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Abalone Aquaculture in Western Australia

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Abalone Aquaculture in Western Australia

Principles and considerations relating to management of abalone aquaculture in Western Australia

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

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Fish for the future

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Contents

Definitions and Abbreviations

1999 Policy	Abalone Aquaculture in Western Australia – Policy Guideline. December 1999. Fisheries Management Paper No. 133.
2010 Policy	Abalone Aquaculture in Western Australia – Aquaculture Policy. June 2010. Fisheries Management Paper No. 242.
2013 Policy	Abalone Aquaculture in Western Australia – Policy. July 2013
Abalone	In this document, unless referred to by species, "abalone" refers to all WA species of the genus *Haliotis*, namely: greenlip abalone (*Haliotis laevigata*); brownlip abalone (*Haliotis conicopora*); Roe's abalone (*Haliotis roei*); blacklip abalone (*Haliotis rubra*); tropical or donkey's ear abalone (*Haliotis asinina*); staircase abalone (*Haliotis scalaris*).
Abalone aquaculture	The keeping, breeding, hatching, culturing or harvesting of abalone under the authority of an aquaculture licence granted under s.92 of the FRMA. Marine farms authorised for abalone aquaculture will generally have tenure by way of an aquaculture lease granted under s.97 of the FRMA.
Abalone farm	A site or location with identified geographic boundaries licensed for the purpose of abalone aquaculture. Abalone farms may be either land-based or marine (refer to the respective definitions below under farm).
Aquaculture gear	Any equipment, implement, device, apparatus or other thing used or designed for use for, or in connection with, aquaculture, whether it contains fish or not and whether it is used for aquaculture or for navigational lighting or marking.
Biosecurity	Protection from the adverse effect an organism has or may have on a) another organism; or b) a human being; or c) the environment, or part of the environment; or d) agricultural activities, fishing or pearling activities, or related commercial activities carried on, or intended to be carried on, in the State or part of the State (per the Biosecurity and Agriculture Management Act 2007).
Broodstock	Adult abalone either collected from the wild (wild broodstock) or hatchery-bred adults (domesticated broodstock) retained for breeding purposes.
CEO	The Director General of the WA Department of Fisheries as Chief Executive Officer for the purposes of the FRMA.
Disease	A clinical or sub-clinical infection affecting the body of an organism. Disease may be caused by external factors, such as infectious disease, or it may be caused by internal dysfunctions, such as autoimmune diseases.
Fish	An aquatic organism of any species, alive or dead, including (a) eggs, spat, spawn, seeds, spores, fry, larva or other source of reproduction or offspring of an aquatic organism; and (b) a part only of an aquatic organism (including the shell or tail); and (c) live rock and live sand, but does not include aquatic mammals, aquatic

	reptiles, aquatic birds, amphibians or pearl oysters (per the definition in the FRMA).
FRMA	Fish Resources Management Act 1994.
FRMR	Fish Resources Management Regulations 1995.
Grow-out	The culture or on-growing of juvenile fish, usually reared in a hatchery, in or on aquaculture gear located within a defined area authorised for that purpose and where private or corporate ownership of the fish is implied. Abalone stocked in grow-out systems are generally older than two years.
Hatchery production	The culture or rearing of mass quantities of juvenile fish to be used for purposes including aquaculture grow-out, stock enhancement or restocking. A hatchery usually encompasses separate facilities for spawning broodstock and rearing eggs, larval and early juvenile fish in hatchery and nursery facilities.
Hybrid	The usually-sterile offspring of genetically dissimilar parents or stock, especially the offspring produced by breeding animals of different varieties or species.
In-shell	Harvested abalone that remain in their shells and that have not been gutted or otherwise processed.
Infiltration gallery	A sea water disposal system designed and located to prevent any release of biological material and contaminants into the surrounding waters; for example, a system that discharges used sea water from a quarantine area or hatchery into an area of sand dune physically separated from the sea.
Interim Policy	Interim Abalone Aquaculture Policy, in effect from 1 November 2011 until the completion of the 2013 policy.
Land-based farm	A farm located on land, generally in a coastal area. A land-based farm growing abalone will usually employ semi-closed or closed production systems and may include hatchery, nursery and grow-out facilities.
Marine farm	A farm located in the marine environment. A marine farm growing abalone will usually employ open or semi-open production systems and be restricted to grow-out activities.
Mean filter rating	The measurement of the average pore size of a filter element. It establishes the particle size above which the filter starts to be effective and may be considered equivalent in meaning to "nominal filter rating".
MEMP	Management and Environmental Monitoring Plan.
Minister	Unless expressly stated otherwise, "Minister" refers to the Minister for Fisheries.
PCR	Polymerase chain reaction.
Precautionary principle	Under the *Fish Resources Management Act 1994* the precautionary principle means that lack of full scientific certainty must not be used as a reason for postponing cost-effective measures to ensure the sustainability of fish stocks or the aquatic environment.
Productive reef area	A natural reef area that produced more than one per cent of the total annual commercial greenlip abalone harvest averaged over the three

	years preceding the date of receipt by the Department of a competent abalone aquaculture application, for which data are available.
Production systems	Open system – where there is no control of either stock movement or water flow; for example, abalone grown on sea-bed structures. Semi-open system – where there is control of stock movement but no control of water flow; for example, culture in barrels or cages suspended on longlines, sea cages and mollusc rack culture. Semi-closed system – where there is control of stock movement and some control of water flow; for example, land-based farms with tanks, ponds or raceways. Closed system – where there is good control of both stock movement and water flow; for example, recirculating land-based farms enclosed in a building.
Quarantine	Maintaining aquatic animals in isolation with no direct or indirect contact with other aquatic animals, to enable observation for a specified period and, if appropriate, testing and treatment, including proper treatment of the discharged waters from the isolated area; control and treatment of incoming water and equipment; and controlled access by personnel.
Ranching[i]	Ranching is the most production-oriented of fisheries enhancement systems and usually involves the release of cultured juveniles into unenclosed environments for harvest at a larger size in "put-grow-and-take" operations. Ranching systems are stocked and harvested to maximise somatic production (commercial fisheries) or the abundance of catchable-sized fish (recreational fisheries) and often involve the manipulation of abundance in ways not achieved in naturally recruiting populations, such as increasing the availability of juvenile and adult habitat through artificial means.
Restocking	The production and release of fish into wild populations where the species historically occurred naturally, to restore severely depleted spawning biomass to a level where it can once again provide regular yields or to restore self-sustaining populations in the wild.
Stock Enhancement[1]	The production and release of fish into wild populations where the species historically occurred naturally, for the purpose of augmenting the natural supply of fish and optimising harvest or increasing catch rates.
Translocation	The transfer of live fish from one place to another by humans.
Triploid	An organism with three times the haploid number of chromosomes in the cell nucleus, as opposed to normal animals, which are diploids with two sets. Triploids are usually sterile and grow faster than haploids.

[1] Note: these guiding principles do not deal with stock enhancement. Stock enhancement is dealt with under the Department of Fisheries Stock Enhancement Policy – Fisheries Management Paper No. 261.

[1] Note: Ranching in the context of this definition is not considered to be abalone aquaculture that is undertaken under the *Fish Resources Management Act 1994* (FRMA) or the *Aquatic Resources Management Act 2016.*

1 Introduction

Abalone aquaculture comprises an important part of Western Australia's growing aquaculture industry. The intent of this principles and considerations paper, which will be used by the Department of Fisheries in respect of management of abalone aquaculture in Western Australia, is to provide for the growth of the abalone aquaculture sector under an effective management framework that focuses on biosecurity and to establish the management measures that will apply.

These principles and considerations apply to the aquaculture of all abalone species found in Western Australian waters.[2]

The objectives of this principles and considerations paper are to:

- establish the management measures that will apply to the abalone aquaculture sector;
- provide clear guidance to applicants on key issues that will be considered in the assessment process for applications to grant or vary authorisations for abalone aquaculture licences and leases; and
- provide for the development and future growth of a sustainable abalone aquaculture industry in Western Australia.

The principles and considerations in this paper apply to aquaculture, including grow-out and marine farming, not to fisheries management activities such as restocking, stock enhancement, and ranching.[3] Some of these activities are closely related, so it can be difficult to distinguish between them; in these cases, the relevance of these principles is determined according to the intended outcome of the activity. For example, where the intent is grow-out for harvest within an authorised aquaculture lease, these principles and considerations apply; however, if the intent is recovery, maintenance or development of wild fisheries, the activity is considered fisheries management and consequently these principles do not apply.

Best practice management measures for abalone aquaculture, including biosecurity, are likely to evolve with changes in knowledge and experience. Accordingly, from time to time, these principles and considerations may be reviewed to ensure their currency and relevance to changes in technology, biosecurity, farming practices and other matters.

[2] Abalone species native to and with potential for aquaculture in Western Australia include greenlip abalone (*Haliotis laevigata*), brownlip abalone (*Haliotis conicopora*) and Roe's abalone (*Haliotis roei*). The brownlip abalone is often regarded as belonging to the same species as the blacklip abalone (*Haliotis rubra*) from the eastern states. There is also some interest in the culture of tropical or donkey's ear abalone (*Haliotis asinina*) and staircase abalone (*Haliotis scalaris*).

[3] See definition of ranching. The Department has developed a separate *Restocking and Stock Enhancement Policy* to provide guidance for proposals involving the release of hatchery-reared seed stocks of all fish species onto natural reefs in Western Australian waters. The *Restocking and Stock Enhancement Policy* includes the release of hatchery-reared abalone seed stocks onto natural reefs; consequently, it is cross-referenced with these principles.

2 Background

These principles and considerations update the 2013 Abalone Aquaculture Policy.

The key issues addressed in the 2013 policy related to broodstock collection; feeds; compliance; spatial separation and location sites; biosecurity; health management and certification; translocation; and grow-out. At that time the major issue was biosecurity and the issue of spatial separation was of particular concern. The 2013 policy also included three genetic zones for greenlip, brownlip and staircase abalone.

With the benefit of tight biosecurity controls, experience, further research, practical knowledge gained, and confidence in the ability of the fish health and other experts to respond rapidly to issues as they arise, there is considered to be capacity for more flexibility in the areas of spatial separation, location of aquaculture gear in marine farms and genetic management, while maintaining strong biosecurity controls, including controls imposed over maximum densities of abalone stocked on grow-out structures.

A key biosecurity measure, which has been retained, ensures marine abalone farms using open productions systems must not be grown at densities that exceed a biomass of three kilograms per square metre.

3 Guiding Principles

In its 2012 *Fisheries Policy Statement*, the Government recognised and supported aquaculture as a legitimate user of the State's land and aquatic resources and as a strategically important industry. The Department of Fisheries (Department) believes the abalone sector of the industry has the capacity to grow substantially and will support that growth by providing an appropriate regulatory framework and a transparent, effective and efficient approvals process.

Having regard for the provisions of the *Fish Resources Management Act 1994* (FRMA) the key principles to be considered when assessing applications for abalone aquaculture are a risk based approach and the precautionary principle.

These principles provide guidance in decision-making, but are not determinative.

3.1 Risk Based Approach

It is not possible to undertake new developments or activities that have no potential risks; therefore, where there are expected to be net community benefits from proposed activities, rather than avoid the risks altogether, governments will often assess the inherent environmental, social and financial risks and, where possible, identify and implement appropriate management or mitigation strategies to reduce the residual risk to acceptable levels. These management strategies generally identify an "appropriate level of protection" and an "acceptable level of risk", which is the amount of residual risk that will be accepted.

The acceptable level of risk can vary with the specific situation; once it has been determined for a particular proposal, it can be applied consistently using standard risk assessment methodology as the management tool to determine whether the proposal (including the associated set of management arrangements) is consistent with meeting the acceptable level of risk.

Recent examples of risk assessment with specific reference to the potential threat posed by the virus that causes abalone viral ganglioneuritis (AVG) can be found in Jones and Fletcher (2011) and Stevens (2012).[4,5] These risk assessments have been considered as part of the principles development process.

The Department has adopted an approach based predominantly on risk and science, particularly in relation to disease, biosecurity matters and genetic management, and is balancing a precautionary approach with opportunity for development of all sectors of the abalone industry. The assessment process for applications to grant or vary authorisations for abalone aquaculture will use similar principles, based on risk, science and the application of appropriate management and mitigation methods.

To provide a clear framework for effective management of risks, contemporary biosecurity management practices and practical measures have been adopted to improve abalone health management based on sound epidemiological principles for disease prevention and control. These measures are consistent with those advocated internationally by the World Organisation for Animal Health (OIE) for the prevention and control of aquatic diseases.

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[4] Jones, J.B. and W.J. Fletcher. 2012. *Assessment of the risks associated with the release of abalone sourced from Abalone Hatcheries for enhancement or marine grow-out in the open ocean areas of WA*. Fisheries Research Report No. 227. 24p..

[5] Stevens, R., 2012. *Disease risk assessment for abalone stock enhancement.* Western Australian Fishing Industry Council.

3.2 Precautionary Principle

Under the *Fish Resources Management Act 1994* (FRMA) the precautionary principle means that lack of full scientific certainty must not be used as a reason for postponing cost-effective measures to ensure the sustainability of fish stocks or the aquatic environment.

Application of a precautionary approach involves careful consideration. It means that the standard of proof used in decisions regarding authorisation of activities should be commensurate with the potential risk to the resource, while taking into account the expected benefits of the activities.[6]

3.3 Fish Resources Management Act 1994

The relevant objects of the FRMA are to:

- develop fisheries and aquaculture in a sustainable way;
- ensure the impact of fishing and aquaculture on aquatic fauna and their habitats is ecologically sustainable and that the use of aquatic resources is carried out in a sustainable manner;
- enable the management of fishing, aquaculture, tourism and associated non-extractive activities that are reliant on fish and the aquatic environment; and
- foster the sustainable development of commercial and recreational fishing and aquaculture, including the establishment and management of aquaculture facilities for commercial purposes.

Aquaculture licences are granted, varied or transferred according to the relevant provisions of the FRMA; namely, s.92, s.142 and s.140 respectively. S.92 provides that, amongst other things, the Chief Executive Officer of the Department of Fisheries (CEO) must be satisfied that it is in the better interests of the State and the community to grant an aquaculture licence and the activities to be conducted under the licence are unlikely to affect other fish or the aquatic environment. Biosecurity and health management issues are relevant considerations in this regard.

Applications for the grant or variation of an aquaculture licence are also assessed according to Administrative Guideline No. 1: *Assessment of Applications for Authorisations for Aquaculture and Pearling in Coastal Waters of Western Australia.* Under s.92A of the FRMA, licence applications are required to include a Management and Environmental Monitoring Plan, which includes provision for biosecurity. Aquaculture leases are granted according to the provisions of s.97 of the FRMA.

[6] Garcia, S. 1996, *The precautionary approach to fisheries and its implication for fishery research, technology and management; an updated review.* FAO Fish. Tech. Pap. No. 350/2

4 How Principles Relate to Activities

4.1 Broodstock Collection

In relation to the supply of broodstock, as for all aquaculture species, the Department's preference is for abalone hatchery operators to acquire stocks from the commercial fishery. In some cases, however, the commercial fishery may not be able to provide abalone in the condition or size required by hatchery operators. The principles therefore continue to allow the collection of abalone through other means, such as an exemption, noting that the effort made by the operators to acquire broodstock from the commercial fishery will be assessed in any applications.

4.2 Aquaculture Feeds

Abalone aquaculture production systems in Western Australia currently use commercial (manufactured) feeds or depend on the stock feeding on naturally-occurring macroalgae or seaweed. Generally, land-based systems use manufactured feeds and marine systems use a combination of manufactured feed and seaweed, or seaweed only, depending on whether the culture units are cages or barrels suspended from longlines, or seabed structures.

To minimise the risk of disease transfer or outbreak arising from pathogens that may be present in them, commercial feeds used must be only those produced by manufacturers that comply with the requirements of specified quality standards and that have in place a defined quality and risk management system. Imported feeds must not be used unless approved by Biosecurity Australia and subject to a permit issued by the Australian Quarantine and Inspection Service. Feeds that contain abalone or abalone products and all unprocessed raw feeds will not be allowed for the purpose of abalone aquaculture.

Supplementary feeding will not be allowed in marine farms using an open production system.

Abalone production in open systems utilising seabed structures as culture units, which enable the abalone stocks to capture and consume naturally-occurring drifting seaweed, are generally considered low risk and may be permitted. The Department does not support the harvesting or collection of seaweed for use as feed in aquaculture production and any future consideration of seaweed harvesting would be subject to a comprehensive environmental study that demonstrates the sustainability of such a practice.

4.3 Compliance

Compliance measures are intended to ensure traceability and differentiation of aquaculture product from wild fishery production. There is also an emphasis on biosecurity within hatchery facilities, including site visits to ensure compliance with licence conditions and biosecurity plans.

4.4 Spatial Separation between Sites and Reefs

The risk of disease agents being transported along various distances can be described as a continuum, in which the number of infectious particles drops steeply with distance from the source, with only a few infectious particles travelling relatively long distances. Although the likelihood of disease spread is reduced almost exponentially with distance from the source, extensive distances are required before the likelihood of infection approaches zero. Other factors that influence the level of risk are the number of infectious particles, host density and the strength and direction of water currents.

Spatial separation between abalone farms can therefore be an important biosecurity tool. Maintaining minimum distances between abalone farms (land-based and marine) and between abalone farms and natural reefs that yield a significant proportion of the commercial abalone fishery production (described herein as "productive reef areas") provides a means of limiting the spread of pathogens.

As a guide to reduce the likelihood of disease spread, the distance between abalone farms, and between abalone farms and productive reef areas, five nautical miles (measured over water) is considered a suitably precautionary distance. However, based on risk assessments, a distance greater than or less than five nautical miles may be required or acceptable, as the case may be.

There is an element of historical hangover in the use of five nautical miles, but the underlying principle is that greater separation can provide greater disease control. Where consideration is given to separation distances of less than five nautical miles between abalone farms or between abalone farms and productive reefs, the Department must consider whether this is an "acceptable level of risk" using the precautionary principle and having regard for appropriate biosecurity controls.

4.5 Disease and Biosecurity

The main known diseases of concern to abalone in Australia, and that cause widespread mortalities and significant economic loss, are perkinsosis and abalone viral ganglioneuritis (AVG). Descriptions of these, together with other abalone diseases by Jones and Stephens (2005), are summarised below.[7]

- **Perkinsosis**

  Perkinsus parasites are responsible for causing perkinsosis in molluscs such as oysters, mussels, clams and abalone. *Perkinsus olseni*, a reportable parasite and the only species known to cause the disease in Australia.

  Clinical signs of the disease were observed in abalone in South Australia and New South Wales, although the causative organism is also present in Western Australia and Victoria. Once introduced, *P. olensi* would be difficult to control or eradicate. Studies by Goggin and Lester (1995) suggest that disease caused by *P. olseni* will continue to be important in the management and future development of the abalone industry, particularly in aquaculture.[8]

- **Abalone Viral Ganglioneuritis**

  AVG is caused by a herpes-like virus that causes rapid mortality in abalone (Hooper *et al.*, 2007, Savin *et al.*, 2010; *cited in* Jones and Fletcher, 2012).[9] Abalone species known to be susceptible to the virus in Australia are greenlip abalone, blacklip abalone and hybrids of these two species. AVG disease outbreaks in Victorian abalone farms and the wild abalone fishery, and in Tasmanian live-holding processing facilities, have resulted in

[7] Jones, B. and Stephens, F. (2005). *Aquatic Animal Health Sub-Program: Development of a National Translocation Policy Using Abalone and Prawns as templates for other aquatic species.* FRDC Draft Final report Project No 2004/080.

[8] Goggin, C. L. and R. J. G. Lester, 1995. Perkinsus*, a Protistan Parasite of Abalone in Australia: A Review*. Mar. Freshwater Res., 46, 639-46

[9] Jones, J.B. and W.J. Fletcher. 2012 *Assessment of the risks associated with the release of abalone sourced from Abalone Hatcheries for enhancement or marine grow-out in the open ocean areas of WA*. Fisheries Research Report No. 227. 24p.

significant mortalities in wild and aquacultured stocks. The virus spreads through direct contact between abalone and through the water column; it can also be spread to healthy abalone by infected or contaminated offal, mucous, shells, fishing equipment and people who have been handling abalone (Crane *et al.*, 2009, cited in Jones and Fletcher, 2012).

The known Australian distribution of the virus that causes AVG includes Victoria and Tasmania. The virus has not been found in naturally-occurring abalone populations in New South Wales, South Australia or Western Australia; however, because several strains of the virus have been identified in Victoria and Tasmania, there is a possibility, albeit low, that strains specific to Western Australia may exist undetected.

- **Other Abalone Diseases**

  Abalone can also be infected by *Vibrio* spp., flavobacteria and non-specific fungal infections. *Vibrio* spp. are easily identified and treated, with impacts usually confined to individual farms, while the consequences of flavobacteria and non-specific fungal infections are not considered as serious.

Abalone may also be affected by unknown and undescribed infectious agents. Biosecurity protocols have been developed to minimise and manage the risk of outbreak and spread of disease through the adoption of best-practice biosecurity procedures.

Key features that provide a high level of biosecurity include the controls on the movement of live abalone (wild-caught broodstock, hatchery-reared juveniles and grow-out stocks) and other possible sources of infection. Such controls are based on the requirement to demonstrate low risk through conducting comprehensive health testing prior to movements being permitted. This approach ensures a high level of confidence in the ability to detect disease agents.

Disease risks in the aquaculture sector are managed through biosecurity strategies that include:

- a requirement for abalone farms to maintain and implement approved biosecurity plans;
- an appropriate health testing and certification regime;
- controls imposed over maximum densities of abalone stocked on grow-out structures;
- establishment of appropriate separation distances between abalone farms; and
- establishment of appropriate separation distances between abalone farms and productive reef areas.

The Department has several staff members who have undergone emergency response training. In the event of an outbreak of disease in abalone, the Department's emergency response would be consistent with that provided in the relevant Aquavetplan manual. The Aquavetplan manuals provide agreed management plans and sets of operational procedures that would be adopted in the event of an aquatic animal disease emergency. A draft Aquavet plan manual has been developed for AVG.[10]

[10] Department of Agriculture, Fisheries and Forestry (2012). Disease Strategy Manual: Abalone viral ganglioneuritis (Version 1.0). In: *Australian Aquatic Veterinary Emergency Plan (AQUAVETPLAN)*, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

4.6 Genetic Management, Translocation and Selective Breeding

Genetic management is undertaken using a risk assessment process that considers:

- genetic separation by imposing a physical or other managerial barrier between aquaculture populations and wild populations; or
- through progeny diversity using explicit broodstock collection and breeding programs to ensure only genetically appropriate progeny are released into the marine environment.

Roe's abalone occurs naturally in WA from Shark Bay to the South Australian border, while greenlip, brownlip and staircase abalone occur naturally from the South Australian border to Busselton. The Department has determined that there is no need to establish genetic zones for these species as these can be managed through the genetic management strategies described above (genetic separation and/or progeny diversity).

Tropical abalone occurs naturally in the north of WA; therefore, any request to move tropical abalone outside the area to which it is endemic will be assessed through the translocation policy on a case-by-case basis.

Applications to translocate abalone from interstate will not be considered at present. Any application for translocation would only be considered following a comprehensive and transparent risk assessment.

Selective breeding programs aim to increase the frequency of individual abalone in farm stocks with desirable commercial characteristics, such as improved growth, survival, disease resistance, yield and quality. In Western Australia, selectively bred abalone may be grown out at marine farms in situations where any likelihood of mixing with wild populations is low.

5 Relating Principles to Management

In making a determination to grant or vary an abalone aquaculture licence and any associated conditions of approval, the CEO will consider the principles of a risk based and precautionary approach set out in Section 3 of this paper.[11] These principles apply to the management of abalone aquaculture of greenlip, brownlip, staircase, Roe's and donkey's ear abalone in land-based farms and marine farms, using open, semi-open, semi-closed and closed production systems, employing culture units that include tanks, artificial substrate located on the seabed and cages and barrels suspended from longlines.

The CEO must also satisfy relevant provisions of the FRMA.

5.1 General Principles and Conditions

5.1.1 Broodstock Collection

The preferred option for abalone aquaculture licence holders to obtain broodstock is to acquire them directly from the commercial sector.

Abalone aquaculture licence holders may be authorised to collect broodstock directly from wild populations, by way of either:

- an Exemption granted under section 7(2)(e) of the FRMA; or
- authorisation under section 257(1)(bd) of the FRMA.

The assessment of an application to collect broodstock will consider the effort made by the operators to acquire broodstock from the commercial fishery.

5.1.2 Location of Aquaculture Gear in Marine Farms

Aquaculture gear in marine farms must only be located on areas of sea bed with a sandy or similar substrate.

5.1.3 Feeds

All manufactured diets or commercial feeds used for abalone grow-out must be produced by manufacturers that comply with the requirements of the relevant Australian quality standard.

Imported feeds must not be used unless approved by the biosecurity services of the Australian Government Department of Agriculture and Water Resources and imported subject to a permit issued by the Australian Quarantine and Inspection Service.

Unprocessed feeds, other than naturally-occurring seaweed, must not be used. In this context, unprocessed feeds include products such as raw fish and those that use abalone in any form. The harvesting of seaweed for abalone feed will generally not be permitted.

Supplementary feeding using commercial feeds will be allowed in land-based farms and marine farms using semi-open production systems.

[11] Aquaculture licences are granted, varied or transferred according to the relevant provisions of the FRMA; namely, s.92, s.142 and s.140 respectively. Applications for the grant or variation of an aquaculture licence are assessed according to Ministerial Policy Guideline No. 8: *Assessment of Applications for Authorisations for Aquaculture and Pearling in Coastal Waters of Western Australia*. Under s.92A of the FRMA, licence applications are required to include a Management and Environmental Monitoring Plan, which includes provision for biosecurity. Aquaculture leases are granted according to the provisions of s.97 of the FRMA.

Supplementary feeding will not be allowed in marine farms using open systems.

5.1.4 Compliance

A person involved in the consignment of any abalone from a licensed site, for sale or processing, must ensure all abalone are accompanied by an accurate copy of a consignment note; and the consignment note must accompany all abalone during transportation.

The consignment note must include details of the number or weight, species and average size of abalone consigned. A duplicate copy of the consignment note must be forwarded to the local office of the Department within 24 hours of the consignment. The licence holder must retain the original copy of the consignment note at the site.

Abalone may be processed in an authorised processing facility at a licensed land-based abalone farm, before being moved to another authorised processor for further processing. On-site processing will be allowed on land-based farms, subject to meeting Biosecurity Plan conditions in relation to disposal of wastes, maintaining records and keeping of shell.

On-site or at-sea processing will not be allowed at marine farms. Abalone harvested from marine farms must only be processed at an authorised, land-based facility.

Routine site inspections will be conducted to ensure compliance by the licence holder with the legislation, licence conditions, biosecurity plans, other protocols and codes of practice.

5.1.5 Spatial Separation and Location of Sites

Abalone farms will be subject to a degree of spatial separation between each other and between the farm and a productive reef area. While five nautical miles (measured over water) is considered a suitably precautionary distance (see Section 4.4), the extent of spatial separation when considering the grant or variation of an abalone aquaculture licence (and for the grant of leases) will be assessed against the precautionary principle and a risk assessment, including available measures to mitigate risk and potential additional biosecurity requirements.[12]

A "productive reef area" is defined as a natural reef area that produced more than one per cent of the total annual commercial greenlip abalone harvest averaged over the three years preceding the date of receipt by the Department of a competent abalone aquaculture application, for which data are available. The definition is based on statutory commercial fisheries catch data submitted to the Department. Where relevant and applicable, other data may be used, such as those collected from recreational catch monitoring programs. Generally, productive reef areas will be consistent with the 10 nautical mile grid areas for which commercial fisheries catch data are reported; however, if finer-scale spatial catch or habitat data are available, that information may be used in the consideration of applications for abalone farm sites on a case-by-case basis.[13]

If an abalone aquaculture licence for a site located within five nautical miles of a productive reef area is cancelled, suspended or not renewed, any future application for an aquaculture

[12] For land-based aquaculture facilities the distance is measured from the water discharge point.

[13] There are no official reports of catch at a finer scale than the 10 nautical mile grid; consequently, where they are available, spatial habitat data may enable a finer-scale decision to be made on separation between sites and productive reef areas. This allows abalone aquaculture proponents to undertake habitat and stock surveys, at their own cost, to support a case for a particular site that, for example, may lie within the 10 nautical mile grid but its boundaries are more than five nautical miles away from the productive reef area.

licence for the site will be considered a new application and subject to the usual assessment process.

Applications to transfer aquaculture licences will be determined by the CEO having regard to the relevant provisions of the FRMA.

Applications for tenure over marine sites, by way of leases issued under s.97 of the FRMA, will be considered having regard to the relevant provisions of the FRMA and any relevant guidelines and policies.

5.2 Biosecurity

5.2.1 Biosecurity Plan

Under the provisions of section 92(A) of the FRMA, applications for an abalone aquaculture licence must be accompanied by a Management and Environmental Monitoring Plan (MEMP); and current licence holders will be required to prepare and lodge with the Department a MEMP. Provisions for biosecurity will be included in the MEMPs.[14]

Biosecurity plans will provide information and processes on matters that include, but may not be limited to:

- the assessment of biosecurity risks and protocols in relation to hatchery, nursery and grow-out areas (including quarantine); treatment of all incoming and discharge waters; and infrastructure, equipment and staff movements;
- disinfection and hygiene practices;
- stock monitoring and health assessment practices;
- methods and processes for the movement of hatchery-reared abalone to marine farms and their placement on the culture units;
- a requirement to immediately report unusual mortalities, noting that the biosecurity plan will specifically define “immediately” and “unusual mortalities”;
- record-keeping and reporting requirements; and
- emergency response plans.

No abalone may be moved from a hatchery except in accordance with a biosecurity plan approved by the Department.

Authorised abalone aquaculture activities located less than five nautical miles from a productive reef area will be subject to additional biosecurity controls specified in the biosecurity section of the MEMP. The minimum additional biosecurity controls are set out below.

- Before being transported from the hatchery, abalone must be held for a minimum period of two weeks in a quarantine facility designed to prevent any contact with other hatchery stocks. The quarantine facility must be supplied by sea water treated using ozonisation or filtered to a nominal five micrometres then treated using ultra-violet irradiation. For quarantine facilities holding broodstock, water discharged from the facility must be directed to an infiltration gallery and not directly into the sea.

[14] Prior to the implementation of a MEMP, abalone aquaculture licence holders have been required to develop and implement a biosecurity plan through a licence condition.

- Abalone held in the quarantine facility must undergo disease testing as specified by the Department.
- Abalone stocked in marine-based grow-out farms must be visually inspected according to an agreed inspection schedule specified in the Biosecurity Plan; a record must be maintained of all inspection times.
- All unusual mortalities and the associated circumstances must be recorded and records maintained and made available to the Department upon request.

An independent audit of compliance with the biosecurity plan must be undertaken annually or as specified by the CEO and at the expense of the licence holder.

The Department will undertake inspections annually, or more frequently if required, to confirm compliance with biosecurity plans. The level of compliance will be commensurate with risk and may need to include a contribution from the beneficiary.

5.2.2 Health Management and Certification

Biosecurity measures regulating the movement of abalone broodstock onto farms from the natural environment include the use of quarantine systems and health surveillance of newly-introduced broodstock abalone.

The highest biosecurity risk associated with abalone marine farms is movement of hatchery-reared stock onto the farms. Disease testing and health certification will therefore be required for all hatchery-reared abalone being moved to another licensed abalone aquaculture facility, before they leave the hatchery. This requirement does not apply to abalone being moved for the purpose of processing or sale.

At the time of submitting samples for testing, hatcheries will be required to provide a written report on the health status of their stocks, in particular in relation to any increase in mortalities or sick animals.

The number of abalone to be tested before being moved from a hatchery will be regularly reviewed by the Department's Supervising Scientist Biodiversity and Biosecurity (Supervising Scientist) and the Principal Research Scientist Fish Health.[15] Current testing strategies are non-specific and may not improve the likelihood of detection of disease. The number of animals required to be tested and the specific tests to be used will be determined by the Supervising Scientist, taking into account the nature of specific diseases of interest, the characteristics of the tests available and the required confidence in the result as determined by risk assessment, not simply a predetermined, fixed figure.

For specific, high-priority diseases, the Supervising Scientist may require regular testing of hatchery stock, not just immediately prior to their movement.

Early clinical signs of disease will help guide the choice of testing strategies and reduce the risk of disease spread; accordingly, hatcheries will be required to report on the health status of their stock, in particular any increase in mortalities or sick animals, at the time of submitting animals for testing.

Disease testing and health certification will be required for all abalone being moved from a land-based facility to the marine environment, or from one marine farm to another.

[15] A reference to the Supervising Scientist Biodiversity and Biosecurity includes reference to an accredited pathologist or epidemiologist.

Licence holders may be required to submit additional animals for disease testing and, or, health certification at the discretion of the Supervising Scientist or Principal Research Scientist Fish Health or according to provisions of the approved biosecurity plan.

For a land-based abalone hatchery or grow-out facility, if a highly virulent or novel infectious agent is suspected by the CEO: no water from the facility must be discharged; quarantine measures must be put into place as directed by the CEO or other authorised officer; and other measures enacted according to the affected facility's biosecurity plan or as directed by the Supervising Scientist.[16] Consideration is also to be given to an immediate shut down of the water supply.

For a marine-based abalone grow-out facility, aquaculture producers need to be aware that a possible response to a confirmed outbreak of disease may include total destocking of the affected farm according to guidelines and emergency management response plans.

There is currently no compensation scheme available for compulsory destocking of a farm.

Future circumstances, such as localised disease outbreaks or the introduction of pests or competitors that alter the status of current biosecurity management, may necessitate the establishment of biosecurity management zones. The CEO will determine whether a biosecurity management zone is required.

5.3 Translocation and Grow-Out

5.3.1 Translocation and Genetic Management

The previous 2013 Abalone Aquaculture Policy used genetic zoning to manage genetic risks associated with land-based aquaculture. The use of a single strategy for managing genetics is not considered comprehensive enough when aquaculture progeny are grown in a diverse range of environments. For example, progeny have been grown out in enclosed on-land facilities, marine-grow-out structures, and within wild fisheries. Instead of genetic zoning, the Department now recommends the development of specific genetic management plans, based on risk assessments of each proposed operation, using genetic management strategies discussed in Section 4.6. These are:

- genetic separation by imposing a physical or other managerial barrier between aquaculture populations and wild populations; or
- through progeny diversity using explicit broodstock collection and breeding programs to ensure only genetically appropriate progeny are released into the marine environment.

These are discussed in more detail in Appendix 1.

Abalone may only be stocked in a marine farm if they are sourced from broodstock lines originally obtained from within Western Australia.

With appropriate risk assessments, approval will be provided on a case by case basis for selectively bred abalone from these broodstock lines to be used in marine grow-out farms in the vicinity of wild stocks in situations where any likelihood of mixing with wild populations is low. In most cases only the first generation offspring of abalone from wild broodstock may be used in marine grow-out farms. Depending on the risk assessment, in order to preserve

[16] This can be done under existing legislation (Regulation 177(2) *Fish Resources Management Regulations 1995*), so there is no legislative impediment to limiting effects of a disease outbreak in a hatchery.

genetic diversity, no approval for subsequent generations of abalone bred from these broodstock lines will be considered.

A rotational broodstock selection strategy should be adopted to ensure the full genetic variability within regional populations is accessed.

Hatcheries may maintain greenlip, brownlip, staircase, tropical or Roe's abalone stock from anywhere within Western Australia without the need for specific size filtration for discharge water, provided that the hatchery is located in an area in which these species of abalone are endemic. If the particular abalone species is not endemic to the area in which the hatchery is located, the specific approval of the CEO is required.

5.3.2 Grow-Out and Selective Breeding

For these principles, "selectively bred abalone" means abalone produced from successive generations of domesticated broodstock, which have been selected for their desirable commercial characteristics such as improved growth and survival.

For the purpose of these principles, hybrid and triploid stocks are not considered "selectively bred".

Land-based abalone farms and hatcheries will be permitted to grow selectively bred and hybrid abalone produced from broodstock lines originating from anywhere in Western Australia, subject to other relevant approvals being granted.

Land-based abalone farms and hatcheries will be permitted to grow selectively bred and hybrid abalone produced from broodstock originating from anywhere in Western Australia, subject to a other relevant approvals being granted. Subject to a risk assessment, the abalone farms and hatcheries may be required to utilise a system that uses a water treatment and discharge system with a mechanism to filter used water to a mean filter rating of 200 micrometres, to prevent the release of eggs or larvae into the wild.

Land-based abalone farms and hatcheries will be permitted to grow greenlip, brownlip, staircase, tropical or Roe's abalone originating from anywhere within Western Australia, provided that the facility is located in an area in which those species of abalone is endemic. If the species of abalone is not endemic to the area in which the facility is located, the specific approval of the CEO is required.

Marine abalone farms using open production systems must not be grown at densities that exceed a biomass of three kilograms per square metre.

Marine abalone farms will be permitted to grow selectively bred abalone produced from broodstock lines originating from anywhere within Western Australia, subject to other relevant approvals being granted.

Marine abalone farms will not be permitted to grow hybrid or polyploid abalone.

Marine abalone farms growing Roe's abalone may use stock derived from broodstock from anywhere within Western Australia south of Moore River, provided that the abalone farm is located in an area in which Roe's abalone is endemic. Broodstock collection from areas to the north of Moore River may be permitted in the future, depending on the recovery of the stock following the significant mortality ensuing from the "marine heat wave" in 2011. If Roe's abalone is not endemic to the area in which the marine farm is located, the specific approval of the CEO is required.

6 Appendix 1

Research Advice prepared by the Executive Director Research, Department of Fisheries June 2016

Background

All animal breeding activities involve inherent genetic risks. Reductions in genetic diversity of broodstock and/or their progeny carry risk for aquaculture producers, as this may affect commercially important traits such as disease resistance, growth rate and fitness (Danzmann et al., 1989; Koehn et al., 1988). In addition, where aquaculture-produced progeny are released into the marine environment where wild stocks are located this may generate a shift or reduction in genetic diversity with the potential to significantly impact wild stocks in these areas by swamping locally adapted genotypes (Allendorf and Ryman, 1987).

This advice will primarily focus on mitigating genetic risk to wild stocks, because this is the Department's primary area of responsibility. Risks to land-based commercial aquaculture production activities will be noted where relevant.

Issue

Previous versions of the Abalone Aquaculture Policy (AAP) have used genetic zoning to manage genetic risks associated with land-based aquaculture. At present there is no consensus on the size and number of genetic zones, with each new study of genetic diversity using a different methodology (see Elliot et al., 2001, Hancock, 2000; Sandoval-Castillo et. al., 2015). The use of this genetic zone approach is also not considered appropriate because it does not deal with the main genetic risks to the wild stock that could arise from marine based aquaculture production.

To manage the genetic risk of aquaculture operations that share the same marine environment as wild fisheries, the AAP currently utilises spatial separation mechanisms for marine grow-out (sea-ranching) and does not address restocking or stock enhancement activities. Marine grow-out and restocking or stock enhancement activities have been occurring in WA abalone fisheries since 2011 and 2004 respectively. Consequently, a more comprehensive and robust approach is required to manage the genetic risks associated with all abalone aquaculture activities.

Analyis

Genetic diversity, effective population size (Ne), and true population size (Np)

Genetic diversity is often linked with the concept of effective population size (Ne). Ne is defined as the number of animals in an 'ideal' population, which has a 1:1 sex ratio, and an equal chance of all breeding individuals being the parent of any progeny (Allendorf and Ryman, 1987). A minimum Ne of around 500 is needed for a population of any species to maintain its historical level of genetic diversity, and retain its long-term adaptive potential (Franklin, 1980). Therefore, the greatest threat to diversity is low Ne. As a species' establishes, both Ne and genetic diversity increase as its population differentiates. True population size (Np) however is always larger than Ne. This is because of the heritable links between original and new populations, as new populations are usually composed of

individuals with existing genes, and not all animals present within a population transfer genes (breed) at the same time. Also, true biological populations are not 'ideal', meaning, they do not conform to 1:1 sex-ratios, or share parenthood of their progeny equally amongst breeders. Typically Ne is less than 10% of Np in wildlife populations, or as low as 0.01% in some fish populations (Frankham, 1995; Mariani and Bekkevold, 2014).

A review of genetic diversity in Australian abalone aquaculture found that the effective population size (Ne) was less than 30 for the East Coast hatcheries surveyed (Evans et al 2004). This is a result of the high fecundity of mature abalone (1-5+ million eggs per female), and an artificially high survival rate of juveniles in a culture environment compared to wild stocks. Given commercial aquaculture operators in general are yet to detect a decline in commercially important traits such as disease resistance, growth and fitness, the small Ne appears to pose a negligible risk to land-based aquaculture.

In marine-based aquaculture (and sea-ranching or enhancement) the low genetic diversity (low Ne) of hatchery-bred progeny would pose a significant risk to wild stocks, if the numbers released into the environment become significant in proportion to the numbers of local wild broodstock. This situation could result in a 'swamping' effect causing a lowering of the local genetic diversity and fitness of the wild stock. To avoid an unacceptable level of risk to the wild stock, a specific genetic management plan would be required to mitigate these risks.

Strategies for management of genetic diversity

The overall management objective of wild stocks is to maintain a natural (high) Ne, because this is the genetic resource on which the long-term survival of wild fisheries depends and aquaculture use as source material (broodstock). There are two main risk management strategies that can be used to achieve this:

a) Genetic Separation: imposing a physical or other managerial barrier between low diversity (low Ne) aquaculture populations and high diversity (high Ne) wild populations. This could involve the use of an appropriate production facility design and management measures such as spatial separation (physical distance), or harvest based controls (harvesting below sexual maturity), etc.

b) Progeny diversity: using explicit broodstock collection and breeding programmes to ensure only genetically appropriate progeny are released into the marine environment. This requires effective genetic monitoring programs and compliance protocols to be developed.

Relative risks to genetic diversity (Ne) of wild stocks from abalone aquaculture activities

Land-based aquaculture: As there is limited to no exchange of aquaculture produced progeny with the marine environment in WA, this form of aquaculture is effectively managed by spatial separation. The genetic risk to wild stocks is therefore negligible (assuming appropriate biosecurity) as the only risks associated with reductions in genetic diversity (Ne) under this scenario are those which potentially affect the economics of the aquaculture operations.

Marine grow-out: The risks generated from the release of hatchery-bred progeny, which have significant reductions or differences in genetic diversity, apply to both the grow-out stock and any nearby wild stocks. The levels of risk to the wild stock will, however, vary based on the genetic ancestry, the scale of the grow-out operation and the distance between the 'cultured' individuals and wild stocks. Effective management should therefore involve both genetic separation and progeny diversity with an appropriate balance between the two strategies, including defining where broodstock can be sourced from, minimum numbers used for spawning and the maximum number of times individual broodstock can be used.

Restocking or stock enhancement: As the aquaculture progeny for enhancement are by definition placed near to wild stock, the risks associated with reductions in genetic diversity essentially apply to only the wild stocks. The levels of risk will depend on the scale of the operation relative to natural recruitment in the population, and the progeny diversity strategy that is applied.

Research advice on genetic management in WA abalone aquaculture

- ***On-land aquaculture operations***: Assuming the use of appropriate production facility designs (biosecurity measures); no specific genetic management is required.
- ***Marine grow-out***: A specific genetic management plan (genetic separation and progeny diversity strategies) needs to be developed for each proposed marine grow-out operation, noting factors such as location, scale, harvest strategies and proximity to wild stocks.
- ***Restocking / stock enhancement***: As no spatial separation options are available a specific progeny diversity strategy needs to be developed for each proposed restocking or stock enhancement activity, noting factors such as location, scale of release programme and natural recruitment of wild stocks.

Marine grow-out policy position

The genetic management principles that need to be applied to abalone marine grow-out are not currently defined within the Abalone Aquaculture Policy (AAP). Instead of using the current genetic zoning, the genetic management principles that have been developed for restocking or stock enhancement which are covered by the Policy on Restocking and Stock Enhancement in Western Australia (FMP 261) should be applied and expanded within the AAP to direct the genetic management strategies for abalone marine grow-out. Details should include, but not be limited to, appropriate broodstock collection and maintenance schedules, spawning management procedures, distance of sea-ranching operation from significant wild stocks, potential spawning biomass of sea-ranched animals, and compliance procedures associated with these details.

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[i] Note: the WA aquaculture community often refer to marine grow-out areas as 'ranching'. However, ranching in the context of this definition is not considered to be abalone aquaculture that is undertaken under both the *Fish Resources Management Act 1994* (FRMA) and the *Aquatic Resources Management Act 2016.*