Commercial Shellfish Aquaculture Leases

Jervis Bay, NSW

Environmental Impact Statement

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ENVIRONMENTAL IMPACT ASSESSMENT CERTIFICATION

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Proposed development

Under the *State Environmental Planning Policy* (State and Regional Development 2011) the proposal is classified as State Significant Infrastructure (c.14 (1)(b) and Schedule 3 (1)(1)) and requires approval from the Minister for Planning and Infrastructure under s.115W of the *Environmental and Planning Assessment Act 1979*.

Certification

We certify that we have prepared this EIS in accordance with the Director-General's Requirements and to the best of our knowledge the information contained in this EIS is neither false nor misleading.

Ian Lyall	Hester Bushell	Graeme Bowley
Project Director	*Project Manager*	*Project Manager*

October 2013

EXECUTIVE SUMMARY

Overview

Fisheries NSW, a division of the Department of Primary Industries, is seeking approval for the establishment of Commercial Shellfish Aquaculture Leases within the open marine embayment of Jervis Bay. Three leases are proposed, including two 20 hectare areas 1.5 and 1.9 kilometres off Callala Beach and a 10 hectare site 0.7 kilometres off Vincentia over an area previously leased for mussel culture. Naturally occurring species to the Jervis Bay region like Blue Mussels, scallops and oysters would be grown.

Aquaculture is permitted in the Jervis Bay Marine Park (JBMP) but cannot exceed more than 2% (440 hectares) of the park and cannot involve feeding or nutrient input. NSW Marine Parks (NSW MP) requested Fisheries NSW to develop an aquaculture strategy to ensure any development is consistent with the management plans for JBMP.

Due to the interest in Jervis Bay from local and interstate shellfish growers and local Indigenous groups, it is timely to have a coordinated approach to assess the potential for aquaculture in Jervis Bay. Fisheries NSW has developed an Environmental Impact Statement (EIS) and draft Environmental Management Plan to accompany an application for three Commercial Shellfish Aquaculture Leases that if approved, would be tendered to shellfish growers.

Jervis Bay is one of only three marine embayments on the NSW coast that are suitable for deepwater shellfish aquaculture. The other embayments are Port Stephens, which has an established edible oyster industry and areas that were approved for Pearl Oyster production, and Twofold Bay which has Blue Mussel aquaculture and previously produced oysters.

The culture of shellfish (mussels, scallops, oysters) is permitted in the Jervis Bay Marine Park Zoning Plan and there is a history of Blue Mussel culture on floating rafts at Vincentia (1977-2008), oyster aquaculture in Currambine and Moona Moona Creeks (1935-1991) as well as the longline culture of scallops (1992-94).

The NSW Government recognises the need to look at opportunities for sustainable and viable aquaculture development. Aquaculture supports the regional economies of NSW and will be an increasingly important contributor to the future food security needs of the State. The proposed Commercial Shellfish Aquaculture Lease project would assist in the strategic and coordinated development of aquaculture in Jervis Bay rather than a piecemeal “adhoc” approach.

Aquaculture not only produces quality sustainable seafood but can be the catalyst for economic development. In other localities in Australia the flow on effects of aquaculture has

provided increased employment opportunities for service industries including the tourism and restaurant and retail sectors.

Figure 1: Regional map of Jervis Bay and the proposed locations for the Commercial Shellfish Aquaculture Leases (Source: Fisheries NSW, 2012).

Rationale

Global demand for seafood is rapidly expanding and seafood consumption per capita is increasing. In 2008, 46% of the seafood consumed worldwide was produced by aquaculture (FAO, 2010). In NSW the supply of locally caught fish is not expected to increase from current sustainable catch levels and approximately 87% of seafood purchased in NSW is imported (Wilkinson, 2004).

Sustainable seafood production is a key focus of the NSW Government's State Aquaculture Steering Committee to support future demands of food security for the state. The gap between capture fishery supply and the growing demand for seafood can only be supplied by aquaculture.

Shellfish aquaculture has occurred in NSW since the 1870s with a history of strong research and development support from Fisheries NSW since the early 1900s. The research and development has involved successful hatchery and nursery studies on a broad range of species, including three species of oyster, two species of scallop and five species of clams and mussels.

Jervis Bay has characteristics that make it highly suitable for shellfish aquaculture, including excellent water quality, it is well sheltered from most prevailing weather conditions, it has a suitable depth profile and it is well serviced with local infrastructure and support industries.

Approvals Pathway

Under *State Environmental Planning Policy (State and Regional Development 2011)* the proposal is classified as State Significant Infrastructure and requires approval from the Minister for Planning and Infrastructure under Section 115W of the *Environmental and Planning Assessment Act 1979.* An Environmental Impact Statement (EIS) has been prepared to accompany the application for approval.

The Department of Planning and Infrastructure issued Director-Generals Requirements to Fisheries NSW for the preparation of an EIS in December 2012. The EIS must include: a description of the project; details of the existing environment; a risk assessment of potential environmental impacts; consultation undertaken; issues raised during consultation; and environmental management and monitoring measures to mitigate potential impacts.

Fisheries NSW has sought approval under the *Control of Naval Waters Regulation 1922* and has been advised that the project has been deemed not to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* administered by the Commonwealth.

Crown Lands have provided land holders consent to Fisheries NSW to lodge the application. An aquaculture lease is required under Section 163 of the *Fisheries Management Act 1994* and a permit is required under the *Marine Parks Act 1997*. The proposed Commercial Shellfish Aquaculture Leases are located in Habitat Protection Zones of the JBMP which permit aquaculture activities.

Strategic Framework

The promotion of sustainable aquaculture was prioritised at the NSW Executive Food Security Group in 2011. This group tasked the government's State Aquaculture Steering Committee to progress initiatives to further develop aquaculture. Under *State Environmental Planning Policy – 62 (Sustainable Aquaculture)*, two strategies have been prepared to guide the development of aquaculture in NSW and promote industry best practice. They include the NSW Oyster Industry and Land Based Sustainable Aquaculture Strategies.

The investigations conducted in preparing this EIS and those undertaken previously for the Marine Aquaculture Research Lease off Port Stephens will provide an evidence base for the development of policy for sustainable aquaculture in the marine waters of NSW.

The Proposal

The proposed Commercial Shellfish Aquaculture Leases would occupy an area of 50 hectares in Jervis Bay (Figure 1) consisting of three leases - two 20 hectare areas off Callala Beach and a 10 hectare site off Vincentia. In siting the leases, the constraints considered included: Marine Park Sanctuary Zones; Commonwealth Waters; designated anchor/mooring areas; wharves and boat ramps; main passage for recreational boating and sailing; Naval training and mooring areas; seagrass beds; rocky reefs; dolphin aggregation areas; most frequented fishing and diving locations; bait gathering areas; water depth; and proximity to former proven lease areas.

If approved, the lease sites will be marked on navigational charts, Roads and Maritime Services (RMS) boating maps and navigation buoys will be positioned on the corners of the lease areas to ensure safe navigation.

The species cultured on the proposed Commercial Shellfish Aquaculture Leases would utilise the naturally occurring plankton and other nutrients in the water. No artificial feeds will be used and no additional nutrients will be added to Jervis Bay resulting in a nett export of nutrients and suspended solids via the harvested stock.

Naturally occurring species to the Jervis Bay region would be grown and may include: Blue Mussel; scallops; Akoya Pearl Oyster; Sydney Rock Oyster; Native (Flat) Oyster; and marine algae. Other species that can be cultured without feed or nutrient input may also be considered for culture.

Broodstock used to produce stock for the proposed Commercial Shellfish Aquaculture Leases will be sourced locally or from the same genetic population and only breeding techniques that ensure genetic integrity will be used. The introduction of exotic pathogens and pests into the region will also be mitigated by implementing strict hatchery and translocation biosecurity controls.

A longline culture system will be used which consists of an anchoring and mooring system where horizontal lines of rope (i.e. backbones) are suspended from the surface by buoys and anchored at both ends. Dropper lines, pyramid nets/cages, lantern nets/cages, panel nets, baskets or trays will contain the shellfish and be attached to the backbones. The use of rafts formerly used in Jervis Bay is not proposed for the Commercial Shellfish Aquaculture Leases.

The visual amenity impacts of the longline infrastructure will be mitigated by:

- use of dark coloured buoys;
- minimising and streamlining surface infrastructure;

- maximising subsurface infrastructure and maintaining a low profile;
- use of service vessels that are similar to existing fishing, dive and whale/dolphin watching vessels that frequently navigate within Jervis Bay;
- the predominantly low profile of the topography on the western side of Jervis Bay;
- the distance from townships and key landmarks; and
- the sea state conditions that are characteristic of Jervis Bay.

The risk of large marine animal entanglement associated with the Commercial Shellfish Aquaculture Leases will be mitigated by the longline design features; a Structural Integrity and Stability Monitoring Program (maintaining taut ropes); a Marine Fauna Interaction Management Plan and a Marine Fauna Entanglement Avoidance Protocol. Longline aquaculture has been practiced in NSW including Jervis Bay, Twofold Bay and Port Stephens for over three decades without entanglement incidents. Similarly, the risk of entanglement has not been a significant issue in the many thousands of hectares of longline infrastructure across Australia.

Development of land based facilities is not part of this proposal as it is only for the water based lease sites. However, it was identified by Fisheries NSW that the region has industrial estates suitable for land based depots and boat ramp facilities particularly at Callala Bay and Woollamia which could be used for servicing the Commercial Shellfish Aquaculture Leases. During lease construction, application may be made to use the Huskisson public wharf to load vessels with infrastructure for deployment.

Risk Assessment and Mitigation

A risk assessment process based on the *National ESD Reporting Framework: The 'How To' Guide for Aquaculture* was used to identify and mitigate potential risks associated with the proposal. A total of 22 risk issues were identified and categorised that had potential to have an impact as a result of the proposal. These risks were identified in either the construction stage or the operational stage of the Commercial Shellfish Aquaculture Leases.

Five issues were identified as representing a 'negligible' risk while 14 issues were assigned a 'low' risk ranking. No issues were identified as representing a 'high' or 'extreme' risk but three were classified as 'moderate', including: (1) water quality and sedimentation; (2) genetics, disease and introduced pests; and (3) entanglement and ingestion of marine debris. These classifications indicate that these issues require ongoing or further management and/or research. Table 1 provides a summary of the three potential moderate risk issues and the proposed mitigation measures.

Table 1: Summary of the three potential moderate risk issues and the proposed mitigation measures for the proposed Commercial Shellfish Aquaculture Leases (modified from Fletcher *et al*., 2004).

Issue	Ranking	Mitigation
Impacts on the Environment (8.2.2)		
Impacts on marine habitats – water quality and sedimentation **(8.2.2.1)**	*Moderate*	▪ Site selection (no environmentally-sensitive or unique areas, mobile sands, similar habitat in direct/wider area, good flushing rates) ▪ Small scale operations (0.4 % of Jervis Bay) ▪ Extensive aquaculture = no feed input ▪ Appropriate stocking densities - below ecological carrying capacity ▪ Water Quality and Benthic Environment Monitoring Program (regular sampling, fallowing if necessary, monitor stocking densities) ▪ Mechanical removal of biofouling - land based disposal
Genetics of wild stocks, disease transmission (cultured stock to wild stock and other marine fauna), cultured stock diseases and introduced pests **(8.2.2.2)**	*Moderate*	▪ Cultured species will be native to Jervis Bay region ▪ Broodstock source - local stocks and/or same genetic population ▪ Disease, Parasite & Pest Management Plan (Appendix 1) o Minimal stress – stocking densities, water quality o Regular health monitoring (surveillance program) o Report 'declared diseases', unexplained mortalities, suspected marine pests and noxious species o Biofouling management o AQUAVETPLAN o Species specific health management protocols as required ▪ Hatchery Management Plan ▪ NSW Hatchery Quality Assurance Scheme standards ▪ Permits and veterinary clearance may be required prior to importing and/or translocating stock ▪ Compliance with *National Biofouling Management Guidelines for Commercial Fishing Vessels* when vessels, equipment etc are sourced from outside the region, represent a marine biosecurity risk
Entanglement and ingestion of marine debris **(8.2.2.4)**	*Moderate*	▪ Longline design features that minimise entanglement risk ▪ Marine Fauna Interaction Management Plan o Marine Fauna Entanglement Avoidance Protocol ▪ Structural Integrity and Stability Monitoring Program o Taut rope policy - no loose lines ▪ Waste Management Plan

Environmental Management

The Environmental Management Plan (EMP) will ensure that the commitments in the EIS, subsequent assessment reports and any approval or licence conditions are fully implemented. A preliminary draft of the EMP has been provided (Appendix 1), which consists of a series of the sub-management plans, monitoring programs and protocols that address the potential environmental impacts identified in Section 8 (Table 1).

The key objective of the EMP is to ensure that the Commercial Shellfish Aquaculture Leases are sustainably managed and that their operation does not have a significant impact on the marine environment, surrounding communities or the operators. The EMP will aim to ensure the following:

- Aquaculture best practices are employed during all stages of the Commercial Shellfish Aquaculture Leases;
- Marine fauna interactions are minimised;
- Water quality is maintained and is within safe levels for humans and marine communities;
- The structural integrity and stability of the longline infrastructure is maintained;
- The occurrence of disease, parasites and pests is minimised and if these events do occur, prompt reporting (as required), management and/or remedial action will be implemented;
- The safety of staff and surrounding communities is maintained;
- Waste is appropriately managed;
- Navigational safety in Jervis Bay is maintained; and
- The performance of the Commercial Shellfish Aquaculture Leases is regularly evaluated by reviewing environmental management reports and monitoring records.

Fisheries NSW and NSW Department of Planning and Infrastructure (NSW DoPI) will ensure that the investors in the leases are bound to undertake a range of environmental monitoring and reporting. The requirements would be part of any planning approval issued by NSW DoPI and would be incorporated into the EMP. Conditions may also be attached to the aquaculture permit or lease issued by Fisheries NSW.

Consultation

Fisheries NSW began the consultation process for this project with relevant stakeholders in August 2012. The aim of informing stakeholders early in the project was to provide as much information as possible about the aquaculture industry and then include issues of concern raised during consultation in this EIS. Information about the project was also provided via

local media and with a *Question and Answer* page on the NSW DPI website. Meetings were held with Local, State and Federal government agencies, environmental and community groups, Jerringa Local Aboriginal Land Council, Wreck Bay Aboriginal Community Council, marine tour operators, sailing clubs, waterway users and local associations. Phone and email contact was also made with a number of groups including recreational and commercial fishes. Consultation included 58 key contacts/calls/emails and 27 face to face meetings.

Conclusion

The proposed Commercial Shellfish Aquaculture Lease project aims to provide strategic and coordinated development of aquaculture in JBMP. NSW MP requested Fisheries NSW to develop an aquaculture strategy to ensure any development is consistent with the management plans for JBMP. Fisheries NSW have also had representation from potential investors interested in developing aquaculture facilities in Jervis Bay.

The EIS provides a thorough and transparent assessment of the potential risks associated with the proposed activity and proposes measures to address the potential impacts of the Commercial Shellfish Aquaculture Lease project and its activities. Through the employment of industry best practice and management strategies, it is concluded that the proposed Commercial Shellfish Aquaculture Leases will not have a significant environmental, social or economic impact.

Comment on the Proposal

The Director-General of the NSW DoPI is exhibiting this environmental assessment for a minimum of 30 days and inviting public comment. The environmental assessment is available for inspection during the exhibition period at the NSW DoPI head office, local council offices as well as on the NSW DoPI and NSW DPI websites. Any person is able to make a written submission during the exhibition period to the Director-General regarding the project.

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Consideration of all relevant environmental planning instruments, particularly Marine Park legislation and plans; including identification and justification of any inconsistencies with these instruments.	4
Description of existing environment using sufficient baseline data.	6
An assessment of the potential impacts of all stages of the development, including any cumulative impacts, taking into consideration relevant guidelines, policies, plans and statutes.	8
Description of measures to avoid, minimise and if necessary, offset the potential impacts of the development, including proposals for adaptive management and/or contingency plans to manage any significant risks to the environment.	8, Appendix 1
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Decommissioning Details of including a process description, waste disposal measures during decommissioning of infrastructure and any bond/financial arrangements in place to ensure lease areas are properly decommissioned, cleaned up and rehabilitated (if necessary)	**Decommissioning** 3.8; 8.1.2; Appendix 1

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Consolidated summary of all the proposed environmental management and monitoring measures, highlighting commitments in the EIS.	Ex. Summary (Table 1)
Economic Benefits Report (qualified quantity surveyor) i. A detailed calculation of the capital investment value (CIV) (as defined in clause 3 of the *Environmental Planning and Assessment Regulation 2000*) of the proposal, including details of all assumptions, and components from which the CIV calculation is derived ii. A close estimate of the jobs that will be created by the development during the construction and operational phases of the development iii. Certification that the information provided is accurate at the date of preparation	i. 8.2.1.6; Appendix 10 ii. 8.2.1.6; Appendix 10 iii. Appendix 10
Consultation ▪ Consult with relevant local, State or Commonwealth government authorities, service providers, community groups or affected landowners.	5

CONTENTS SPECIFIC TO COMMONWEALTH GUIDELINES

Commonwealth EPBC Act Guidelines (Environment Minister Requirements)

Guideline	Report Section
To ensure there are no significant impacts to the humpback whale (Megaptera novaeangliae) and the southern right whale (Eubalaena australis), the person taking the action must ensure: ▪ backbone line ropes on the longline culturing system are at least 25 mm in diameter; ▪ visual inspections of backbone line and buoys are undertaken weekly (weather permitting) to ensure that all backbone ropes are taut; and ▪ the longline culturing system's anchors, chains and moorings are serviced at least once a year, to maintain good order and condition.	3.5 - Structure Design 8.1.5 - Structural Integrity and Stability - Longline Infrastructure 8.2.2.4 - Entanglement and Ingestion of Marine Debris Appendix 1 o 3.2.1 Structural Integrity and Stability Monitoring Program o 3.3.1 Marine Fauna Entanglement Avoidance Protocol

LIST OF ABBREVIATIONS

ABARE	Australian Bureau of Agricultural and Resource Economics
AHIMS	Aboriginal Heritage Information Management System
AIMS	Australian Institute of Marine Science
CMA	Catchment Management Authority
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry
DEH	Department of Environment and Heritage
DGRs	Director-General's Requirements
DPIWE	Department of Primary Industries, Water and Environment (Tasmania)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
ESD	Ecologically Sustainable Development
FAD	Fish Attracting (or Aggregating) Device
FAO	Food and Agriculture Organization
FRDC	Fisheries Research and Development Corporation
GIS	Geographic Information Systems
GNS	Greynurse Shark
IALA	International Association of Lighthouse Authorities
JBMP	Jervis Bay Marine Park
JRA & DSA	Jenny Rand and Associates and Dain Simpson Associates
KTP	Key Threatening Process
LALC	Local Aboriginal Land Council

LGA	Local Government Area
METOC	Navy Meteorology and Oceanography
NES	National Environmental Significance
NPWS	National Parks and Wildlife Service
NSW DEC	New South Wales Department of Environment and Conservation
NSW DPI	New South Wales Department of Primary Industries
NSW DoPI	New South Wales Department of Planning and Infrastructure
NSW FM Act	New South Wales *Fisheries Management Act 1994*
NSW MP	New South Wales Marine Parks
NSW OEH	New South Wales Office of Environment and Heritage
NSW RMS	New South Wales Roads and Maritime Services
NSW TSC Act	New South Wales *Threatened Species Conservation Act 1995*
POEO Act	*Protection of the Environment Operations Act 1997*
PSFI	Port Stephens Fisheries Institute
RAN	Royal Australian Navy
TMP	Traffic Management Plan
TOC	Total Organic Carbon
WH&S	Work Health and Safety

GLOSSARY OF TERMS

Ambient	Of or relating to the immediate surroundings.
Anchoring and Mooring System	The series of ropes, chains, weights and anchors used to keep the longlines in place in the ocean.
Anoxic	Absence of or low concentrations of oxygen.
Aquaculture	Cultivating fish or marine vegetation for the purposes of harvesting the organisms or their progeny with a view to sell or keep the organisms in a confined area for commercial purposes (e.g. a fish-out pond).
Areas of Conservation Significance	For the purposes of the proposal, it refers to Marine Protected Areas, Ramsar wetlands and areas of critical habitat declared under the *Fisheries Management Act 1994* and the *Threatened Species Conservation Act 1995.*
Attenuation	To reduce in force, value, amount or degree.
Average Peak Wave Period (Tp)	The wave period associated with the most energetic waves in the total wave spectrum at a specific point.
Benthic	Living in or on the seabed.
Biofouling	The settlement, attachment and growth of organisms (e.g. microorganisms, plants, algae and animals) on submerged surfaces in aquatic environments.
Breaking Waves	Waves can break in three modes: spilling, surging and plunging. Waves break when the speed of the crest exceeds the speed of the advance of the wave as a whole i.e. as waves increase in height through the shoaling process, the crest of the wave tends to speed up relative to the rest of the wave.
Broodstock	The group of mature or parent animals used in aquaculture for breeding purposes i.e. to produce stock.
Cardinal Marks	A sea mark, usually a buoy or other floating or fixed structure, used to indicate the direction of safe water or the position of a hazard.
Decommissioning	A general term for a formal process to dismantle or remove something from service i.e. removal of longline infrastructure.
Deepwater	Water that is sufficiently deep enough to avoid or minimise the effect of the ocean bottom on surface waves. Water deeper than one-half the surface wave length is generally considered deepwater.
Diffraction	A deviation in the direction of a wave at the edge of an obstacle in its path.
Ecologically Sustainable Development	For the purposes of the proposal, it refers to the principles outlined in s.6(2) of the *Protection of the Environment Administration Act 1991*.

Endemic	The ecological state of an organism being unique to a defined geographic region.
Environmental Impact Statement	A detailed study based on environmental assessment to determine the type and level of effects that a proposed project may have on the natural environment. Its objectives are to assess if the potential impacts are acceptable; to design appropriate monitoring, mitigation, and management measures and investigate acceptable alternatives.
Epifauna	Animals that live on or are attached to the surface of subtidal habitat or the seabed.
Eutrophication	Over enrichment of a water body with nutrients, resulting in depletion of oxygen concentration and excessive growth of organisms.
Fallowing	A good husbandry practice that involves moving longlines over different seabed areas in order to minimise the build up of organic wastes in any one area, and to subsequently allow these areas enough time for natural marine processes and the environment to assimilate any wastes.
Green Field Site	A piece of land that has not previously been built on.
Habitat Protection Zone	A marine park zone which aims to conserve marine biodiversity by protecting habitats and reducing high impact activities. Recreational fishing, some forms of commercial fishing and aquaculture, fishing competitions and tourist activities are permitted in Habitat Protection Zones.
Infauna	Aquatic animals living in the sediment.
In situ	Situated in the original, natural or existing place or position.
Key Threatening Process	A process that threatens or that could potentially threaten the survival or evolutionary development of species, populations or ecological communities.
Macrofauna	Organisms retained in a sieve of 1.0 mm and associated with sediment environments.
Marine Protected Area	An area of sea especially dedicated to the protection and maintenance of biological diversity and associated natural and cultural resources and is managed through legal means.
Matters of National Environmental Significance	Matters of national environmental significance are protected under national environment law – the *Environment Protection and Biodiversity Conservation Act 1999*. These include listed threatened species and communities**,** listed migratory species**,** Ramsar wetlands of international importance**,** Commonwealth marine environment**,** world heritage properties**,** national heritage places**,** the Great Barrier Reef Marine Park and nuclear actions.
Microtidal	A tidal range of less than two metres.
Middens	Middens are mounds of food refuse that have accumulated at camping spots close to food resources.

Nitrogen Cycling	The biochemical cycle of nitrogen involving fixation, nitrification, decomposition and denitrification.
Offshore Zone	Coastal waters to the seaward of the near-shore zone. In the offshore zone, swell waves are unbroken and their behaviour is not influenced by the presence of the seabed.
Oxic	Designating an environment or process in which oxygen is involved or present.
Precautionary Principle	A principle of ESD which states that where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
Pelagic	Organisms that inhabit open water.
Plankton	Organisms (< 0.5 mm) that drift with the ocean currents.
Pseudofaeces	Refers to the suspended particles consumed by bivalves but have been rejected as unsuitable for food. The rejected particles are wrapped in mucus, and are expelled without having passed through the digestive tract.
Ramsar Wetlands	Refers to wetlands listed under the Ramsar Convention, which is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the sustainable use of all of the wetlands in their territories.
Regular Monitoring	Periodic recording of a set of parameters.
Risk	The likelihood of an undesired event (or impact) occurring as a result of some behaviour or action.
Risk Management	The culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects.
Sanctuary Zone	A marine park zone which provides the highest level of protection to habitat, animals, plants and areas of cultural significance by prohibiting all forms of fishing and collecting activities, and anchoring on reefs. Only activities that do not harm plants, animals and habitats are permitted.
Sedimentation	The settling of particles to settle out of the fluid in which they are suspended (e.g. out of the water column of the ocean onto the seabed).
Semidiurnal Tide	Two high tides and two low tides each day.
Shallow Water	The depth in which surface waves are noticeably affected by bottom topography. Generally, water depth less than one-half the surface wave length is considered shallow water.
Shoaling	The influence of the seabed on wave behaviour. Shoaling only becomes significant in water depths of 60 m or less which is manifested as a reduction in wave speed, a shortening in wave length and an increase in wave height.

Significant Impact	A significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted and upon the intensity, duration, magnitude and geographic extent of the impacts.
Spat	Spawn or larvae of shellfish.
Standing Biomass	Is the maximum fish biomass that may be supported in a system on a continuing basis.
State Significant Infrastructure	A range of infrastructure types as designated under the State Environmental Planning Policy (State and Regional Development) 2011.
Storm or Severe Weather Event	A period of high wave activity. For the NSW coastline, a storm event is usually defined as the time when a significant wave height is recorded at greater than 3 m at an offshore wave recording station.
Subsurface	Below the water's surface.
Total Organic Carbon	The amount of carbon bound in an organic compound which is often used as a non-specific indicator of water quality.
Wave Climate	The average wave conditions at a place over a period of years, such as height, direction and period.
Wave Height	The vertical distance between a wave crest and preceding or succeeding wave trough.
Wave Length	The distance between consecutive wave troughs or wave crests.
Wave Period (T)	The time taken for consecutive wave crests or wave troughs to pass a given point.
Wave Reflection	The seaward return of an incident wave when it impinges on a steep beach, barrier or other reflecting surface.
Wave Refraction	The tendency of wave crests to become parallel to bottom contours as waves move into shallower waters. This effect – i.e. the slowing down of waves in shallower waters, is caused by the shoaling process.

1 INTRODUCTION

Fisheries NSW, a division of the NSW Department of Primary Industries (NSW DPI) is seeking approval for the establishment of Commercial Shellfish Aquaculture Leases within the open marine embayment of Jervis Bay. Three leases are proposed with a total area of 50 hectares consisting of two 20 hectare areas off Callala Beach and a 10 hectare site off Vincentia.

Extensive aquaculture is permitted in the Jervis Bay Marine Park (JBMP) but cannot exceed more than 2% (440 hectares) of the park. Only those species which can be grown without the use of supplementary feed inputs may be cultured within the embayment (e.g. filter feeders such as shellfish and algae).

NSW Marine Parks (NSW MP) requested Fisheries NSW to develop an aquaculture strategy to ensure any aquaculture development is conducted in accordance with a sustainable aquaculture management plan (NSW MP, 2009b). Fisheries NSW have also had representation from potential investors interested in developing aquaculture facilities in Jervis Bay. The proposed Commercial Shellfish Aquaculture Lease project will assist in the strategic and coordinated development of appropriate aquaculture within Jervis Bay rather than a piecemeal “adhoc” approach.

The main infrastructure will consist of an anchoring and mooring system to which longlines will be attached. The longlines may support dropper lines, pyramid nets/cages, lantern nets/cages, panel nets, baskets or trays, which will contain the cultured shellfish. Navigation buoys will also be positioned on the corners of each lease.

Jervis Bay is one of only three marine embayments on the NSW coast that are suitable for extensive aquaculture. The other embayments are Port Stephens, which has an established edible oyster industry and Twofold Bay, which already has extensive Blue Mussel aquaculture (Joyce *et. al*., 2010). Jervis Bay has the advantage over Twofold Bay of being close to the Sydney markets resulting in reduced transport costs. The proposed leases would assist in providing a reliable supply of sustainable seafood during seasonal fluctuations that may affect Port Stephens and Twofold Bay.

Jervis Bay has a history of aquaculture with Fisheries NSW archives showing oyster aquaculture occurring in Currambene and Moona Moona Creeks from 1935 untill 1991. The late 1970s saw the commencement of the culture of Blue Mussels suspended from rafts in Jervis Bay and in the 1990s Fisheries NSW also undertook scallop aquaculture and ranching (seeding the seafloor) research, which saw over four million scallops farmed and released. This project picks up on the constraint mapping, preliminary environmental assessment and

draft aquaculture industry development plan initiated in 2009. Mussel rafts were previously located on two leases off Vincentia but ceased operation in 2008 after an application to proceed to commercial operation was withdrawn by the operator. The use of rafts is not proposed as part of this proposal.

The proposed Commercial Shellfish Aquaculture Leases are located in a Habitat Protection Zone of JBMP, which is a multiple use zone that caters for a wide range of sustainable activities. The activities associated with the proposed Commercial Shellfish Aquaculture Leases are permissible within this zone.

The NSW Government recognises the need to look at opportunities for sustainable and viable aquaculture development. Aquaculture supports the regional economies of NSW and will be an increasingly important contributor to the future food security needs of the State.

The location, the structural design of the longline infrastructure, the species cultured and a draft EMP are outlined in this EIS but will be finalised subject to development approval.

Statutory obligations under State and Commonwealth legislation, areas of responsibility for government departments and key considerations for the EIS were identified in the Preliminary Environment Assessment of the proposal carried out by Fisheries NSW in November 2012. Requirements to satisfy State legislation were subsequently issued to Fisheries NSW in December 2012. Under the *State Environmental Planning Policy* (State and Regional Development 2011) the proposal is classified as State Significant Infrastructure (c.14 (1)(b) and Schedule 3 (1)(1)) and requires approval from the Minister for Planning and Infrastructure under s.115W of the *Environmental and Planning Assessment Act 1979*. Guidelines have been issued to meet the requirements of State legislation – the Director-General's Requirements (Appendix 2). The assessment and approvals process is outlined in Figure 2. This EIS has been submitted to NSW DoPI in support of the development application for this proposal.

The main requirements of the EIS include the following:

- Provide a detailed description of the project proposal, including the need for the project, a justification for the development, staging of the development, interactions with other developments and plans of any proposed building works;
- Consider relevant environmental planning ínstruments, particularly Marine Parks legislation and plans, including identification and justification of any inconsistencies with these instruments;
- Undertake a risk assessment of potential environmental impacts associated with the project (construction and operation), identify key issues for further assessment,

detail mitigation measures and any potentially significant residual environmental impacts after the application of proposed mitigation measures;

- Provide a description of the existing environment using sufficient baseline data;
- Provide an assessment of the potential impacts of all stages of the development and a description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of the development;
- Provide a consolidated summary of all the proposed environmental management and monitoring measures;
- Consult with relevant local, State or Commonwealth government authorities, service providers, community groups or affected landowners and present their views, including:
    - Environment Protection Authority;
    - Office of Environment and Heritage;
    - Roads and Maritime Services;
    - NSW Marine Parks;
    - NSW Food Authority;
    - NSW Land and Property Management Authority;
    - Shoalhaven City Council;
    - National Parks and Wildlife Service;
    - NSW Department of Primary Industries; and
    - Department of Defence.
- Provide a report on the capital investment value of the proposal;
- Carry out a detailed impact assessment of key issues specified in the State guidelines and those identified in the risk analysis. This includes issues relating to:
    - *Biodiversity*
        - Baseline assessment (habitat types, species types/assemblages);
        - Assessment of impacts on critical habitats, threatened and protected species, populations, communities and their habitat;
        - Potential for native fauna aggregation around the lease areas, including impacts from any draw down effects from nearby natural reefs and changes to fish swim paths and behaviour;
        - Entanglement, potential disturbance of whale resting behaviour and proposed mitigation measures;
        - Potential loss of plastic from lease infrastructure and mitigation measures to prevent ingestion by marine organisms;

        - Artificial lights, acoustic pollution and vessel strikes.
    - *Water Quality*
        - Background conditions and trigger values;
        - Impacts of potential turbidity from construction and servicing;
        - Impacts of nutrients and faceces; and
        - Impacts of biofouling.
    - *Disease Risks and Management*
        - Disease risks associated with cultured stock;
        - Genetic integrity of local wild stocks;
        - Disease and pest management protocols; and
        - Impacts on other aquaculture operations.
    - *Navigation and Safety*
        - Impacts lease infrastructure and vessel traffic on other water-based traffic and activities; and
        - Measures to ensure the safety of all recreational users of Jervis Bay.
    - *Heritage*
        - Consult with local Indigenous people;
        - Consider any Aboriginal Land Claims;
        - Impacts on Aboriginal heritage sites/places; and
        - Protocols and measures to minimise risk of harm to important Aboriginal heritage sites/places.
    - *Visual Amenity*
        - Assess the visual impacts of the lease infrastructure.
    - *Noise*
        - Assess potential impacts of noise during construction and operation.
    - *Coastal Processes*
        - Coastal hazards, wave run up/reflection;
        - Adequacy of structure's stability and height of projected sea level rise;
        - Changes of wave behaviour including wave dispersion and creation via amendments to orbital/oscillatory motions; and
        - Potential impacts on stability of shoreline of Jervis Bay.
    - *Waste Management*
        - Identify the volume, type and classification of all waste/s generated during the construction and operation stage; and

        - Details of waste minimisation, management, treatment and disposal measures.
    - *Traffic, Access and Parking*
        - Details of vehicle, boat and trailer type, traffic generation, proposed boat access and parking arrangements; and
        - Assess road, access (e.g. wharf and/or jetty) and parking capacity.
    - *Food Safety*
        - How NSW Food Authority standards and requirements will be met for seafood harvested for sale (i.e. seafood handling and processing).
    - *Socio-economics*
        - Direct and indirect socio-economic impacts on all users of Jervis Bay and wider community; and
        - Consider any impacts associated with restricting the access of other users to this part of Jervis Bay.
    - *Construction*
        - Measures to minimise potential noise, air quality, traffic, soil, water and waste impacts.
    - *Decommissioning*
        - Process description and waste disposal measures; and
        - Bond/financial arrangements to ensure lease areas are properly decommissioned, cleaned up and rehabilitated.
- Outline project monitoring:
    - Integrity and effectiveness of longlines and supporting infrastructure;
    - Protocols/contingency measures for dealing with unexpected infrastructure damage e.g. during a storm event;
    - Water quaity and benthic monitoring to monitor potential impacts on threatened/protected species and communities;
    - On-going disease and pest management procedures;
    - Navigational impacts on all water-based traffic;
    - Marine animal behavior monitoring and incident management protocols (e.g. entanglement).

Requirements to satisfy Commonwealth legislation were also issued to Fisheries NSW in May 2013. The proposal required assessment by the Australian Government Environment Minister under the *Environment Protection and Biodiversity Conservation Act 1999*. Fisheries NSW submitted a Referral of Proposed Action form to DSEWPaC for assessment.

DSEWPaC has advised that the proposed Commercial Shellfish Aquaculture Leases have been deemed to not be a controlled action provided the proposed action is undertaken in the manner set out in their decision (Appendix 2). The guidelines issued to meet the requirements of Commonwealth legislation include:

- Backbone line ropes on the longline culturing system are at least 25 mm in diameter;
- Visual inspections of backbone line and buoys are to be undertaken weekly (weather permitting) to ensure that all backbone ropes are taut; and
- The longline culturing system's anchors, chains and moorings are to be serviced at least once a year, to maintain good order and condition.

These guidelines are intended to ensure that the Commercial Shellfish Aquaculture Leases do not have a significant impact on humpback and southern right whales.

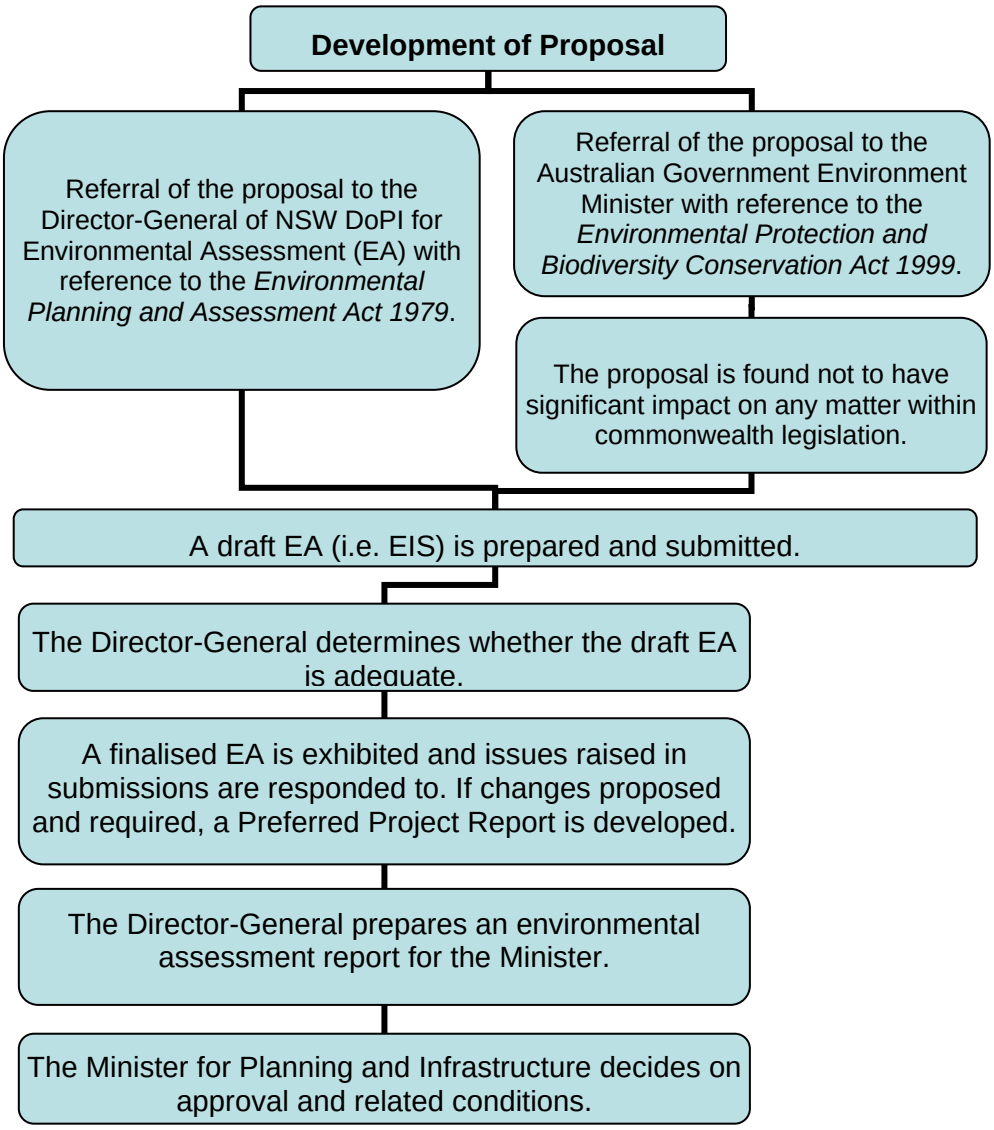

Figure 2: Steps in the assessment and approvals process.

Study Team

Fisheries NSW has coordinated a team of environmental practitioners with extensive experience in fisheries biology, marine ecology, aquaculture, environmental management, Geographic Information Systems (GIS), policy and NSW coastal processes.

Services and expertise of a range of personnel were engaged during the completion of this EIS including:

- Marine scientist/contractor, Hester Bushell, to provide an overview of the existing environment and conduct the risk analysis, assess potential impacts associated with the proposed Commercial Shellfish Aquaculture Leases, provide mitigation and management recommendations, and assist with the development of a draft EMP;
- Fisheries NSW Policy Officer Aquaculture, Graeme Bowley, to provide an overview of the proposed project, assist with the assessment of impacts and the development of a draft EMP and assist in conducting community consultation;
- Fisheries NSW Manager Aquaculture, Ian Lyall, to conduct community consultation and correspondence with NSW DoPI, potential industry partners, manufacturers and research scientists, as well as assist with the development of the EIS;
- Fisheries NSW Senior Policy Officer Aquaculture, Tim Gippel, to review relevant State and Commonwealth legislative requirements and ensure compliance with relevant approvals, permits and notifications;
- Fisheries NSW, PSFI research scientist, Wayne O'Connor, to provide expertise on shellfish aquaculture such as genetic integrity, disease and pest management, and assist with the development of the EIS;
- Fisheries NSW Senior Conservation Manager Threatened Species, Peter Gallagher, to provide advice on the assessment of impacts on threatened and protected species, populations and ecological communities;
- Fisheries NSW Aquaculture GIS Officer, Antonia Creese; to provide GIS support;
- Biosecurity NSW Strategy Leader, Melissa Walker, to provide advice about potential biosecurity issues; and
- Fisheries NSW Senior Conservation Manager, Allan Lugg; to provide advice on the potential impacts on areas of conservation significance and threatened and protected species.

2 REVIEW OF EXISTING INFORMATION ON MARINE AQUACULTURE

2.1 Introduction

"Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants". Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding and protection from predators. Farming also implies individual or corporate ownership of the stock being cultivated (FAO, 1988).

Aquaculture has been traditionally undertaken in a number of countries for centuries and has grown rapidly worldwide in the last 50 years. In Australia aquaculture has been practiced for approximately 40,000 years by Aboriginal communities who used sophisticated fish traps to capture and hold fish. The Aboriginal fish traps in the Brewarrina region of NSW still exist today and stand as a testament to Aboriginal knowledge of engineering and fish migration. In Victoria there are also remains and archaeological evidence in the Lake Condah region of a settled Aboriginal community farming eels for food and trade in what is considered to be the earliest and possibly largest ever land based aquaculture venture in Australia.

The NSW oyster industry has a history dating back to the 1870's in the Georges River and is now the State's largest aquaculture sector. In the 19th century Acclimatisation Societies undertook aquaculture to produce fish species for stocking rivers and streams. Trout and aquarium industries were the key aquaculture industries in NSW until the 1980's saw the advent of tiger prawn farms on the north coast and native fish hatcheries in inland NSW. By the 1990's Silver Perch, Yabbies, Barramundi, Snapper and Blue Mussels were being cultivated.

There are a variety of aquaculture production systems used to culture finfish, crustaceans, molluscs and algae. The choice of systems depends upon the physiological requirements of the species (e.g. space, water quality and nutrition), the site (i.e. offshore, estuarine or land based) and operational criteria (e.g. proximity to services and markets). Floating sea cages with suspended nets are typically used in inshore areas or in estuarine waters and longlines (suspended cultivation) or post and rail infrastructure are also used for marine aquaculture. Land based facilities include earthen and lined ponds, tanks and aquaria. The fundamental aspect of any suitable aquaculture development is access to good quality water.

2.2 Marine Aquaculture Worldwide

Worldwide production from wild capture fisheries has levelled off (Figure 3) and it is unlikely that new fishing grounds will be found in the future. If the harvest of wild fisheries products

remains at current levels there will not be enough supply to meet the growing worldwide demand for seafood products. Aquaculture has the potential to meet this gap.

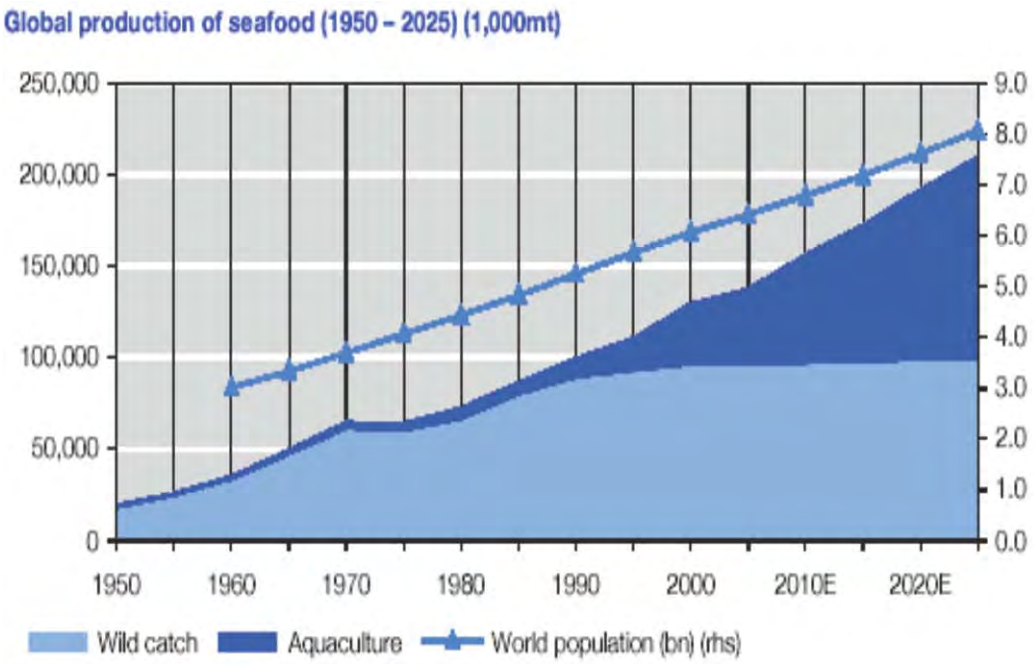

Figure 3: Global production of seafood and world population (1950 - 2025) (Source: A. Obach, 2012).

Aquaculture is developing and expanding in almost all regions of the world to meet the demand for seafood products. Aquaculture produces a wide variety of animal and plant species including finfish, crustaceans, molluscs, echinoderms, polychaetes, as well as seaweeds and other aquatic plants. These products are mainly used for human consumption, but can also be used for chemical extraction, pharmaceuticals, stock feed, jewellery and ornamental purposes.

FAO reports that world aquaculture production has increased substantially with less than three million tonnes produced in 1970 and increasing to 52.5 million tonnes in 2008 (Figure 4). This rate of increase is three times greater than that for world meat production. Projections by FAO estimate that in order to maintain the current level of per capita seafood consumption, worldwide aquaculture production will need to reach 82 million tonnes by 2050 (FAO, 2011).

FAO estimates that marine based aquaculture production using seawater (in the sea and/or in ponds) accounts for 32.3% of world aquaculture production by quantity and 30.7% by value (FAO, 2011). Aquaculture in seawater produces many high-value finfish, crustaceans and abalone species but also large quantities of oysters, mussels, clams, cockles and scallops. The cultured marine species are predominately of relatively high commercial value and for many of these species the aquaculture production is substantially higher than the past highest wild capture recorded catches.

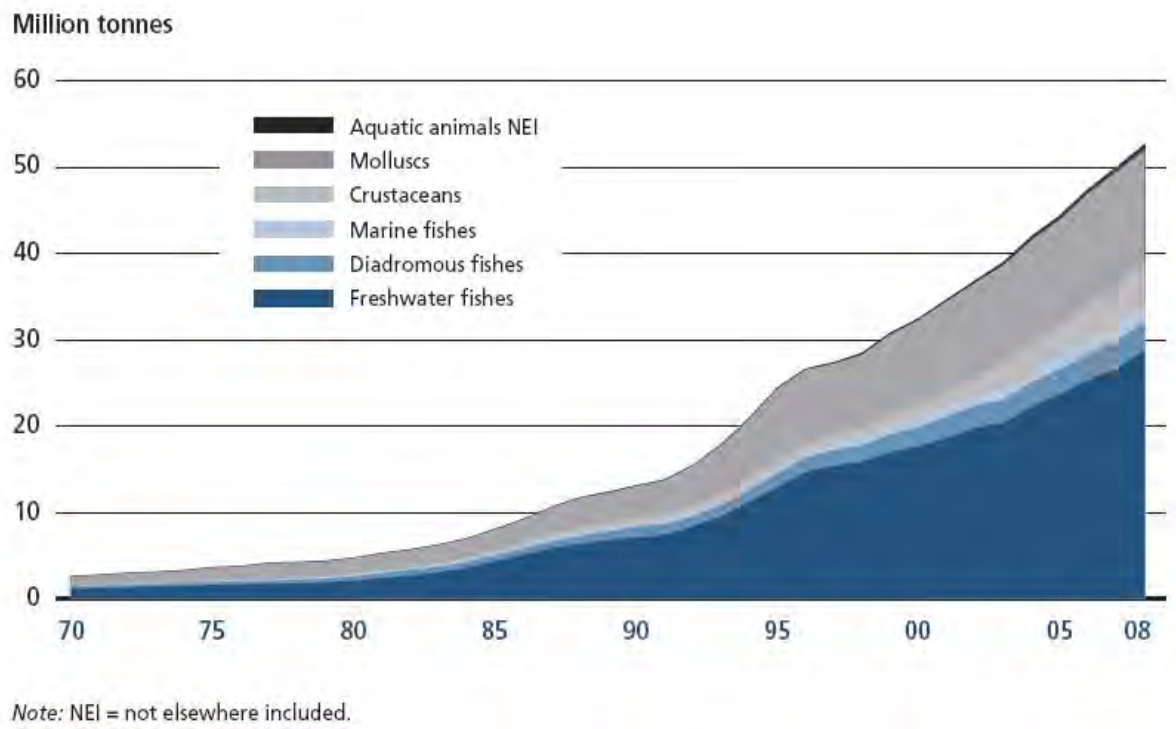

Figure 4: Trends in world aquaculture production – major species groups between 1970 and 2008 (Source: FAO, 2011).

Aquaculture is making an important contribution to worldwide food security and is doing this through the responsible sustainable use of resources. Aquaculture relies upon high standards of water quality and environmental protection parameters. This focus has resulted in improved environmental management by the aquaculture industry and the adoption of best management practices.

2.3 Marine Aquaculture in Australia

The Australian aquaculture industry occurs in marine, estuarine and freshwater systems. The industry is predominantly based in regional Australia and makes a positive contribution to some regional economies (Figure 5). For example, employment in the aquaculture sector rose by 16 per cent (588 people) to 4373 people in 2010–11(ABARES, 2012).

Although the Australian aquaculture industry is a relatively new industry, it has grown in volume at an average rate of around 12% per annum since 1992–93. The gross value of aquaculture production in 2010-11 was $948.1 million and accounted for 43% of the gross value of fisheries production. The majority of this value came from marine production systems producing high value species such as salmonids, tuna, prawns and oysters.

NSW aquaculture production of edible oysters and mussels by value represented about 35.4% of the Australian industry in 2010-11 (ABARES, 2012).

A key factor contributing to the rapid growth of aquaculture in recent years has been a strong focus on research and development. This has resulted in better species selection, improved culturing techniques and feeds; better fish health and disease management and the adoption of best practises to ensure the long-term environmental sustainability of aquaculture.

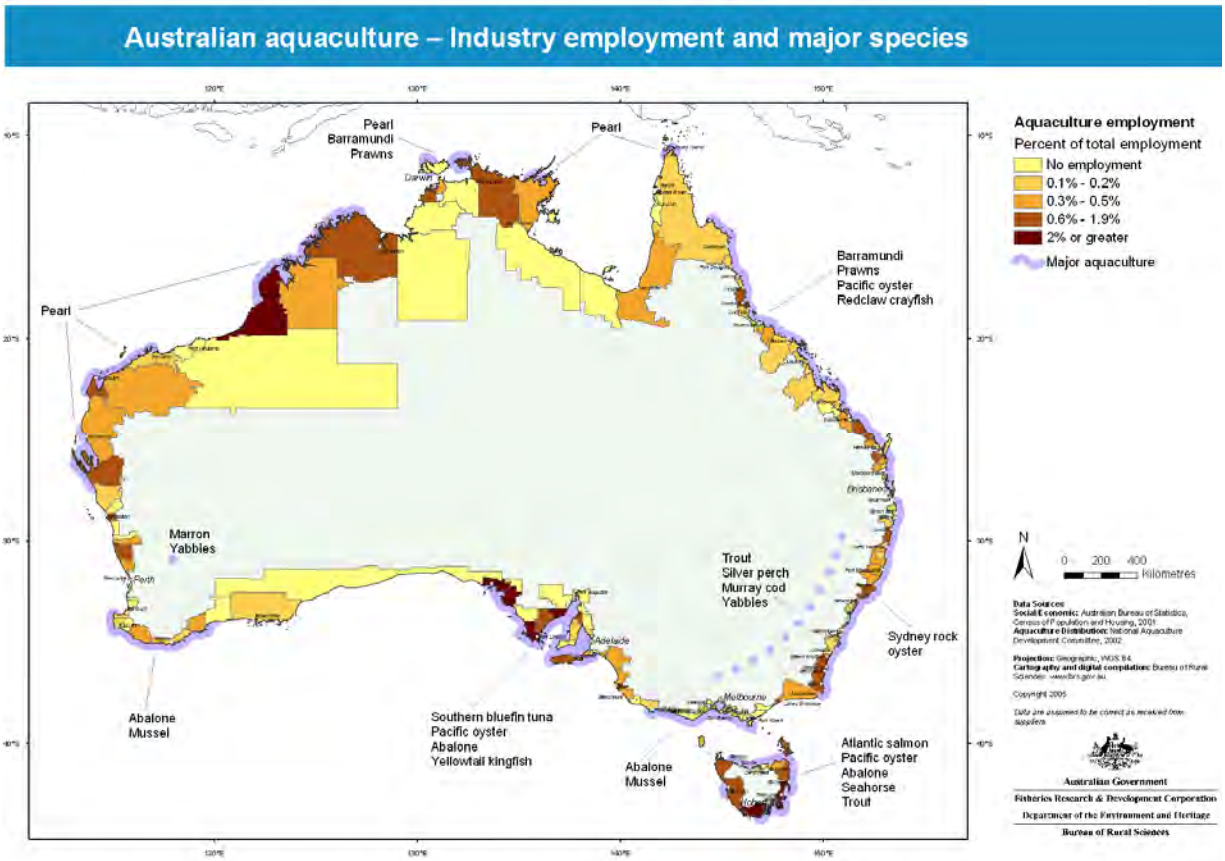

Figure 5: The percentage of employment in the aquaculture industry in Australia, including the major species (Source: Web Reference 1).

With an extensive coastline, aquaculture offers many biological and environmental benefits over other forms of aquaculture. Results of recent environmental monitoring from South Australian, Tasmanian and Queensland aquaculture farms indicate limited environmental impacts on surrounding environments. Recent improvements in the engineering of infrastructure for farming operations have also resulted in equipment that has the capability to operate in harsh environmental conditions.

NSW Aquaculture

Shellfish culture in NSW started in the 1870s with the culture of Sydney Rock Oysters in Georges River. Shellfish aquaculture research has been carried out by scientists and staff at Port Stephens Fisheries Institute (PSFI) since the early 1970s. Sydney Rock Oysters, Pacific Oysters, Scallops, Native (Flat or Angasi) Oyster, Mussels, Pearl Oyster, Pippi and Clams have been the focus of aquaculture research at PSFI.

In 2010–11 the gross value of NSW fisheries production was $123.5 million, of which the wild-catch sector accounted for $75.4 million or 61%. The aquaculture sector, which was valued at $48.1 million, accounted for 39% (ABARES, 2012).

The NSW aquaculture sector produced 4669 tonnes ($48.1 million) of seafood in 2010–11. The edible oyster production was worth $36 million and is conducted in 31 estuaries along the NSW coast utilising approximately 3,000 hectares of leases. Other aquaculture products included prawns (148 tonnes, $1.7 million), mussels (29 tonnes, $0.2 million) and yabbies (19 tonnes, $0.2 million). In 2010–11 these products combined to account for 4% of the total volume and total value of NSW aquaculture production.

By comparison the most valuable wild-caught fisheries product in NSW is prawns which has accounted for around 20% of the total value of wildcatch production in the five years up to 2010–11. In 2010–11 the sector harvested 1399 tonnes of prawns worth $14.6 million. The wild-catch also comprised a wide range of finfish species, including Sea Mullet (3046 tonnes, $7.6 million), Eastern School Whiting (1222 tonnes, $3.2 million), Bream (321 tonnes, $3.5 million), Snapper (287 tonnes, $2.8 million) and Australian Salmon (789 tonnes, $1.0 million) (ABARES, 2012).

Jervis Bay is one of only three marine embayments on the NSW coast that are suitable for extensive aquaculture. The other embayments are Port Stephens, which has an established edible oyster industry and Twofold Bay, which already has extensive Blue Mussel aquaculture (Joyce *et. al*., 2010).

Jervis Bay has characteristics that make it highly suitable for shellfish aquaculture, including excellent water quality, it is well sheltered from most prevailing weather conditions, it has a suitable depth profile and it is well serviced with local infrastructure and major seafood markets.

The NSW Government has developed a whole of government approach to the development of the oyster and land based aquaculture industries in NSW to promote sustainable industry development. NSW Oyster Industry and Land Based Sustainable Aquaculture Strategies detail a streamlined approval process and advice on best aquaculture practice for species, site selection, design and operation. Research undertaken on aquaculture production in the marine environment will assist with the development of policy and management practices for any future marine aquaculture developments in NSW.

3 DESCRIPTION OF THE PROPOSAL

3.1 Description of the Proposal

Fisheries NSW is proposing to develop a sustainable shellfish aquaculture industry within Jervis Bay by seeking approval for commercial leases. Three leases are proposed, including two 20 hectare areas off Callala Beach and a 10 hectare site off Vincentia. If the lease areas are approved they will be offered to commercial aquaculture proponents through a tender process.

3.2 Principal Objective and Rationale of the Proposal

The principal objective of the proposed Commercial Shellfish Aquaculture Lease project is to facilitate the development of a sustainable shellfish aquaculture industry in Jervis Bay. This involves the identification of areas suitable for the aquaculture leases within Jervis Bay, environmental impact and risk assessment, development of risk mitigation strategies and stakeholder consultation, as well as the subsequent approval process.

NSW MP requested Fisheries NSW to develop an aquaculture strategy to ensure any aquaculture development is conducted in accordance with a sustainable aquaculture management plan. Fisheries NSW have also had representation from potential investors interested in developing aquaculture facilities in Jervis Bay.

Essentially, the proposed Commercial Shellfish Aquaculture Lease project will assist in the strategic and coordinated development of aquaculture in Jervis Bay rather than a piecemeal “adhoc” approach. Progressing the approvals for this proposal is a priority project of the State Aquaculture Steering Committee.

Worldwide and in Australia, aquaculture developments are providing economic benefit through sustainable production of quality seafood. Aquaculture has the potential to create employment, reduce harvesting pressure on natural fish populations and produce seafood of the highest quality. Demand for high quality, locally produced seafood is increasing in NSW and tourism linked to fine food and wine trails is an increasing market (Joyce *et. al*., 2010). On the Eyre Peninsula in South Australia for example, tourism has been linked to the aquaculture and fishing industries with the promotion of an ‘Aquaculture and Seafood Trail’. Similarly, in Twofold Bay marine based tour operators have been able to diversify the tourism experience they provide by incorporating the mussel leases and supplying fresh local mussels.

Australia wide the cultured mussel sector has shown good growth over the past decade. In 2006/07 Australian mussel production was about 3,200 tonnes with a value of $3.2 million and by 2009/10 production reached about 3,500 tonnes with a value of $10 million (ABARE,

2011). The average Australian farm gate price was $2.92/kg but NSW attained a price of $4.30/kg (Austasia Aquaculture, 2010). In 2009/10, 2,433 tonnes of mussels worth $9.3 million were imported to Australia (99% were frozen New Zealand Mussels). Over this period 2,810 tonnes of scallops were imported which were valued at $434 million. The aquaculture industry in NSW is dominated by edible oyster farming which is the oldest aquaculture industry in the state and is worth around $39 million annually. Sydney Rock Oysters are the most commonly cultured species.

Significant flow-on benefits are anticipated from the purchase of materials, services and labour associated with the operation of the Commercial Shellfish Aquaculture Leases in Jervis Bay. In South Australia for example, each job generated directly from oyster and mussel farming processing and transport is thought to generate an additional 1.81 -1.91 jobs in the rest of the state (EconSearch, 2012).

3.3 Cultured Species

The species of shellfish or other organisms to be cultured on the proposed Commercial Shellfish Aquaculture Leases would be species that naturally occur within the Jervis Bay region. The following list is not exclusive. Other species may be cultured provided that the species to be farmed meets the criteria set out in the Jervis Bay Marine Park Zoning and Operational Plans and the general approval of the project development consent approvals.

3.3.1 Blue Mussel (Mytilus edulis)

Description

Mussels are bivalves (two shelled molluscs) which have a shell that is held together by a ligament (adductor muscle) (Figure 6). Mussels also have a 'foot' and byssal threads which are used to move around and to attach to hard surfaces. Males have cream or white flesh and females have orange flesh.

Male and female mussels mature within two years of age at a length of about 4.5 to 5 cm and gonadal egg development begins when the water temperature drops below 21°C (optimum 12 to 19.5°C) (Marine Pollution Research, 2008). Mussels are 'broadcast spawners', that is, eggs and sperm are released into the water column where fertilisation occurs. Larvae (average size - 0.07 mm) drift in the plankton for several weeks before settling on a hard substrate (Web Reference 2).

Figure 6: Blue Mussel (*Mytilus edulis*) (Source: FRDC, 2012).

Blue Mussels are filter feeders straining phytoplankton (microscopic plant-like organisms) and other organic material from the water. Consequently, this species prefer sites with moderate water movement. The preferred size range for plankton is 4 to 120 microns but the majority of food is usually less than 20 microns (PIRSA, 2000). Predators of mussels include fish (snapper, bream, leatherjackets, puffer fish), seastars and crabs (Marine Pollution Research, 2008).

Distribution

In Australia, Blue Mussels are found from Fremantle in Western Australia to Forster in NSW, as well as Tasmania. In NSW, Blue Mussels are predominantly found on the South Coast, although episodic settlement has occurred as far north as Port Stephens and Forster.

Blue Mussels inhabit a wide range of estuarine and marine environments. They are sessile attaching to rocks, jetties, piers and sometimes form dense beds on sandy flat substrates. Blue Mussels can be found from the low tide level to a depth of 10 m. Distribution is limited by high water temperatures (higher limit - 28°C) and low salinities (lower limit - 15-18 ‰). Blue Mussels exhibit maximum growth within a temperature range of 16 to 22°C (PIRSA, 2000) and salinity range of 25 to 35 ‰.

Aquaculture

In Australia, mussel farming is undertaken in embayments in the southern states primarily on longline infrastructure. The Blue Mussel is the only marine mussel species farmed in

Australia. Other mussel species are cultured around the world both in embayments and open ocean sites.

Mussel aquaculture is currently undertaken in Twofold Bay where there is approximately 50 hectares approved for extensive shellfish culture. These mussels are cultured using dropper lines on longline systems.

Blue Mussel aquaculture has also been undertaken in Jervis Bay representing the longest continuous aquaculture operation in the bay (i.e. 1977 to 2008). In NSW, Twofold Bay is the only known reliable area for natural spat (juvenile stock) settlement of this species, although episodic settlement has occurred in coastal bays and estuaries including Port Stephens and Jervis Bay (Marine Pollution Research, 2008). Given the variability of Blue Mussel spat fall, Twofold Bay supplied mussel spat for the Jervis Bay operations in the past.

Blue Mussel aquaculture also occurs in other Australian States, including:

- Port Phillip and Westernport Bays in Victoria;
- Bays around Cygnet, Port Arthur, Dover and Spring Bay in Tasmania;
- Boston and Proper Bays and around Wallaroo in South Australia; and
- King George, Cockburn and Warnboro Sounds in Western Australia.

Each year more than 3000 tonnes of mussels are harvested by Australian producers which equate to less than 1% of global production. Globally, the largest producers of mussels are China (27%), Thailand (17%) and Spain (13%), while the Netherlands, Spain and New Zealand are the largest exporters (Web Reference 3).

Growth rates of Blue Mussels vary but can be rapid. Blue Mussels can reach a length of 32-92 mm after 12 months and 53-110 mm after 18 months. For mussels cultured on longlines, density, depth and food availability largely determine the rate of growth. Decreased growth is observed at high stocking densities and greater depths. Mussels that are stressed (e.g. from lack of food or exposure to extreme wave action) usually exhibit retarded growth rates and shell deformations rather than mortality (Marine Pollution Research, 2008).

The commercial stocking rate for mussels on growout lines is usually 200 to 400 mussels/m of rope. Stocking densities vary from 3-8 kg/m of dropper line with an average of 5 kg/m. The variation is in relation to both mussel density and growth stage. The average stocking rate of 300 mussels/m would have an early growout crop weighing about 4 kg/m. Under normal growing conditions the pre-harvest weight would be about 7 kg/m (Marine Pollution Research, 2008).

3.3.2 Commercial Scallop (Pecten fumatus) and Doughboy Scallop (Chlamys asperrima)

Description

Scallops are bivalve molluscs that belong to the Family Pectinidae. Commercial Scallops (*Pecten fumatus)* and Doughboy Scallops (*Chlamys asperrima)* are among the main species marketed. Commercial Scallops can be distinguished by their equal-sized, circular shaped shells that are thin but strengthened by radiating ribs (Figure 7). Also, the upper valve is flat and the lower valve is deeply convex. This species can obtain a length of up to 14 cm but are usually 6 to 9 cm. Doughboy Scallops have two cupped shells and can reach 10 cm in length but more commonly reach 5 to 7 cm in Jervis Bay (Web Reference 2).

Scallops are bottom dwelling filter feeders that strain phytoplankton (microscopic plant-like organisms) and other organic material from the water. Consequently, these species prefer sites with moderate water movement.

Scallops reproduce by broadcast spawning and fertilisation occurs in the water column. Larvae drift in the plankton for several weeks before attaching to an object with their byssal threads. Many species loose the byssal threads as they grow (e.g. length of about 1.5 cm for Commercial Scallops) and become free-swimming (Web Reference 2). Swimming occurs by clapping their shells quickly, which moves a jet of water past the shell hinge and propels the scallop forward.

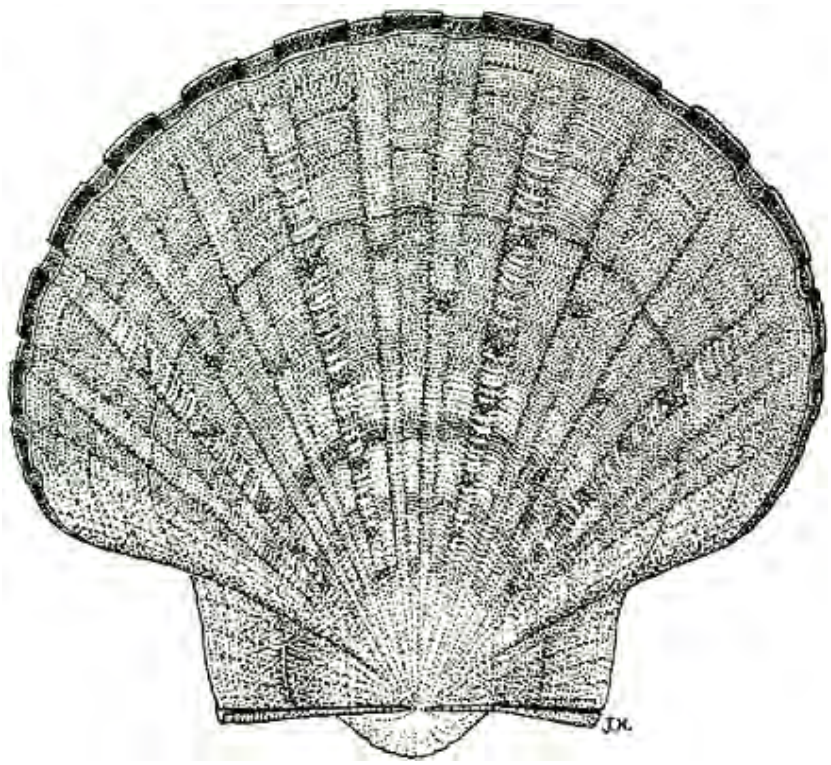

Figure 7: Commercial Scallop (*Pecten fumatus*) (Source: NSW DPI, 2012).

Distribution

Commercial Scallops and Doughboy Scallops are distributed throughout southern Australia from mid NSW to mid Western Australia, including Tasmania. Scallops are benthic organisms that are usually found on the surface of or buried in soft sand or muddy sediments at depths of 1 to 120 m (Web Reference 2).

Harvesting

Commercial Scallops are mainly harvested in Victoria and Tasmania with smaller fisheries in South Australia and previously in Jervis Bay. Doughboy Scallops are caught in Bass Strait, South Australia and previously in Jervis Bay. Saucer Scallops (*Amusium* species) are another key commercial species, which are fished in northern Australia, particularly Western Australia and Queensland. Wild caught scallops are predominantly harvested using scallop dredges or bottom trawls but hand harvesting by divers has recently commenced. The numbers of wild stocks fluctuate dramatically year-to-year, which often leads to large scale seasonal closures of the fishery (Web Reference 4).

Aquaculture

Worldwide, a 'boom' or 'bust' pattern is typical of scallop fisheries associated with the low and variable recruitment of juveniles, including the Commercial Scallop (*Pecten fumatus*) throughout southern Australia (Web Reference 5).

Juvenile scallops, caught from the wild, are grown to a size of about 40 mm in pearl and lantern cages before being released on the sea bed. Unfortunately, attempts to catch scallop spat in the wild in Australia have been highly variable in their success and in NSW, particularly poor. This has lead to research into the development of cheap reliable hatchery and nursery rearing techniques (Web Reference 5).

NSW DPI supported by a Fisheries Research and Development Corporation grant, from 1992 to 1994 led to the development of reliable cost effective hatchery production of scallops. Hatchery produced scallop seed stock from the PSFI was used in bottom seeding and farming trials in Jervis Bay. A total of more than four million scallop spat were produced for seeding and farming trials and over 250 000 scallops ranging in size from 20-60 mm were released into Jervis Bay (Web Reference 5).

Currently there is no commercial fishery for scallops as scallop and oyster dredging is now prohibited in Jervis Bay. Fisheries NSW researchers have also investigated the aquaculture potential of culturing scallops on longlines in Jervis Bay with positive results.

3.3.3 Akoya Pearl Oyster (Pinctada fucata)

Description

Akoya Pearl Oysters belong to the Family Pteriidae due to their ovate shell, a straight hinge line and an interior nacreous or pearl layer (Figure 8). This species has a thin and brittle shell that is brown to tan in colour with darker brown lines and is capable of producing pearls (Sterrer, 1986).

Akoya Pearl Oysters are filter feeders that strain phytoplankton and other organic material from the water. Consequently, these species prefer sites with moderate water movement.

Figure 8: Akoya Pearl Oyster (*Pinctada fucata*) (Source: Shell Museum, 2011).

Distribution

Akoya Pearl Oysters inhabit rocky, sandy and shallow areas in harbours, bays, sounds and lagoons in both the Northern and Southern Hemispheres (O'Connor & Lawler, 2004). This species is among the most wide spread of the Pearl Oysters and is particularly common in the Asia Pacific region. Within Australia, Akoya Pearl Oysters are found from southern Western Australia around the northern coastline and as far south as Victoria on the east coast. This species occurs naturally along much of the NSW coast including Port Stephens (O'Connor *et al*., 2003) and Jervis Bay.

Harvesting

In some areas, Akoya Pearl Oysters are harvested directly from the wild largely for the collection of naturally occurring pearls. However, recently wild collection has reduced and most of the oysters are hatchery produced. Akoya Pearl Oysters are not currently harvested in Australia but other Pearl Oyster species are commercially fished.

Aquaculture

Akoya Pearl Oysters have been cultured for pearls for over a centuries. Most notably, this species is found in Japan and has formed the basis of a billion dollar pearling industry (O'Connor *et al*., 2003). A small pearl production industry has existed in Australia for over a decade. A range of Pearl Oyster species are currently produced in Western Australia and Queensland. In NSW commercial production of Akoya Pearl Oysters has been undertaken in Port Stephens, Brisbane Water and Botany Bay while trial harvests have occurred in Jervis Bay.

3.3.4 Sydney Rock Oyster (Saccostrea glomerata)

Description

Sydney Rock Oysters possess a smooth, thick shell with small teeth on the internal rim of the shell, generally near the hinge (Figure 9). The mantle edges and the adductor muscle scar are pale in colour. This species can reach approximately 60g in 3 years and have been known to live for up to 10 years (Web Reference 2). Sydney Rock Oysters are filter feeders that strain phytoplankton (microscopic plant-like organisms) and other organic material from the water. Consequently, these species prefer sites that are frequently flushed (Web Reference 2).

Sydney Rock Oysters are 'broadcast spawners', that is, eggs and sperm are released into the water column where fertilisation occurs. This species, like most oysters, changes sex during their life. The first spawning is usually as a male and subsequent spawnings as a female. Larvae drift in the plankton for up to 3-4 weeks before attaching to substrate using their larval foot. Survival rates during this phase are less than 0.1%. The surviving oysters are then called 'spat' and will grow to maturity in about 3 to 4 years remaining in their chosen locality (Web Reference 6).

Figure 9: Sydney Rock Oyster (*Saccostrea glomerata*) (Source: NSW DPI, 2005).

Distribution

Sydney Rock Oysters are endemic to Australia and New Zealand and inhabit sheltered estuaries, rivers and bays, from eastern Victoria up to Hervey Bay in Queensland and across the tropical north to Shark Bay in Western Australia (Nell, 2001). This species is capable of tolerating a wide range of salinities and temperatures but optimal conditions are a salinity of 25 to 35 ppm and water temperatures of 18-30°C (Joyce *et al*., 2010). Sydney Rock Oysters prefer intertidal estuarine habitats such as mangroves, rocks and man-made structures but also occur subtidally on natural dredge beds (Nell, 2001).

Aquaculture

Sydney Rock Oyster farming occurs in southern Queensland and NSW. There is also a small emerging industry in Albany, Western Australia. Production of oysters in Australia has remained relatively stable since the production of Sydney Rock Oysters peaked in the mid 1970s at 13 million dozen. Production stabilized at around 8 million dozen at the end of the 1990s (Nell, 2001).

Cultivation of Sydney Rock Oysters in NSW is generally carried out in riverine estuaries or shallow lagoons. In Jervis Bay, small scale rack and tray aquaculture of Sydney Rock Oysters occurred in Currambene Creek, Moona Moona Creek, Callala Creek and Cararma Inlet from 1935 until mid 1990s. There has been no active Sydney Rock Oyster leases in Jervis Bay since 1996 (Marine Pollution Research, 2008).

3.3.5 Native Oysters (Ostrea angasi)

Description

Native Oysters (also known as Flat or Angasi Oysters) are roughly egg-shaped with valves of unequal size and shape. The shell margin is slightly irregular and is white or cream in colour on the inner surface and purplish-green to olive-brown or gray on the outer shell surface (Figure 10). The environment in which an oyster lives can have a strong influence on its shape i.e. irregular if attached to hard rocky substrate or very flat when found on soft substrate (Web Reference 2).

Native Oysters are filter feeders that strain phytoplankton and other organic material from the water. This species can attain a diameter of about 25 cm but are usually less than 10 cm (Web Reference 2).

Most oyster species, including the Native Oyster, change sex during their life. The first spawning is usually as a male and subsequent spawnings as a female. Fertilisation takes place in the water column and the larvae drift in the plankton for up to 3-4 weeks and then settle on a suitable hard clean surface. Survival rates during this phase are less than 0.1%.

The surviving oysters are then called 'spat' and will grow to maturity in about 3 to 4 years (Web Reference 6).

Figure 10: Native Oyster (*Ostrea angasi*) (Source: NSW DPI, 2004).

Distribution

The Native Oyster is found throughout the marine and estuarine habitats of southern Australia, including southern Queensland, the entire coast of NSW, South Australia, Western Australia and Tasmania.

Native Oysters live in the subtidal zone at depths of about 2 to 20 m. This species usually attaches to hard substrates before later breaking free to settle on sand or soft mud (Web Reference 2). Optimal temperatures for this species are between 10 to 18°C but it will tolerate higher temperatures (Joyce *et al*., 2010). Native Oysters are commonly found in Jervis Bay.

Harvesting / Aquaculture

Native Oysters have previously been commercially harvested from Jervis Bay since 1968 in conjunction with scallop harvesting (i.e. mainly incidental catch). There was one commercial fisher dredging for this species in 1991. Currently there is no commercial fishery for Native Oysters as scallop and oyster dredging is prohibited in Jervis Bay (Marine Pollution Research, 2008).

For the past five years several million seed Native Oysters were produced by scientists at the PSFI (Fisheries NSW). These small 0.5 mm but cheap ex-hatchery spat were supplied to oyster farmers that had each set up field nurseries at sites in Pambula Lake, Merimbula, Bermagui, Narooma, Batemans Bay, Port Stephens and Yamba. Farmers on the NSW south

coast have now established small scale hatcheries to meet their own needs (Web Reference 6). A commercial aquaculture industry for Native Oysters is also developing in the southern states of Australia.

3.3.6 Other species

Marine algae and any other species that can be cultured without feed or nutrient input could also be considered for culture on the proposed Commercial Shellfish Aquaculture Leases. However, only those species that naturally occur in Jervis Bay will be permitted for culture.

3.4 Site Description

The proposed Commercial Shellfish Aquaculture Leases are located within the open marine embayment of Jervis Bay which is located on the south coast of NSW (Figure 11). Jervis Bay is approximately 180 km south of Sydney and 20 km southeast of Nowra - the region's largest town. It is populated predominately on the western side of the bay which includes the towns of Callala Beach, Hyams Beach, Vincentia, and Huskisson.

Figure 11: Regional map of Jervis Bay and the proposed locations for the Commercial Shellfish Aquaculture Leases (Source: Fisheries NSW, 2012).

3.4.1 Lease Sites

The proposed Commercial Shellfish Aquaculture Leases would occupy a total area of 50 hectares consisting of the following:

- Callala Lease (north) - 20 hectares (Coordinates: -35° 1' 11.899" 150° 42' 39.666"; -35° 1' 27.615" 150° 42' 53.655"; -35° 1' 33.944" 150° 42' 43.147"; -35° 1' 18.228" 150° 42' 29.158");
- Callala Lease (south) - 20 hectares (Coordinates: -35° 1' 38.188" 150° 42' 21.156"; -35° 1' 53.796" 150° 42' 35.324"; -35° 2' 0.206" 150° 42' 24.887"; -35° 1' 44.597" 150° 42' 10.720"); and
- Vincentia Lease - 10 hectares (Coordinates: -35° 3' 35.483" 150° 41' 13.244"; -35° 3' 42.122" 150° 41' 21.910"; -35° 3' 49.960" 150° 41' 13.027"; -35° 3' 43.321" 150° 41' 4.361").

The Callala Leases (north and south) are located approximately 1.5 km and 1.9 km southeast of Callala Beach, respectively. The Vincentia Lease is approximately 660 m north of Orion Beach in Vincentia (Figure 12). The proposed dimensions of the leases are 600 m x 340 m for the Callala Leases and 300 m x 340 m for the Vincentia Lease. However, the exact dimensions and layout of the sites in the proposed locations will be finalised once a formal survey is undertaken by a registered surveyor during placement of the lease corner navigation buoys.

The proposed leases are located in a Habitat Protection Zone of the JBMP which is a multiple use zone that caters for a wide range of sustainable activities. The proposed aquaculture lease activities are permissible within this zone. The nearest Sanctuary Zone (highest protection) is located approximately 1 km south of the southern Callala Lease (Figure 13). The Vincentia Lease is located over one of the two former mussel aquaculture leases that were operational at this location.

The proposed Commercial Shellfish Aquaculture Leases are located over an area of fine to medium grained sand and small cobble with a depth of about 10 m. The Vincentia Lease is afforded some protection from prevailing weather conditions by Plantation Point and the Callala Leases are on the leeward side of Beecroft Peninsula.

Figure 12: Aerial view of the location of the proposed Commercial Shellfish Aquaculture Leases and the former Blue Mussel leases in Jervis Bay (Source: Fisheries NSW & Google Earth, 2013).

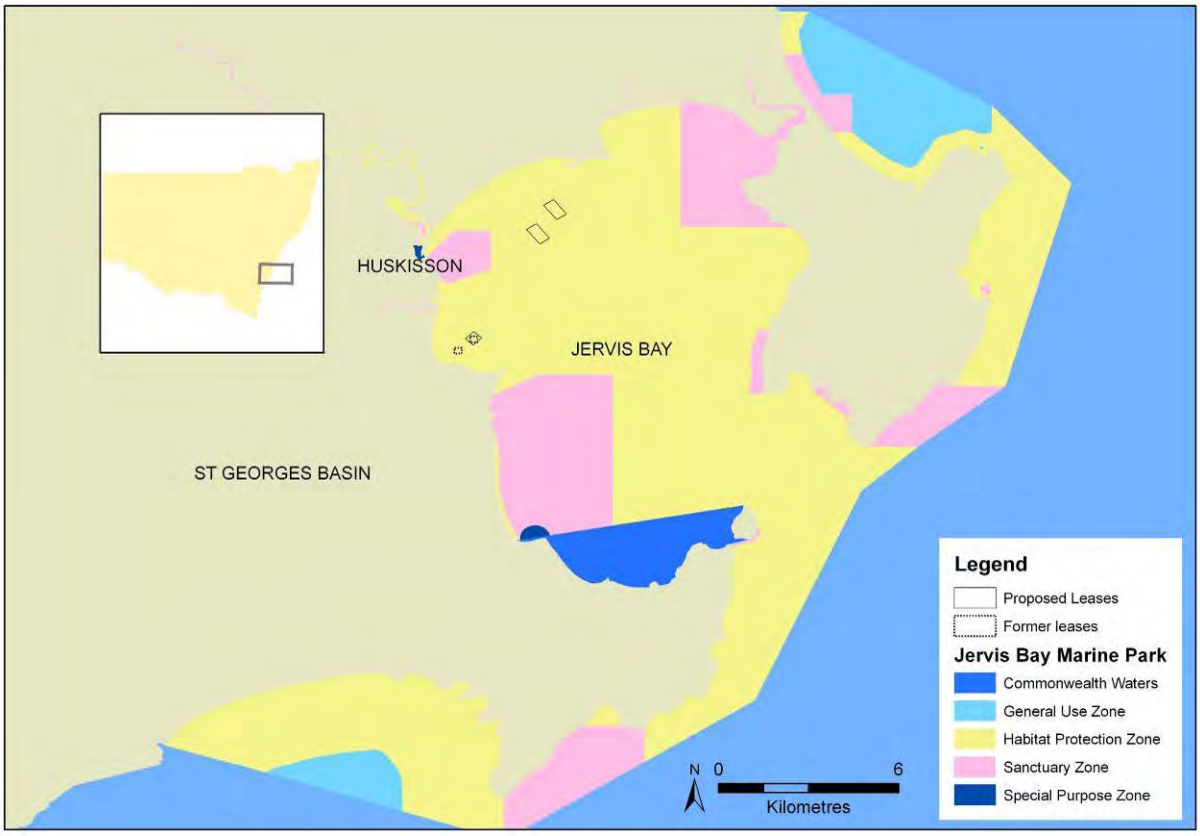

Figure 13: Jervis Bay Marine Park zones relative to the proposed Commercial Shellfish Aquaculture Leases (Source: Fisheries NSW, 2012).

3.4.2 Land Based Site

This proposal does not include the development of new land based sites. Permanent land based activities (e.g. gear storage and processing) would be subject to a separate approval (under Part 4 of the *Environmental Planning and Assessment Act 1979*). It is proposed that existing boating facilities at Woollamia, Huskisson or Callala Bay and existing industrial zoned lands will be utilised for operational activities.

3.5 Structure Design

The proposed Commercial Shellfish Aquaculture Lease infrastructure will consist of longline culture systems which will include an anchoring and mooring system that is connected to backbone ropes from which culturing apparatus would be suspended. The number of longlines within each lease may vary depending on the wave climate, depth and currents at each site. The use of rafts is not proposed as part of this proposal.

The anchoring and mooring system would consist of anchors at each end of the system connected to lengths of chain and polypropylene hard lay UV stabilised rope (25-35 mm diameter) which would be connected to the main backbone rope of similar dimensions. Longline systems may comprise of a single backbone or double backbone. The weight of the anchor blocks will be dictated by the weight of the product, the overall length of longline and the wave climate at each site (Marine Pollution Research, 2008). It is estimated that the primary anchors will be about 100 kg (Figure 14) and the smaller stablising anchors will be around 40 kg.

Figure 14: Examples of stingray anchors that may be used as primary anchors on the Commercial Shellfish Aquaculture Leases (Source: Jeyco, 2013).

The apparatus used to culture the shellfish will vary depending on the species cultured and may include:

- Dropper lines which are lengths of specially manufactured rope that enables certain shellfish species to adhere to them (Figure 15). Dropper lines can also be continuous where they are looped along the backbone in a continuous line;
- Pyramid nets and/or cages which are meshed containers in the shape of a pyramid in which the cultured stock are contained (Figure 16);
- Pocketed panel nets are generally a rectangular shaped structure which has a mesh like structure consisting of a number of “pockets” in which stock are placed for culture (Figure 16);
- Lantern nets and/or cages which are cylindrical shaped apparatus with an outer cover of mesh and a number of cross sectional layers in which the stock are placed for culture (Figure 16); and
- Baskets or trays which are generally constructed from plastic mesh and are available in a range of shapes and sizes. This apparatus is commonly used for the intertidal culture of oysters.

The pyramid, pocketed, lantern, basket and tray culture apparatus may be attached in multiples along a culture rope suspended under the backbone of the longline system. The culture lines (i.e. the lines in which the stock are secured to) will be spaced at intervals no less than 0.5 m apart to ensure efficient feeding of the shellfish. The culture lines will also be about 4-5 m in length which will ensure that the stock sits above the seabed to minimise predation and the obstruction of the movement of bottom dwelling fauna (Marine Pollution Research, 2008).

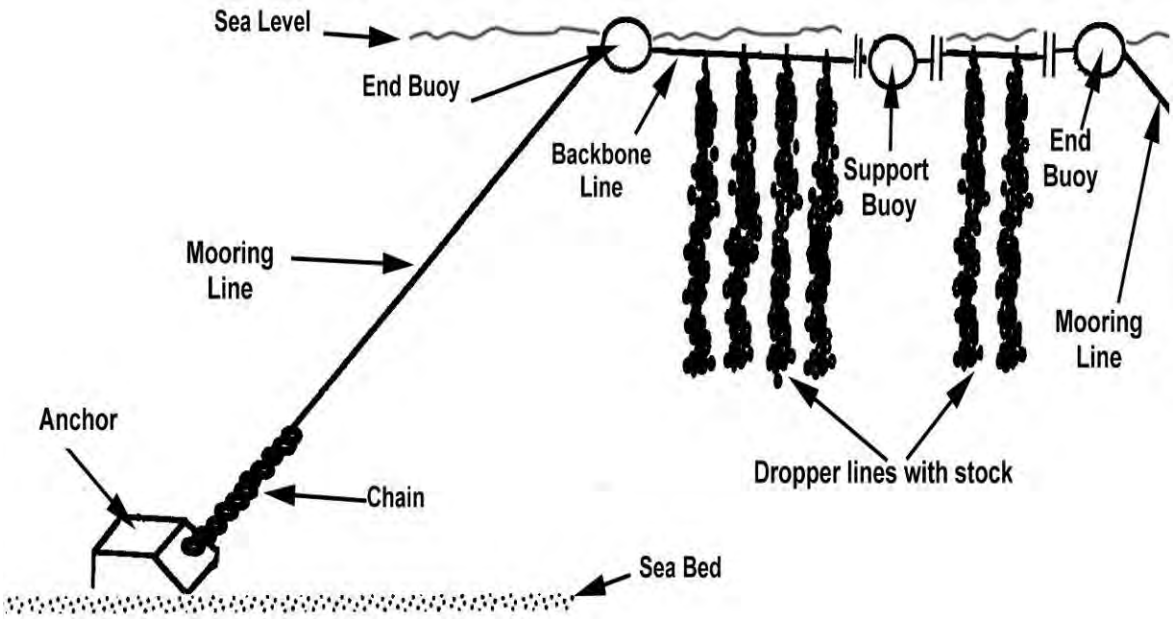

Figure 15: A schematic diagram of a longline system typically used for Blue Mussel culture (Source: Fisheries NSW, 2012).

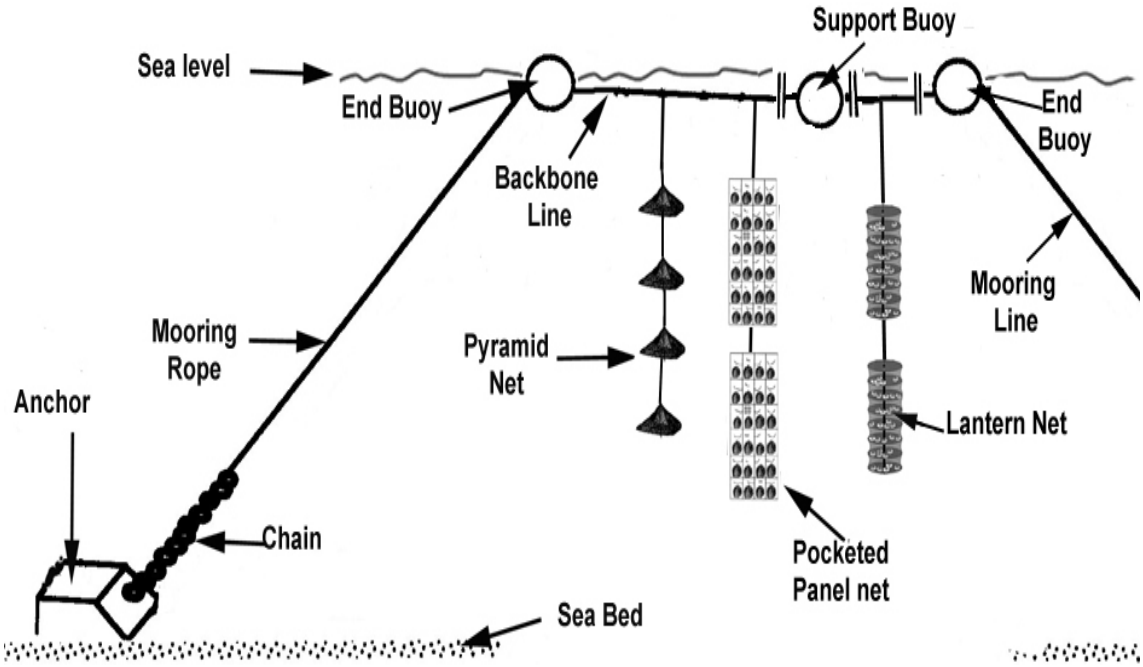

Figure 16: A schematic diagram of a longline system and cages typically used for shellfish culture (Source: Fisheries NSW, 2012).

Buoys will be attached to the longlines to assist with supporting the system. The number of buoys used along each longline will vary depending on the growth stage of the stock and the need to secure cultured stock at an appropriate depth off the seabed away from potential predators. Buoys are usually positioned 20-30 m apart when stocked with juveniles and as the crop increases in biomass additional buoys may be placed along the longlines. The support buoys generally have a volume of 150-200 litres and are black in colour (Figure 17).

Floatation from the buoys combined with the anchors and chains would also assist with the maintenance of taut ropes to prevent marine fauna entanglement.

Figure 17: Longline mussel infrastructure – double lines suspended below buoys (Source: Fisheries NSW, 2009).

The standard length of the longlines used for offshore pearl farming in Western Australia (which experience cyclonic storms and up to 10 m tides) and on mussel farms in Twofold Bay is 150 m (PSMC, 1997 cited Marine Pollution Research, 2008). The length of the longlines on the Commercial Shellfish Aquaculture Leases may range from 100 m to 500 m depending on the species cultured and site characteristics.

Longlines are typically positioned 15 to 50 m apart depending on the depth and prevailing sea conditions at the lease site. This gap between the longlines (i.e. backbone lines) ensures the stock can efficiently feed and service vessels can access all areas of leases (Marine Pollution Research, 2008).

Longlines are often aligned parallel to the predominant direction of waves to minimise mechanical stress on the infrastructure and obstructions to coastal processes. Longline systems typically appear as an orderly line of buoys when viewed at right angles to or at the ends of the lines but can appear disorderly when viewed from other angles.

Figure 18 is an example of a schematic plan of a longline lease illustrating the layout of the structural components from an aerial and cross sectional view.

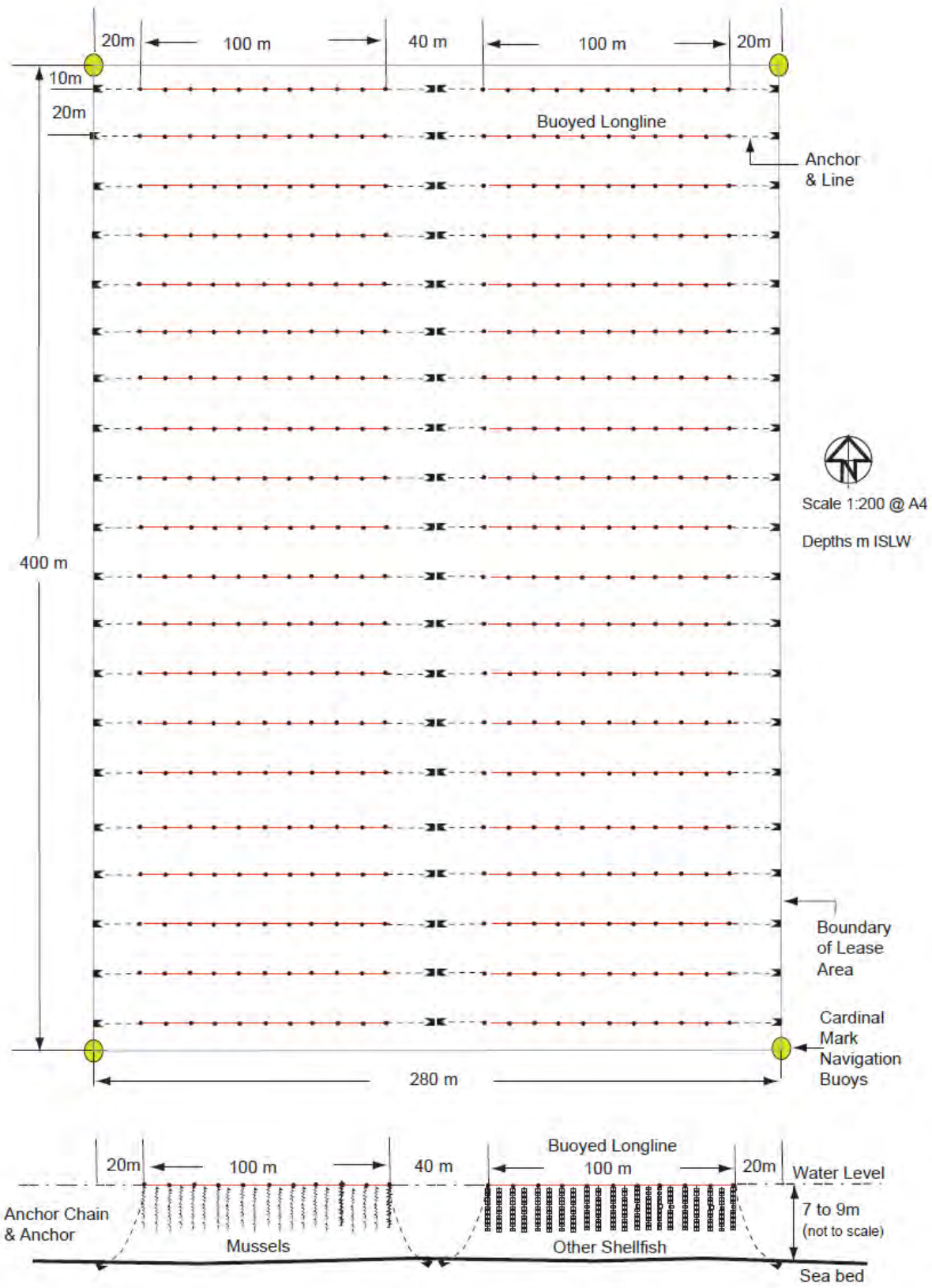

Figure 18: An example of a schematic plan of a longline lease illustrating the layout of the structural components from an aerial and cross sectional view (Source: Marine Pollution Research, 2008).

At least four navigation buoys will be positioned on the corners of the proposed leases in accordance with NSW Roads and Maritime Services (NSW RMS) and International

Association of Lighthouse Authorities (IALA) requirements (Solar Technology Australia, n.d.; IALA, 2008) (Figure 19). These requirements generally require the following:

- In the instance where vessels can navigate safely around the entire circumference of the lease, Cardinal marks must be used.
- Where Cardinal marks are used, Markers must have a day mark and a light.
- The focal point of the light should be at least 600mm above the water level.
- The day mark may be mounted above or below the light. In the instance where the light is the highest point, the centre of the day mark must be at 600 mm above water level.
- The light shall have a flash character to suit the type of cardinal mark or a minimum 1-second on 2-second off for the channel markers.
- The range of the light must be at least 1 nautical mile in clear conditions (Transmissivity of 0.74).
- The light must have a minimum vertical divergence of 9 degrees.
- The buoy tower shall be coloured according IALA recommendations.
- The buoy shall be located so that it does not encroach within 10 m of the lease structure.

Figure 19: A cardinal/navigation marker commonly used to mark the boundaries of aquaculture leases (Source: NSW DPI, 2012).

3.6 Construction and Operation of the Project

3.6.1 Transportation

During the construction stage the movement of vessels between the proposed Commercial Shellfish Aquaculture Leases and shore facilities may range from 0-6 return trips per day per lease to install the proposed infrastructure. Once the infrastructure is established the movement of vessels would be in the range of 0-3 return trips per day per lease to undertake activities such as inspections, repairs, maintenance, cleaning and harvesting.

Vehicular movements to provide goods and services to the vessels would again be highest during the construction stage. This would include trucks to supply the required components of the infrastructure and equipment required to carry out the installation. It is expected the number of vehicular movements to be within the range of 0-6 movements per day to the wharf and boat ramp facilities in Jervis Bay. Once the infrastructure is established the number of vehicular movements would largely be reduced to the movements of staff travelling from the land based site/s to the wharf and boat ramp facilities to service the leases.

3.6.2 Operation Hours

During the construction stage, the proposed operation hours will be between 7:00 am and 6:00 pm from Monday to Friday and between 8:00 am and 1:00 pm on Saturdays. This is in accordance with the standard hours of work recommended by NSW DECC (2009) in the *Interim Construction Noise Guideline*.

Operational and maintenance times are expected to vary from day to day depending on prevailing weather conditions, the day length at that time of year and on seasonal farming cycles. During summer for example, main operational activities may commence early in the morning to avoid the strong north easterly and southerly winds that often prevail during the afternoons in this region. Routine lease servicing work would not be scheduled on Saturdays or Sundays. Emergency call outs to the leases e.g. for repairs due to storms or reports of suspicious activities, could occur at any time including during the night.

3.7 Cultivation and Post-Cultivation Practices

Shellfish spat of the species to be cultured on the proposed Commercial Shellfish Aquaculture Leases may be produced at the PSFI, authorised industry hatchery facilities and/or natural spatfall may be collected. Hatchery spat will originate from local broodstock or if unavailable, broodstock will be sourced from other localities but from individuals within the same genetic population. During the hatchery stage spat will be monitored for diseases (unexplained mortalities will be reported) and parasites where it will be quarantined and

inspected prior to transportation to the proposed leases. Naturally caught spat translocated to Jervis Bay will undergo strict protocols to manage the risks of inter-estuarine movement of stock.

The apparatus used to culture the shellfish will vary depending on the species cultured and may include dropper lines, pyramid nets and/or cages, pocketed panel nets, lantern nets and/or cages or baskets and trays (See Section 3.5). Where apparatus or culture equipment is sourced (second hand) from existing aquaculture businesses, it will undergo appropriate cleaning and drying protocols prior to movement into Jervis Bay to mitigate the risk of translocation of marine pests or diseases.

Shellfish are filter feeding organisms and therefore the stock will obtain their food from the water column feeding on naturally occurring seston (i.e. phytoplankton, zooplankton, suspended organic and inorganic matter). Plankton concentrations are constantly replenished by the oceanic currents, tides and coastal upwelling waters which flush the embayment. There is an occasional supply of detritus from stormwater runoff (via creeks and coastal lands) and from the seabed which gets stirred up during storm events (Marine Pollution Research, 2008).

The health of the stock on the proposed Commercial Shellfish Aquaculture Leases will be monitored on a regular basis (weather permitting) to identify any disease or parasite issues that may arise. There is a legislative requirement that any unexplained or unusual mortalities be reported to Fisheries NSW to enable appropriate investigation to exclude notifiable aquatic diseases and where possible, identify causative agents.

The longline infrastructure will be cleaned of naturally occurring biofouling on a regular basis to reduce the potential to attract wild fish and harbour disease or parasites. Biofouling may be inspected for any suspected marine pest species prior to disposal. On the completion of grow out, stock will be harvested for transportation back to a land based facility for processing and/or sold to commercial outlets.

Harvesting does not include the use of a dredge as stock is harvested from the growing infrastructure.

Harvesting for human consumption will be in accordance with NSW Shellfish Program, which is administered by the NSW Food Authority under the *Food Act 2003*. The objective of the program is to protect the health of consumers purchasing shellfish through the administration and application of procedures described in the *New South Wales Shellfish Program Operations Manual*.

3.8 Decommissioning

In accordance with the provisions of the *Fisheries Management Act 1994*, the operator/s of the proposed Commercial Shellfish Aquaculture Leases will be authorised for their activities under an aquaculture permit and leases. Under these provisions the permit holder/s will be required to enter into an Aquaculture Lease Security Arrangement (Bond) with Fisheries NSW.

It is a condition of the aquaculture permit that all infrastructure is removed from the lease area/s if operations cease. In the event that an operator is not in a position to undertake the decommissioning, the Bond will be utilised to undertake required infrastructure removal works.

3.9 Project Alternatives

3.9.1 Alternative Sites in the Region

Jervis Bay is one of only three marine embayments on the NSW coast that are suitable for extensive aquaculture. The other embayments are Port Stephens, which has an established edible oyster industry and Twofold Bay, which already has extensive Blue Mussel aquaculture (Joyce *et. al*., 2010).

The proposed Commercial Shellfish Aquaculture Lease application is in response to the request from NSW MP for Fisheries NSW to develop a strategy for the sustainable development of aquaculture within Jervis Bay Marine Park (JBMP). The project will assist in the strategic and coordinated development of aquaculture within Jervis Bay rather than a piecemeal “adhoc” approach. Fisheries NSW have also had representation from a number of potential investors interested in developing aquaculture facilities in Jervis Bay. Consequently, consideration of alternatives sites in the region is not applicable in this circumstance.

The concept of using the Shoalhaven/Crookhaven Rivers for the establishment of the Commercial Shellfish Aquaculture Leases was investigated. This location was deemed unsuitable because of the depth profile (shallow), salinity levels (freshwater impacts) and available area as oyster farming leases already occupy 148.42 ha and navigation channels could potentially be impacted should any expansion be undertaken.

3.9.2 Alternative Sites in Jervis Bay

Investigations were directed by the following criteria in determining the location of the proposed Commercial Shellfish Aquaculture Leases:

- Existing or previous shellfish aquaculture activity;

- Suitability of the site to support longline aquaculture culture;
- Suitability of the environment and avoiding sensitive areas;
- Availability of maritime services;
- Availability of boating facilities (e.g. wharfs and boat ramps);
- Availability of potential land based facilities; and
- Constraint mapping to consider Commonwealth Waters and Naval, commercial and recreational uses.

The proposed sites for the Commercial Shellfish Aquaculture Leases were identified as the preferred locations within Jervis Bay that met the above criteria.

More specifically, Fisheries NSW identified that the sites for the Commercial Shellfish Aquaculture Leases must also possess the following features:

- Adequate water depth to accommodate the longline infrastructure and minimise effects on the benthic environment;
- Unconsolidated soft sediment seafloor;
- Sufficient distance from environmentally-sensitive and unique areas e.g. seagrass beds, mangroves, reefs and marine fauna aggregation areas;
- Sufficient current flow;
- Well mixed saline waters and not influenced by large continous influxes of freshwater;
- Not influenced by significant inputs of sewage, stormwater or other pollutants;
- Outside any recognised navigation channels, shipping port approaches and designated mooring/achoring areas;
- Outside Department of Defence training areas and mooring areas;
- Outside any predominant vessel routes to nearby localities;
- Sufficient distance from Commonwealth Waters;
- Sufficient distance from significant recreational and commercial areas e.g. fishing grounds, diving sites and dolphin/whale watching areas;
- Sufficient distance from residential areas;
- Sufficient distance from other aquaculture activities if present;
- If located within a marine park, the zone must permit aquaculture i.e. Habitat Protection Zone or General Use Zone, and must be a reasonable distance from Sanctuary Zones;

- Within the natural distribution range of the shellfish species that are proposed for cultivation;
- Receives some shelter from prevailing weather conditions (preferably); and
- Limited visibility of the sites from major land based vantage points (preferably).

After considering all of these features, a small area of Jervis Bay was classified as potentially suitable sites for the Commercial Shellfish Aquaculture Leases (See Figures 13, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33 and 34).

3.9.3 No-Project Option

The purpose of the proposed action is to respond to the request from NSW MP to develop an aquaculture strategy to ensure any aquaculture development is conducted in accordance with a sustainable aquaculture management plan. The proposed action is also in response to the renewed interest from intra and interstate shellfish growers and local indigenous groups in establishing aquaculture facilities in Jervis Bay. It is considered timely to have a coordinated approach to the feasibility of aquaculture in Jervis Bay.

There are a range of consequences for the community of not proceeding with the proposed Commercial Shellfish Aquaculture Leases, including the following:

- If the proposed Commercial Shellfish Aquaculture Lease project was not undertaken the opportunity to adopt a strategic, coordinated and sustainable approach to the development of aquaculture within Jervis Bay would be lost.
- Not proceeding with the project may in turn result in non strategic, piecemeal “adhoc” and potentially inappropriate and unsustainable development.
- Valuable knowledge about sustainable marine aquaculture would not be able to be validated and/or collected, which would assist to inform future developments of extensive aquaculture in NSW.
- There would be a loss of direct economic benefit to the local economy of the Jervis Bay region associated with sustainable seafood supply, employment positions, the purchase of goods, such as fuel and materials, and the use of services, such as vessel and vehicle servicing, as well as accommodation and food services for visiting personnel.
- The proposed Commercial Shellfish Aquaculture Leases provide an opportunity for tourist operators to diversify visitors’ experiences by visiting the aquaculture leases; it is likely to increase community awareness about sustainable seafood production and may encourage an interest in tourists to source fresh local seafood. The potential for

these benefits will be lost if the proposed Commercial Shellfish Aquaculture Lease project is not undertaken.

- Aquaculture is essential to achieving worldwide food security and meeting the demand for seafood products around the globe. In 2009–10 the gross value of NSW fisheries production was $132.9 million, of which the aquaculture sector accounted for $52.4 million or 39% (ABARES, 2011). As the gap between capture fishery supply and the growing demand for seafood can only be met by aquaculture, it is important that aquaculture production increases in the future. The potential for the NSW Government to contribute to these efforts will be limited if the proposed Commercial Shellfish Aquaculture Lease project is not undertaken.
- There would be a loss in ongoing water quality monitoring under the NSW Shellfish Program.
- The proposed Commercial Shellfish Aquaculture Leases could provide an opportunity for education and research platforms for local schools and universities. The potential for this benefits will be lost if the project is not undertaken.
- Shellfish culture assists in removal of excess nutrients from pollution sources and is an active carbon sink and this benefit would be lost.

NSW currently imports approximately 87% of its seafood. Sustainable seafood production is a key focus of the NSW Government's State Aquaculture Steering Committee to support future demands of food security for the State. The "do nothing" option was therefore considered to not be an appropriate alternative.

3.10 Justification of Preferred Option

Sustainable seafood production is a key focus of the NSW Government's State Aquaculture Steering Committee to support future demands of food security for the State. The gap between capture fishery supply and the growing demand for seafood can only be met by aquaculture. The NSW Government recognises the need to look at opportunities for sustainable and viable aquaculture development that is built upon sound research. Aquaculture supports the regional economies of NSW which will be an increasingly important contributor to the future food security needs of NSW.

NSW has very few sites that are suitably sheltered to support shellfish longline aquaculture and which are unconstrained by other activities.

Jervis Bay has a history of extensive (shellfish) farming starting in the late 1970s with the culture of Blue Mussels suspended from rafts. The culture of Blue Mussels was initially

undertaken by the University of NSW and then by private enterprises. The quality of Jervis Bay mussels received strong recognition from the local community and visiting tourists.

In the 1990s Fisheries NSW also undertook scallop aquaculture and ranching (seeding the seafloor) research, which saw over four million scallops farmed and released. Oyster leases also previously operated in Currambene Creek until the 1990s. Mussel rafts were previously located on two leases off Vincentia but ceased operation in 2008 after an application to proceed to commercial operation was withdrawn by the operator.

Jervis Bay possesses the physical, geographical and ecological characteristics considered suitable for near-shore aquaculture within NSW (Joyce *et al*., 2010), including excellent water quality, it is well sheltered from most prevailing weather conditions, it has a suitable depth profile and it is well serviced with local infrastructure and major seafood markets.

Fisheries NSW has been working with NSW MP since 2005 in the development of a strategy for the establishment of extensive aquaculture in JBMP. The proposed Commercial Shellfish Aquaculture Lease project would ensure that the development of this activity is strategic and coordinated and that a piecemeal “adhoc” approach is avoided.

The proposed Commercial Shellfish Aquaculture Leases are also valuable sites upon which important research can be undertaken to validate environmental monitoring and further develop industry best practice. The leases would provide the opportunity for Fisheries NSW, the Shoalhaven Campus of the University of Wollongong (UOW) and other organisations to undertake aquaculture and other applied marine research.

The proposed sites have been identified through an investigation into the constraints within Jervis Bay. The sites are located outside recognised navigation channels and approaches, outside any predominant vessel routes to nearby localities, predominantly outside of commercial areas (e.g. fishing grounds, diving sites and dolphin/whale watching areas), located outside of Commonwealth Waters, located outside of Naval training and operation areas, located in a marine park zone which permits aquaculture and is within the natural distribution range of the species that are proposed for cultivation. There is also limited visibility of the proposed sites from major land based vantage points in the region.

Potential impacts were assessed to be not significant when considered in context with the small scale (0.4% of Jervis Bay) of the proposed Commercial Shellfish Aquaculture Leases, the extensive culture practice (no feed), the use of appropriate stocking densities, the minor increases in vessel movements and vehicular traffic, the distance from key landmarks, critical habitat and reefs, as well as the use of design features that will minimise visual impacts. Noise generated will predominately be characteristic of the area and service

vessels will be similar to existing vessels that use Jervis Bay although the noise will be smaller than that generated by Naval aircraft using the bay for exercises.

Potential impacts were also assessed to be not significant when considered in context of the characteristics of the proposed site, including the good flushing rate, the soft sediment seafloor, depth and the extensive area of similar habitat in the direct and wider area. Also, only a relatively small area of habitat will be disturbed from the installation of the longline infrastructure (i.e. only the anchors and sections of chains will be in contact with the seabed).

The proposed sites are not high use areas, safe navigation will not be obstructed, the sites are not of significant commercial importance and the leases will be clearly delineated with navigation buoys. Items and places of heritage significance in the region are located a sufficient distance away from the proposed sites to ensure no direct or indirect impacts. Broodstock will be sourced locally or from the same genetic population, and hatchery protocols will ensure that genetic integrity is maintained, healthy shellfish are stocked onto the leases and translocation protocols will assess pest and disease issues.

Significant flow-on economic benefits are anticipated from the supply of sustainable seafood, purchase of materials, services and labour associated with the operation of the Commercial Shellfish Aquaculture Leases in Jervis Bay. In South Australia for example, each job generated directly from oyster and mussel farming processing and transport is thought to generate an additional 1.81 -1.91 jobs in the rest of the state (EconSearch, 2012). The proposed leases will also provide the tourism industry with an opportunity to diversify experiences available to visitors.

The results from the monitoring programs and reviews of the effectiveness of the management plans, protocols and other mitigation measures will provide valuable information to support evidence based policy development for future sustainable seafood production in NSW.

Through the employment of industry best practice, management plans, protocols and monitoring programs identified in this EIS and draft EMP it is concluded that the proposed Commercial Shellfish Aquaculture Leases will not have a significant environmental, social or economic impact.

4 STATUTORY FRAMEWORK

4.1 Relevant State Legislation

Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act provides a framework for environmental planning in NSW and includes provisions to ensure that proposals with the potential to significantly affect the environment are subject to detailed assessment. The EP&A Act is administered by NSW Department of Planning and Infrastructure (NSW DoPI) and provides for various planning instruments including State Environmental Planning Policies and Local Environment Plans, as well as specifying which types of developments require development approval.

The objectives of the EP&A Act include:

- the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment;
- the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats; and
- promoting ecologically sustainable development.

Under the *State Environmental Planning Policy* (State and Regional Development 2011) this proposal is classified as State Significant Infrastructure (c.14 (1)(b) and Schedule 3 (1)(1)) and requires approval from the Minister for Planning and Infrastructure under s.115W of the EP&A Act. An EIS has been prepared to accompany the proposed Commercial Shellfish Aquaculture Lease development application.

Threatened Species Conservation Act 1995 (TSC Act)

The TSC Act is administered by NSW Office of Environment and Heritage (NSW OEH) and includes provisions to declare and protect threatened species, populations and ecological communities. Species populations and ecological communities identified as ‘endangered’ ‘critically endangered’ and ‘vulnerable’ are listed in Schedules 1, 1A and 2 of the TSC Act, respectively.

The TSC Act also lists ‘key threatening processes’ that may threaten the survival of those species, populations and ecological communities. Marine birds, mammals and reptiles are included in schedules of the TSC Act. In addition, the TSC Act provides for the identification

of habitat that is critical to the survival of an endangered species, population or ecological community.

An assessment of significance on all threatened species that may occur in the area of the proposed development is required.

Fisheries Management Act 1994 (FM Act)

Provisions for the protection of fish and marine vegetation are administered by Fisheries NSW under the FM Act. Threatened species populations and ecological communities identified as 'endangered' 'critically endangered' and 'vulnerable' are listed in Schedules 4, 4A and 5 of the FM Act, respectively.

The FM Act also lists 'key threatening processes' that may threaten the survival of those species, populations and ecological communities. Part 2 (19) of the FM Act allows for the declaration of 'protected species', which, though not currently declining, must be protected so they do not become threatened in future. Provisions for the protection of aquatic habitats and aquatic reserves are included under Part 7 of the FM Act. In addition, Division 3 Part 7A of the FM Act provides for the identification of habitat that is critical to the survival of an endangered species, population or ecological community.

An aquaculture lease issued under Section 163 of the FM Act is required for the proposed project. The activities will also be authorised under an aquaculture permit issued under Section 144(1) of the FM Act.

Aquaculture permit and leases are subject to conditions that regulate species, structures, farming activities, monitoring requirements and reporting declared diseases (including pests and parasites listed Schedule 6B of the FM Act) or unexplained or unusual mortality events. Quarantine provisions in the FM Act enable the making of Quarantine Orders including conditions for areas of suspected or confirmed presence of declared diseases and noxious fish and marine vegetation, including (but not limited to) an area that is the subject of an aquaculture permit. There is also provision in the FM Act to report noxious fish and marine vegetation (listed Schedule 6C of the FM Act).

Marine Parks Act 1997 (MP Act)

Provisions for the protection of marine biological diversity, marine habitats and ecological processes in marine parks, as well as ecologically sustainable resource use are administered by NSW DPI under the MP Act.

Before determining a development application under the EP&A Act for a development within a marine park, an approval authority must take into consideration:

- the objects of this Act specified in Section 3;

- the objects of the zoning plan for the marine park zone;
- the permissible uses of the area concerned under the regulations; and
- any relevant marine park closures.

It is proposed that the leases will be located in the Habitat Protection Zone within Jervis Bay Marine Park (JBMP). The objects of this zone are:

- to provide a high level of protection for biological diversity, habitat, ecological processes, natural features and cultural features (both Aboriginal and non-Aboriginal) in the zone, and
- to provide opportunities for recreational and commercial activities (including fishing), scientific research, educational activities and other activities, so long as they are ecologically sustainable and do not have a significant impact on any fish populations or on any other animals, plants or habitats.

Aquaculture is a permissible use in the Habitat Protection Zone with the approval of the relevant Ministers and subject to the provisions of the zoning plan for the marine park, in accordance with c 1.18 of the *Marine Parks (Zoning Plans) Regulation 1999*. The zoning plan for Jervis Bay Marine Park stipulates that, in the habitat protection zone, only extensive aquaculture is permitted (MP(ZP)R Cl.3.7). A permit in accordance with Clause 12 of the *Marine Parks Regulation 2009* will be required to undertake the proposed activity.

National Parks and Wildlife Act 1974 (NPW Act) and the National Parks and Wildlife Regulation 2009 (NPWR)

Under the NPW Act, the Director-General of the NPWS is responsible for the care, control and management of all national parks, historic sites, nature reserves, reserves, Aboriginal areas and State game reserves. State conservation areas, reserves and regional parks are also administered under the NPW Act. The Director-General is also responsible under this legislation for the protection and care of native fauna and flora, and Aboriginal places and objects throughout NSW. The NPW Act and the NPWR are administered by NSW OEH.

Crown Lands Act 1989

Submerged land is generally classified as a type of Crown land. Submerged land includes most coastal estuaries, many large riverbeds, many wetlands and the State's territorial waters, which extend 3 nautical miles (5.5 km) out to sea. The principles of Crown land management are that:

- environmental protection principles be observed in relation to the management and administration of Crown land;

- the natural resources of Crown land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible;
- public use and enjoyment of appropriate Crown land be encouraged;
- where appropriate, multiple use of Crown land be encouraged;
- where appropriate, Crown land should be used and managed in such a way that both the land and its resources are sustained in perpetuity; and
- Crown land be occupied, used, sold, leased, licensed or otherwise dealt with in the best interests of the State consistent with the above principles.

The proposed area for the Commercial Shellfish Aquaculture Leases is located on submerged Crown land and therefore required landowner's consent through NSW DPI Catchments and Lands (Crown Lands Division) to lodge this EIS (which was granted) (Appendix 9).

Coastal Protection Act 1979 (CP Act)

The CP Act is administered by NSW OEH and its objectives include:

- to protect, enhance, maintain and restore the environment of the coastal region, its associated ecosystems, ecological processes and biological diversity, and its water quality;
- to encourage, promote and secure the orderly and balanced utilisation and conservation of the coastal region and its natural and man-made resources, having regard to the principles of ecologically sustainable development; and
- to recognise and foster the significant social and economic benefits to the State that result from a sustainable coastal environment, including:
- benefits to the environment; and
- benefits to urban communities, fisheries, industry and recreation.

Under the CP Act, the proposed Commercial Shellfish Aquaculture Leases are in the coastal zone as defined by Section 4 of the Act. However, in accordance with Section 37B of the CP Act the area of the leases do not require the concurrence of the Minister administering the CP Act.

Heritage Act 1977

Under the *Heritage Act 1977*, historic shipwrecks are the remains of any ship (including articles associated with the ship) that has been situated in State waters (within the 3 nautical mile limit) or otherwise within the limits of the State, for 75 years or more, or that is the subject of a historic shipwrecks protection order. Under Section 51 of the *Heritage Act 1977,*

a permit is required to move, damage, or destroy any historic shipwreck. The *Heritage Act 1977* does not apply to State waters that are waters to which the *Commonwealths Historic Shipwrecks Act 1976* applies. There are also provisions in the *Heritage Act 1977* which allow for the declaration of an Interim Heritage Order. NSW OEH is responsible for administering this Act.

Maritime Services Act 1935 (MS Act)

The MS Act, administered by NSW Roads and Maritime Services, sets out a range of authorisations for a variety of works in and adjacent to navigable waters. Notification under Section 13Z of the MS Act to grant an aquaculture lease under Part 6 of the FM Act is also required.

NSW Coastal Policy 1997 and *State Environmental Planning Policy No. 71 – Coastal Protection*

The *NSW Coastal Policy* 1997, administered by NSW DoPI, applies to Shoalhaven City Council and the proposal lies in the coastal zone as defined by the policy. *State Environmental Planning Policy No. 71 – Coastal Protection* gives legal force to certain elements of the coastal policy and provides a development assessment framework for new development in the coastal zone. More specifically, the policy aims to:

- protect and manage the natural, cultural, recreational and economic attributes of the NSW coast;
- protect and preserve the marine environment of NSW; and
- manage the coastal zone in accordance with the principles of ecologically sustainable development.

The policy applies to the coastal waters of the State and includes the seabed, subsoil and airspace in that zone. Clause 8 matters for consideration of *State Environmental Planning Policy No 71—Coastal Protection* apply to the proposed development.

Aboriginal Land Rights Act 1983 (ALR Act)

The ALR Act, administered by the Office of the Registrar, provides a mechanism for compensating Aboriginal people of NSW for loss of their land. The preamble of the ALR Act states that land was traditionally owned and occupied by Aboriginal people and accepts that as a result of past Government decisions, the amount of land set aside for Aboriginal people had been reduced without compensation.

To redress the loss of land Aboriginal Land Council's which are established under the Act can claim vacant crown land, which if granted, is transferred as freehold title. Vacant Crown

land can include land below the mean high water mark and state waters (See *Crown Lands Act 1989*).

A Local Aboriginal Land Council has the following functions in relation to the acquisition of land and related matters:

- in accordance with the ALR Act and the regulations, to acquire land and to use, manage, control, hold or dispose of, or otherwise deal with, land vested in or acquired by the Council;
- functions relating to the acquisition of land and any other functions conferred on it by or under Part 4A of the NPW Act;
- to submit proposals for the listing in Schedule 14 to the NPW Act of lands of cultural significance to Aboriginal persons that are reserved under the NPW Act;
- to negotiate the lease by the Council or by the Council and one or more other Aboriginal Land Council's of lands to which Section 36A applies to the Minister administering the NPW Act;
- when exercising its functions with respect to land that is the subject of a lease, or proposed lease, under Part 4A of the NPW Act, to act in the best interests of the Aboriginal owners of the land concerned;
- to make written applications to the NSW Aboriginal Land Council for the acquisition by the NSW Aboriginal Land Council of land on behalf of, or to be vested in, the Local Aboriginal Land Council; and
- to make claims to Crown lands.

A Local Aboriginal Land Council has the following functions in relation to land use and management:

- to consider applications to prospect or mine for minerals on the Council's land and to make recommendations to the NSW Aboriginal Land Council in respect of such applications; and
- to protect the interests of Aboriginal persons in its area in relation to the acquisition, management, use, control and disposal of its land.

A Local Aboriginal Land Council has the following functions in relation to Aboriginal culture and heritage:

- to take action to protect the culture and heritage of Aboriginal persons in the Council's area, subject to any other law; and
- to promote awareness in the community of the culture and heritage of Aboriginal persons in the Council's area.

The proposed Commercial Shellfish Aquaculture Leases do not grant exclusive use.

Protection of Environment Operations Act 1997 (POEO Act)

The POEO Act, administered by NSW OEH, ultimately aims to protect, enhance and restore the quality of the environment in NSW, to reduce risk to human health and promote mechanisms that minimise environmental degradation through a strong set of provisions and offences.

A licence is required from NSW EPA if any of the activities associated with the proposal are determined to be a Scheduled Activity under Schedule 1 of the Act. Longline aquaculture is not considered to be a Scheduled Activity and a licence will not be required for the proposed Commercial Shellfish Aquaculture Leases.

Environmentally Hazardous Chemicals Act 1985 (EHC Act)

The EHC Act, administered by NSW OEH, governs the use and disposal of potentially hazardous chemicals and waste material. Any use and/or removal of hazardous chemicals and material defined under the EHC Act require licensing and must be appropriately declared. At this stage it is not expected that any hazardous chemicals will be used.

Food Act 2003

The *Food Act 2003* is administered by the NSW Food Authority with the object of ensuring food for sale is both safe and suitable for human consumption. A Food Authority Licence under the *Food Regulation 2010* will be required for shellfish cultured for human consumption.

4.2 Relevant Commonwealth Legislation

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act is administered by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) and aims to:

- provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance (NES);
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources;
- promote the conservation of biodiversity; and
- provide for the protection and conservation of heritage.

In the aquatic environment, the Act lists the following matters of NES:

- nationally threatened species, ecological communities, critical habitats and key threatening processes (including marine species);
- migratory species;

- Ramsar wetlands of international importance; and
- Commonwealth marine areas (extends between 3-200 nautical miles from the coast).

Threatened fauna and flora are listed in any one of the following categories as defined in Section 179 of the EPBC Act as:

- extinct;
- extinct in the wild;
- critically endangered;
- endangered;
- vulnerable; or
- conservation dependent.

Species listed as ‘extinct’ or ‘conservation dependent’ are not considered matters of national environmental significance (protected matters).

The proposed development is required to be assessed according to the EPBC Act, the EPBC Act Policy Statement 1.1 (Significant Impacts Guideline: SIG 1.1) and the EPBC Act Policy Statement 2.2 (Offshore Aquaculture).

Fisheries NSW submitted a Referral of Proposed Action form to DSEWPaC for assessment under the EPBC Act. DSEWPaC has advised that the proposed Commercial Shellfish Aquaculture Leases have been deemed to not be a controlled action under the EPBC Act (Appendix 2).

Control of Naval Waters Act 1918 (CNW Act)

The CNW Act is administered by the Department of Defence and its purpose is to provide for the protection of installations and/or land owned or used by the Commonwealth for purposes related to the defence of the Commonwealth. In particular, the declaration of Naval waters allows for access control to be invoked in times of heightened security, when active policing of the waters is likely to be required and involves approaching facilities. It is the policy of the Royal Australian Navy (RAN) to maintain Naval waters only around facilities required for strategic needs.

Jervis Bay has been declared Naval Waters under the CNW Act and therefore approval to undertake the proposed Commercial Shellfish Aquaculture Leases development and activities is required from the Superintendent of Naval Waters. This approval from the Superintendent of Naval Waters has been granted.

Historic Shipwrecks Act 1976 (HS Act)

The HS Act, administered by DSEWPaC, protects historic wrecks and relics in Commonwealth Waters, extending from below the low water mark to the edge of the continental shelf. For the purposes of this study, any shipwrecks within the footprint of any proposed aquaculture lease would be under the jurisdiction of the HS Act. Under Section 4 of the HS Act, all shipwrecks 75 years of age and older are declared historic and afforded automatic protection. At the time of writing, vessels wrecked before 1933 are protected under the HS Act. Other shipwrecks can be declared historic and granted this protection on an individual basis according to their particular merits.

Under Section 13 of the HS Act, it is an offence to damage, interfere, remove or destroy an historic shipwreck or artefacts associated with it. A permit can be issued under special circumstances, with conditions, to carry out a specified action that would otherwise be prohibited under Section 13. For shipwrecks under threat, a protected zone can be declared that can prohibit certain activities within a specified radius around the wreck. Under Section 17 of the HS Act persons discovering a shipwreck are legally obligated to notify the appropriate authorities of the discovery.

Native Title Act 1993

Native Title is the name Australian law gives to the traditional ownership of land and waters that have always belonged to Aboriginal people according to their traditions, laws and customs. Native Title might continue to exist in areas such as beaches, oceans and other waters that are not privately owned. Registered native title claimants gain a right to be notified of, and to comment on, certain acts which government proposes doing ('future acts') which may affect land in their claim area. The Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA) administers this Act.

The proposed Commercial Shellfish Aquaculture Leases do not grant exclusive use and do not extinguish native title.

Policy on Ecologically Sustainable Development (ESD)

Australia's National Strategy for Ecologically Sustainable Development 1992 (NSESD) defines ecologically sustainable development (ESD) as 'using, conserving and enhancing the community's resources so that ecological processes on which life depends are maintained and the total quality of life, now and in the future, can be increased'.

The main objectives of ESD are:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;

- to provide for equity in and between generations; and
- to protect biological diversity and maintain essential ecological processes and life-support systems.

The main principles of ESD state that:

- decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations;
- where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- the global dimension of environmental impacts of actions and policies should be recognised and considered;
- the need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised;
- the need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised;
- cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms; and
- decisions and actions should provide for broad community involvement on issues which affect them.

5 CONSULTATION

Fisheries NSW commenced the consultation process for the proposed Commercial Shellfish Aquaculture Leases with relevant stakeholders in August 2012. The majority of consultation was undertaken with preliminary telephone calls which were followed by face to face meetings in the Jervis Bay region. Stakeholders were provided with information about the Commercial Shellfish Aquaculture Leases and emerging shellfish aquaculture industry and any issues raised during consultation were addressed in this EIS. Information was also provided via email and with a *Question and Answer* page on the NSW DPI website. Consultation carried out to–date includes:

- August 2012: Meeting/consultation with the Shoalhaven City Council, Jerrinia Local Aboriginal Land Council and Wreck Bay Aboriginal Community Council;
- October 2012: A focus planning meeting with state agencies was held. Fisheries NSW presented the project to Shoalhaven City Councillors (including local Mayor the Hon Joanna Gash MP, Member for Gilmore) and Council planning staff. Consultation commenced with local government, environmental and community groups, recreational and commercial fishers, marine tour operators, waterway users, local associations and local Aboriginal leaders;
- October 2012:
    - A Question and Answer page was listed on the Fisheries NSW website, http://www.dpi.nsw.gov.au/fisheries/aquaculture
    - A media release from the Minister for Primary Industries was issued (http://www.dpi.nsw.gov.au/fisheries/aquaculture) which resulted in local press including: the South Coast Register, Australian Fishing, The Fish Site, Daily Telegraph, WIN TV, local radio; and
    - Radio interviews were conducted with ABC Illawarra and 2ST.
- November 2012: An application was lodged with NSW Department of Planning and Infrastructure for a State Significant Infrastructure project. Director General's Requirements were received December 2012 and are summarised at: http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=5657. The State Aquaculture Steering Committee (DG level interagency committee), the NSW Aquaculture Research Advisory Committee and the NSW Shellfish Committee were briefed on the project; and
- December 2012 – mid 2013: Stakeholder consultation continues with calls, emails and face to face meetings at Nowra and around Jervis Bay. The Marine Incident

Exercise 'Bherwerre' conducted at HMAS Creswell to consider an oil spill response in the Bay was also attended with issues relating to potential aquaculture sites raised.

Consultation has included 58 key contacts (calls/emails) and 27 face to face meetings. A list of all stakeholders engaged during the consultation stage of the project is provided below (Table 2).

Table 2: A list of all stakeholders that were consulted about the Commercial Shellfish Aquaculture Leases.

Stakeholders	
Jerrinia Local Aboriginal Land Council	NSW Advisory Council on Recreational Fishing
Wreck Bay Aboriginal Community Council	Crest Diving
University of Wollongong – Shoalhaven Campus	Oceantrek Diving Resort
Jervis Bay Chamber of Commerce & Tourism	Jervis Bay Paddle
Jervis Bay Cruising Yacht Club Inc	Jervis Bay Eco Adventures
Jervis Bay Divers Club Inc	Jervis Bay Sailing Charters
Jervis Bay Sailing Club	Duncan Marshall ("Creating Callala")
Jervis Bay Regional Alliance Inc	Southern Rivers CMA
Marine Rescue Jervis Bay	Attila Kasko – conservation
Jervis Bay Tourism	Jack Soeters - conservation
Vincentia Sailing Club Incorporated	Australian Conservation Foundation - Shoalhaven Branch
Vincentia High School	Commercial fishers (Ocean Trap and Line, Estuary General, Abalone, Lobster)
Vincentia Ratepayers & Residents Association	Recreational fishers and fishing clubs
Vincentia Chamber of Commerce	Jervis Bay Penguin Study Group
Huskisson Woollamia Community Voice Inc	Jervis Bay Protection Committee
Huskisson Chamber of Commerce & Tourism Inc	Archer Fishing Club
Huskisson Wharf Management Committee	Huskisson Bowling Club Fishing Club
Callala Bay Community Association Inc	Callala RSL Sport Fishing Club
Callala Beach Progress Association Inc	Huskisson RSL Amateur Fishing Club
Callala Business Chamber and Tourism Inc	Jervis Bay Game Fishing Club
Shoalhaven Oyster Farmers	Navy – Department of Defence
Regional Food and Wine Show	NSW Food Authority

Dolphin Wild Cruises	Shoalhaven City Council
Dolphin Watch Cruises	National Parks and Wildlife Service
Environment Protection Authority	NSW Department of Primary Industries
NSW Roads and Maritime Services	NSW Marine Parks
NSW Office of Environment and Heritage	Department of Sustainability, Environment, Water, Populations and Communities
Booderee National Park	Hyams Beach Villagers Association
NSW Land and Property Management Authority	Shoalhaven Water

5.1 Statutory Authorities

State Agencies

On 26 October 2012 a planning focus meeting with NSW Government agencies and Shoalhaven City Council was held at Council offices.

A Preliminary Project Outline for the Commercial Shellfish Aquaculture Leases was provided to NSW Department of Planning and Infrastructure so the Director-General's Requirements for an Environmental Impact Statement could be developed. The Preliminary Project Outline also assisted with informing government agencies about the project. From NSW Government agency feedback, the Director-General's Requirements were developed.

The Director-General's Requirements advised that relevant local, State and Commonwealth government authorities, service providers, community groups and affected landowners should be consulted regarding the Commercial Shellfish Aquaculture Lease project. See http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=5657.

In particular, the Director-General's Requirements requested consultation with the following stakeholders:

- Environment Protection Authority;
- NSW Roads and Maritime Services;
- NSW Office of Environment and Heritage;
- NSW Marine Parks;
- NSW Food Authority;
- NSW Land and Property Management Authority;
- National Parks and Wildlife Service;
- Shoalhaven City Council;

- NSW Department of Primary Industries; and
- Department of Defence.

Key issues raised during consultation to date with statutory authorities (excluding Director-General's Requirements) are listed in Table 3.

Table 3: Issues of concern raised during consultation with statutory authorities.

Issue	EIS Section
Wildlife entanglement	8.2.2.4; Appendix 1
Structural integrity of lease infrastructure	8.1.5; Appendix 1
Security arrangements (bond) for aquaculture ventures in case of lease clean up	8.1.2; 8.2.2.9
Noise and visual amenity	8.1.3; 8.2.1.1; 8.2.1.4
Landowners consent to lodge application	4.1; Appendix 9
Land/water interface to service potential aquaculture ventures	8.1.4; 8.1.7; 8.2.1.2
Location of land based facilities	3.4.2; 8.1.4
Commercial use of boat launching facilities	6.14; 8.1.4; 8.1.7; 8.2.1.2
Proposal must not impact the operational capacity of the Department of Defence in Jervis Bay	6.15; 8.1.7; 8.2.1.2
Access by way of Commonwealth lands for commercial activity would be restricted	8.1.4
Activity should be outside the Naval firing safety trace	6.15
Historical ship and plane wrecks	6.16.2; 8.2.1.3
Items listed in the Director-General's Requirements issued by NSW DoPI	Appendix 2; Contents Specific To State Guidelines

Federal Agencies

On the 26 February 2013, Fisheries NSW wrote to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) to submit a Referral of Proposed Action form for assessment under the *Environmental Protection and Biodiversity Conservation Act 1999*. On the 20 March 2013 Fisheries NSW also met with staff of the Booderee National Park.

5.2 Non-Statutory Authorities

Non-statutory groups were phoned, emailed and/or invited to meetings. Face to face meetings have been held with: the Wreck Bay Aboriginal Community Council; Jerrinia Local Aboriginal Land Council; University of Wollongong; Huskisson Woollamia Community Voice; Jervis Bay Sailing Club; Vincentia Sailing Club; Jervis Bay Chamber of Commerce and Tourism and members; Oceantrek Dive Resort; Conservation group representatives; Vincentia Ratepayers and Residents Association; Callala Business Chamber and Tourism Incorporated and Callala Beach Progress Association.

Key issues raised during consultation with non-statutory are listed in Table 4.

Table 4: Issues of concern raised during consultation with non-statutory authorities.

Issue	EIS Section
Identification of culturally significant Indigenous sites and ensuring access is not restricted for cultural purposes or that they are impacted	6.16.1; 8.2.1.3
Opportunity for business and employment opportunities for Indigenous stakeholders	8.2.1.6
Indigenous involvement in planning processes	5
Access to Commonwealth Waters in the south of Jervis Bay for aquaculture	3.9.2; 3.10
Access to wharf/boat ramp facilities to support aquaculture proposals	8.1.4; 8.2.1.2
Water quality and sewage overflow impacts at Vincentia	6.7; 8.2.1.5; 8.2.2.1; Appendix 1
Support for sustainable seafood production	2.3, 8.2.1.6
Ensuring Jervis Bay produced seafood is accessible locally	8.2.1.6
Support for employment, training and research opportunities	8.2.1.6
Potential impact on sailing courses, opportunity to realign leases to avoid set courses	6.14.3; 8.1.7
Suggestion to provide advisory material re navigation around leases	8.1.7; 8.2.1.5
Appropriate marking of leases for day/night conditions	8.1.7
Advice required on access to leases for fishers/spearfishers/divers/boaters/kayakers/paddle-boarders and OHS implications	8.1.7; 8.2.1.5
Visual amenity	8.2.1.1

Potential impact on tourism industry	8.1.7; 8.2.1.1; 8.2.1.6
Leases presenting a navigational hazard	8.1.7
Against environmental impact, potential for benthic impact	8.1.1; 8.1.2; 8.2.2.1
Not support intensive (feeding) aquaculture in Jervis Bay	8.2.2.1
Not support use of Huskisson wharf for processing mussels	8.1.4, 8.2.2.9
Lease security and decommissioning	8.1.2; 8.1.5, 8.2.2.9
Translocation of stock and potential for importation of species/pests/diseases	8.2.2.2
Opportunity for shellfish predators to increase in numbers	8.2.2.7
Composition of the seafloor under leases – avoiding seagrass	8.1.1; 8.2.2.1
Entanglement of marine animals	8.2.2.4; Appendix 1
Potential impact from increased stock numbers – settlement, fouling and other impacts	8.1.2; 8.2.2.9; Appendix 1
Environmental monitoring procedures and independent testing/reporting	8.2.2.1; Appendix 1
Vessel access (shallow bar an issue) and whether any mangroves would be removed	8.1.4; 8.2.1.2
Land and sea approval should be one application	3.2; 3.10
Water quality impacts	8.2.2.1
Avoiding commercial fishing hauling grounds at the northern end of Jervis Bay	6.14.1; 8.1.7
Concern regarding Marine Park Zoning Plan and maximum area allowable (440 ha) for extensive aquaculture in Jervis Bay in existing legislation and impact on integrity of Marine Park	1; 3.2; 3.10
Re-alignment of leases to reduce impact on sailing	8.1.7
Local impact – potential for nett export of nutrients	8.2.2.1
Aquaculture should be focused on land based facilities for sustainable seafood production	3.2; 3.10
Impact on genetics of local shellfish stocks	8.2.2.2
Culture of local species	8.2.2.2
Use of Shoalhaven/Crookhaven River as an alternative site	3.2; 3.9.1; 3.10

Pressure for a marina may arise if project successful	3.2; 3.10; 8.1.4; 8.2.1.2
Support a drive-in drive-out approach from industrial estate	8.1.4; 8.2.1.2
Chemical use	8.2.2.9; Appendix 1
Use suspended longlines rather than floating longlines	3.5
Concern re increased boating traffic	8.2.1.2
Dredge harvest of shellfish not supported	3.2; 3.3.5; 3.5; 3.7
Support for local business development including tourism potential	8.2.1.6

Issues raised during statutory and non-statutory consultation will also be addressed in the draft Environmental Management Plan (Appendix 1).

6 THE EXISTING COASTAL ENVIRONMENT

6.1 Coastal Climate

The locality of Jervis Bay experiences a subtropical climate with mean maximum air temperatures ranging from 24.7˚C in January to 15.7˚C in July, while mean minimum air temperatures range from 18.6˚C in February and 9.8˚C in July. The highest average monthly rainfall for the region occurs in February (154.9 mm) and between May and July (119.1-127.1 mm), while the lowest rainfall occurs during August and September (49.9-61.2 mm) (Figure 20).

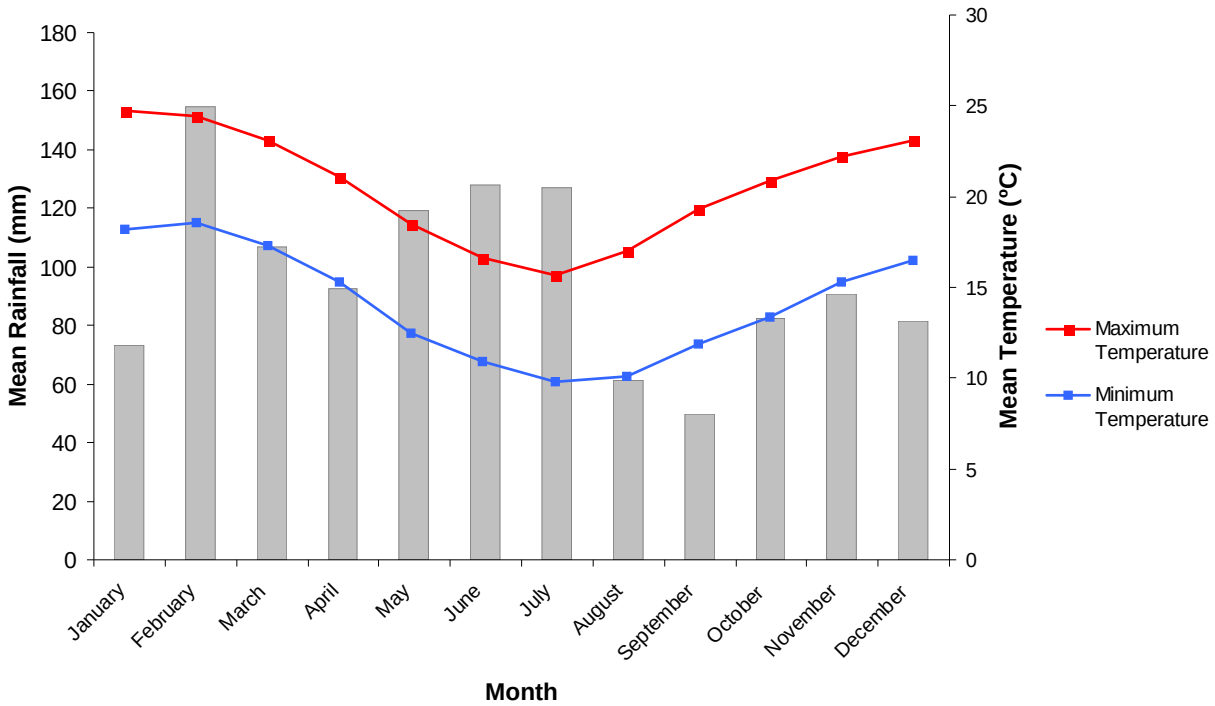

Figure 20: Mean monthly rainfall (2001-2011) and mean monthly maximum and minimum temperature (2001-2011) for Jervis Bay (Point Perpendicular AWS) (35.09˚S 150.80˚E) (Source: Bureau of Meteorology & Fisheries NSW, 2012).

Wind speed and direction vary noticeably from the morning to the afternoon. During spring and summer southerly and northerly breezes dominate the morning wind pattern while afternoon winds are predominately from the northeast and the south. During autumn and winter, westerly and north westerly winds prevail in the morning and southerly and westerly are characteristic of the afternoon.

Mean morning wind speed varies across the year with the greatest speed experienced during late autumn and winter (maximum 19.1 km/h in June) (Figure 21). Average wind speeds in the afternoons are greatest during spring and summer (maximum 22.5 km/h in November).

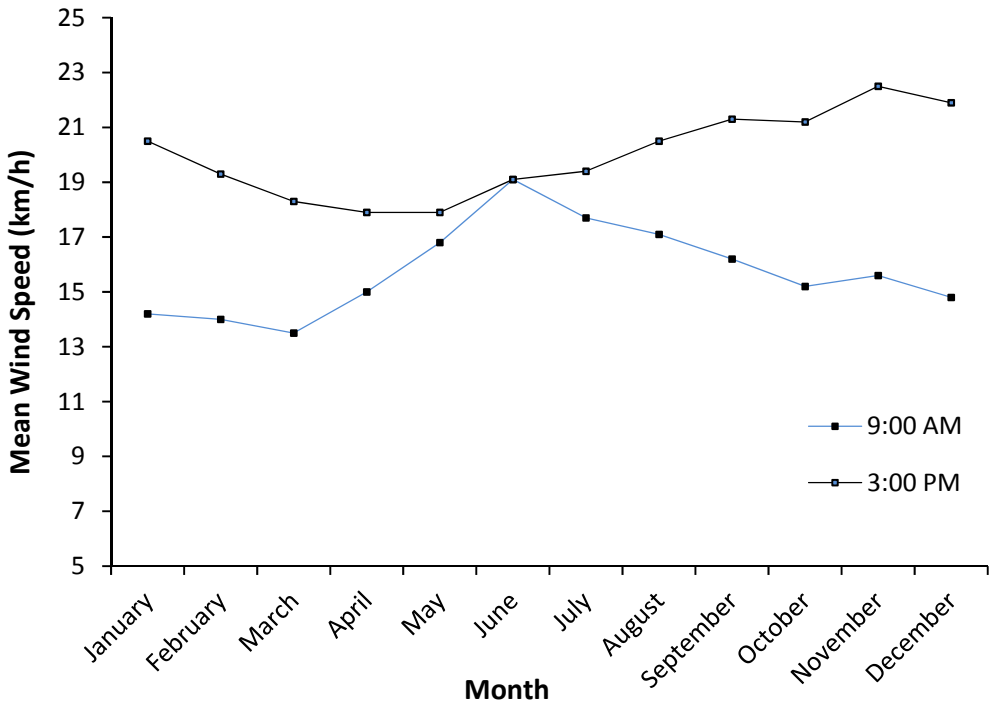

Figure 21: Mean monthly 9 am and 3 pm wind speed (1957-2004) for Jervis Bay (Point Perpendicular Lighthouse) (35.09S 150.80˚E) (Source: Bureau of Meteorology & Fisheries NSW, 2012).

Climate Change

Potential impacts of climate change include sea level rise, changes in seawater temperatures, increased frequency and severity of severe weather events and ocean acidification. Scenarios for NSW suggest that coastal temperatures may increase between 0.2 - 1.6° C by 2030 (Smith *et. al*., 2010) while sea level may rise by 0.18 – 0.91 m by 2090 – 2100 (NSW DECC, 2007b).

A number of serious consequences for coastal human communities, infrastructure and the marine environment are expected in the long-term as a result of these changes (Smith *et. al*., 2010).

6.2 Bathymetry

Jervis Bay is approximately 15 km (north-south) by 8 km (east-west) with a total area of 124 km^2 (Joyce *et al*., 2010). The bathymetry of Jervis Bay resembles a basin (Figure 22) with increasing depth from the coastline to the bay's centre which has a maximum depth of 35 m.

The entrance in the southeast corner is 3.5 km wide and is relatively deep (e.g. 40-50 m at the mouth). A maximum depth of about 65 m occurs near the eastern marine park boundary (NSW MP, 2010). The average depth across the bay is 15-25 m. The proposed leases are situated in waters with a depth of about 10 m.

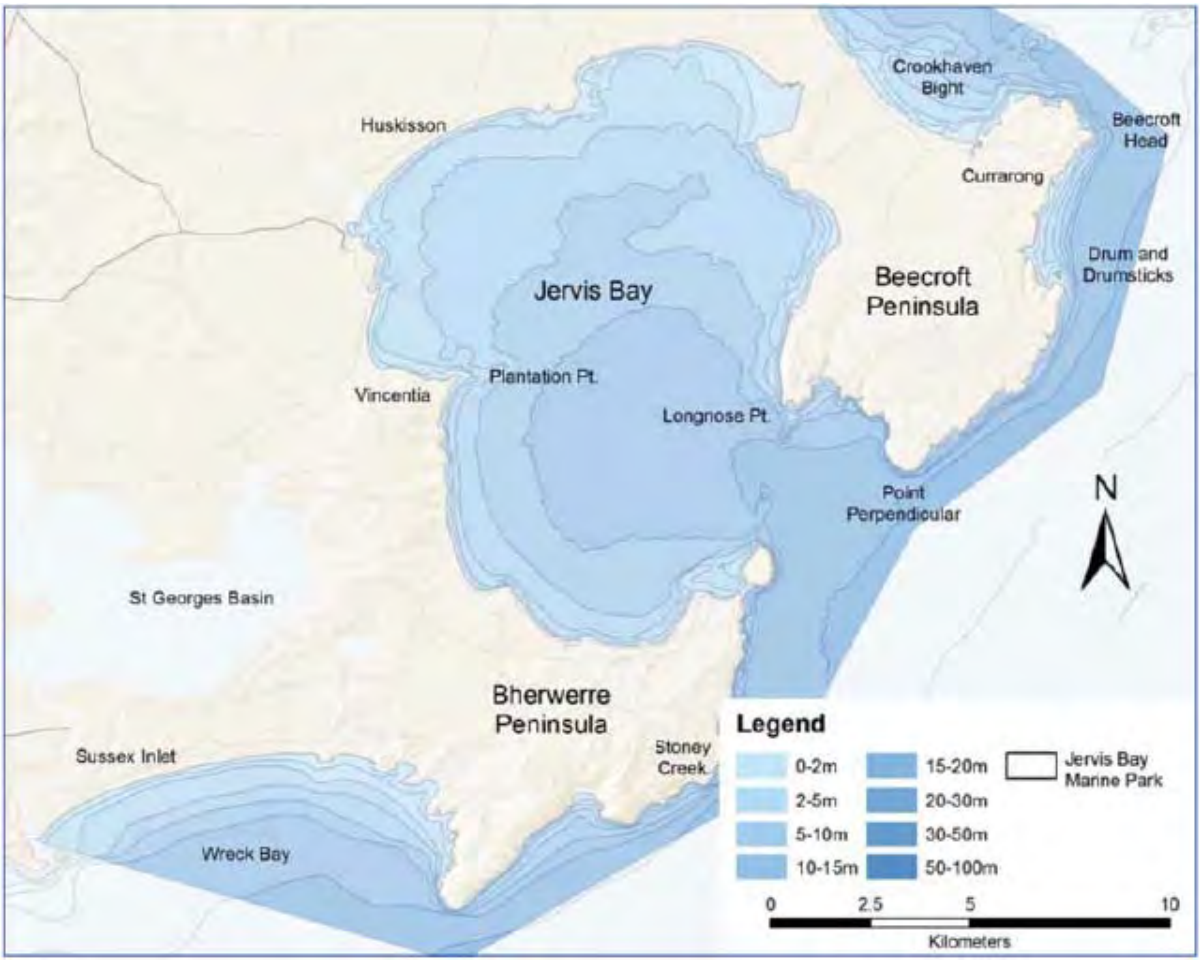

Figure 22: Broadscale bathymetry of JBMP (Source: NSW MP, 2008a).

6.3 Substrate Characteristics

Jervis Bay is situated within the southern part of the geological region known as the Sydney Basin (NSW MP, 2010). There are prominent rocky reef outcrops seaward of most headlands within the bay e.g. the reef off Plantation Point extends more than 1 km from the shore. Extensive subtidal rocky reefs are present outside the bay, with many offshore from Currarong Beach and Wreck Bay, as well as extending from the Bherwerre and Beecroft Peninsulas (NSW MP, 2010). Steep drop-offs, large boulders, caves and overhangs characterise the reefs extending from the north and south headlands.

Fine to medium grained sand is the dominant sediment type in Jervis Bay, which is well sorted due to reworking of the sediments by waves and currents (NSW MP, 2010). Due to stronger currents, the region around the bay entrance contains a higher proportion of coarser grained sediments (NSW MP, 2010). Up to 80% of the sediment is made up of carbonate debris. Sand dominated beaches are present on all foreshores in Jervis Bay and many are interspersed with rocky reefs and varying amounts of boulders, cobbles or pebbles. The sediment type changes from fine to medium through to muddy sand outside the bay at depths of about 60 m (NSW MP, 2010).

6.4 Hydrology

There is constant transportation of water into and out of the bay due to a circular flow that enters the bay on the southern side and discharges from the bay near the seabed on the northern side (Figure 23) (CSIRO, 1994). The hydrological processes in the bay are mainly driven by oceanic processes (e.g. currents).

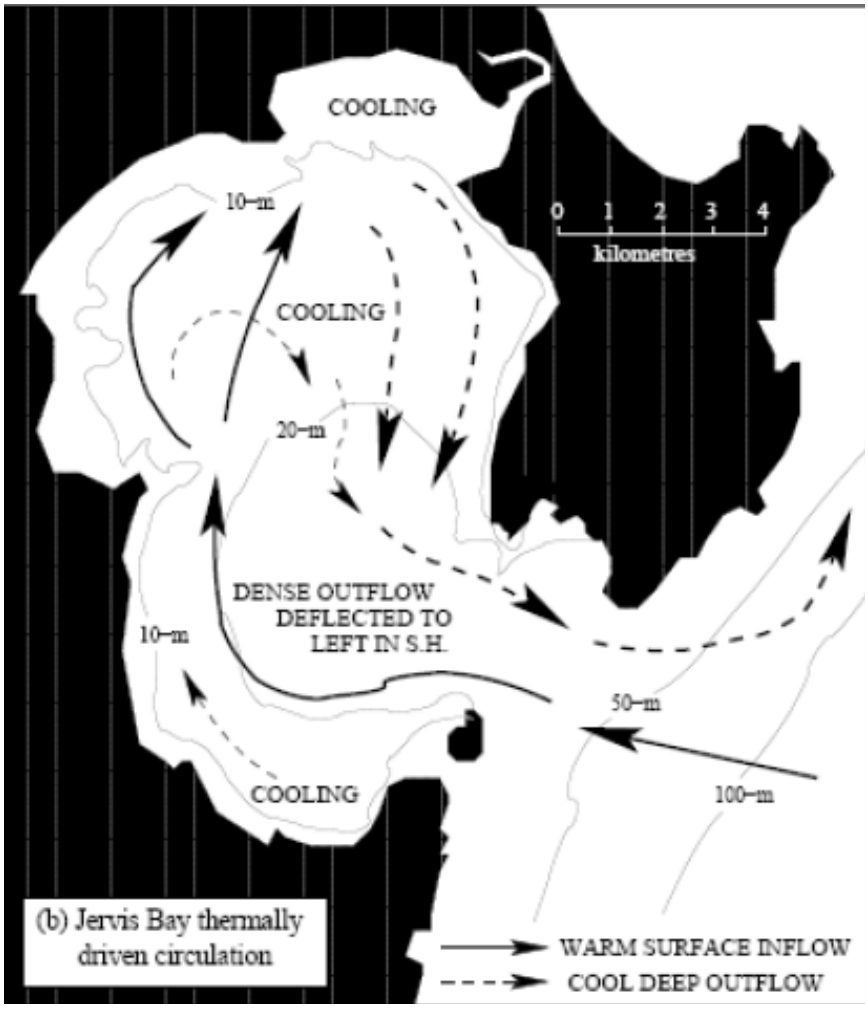

Figure 23: Thermally driven circulation within Jervis Bay (Source: England & Moore, 2005).

Current flows in Jervis Bay characteristically persist in one direction for long periods of time (e.g. several months). Water inflow at the mouth of Jervis Bay enters at about 0.2 m/s (England & Moore, 2005) while current speed inside the bay (around proposed lease areas) is around 0.5 cm/s but ranges from 0.3-12 cm/s (Holloway *et al*., 1989).

Overall thermohaline circulation, eddies, tidal processes and coastal trapped wave formation are considered the four main types of currents influencing water circulation in Jervis Bay (Joyce *et al*., 2010). Calculations of flushing times reveal that it takes 6 to 20 days for water to circulate the bay. The variations are caused by differences in the strength of the currents at the entrance of the bay, thermal stratification, varying depths and the shape of the bay (Holloway, 1995).

There are no major freshwater estuaries that flow into the bay but Currambene Creek is the main source of freshwater during periods of heavy rainfall (Joyce *et al*., 2010). During these events the water mass typically remains on the surface and there is no substantial mixing within the water column as it flows out of the bay. Thermal stratification is typically quite strong for most of the year. Surface to sea bed temperature differences can reach 5°C in summer (Holloway, 1995).

Jervis Bay is also affected by the East Australian Current (EAC) which flows southwards and Tasman Sea waters which move northwards (Joyce *et al*., 2010). These water masses alter ambient water temperatures at the mouth of Jervis Bay and the prevailing winds determine if currents enter the bay or extend along the shelf (Holloway *et al*., 1991 cited in Joyce *et al*., 2010).

6.5 Tides

Tides in the Jervis Bay region are semidiurnal (i.e. two high tides a day) and microtidal with a range of 2 m for spring tides. Tidal currents during ebb and flood flow are very weak with speeds of 0.07 m/s at the entrance of Jervis Bay and less than 0.01 m/s in the inner northern areas of the bay (Holloway *et al*., 1989). The weak tides means there is minimal net horizontal transport of water or dissolved material by the oscillatory tidal flow (Holloway, 1995).

6.6 Wave Climate

Waves travelling from deep water to the shallower areas may be transformed by the processes of refraction, shoaling, attenuation, reflection, breaking and diffraction (Demirbilek, 2002). At the depth of the proposed leases (about 10 m), the main wave transformation processes are likely to be refraction, shoaling, diffraction and reflection. Orbital velocities and accelerations in the water column below are also generated by waves.

Waves and swells in Jervis Bay are predominately from a southward direction with a wave period of 6-14 seconds (McCowan *et al.,* 1987 cited in Joyce *et al.,* 2010). Mean wave height ranges from 1-2 m and the maximum recorded wave height is 7 m (Brown *et al*., 1995). As energy enters at the mouth it is distributed along the circumference of the whole bay so wave energy is generally small (Joyce *et al.,* 2010).

6.7 Water Quality Characteristics

Jervis Bay is considered to have high levels of water quality and clarity. There are no major rivers that drain into the bay, there are no heavily disturbed or densely settled areas and there are no heavy industrial or commercial operations around the bay. There are also no major marine pest infestations within the bay.

Potential sources of nutrients within Jervis Bay include runoff off from the surrounding catchment (e.g. septic tanks and storm water), sewage plants and outfalls, offshore upwelling and groundwater discharges (Brown *et al.,* 1995).

The total catchment area of Jervis Bay is about 400 km^2 which is very small when compared to the large water area (i.e. 102 km^2) (West, 1987). The creeks and gullies that flow into the bay include: Telegraph Creek, Flat Rock Creek, Duck Gully, Blenheim Gully, Moona Moona Creek, Currambene Creek, Callala Creek, Carama Inlet, Duck Creek, Bream Creek, Aborigines Gully, Cal Creek, Gardeners Gully and Wowly Gully. Currambene Creek followed by Carama Inlet are the largest of the creek bodies (Cho, 1995).

During periods of wet weather and high runoff, considerable amounts of fine muds may enter the bay. The suspended material carried into the bay by Currambene Creek can be detected over 1 km from the mouth of the creek (CSIRO, 1993). Plumes of freshwater from Currambene Creek have been observed to extend as far as Point Perpendicular during high rainfall events - a distance of over 10 km. Much of the mud is thought to be transported directly out to sea due to the flushing rate in the bay and the relatively short distance to the mouth (Ward, 1995).

Prichard *et al*. (2003) found that the sea surface waters off the NSW coast typically have an oxidised nitrogen content of 10 µg/L and reactive phosphorus content of 8 µg/L. The deeper nutrient rich waters typically have an oxidised nitrogen content ranging from 70 to 140 µg/L and reactive phosphorus of content of 20 to 25µg/L. These nutrient rich deeper waters may occasionally reach the surface during upwelling events.

There are two tertiary treated sewerage discharge points that empty directly into Jervis Bay. These discharges points are primarily for emergency discharges and are located at Plantation Point and at HMAS Creswell. There is also an ocean outfall outside of the bay near Wreck Bay village (Jones *et al*., 1995). There are also a number of sewage pump stations in the Vincentia and Callala Bay areas which may in times of emergency also indirectly discharge into Jervis Bay.

There is also potential input of nutrients from groundwater discharges (Brown *et al*., 1995). The concentration of nitrogen in groundwater behind the dunes along the shoreline of Jervis Bay is high but the total amount of nutrients that groundwater contributes to the bay is unknown (Ward, 1995).

High concentrations of nutrients can result in excessive algal blooms in the bay. Phytoplankton biomass has been recorded at 163.4 ± 38.6 cells/ml on an incoming tide and 53.2 ±12.9 cells/ml on an outgoing tide (Cheong, 2004). Chlorophyll-a has been recorded at >3mg/m^3 at the surface and 1-2mg/m^3 at 10 m (Dela-Cruz *et al*., 2003). On an incoming tide,

zooplankton biomass has been recorded at 1316.4 ± 259.4 organisms/L, while on an outgoing tide it has been recorded at 444.9 ± 87.9 organisms/L (Cheong, 2004).

Turbidity within the bay is about 2.2 NTU during an incoming tide and about 2.3 NTU on an outgoing tide (Cheong, 2004). Dissolved oxygen levels are high but are slightly lower (i.e. < 80%) at the creeks, and pH is similar to that of seawater due to high flushing rates (Brown *et al.,* 1995).

The average salinity of the marine waters within Jervis Bay is 35.62 ‰ (Figure 24). Salinity within the bay remains relatively constant throughout the year except after periods of heavy rainfall when fresh water input lowers the salinity (Holloway, 1995).

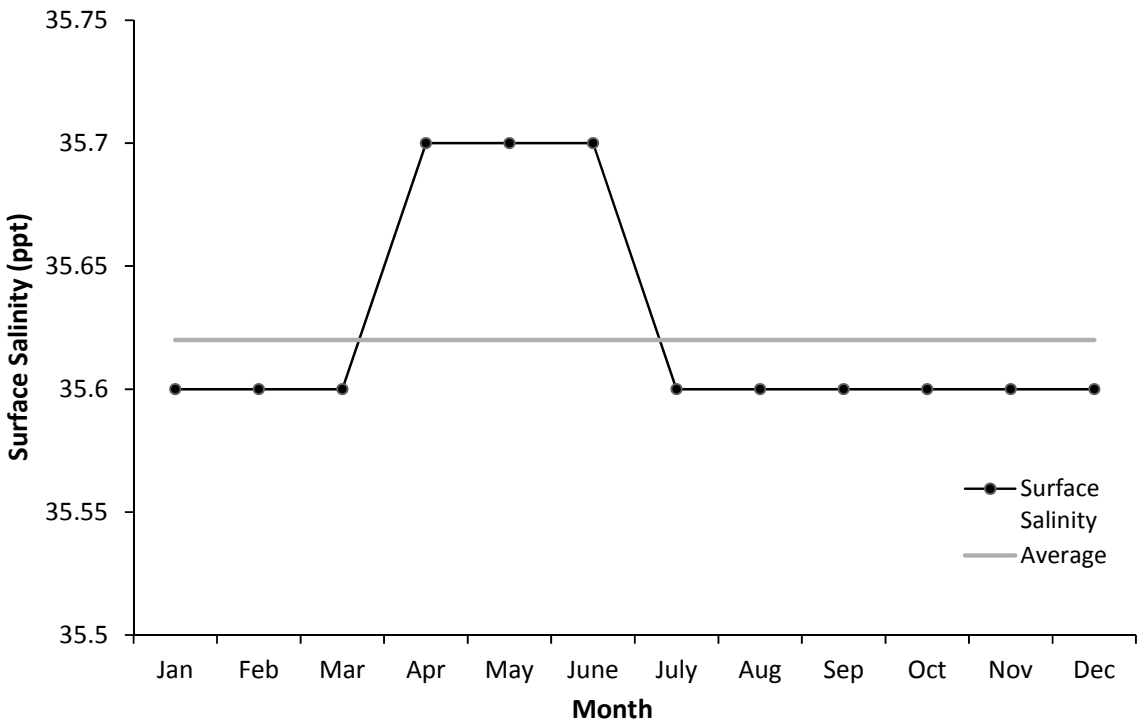

Figure 24: Monthly sea surface salinity averages for Jervis Bay (32.03˚S 150.44˚E) (Source: METOC, 2011; Fisheries NSW, 2012).

6.8 Sea Surface Temperature

Sea surface temperatures around the Jervis Bay region are highest during February with a monthly average of 22.1˚C, while 15.9˚C is the lowest mean sea surface temperature which was recorded for August (Figure 25).

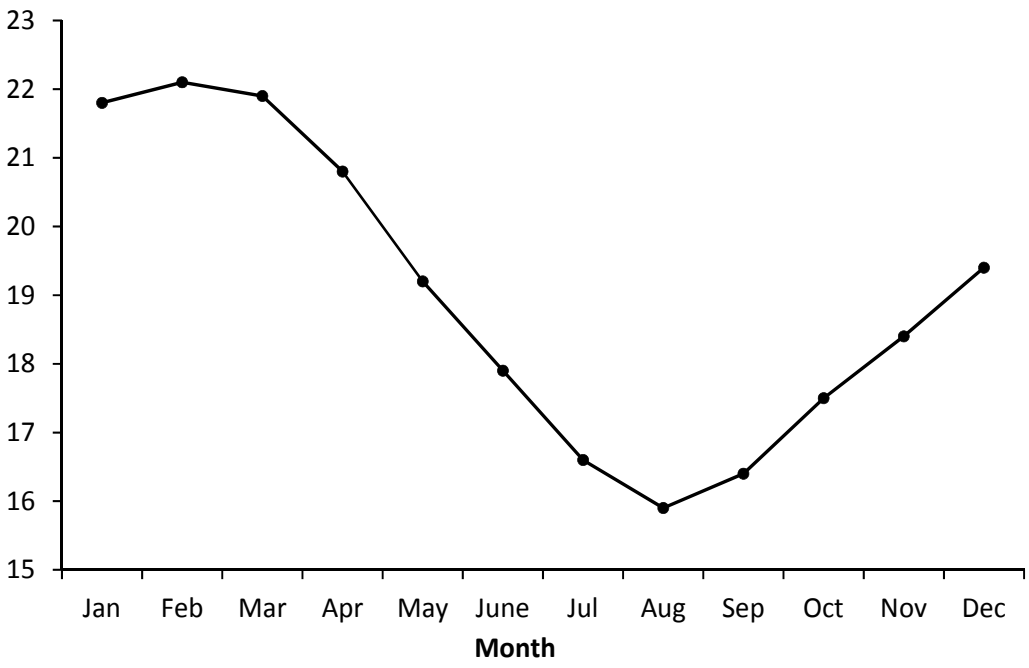

Figure 25: Monthly sea surface temperature averages for Jervis Bay (35.03˚S 150.44˚E) (Source: METOC & Fisheries NSW, 2012).

6.9 Benthic Habitats

A diverse range of habitats exist within the Jervis Bay Marine Park, including sandy beaches, mangroves, seagrass beds, intertidal rocky shores, subtidal rocky reefs, drift algae communities and soft substrate habitats (Figure 26) (Joyce *et al.,* 2010).

Underwood and Atkinson (1995) identified that several distinct habitats occur on the shallow reefs (i.e. depth < 20 m) in Jervis Bay, including the following:

- fringe habitat - occurs below low tide level to a depth of about 3 m and is dominated by brown, turfing and red algal species;
- kelp forest habitat - occurs at depths greater than 2 m and is characterised by a dense canopy of macroalgae and a understorey of algae and encrusting animals;
- barrens habitat - occurs at depths greater than 2 m and is devoid of macroalgae but is often covered with encrusting coralline algae and sessile invertebrates; and
- sponge habitat - occurs in the deeper sections of shallow reefs, particularly near walls, overhangs, caves and the understorey of macroalgae.

The benthic assemblages on intermediate depth reefs in the marine park are poorly known because few surveys have been conducted (NSW MP, 2010). However, in other temperate regions reefs at such depths include a broad range of sessile species such as sponges, ascidians, black corals, hydrozoans, gorgonians, bryozoans, soft corals and anemones.

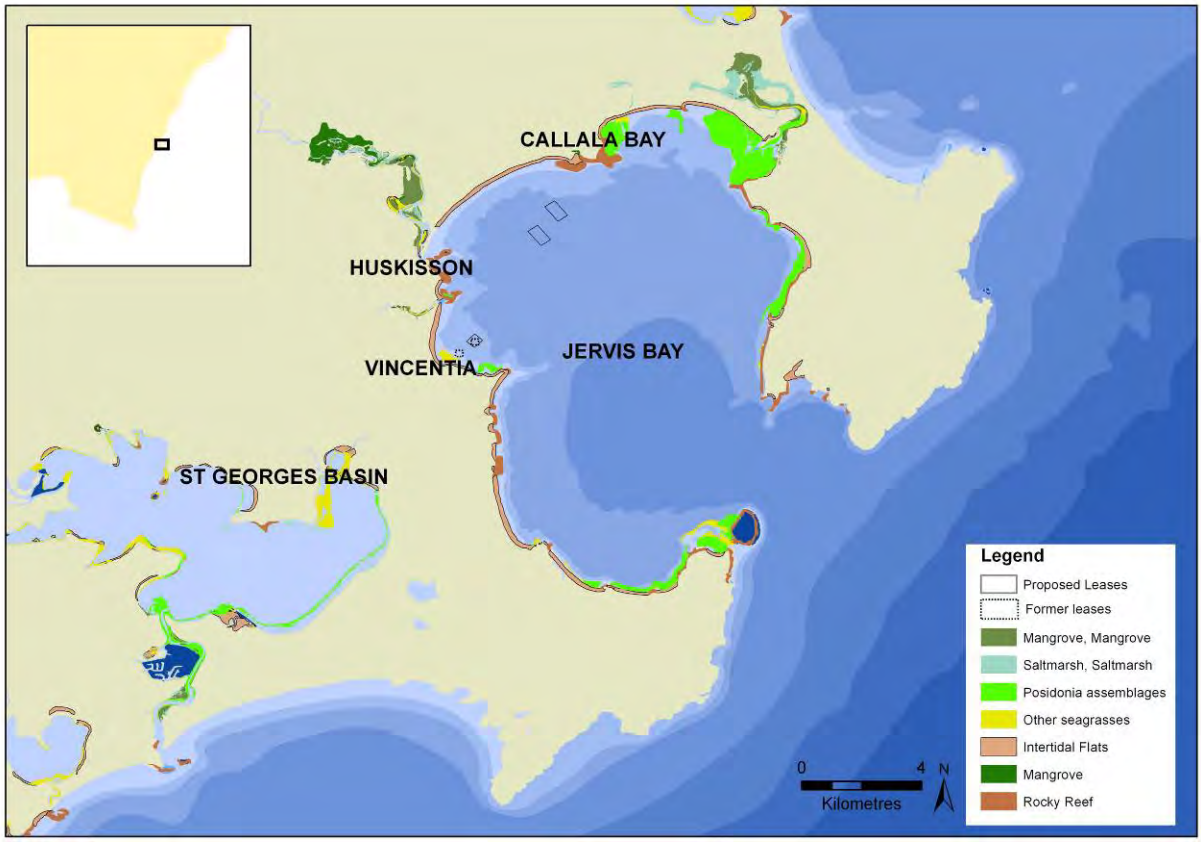

Figure 26: Benthic habitat types present within Jervis Bay. (Source: Fisheries NSW, 2012).

CSIRO (1994) identified five distinctive benthic assemblages (Figure 27) in Jervis Bay, including:

- wave rippled sand - consisting of small heart urchins (*Echinocardium cordatum*), corophiid amphipods and deposit-feeding polychaete worms (Anderson *et al*., 2009). Fewer urchins were present in the areas of coarser-grained sediments near the entrance to the bay;
- drift algae - consisting primarily of unattached banks of the red algae, *Gracilaria edulisor* and *Acrosorium venulosum*. Several other species of red algae (e.g. *Rhodymenia australis* and *Ceramium lentiforme*) can also bloom within the bay (Millar, 1995);
- bivalve clumps - consisting of algae and aggregates of sessile invertebrates dominated by Hairy Mussels (*Trychomya hirsuta*), and less commonly Native Oysters (*Ostrea angasi*) and several species of scallops (*Chlamys asperrima* and *C. bifrons*);
- polychaete hummocks - consisting of mounds of sediment surrounding dense aggregations of the polychaete, *Mesochaetopterus* sp. that form sand-encrusted tubes; and
- bioturbated sand.

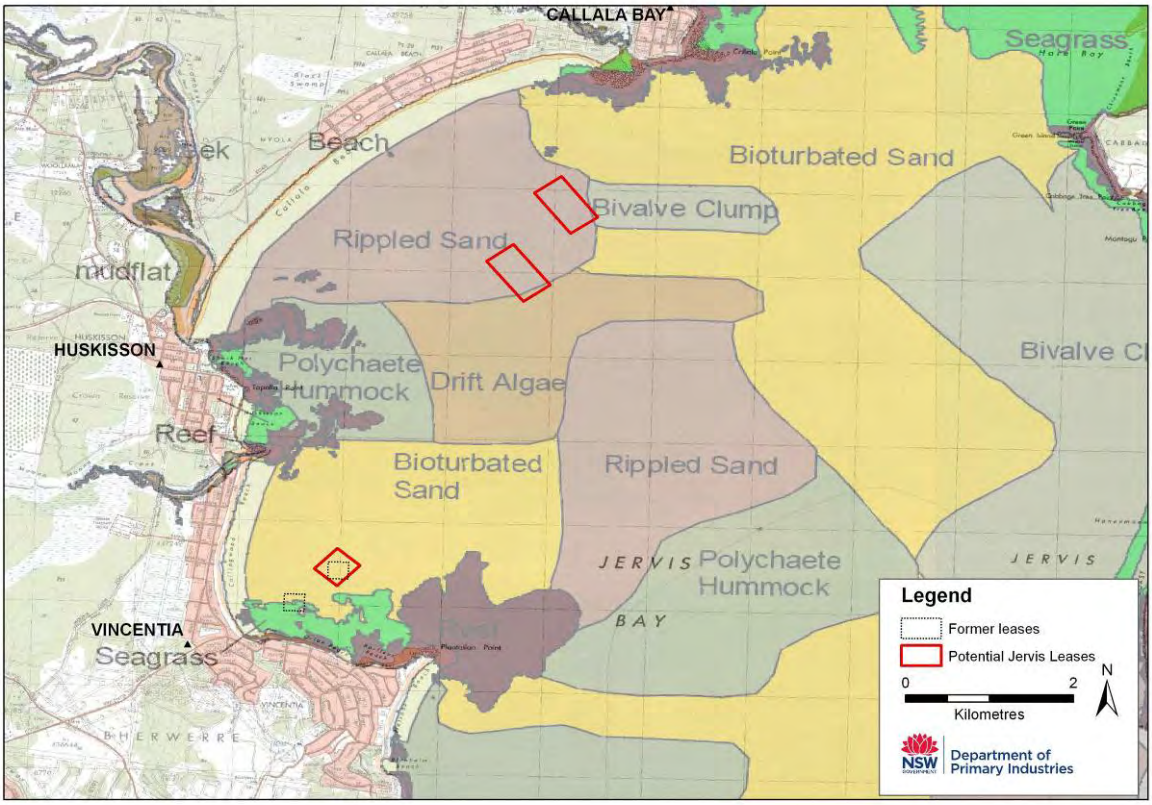

Figure 27: Benthic habitat types present within Jervis Bay (Source: CSIRO, 1994; Joyce *et al*., 2010).

Soft sediment benthic habitats in Jervis Bay are dominated by infaunal species such as crustaceans (e.g. amphipods), molluscs (e.g. gastropods and bivalves) and polychaetes (CSIRO, 1994). Other invertebrate groups that also occur in Jervis Bay include echinoderms, nemerteans, sipunculans and phoronids (Jacoby *et al*., 1995). The areas proposed for the aquaculture leases consist primarily of fine to medium grained sand and small cobble.

Other benthic animals recorded within Jervis Bay include seastars, sea pens, stingarees, Port Jackson Sharks, Fiddler Rays and a range of fish species, including: Bearded Cod, Eastern Red Scorpion Cod, Eastern Fortescue, Soldierfish, Long-spine Flathead, Half-banded Seaperch, Wood's Siphonfish, Yellow-tail Scad, Crested Weedfish, Little Weed Whiting, Pygmy Leatherjacket and Rough Leatherjacket (Jacoby *et al*., 1995).

Large expanses of seagrass habitat also occur throughout Jervis Bay in areas with a depth of about 2-12 m and within surrounding estuaries. At least four species of seagrass are found within the bay, including: eelgrass (*Zostera capricorni*), strapweed (*Posidonia australis*), Tasman grasswrack (*Heterozostera tasmanica)* and paddleweed *(Halophila ovalis*). Strapweed is restricted mostly to waters outside the estuaries. The largest seagrass beds are in Hare Bay, which is dominated by *Posidonia australis*, particularly around Carama Inlet along the shore between Green Island and Bindijine, at Callala Bay, and inside Plantation Point (Kirkman *et al*., 1995). There is considerable spatial variability in the density and biomass of *Posidonia australis* within individual beds and between bays (CSIRO, 1994).

6.10 Flora and Fauna

NSW BioNet Atlas

A total of 389 fauna species and 1117 flora species are listed in the NSW BioNet Atlas records (search conducted on 24 September 2012) in the locality of Jervis Bay (-34.95 N, 150.66 W 151.2 E, -35.35 S) (Appendix 3). Of the listed fauna species, there are 83 mammal species, 23 amphibian species, 26 reptile species and 257 bird species.

Ninety nine species are estimated to potentially inhabit or utilise the marine and/or estuarine environments of Jervis Bay, including six flora species, 20 mammal species (whales, dolphins and the dugong), five reptile species and 68 bird species, including seabirds, waders and intertidal species.

The six marine/estuarine flora species listed include the grey mangrove (*Avicennia marina subsp. australasica*), river mangrove (*Aegiceras corniculatum*), strapweed (*Posidonia australis*), paddleweed (*Halophila ovalis*), grasswrack (*Heterozostera tasmanica*), eelgrass (*Zostera capricorni*).

Marine mammal sightings include the southern right whale (*Eubalaena australis*), Australian fur seal (*Arctocephalus pusillus doriferus*), New Zealand fur seal (*Arctocephalus forsteri*), dwarf minke whale (*Balaenoptera acutorostrata*), blue whale (*Balaenoptera musculus*), humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), gray's beaked whale (*Mesoplodon grayi*), strap-toothed beaked whale (*Mesoplodon layardii*), common dolphin *(Delphinus delphis)*, dugong (*Dugong dugon)*, bottlenose dolphin (*Tursiops truncates*), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), leopard seal (*Hydrurga leptonyx*), risso's dolphin *(Grampus griseus)* and the killer whale *(Orcinus orca).*

The five marine reptiles listed for the region searched include the green turtle (*Chelonia mydas)*, leatherback turtle (*Dermochelys coriacea)*, unidentfied sea turtle (Cheloniidae sp.), hawkesbill turtle (*Eretmochelys imbricate*) and the yellow-bellied sea snake (*Pelamis platurus).* In addition, the loggerhead turtle (*Caretta caretta*) was not listed in the NSW BioNet Atlas but has been sighted in Jervis Bay waters.

In regards to the 68 bird species recorded, 41 species predominately inhabit and/or feed in the marine environment including storm petrels, terns, albatrosses, darters, the osprey, sea eagles, little penguins (*Eudyptula minor)*, cormorants, shearwaters, Australasian gannets (*Morus serrator*) and giant petrels. The remaining 22 bird species predominately inhabit and/or feed in the intertidal, sandflat and/or shoreline environment and include sandpipers, curlews, godwits, tattlers, whimbrels, turnstones, plovers, oystercatchers, herons and egrets.

6.11 Threatened and Protected Species, Populations and Communities (State Legislation)

State legislation relevant to threatened and protected species, populations and ecological communities includes the *Threatened Species Conservation Act 1995* (TSC Act), which protects all listed species except for fish and marine vegetation, which are protected under the *Fisheries Management Act 1994* (FM Act).

The NSW Office of Environment and Heritage Threatened Species Database (Web Reference 7) and the Department of Primary Industries – Threatened and Protected Species Listing (Web Reference 8) were searched for threatened species, populations and communities listed under relevant Schedules of the TSC Act and FM Act that are likely or predicted to occur in the study region.

The search was carried out in September 2012 and included species of marine fish, marine mammals, marine reptiles, marine algae/vegetation, marine invertebrates and seabirds. The threatened species search covered the Southern Rivers - marine zone Catchment Management Authority subregion. A precautionary approach was adopted where a broad-scale assessment of all threatened species that could potentially occur in the wider region was conducted to ensure all necessary species were considered. The results of the database search for the Southern Rivers - marine zone are listed in Table 5.

Species protected under the TSC Act and the FM Act potentially occurring in the Southern Rivers marine zone included:

- the ‘presumed extinct’ Green Sawfish (*Pristis zijsron);*
- the ‘critically endangered’ Greynurse Shark *Carcharias taurus);*
- the ‘endangered’ Scalloped Hammerhead (*Sphyrna lewini*);
- the ‘endangered’ blue whale (*Balaenoptera musculus);*
- the 'endangered' southern right whale (*Eubalaena australis*);
- the ‘endangered’ dugong (*Dugong dugon);*
- the ‘endangered’ Southern Bluefin Tuna (*Thunnus maccoyii);*
- the ‘endangered’ loggerhead turtle (*Caretta caretta*);
- the 'endangered' leatherback turtle (*Dermochelys coriacea);*
- the ‘critically endangered’ beach stone-curlew (*Esacus neglectus*);
- the ‘endangered’ little tern (*Sterna albifrons*);
- the ‘endangered’ pied oystercatcher (*Haematopus longirostris*);
- the ‘endangered’ southern giant petrel (*Macronectes giganteus*);
- the ‘endangered’ wandering albatross (*Diomedea exulans*);

- the ‘endangered’ curlew sandpiper (*Calidris ferruginea*);
- 33 species were listed as ‘vulnerable’ under the TSC Act (excluding terrestrial species), which were mainly seabirds but also included New Zealand fur seals (*Arctocephalus forsteri*), Australian fur seals (*Arctocephalus pusillus*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*) and green turtles (*Chelonia mydas*);
- three species were listed as 'vulnerable' under the FM Act, including the Black Rockcod (*Epinephelus daemelii*), the White Shark (*Carcharodon carcharias*) and the Great Hammerhead (*Sphyrna mokarran*); and
- 43 species were identified as ‘protected’ under the FM Act, including the Goldspotted Rockcod (*Epinephelus coioides*), Elegant Wrasse (*Anampses elegans)*, Giant Queensland Groper *Epinephelus lanceolatus),* Bluefish *(Girella cyanea*), Eastern Blue Devil Fish (*Paraplesiops bleekeri)*, Herbsts Nurse Shark (*Odontaspis ferox*) and 37 species of syngnathiforms (i.e. seahorses, pipefish, pipehorses, ghost pipefish, seamoths and seadragons), notably the Weedy Seadragon (*Phyllopteryx taeniolatus*).

Table 5: Threatened and protected species listed under the TSC Act (1995), FM Act (1994) and EPBC Act (1999) that may occur in the Jervis Bay region.

Latin Name(s)	Common Name(s)	FM Act / TSC Listing	EPBC Listing			
			Status	Migratory Species	Listed Marine Species	Cetacean and Other
Birds						
Albatross						
Diomedea (exulans) amsterdamensis	Amsterdam Albatross		E	✓	✓	
Diomedea antipodensis	Antipodean Albatross	V	V	✓	✓	
Diomedea dabbenena/exulans exulans	Tristan Albatross		E	✓	✓	
Diomedea exulans (sensu lato)	Wandering Albatross	E	V	✓	✓	
Diomedea exulans gibsoni	Gibson's Albatross	V	V	✓	✓	
Phoebetria fusca	Sooty Albatross	V			✓	
Thalassarche (melanophris) impavida	Campbell Albatross		V	✓		
Thalassarche bulleri	Buller's Albatross		V	✓	✓	
Thalassarche cauta cauta	Shy Albatross, Tasmanian Shy Albatross	V	V	✓	✓	
Thalassarche cauta salvini	Salvin's Albatross		V	✓	✓	
Thalassarche cauta steadi	White-capped Albatross		V	✓	✓	
Thalassarche melanophris	Black-browed Albatross	V	V	✓	✓	
Thalassarche chrysostoma	Grey-headed Albatross		E	✓	✓	
Thalassarche eremita	Chatham Albatross		E	✓	✓	
Petrels and Shearwaters						
Calonectris / Puffinus leucomelas,	Streaked Shearwater			✓	✓	
Macronectes giganteus	Southern Giant-Petrel	E	E	✓	✓	
Macronectes halli	Northern Giant-Petrel	V	V	✓	✓	
Pterodroma leucoptera leucoptera	Gould's Petrel	V	E	✓		
Pterodroma neglecta neglecta	Kermadec Petrel (western)	V	V			
Pterodroma nigripennis	Black-winged Petrel	V			✓	
Pterodroma solandri	Providence Petrel	V		✓	✓	
Puffinus assimilis	Little Shearwater	V			✓	
Puffinus carneipes Ardenna carneipes	Flesh-footed Shearwater	V		✓	✓	
Puffinus griseus	Sooty Shearwater			✓	✓	
Puffinus pacificus	Wedge-tailed Shearwater			✓	✓	
Puffinus tenuirostris	Short-tailed Shearwater			✓	✓	
Stormpetrels						
Fregetta grallaria grallaria	White-bellied Storm Petrel	V	V			
Gulls and Terns						
Catharacta skua	Great Skua				✓	

Gygis alba	White Tern	V			✓	
Procelsterna cerulean	Grey Ternlet	V			✓	
Sterna albifrons	Little Tern	E		✓	✓	
Onychoprion fuscata	Sooty Tern	V			✓	
Sternula nereis nereis	Fairy Tern		V			
Birds of Prey						
Pandion cristatus (haliaetus)	Eastern Osprey	V		✓	✓	
Shorebirds						
Calidris alba	Sanderling	V		✓	✓	
Calidris tenuirostris	Great Knot	V		✓	✓	
Charadrius leschenaultii	Greater Sand-plover	V		✓	✓	
Charadrius mongolus	Lesser Sand-plover	V		✓	✓	
Esacus neglectus	Beach Stone-curlew	C E			✓	
Haematopus fuliginosus	Sooty Oystercatcher	V				
Haematopus longirostris	Pied Oystercatcher	E				
Limicola falcinellus	Broad-billed Sandpiper	V		✓	✓	
Limosa limosa	Black-tailed Godwit	V		✓	✓	
Xenus cinereus	Terek Sandpiper	V		✓	✓	
Ardea alba	Great Egret, White Egret			✓	✓	
Ardea ibis	Cattle Egret			✓	✓	
Calidris ferruginea	Curlew Sandpiper	E		✓	✓	
Arenaria interpres	Ruddy Turnstone			✓	✓	
Calidris acuminata	Sharp-tailed Sandpiper			✓	✓	
Calidris canutus	Red Knot, Knot			✓	✓	
Calidris melanotos	Pectoral Sandpiper				✓	
Calidris ruficollis	Red-necked Stint			✓	✓	
Charadrius bicinctus	Double-banded Plover			✓	✓	
Charadrius veredus	Oriental Plover, Oriental Dotterel			✓	✓	
Gallinago hardwickii	Latham's Snipe, Japanese Snipe			✓	✓	
Heteroscelus brevipes	Grey-tailed Tattler			✓	✓	
Limosa lapponica	Bar-tailed Godwit			✓	✓	
Numenius madagascariensis	Eastern Curlew			✓	✓	
Numenius minutus	Little Curlew, Little Whimbrel			✓	✓	
Numenius phaeopus	Whimbrel			✓	✓	
Pluvialis fulva	Pacific Golden Plover			✓	✓	
Rostratula benghalensis (sensu lato)	Painted Snipe			✓	✓	
Rostratula australis	Australian Painted Snipe	E	V			
Tringa glareola	Wood Sandpiper			✓	✓	

Tringa stagnatilis	Marsh Sandpiper, Little Greenshank			✓	✓	
Charadrius ruficapillus	Red-capped Plover				✓	
Gallinago megala	Swinhoe's Snipe			✓	✓	
Gallinago stenura	Pin-tailed Snipe			✓	✓	
Himantopus himantopus	Black-winged Stilt				✓	
Thinornis rubricollis	Hooded Plover	CE			✓	
Tropicbirds						
Phaethon rubricauda	Red-tailed Tropicbird	V			✓	
Boobies						
Sula dactylatra	Masked Booby	V		✓	✓	
Swifts						
Apus pacificus	Fork-tailed Swift			✓	✓	
Penguins						
Eudyptula minor	Little Penguin				✓	
Terrestrial Birds						
Haliaeetus leucogaster	White-bellied Sea-Eagle			✓	✓	
Hirundapus caudacutus	White-throated Needletail			✓	✓	
Merops ornatus	Rainbow Bee-eater			✓	✓	
Monarcha melanopsis	Black-faced Monarch			✓	✓	
Myiagra cyanoleuca	Satin Flycatcher			✓	✓	
Neophema chrysogaster	Orange-bellied Parrot	CE	CE	✓	✓	
Rhipidura rufifrons	Rufous Fantail			✓	✓	
Xanthomyza phrygia, Anthochaera phrygia	Regent Honeyeater	CE	E	✓		
Lathamus discolor	Swift Parrot	E	E		✓	
Botaurus poiciloptilus	Australasian Bittern	E	E			
Dasyornis brachypterus	Eastern Bristlebird	E	E			
Amphibians						
Heleioporus australiacus	Giant Burrowing Frog	V	V			
Litoria aurea	Green and Golden Bell Frog	E	V			
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V			
Fish						
Marine Fish						
Anampses elegans	Elegant wrasse	P				
Epinephelus coioides	Goldspotted Rockcod	P				
Epinephelus daemelii	Black Rockcod	V	V			
Epinephelus lanceolatus	Giant Queensland groper	P				
Girella cyanea	Bluefish	P				

Paraplesiops bleekeri	Eastern blue devil fish	P				
Diadromous Fish						
Prototroctes maraena	Australian Grayling	P	V			
Freshwater Fish						
Macquaria australasica	Macquarie Perch	E	E			
All Syngnathiformes						
6 Seahorses including						
Hippocampus abdominalis	Bigbelly, Eastern or New Zealand Potbelly Seahorse	P			✓	
Hippocampus whitei	White's, Crowned or Sydney Seahorse	P			✓	
Hippocampus breviceps	Short-head Seahorse, Short-snouted Seahorse	P			✓	
19 Pipefish including						
Festucalex cinctus	Girdled Pipefish	P			✓	
Filicampus tigris	Tiger Pipefish	P			✓	
Heraldia nocturna	Upside-down Pipefish	P			✓	
Hippichthys penicillus	Beady Pipefish, Steep-nosed Pipefish	P			✓	
Histiogamphelus briggsii	Crested Pipefish, Briggs' Crested Pipefish, Briggs'	P			✓	
Lissocampus runa	Javelin Pipefish	P			✓	
Maroubra perserrata	Sawtooth Pipefish	P			✓	
Notiocampus ruber	Red Pipefish	P			✓	
Stigmatopora argus	Spotted Pipefish, Gulf Pipefish	P			✓	
Stigmatopora nigra	Widebody, Wide-bodied or Black Pipefish	P			✓	
Syngnathoides biaculeatus	Double-end(ed) or Alligator Pipefish	P			✓	
Trachyrhamphus bicoarctatus	Bentstick, Bend Stick or, Short-tailed Pipefish	P			✓	
Urocampus carinirostris	Hairy Pipefish	P			✓	
Vanacampus margaritifer	Mother-of-pearl Pipefish	P			✓	
Cosmocampus howensis	Lord Howe Pipefish	P			✓	
Kimblaeus bassensis	Trawl Pipefish, Bass Strait Pipefish	P			✓	
Vanacampus phillipi	Port Phillip Pipefish	P			✓	
4 Ghost pipefish including						
Solenostomus cyanopterus	Robust or Blue-finned Ghost Pipefish	P			✓	
Solenostomus paegnius	Rough-snout Ghost Pipefish	P			✓	
Solenostomus paradoxus	Ornate, Harlequin or Ornate Ghost Pipefish	P			✓	
5 Pipehorses including						
Acentronura tentaculata	Shortpouch Pygmy Pipehorse	P			✓	
Solegnathus spinosissimus	Spiny or Australian Spiny Pipehorse	P			✓	
1 Seadragon						

Phyllopteryx taeniolatus	Weedy Seadragon	P			✓	
2 Seamoths						
Eurypegasus draconis	Short-bodied little dragon fish	P				
Pegasus volitans	Slender Seamoth	P				
Sharks						
Carcharias taurus	Greynurse Shark	CE	C E			
Carcharodon carcharias	White Shark	V	V	✓		
Pristis zijsron	Green Sawfish	Extinct	V			
Rhincodon typus	Whale Shark		V	✓		
Sphyrna mokarran	Great Hammerhead	V				
Sphyrna lewini	Scalloped Hammerhead	E				
Lamna nasus	Porbeagle, Mackerel Shark			✓		
Mammals						
Seals						
Arctocephalus forsteri	New Zealand Fur Seal	V			✓	
Arctocephalus pusillus	Australian Fur Seal	V			✓	
Whales and Dolphins						
Balaenoptera acutorostrata	Minke Whale					✓
Balaenoptera bonaerensis	Antarctic Minke Whale			✓		✓
Balaenoptera edeni	Bryde's Whale			✓		✓
Balaenoptera musculus	Blue Whale	E	E	✓		✓
Caperea marginata	Pygmy Right Whale			✓		✓
Berardius arnuxii	Arnoux's Beaked Whale					✓
Delphinus delphis	Common Dolphin or Short-beaked Common Dolphin					✓
Eubalaena australis	Southern Right Whale	E	E	✓		✓
Grampus griseus	Risso's Dolphin, Grampus					✓
Globicephala macrorhynchus	Short-finned Pilot Whale					✓
Globicephala melas	Long-finned Pilot Whale					✓
Lagenorhynchus obscurus	Dusky Dolphin			✓		✓
Megaptera novaeangliae	Humpback Whale	V	V	✓		✓
Orcinus orca	Killer Whale, Orca			✓		✓
Physeter macrocephalus	Sperm Whale	V		✓		✓
Kogia breviceps	Pygmy Sperm Whale					✓
Kogia simus	Dwarf Sperm Whale					✓
Lissodelphis peronii	Southern Right Whale Dolphin			✓		✓
Mesoplodon bowdoini	Andrew's Beaked Whale					✓
Mesoplodon densirostris	Blainville's Beaked Whale, Dense-beaked					✓

	Whale					
Mesoplodon hectori	Hector's Beaked Whale					✓
Mesoplodon layardii	Strap-toothed Beaked Whale					✓
Mesoplodon mirus	True's Beaked Whale					✓
Pseudorca crassidens	False Killer Whale					✓
Ziphius cavirostris	Cuvier's Beaked Whale, Goose-beaked Whale					✓
Tursiops aduncus	Indian Ocean or Spotted Bottlenose Dolphin					✓
Tursiops truncatus s. str.	Bottlenose Dolphin					✓
Sirens						
Dugong dugon	Dugong	E		✓	✓	✓
Terrestrial Mammals						
Chalinolobus dwyeri	Large-eared Pied Bat, Large Pied Bat	V	V			
Dasyurus maculatus maculatus	Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	V	E			
Isoodon obesulus obesulus	Southern Brown Bandicoot (Eastern)	E	E			
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V			
Phascolarctos cinereus	Koala	V	V			
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	V	V			
Pseudomys novaehollandiae	New Holland Mouse		V			
Pteropus poliocephalus	Grey-headed Flying-fox	V	V			
Reptiles						
Marine Reptiles						
Caretta caretta	Loggerhead Turtle	E	E	✓	✓	
Chelonia mydas	Green Turtle	V	V	✓	✓	
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle, Luth	E	E	✓	✓	
Eretmochelys imbricata	Hawksbill Turtle		V	✓	✓	
Natator depressus	Flatback Turtle		V	✓	✓	
Terrestrial Reptiles						
Hoplocephalus bungaroides	Broad-headed Snake	E	V			
Terrestrial Plants						
Caladenia tessellata	Thick-lipped Spider-orchid, Daddy Long-legs	E	V			
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V			
Genoplesium vernale	East Lynne Midge-orchid	V	V			
Melaleuca biconvexa	Biconvex Paperbark	V	V			
Prasophyllum affine	Jervis Bay Leek Orchid, Culburra Leek-orchid, Kinghorn Point Leek-orchid	E	E			
Prostanthera densa	Villous Mintbush	V	V			

Pterostylis gibbosa	Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood	E	E			
Pterostylis sp. Flat Rock Creek	Spring Tiny Greenhood	E	C E			
Rhizanthella slateri	Eastern Underground Orchid	V	E			
Syzygium paniculatum	Magenta Lilly Pilly, Magenta Cherry, Pocket-less Brush Cherry, Scrub Cherry, Creek Lilly Pilly,Brush Cherry	E	V			
Thesium australe	Austral Toadflax, Toadflax	V	V			
Triplarina nowraensis	Nowra Heath-myrtle	E	E			

Note: V = vulnerable, E = endangered, CE = critically endangered and P = protected.

= The TSC Act and FM Act species listings were cross-referenced with the EPBC Act species listings. Some species were listed in the State search results for example, also were listed under the EPBC Act but did not appear in the EPBC Protected Matters search results for the Jervis Bay region. Hence, the highlighted boxes indicate the State or Commonwealth listing of that particular species that was not detected in the search results. The species profile assessments (both State and Commonwealth) will be conducted on the species listed in the search results. Additional species may be assessed (those highlighted) if considered appropriate.

6.12 Matters of National Environmental Significance (Commonwealth Legislation)

The proposed Commercial Shellfish Aquaculture Leases will be assessed with reference to the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) and according to the EPBC Act Policy Statement 1.1 (Significant Impacts Guideline 1.1) in conjunction with EPBC Act Policy Statement 2.2 (Offshore Aquaculture).

The EPBC Act Protected Matters Search Tool (Web Reference 9) generated a summary of matters of National Environmental Significance (NES) which may relate to or occur in the area of the proposed Commercial Shellfish Aquaculture Leases. The Protected Matters Search Tool was consulted on 25th September 2012 using the 'Report by Coordinates' option which involved the use of a geographical coordinate (35.109798S 150.781059E) within Jervis Bay and a 20 km buffer zone (i.e. total area searched = 314 km^2). The search results (See Appendix 8) included a range of marine, intertidal and terrestrial fish, bird, mammal, reptile, amphibian and plant species which are listed under the following classifications:

63 Listed Threatened Species

- 3 'critically endangered', including:
  - 1 terrestrial bird;
  - 1 terrestrial plant;
  - 1 marine animal;
- 21 'endangered', including:
  - 6 terrestrial animals;
  - 4 terrestrial plants;
  - 1 freshwater fish;
  - 10 marine animals;
- 39 'vulnerable', including:
  - 7 terrestrial animals;
  - 7 terrestrial plants;
  - 3 amphibians;
  - 1 freshwater fish;
  - 21 intertidal/marine animals.

76 Migratory Species

- 22 marine birds;
- 28 intertidal and/or wading birds;
- 8 terrestrial birds;

- 10 marine mammals;
- 3 sharks; and
- 5 reptiles.

92 Listed Marine Species

- 5 marine reptiles;
- 2 fur seals;
- 1 dugong;
- 22 marine birds;
- 32 intertidal and/or wading birds;
- 9 terrestrial birds; and
- 21 syngnathiforms.

27 Whales and Other Cetaceans

- 6 dolphins and
- 21 whales.

Other matters protected by the EPBC Act, some of NES, detected for the area searched included (Figure 28):

- 1 Commonwealth Marine Area;
- 1 Listed Threatened Ecological Communities
    - Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (Critically Endangered)
- 4 Commonwealth Land listings, including:
    - Australian Telecommunications Commission
    - Booderee National Park
    - Defence Housing Authority
    - Defence - Beecroft Rapier Range
- 11 Commonwealth Heritage Places;
    - Beecroft Peninsula (Natural)
    - Jervis Bay Territory (Indigenous)
    - Crocodile Head Area (Indigenous)
    - Currarong Rockshelters Area (Indigenous)
    - Cape St George Lighthouse Ruins and Curtilage (Historic)
    - Christians Minde Settlement (Historic)

    - Jervis Bay Botanic Gardens (Historic)
    - Point Perpendicular Lightstation (Historic)
    - Royal Australian Naval College (Historic)
    - Hive Survivor Camp (Historic)
    - Jervis Bay Fishing Heritage Area
- 2 Commonwealth Reserves;
    - Booderee
    - Booderee Botanic Gardens
- 2 State and Territory Reserves;
    - Jervis Bay
    - Woollambia
- 1 Regional Forest Agreement;
- 5 Nationally Important Wetlands
    - Beecroft Peninsula
    - Jervis Bay
    - Jervis Bay Sea Cliffs
    - St Georges Basin
    - Wollumboola Lake

No World Heritage properties, National Heritage Places, Wetlands of International Significance (Ramsar), Commonwealth Marine Areas or Threatened Ecological Communities were found on or adjacent to the location of the proposed leases.

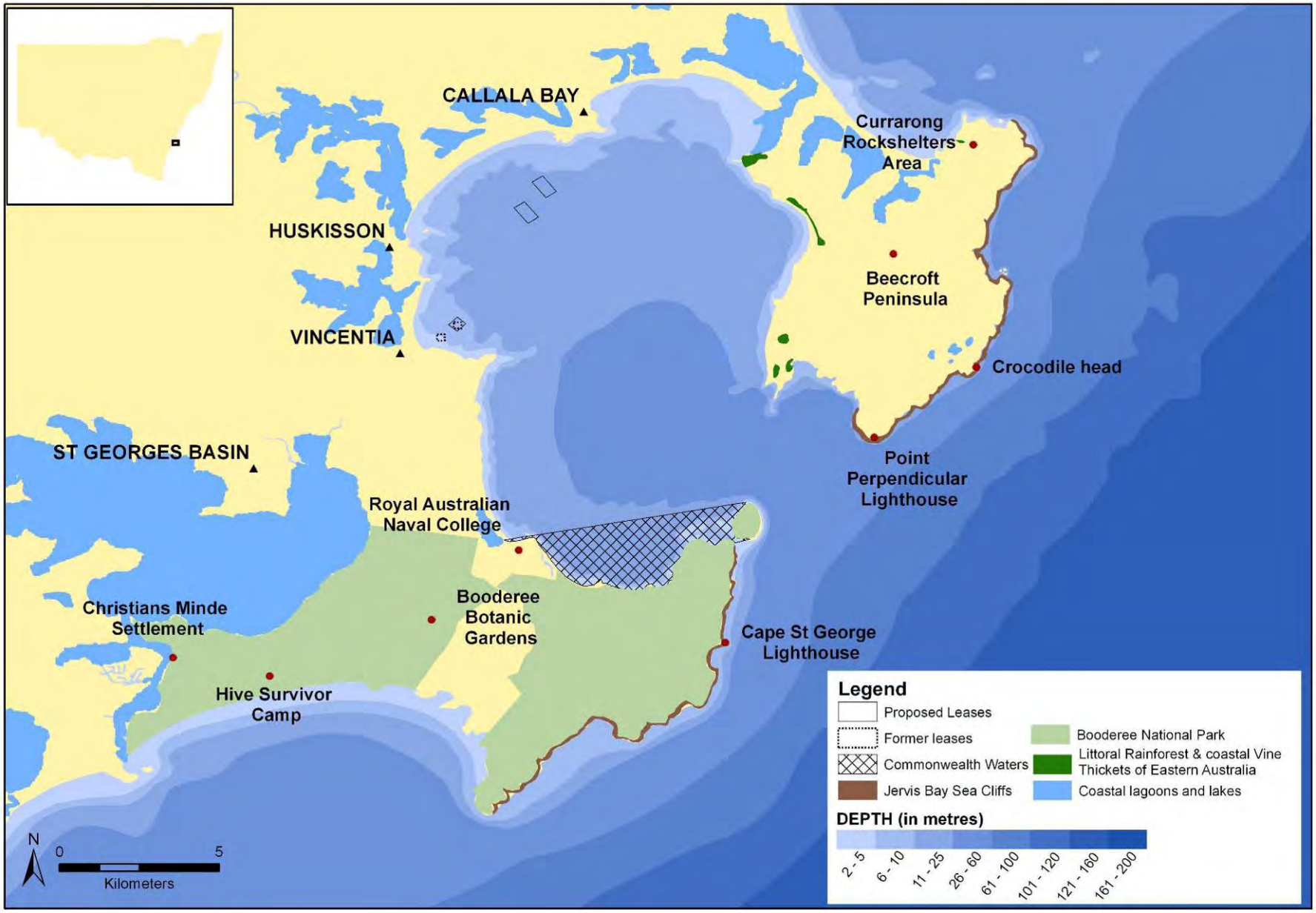

Figure 28: Location of some of the matters protected by the EPBC Act (Source: Fisheries NSW, 2012).

6.13 Areas of Conservation Significance

For the purpose of this EIS, areas of conservation significance include Marine Protected Areas, Ramsar wetlands, national parks, nature reserves and areas of critical habitat declared under the TSC Act and FM Act. Marine parks are areas of marine waters and lands permanently set aside to protect the biological diversity of our marine animals and plants, and to provide protection for unique and representative areas. Marine parks are zoned for multiple uses such as recreation, fishing and tourism (Web Reference 10).

Aquatic reserves have been established to provide representative samples of marine life and habitats, and protect biodiversity. Aquatic reserves are generally small compared with marine parks but play a significant role by protecting vulnerable and threatened species, important habitat and nursery areas and have research and educational roles (Web Reference 10).

National parks and nature reserves are areas of predominantly untouched land in a natural condition and are considered to have high conservation value. The primary purpose is to protect and conserve unique, outstanding or representative ecosystems, native animal and plant species or natural phenomena (Web Reference 10). National parks and nature reserves are generally terrestrial but there are some with associated marine components.

The Jervis Bay Marine Park (JBMP) extends from Kinghorn Point in the north to Sussex Inlet in the south from the mean high water mark to approximately 1.5 nautical miles offshore. The park covers an area of approximately 21,100 hectares which is managed via a zoning plan consisting of Sanctuary, Habitat Protection, Special Purpose and General Use Zones. The proposed Commercial Shellfish Aquaculture Leases are located within the JBMP. The approximate distances to areas of conservation significance near and/or within Jervis Bay are listed in Table 6.

Table 6: Distance of the proposed Commercial Shellfish Aquaculture Leases to areas of conservation significance in the Jervis Bay region. Site A = northern Callala Lease, Site B = southern Callala Lease, Site C = Vincentia Lease.

Area of Conservation Significance	Designation	Distance to Site A (km)	Distance to Site B (km)	Distance to Site C (km)
State Protected Areas				
Jervis Bay	Marine Park	0	0	0
Sanctuary Zone (Currambene Creek Mudflats Sanctuary Zone)	Marine Park	3.3	2.7	3.3
Sanctuary Zone (Hare Bay)	Marine Park	3.1	3.6	6.6
Sanctuary Zone (Huskisson)	Marine Park	1.7	1.0	1.8
Sanctuary Zone (Hyams Beach)	Marine Park	5.2	4.4	1.8

Sanctuary Zone (Bowen Island)	Marine Park	12	11.3	9.8
Sanctuary Zone (Point Perpendicular – Crocodile Head)	Marine Park	11.5	11.3	11.4
Sanctuary Zone (The Docks)	Marine Park	9.0	8.8	9.2
Sanctuary Zone (Groper Coast)	Marine Park	6.7	6.5	7.4
Sanctuary Zone (Wowly Gully)	Marine Park	3.2	4.1	8.1
Sanctuary Zone (Moona Moona Creek)	Marine Park	4.5	3.6	1.5
Commonwealth Protected Areas				
Beecroft Peninsula	Nationally Important Wetlands	7.7	6.8	6.6
Jervis Bay	Nationally Important Wetlands	0	0	0
Jervis Bay Sea Cliffs	Nationally Important Wetlands	10.4	10.3	10.4
St Georges Basin	Nationally Important Wetlands	10.2	9.3	5.5
Wollumboola Lake	Nationally Important Wetlands	7.1	8.1	12.2
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Listed Threatened Ecological Communities (Critically Endangered)	5.1	5.7	8.2
Booderee	National Park	10.8	10	6.4
Jervis Bay	National Park	2.0	3.5	1.3
Woollamia	Nature Reserve	5.5	4.9	4.4

6.14 Commercial and Recreational Activities

Commercial and recreational boats potentially utilise the areas proposed for the Commercial Shellfish Aquaculture Leases within Jervis Bay. Waterway users include recreational boaters, recreational fishers, commercial dolphin and whale watching operators, SCUBA diving operators, sailing vessels, kite surfers, wind surfers, commercial fishers, cruise ships and Naval vessels. Aquaculture activities have historically occurred in Jervis Bay however, currently there are no aquaculture activities or infrastructure within the bay. Existing boating access infrastructure in Jervis Bay includes a number of jetties, boat ramps and public wharves (Figure 29).

6.14.1 Commercial Fishing

The commercial fisheries that may occur within Jervis Bay Marine Park (JBMP) are: ocean hauling estuary general, ocean trap and line, ocean trawling, lobster and abalone. As Jervis

Bay is classed as ‘estuary’ waters, only estuary general and ocean hauling fisheries can occur inside the bay. The remaining fisheries are restricted to the waters at the entrance and outside the bay (NSW MP, 2008a).

Specific statistics are not available for the marine park as commercial fishing in this area is not distinguished from other commercial fishing in the region. There are approximately 34 commercial fishers who fish on a regular or seasonal basis within JBMP. The marine park spans the boundary between Ocean Zones 7 and 8 (latitude 35°S) and is within Ocean Hauling Region 6 (NSW MP, 2008a). Ocean hauling is the largest commercial fishery in the marine park, which is permitted on Long Beach, Currarong Beach, Hare Bay between Wowly Gully and Red Point, Whiting Beach, Callala Beach, Mary Beach and Bherwherre Beach. The key species targeted are Australian Salmon, Sea Mullet, Bream and Whiting (NSW MP, 2008a).

Fish trawling is permitted in Crookhaven Bight and in Wreck Bay general use zones where Silver Trevally, Tiger Flathead, Red Spot Whiting, Redfish and Octopus are the key species targeted. Garfish netting is also undertaken in Crookhaven Bight. Purse seining is permitted at two designated locations within the bay and in general use zones for bait for the tuna fishery but it is undertaken rarely (NSW MP, 2008a). The two restricted areas for purse seine and lift netting for bait are located near Bowen Island and another is located in the middle of the bay (Figure 29).

Overall, commercial fishing within Jervis Bay has shown a strong downward trend. The zoning plan, the buy-out of commercial fishing businesses associated with the implementation of the zoning plan, rising fuel prices and competition from imports are among the factors that have contributed to the decline in commercial fishing activity in the area (NSW MP, 2008a). All commercial fishers would be able to continue to utilise Jervis Bay as a fishing ground but a safe distance from the Commercial Shellfish Aquacultures Leases would need to be maintained.

Extensive aquaculture is permitted within Jervis Bay but cannot exceed 2% of the area of the marine park (440 hectares) (NSW MP, 2008a). Experimental mussel farming commenced operations in Jervis Bay on a small scale in 1977. The most recent operator of this operation planned to expand and submit a development application and environmental impact statement for the lease area in Jervis Bay, but decided to cease operations in April 2008. Oyster leases previously established in Currambene Creek were surrendered in the late 1990s. There has also previously been an intermittent fishery for commercial scallops and flat oysters in Jervis Bay for many years.

Between 1991 and 1997, Fisheries NSW had two Fisheries Research and Development Corporation funded scallop research programs based in Jervis Bay. The first was designed

to establish hatchery production techniques for scallops and required monitoring of the reproductive biology of populations of scallops in the Murray's Beach and Honeymoon Bay areas. The second program saw the hatchery techniques used to produce scallops to assess the potential for scallop reseeding in the bay. In order to grow the scallops to a size at which they could be released, long-lines were constructed and installed at Murray's Beach on which over four million scallops were farmed before release in Jervis Bay.

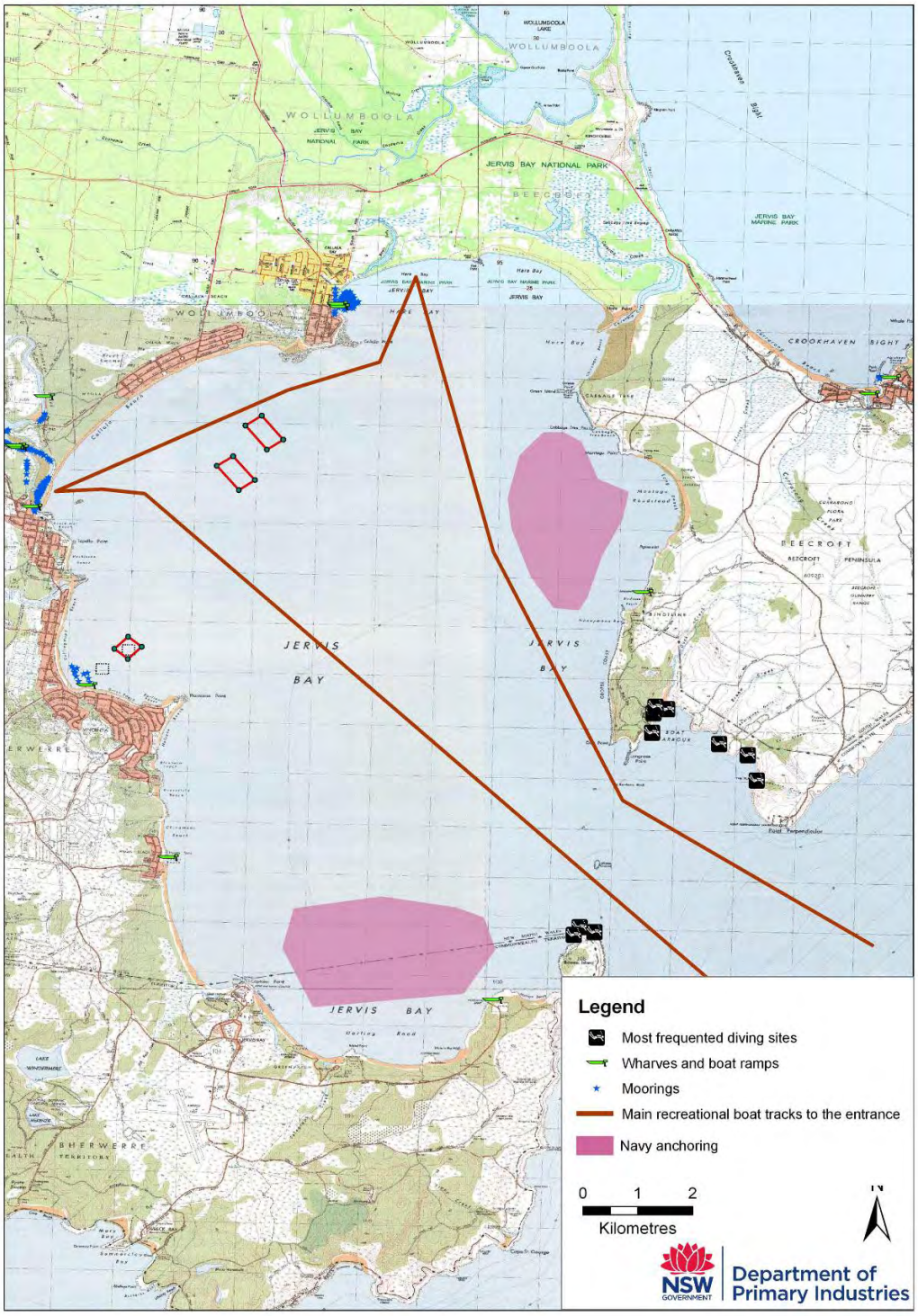

Figure 29: Indicative vessel tracks, Naval use areas and moorings within Jervis Bay (Source: NSW DPI, 2008).

6.14.2 Marine Tourism Operations

Tourism is one of the main industries in Shoalhaven LGA which is continuing to grow. In 2011 the Shoalhaven region attracted about 38,000 international visitors, 1.232 million domestic overnight visitors and 1.247 million domestic day-trippers. It is estimated that approximately $6.78 million was spent in the region by these visitors (JRA & DSA, 2012).

Commercial marine activities in the marine park account for a significant proportion of the millions spent in the region (e.g. $2.4 million in 2008) (NSW MP, 2008a). There is a range of marine tourism operators in the marine park which offer a range of activities including charter fishing, wildlife watching tours, dive charters, jet boat rides, boat hire, including canoes and kayaks, non-motorised water sports, swimming, snorkelling, paddle boards, kite surfers and a variety of cruises.

Scuba diving in particular, is very important to the local economy where there are more than 10,000 charter boat dives undertaken in the marine park annually. The most commonly dived sites are the shallow rocky reefs, submerged cliff faces and caves around Bowen Island and Beecroft Peninsula (NSW MP, 2008a). Around 90% of all divers are from areas other than Jervis Bay and Nowra. There is also an industry based on dolphin watching and sightseeing that operates out of Huskisson; dolphin watching and sightseeing tours are conducted all year round, and whale watching tours occur during the migrations of humpback whales and southern right whales from June to November (NSW MP, 2008a).

6.14.3 Recreational Boating and Fishing

Recreational boating and fishing are popular activities within Jervis Bay Marine Park (JBMP). Recreational fishing includes angling, boat-based spearfishing, shore-based spearfishing concentrated around rock platforms on the western side of the bay and shore-based fishing on beaches and rocky shores (Figure 30) (NSW MP, 2008a).

The seagrass beds close to the shore in Jervis Bay are frequented regularly by squid fishers and the open waters around the entrance of the bay are largely used for bottom fishing, trolling, balloon fishing and rock fishing (Figure 31) (NSW MP, 2009b).

High use areas offshore for recreational fishing and spearfishing include around Point Perpendicular, Bowen Island, Plantation Point and Longnose Point. Key species targeted in the marine park are snapper, flathead, squid, bream and kingfish. Hand-collected species for bait or food include lobster, abalone, pipis, crabs, beachworms, yabbies, ribbon weed and sea cabbage (NSW MP, 2008a).

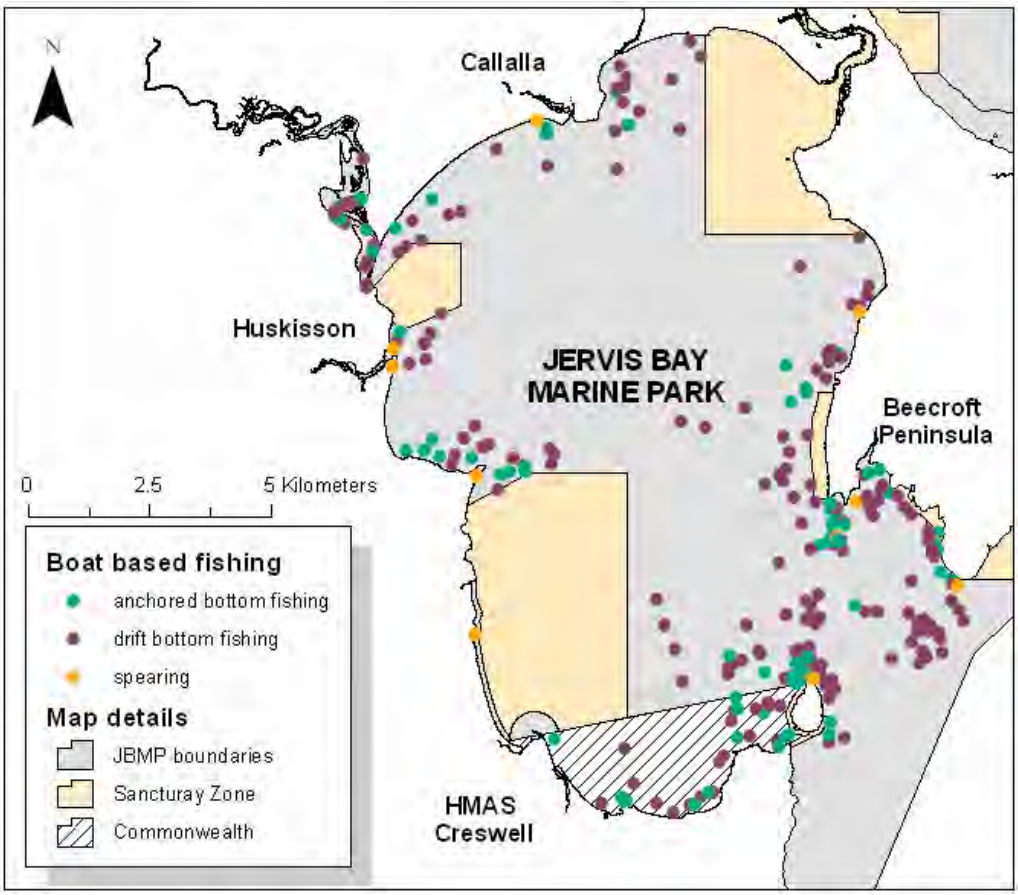

Figure 30: Boat-based fishing in Jervis Bay (February 2003-2005) (Source: NSW MP, 2009b).

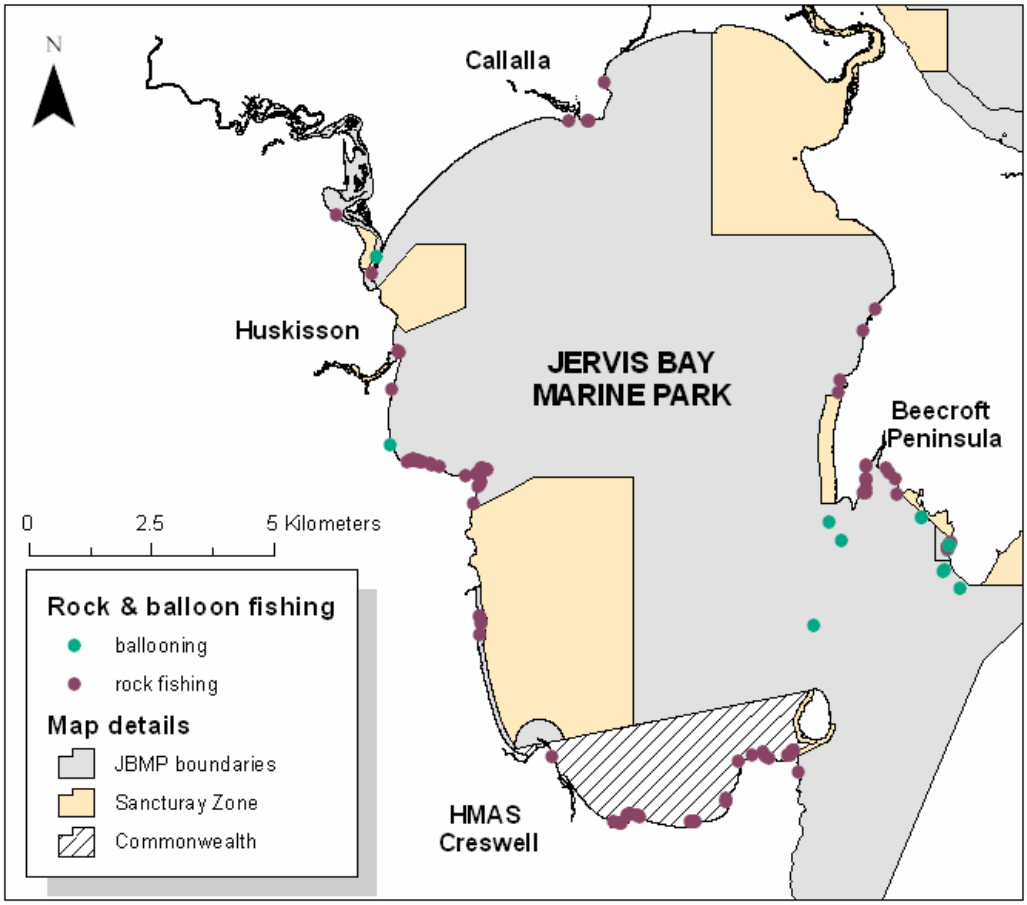

Figure 31: Rock and ballon fishing in Jervis Bay (February 2003-2005) (Source: NSW MP, 2009b).

NSW Marine Parks, NSW Roads and Maritime Services, Marine Rescue NSW and local sailing and fishing clubs were consulted to gather information on vessel traffic in the direct and wider region. The recreational vessels that use the waters of Jervis Bay range from small tinnies, sailing boats through to luxury yachts. The number of daily vessels movements (including commercial vessels) in Jervis Bay has been estimated to be about 250 - 300 during peak periods (i.e. school holidays, public holidays and long weekends during the warmer months) and about 15 - 20 vessel movements outside those peak periods (F. Clements - A/Manager, Jervis Bay Marine Park 2013, *pers comm*.). Figure 29 illustrates the main recreational boat tracks to the main wharfs, boat ramps and moorings.

Recreational fishing, diving and sailing competitions are predominately held during the warmer months of the year. Local sailing clubs for example, hold races on a regular weekly and fortnightly basis from September to May, sailing a range of craft, including: keel boats, trailer-sailers, off-the-beach dinghies and catamarans, as well as larger catamarans.

6.15 Naval Operations and Commonwealth Waters

The Royal Australian Navy (RAN) first became involved with Jervis Bay in 1911 when the area was inspected as a prospective site for a Naval College. A significant Naval presence in Jervis Bay continues today, which includes Beecroft Peninsula Firing Range, the airfield at Jervis Bay Range Facility and the Naval College. Jervis Bay has been a major anchorage for the fleet since 1913 (Swinden, 1995).

Ships exercise in the bay regularly but their anchorages are normally confined to the southern section between Bowen Island and Captain's Point. There has been increased usage of Jervis Bay by RAN in the last 20 years. In 1981, Beecroft Peninsula was officially transferred to the Commonwealth from the NSW Government in exchange for some of the Department of Defence's land on Sydney Harbour foreshore. Beecroft Peninsula Firing Range, comprising approximately 240 hectares, is used regularly for gunnery practice by RAN and foreign warships. Military aircraft also use the range for bombing practice (Swinden, 1995).

Jervis Bay has been declared Naval Waters under the *Control of Naval Waters Act 1918* which restricts the activities within these waters. The main area of restriction is designated by what is known as the Naval trace area which occupies a large proportion of the bay (Figure 32). Department of Defence has advised that aquaculture would not be permitted within the Naval Trace area. Further, the Department of Defence have reserved the right, to enact and or enforce any and all powers authorised by the above legislation.

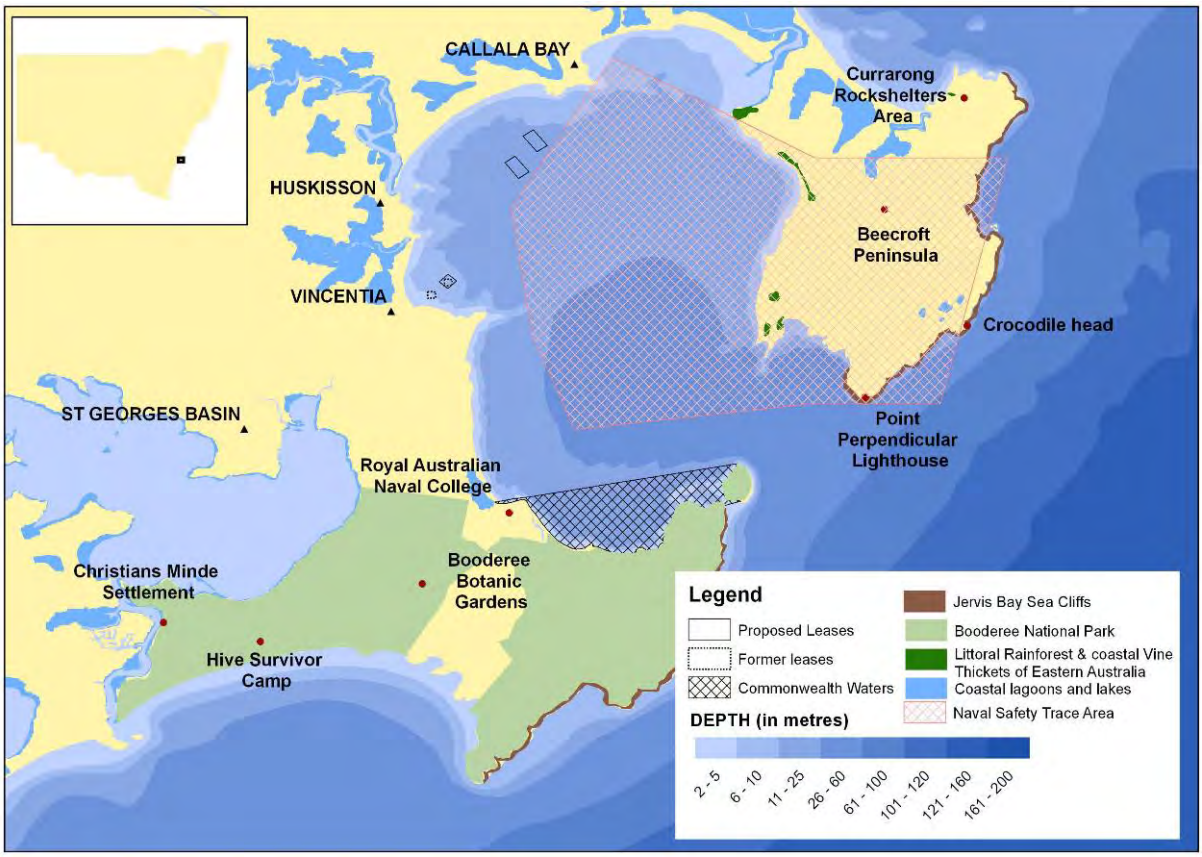

Figure 32: Naval trace and Commonwealth Waters restricted areas (Source: Fisheries NSW, 2013).

A Commonwealth Marine Area is situated within Jervis Bay and is part of Booderee National Park (Figure 33) which is a Commonwealth reserve on Aboriginal land (Web Reference 11). It consists of an 840 hectare area extending south of the line between Captains Point and the northern tip of Bowen Island, and represents approximately 7% of Jervis Bay (Web Reference 12).

Booderee National Park is jointly managed by the Wreck Bay Aboriginal Community Council (the traditional owners of the Bherwerre Peninsula) and the Department of Sustainability, Environment, Water, Population and Communities (Web Reference 13). However, NSW NPWS, Fisheries NSW, Shoalhaven City Council, Department of Defence and other NSW land management agencies are also involved with the management of the marine waters of the Park.

Bowen Island, on the eastern boundary of the Commonwealth Marine Area, supports a substantial colony of little penguins (*Eudyptula minor*) and breeding colonies of three species of shearwater, including wedge-tailed shearwaters (*Puffinus pacificus*), little shearwaters (*Puffinus assimilis*) and short-tailed shearwaters (*Puffinus tenuirostris*) (Web Reference 14).

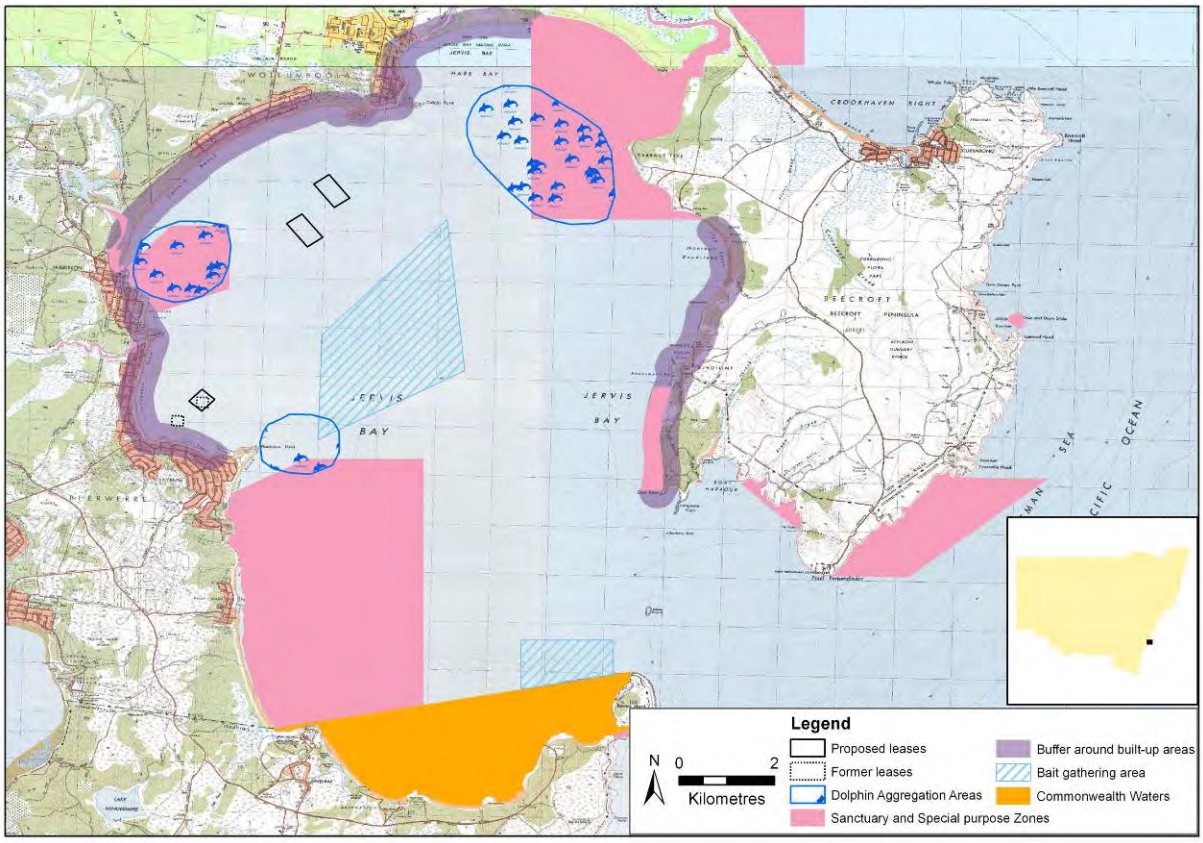

Figure 33: Location of bait gathering areas, dolphin aggregation areas and Commonwealth Waters within Jervis Bay (Source: NSW DPI, 2012).

6.16 Heritage

6.16.1 Aboriginal Heritage

Evidence suggests that earliest occupation of south-east NSW goes back 20,000 years. This estimate is based on carbon-14 dating techniques used in the archaeological research of a rock shelter 25 km south of Jervis Bay at Burrill Lake. Another record at the base of an open site at Bass Point, about 20 km north of Jervis Bay, was dated at 17,500 BC (Zakharov, 1987).

There are a number of Aboriginal communities in the area who utilise the Jervis Bay Marine Park (JBMP) for community, ceremonial, recreational and commercial purposes. These include the Jerrinia, Murramarang and Wreck Bay communities (NSW MP, 2008a). The Wreck Bay village community dates from around 1890 when Aboriginal fishermen intermittently camped at Summercloud and Mary Bays while fishing the waters between Sussex Inlet and St. Georges Head. They came from various Aboriginal Communities from La Perouse in Sydney to the far South Coast (Zakharov, 1987).

For over 3000 years, indigenous people have had strong ties to the land and sea around Jervis Bay. Indigenous use of the marine park is an integral part of the local culture. Marine resources, including fish and other animals, are regularly harvested for a range of purposes,

including for use in community gatherings and celebrations, and as food for individuals and their extended families. NSW MP conducts field trips and other activities with Aboriginal elders and community members to facilitate cultural exchange and community capacity building (NSW MP, 2008a).

Beecroft Peninsula is one of the richest places in Australia for Aboriginal sites and is considered the spiritual birthplace of 13 Aboriginal tribes of the south coast of NSW. It contains more than 200 sites of significance which makes it one of the highest concentrations of special Aboriginal places in Australia (Zakharov, 1987). Beecroft Peninsula is the location of the sacred sites of the Jerrinia people and some of these are also known to non-Aborigines. Coastal middens and estuarine middens are the most common sites around the bay but there are also rock shelters with some containing Aboriginal rock art, burial sites, axe grinding groove sites, stone arrangements for ceremonial purposes and sacred trees from which bark was removed to be used for shelter or for making canoes (Cho, 1995).

Significant sites for the collection of marine animals and plants for traditional and commercial use are, among other places, Callala Beach, Bindijine Beach, Long Beach, Silica Bay, Boat Harbour, Green Point, along Groper Coast, and Murrays Beach and Hole-In-the-Wall in Commonwealth Waters. Many of the coastal areas on the western side of Beecroft Peninsula are also important sites (NSW MP, 2003).

A significant site in Aboriginal spiritual beliefs is the Drum and Drum Sticks and Gum Getters area on the ocean side of Beecroft Peninsula. Wreck Bay and the beaches on the western side of St Georges Head are important areas for traditional and commercial activities and have cultural ties to the Jerrinia, Murramarang and Wreck Bay communities. Beach hauling remains a significant commercial fishing activity for Aboriginal people in Jervis Bay. Members of the Jerrinja and Wreck Bay Aboriginal communities participate in the commercial ocean hauling fishery (NSW MP, 2003).

6.16.2 European Heritage

European association with Jervis Bay started in 1770 with Captain James Cook, who supplied the names for St Georges Head, Cape St George and Longnose Point despite never landing in the area (Cho, 1995).

Over the past 200 years Jervis Bay has supported an array of industries including ship building, whaling, grazing and dairying, timber and as a Naval training base. Most recently Jervis Bay has become a premier tourist facility (NSW MP, 2008a).

Jervis Bay has a strong maritime history that includes lighthouses, ship building, cargo transport, shipwrecks and an active Naval training base. There are at least 19 known shipwrecks in the marine park, many of which are important attractions for scuba divers.

Most shipwrecks are located in Wreck Bay, on the eastern side of St Georges Head, and at Currarong. Many of the wrecks have been assessed by the NSW Heritage Office as being historically, technically, scientifically or archaeologically significant.

A desktop review of plane and shipwrecks was carried out in February 2013 to determine if there were any known or potentially occurring maritime heritage sites in close proximity to the proposed Commercial Shellfish Aquaculture Leases. The NSW Historic Shipwrecks Database (Web Reference 15) and the Australian National Shipwreck Database (Web Reference 16) were searched. Only two wreckages were detected within Jervis Bay including the *Mercury* shipwreck and the *Fairey Firefly* plane wreck (Figure 34). The distance of these sites from the closest lease, the northern Callala Lease, is approximately 2 km and 2.4 km, respectively.

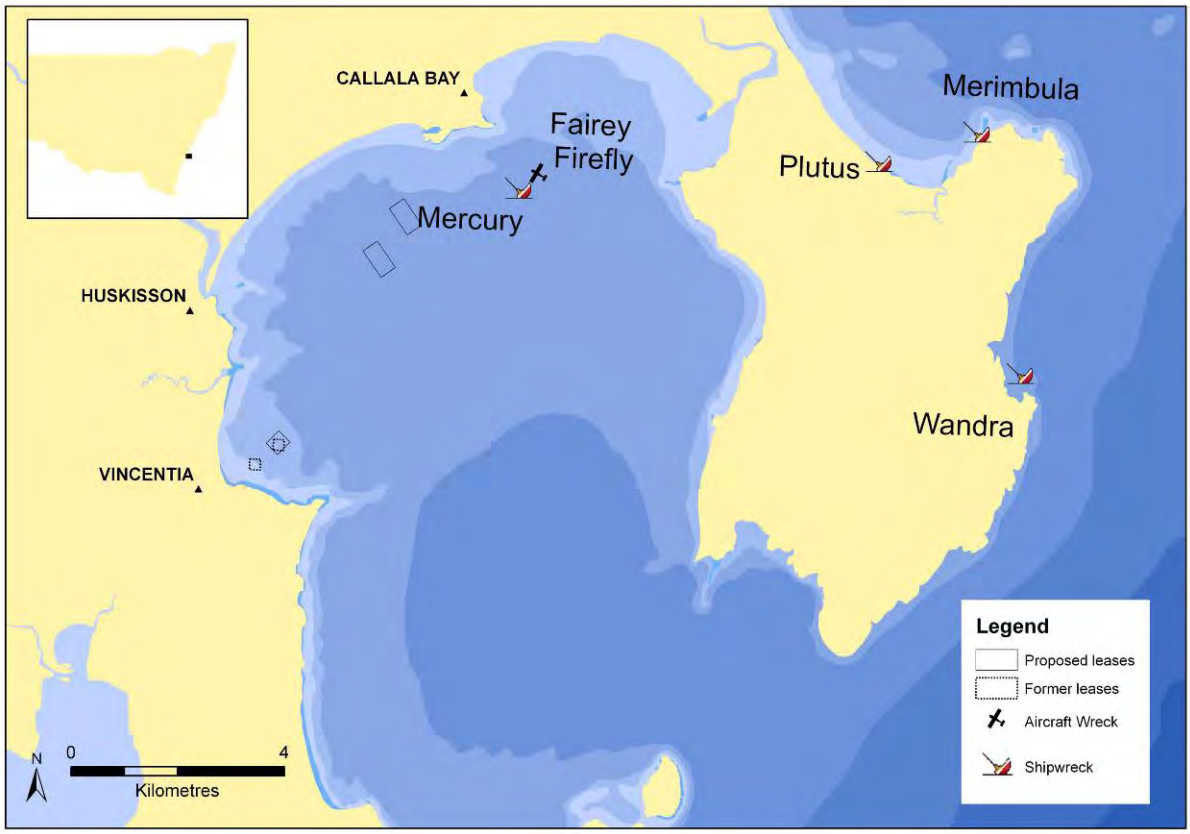

Figure 34: Plane and shipwrecks in Jervis Bay that are in close proximity to proposed leases (Source: Fisheries NSW, 2012).

6.17 Social and Economic Description

The Shoalhaven LGA spans an area of 4,660 km^2 and has a population of approximately 92,812. According to the 2011 Census, the population experienced a 5% growth rate between 2006 and 2011 (Web Reference 17). The average annual population growth rate during the 1990's also remained consistently above the state average. Forecasts based on medium level growth indicate that the population will reach 113,500 by 2021, which represents an increase of 22.2% (Web Reference 17).

The economy of the Shoalhaven LGA is made up of retail, health and social services, accommodation and food, defence, tourism, agriculture, construction, education, manufacturing and public administration. The most significant industries are health care and social assistance, retail trade and public administration and safety, which employ about 37.5% of the entire workforce (Web Reference 17).

7 RISK ASSESSMENT METHOD

The perceived risks associated with marine shellfish aquaculture need to be addressed to ensure Ecologically Sustainable Development (ESD) of this industry (de Jong & Tanner, 2004). A risk assessment was conducted on the potential impacts associated with the Commercial Shellfish Aquaculture Leases using the *National ESD Reporting Framework: The 'How To' Guide for Aquaculture* (Fletcher *et al.,* 2004) which is based on Standards Australia and Standards New Zealand (1999; 2000) risk management methods which are used by a variety of industries to conduct risk assessments.

Risk refers to "the chance of something happening that will have an impact on objectives" (Standards Australia and Standards New Zealand, 1999). The main objectives of the risk assessment was to assist with the separation of minor acceptable risks from major unacceptable risks and assist with the development of mitigation measures to avoid undesirable outcomes (Fletcher *et al.,* 2004). A variety of sources were used to ensure all risk sources associated with the Commercial Shellfish Aquaculture Leases were identified, including consultation meetings to discover stakeholder opinions and perceptions, expert panels, literature reviews, examination of historical records and government guidelines.

The risk assessment identified knowledge gaps and areas that need further research, which in turn assisted with the development of the project's objectives. The focus of the risk assessment was environmental impacts but consideration was also given to social and economic issues. The generic component trees outlined in the National ESD Reporting Framework were modified so they were appropriate and applicable to the Commercial Shellfish Aquaculture Leases.

Each issue was examined in terms of current knowledge and the proposed mitigation, management and monitoring measures, and then assigned a risk ranking. Two factors were used to analyse the risks - the potential consequences arising from activities on the marine environment (Table 7) and the community (Table 8) and the likelihood that this consequence will occur (Table 9) (Fletcher *et al.,* 2004). Table 10 depicts the risk matrix which is based on arithmetical calculation of the Consequence x Likelihood (0-30) that is used to separate the risk values into five risk ranking categories from 'negligible' to 'extreme'.

Any issues that were assigned with negligible risk were eliminated from subsequent assessments and a short justification is provided to support this classification (Table 11). Full management reports are recommended for issues that have been identified as having sufficient risk or priority (i.e. 'moderate, 'high' or 'extreme' risk) (Fletcher *et al*., 2004). A management report requires the establishment of operational objectives, indicator levels,

acceptable levels and management responses for a particular issue. Management reports will form a component of the EMP and will be finalised upon development approval.

Table 7: Consequence levels for the impact of the Commercial Shellfish Aquaculture Leases on ecosystems, habitats and populations (modified from Fletcher *et al*., 2004).

Level	Descriptor
Negligible (0)	Very insignificant impacts to habitats or populations. Unlikely to be even measurable at the scale of the stock/ecosystem/community against natural background variability. Activity only occurs in very small areas of the habitat, or if larger area is used, the impact on the habitats from the activity is unlikely to be measurable against background variability.
Minor (1)	Possibly detectable but minimal impact on structure/function or dynamics. None of the affected species play a keystone role – only minor changes in relative abundance of other constituents. Measurable impacts on habitat(s) but these are very localised compared to total habitat area.
Moderate (2)	Maximum appropriate/acceptable level of impact (e.g. full assimilation rate for nutrients) Measurable changes to the ecosystem components without there being a major change in function (i.e. no loss of components). There are likely to be more widespread impacts on the habitat but the levels are still considered acceptable given the percentage of area affected, the types of impact occurring and the recovery capacity of the habitat.
Severe (3)	This level will result in wider and longer term impacts. Ecosystem function altered measurably and some function or components are locally missing/declining/increasing outside of historical range &/or allowed/facilitated new species to appear. 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.
Major (4)	Very serious impacts with a relatively long time frame and are likely to be needed to restore to an acceptable level. A major change to ecosystem structure and function (different dynamics now occur with different species/groups now the major components of the region). Substantially too much of the habitat is being affected, which may endanger its long-term survival and result in severe changes to ecosystem function.
Catastrophic (5)	Widespread and permanent/irreversible damage or loss will occur – unlikely to ever be fixed (e.g. extinctions). Total collapse of ecosystem processes. Long-term recovery period may be greater than decades. Effectively the entire habitat is in danger of being affected in a major way/removed.

Table 8: Consequence levels for the impact of the Commercial Shellfish Aquaculture Leases on the community, including potential social, economic and political issues (modified from Fletcher *et al*., 2004).

Level	Descriptor
Negligible (0)	Very insignificant impacts – would not have any flow-on impacts to the local community, particularly other waterway users.
Minor (1)	May have minor impacts on the community (e.g. small loss of amenity, minor increase in road and vessel traffic, minor increase in noise levels, minor economic losses and minor WH&S risks) but these impacts would be easily absorbed.
Moderate (2)	Some loss of amenity, increase in noise levels, increased road and vessel traffic, impacts on heritage values, negative interactions with other waterway users, income loss, navigation and WH&S issues - to which the community will adjust to over time. Some community concern about impacts which may translate to some political action or other forms of protest.
Severe (3)	Significant loss of amenity, significant impacts on traffic levels, heritage items, noise levels, navigation safety and interactions with other waterway users, as well significant reductions in income and significant WH&S risks. Significant levels of community concern over the future of the community, which may translate to political action or protest.
Major (4)	High level of community impacts which the community could not successfully adapt to without external assistance. Significant level of protest and political lobbying likely. Significant loss of amenity, significant increase in noise levels, road and vessel traffic, WH&S risks and navigation issues. Significant impacts on other waterway users, heritage values and the local economy.
Catastrophic (5)	Large-scale impacts well beyond the capacity of the community to absorb and adjust to. Large scale loss of amenity, major increases in noise levels, road and vessel traffic, WH&S risks and navigation issues. Major impacts on other waterway users, heritage values and the local economy. Total change in the nature of the community.

Table 9: Likelihood definitions (modified from Fletcher *et al*., 2004).

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

Table 10: Risk matrix – risk value is indicated by number in cells and the risk rankings are indicated by the different shades (modified from Fletcher *et al*., 2004).

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

Table 11: Risk rankings and outcomes (modified from Fletcher *et al*., 2004).

Risk Rankings	Risk Values	Proposed Mitigation / Management	Reporting Requirements
Negligible	0	No additional management measures needed to achieve acceptable performance.	Short justification only
Low	1 - 6	No additional management measures needed to achieve acceptable performance.	Full justification needed
Moderate	7 -12	Possible increases to management measures.	Full management report
High	13 -18	Possible increases to management measures.	Full management report
Extreme	>19	Additional management measures are likely.	Full management report

Risk mitigation is achieved by the implementation and evaluation of regulatory and/or voluntary management responses which are detailed in the EMP. The EMP states the goals and objectives for the Commercial Shellfish Aquaculture Leases and provides a detailed overview of the proposed management initiatives that have been designed to mitigate the risk of the undesirable events.

Risk monitoring aims to collect information to assess whether the management initiatives (i.e. the EMP consisting of monitoring programs and protocols), are effective at minimising the risk of the undesirable event. Monitoring programs will also be implemented to enable

validation of management efforts, as well as highlight areas that need additional or alternative management responses if current initiatives prove to be ineffective.

Consultation with the various stakeholders, including aquaculture managers, research scientists, manufacturers, recreational and commercial fishers, Aboriginal leaders and marine tourism operators have also been conducted to provide information and feedback for decision-making. This approach aims to address any issues that require additional management actions and/or research to ensure ecological sustainability and that stakeholders are not significantly impacted by the Commercial Shellfish Aquaculture Leases.

The assigned risk ranking was based on scientific literature and expert opinion, and is intended to reflect what is considered to be likely over the next ten years (Fletcher *et al.,* 2004). Where there was little or no information available on the issue in NSW, a broader literature search was conducted to find any relevant information from other states or overseas (de Jong & Tanner, 2004).

Representatives from the aquaculture industry, government, research and development, conservation groups and community groups provided input about issues of concern which were considered in the risk assessment.

Justification - Risk Assessment Method

A range of risk assessment processes were reviewed, including the multi-stage risk assessment process developed by NSW DPI for commercial fisheries management (Astles *et al*., 2006) but the National ESD Reporting Framework was considered the most appropriate risk assessment process for the Commercial Shellfish Aquaculture Leases.

The National ESD method is specific to aquaculture and has been designed to be used nationally by the aquaculture industry. The method enables a range of environmental and socio-economic issues to be reviewed in a succinct manner and in a relatively short time frame when compared with other risk assessment methods. It has proven effective in identifying and prioritising issues and ensuring appropriate allocation of management effort. The method also encourages effective management by establishing predetermined outcomes that must be achieved for issues that are identified as potentially representing a substantial risk to the environment and/or community (Fletcher *et al.,* 2004).

Furthermore, the proposed Commercial Shellfish Aquaculture Leases are a small scale operation in a well flushed embayment in which no significant impacts were detected from shellfish farming when it was previously undertaken in Jervis Bay. Consequently, the National ESD method was considered to be the most appropriate method to achieve the overall goal of the risk assessment - to identify and prioritise environmental and socio-

economic risks and ensure appropriate management efforts are allocated to each issue to prevent adverse impacts.

Uncertainty

To assist in assigning the correct risk level to the potential issues identified for the Commercial Shellfish Aquaculture Leases, the risk assessment was reviewed and critiqued by a broad range of people with experience and expertise in a range of areas in Fisheries NSW (e.g. research scientists, aquaculture managers, conservation and threatened species managers).

An extensive range of stakeholders were also consulted to identify issues of concern, state their opinions and make enquiries. Stakeholders and the community also have the opportunity to provide feedback and make a submission about the risk assessment or any other component of the EIS when it goes on exhibition for public comment. This will also assist with ensuring that risk rankings are correct and adequate management attention is given to each potential impact.

8 ASSESSMENT OF IMPACTS

A total of 22 risk issues were identified and categorised in either the construction stage or the operational stage of the Commercial Shellfish Aquaculture Leases (Figure 35). The construction stage includes issues related to site selection, construction and the installation of the longline infrastructure. The 15 issues associated with the operational stage were then divided into impacts on the community or impacts on the environment. Five issues were identified as representing a 'negligible' risk while 14 issues were assigned a 'low' risk ranking. No issues were identified as representing a 'high' or 'extreme' risk but three were classified as 'moderate', including: (1) water quality and sedimentation; (2) genetics, disease and introduced pests; and (3) entanglement and ingestion of marine debris.

The 'moderate' classifications indicate that these issues require further management and/or research. However, management responses to 'moderate' issues are unlikely to need to be immediate or drastic (de Jong & Tanner, 2004). Management responses will generally be in the nature of continuous improvements over the next 5 to 10 years to reduce the risk level to 'low' or 'negligible' (de Jong & Tanner, 2004).

The Commercial Shellfish Aquaculture Leases will provide researchers with an opportunity to investigate issues of concern, which will assist the NSW Government with gaining a greater understanding about the impacts of marine shellfish aquaculture and achieving sustainability without adversely impacting on the environment or local communities.

Table 12 provides a summary of the potential environmental, social and economic issues associated with the proposed Commercial Shellfish Aquaculture Leases, as well as the consequence, likelihood and risk ranking values recorded for each issue during the risk assessment.

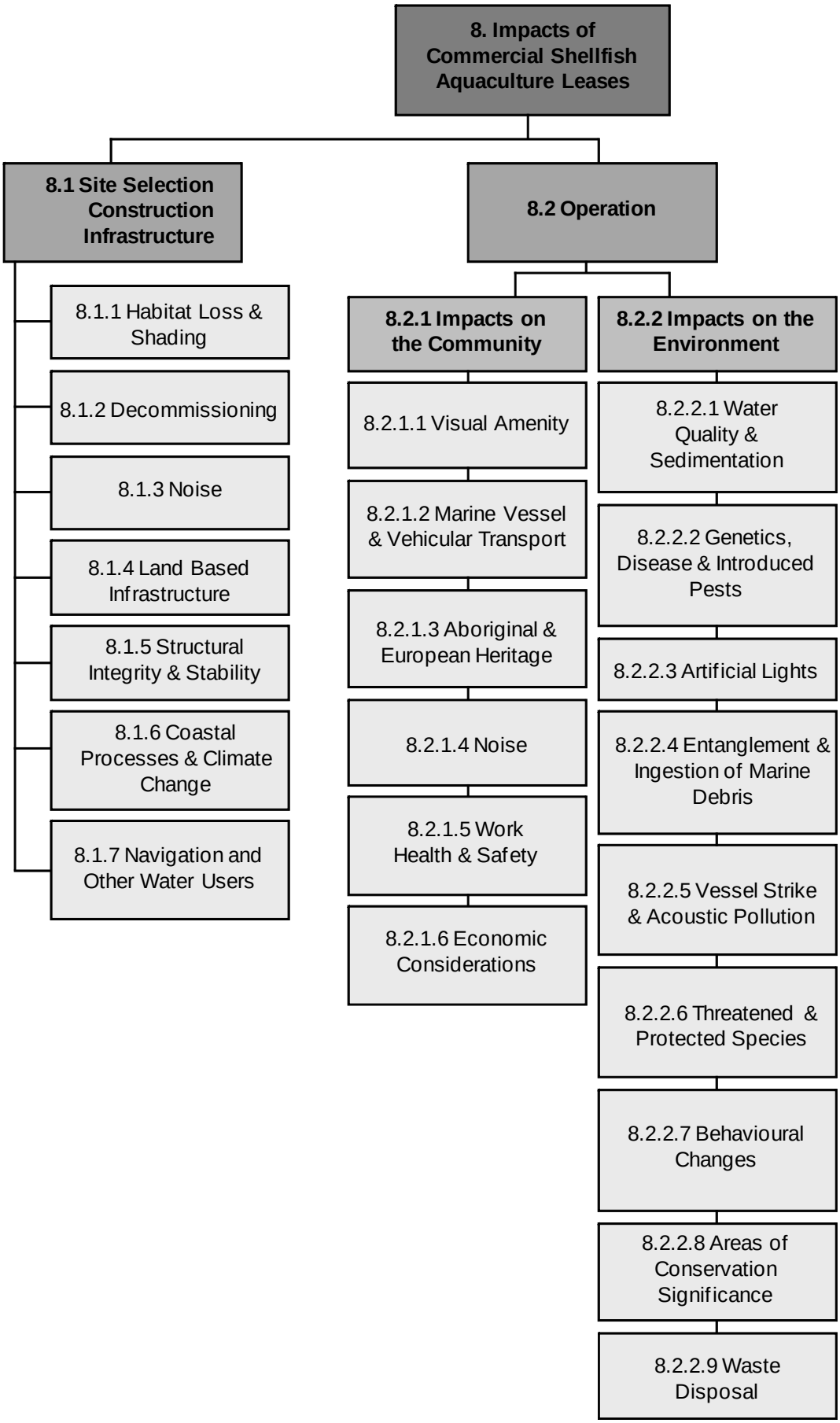

Figure 35: Component Tree – Environmental and socio-economic impacts of the proposed Commercial Shellfish Aquaculture Leases (modified from Fletcher *et al*., 2004).

Table 12: Summary of environmental, social and economic issues including consequence, likelihood, risk ranking values for the proposed Commercial Shellfish Aquaculture Leases (modified from Fletcher *et al*., 2004).

Issue	Consequence	Likelihood	Risk Ranking	Ranking
Site Selection / Construction / Infrastructure (8.1)				
Significance of habitat loss and shading due to the installation of longline infrastructure **(8.1.1)**	0	6	0	Negligible
Decommissioning **(8.1.2)**	1	6	6	Low
Impact on noise levels – construction and deployment stage **(8.1.3)**	1	6	6	Low
Impacts on existing land based infrastructure **(8.1.4)**	1	6	6	Low
Structural integrity and stability of longline infrastructure **(8.1.5)**	1	6	6	Low
Impact of longlines on coastal processes/water flow and climate change **(8.1.6)**	1	6	6	Low
Impact of longline infrastructure on navigation and other waterway users **(8.1.7)**	1	6	6	Low
Operation (8.2)				
Impacts on the Community (8.2.1)				
Impacts on visual amenity **(8.2.1.1)**	1	6	6	Low
Impacts of marine vessel and vehicular transport **(8.2.1.2)**	1	6	6	Low
Impacts on Aboriginal and European heritage **(8.2.1.3)**	0	6	0	Negligible
Impacts on noise levels – operational stage **(8.2.1.4)**	1	6	6	Low
Work health and safety issues **(8.2.1.5)**	1	6	6	Low
Impacts on the local economy **(8.2.1.6)**	0	6	0	Negligible
Impacts on the Environment (8.2.2)				
Impacts on marine habitats – water quality and sedimentation **(8.2.2.1)**	2	4	8	Moderate
Genetics of wild stocks, disease transmission (cultured stock to wild stock and other marine fauna), cultured stock diseases and introduced pests **(8.2.2.2)**	4	3	12	Moderate
Impacts of artificial lights on fauna species **(8.2.2.3)**	0	6	0	Negligible
Entanglement and ingestion of marine debris **(8.2.2.4)**	2	4	8	Moderate

Risk of vessel strike and acoustic pollution **(8.2.2.5)**	1	6	6	Low
Impacts on threatened and protected species **(8.2.2.6)**	1	6	6	Low
Impacts on the behaviour of marine fauna including the creation of FADs **(8.2.2.7)**	1	6	6	Low
Impacts on Areas of Conservation Significance - MPA, national parks and critical habitat **(8.2.2.8)**	1	6	6	Low
Waste disposal - bio/general/equipment waste **(8.2.2.9)**	0	6	0	Negligible

8.1 Site Selection / Construction / Infrastructure Risks

This section investigates issues relating to site selection and the construction and deployment stage of the proposed Commercial Shellfish Aquaculture Leases.

8.1.1 Habitat Loss and Shading

Table 13: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue of habitat loss and shading caused by the installation of the longline infrastructure (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the installation of the longline infrastructure result in significant shading of the marine benthic environment or significant loss of marine habitat through modification, isolation, disturbance or fragmentation?
Level of Impact	Individual facility
Comments and Considerations	▪ *What habitat will be modified, removed, isolated and/or fragmented by the installation of the longline infrastructure?* ▪ *How much habitat will be disturbed?* ▪ *Will the longline infrastructure cause shading of the seabed or water column?* ▪ *Is this area of habitat critical to the survival of any resident or vagrant species in the direct or wider area?* ▪ *Is this habitat unique, under threat and/or restricted in extent/scale?* ▪ *Is similar habitat available in the direct and wider area?* ▪ *Are environmentally-sensitive areas (e.g. seagrass, mangroves and corals) present in or in close proximity to the Commercial Shellfish Aquaculture Leases?*
Description	▪ Total lease area = 50 ha (exclusion will only occur beneath longlines) ▪ Average water depth = 10 m ▪ Clearance between culture apparatus and seabed =approx 5 m ▪ Maximum volume of water column occupied by longlines (including 200L buoys and double backbone) o Callala Leases = 45,000 m^3 (each) o Vincentia Lease = 22,500 m^3 ▪ Total seabed area occupied by primary and stabilising anchors o Callala Leases = 120 m^2 (each lease) o Vincentia Lease = 75 m^2
Proposed Management – Mitigation and Monitoring	▪ Small scale operations (0.4% of Jervis Bay) ▪ Site selection o No environmentally sensitive or unique areas o Habitat type beneath longlines = fine to medium grained sand and small cobble o An extensive area of similar habitat is available in the direct and wider area

	▪ Open streamlined infrastructure design ▪ Minimal disturbance to seabed i.e. anchors only			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	0	6	0	**Negligible**
Reporting Requirements	Short justification			

Justification for Ranking

The proposed Commercial Shellfish Aquaculture Leases are a relatively small scale operation occupying only 0.4% of Jervis Bay. The installation of the longline infrastructure will impact on a relatively small area of soft sediment habitat beneath the longlines (via shading) and anchor blocks (via smothering and/or exclusion).

There will be two primary anchors at each end of the longlines and each anchor is likely to occupy about 1.5 m^2. Depending on the species grown and the particular longline infrastructure required, 2-5 stabilising anchors will be required per longline which will each occupy an area of up to 1 m^2. Each lease will have about 15 rows of longlines and each longline will not exceed 600 m on the Callala Leases and no more than 300 m on the Vincentia Lease. The Callala Leases are likely to require 3-5 stablising anchors per longline while the Vincentia Lease will most likely only need two secondary anchors. Based on these criteria the total area of seabed impacted by the installation of the anchors is about 120 m^2 on each of the Callala Leases and 75 m^2 on the Vincentia Lease (i.e. a maximum of 315 m^2 for the three leases).

The installation of the longline infrastructure will result in loss of a relatively small area of pelagic habitat from the water's surface down to a depth of about 10 m which will be occupied by floating buoys, longline backbone ropes, culture apparatus, mooring lines and anchors. However, there will be a clearance of about 5 m from the culture apparatus to the seabed.

The total volume of the water column that will be occupied by the longline infrastructure will depend if single or double backbone lines are used. If double backbones are used then the maximum volume of the water column that will be occupied by the infrastructure will be approximately 45,000 m^3 for each of the 20 hectare leases and 22,500 m^3 for the 10 hectare lease. Hence, the maximum volume of water occupied by the three leases is approximately 112,500 m^3 but this would be less if single backbone lines are used. This is based on the criteria that the buoys will be have a length of about 1 m, the culture apparatus will positioned no more than 5 m below the surface, each lease will have about 15 rows of

longlines and each longline will not exceed 600 m on the Callala Leases and no more than 300 m on the Vincentia Lease.

Marine fauna are not excluded completely from the lease areas - the longline infrastructure will consist of a series of buoys and lines running parallel to each other and separated by about 15-20 m of open water. The two leases off Callala will also be separated by about 530 m of open water. Dolphins and fairy penguins for example, were regularly sighted moving through the pearl farm in Port Stephens and around the work boats (Umwelt, 2003). Similarly, reports on pearl farms in Western Australia indicate that resident dolphin populations have doubled following the installation of the longline infrastructure. Female dolphins have been observed calving within the pearl farms and using the longline areas to shelter from sharks and other predators (Umwelt, 2003).

Shellfish farms also provide a substrate for growth for a wide range of microscopic flora and macroscopic fauna, including ascidians, hydroids, sea horses, molluscs, crustaceans and byrozoans. Additional habitat is also provided to species such as finfish, sharks and rays. Pink Snapper for example, have been observed congregating around longlines in Cockburn Sound, Western Australia, consuming large quantities of mussels during spawning season (WAMPA, 2005). Fisheries NSW is aware that the former mussel lease sites held good populations of Yellowtailed Scad, Yellowfin Bream, Luderick and sea horses.

The seabed beneath the areas proposed for the Commercial Shellfish Aquaculture Leases in Jervis Bay primarily consist of fine to medium grained sand and small cobble (Figure 36) and have a water depth of approximately 10 m (CSIRO, 1994; Joyce *et al*., 2010). There are no environmentally sensitive or unique areas within the areas proposed for the leases. Seagrass beds, rocky reefs and mangroves are present in Jervis Bay but are considered to be a sufficient distance away from the leases to avoid significant impact on these habitats.

Many studies have been conducted on the impacts of longline farms on the benthic environment in Australian waters and in most cases the impacts have been found to be highly localised and restricted to the area beneath or in the immediate vicinity of longlines. A study by Gifford (2006) for example, found no evidence of impact on benthic fauna beneath a pearl farm or to seagrass beds at Wanda Head, Port Stephens. Similarly, the mussel farming activities in Twofold Bay have also had minimal environmental impact despite shellfish being farmed at shallower depths (10 m), slower current speeds and higher stocking densities (approximately four times greater) than the pearl farm at Wanda Head (O'Conner *et al*., 2002).

The Commercial Shellfish Aquaculture Leases are not located in any known important foraging, breeding or resting habitat for any marine fauna species. Notably, the proposed leases are positioned outside of recognised dolphin aggregation areas within Jervis Bay

(Figure 37). There are extensive areas of similar habitat in the direct and wider study area. The installation of the longlines will not isolate any habitat area which is considered unique in the direct or wider region and adjacent soft sediment and pelagic habitat is likely to support very similar fauna and flora assemblages to those in the immediate vicinity of the longline infrastructure.

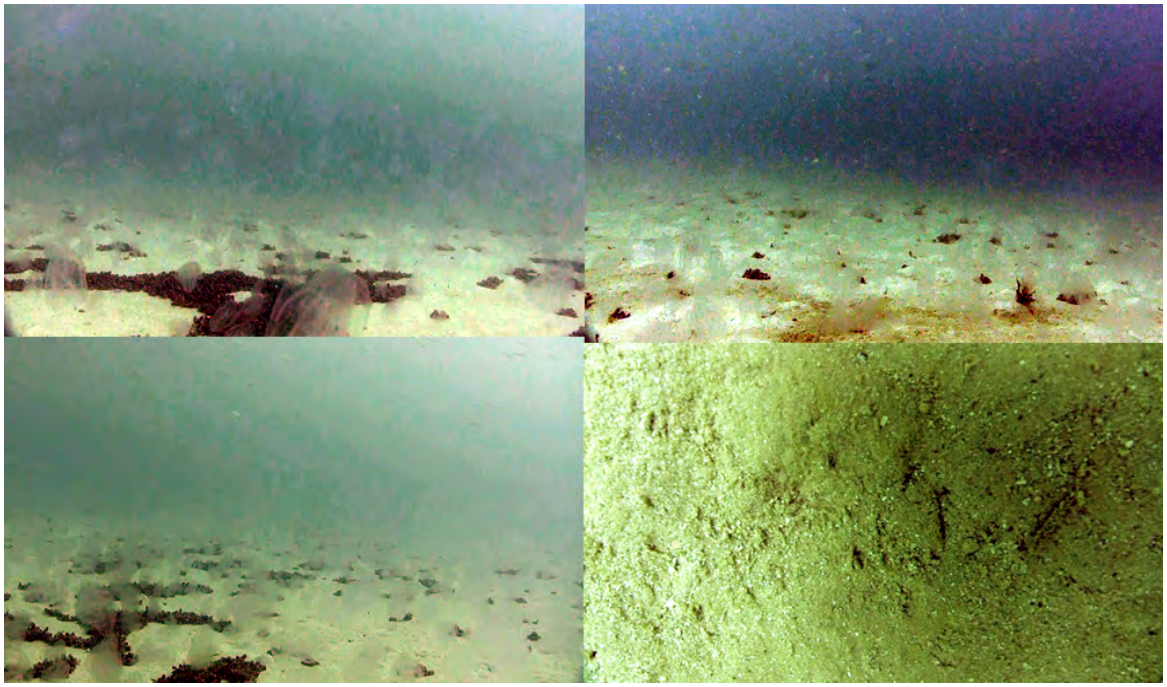

Figure 36: A typical view of the seabed beneath the proposed leases showing numerous jellyfish present at time of the photograhs being taken (Source: NSW MP, 2013).

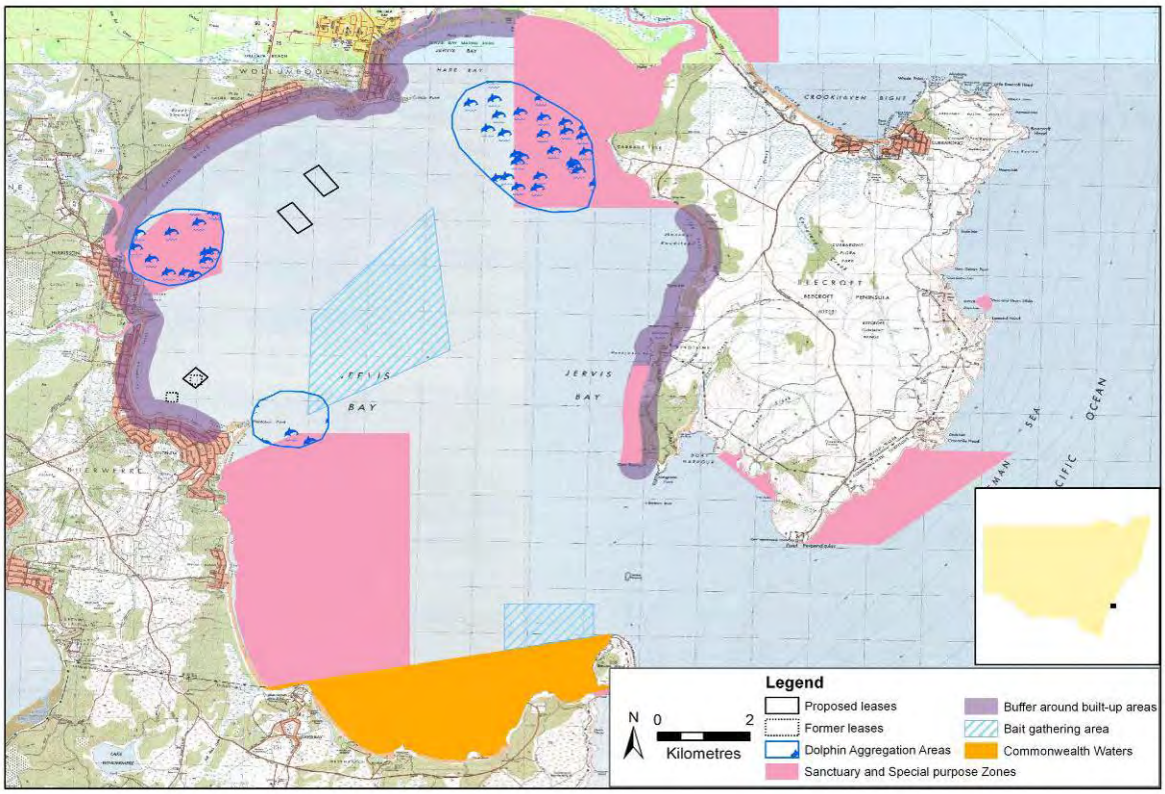

Figure 37: Location of recognised dolphin aggregation areas in Jervis Bay (Source: NSW DPI, 2012).

Conclusion

The area of soft sediment and pelagic habitat that is expected to be impacted by the Commercial Shellfish Aquaculture Leases (i.e. habitat loss and shading) was assessed to be 'negligible' when considered in context with the small scale of the proposal, the extent of soft sediment substratum, absence of environmentally sensitive or unique areas within the proposed areas and the findings from monitoring studies on other longlines farms. The longlines will not isolate any habitat area, extensive areas of similar habitat are available in the direct and wider study area and adjacent soft sediment and pelagic habitat is likely to support very similar fauna and flora assemblages to those in the immediate vicinity of the leases.

8.1.2 Decommissioning

Table 14: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the decommissioning of the Commercial Shellfish Aquaculture Leases (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the Commercial Shellfish Aquaculture Lease areas be significantly degraded that rehabilitation will be required to restore its pre-existing state if the leases were decomissioned?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Will the lease areas need rehabilitation if decommissioned?* ▪ *Will the pre-existing state of the environment return after aquaculture activities cease?* ▪ *How long will it take for the environment to return to its pre-existing state, notably the benthic environment?* ▪ *What surety is there that the areas will be rehabilitated if required?*			
Description	▪ Proposed duration for leases = undefined ▪ If decommissioned, all infrastructure would be removed i.e. longlines, mooring system and anchors			
Proposed Management – Mitigation and Monitoring	▪ Site Selection o Habitat - fine to medium grained sand and small cobble o Well flushed bay ▪ Minimal disturbance to seabed i.e. anchors only ▪ Extensive aquaculture = no feed input ▪ Small scale operations (0.4% of Jervis Bay) ▪ Appropriate stocking densities ▪ Water Quality & Benthic Environment Monitoring Program (Appendix 1) o Regular sampling – before and during operation stage o Fallowing and/or reduce stocking densities if impact detected ▪ Aquaculture Lease Security Arrangement (Bond)			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

Many studies have been conducted on the impacts of longline farms on the benthic environment in Australian waters and in most cases the impacts have been found to be highly localised and restricted to the area beneath or in the immediate vicinity of longlines. Extensive aquaculture farming in NSW has included scallop longline aquaculture in Jervis Bay (now ceased operating), raft culture of mussels in Jervis Bay (now ceased operating), longline mussel farm in Twofold Bay and Akoya pearl cultivation in Port Stephens. As part of the conditions of approval required by NSW DPI, monitoring of benthic organisms and total organic carbon (TOC) in sediments below lease sites and control sites is required. The following is a summary of the results of environmental monitoring to date:

- The impact of a scallop longline in Jervis Bay remained within the assimilative capacity of the environment in that no significant increases in organic material were detected in sediment samples from in and around the site (Heasman *et al*., 1998).
- An assessment of potential ecological impacts of longline mussel farming in Twofold Bay found that there was no evidence of change in the total number of different fauna groups, dominant taxa or the overall structure of the benthic assemblages found below the mussel longlines (Lasiak & Underwood, 2002).
- The operation of aquaculture leases did not have a measurable effect on TOC in sediments in Twofold Bay. No significant differences in TOC levels were detected in comparisons between the lease sites and the means of their respective controls (NSW Fisheries, 1996). The results of benthic fauna surveys more than a decade later revealed only a small amount of evidence of ecological impact which was only within the bay where the mussel farm was located (Underwood & Hoskins, 1999).
- The results of a monitoring program on a pearl farm at Wanda Head, Port Stephens found no change in nitrogen, phosphorus or TOC in sediment beneath the lease (O'Conner *et al*., 2002). Studies also found no evidence of impact on benthic fauna beneath the farm or to seagrass beds at Wanda Head (Gifford, 2006).
- The farming activities in Twofold Bay have had a minimal impact despite the mussels being farmed at shallower depths (10 m), slower current speeds and higher stocking densities (approximately four times greater) than the pearl farm at Wanda Head (O'Conner *et al*., 2002).
- The results of the monitoring program in 2012 of the mussel farm in Twofold Bay (Eden Sea Farms) confirm the large spatial variability in TOC and support the conclusion that the operation of the mussel leases has not led to a significant increase in TOC when compared to the control sites. No significant impact on TOC

levels has been detected in the last three surveys (i.e. 2007, 2009 and 2012) so additional management has not be considered necessary (Cardno Ecology Lab, 2012).

These NSW examples are relatively small scale compared to the large area of longline installed in Western Australia and internationally.

Crawford *et al*. (2003) investigated the benthic environment under and near three shellfish farms in Tasmania which had a relatively high level of production over many years. Sediment deposition, sediment sulphide concentrations, redox values, organic carbon content and water turbidity levels near the bottom were not significantly different between sites outside the farm, at the boundary and sites within the farm. Dense beds of seagrass were observed in video surveys both outside the farm and under trays of oysters on one of the farms (Crawford *et al*., 2003). The benthic infauna did not show clear signs of organic enrichment, and neither univariate nor multivariate measures of benthic infauna were significantly different between sites inside and outside the farm, although they were different between farms. This study concluded that shellfish farming was having little impact on the benthic environment in Tasmania. The farms investigated also had characteristics less than ideal for shellfish culture i.e. low current flows, sediment with high silt and clay content and relatively shallow depths (Crawford *et al*., 2003).

A review of the ecological effects of farming shellfish in New Zealand also indicated that seabed effects were low to moderate, consisting of minor enrichment of seabed sediments (organic content increased by ~7.5%), increased build up of shell debris directly beneath the leases, and increased aggregations of starfish and other epifauna in some instances (Keeley et al., 2009). Seabed effects were found to be most pronounced directly beneath the leases, reduced rapidly with distance, and were usually difficult to detect within 20 to 50 m from the farm. Water depth and current speeds were found to be the most important factors influencing the magnitude of effects. Locating farms in well-flushed areas where species and habitats of environmental significance are not present has been found to greatly minimise impact (Keeley *et al*., 2009).

Studies that have detected significant impacts from shellfish farms (e.g. extensive bacterial mats, changes in benthic community composition and localised depletion of plankton) have usually been where leases were over-stocked (Ysebaert *et al*., 2009) and exceeded the ecological carrying capacity of the region (Joyce *et al*., 2010).

To ensure that Commercial Shellfish Aquaculture Leases have a minimal impact, appropriate stocking densities will be used, the leases will be separated from each other, appropriate culture techniques will be implemented (including biofouling removal) and the water quality and benthic environment will be monitored regularly. Jervis Bay is also well

flushed and the leases will be situated in areas with a water depth of at least 10 m and aligned with the direction of the prevailing wave climate to minimise impediments to water flows. If a significant impact on water quality and/or the benthic environment is detected during the operation of the leases, fallowing (i.e. removal of stock and potentially equipment) of sites or reducing stocking densities will be considered.

In accordance with the provisions of the *Fisheries Management Act 1994*, the operator/s of the proposed Commercial Shellfish Aquaculture Leases will be authorised for their activities under an aquaculture permit and lease/s. Under these provisions the permit holder/s will be required to enter into an Aquaculture Lease Security Arrangement (Bond) with Fisheries NSW.

It is a condition of the aquaculture permit that all infrastructure is removed from the lease area/s if operations are expired, cancelled or surrendered. Leases must be cleared of all stock, cultivation materials and equipment before the lessee can be discharged from legal responsibility for the area. In the event that an operator is not in a position to undertake the decommissioning, the Bond will be utilised to undertake required infrastructure removal works.

As the substrate underneath the lease area is primarily composed of fine to medium grained sand and small cobble, no earth works will be required to rehabilitate the site. The only substrate disturbance will be the removal of the anchors and/or stablising anchors, which would only occupy an area of about 1.5 m^2 each. The sandy substrate is relatively mobile and with wave action and water currents constantly circulating within the bay, the sands should naturally redistribute over the disturbed area.

Conclusion

The risk of the Commercial Shellfish Aquaculture Lease areas becoming significantly degraded and requiring rehabilitation was assessed to be ‘low’ when considered in context with the monitoring results from other longline farms in Australia, the good flushing rate of Jervis Bay, the type of substrate present, the small scale of the operations, sustainable stocking densities, the implementation of Water Quality & Benthic Environment Monitoring Program and the Aquaculture Lease Security Arrangement. All of which indicate that it is highly likely that the soft sediment environment within the boundaries of the leases will not be significantly impacted and any minor impacts will return to pre-existing conditions relatively quickly after the removal of the longline infrastructure.

8.1.3 Noise

Table 15: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue of noise during the construction and deployment stage (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will uncharacteristic noise levels be generated during the construction and deployment stage (i.e. in level, type and/or duration) and is it likely to have a significant impact on adjacent communities and/or marine fauna?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *What types of machinery will be employed during the construction and deployment stage?* ▪ *Will there be a significant increase in noise levels during the construction and deployment stage of the project?* ▪ *Is the noise uncharacteristic for the construction and deployment sites and likely to exceed acceptable levels?* ▪ *Will the noise generated during the transport and deployment of the longline infrastructure disturb marine fauna?* ▪ *What is the duration of the construction and deployment stage?* ▪ *What mitigation and management measures are available to minimise the level of noise generated?*			
Description	▪ Proposed construction site = land zoned for industrial activities ▪ Noise generated will not be uncharacteristic for area ▪ Construction/pre-assemblage and deployment stages = short-term duration (i.e. several weeks) ▪ Types of machinery = outboard motors, diesel/motor generator, mobile crane, truck, hand and small power tools			

Proposed Management – Mitigation and Monitoring	▪ Comply with *Protection of the Environment Operations (Noise Control) Regulation 2008*
	▪ Comply with industry best practice for noise management
	▪ Marine Fauna Interaction Management Plan & Observer Protocol (Appendix 1)
	  o Employ observers when transporting and deploying longline infrastructure
	  o Comply with the NPWS maximum approach distance for marine mammals			

Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

(a) Impact on the Community

Noise will be generated in conjunction with the construction, transport and deployment of the longline infrastructure. When assessing the impact of noise generated during the construction stage, it is recommended that consideration is given to ambient noise levels, existing land uses, noise source level, duration of operation and deployment activities, presence of noise softening measures (e.g. buildings or topography variations) and the sensitivity of the receiving environment (Cardno Ecology Lab, 2010).

NSW OEH is responsible for the regulation of noise from activities scheduled under the *Protection of the Environment Operations Act 1997* (POEO Act). The *POEO (Noise Control) Regulation 2008* also sets certain limits on noise emissions from vessels, motor vehicles and domestic use of certain types of equipment (Web Reference 18). The proposed activity is not scheduled under the POEO Act. Similarly, the *Interim Construction Noise Guideline* outlines how impacts from construction related noise are managed (NSW DECC, 2009). These regulations and guidelines will be referred to during the construction and deployment stage of the project to ensure compliance with all relevant provisions (Web Reference 18).

Industry best practices for noise management will be employed during the construction and deployment of the longline infrastructure to minimise the impacts of noise. Some examples of industry best practices include:

- Use of well-maintained sound suppression devices (e.g. barriers, baffles and mufflers) when operating equipment;
- Acknowledging concerns and complaints and aiming to resolve them cooperatively;
- Manoeuvring vessels with minimal acceleration to minimise boat motor noise;
- Use of marine radios to communicate between vessels;
- Use courteous language in the vicinity of other waterway users;
- Ensure truck drivers are informed of designated vehicle routes, parking locations, acceptable delivery hours and other relevant practices e.g. no extended periods of engine idling and minimising the use of engine brakes;
- Maintaining good communication between the community and lease staff; and
- Due to the potential for surrounding communities to be impacted by the noise generated during the construction stage, hours of operation are recommended as follows:
    - Monday to Friday – 7 am to 6 pm;
    - Saturday – 8 am to 4 pm; and

- Avoiding construction work on Sundays or Public Holidays where possible.

The most likely construction site for the partial pre-assemblage of the longline infrastructure is Woollamia Industrial Estate. This area hosts a range of businesses which undertake a variety of industrial activities. The Woollamia Industrial Estate is also isolated from nearby residences by tracts of vegetation which dampen noise impacts from the estate. Consequently, the noise associated with the construction/pre-assemblage of the infrastructure will not be uncharacteristic for the area. The longline construction will be undertaken in accordance with approvals for the selected land based site which will be lodged in a separate application submitted by the lease operator/s.

The waters of Jervis Bay are currently used by a range of vessels from small tinnies to commercial tourist vessels and large Naval vessels. These waters are also frequented by Naval helicopters undertaking training exercises. The vessels used to deploy the longline infrastructure will be similar to existing vessels that use the bay. The vessels used during the deployment of the infrastructure will not introduce noise that is uncharacteristic of the acoustic environment of Jervis Bay.

Conclusion

The risk of the noise associated with the construction (i.e. pre-assemblage) and deployment of the longline infrastructure having a significant impact on the community was assessed to be 'low' when considered in context with the proposed location for construction/pre-assemblage which is an existing industrial area, the industry best practices that will be implemented, the existing acoustic environment of Jervis Bay and the small scale and short-term nature of the works.

(b) Impact on Marine Fauna

Some human activities such as oil exploration, coastal construction, seismic surveying and marine vessel transport, produce noises that overlap the hearing frequency of marine mammals which can interfere with communication and ambient sounds (Miller *et al*., 2000; Foote *et al*., 2004). Sound is the primary means for marine mammals, especially cetaceans, to communicate, detect prey and predators, navigate and obtain information about their environment (Hatch & Wright 2007; Weilgart, 2007a).

Marine fauna behaviour can potentially be disrupted by exposure to anthropogenic noise, including temporary shifts of migratory corridors or habitat areas, masking of calls to prey, conspecifics and/or important environmental sounds, as well as short-term behavioural reactions (Richardson *et al*. 1985). In particular, short-term reactions of cetaceans to disturbances range from alteration of dive rates, changes in direction and speed to increased

aerial behaviour (Garciarena 1988; Blane and Jaackson 1995; Rivarola *et al*., 2001; Magalhães *et al*., 2002).

Responses of cetaceans to anthropogenic sound sources have been found to vary within and between species, habitat and sound type (Gulesserian, 2009). However, generally cetaceans appear to have a greater reaction threshold to steady, continuous sounds from stationary industrial activities, such as drilling, and a lower threshold to sound that is novel or increases in strength, such as an approaching vessel (Richardson *et al*., 1995; Richardson and Wursig, 1997). The behavioural state of an animal before being exposed to the activity has been found to strongly influence this threshold. Cetaceans for example, tend to be more responsive to potential disturbances when resting and less reactive when socialising, mating or feeding (Richardson and Wursig, 1997). In addition, an animal's age, sex and environmental factors (e.g. season and location) have been found to influence responses to stimuli (Perry 1998; Weilgart, 2007b).

There is the potential for the transport and deployment of the longline infrastructure to introduce anthropogenic noise (i.e. acoustic pollution) into the marine environment via increased marine vessel transport due to the installation of the aquaculture infrastructure. Marine vessel movements between the Commercial Shellfish Aquaculture Leases and wharf facilities may be 0-6 return trips per day during the deployment stage. The vessel movements associated with the deployment of the longline infrastructure would represent a small increase in movements in Jervis Bay and it would only be for a short duration (i.e. several weeks). Once the longline infrastructure has been installed the number of marine vessel movements is expected to decrease to about 0-3 return trips per day per lease.

Observers will be employed to keep watch for cetaceans, pinnipeds and turtles while transporting and deploying the longline infrastructure to mininise any impacts associated with potential acoustic pollution. A travel distance of 50 to 300 m (depending on species) from vessels will be maintained if there are any reports or sightings of marine fauna during transportation (Web Reference 19). Similarly, deployment operations will not be carried out until marine fauna are beyond 50 to 300 m from the boundary of the leases.

The 50 to 300 m distance is based on the prescribed approach distances to marine mammals (i.e. 300 m for a whale cow and calf pair, 50 m for dolphins and 100 m for a dolphin and calf) in NSW as stated in Clause 61 of the *NSW National Parks and Wildlife Regulation 2009* (Web Reference 19). However, the proponent will be required to consult with NSW OEH prior to commencement of the deployment stage to determine the latest approach distances to marine mammals in NSW and these distances will be included in all protocols related to marine fauna and the operation of the Commercial Shellfish Aquaculture Leases.

If there are any signs of distress indicated by sudden or erratic changes in behaviour, including quick dives, aggressive behaviour and irregular changes in swimming speed and/or direction, the distance from animals will be increased. If signs of extreme distress become apparent, deployment operations will cease until the animals are well away from the Commercial Shellfish Aquaculture Leases (Web Reference 19).

A Marine Fauna Interaction Management Plan will be implemented during the deployment of the longline infrastructure, which includes an Observer Protocol (Appendix 1). The operators will be required to monitor interactions between marine fauna, the longline infrastructure and service vessels. The behaviour and movement pathways of marine fauna, as well as details of the activities occurring in the area and the responses of lease personnel will be documented.

Conclusion

The risk of marine fauna being significantly impacted by noise generated during the transportation and deployment of the longline infrastructure was assessed to be ‘low’ when considered in context with the short duration of the activity, the existing noise levels and the management measures that will be implemented i.e. minimum approach distances, Marine Fauna Interaction Management Plan and Observer Protocol.

8.1.4 Land Based Infrastructure

Table 16: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – impacts on existing land based infrastructure (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the existing land based infrastructure (i.e. roads, boat ramps, wharfs, jetties and waste facilities) be significantly impacted by the construction and/or operation of the Commercial Shellfish Aquaculture Leases?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Is the necessary infrastructure (e.g. roads, wharfs, jetties, electricity & moorings) available in the Jervis Bay region?* ▪ *Will any upgrades of existing infrastructure be required?* ▪ *Will there be any impacts on assets e.g. breakwaters or boat ramps?* ▪ *Will the construction and deployment of the longline infrastructure impact on air, soil and/or water quality?* ▪ *Are there any issues relating to waste management during the construction and deployment stage that need to be considered?*			
Description	▪ No new infrastructure required as existing land based facilities are adequate, including: o Woollamia Industrial Estate o Woollamia boat ramp o Callala Bay boat ramp			
Proposed Management – Mitigation and Monitoring	▪ Consultation with community to determine the most appropriate facilities to be used at the land/water interface ▪ Small increase in vehicular and marine vessel movements relative to existing traffic			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

The Commercial Shellfish Aquaculture Leases proposal does not involve the construction of any new land based infrastructure or any upgrades of existing water access facilities in the Jervis Bay region. Any development of land based facilities associated with the proposed Commercial Shellfish Aquaculture Leases will need to be evaluated through a separate development approval process by the Shoalhaven City Council.

Land based infrastructure such as a depot/warehouse and launching facilities will be required to operate and maintain the proposed Commercial Shellfish Aquaculture Leases. In discussions with staff from Shoalhaven City Council, it was identified that the depot/warehouse(s) should be established on land zoned for industrial purposes to ensure that supporting services and infrastructure would be available.

There are some limited land based facilities within Booderee National Park but it is unlikely that these would be utilised due to restrictions on commercial activities within the park. Currently, the only land developed for industrial purposes in close proximity to Jervis Bay is located off Woollamia Road in Woollamia (near Huskisson) (Figure 38). The most appropriate location for land based site is at the Woollamia Industrial Estate.

Figure 38: Woollamia Industrial Estate and boat ramp (insert) in Jervis Bay (Source: Google Earth & Fisheries NSW, 2013).

Depot/warehouse facilities will be required for the storage of vessels, maintenance materials, new or used infrastructure and the harvested product (Figure 39). In addition, value adding facilities such as product cleaning, processing, packaging and refrigeration, may also be stored or used within the depot/warehouse facilities.

Daily operations and maintenance activities associated with the Commercial Aquaculture Shellfish Leases will generate wastes, such as worn infrastructure, damaged equipment, damaged product, biofouling and general waste, which may need to be stored at the land based site prior to its disposal at approved waste management facilities.

Figure 39: Industrial shed and working punt (insert) - an example of a suitable land based facility and vessel that may be used by the operators of the leases (Source: Fisheries NSW, 2010).

There are a number of land/water access points in Jervis Bay but the Woollamia and Callala Bay boat ramps are considered the most suitable locations to launch and retrieve the large trailer vessels that will be used to operate and maintain the leases.

Woollamia boat ramp is located about 1 km from Woollamia Industrial Estate and access to Jervis Bay is via Currambene Creek. The boat ramp has two lanes, wharf facilities on both sides and a parking area with over 40 formal parking bays (Figure 40). The ramp is currently used by both commercial and private vessel operators with peak usage during summer.

Figure 40: Woollamia boat ramp, carpark (left) and wharf facilities (right) (Source: Fisheries NSW, 2013).

The boat ramp at Callala Bay is a single lane ramp which lauches directly into the embayment of Jervis Bay and has over 20 formal car and trailer parking spaces (Figure 41). The closest established industrial area to this township is located in South Nowra about 20 km from the Callala Bay boat ramp.

Figure 41: Callala Bay boat ramp and parking area (insert) (Source: Fisheries NSW, 2013).

There is also a public wharf facility located in Huskisson, which may be used during the construction stage and occasionally during the operational stage to load service vessels. Any use of this wharf would need to be done in consultation with the Huskisson Wharf Management Committee. This wharf is not currently being considered for activities such as cleaning of product, sales or regular daily operational and maintenance activities.

During the construction stage the movement of vehicles and marine vessels between the leases, wharf facilities and depot/warehouse may be as high as six return trips per lease per day to install the longline infrastructure. Once the infrastructure is installed the movement of vehicles and marine vessels is expected to be in the range of 0-3 return trips per day per lease to undertake inspections, maintenance and harvesting. Vehicular and marine vessel traffic associated with leases would represent a very small proportion of the total number of vehicles and marine vessels in Jervis Bay on any given day.

To avoid potential risks and conflicts associated with limited parking spaces in the car parks next to the boat ramps at Woollamia and Callala Bay, the operators may return vessel trailers back to the depot/warehouse or another suitable location after vessels have been launched.

There are no obvious concerns relating to waste management or degradation of air, soil or water quality during the various stages of the Commercial Shellfish Aquaculture Lease project should the activities proceed in the existing industrial area.

There are no obvious concerns relating to waste management or degradation of air, soil or water quality at the land based site during the various stages of the Commercial Shellfish Aquaculture Lease project as the activities will occur in an existing industrial area.

Conclusion

The risk of existing land based infrastructure in Jervis Bay, including roads, boat ramps, jetties and wharves, being significantly impacted by activities associated with the construction and operational stages of the Commercial Shellfish Aquaculture Leases was assessed to be ‘low’ when considered in context with the relatively small increase in vehicular and marine vessel traffic, and the community consultation that was undertaken to determine the most appropriate land/water access points.

8.1.5 Structural Integrity and Stability – Longline Infrastructure

Table 17: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – structural integrity and stability of the longline infrastructure (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will severe weather significantly impact on the structural integrity and stability of the longline infrastructure?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *How will structural integrity of the longline infrastructure be ensured?* ▪ *Will the longline infrastructure be able to withstand severe weather events?* ▪ *Is it possible that parts of the infrastructure may break free and become navigation hazards?*			
Description	▪ Anchoring and bridle system o Heavy chains o Suitably sized anchors (dependent on conditions at each lease) o Polypropylene rope (diameter of 25-35 mm) ▪ Wave climate o Wave energy disperses over whole bay = generally small o Predominant wave/swell direction = south o Mean wave height = 1-2 m o Maximum recorded wave height = 7 m o Wave period = 6-14 seconds			
Proposed Management – Mitigation and Monitoring	▪ Structural Integrity and Stability Monitoring Program (Appendix 1) o Regular inspections and maintenance o Inspections and maintenance immediately after severe weather o Longlines will be checked for damage after being cleaned of biofouling ▪ Design and modifications o Use of existing and proven technologies ▪ Suitably qualified personnel to oversee the installation of longline infrastructure			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

Longline aquaculture within the marine environment has been undertaken worldwide for more than 40 years. Longline infrastructure is designed and constructed using established engineering knowledge and ongoing research ensures that engineering standards continue to improve.

Ongoing research is being undertaken into engineering parameters in a range of environments to ensure the sustainable development of aquaculture infrastructure (Web Reference 20). This research is published in the scientific journal, *Aquacultural Engineering*, which aims to apply knowledge gained from basic research, which in turn can potentially be translated into commercial operations (Web Reference 20).

The development of the longline infrastructure will be done utilising proven technologies and established engineering knowledge and models will be used during the design process. The design will accommodate the dynamic marine environment of Jervis Bay and be tailored to withstand the recorded maximums for wave height, tidal range, swell and wind speed (See Section 6.1, 6.5 and 6.6). Utilisation of the latest engineering knowledge will mitigate the risk of equipment failure and the occurrence of stock losses.

Aquaculture engineering knowledge and longline technology has developed greatly since the initial deployment of aquaculture infrastructure in Jervis Bay in the late 1970s. Initially NSW offshore marine shellfish aquaculture was conducted using rafts from which the culturing apparatus was suspended. This was the standard practice worldwide for culturing shellfish species such as mussels, oysters and scallops. Raft technology was found to have a number of limitations in the high energy coastal environments of NSW, especially during heavy seas which often resulted in damage to the infrastructure and loss of large quantities of stock. In response to this, the aquaculture industry in NSW investigated the use of longline systems which were being used in similar environments overseas and in other states of Australia. The use of rafts is not proposed as part of this proposal.

Longline culture has been used successfully in Twofold Bay for more than 20 years and has replaced rafts as the preferred culturing infrastructure. The longlines installed in Twofold Bay have regularly withstood significant storm events with wave heights of about 6 m and only experienced very minor losses of stock. The rafts on the other hand have been severely damaged or destroyed with significant stock losses (C. Boyton - Director, Eden Sea Farms 2013, *pers. comm*.).

Wave energy is generally small within Jervis Bay because as energy enters at the mouth it is distributed across the circumference of the whole bay (Joyce *et al*., 2010). Waves and swells are predominately from a southward direction with a mean wave height of 1-2 m while the maximum recorded wave height is 7 m (Brown *et al*., 1995). Waves and swells are

predominately from a southward direction with a wave period of 6-14 seconds (McCowan *et al.,* 1987 cited in Joyce *et al.,* 2010). Further analysis of the region's wave climate will be undertaken by structural engineers and/or longline manufacturers to ensure structural integrity and stability of the infrastructure in all weather conditions.

The longline infrastructure will consist of anchoring systems and a longline backbone from which the culturing apparatus will be suspended. The anchoring system will consist of suitably sized anchor/s to suit the environmental conditions at each lease. Attached to the anchor/s will be a length of heavy chain which will be connected to the mooring lines (made of polypropylene rope) with a thickness of 25-35 mm. The length of heavy chain will assist in ensuring that the longline infrastructure remains in the designated location and it will also act as a ballast to maintain the infrastructure in a taut state whilst allowing for depth changes associated with tides and wave action. The maintenance of tightly tensioned ropes is crucial to prevent marine fauna entanglement.

The longline backbone used to support the culturing apparatus is then attached to the mooring line. Plastic buoys are placed at appropriate intervals along the backbone to support the infrastructure and stock being cultured. The number of plastic buoys installed along the backbone will depend on the quantity of the stock being cultured. The basic design of the proposed longline infrastructure is illustrated in Figure 42.

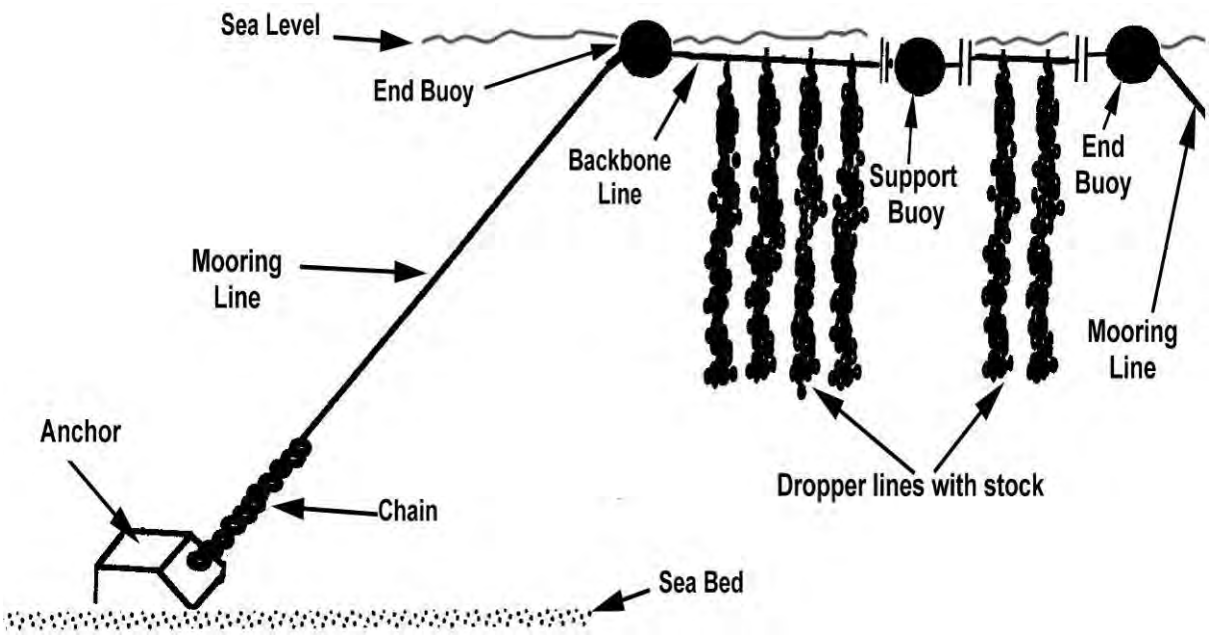

Figure 42: A schematic diagram of the basic components of the longline infrastructure (Source: Fisheries NSW, 2012).

All longline infrastructure will be routinely inspected (including *in situ* diving assessments) and cleaned of biofouling as part of the ongoing operation of each lease to ensure all components remain structurally sound and stable. Notably, the backbone lines and buoys will be required to be visually inspected every week (weather permitting) to ensure all

backbone lines are taut. Cleaning of the longlines will be undertaken every 2-4 weeks or when considered necessary (e.g during winter months cleaning may be needed less frequently due to slow growth rates). The mooring infrastructure (anchors, chains and mooring ropes) will be serviced at least once a year to maintain good order and condition. Inspections and maintenance of the longline infrastructure will also be conducted after severe weather to ensure that structural integrity has not been compromised. The inspection and maintenance procedures will be described in the Structural Integrity and Stability Monitoring Program (Appendix 1).

The operator/s of the proposed Commercial Shellfish Aquaculture Leases will be authorised for their activities under an aquaculture permit and lease/s in accordance with the provisions of the *Fisheries Management Act 1994.* Under these provisions the permit holder/s are responsible for maintaining their lease infrastructure to appropriate standards and be responsible for any lease infrastructure that may leave the lease area. Permit holders are also required to enter into an Aquaculture Lease Security Arrangement (Bond) with Fisheries NSW. In the event that longline infrastructure breaks away from the lease due to an extreme weather event, vandalism or unexplained equipment failure, the bond can be used to clean up any shellfish debris or lost infrastructure if the operator fails to attend to removing the waste.

Conclusion

The risk of the structural integrity and stability of the longline infrastructure being significantly impacted (i.e. becoming dislodged or compromised in any way) by severe weather was assessed to be ‘low’ when considered in context with the predominately low wave energy in Jervis Bay, the use of existing technologies that have proven effective overseas, other Australian states and in similar embayments in NSW, the use of suitably qualified personnel to oversee the installation of the infrastructure, and the implementation of a Structural Integrity and Stability Monitoring Program which will include regular inspections and maintenance.

8.1.6 Coastal Processes and Climate Change

Table 18: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – climate change and impacts of the longline infrastructure on coastal processes and water flow (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the installation of the longline infrastructure have a significant impact on coastal processes and water flow in Jervis Bay? Is climate change likely to have a significant impact on the operation of the leases?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Will the longline infrastructure interrupt water movement in Jervis Bay e.g. flushing rates, wave action, water circulation or any other coastal processes?* ▪ *Is the longline infrastructure likely to cause changes in wave behaviour, including wave dispersion and creation via amendments to orbital/oscillatory motions?* ▪ *Is coastal inundation or wave run up/reflection an issue?* ▪ *Is climate change expected to have a significant impact on the operation of the Commercial Shellfish Aquaculture Leases?*			
Description	▪ Wave processes in Jervis Bay = refraction, shoaling, diffraction and reflection o Wave climate = low/moderate (energy distributes across bay) o Predominant wave direction = south o Mean wave height = 1 - 2 m ▪ Semidiurnal and microtidal (mean range 2 m) ▪ Ebb and flood flow = 0.01 to 0.07 m/sec ▪ Current flow = clockwise direction, enters southern end of bay and discharges near seabed on northern side o Mouth of bay = 0.2 m/s o Inside bay = 0.3 - 0.12 cm/s			
Proposed Management – Mitigation and Monitoring	▪ Longline infrastructure design o Open, streamlined and flexible ▪ Small scale (0.4 % of Jervis Bay) ▪ Biofouling removal - regular cleaning of ropes, moorings and culture apparatus ▪ Jervis Bay – well flushed			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

Coastal Processes

Waves travelling from deep water to the shallower areas may be transformed by the processes of refraction, shoaling, attenuation, reflection, breaking and diffraction (Demirbilek, 2002). At the depth of the proposed Commercial Shellfish Aquaculture Leases (10 m), the main wave transformation processes are likely to be refraction, shoaling, diffraction and reflection. Orbital velocities and accelerations in the water column below are also generated by waves.

There is constant transportation of water into and out of Jervis Bay due to a circular flow that enters the bay on the southern side and discharges from the bay near the seabed on the northern side (CSIRO, 1994). The hydrological processes in the bay are mainly driven by oceanic processes (e.g. currents). Calculations of flushing times reveal that it takes 6 to 20 days for water to circulate the bay. The variations are caused by differences in the strength of the currents at the entrance of the bay, thermal stratification, varying depths and the shape of the bay (Holloway, 1995).

Tides in the Jervis Bay region are semidiurnal (i.e. two high tides a day) and microtidal with a range of 2 m for spring tides. Tidal currents during ebb and flood flow are very weak with speeds of 0.07 m/s at the entrance of Jervis Bay and less than 0.01 m/s in the inner northern areas of the bay (Holloway *et al*., 1989). The weak tides means there is minimal net horizontal transport of water or dissolved material by the oscillatory tidal flow (Holloway, 1995).

Waves and swells in Jervis Bay are predominately from a southward direction with a wave period of 6-14 seconds (McCowan *et al.,* 1987 cited in Joyce *et al.,* 2010). Mean wave height ranges from 1-2 m and the maximum recorded wave height is 7 m (Brown *et al*., 1995). As energy enters at the mouth it is distributed along the circumference of the whole bay so wave energy is generally small (Joyce *et al.,* 2010).

Overall thermohaline circulation, eddies, tidal processes and coastal trapped wave formation are considered the four main types of currents influencing water circulation in the bay (Joyce *et al*., 2010).

Infrastructure in the marine environment has the potential to alter existing coastal processes. In particular, solid obstructions can potentially have significant ramifications on current and wave processes e.g. changes to current velocity and direction, wave dispersion and creation via amendments to orbital and oscillatory motions, wave run-up, reflection, refraction and diffraction. Changes to these processes could also potentially alter natural patterns of sediment transport.

Currents and waves are key agents for transporting nutrients and wastes (Stevens *et al*., 2008). Lower current speeds within farmed areas could reduce the supply of plankton for the cultured shellfish and increase the risk of food supply depletion, which could limit production (Aure *et al*., 2007) and the dispersal of wastes (Weise *et al*., 2009). Consequently, the potential reduction in water speeds caused by farms should be taken into account when assessing the impact of farms on carrying capacity (Boyd & Heasman, 1998; Aure *et al.*, 2007). Numerical modelling has shown that significant effects on current speeds can occur when aquaculture covers a large proportion of a bay (Grant & Bacher, 2001).

The proposed longline infrastructure is not a solid obstruction but an open and streamlined structure of ropes and culture apparatus, which will be secured to the seafloor using a system of anchors and chains. The supporting buoys and backbone will float on or near the water's surface and will have a degree of flexibility. Only the anchoring system will be in contact with the seabed so bottom currents beneath the proposed leases are unlikely to be altered significantly. Consequently, the subsurface infrastructure of the Commercial Shellfish Aquaculture Leases is not expected to significantly impede the path of waves or currents, which are expected to pass under, over and through this infrastructure with no significant alteration to coastal processes or the stability of the shoreline in Jervis Bay.

Studies which have found that longline shellfish farms can reduce current speeds beyond the boundaries of farms and bays but these have largely been farms that represent 10% or more of the bay (e.g. Plew, 2011). The total area proposed for the three Commercial Shellfish Aquaculture Leases is 50 hectares, which represents 0.4% of Jervis Bay. Consequently, the impact of the longline infrastructure on current flows is also considered to be insignificant when considered in context with the small proportion of the bay that the leases would occupy. In addition, the longline and mooring infrastructure, as well as the culture apparatus, will be cleaned regularly to ensure biofouling does not build up and obstruct water movement through the leases.

Climate Change

Nationally, the effects of climate change are being addressed by the National Climate Change Adaptation Research Facility (NCCARF). NCCARF is leading the research community in a national interdisciplinary effort to generate the information needed by decision-makers to manage the risks of climate change in areas such as water resources, health, emergency management and primary industries. NCCARF will synthesise knowledge, coordinate research activities, broker research partnerships and provide information for decision makers in a form relevant to their sectoral or regional needs. The Facility is hosted by Griffith University in partnership with seven other universities and the Queensland Government. The Australian Government is providing $10 million to support

core functions of the Facility including marine biodiversity and resources (S. Fielder 2012, *pers. comm*.).

Collaborative research has commenced between various government departments, education insititutions and research organisations e.g. NSW DPI (PSFI), University of Tasmania (UTAS), University of Technology Sydney (UTS) and James Cook University (JCU), to assess the effects of climate change on marine shellfish and finfish species, and determine the long-term feasibility of marine aquaculture in the various states.

University of Tasmania and NCCARF for example, produced a report - *Climate Change Adaptation in the Australian Edible Oyster Industry: an analysis of policy and practice,* which reviews and synthesises knowledge about climate impacts, the potential to build adaptive capacity and resilience, and to define adaptation options within the Australian edible oyster industry (Leith & Haward, 2010). The focus was on the three main oyster growing states - NSW, South Australia and Tasmania, and the development and application of a rigorous social research methodology to integrate knowledge from diverse stakeholders in order to find pathways for adaptation in policy and practice.

The approach is referred to as Rapid Collaborative Vulnerability Assessment (RCVA), which draws together information and knowledge from various scientific disciplines and researchers, government agencies and their staff, and the local understandings and experience of oyster growers and industry representatives. The outcome is a broad-ranging and inclusive view of options and priorities for managing climate variability and change in the sector. Possibilities for improving policies and practice are highlighted, as well as the institutions and networks which underpin communication, knowledge production and decision-making (Leith & Haward, 2010).

Concerns about the impact of climate change on the operation of the Commercial Shellfish Aquaculture Leases, include the impact of sea level rise, temperature changes, increased frequency and severity of severe weather, and ocean acidification.

Sea level on the NSW coast is expected to increase by 0.18 – 0.91 m by 2090 – 2100 (NSW DECC, 2007b), which is expected to have little effect on the proposed Commercial Shellfish Aquaculture Leases in the short to medium term. Coastal temperatures are predicted to increase by 0.2 - 1.6° C by 2030 (Smith *et. al*., 2010). According to Leith & Haward (2010), potential changes to sea water temperatures are not thought to be likely to have a direct impact but the synergistic impacts of temperature and other factors needs to be considered. Increased sea water temperatures for example, could affect the distribution and severity of disease outbreaks and Harmful Algal Blooms (HABs). Conversely, elevated sea water temperatures could increase growth rates of shellfish in southern NSW (Leith & Haward, 2010).

Increased frequency and severity of storms due to climate change could increase mechanical stress on aquaculture infrastructure, stock losses and reduce potential work hours on leases (Hobday *et al*., 2008). Wind speed is predicted to increase by about 4% which would be accompanied by increased wave energy. Rainfall is predicted to become more sporadic with heavy rainfall events followed by longer periods of dry weather and increasing evapotranspiration. These changes could exacerbate turbidity and bacterial contamination in wet periods and reduce nutrient availability in dry periods (Leith & Haward, 2010).

No major rivers drain into Jervis Bay, the total catchment area (400 km^2) is very small compared to the area of the bay (124 km^2) and there are no heavily disturbed, densely settled areas or heavy industrial/commercial operations. During high rainfall events, considerable amounts of fine muds may enter the bay but the water mass typically remains on the surface where there is no substantial mixing within the water column as it flows out of the bay (Holloway, 1995). Jervis Bay is well flushed where water is constantly transported in and out of the bay with a flushing time of six to 20 days (Holloway, 1995). Consequently, it is considered unlikely that changes in rainfall will have a significant impact on turbidity, bacterial contamination and nutrient availability in Jervis Bay.

Southern NSW may be affected by increased salinity in embayments and inlets due to the predicted increase in evaporation driven by increases in land and air temperatures and reduced rainfall (Leith & Haward, 2010). There is also strong evidence to suggest that changing salinity regimes may impact on disease processes. The average salinity of the marine waters within Jervis Bay is 35.62 ‰ (Figure 24). Salinity within the bay remains relatively constant throughout the year except after periods of heavy rainfall when fresh water input lowers the salinity (Holloway, 1995). As Jervis Bay is well flushed, it is considered unlikely that the bay will experience a significant increase in salinity.

Estimates of surface pH reduction (i.e. ocean acidification) from modelling range from a decrease in 0.3 to 0.5 pH units over the next 100 years and up to 1.4 pH units over the next 300 years (Leith & Haward, 2010). Calcified marine organisms including shellfish will require more energy to build and maintain calcified structures (Hobday *et al*., 2008). Australian studies have shown that increased carbon dioxide concentrations and water temperature have profound effects on the reproduction and growth of both Sydney Rock Oysters and Pacific Oysters (Parker *et al*., 2009; Parker *et al*., 2010). A study by Parker *et al*., (2010) provides preliminary evidence that selective breeding may be a potential solution to reduce the impacts of elevated carbon dioxide on shellfish species.

The full impacts of climate change on molluscs have not yet been evaluated. However, significant impacts from the primary changes forecasted (e.g. temperature and pH) are

unlikely to drastically impact on the species to be cultured during the first term (15 years with a right of first renewal for an additional 15 years) of the leases due to the following:

- The impact of many environmental variables is a function of not only the extent of the change but also the rate at which they change. A progressive increase to a higher temperature can be less stressful than rapid fluctuations within a more confined temperature range. Jervis Bay is large and a comparatively stable water body with few freshwater inputs and therefore less likely to fluctuate as rapidly as the estuaries currently used for the production of many of the listed species (W. O'Connor 2013, *pers. comm*.).
- Sydney Rock Oysters, Native Oysters, Blue Mussels and Akoya Pearl Oysters are commonly found in estuarine environments, in which temperature and pH variation is typically greater than would be expected in Jervis Bay. These species have some capacity to cope with changing pH concentrations which will assist to mitigate potential impacts associated with ocean acidification (W. O'Connor 2013, *pers. comm*.).
- The proposed shellfish species naturally occur in waters north of Jervis Bay and therefore are likely to have the ability to tolerate increased water temperatures.
- Most research to date has indicated that the early developmental stages of molluscs are the most sensitive to ocean acidification. All of the species proposed for the Commercial Shellfish Aquaculture Leases have been produced in commercial quantities in hatcheries, which would be the only likely source of juvenile scallops, Native Oysters and Pearl Oysters. In the controlled environment of a hatchery the pH and temperature of seawater can be modified to meet the needs of the early developmental stages of each species and protect them during the life stage that is most vulnerable to environmental change (W. O'Connor 2013, *pers. comm*.).

As water temperatures rise along the NSW coastline shellfish species from subtropical to tropical zones will start to colonise the waters of NSW. This provides the opportunity to either culture these species in addition to the species proposed for the Commercial Shellfish Aquaculture Leases or alternatively they may replace the proposed species.

The development of the longline infrastructure will be done utilising proven technologies and established engineering knowledge and models will be used during the design process. The design will accommodate the dynamic marine environment of Jervis Bay and be tailored to withstand the recorded maximums for wave height, tidal range, swell and wind speed (See Section 6.1, 6.5 and 6.6). Utilisation of the latest engineering knowledge will mitigate the risk of equipment failure and the occurrence of stock losses. Longline aquaculture systems are

used in a range of climate zones and have been engineered to withstand cyclonic conditions in the tropics. The longlines installed in Twofold Bay for example, have regularly withstood significant storm events with wave heights of about 6 m and only experienced very minor losses of stock.

Conclusion

The risk of coastal processes and water flow being significantly impacted by the installation of the longline infrastructure was assessed to be ‘low’ when considered in context with the open, streamlined and flexible design of the longline infrastructure, the small scale of the operations (0.4% of Jervis Bay) and the regular removal of biofouling. The risk of climate change significantly impacting on the operation of the Commercial Shellfish Aquaculture Leases was also assessed to be 'low' when considered in context with the characteristics of Jervis Bay (good flushing rate), the relatively broad temperature and salinity tolerances of the proposed species, the ability of the proposed species to adapt to climatic changes, the availability of controlled hatchery facilities and the use of existing longline technologies that have been proven to withstand cyclonic conditions.

8.1.7 Navigation and Interactions with Other Waterway Users

Table 19: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – impacts of the Commercial Shellfish Aquaculture Leases on navigation and other waterway users (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the Commercial Shellfish Aquaculture Leases have a significant impact on navigation and other waterway users in Jervis Bay?
Level of Impact	Individual facility
Comments and Considerations	▪ *Will the leases be a navigation hazard for other waterway users?* ▪ *Are the leases in a high use area or area of restricted navigation?* ▪ *Will the boundaries of the leases be marked with buoys and/or lights?* ▪ *How will waterway users be informed and notified about the installation of the longline infrastructure?* ▪ *Can other waterway users enter and anchor in or near the lease area?* ▪ *Will the leases exclude other waterway user groups (e.g. dive operators, sailors, recreational and commercial fishers, dolphin/whale watching operators) from using an area they previously had access to?* ▪ *Will the leases exclude other waterway users from an area that is unique in the direct and wider study area?* ▪ *How will the security of the leases be maintained?*
Description	▪ Area of Commercial Shellfish Aquaculture Leases = 50 ha (0.4% of Jervis Bay) ▪ At least four navigational marks will be delineate each lease ▪ Other waterway users include recreational and commercial fishers, dive and fishing charters, sailors and whale/dolphin watch operators
Proposed Management – Mitigation and Monitoring	▪ Location = marine embayment o Outside any recognised navigation channels or shipping port approaches o Does not obstruct recognised or significant commercial areas e.g. fishing grounds, diving sites and whale/dolphin watching areas ▪ Staff will be required to have relevant licences and qualifications, undergo regular training and abide by NSW Maritime regulations ▪ Four or more navigational marks will delineate the leases in accordance with the requirements of Roads and Maritime Services ▪ Target user groups will be informed about general boating rules in the vicinity of the leases – keep safe distance ▪ Australian Hydrographic Office will be notified, a 'Notice to Mariners' will be issued and official charts amended ▪ Relevant publications and maps will be amended to include the leases ▪ Traffic Management Plan (Appendix 1) ▪ Comply with the *Australian Aquaculture Code of Conduct*

Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

The degree of impact of aquaculture infrastructure on the safe navigation of vessels and other waterway users in an area depends on its placement in relation to features such as narrow channels, established navigation channels, identified anchorages, recreational, Naval and commercial areas, as well as how clearly marked and visible the structures are to other waterway users, particularly during severe weather.

Waterway users in Jervis Bay include recreational boaters, recreational fishers, commercial dolphin and whale watching operators, SCUBA diving operators, sailing vessels, kite surfers, wind surfers, commercial fishers and Naval vessels. Vessels which access Jervis Bay may be launched from one of the five boat ramps within the bay, including Currambene Creek and/or moored off Callala Bay or Collingwood Beach. Figure 43 and 44 illustrate the main vessel tracks, Naval use areas and moorings within Jervis Bay, as well as the locations of commercial activities such as bait gathering and key dolphin aggregation areas.

The proposed Commercial Shellfish Aquaculture Leases are contained in the marine embayment of Jervis Bay and are not located in any recognised navigation channels or shipping port approaches, and are outside Naval mooring, transiting, training and restricted areas. The proposed areas are not located within any recognised or significant commercial areas e.g. fishing grounds, diving sites and whale/dolphin watching areas.

Concerns were expressed about the potential for sailors to capsize their vessels near the proposed leases, drift onto the longline infrastructure and become entangled. It was suggested that this would be more of a concern during major regattas, when large numbers of visiting sailing vessels could be using the bay. The use of thick ropes which are kept under tension at all times will minimise the risk of entanglement of capsized sailing vessels. The sailing clubs in Jervis Bay will be encouraged to brief all sailors about the presence of the leases prior to all races. Leases will also be identified on NSW RMS waterway maps.

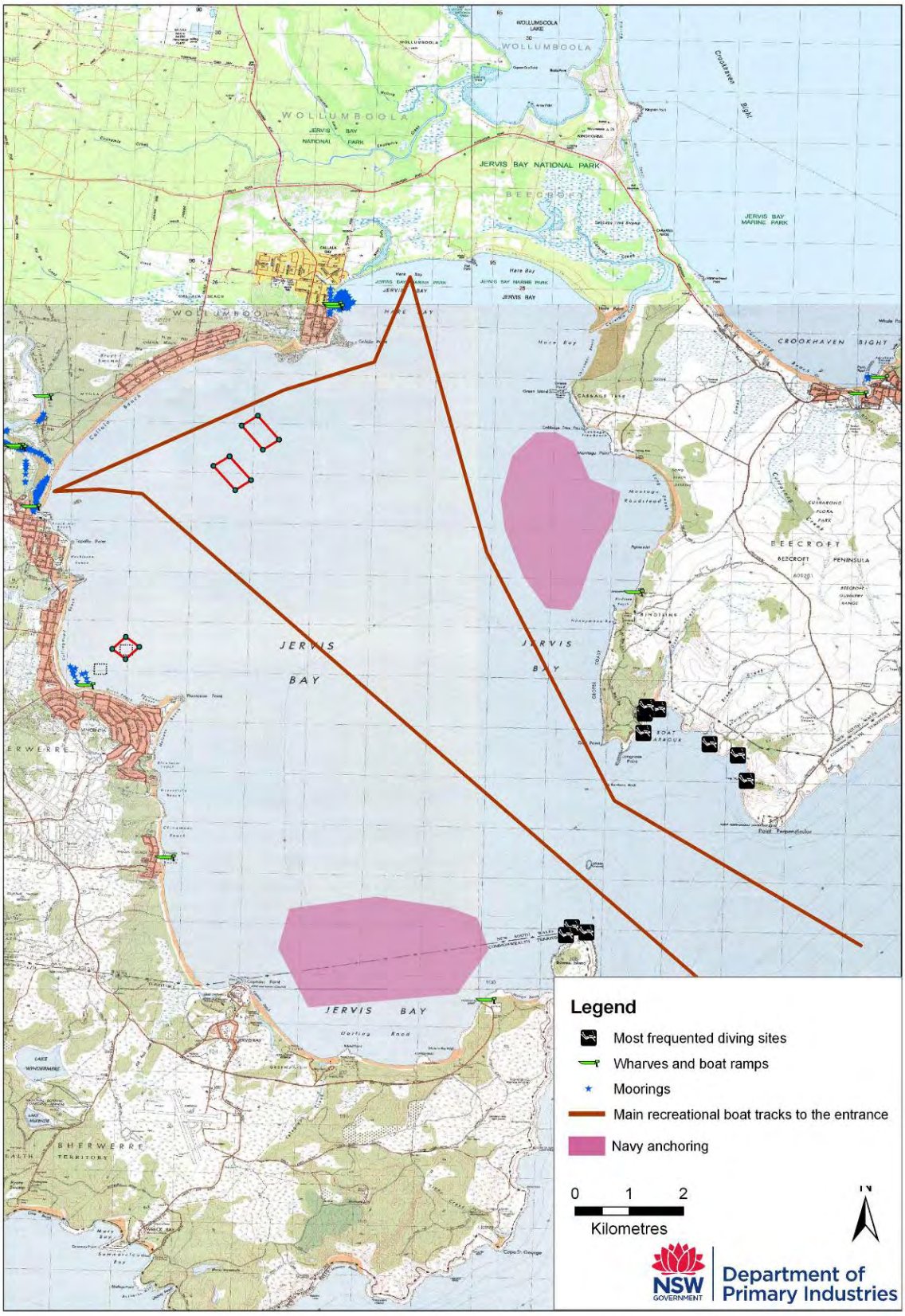

Figure 43: Indicative vessel tracks, Naval use areas and moorings within Jervis Bay (Source: NSW DPI, 2008).

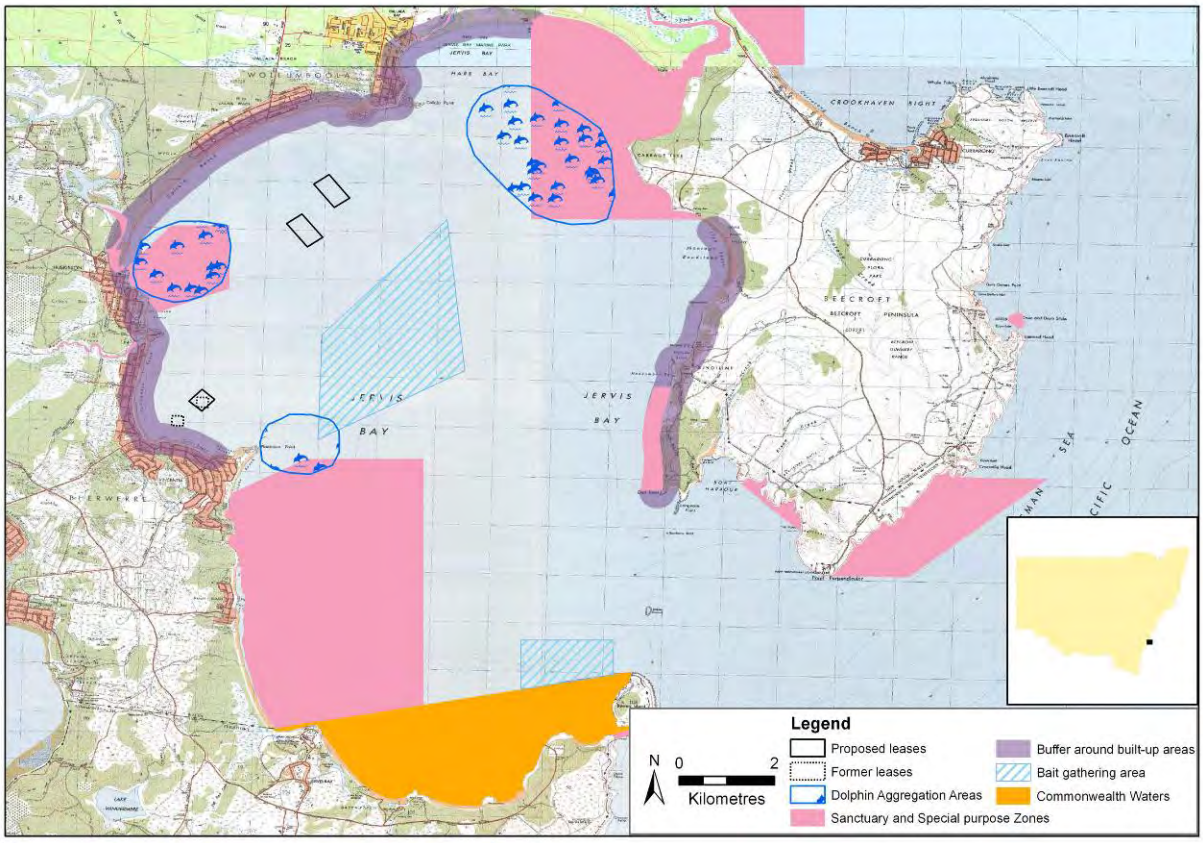

Figure 44: Locations of commercial activities including bait gathering and key dolphin aggregation areas (Source: Fisheries NSW, 2013).

The proposed Vincentia Lease area also has a history of aquaculture activity where raft culture was used for about 30 years with no reports of serious risks to safe navigation.

During discussions with the Jervis Bay and Vincentia Bay Sailing Clubs it was requested that the leases be repositioned from that shown in the preliminary mapping information. In response to this, the two leases off Callala Beach were moved in a north easterly direction and the Vincentia lease was also moved to the north to be located over one of the previous aquaculture leases at this location. It is anticipated that the movement of the leases and the repositioning over the former lease area, which Vincentia Sailing Club had previously coexisted with, will assist in mitigating potential impacts of the leases.

The proposed Commercial Shellfish Aquaculture Leases cover an area of 50 hectares (0.4% of Jervis Bay) which is not unique in the direct or wider area. Target waterway user groups will be informed about general boating rules in the vicinity of the leases and will be encouraged to use caution when passing and/or anchoring in the vicinity of the leases. It will be an offence to interfere with or damage the longline infrastructure or stock under the FM Act. The combination of operational visits to the leases along with remote surveillance measures will be employed to ensure the security of the leases.

To ensure weather conditions are suitable for the deployment of the longline infrastructure, the weather forecast for NSW coastal waters will be consulted. Transportation of the

infrastructure will occur during appropriate sea states to ensure successful deployment and minimise the risk of incidents and infrastructure damage.

It is a NSW RMS requirement that the extremities of aquaculture leases are marked with appropriate navigational marks. In the marine environment these marks are required to be lit and the leases must be marked on navigational charts to aid safe navigation. At least four navigation buoys will delineate each lease (i.e. positioned on the corners) in accordance with NSW RMS requirements and IALA recommendations. Figure 45 illustrates examples of navigation buoys currently used on marine aquaculture leases.

Figure 45: A navigation marker commonly used to mark the boundaries of aquaculture leases (Source: NSW DPI, 2012).

Navigation safety in the area of the Commercial Shellfish Aquaculture Leases will also be maintained by ensuring that all staff partaking in marine vessel transport obtain relevant licences and qualifications, undergo regular training and abide by NSW Roads and Maritime Services regulations and the *Australian Aquaculture Code of Conduct* (Appendix 4). The Code of Conduct specifies that aquaculturists respect the safety and rights of other waterway users by recognising their needs, promoting methods to minimise user conflicts, encouraging consultation with all waterway users to enable concerns to be identified and resolved, promoting goodwill in the community and providing opportunities for education (Web Reference 21).

The Australian Hydrographic Office will be notified of the location of the Commercial Shellfish Aquaculture Leases, a ‘Notice to Mariners’ will be issued and official charts will be amended. NSW Roads and Maritime Services will also be notified of the location of the leases so relevant publications and maps can be amended (e.g. Figure 46).

A Traffic Management Plan will be implemented to minimise and monitor any impacts on navigation and other waterway users during the construction and operational stage (Appendix 1). All interactions with between the Commercial Shellfish Aquaculture Leases and other waterway users will be documented on a daily basis and reviewed periodically.

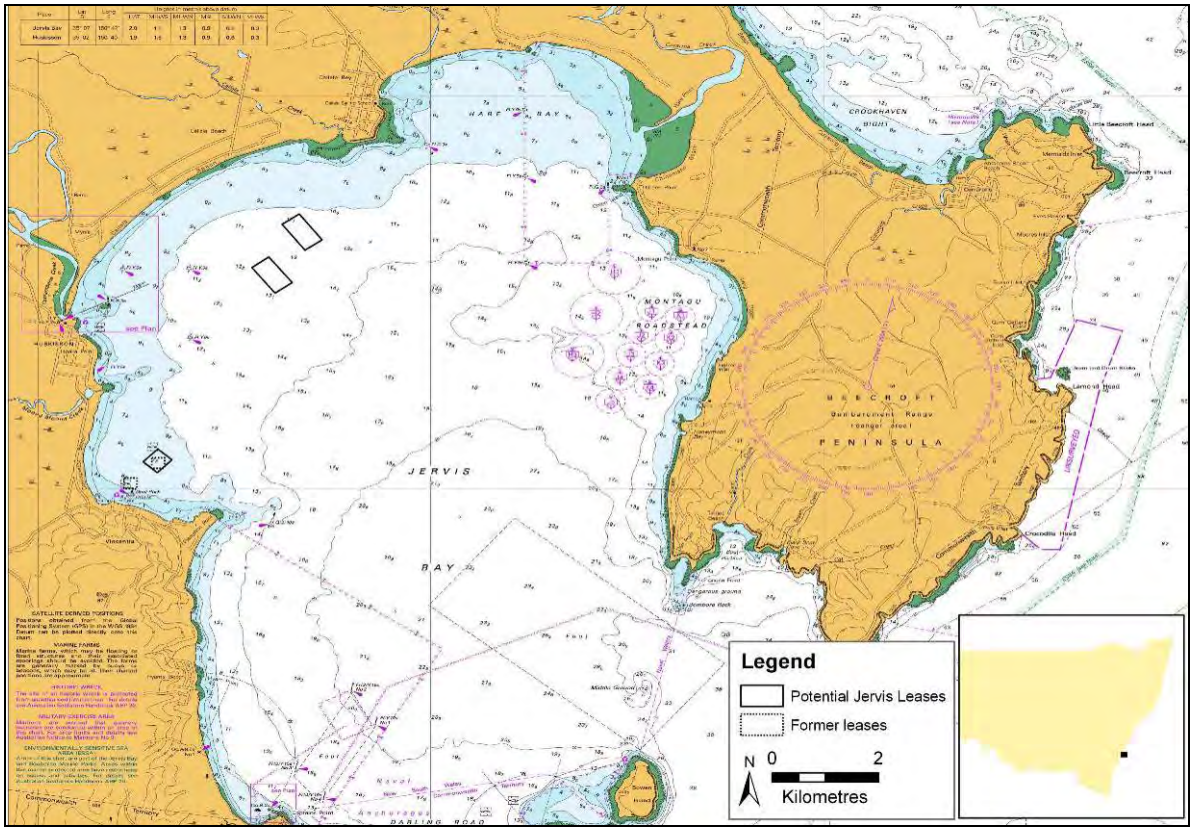

Figure 46: Navigation charts such as this would be updated to include the boundary of the Commercial Shellfish Aquaculture Leases and navigation markers that will delineate the lease areas (NSW RMS, 2011).

Conclusion

The risk of safe navigation and other waterway users being significantly impacted by the Commercial Shellfish Aquaculture Leases and its operation is considered to be 'low' as it is not located in a high use area, it is not obstructing safe navigation, it is not located in area of significant recreational or commercial importance and the area is not unique in the direct or wider study area.

Additionally, appropriate navigational marks will be displayed, notifications will be made to relevant authorities and the community, amendments will be made to relevant documents, operators will be required to act in accord with the *Australian Aquaculture Code of Conduct* and waterway user interactions will be regularly reviewed.

8.2 Operational Risks

This section investigates issues relating to the operation of the proposed Commercial Shellfish Aquaculture Leases.

8.2.1 Impact on the Community

8.2.1.1 Visual Amenity

Table 20: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – visual amenity (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the Commercial Shellfish Aquaculture Leases have a significant impact on visual amenity in Jervis Bay?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Will the longlines be visible from the shore and/or any vantage points?* ▪ *Can the longlines be designed to minimise their visibility from a distance e.g. colour, profile and size?* ▪ *Will the work vessels be different to existing vessels that use the bay?*			
Description	▪ Land based vantage points o Callala Point o Callala Beach o Huskisson Point o Vincentia ▪ Distance to nearest landmarks o Callala Point = 2.2 km o Callala Beach = 1.5 - 1.9 km o Huskisson Point = 2.9 km o Vincentia residential area = 0.66 km ▪ Navigation lights may be visible from beach at night			
Proposed Management – Mitigation and Monitoring	▪ Design features that minimise visibility (e.g. dark coloured materials, low profile and subsurface infrastructure ▪ Vessels used will be similar to existing vessels that frequent the bay ▪ Small scale operations - 0.4% of Jervis Bay			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

Visual impacts are subjective and difficult to quantify as perceptions and attitudes vary considerably (O'Hanlon, 2004). Marine aquaculture facilities are often placed in open waters where there are no permanent man made structures. The installation of aquaculture infrastructure can alter views from passing vessels and potentially adjacent land areas (O'Hanlon, 2004).

A number of design features will be used to minimise the visibility of the longline infrastructure, including the use of dark coloured buoys, minimising and streamlining surface infrastructure, maximising subsurface infrastructure and maintaining a low profile. Service vessels will also be similar to existing fishing, dive and whale/dolphin watching vessels that frequently navigate within Jervis Bay and are visible from the surrounding townships.

The Commercial Shellfish Aquaculture Lease infrastructure will consist of longline systems with either single or double backbones from which the culture apparatus will be connected and suspended (Figure 47). The anchoring and mooring system will largely not be visible from the surface except for where the lengths of polypropylene mooring rope comes to the surface and attaches to the end buoys. The end and support buoys will be partly visible above the surface of the water depending on the biomass of stock cultured. During low stocking periods the buoys may be approximately 30 to 40 cm above the water level and as the stock grows the level could be as low as the surface of the water.

A minimum of four navigation buoys, including flashing lights, will be secured at the corners of each lease, which are likely to be visible from the townships of Jervis Bay at night.

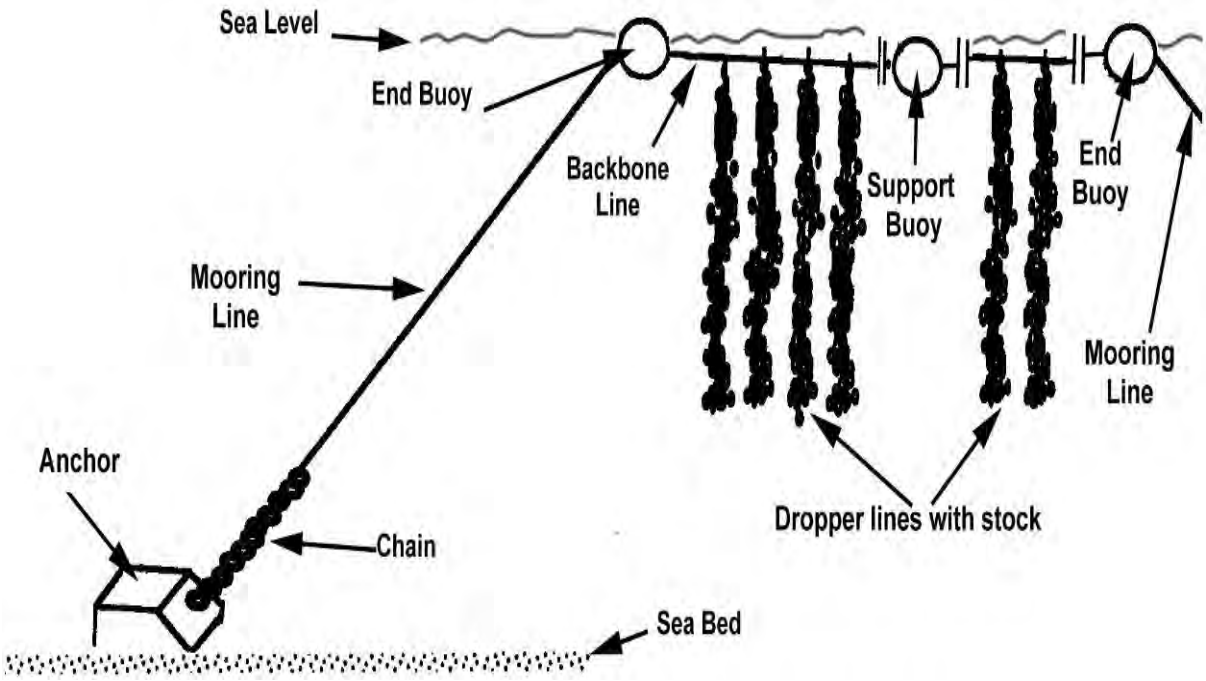

Figure 47: A schematic diagram of the basic components of the longline infrastructure (Source: Fisheries NSW, 2012).

Fisheries NSW visited land based localities in the region to determine potential impacts of the Commercial Shellfish Aquaculture Leases on the visual amenity of the townships of Jervis Bay. Coastal sand dunes along the beach front of Callala Beach predominately screen this township from views of the leases. Only elevated residences have views over Jervis Bay in the direction of the proposed locations for the Commercial Shellfish Aquaculture Leases. Vegetation and topography predominantly screen the townships of Myola, Callala Bay and Huskisson from views of the leases.

The township of Vincentia is situated across a flat coastal strip adjacent to Collingwood Beach and elevates to a hill side to the south of Orion Beach. The residences along the flat coastal strip are predominantly screened of views over Jervis Bay by topography. Only elevated residences have views over Jervis Bay towards the Commercial Shellfish Aquaculture Leases. The residences located on the hill to the south of the Orion Beach are predominantly screened by vegetation and other buildings - only glimpses of Jervis Bay can be seen from this locality. Figure 48 shows the view from the Vincentia Lease looking towards the township of Vincentia.

Figure 48: View from the approximate location of the Vincentia Lease looking towards Vincentia (Fisheries NSW, 2013).

The majority of residences along the coastal areas of Jervis Bay are screened from views of the bay. Only multi storey residences located behind the foredunes of Jervis Bay and some on the elevated positions in Vincentia have views over the bay. However, the distance of the Commercial Shellfish Aquaculture Leases from the shoreline will greatly minimise potential impacts on visual amenity.

Approximate distances from several locations along the shoreline of Jervis Bay to the proposed locations of the Commercial Shellfish Aquaculture Leases are shown in Figure 49.

Figure 49: Approximate distances from shoreline to the proposed Commercial Shellfish Aquaculture Leases (Source: Google Earth & Fisheries NSW, 2013).

Fisheries NSW conducted a visual assessment on four land based locations in the Jervis Bay region that could have views of the Commercial Shellfish Aquaculture Leases. The locations included Callala Point, Callala Beach, Voyager Memorial Park at Huskisson and Vincentia. To assess what would be likely to be visible from the land based sites the NSW Marine Parks (NSW MP) vessel (Figure 50) was positioned on the leases as a point of reference. The NSW MP vessel has a similar visual profile to the vessels that would be used to operate and maintain the Commercial Shellfish Aquaculture Leases. The black line along the side (sponson) of the NSW MP vessel is about the height of the support buoys when the longlines are lightly loaded.

The arrows on Figure 51 indicate the approximate location and direction from which the photos of the NSW MP vessel were taken. The numbers correspond with the photo and location of the vessel on the respective leases.

Figure 50: The NSW MP vessel within Jervis Bay which was used to assist with the visual impact assessment as a point of reference (Source: Fisheries NSW, 2013).

Figure 51: Locations from which photos were taken and of the locations of the NSW MP vessel on the three leases (Source: Google Earth & Fisheries NSW, 2013).

The following provides a brief description of the location from which the photos were taken:

- Photo 1 was taken from a lookout (facing a southerly direction) on Callala Point near the corner of Marine Parade and Morton Street, Callala Bay (Figure 52);
- Photo 2 was taken standing on a sand dune (facing an easterly direction) at the end of Princess Street, Callala Beach (Figure 53);
- Photo 3 was taken from an elevated position (facing a north easterly direction) in Voyager Memorial Park, Huskisson (Figure 54);
- Photo 4 was taken from an elevated position (facing a north easterly direction) at the end of Vincent and Holden Street, Vincentia (Figure 55);
- Photo 5 was taken from an elevated position (facing a north westerly direction) near the Vincentia Sailing Club clubrooms on Plantation Point (Figure 56).

Figure 52: Photo 1 - Taken from Callala Point with the black arrow showing the location of the NSW MP vessel (Source: Fisheries NSW, 2013).

Figure 53: Photo 2 - Taken from the sand dunes at the end of Princess Street, Callala Beach. The black arrow indicates the location of the NSW MP vessel (Source: Fisheries NSW, 2013).

Figure 54: Photo 3 - Taken from an elevated position within the Voyager Memorial Park, Huskisson. The black arrow indicates the approximate location of the NSW MP vessel and a tourist (dolphin watch) vessel can be seen to the right of the arrow about halfway between the NSW MP vessel and Huskisson (Source: Fisheries NSW, 2013).

Figure 55: Photo 4 - Taken from an elevated position at the end of Vincent and Holden Street, Vincentia. The black arrow indicates the location of the NSW MP vessel (Source: Fisheries NSW, 2013).

Even though the weather conditions were calm on the day that the photos were taken, it is apparent that the NSW MP vessel is not highly visible. This would suggest that the buoys, which are significantly smaller than the vessel, would have a minimal impact on visual amenity.

Figure 56: Photo 5 - Taken from near the Vincentia Sailing Club clubhouse on Plantation Point, Vincentia. The black arrow indicates the location of NSW MP vessel (Source: Fisheries NSW, 2013).

To further support Fisheries NSW's findings from the visual impact assessment, photos were taken of the mussel farm in Twofold Bay using the same camera and from similar elevations to the photos taken in Jervis Bay (Figures 57). The photos were taken from the shoreline of Cocora Point and Cocora Beach, Twofold Bay. Despite the calm sea state conditions, the longline infrastructure is only slightly visible from the shoreline. The Commercial Shellfish Aquaculture Leases are greater distances offshore (up to 3 times) than the Twofold Bay mussel farm so the infrastructure will be less visible than what is illustrated in Figure 58.

Figure 57: View of an existing Blue Mussel farm from Cocora Point, Twofold Bay, which is about 200 m offshore (Source: Fisheries NSW, 2012).

Figure 58: View of an existing Blue Mussel farm from Cocora Beach, Twofold Bay, which is about 440 m offshore. The buoys are just visible between the point and the offshore reef (Source: NSW Fisheries, 2012).

A number of water based activities impact on the visual amenity of Jervis Bay, including sailing, windsurfing, recreational boating, commercial tourist vessels and Australian Navy activities such as vessel and aircraft movements. In addition, the prevailing wave and swell direction in Jervis Bay is from a southward direction and the mean wave height is about 1-2 m (Brown *et al*., 1995). Also, the height of the buoys under light loads is likely to be about 40 cm above the water surface. Considering these factors, it is unlikely that the longline structure will be noticeably visible from surrounding townships in Jervis Bay.

Conclusion

The risk of the visual amenity of Jervis Bay being significantly impacted by the installation of the Commercial Shellfish Aquaculture Leases infrastructure and activities associated with the operation of the leases is considered to be ‘low’ due to the predominantly low profile of the topography on the western side of Jervis Bay, the distance from townships and key landmarks, the infrastructure design features that will be utilised, the use of vessels that are similar to existing boats in the area and the sea state conditions that are characteristic of Jervis Bay.

8.2.1.2 Marine Vessel and Vehicular Transport

Table 21: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – marine vessel and vehicular transport associated with the operation of the Commercial Shellfish Aquaculture Leases (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will marine vessel and vehicular transport associated with the operation of the Commercial Shellfish Aquaculture Leases have a significant impact on the communities and visitors of the Jervis Bay region?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Will there be a significant increase in the number of marine vessel movements in Jervis Bay due to daily operations and maintenance?* ▪ *Will there be a significant increase in the number of road vehicle movements around the Jervis Bay region due to daily operations and maintenance?* ▪ *Is the expected increase in marine vessel and vehicle movements likely to pose navigation and/or congestion issues on the waterways or roads of Jervis Bay?*			
Description	▪ Marine vessel movements o 0-3 trips per lease each day ▪ Vehicular movements o 0-3 trips per lease each day			
Proposed Management – Mitigation and Monitoring	▪ Minor increase in marine vessel and vehicular movements ▪ Staff will be required to obtain relevant licences, qualifications, regular training and abide by regulations ▪ NSW Roads and Maritime Services will be notified when longline installation is to commence ▪ Vehicle loads will be safely secured and covered if required ▪ Movements of vehicles will be limited to predominately normal working hours ▪ Trailers may be parked outside of the boat ramp parking areas during peak periods to mitigate potential of increased congestion ▪ Appropriate flags, symbols and signs will be displayed ▪ Traffic Management Plan (Appendix 1)			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

(a) Marine Vessel Transport

Purpose designed and built boats will be used for the operation and maintenance of the Commercial Shellfish Aquaculture Leases. The vessels may be punt type vessels with a length of about 8-10 m which are suitable to be trailered between land based sites and the boat ramps. Oyster aquaculture in South Australia and Tasmania use vessels of this basic design to service the longlines on their leases (Figure 59).

Figure 59: A vessel used to service oyster leases in South Australia (Source: Fisheries NSW, 2010).

The service vessels will contain equipment for the cleaning and maintainence of the longline infrastructure, moorings and culture apparatus, as well as for harvesting stock and conducting other general duties. Other vessels may be contracted out for short periods in addition to the service vessels to assist with specialised activities such as the installation of the longline infrastructure and the navigation marker buoys.

The waters of Jervis Bay are currently used by a range of vessels from small tinnies through to large Naval vessels and commercial tourist vessels. The number of daily vessel movements in Jervis Bay has been estimated to be about 250 - 300 during peak periods (i.e. school holidays, public holidays and long weekends during the warmer months) and about 15 - 20 vessel movements outside those peak periods (F. Clements - A/Manager, Jervis Bay Marine Park 2013, *pers comm*.).

During the operational stage of the Commercial Shellfish Aquaculture Leases marine vessel movements are expected to be in the range of 0-3 return trips per lease per day to undertake inspections, cleaning and maintenance. Consequently, the vessel movements associated with the operation of the Commercial Shellfish Aquaculture Leases will represent an increase

of approximately 2% during the peak periods and potentially up to 30% outside these times of the year.

A number of management measures will be required to be implemented by the operators to ensure the safety of staff and other waterway users while partaking in marine vessel transport. Staff will be required to have relevant licences and qualifications, undergo regular training, abide by NSW Maritime regulations and consult the weather forecast for NSW coastal waters before departing for daily operations and maintenance. Appropriate flags, symbols and signs will also be displayed on marine vessels, such as the Diver Down flag. A Traffic Management Plan will be implemented throughout the operational stage to ensure service vessels associated with the Commercial Shellfish Aquaculture Leases do not cause congestion, impede safe navigation or have any other impact on other waterway users (Appendix 1).

Concerns have been raised about potential fuel or oil spills associated with marine vessel movements in the region. NSW Roads and Maritime Services is the responsible regulatory authority under the POEO Act for pollution (including fuel and oil spills) from vessels in the marine park. NSW Roads and Maritime Services will be contacted immediately if any pollution is detected. In the very unlikely event of a large scale and/or severe pollution incident, the event will be managed in accordance with the *NSW State Waters Marine Oil and Chemical Spill Contingency Plan*.

Conclusion

The risk of the marine vessel transport associated with the Commercial Shellfish Aquaculture Leases having a significant impact on other recreational or commercial waterway users via impeding safe navigation and/or access to wharf, mooring and jetty facilities was assessed to be ‘low’ when considered in context with the relatively minor increase in marine vessel movements and the Traffic Management Plan that will be implemented.

(b) Vehicular Transport

The number of vehicular movements associated with the Commercial Shellfish Aquaculture Leases during the operational stage is likely to between 0-3 return trips per day to transfer personnel and supplies for daily inspections and maintenance, as well as transport harvested stock. Consequently, it is considered unlikely that vehicular movements associated with the leases will have a significant impact on other road users via impeding safe driving, increasing congestion levels on roads, in parking areas, around boat ramps or waste facilities. Similarly, it is considered unlikely that the leases will impact on the integrity of pavements and other road infrastructure due to the relatively minor increase in vehicular traffic.

The Woollamia and possibly the Callala Bay boat ramps may be used by the operators of the Commercial Shellfish Aquaculture Leases to transfer the service vessels in and out of the water each day. The service vessels will be kept at an approved land based site or possibly on an approved NSW Roads and Maritime Services mooring when not in use on the leases. Both the Woollamia and the Callala Bay boat ramps have vehicle and trailer parking areas in the immediate vicinity (Figure 60; Figure 61).

Figure 60: Woollamia boat ramp, carpark (left) and wharf facilities (right) (Source: Fisheries NSW, 2013).

Figure 61: Callala Bay boat ramp and parking area (insert) (Source: Fisheries NSW, 2013).

Woollamia and Callala Bay boat ramp carparks and boat launching ramps operate at full capacity during peak periods, notably on long weekends, public holidays and during the Christmas and Easter school holidays (G. Pullen - Economic Development Manager, Shoalhaven City Council 2013, *pers. comm*.)

The operators of the Commercial Shellfish Aquaculture Leases may use the boat ramps on a daily basis and therefore they will be proficient at launching and retrieving their vessels. It is expected that minimal time will be spent on the boat ramps which will mitigate potential user conflicts and ensure the boat ramp functions efficiently, especially during times of high use. During peak periods when the boat ramp parking areas are likely to reach their full capacity, the operator/s of the Commercial Shellfish Aquaculture Leases may be required to park their boat trailers at a different location such as the land based site e.g. Woollamia Industrial Estate.

The operators will also be required to implement a Traffic Management Plan to ensure the safety of staff and other road users involved with vehicle transport (Appendix 1). Staff will need to have relevant licences and qualifications, undergo regular training and abide by NSW RMS regulations. All vehicles transporting materials will have their loads safely secured and covered if required. To comply with noise regulations the movements of vehicles, notably trucks and construction vehicles, will be limited to normal working hours and signage will be erected to warn motorists of traffic entering and leaving land based sites if considered necessary.

Conclusion

The risk of the vehicular traffic associated with the Commercial Shellfish Aquaculture Leases having a significant impact on other road users via impeding safe driving or increasing congestion levels on roads, in parking areas, around boat ramps or waste facilities was assessed to be ‘low’ when considered in context with the relatively minor increase in vehicular traffic and the Traffic Management Plan that will be implemented.

8.2.1.3 Aboriginal and European Heritage

Table 22: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – Aboriginal and European heritage items and areas (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the Commercial Shellfish Aquaculture Leases have a significant impact on Aboriginal or European heritage items or areas?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Are there any Aboriginal or European Heritage items and/or areas in Jervis Bay?* ▪ *Are there any shipwrecks and plane wrecks in Jervis Bay?* ▪ *Will the Commercial Shellfish Aquaculture Leases and associated activities have an impact on any heritage items?*			
Description	▪ Original inhabitants of Jervis Bay area = Jerrinia, Murramarang and Wreck Bay communities ▪ Aboriginal heritage o Beecroft Peninsula (numerous sites of Aboriginal significance) ▪ European settlement of Jervis Bay (large numbers) = 1950s ▪ European heritage o *SS Mercury* shipwreck = 2 km (east northeast of northern Callala Lease) o *Fairey Firefly plane wreck* = 2.4 km (east northeast of northern Callala Lease)			
Proposed Management – Mitigation and Monitoring	▪ Consultation and database search results support the assessment that no items or areas of heritage significance in area proposed for leases ▪ Significant buffer zone between land based heritage sites/areas, marine heritage sites/areas (e.g. ship and plane wrecks) and the marine based leases			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	0	6	0	**Negligible**
Reporting Requirements	Short justification			

Justification of Ranking

(a) Aboriginal Heritage

"Aboriginal communities have an association and connection to the land. The land and water within a landscape are central to Aboriginal spirituality and contribute to Aboriginal identity.

Aboriginal communities associate natural resources with the use and enjoyment of foods and medicines, caring for the land, passing on cultural knowledge and strengthening social bonds. Aboriginal heritage and connection to nature are inseparable from each other and need to be managed in an integrated manner across the landscape" (DECCW, 2010a).

Relevant NSW and Commonwealth Legislation

NSW Aboriginal heritage management is guided by the following legislation (NSW OEH, 2011a):

- *National Parks and Wildlife Act 1974;*
- *Environmental Planning and Assessment Act 1979*;
- *Heritage Act 1977*;
- *Aboriginal Land Rights Act 1983*;
- *Native Title Act 1993* (Commonwealth); and
- *NSW Native Title Act 1994*.

Under the *National Parks and Wildlife Act 1974*, Aboriginal objects and Aboriginal places in NSW are protected and any proposed activity that may harm an Aboriginal object or a declared Aboriginal place must be investigated and assessed (Web Reference 22). After consulting with the NSW NPWS it became apparent that the proposed Commercial Shellfish Aquaculture Leases are not subject to the Act as it is sea based. Nevertheless, the proponent still wants to assess if there are any items or areas of Aboriginal heritage value that may be impacted by the proposed activity.

Review of Existing Information

Information and data on Aboriginal heritage in the Jervis Bay region was sourced from literature, previous heritage studies, database searches and community consultation.

i. Literature

Evidence suggests that earliest occupation of south-east NSW goes back 20,000 years. This estimate is based on carbon-14 dating techniques used in the archaeological research of a rock shelter 25 km south of Jervis Bay at Burrill Lake. Another record at the base of an open site at Bass Point, about 20 km north of Jervis Bay, was dated at 17,500 BC (Zakharov, 1987).

There are a number of Aboriginal communities in the area who utilise the Jervis Bay Marine Park (JBMP) for community, ceremonial, recreational and commercial purposes, including the Jerrinia, Murramarang and Wreck Bay communities (NSW MP, 2008a). The Wreck Bay village community dates from around 1890 when Aboriginal fishermen intermittently camped

at Summercloud and Mary Bays while fishing the waters between Sussex Inlet and St. Georges Head. They came from various Aboriginal Communities from La Perouse in Sydney to the far South Coast (Zakharov, 1987).

For over 3000 years, indigenous people have had strong ties to the land and sea around Jervis Bay. Indigenous use of the marine park is an integral part of the local culture. Marine resources, including fish and other animals, are regularly harvested for a range of purposes, including for use in community gatherings and celebrations, and as food for individuals and their extended families. NSW MP conducts field trips and other activities with Aboriginal elders and community members to facilitate cultural exchange and community capacity building (NSW MP, 2008a).

Beecroft Peninsula is one of the richest places in Australia for Aboriginal sites and is considered the spiritual birthplace of 13 Aboriginal tribes of the south coast of NSW. It contains more than 200 sites of significance which makes it one of the highest concentrations of special Aboriginal places in Australia (Zakharov, 1987). Beecroft Peninsula is the location of the sacred sites of the Jerrinja people and some of these are also known to non-Aborigines. Coastal middens and estuarine middens are the most common sites around the bay but there are also rock shelters with some containing Aboriginal rock art, burial sites, axe grinding groove sites, stone arrangements for ceremonial purposes and sacred trees from which bark was removed to be used for shelter or for making canoes (Cho, 1995).

Significant sites for the collection of marine animals and plants for traditional and commercial use include Callala Beach, Bindijine Beach, Long Beach, Silica Bay, Boat Harbour, Green Point, along Groper Coast, and Murrays Beach and Hole-In-the-Wall in Commonwealth Waters. Many of the coastal areas on the western side of Beecroft Peninsula are also important sites (NSW MP, 2003).

Another significant site in Aboriginal spiritual beliefs is the Drum and Drum Sticks and Gum Getters area on the ocean side of Beecroft Peninsula. Wreck Bay and the beaches on the western side of St Georges Head are important areas for traditional and commercial activities and have cultural ties to the Jerrinja, Murramarang and Wreck Bay communities. Beach hauling remains a significant commercial fishing activity for Aboriginal people in Jervis Bay. Members of the Jerrinja and Wreck Bay Aboriginal communities participate in the commercial ocean hauling fishery (NSW MP, 2003).

ii. Field Investigations

The locations proposed for the Commercial Shellfish Aquaculture Lease are not in the immediate vicinity of landscape features that may indicate the presence of Aboriginal objects, such as headlands, sand dune systems, cliff faces, caves or rock shelters. The proposed

locations are offshore in a well flushed marine environment with a depth of about 10 m over a seabed with a substrate of mobile sands. There is no record of any detailed archaeological investigations of the seabed in Jervis Bay and this is considered to be largely due to the mobile nature of the sandy seabed and current flows in this region which would hamper such investigations. Field investigations of the seabed beneath the proposed leases have not been conducted after considering these factors.

iii. Database Searches

A database search was conducted to identify any documented Aboriginal cultural heritage issues pertaining to the proposed location and surrounding areas which may be impacted by the Commercial Shellfish Aquaculture Leases. Fisheries NSW undertook a search of the Aboriginal Heritage Information Management System (AHIMS) database. The AHIMS contains information and records about Aboriginal objects that have been reported to the Director-General of the Department of Premier and Cabinet, and Aboriginal places which have been declared by the Minister to have special significance with respect to Aboriginal culture (Web Reference 23).

Two searches of the AHIMS database were conducted on 3 October 2012 - one for the Callala Bay region (search area: -35.03372, 150.68194; -35.00427, 150.73111) and one for the Vincentia region (search area: -35.07392, 150.67195; -35.04447, 150.72112). The search results indicated the presence of Aboriginal sites in the specified areas. Four Aboriginal sites were detected in the Callala Bay region and nine were detected in the area searched near Vincentia. An extensive search was then conducted to determine the type and location of the sites detected (Figure 62).

During the mapping of the recorded sites using data provided in the extensive search report, it was identified that three sites within the Callala Bay area were mapped as being within the marine environment of Jervis Bay. To clarify the location of these sites a copy of the data record was obtained from the AHIMS registrar. After examination of these records it was found that two of the recorded sites were actually land based sites. The third site had unfortunately been misreported and was actually located at Albion Park, 45 km north of Jervis Bay (Aboriginal Site Record 58-2-0432) (Appendix 5).

A search of the NSW Atlas of Aboriginal Places was also conducted using the search by location option (Web Reference 24). Under Section 84 of the *National Parks and Wildlife Act 1974*, land may be declared as an Aboriginal Place by the Minister for the Environment when it is or was of special significance to Aboriginal culture. Aboriginal Places can have spiritual, ceremonial, historical, social, educational value and/or other significance such as natural resource use or contain objects such as burials, middens, or rock art (Web Reference 24). No Aboriginal Places were detected in the search for the Jervis Bay region.

In addition, the National Native Title Tribunal database (Web Reference 32) was searched and there were no land claims identified under the *Native Title Act 1993* in the vicinity of the proposed sites for the Commercial Shellfish Aquaculture Leases.

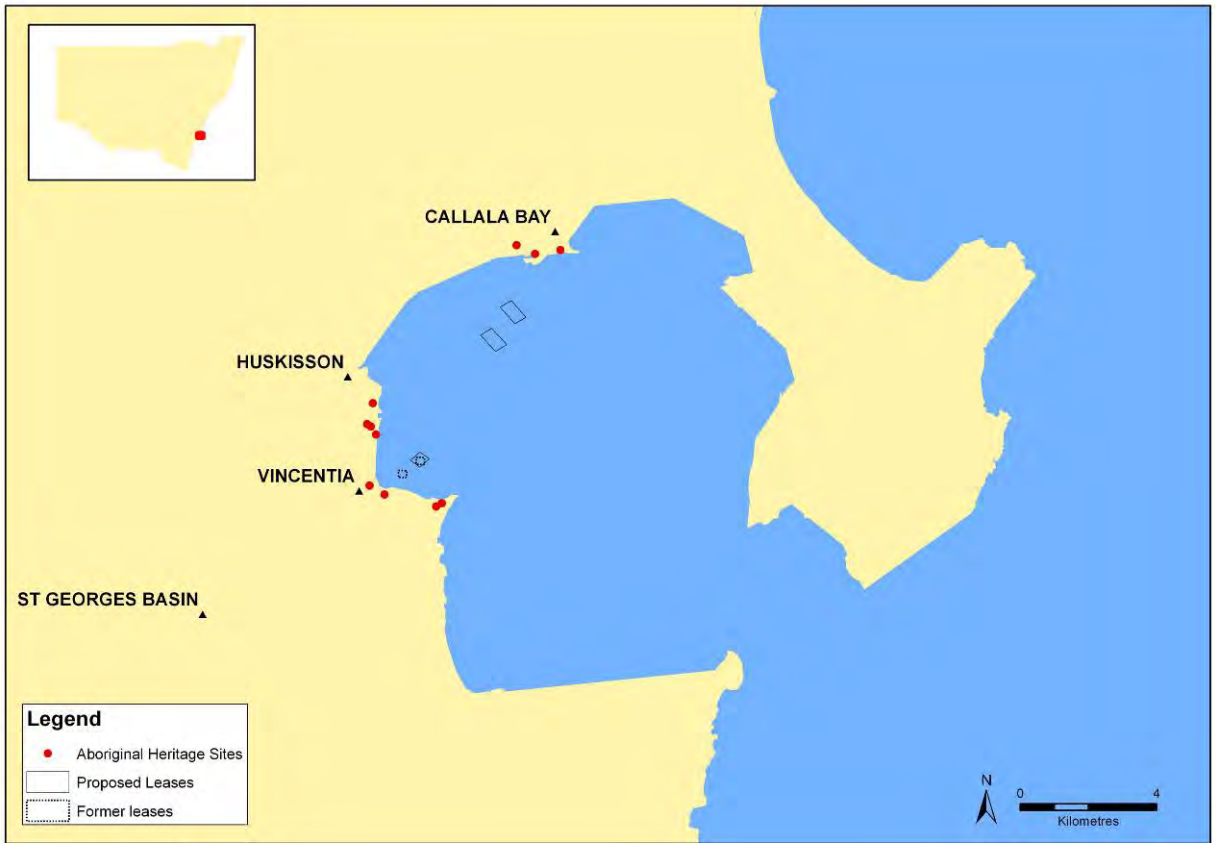

Figure 62: Location of Aboriginal sites near the proposed leases that were identified in AHIMS database search (Source: Fisheries NSW, 2012).

The *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* has been developed to support the process of investigating and assessing Aboriginal cultural heritage (Web Reference 23). The Due Diligence Code was reviewed by Fisheries NSW to determine if it was applicable to the Commercial Shellfish Aquaculture Leases and if an Aboriginal Heritage Impact Permit (AHIP) was required.

Fisheries NSW also consulted with the Jerrinia Local Aboriginal Land Council and Wreck Bay Aboriginal Community, and no additional sites were identified during these meetings. The Due Diligence Code and the AHIP were deemed not applicable to the proposal as all of the recorded Aboriginal sites are land based so it is considered unlikely that the proposal would have a significant impact on these sites.

The development application for the proposed Commercial Shellfish Aquaculture Leases only involves the establishment of leases within the waters of Jervis Bay. Any future associated land based development would need to be considered under a separate development application through the Shoalhaven City Council.

iv. Community Consultation

Community consultation has attempted to investigate the full extent of Aboriginal cultural heritage which may be impacted as a result of the proposed Commercial Shellfish Aquaculture Leases. Fisheries NSW has consulted with the Jerrinia Local Aboriginal Land Council and Wreck Bay Aboriginal Community Council. Consultation has been undertaken in the form of meetings, emails, and telephone conversations.

During the meetings with the Jerrinia Local Aboriginal Land Council and Wreck Bay Aboriginal Community Council, no concerns were raised about potential impacts of the Commercial Shellfish Aquaculture Leases on known culturally significant sites. However, concerns were raised about the potential for the leases to impact on the natural processes within Jervis Bay as they have a strong association with land and sea country and want to ensure they continue to have access to traditional areas. Issues relating to potential impacts on natural process are addressed in Section 8.2.2.1, 8.2.2.2, 8.2.2.7 and 8.2.2.8.

(b) European Heritage

Relevant NSW and Commonwealth Legislation

Non-indigenous heritage in NSW is guided by the following legislation:

- *NSW Heritage Act 1977*; and
- *Historic Shipwrecks Act 1976*.

NSW Heritage Act 1977 protects items of natural and cultural environmental heritage in NSW which includes places, works, relics and buildings of cultural, scientific, historic, social, archaeological, architectural, natural or aesthetic significance (Web Reference 25). Shipwrecks identified in the NSW Historic Shipwrecks Database are also protected under this Act. The *Historic Shipwrecks Act 1976* protects historic wrecks and relics in Commonwealth Waters.

Review of Existing Information

i. Literature

European association with Jervis Bay started in 1770 with Captain James Cook, who supplied the names for St Georges Head, Cape St George and Longnose Point despite never landing in the area (Cho, 1995).

Over the past 200 years Jervis Bay has supported an array of industries including ship building, whaling, grazing and dairying, timber and as a Naval training base. Most recently Jervis Bay has become a premier tourist facility (NSW MP, 2008a).

Jervis Bay has a strong maritime history that includes lighthouses, ship building, cargo transport, shipwrecks and an active Naval training base. There are at least 19 known shipwrecks in the marine park, many of which are important attractions for scuba divers. Most shipwrecks are located in Wreck Bay, on the eastern side of St Georges Head, and at Currarong. Many of the wrecks have been assessed by the NSW Heritage Office as being historically, technically, scientifically or archaeologically significant.

Jervis Bay also has a history of aquaculture with Fisheries NSW archives showing oyster aquaculture occurring in Currambene and Moona Moona Creeks from 1935 untill mid 1990s.

Database Searches

Plane and Shipwrecks

A desktop review of plane and shipwrecks was carried out in February 2013 to determine if there were any known or potentially occurring maritime heritage sites in close proximity to the proposed Commercial Shellfish Aquaculture Leases. The NSW Historic Shipwrecks Database (Web Reference 15) and the Australian National Shipwreck Database (Web Reference 16) were searched. Only two wreckages were detected within Jervis Bay including the *Mercury* shipwreck and the *Fairey Firefly* plane wreck (Figure 63). The distance of these sites from the closest lease, the northern Callala Lease, is approximately 2 km and 2.4 km, respectively.

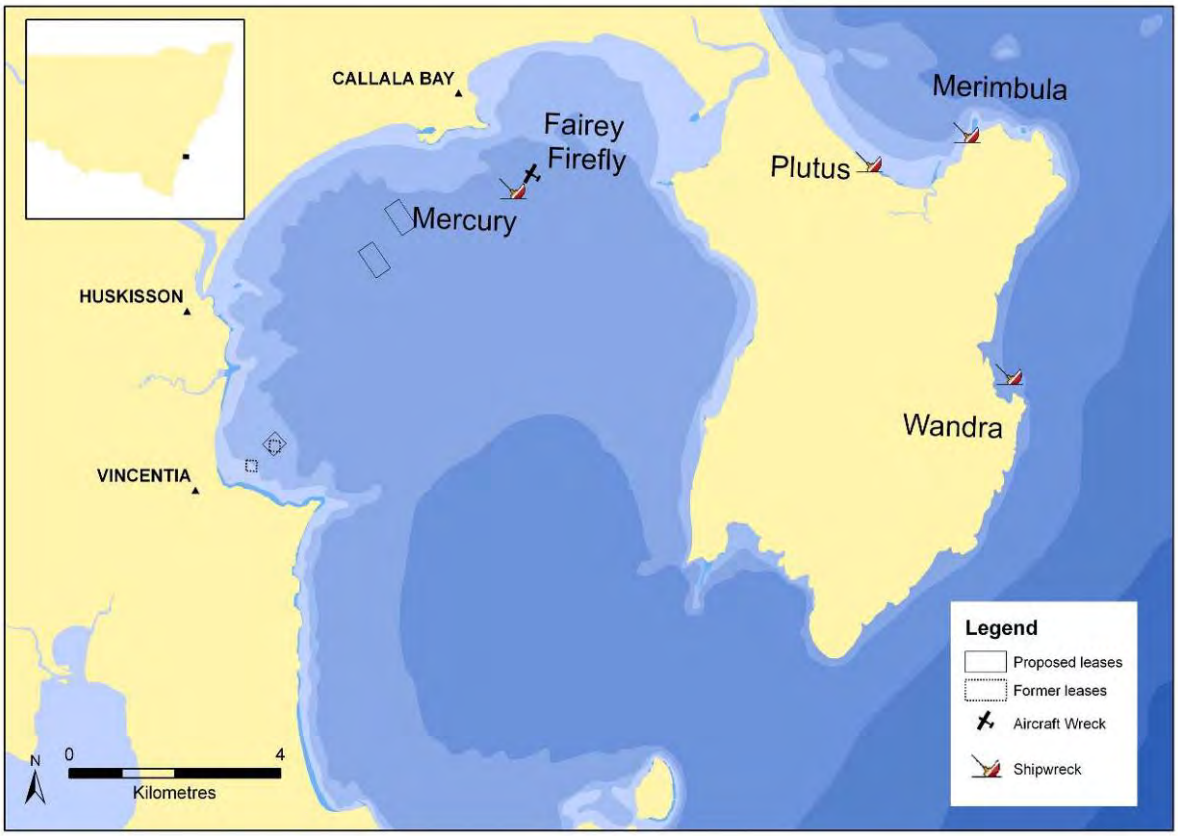

Figure 63: Plane and shipwrecks in Jervis Bay that are in close proximity to proposed leases (Source: Fisheries NSW, 2012).

ii. Community Consultation

Fisheries NSW consultated with government agencies and community groups and no additional maritime archaeological sites were identified during these meetings.

Conclusion

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on Aboriginal and European heritage items and/or areas in Jervis Bay was assessed to be 'negligible' when considered in context with the findings from the AHIMS database search, the consultation with the Jerrinia Local Aboriginal Land Council and Wreck Bay Aboriginal Community Council and the results of the desktop/database searches (i.e. no heritage items detected in the immediate vicinity of the Commercial Shellfish Aquaculture Leases). The identfied items and places of heritage significance were either land based or located a sufficient distance away to mitigate potential direct and indirect impacts.

In addition, no excavation work is proposed for the Commercial Shellfish Aquaculture Leases and the only modification of the mobile sandy seabed will occur from the installation of the anchors. Only a relatively small area will be disturbed by the anchors and this is expected to return to pre-existing conditions if the sites were decommissioned.

8.2.1.4 Noise

Table 23: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – noise levels during the operational stage of the Commercial Shellfish Aquaculture Leases (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will uncharacteristic noise levels be generated during the operational stage (i.e. in level, type and/or duration) and is it likely to have a significant impact on adjacent communities?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *What types of machinery will be employed during the operational stage?* ▪ *Will there be a significant increase in noise levels during the operational stage of the project?* ▪ *Is the noise uncharacteristic for the sites or exceed acceptable levels?* ▪ *Will the noise disturb nearby residential areas?* ▪ *What time of day will the daily operations and maintenance be carried out?* ▪ *What mitigation and management measures are available to minimise the level of noise generated?*			
Description	▪ Types of machinery = outboard motors, onboard motors, diesel generator, hand and small power tools ▪ Operational noise on leases will largely not be uncharacteristic for embayment (e.g. vessels) ▪ Distance of nearest lease to residential areas: Callala Point = 2.2 km; Callala Beach = 1.5 km; Huskisson = 2.9 km; Collingwood Beach = 910 m; Orion Beach = 660 m			
Proposed Management – Mitigation and Monitoring	▪ Comply with *Protection of the Environment Operations (Noise Control) Regulation 2008* ▪ Comply with Industry Best Practice for Noise Management ▪ Hours of operation = daylight hours ▪ Small increase in vehicle and vessel movements (0-3 trips per lease per day) ▪ Vessels used will be similar to existing local recreational and commercial fleet - noise will not be uncharacteristic of the area ▪ Noise calculations (attenuation with distance) using online model suggest minimal impact on residential areas			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

NSW OEH is responsible for the regulation of noise from activities scheduled under the *Protection of the Environment Operations Act 1997* (POEO Act). The *POEO (Noise Control) Regulation 2008* also sets certain limits on noise emissions from vessels, motor vehicles and domestic use of certain types of equipment (Web Reference 18). This act and regulation will be consulted throughout the operational stage to ensure compliance with all relevant provisions (Web Reference 18).

When assessing the impact of noise generated during the operational stage of the Commercial Shellfish Aquaculture Leases, consideration has been given to ambient noise levels, existing land uses, noise source level, duration and frequency of the operation activities, presence of noise softening measures (e.g. buildings or topography variations) and the sensitivity of the receiving environment (Cardno Ecology Lab, 2010).

The principal source of noise in Jervis Bay is generated by the sea state conditions and vessel movements undertaken by existing waterway users. Existing vessels in Jervis Bay consist of small recreational fishing boats, dive boats, dolphin/whale watching boats, luxury cruisers, Naval vessels and commercial fishing vessels. In addition to vessel noise, the Navy frequently undertakes training exercises in the bay that often involve the use of helicopters.

The operation of the Commercial Shellfish Aquaculture Leases will cause a slight increase in noise levels in Jervis Bay due to the movements of the service vessels, on board equipment and incidental noise from personnel. Noise levels vary depending on weather conditions, background noise, the equipment used and the season. During peak periods for example, commercial and recreational vessel traffic increases significantly (up to 300 movements per day) (F. Clements - A/Manager, Jervis Bay Marine Park 2013, *pers comm*.) so ambient noise levels are characteristically greater during this time of year.

Similarly, during windy days potential noise impacts are likely to be significantly lower than during still conditions. There also appears to be an association with the perceptions of the severity of noise impacts and the visibility of a lease from a residential area i.e. noise is perceived as more of an impact when it is associated with other amenity issues (Umwelt, 2003).

The operation of the Commercial Shellfish Aquaculture Leases will not involve a significant increase in vessel movements in Jervis Bay, where it expected that there will be 0-3 trips per day per lease. Service vessels will be similar to existing recreational and commercial vessels so the noise generated is not considered to be uncharacteristic of the area. Other types of machinery that may be used during the operational stage include onboard motors that drive lease servicing equipment (84 dB), outboard motors (80 dB), cleaning and winching system, diesel generator and hand/small power tools.

Industry best practices for noise management will also be employed during the operation of the Commercial Shellfish Aquaculture Leases to minimise the impacts of noise on surrounding communities. Some examples of industry best practices include:

- Use of well-maintained sound suppression devices (e.g. barriers, baffles and mufflers) when operating equipment;
- Acknowledging concerns and complaints and aiming to resolve them cooperatively;
- Manoeuvring vessels with minimal acceleration to minimise boat motor noise;
- Use of marine radios to communicate between vessels;
- Use courteous language in the vicinity of other waterway users;
- Ensure truck drivers are informed of designated vehicle routes, parking locations, acceptable delivery hours and other relevant practices e.g. no extended periods of engine idling and minimising the use of engine brakes;
- Maintaining good communication between the community and lease staff; and
- Hours of operation will predominately be restricted to daylight hours. Night operations will only occur in response to emergency incidents, such as after severe weather or reports of suspicious activities. Hours of operation are recommended as follows:
    - Monday to Friday – 7 am to 6 pm;
    - Saturday – 8 am to 4 pm; and
    - Avoiding work on Sundays or Public Holidays where possible.

The operators of the Commercial Shellfish Aquaculture Leases will also be requested to fit the service vessels with four stroke outboard motors, transit routes to and from the leases will be set to remain at least 400 m from the foreshore where possible and the entry and exit point on the lease will be the area furthest from the foreshore (Umwelt, 2003). In addition, workers will be made aware that sound travels largely unimpeded across water and that every effort should be made to minimise noise while on the leases (Umwelt, 2003).

A pearl farm at Wanda Head, Port Stephens (NSW) implemented a range of modifications to vessels and work place practices to alleviate potential noise generation (Umwelt, 2003), including:

- Rubber matting or an equivalent noise insulating material was attached to the working area along the side of the cleaning punt to alleviate the problem of noise generation from longline floats striking the side or gunnels of the vessels;
- Rubber matting was placed on noise generation surfaces of the punt to reduce noise generated from work implements and infrastructure striking these surfaces;

- Routine maintenance of the vessels including chandlery, pumps, motors and filters and as well as cleaning equipment and winches;
- Lifting and work equipment was secured while not in use;
- Routine servicing of bushings, bearings and mechanical components of winches, cleaning machines, pumps and engines and hydraulic equipment;
- The power unit (diesel motor, hydraulic pump and water pumps) was insulated;
- All taps and valves were insulated, where possible, to reduce valve noise;
- The power unit was mounted on anti-vibration mounts to reduce transmission of noise and vibration through the hull of the boat; and
- The hull of the boat below the cleaning power unit was foam filled, which reduced the transmission of noise and vibration through the deck and hull of the boat.

These work place practices and modifications to vessels may be adopted by the operators of the Commercial Shellfish Aquaculture Leases if deemed appropriate. The operators of the leases will also regularly review workplace practices and the equipment used to ensure noise emissions are minimised, which may include public consultation to assist with identifying potential noise issues (Umwelt, 2003).

An online modelling program that calculates the damping of sound level with distance was used to estimate the noise impact at five main residential areas in Jervis Bay due to the operation of the Commercial Shellfish Aquaculture Leases (Web Reference 26). The loudest source of noise generated by the leases is the operation of the onboard motors that drive the lease servicing equipment on the service vessels. Hence, an estimate of the nosie generated by the onboard motors, which is 84 dB, was used in the modelling program to predict the noise levels at the key land based locations in Jervis Bay (Table 24).

Table 24: Estimates of the attenuation of noise associated with the operation of the Commercial Shellfish Aquaculture Leases at a range of locations in Jervis Bay (Source: Fisheries NSW, 2013).

Location	Callala Point	Callala Beach	Huskisson	Collingwood Beach	Orion Beach
Callala Lease (northern)	8.6 dB	14.4 dB	0.14 dB	N/A	N/A
Callala Lease (southern)	2.9 dB	10.8 dB	4.1 dB	N/A	N/A
Vincentia Lease	N/A	N/A	N/A	20.2 dB	23.7 dB

Figure 64 provides an overview of noise levels (dB) emitted by common sources to provide a comparative to the noise emitted from the operation of the leases.

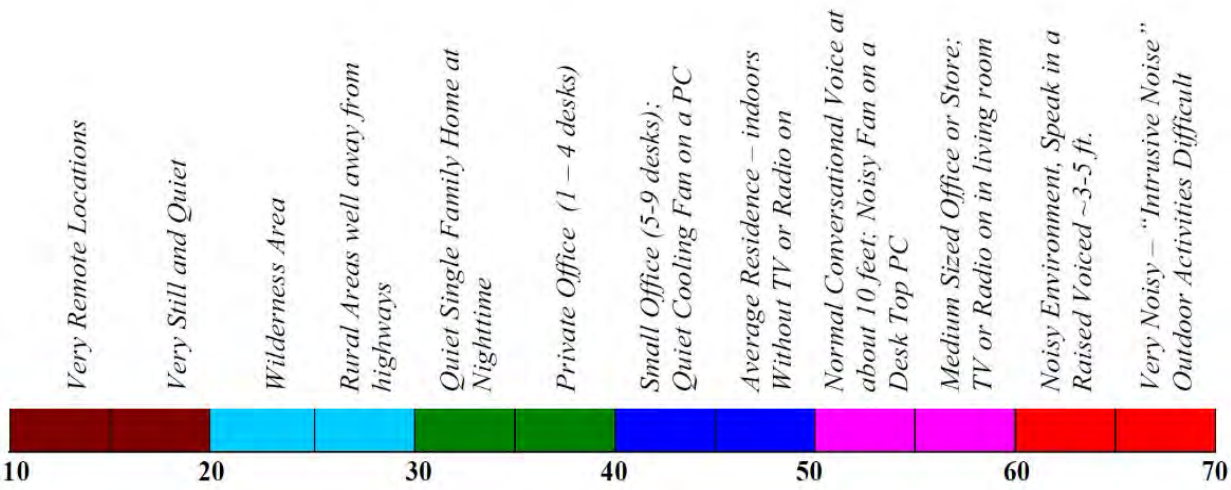

Figure 64: Examples of noise levels (dB) emitted by common sources (Source: Ray, 2010).

The modelling results suggest that the noises associated with the daily operation of the Commercial Shellfish Aquaculture Leases are likely to be difficult to hear from nearby beaches and residential areas. However, the models predict the damping of the sound without the effects of surfaces, barriers, reflections, wind and atmospheric effects, and are also done in isolation to other background noises (e.g. wind in trees, vehicles, people speaking, etc) in the residential areas. The distance of the leases from the surrounding residential areas (i.e. Callala Beach, Callala Bay, Huskisson and Vincentia), the normal daytime operation hours, the sea state, wind conditions and existing background noise will ensure further attenuation of any noise generated by service vessels and associated operational and maintenance activities.

Conclusion

The risk of the noise associated with the operation of the Commercial Shellfish Aquaculture Leases having a significant impact on surrounding communities was assessed to be 'low' when considered in context with the relatively small increase in vehicle and vessel movements, the restrictions on operation hours, the noise being predominately characteristic of the area, the distances from residential areas, the results of the noise attenuation calculations and the implementation of industry best practices.

8.2.1.5 Work Health and Safety

Table 25: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – WH&S hazards (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the Commercial Shellfish Aquaculture Leases have significant WH&S hazards associated with their installation and/or operation?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *What are the WH&S risks associated with the leases e.g. fatigue, manual lifting of heavy object, rope maintenance and collisions?* ▪ *How will WH&S risks associated with the installation and operation of the leases be mitigated, monitored and managed?* ▪ *Are there any potential pollutant sources in the region that could potentially contaminate the stock and make it unsafe for consumption?* ▪ *How will WH&S risks be mitigated, monitored and managed?*			
Description	▪ Potential WH&S hazards o SCUBA diving o Pre-assemblage and installation activities o Service and maintenance activities o Contamination of stock and the environment o Waste disposal o Navigation			
Proposed Management – Mitigation and Monitoring	▪ Environmental Management Plan (Appendix 1) o WH&S Management Plan o Traffic Management Plan o Waste Management Plan o Structural Integrity & Stability Monitoring Program o Water Quality & Benthic Environment Monitoring Program o Marine Fauna Interaction Management Plan o Disease, Parasite & Pest Management Plan ▪ NSW Shellfish Program ▪ State arrangement for oil and chemical spill responses - experienced and trained personnel, equipment and contingency plans			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

Work Health and Safety (WH&S) legislation replaced the Occupational Health and Safety (OHS) legislation in NSW on 1 January 2012. The new legislation provides greater consistency, certainty and clarity across Australia in making workplace health and safety duties easier to understand. This will enable the operators of the Commercial Shellfish Aquaculture Leases to initiate and utilise nationwide safety policies and procedures developed for longline farming activities in other states.

There are a number of potential WH&S hazards associated with the installation and operation of the Commercial Shellfish Aquaculture Leases. The main hazards identified include SCUBA diving, pre-assemblage and installation activities, service and maintenance activities, contamination of stock and the environment, waste disposal and navigation issues.

SCUBA divers will be required to assist with structural installations, inspections, maintenance and repairs, as well as with environmental monitoring (e.g. collecting benthic samples). WH&S hazards associated with these activities include diving related injuries (e.g. decompression illness), fatigue and marine animal encounters. To mitigate these potential WH&S risks, all diving staff will be required to have relevant qualifications, undergo a WH&S induction program, and a WH&S Management Plan (Appendix 1) will be implemented, including Safe Work Method Statements for SCUBA diving.

Personnel involved with the pre-assemblage and installation stages will be required to assemble and deploy the longline infrastructure, which will include the transportation of materials on marine vessels and vehicles, use of a range of machinery and equipment (e.g. cranes, winches, welders and power tools), lifting heavy loads and navigating within an embayment. WH&S hazards associated with these activities include physical injuries from machinery and equipment use, manual lifting and/or fatigue, as well as navigation hazards and collisions.

The operators will be required to undertake frequent marine vessel and vehicular movements between the leases and the land based site/s. Staff working on marine vessels will undertake deckhand duties, cleaning/biofouling removal, inspections and maintenance of the infrastructure, waste disposal, water quality sampling and harvesting stock, while staff involved with vehicular transport will be transferring vessels, stock, personnel, materials and supplies. WH&S hazards associated with these activities include physical injuries from manual lifting and maintenance duties, fatigue, navigation hazards and collisions, and associated food safety and human health issues.

Jervis Bay is considered to have high levels of water quality and clarity. There are no major rivers that drain into the bay, there are no heavily disturbed or densely settled areas and there are no heavy industrial or commercial operations around the bay. There are also no

major marine pest infestations within the bay. Potential WH&S hazards to human health associated with the operation of the Commercial Shellfish Aquaculture Leases include contamination of stock and water quality decline. Runoff from the surrounding catchment, sewage outfalls, offshore upwelling, groundwater discharges and oil spills are among the potential sources of pollutants in Jervis Bay (Brown *et al.,* 1995).

The NSW Shellfish Program is a compulsory, industry funded program that assists in ensuring the public health safety of shellfish grown and harvested from NSW waters. The NSW Shellfish Program is administered by the NSW Food Authority under the *Food Act 2003*. The objective of the program is to protect the health of shellfish consumers through the administration and application of procedures described in the *New South Wales Shellfish Program Operations Manual* that:

- assess the risk of shellfish contamination by pathogenic bacteria and viruses, biotoxins and chemicals derived from the growing area;
- control the harvest of shellfish in accordance with the assessed risk; and
- protect shellfish from contamination after harvesting.

In the unlikely event of an oil spill, the infrastructure and/or cultured stock may be contaminated by oil and/or chemical dispersants and flocculants if used. The impact on the stock would depend on a number of factors, such as the severity of the oil spill, the type of oil, the timing of the response to the incident and the procedures used to manage the spill.

Transport for NSW conducts regular State maritime oil and chemical spill response exercises to ensure that the response agencies have the necessary skills and resources to promptly respond to an oil or chemical spill. There is a State arrangement consisting of experienced and trained personnel, equipment and contingency plans. Personnel from the maritime, emergency services agencies, local government and volunteer organisations in NSW participate in regular exercises (Web Reference 27). Also the Department of Defence (Navy) have trained staff and equipment located at HMAS Creswell on the south western shores of Jervis Bay.

The operators of the Commercial Shellfish Aquaculture Leases staff will be required to induct staff before they are permitted to undertake any activity associated with the leases. During inductions details of obligations under the *Work Health and Safety Act 2011,* risks and hazards associated with the Commercial Shellfish Aquaculture Leases, personal protective equipment (PPE) requirements and incident reporting procedures will be described.

Risk levels associated with potential Commercial Shellfish Aquaculture Lease WH&S hazards and the proposed mitigation measures are described in further detail in the following sections:

- Marine vessel movements and vehicular transport (Section 8.2.1.2);
- Navigation (Section 8.1.7);
- Structural integrity and stability of longline infrastructure (Section 8.1.5);
- Water quality (Section 8.2.2.1);
- Genetics, disease and introduced pests (Section 8.2.2.2); and
- Waste disposal (Section 8.2.2.9).

Mitigation measures for potential WH&S hazards include the following management plans and monitoring programs which form part of the EMP (Appendix 1):

- WH&S Management Plan;
- Traffic Management Plan;
- Waste Management Plan;
- Structural Integrity and Stability Monitoring Program;
- Marine Fauna Interaction Management Plan;
- Disease, Parasite and Pest Management Plan; and
- Water Quality and Benthic Environment Monitoring Program.

There are also WH&S issues relating to the use of the Commercial Shellfish Aquaculture Leases by other waterway users. To mitigate these potential impacts, the leases will be clearly marked with appropriate navigation buoys, listed on navigation charts, a notice to mariners will be issued and public information will be provided on the NSW DPI website regarding the operation of the leases including waterway user obligations. In particular, the use of thick ropes which are kept under tension at all times will minimise the risk of the unlikely event of capsized sailing vessels becoming entangled in the longline infrastructure. The sailing clubs in Jervis Bay will also be encouraged to brief all sailors about the presence of the leases prior to all races. Aquaculture permit holders must also have the required public liability insurance to cover any potential public liability claims due to farming operations.

For personal safety, recreational boaters, fishers, spear fishermen and divers will be encouraged to exercise caution when passing and/or anchoring in the vicinity of the leases which will be delineated by at least four yellow cardinal markers. Under the FM Act it is an offence to interfere or damage anything (e.g. infrastructure or stock) in the lease areas.

Fishers will be encouraged not to fish amongst lease infrastructure to avoid losing lures and hooks on the infrastructure which then can have to potential to injure lease workers.

Conclusion

The risk associated with WH&S matters during the construction, deployment and operational stages of the Commercial Shellfish Aquaculture Leases was assessed to be 'low' when considered in context with the EMP that will be implemented to minimise the risks associated with potential hazards and the required commitment of the operators to ensure that all staff personnel and the other waterway users are made aware of their obligations under the WH&S Act and other relevant legislation.

8.2.1.6 Economics

Table 26: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – economic impacts (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	What will be the economic impacts of the Commercial Shellfish Aquaculture Leases on the regional economy?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Will the Commercial Shellfish Aquaculture Leases contribute to the local economy?* ▪ *How many people will the Commercial Shellfish Aquaculture Leases employ?* ▪ *Is it possible that Commercial Shellfish Aquaculture Leases will impact on tourism?*			
Description	▪ Value of infrastructure, goods and services to be sourced from regional and state suppliers = approximately $840,000 (water based component of lease activities) ▪ Provision of jobs o Approximately 12-15 FTE direct jobs o Approximately 8-10 FTE indirect jobs o Induced jobs as a result of expenditure in the community from wage earners and through linkages with seafood outlets, restaurants and tourism ▪ Sale of produce through local restaurants and seafood outlets and incorporation into tourism activities			
Proposed Management – Mitigation and Monitoring	▪ Goods and services will be obtained locally where possible ▪ Locally skilled personnel will be employed where appropriate ▪ Tourism activities will be incorporated where feasible without compromising the aquaculture objectives ▪ Product will be supplied to local restaurants and seafood outlets			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	0	6	0	**Negligible**
Reporting Requirements	Short justification			

Justification of Ranking

Worldwide and across Australia aquaculture has contributed to regional economies to meet the demands of consumers for quality seafood. Aquaculture in NSW provides socio-economic benefits to communities particularly in rural regions, which often have limited

economic opportunities. The local production of seafood by the aquaculture industry also ensures that consumers have access to reliable, affordable and quality seafood. However, NSW is currently a net importer of seafood where about 85% of seafood consumed in the state is imported.

Aquaculture enterprises create local economic benefits through the purchase of goods and services creating a 'multiplier effect'. The economic benefits of the aquaculture industry can be measured using three key indicators: Gross Domestic Product (GDP), employment and labour income. These benefits in turn can be measured at three levels of activity: direct, indirect and induced. *Direct activity* captures the effect of the aquaculture industry itself (e.g. hatcheries, grow-out operations and processing); *indirect activity* captures effects in the industries supplying goods and services to the aquaculture industry, and *induced activity* captures the effects arising from spending the income earned by those employed in direct and indirect activities (Gardner-Pinfold Consulting Economists, 2010).

A study on the economic impact of mussel aquaculture in New Zealand in the Waikato region identified aquaculture as an important industry contributing to the social and economic wellbeing of communities primarily by creating jobs and contributing directly and indirectly to the local, regional and national economy. In the Waikato region the majority of contributions ($18.9 million) to regional GDP ($27 million) are sourced from the direct impact of revenue generated by the aquaculture industry. Indirect impacts include the value-added by those who provide inputs to the aquaculture industry such as fuel, utilities and professional services (e.g. accountancy and legal services). These indirect impacts contribute $3.7 million to the regional GDP. Induced impacts arising largely from the spending of households who receive wages and salaries resulting from aquaculture activity contributed an additional $4.3 million. There is direct employment of 270 full-time equivalents (FTE) in the farming and processing sectors. Aquaculture also generates the equivalent of an additional 100 jobs throughout the region as a result of flow-on effects to other activities and industries (Irvine *et al*., 2007).

A report on the economic impact of aquaculture in South Australia and its regional economies in 2010/2011 found that the industry generated about $304 million (i.e. $229 million on-farm and $75 million in downstream activities). Approximately 70% of the output was generated in regional South Australia. Direct employment was estimated to be 1,113 FTEs (727 on-farm and 386 in downstream activities) with 1,536 flow-on jobs giving a total employment of 2,649 FTEs (Econsearch, 2012).

Eden Sea Farms Pty Ltd operates a mussel farm in Twofold Bay on the south coast of NSW. Fifty percent of the goods and services required are purchased in the region. The mussel farm currently provides direct employment for about 3 FTEs, 2-3 part-time equivalents (PTE) and a transport position. The mussel farming activities indirectly provide employment

opportunities across the region through the sale of produce to wholesalers, more than 20 restaurants, processors (e.g. Eden Smokehouse) and seafood outlets. The operators also provide bait and burley to recreational fishers.

The Commercial Shellfish Aquaculture Leases are expected to have direct and indirect benefits to the regional economy of Jervis Bay. Significant flow-on benefits are anticipated from the purchase of materials, services and labour associated with the operation of the leases in Jervis Bay. In South Australia for example, each job generated directly from oyster and mussel farming processing and transport is thought to generate an additional 1.81 -1.91 jobs in the rest of the state (EconSearch, 2012). Employment positions will include staff and/or contractors for construction and deployment of the longline infrastructure, as well as for service and maintenance activities.

The proposed Commercial Shellfish Aquaculture Leases are estimated to require approximately $838,871 (GST inclusive) in goods and services to construct and install the longline infrastructure (See Appendix 10). The infrastructure can be divided into work vehicles and vessels, navigation infrastructure and lease infrastructure. Appendix 10 provides an overview of the potential infrastructure components and their respective estimated cost. Many of these goods and services could be obtained from the Shoalhaven region. In addition, the operator/s will need to lease/purchase and/or develop an appropriate land based facility from which to service the lease/s. The land based facility may have to undergo a separate approval process through the Shoalhaven City Council.

The proposed aquaculture industry is not expected to significantly change the demographics of the Shoalhaven region but will generate a range of full-time direct and indirect employment opportunities. It is estimated that the proposed leases will create 12-15 direct FTE positions on the farms with possibly a further 8-10 indirect FTE positions in processing/value adding of the product and land based services activities. These employment opportunities are particularly important for the Shoalhaven region as it has a higher unemployment rate than the average for rural NSW (Figure 65).

The former aquaculture leases near Vincentia not only provided fresh local seafood directly from the farm and through restaurants and seafood outlets but were also used directly and indirectly by marine tourism operators (e.g. dive operators and cruise vessels). The Commercial Shellfish Aquaculture Leases will provide the Jervis Bay tourist industry with an opportunity to diversify visitors' experiences by visiting the shellfish aquaculture facilities. This in turn creates greater community awareness about aquaculture and encourages an interest in tourists to source fresh local seafood.

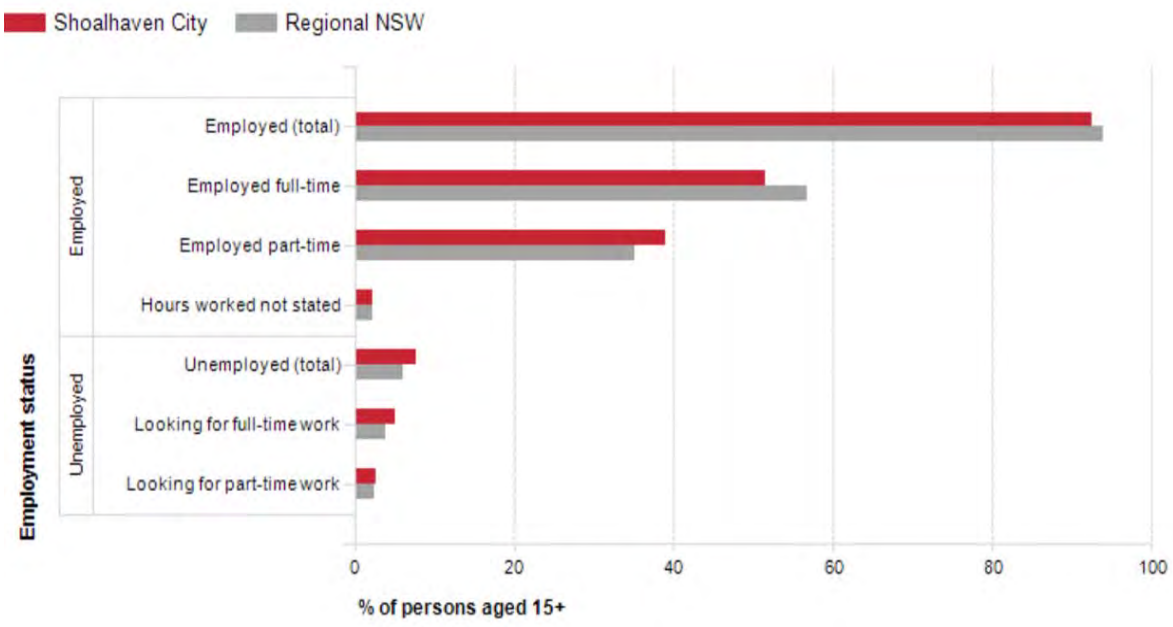

Figure 65: Employment status of Shoalhaven City and regional NSW in 2011 (Source: Australia Bureau of Statistics, 2011).

On the Eyre Peninsula in South Australia for example, a seafood trail has been established to showcase the region's aquaculture industry. The seafood trail includes aquaculture farm visits where you can taste and purchase seafood directly from the suppliers (Web Reference 28). Similarly, in Twofold Bay on the south coast of NSW marine based tourist operators have been able to diversify their tourism experience by discussing mussel farming in the bay during other tourist activities. These examples showcase how a resource can be shared and sustainably managed, and also illustrate how aquaculture can attract tourists, enhance their experience and contribute to the regional economy.

The establishment of the proposed Commercial Shellfish Aquaculture Leases in combination with the Twofold Bay mussel farm may also provide opportunities for goods and service industries located outside of the south coast of NSW to consider establishing subsidiary business in the region.

Conclusion

The risk of the Commercial Shellfish Aquaculture Leases having a negative impact on the regional economy of Shoalhaven region was assessed to be 'negligible' when considered in context with the fact that aquaculture has been a catalyst for economic development in other localities in Australia. The proposed leases will provide increased employment opportunities and use of local goods and services, as well as provide the tourism industry with an opportunity to diversify experiences available to visitors.

8.2.2 Impacts on the Environment

8.2.2.1 Water Quality and Sedimentation

Table 27: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – impacts on marine habitats in Jervis Bay and the wider region (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the Commercial Shellfish Aquaculture Leases have a significant impact on marine habitats in Jervis Bay and the wider region, including water quality and sedimentation?
Level of Impact	Individual facility
Comments and Considerations	▪ *What habitats are present in the direct and wider study area?* ▪ *Could the activity cause changes to the benthic communities e.g. sedimentation, turbidity and nutrients?* ▪ *Have impacts on benthic habitats been found to be far reaching or localised for other longline farms in Australian waters?* ▪ *Are there issues in relation to the proposed stocking densities and waste discharge?* ▪ *How will stocking density and associated discharges be monitored and managed?* ▪ *Are dissolved waste inputs (i.e. dissolved metabolic product and faeces) within acceptable levels so as to avoid adverse impacts on water quality?* ▪ *What are the acceptable levels of dissolved wastes according to the Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters?* ▪ *What is the likely extent of sedimentation?* ▪ *How will cumulative impacts on marine habitats i.e. water quality and benthos be monitored?* ▪ *What measures will be implemented to mitigate, monitor and manage water quality and sedimentation issues?*
Description	▪ Direct marine habitats = soft sediment (sand) ▪ Wider marine habitats = rocky reef, seagrass bed and mangrove communities ▪ Inputs into marine environment o Faeces and pseudofaeces o Biofouling and sediment
Proposed Management – Mitigation and Monitoring	▪ Site Selection o No environmentally-sensitive or unique areas o Habitat - fine to medium grained sand and small cobble o An extensive area of similar habitat is available in the direct and wider area o Good flushing rates ▪ Small scale operations (0.4 % of Jervis Bay)

	▪ Extensive aquaculture = no feed input ▪ Appropriate stocking densities - below ecological carrying capacity ▪ Water Quality & Benthic Environment Monitoring Program (Appendix 1) o Regular sampling - before and during operation stage o Fallowing and/or reduce stocking densities if impact detected ▪ Mechanical removal of biofouling - land based disposal			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	2	4	8	**Moderate**
Reporting Requirements	Full management report (Appendix 1)			

Justification of Ranking

Site Selection

A diverse range of habitats exist within the Jervis Bay Marine Park (JBMP), including sandy beaches, mangroves, seagrass beds, intertidal rocky shores, subtidal rocky reefs, drift algae communities and soft substrate habitats (Figure 26; Figure 27) (Joyce *et al*., 2010). The site selection process for the Commercial Shellfish Aquaculture Leases carefully considered the habitat types within Jervis Bay and avoided sensitive and unique habitats such as rocky reefs, seagrass beds, mangroves and Sanctuary Zones. It is proposed that the Commercial Shellfish Aquaculture Leases will be situated at depths of about 10 m and over soft sediment habitat (predominately sand), which is extensively represented in Jervis Bay.

Waste Inputs

The cultured species will only be grown using extensive aquaculture techniques which utilises the naturally occurring plankton and other nutrients in the waters of Jervis Bay to growout the stock. No artificial feeds will be used and no additional nutrients will be added to Jervis Bay waters resulting in a nett export of nutrients via the harvested stock.

The main types of waste inputs into the marine environment from longline aquaculture include faeces, pseudofaeces, biofouling and the resuspension of sediments (Kaiser *et al*., 1998). The input of the organic matter can cause changes to the physical, chemical and biological characteristics of the receiving marine environment. The magnitude of the impact largely depends on the cultured species, husbandry practices, stocking densities, dispersion of wastes by currents and the environmental carrying capacity of the region to assimilate organic inputs (Kaiser *et al*., 1998; Gavine & McKinnon, 2002). Figure 66 illustrates the range of potential issues associated with shellfish farming which have broadly been classified into

three main areas, including (1) effects on seabed, (2) effects on water column and (3) wider ecological effects - effects on fish, mammals and the spread of invasive species or disease.

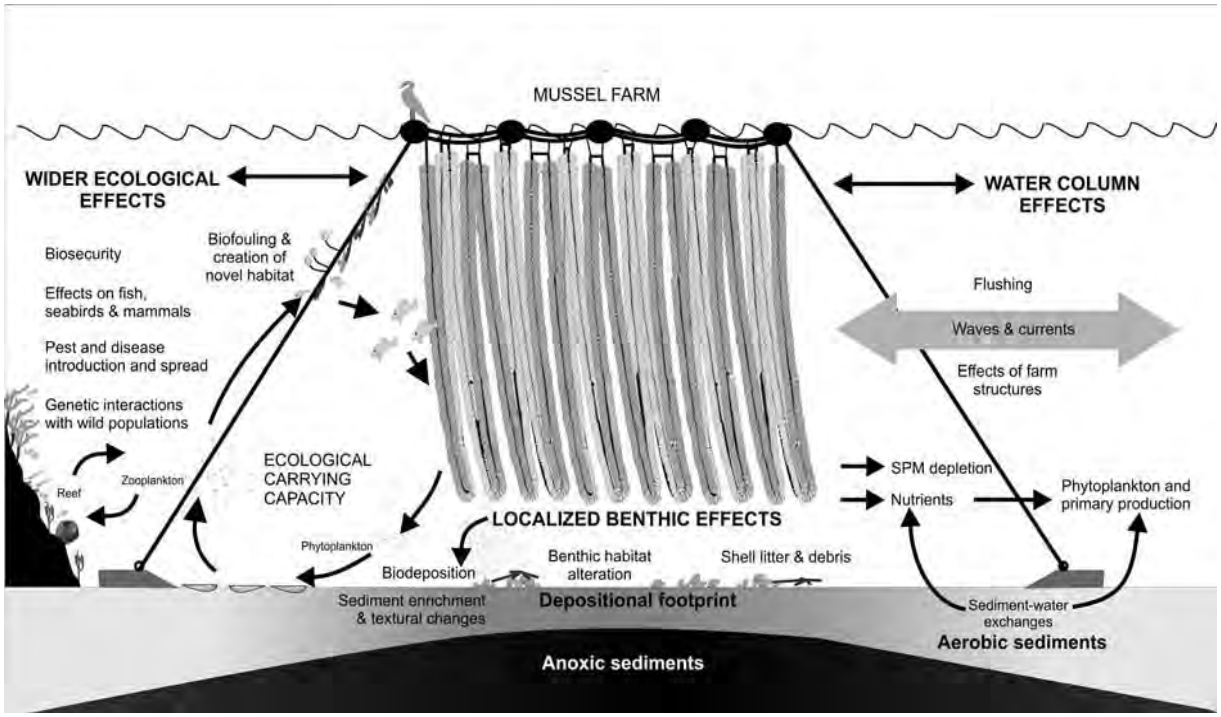

Figure 66: Potential ecological issues associated with shellfish farming (Source: Keeley *et al*., 2009).

Water Quality and Dissolved Products

As shellfish aquaculture is extensive (i.e. no input of feed), the ecological impact is essentially a redistribution of nutrients (Joyce *et al*., 2010). Nutrients, in the form of seston (i.e. phytoplankton, zooplankton, suspended organic and inorganic matter) are filtered from the water by shellfish. Some of the seston is used by the shellfish for metabolic growth and the remainder of the organic waste is returned to the water as faeces or pseudofaeces. Consequently, shellfish culture is integrally linked to the surrounding environment through water circulation and primary production (Joyce *et al*., 2010).

Dissolved metabolic products originating from the shellfish predominantly consist of nitrogen and phosphorus. The release of dissolved nutrients directly into the water column can potentially cause localised enrichment and stimulate phytoplankton growth (Keeley *et al*., 2009). However, shellfish aquaculture usually results in a net removal of nutrients from the water column. Reduced phytoplankton concentrations, a net loss of nitrogen from the system and a decrease in suspended matter can occur in waters which have shellfish farms (Crawford, 2001). The results of a study on a pearl farm at Wanda Head, Port Stephens, indicate that for every tonne of oyster material harvested about 14 kg of nitrogen, 0.7 kg of phosphorus and up to 8 kg of metals are removed from the environment (Umwelt, 2003).

Removing excess nutrients from the water column and reducing turbidity by removing suspended solids and phytoplankton is viewed as a potentially positive effect in degraded

estuaries but it may result in a reduction of nutrients that are essential to the functioning of the ecosystem if the area is relatively unaffected by human activities (Crawford, 2001). Seagrass beds for example, have been found to benefit from shellfish farms by reducing and/or controlling elevated levels of nutrients and metals (Crawford, 2001). Selective feeding of cultured shellfish can also potentially alter the composition of phytoplankton and zooplankton communities (Keeley *et al*., 2009).

During the cleaning of the longline infrastructure, there is likely to be a localised and temporary resuspension of sediment and organic material creating a visual 'plume' around the vessel. However, the suspended material is expected to be dispersed by wind, tidal currents and settling under gravity, which has been observed on a pearl farm at Wanda Head in Port Stephens (Umwelt, 2003).

The overall area of the Commercial Shellfish Aquaculture Leases is a relatively small portion of Jervis Bay (0.4% of the embayment). There is the potential for localised effects to occur but these will be avoided by ensuring that the stocking densities are kept below the ecological carrying capacity of the bay (Joyce *et al*., 2010). Water quality parameters will be monitored on a regular basis to ensure early detection of potential problems. However, impacts are expected to be minimal as shellfish feed on naturally occurring seston in the water column and there will be no additional inputs of feed or nutrients (Inspiring Place, 2001).

The shellfish farms may potentially improve water quality in Jervis Bay by removing excess algae, nutrients and metals from the water column when the stock is harvested. The current and tidal flows which continually circulate the waters within Jervis Bay will also assist to ensure that dissolved nutrients from this activity will be assimilated rapidly with negligible impact.

Particulate Matter and Biosedimentation

Faeces, pseudofaeces, dislodged shellfish and fouling organisms can accumulate on the seabed beneath longline farms and cause changes to the physico-chemical characteristics and benthic community structure of the receiving benthic environment (Cranford *et al*., 2006). Faeces and pseudofaeces are predominately composed of organic nitrogen compounds which are denser than seawater so these particles typically settle on the seabed in the immediate vicinity of longlines (Islam, 2005).

The material deposited on the seabed by the shellfish will be utilised by microorganisms and benthic fauna in the area. The amount deposited, current flows and the number/types of microorganisms and benthic fauna present will largely determine how this material is utilised (Mitchell, 1999 cited in Inspiring Place, 2001). If deposits are excessive and the utilisation

rate is exceeded by supply a depletion of oxygen in the area can occur (i.e. sediments become anoxic), which can lead to a range of environmental problems as well as impacting on shellfish growth. Changes to sedimentary habitat and the benthic community structure can occur as a result (e.g. a shift from suspension feeders to scavenging gastropods and deposit feeding species) (Joyce *et al*., 2010).

The severity of biological and physico-chemical impacts on the benthos depends on the type of waste (i.e. organic or inorganic) and the extent of accumulation (Joyce *et al*., 2010), which depends on water currents, tidal flows and depth beneath a farm (Gavine & McKinnon, 2002). The results of several studies suggest that the accumulation of waste shells and attached algae has a greater effect on the seabed than the biodeposition of faeces and psuedofaeces (Grant *et al.,* 1995; Crawford *et al*., 2001). Stocking densities, current flows and farm management have largely negated benthic impacts in Tasmania (Mitchell, 1999 cited in Inspiring Place, 2001). Similarly, Kaiser *et al*. (1998) concluded that use of appropriate culture techniques can minimise environmental changes as a result of shellfish farming. The studies that have detected significant impacts, such as extensive bacterial mats (Dahlback & Gunnarsson, 1981), changes in benthic community composition and anoxic sediments (Diaz & Rosenburg, 1995), have largely been on farms that were overstocked.

Most studies conducted on the impacts of longline farms on the benthic environment in Australian and international waters have found that impacts are minimal (Kaiser *et al*., 1998; Underwood & Hoskins, 1999; Kaiser *et al*., 2000; Crawford, 2001; O'Conner *et al*., 2002; Lasiak & Underwood, 2002; Crawford *et al*., 2003), highly localised and restricted to the area beneath or in the immediate vicinity of longlines (Keeley *et al*., 2009).

Extensive aquaculture farming in NSW has included scallop longline aquaculture in Jervis Bay (now ceased operating), raft culture of mussels in Jervis Bay (now ceased operating), longline mussel farm in Twofold Bay and Akoya pearl cultivation in Port Stephens. As part of the conditions of approval required by NSW DPI, monitoring of benthic organisms and total organic carbon (TOC) in sediments below lease sites and control sites is required. The following is a summary of the results of environmental monitoring to date:

- The impact of a scallop longline in Jervis Bay remained within the assimilative capacity of the environment in that no significant increases in organic material were detected in sediment samples from in and around the site (Heasman *et al*., 1998);
- An assessment of potential ecological impacts of longline mussel farming in Twofold Bay found that there was no evidence of change in the total number of different fauna groups, dominant taxa or the overall structure of the benthic assemblages found below the mussel longlines (Lasiak & Underwood, 2002);

- The operation of aquaculture leases did not have a measurable effect on TOC in sediments in Twofold Bay. No significant differences in TOC levels were detected in comparisons between the lease sites and the means of their respective controls (NSW Fisheries, 1996). The results of benthic fauna surveys more than a decade later revealed only a small amount of evidence of ecological impact which was only within the bay where the mussel farm was located (Underwood & Hoskins, 1999);
- The results of a monitoring program on a pearl farm at Wanda Head, Port Stephens found no change in nitrogen, phosphorus or TOC in sediment beneath the lease (O'Conner *et al*., 2002). Studies also found no evidence of impact on benthic fauna beneath the farm or to seagrass beds at Wanda Head (Gifford, 2006);
- The farming activities in Twofold Bay have had a minimal impact despite the mussels being farmed at shallower depths (10 m), slower current speeds and higher stocking densities (approximately four times greater) than the pearl farm at Wanda Head (O'Conner *et al*., 2002); and
- The results of the monitoring program in 2012 of the mussel farm in Twofold Bay (Eden Sea Farms) confirm the large spatial variability in TOC and support the conclusion that the operation of the mussel leases has not led to a significant increase in TOC when compared to the control sites. No significant impact on TOC levels has been detected in the last three surveys (i.e. 2007, 2009 and 2012) so additional management has not be considered necessary (Cardno Ecology Lab, 2012).

These NSW examples are relatively small scale compared to the large area of longline installed in Western Australia and internationally.

Crawford *et al*. (2003) investigated the benthic environment under and near three shellfish farms in Tasmania which had a relatively high level of production over many years. Sediment deposition, sediment sulphide concentrations, redox values, organic carbon content and water turbidity levels near the bottom were not significantly different between sites outside the farm, at the boundary and sites within the farm. Dense beds of seagrass were observed in video surveys both outside the farm and under trays of oysters on one of the farms (Crawford *et al*., 2003). Video surveys also revealed that there were fine filamentous algae and patchy bacterial mats directly under some longlines. The benthic infauna did not show clear signs of organic enrichment, and neither univariate nor multivariate measures of benthic infauna were significantly different between sites inside and outside the farm, although they were different between farms. This study concluded that shellfish farming was having little impact on the benthic environment in Tasmania. The farms investigated also had

characteristics less than ideal for shellfish culture i.e. low current flows, sediment with high silt and clay content and relatively shallow depths (Crawford *et al*., 2003).

A review of the ecological effects of farming shellfish in New Zealand also indicated that seabed effects were low to moderate, consisting of minor enrichment of seabed sediments (organic content increased by ~7.5%), increased build up of shell debris directly beneath the leases, and increased aggregations of starfish and other epifauna in some instances (Keeley et al., 2009). Seabed effects were found to be most pronounced directly beneath the leases, reduced rapidly with distance, and were usually difficult to detect within 20 to 50 m from the farm. Water depth and current speeds were found to be the most important factors influencing the magnitude of effects. Locating farms in well-flushed areas where species and habitats of environmental significance are not present has been found to greatly minimise impact (Keeley *et al*., 2009).

Biodeposition and sedimentation from the proposed Commercial Shellfish Aquaculture Leases will be minimised by ensuring that appropriate stocking densities are used which will reduce the quantity of waste produced (Joyce *et al*., 2010). Significant localised particle depletion could occur if large numbers of bivalves were cultured and removed particles faster than the tidal exchange replenished them. This could in turn depress natural populations of secondary producers (Cranford *et al*., 2006).

The orientation of the longline infrastructure will also assist to minimise potential environmental impacts. The longlines will be aligned with the prevailing wave and swell direction in Jervis Bay, where possible (i.e. south to southeast). This orientation will minimise impediments to water flows by reducing the obstructed area in which currents will flow through as water circulates in and out of the bay. The orientation will also assist to reduce the stress placed on the culture apparatus. Reduced water flow velocity could cause the rates of sedimentation of suspended matter from the water column to increase under the leases or in a concentrated area (Umwelt, 2003).

Overall, Jervis Bay is a well flushed embayment where it is estimated that it takes six to 20 days for water to circulate the bay (Holloway, 1995). The proposed Commercial Shellfish Aquaculture Leases are also a small scale operation (50 hectares = 0.4% of Jervis Bay) and the leases will be spread throughout the bay. However, currents near the proposed lease locations can be weak and inconsistent (Joyce *et al*., 2010) e.g. currents range from 0.3-12 cm/s in the bay and tidal movement can be as low as 0.01 m/s (Holloway *et al*., 1989) so monitoring of water quality and the benthic environment is important to ensure that the aquaculture operations are not having a significant impact.

A Water Quality and Benthic Environment Monitoring Program will be implemented to ensure that the aquaculture activities are not having a significant impact on the environment and

surrounding communities. The monitoring program will examine the physico-chemical environment and benthic community structure by regularly sampling before and during the operation of the Commercial Shellfish Aquaculture Leases, including control sites and sites within the leases (Appendix 1). Spatially and temporally replicated baseline data for water quality and benthic parameters will be required before aquaculture activities can commence (Joyce *et al*., 2010). If any parameters are outside the acceptable range, notably water quality and sediment levels, monitoring effort may be increased and practices will be modified until acceptable levels are regained. For example, fallowing (i.e. removal of stock and potentially equipment) of sites or reducing stocking densities will be considered. However, if the results of the monitoring program indicate negligible impact after the first five years of full scale production, monitoring requirements could potentially be decreased and consideration may be given to the use of low cost but high value methods e.g. photographic/video monitoring (Joyce at al., 2010).

A Waste Management Plan will also be implemented for the Commercial Shellfish Aquaculture Leases, which will include the regular removal of biofouling and deposited sediment from the longline infrastructure, mooring lines and culture apparatus (See Section 8.2.2.9). Removal of biofouling and deposited sediment is important to maintain water quality and reduce resistance to currents and wave action (Willemsen, 2005). Removal of biofouling from culturing apparatus will either be conducted at a land based site or by using specifically designed pressure cleaning equipment on the leases. All material that is collected in the filters and tanks will be disposed of at an approved land based treatment facility (Umwelt, 2003). Cleaning of the longlines will be undertaken every 2-4 weeks or when considered necessary (e.g during winter months cleaning may be needed less frequently due to slow growth rates) and the mooring apparatus will be cleaned at least once a year.

During the process of cleaning infrastructure and culture apparatus, stock and biofouling can fall off onto the seabed and deposited sediment can be resuspended. The accidental loss of stock will be largely prevented by containing shellfish within nets, cages, baskets, panels and/or trays or the use of specially designed dropper lines. A visual 'plume' can be created during the cleaning process and can potentially have an impact on the benthic environment. However, the suspended material is expected to be dispersed by wind, tidal currents and settling under gravity, which has been observed on a pearl farm at Port Stephens (Umwelt, 2003). The benthic sediments and seagrass beds adjacent to the pearl farm at Wanda Head (Port Stephens) for example, were monitored and the results from initial and ongoing surveys found no detectable difference between the lease sites and adjacent control sites (Umwelt, 2003).

Conclusion

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on marine habitats in Jervis Bay and the wider region was assessed to be 'low' when considered in context with the flushing rate of the bay, the small scale of the operations, the use of appropriate stocking densities, the physical characteristics of the sites, the absence of feed inputs, the Water Quality and Benthic Environment Monitoring Program and the regular removal of biofouling. In addition, reviews of existing Australian longline farms indicate that impacts on water quality and the benthic environment are largely minimal and highly localised. Furthermore, shellfish aquaculture can potentially improve water quality in a region by removing excess nutrients and metals from the water column.

However, the overall risk is considered to be 'moderate' to ensure adequate management attention is given to these issues, notably sedimentation, until the Commercial Shellfish Aquaculture Leases have been in operation for an extended period of time and validated this assessment.

8.2.2.2 Genetics, Disease and Introduced Pests

Table 28: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – genetics (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the cultured stock have a significant impact on the genetic integrity of wild populations, competition and predation levels and/or food chains? Will the Commercial Shellfish Aquaculture Leases have a significant impact on the occurrence of pathogens in wild populations and/or significantly increase the risk of the establishment of pests?
Level of Impact	Individual facility
Comments and Considerations	▪ *Are the cultured stock likely to threaten wild stocks by causing increased competition for resources e.g. space, food or food chains?* ▪ *Are the cultured stock native to the region i.e. is Jervis Bay within their natural range?* ▪ *Will the cultured stock have an impact on the genetic integrity of wild stocks?* ▪ *Will the Research Lease exacerbate the KTP - 'introduction of non-indigenous fish and marine vegetation to the coastal waters of NSW (FM Act)?* ▪ *Are any measures going to be taken to ensure that the genetic composition of broodstock is maintained at an appropriate level?* ▪ *What processes and regulations are in place to ensure that wild caught and hatchery spat is disease free before secured on the leases?* ▪ *Are cultured stocks likely to transfer diseases to wild stock?* ▪ *Is it likely that disease from cultured stock may be passed on to other fauna in the region via the passage of pathogens through the water or intermediary hosts?* ▪ *Will the leases exacerbate the KTP - 'introduction of non-indigenous fish and marine vegetation to the coastal waters of NSW?* ▪ *Will the health of cultured stock be closely monitored?*
Description	▪ Cultured species are native to NSW waters ▪ Native disease and parasites - minor/controllable ▪ Exotic disease and parasites - negligible/low risk
Proposed Management – Mitigation and Monitoring	▪ Broodstock source - local stocks and/or same genetic population ▪ Disease, Parasite & Pest Management Plan (Appendix 1) o Minimal stress – stocking densities, water quality o Regular health monitoring (surveillance program) o Report 'declared diseases', unexplained mortalities, suspected marine pests and noxious species o Biofouling management o AQUAVETPLAN o Species specific health management protocols as require

	▪ Hatchery Management Plan ▪ NSW Hatchery Quality Assurance Scheme accreditation			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	4	3	12	**Moderate**
Reporting Requirements	Full management report (Appendix 1)			

Justification of Ranking

Endemism and Genetic Integrity

The introduction and translocation of commercial shellfish species potentially poses a number of risks. These risks are outlined by the *National Policy for the Translocation of Live Aquatic Organisms* (MCFFA, 1999) and include environmental and ecological issues. Environmental issues include the potential for genetic shifts in wild populations.

A loss of genetic diversity is a potential concern if cultured stock cross breed with wild populations (Pillay, 2004). The genetic integrity of wild stocks is most at risk when shellfish originate from broodstock outside the range of the local genetic population. Limits and restrictions will be applied to ensure application of the endemism rule on the source of spat or juveniles for the species to be cultivated in Jervis Bay. All hatchery produced spat for the Commercial Shellfish Aquaculture Leases will be derived from broodstock that has either been collected from wild stocks local to the marine farming activity or from the same recognised genetic population. If spat are to be hatchery reared, broodstock will be collected in sufficient numbers to ensure the genetic diversity of spat is not compromised. There will be no use of genetically modified organisms.

The degree of endemism in Jervis Bay for shellfish such as mussels, oysters and scallops is considered low as spat of these species that settle in Jervis Bay can be derived from planktonic stages originating in spawning populations well up or down the Australian east coast and carried to Jervis Bay by ocean currents (NSW MP, 2008b). The larvae of these species can remain free swimming in the water column for weeks before settling and can be dispersed over great distances. Examples of this can be seen in reports of tropical species brought down the coast via eddies from the East Australian Current. The Tropical Scallop (*Amusium ballotti*) has been found in Jervis Bay (Smith, 1991), while cool water species such as the Queen Scallop (*Chlamys bifrons)* have also been reported (CSIRO, 1994). The regular appearance of tropical coral reef fish species in summer in southern NSW (Booth *et al.*, 2007) is another example of the capacity for currents to move juveniles well beyond what is considered their normal range.

Any new aquaculture venture proposed for Jervis Bay will need to take these issues into account. Whilst the arguments put forward for the continued collection of spat from other estuaries based on the Twofold Bay mussel spat experience can be developed for other species, the ideal situation for aquaculture in Jervis Bay would be to use spat cultivated from wild shellfish collected directly from the bay. There also needs to be a reasonable turn-over of wild parent stock to ensure continued genetic variation.

Resource Competition

There is the potential for cultivated spawning shellfish species to influence the distribution of individual shellfish species within Jervis Bay with possible consequences for the balance or makeup of wild assemblages of biota. The extent of competition between cultured stock and wild stock is largely dependent on the ecological niches they occupy, feeding habits and survival rates. Concerns exist that an increase in the number of mussels introduced to Jervis Bay will increase the size of the spawning population in the bay and increase recruitment pressure on rocky shores and rocky reefs.

The Twofold Bay mussel farming operation suggests that recruitment from cultured stocks is unlikely to be a problem and that the potential increase in populations arising from farm spawnings was less than the background variation in natural spawning of mussels. Certainly, practical experience gathered in Jervis Bay has recorded heavy natural spatfall occurring but these settlements have been sporadic and insufficiently reliable in timing for commercial purposes (W. O'Connor 2013, *pers comm*.). The consequence of these 'windfall' spatfalls indicate that there can be spikes of settlement of various shellfish species from time to time (Fuentes *et al*., 1992, Heasman *et al.* 1994). That is, there is already a certain natural dynamism in the makeup of the assemblages of species in the various habitats in Jervis Bay. This phenomenon is not restricted to shellfish but has been observed and documented for a number of other invertebrate species.

The capacity for cultured stocks to contribute to wild recruitment also needs to consider the characteristics of the spawning cycle for shellfish (which take a number of years to reach full spawning potential), the farming methods (which remove the larger and more mature specimens for sale prior to them spawning) and the lack of appropriate spawning triggers in Jervis Bay (in effect a sudden and prolonged cold snap). Collectively these factors generally work together to reduce the likelihood there would be large farming-induced spawning events in Jervis Bay.

For example, cultured mussels in Jervis Bay were previously harvested between about 10 and 14 months of age. Figure 67 indicates that at this age the mussels have low reproductive capacity and therefore would not be significantly contributing to the wild population of mussels in Jervis Bay. This would equally apply to other shellfish species proposed for

culture on the Commercial Shellfish Aquaculture Leases, where fecundity will increase with size/age (Cole, 1941; Sause *et al.,* 1987). Shellfish are generally harvested at their reproductive peak condition (prior to spawning) which further reduces their capability to contribute to wild populations. In the case of Pearl Oysters, deliberate attempts are made to prevent reproductive condition improving as it hinders pearl nucleus insertion (O'Connor *et al*., 2003).

Mussel farming had occurred previously in Jervis Bay from late 1970s to 2008 with no significant impacts from recruitment being identified.

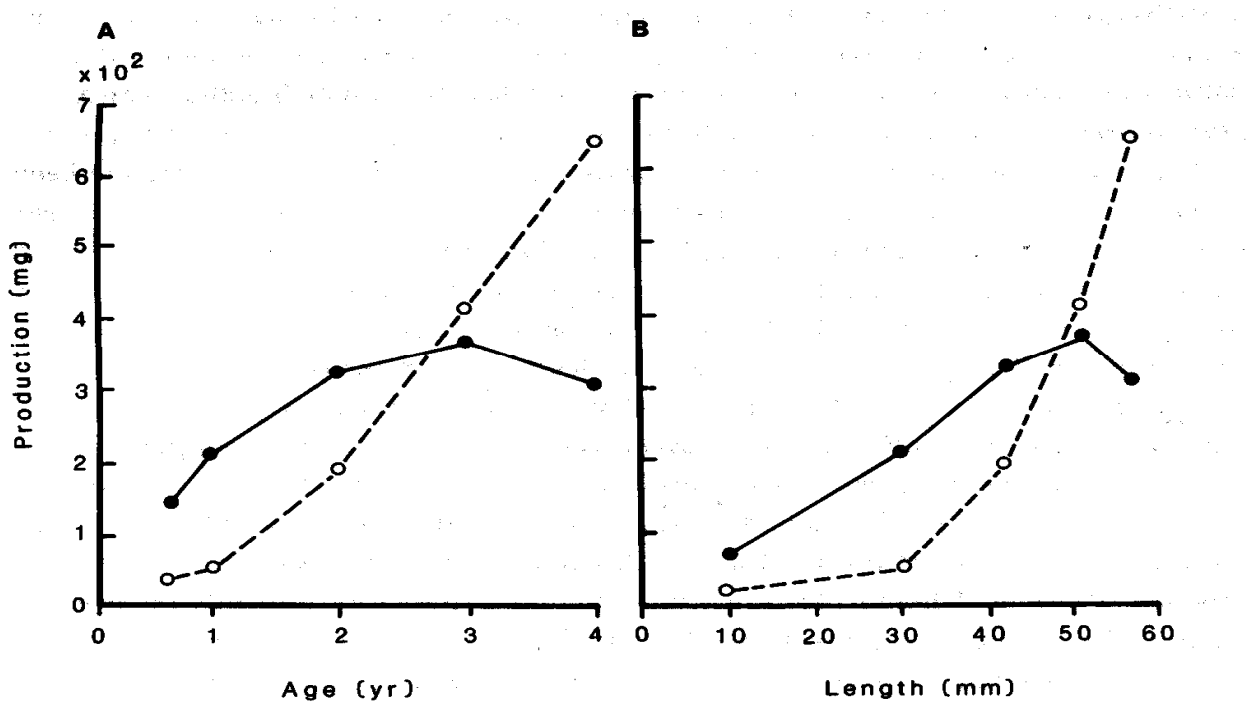

Figure 67: Somatic (solid circles) and gamete (open circles) production as a function of age and shell length in low shore *Mytilus edulis* from Long Island, New York, North America (Source: Rodhouse *et al*., 1986).

If aquaculture spawning related changes in wild assemblages of biota were to be observed as a significant issue then this could be overcome by breeding functionally sterile spat for cultivation. This is currently done for a number of species (both Sydney Rock Oysters and Pacific Oysters) and can be achieved through various means including the mating diploid and tetraploid parents and selecting out the (non breeding) triploid spat for farming. However, cultivation of sterile spat requires extensive hatchery facilities and cultivation of wild spat also requires some hatchery facilities. These facilities are currently not available in the region and are unlikely to be established until there is a viable industry to support. Thus in the interim, it is suggested that early aquaculture ventures in Jervis Bay may need to rely on a mix of traditional collection of spat plus spat collected or grown in small hatchery facilities for other local species.

Disease

A wide variety of disease causing organisms and parasites exist worldwide (de Jong & Tanner, 2004). Disease is not just the result of the pathogen itself but a complex interaction between the pathogen, the aquatic animal and the environmental conditions (PIRSA, 2002). Pathogens types include parasites, fungi, bacteria and viruses, which usually infect shellfish when their immune system is depressed, the epidermis is damaged and/or succeeding periods of severe stress caused by factors such as poor water quality or rough handling (Barker *et al.,* 2009). Disease and parasites are likely to spread faster in farms than in the wild but strict health monitoring programs help to ensure early identification of pathogens so appropriate management is implemented before severe infestations occur (PIRSA, 2003). However, prevention of infections is generally much easier than control and can usually be achieved by careful handling, good husbandry practices and maintenance of water quality (PIRSA, 2003; Barker *et al.,* 2009).

The accidental introduction of exotic pathogens and subsequent infection of existing native species also poses a threat to the marine environment. These exotic pathogens may be introduced with the commercial species itself, or alternatively, shellfish culture (including translocation of un-clean infrastructure) may facilitate the transfer of endemic pathogens to new areas.

Scallops are known to be affected by a range of diseases overseas, however to date there have been no records of disease in either *P. fumatus* or *C. asperrima*. In trial cultivation of scallops in Jervis Bay no disease was observed other than bucephalid parasitism, which only affected wild stocks of both species (Heasman *et al*., 1996). The risk of introduction of non endemic scallop diseases is considered to be low as there is no external source of wild caught scallops that could be translocated to Jervis Bay. Cultivation would therefore be dependent on hatcheries that would source broodstock locally and thus reduce the risk of importing disease to a naïve population.

Pearl Oysters (*Pinctada fucata*) have been cultivated in NSW for over a decade, including Jervis Bay (O'Connor *et al*., 2003), and there have been no reports of parasites or diseases. Akoya virus is listed on the national notifiable diseases register but has never been detected in Australia.

Mussels are also known to be affected by disease, however the history of cultivation of mussels in Jervis Bay and Twofold Bay extends back over 30 years without recorded disease outbreaks. Mussel cultivation throughout Australia has been free of disease events. This suggests that while the emphasis should be placed at a national scale to protect the industry as a whole, need for vigilance at the local scale, by implementation of local monotiring protocols is also important, particularly given the range of disease vectors that are possible.

Two oyster species have been cultured or harvested from Jervis Bay and are considered potential candidates for cultivation on the Commercial Shellfish Aquaculture Leases: Sydney Rock Oysters and Native (Flat or Angasi) Oysters. Both are affected by disease. Sydney Rock Oysters have two major pathogens - *Marteilia sydneyi* (QX) and *Bonamia roughleyi* (currently ascribed as the causative agent for Winter Mortality). .QX disease outbreaks have been recorded since the mid 1970s in a number of estuaries in NSW and QLD. To date Sydney Rock Oysters are the only species to have been affected by QX despite the co-occurrence of other species. QX has not been recorded to have caused losses south of the Georges River in NSW.

Winter Mortality affects estuaries in central and southern NSW and has been observed in estuaries adjacent to Jervis Bay and within the bay at Currambene Creek. There is a paucity of information on Winter Mortality but it has not been reported to affect species other than Sydney Rock Oysters. The incidence of Winter Mortality is thought to increase under regimens of high and stable salinity (Wolf, 1976) and so rock oysters cultured in Jervis Bay should be carefully monitored.

To prevent the spread of QX, strict protocols are in place that would preclude importing oysters from QX affected estuaries (Web Reference 33). Sensitive genetic tests are readily available for the detection of QX (Kleeman & Adlard, 2000) and it is possible to test stocks prior to translocation in instances where infection is possible or suspected. The model for transmission of QX to oysters is thought to involve at least a secondary host (possibly a polychaete worm) and it is not thought to be vertically transferred between parent and offspring (Kleeman & Adlard, 2000; Kleeman *et al*., 2002). QX free batches of spat have been produced on a number of occasions from adults known to have been exposed to the parasite and with simple hygiene protocols, hatchery produced oyster spat pose little risk of harbouring the disease.

Native Oysters are affected by a parasite, *Bonamia* sp., which has been responsible for significant stock losses in other states in both culture and the wild (Victoria, Tasmania and Western Australia). *Bonamia* generally affects older oysters but it has been observed in juveniles and larvae in Europe. To date, there have been no recorded losses due to *Bonamia* in NSW but the pathogen has been detected in stocks at various locations throughout the State at quite high frequencies (>25% - Heasman *et al.,* 2004). Jervis Bay has natural populations of Native Oysters that have previously supported a commercial fishery. While it is highly likely these stocks harbour the parasite, sourcing any broodstock for hatchery production from local stocks would again serve to maintain genetic integrity and limit the chance of the introduction of non endemic diseases.

All of the above mentioned commercial shellfish species are variously affected by mudworm species (*Polydora sp. and Boccardia sp.*). For most, the impact is not great and the worms and shellfish coexist. However, losses can occur if infestations are severe. Cultivation methods are usually tailored to prevent or limit mudworm as it severally affects marketability. Maintaining stocks and culture equipment free of mud and silt is a key control method to deter mudworm (Nell & Smith, 1988). Growing shellfish in suspended culture in areas with wave or wind movement can help to prevent silt accumulation and reduce mudworm impacts. Where feasible, air drying stock can also assist (oysters). Mudworm is not uncommon in Jervis Bay and has been observed in wild oysters and scallops (O'Connor *et al*., 1999).

Disease Management

Stress to stock will be minimised wherever possible to reduce the risk of disease outbreaks and infections as environmental stresses lower their natural resistance (Snieszko, 1974). Stock stress levels will be minimised by appropriate site selection and maintaining appropriate stocking densities (Barker *et al*., 2009), which will vary depending on the species cultured, the culture apparatus used and environmental conditions at each site.

Regular monitoring of the health of the cultured stock on the longlines will be undertaken and if signs of disease are detected, prompt reporting to NSW DPI (as required) and treatment will occur. This is to ensure that the occurrence and severity of disease and parasite infections are kept under control. Any known or suspected case of a notifiable aquatic disease ('declared diseases') listed under the FM Act, as well as any unexplained or unusual mortalities and disease outbreaks will be investigated by NSW DPI.

Biofouling on the longline infrastructure and culture apparatus can potentially harbour pathogens and reduce water flow and quality, which in turn can increase the risk of cultured stock contracting pathogens (Braithwaite *et al*., 2007). Biofouling can also act as an attractant to marine species both as food and refuge and can increase intraspecific food competition. Therefore, its removal reduces its ability to harbour naturally occurring diseases and parasites (Braithwaite *et al*., 2007). Cleaning of the longlines may be undertaken every 2-4 weeks where possible in summer months and as required during winter months. The mooring apparatus will also be cleaned at least once a year. Infrastructure will either be taken to the land based site for cleaning or it will be cleaned on-site using pressure cleaning equipment (Waste Management Plan - Appendix 1).

Hatchery Disease Management

The initial step in preventing the occurrence of diseases and parasites in aquaculture stocks starts with the production of quality disease and parasite free hatchery spat. This is accomplished through the implementation of strict hatchery procedures.

The *Manual for Hatchery Production of Sydney Rock Oysters (Saccostrea glomerata)* will be used as a guideline for the development of hatchery best practices. Notably, the manual provides details of symptoms and control/prevention methods for specific pathogens in hatcheries (O'Connor *et al.,* 2008). A Hatchery Management Plan will be required for the supply of hatchery produced spat for the Commercial Shellfish Aquaculture Leases (Appendix 1).

Port Stephens Fisheries Institute (PSFI) hatchery facility may be used to produce the spat for stocking the Commercial Shellfish Aquaculture Leases. In addition to using the above manual the PSFI hatchery facilities are also accredited under the *NSW Hatchery Quality Assurance Scheme* (HQAS) (NSW DPI, 2010). This scheme was developed to produce native freshwater fish fingerlings for recreational fishing enhancement stocking programs and aquaculture production but the HQAS standards of maintaining genetic integrity and producing stock that are healthy and free of pests and non-target species (NSW DPI, 2010) are considered to be applicable and will be used for the culture of shellfish spat for the Commercial Shellfish Aquaculture Leases. A feature of the HQAS is the maintenance of a Health Management Plan, surveillance and early detection of disease, prompt response and treatment of stock and biosecurity procedures for the facility and stock management.

Translocation

The hatchery produced spat will be subject to stringent hatchery practices and surveillance regimes, as well as possibly ozone treatment to mitigate any risk of introducing disease or parasites to the Commercial Shellfish Aquaculture Leases (Appendix 1).

Hatchery produced spat will be sampled and thoroughly examined before they are translocated to the leases. Visual inspections for any signs of disease or parasites, histopathological examinations and the polymerase chain reaction (PCR) investigations may be used to test for pathogens. If any known or suspected case of disease or parasites is detected, the infected stock will be quarantined and treated or if unable to be treated they will be destroyed and appropriately disposed.

Natural spat sourced from outside of Jervis Bay will also be subject to the above examinations and testing along with any required treatment protocols to mitigate the potential to introduce diseases or pests.

Movements of shellfish between estuaries or a hatchery to an estuary will also have to be recorded (shipment log book) in order to track shellfish shipments to support biosecurity controls.

Emergency Biosecurity Procedures

Emergency response protocols to deal with aquatic animal disease events have been developed by NSW DPI in accordance with the provisions of *Australian Aquatic Veterinary Emergency Plan* (AQUAVETPLAN). AQUAVETPLAN was developed with the aim of building and enhancing the capacity of the management of aquatic animal health in Australia.

A series of manuals detailing approaches to national disease preparedness and aquaculture animal disease events, including technical response and control strategies and guidelines for dead stock disposal are provided in the AQUAVETPLAN (Web Reference 34). Details of these procedures will be contained in the Disease, Parasite and Pest Management Plan (Appendix 1).

NSW DPI has demonstrated experience and capacity to deal with aquatic animal disease emergencies. For example, NSW DPI has had to respond to and manage QX and Pacific Oyster Mortality Syndrome (POMS) events in the NSW oyster industry and a suspected outbreak of *Didemnum vexillum,* a type of sea squirt, on the multipurpose wharf at Twofold Bay.

Pests

One of the potential risks of aquaculture is the inadvertent introduction of species into waterways beyond their natural range or to areas within their natural range that have distinct genetic stocks or populations. Translocation of aquatic organisms has a number of inherent risks for the receiving aquatic habitats as well as for endemic organisms including:

- Predation;
- Introduction of disease or parasites;
- Competition, directly or indirectly for food and space;
- Significant adverse impact on habitat and native aquatic ecology; and
- Hybridisation with native populations that can affect genetic integrity.

The *National Policy for the Translocation of Live Aquatic Organisms* (Translocation Policy) (MCFFA, 1999) has been developed to meet the needs of Australia's aquaculture and aquarium industries for the translocation of species within jurisdictions and across jurisdictional boundaries. These guidelines set out a risk assessment process for considering translocation issues. All proposals must be assessed according to the Translocation Policy.

The introduction of exotic species is an issue which can only be dealt with on a national basis. However, the expanding aquaculture industry around Australia is one of the prime moving forces in establishing the National Strategy to control this issue. The shellfish farming

industry should work with tourism operators, recreational and commercial fishermen, and other interest groups to minimise the threat from introduced species.

The Aquatic Biosecurity Unit in NSW DPI deals with issues of disease and pests in both wild and aquaculture populations, disease investigations associated with fish kills, and other factors which may impact on aquatic species health. Threats are managed by implementing strategies and operational policies based on assessment of risk. A protocol for the translocation of aquaculture stock into and out of Jervis Bay will be prepared based on the Translocation Policy. An example of a mussel translocation policy is the *Victorian Protocol for the Translocation of Blue Mussels* (Anon, 2006).

In Jervis Bay, the introduction of exotic pathogens and pests into the surrounding region will be minimised by sourcing and culturing species that are endemic to the waters of Jervis Bay. Biosecurity procedures mitigate the risk of introducing exotic pests and diseases will also be implemented. A protocol for the translocation of aquaculture stock into and out of Jervis Bay will be prepared based on the *National Translocation Policy Guidelines* before the commencement of any aquaculture operations. The translocation of stock within NSW may require notification to NSW DPI according to existing legislative translocation requirements and protocols designed to mitigate the risk of transfer of known oyster diseases (QX and POMS) and non-native species (Pacific Oysters) (Web Reference 33).

Consideration also needs to be given to the translocation of culture equipment, which can harbour native and exotic pests and diseases such as toxic phytoplankton. For general culture equipment (trays, cages, baskets etc) simple cleaning and air drying protocols exist that are extremely effective in preventing accidental translocations. These procedures are clearly described in a range of existing translocation protocols and legislative instruments that are used in the oyster industry. Mussels however, can pose an additional risk as the translocation of spat is traditionally via the dropper ropes on which they have settled. These ropes can potentially harbour other organisms and the delicate nature and attachment of the mussel spat prevents the use of aggressive cleaning techniques or drying. However, where a biosecurity risk is identified Mussel spat can be removed from the droppers and appropriate treatments can be applied to mitigate the risk. Mussels to be cultivated can then be reattached to new or treated dropper lines.

The experience of many years of mussel cultivation in Jervis Bay based on spat collected from Twofold Bay, there is no indication that changes have occurred to wild stocks or local assemblages of animals, and there have been no apparent introductions of pest species. This result can be attributed to a number of natural and specific farming practices. A combination of trialled spat collection and transportation methods from Twofold Bay plus the developed awareness and testing for introduced species (including planktonic species) by

farmers working in conjunction with government agencies have worked to mitigate the introduction of pest species into Jervis Bay via the mussel spat collection route.

NSW DPI Aquatic Biosecurity Unit is responsible for investigating reports of new aquatic pests and disease occurrences in NSW. If specific new pest or disease issues are identified, the Minister can respond according to the level of threat, by means of implementing relevant Quarantine Orders, targeted translocation protocols and procedures.

Conclusion

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on genetic integrity of wild stocks and the occurrence of diseases and pests is thought to be 'low' when considered in context with the implementation of the Disease, Parasite and Pest Management Plan that is required to be implemented by the lease operator/s.

The Disease, Parasite and Pest Management Plan will include guidelines and protocols for surveillance regimes and monitoring, how to reduce stress to stock, the implementation of strict husbandry practices, the reporting of any unusual mortality or suspected notifiable aquatic diseases, the removal of biofouling and compliance with the hatchery protocols. Also, broodstock will be sourced locally or from the same genetic population and only breeding techniques that will ensure genetic integrity will be used.

The introduction of exotic pathogens and pests into the surrounding region will also be mitigated by culturing species that are native to NSW waters and implementing biosecurity procedures.

However, the overall risk is considered to be 'moderate' to ensure adequate management attention is given to these issues until the leases have been in operation for an extended period of time to validate this assessment.

8.2.2.3 Artificial Lights

Table 29: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – impacts of artificial lights on light sensitive species (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the installation of at least four navigation lights on the corners of the Commercial Shellfish Aquaculture Leases and the use of service vessel lights have a significant impact on any light sensitive species, notably seabirds?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *What type of navigational lights will be installed to mark out the boundary of the leases?* ▪ *Will the service vessels be operating at night and coming in close proximity to nesting seabird habitat?* ▪ *Is the lighting or illumination likely to have any impact on any light sensitive species?*			
Description	▪ Possible light sensitive species o Little penguins o Wedge-tailed shearwaters o Little shearwaters o Short-tailed shearwaters ▪ Four navigation lights on corners of leases o Range ≥ 4 nautical miles o Flashing o Vertical divergence ≥ 9 degrees			
Proposed Management – Mitigation and Monitoring	▪ Site selection o Distance from offshore islands = 9.8 - 12 km ▪ Hours of operation = predominately daylight ▪ Navigation lights - low intensity flashing white strobe lights with a low profile ▪ Vessel lights – shielded and concentrated downwards			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	0	6	0	**Negligible**
Reporting Requirements	Short justification			

Justification of Ranking

Artificial lights (i.e. navigation and vessel lights) associated with aquaculture projects can potentially cause disorientation and stress to some species of seabirds and possibly impede their navigation abilities when returning to their nests at night. Bowen Island in Jervis Bay is home to 5000 breeding pairs of little penguins (*Eudyptula minor).* The little penguin is the only penguin species that breeds in Australia (DECCW, 2010a) and is a diurnal forager that mainly feeds in inshore waters around the mainland coast or breeding islands (Gales & Pemberton, 1990). Other seabird species also nest on the island, including wedge-tailed shearwaters (*Puffinus pacificus*), little shearwaters (*Puffinus assimilis*), short-tailed shearwaters (*Puffinus tenuirostris*) and sooty oystercatchers (*Haematopus fuliginosus*).

There is a paucity of literature about the impact of artificial lights on the seabird species, including why they are attracted to them (Verheijen, 1985). McNeil *et al*. (1993) proposed that nocturnal birds may be more sensitive to lights because these species have larger eyes than diurnal birds and their retinas have a greater number of photoreceptor cells. Montevecchi (2006) suggested that species which consume bioluminescent prey are likely to have greater sensitivity to artificial lights. Inexperience may also be an important factor as young birds rely on visual cues (e.g. moon or starlight) to reach the ocean during their first flight and illuminated areas may cause confusion and impede their navigation abilities.

A range of studies have been conducted on the impacts of light pollution associated with street lighting, house lights, shopping centres and offshore oil rigs on wildlife (Verheijen, 1985; Rodriguez & Rodriguez, 2006). The lighting associated with these sources has been found to disrupt migrating birds, cause behavioural anomalies, disorientation and increase mortalities of some seabird species (Rodriguez & Rodriguez, 2006). Several cities in the United States and Canada have reduced the light emitted from skyscrapers at night during migration seasons and saved millions of birds from dying as a result of disorientation. The National Audubon Society in New York and the Toronto Fatal Light Awareness Program are among the initiatives that have instigated these changes (The Royal Commission of Environmental Pollution, 2009).

Light pollution in Jervis Bay is primarily from the residential areas of HMAS Creswell, Hyams Beach, Vincentia, Huskisson, Callala Beach and Callala Bay. There is also the Jervis Bay Airport operated by the RAN which is about 2 km south of Jervis Bay Village and a lighthouse at Point Perpendicular. Naval and other visiting vessels regularly moor over night in the embayment creating a source of light pollution on the waters of Jervis Bay. Also existing navigation marks exist in the vicinity of Huskisson, Vincentia and Callala. Hence, the seabirds that nest on Bowen Island are already exposed to a variety of sources of artificial light associated with the towns, vessels and other facilities in the area.

The artificial lighting associated with the Commercial Shellfish Aquaculture Leases will consist of at least four low intensity navigation strobe lights attached to buoys and positioned with a low profile on the corners of the leases in accordance with NSW Maritime requirements. These requirements include a light that has a range of at least four nautical miles in clear conditions (transmissivity of 0.74), a flash character to suit the type of cardinal mark and a minimum vertical divergence of nine degrees (Solar Technology Australia, n.d.; IALA, 2008). Flashing white strobe lights are considered less likely to attract night-migrating birds at night than non-flashing white and red lights (Web Reference 29). In addition, service vessels will be fitted with the standard navigational safety lights (e.g. masthead, side, stern and all round lights) appropriate to the type and size of the vessels.

The Commercial Shellfish Aquaculture Leases are located 9.8 to 12 km from Bowen Island so it is considered likely that the seabirds nesting on Bowen Island would not be disturbed by light emissions from the navigation buoys. The hours of operation for the leases will be predominately restricted to daylight hours and night work may occur if there is an emergency, such as to repair infrastructure from storm damage or due to vandalism. If night operations are undertaken, lighting on service vessels will be restricted to interior and navigation lights, external work lights will be shielded to concentrate light downward specifically onto the work site. Reed *et al*. (1985) for example, found that the number of grounded petrels decreased by more than 40% on Kauai, Hawaii when lights were shielded to avoid upward radiation. Similarly, shielding and changing the frequency of lighting on oil rigs was found to reduce light pollution impacts on seabirds in the North Sea (Van De Laar, 2007).

Conclusion

The risk of artificial lights used during the operation of the Commercial Shellfish Aquaculture Leases having a significant impact on light sensitive species, notably the little penguin, was assessed to be ‘negligible’ when considered in context with the distance from Bowen Island, the use of low intensity flashing white strobe lights with a low profile, the lighting of existing navigation marks, the hours of operation predominately being during the daytime and the measures that will be implemented to shield vessel lights if night work is required.

8.2.2.4 Entanglement and Ingestion of Marine Debris

Table 30: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – entanglement and ingestion of marine debris (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the Commercial Shellfish Aquaculture Leases have a significant impact on the occurrence of entanglements and ingestion of marine debris?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Is the longline infrastructure likely to result in entanglements of marine fauna?* ▪ *What species are susceptible to entanglements based on findings from other longline farms in Australian waters?* ▪ *Will the facility increase the risk of marine fauna ingesting marine debris i.e. will it release any solid waste into the environment?* ▪ *How will entanglements be mitigated, monitored and managed?* ▪ *How will an entanglement be dealt with if it occurs e.g. emergency response team?* ▪ *How will lines be kept taught constantly to ensure the risk of entanglements is minimised?*			
Description	▪ KTP – entanglement and ingestion of marine debris ▪ Backbone, culture, mooring and spat lines = potential entanglement ▪ Infrastructure and operational activities could generate marine debris if not mitigated and managed			
Proposed Management – Mitigation and Monitoring	▪ Longline design features - minimise entanglement risk o Thick diameter ropes and lines (25-35 mm diameter) ▪ Marine Fauna Interaction Management Plan (Appendix 1) o Marine Fauna Entanglement Avoidance Protocol ▪ Structural Integrity and Stability Monitoring Program (Appendix 1) o All ropes and lines will be kept taut (taut rope policy) ▪ Waste Management Plan (Appendix 1)			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	2	4	8	**Moderate**
Reporting Requirements	Full management report (Appendix 1)			

Justification of Ranking

The Key Threatening Process (KTP) - entanglement and ingestion of marine debris, which is listed under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*, is potentially relevant to the Commercial Shellfish Aquaculture Leases. Entanglement refers to the process in which wild fauna become caught in the physical structures of mariculture facilities (McCord *et al*., 2008). Marine debris consists of plastics, packaging materials, fishing gear (nets, ropes, line and buoys) and convenience items and is sourced from ship waste, the seafood industry, recreational activities and both rural and urban discharges into rivers, estuaries and coastal areas.

Marine animals can become entangled in or ingest anthropogenic debris which can lead to a range of lethal and sub-lethal effects, such as reduced reproductive success, fitness, ability to catch prey and avoid predators, strangulation, poisoning by polychlorinated biphenyls, infections, blockages, increased drag, perforations and loss of limbs (Web Reference 30).

A range of marine fauna are potentially vulnerable to entanglement in aquaculture infrastructure and ingesting marine debris including whales, dolphins, seals, sharks, teleosts, marine turtles and seabirds.

Whales

A range of whale species have been sighted in the coastal waters of southern NSW, including humpback whales, southern right whales, dwarf minke whales, blue whales, sperm whales, Gray's beaked whales, strap-toothed beaked whales, killer whales, Hector's beaked whales, true's beaked whale, false killer whales, Cuvier's beaked whales, Antarctic minke whales, Bryde's whales, pygmy right whales, Arnoux's beaked whales, short-finned pilot whales, long-finned pilot whales, pygmy sperm whales, Andrew's beaked whale and Blainville's beaked whales (Appendix 3 and 6).

The risk of entanglement of humpback whales (*Megaptera novaeangliae*) and southern right whales (*Eubalaena australis*) is of particular concern because they are among the most commonly sighted species in Jervis Bay, they often swim close to the coast, are frequently sighted resting in large embayments and their populations are increasing steadily (Allen & Bejder, 2008; Web Reference 31). Humpback whales and southern right whales migrate along the east coast of Australia while on their annual migration between their feeding and breeding grounds from May to December each year. The habitat usage in Jervis Bay of these whales has been observed and sometimes recorded by tourism industry representatives or the community however, no formal surveys or analysis of this data has been undertaken (Matt Carr – Manager, Jervis Bay Marine Park 2013, pers comm.). As Jervis Bay is adjacent to their migration route, the longline infrastructure of the Commercial Shellfish Aquaculture

Leases could potentially impact upon resting habitat availability and represent an entanglement hazard.

The overall risk of entanglement of humpback and southern right whales in Jervis Bay is seasonal with elevated risk during the southern migration (whales enter the bay more frequently at this time) as calves are involved. Severe weather (i.e. heavy sea/swell conditions) also increases the risk of collision and entanglement, which is further complicated by the ability to implement a rescue response plan during severe weather (Marine Pollution Research, 2008).

Sperm whales (*Physeter macrocephalus*) generally inhabit deep waters greater than 200 m but there has been the occasional sighting in the inshore waters of NSW (Bannister *et al*., 1996). Consequently, it is possible that sperm whales may pass through the waters off Jervis Bay but it is considered unlikely that this species will enter the shallow waters near the proposed leases. Similarly, blue whales (*Balaenoptera musculus*), minke whales (*Balaenoptera acutorostrata*), pilot whale (*Globicephala* spp.), false killer whales (*Pseudorca crassidens*) and orcas (*Orcinus orca*) mainly inhabit oceanic waters but there has been the occasional sighting of these species in the inshore waters of NSW (Bannister *et al*., 1996). Orcas, pilot, false killer and minke whales are occasionally sighted in the Jervis Bay region. Sightings of other whale species in Jervis Bay are rare. It is possible that Jervis Bay could represent a proportion of resting habitat for these species, especially for the migratory species.

There are very few reported cases of negative whale interactions with longline farms in Australian waters. There is a single reported fatality case of a Bryde's whale becoming entangled in a mussel spat line in Australian waters (Great Barrier Reef) in 1996. Similarly, there are two reported cases of mortality of the Bryde's whale due to entanglement in mussel spat collectors in New Zealand (Lloyd, 2003). However, spat lines have narrow diameters and are often only lightly anchored (Baker, 2005) so the risk of entanglement is considered to be significantly greater for this type of infrastructure (Lloyd, 2003). Entanglement risk to large whales is significantly reduced if ropes and lines are kept tightly tensioned and have a thick diameter (Baker, 2005).

Prior to the commencement of mussel farming in Twofold Bay (NSW) an extensive review of the threat of entanglement of marine fauna in aquaculture lines was conducted and the conclusion was that there was no significant risk posed (Pacific Seafood Management Consulting Group, 1996). Growing mussels on longlines and rafts has been practiced in areas frequented by whales in NSW, including Jervis Bay and Twofold Bay, for over 20 years without entanglement incidents (NSW DPI, 2005). Similarly, a pearl farm at Wanda Head,

Port Stephens had operated from 1999 to 2009 and no incident of whale entanglement has been recorded.

Humpback and southern right whales are regular visitors to Twofold Bay (NSW) and have been sighted in close proximity to mussel leases and appeared to have negotiated the longlines without any issues arising (NSW DPI, 2005). Similarly, longline aquaculture is also carried out in Great Oyster Bay and Mercury Passage (Tasmania) which is in the migration path of these two species. There is no evidence to suggest entanglement is an issue of significant concern in these areas (NSW DPI, 2005). There is a general consensus that longline systems do not represent a significant threat to whales provided that lines are kept taut, no netting is used, vessel speed restrictions are enforced in areas surrounding leases and a contingency plan is implemented to address potential issues that may arise (NSW DPI, 2005).

The taut rope system that is proposed to be used on the Commercial Shellfish Aquaculture Leases is similar to what is used on pearl farms along the Western Australian coast since 1961. There are tens of thousands of hectares of longlines established within and adjacent to whale migration routes along the Western Australian coast with more than 30,000 humpback whales migrating up and down the coast every year. Notably, longline aquaculture occurs north of Cape Leveque, which is an important area for humpback whale calving and breeding, and in Albany, which is habitat for southern right whales during the breeding season (NSW DPI, 2005).

There are records of entanglements of large baleen whales in Western Australia in the fishing gear of the West Coast Rock Lobster Fishery (WCRLF) accounting for over 90% of whale entanglements (Campbell, 2011). The WCRLF uses much finer ropes than those proposed for the Commercial Shellfish Aquaculture Leases, and the ropes are free floating via small buoys and not maintained in a taut state. These incidences of entanglement were investigated to determine what factors, if any, could explain the rate of interaction e.g. increasing population sizes (Campbell, 2011). Based on the estimated whale population growth rate of 10% it was speculated that the rate of entanglement could double approximately every seven years. Analysis of entanglement data however, revealed that incidences have increased over the years but the rate of increase has been considerably lower than what was expected. This may be correlated to a range of mitigation actions undertaken by the WCRLF, including changes to practices and rope length, as well as reduced fishing effort (Campbell, 2011).

In regards to longline aquaculture in Western Australia, there are no known fatalities of whales due to entanglement in the past five decades that longlines have been used (Umwelt, 2003). However, there are five records of entanglements of humpback whales between 1982

and 2010 (Groom & Coughran, 2012). Three incidents were associated with pearl aquaculture gear where two whales were completely disentangled and one mostly freed. The other two incidents were associated with abalone and mussel aquaculture gear (Groom & Coughran, 2012).

The rigidity associated with the longline design of taut ropes and lines will allow the infrastructure to be forced aside by any large animal (i.e. dolphins and whales) that makes contact with it and effectively 'bounce off' it rather than becoming entangled (Umwelt, 2003; Marine Pollution Research, 2008).

In the unlikely event that a large whale did enter the 'corridors' between sets of longlines and become disoriented, the whale should be capable of pushing through the vertical culture ropes with ease and/or safely pass beneath them provided that the longlines are secured at the appropriate position in the water column (Pacific Seafood Management Consulting Group, 1996). Alternatively, there should be enough space for whales to tranverse within the 'corridor' (i.e. 15-50 m between each longline). Notably, the proposed design for the longline infrastructure includes a 'clear zone' of about 4-5 m between the culture apparatus and the seabed.

Potential negative interactions between whales and the longline infrastructure on the Commercial Shellfish Aquaculture Leases can be minimised if appropriate mitigation measures are implemented (See below – Mitigation Measures).

Dolphins

Jervis Bay has a resident population of about 60 Indo Pacific bottlenose dolphins (*Tursiops aduncus*) (NSW MP, 2008b). Indo Pacific bottlenose dolphins can been seen in any part of Jervis Bay but are generally found in the shallow waters around the outer limits (i.e. around or inshore of the 15 m contour) with most key aggregation sites around rocky reef and seagrass habitats (Mandelc, 1997; Moller, 2001; Moller *et al*., 2002) in the northern part of the bay, largely between Callala Point and Honeymoon Bay. Dolphins with calves are generally found over seagrass beds (Marine Research Pollution, 2008). The common bottlenose dolphin (*Tursiops truncatus)* is also regularly observed in the area but is rarely sighted inside of Jervis Bay (NSW MP, 2008b) and thus is unlikely to have any interaction with the proposed leases.

Growing mussels on ropes strung beneath longlines and rafts has been practiced in areas frequented by dolphins without entanglement incidents in NSW (i.e. Twofold Bay, Jervis Bay and Port Stephens) for more than 20 years (NSW DPI, 2005) and Australia wide for the past 40 years (Umwelt, 2003). Many estuaries in NSW also have numerous boat moorings which have similar submerged rope infrastructure to that of longline cultures. Jervis Bay and Port

Stephens for example, have about 240 and 800 moorings respectively, and to Fisheries NSW knowledge no entanglements have occurred involving the resident dolphins or turtles at either location.

An international survey involving literature reviews and consultation with researchers associated with the longline shellfish industry (including Prince Edward Island, British Columbia, Californian Coast and Noramandy Coast) revealed no incidents of dolphin entanglement in bivalve culture infrastructure (Pacific Seafood Management Consulting Group, 1996).

The culture apparatus represents a physical structure in the water column that would not naturally occur, which modifies the movements of dolphins within aquaculture lease areas. Dolphins have been observed on numerous occasions moving through the longline pearl leases in Port Stephens as individuals and pods (Umwelt, 2003).

The rigidity associated with the longline design of taut ropes and lines will allow the infrastructure to be forced aside by any large animal (i.e. dolphins and whales) that makes contact with it and effectively 'bounce off' it rather than becoming entangled (Umwelt, 2003; Marine Pollution Research, 2008).

Potential negative interactions between dolphins and the longline infrastructure on the Commercial Shellfish Aquaculture Leases can be avoided if appropriate mitigation measures are implemented (See below – Mitigation Measures).

Seals

Jervis Bay is used year-round as a haul-out site for an increasing number of non-breeding seals. The species that occur in this area include the Australian fur seal (*Arctocephalus pusillus doriferus),* the New Zealand fur seal *(Arctocephalus forsteri)* and on rare occasions, the leopard seal (*Hydrurga leptonyx*) and subantarctic fur seal (*Arctophoca tropicalis*). There is a fur seal haul-out at Steamers Head (south of Jervis Bay) which was established in 1989 and supports both Australian and New Zealand fur seals for most of the year. Haul-out sites for both Australian and New Zealand fur seals occur around St George's Head, Beecroft Peninsula (e.g. Drum and Drum Sticks and Lamond Head) and Crookhaven Bight (NSW MP, 2009b).

Fur seals are prone to entanglement in plastic objects, discarded fishing gear and other marine debris but are not considered to be at risk of entanglement in the longline infrastructure (Pacific Seafood Management Consulting Group, 1996). Seals could fish around the structures and 'play' with loose culture lines or baskets (particularly young seals) (Marine Pollution Research, 2008). However, appropriate infrastructure design and maintenance will minimise the risk of entanglement associated with this potential interaction

e.g. taut lines, heavy culture lines and appropriate design of baskets (See below - Mitigation Measures).

Dugongs

Dugongs predominately inhabit northern Australian waters but occasionally visit the coastal and estuarine waters of NSW (Web Reference 31). Five separate sightings of individuals and pairs in estuaries on the central coast of NSW were documented during the austral summer of 2002/03. Allen *et al*. (2004) suggested that warm currents, low rainfall and the abundance of seagrass (primary food source) may have drawn some individuals south of their accepted range.

Jervis Bay Marine Park has some of the most extensive seagrass beds on the NSW coast. At least four species are found in the marine park, including eelgrass (*Zostera capricorni*), strapweed (*Posidonia australis*), paddleweed (*Halophila ovalis*) and Tasman grass-wrack (*Heterozostera tasmanica*) (NSW MP, 2008b). The largest seagrass meadows in the marine park are in Hare Bay, which is dominated by *Posidonia*, particularly around Carama Inlet, at Callala Bay, inside Plantation Point and along the shore between Green Island and Bindijine (Kirkman *et al*, 1995; West *et al*., 2006). Hence, the region could potentially represent an important foraging ground for dugongs in the future.

No seagrass beds are present in the immediate vicinity of Commercial Shellfish Aquaculture Leases but some are just off Orion Beach which is about 500 m from the Vincentia Lease. However, it is considered unlikely that the proposed activity would represent a significant entanglement risk to dugongs due to their relatively rare occurrence. Dugongs are only occasionally sighted in Jervis Bay waters and these individuals are generally considered to be non-breeding vagrants.

The proponent will adopt a precautionary approach and implement a range of mitigation measures to ensure the risk of entanglement and ingestion of marine debris is minimal (See below – Mitigation Measures).

Sharks, Rays and Teleosts

Over 216 species of teleosts (bony fish), rays and sharks are recorded within JBMP (NSW MP, 2008b). Teleosts that inhabit seagrass beds in Jervis Bay include Snapper (*Pagrus auratus*), Yellowfin Bream (*Acanthopagrus australis*), Tarwhine (*Rhabdosargus sarba*), Luderick (*Girella tricuspidata*), Spotted Pipefish (*Stigmatopora argus*), Bridled Leatherjacket (*Acanthaluteres spilomelanurus*), Sailfin Goby (*Nesogobius pulchellus*) and Weed Whiting (*Neoodax balteatus*). More than 100 fish species live in the subtidal sand-dominated habitats in Jervis Bay, including several species of Mullet, Whiting and Flathead. Drift algal habitat is dominated by Weed Whiting (*Neoodax balteatus*), Crested Weedfish (*Cristiceps australis*)

and Woods Siphonfish (*Siphamia cephalotes*). Sprats (*Hyperlophus vittatus* and *Sardinops neopilchardus*), Anchovies (*Engraulis australis*), Silversides (*Atherinason hepsetoides*, *Atherinosoma presbyteroides*), Mullet (*Myxus elongates*) and Sand Whiting (*Sillago ciliata*) are the most abundant species in areas of sandy beach habitat in Jervis Bay (NSW MP, 2008b).

Ray species in the Jervis Bay region generally belong to three families, including (1) stingrays (Family Dasyatididae) e.g. Smooth Stingray (*Dasyatis brevicaudata*); (2) stingarees (Family Urolophidae) e.g. Common Stingaree (*Trygonoptera testacea*) and (3) skates (Family Rajidae). Species such as the Eastern Fiddler Ray (*Trygonorrhina* sp.) and the Numbfish (*Hypnos monopterygium*) are also frequently sighted in JBMP. Many of these species are temporary residents and move over large areas but some species e.g. Common Stingaree are considered to be permanent residents inhabiting deep sandy areas (NSW MP, 2008b).

Shark species within JBMP include Spotted Wobbegongs (*Orectolobus. maculatus*), Greynurse Sharks (*Carcharias taurus*), Port Jackson Sharks (*Heterodontus portusjacksoni*), Angel Sharks (*Squatina australis*), Bronze Whalers (*Carcharhinus brachyurus*), Hammerheads (*Sphyrna* spp.), Mako Sharks (*Isurus oxyrinchus*) and White Sharks (*Carcharodon carcharias*).

There is a paucity of information pertaining to entanglement interactions with mariculture infrastructure and teleosts, rays and sharks. However, there is little evidence to suggest that entanglement in longline infrastructure is an issue of concern, particularly for teleosts and rays due to their small size, the absence of netting and loose lines and the thick diameter ropes that will be used.

Of particular conservation importance is the critically endangered Greynurse Shark, which may use Jervis Bay as a foraging ground. The most significant habitat in JBMP for this species is the 'The Docks' which is located approximately 9 km from the nearest lease and is on the northern side of the entrance to Jervis Bay. Greynurse Sharks are also observed at The Drum and Drumsticks, Boat Harbour and Weedy Valley. The Drum and Drumsticks are located outside of Jervis Bay on the eastern side of Beecroft Peninsula, Boat Harbour is just west to The Docks, and Weedy Valley is located on the northern tip of Bowen Island at the entrance to the bay (Otway *et al*., 2003). Greynurse Sharks are usually observed in the summer-autumn months.

Critical habitat zones for Greynurse Sharks typically consist of rocky reefs and islands surrounded by sandy-bottomed gutters and rocky submarine caves extending to a depth of 190 m (Web Reference 8). During the day this species can be observed hovering or slowly swimming around high relief reefs, while at night they become more active and hunt over soft substrata and rocky reefs (Smale, 2005).

The potential risk of entanglement of sharks in longline infrastructure while foraging in the area will be mitigated by implementing a range of mitigation measures e.g. taut ropes, thick diameter lines, heavy culture lines and regular inspections and maintenance (See below – Mitigation Measures).

Marine Turtles

In NSW there are resident groups of green turtles (*Chelonia mydas*), loggerhead turtles (*Caretta caretta*) and hawksbill turtles (*Eretmochelys imbricata*) while leatherback (*Dermochelys coriacea*) and flatback turtles (*Natator depressus*) are occasionally sighted (Environment Australia, 2003). Most of these species are vagrants which are thought to use the warm waters of the Eastern Australian Current each summer to disperse southward. The NSW marine turtle populations are at the southern limits of the species known distribution and outside the limits of the normal breeding ranges (Cogger, 2003).

According to Environment Australia (2003), there is no available evidence to suggest any turtle mortalities from aquaculture activities. However, there are concerns about the potential impact of entanglement and ingestion of marine debris associated with the Commercial Shellfish Aquaculture Leases on turtles foraging and resting in Jervis Bay.

Green turtles are sighted quite regularly in the embayment and leatherback turtles are seen occasionally. Green turtles mainly inhabit shallow waters and seagrass beds so the risk of interaction with longline infrastructure will increase with decreasing distance from these habitat areas in the bay. Direct interaction between turtles and longline infrastructure is considered unlikely but turtles are highly vulnerable to marine debris (Marine Pollution Research, 2008).

Operator/s of the Commercial Shellfish Aquaculture Leases will be required to implement a range of mitigation measures to ensure the risk of entanglement and ingestion of marine debris is minimised e.g. taut ropes, thick diameter lines, heavy culture lines and regular removal of biofouling (See below – Mitigation Measures).

Seabirds

There are a range of resident and migratory seabird and shorebird species that inhabit the coastal waters and intertidal zone in the Jervis Bay region, including cormorants, pelicans, penguins, shearwaters, giant-petrels, storm-petrels, terns, gannets, darters, gulls, albatrosses, sea eagles, ospreys, herons, egrets, oystercatchers, plovers, sandpipers, curlews and godwits (Appendix 3).

Notably, Bowen Island is home to about 5000 breeding pairs of little penguins (*Eudyptula minor)* and is also a nesting site for wedge-tailed shearwaters (*Puffinus pacificus*), little

shearwaters (*Puffinus assimilis*), short-tailed shearwaters (*Puffinus tenuirostris*) and sooty oystercatchers (*Haematopus fuliginosus*).

The little penguin is the only penguin species that breeds in Australia (DECCW, 2010a) and is a diurnal forager that mainly feeds in inshore waters (including within Jervis Bay) around the mainland coast or breeding islands (Gales & Pemberton, 1990). This species is prone to entanglement in plastic six pack yokes and discarded fishing line and nets made of fine filament. However, little penguins do not appear to be at risk of becoming entangled in looped or unlooped material of a diameter greater than 20 mm, especially as they feed underwater by sight during daylight hours (Pacific Seafood Management Consulting Group, 1996).

Seabirds could potentially be vulnerable to accidental collision with the longline infrastructure when aerial diving for schooling fish within the longline farms. There is also a potential risk of ingestion of marine debris, as well as a risk of entanglement of diving birds in loose culture lines (Marine Pollution Research, 2008). These risks however, will be mitigated on the Commercial Shellfish Aquaculture Leases by appropriate infrastructure design and maintenance (e.g. taut lines, heavy culture lines and appropriate design of baskets) and the implementation of a Waste Management Plan (See below - Mitigation Measures). In addition, many seabird species may take advantage of the longline infrastructure as temporary roosting sites while foraging (Marine Pollution Research, 2008).

Mitigation Measures

The following mitigation measures will be implemented to minimise the risk of entanglement and ingestion of marine debris to marine fauna:

- Utilisation of longline design features and operational practices that minimise the risk of the entanglement of marine fauna including:
    - highly visible, thick, rigid ropes and anchor lines (Hoagland *et al*., 1998) (e.g. 25-35 mm diameter);
    - culture lines will not extend for the full depth of water below the longline backbone;
    - weight of shellfish biomass will ensure culture lines are kept taut but when the lines are first deployed they may be weighted; and
    - deployment of culture lines will occur predominately outside the whale migratory season to mitigate the risk of entanglement.
- Implementation of Structural Integrity and Stability Monitoring Program (Appendix 1), including:

  - keep all ropes and lines tightly tensioned (taut rope policy) (Hoagland *et al*., 1998) so if marine fauna do come in contact with the infrastructure there is no slackness within the lines to enable entanglements;
  - regular inspections, maintenance and repair of longline infrastructure to maintain structural integrity and minimise the occurrence of marine debris (Hoagland *et al*., 1998), particularly after severe weather;
  - at least annual servicing of longline infrastructure including anchors, chains and mooring ropes;
  - ensuring lines and culture apparatus are positioned correctly in the water column by monitoring the number of buoys comparative to the weight of the stock on each longline; and
  - regular removal of biofouling and sediment to assist with the maintenance of the structural integrity of the longline infrastructure.

- Implementation of the Waste Management Plan (Appendix 1), including:
  - obsolete infrastructure (e.g. worn ropes) and domestic garbage will be secured in storage bins on vessels which will have tightly fitted lids. All waste will be disposed of at an approved land based facility;
  - all gear that can be marked (e.g. buoys) will be labelled uniquely to identify it as the property of the lease operator/s in the unlikely event that components were to break free; and
  - regular cleaning of biofouling and sediment to reduce the amount of potential food available which may attract marine fauna e.g. turtles.
- Implementation of the Marine Fauna Interaction Management Plan (Appendix 1) which will involve the monitoring and recording of marine fauna interactions with the longlines, vessels and/or humans during the operational stage. Sightings will be recorded in an appropriate format to ensure that data collected over time is relevant, comparable and consistent (Pacific Seafood Management Consulting Group Pty Ltd, 1996).
- Implementation of the Marine Fauna Entanglement Avoidance Protocol (Appendix 1) which will include:
  - a response plan and Entanglement Committee (including MPA, NPWS and Fisheries NSW staff) for entanglement incidences including procedures to be followed, training and equipment required and reporting incidents;

- a formal commitment from the operator/s to respond to marine mammal entanglements on the leases, including promptly notifying relevant authorities and/or personnel, maintaining an observer on site to assist with communication until authorised rescue teams arrive and providing logistical assistance if needed e.g. use of vessels (Pacific Seafood Management Consulting Group, 1996);
- employees will be trained in the reporting and handling of injured or entangled fauna where appropriate;
- a training/reference manual will be prepared and kept on service vessels to provide initial guidance for fauna handling and First Aid (Umwelt, 2003); and
- the implementation and effectiveness of the mitigation measures will be monitored and if deemed inadequate, modifications will be required until there is no significant risk of entanglement and marine debris pollution.

Conclusion

Longline aquaculture has been practiced in Jervis Bay, Twofold Bay and Port Stephens for over three decades without entanglement incidents. Similarly, the risk of entanglement has not been a significant issue in the many thousands of hectares of longline infrastructure across Australia.

The risk of entanglement and ingestion of marine debris associated with the Commercial Shellfish Aquaculture Leases was assessed to be ‘low’ when considered in context with the longline design features, the Structural Integrity and Stability Monitoring Program (notably the taut rope policy), the Marine Fauna Interaction Management Plan, the Marine Fauna Entanglement Avoidance Protocol and the Waste Management Plan that will be implemented.

However, the overall risk is considered to be ‘moderate’ to ensure adequate management attention is given to these issues until the leases have been in operation for an extended period of time and validated this assessment.

8.2.2.5 Vessel Strike and Acoustic Pollution

Table 31: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – vessel strike and acoustic pollution (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the operation of the Commercial Shellfish Aquaculture Leases have a significant impact on the occurrence of vessel strikes and/or the level of acoustic pollution?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Will there be an increased risk of vessel strikes to marine fauna due to marine vessel traffic associated with daily operations and maintenance of the facilities?* ▪ *Will observers need to be employed to reduce the risk of vessel strikes?* ▪ *Is the noise generated by the facilities and associated activities likely to disturb any species of marine fauna?* ▪ *If vessel strikes and acoustic pollution are considered potential threats to marine fauna, what measures would be implemented to mitigate, monitor and manage these impacts?*			
Description	▪ Marine vessel movements associated with leases o Small increase of 0-3 return trips per day (Jervis Bay waters)			
Proposed Management – Mitigation and Monitoring	▪ Observer Protocol ▪ Maintain appropriate distances from marine fauna ▪ Adhere to NSW Roads and Maritime Services speed limits ▪ Slow down in sensitive areas ▪ Hours of operation = predominately daylight ▪ Vessel motors – well maintained			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

Vessels in Jervis Bay consist of small recreational fishing boats, dive boats, dolphin and whale watching boats, luxury cruisers, sailing vessels, commercial fishing vessels and Naval vessels. The number of vessels in Jervis Bay and associated acoustic pollution levels vary according to weather conditions and seasons. Commercial and recreational vessel traffic is

significantly greater over summer, particularly around Christmas and New Year (around 300 vessel movements), and decreases substantially during winter (about 20 vessel movements). NSW RMS are responsible for managing vessel safety and navigation in Jervis Bay.

Shellfish aquaculture operations largely do not require intensive day to day activities on site, except during the deployment, thinning and harvesting stages. During the operational stage of the Commercial Shellfish Aquaculture Leases, marine vessel movements will be in the range of 0-3 return trips per day per lease to undertake inspections and maintenance. Consequently, vessel movements in the Jervis Bay region to service the leases will only increase boating traffic in bay by approximately 2% during peak periods. This minor increase is not expected to have a significant impact on the occurrence of vessel strikes to marine fauna or acoustic pollution levels.

The risk of vessel strikes will be reduced by restricting vessel movements and maintenance activities to predominately daylight hours. The lease service vessels, because of there design, are usually restricted to low cruising speeds. Marine vessel motors will also be well maintained to ensure engine noises are kept to a minimum.

An Observer Protocol will be implemented where operators will routinely keep watch for marine fauna, notably dolphins, turtles and seals, when travelling between the leases and land based facilities. Vessels will be required to adhere to NSW RMS speed limits and slow down in sensitive areas if they traverse them. Sensitive areas in Jervis Bay include seagrass beds and important feeding areas for dolphins, including (1) the large areas of soft sediment and seagrass in the Hare Bay Sanctuary Zone, (2) the soft sediment and mosaic of reef habitat in Huskisson Sanctuary Zone, and (3) the inshore and rocky reef habitat in Hyams Beach Sanctuary Zone (NSW MP, 2009b). Lease vessels will be required to slow down to a maximum speed of 25 knots if marine fauna are observed within 200 m of the vessel.

Conclusion

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on the occurrence of vessel strikes to marine fauna or acoustic pollution levels was assessed to be ‘low’ when considered in context with the small increase in vessel movements and the mitigation measures that will be implemented, including the Observer Protocol, adhering to speed restrictions, slowing down in sensitive areas, maintaining appropriate distances from marine fauna, restricting lease activities to predominately daylight hours and maintaining vessel motors.

8.2.2.6 Threatened / Protected Species and Matters of NES

Table 32: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – impacts on threatened species, protected species and matters of NES (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the operation of the Commercial Shellfish Aquaculture Leases have a significant impact on threatened species, protected species and/or matters of NES?
Level of Impact	Individual facility
Comments and Considerations	▪ *Are any threatened or protected species likely to be impacted by the leases?* ▪ *Are the leases going to disturb habitat of any threatened or protected species e.g. foraging, breeding, resting or migratory habitat?* ▪ *Will the leases have a significant impact on matters of NES and/or other protected matters listed under the EPBC Act?* ▪ *What measures will be implemented to mitigate, monitor and manage potential impacts on threatened / protected species and matters of NES?*
Description	▪ Threatened and protected species (State) o 1 'presumed extinct' species o 2 'critically endangered' species o 12 'endangered' species o 36 'vulnerable' species o 43 'protected' species ▪ Matters of NES (Commonwealth) o 63 'threatened' species o 76 'migratory' species o 92 'listed marine' species o 27 'whales and other cetacean' species o 1 Commonwealth Marine Area o 1 Listed Threatened Ecological Community o 4 Commonwealth Land Listings o 11 Commonwealth Heritage Places o 5 Nationally Important Wetlands
Proposed Management – Mitigation and Monitoring	▪ Assessment of Significance - State (Appendix 7) ▪ Assessment of Significance - Commonwealth (Appendix 8) ▪ Environmental Management Plan (Appendix 1) ▪ Small scale operations - 0.4% of Jervis Bay
Risk Assessment Values	

Organisation / Person	Consequence	Likelihood	Risk Value	Risk Ranking
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

(a) Assessment of Significance (State)

The NSW Office of Environment and Heritage Threatened Species Database (Web Reference 7) and the Department of Primary Industries – Threatened and Protected Species Listing (Web Reference 8) were searched for threatened and protected species, populations and communities listed under the *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act) that are likely or predicted to occur in the Southern Rivers - marine zone Catchment Management Authority subregion (Appendix 6).

Only threatened species that were known or considered likely to occur in Jervis Bay and/or known to utilise habitat in the region were considered further in an Assessment of Significance (Appendix 7). Hence, terrestrial species were excluded from the assessment as the proposed activity is marine based. Threatened marine and intertidal species were assessed according to the *Threatened Species Assessment Guidelines* (NSW DECC, 2007a; NSW DPI, 2008). 'Protected' species do not require an Assessment of Significance and were therefore not assessed.

Overall, six species of fish, three species of marine turtle, four cetacean species, two pinnipeds, one sirenian (the dugong) and 33 species of seabirds were assessed according to the assessment guidelines issued and in force under Section 94A of the TSC Act and Section 220ZA of the FM Act.

Fish

Species of threatened fish listed under the FM Act considered likely to occur in the wider study area include:

- the 'critically endangered' Greynurse Shark (*Carcharias taurus*);
- the 'endangered' Scalloped Hammerhead (*Sphyrna lewini*);
- the 'vulnerable' Great Hammerhead (*Sphyrna mokarran*);
- the 'vulnerable' White Shark (*Carcharodon carcharias*);
- the 'presumed extinct' Green Sawfish (*Pristis zijsron*);
- the 'vulnerable' Black Rockcod (*Epinephelus daemelii*); and
- the 'protected' Syngnathiformes (e.g. seahorses, seadragons, pipefish etc).

Potential impacts on these fish which could occur or be exacerbated by the proposed Commercial Shellfish Aquaculture Leases were identified as:

- the potential to increase the impact of the key threatening process (KTP) of '*injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris'* (EPBC Act);
- the potential to alter food resources and behaviour (e.g. FAD);
- physical disturbance (e.g. noise);
- habitat modification and/or exclusion;
- pollution;
- change of distribution due to removal of potential habitat; and
- the potential to attract fish from Sanctuary Zones to the lease areas where they may be vulnerable to fishing activities.

The Assessments of Significance revealed that the Commercial Shellfish Aquaculture Leases are unlikely to have a significant impact on any of the species identified above so Species Impact Statements were not conducted (Appendix 7). Important breeding, feeding or resting areas are unlikely to be impacted by the proposed aquaculture activities and a range of mitigation measures will be implemented to manage potential risks.

Cetaceans

Cetacean species protected under the TSC Act that are likely to occur in the wider region include:

- the 'endangered' southern right whale (*Eubalaena australis*);
- the 'vulnerable' humpback whale (*Megaptera novaeangliae*);
- the 'vulnerable' sperm whale (*Physeter macrocephalus*); and
- the 'endangered' blue whale (*Balaenoptera musculus*).

Records show that the southern right whale and humpback whale visit Jervis Bay during their annual migration between their feeding and breeding grounds from May to December each year. The whale's usage of habitat in Jervis Bay of these whales has been observed and sometimes recorded by tourism industry representatives and the community. However, no formal surveys or analysis of this data has been undertaken (Matt Carr- Manager, Jervis Bay Marine Park 2013, pers comm.). Sperm whales and blue whales are not commonly sighted in Jervis Bay but could occur in the wider region.

Potential impacts on cetaceans which could occur or be exacerbated by the Commercial Shellfish Aquaculture Leases were identified as:

- increased risk of vessel strike;
- increased acoustic pollution;
- modification and/or exclusion from potential resting habitat; and
- the potential to increase the impact of the KTP of '*entanglement or ingestion of anthropogenic debris in marine and estuarine environments*' (TSC Act).

The Commercial Shellfish Aquaculture Leases are not considered to have a significant impact on any cetacean species such that a Species Impact Statement would be necessary (Appendix 7). This is mainly due to the transient nature of the species and that important, mating, feeding or resting areas are unlikely to be impacted by the proposed operations, as well as the range of mitigation measures that will be implemented to manage the potential risks.

Marine Turtles

Marine turtle species that are likely to occur in the wider study area and that are listed under the TSC Act include:

- the '*vulnerable'* green turtle (*Chelonia mydas*);
- the '*endangered'* leatherback turtle (*Dermochelys coriacea*); and
- the '*endangered'* loggerhead turtle (*Caretta caretta*).

Potential impacts on marine turtles that could occur or be exacerbated by the proposed Commercial Shellfish Aquaculture Leases were identified as:

- increased risk of vessel strike;
- increased acoustic pollution;
- reduced availability of foraging and/or resting habitat e.g. due to shading, exclusion and/or sedimentation; and
- the potential to increase the impact of the KTP of '*entanglement or ingestion of anthropogenic debris in marine and estuarine environments*' (TSC Act).

The Commercial Shellfish Aquaculture Leases are not considered to have a significant impact on marine turtles such that a Species Impact Statement would be necessary (Appendix 7). This was mainly due to the absence of important nesting, mating or feeding areas in Jervis Bay, as well as the mitigation measures that will be implemented to manage these potential risks.

Pinnipeds and Sirenians

Pinniped and sirenian species considered likely to occur in the wider study area include:

- the 'vulnerable' Australian fur seal (*Arctocephalus pusillus doriferus*);

- the ‘vulnerable’ New Zealand fur seal (*Arctocephalus forsteri*); and
- the ‘endangered’ dugong (*Dugong dugon*).

The Australian fur seal, the New Zealand fur seal and dugong do occur in the wider region. There are fur seal haul-out sites at Steamers Head (south of Jervis Bay), Drum and Drum Sticks, and Lamond Head (north eastern side of Jervis Bay adjacent to Beecroft Peninsula) (NSW MP, 2009b).

Potential issues which could occur or be exacerbated by the Commercial Shellfish Aquaculture Leases on pinnipeds and sirenians were identified as:

- increased risk of vessel strike;
- increased acoustic pollution;
- reduced availability of foraging and/or resting habitat e.g. due to shading, sedimentation or exclusion; and
- the potential to increase the impact of the KTP of ‘*entanglement or ingestion of anthropogenic debris in marine and estuarine environments*’ (TSC Act).

Although there are seal colonies outside Jervis Bay, the Commercial Shellfish Aquaculture Leases are not considered to have a significant impact such that a Species Impact Statement would be necessary (Appendix 7). This is mainly due to the distance of the leases from the haul-out sites and the range of mitigation measures that will be implemented to manage the potential risks. Similarly, it is considered unlikely that the proposed activity would have a significant impact on dugongs due to their relatively rare occurrence. Dugongs are only occasionally sighted in Jervis Bay waters and these individuals are generally considered to be non-breeding vagrants.

Seabirds

A generic assessment was undertaken for some species that use the same foraging techniques and/or habitat e.g. seabirds in the same species group such as albatrosses and shorebirds. A few other seabird species were also excluded from the assessment due to their distribution in NSW being restricted to isolated islands, such as Lord Howe Island or due to sightings being extremely rare or nonexistent in NSW, which was revealed when their distribution was cross referenced with other literature.

Seabird species listed under the TSC Act that are known to roost or breed on land near the proposed Commercial Shellfish Aquaculture Leases include:

- the ‘endangered’ pied oystercatcher (*Haematopus longirostris*) – rocky shores around Jervis Bay and along the coast just above the high water mark;
- the 'vulnerable' sooty oystercatcher (*Haematopus fuliginosus*) - nests on Bowen Island and above high water mark in estuaries;

- the 'vulnerable' little shearwater (*Puffinus assimilis*) - nests on Bowen Island;
- the 'endangered' little tern (*Sterna albifrons*) - Lake Wollumboola (north of Jervis Bay);
- the 'critically endangered' hooded plover (*Thinornis rubricollis*) - Bherwerre Beach (Wreck Bay);

Bowen Island is located 9.8 to 12 km from the proposed Commercial Shellfish Aquaculture Leases, while Lake Wollumboola and Bherwerre Beach are located outside of the Jervis Bay embayment more than 30 km (via water) from the nearest lease.

Potential impacts on seabirds which could occur or be exacerbated by the proposed Commercial Shellfish Aquaculture Leases were identified as:

- alteration of food sources (i.e. behavioural changes);
- physical disturbance e.g. noise;
- disturbance and disorientation due to artificial lights (navigation and vessel lights);
- habitat modification and/or exclusion; and
- the potential to increase the impact of the KTP of '*entanglement or ingestion of anthropogenic debris in marine and estuarine environments*' (TSC Act).

The Commercial Shellfish Aquaculture Leases are not considered to have a significant impact on any seabird species such that a Species Impact Statement would be necessary (Appendix 7). This is mainly due to the distance of the leases from nesting and roosting sites, and the range of mitigation measures that will be implemented to manage the potential risks.

(b) Assessment of Significance (Commonwealth)

Fisheries NSW assessed the potential impacts of the Commercial Shellfish Aquaculture Leases with reference to the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) and according to the *EPBC Act Policy Statement 1.1 (Significant Impacts Guideline 1.1)* in conjunction with *EPBC Act Policy Statement 2.2 (Offshore Aquaculture).*

The matters of national environmental significance (NES) which need to be considered and assessed under the EPBC Act include:

- listed threatened species and ecological communities;
- migratory species protected under international agreements;
- Ramsar wetlands of international importance;
- the Commonwealth marine environment;
- World Heritage properties;
- National Heritage places;
- Great Barrier Reef Marine Park; and

- nuclear actions.

The EPBC Act Protected Matters Search Tool (Web Reference 9) generated a summary of matters of National Environmental Significance (NES) which may relate to or occur in the area of the proposed Commercial Shellfish Aquaculture Leases. The Protected Matters Search Tool was consulted on 25th September 2012 using the 'Report by Coordinates' option which involved the use of a geographical coordinate (35.109798S, 150.781059E) within Jervis Bay and a 20 km buffer zone (i.e. total area searched = 314 km^2) (Appendix 6). The search results included a range of marine, intertidal and terrestrial fish, bird, mammal, reptile, amphibian and plant species which are listed under the following classifications:

63 Listed Threatened Species

- 3 'critically endangered'
  - 1 terrestrial bird;
  - 1 amphibian (frog); and
  - 1 shark.
- 21 'endangered'
  - 6 marine birds;
  - 4 terrestrial birds;
  - 1 freshwater fish;
  - 2 marine mammals;
  - 2 terrestrial mammals;
  - 2 marine reptiles; and
  - 4 terrestrial plants.
- 39 'vulnerable'
  - 13 marine birds;
  - 1 shorebird;
  - 3 amphibians (frogs);
  - 1 marine fish;
  - 1 diadromous fish;
  - 2 sharks;
  - 1 marine mammal;
  - 6 terrestrial mammals;
  - 3 marine reptiles;
  - 1 terrestrial reptile; and

- 7 terrestrial plants.

76 Migratory Species

- 21 marine birds;
- 25 shorebirds;
- 8 terrestrial birds;
- 4 terrestrial birds;
- 10 marine mammals;
- 3 sharks; and
- 5 reptiles.

119 Listed Marine Species

- 5 marine reptiles;
- 2 fur seals;
- 1 dugong;
- 22 marine birds;
- 32 shorebirds;
- 9 terrestrial birds; and
- 21 syngnathiforms.

27 Whales and Other Cetaceans

- 6 dolphins and
- 21 whales.

An assessment was conducted on these matters protected by the EPBC Act which could potentially be impacted directly or indirectly by the operation of the leases (Appendix 8). Terrestrial species were not assessed as they are considered unlikely to interact with the Commercial Shellfish Aquaculture Leases. Some species assessed in regards to the matters of NES were included in multiple categories. For example, the southern giant petrel (*Macronectes giganteus*) is listed as endangered in the 'threatened' species list and as a 'migratory' species and a 'listed marine' species.

In addition to those identified by the EPBC Act Protected Matters Report, an assessment was conducted on several species that are listed under the EPBC Act and are known to occur in the Jervis Bay region but did not appear in the search results. These included the black-winged petrel (*Pterodroma nigripennis*), providence petrel (*Pterodroma solandri*), little shearwater (*Puffinus assimilis*), flesh-footed shearwater (*Puffinus carneipes*), white tern (*Gygis alba*), grey ternlet (*Procelsterna cerulean*), sooty tern (*Onychoprion fuscata*), eastern

osprey (*Pandion cristatus*), beach stone-curlew (*Esacus neglectus*), red-tailed tropicbird (*Phaethon rubricauda*), masked booby (*Sula dactylatra*), swinhoe's snipe (*Gallinago megala*), pin-tailed snipe (*Gallinago stenura*), Ornate Ghost Pipefish (*Solenostomus paradoxus*), Steep-nosed Pipefish (*Hippichthys penicillus*), Short-tailed Pipefish (*Trachyrhamphus bicoarctatus*), Girdled Pipefish (*Festucalex cinctus*), Tiger Pipefish (*Filicampus tigris*) and Green Sawfish (*Pristis zijsron*).

Other matters protected by the EPBC Act detected for the area searched included:

- 1 Commonwealth Marine Area;
- 1 Listed Threatened Ecological Community;
- 5 Commonwealth Land;
- 11 Commonwealth Heritage Places;
- 3 Commonwealth Reserves; and
- 5 Nationally Important Wetlands.

Commonwealth Marine Area

A Commonwealth Marine Area is situated within Jervis Bay approximately 10.4 km from the northern Callala Lease, 9.6 km from the southern Callala Lease and 6.7 km from the Vincentia Lease (Figure 13). The Commonwealth Marine Area is part of Booderee National Park which is a Commonwealth reserve on Aboriginal land (Web Reference 12). Booderee National Park is jointly managed by the Wreck Bay Aboriginal Community Council (the traditional owners of the Bherwerre Peninsula) and the DSEWPC (Web Reference 13). However, NSW NPWS, Fisheries NSW, Shoalhaven City Council, Department of Defence and other NSW land management agencies are also involved with the management of the marine waters of the Park.

The Commonwealth Marine Area is 840 hectares extending south of the line between Captains Point and the northern tip of Bowen Island. This area represents approximately 7% of Jervis Bay and is the equivalent of about 4% of the total area of the JBMP. A diversity of marine habitats and biota occur within the area, many species are at the northern and southern limits of their ranges and the littoral and sub littoral plant communities are of both local and state wide significance. Bowen Island, on the eastern boundary of the Commonwealth Marine Area, supports a substantial colony of little penguins (*Eudyptula minor*) and breeding colonies of three species of shearwater including wedge-tailed shearwaters (*Puffinus pacificus*), little shearwaters (*Puffinus assimilis*) and the short-tailed shearwaters (*Puffinus tenuirostris*) (Web Reference 11).

Activities are undertaken in the waters of Booderee National Park include recreational activities, educational activities, scientific research, commercial tourism operations and Naval activities.

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on the Commonwealth Marine Area within Jervis Bay was assessed to be ‘low’ when considered in context with the distance between the leases and the Marine Area, the relatively small area of habitat will be disturbed by the installation of the longline infrastructure and the relatively small scale (0.4% of Jervis Bay) of the operations. Also previous aquaculture activities in Jervis Bay had no significant impact on the Commonwealth Marine Area in Jervis Bay.

Listed Threatened Ecological Communities

Littoral Rainforest and Coastal Vine Thickets of Eastern Australia are listed as 'critically endangered' and as a threatened ecological community under the EPBC Act. Its distribution within the Jervis Bay region is illustrated in Figure 71. It is unlikely that the Commercial Shellfish Aquaculture Leases will have a significant impact on the littoral rainforest and coastal vine thickets as it is a land based community that is 5.1 to 8.2 km from the marine based proposal. Therefore, no further investigations or assessments will be conducted on this matter of NES.

Commonwealth Land

Four Commonwealth Land listings were generated in the search results of the EPBC Act Protected Matters Search Tool, including:

- Australian Telecommunications Commission;
- Booderee National Park;
- Defence Housing Authority; and
- Defence - Beecroft Rapier Range.

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on the listed Commonwealth Land areas surrounding Jervis Bay is considered to be 'negligible'. The proposal involves marine based activities and is therefore unlikely to impact on land based localities. The potential impacts of navigation lights on nesting seabirds on Bowen Island (part of Booderee National Park) are addressed in Section 8.2.2.4. However, considering the distance of the island to the proposed lease areas (i.e. 9.8 - 12 km) and the existing light sources from shoreline residential development and moored vessels, it is considered unlikely to represent a significant issue.

Commonwealth Heritage Places

Eleven Commonwealth Heritage Places were listed for the area searched in Jervis Bay using the EPBC Act Protected Matters Search Tool, including:

- Beecroft Peninsula (Natural);
- Jervis Bay Territory (Indigenous);
- Crocodile Head Area (Indigenous);
- Currarong Rockshelters Area (Indigenous);
- Cape St George Lighthouse Ruins and Curtilage (Historic);
- Christians Minde Settlement (Historic);
- Jervis Bay Botanic Gardens (Historic);
- Point Perpendicular Lightstation (Historic);
- Royal Australian Naval College (Historic);
- Hive Survivor Camp (Historic); and
- Jervis Bay Fishing Heritage Area (Historic).

In addition to the EPBC Act Protected Matters Search Tool, other databases on land based heritage and maritime sites on the DSEWPC website were searched, including: the Commonwealth Heritage List, the National Heritage List and the Australian National Shipwreck Database. No additional heritage places within the area of the proposed leases were identified. The location of the Commonwealth Heritage Places within the Jervis Bay region relative to the proposed Commercial Shellfish Aquaculture Leases is illustrated in Figure 71.

Further investigations will not be conducted on the land based heritage places identified as the activities associated with the proposed Commercial Shellfish Aquaculture Leases are marine based and should not significantly impact on the terrestrial environment. Further details about the 11 Commonwealth Heritage Places are provided in Appendix 5.

Commonwealth Reserves

Two Commonwealth Reserves were listed in the search results of the EPBC Act Protected Matters Search Tool, including:

- Booderee National Park; and
- Boderee Botanic Gardens.

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on the two listed Commonwealth Reserves is considered to be 'negligible'. The proposal involves marine based activities and is therefore unlikely to impact on land based localities.

Nationally Important Wetlands

Five nationally important wetlands were listed in the search results of the EPBC Act Protected Matters Search Tool, including:

- Beecroft Peninsula;
- Jervis Bay;
- Jervis Bay Sea Cliffs;
- St Georges Basin; and
- Wollumboola Lake.

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on nationally important wetlands within Jervis Bay was assessed to be 'negligible' when considered in context with the distance between the leases and the wetlands, the relatively small area of habitat that will be disturbed by the installation of the longline infrastructure and the relatively small scale (0.4% of Jervis Bay) of the operations. Also previous aquaculture activities in Jervis Bay had no significant impact on the wetlands in the Jervis Bay region. The location of the wetlands within the Jervis Bay region relative to the proposed Commercial Shellfish Aquaculture Leases is illustrated in Figure 71.

Potential impacts associated with all stages of the proposed Commercial Shellfish Aquaculture Leases, including construction, deployment, operation and potential decommissioning were considered during the assessment of matters of NES and other matters protected under the EPBC Act.

Conclusion

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on threatened species or migratory species listed under the EPBC Act was assessed to be 'low' when considered in context with the characteristics of the proposed site, including the absence of environmentally sensitive or unique areas, the soft sediment seafloor (mobile sands) and the extensive area of similar unobstructed habitat in the direct and wider area. The introduction of exotic pathogens and pests will be minimised by implementing strict biosecurity procedures and regularly removing biofouling. Broodstock will be sourced locally or from the same genetic population.

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact was also assessed to be 'low' when considered in context with the small scale of the proposal (0.4% of Jervis Bay), the sustainable stocking densities, the minor increases in vessel movements and vehicular traffic, the distance from reefs and seagrass beds, as well as the use of design features and daily maintenance procedures that will minimise entanglement risks. Noise

generated will predominately be characteristic of the area and service vessels will be similar to existing vessels that use Jervis Bay.

A range of industry best practices, management plans, protocols and monitoring programs identified in the EIS and EMP will also be implemented to mitigate any potential risks associated with entanglement, ingestion of marine debris, vessel strike, acoustic pollution, artificial lights, genetic integrity, disease, pests, water quality, behavioural changes and pollution.

8.2.2.7 Behavioural Changes

Table 33: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – impacts on marine fauna behaviour (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the operation of the Commercial Shellfish Aquaculture Leases have a significant impact on the behaviour of any species?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *Is the facility situated in any known migratory pathways?* ▪ *Will the operation interfere with foraging, breeding and/or resting habitat of any marine fauna species?* ▪ *Are any species expected to experience behavioural changes due to the operation of the Commercial Shellfish Aquaculture Leases e.g. changes to fish swim paths and/or behaviour?* ▪ *Are the leases likely to attract aggregations of native fauna e.g. function as Fish Aggregating Devices?* ▪ *Are the leases likely to have any draw down effects on nearby natural reefs and/or Sanctuary Zones?* ▪ *What measures will be implemented to mitigate, monitor and manage potential impacts on migratory pathways and behavioural changes?*			
Description	▪ East coast – migratory pathway for whales ▪ Jervis Bay – 60 resident and transient Indo-Pacific bottlenose dolphins ▪ Steamers Head, Drum and Drum Sticks and Lamond Head – fur seal haul out sites ▪ Distance to Sanctuary Zones = 1 km to 12 km			
Proposed Management – Mitigation and Monitoring	▪ Small scale operations (0.4% of Jervis Bay) o Infrastructure represents minor and localised alterations to bay ▪ Buffer zone between leases and natural reefs, Sanctuary Zones and haul-out sites ▪ Regular removal of biofouling - reduce attraction of marine fauna ▪ Marine Fauna Interaction Management Plan (Appendix 1)			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

Whales

Humpback and southern right whales migrate between summer feeding grounds in Antarctica and warmer winter breeding grounds in the tropical and subtropical areas along the east coast of Australia (Web Reference 7) with individuals migrating up to 10,000 km each year (Baker *et al.,* 1990). The northern migration occurs between May to August while the southern migration to Antarctic waters occurs during September to December. Whales typically stay closer to the coast in shallower waters during the southward migration, particularly calving females and females with young, and are frequently sighted resting in large embayments (Bannister *et al*., 1996; Web Reference 7; Web Reference 31).

Several factors have been attributed as triggers for the northward migration including prey availability, location of feeding ground, breeding condition, water temperature, the extent of sea-ice, predation risk and reduced light conditions (Vang, 2002; DEH, 2005a). The east Australian humpback whale population migrates along the continental shelf close to the coast up to southern Queensland and from there whales disperse into the lagoonal waters of the Great Barrier Reef (Paterson *et al.,* 1994 cited in Vang, 2002).

Humpback whales have been found to exhibit a high degree of site fidelity towards both breeding and feeding grounds (Clapham *et al.,* 1993). The migratory movements of the eastern Pacific humpback whales are clearly non-random (Vang, 2002). Urban *et al.* (2000) for example, found evidence of preferred migratory destinations. Several studies suggest that humpback whale site fidelity is a maternally driven trait (Baker *et al.*, 1994; Urban *et al*., 2000) but there is also evidence to suggest that a combination of genetic traits and imprinting is used by whales to return to breeding grounds (Baker *et al.,* 1994).

Speculations about navigation tools used by migrating whales include following bottom topography parallel to the coast and “spy-hopping” to maintain orientation (Gaskin, 1982 cited in Vang, 2002), as well as following the direction of ocean currents and other water masses (Matthews, 1966). Females at the end of lactation and weaning yearlings are the first to commence the northward migration, which are followed by juveniles, mature males with resting females and lastly, females in late pregnancy (Matthews, 1966). Conversely, females in early pregnancy and juveniles are the first to commence the southern migration, followed by mature males and females in early lactation (Matthews, 1966).

There is a paucity of information on the critical habitat of humpback and southern right whales, as well as the adaptability and flexibility of their habitat requirements (DEH, 2005a; DEH, 2005b). Narrow corridors and a funnelling effect have been observed along a few sections of the east Australian coastline where physical and other barriers cause the majority of the population to pass close to the shore (i.e. within 30 km of the coast) which in turn leads

to the formation of large assemblages (DEH, 2005a). Islands with suitable water temperature are also conducive to the formation of large whale assemblages (Matthews, 1966). On the east coast of Australia these important migratory pathways for humpbacks include the eastern sides of Stradbroke Island and Moreton Bay Island in Queensland (DEH, 2005a). Important resting areas for humpbacks on the east coast used during the southern migration include the Whitsundays, Hervey Bay, Moreton Bay, the Swain Reefs complex, the Great Barrier Reef, the Palm Island Group and Bell Cay in Queensland, as well as Cape Byron and Twofold Bay in NSW (Figure 68) (DEH, 2005a). Southern right whale migration patterns are poorly known but this species is known to frequent inshore areas including large embayments (Figure 69) (DEH, 2005a).

The size of the east Australian humpback whale population is currently estimated at about 19,400 with an annual rate of increase of approximately 10.9% (Noad *et al*., 2011), while the population size of southern right whales has been estimated at 2,250 individuals with a 7% annual rate of increase (Web Reference 31). Concerns have been raised about the impact that coastal aquaculture infrastructure may have on the migratory pathways of these whales, particularly as these species frequent inshore waters and their populations are expected to continue to increase in the future.

Whales are regularly sighted in coastal waters off Jervis Bay during the migration season (June to November) but no area has been identified as important resting, calving or feeding habitat in the region. As Jervis Bay is an embayment, it is not directly within their migratory pathways but the bay does represent whale resting habitat.

The proposed Commercial Shellfish Aquaculture Leases are a small scale operation where the total lease area is 50 hectares, which represents 0.4% of the bay. For whales that travel into Jervis Bay, there is expansive areas of unobstructed waters in which they can safely navigate through and use as resting habitat. The longline infrastructure represents a minor and very localised alteration to the bay. It is expected that the area obstructed by the longline infrastructure is unlikely to have a significant impact on whale behaviour given that there are extensive areas of similar habitat available in the direct and wider study area, and Jervis Bay is considered transitory habitat for whales. The lease areas are also remote from the entrance of Jervis Bay where whales enter and exit the bay. However, a Marine Fauna Interaction Management Plan will be implemented to monitor the movement patterns of whales in Jervis Bay, interactions with the Commercial Shellfish Aquaculture Leases and any behavioural changes.

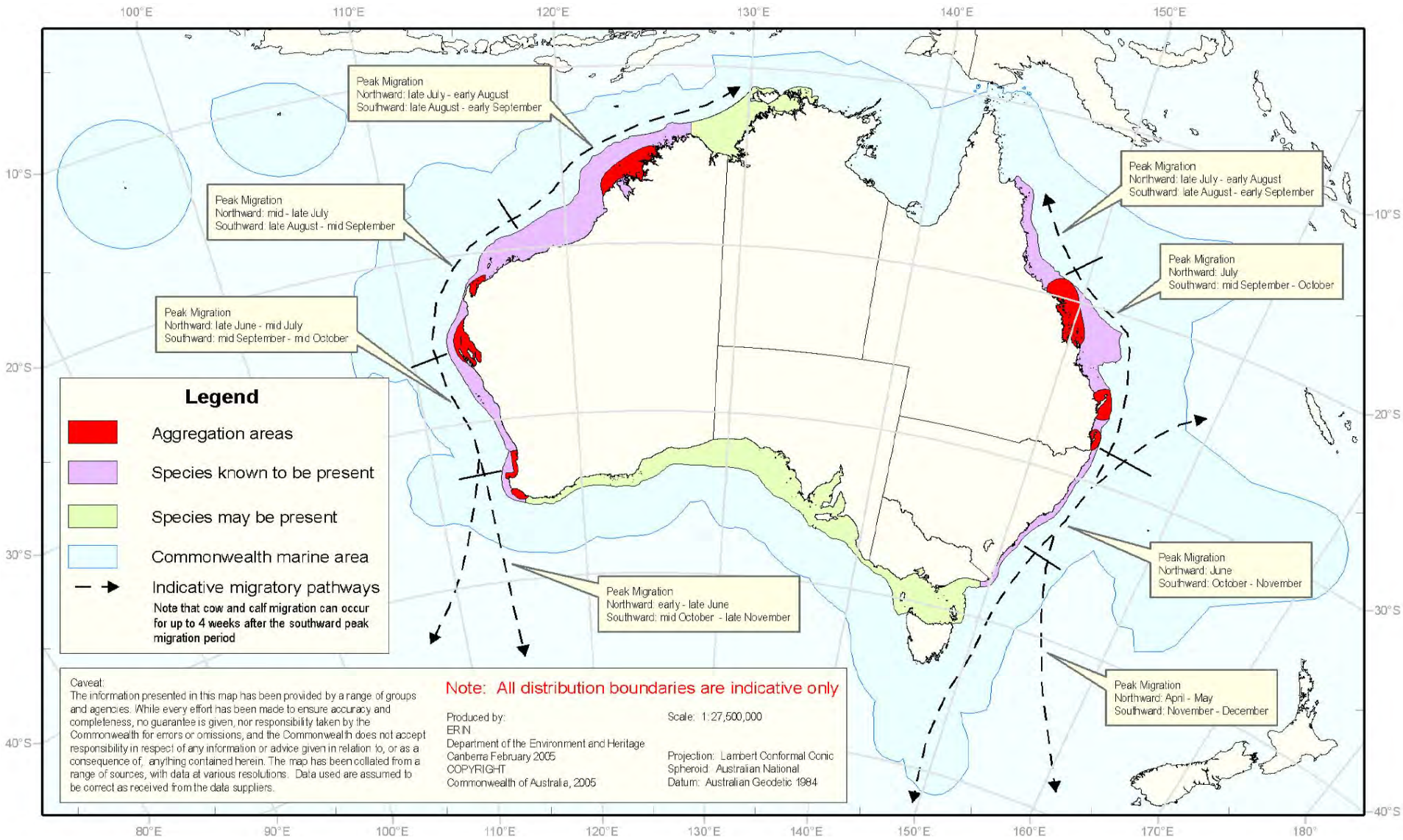

Figure 68: Distribution, migration and recognised aggregation areas of the humpback whale (Source: DEH, 2005).

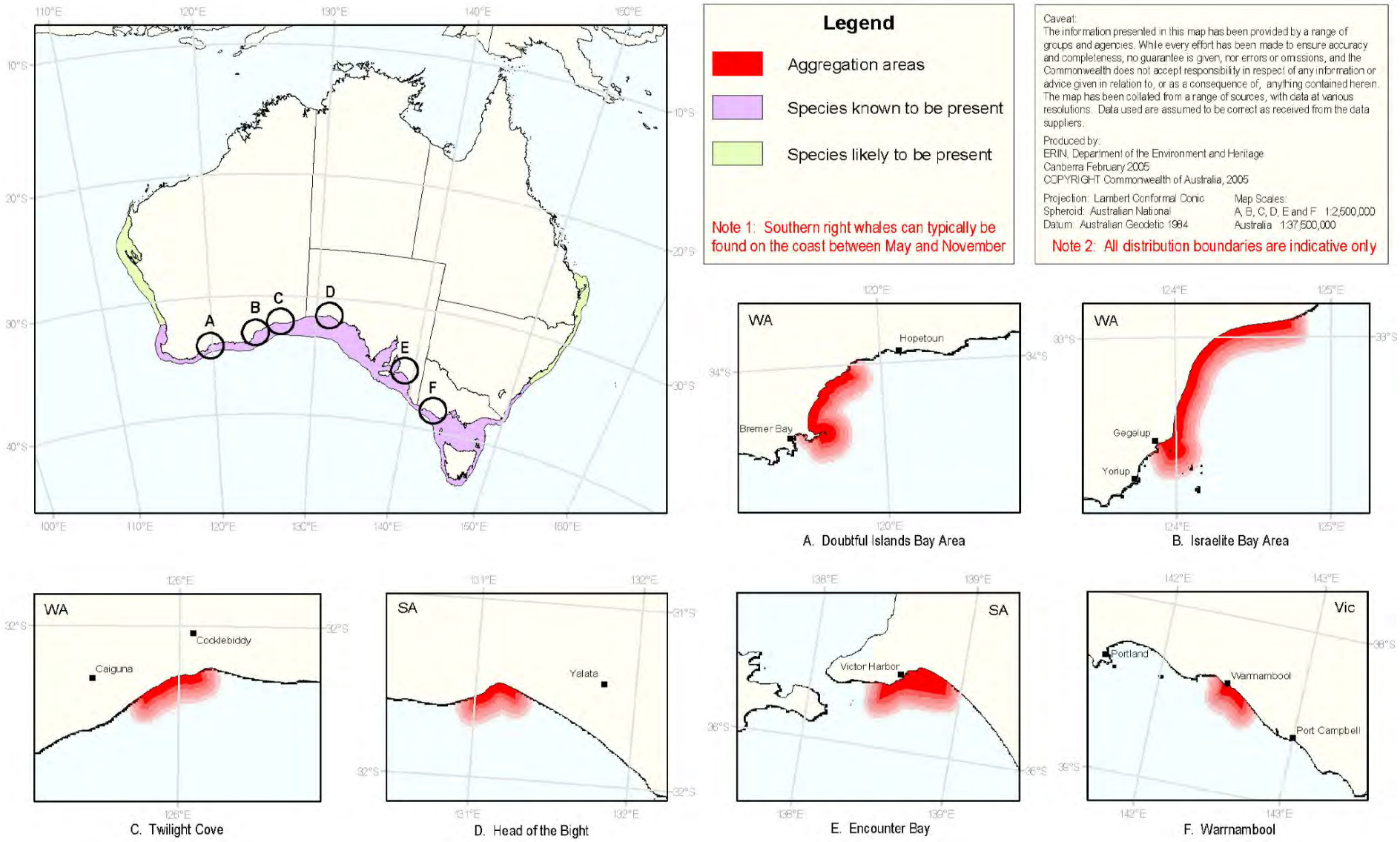

Figure 69: Distribution and recognised aggregation areas of the southern right whale (Source: DEH, 2005

Dolphins

Jervis Bay has a resident population of about 60 Indo Pacific bottlenose dolphins (*Tursiops aduncus*) (NSW MP, 2008b). Indo Pacific bottlenose dolphins can been seen in any part of Jervis Bay but are generally found in the shallow waters around the outer limits (i.e. around or inshore of the 15 m contour) with most key aggregation sites around rocky reef and seagrass habitats (Mandelc, 1997; Moller, 2001; Moller *et al*., 2002) in the northern part of the bay, largely between Callala Point and Honeymoon Bay. Dolphins with calves are generally found over seagrass beds (Marine Research Pollution, 2008). The common bottlenose dolphin (*Tursiops truncatus*) is also regularly sighted in the area but is rarely sighted inside of Jervis Bay (NSW MP, 2008b) and thus is unlikely to have any interaction with the proposed leases.

The longline culture apparatus represents a physical structure in the water column that would not naturally occur, which modifies the movements of dolphins within aquaculture lease areas. Dolphins have been observed on numerous occasions moving through the longline pearl leases in Port Stephens as individuals and pods (Umwelt, 2003). Similarly, there are reports of resident dolphin populations doubling following the establishment of pearl farms in Shark Bay, Western Australia (i.e. Blue Lagoon Pearls). Female dolphins have been observed using these farms to calve and shelter from predators (Umwelt, 2003).

Conversely, there are reports of dolphins avoiding aquaculture farms e.g. Shark Bay Marine Park, Western Australia (Mann, 1999). This avoidance is thought to be due to the numerous lines and buoys that may inhibit the movement of schooling fish on which dolphins feed and therefore make it difficult for dolphins to efficiently aggregate their prey (Wursig & Gailey, 2002). However, the proposed leases are located outside of key dolphin aggregation areas (i.e. rocky reef and seagrass habitats) and represent 0.4 % of Jervis Bay so the longline infrastructure will only cause minor and localised disruptions to movements in the bay.

Potential negative interactions between dolphins and the longline infrastructure on the Commercial Shellfish Aquaculture Leases can be avoided if appropriate mitigation measures are implemented (See below – Mitigation Measures).

Seals

The Australian fur seal (*Arctocephalus pusillus doriferus*) and the New Zealand fur seal (*Arctocephalus forsteri*) are commonly recorded in the Jervis Bay region but there are also occasional sightings of leopard seals (*Hydrurga leptonyx*) and subantarctic fur seals (*Actophoca tropicalis*). There is a fur seal haul-out at Steamers Head (south of Jervis Bay) which was established in 1989 and supports both Australian and New Zealand fur seals for most of the year. Haul-out sites for both Australian and New Zealand fur seals also occur

around St George's Head, Beecroft Peninsula (e.g. Drum and Drum Sticks and Lamond Head) and Crookhaven Bight (NSW MP, 2009b).

The likely congregation of wild fish around the longlines could potentially attract seals to the vicinity of the Commercial Shellfish Aquaculture Leases and potentially modify their feeding behaviour. It is considered unlikely that the Commercial Shellfish Aquaculture Leases will have a significant impact on seals due to the distance between the proposed leases and the haul-out sites, and the range of mitigation measures that will be implemented to minimise negative interactions (See below - Mitigation Measures).

Fish

Over 216 species of fish, sharks and rays are recorded within JBMP (NSW MP, 2008b). Fish species that inhabit seagrass beds in Jervis Bay include Snapper (*Pagrus auratus*), Yellowfin Bream (*Acanthopagrus australis*), Tarwhine (*Rhabdosargus sarba*), Luderick (*Girella tricuspidata*), Spotted Pipefish (*Stigmatopora argus*), Bridled Leatherjacket (*Acanthaluteres spilomelanurus*), Sailfin Goby (*Nesogobius pulchellus*) and Weed Whiting (*Neoodax balteatus*).

More than 100 fish species live in the subtidal sand-dominated habitats in Jervis Bay, including several species of mullet, whiting and flathead. Drift algal habitat is dominated by Weed Whiting (*Neoodax balteatus*), Crested Weedfish (*Cristiceps australis*) and Woods Siphonfish (*Siphamia cephalotes*). Sprats (*Hyperlophus vittatus* and *Sardinops neopilchardus*), anchovies (*Engraulis australis*), silversides (*Atherinason hepsetoides*, *Atherinosoma presbyteroides*), mullet (*Myxus elongates*) and Sand Whiting (*Sillago ciliata*) are the most abundant species in areas of sandy beach habitat in Jervis Bay (NSW MP, 2008b).

The Commercial Shellfish Aquaculture Leases could potentially function as artificial reefs and therefore, may act as fish aggregating devices (FAD). The term FAD has been used for a wide variety of drifting, surface floating or mid-water objects which have the primary purpose of facilitating the harvest of fish (mostly pelagic species) (Pears & Williams, 2005). Artificial structures provide novel foraging habitat, breeding habitat, detrital food sources, refuge from predators for some species and biodeposits can contribute to seabed enrichment issues. Shellfish farms can also affect fish populations by changing fishing pressures and aggregation behaviour (Keeley *et al*., 2009).

Artificial reefs and FADs are permitted within marine parks in NSW provided they are assessed in accordance with the objects of the *Marine Parks Act 1997* and any other legislative or regulatory requirements (NSW MP, 2009a). The proposal is considered to be

consistent with the MPA policies on artificial reefs and FADs and with the objects of the *Marine Parks Act 1997*.

If the Commercial Shellfish Aquaculture Leases function as artificial reefs or FADs, there is the potential for 'draw down' effects on natural reef areas, which in turn could cause changes to natural reef and fish assemblages. If fish are drawn away from the protection of their natural habitat and Sanctuary Zones for example, they may become more susceptible to capture, which in turn could impact on the dynamics of adjacent natural reef assemblages (Cardno Ecology Lab, 2010).

Shellfish farms are generally viewed positively by fishermen as providing additional habitat for fish and invertebrates (Joyce *et. al*., 2010). Recreational fishing is currently allowed in proximity to the areas proposed for shellfish farms so the overall biological effects of the leases on Sanctuary Zones is difficult to assess. The migration of fish from protected areas to shellfish farms could potentially reduce overall habitat competition within Sanctuary Zones and allow increased recruitment and survival of remaining stocks within the protected areas, while also supporting new populations around the shellfish farms (Connelly & Colwell 2005; Costa-Pierce & Bridger cited in Joyce *et. al*., 2010).

In Cockburn Sound, Western Australia for example, Pink Snapper were observed congregating around longlines during spawning season consuming large quantities of mussels (WAMPA, 2005). Rays have also been observed feeding off shellfish which had fallen off longlines (WAMPA, 2005), while larger predatory fish have been recorded preying on the congregation of smaller fish. Shellfish farms may also provide a substrate for growth of a wide range of microscopic plants and animals, which in turn attract a range of fauna such as ascidians, hydroids, sea horses, molluscs, crustaceans and byrozoans.

Effects on adjacent natural reefs are likely to be dependent on factors such as the distance from the Commercial Shellfish Aquaculture Leases and the type of fish found on nearby reefs that may be attracted to the longlines. Investigations of fish assemblages inhabiting artificial reefs have shown that the local area of influence may range from 5 to 50 m depending on the reef size and local environmental conditions (Fabi & Sala, 2002). The most extensive rocky reef habitat in Jervis Bay extends offshore from Plantation Point, Huskisson and Callala Bay. The distances of the Commercial Shellfish Aquaculture Leases from these reefs are considered sufficient to minimise the risk of attracting significant numbers of native fauna, notably fishes, from nearby natural reefs.

It is considered unlikely that the Commercial Shellfish Aquaculture Leases will have a significant impact on any species of fish due to the distance from key habitat areas (e.g. reefs and seagrass beds) and the range of mitigation measures that will be implemented to minimise negative interactions (See below - Mitigation Measures).

It should also be noted that it is not an intention of the Commercial Shellfish Aquaculture Leases to attract or facilitate the harvest of wild fish.

Seabirds

Birds can be major predators on finfish aquaculture farms, notably diving seabirds such as cormorants and gannets, which are known to be persistent in their attempts to predate on farm stock. The likely congregation of wild fish around the longlines has also been known to attract seabirds to farms, modify their feeding behaviour and result in habituation due to a predictable food source (Joyce *et al*., 2010).

Farming activities can also cause disturbance to seabirds from the noise and human activity associated with the operation of the farms (Inspiring Place, 2001). Aquaculture leases situated near important intertidal habitat for shorebirds or deepwater operations in close proximity to important coastline for birds can impact on roosting, nesting and feeding activities if adequate buffers are not maintained (Inspiring Place, 2001).

It is considered unlikely that the Commercial Shellfish Aquaculture Leases will have a significant impact on any species of seabird due to the distance from key habitat areas (e.g. Bowen Island, the shoreline and wetlands) and the range of mitigation measures that will be implemented to minimise negative interactions (See below - Mitigation Measures).

Mitigation Measures

The operator/s will be required to minimise any risks of negative marine fauna interactions including behavioural changes, through the implementation of a range of proven mitigation measures, including:

- Implementation of daily operational and maintenance procedures that minimise the attraction of potential marine predators including:
    - regular cleaning of longline and mooring infrastructure, as well as the culture apparatus, to reduce the amount of natural food available (i.e. regular removal of biofouling);
- Implementation of the Marine Fauna Interaction Management Plan which will involve recording and monitoring interactions with marine fauna during the operational stage, including interactions with the longlines, vessels or humans, as well as any behavioural changes such as in movement corridors and foraging/socialising patterns (Appendix 1).
- Implementation of Structural Integrity and Stability Monitoring Program (Appendix 1)
    - regular inspections, maintenance and repair of longline infrastructure; and

- maintain rope tautness and net integrity, particularly after severe weather (Kemper *et al.,* 2003).

Conclusion

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on the behaviour of marine fauna was assessed to be 'low' when considered in context with the small scale of the operations, the extensive area of unobstructed waters in Jervis Bay, the buffer zone between the leases and key aggregation areas (e.g. natural reefs, seagrass beds and Sanctuary Zones), as well as the range of mitigation measures that will be implemented to minimise negative interactions with marine fauna (e.g. biofouling removal and Marine Fauna Interaction Management Plan).

8.2.2.8 Areas of Conservation Significance

Table 34: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – impacts on areas of conservation significance (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the operation of the Commercial Shellfish Aquaculture Leases have a significant impact on any areas of conservation significance?
Level of Impact	Individual facility
Comments and Considerations	▪ *What areas of conservation significance are present in the region?* ▪ *How far are the areas of conservation significance from the leases?* ▪ *Are any of the areas of conservation significance likely to be impacted by the leases?* ▪ *Are any areas of 'critical habitat' likely to be impacted by the leases?* ▪ *What measures will be implemented to mitigate, monitor and manage any potential impacts on areas of conservation significance?*
Description	Distance to areas of conservation significance: ▪ Jervis Bay Marine Park ▪ Sanctuary Zone (Currambene Creek Mudflats Sanctuary Zone) = 2.7 - 3.3 km ▪ Sanctuary Zone (Hare Bay) = 3.1 - 6.6 km ▪ Sanctuary Zone (Huskisson) = 1.0 - 1.8 km ▪ Sanctuary Zone (Hyams Beach) = 1.8 - 5.2 km ▪ Sanctuary Zone (Bowen Island) = 9.8 - 12 km ▪ Sanctuary Zone (Point Perpendicular/Crocodile Head) = 11.3 - 11.5 km ▪ Sanctuary Zone (The Docks) = 8.8 - 9.2 km ▪ Sanctuary Zone (Groper Coast) = 6.5 - 7.4 km ▪ Sanctuary Zone (Wowly Gully) = 3.2 - 8.1 km ▪ Sanctuary Zone (Moona Moona Creek) = 1.5 - 4.5 km ▪ Nationally Important Wetlands (Beecroft Peninsula) = 6.6 - 7.7 km ▪ Nationally Important Wetlands (Jervis Bay) = 0 km ▪ Nationally Important Wetlands (Jervis Bay Sea Cliffs) = 10.3 - 10.4 km ▪ Nationally Important Wetlands (St Georges Basin) = 5.5 - 10.2 km ▪ Nationally Important Wetlands (Wollumboola Lake) = 7.1 - 12.2 km ▪ Listed Threatened Ecological Communities (Critically Endangered) = 5.1 - 8.2 km ▪ National Park (Booderee) = 6.4 - 10.8 km ▪ National Park (Jervis Bay) = 1.3 - 3.5 km ▪ Nature Reserve (Woollamia) = 4.4 - 5.5 km

Proposed Management – Mitigation and Monitoring	▪ Site selection (sand substratum, no environmentally sensitive or unique areas in close proximity to leases) ▪ Buffer zone between areas of conservation significance and the leases ▪ Small scale operations (0.4% of Jervis Bay) ▪ Appropriate stocking densities ▪ Leases located in Habitat Protection Zone - activity permitted in this zone ▪ Water Quality and Benthic Environment Monitoring Program o Regular sampling – before and during the operations			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	1	6	6	**Low**
Reporting Requirements	Full justification			

Justification of Ranking

Areas of conservation significance include Marine Protected Areas, Ramsar wetlands, national parks, nature reserves and areas of critical habitat declared under the *Fisheries Management Act 1994* and the *Threatened Species Conservation Act 1995*. Areas of conservation significance in the Jervis Bay region include the Jervis Bay Marine Park (JBMP), ten Sanctuary Zones within the bay (Figure 70), five nationally important wetlands (three of which are outside the bay), two national parks (land based) and one nature reserve (land based) (Figure 71). The distances between these conservation areas and the Commercial Shellfish Aquaculture Leases are listed in Table 34. There are no areas declared as critical habitat of any species within the marine waters of Jervis Bay.

Aquaculture is permissible within General Use and Habitat Protection Zones of JBMP but is prohibited within Sanctuary Zones. The site selection process for the Commercial Shellfish Aquaculture Leases carefully considered the habitat types within Jervis Bay and avoided sensitive and unique habitats (i.e. areas of conservation significance) such as rocky reefs, seagrass beds, mangroves and Sanctuary Zones. It is proposed that the Commercial Shellfish Aquaculture Leases will be situated in Habitat Protection Zones over a habitat type consisting of soft sediment (predominately sand), which is extensively represented in Jervis Bay. The installation of the longline infrastructure is unlikely to have a significant impact on this dynamic habitat type. There are also extensive areas of this habitat in the direct and wider study area. In addition, the proposed Commercial Shellfish Aquaculture Leases are small scale operations (0.4% of Jervis Bay) and appropriate stocking densities will be used i.e. not exceed the ecological carrying capacity of the bay.

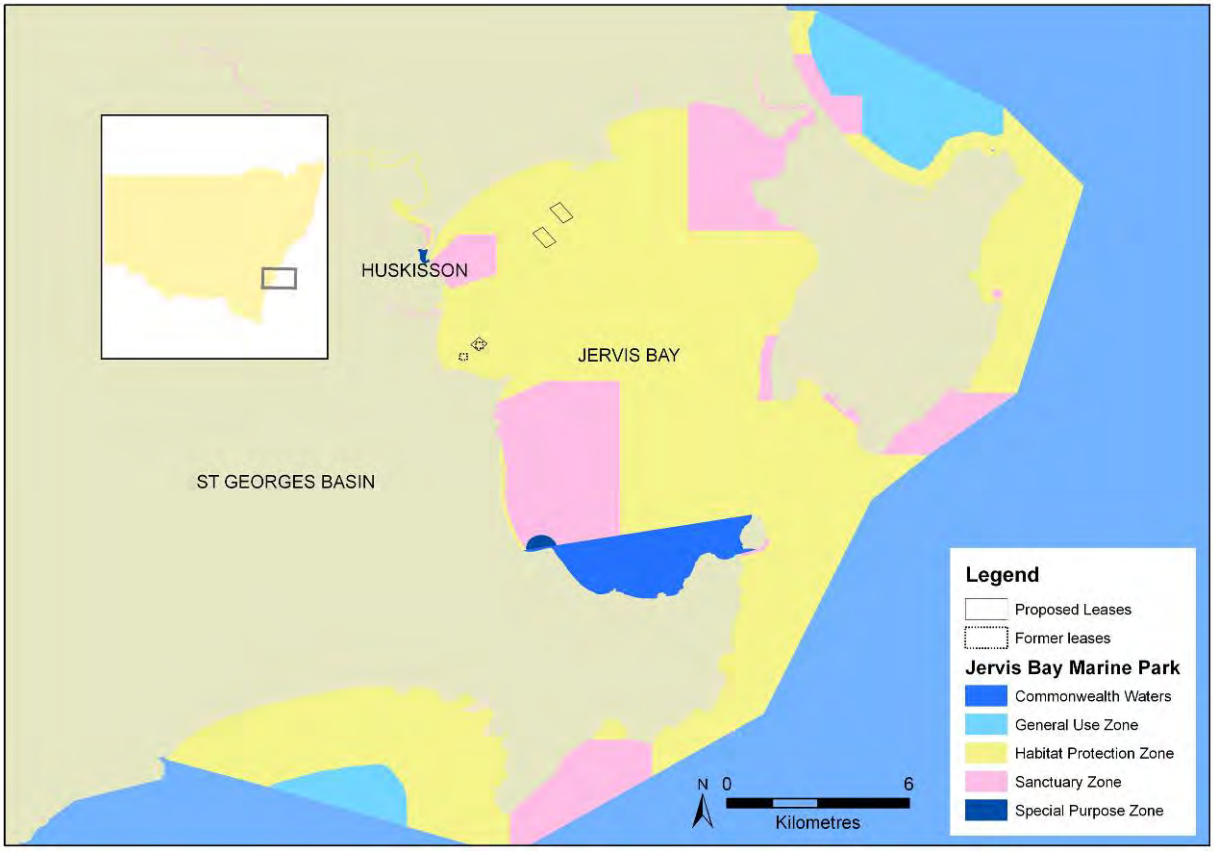

Figure 70: Location of the Sanctuary Zones (pink) within JBMP relative to the Commercial Shellfish Aquaculture Leases (Source: Fisheries NSW, 2012).

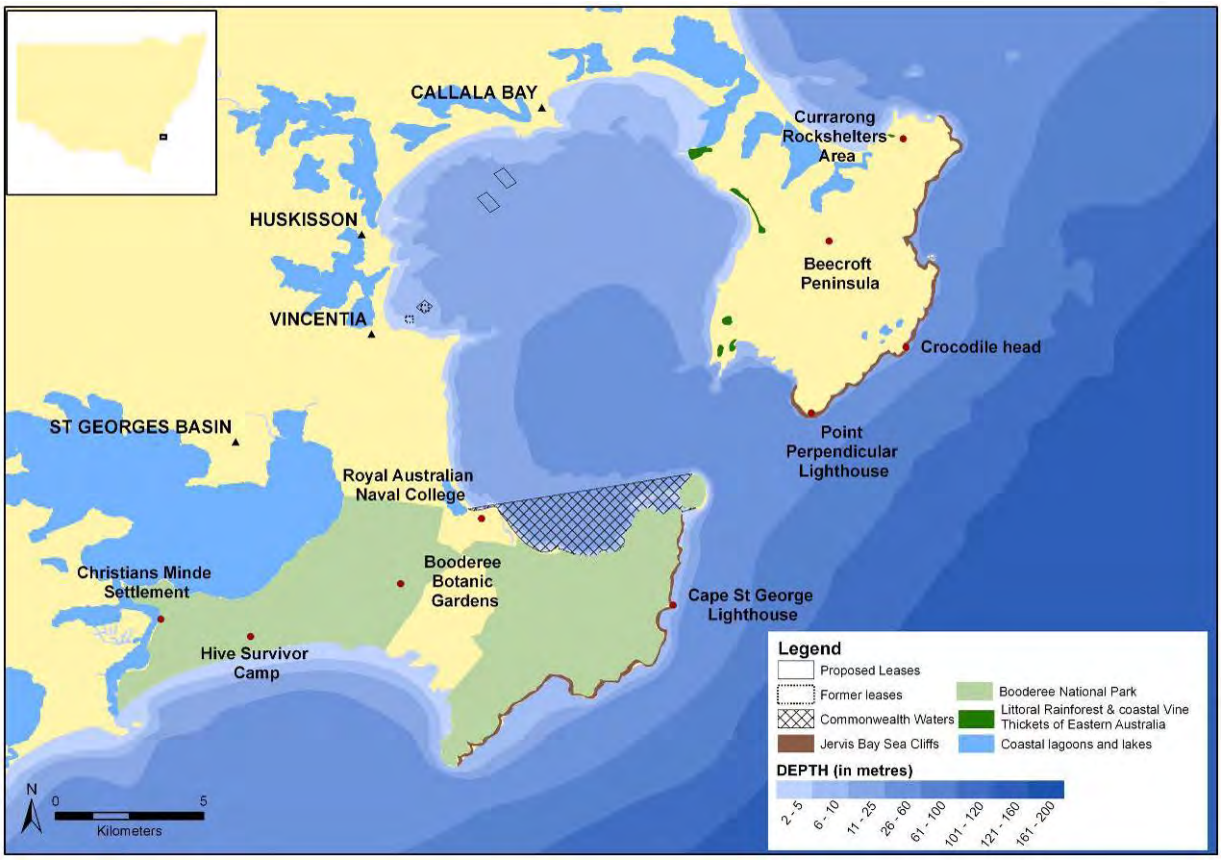

Figure 71: Location of nationally important wetlands, national parks and nature reserves relative to the proposed Commercial Shellfish Aquaculture Leases (Source: Fisheries NSW, 2012).

Many studies have been conducted on the impacts of longline farms on the benthic environment in Australian and international waters, and in most cases impacts have been found to be minimal, highly localised and restricted to the area beneath or in the immediate vicinity of longlines (NSW Fisheries, 1996; Heasman *et al*., 1998; Kaiser *et al*., 1998; Underwood & Hoskins, 1999; Kaiser *et al*., 2000; Crawford, 2001; Lasiak & Underwood, 2002; O'Conner *et al*., 2002; Crawford *et al*., 2003; Gifford, 2006, Keeley *et al*., 2009; Cardno Ecology Lab, 2012). A review of the ecological effects of shellfish farming in New Zealand for example, found that seabed effects were most pronounced directly beneath the leases, reduced rapidly with distance, and were usually difficult to detect within 20 to 50 m from the farm (Keeley *et al*., 2009).

A Water Quality and Benthic Environment Monitoring Program will be implemented and water and sediment samples will be collected before and during the operation of the leases for analysis (Appendix 1). If any monitored parameters are outside the acceptable range, farming practices will be modified until acceptable levels are regained.

The listed threatened ecological community - Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (critically endangered), will not significantly be impacted by the Commercial Shellfish Aquaculture Leases primarily due to the distance between this community (land based) and the leases (marine based) (See Section 8.2.2.6). Similarly, no area of national park, nature reserve or wetland will be modified or destroyed. The leases will also not change the hydrological regime, impact on water quality, native species or introduce invasive species to the surrounding wetlands. Notably, three of the five wetlands listed as 'nationally important' in the region occur outside the bay. There is a significant buffer zone between the wetlands and the proposed leases.

Matters identified in the *Guidelines for Developments Adjoining Land and Water Managed by the Department of Environment, Climate Change and Water* were also considered in context of the Commercial Shellfish Aquaculture Leases (DECCW, 2010b). The applicable issues included noise, visual amenity, cultural heritage, artificial lights and waste water, which have been assessed in Section 8.2.1.1, Section 8.2.1.3, Section 8.2.1.4, Section 8.2.2.4 and Section 8.2.2.9, respectively.

Conclusion

The risk of the Commercial Shellfish Aquaculture Leases having a significant impact on areas of conservation significance was assessed to be ‘low’ when considered in context with the distance between these areas (buffer zone), the characteristics of the sites selected, the small scale of the operations, the sustainable stocking densities, the results of monitoring studies on existing longline farms and the range of mitigation and management measures that will be implemented to prevent detrimental impacts.

8.2.2.9 Waste Disposal

Table 35: Summary of comments, proposed management measures, risk assessment values and reporting requirements for the issue – waste disposal (modified from Fletcher *et al*., 2004; Vom Berg, 2008).

Issue	Will the waste generated from the operation of the Commercial Shellfish Aquaculture Leases have a significant impact on the environment or humans?			
Level of Impact	Individual facility			
Comments and Considerations	▪ *What is the protocol for disposing of biofouling, damaged stock and sediment?* ▪ *What is the protocol for disposal of general waste and worn infrastructure?* ▪ *What measures will be implemented to mitigate, monitor and manage issues associated with waste disposal?*			
Description	▪ Waste production o Bio waste (i.e. biofouling, damaged, moribund or sick stock and sediment) o General waste o Obsolete/worn infrastructure			
Proposed Management – Mitigation and Monitoring	▪ Waste Management Plan (Appendix 1) o Biofouling, damaged, moribund or sick stock and sediment will be disposed of at an approved land based treatment facility or value added (e.g. composting, fishing bait or berley) ▪ Structural Integrity and Stability Monitoring Program (Appendix 1)			
Risk Assessment Values				
Organisation / Person	**Consequence**	**Likelihood**	**Risk Value**	**Risk Ranking**
NSW DPI	0	6	0	**Negligible**
Reporting Requirements	Short justification			

Justification of Ranking

The operation of the Commercial Shellfish Aquaculture Leases will generate a range of wastes, including bio waste (i.e. biofouling, damaged stock and sediment), general waste (e.g. plastic, containers and bags) and obsolete/worn infrastructure (e.g. ropes and buoys). In accordance with the NSW EPA waste classification guidelines, the bio wastes would be classified as General Solid Wastes (Putrescibles) and the general waste and obsolete/worn infrastructure would be classified as General Solid Wastes (Non - Putrescibles) (NSW DECC, 2008).

The longline infrastructure will be colonised naturally by a range of marine biofouling organisms, such as sponges, algae, ascidians, molluscs and barnacles. Sediment from the water column also settles on ropes and other longline components. Removal of biofouling and sediment from the infrastructure is important to reduce resistance to currents and wave action which may jeopardise its integrity e.g. stress moorings and cause the stock to sit too closely to the seabed (Braithwaite *et al*., 2007). Biofouling removal is also important to maintain water quality, reduce the availability of habitat for diseases and parasites and to minimise the attraction of wild fauna (e.g. herbivorous fishes) which feed on it and can cause damage to the infrastructure (Braithwaite *et al*., 2007) and cultured stock.

Biofouling removal also assists to prevent loss of production. Biofouling can increase the number of buoys and longlines required to mantain buoyancy (which increases equipment costs), it can reduce the feeding ability of shellfish and it can cause stock to fall off culture components. Loss of production can also occur if labour associated with handling culture ropes increases and if significant volumes of wastes are generated that require disposal. In addition, biofouling can reduce the availability of substrate for spat settlement (Pacific Seafood Management Consulting Group, 1996).

The lease infrastructure will be cleaned on a regular basis in order to remove biofouling, damaged stock and sediment. Cleaning of the longlines will be undertaken every 2-4 weeks or when considered necessary (e.g during winter months cleaning may be needed less frequently due to slow growth rates). The decrease in water temperature during this time of the year causes the growth of shellfish to slow down considerably and cleaning of the infrastructure can be detrimental to their condition (Umwelt, 2003). The mooring apparatus will also be cleaned, which will occur at least once a year. During cleaning of infrastructure, observations will be made for unusual marine organisms or suspected marine pests that will be duly reported to NSW DPI.

Infrastructure including culture apparatus will either be taken to the land based site for cleaning, cleaned in situ or it will be cleaned on-site using pressure cleaning equipment. On board pressure cleaning equipment used for the culture apparatus (which will depend on the types of species cultured), would consist of a power unit (pump), filter unit and cleaning unit. A winch will be used to pull the longlines up from the water, which will then be attached to rollers along the side of the vessel. Lines, nets, cages, baskets and/or trays containing the shellfish will be pulled onto the vessel and positioned on a conveyor belt that will take them through a cleaning unit consisting of a series of high pressure sprays and collection tanks (Umwelt, 2003). Biofouling and sediment will be removed and then the lines, cages and/or nets will be returned to the leases.

Water used in the on board cleaning process will be pumped from and returned to Jervis Bay. The water from the cleaning process will flow to the filter unit and pass through a series of meshes and collection boxes before it is discharged back into the bay. No chemicals will be involved in the cleaning process. All material that is collected in the filters and tanks will be disposed of at an approved land based treatment facility (Umwelt, 2003).

Dumping of bio waste (i.e. biofouling, damaged stock or sediment) overboard or near public facilities (e.g. jetties, ramps) will not be allowed - all material will have to be disposed at an approved waste facility. Biofouling waste and damaged stock could also potentially be used for composting.

During the operation of the leases, the longline, anchor and mooring infrastructure, including ropes, culture apparatus, buoys and moorings will wear and need to be replaced. The longline infrastructure will be inspected regularly to ensure all components remain structurally sound and stable. Inspections of the longline infrastructure will also be conducted after cleaning and severe weather to ensure that structural integrity has not been compromised. The inspection and maintenance procedures will be described in the Structural Integrity and Stability Monitoring Program (Appendix 1).

The operator/s of the proposed Commercial Shellfish Aquaculture Leases will be authorised for their activities under an aquaculture permit and lease/s in accordance with the provisions of the *Fisheries Management Act 1994.* Under these provisions the permit holder/s are responsible for maintaining their lease infrastructure to appropriate standards and be responsible for any lease infrastructure that may leave the lease area. Permit holders are also required to enter into an Aquaculture Lease Security Arrangement (Bond) with Fisheries NSW. In the event that longline infrastructure breaks away from the lease due to an extreme weather event, vandalism or unexplained equipment failure, the bond can be used to clean up any shellfish debris or lost infrastructure if the operator fails to attend to removing the waste.

The daily operation of the Commercial Shellfish Aquaculture Leases will also generate general waste, such as plastics, containers and bags. These wastes will be secured in waste bins on the service vessels and transported by road to an appropriate waste disposal facility in the area. On board operations will also involve the use of fuel and oil products, which will be secured in storage containers with tightly fitted lids. Regular servicing of all boats and equipment, as well as daily inspections and appropriate ‘start up’ and ‘shut down’ procedures will ensure early identification of any issues (e.g. potential spillages or leaks) and prompt remedial action by appropriately trained staff. Any residual or out of date products will be transferred to land based facilities and disposed of in an appropriate manner.

The Commercial Shellfish Aquaculture Leases will also follow industry best practice guidelines such as:

- Waste materials will be reduced, reused and recycled where possible;
- Longline infrastructure removed from the lease will be returned to shore for processing, recycling or disposal;
- Collected biofouling and general wastes will be returned to shore for disposal;
- All sewage wastes will be contained on service vessels in onboard holding tanks or chemical toilets and disposed of through an approved vessel sewage discharge point on return to port; and
- Residual materials that cannot be reused or recycled will be disposed of at an approved waste management facility.

Waste handling, transport and disposal procedures, inspection schedules and industry best practices will be detailed in the Waste Management Plan (Appendix 1).

Conclusion

The risk of waste generated from the operation of the Commercial Shellfish Aquaculture Leases having a significant impact on the environment or humans was assessed to be 'negligible' when considered in context with the Waste Management Plan and Structural Integrity and Stability Monitoring Program that will be implemented to ensure that wastes are appropriately handled, transported and disposed.

9 ENVIRONMENTAL MANAGEMENT

The Environmental Management Plan (EMP) will ensure that the commitments in the EIS, subsequent assessment reports and any approval or licence conditions are fully implemented. Appendix 1 contains a preliminary draft of the EMP which consists of a series of the sub-management plans, monitoring programs and protocols that address the potential environmental impacts identified in Section 8. The EMP will be finalised upon development approval and will include information such as operational objectives, indicators, performance criteria, sampling methods, data requirements, timeframes, specific locations and emergency response plans.

The objectives of the EMP are to ensure that the Commercial Shellfish Aquaculture Leases are sustainably managed and that their operation does not have a significant impact on the marine environment, surrounding communities or the operators. The EMP will aim to ensure the following:

- Aquaculture best practices are employed during all stages of the Commercial Shellfish Aquaculture Leases;
- Marine fauna interactions are minimised;
- Water quality is maintained and nutrient inputs are kept within safe levels for humans and marine communities;
- The structural integrity and stability of the longline infrastructure is maintained;
- The occurrence of disease, parasites and pests is minimised and if these events do occur, prompt reporting, management and/or remedial action will be implemented;
- The safety of staff and surrounding communities is maintained;
- Waste is appropriately disposed;
- Navigational safety in Jervis Bay is maintained; and
- The performance of the Commercial Shellfish Aquaculture Leases is regularly evaluated by reviewing environmental management reports and monitoring records.

The EMP will be used as a reference for the operators, staff and contractors employed during the various stages of the Commercial Shellfish Aquaculture Leases. Fisheries NSW will be committed to and responsible for ensuring that the operators implement all mitigation and management measures as described in the EMP.

10 CONCLUSION

Sustainable seafood production is a key focus of the NSW Government's State Aquaculture Steering Committee to support future demands of seafood supply for the State. The gap between capture fishery supply and the growing demand for seafood can only be met by aquaculture. The NSW Government recognises the need to look at opportunities for sustainable and viable aquaculture development that is built upon sound research. Aquaculture supports the regional economies of NSW and will be an increasingly important contributor to the future food security needs of the state.

Shellfish aquaculture has occurred in NSW since the 1870s with a history of strong research and development support from Fisheries NSW since the early 1900s. The research and development has involved successful hatchery and nursery studies on a broad range of species, including three species of oyster, two species of scallop and five species of clams and mussels.

Historically aquaculture has occurred in Jervis Bay since before the 1930's and has included the culture of oysters, mussels and scallops. Jervis Bay has characteristics that make it highly suitable for shellfish aquaculture, including excellent water quality, it is well sheltered from most prevailing weather conditions, it has a suitable depth profile and it is well serviced with local infrastructure and major seafood markets.

The proposed Commercial Shellfish Aquaculture Lease project aims to provide strategic and coordinated development of aquaculture in Jervis Bay Marine Park. NSW MP requested Fisheries NSW to develop an aquaculture strategy to ensure any aquaculture development is conducted in accordance with a sustainable aquaculture management plan. Fisheries NSW have also had representation from potential investors interested in developing aquaculture facilities in Jervis Bay.

Potential impacts were assessed as not significant when considered in context with the small scale of the Commercial Shellfish Aquaculture Leases (0.4% of the bay), the appropriate stocking densities, the minor increases in vessel movements and vehicular traffic and environmentally important areas (e.g. reefs, seagrass beds and critical habitat), as well as the use of design features that will minimise visual impacts. Noise generated will predominately be characteristic of the area and service vessels will be similar to existing vessels that use Jervis Bay.

Potential impacts were also assessed as not significant when considered in context with the characteristics of the proposed sites, including the absence of environmentally sensitive areas, the soft sediment seafloor (mobile sands), the good flushing rate and the extensive area of similar habitat in the direct and wider area. Only a small area of habitat will be

disturbed from the installation of the anchors. The locations of the proposed leases are also not within the recognised migratory pathway for cetacean species along the NSW coastline.

The proposed sites are also not a high use area, safe navigation will not be obstructed, the site is not of significant commercial importance and the lease will be clearly delineated with navigation buoys. Items and places of heritage significance in the region are located a sufficient distance away from the proposed sites to ensure no direct or indirect impacts.

Broodstock will be sourced locally or from the same genetic population, and hatchery protocols will ensure that genetic integrity is maintained, healthy fish are stocked onto the longlines and pest or unwanted organisms are not introduced to the site.

In addition, there are no World Heritage properties, National Heritage Places, Wetlands of International Significance (Ramsar), Commonwealth Marine Areas or Threatened Ecological Communities were found on or adjacent to the location of the proposed leases. Many of the matters listed under the EPBC Act are land based, including a number of threatened and migratory species, the listed threatened ecological community, the Commonwealth Land areas, many of the Commonwealth Heritage Places and Commonwealth Reserves. As the proposed leases are marine based, interactions between these areas are considered to be very unlikely.

The Commercial Shellfish Aquaculture Leases may act as a catalyst for economic development as it will provide increased employment opportunities and use local goods and services, as well as provide the tourism industry with an opportunity to diversify experiences available to visitors. The results from the monitoring programs and reviews of the effectiveness of the management plans, protocols and other mitigation measures will also provide valuable information to support evidence based policy development for future sustainable seafood production in NSW.

The EIS provides a thorough and transparent assessment of the potential risks associated with the proposed activity and proposes a number of measures to address the potential impacts of the Commercial Shellfish Aquaculture Lease project and its activities. Through appropriate site selection and culture equipment, as well as the employment of industry best practice, management plans, protocols and monitoring programs identified in the EIS and EMP it is concluded that the proposed activity will not have a significant environmental, social or economic impact.

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