthic primary producers) is detailed in the Environmental Monitoring Program (Appendix C).
- Each monitoring event will be recorded by the Environment Officer in a report card type summary format (see example template in Appendix C).
- Daily records of fish feeding behaviour and weekly estimates of biomass will be kept. Weekly review of these records will be undertaken to regulate feed quantities as appropriate.
- Reports will be submitted to DEC and DoF quarterly (after each monitoring event) and annually detailing the results of all monitoring undertaken in accordance with the Environmental Monitoring Program and records of fish feed quantity in relation to fish biomass and feeding behaviour.

8.6 Reactive Management Strategies

- The reactive management strategies for macroalgae (benthic primary producers) are detailed in the Environmental Monitoring Program (Appendix C).

9. SEAGRASS

Seagrasses are important benthic primary producers (BPP) and they provide an important habitat for a diversity of marine biota, including some commercial (rock lobster) and recreational species. Seagrasses also act to trap sediment and maintain pelagic water quality and light penetration. Seagrass meadows are present over 215 square kilometres, or about 25% of the total area of the Marine Park. Nine species of seagrass have been recorded in the JBMP, which is considered to be a high diversity. The majority of species are slow-growing perennial genera such as Posidonia and Amphibolis: some ephemeral species such as Halophila also occur, but are not abundant. The seagrass meadows in the Marine Park are in generally good condition, with the exception of some localised mooring damage (CALM and MPRA 2005). Very little seagrass (less than 5% cover) exists within the WKL aquaculture licence.

9.1 Policy

- The pilot project will not result in any loss of perennial seagrass outside the aquaculture licence area.

9.2 Objectives

- To quantify the diversity and extent of seagrass in the vicinity of the pilot project
- No loss of seagrass diversity or biomass in the marine park
- Manage water quality and benthic impacts to prevent loss of seagrass.

9.3 Environmental Quality Standards

- Monitoring, reporting and management undertaken as detailed in the Environmental Monitoring Program (Appendix C)
- No significant change in seagrass diversity or biomass in the marine park before and after the pilot project.

9.4 Proactive Management Strategies

- There will be no anchoring either directly in or within swinging distance of seagrass beds in any circumstances (note: work vessels will tie to cages rather than anchor).
- Transport routes for work vessels will avoid shallow seagrass beds.
- All seapen moorings shall be located away from seagrass beds.

- The quantity of feed delivered to farm fish shall be regulated based on regular fish body weight measurements (to establish biomass) and observations of fish feeding behaviour to minimise metabolic and uneaten food waste, therefore reducing potential impacts on seagrass communities.
- All farm fish mortalities shall be removed daily to avoid decomposition and subsequent negative impacts on seagrass communities.
- Fish stocking densities will be low (< 15 kg/m3) to reduce the likelihood and severity of potential macroalgal community impacts.

9.5 Monitoring, Recording and Reporting

- The monitoring program for seagrass (benthic primary producers) is detailed in the Environmental Monitoring Program (Appendix C.
- Each monitoring event will be recorded by the Environment Officer in a report card type summary format (see example template in Appendix C).
- Daily records of fish feeding behaviour and weekly estimates of biomass will be kept. Weekly review of these records will be undertaken to regulate feed quantities as appropriate.
- Reports will be submitted to DEC and DoF quarterly (after each monitoring event) and annually detailing the results of all monitoring undertaken in accordance with the Environmental Monitoring Program and records of fish feed quantity in relation to fish biomass and feeding behaviour.

9.6 Reactive Management Strategies

- The reactive management strategies for seagrass (benthic primary producers) are detailed in the Environmental Monitoring Program (Appendix C).

10. CETACEANS AND TURTLES

Six species of toothed whale and eight species of baleen whale have been recorded in the JBMP area and the deeper waters offshore, including the bottle-nosed dolphin (Tursiops truncates) and humpback whale (Megaptera novaeangliae), which are regularly seen in the marine park waters. Five of the eight baleen whale species recorded from the marine park are threatened due to over-exploitation from previous whaling activities. These species are protected under the Wildlife Conservation Act 1950.

At least three species of sea turtle have also been recorded in the JBMP and are thought to be present year-round. However, there has been no recorded turtle breeding in the marine park. Physical collisions, boat noise and entanglement are thought to be potential threats to these species (CALM and MPRA 2005).

10.1 Policy

- The pilot project will not significantly disturb cetaceans and turtles in the Marine Park.

10.2 Objectives

- No human interactions with cetaceans or turtles
- No injuries to cetaceans or turtles as a result of the pilot project (including through collision with boats or entanglement)
- To minimise noise disturbance to cetaceans and turtles from the project operations
- To record and report all sightings of cetaceans and turtles to aid in the implementation of reactive management strategies and add to the existing knowledge base on these species.

10.3 Environmental Quality Standards

- No collisions with turtles or cetaceans.
- No entanglements of turtles or cetaceans in equipment associated with the pilot project.
- Quarterly and annual reporting of cetacean and turtle sightings.

10.4 Proactive Management Strategies

- All staff shall be inducted in and comply with the WKL Wildlife Interaction Avoidance Strategy consistent with DEC policy (Appendix C).
- Feeding, touching or swimming with cetaceans or turtles is not permitted.

- A dedicated marine fauna watch person will be in place to search for cetaceans and turtles during journeys between the shore/mooring and sea pens to avoid collisions.
- All nets, ropes and cages shall be maintained in proper working order, being taught and without damage that may enable entanglement of cetaceans or turtles.
- Nets, ropes and cages shall be inspected daily for cetaceans and turtles that may have become entangled.
- No littering. All rubbish is to be placed in dedicated waste bins, which will have secure lids and be secured to the vessel or work platform. No rubbish will remain on the site or be disposed at sea.

10.5 Monitoring, Recording and Reporting

- All interactions between animals and staff or animals and aquaculture equipment (including entanglement or collisions) will be recorded and reported to the WKL Environment Officer.
- All sightings of cetaceans and turtles, including any dead animals, within 500m of the seapens or work vessel routes will be recorded. Report all sightings quarterly as per the WKL Wildlife Interaction Avoidance Strategy (Appendix D).
- Immediately report any cetacean or turtle in distress, including entangled or stranded animals, to the WKL Environment Officer and DEC's Wildcare Hotline on (08) 9474 9055 (24-hour emergency number) or the DEC Duty Officer on (08) 9334 0224, in addition to the DEC District Office in Jurien Bay on (08) 9652 1911.

10.6 Reactive Management Strategies

- If a collision occurs between a work vessel and a cetacean or turtle, or a cetacean or turtle is found entangled in the sea pen netting, immediately contact the WKL Environment Officer and DEC's Wildcare Hotline on (08) 9474 9055 (24-hour emergency number) or the DEC Duty Officer on (08) 9334 0224.
- If turtles and/or cetaceans are frequently sighted within 500 m of the sea pens or work vessel routes, a reduced speed should be adopted for all work vessels.
- If cetaceans or turtles are found entangled in aquaculture equipment, the cause of entanglement will be reviewed by the WKL Environmental Officer and maintenance practices will be adjusted accordingly.

11. SEA LIONS

The endemic Australian sea lion (Neophoca cinerea) is listed under the Wildlife Conservation Act 1950 as requiring 'special protection'. This species occurs regularly within the JBMP and is known to breed on the nearby Buller, North Fisherman and Beagle Islands. These breeding grounds are utilised at all times during the sea lions' 17-18 month breeding cycle, which includes a five month breeding season, although maximum use occurs during the pupping season (Gales et al. 1992). Access to these islands is prohibited at all times (CALM and MPRA 2005).

Sea lions are susceptible to disturbance from boating activities near breeding islands and haul-out sites. Artificial feeding regimes, entrapment, litter, competition for marine resources and pollution may also impact upon sea lions. Of these, human disturbance and entrapment are currently considered to be major pressures. The small existing population of this species in and around the JBMP is stable, although the slow breeding rate of the animals renders them highly vulnerable to human disturbance (CALM and MPRA 2005).

Gales and others (1992) performed a study of the breeding and movements of Australian sea lions in the Jurien Bay Marine Park. The study found that N. cinerea has a 17-18 month seasonal breeding cycle, including a 5-month breeding season, and suggested that this cycle was unique to each of the breeding colonies.

Sea lion breeding grounds are located on. Human-sea lion interaction is controlled by the Wildlife Conservation (Close Season for Marine Mammals) Notice 1998.

11.1 Policy

- The pilot project will not significantly disturb Australian sea lions in the Marine Park.

11.2 Objectives

- No human interactions with sea lions
- No consumption of farmed fish (dead or alive) by sea lions
- No injuries to sea lions from collision with boats or entanglement
- Minimise noise disturbance to sea lions
- Record and report all interactions with sea lions to aid in the implementation of reactive management strategies.

11.3 Environmental Quality Standards

- No collisions with sea lions
- No access of sea lions to seapens
- No entanglements of sea lions in equipment associated with the pilot project.

11.4 Proactive Management Strategies

- All staff shall be inducted in and comply with the WKL Wildlife Interaction Avoidance Strategy (Appendix D).
- Feeding, touching or swimming with sea lions is not permitted.
- A dedicated marine fauna watch person will be in place to search for sea lions during journeys between the shore/mooring and sea pens to avoid collisions.
- All nets, ropes and cages shall be maintained in proper working order, being taught, without damage that may enable entanglement of sea lions.
- Nets, ropes and cages shall be inspected daily for sea lions that may have become entangled.
- No littering. All rubbish is to be placed in dedicated waste bins, which will have secure lids and be secured to the vessel or work platform.
- WKL will not allow the use “Seal Crackers” or other active deterrent systems.

11.5 Monitoring, Recording and Reporting

- All interactions between animals and staff or animals and aquaculture equipment (including entanglement or collisions) will be recorded in the wildlife log book and reported to the WKL Environment Officer.
- All sightings of sea lions, including any dead animals, within 500 m of the seapens or work vessel routes will be recorded in the wildlife log book. Report all sightings quarterly and annually as per the WKL Wildlife Interaction Avoidance Strategy (Appendix D).
- Immediately report any sea lion in distress, including entangled or stranded animals, to the WKL Environment Officer and DEC’s Wildcare Hotline on (08) 9474 9055 (24-hour emergency number) or the DEC Duty Officer on (08) 9334 0224, in addition to the DEC District Office in Jurien Bay on (08) 9652 1911.

11.6 Reactive Management Strategies

- If a collision occurs between a work vessel and a sea lion, or a sea lion is found entangled in the sea pen netting, immediately contact the WKL Environment Officer and DEC’s Wildcare

Hotline on (08) 9474 9055 (24-hour emergency number) or the DEC Duty Officer on (08) 9334 0224.

- If sea lions are frequently sighted within 500 m of the sea pens, records of behavioural observations should be reviewed and the cause and effect pathway identified. Reducing feeding rates, fallowing, reducing stocking rates or other procedures as relevant will be considered to reduce behavioural changes due to the presence of aquaculture activities.
- If sea lions are frequently sighted within 500 m of the sea pens or work vessel routes, a reduced speed should be adopted for all work vessels.
- If sea lions are found entangled in aquaculture equipment, the cause of entanglement will be reviewed by the WKL Environmental Officer and maintenance practices will be adjusted accordingly.

12. FINFISH

Fish fauna in the JBMP include warm-temperate, subtropical and tropical species, many of which are important from both ecological and tourism perspectives. There are an estimated 250 species of fish present in the park, including two protected species, the great white shark Carcharodon carcharias, and the leafy sea dragon Phycodorus eques (CALM and MPRA 2005):

Fishing is currently the major stress upon fish species in the marine park. Although non-target finfish species are likely to be in a close to natural state, the status of many target species is not known. Other activities which degrade critical habitats and trophic interactions are also identified as potential future pressures (CALM and MPRA 2005).

The State of the Fisheries Report 2004/05 highlights the concerns and threats to stocks of the dusky whaler, whiskery shark and sandbar sharks (McAuley and Gaughan 2005). There is also some concern for populations of grey nurse sharks in Western Australia. The International Union for Conservation of Nature (IUCN) has listed grey nurse sharks as 'near-threatened' in Western Australia. Grey nurse sharks are considered vulnerable under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (October 2001) and protected in Western Australian waters under the Wildlife Conservation Act 1950. Other species that are not listed under either the EPBC Act or the IUCN Red List but are considered vulnerable to overexploitation on the west coast of Western Australian include Westralian dhufish, baldchin groper, mulloway, salmon and blue groper (DoF 2001).

In Western Australia, wild yellowtail kingfish Seriola lalandi are known to be present at least as far north as the Abrolhos Islands. Recreational fishing upon the species is not permitted in the Abrolhos, however, and currently very little information exists on the distribution, movement or population dynamics of the wild population in Western Australia. Small yellowtail kingfish (less than 60 cm) do not generally travel more than 50km, whereas fish up to 90 cm move distances greater than 50 km (Hutson et al 2007a). Longer migrations are also possible, although they are believed to be rare (Hutson et al 2007a). Tagging data on the genetically similar Seriola hippos also shows that fish from Perth can move up to 2400 km into South Australian waters (Rowland, A., Murdoch University, unpublished data).

12.1 Policy

- The pilot project will not result in an alteration to natural levels of finfish abundance and size composition in the Marine Park.

12.2 Objectives

- No death of finfish from entanglements in aquaculture equipment

- Early detection and treatment of disease in farmed fish will be undertaken, without transfer to wild finfish
- To prevent the escape of farmed fish
- To minimise supplied feed available to wild finfish.

12.3 Environmental Quality Standards

- Zero finfish deaths from entanglements in aquaculture equipment
- No introduction of disease to wild finish in the marine park
- Low abundance of wild finish observed feeding on farm fish feed
- Zero escapes from the operation.

12.4 Proactive Management Strategies

- All staff shall be fully inducted in and comply with the WKL Wildlife Interaction Avoidance Strategy (Appendix D).
- Feeding, touching or swimming with finfish, including sharks and rays, is not permitted.
- The quantity of feed delivered to farm fish shall be regulated 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 on the feed available to wild finfish.
- Proper installation and maintenance of bird exclusion netting to reduce the chance of fish escapes.
- Proper regular maintenance and appropriate net gauge to minimise risk of fish escapes.
- No fishing by staff during operations to avoid pressure on fish stocks.
- Regular health monitoring and disease testing (including continuous and regular scheduled behavioural inspection and regular quantitative inspection) of farm stock and implementation of an appropriate response plan in the case of health decline of farm fish for disease and subsequent treatment where relevant.
- Ensure proper hygiene and maintenance of cages and nets to reduce risk of disease.
- Ensure fish transfer and harvesting operations are designed to eliminate the chance of escape by farmed fish.
- Use hydrogen peroxide for disease treatment to prevent effects of treatment on other animals or the environment.

12.5 Monitoring, Recording and Reporting

- Record the behavioural responses of farmed fish daily to ensure changes are noted and an appropriate response taken (such as disease treatment or regulation of feed quantities).
- Report impending disease treatment to the WKL Environment Officer.
- Record all disease treatment provided to farm fish, along with subsequent success or failure of treatment. Report quarterly and annually to DEC on all disease treatment and treatment outcomes.
- Report all instances of large (>5%) mortalities to the DoF Principal Fish Pathologist within 24 hours.
- Require all fingerlings brought on site to undergo health certification prior to transfer from the hatchery to the marine environment.
- Develop a Biosecurity Plan for the site.
- Report all instances of fish escapes to the CEO of the Department of Fisheries.
- Record quantities and type of by-catch during transfer and harvesting of farm fish, if any. The WKL Environmental Officer shall review these records after each transfer or harvesting event and enact procedural or equipment changes where necessary to minimise or avoid by-catch. By-catch will be reported quarterly and annually to DEC. Any by-catch of protected species must be reported to the Australian Fisheries Management Authority (AFMA).
- Record and report any interactions between animals and staff or animals and aquaculture equipment immediately to the WKL Environmental Officer.
- Record all sightings of sharks, rays or protected finfish including any dead animals, within 500 m of the sea pens or work vessel routes as per the WKL Wildlife Interaction Avoidance Strategy (Appendix D).
- Record behavioural observations (such as schooling, aggression or feeding), types and approximate numbers of fish daily around aquaculture equipment, including specific observations during fish feeding.
- Immediately report any sharks, rays or protected finfish (or other finfish as deemed appropriate) in distress, including entangled or stranded animals, to the WKL Environment Officer and DEC's Wildcare Hotline on (08) 9474 9055 (24-hour emergency number) or the DEC Duty Officer on (08) 9334 0224, in addition to the DEC District Office in Jurien Bay on (08) 9652 1911.

12.6 Reactive Management Strategies

- Ensure any by-catch of wild finfish during transfer and harvesting of farm fish is returned immediately to the ocean if alive, or disposed of as per farm fish mortalities if dead.

- Any potential transfer of disease to wild finfish should be reported to the WKL Environmental Officer immediately and to DEC, MPRA and DoF within 1 working day.
- In the event of frequent disease, stocking densities and nutrition levels shall be reviewed and adjusted as relevant.

13. SEABIRDS

Nesting areas for at least 15 species of seabird exist within the JBMP. These island nesting areas are of considerable ecological importance, since breeding colonies now exist only on the island nature reserves and rocky outcrops free from introduced predators, rather than on the mainland coast. They also serve as a tourist attraction. The nesting sites are currently in very good condition; however, human activity on or close to the islands is considered to be disruptive (CALM and MPRA 2005).

13.1 Policy

- The pilot project will not significantly disturb seabird populations in the marine park.

13.2 Objectives

- No death of birds from entanglements in aquaculture equipment
- No artificial feeding of birds via either farm fish or supplied feed
- No interaction of seabirds with sea cages.

13.3 Environmental Quality Standards

- Zero bird deaths from entanglements in aquaculture equipment
- No farm fish taken by birds
- Infrequent observations of birds feeding on farm fish feed.

13.4 Proactive Management Strategies

- All staff shall be fully trained in and comply with the WKL Wildlife Interaction Avoidance Strategy (Appendix D).
- The quantity of feed delivered to farm fish shall be regulated 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 feed available to seabirds.
- Proper installation and maintenance of bird exclusion netting shall be undertaken to ensure no entanglement of birds.
- Feeding or touching birds is not permitted.

13.5 Monitoring, Recording and Reporting

- The quantity of feed delivered to each cage unit per feeding session should be recorded, along with the behavioural responses of farm fish. These records should be regularly reviewed in order to regulate quantities of feed delivered and minimise feed available to birds.
- Record and report any interactions between animals and staff or animals and aquaculture equipment immediately to the WKL environment manager.
- Record all sightings of protected birds, including any dead animals, within 500m of the seapens or work vessel routes as per the WKL Wildlife Interaction Avoidance Strategy (Appendix D).
- Record behavioural observations, types and approximate numbers of birds daily around aquaculture equipment, including specific observations during fish feeding.
- Immediately report any bird in distress, including entangled animals, to the WKL Environment Officer and DEC's Wildcare Hotline on (08) 9474 9055 (24-hour emergency number) or the DEC Duty Officer on (08) 9334 0224, in addition to the DEC District Office in Jurien Bay on (08) 9652 1911.

13.6 Reactive Management Strategies

- If a collision occurs between a work vessel and a protected bird, or any bird is found entangled in the sea pen netting, immediately contact the WKL Environment Officer and DEC's Wildcare Hotline on (08) 9474 9055 (24-hour emergency number) or the DEC Duty Officer on (08) 9334 0224, in addition to the DEC District Office in Jurien Bay on (08) 9652 1911.
- If large numbers of birds frequently occur around or on the sea pens, records of behavioural observations should be reviewed and the cause and effect pathway identified. Reducing feeding rates, fallowing, reducing stocking rates or other procedures as relevant will be modified to reduce behavioural changes in birds (or other carnivorous conservation significant marine fauna) due to the presence of aquaculture activities.
- If seabirds are found entangled in aquaculture equipment, the cause of entanglement will be reviewed by the WKL Environmental Officer and maintenance practices will be adjusted accordingly to prevent future incidents.

14. REFERENCES

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Appendix A – Description of the Project

1. Description of Activities - 200 Tonne Pilot Aquaculture Project

The proposed operation is for a two year pilot program to produce up to 200 tonnes of yellowtail kingfish within designated aquaculture zones of the Jurien Bay Marine Park. This is a small scale operation on 30 hectares of licensed area within the Hill River Special Purpose (Aquaculture) Zone. This pilot study will provide the information required to determine the technical feasibility and environmental monitoring and management requirements of a larger commercial scale operation. Following the pilot study, there are plans to expand the aquaculture operation within the Hill River Aquaculture Zone and potentially in the Seaward Ledge Special Purpose (Aquaculture) Zone.

WKL has onshore and offshore facilities to support the aquaculture venture. WKL holds three aquaculture licenses within the Hill River Aquaculture Zone. License Area C has been moved to a location with less seagrass, and is now represented on figures.

Sea-based infrastructure will include two sea pen systems (see Appendices 1 and 2 for a schematic of the planned sea pen layout). A single polar circle sea pen, based on the floating ring (polar circle) sea pen system currently used for Atlantic salmon aquaculture in Tasmania and the yellowtail kingfish industry of South Australia will be utilized for early development work. This system uses flexible nylon or other synthetic net materials. Net changes are required as nets become overgrown by fouling organisms (i.e. antifouling will not be used on sea pen netting), and to increase net gauge as fish grow. Above the water there is a rail and netting to exclude seals.

The second and principal sea pen system will use the System Farm® approach. The System Farm approach is to use square, metal mesh sea pens which can be linked together creating a stable platform. The System Farm module will consist of 24×24 m pen units. It is anticipated that 6 units will be adequate for the proposed 200 tonne operation.

Both sea pen systems are moored with the use of anchors, chain and rope. It is relatively easy to move pens, even when stocked. This means that sea pens can be moved to a new location to allow fallowing of sites, even within a production run. Bird barrier netting will be installed to both systems.

Fish will be fed an extruded, pelletised, sinking commercial feed, of which the major constituents are protein (~50%), lipids (~17%), carbohydrates (~15%), moisture (~8%) and ash (~10%). Yellowtail kingfish are fast growing fish and are anticipated to attain a market size of approximately 3-4 kg in size within approximately 15 months.

Figures for estimated nutrient production for this proposed operation have been derived from a mathematical model developed by Dr Simon Stone and Skrettings International, the producer of the Yellow tail kingfish feed (Table 1). While the details of this model are not available, the figures in this table closely match the relative proportions of waste materials resulting from feed additions to other species of fish in sea pens which have been published (Black 2001; Enell 1995; Nash 2001; Pearson and Black 2001).

Table 1. Fish growth, biomass, and waste production estimates based on growth results from South Australia.

	Start	Month 3	Month 6	Month 9	Month 12	Month 15	Month 18	Month 21	Month 24
Fish Stage									
Biomass cohort 1 (tonnes)	0.3	8.2	27.9	51.2	71.5	89.7	103.6	78.5	20.6
Harvest cohort 1							15.0	25.0	22.2
Biomass cohort 2 (tonnes)			0.2	14.3	39.8	54.4	72.1	98.7	109.7
Harvest cohort 2									25.0
Biomass total (tonnes)		8.2	28.0	65.6	111.4	144.1	190.7	202.2	152.5
Feed									
Total feed consumed (tonnes/ month)		5.6	13.3	24.7	20.6	22.4	35.6	34.2	20.6
Waste at FCR 1.8									
Total N waste (kg / day)		10.33	24.53	45.56	37.99	41.31	65.66	63.08	37.99
Total P waste (kg / day)		1.81	4.31	8.00	6.68	7.26	11.54	11.08	6.68
Total DM waste (kg / day)		44.80	106.40	197.60	164.80	179.20	284.80	273.60	164.80

*This description of activities will be expanded to include more detail in the final EMMP which will be completed and signed off by DoF and DEC before the fish stock reaches 3 tonnes (or within 2 months).

1.1 Summary of best management practice husbandry protocols:[1]

Five main areas to be addressed:

1. net and cage management
2. feeding protocols
3. fish health and parasite management
4. harvesting and fish transfer
5. management of mortalities.

[1] **Further detail will be provided in the final EMMP through the creation of individual value-based EMPs (e.g. water quality EMP)

1.1.1 Net and cage management

Polar circle

WKL will be using the polar circle system for early stages of the production cycle and as a comparison for the System Farm operation.

For the first stage we will be stocking fingerlings 5-100 g into small ring nets which are suspended inside the main polar circle. The main polar circle is 80 m circumference cage system ~25 m diameter; this will have predator nets on the outside to exclude seals and other predators. There will also be containment net on the inside of the 80 m cage. Inside the 80 m cage there will be two or three smaller “mini-Polar Circles” of 6 m diameter. These will have nets to contain the fingerlings.

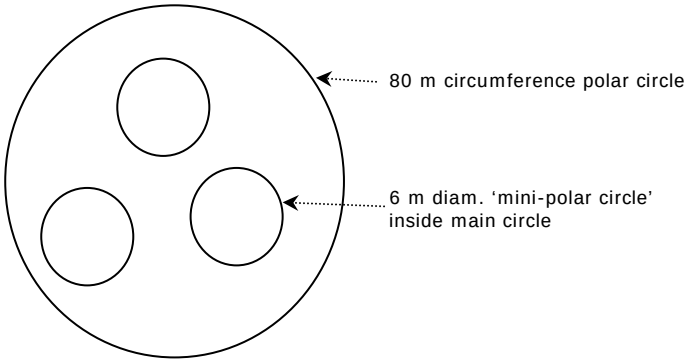


Figure 1 Polar Netting Arrangement

The nets on the small cages will be changed at regular intervals to ensure that the mesh size is appropriate for the fingerling size and that the mesh apertures are not occluded by fouling organisms and seaweeds. The fish grow very fast at these early stages, which means that net changes are based as much on the need for appropriate mesh size, as for cleanliness and fouling condition on the mesh fabric.

The nets on these small circles will be changed as required, the timing of which will vary depending on water temperature, the aim will be to keep them proactively clean at all times.

The nets that have been replaced will be removed to shore facility for cleaning, drying and storage.

The net change processes are based on the very well established protocols that have been developed in the global salmon sea cage industry and also used in the South Australian Yellowtail kingfish industry. In principle the following steps are involved:

1. Assessment of net condition, to justify the need to change net
2. If nets are being changed to a larger aperture mesh size then there needs to be a measurement of average fish size and variation in fish size to ensure that there is no loss of smaller fish through mesh.
3. The old net is pulled up slightly to allow space for the new net.
4. New net is put in place under the old net and attached to the rings and hooks on the polar circle frame
5. When the new net is attached and in place the old net can be unhooked and removed from the water.

6. This is a combination of manual work with lifting equipment from support boats for heavy lifting eg removal of old nets.
7. The old net is loaded on the boat folded returned to shore for cleaning, drying, checking and storage.

System Farm

The System Farm does not have net changes in quite the same way as the Polar Circle system. The main brass nets have a large mesh aperture 40 mm on the bar; these act as predator nets during early stages of the culture process, with the small fish being contained by nylon nets which are suspended on the inside of the brass net. During these early stages fouling is controlled by having a net that is larger than the square cage. When nets become slightly fouled, or just as a pre-emptive measure, the submerged half of the net is winched out and the new part then folds into the water and becomes the containment net. This allows the net that has been in the water to be dried and exposed to air and sunlight; this kills parasite eggs and the fouling organisms. When used pre-emptively there is no excessive build up of fouling organisms and biomass and this limits issues associated with managing dirty nets. It also has profound implications for health management because a number of diseases and parasite lifecycles are closely associated with the fouling communities on older nets.

When the containment net needs to changed to a larger mesh aperture the old net is elevated slightly, the new net is fed under the old net and then the old net can be removed.

For later stages of the culture process when fish are larger the nylon containment nets are removed and the fish are released into the cage formed by the brass nets.

Biofouling communities are inhibited from developing on the brass nets; this means that “net changes” are not required for a substantial part of the kingfish growth cycle. Disease and parasite management are also improved because the biofouling and biofilms that are associated with these problems are greatly reduced with this culture system.

1.1.2 Feeding protocols

The yellowtail kingfish are fed exclusively formulated diets; these will be produced by Skrettings in Tasmania for the first part of this trial. Other feed producers may be used subsequently, but the principles do not change, these diets are all based on fish meal with plant products and other additives. Fundamentals such as nutritional composition and feed physical characteristics are a function of kingfish biology and logistics of feed manufacture, storage and handling. These products must meet AQIS standards of biosecurity with respect to imported components.

Feed protocols:

1. For this pilot stage operation we will not be implementing automated feeding systems because the cost, scaling and logistics are not appropriate for this small operation. Feeding will be done manually, based on feed schedules, theoretical requirements of the estimated biomass and on visually assessed feeding responses by the fish.
2. Feed will be delivered to the fish farm by boat in 25 kg bags.
    a. For the Polar Circle the feed remains on the boat and is delivered to the fish by a portable blower system which ‘sprays’ the feed onto the water surface
    b. For the System Farm, bags of feed, sufficient for a few days will be delivered and loaded onto the central walkway
3. Juvenile fish are fed four times per day with this schedule determined by the operations manager based on established fish husbandry criteria and regular measurements of fish body weight.

4. The feed is delivered to the fish by a small portable blower system, this has a feed reservoir and delivery outlet. This sits in the boat for use with the Polar Circle; with the System Farm the feeder can be wheeled up the walkways. The blower delivers the pellets onto the water surface with the operator directing the spread of feed to ensure an even distribution of feed to the fish.
5. The quantity of feed delivered is based on the calculated feed requirement based on the estimated biomass which is determined from regular fish body weight measurements.
6. The operator is also trained to regulate the actual feed delivered based on behavioural observations of the feeding responses of the fish. Daily records include the observations of the feed operator which score the feed response based on established criteria.
7. The quantity of feed delivered to each cage unit is recorded.
    a. These feed records for each production unit are an essential component of the aquaculture operation. They ensure that the management can determine operational efficiency with regard to feed costs and other production criteria.
    b. This accurate recording of fish feed inputs is also a valuable record with respect to the environmental monitoring and management plans.
8. With more developed operations the feed-back control on feed delivery can include manual and automated feedback responses to fish behavioural responses and record of settlement of uneaten feed.

1.1.3 Fish health and parasite management

Yellowtail kingfish have relatively few disease problems, the main management problem that has been well documented in South Australia is the prevalence of external parasites: skin flukes and gill flukes. In South Australia there are a number of other health problems directly related to the low water temperatures that occur during the winter months. The water temperature in Spencer Gulf drops to 12°C, which is significantly below the preferred temperature of YTK. This means that the fish are physiologically stressed by the low temperature and therefore become susceptible to bacterial diseases and a number of less specific but serious pathologies associated with the metabolic depression due to the low temperature.

The minimum water temperatures recorded in Jurien Bay are well above the temperatures associated with the problems in South Australia; our minimum winter water temperature is 16 °C. We therefore do not expect to see the type of low temperature related health issues that impact the South Australian operations.

The two main external parasites prevalent in South Australia have been recorded in Western Australia on YTK: *Benedenia seriolae* and *Zeuxapta seriolae.* We recognise that parasite management is an issue we will need to address. One of the reasons for selecting the System Farm as our main production unit is that it is eminently suited to the management systems required to control flukes. The fluke life cycle is ‘direct’ and accumulation of eggs on ‘dirty’ nylon nets is the major source of infection onto farmed YTK. As discussed under “Net and cage management” the ability to keep nets pre-emptively clean and free of major biofouling build up is a major advantage in limiting the ability of fluke eggs to attach and accumulate in the vicinity of the farmed fish.

The other significant advantage of the System Farm is that it has excellent stable work platforms that facilitate efficient management actions in most weather conditions. This is not the case with Polar Circles, in rough weather it is hazardous or impossible to perform operations like net changes or fish bathing. If fish become infected the standard treatment is to bathe the fish in a dilute solution of hydrogen peroxide. This is based on established protocols:

1. Fish are assessed for levels of parasite infection; this is done visually by observing fish behaviour; infected fish show ‘rubbing’ behaviours and may be listless or off their food. More quantitative assessment is done by anaesthetising a small number of fish, treating these fish with bathing solution causes attached gill and skin flukes to drop off the fish, these detached animals can be counted to give a quantitative score of the infection rate.
2. Based on the qualitative and quantitative scores a decision is made to treat the fish.
3. The fish are concentrated using a seine net, a rubber liner is used to create a bath, the water volume is known and hydrogen peroxide at concentration of 100 ppm is established. The bathing solution is aerated and mixed; the fish are passed though this solution in batches to ensure an appropriate exposure time.
4. The used bath solution can be disposed off into the local environment because it is a very dilute solution which is also rapidly diluted by water movement and dispersion. Hydrogen peroxide is a very unstable chemical that has zero residual effect on the dosed fish or the environment, it decomposes very rapidly into water and oxygen.

There are few other diseases of YTK that need treating, but if there was a need to treat with medication this would done under veterinary supervision.

1.1.4 Fish harvesting and fish transfers

It is envisaged that the main harvesting of fish would occur after 15 months when the fish would be ~4 kg whole weight. There could be some limited test harvesting of smaller fish prior to this time. Fish are harvested using techniques developed in the salmon industry. These ensure that the highest standards of fish product quality, fish welfare and environmental and occupational health and safety are maintained. In summary:

1. Decision is made to harvest based on economic and logistical criteria, body and condition assessment based on sampling of stock.
2. Fish in the main cage area are crowded up using seine net; the crowded fish can then be shifted using a “fish pump”. A fish pump is well developed piece of equipment specifically designed to move whole live fish with minimal stress or physical damage. They mostly work on principle of water displacement with the fish being transferred with the water.
3. Using the fish pump the fish are transferred to a ‘killing bench’ where they pass past through a channel, in this channel they are oriented correctly and then contact a pneumatic stunner that kills the fish. The freshly killed fish then passes to an operator or separate machine that bleeds the fish; the bled fish are then transferred to 1 tonne bins with ice slurry. All blood water and fish products are retained and transported back to shore.

The fish pump principle is also used for fish management, where fish may need to be transferred between sea cages.

1.1.5 Management and disposal of mortalities

With the large numbers of fish in an aquaculture operation there is a small but predictable number of mortalities. This should be <10 % of the total number of fish stocked over the life of the crop. A disproportionate number of these mortalities would normally occur in the early stages of the crop life. Mortalities are removed from the sea cage bottom every day by divers. This is for health management reasons but is also to discourage scavenging/predation by sharks and seals.

These collected mortalities are transported back to shore and will be disposed of to landfill, composting or other secondary uses such as fish silage.

<u>Catastrophic mortality</u>

A major fish kill due to disease or other unforeseen cause can result in a substantial quantity of fish that needs to be disposed of. These would be disposed of by landfill in appropriate landfill disposal sites. Smaller quantities of fish can be disposed of by composting, as per USEPA guidelines or by ensilage. Ensilage can be used as a means to stabilise fish biomass for subsequent disposal by composting or landfill.

1.1.6 Strategies to prevent negative interaction between Sea lion species, other marine fauna and birds and Aquaculture Activities

It is imperative for all Marine Farm Operators to acknowledge the fact that they share the waters to be farmed with existing wild life. Marine animals, seals or birds, must never 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 behaviours from animals to staff, alteration in natural behaviour and reproductive outcomes.

The points below are a guide to prevent the development of negative behaviours and to avoid negative interactions between the animals and the farm operations.

- WKL will establish and implement a Wildlife Interaction Avoidance Strategy. This will ensure that crewmembers will be fully trained in the correct manner to interact with wild life, and the respect required in such dealings, and held accountable for their interactions between themselves and wild life present in the area. Under **NO CIRCUMSTANCES** will any employee of WKL feed Sea lions or make available any dead kingfish for sea lion consumption.
- As part of this strategy WKL will have a monitoring and reporting policy to 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 WKL environment manager.
- WKL will have a company policy regarding the adherence to the Wildlife Interaction Avoidance Strategy and the correct attitude to be taken with all wild life. Failure to comply with said policy will lead to disciplinary action being taken, which may include dismissal, and if the circumstance dictates, prosecution in accordance with applicable laws.
- WKL will use both the Polar Circle type technology, and also the steel System Farm type of enclosure, although it is expected that the predominant method will be the steel System Farm type. In both cases however, there will be specification to the manufacturers that "sea lion proofing" is a mandatory requirement.
    - Both systems come complete with Seal proof exclusion fencing above water, making it impossible for said animals to use the farm structures as haul-out zones. These above surface barrier systems would be comprised of physical barriers, with additional low energy electric deterrent fences as an option, such as the Seal Guard ® system, (see page 82, National Assessment of Interactions between Humans and Seals).

    - Sub-surface exclusion or “predator netting” will be mandatory on fish enclosures farmed by WKL. There are many ways we can effect this requirement. However the best by far, which has resulted in zero negative interactions between the aquaculture operations seals is the use of metallic nets. See pages 83, 84 & 85 in the *National Assessment of Interactions between Humans and Seals: Fisheries, Aquaculture and Tourism* volume for reports on dramatic success with this system. The design, type and operational of the use of metal nets has improved even further since this article was written.

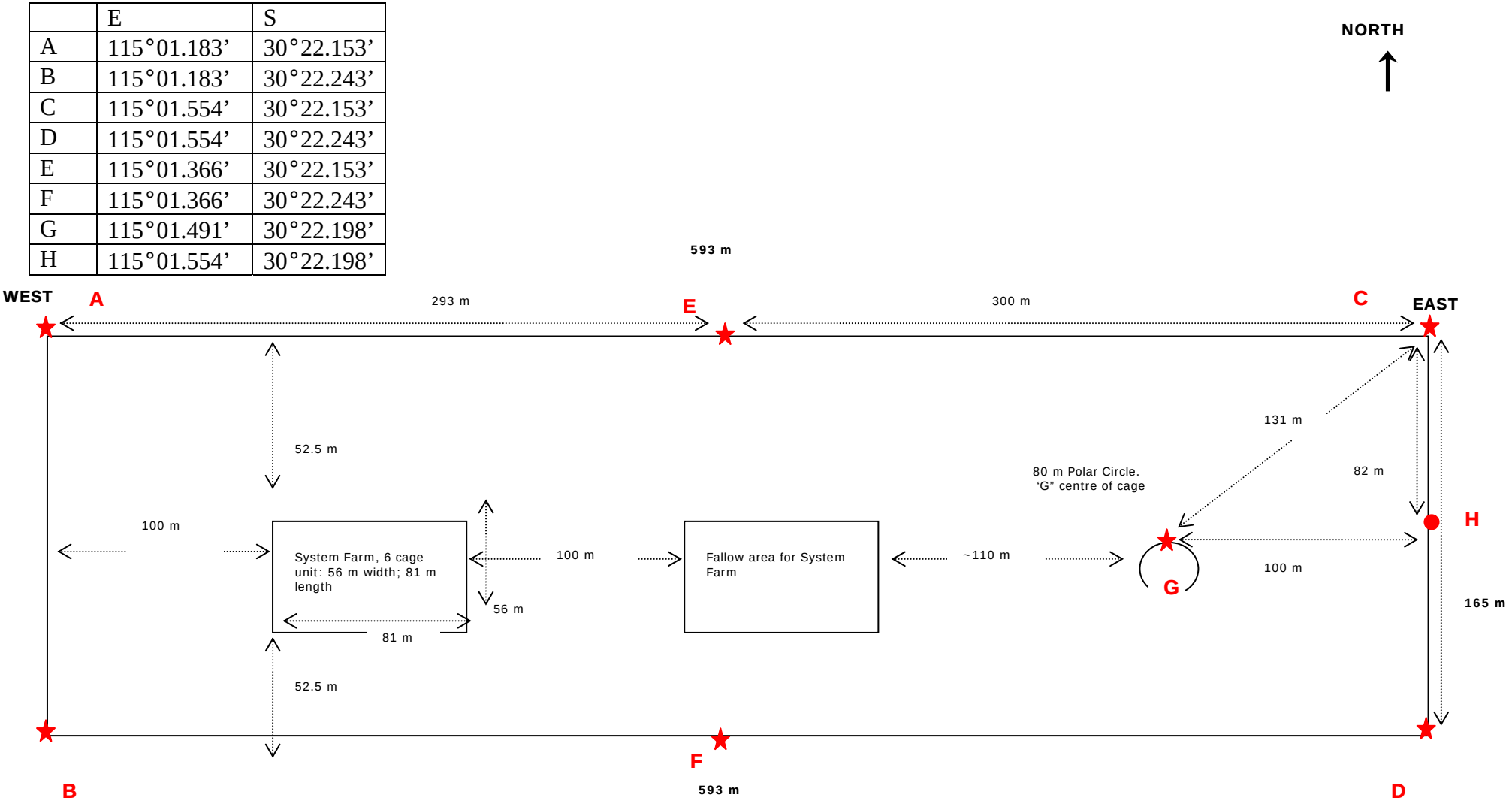
- It is vital that the type of predator netting we employ will be sea lion friendly. WKL will ensure all meshes used in our operation are of a size and specification that prevent entanglement by sea lions.
- WKL will use industry best practice with selection and management of sea pens; this includes 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 by seals and the negative interactions associated with these learnt behaviours.
- Sea cages will have well maintained bird exclusion netting. This excludes birds that may be predatory on small fish, but equally important, it excludes opportunistic feeding by birds on feeds supplied to the cultured fish. 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 by wild birds because of the negative impacts this can have on natural behaviour and ecology.
- WKL will implement rigorous maintenance programs for all marine infrastructures to ensure that there is no capacity for entanglements of marine fauna in ropes or cages.
- WKL will ensure through careful management that feed losses to the environment are minimized. This helps to reduce the availability of feed to wild fish and thereby prevents the aggregation of wild fish around the cages which can attract sea lions
- Wherever there is livestock, there is inevitably a small percentage of dead stock. WKL will dispose of any/all mortalities from our operation in a timely and responsible manner, in accordance with licensing conditions. Dead fish will not be allowed to remain in cage structures, thereby removing the scent trail that will attract Sea lions and other predators including sharks
- WKL will not allow use “Seal Crackers” or other active deterrent systems as used in other states to deter seals or sea lions.

Schematic of arrangement of cages and marker buoys on Area C; Hill River licensed aquaculture area No. 1335

Approximate scale 25 m: 10mm

Coordinates of markers – Datum GDA94

	E	S
A	115°01.183’	30°22.153’
B	115°01.183’	30°22.243’
C	115°01.554’	30°22.153’
D	115°01.554’	30°22.243’
E	115°01.366’	30°22.153’
F	115°01.366’	30°22.243’
G	115°01.491’	30°22.198’
H	115°01.554’	30°22.198’



Appendix B – Risk Assessment for Pilot Project 200t Trial

1. Risk Assessment for 200 tonne trial

Table 1 Risk Assessment Consequence and Likelihood Definitions (after Fletcher et al. 2004)

Consequence				
Level		**Habitat (ecological)**	**Ecosystem**	**Social**
Negligible	0	Insignificant impacts to habitat or population of species making up the habitat - probably not measurable levels of impact. Activity only occurs in very small areas of the habitat, or if larger area is used, theimpact on the habitat from the activity is unlikley to be measurable against background variability.	Generally - insignificant impacts to habitats or populations, unlikley to be measurable against gbackground variability. Ecosystems - interactions may occur but it is unlikely that there would be any change outside of natural variation.	No impact
Minor	1	Measurable impacts on habitats but these are very localised compared to total habitat area.	None of the affected species play a keystone role - only minor changes in relative abundance of other constituents.	Minor impacts on the local community (e.g. small numbers of lost jobs or minor amenity decrease) - but effects easily absorbed by the community.
Moderate	2	More widespread impacts on habitat likely, but the levels are still considered acceptable giventhe % area affected, types of impact occurring, and the recovery capacity fo the habitat.	Measurable changes to the ecosystem components without there beind a major change in function (no loss of components).	Some increase in unemployment and decrease in overall income, to which the community will adjust over time. Some community concern about loss of amenity that may result in political action or other forms of protest.
Severe	3	The level of impact on habitats may be larger than is sensible to ensure that the habitat will not be able to recover adequately, or it will cause strong downstream effects from loss of function.	Ecosystem function altered measurably and some function or components are locally missing/declining/increasing outside of historical range and/or allows/facilitates new species to appear. Recovery in years.	Significant reduction in employment and income associated with the fishery, significant income and employemnt flow-on effects to other businesses. Significan level of community concern about the future of the community which may result in political action or protest.
Major	4	Substantially too much of the habitat is being affected, which may endanger its long-term survival and result in severe changes to ecosystem function. (note, 10-30% loss suggested as threshold for critical to fragile habitats, 70-90% for others - Fletcher et al, 2004)	Major change to ecosystem structure and function. Recovery in years to decades.	High level of community impacts which the community could not adjust to without external assistance. Significant amount of protest or political lobbying likely. Large-scale employment and income losses in the seafood sector of the local economy. Significan flow-on effects of increasing unemployment and decreasing income. Decline in population and expendeture-based services (e.g. schools, banks, supermarkets). Population declines due to lack of available work.
Catastrophic	5	Effectively the entire habitat is in danger of being affected in a major way or removed. (note: Fletcher et al, 2004 suggests > 90% for for most habitats, >50% for fragile and >30%)	Total collapse of ecosystem processes. Long-term recovery period may be greater than decades.	Large-scale impacts well beyond the capacity of the community to absorb or adjust to. Likely to lead to large-scale rapid decline in community income and increase in unemployment in areas directly and indirectly related to fishing. May lead to large-scale and rapid reduction in population as families leave the region. Likely to lead to high levels of political action, protest and conflict. Significant reduction in access to private and public sector services, as businesses become unviable and target populations needed to attract government and commercial services decline below threshold levels. Total change in the nature of the community (e.g. from from rural to industrial).

Likelihood

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
Occasional	5	may occur in exceptional circumstances
Likely	6	it is expected to occur

Table 2 Risk Calculation Matrix (after Fletcher et al. 2004)

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

Table 3 Risk Calculation Matrix (after Fletcher et al. 2004)

Risk Ranking	Risk Values	Likely Management Response	Likely Reporting Requirements
Negligible	0	None	Short Justification Only
Low	1-6	None Specific	Full Justification Needed
Moderate	7-12	Specific Management Needed	Full Performance Report
High	13-19	Possible Increases to Management Needed	Full Performance Report
Extreme	>19	Likely Additional Managament Needed	Full Performance Report

Table 4 Risk Assessment for WKL Aquaculture 200 tonne Pilot Project

Category	Ecological Value	Hazard	Risk Assessment (before management)
Water and Sediment Quality	Water and Sediment Quality	Nutrient enrichment due to food and metabolic waste from aquaculture activities.	Environmental - rare(2)*minor(1)=2 (low risk) Nutrient enrichment may cause a wide spread, short to medium term impact on ecological processes, however is unlikely to occur due to high flushing rates. Social - rare(2)*minor(1)=2 (low risk) It is possible that negative public perceptions may be raised in State media regarding aquaculture potential impacts.
		Hydrocarbon spill due to bunkering and/or operation of aquaculture vessels and machinery.	Environmental - remote(1)*negligible (0) = 0 (no risk) Hydrocarbons will largely be limited to modest inventories of diesel ans spills would be very small in scale. Extensive hydrocarbon spills are unlikely. Social - remote(1)*negligible (0) = 0 (no risk) Public reaction to a diesel 'shimmer' could possibly be raised in State media.
		Heavy metal / toxic residues from fouling control coatings on aquaculture infrastructure and vessels.	Environmental - remote(1)*minor (1) = 1 (low risk) Toxic residues could have a considerable impact and recovery may be slow without intervention, but amounts would be low and localised. With no antifoulant use planned, likelihood is near zero. Social - remote(1)*minor (1) = 1 (low risk) It is unlikely toxic residues due to aquaculture activities will be a cause of social concern, however negative public perception could be raised at a State level.

Category	Ecological Value	Hazard	Risk Assessment (before management)
		Introduction of marine non-indigenous species (e.g. bloom causing phyto- and zoo-plankton).	Environmental - remote(1)*moderate (2) = 2 (low risk)The potential impact of invasive marine species is major, however is unlikely to be caused by kingfish aquaculture activities with local fish species.Social - remote(1)*moderate (2) = 2 (low risk)In the event of an invasive species introduction, the State and National government would become involved with resulting regulatory intervention. However, the likelihood of introduction is low.
Geomorphology	Structural complexity of the geomorphology Coastal landforms	Modification of geomorphology due to aquaculture infrastructure: - Moorings – small scale modification to benthic topography, habitat and hydrodynamics. - Floating structures – artificial habitat.	Environmental - remote(1)*minor (1) = 1 (low risk) Total area of artificial habitat due to anchors and floating pens negligible compared to Jurien Bay Marine Park (JBMP). Rare that it will have a measurable environmental impact across the JBMP. Social - remote(1)*negligible (0) = 0 (no risk) Unlikely that a social issue will arise due to impacts to geomorphology.
Intertidal reef platforms	Diversity of flora and fauna Abundance of protected flora and fauna Abundance of targeted flora and fauna species	Physical disturbance due to collision by drifting (non-secure) sea-cages.	Environmental - unlikely (3)*minor (1) = 3 (low risk) Disturbance would be of small spatial scale and recovery rapid. Failed moorings have occurred in the industry previously. Social - unlikely (3)*minor (1) = 3 (low risk) The public reaction to a non-secure sea pen is likely to be more severe than the environmental impact and could draw State media attention.

Category	Ecological Value	Hazard	Risk Assessment (before management)
Seagrass meadows	Seagrass meadows	Nutrient enrichment due to food and metabolic waste from aquaculture activities creating increased turbidity and light attenuation.	Environmental - unlikely (3)*severe (3) = 9 (moderate risk)Broad scale nutrient enrichment is unlikely given the scale of the operation and the flushing regime. Local impacts should be minor as there is nearly zero seagrass within the license area.Social - unlikely (3)*severe (3) = 9 (moderate risk)Any water quality or seagrass decline may be attributed to the aquaculture activity by the public.
		Smothering of seagrass beds due to increased settlement of particulates from aquaculture food and metabolic wastes.	Environmental - remote (1)*severe (3) = 3 (low risk) Smothering is not likely to be of a significant scale because there is very little seagrass within the license area. Social - remote (1)*minor(1)) = 1 (low risk) Possible basis for objection by the public on regional scale.
Seagrass meadows continued	Seagrass meadows continued	Direct shading effects caused by aquaculture infrastructure.	Environmental - remote (1)*severe (3) = 3 (low risk) Direct impact due to shading is possible, but of small spatial scale - directly beneath cages. Social - remote (1)*minor (1) = 1 (low risk) Possible basis for objection by the public.
		Direct disturbance caused by anchor scarring.	Environmental - unlikely (3)*moderate (2) = 6 (low risk) Anchoring is likely to cause small, localised impacts. Social - unlikely (3)*moderate (2) = 6 (low risk) Possible basis for objection by the public.

Category	Ecological Value	Hazard	Risk Assessment (before management)
Macroalgal communities	Macroalgal communities	Nutrient enrichment due to food and metabolic waste from aquaculture activities creating increased turbidity and light attenuation.	Environmental - remote (2)*severe (3) = 6 (low risk) Broad scale nutrient enrichment is unlikely given the scale of the operation and the flushing regime. Local impacts should be minor as there is no macroalgae within the license area. Social - unlikely (3)*minor(1) = 3 (low risk) Macroalgae decline is generally not a concern to the public.
		Smothering of macroalgae communities due to increased settlement of particulates from aquaculture food and metabolic wastes.	Environmental - remote (1)*severe (3) = 3 (low risk)Smothering is not likely to be of a significant scale because there is no macroalgae within the license area.Social - unlikely (3)*minor(1) = 3 (low risk)Macroalgae decline is generally not a concern to the public.
		Direct shading effects caused by aquaculture infrastructure.	Environmental - remote (1)*severe (3) = 3 (low risk) Direct impact due to shading is possible, but of small spatial scale - directly beneath cages. Social - unlikely (3)*minor(1) = 3 (low risk) Macroalgae decline is generally not a concern to the public.
		Direct disturbance caused by anchor scarring.	Environmental - unlikely (3)*moderate (2) = 6 (low risk) Anchoring is likely to cause small, localised impacts. Social - unlikely (3)*minor(1) = 3 (low risk) Macroalgae decline is generally not a concern to the public.

Category	Ecological Value	Hazard	Risk Assessment (before management)
Invertebrate communities	Invertebrate communities	Shift in biodiversity due to increased nutrient load and/or smothering from aquaculture feed and metabolic wastes.	Environmental - likely (6)*moderate (2) = 12 (moderate risk) Localised shifts in biodiversity / abundance probable directly under / adjacent to sea pens. Evidence suggests that there is not loss of components. Social - likely (6)*minor (1) = 6 (low risk) Public concern over benthic fauna generally low. Not expected to affect benthic habitats beyond the license area.
	Targeted invertebrate species	Shift in biodiversity due to introduction of NIS.	Environmental - remote (1) * major (4) = 4 (low risk) The potential impact of invasive marine species is major, however is unlikely to be caused by kingfish aquaculture activities. Social - remote (1) * major (4) = 4 (low risk) In the event of an invasive species introduction, the State and National government would become involved with resulting Regulatory intervention. However, the likelihood of introduction is low.
Finfish	General	Genetic alteration of wild kingfish population.	Environmental - unlikely (3) * minor (1) = 3 (low risk) The consequence of escapee fish interacting genetically with wild populations is low because broodstock are local and likelihood of escape is small. Social - unlikely (3) * minor (1) = 3 (low risk) It is possible potential genetic impacts will be voiced on a regional scale as objection against aquaculture activities, but no economic effects would result from an escape.

Category	Ecological Value	Hazard	Risk Assessment (before management)
		Spread of disease to wild fish (particularly kingfish) populations.	Environmental - unlikely (3) * minor (1) = 3 (low risk) Disease will move between wild and farmed fish in both directions therefore impact to wild fish on a population level unlikely. Social - unlikely (3) * minor (1) = 3 (low risk) Potential basis for objection to aquaculture activities by public.
Finfish Continued	Targeted finfish species	Predation on or competition for food sources due to kingfish escapees.	Environmental - unlikely (3) * minor (1) = 3 (low risk) Short-term impact on prey items may occur in the event of a major escape event, but local kingfish are present, so no "new" predators. Social - unlikely (3) * minor (1) = 3 (low risk) Negative media on a local scale, with an emphasis on potential impact on popular recreational species.
Seabirds	Seabirds	Altered foraging behaviour due to supplemental feeding on aquaculture feeds.	Environmental - unlikely (3) * moderate (2) = 6 (low risk)Altered foraging behaviour and changes to diet may have a impact on a population level, but likelihood is low due to use of sinking feed and bird netting.Social - unlikely (3) * moderate (2) = 6 (low risk)Interactions with sea- and migratory-birds may induce intervention by State and National regulatory bodies, but interactions are unlikely.
		Entanglement of seabirds in bird barrier netting.	Environmental - unlikely (3) * minor (1) = 3 (low risk) Entanglement is possible, however is unlikely to occur and impact would be on the individual, not population level. Social - unlikely (3) * minor (1) = 3 (low risk) Interactions with sea- and migratory-birds may induce intervention by State and National regulatory bodies, but interactions are unlikely.

Category	Ecological Value	Hazard	Risk Assessment (before management)
Cetaceans and turtles	Cetaceans and turtles	Collision with vessels.	Environmental - rare (2) * minor (1) = 2 (low risk) Death of individuals may have an impact on a population level, but are unlikely especially with best management practices and EMPs in place. Social - rare (2) * minor (1) = 2 (low risk) Interactions with cetaceans and turtles will induce intervention by State and National regulatory bodies due to protected status.
		Entanglement with ropes / netting.	
Sea lions	Sea lions	Altered foraging behaviour due to predation on farmed fish.	Environmental - unlikely (3) * minor (1) = 3 (low risk) Altered foraging behaviour and changes to diet may have an impact on a population level. Likelihood is low due to seal barrier use. Social - unlikely (3) * minor (1) = 3 (low risk) Interactions with sea lions will induce intervention by State and National regulatory bodies due to protected status.
		Entanglements in nets	Environmental - unlikely (3) * minor (1) = 3 (low risk)Entanglement and death of individuals may have an impact on a population level. Likelihood is low.Social - unlikely (3) * minor (1) = 3 (low risk)Interactions with sea lions will induce intervention by State and National regulatory bodies due to protected status.

Appendix C – Environmental Monitoring Program

Environmental Monitoring Program

1. Introduction

1.1 Rational

This Environmental Monitoring Program for the Western Kingfish Limited (WKL) Aquaculture Pilot Project has three main goals:

1. to quantify the effects of operations on the marine environment
2. to evaluate those effects against trigger values so that appropriate management actions can be implemented when necessary to limit those effects.
3. to evaluate the effectiveness of those management actions when they are implemented

In a broader context, this Environmental Monitoring Program will also be used to establish baseline data and to extrapolate impacts for input into the environmental assessment process anticipated for future development stages of WKL's aquaculture operations in the Jurien Bay Marine Park.

In addition to traditional environmental monitoring, regular monitoring and inspection of infrastructure, equipment, and operational procedures will be implemented to ensure early detection of potential problems.

1.2 Infrastructure Inspection

The sea pen infrastructure, mooring equipment, support vessels, and operational equipment (e.g. feeding machinery) will be inspected on a monthly basis for damage or potential problems, with annual inclusion of inspection results into reports, more frequent if problems arise. Nets will be inspected daily, to detect damage, evaluate the extent of biofouling, and to identify the presence of fatalities or entangled wildlife. Future operational procedures will also be audited as required by the standard operating procedures (SOPs; developed as part of the pilot project).

1.3 Monitoring Against Trigger Values

The general procedure for identifying the environmental values to be protected, defining objectives, and implementing monitoring and management procedure to help met those objectives is summarised in Figure 1. This procedure involves measuring indicator (water quality) variables (chlorophyll-a, light attenuation, oxygen) against triggers called environmental quality guidelines (EQGs) and increasing monitoring intensity to examine seagrass health measures (against Environmental Quality Standards, EQSs) when those water quality triggers are exceeded.

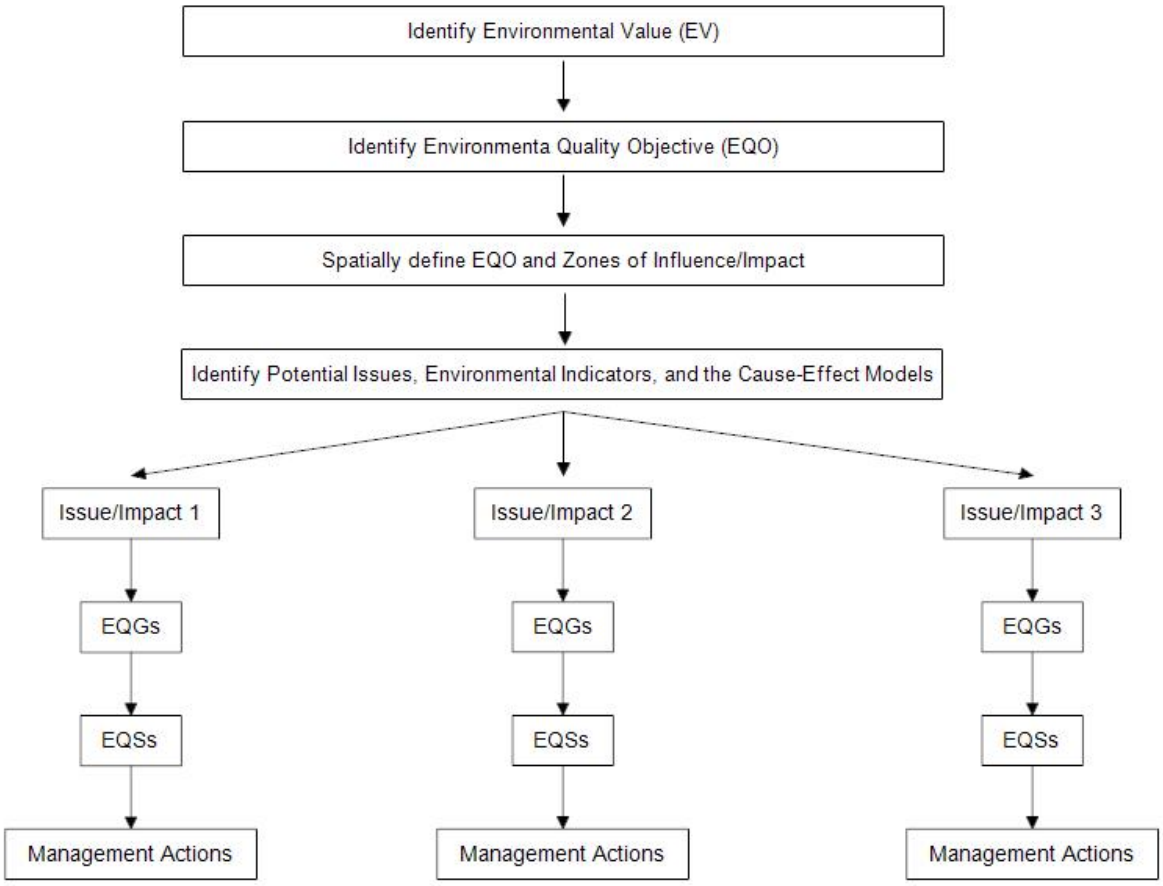


Figure 1 The procedure for implementing an integrated monitoring and management strategy. After SA Environmental Protection Agency and WA Department of Environment (2004).

This monitoring program is designed to measure variables indicative of the cause-effect pathway by which the pilot project could potentially affect the environment. Figure 2 depicts the most important cause-effect pathways expected to result in water quality impacts from aquaculture pilot project. The indicator variables (chlorophyll, turbidity, dissolved oxygen) will provide early warning of possible impacts. Triggers have been established for these parameters of concern to allow early identification of potential impacts, and to facilitate mitigation of the effects through a set of management strategies.

This document identifies preliminary trigger values (Attachment A), which are, at this point, highly conservative and based on limited local baseline data, or in the absence of even that, on arbitrary regulations (which are not based on cause-effect relationships) and are designed for different environments. This document also identifies management actions (Attachment A) which are designed to be conservative in the absence of appropriate, site specific baseline data. The preliminary trigger values and management actions will allow the pilot project to get underway by creating a mechanism for monitoring and managing the impacts (if any) from the initial stages of the pilot. Once the pilot project is underway, site specific data will be collected and more appropriate trigger values can be identified. This document forms part of an adaptive management approach and has been developed as a first step in this process.

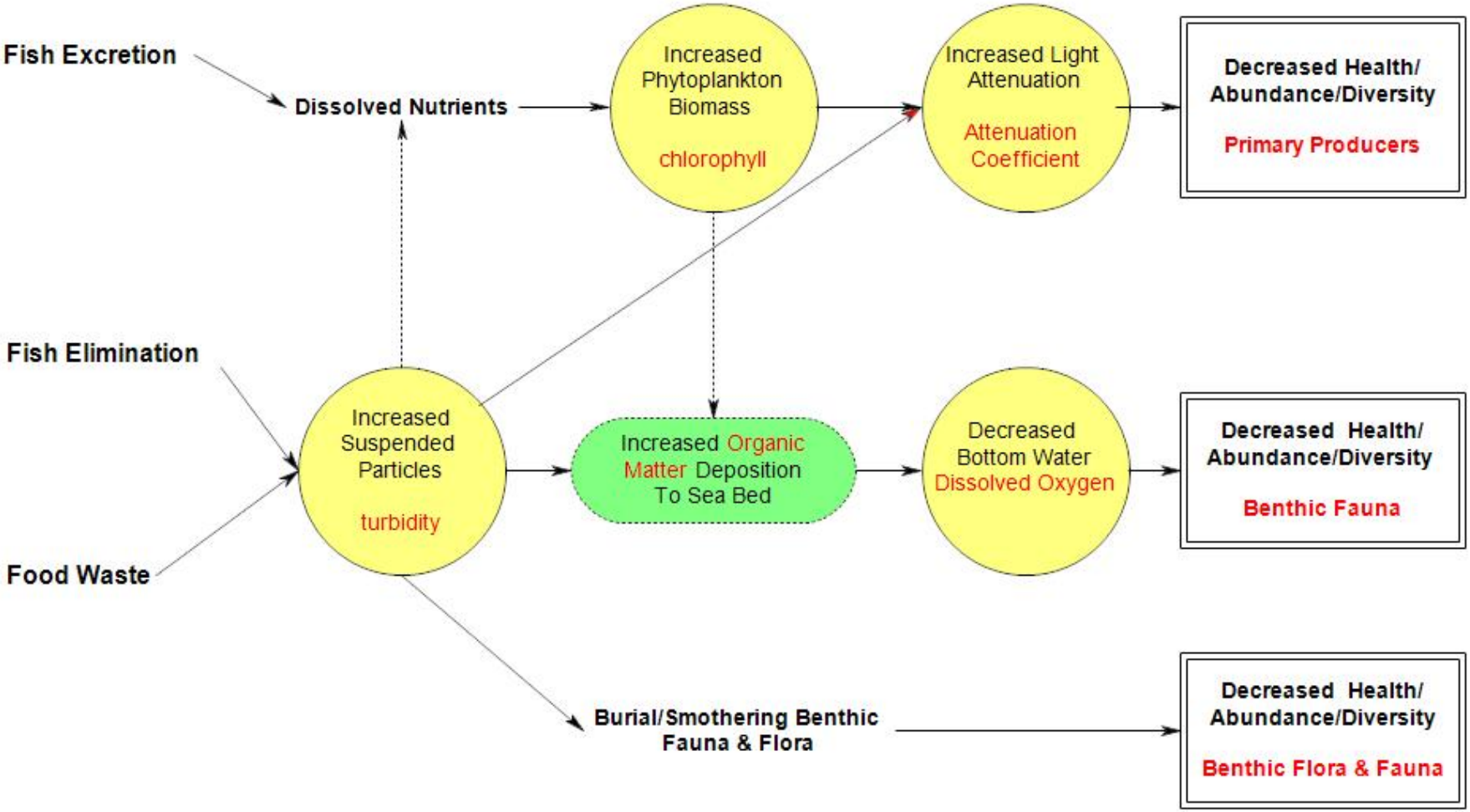


Figure 2. Cause-effect pathways measured by the environmental monitoring program.

The main aim of the trigger setting process is to identify meaningful trigger values. The aim of trigger values is to provide insight into potential environmental impacts prior to their actual occurrence. To this aim, the trigger values included in this document will be continually re-evaluated as part of the pilot project, and adjusted when necessary (in consultation with DEC and DoF) with the aim of identifying meaningful triggers which reflect the levels at which ecological impacts are likely to occur, and preventing those impacts.

1.4 Interim Trigger Values

Monitoring against trigger values will involve indicator variables which are relatively simple to measure and provide early-warning indicators of change (EPA 2004). For these indicator variables (dissolved oxygen, turbidity, and chlorophyll a) continuous measurement technology will be used. One set of data, from the edge to the aquaculture license, will be telemetered to shore so that it can be monitored in real time. An initial monitoring stage will occur lasting three months. At the end of this stage, these data will be examined and a determination will be made regarding whether these variables are providing useful information. Any redundant measurements will then be considered for removal from the continuous monitoring program. This removal will be reconsidered each time the periodic monitoring program is conducted (quarterly) as well. Any changes would be made in consultation with DEC and DoF.

The initial continuous measurements will ensure adequate statistical power is easily achieved and will provide a good definition of natural variability for baseline and reference data. Periodic biological sampling will be required as well, which will entail more detailed measurements that provide definitive assessment of the impacts on the environmental values (e.g. seagrass, macro algae, benthic fauna). The results of ongoing comparisons among water quality and biological data will feed into the decision schemes that dictate the necessity for higher level monitoring and/or management actions (Attachment A).

1.5 Hydrodynamic Modelling

During the first year of the pilot project, hydrodynamic modelling will be conducted. This modelling will cover the vicinity of the sea cages and the impact and reference sites originally proposed by this monitoring program. Two dimensional modelling will be performed initially, but once that is working properly, three dimensional modelling will be used to help predict the spread of dissolved and particulate waste from, the aquaculture pens. Careful calculations of feeding rates, feed composition, etc. will aid in precise predictions of expected nutrient and particle releases from the operation. The modelling will be used to predict the zone of influence from the aquaculture project in a quantitative and spatially explicit way. The modelling will classify the area of interest into four zones:

1. Area of Impact – the area where impacts (irreversible or long-term habitat loss or ecological change) are likely to occur. The management plan must aim to maintain this area within the WKL aquaculture license area.
2. Area of Moderate Influence – the area where the aquaculture operation is expected to influence conditions, such as water quality, but this influence is not expected to result in any long-term impact on the ecosystem, though short term changes may be expected. The management plan must aim to maintain this area within the aquaculture zone.
3. Area of Influence – the area where there are occasional influences to the ecosystem, but they are short lived and have no impact on the organisms or habitat. The management plan must aim to maintain this area outside the sanctuary zone.

4. Area of No Influence/ Reference – the area where there is not likely to be any impact from the aquaculture operation. These areas would be suitable for the placement of reference monitoring locations.

Once preliminary modelling is completed and these zones are delineated, the placement of monitoring sites will be re-examined in light of this classification, and adjustments made as necessary. The model will be prepared from the time of the pilot project commencement through to the availability of the first current measurements at the site. Once two months of current data are available, the model can be validated and preliminary predictions will be made. Model adjustments will be ongoing throughout the pilot project until representative data are incorporated from throughout the range of conditions experienced at this location. If the predicted zones of influence change significantly, monitoring stations will be revisited. Predictions of the above zones will be included in the first annual report from the monitoring program.

2. Monitoring Plan

2.1 Identification of Preliminary Trigger Values

Baseline water and sediment quality conditions for the area of the Jurien Bay Marine Park were extracted from existing technical reports including *Central West Coast Marine Biodiversity and Conservation Programme* (CALM, 2004/2005) and *Background Quality of the Marine Sediments of Mid-West Coast* (DEC, 2007). These data will represent the baseline condition of the Jurien Bay Marine Park area until more suitable reference data can be collected at the site of the pilot project and its associated impact and reference monitoring sites. These preliminary "baseline" data were used to establish preliminary trigger values (environmental quality guidelines) applicable for the initial phase of the pilot project.

Comparisons where made based on the appropriateness of sites used in the Central West Coast study (CALM, 2004/2005) to the proposed area of the WKL aquaculture operation. Specifically the suitability of sites was determined by closeness to the pilot project site (shown in Attachment B), and general similarity of habitat i.e. Deep Lagoonal >10m depth and east of the barrier reef. Where data was lacking (Deep Lagoonal data was recorded only over Feb/March 2004), data was analysed from the Shallow Lagoon sites or pooled across locations (North – South i.e. Hill River, Fishermans Is. and Nambung Bay). Individual parameter descriptions detailed below provide further site-specific characteristics.

Sediment quality characteristics developed from the DEC (2007) *Background Quality of the Marine Sediments* publication, were taken only from the Jurien Bay dataset. The sites selected for this study were chosen at locations where anthropogenic influences were believed to be minimal and based on the location of the sites sampled for determining baseline water quality data. Some trigger criteria were also based on national sediment quality guidelines (ISQC-low) recommended in ARMCANZ and ANZECC (2000).

The interim trigger levels set for water and sediment quality conditions have been based on a dataset limited in temporal or spatial resolution and are consequently conservative values. The trigger levels are likely to be exceeded during the preliminary phases of the aquaculture operation due to natural variation in environmental conditions. As such, it must be acknowledged that the setting of trigger levels will be an adaptive process. Once data are collected at appropriate reference and impact sites (with high temporal resolution and over a prolonged time frame) these triggers will be re-examined and adjusted. Furthermore, proposed management responses may also require ongoing re-evaluation.

2.1.1 Trigger Selection - Dissolved Oxygen (bottom waters)

- Deep Lagoonal sites (Pooled mean from North-South locations) 106.4% (se+/- 0.9) & median 106%
- Deep Lagoonal sites (Hill River) pooled mean 106.2% (se+/- 2.1) & median 105.5%
- Hill River all Locations (Pooled from East-West) 99.4% (se+/- 0.13)

The elevated dissolved oxygen saturation levels predominantly in excess of 100% even at sites >10m is indicative of benthic primary production (e.g. seagrass at the sample sites for the CALM water quality study). While acknowledging the pristine nature of the JBMP, setting trigger levels above dissolved oxygen saturation (i.e. >100%) is an unrealistic demand for any proposal in light of the fact the elevated DO values (>100%) from the CALM study are likely the result of benthic primary production activity. The benthic habitat at the proposed aquaculture operation is bare sand.

The trigger levels derived from the Cockburn Sound Coastal Waters Study (EPA 2005) (e.g. 90% DO saturation) still represent an unrealistic management trigger for the pilot project, so the 80th %ile is used. Trigger levels will be re-evaluated after data collection at impact and reference sites.

2.1.2 Trigger Selection - Dissolved Oxygen (water column)

- Deep Lagoon pooled with Shallow Lagoon at Hill River location mean water column DO = 101.0% (+/-0.2) & median 101%.

A management trigger of higher than oxygen saturation represents an unrealistic target for the aquaculture operation, particularly in light of the limited temporal data available for comparable sites i.e. Deep Lagoon. Subsequently, an interim trigger value of 80% oxygen saturation has been adopted. This trigger value will be re-evaluated, when further data measurements become available.

2.1.3 Trigger Selection - Light Attenuation

- Mean Light Attenuation Coefficient (k) was calculated (Deep Lagoon Sites, Hill River for Feb/March period) k=0.012 (+/- 8.9x10^{-3}) & median 0.019 & 70%tile value k=0.011 & 80%ile k= 0.015;
- Mean (Deep Lagoon Pooled locations North South) k=0.016(+/-5.4x10^{-3}) & median 0.010 & 70%tile value k=0.014 & 80%ile k= 0.016

The light attenuation trigger levels are preliminary and should be revised in future based on the acquisition of a more complete (annual) data set. The calculated value is based on data from the February 2004 period only. It should be acknowledged that the current trigger value may frequently be exceeded during natural events such as periods of increased river flow and may require alteration at a later time. The values measured at reference sites will be important to determine whether the present trigger values require adjustment. Prior to further data collection, management actions will be initiated based on Cockburn Sound Water Quality Levels (High Protection k=0.09) (EPA 2005).

2.1.4 Trigger Selection – Chlorophyll-a

- Based on Hill River location data pooled from Shallow/Deep Lagoon sites the mean Chl-a value = 0.2 ugL^{-1} (+/-0.02) & median = 0.2 ugL^{-1}. The corresponding 80%ile trigger value = 0.3 ugL^{-1}.

2.1.5 Trigger Selection - Total Suspended Solids

- Based on Hill River location data pooled from Shallow/Deep Lagoon sites the mean TSS value = 2.23 mgL^{-1} (+/-0.36) & median = 1.42 mgL^{-1}. The corresponding 70%ile trigger value = 1.91 mgL^{-1} 80%ile trigger value = 2.55 mgL^{-1}.

2.1.6 Trigger Selection - Organic Matter in Sediments

- The values for background marine sediments were determined utilising the Jurien Bay site datasets from the DEC commissioned sediment quality report. The measurements were made only once, in May 2005. The mean Total Organic Carbon measurement = 977.5 mgL^{-1} (+/- 120.8) and TOC % =0.10.

2.2 Timing and Location of Monitoring Sites

The plan for the monitoring program is summarised in Table 1. Monitoring intervals will be based on the calendar (quarterly sampling). This will allow assessment of seasonal variability, which is important as one goal of this monitoring program is to establish baseline conditions at the site.

Table 1: Environmental monitoring structure

	Water Quality Continuous	Water Quality Periodic	Sediment Quality & Benthic Fauna	Benthic Primary Producers
Frequency	Continuous (highest frequency allowable within constraints of battery life and maintenance/ download interval e.g. hourly).	Quarterly	Quarterly	Quarterly
Duration	Initially 6 months, then as needed through to end of pilot project.	Earliest possible through end of trial + 6 months.	Earliest possible through end of trial + 6 months.	Earliest possible through end of trial + 6 months.
Parameters	temperature, salinity, chl. a, turbidity, dissolved oxygen, light attenuation coefficient - monthly download except station 1= telemetry for continuous access	temperature, salinity, chl. a, turbidity, dissolved oxygen, light attenuation coefficient – all in profile mode plus surface and bottom water dissolved nutrients (C, N, P)	Sediment redox potential, sulphide concentration, faunal assessment (counting, identification to highest level possible), quantitative visual assessment*	Seagrass and Macroalgae identification, percent cover by species (seagass), genus (macroalgae), seagrass shoot density & depth range (summer only)
Reporting	Continuous access to telemetered and monthly downloaded data; quarterly and annual reports with synthesis and analysis.	Quarterly (after each sampling interval) and annual reports with synthesis and analysis.	Quarterly (after each sampling interval) and annual reports with synthesis and analysis.	Quarterly (after each sampling interval) and annual reports with synthesis and analysis.

Attachments C and D show the approximate placement of monitoring stations, while Table 2 describes them. Monitoring for all parameters will take place at each station. Where possible, monitoring stations have been located near previous or ongoing studies of water quality, sediment quality and seagrass health.

Station 1 is designed to confirm that the impact does not extend beyond the license area, a requirement of the license issued by the Department of Fisheries. This station will also serve as the early warning indicator of possible effects. It will initially be placed along the northern boundary of the license area because that is the expected direction of the currents and because that will place it between the aquaculture operation and the sanctuary zone. This will provide early detection of water quality changes that could potentially affect the sanctuary zone. To facilitate the use of this station as an early warning indicator, water quality data collected here will be transmitted to shore in real time. Station 2 is located to act as a seagrass impact site because there is no seagrass within the license area. This is within the seagrass bed closest to the aquaculture operation. It's location may be revised once hydrodynamic modelling is completed if the zone of influence prediction indicates that a different seagrass area would be more appropriate. Station 3 is designed to confirm that any impacts within the aquaculture zone do not extend beyond the zone to the general use or sanctuary areas. This will serve as an additional early warning layer for the sanctuary zone. If triggers are frequently exceeded here, or if Station 1 does not provide sufficient early warning (i.e. if station 1 does not respond before station 3) additional stations along this boundary between the aquaculture and

* For details see Macleod, C, et al. 2004, *Development of novel methods for the assessment of sediment condition and determination of management protocols for sustainable finfish cage aquaculture operations*, Tasmanian Aquaculture and Fisheries Institute, Hobart, Macleod, C and S Forbes 2004, *Guide to the assessment of sediment condition at marine finfish farms in Tasmania*, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Hobart.

general use/ sanctuary zone will be considered. Station 4 closely monitors the sanctuary zone to confirm that there are no impacts taking place there. Its location is intended to be within the sensitive seagrass beds there, but may need to be moved after initial data collection and habitat mapping are completed with the aim of choosing a site that is most representative of the dominant ecosystem within the sanctuary zone. Station 5 is a reference site due to its distance from the license. It is also co-located with a water quality sampling site from a previous study, allowing a direct comparison between this and previous sampling programs. Station 6 is another reference site for this project, located further offshore and a large distance from the operation. This site serves a dual purpose as it will also collect baseline data for assessing potential future operations. Station 7 will be located within and surrounding the aquaculture sea pens themselves. This will be useful for husbandry purposes and will provide an additional early detection mechanism for potential impacts. The location of sampling stations and their designation as continuous or periodic will be reviewed and subject to change following hydrodynamic modelling and zone of influence prediction and/or initial data collection.

Table 2: Summary of pilot project monitoring stations

Station Number	Description	Impact/Control/Confirmation	Sampling Plan
1	Edge of license area	Impact	Continuous (telemetered data real-time, weekly analysis)
2	Closest seagrass bed to license area (may be relocated after hydrodynamic modelling. (reassessed after 1st year)	Confirmation	Periodic (quarterly for first year)
3	Edge of aquaculture zone (reassessed after 1st year) aligned along current direction from cage	Confirmation	Continuous (monthly download)
4	Sanctuary zone	Confirmation/Control	Continuous (monthly download)
5	Scientific Reference Zone	Control	Continuous (monthly download)
6	Seaward ledge	Control	Periodic (quarterly for first year)
7	Inside sea pen	Impact	Daily (weekly analysis)

2.3 Water Quality Monitoring Strategy

2.3.1 Continuous Measurements

Stations 1 (edge of license area), 3 (edge of aquaculture zone), 4 (Sanctuary Zone), and 6 (Seaward Ledge) will be fitted with continuous monitoring sondes located near the bottom, which measure temperature, salinity, dissolved oxygen, chlorophyll, and turbidity. These continuous stations will also have pairs of light sensors located at different depths in the water column to allow calculation of light attenuation. In addition, all stations will be equipped with *Hobo* light sensors. These sensors may not

be as reliable as the wiped PAR sensors described above, and measure a broader spectrum of light, but will provide continuous measurement of temperature and light at two depths per station to serve as an early warning indicator of increased light attenuation (the ecological impact of greatest concern) at the sites where it is not practical to have continuous monitoring equipment. All "continuous" stations will be sampled on the periodic schedule as well, providing profiles of the parameters throughout the water column. These profiles will be assessed for evidence of stratification, and if it is observed, alternative equipment distribution will be investigated to capture the water quality of the layered system.

Continuous measurement data will be downloaded on a regular schedule approximately monthly, but this interval can be shortened if the data indicate that water quality is declining (see management actions). Additionally, station 1 will be fitted with a telemetry system which will allow real-time data transmission to shore for WKL access and access via the internet to third parties, such as DEC, DoF, and MPRA personnel or WKL subcontractors. These telemetered data will provide early warning indicators of potential exceedances and will help to determine when additional downloading of the other continuous monitoring equipment should be performed.

2.3.2 Periodic Measurements

All stations will be visited on the periodic monitoring schedule. At this time, vertical profiles of water quality parameters will be measured with the water quality sondes, and discrete samples will be taken for laboratory analysis of chlorophyll a, total suspended solids, dissolved nutrients (N, P, and C). It is anticipated that dissolved nutrient analyses will not provide much information because inputs of bio-available nutrients are likely to be rapidly taken up by phytoplankton. If this proves to be the case, monitoring for dissolved nutrients may be ceased. If necessary, samples could continue to be collected and stored, and only analysed if other monitoring data indicate that changes are expected. The periodic sampling interval will be quarterly at the beginning of the project, but after the first year of the project this interval will be re-examined. It is likely that this frequency will need to be reduced for the long-term operation of the project to better align with the rest of the finfish aquaculture industry in Australia.

Periodic water quality measurements will be made concurrently with sediment and benthic flora and faunal sampling as described below.

2.3.3 Daily Measurements

In addition to the periodic schedule, Station 7, located at the aquaculture sea pen, will be measured every day with the same sonde used in the continuous monitoring activities, but it will be used in profiling mode. This will assist in husbandry as well as provide daily water quality monitoring at that site. This will also allow early detection of any water quality declines.

2.3.4 Statistical Approach

All monitoring activities will be conducted with the goal of providing a statistical power of 0.8 for any analysis that is intended to be applied to the results. The number of samples required to achieve this level of power will be the minimum number of measurements made for each parameter. A statistical significance (α) level of 0.05 will be applied to all tests. Statistical power will not be the only determinant of data quality, but will serve to provide minimum standards for data collection. Meaningful conclusions which carry scientific certainty will always be the goal. Additionally, the program aims to capture the full range of natural variability, both spatial and temporal.

2.4 Benthic Sampling Strategy

Benthic primary producers will be assessed separately from other benthic impacts (geochemical and faunal) because the goals of the sampling design need to be different for these two types of effects. Additionally, sampling methods for chemical parameters and benthic fauna are destructive and therefore prevent accurate assessment of primary producers at the same sampling sites. Benthic impacts will always be assessed according to the periodic sampling schedule at all sites. Representative measurements with sufficient replication to provide statistical power (0.8) will be made in the immediate area of stations 1-6. At station 7, the benthic monitoring will be more intensive (see Section 2.4.1 below) to allow delineation of the area of impact.

2.4.1 Benthic Primary Producers

Spatially defining the trigger values for benthic primary producers requires setting the "level of protection" applicable to the environment (EPA 2004). Initially, the level of protection for the pilot project area (special purpose aquaculture zone) will be set at level C (Table 3). This designation will be finalised in consultation with DoF, DEC, and MPRA as part of the implementation of the EMMP.

Table 3 Definitions of Levels of Protection, adapted from EPA Guidance Statement No. 29 (2004)

Category	Description	Cumulative loss threshold (percentage of original BPPH within a defined management unit)
A	Extremely special areas	0%
B	High protection areas other than above	1%
C	Other designated areas	2%
D	Non-designated areas	5%
E	Development areas	10%
F	Areas where cumulative loss thresholds have been significantly exceeded	0%

2.4.2 Benthic Primary Producer Habitat Mapping

Benthic primary producers have been assessed within the aquaculture license. This will serve as the habitat map for that area, representing the condition before the project began. A preliminary benthic primary producer habitat map will be created and ground-truthed during the first growing season during the pilot project. This initial ground-truthing will be done with drop-camera surveys targeted to areas designated as representative during the preliminary mapping. The preliminary habitat map will be based on classification of aerial photography obtained from *Landgate* combined with bathymetry maps. These analyses will be augmented by existing habitat maps for the marine park which were created in the late 1990's. Once this preliminary habitat map is ground-truthed, an assessment will be made regarding the suitability of this approach. If ground-truthing shows that this method is not sufficient to map the area, other methods, such as hyper-spectral imagery, will be considered. And more thorough ground-truthing within identified seagrass beds will be conducted to identify seagrass to species level and other primary producers to genus or family level.

Benthic primary producer habitat mapping will encompass the entire area predicted to fall within the zone of influence. If the modelling is not completed to a stage where preliminary zones can be

delineated by the first BPPH survey, the survey will cover the entire area covered by the monitoring program “impact” sites.

2.4.3 Benthic Primary Producer Monitoring

The preliminary set of sampling locations is tentative and subject to revision if necessary based on the accurate location of seagrass beds. Sites 2 and 4 (Attachments C and D) are intended to be placed in seagrass beds as close as possible to the locations indicated. The final exact placement will be determined on site.

Permanent transects will be set up in the area of the sampling stations with sufficient sample numbers to provide statistical certainty and be representative of the community (exact quadrat layout and sample numbers will be dependent on the characteristics of the bed (e.g. size and patchiness of seagrass beds) and cannot be determined until the initial benthic primary producer habitat survey is conducted or the site is examined. Standard benthic primary producer health measurements will be conducted based on the well established methods outlined in the State Environmental (Cockburn Sound) Policy (EPA 2005). Quadrats will be sampled for percent cover (species level for seagrass, genus or family for other primary producers), shoot density for seagrass, and once annual seagrass depth distribution, in summer.

2.4.4 Statistical Approach

Multiple statistical comparisons are possible for benthic primary producer habitat (BPPH) to determine whether a difference exists. First, the affected habitat can be compared to itself (before and after/during). The same comparison can be performed for reference sites. Then the affected and reference site(s) levels of change could be compared to one another. These types of measures of difference between two samples are best evaluated statistically using a t-test. The “effect” sample group and the “reference” sample group can be compared using a t-test for independent samples. The same test (independent) could be used for the before and after if comparing different members of the before and after population (as would be the case comparing data collected by other parties before this project to data collected by this monitoring program). For comparing before and after data collected on the same permanent transects established for this monitoring program, the t-test for dependent samples could be used. As the within sample variation is more easily identified and excluded in this design, this type of analysis will be more sensitive. These t-test models would be used only if the distributions meet the normal assumption. If not, non-parametric equivalents should be used.

2.5 Benthic Macrofauna and Sediment Geochemistry

A great deal of research has been conducted regarding the best methods for measuring the benthic effects of aquaculture (Glencross 2004; Janowicz and Ross 2001; Macleod et al. 2004; Macleod and Forbes 2004; Wildish et al. 2001). Methodology for benthic assessments will be based on the established methods recommended for aquaculture in Australia (Macleod and Forbes 2004). This will include measurements of sediment redox condition and sulphide concentration as well as faunal enumeration and identification. It is anticipated, based on previous work (Wildish et al. 2001), that geochemical measurements will be equally valuable and more cost-effective than macro-faunal measurements for determining the effects of aquaculture on the benthic environment. This hypothesis will be tested for its applicability to these particular circumstances and environment during the aquaculture pilot project.

The benthic sampling strategy designed to assess direct impacts will be conducted using transects radiating from beneath the sea pen. Four transects will be set up on the North, South, East, and

West bearings from the centre of the sea pen. Quadrats will be sampled along these established transects according to the methods described by Macleod and Forbes (2004). Quadrats will be placed at 0, 25, 75, 150 and 300 m. Note: the area of impact is anticipated to be within 50 m of the sea pen, and this design will clarify that issue, allowing a description of the benthic impact footprint as well as a prediction of the zone of impact for future proposed operations. These distances and the spatial resolution of samples will be adjusted, as appropriate, after the initial data are analysed.

2.5.1 Statistical Approach

Multivariate statistical; methods will be necessary to assess the patters evident in the benthic faunal communities consisting of multiple species, occupying multiple ecological niches, across seven locations, over time, and affected by local biogeochemical processes. Traditional analyses of variance may demonstrate some simple relationships, while cluster analyses may elucidate community patterns and principle components analysis may shed light on the interactions between organisms and their environment, including the changes to that environment resulting from this pilot project. Assessing benthic community composition for change over space and time will be critical to quantifying the effects of the pilot project and projecting the effects of future expansions. Several new software packages have been developed to provide these and other more sophisticated analyses specifically designed to address these questions and WKL is currently undergoing an evaluation of these in an effort to choose the most appropriate.

2.6 Preliminary Management Actions

During the aquaculture operations, management actions will be instituted when the monitoring plan demonstrates that trigger levels are exceeded (Attachment A). The management responses are tiered, and designed to be worked through in a consecutive fashion, with continued monitoring throughout. Between every action taken, monitoring should continue and time should be allowed to see if the management action has had any effect before the next management action is implemented. It is impossible to set a given time to wait between management actions, as that will depend on the particular type of exceedance and the action in questions. An appropriate time will be determined based on the cause-effect processes involved.

In instituting management actions in response to exceedance, the first goal will be to identify whether exceedances are caused by natural variation. This will be done by comparing to the other impact sites and reference site data, and by looking at local conditions (see trigger table for suggested parameters to examine) for unusual circumstances which may have caused the exceedance. If the exceedance is indicative of a regional pattern (i.e. is happening at reference sites too) or it is explainable due to unusual conditions, monitoring will continue to see if the condition resolves itself naturally. If the exceedance is still a problem once conditions have changed, or is not explained by natural conditions, then the next steps in the management action chain will be instituted. These next steps will include re-evaluation of the trigger values, especially if natural variability is causing frequent exceedances or if exceedances are not resulting in impacts to the ecosystem. In some circumstances, it may be appropriate to alter trigger values to better reflect site specific conditions or the conditions at which impacts are to be expected. This would always be done in consultation with DEC and DoF. If further monitoring and biological sampling indicates that impacts may be occurring, then steps will be taken to modify operations in an attempt to prevent further exceedance and possible impact.

Management responses linked to monitoring results are critical for effective monitoring and management of the pilot project. At this stage of the aquaculture project, preliminary management actions have been set. However, given the conservative nature of the trigger values, the higher level

management actions are not likely to be appropriate given the scale of the impacts (or lack there of) likely to result from exceedance. It is proposed that for the first 12 months of the pilot project, any trigger exceedance is thoroughly investigated, including biological sampling to detect any impacts. But WKL proposes that the more severe actions, such as adjusting husbandry practices or unplanned fallowing, will not be instituted (unless ecological impacts are detected outside the aquaculture zone) until the triggers and management responses are reviewed in light of on-site data collection, mechanistic cause-effect links, and discussion among Western Kingfish Limited, DEC, and DoF. The exception to this would be if triggers are exceeded in the sanctuary zone. In this case, the full set of management responses would be instituted in sequence and the causes of these impacts fully investigated.

2.7 Reporting

Reports on routine download of continuous data will be submitted to DEC and DoF after each monthly download in a report card type summary format (see example template in Attachment B). After each quarterly periodic sampling event, reports will be submitted with data summarised and presented with accompanying analysis of results and interpretation, including any recommendations for changes to the monitoring program or management actions. Additionally, annual reports will be submitted summarising the year's results, seasonal trends, and drawing conclusions assessing the effectiveness of the monitoring and management plan and discussing any proposed changes or other issues that arise. In addition to water quality and benthic sampling results, quarterly and annual reporting will also encompass inspection and observation logs for equipment, feeding operations, marine fauna, etc. as indicated by the management plans.

Figure 3 depicts the responsibility and reporting structure of the marine operations sector of Western Kingfish Limited's Aquaculture Pilot Project. All Marine Attendants and Farm Hands report to Marine Operations Manager Peter Rayner. He reports directly to Environmental Manager, Alan Savage who is also the deputy general manager. These two individuals bear the responsibility for ensuring that all WKL staff are informed about and understand their duties in relation to the environmental management of the Pilot Project. Mr. Rayner will oversee all day-to-day operations of the pilot project and ensure that it complies with all environmental regulations and is managed in accordance with the EMMP. He is responsible for informing Mr. Savage whenever changes to the operational procedures are made or when the EMMP is hindering operations. Mr. Savage will then be responsible for making any amendments to the EMMP or for discussing changes with DEC and DoF staff.

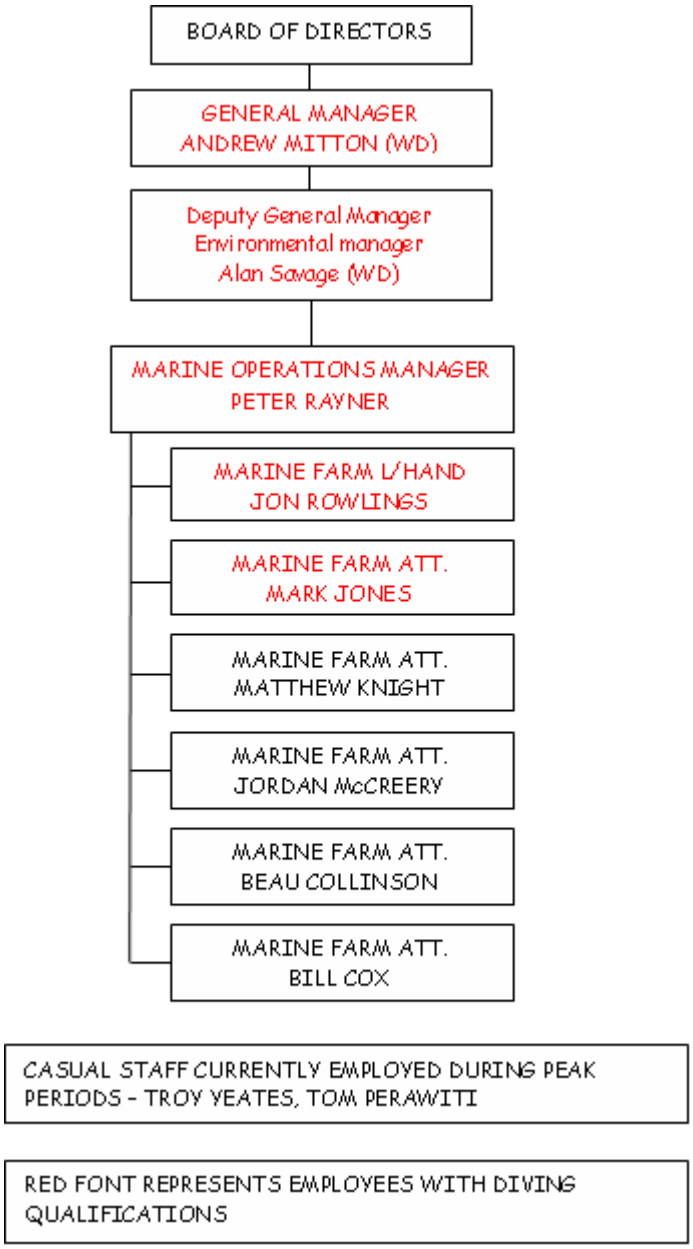
Reports will also be generated after trigger exceedances or other incidents (e.g. entanglement of fauna, escape events, etc.). The scope of this reporting will be appropriate to the seriousness of the events, but will always entail a description of the event/exceedance, information about the likely causes, the management actions implemented, and the plan to a) prevent further problems and b) monitor the effects of any management actions implemented.

When incidents occur (such as entangled animals, collisions) or triggers are exceeded, the staff member directly involved will report it to his/her supervisor, the marine operations manager, immediately. The marine operations manager will be responsible for informing the WKL environmental manager, within one business day. The environmental manager will then be responsible for ensuring that the appropriate authorities are notified, as indicated in the applicable management plan. When this circumstance requires that the DEC Wildcare Hotline be called, the marine operations manager will be responsible for this reporting if he is on duty. If not, the staff member who discovers the problem will immediately report the animal in distress.

All trigger exceedances will be reported to DEC and DoF when they are discovered. When triggers 1 or 2 are exceeded, the environmental manager will report that to the DEC and DoF within one week.

When Trigger 3 is exceeded, the environmental officer will report to the DEC and DoF within three business days. Any results from an investigation of the Biological/Confirmation Trigger will be reported to the DEC and DoF immediately.

Figure 3 Organisational Responsibilities for Western Kingfish Limited



ATTACHMENT A: Triggers and Management Actions

Water Quality and Benthic Flora/Fauna Monitoring Triggers

Any triggers below represent INTERIM TRIGGERS. A review of triggers will take place after 3 months of monitoring are complete, and all triggers will be subject to change at that point, in consultation with the DEC and DoF.

Monitoring criteria	**Association with cause/effect pathway**	**Frequency/Timing**	**Trigger 1**	**Trigger 2**	**Trigger 3**
Chlorophyll a	Excessive water column productivity, indicated by high levels of chlorophyll a, leads to increased sedimentation of labile organic matter. Decomposition of this matter can reduce the DO concentration.	**Continuous Telemetered (site 1), Daily with weekly analysis (site 7), Continuous with monthly download (sites 3,4,5) and Quarterly (sites 2,6)**	3 day running median for any impact site exceeds background 80%ile Interim "background" 80th %ile value = 0.3 ugl^{-1} (Background value should be compared/determined at control sites and the above adjusted as appropriate)	3 day running median for any impact site exceeds background 90%ile Interim "background" 90th %ile value = 0.36 ugl^{-1} (Background value should be compared/determined at control sites and the above adjusted as appropriate)	3 day running median for any impact site exceeds background 95%ile Interim "background" 95th %ile value = 0.58 ugl^{-1} (Background value should be compared/determined at control sites and the above adjusted as appropriate)
DO (water column)	Nutrient enrichment stimulates algal growth and production often leading to an input of particulate matter. DO levels reflect an equilibrium between oxygen production / consumption processes and the rate at which DO is added to the system. Production and consumption of DO is impacted by algal biomass and biological oxygen demand. The decomposition of organic matter by aerobic micro-organisms can rapidly deplete oxygen levels. Consequently, potential changes to benthic habitat and faunal assemblages often resulting in decreased diversity / abundance of communities.	**Quarterly (sites 1-6), daily with weekly analysis site 7**	The daytime value for any impact site exceeds background 80%ile. Interim "background" 20th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate) Note: existing data 20th %ile = 99% saturation; not in use because no comparable site available	The daytime value for any impact site exceeds background 90%ile. Interim "background" 10th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate) Note: existing data 10th %ile = 98% saturation; not in use because no comparable site available	The daytime value for any impact site exceeds background 95%ile. Interim "background" 5th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate) Note: existing data 5th %ile = 95% saturation; not in use because no comparable site available

DO (bottom)	Reduced DO in water near the sediment surface due to excessive oxygen demand in organically enriched sediments. The decomposition of organic matter by aerobic micro-organisms can rapidly deplete oxygen levels. Consequently potential changes to benthic habitat and faunal assemblages often resulting in decreased diversity / abundance of communities	**Continuous Telemetered (site 1), Daily (site 7), Continuous with monthly download (sites 3,4,5) and Quarterly (sites 2,6)**	3 day (daytime only) running median for any impact site exceeds background 80%ile. Interim "background" 20th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate) Note: existing data 20th %ile >100% saturation; not in use because no comparable site available	3 day (daytime only) running median for any impact site exceeds background 90%ile. Interim "background" 10th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate) Note: existing data 10th %ile >100% saturation; not in use because no comparable site available	3 day (daytime only) running median for any impact site exceeds background 95%ile. Interim "background" 5th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate) Note: existing data 5th %ile > 100% saturation; not in use because no comparable site available
TSS/Turbidity	Elevated TSS/turbidity decreases light penetration through the water column, reducing clarity and light available to benthic communities such as seagrass	**Turbidity: Continuous Telemetered (site 1), Daily (site 7), Continuous with monthly download (sites 3,4,5) and Quarterly (sites 2,6)** **TSS: Quarterly** **Site-specific relationship between turbidity and TSS to be determined. 3 day running median to be used then. Until then, quarterly sample of TSS only to be used.**	3 day running median (turbidity) or the value for TSS for any impact site exceeds background 80%ile. Interim "background" 80th %ile value = 2.55 mgl^{-1} TSS Interim "background" for turbidity not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)	3 day running median (turbidity) or the value for TSS for any impact site exceeds background 90%ile Interim "background" 90th %ile value = 2.99 mgl^{-1} TSS Interim "background" for turbidity not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)	3 day running median (turbidity) or the value for TSS for any impact site exceeds background 95%ile Interim "background" 95th %ile value = 9.08 mgl^{-1} TSS Interim "background" for turbidity not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)

Nitrogen		**Quarterly for first 15 months, monthly for months 15-18 of growth cycle**	The value* for any impact site exceeds background 80%ile. Interim "background" 80th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)	The value* for any impact site exceeds background 90%ile Interim "background" 90th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)	The value* for any impact site exceeds background 95%ile Interim "background" 95th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)
Phosphorus		**Quarterly for first 15 months, monthly for months 15-18 of growth cycle**	The value* for any impact site exceeds background 80%ile. Interim "background" 80th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)	The value* for any impact site exceeds background 90%ile. Interim "background" 90th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)	The value* for any impact site exceeds background 95%ile. Interim "background" 95th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)
RDL	Redox Discontinuity Level approaches sediment surface with decreased oxygen in sediments resulting from organic loading, which is respired by micro-organisms, thereby drawing down pore water oxygen	**Quarterly**	Mean of 3 replicate samples for any impact site exceeds background 80%ile. Interim "background" 80th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)	Mean of 3 replicate samples for any impact site exceeds background 90%ile Interim "background" 90th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)	Mean of 3 replicate samples for any impact site exceeds background 95%ile Interim "background" 95th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)

Organic matter in sediments	Sediment organic matter is derived from plant and animal detritus, bacteria or plankton formed in situ or derived from natural and anthropogenic sources such as fish waste. Elevated levels are an indicator of potential for sediment to become anoxic.	**Quarterly**	Mean value of 3 replicate samples for any impact site exceeds background 80%ile. Interim "background" 80th %ile value = 1120 mgkg^{-1} (Background value should be compared/determined at control sites and the above adjusted as appropriate)	Mean value for 3 replicate samples for any impact site exceeds background 90%ile Interim "background" 90th %ile value = 1210 mgkg^{-1} (Background value should be compared/determined at control sites and the above adjusted as appropriate)	Mean value for 3 replicate samples for any impact site exceeds background 95%ile Interim "background" 95th %ile value = 1255 mgkg^{-1} (Background value should be compared/determined at control sites and the above adjusted as appropriate)
Metals in sediment	**At low concentrations many of these metals are essential for life. However, many metals or metalloids can be toxic at high concentrations. Not likely to be influenced by feed, small chance of leaching/corrosion of metal cages.**	**Annual**	The value* for any impact site exceeds background 80%ile. Interim "background" 80th %ile value = existing data for JBMP: [mg/kg] Aluminium 262 Arsenic 3.08 Cadmium 0.12 Chromium 10.8 Copper <0.2 Lead <1 Mercury <0.01 Nickel 0.7 Silver <0.2 Zinc 0.76 (Background value should be compared/determined at control sites and the above adjusted as appropriate)	The value* for any impact site exceeds background 90%ile. Interim "background" 90th %ile value = not available (Background value should be compared/determined at control sites and the above adjusted as appropriate)	The value* for any impact site exceeds background 95%ile. Interim "background" 95th %ile value = ANZECC guidelines: [mg/kg] Aluminium n/a Arsenic 20 Cadmium 1.5 Chromium 80 Copper 65 Lead 50 Mercury 0.15 Nickel 21 Silver 1.0 Zinc 200 (Background value should be compared/determined at control sites and the above adjusted as appropriate)

Biological "Confirmation" Triggers					
Seagrass	**Increased nutrients fuel phytoplankton growth which increases light attenuation; decreases in light attenuation (from increased suspended sediments of phytoplankton growth) decreases light available for benthic primary producers (BPPs), decreasing health of BPPs and decreasing it's depth limit**	**Quarterly**			**Any permanent change in above ground biomass (extent and density) of seagrass (within limit of measurement accuracy)**
Macroalgae		**Quarterly**			**Any reduction in species diversity or habitat for macroalgae (within limits of measurement accuracy)**
Benthic Fauna	**Increased deposition of organic matter can cause burial of organisms, and microbial breakdown of that organic matter can decrease bottom water and sediment pore water dissolved oxygen, which decrease health of benthic organisms.**	**Quarterly**			**Any change in abundance and size composition of benthic invertebrates, any loss of protected species, any loss of species diversity (high protection areas only) (all within limits of measurement accuracy)**
* 3 replicates obtained, 1 analysed initially to save costs, if trigger exceeded, other 2 analysed for confirmation. If no outlier, mean of 3 replicates used.					

Monitoring Site Location	Management Responses				
	Timing	**Trigger 1**	**Trigger 2**	**Trigger 3**	**Biological/Confirmation trigger**
Licensed Area (sites 1 and 7)	Daily/Continuous data availability. Weekly analysis normally. Shortens to bi-weekly then daily if triggers are exceeded, and continues until resolved. Management actions applied when exceedance is captured by measurement.	• Investigate possible causes • Download other instruments • Report on whether exceedance is project related. If attributable: • Consider trigger 2 management responses • Continue monitoring • Contact DoF if advice required	• Audit feeding practices. If feeding practices are likely to be a causal factor, instigate Trigger 3 Management actions • If exceedance is frequent, add more monitoring sites to increase confidence in monitoring results • Continue monitoring • Report to DoF and DEC	• Investigate possible causes (immediately) • Report on whether exceedance is project related (immediately). • Reduce feeding rates • Move sea pens to fallowing area • Continue monitoring. • Report to DoF and DEC	• Investigate possible causes (immediately) • Report on whether exceedance is project related (immediately). If attributable consider: • Reduce stocking density • Continue monitoring
Aquaculture Zone (sites 2, 3)	Continuous data collection, monthly download (site 3). Download goes to fortnightly, then weekly, then bi-weekly, then daily (as necessary) if triggers are exceeded in record but not caught in time to act. Remains that interval until resolved and then interval re-examined in light of resolution. Management actions applied when exceedance is captured by measurement. Station 2: Quarterly	Investigate whether exceedance is likely to be attributed to the project, provide evidence to DEC that exceedance is / isn't attributed to the project within 2 weeks. If attributable: • Download all other instruments • Audit feeding/husbandry practices. • If exceedances are frequent: consider	• If feeding practices are likely to be a causal factor of exceedance, reduce feeding rates • Move sea pens to fallowing area • Continue monitoring • Report to DoF and DEC	• Investigate possible causes (immediately) • Report on whether exceedance is project related (immediately). • Reduce stocking density. • Continue monitoring • If stocking density reduction is not effective (i.e. values remain above trigger or biological impacts continue) instigate trigger 4	• Investigate possible causes (immediately) • Report on whether exceedance is project related (immediately). If attributable: and all other management options have been exhausted: • Seek DoF/DEC advice • Seek emergency variance to move cages to other area • Cease operations

		adding more monitoring sites to increase confidence in monitoring results • Consider trigger 2 management responses • Continue monitoring • Report to DoF and DEC		management responses • Continue monitoring • Report to DEC and DoF	
Sanctuary and Scientific Ref Zones (sites 4, 5 and 6)	Continuous data collection, monthly download (sites 4&5). Download goes to fortnightly, then weekly, then bi-weekly, then daily (as necessary) if triggers are exceeded in record but not caught in time to act. Remains that interval until resolved and then interval re-examined in light of resolution. Management actions applied when exceedance is captured by measurement. Station 6: Quarterly	Investigate whether exceedance is likely to be attributed to the project, provide evidence to DEC that exceedance is / isn't attributed to the project within 1 week. If attributable, consider: • If feeding practices are likely to be a causal factor of exceedance, reduce feeding rates • Move sea pens to fallowing area • Instigate trigger 2 management response. • Continue monitoring • Report to DoF and DEC	• Investigate possible causes (within 3 business days) • Report on whether exceedance is project related (within 3 business days). If attributable, consider: • Move sea cages • Reduce stocking density. • Continue monitoring • If stocking density reduction is not effective instigate trigger 3 management responses • Continue monitoring • Report to DEC and DoF	• Investigate possible causes (immediately) • Report on whether exceedance is project related (immediately). If attributable and if all trigger 2 options have been exhausted: • Seek DoF/DEC advice • Seek emergency variance to move cages to other area • Cease operations	• Investigate possible causes (immediately) • Report on whether exceedance is project related (immediately). If attributable: and all other management options have been exhausted: • Seek DoF/DEC advice • Seek emergency variance to move cages to other area • Cease operations

ATTACHMENT B: Example Report Card Template

Example Report Card: ***Maintaining a Pristine Ecosystem in Areas of Maximum/High Protection***					
Environmental Quality Indicator		Measured Value & Statistics	Trigger Exceedance (y/n)	*Management Actions	Comment
Physical/Chemical Measurements	- Chl a (ug/m^3)	Mean: 0.4 Median: 0.2 Range: 0.1-0.9	Y	Compare data to reference sites	e.g. Elevated Chl-a is consistent with data from reference sites. Natural spike in Chl-a attributed to climatic conditions (storm with offshore winds during this period). Re-evaluate trigger levels factoring in natural variability.
	- Light Attenuation				
	- Dissolved Oxygen	80% saturation for 5 days	Y	Examined weather records – no evidence of cause; downloaded other instruments – similar trend at impact sites, not at reference or sanctuary sites; audit feeding practices by husbandry manager	Next plan is: If this audit demonstrates over-feeding, will reduce feeding rates. If not, will implement extra round of benthic faunal sampling, if effects observed, consider alteration to feeding practices or moving sea pens to allow fallowing.
	- Total Suspended Solids				
Biological Measurements	- Phytoplankton blooms - Seagrass median shoot density				
Toxicants in Water	- Metals/ metalloids - Pesticides - Herbicides - Anti-fouling agents				
Toxicants in Sediments	- Metals/metalloids - Organometallics (e.g. TBT) - Total organic Carbon				

ATTACHMENT C: Monitoring locations shown on aerial imagery

Jurien
Bay

Seaward Ledge

6

Puerulus

JURIEN

Boullanger Island

4

3

Hill River
Special Purpose Zone

Licence Area C

1

7

2

LEGEND

- Licence Area C
- Special Purpose Zones
- Jurien Bay Marine Park
- Proposed Marine Reserve
- Monitoring location & number

N

0 500 1000 1500 2000 2500

Metres
GDA94 MGA Zone50

Booker Rocks

Hill River
Special Purpose Zone

5

Marine Park

ATTACHMENT D: Monitoring locations shown on bathymetric chart

JURIEN BAY

Middle Head

Q.10M
Iso.4s 10M

Favorite I
(14)

Seaward Ledge
Fl(5)Y.20s
Seaward Ledge

Historic Wreck
(see Note)

Boullanger I

Jurien
Island Point

Puerulus

The Boomer

Whitlock I
(9)

Escape I
(12)
Fl(3)15s10M

Boullanger Island

Foul Passage

Essex Rocks
(5)

Hill River
Special Purpose Zone

Licence Area C

Coffins

Booker Rks

Booker Rocks

Hill River
Special Purpose Zone

Outer Rocks
(6)

LEGEND

- Licence Area C
- Special Purpose Zones
- Jurien Bay Marine Park
- Proposed Marine Reserve
- Monitoring location & number

N

0 500 1000 1500 2000 2500
Metres
GDA94 MGA Zone50

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Appendix D – WKL Wildlife Interaction Prevention Strategy

WKL Wildlife Interaction Avoidance Strategy

1. Introduction

The Jurien Bay Marine Park is home to a variety of wildlife, including several species of conservation significance. The Western Kingfish Limited (WKL) Pilot Project has the potential to impact upon the wildlife of the Jurien Bay Marine Park through its operations and through potential interactions between staff or equipment and wildlife.

It is imperative for all aquaculture operators to acknowledge the fact that they share the waters to be farmed with existing wildlife. Marine animals, such as sea lions, birds, cetaceans and turtles, must never be allowed to "gain reward" from the aquaculture 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 aquaculture operational activities. Such negative interactions can include predation of farmed fish, aggressive behaviours from animals to staff and alteration in natural behaviour and reproductive outcomes.

Interactions between marine fauna and aquaculture equipment can also have significant negative effects on wildlife. Sea lions, dolphins, sharks and turtles could potentially become entangled in poorly maintained nets, or be killed or injured by collision with vessels operating as part of the aquaculture activities.

This strategy has been produced to manage these and other potential impacts on wildlife through the avoidance of interaction between project staff, process and equipment with the wildlife of the Jurien Bay Marine Park.

The primary goal of this document is to prevent interactions between pilot project staff and equipment. Although the implementation of this strategy will reduce potential interactions and their impacts, this goal may not be totally achievable. Nevertheless, WKL will strive for avoidance of interactions with wildlife.

All staff will be trained to implement this strategy. This will ensure that crewmembers will be fully aware of the correct manner in which to interact with wildlife, and the respect required in such dealings. Personnel will also be held accountable for the interactions between themselves and wildlife present in the area.

WKL will have a company policy regarding the adherence to the Wildlife Interaction Avoidance Strategy and the correct attitude to be taken with all wildlife. Failure to comply with this policy will lead to disciplinary action being taken, which may include dismissal, and if the circumstance dictates, prosecution in accordance with applicable laws.

2. Aims and Objectives

The primary aim of this strategy is to ensure that the pilot project does not significantly disturb wildlife in the Marine Park.

The objectives of this strategy include:

- no human interactions with wildlife
- no injuries to wildlife from collision with boats or entanglement
- minimise noise disturbance to wildlife

- record and report all sightings of conservation significant species to aid in the implementation of reactive management strategies and add to the existing knowledge base on these species
- records and report sightings of other wildlife in close proximity to the pilot project operations.

3. Human Interactions with Wildlife

The wildlife of the Jurien Bay Marine Park is a mixture of tropical and temperate species, with tropical species comprising around 35% of marine fauna found in the region (CALM, 1998). Marine wildlife includes 14 species of cetaceans (five of which are listed as rare or likely to become extinct), a variety of sea an shorebirds which nest on the islands and the Australian sea lion, a species that is specially protected under the Western Australian *Wildlife Conservation Act 1950*. A rich finfish fauna also occurs in the Jurien Bay Marine Park, along with a diverse marine invertebrate community, which includes a number of endemic species.

Interactions between people and wildlife may cause stress to animals and are also dangerous to people. Inappropriate use or lack of maintenance on equipment can lead to injury or death of wildlife and litter has the potential to impact on wildlife and can cause death by choking or entanglement.

In order to prevent stress, injury or death of wildlife, as well as limit danger to personnel from wildlife, the following key rules shall apply to all aquaculture activities and all staff working on the pilot project:

- Feeding, touching or swimming with wildlife is not permitted:
    - Under NO CIRCUMSTANCES will any employee or contractor of WKL feed wildlife, including sea lions, cetaceans, turtles and birds, or make available any dead kingfish for consumption by wildlife.
- No littering. All rubbish shall be placed in dedicated waste bins, which will have secure lids and which are secured to the vessel or work platform and returned to shore for appropriate disposal.
- Staff will record any interactions with wildlife according to WKL policy (see section 12)

4. Sea Pens

WKL will use both the Polar Circle type technology, and also the steel System Farm type of enclosure for the pilot project, although it is expected that the predominant method will be the steel System Farm type. Both systems come complete with seal proof exclusion fencing above the water, making it impossible for these animals to use the farm structures as haul-out zones. These above surface barrier systems are comprised of physical barriers, with additional low energy electric deterrent fences as an option, such as the Seal Guard® system, (see page 82, National Assessment of Interactions Between Humans and Seals).

Sub-surface exclusion or “predator netting” will be mandatory on sea pens utilised by WKL. And will be implemented during the pilot project through the use of metallic nets. The *National Assessment of Interactions between Humans and Seals: Fisheries, Aquaculture and Tourism* describe the past successes of this system. The design, type and operational of the use of metal nets has improved even further since this article was written.

All meshes used in WKL sea pen operations are of a size and specification that prevent entanglement by sea lions. Industry best practice was used with selection and management of sea pens, including the 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 by seals and the negative interactions associated with these learnt behaviours.

Sea cages will also have well maintained bird exclusion netting. This excludes birds that may be predatory on small fish, but equally important, it excludes opportunistic feeding by birds on feeds supplied to the cultured fish. These birds can have undesirable sanitary and maintenance implications on cage infrastructure and can transmit diseases to the cultured fish. Bird exclusion netting is designed to minimise or negate the risk of birds becoming entangled in it, provided it is properly installed and maintained.

5. Vessel Movements

Normal operations of the pilot project are likely to involve at least eight vessel movements per day between the shore/mooring and the sea pens (based on four feeding sessions per day). Vessel movements during maintenance periods may be higher. The potential exists for injury to or death of wildlife due to collision with marine vessels. Additionally, the noise of marine vessels can potentially disturb some wildlife, such as cetaceans and turtles. The following sections describe the actions that shall be undertaken by relevant staff to ensure the pilot project meets its aim in regard to the avoidance of interaction with wildlife.

5.1 General

- When multiple personnel are on board a vessel, a “lookout” person will be in place to search for cetaceans, sea lions, turtles and other wildlife during all vessel movements (including between the shore or mooring and sea pens, between individual sea pens and any other vessel movement) to avoid collisions with wildlife. This will be the responsibility of the skipper when he/she si alone on board.
- A vessel must not block the direction of travel of any wildlife, particularly a whale, dolphin or turtle, or any passage of escape available to wildlife from an area where escape is otherwise prevented by a barrier, shallow water, vessel or some other obstacle to the animal's free passage.
- Wherever possible, wide, deep channels will be used as transport routes for work vessels between the shore and the sea pens to avoid disturbance to wildlife habitat. Shallow areas and seagrass beds will be avoided.
- Wherever possible outboard motors on work vessels should be able to tilt up in the event of a collision (rather than lock-down).
- Project vessels will be stored within the JBMP when not in use. No vessels used in the marine park for the pilot project will discharge any ballast water to minimize the risk of introduction of non-indigenous species.
- All vessels and machinery will be maintained in proper working order, including implementing a program of preventative maintenance, to minimise the transmission of noise into the water and to minimise the risk of a hydrocarbon spill due to bunkering and/or operation of aquaculture vessels and machinery.
- An emergency response plan will be developed and implemented in the case of a hydrocarbon spill as a result of aquaculture operations.

5.2 Whales

- A vessel must not cause a whale to alter its direction or speed of travel.
- A vessel must not disperse or separate a group of whales or dolphins.

- A vessel, whether under power or drifting, must not approach a whale from a direction within an arc of 60° of the whale's direction of travel or an arc of 60° of the whale's opposite direction of travel (Figure 1). A vessel must not approach a whale within a distance of 100 m.
- No more than three vessels may be within 300 m (within the caution zone; Figure 1) of a whale at any one time.
- Where a whale approaches a vessel and the distance between the whale and the vessel becomes less than 100 m, the vessel master must place its motor or motors in neutral or move the vessel at less than five knots away from the whale until the vessel is at least 300 m from the whale.
- At any sign of the whale becoming disturbed or alarmed, the vessel must move the vessel at less than five knots away from the whale until the vessel is at least 300 m from the whale. Whale disturbance signs include:
    - diving for prolonged periods
    - regular changes in direction or speed of swimming
    - hasty dives
    - changes in breathing patterns
    - increased time spent diving compared to time spent at the surface
    - changes in acoustic behaviour
    - swimming evasively
    - aggressive behaviours such as tail slashes and trumpet blows.

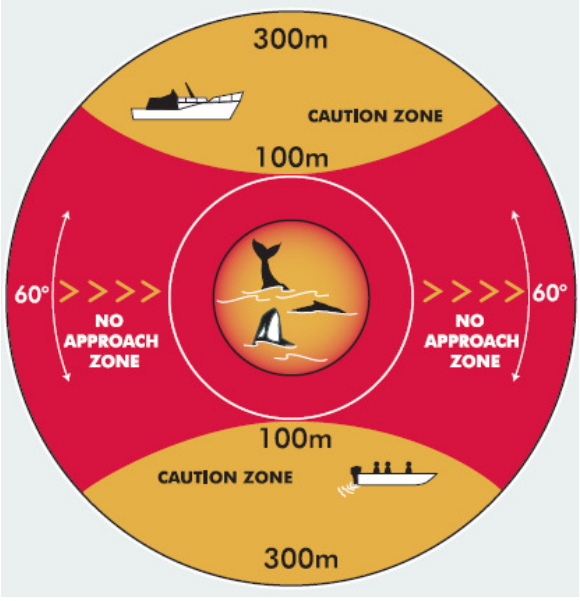


Figure 1: Distances to be maintained between vessels and whales.

5.3 Dolphins

- A vessel, whether under power or drifting, must not approach a dolphin from a direction within an arc of 60° of the dolphin's direction of travel or an arc of 60° of the dolphin's opposite

direction of travel (Figure 2). A vessel must not approach a dolphin within a distance of 50 metres.

- No more than three vessels may be within 150 m (within the caution zone; Figure 2) of a dolphin at any one time.

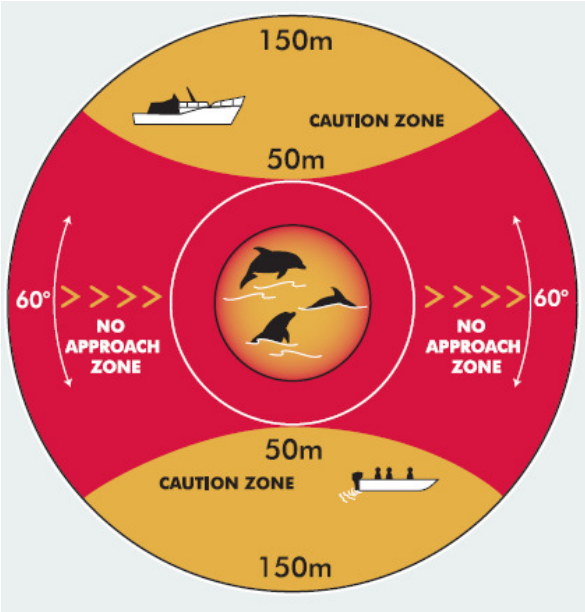


Figure 2: Distances to be maintained between vessels and dolphins.

5.4 Whale Sharks

- In the unlikely event that a whale shark is observed, a vessel must observe the same requirements as for a whale, however, only one vessel may be within a 400 m radius of a whale shark at any one time.

5.5 Sea Lions and Turtles

- Vessels will maintain a distance of at least 50 m from sea lions and turtles wherever possible and will never purposely approach a sea lion or turtle. A sea lion and turtle identification guide is available as Attachment C, to be displayed onboard work vessels and on work platforms.

Table 1: Distances to be maintained between vessels and macrofauna

Species	Minimum distance to be maintained	Bow riding	Other requirements
Whale	Wherever possible, no closer than 300 m (in accordance with figures 1 and 2). Always no closer than 100 m.	Do not deliberately encourage bow riding When animals are bow riding, do not change course or speed suddenly If there is a need to stop, reduce speed gradually	CAUTION ZONE: No wake speed Maximum of 3 vessels Do not enter caution zone if animals are stranded, entangled or distressed NO APPROACH ZONE: Do not enter No waiting in front of direction of travel Do not approach from the rear
Dolphin	Wherever possible, no closer than 150 m (in accordance with figures 1 and 2). Always no closer than 50 m.		
Whale Shark	Wherever possible, no closer than 300 m (in accordance with figures 1 and 2). Always no closer than 100 m	N/A	No more than one vessel within 400 m of a whale shark at any time.
Sea Lion	50 m	N/A	Never purposely approach a sea lion.
Turtle	50 m	N/A	Never purposely approach a turtle.

6. Nets, Ropes and Cages

- Rigorous maintenance programs for all marine infrastructure, particularly nets, ropes and cages, will be implemented to ensure there is no capacity for entanglements of marine fauna.
- Nets, ropes and cages shall be maintained in proper working order, being taught, without holes that may cause entanglement of wildlife and without fouling.
- All maintenance to nets and cages will follow protocols to be developed throughout the pilot project.
- Nets, ropes and cages shall be inspected daily for any wildlife that has become entangled.
- Any nets stored on sea pens will be secured to the platform to prevent nets falling into the water and the potential for wildlife to become entangled in them.

7. Feeding

7.1 Feeding protocols

Farmed yellowtail kingfish are fed exclusively formulated diets based on fish meal with plant products and other additives. Fundamentals such as nutritional composition and feed physical characteristics are a function of kingfish biology and logistics of feed manufacture, storage and handling. These products must meet AQIS standards of biosecurity with respect to imported components.

Feeding will be based on the following:

- An automated feeding system will not be used for the pilot project as the cost, scaling and logistics are not appropriate for this small operation. Feeding will be undertaken manually, based on feed schedules, theoretical requirements of the estimated biomass and on visually assessed feeding responses by the fish.
- Juvenile fish are fed four times per day with this schedule determined by the operations manager based on established fish husbandry criteria and regular measurements of fish body weight. The quantity of feed delivered is based on the calculated feed requirement based on the estimated biomass, determined from regular fish body weight measurements.
- Feed will be delivered to the fish farm by boat in 25 kg bags.
- For the Polar Circle the feed remains on the boat and is delivered to the fish by a portable blower system (see below).
- For the System Farm, bags of feed, sufficient for a few days will be delivered and loaded onto the central walkway.
- The feed is delivered to the fish by a small portable blower system with a reservoir and delivery outlet, which 'sprays' the feed onto the water surface This sits in the boat for use with the Polar Circle; with the System Farm the feeder can be wheeled up the walkways. The blower delivers the pellets onto the water surface with the operator directing the spread of feed to ensure an even distribution of feed to the fish.
- The operator is trained to regulate the actual feed delivered based on behavioural observations of the feeding responses of the fish. Daily records include the observations of the feed operator which score the feed response based on established criteria.
- The quantity of feed delivered to each cage unit at each feeding session is recorded.
- These feed records for each production unit are an essential component of the aquaculture operation. They ensure that the management can determine operational efficiency with regard to feed costs and other production criteria.
- This accurate recording of fish feed inputs is also a valuable record with respect to the environmental monitoring and management plans.
- With more developed operations the feed-back control on feed delivery can include manual and automated feedback responses to fish behavioural responses and record of settlement of uneaten feed.

7.2 Feeding Management

WKL will ensure through careful management that feed losses to the environment are minimised. This will help to reduce the potential for interactions with wildlife, including the availability of feed to

wildlife such as fish and birds. It is vital that there is no encouragement of opportunistic feeding by wild fish or birds because of the negative impacts this can have on natural behaviour and ecology. Feeding activities shall be managed in accordance with the following points to minimise their effect on wildlife in the Jurien Bay Marine Park.

- The quantity of feed delivered to each cage unit per feeding session shall be regulated based on regular fish body weight measurements (to estimate biomass) and observations of fish feeding behaviour to ensure minimal feed remains uneaten by farm fish and is therefore available for consumption by wildlife;
- Feed bags stored on the System Farm work platform must be secured in place and must in good condition, with no holes, tears or rips. These bags must not be accessible to birds, and have no potential to fall into sea pens; and
- Staff will be adequately trained in the use of the portable blower system used to deliver feed into the sea pens to ensure minimal or no spillage and no spraying of feed outside of sea pens.

8. Farm Fish Mortalities

Wherever there is livestock, there is inevitably a small percentage of dead stock. WKL will dispose of all mortalities from operation in a timely and responsible manner, in accordance with licensing conditions. Dead fish will not be allowed to remain in cage structures, thereby removing the scent trail that may attract sea lions and other predators including sharks.

- Dead fish will be removed daily from sea pens to avoid predation by sea lions, sharks and other wildlife; and
- All dead fish removed will be stored in enclosed containers until transport back to land (on the same day as collection) for appropriate land-based disposal.

9. Farm Fish Health and Disease Treatment

Yellowtail kingfish have relatively few disease problems, although the prevalence of external parasites (skin flukes and gill flukes) appears to transpire occasionally. In South Australia a number of other health problems directly related to low water temperatures have also been documented. The minimum water temperatures recorded in Jurien Bay are well above the temperatures associated with these problems in South Australia and these diseases are highly unlikely to arise during the pilot project.

The external parasites *Benedenia seriolae* and *Zeuxapta seriolae* may occur during the current operations. The System Farm production unit is eminently suited to the management systems required to control flukes. The fluke life cycle is ‘direct’ and accumulation of eggs on ‘dirty’ nylon nets is the major source of infection onto farmed fish. The ability to keep nets pre-emptively clean and free of major biofouling build up is a major advantage in limiting the ability of fluke eggs to attach and accumulate in the vicinity of the farmed fish.

If fish do become infected the standard treatment is to bathe fish in a dilute solution of hydrogen peroxide, following established protocols as follows:

- Fish are assessed for levels of parasite infection by observing fish behaviour (infected fish show ‘rubbing’ behaviours and may be listless or off their food). More quantitative assessment is also undertaken by anaesthetising and treating a small number of fish within a contained area. Any gill and skin flukes caused to drop off the fish can be counted to give a quantitative score of the infection rate.

- Based on the qualitative and quantitative scores, a decision is made to treat the fish.
- Fish are concentrated using a seine net and a rubber liner is used to create a bath. The water volume is known and hydrogen peroxide at concentration of 100 ppm is established. The bathing solution is aerated and mixed and the fish passed though the solution in batches to ensure an appropriate exposure time.
- The used bath solution can be disposed off into the local environment as it is very dilute. The solution is also further diluted by water movement and dispersion. Hydrogen peroxide is very unstable (it decomposes very rapidly into water and oxygen) and has zero residual effect on the dosed fish or the environment.

Any other disease treatments required would completed under veterinary supervision and in accordance with environmental best practice.

- The health of farm fish will be monitored regularly to ensure adequate disease treatment is provided and to avoid the transmission of disease to wildlife.
- Disease treatment will be conducted in accordance with best practice techniques for aquaculture.

10. Transfer and Harvesting

- Ensure fish transfer and harvesting equipment is designed to eliminate or minimise escape events;
- Ensure that escapee recapture is designed to eliminate or minimise bycatch;
- All blood water and fish products associated with harvesting will be kept in secure, enclosed containers for transport to shore for appropriate disposal.

11. Distressed Wildlife

- Immediately report any wildlife in distress, including entangled or stranded animals and dead animals, to the WKL Environment Officer and DEC's Wildcare Hotline on (08) 9474 9055 (24-hour emergency number) or the DEC Duty Officer on (08) 9334 0224.
- If a collision occurs between a work vessel and wildlife or an animal is found entangled in the sea pen netting, immediately contact the WKL Environment Officer and DEC's Wildcare Hotline on (08) 9474 9055 (24-hour emergency number) or the DEC Duty Officer on (08) 9334 0224. Any collision with or entanglement of a cetacean or turtle, associated with the pilot project, must also be reported to DEC, the Western Australian Museum, the Western Australian Fishing Industry Council and the Department of Environment, Water, Heritage and the Arts. Any injury to or death of a protected species must be reported to the Australian Fisheries Management Authority (AFMA).
- In the case of an animal in distress, help the animal through advice from the contacted authority or through common sense if advice is not available. Staff will act only if safe to do so and will not, under any circumstances, put their own safety at risk to assist wildlife in distress.
- A list of emergency contact numbers for display on board vessels and on work platform is provided as Attachment B.

12. Monitoring, recording and reporting

- A daily record of all interactions with wildlife will be kept as detailed below. The template provide as Attachment A will be used for recording all wildlife sightings, observations and

interactions (two worked examples are also provided in this template). A copy of this template will be kept with the vessel log book on board work vessels at all times. The following dealings with wildlife will be recorded:

  - The number of sea lions, cetaceans, turtles, birds, large finfish (such as sharks) and other animals in the area of the sea pens and behavioural observation of these species;
  - All sightings of cetaceans, sea lions, turtles and any other species of conservation significance within 500 m of the sea pens or work vessel routes; and
  - Any specific interactions with wildlife, such as aggression by wildlife to pilot project personnel, access of wildlife to sea pens and collision with or entanglement of wildlife in pilot project equipment. Any such interaction shall also be reported immediately to the WKL Environment Officer.

- To enable identification of species of conservation significance, staff will have access to and be familiar with identification guides such as the Australian Fisheries Management Authority's (AFMA) Protected Species Guide (available at http://www.afma.gov.au/environment/eco_based/publications/id_guide.pdf) and the APPEA Search Australian Whales and Dolphins: Interactive CD Rom Identification Guide. A copy of the former will be kept on board work vessels along with binoculars to aid in the identification of any species of conservation significance sighted;
- The Environmental Officer shall review the records of wildlife sightings and interactions weekly. If turtles, sea lions and/or cetaceans are frequently sighted within 500 m of the sea pens or work vessel routes, a reduced speed will be adopted for all work vessels;
- If any wildlife is found entangled in aquaculture equipment, the cause of entanglement will be reviewed by the WKL Environmental Officer and maintenance and operational practices will be adjusted accordingly;
- A consolidated report of all recorded sightings and interactions with wildlife shall be submitted to DEC as part of the EMMP Quarterly and Annual Reports.
- All recorded sightings of cetaceans will also be reported quarterly by completing and submitting the template available at:

  http://aadc-aps.aad.gov.au/aadc/whales/Whale_and_Dolphin_sightings_report_summary_v2.xls
- All monitoring data will be made available to DEC and MPRA within 7 days of a request for such data by either agency.

ATTACHMENT A: Wildlife interaction and sightings template

Table 1: Wildlife interaction and sightings template

							Species details							Weather/sea conditions		
Sighting No.	**Date**	**Time** (24 hour)	**Animal seen from** (land/ vessel/ sea pen)	**Latitude** (deg min sec S)	**Longitude** (deg min sec E)	**Your activity** (feeding/ net maintenance/ transport)	**Species -** Using identification guides	**How sure?** (very sure/ sure/ not sure)	**Total no of animals**	**Description of sighting and animal behaviour** (e.g. breaching/ bow riding/ feeding)	**Other animals present** (including fish, birds, etc.)	**Other notes**	**Photo/Video taken?** (Y/N)	**Sea state** (see Table 2)	**Cloud cover** (oktas*)	**Overall visibility**
1	30/1/08	0830	vessel	17 43 0	121 57 0	transport	Humpback whale	sure	4	breaching	lots of small tuna	none	Yes-photos	2	1 - clear sky	Good
2	2/2/08	1340	Sea pen	17 48 0	121 60 0	feeding	Silver gulls	Very sure	~50	Flying / circling over sea pens	none	Some birds attempting to access feed	No	3	8 – totally overcast	Low
3																
4																
5																

* Cloud cover observations are measured in oktas (eighths). The sky is visually inspected to produce an estimate of the number of eighths of the dome of the sky covered by cloud. A completely clear sky is recorded as zero okta, while a totally overcast sky is 8 oktas. The presence of any trace of cloud in an otherwise blue sky is recorded as 1 okta, and similarly any trace of blue on an otherwise cloudy sky is recorded as 7 oktas.

Table 2: Sea state (Beaufort Number) descriptions

Beaufort Number	Wind Speed (knots)	Wind Description	Specification for use on land
0	less than 1	mirror calm	Sea like a mirror
1	1 to 3	light air	Ripple with the appearance of scales are formed, but without foam crests.
2	4 to 6	light breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break.
3	7 to 10	gentle breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.
4	11 to 16	moderate breeze	Small waves, becoming larger; fairly frequent white horses.
5	17 to 21	fresh breeze	Moderate waves, taking a more pronounced long form; many white horses are formed. Chance of some spray.
6	22 to 27	strong breeze	Large waves begin to form; the white foam crests are more extensive everywhere. Probably some spray.
7	29 to 33	near gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
8	34 to 40	gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind.
9	41 to 47	severe gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.
10	48 to 55	storm	Very high waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes on a white appearance. The 'tumbling' of the sea becomes heavy and shock-like. Visibility affected.
11	56 to 63	violent storm	Exceptionally high waves (small and medium-size ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected.
12	more than 63	hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.

Tables adapted from http://aadc-maps.aad.gov.au/aadc/whales/Whale_and_Dolphin_sightings_report_summary_v2.xls

ATTACHMENT B: Wildlife emergency contact numbers

WILDLIFE EMERGENCY CONTACT NUMBERS

- WKL Environment Officer:

- DEC's Wildcare Hotline:
  (08) 9474 9055
  (24-hour emergency number)

- DEC Duty Officer:
  (08) 9334 0224

In the case of an animal in distress, help the animal through advice from the contacted authority or through common sense if advice is not available. Staff will act only if safe to do so and will not, under any circumstances, put their own safety at risk to assist wildlife in distress.

Other important numbers:

Western Australian Museum: (08) 9212 3700

Western Australian Fishing Industry Council: (08) 9492 8888

Department of Environment, Water, Heritage and the Arts: (02) 6274 1111

Australian Fisheries Management Authority: 1300 723 621

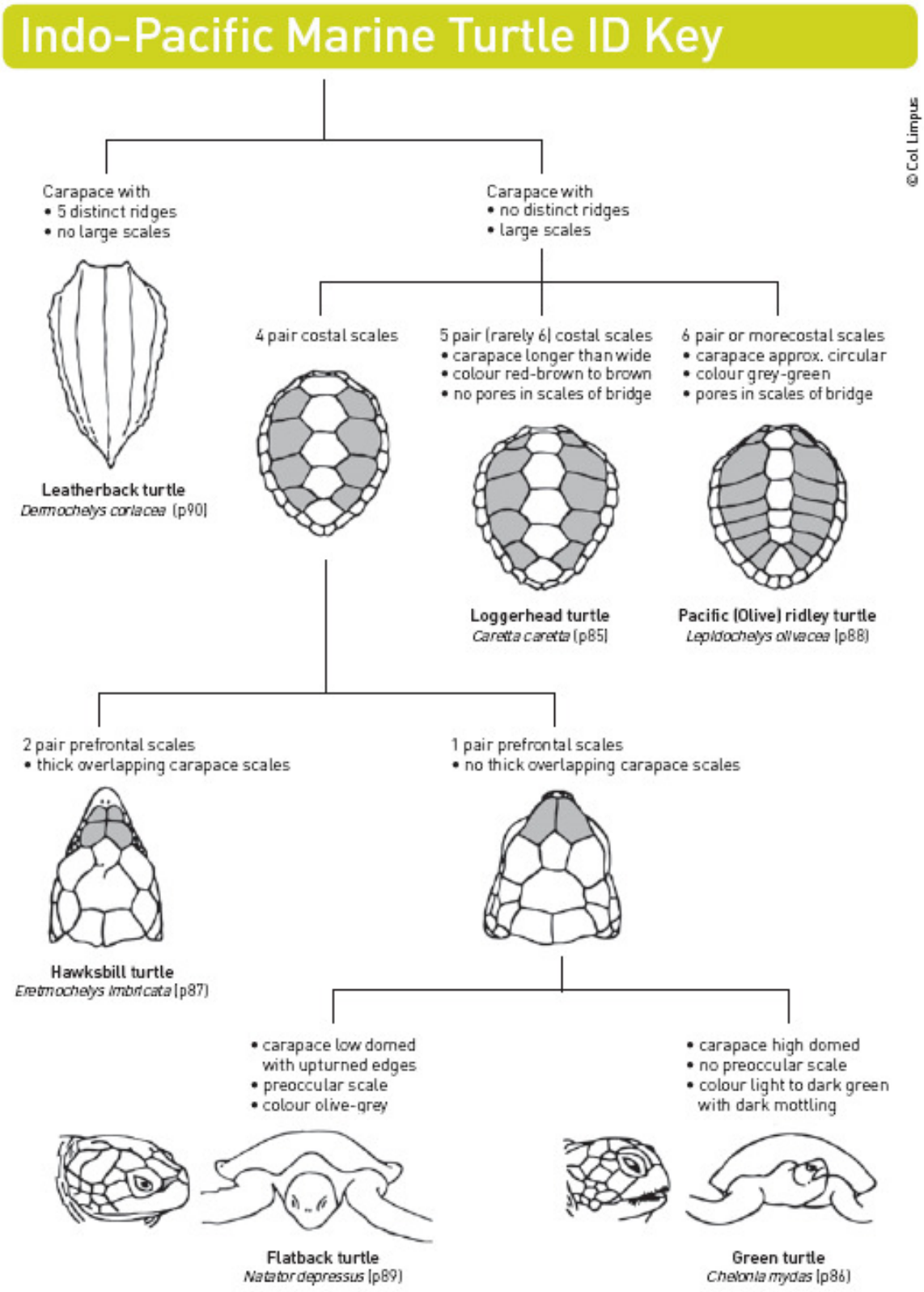
ATTACHMENT C: Sea lion and turtle identification guide

Australian Sea Lion

Australian sea lion
Neophoca cinerea

CAAB No: 41131005
FAO Code: ASL

- Both sexes have stocky bodies, a large head and short narrow flippers
- Male is dark brown with pale coloured mane on the back of the neck
- Adult males up to twice the weight and length of females
- Females are silver-grey to fawn on the back and creamy coloured underneath
- Juveniles have a similar colouration to females



Source: AFMA Protected Species ID Guide.

Available at http://www.afma.gov.au/environment/eco_based/publications/id_guide.pdf