Disease Risk Assessment for abalone stock enhancement

Australian Government

Fisheries Research and Development Corporation

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Dan Machin

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A special thank you is extended to Peta Main, Elite Business Coaching for facilitating the workshop and Neil MacGuffie for exceptional input and moral support pre-, post and during the workshop.

NON TECHNICAL SUMMARY

2011/046 Disease risk assessment for abalone stock enhancement

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OBJECTIVES:

1 Independent risk assessment of the raw biosecurity risks posed by the commercial scale abalone stock enhancement.

2 Independent risk assessment of the residual biosecurity risks posed by the commercial scale abalone stock enhancement, following staged implementation of risk mitigation measures.

OUTCOMES ACHIEVED TO DATE

The major output was a rigorous risk assessment, featuring an evaluation of the raw and residual risk of abalone stock enhancement.

The outcome is that this will greatly assist in understanding whether the health status of abalone industries can reasonably be protected, during any commercial scale abalone stock enhancement.

This outcome was achieved, with the participation of the majority of WA industry and a number of interstate observers in the first two days of the risk assessment process. It highlighted the need for any stock enhancement project to be part of an integrated, whole of industry, targeted surveillance and biosecurity program to establish and maintain the health status of Western Australia's abalone herd(s).

Both commercial fishery and aquaculture industries discovered the need to understand the risks; the control measures associated with biosecurity to ensure the long-term productivity, sustainability and value of fisheries resources are adequately protected. Outcomes have social and community implications through adjunct protection of the recreational fishery for abalone, and natural biodiversity.

This outcome was achieved, with the participation of the majority of industry in the first two days of the risk assessment process. It highlighted (1) the need for state authority to provide a biosecurity quality management system that provides, continuously, basic biosecurity conditions, which will enable WA to maintain the health status of its abalone herd(s); and (2) commercial fishery sector should improve its biosecurity risk managements to ensure it consistently meet its own and the State's standards of biosecurity.

The nature of Australia's seafood industry has necessitated the translocation of aquatic organisms within and between jurisdictional boundaries. This comes with a number of inherent risks for any receiving environment. To manage these risks, decision making authorities, under the auspices of the *"National policy for the*

translocation of live Aquatic Organisms – issues, principles and guidelines for Implementation (Anon. 1999), use scientifically based hazard pathways, risk analysis and risk control measures to determine, if a translocation can be undertaken with an appropriate level of protection (ALOP).

Abalone stock enhancement remains one of the few viable alternatives for increasing the profitability and biomass of a fishery without compromising the current fishery in terms of access or allowable catches (Hart, Farbris & Daume, 2007). Economically viable stock enhancement could provide the fishery with stock numbers towards virgin levels, thus increasing catch rates and ultimately economic efficiency and profitability.

Relatively few abalone diseases are known worldwide. This has been recognised to be a result of the lack of examination (absence of proof, rather than proof of absence). In this context, this study, utilising an expert and technical panels, undertook a disease risk assessment of abalone stock enhancement to determine what risk control measures are required to mitigate the inherent risks. The method used was consistent with both the Australian Standard AS/NZS 4360 and ISO 31000:2009

The study found that a range of risk control measures would enable the stocking of open systems with aquatic animals of higher than or equal health status to that of aquatic animals already living in the considered areas.

Based on the panel's discussion the report made following suggestions regarding basic biosecurity conditions and quality management systems:

<u>Basic Biosecurity Conditions</u>

- Need to be in place for two years prior to beginning operations;
- Integrated industry biosecurity management for the entire abalone industry;
- Allow the movement of stock between areas of equivalent health status; or to areas of lower health status;
- Aquaculture farms would benefit from establishing compartment freedom (see: http://www.oie.int/) from notifiable diseases;
- The authorities should establish the health status of wild stock to enable defining and zoning of areas and/or setting of biosecurity management areas.

<u>Quality Management System (QMS)</u>

- Should be based on ISO 9001;
- Setting of biosecurity planning and plan standards for fishing, farming and stock enhancement,
- The setting of biosecurity audit guidelines, independent certification and compliance;
- Incorporation of regulation and penalties for biosecurity matters for processors, fishers and farmers, including legal powers to control all activities, in case of an emergency disease incident;
- Need for compulsory disease reporting in all sectors;
- Build capacity in industry emergency response preparedness; disease recognition; and
- Annual audit and review of effectiveness of the biosecurity QMS.

KEYWORDS: Risk Assessment, abalone, stock enhancement, aquaculture,

1. Background

"All introductions and transfers of marine organisms carry risks associated with target and non-target species (including disease agents). Once established, introduced species can spread from foci of introductions and have undesirable ecological, genetic, economic, and human health impacts" (ICES, 2004).

The nature of Australia's seafood industry has necessitated the translocation of aquatic organisms within and between jurisdictional boundaries. This comes with a number of inherent risks for any receiving environment. To manage these risks, decision making authorities, under the auspices of the *"National policy for the translocation of live Aquatic Organisms – issues, principles and guidelines for Implementation* (anon. 1999), use scientifically based hazard pathways, risk analysis and risk control measures to determine if a translocation can be undertaken with an appropriate level of protection.

In the above context, it is critical that such risk assessments are consistent with the following:

- World Trade Organisation and Sanitary and Phytosanitary principles;
- Office International des Épizooties (OIE) *Aquatic Animal Health Code* (2011);
- *ICES Code of Practice on the Introductions and Transfers of Marine Organisms* (2004);
- Commonwealth Government's Mutual Recognition Act 1992; and
- Inter-Government Agreement on Biosecurity (IGAB)

Ultimately, the aim is to only stock open systems and farming facilities with aquatic animals of higher than or equal health status to that of aquatic animals already living in the considered areas (OIE, 2011).

Australia's aquatic animal fauna is host to a wide range of aquatic animal pathogens. However only a small proportion of these are known to science and new diseases are discovered regularly. In abalone, over the last decade, the following has been observed:

- several significant new abalone diseases,
- recognition that disease has played a part in the decline of some wild abalone populations; and
- no documented examples are known of abalone populations recovering from catastrophic impacts.

Relatively, few abalone diseases are known worldwide possibly due to the lack of examination (absence of proof, rather than proof of absence) (Handlinger et al 2006) and that more diseases are likely to emerge with increased development of abalone aquaculture and greater numbers of live holding facilities.

In 2005 in Australia Abalone Viral Ganglioneutris (AVG) caused by abalone herpes virus (AbHV) emerged. This is now recognised as a major commercial threat to both the wild capture and the aquaculture industries, and an environmental threat to wild populations in general. Following the identification of AVG disease in Tasmania in 2011 there was a perception that the biosecurity risk to Western Australia would increase as a result of the proposed, commercial scale, stock enhancement project by the Department of Fisheries WA and Industry in Western Australia. The project to

conduct a disciplined, open transparent risk assessment was conceived and developed to address this perception and determine the extent of the risk and whether it would be increased as a result of enhancement.

It is in this context that the risk assessment of abalone stock enhancement was undertaken.

2. Need

Abalone stock enhancement remains one of the few viable alternatives for increasing the profitability and biomass without compromising the current fishery in terms of access or allowable catches (Hart, Farbris & Daume, 2007). Economically viable stock enhancement could provide the fishery with stock numbers towards virgin levels, thus increasing catch rates and ultimately economic efficiency and profitability.

Prior to the commercialisation of abalone stock enhancement the industry wanted to understand the biosecurity risks of the larger scale stock enhancement project; in other words to weigh up the potential economic gains against biosecurity risks. The 2010/11 AVG outbreak in Tasmania highlighted the requirement for industry to be vigilant regarding potential disease vectors.

In order to protect the valuable abalone industry from potential biosecurity threats, there was a need to undertake a risk assessment to quantify raw and residual risks associated with commercialization of abalone stock enhancement. Although being carried out in WA, this risk assessment has national significance to the abalone industry.

3. Objectives

The objectives of the project were:

1 Independent risk assessment of the raw biosecurity risks posed by the commercial scale abalone stock enhancement.

2 Independent risk assessment of the residual biosecurity risks posed by the commercial scale abalone stock enhancement, following staged implementation of risk mitigation measures.

5 Methods

The Risk assessment was adapted from *Risk Assessment of abalone Fishing and farming activities – using abalone Viral Ganglioneuritis as a case study* (Unpublished. Anon. 2010) and “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” Jones and Fletcher (Fisheries Research Report 227, 2012. 20p). This method is consistent with both the Australian Standard AS/NZS 4360 and ISO 31000:2009, and consists of the following elements:

1. Establish a scope and an appropriate level of protection.

2. Describe the risk pathways for stock enhancement. Each pathway was sequentially numbered (Figure 1)

3. For each risk pathway, score the raw likelihood. This score considered both (a) "general assumptions" (Appendix 4); and (b) Table 1 (Appendix 5). The raw likelihood score is based on no controls measures;

4. For each risk pathway, score the raw consequence. This score considered both (a) "general assumptions" (Appendix 4) and (b) Table1 (Appendix 5). The raw consequence score was based on no controls measures;

5. For each risk pathway, the scores from steps 3 and 4 were summed to determine the raw risk assessment value, which will range between 6-36.

6. For each risk pathway, the corresponding assessment score was assigned (negligible to extreme). These scores are located in Table 3, Appendix 5.

7. For each risk pathway, the current control measure used to mitigate the risk was then described.

8. For each risk pathway's current control measure, rate its effectiveness using the following scale. The control effectiveness estimates the probability that the measure will control the threat effectively.

   Rating Control Effectiveness

100%	Excellent
80%	Good
50%	Satisfactory
< 50%	Inadequate

9. For each risk pathway, the raw risk value was multiplied by one, minus control effectiveness rating (e.g. 1 - 80% = 0.2) to determine the residual risk.

10. For each risk pathway, the table from Appendix 6 was used to determine the appropriate risk response.

11. For each risk pathway that requires an additional control measure(s), the “control effectiveness” of the combined control measures was re-rated to determine the risk score following steps 8-9.

12. For each score a justification, based on scientific evidence, was provided. The evidence should be referenced where possible.

13. To ensure consistency in risk evaluation, the raw risk scores were included from the Tasmania DPIPWE (Anon, 2010) risk assessment (Table 5, Appendix 6).

Each expert panel member independently scored all of the above elements. After which, a facilitated discussion was held until a convergence of risk scores was reached. The Fisheries Research Development Corporation's Aquatic Animal Health Sub Program technical panel reviewed this final risk assessment. By way of context, prior to embarking on risk assessment process the investigator held a two-day, independently facilitated workshop. At the workshop stakeholders determined all the risk pathways for entire abalone industry (recreational, commercial fishing, aquaculture and research & compliance); and collectively assessed the risk of commercial fishing and aquaculture.

Whilst there is a range of hazards that have been identified by Jones & Stephens (2006)

- *Perkinsus* sp
- *Vibrio* spp
- Flavobacteria
- Non-specific fungal infections;
- Mudworm infections;
- Gill cillates;
- Cestode metacercariae
- Parasitic flukes
- Shell fouling organisms;
- Parasites/viruses/rickettsia-like organisms of unknown significance

the risk assessment focussed on an AVG case study, given the pathogenicity of its causative agent, and therefore the ability to highlight any systemic deficiencies in the management of abalone biosecurity.

Scope

To assess the disease risk posed by translocation of juveniles from any abalone hatchery to the open system for stock enhancement or reseeding purposes.

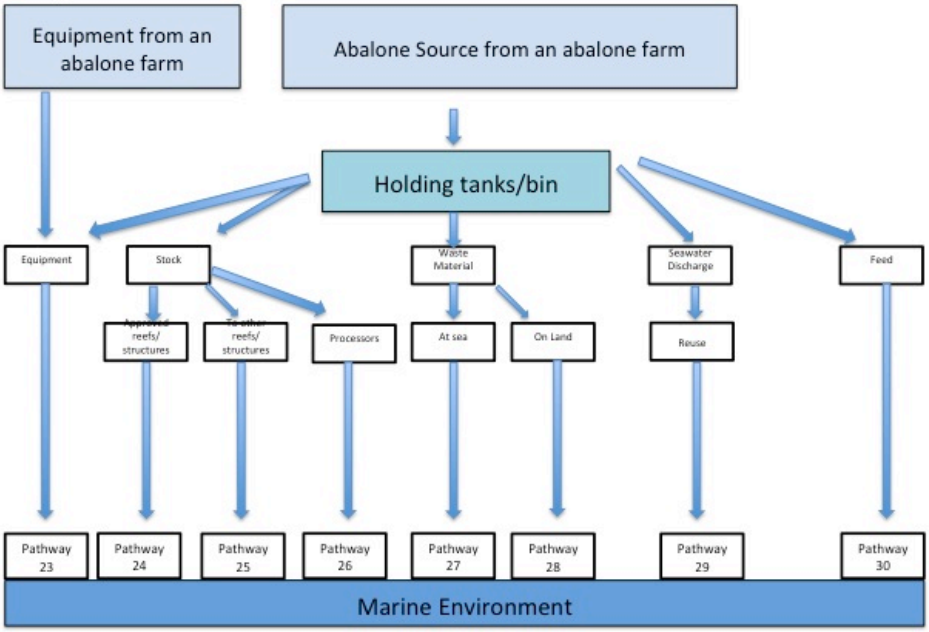
Appropriate level of Protection

The level of protection is conservatively set at very low or below, while not based on a zero risk approach.

Risk Pathways

The following risk pathways were identified for abalone stock enhancement only

Pathways 23-30: Stock Enhancement



Results and Discussion

The panel identified from the raw risk assessment that a majority of the risk pathways (17 of the 20) required control measures to ensure that risks are mitigated (Refer to Appendix 7: for the Risk Assessment table). The high-risk pathways identified were the (a) Movement of live animals to stock enhancement sites and (b) Inappropriate disposal of shells and waste material (viscera) into the marine environment.

Table 6: Raw Risk Score

		Negligible Impact	Very Low Impact	Low Impact	Moderate Impact	High Impact	Extreme Impact
	Rating (score)	**1**	**2**	**3**	**4**	**5**	**6**
High Likelihood	**6**					Row 2,	
Moderate Likelihood	**5**				Row 5	Row 6,	
Low Likelihood	**4**				Row 7	Row 8,10,11,12,14, 18	Row 3
Very Low Likelihood	**3**				Row 19	Row 1,4,13,15, 16	
Extremely Low Likelihood	**2**						Row 9, 20
Negligible Likelihood	**1**						

The panel identified that current control measures used by the Department of Fisheries, effectively mitigated of the majority of the risk pathways (15 of the 20). It mitigated 6 of 9 of the stock enhancement; and 9 of 11 of the miscellaneous pathways, respectively. Additional control measures were suggested for the following risk pathways to ensure that these risks were further mitigated.

High Risk Score

- Inappropriate disposal of shells and waste material (viscera) into the marine environment (Row 6).

Moderate Risk Score

- Unintentional transfer of live animals from farm/stock enhancement site to the marine environment via feral or escaped stock (Row 3)
- Discharge of contaminated seawater infected by abalone from holding tanks (Row 8);
- Movement of the virus from an infected area to an uninfected area/reefs by human activity not mentioned in other threat pathways (Row 10);
- Movement of the virus from infected area to an uninfected area/reefs by other animals (carriers, vectors, predators, scavengers etc.) (Row 11)

- Movement of equipment and personnel by commercial fishers from infected stocks/areas within WA to uninfected stocks/areas (Row 12)
- Movement of the virus through natural movement of abalone or via water currents (Row 14)

Low Risk Score

- Inappropriate disposal of diseased/dead abalone, shells and waste material such as viscera on land (Row 7)
- Movement of live animals to stock enhancement sites (Row 2);
- Movement of equipment and personnel by commercial fishers from infected stocks/areas outside of WA to uninfected stocks/areas within WA (Row 13)
- Illegal abalone fishing activities (Row 15)

The panel did not assess the following pathways. Each of these dot points refers to rather complex arguments, well beyond the scope of this project:

1. Potential for abalone hybrids to create new disease eg via spontaneous generation of new viruses (Row 17);
2. Potential for selective breeding programs to facilitate transmission of diseases (Row 18); and
3. High stocking rate impacts on incubation times for clinical disease (Row 19)

This was because:
(1) the scientific evidence indicates that this is highly unlikely (Jones, pers comm);
(2) the risk is managed as part of the abalone farming risk management; and
(3) is considered under the general assumptions (Appendix 4), respectively.

Table 7: Current Controls Risk Score

		Negligible Impact	Very Low Impact	Low Impact	Moderate Impact	High Impact	Extreme Impact
	Rating (score)	1	2	3	4	5	6
High Likelihood	6						
Moderate Likelihood	5					Row 6	
Low Likelihood	4				Row 7	Row 8,10,11,12,14	Row 3
Very Low Likelihood	3				Row 5	Row 2,13,15	
Extremely Low Likelihood	2				Row 1	Row 4,16, 20	Row 9
Negligible Likelihood	1						

The following additional control measures to reduce the risks associated are presented in Table 8. These all require actions by the State authority.

Table 8: The proposed additional control measures for risk pathways that had high, moderate and low risk scores, based on existing control measures.

Risk Pathway	Current Controls	Additional Proposed Controls	Row No. Reference (Appendix 7)
High Risk Scores			
Inappropriate disposal of shells and waste material (viscera) into the marine environment	Shells have to be landed but viscera is still disposed of at sea	• Shucking at sea must be in an area with the same health status as the point of harvest. • Establish regulations, licence conditions, breaches and penalties under FRMA eg. Bio Security Plan, peer reviewed & independently audited	Row 6
Moderate Risk Scores			
Unintentional transfer of live animals from farm/stock enhancement site to the marine environment via feral or escaped stock	No Controls	Policy that all artificial structures to provide a sand barrier between it and reef.	Row 3
Discharge of contaminated seawater infected by abalone from holding tanks	No Controls	Establish protocols for preventing water being discharged into zones of different health status in the marine environment as a condition of licence	Row 8
Movement of the virus from an infected area to an uninfected area/reefs by human activity not mentioned in other threat pathways	No Controls	• Ongoing awareness program. MOU with commercial & recreational fishers to control activities movement in the event of a disease. • Time and movement restriction implemented under an animal emergency response. • Powers to impose quarantine area in the event of a disease outbreak and penalties for deliberate infection.	Row 10
Movement of the virus from infected area to an uninfected area/reefs by other animals (carriers, vectors, predators, scavengers etc.)	No Controls	Uncontrolled - no realistic management or controls are available to mitigate the risk	Row 11
Movement of equipment and personnel by commercial fishers (other than abalone) from infected stocks/areas within WA to uninfected stocks/areas.	No Controls	• Ongoing awareness program. MOU with commercial & recreational fishers to control activities movement in the event of a disease. • Time and movement restriction implemented under an animal emergency response. • Powers to impose quarantine area in the event of a disease outbreak and penalties for deliberate infection.	Row 12
Movement of the virus through natural movement of abalone or via water currents	No Controls	Uncontrolled - no realistic management or controls are available to mitigate the risk.	Row 14
Low Risk Scores			
Inappropriate disposal of mortalities, shells and waste material such as viscera on land	No Controls	Use municipal land fill sites ensure waste is immediately covered	Row 7
Movement of live animals to stock enhancement sites	Stock enhancement using hatchery seed stock covered under Biosecurity Management Plan and translocation approval. Mandatory reporting of disease	• Establish regulations, breaches and penalties under FRMA eg. mandatory reporting of disease, Biosecurity Plan, peer reviewed & independently audited . • Improved compliance, especially at key risk periods. • Establish active and passive surveillance programs to determine the relative health status of abalone populations. • Set up biosecurity areas, based on equivalent health status of stock • Time and movement restriction implemented under an animal emergency response. • Powers to impose quarantine area in the event of a disease outbreak and penalties for deliberate infection. • Practice emergency response procedures. • MOU with commercial & recreational fishers to control activities movement in the event of a disease. • Complete policy to clarify Departmental position on restocking & stock enhancement, covering sea ranching, including distance between farms and fisheries stock. • Analysis of risk behaviour and development of education awareness program. • Training of aquaculture and fishers on clinical diseases of abalone.	Row 2
Movement of equipment and personnel by commercial fishers (other than Abalone) from infected stocks/areas outside of WA to uninfected stocks/areas within WA	No Controls	Ongoing awareness program. Provision of a wash-down facility at Eucla for trailered vessels. No controls on movement of vessels from South Australia.	Row 13
Illegal abalone fishing activities	Department has surveillance and enforcement on illegal abalone fishing.	Uncontrolled - no realistic management or controls are available to mitigate the risk.	Row 15

The panel found that the additional control measures effectively mitigated 8 out of 9 of the stock enhancement risk pathways and 6 out of 11 of the miscellaneous pathways to below a “Very Low Risk Score” (Table 9).

Table 9: Additional Controls Risk Score

		Negligible Impact	Very Low Impact	Low Impact	Moderate Impact	High Impact	Extreme Impact
	Rating (score)	1	2	3	4	5	6
High Likelihood	6						
Moderate Likelihood	5						
Low Likelihood	4					Row 11,14	
Very Low Likelihood	3					Row 2,10,15,16	
Extremely Low Likelihood	2				Row 3,4,6, 8	Row 12,13	
Negligible Likelihood	1			Row 7	Row 5	Row 1,9,20	

The key theme of panel discussions related to confidence in the control measures to provide the desired level of protection. These themes fell into to overarching categories (1) Basic Biosecurity Conditions and (2) The nature of the quality management system. They reflect the Aquatic Animal Code (2011) and Cameron (2004) advice on the principles for the design and conduct surveys to show the presence or absence of infectious disease in aquatic animals.

<u>Basic Biosecurity Conditions</u>

- Need to be in place for two years prior to beginning operations;
- Integrated industry biosecurity management for the entire abalone industry;
- Allow the movement of stock between areas of equivalent health status; or to areas of lower health status;
- Aquaculture farms would benefit from establishing compartment freedom (see: http://www.oie.int/) from notifiable diseases;
- The authorities should establish the health status of wild stock to enable defining and zoning of areas and/or setting of biosecurity management areas.

<u>Quality Management System (QMS)</u>

- Should be based on ISO 9001;
- Setting of biosecurity planning and plan standards for fishing, farming and stock enhancement,
- The setting of biosecurity audit guidelines, independent certification and compliance;
- Incorporation of regulation and penalties for biosecurity matters for processors, fishers and farmers, including legal powers to control all activities, in case of an emergency disease incident;
- Need for compulsory disease reporting in all sectors;
- Build capacity in industry emergency response preparedness; disease recognition; and
- Annual audit and review of effectiveness of the biosecurity QMS.

In addition, to the above the panel discussed mechanisms to provide further incentives for rapid emergency response. The panel suggested that the state authority investigate either an emergency aquatic animal health response agreement to formally put into place cost sharing and compensation arrangements with the commonwealth government and industry; and/or an insurance program that would enable recovery following any natural disaster;

The panel agreed that it is essential that the state authority underpin the above biosecurity arrangements with health monitoring and surveillance programs, across industry (Handlinger, 2006). This is to reduce the risk of disease, establish zones and to meet future market expectations and translocations requirements.

6. Benefits and adoption

The major benefit was the increased knowledge of the risk assessment process and the need for an integrated management of the sectors, which includes an integrated biosecurity quality management system. This has utilised knowledge developed from FRDC funded projects on abalone health and translocation since 1998.

The advice from this project will inform state authorities on:

- The range of risk control measures that would enable the stocking of open systems with aquatic animals of higher than or equal health status to that of aquatic animals already living in the considered areas; and

- The level of integration needed to provide, continuously, basic biosecurity conditions.

So it can sustainably improve productivity of the combined abalone industry.

It is important that state authorities ensure the ALOP is consistently applied within and between sectors, and other traded commodities and the trade related activities, in order that it meet its national and international biosecurity and trade agreements obligations.

7. Further Development

The major areas for future development are:

(A) the establishment of an integrated continuing, targeted health surveillance program for the wild capture and aquaculture industry. This especially important for the establishment of both zones and early warning systems for disease incursion and new diseases. The programme protocols should include routine health monitoring for establishing an official status as free from specific disease and be effective in limiting the impact of disease.

(B) It is incumbent that government and industry to ensure that all sectors continuously maintain their biosecurity arrangements to meet the ALOP.

(C) Need to standardise biosecurity planning across jurisdictions; these need to be approved by Australia's competent authority and

(D) Need to standardise the risk assessment score matrix, likelihood and consequence thresholds (Appendix 5: Table 1 & 2).

8. Outputs and Outcomes

The major output was a rigorous risk assessment, featuring an evaluation of the raw and residual risk of abalone stock enhancement.

The outcome is that this will greatly assist in understanding whether the health status of abalone industries can reasonably be protected, during any commercial scale abalone stock enhancement.

This outcome was achieved, with the participation of the majority of WA industry and a number of interstate observers in the first two days of the risk assessment process. It highlighted the need for any stock enhancement project to be part of an integrated, whole of industry, targeted surveillance and biosecurity program to establish and maintain the health status of Western Australia's abalone herd(s).

Both commercial fishery and aquaculture industries discovered the need to understand the risks; the control measures associated with biosecurity to ensure the long-term productivity, sustainability and value of fisheries resources are adequately protected. Outcomes have social and community implications through adjunct protection of the recreational fishery for abalone, and natural biodiversity.

This outcome was achieved, with the participation of the majority of industry in the first two days of the risk assessment process. It highlighted (1) the need for state authority to provide a biosecurity quality management system that provides, continuously, basic biosecurity conditions, which will enable WA to maintain the health status of its abalone herd(s); and (2) commercial fishery sector should improve its biosecurity risk managements to ensure it consistently meet its own and the state's standards of biosecurity to provide the ALOP.

9. Conclusion

This risk assessment achieved all the major objectives, including increasing the awareness and knowledge of risk assessment and mitigation processes and joint responsibilities for basic biosecurity.

Additional work is needed to implement these responsibilities, as it requires the integration of industry management; biosecurity conditions and certification; regulation and compliance; emergency response preparedness; and on-going health surveillance. These measures, when combined with an annual review of the effectiveness of biosecurity measures, will provide optimal biosecurity management arrangements for all abalone fishing, farming or stock enhancement activities, and ensure future market access.

10. References

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Appendix 1: Intellectual Property

It has been identified that no new intellectual property was developed from the workshop.

Appendix 2: List of Forum Participants

Name	Organisation	Interests in which states?
Abalone Aquaculture		
Dan Machin	Aquaculture Council of Western Australia	
Shane McLinden		TAS/WA/SA/VIC
Craig Kestel		WA
Ranching/Stock Enhancement/Re-seeding		
Brad Adams		WA
Neil Baile		
Brian Sell		
Commercial Fishing		
Kym Penalurick		
Ian Taylor	Abalone Industry Association of WA	
Kerry Rowe		WA
John Isle		WA
John South		WA
Brian Sell		WA
Arnold Piccoli		WA
John Brindle		WA
Kim Walshe		WA
Jay Shoesmith		WA
Jenny Rickerby		WA
Harry Peeters		WA
Steve Beres		WA
George Beres		WA
Peter Rickerby		WA
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Brian Jones		
Anthony Hart		
Fran Stephens		
Kerry Rowe		
Dan Machin		

Appendix 3: Glossary

Appropriate level of Protection (or Acceptable Level of Risk): The level of protection deemed appropriate by the member [state] establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. (SPS Agreement, Annex A, Definition 5, words in [] are ours).

Open systems: Systems where there is no control of either host movement or water flow e.g. wild caught fisheries.

Semi-open systems: Systems where there is control of host movement but no control of water flow e.g. net pen culture.

Semi-closed systems: Systems where there is control of host movement and some control of water flow e.g. pond culture, race culture.

Closed systems: Systems where there is good control of both host movement and water flow e.g. aquaria.

Biodiversity: Biological diversity or biodiversity refers to the variety of life forms: the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecosystem diversity (Anon. 1993).

Environment: Environment is made up of physical, biological, chemical and social components (HB 203:2004).

Pathogenicity: The quality or state of being pathogenic, the potential ability to produce disease (Shapiro-Ilan et al. 2005).

Risk: The chance of something happening that will have an impact on objectives. It is measured in terms of a combination of the consequences of an event and their likelihood (AS/NZS 4360: 2004). Note that the “objectives” are those of the community, not the proponent.

Risk Analysis: A systematic process to understand the nature of and to deduce the level of risk (Australian Standard AS/NZS 4360: 2004).

Risk Assessment: The overall process of risk identification, risk analysis and risk evaluation. It is an iterative process, as set out in the Australian Standard AS/NZS 4360: 2004.

Risk Evaluation: The process of comparing the level of risk against risk criteria (Australian Standard AS/NZS 4360: 2004)

Risk Identification: The process of determining what, where, when, why and how something could happen (Australian Standard AS/NZS 4360: 2004).

Risk Management: The culture structures and processes that are directed towards realising potential opportunities whilst managing adverse effects (Australian Standard AS/NZS 4360: 2004).

Translocation:
(1) The movement of live aquatic material (including all stages of the organisms life cycle and any derived viable genetic material): -beyond its accepted distribution; to areas which contain genetically distinct populations; or to areas with superior parasite or disease status (Anon. 1999).

Alternatively:
(2) The movement of living organisms from one area with free release in another. (International Union for the Conservation of Nature and Natural Resources (IUCN 1987). The IUCN distinguish three different classes of translocation:

- Introduction of an organism: is the intentional or accidental dispersal by human agency of a living organism outside its historically known native range;

- Reintroduction of an organism: is the intentional movement of an organism into part of its native range from which it has disappeared or become extirpated in historic times as a result of human activities or natural catastrophe;

- Restocking: is the movement of numbers of plants or animals of a species with the intention of building up the number of individuals of that species in that habitat (ICUN 1995).

Appendix 4: General Assumptions (adapted from Anon. 2010)

During the development of this risk assessment a number of important assumptions were made regarding pathogen distribution, reporting time frames and disease epidemiology. A description of general assumptions is outlined within this section.

Distribution of pathogen
It was assumed that abalone stock within west Australian waters may become infected with AVG-1 (Vic) at some time but the exact location and timing of introduction is not known. Therefore, it is assumed that there is potential for infected abalone to be inadvertently moved around the state with normal fishing and farming practices before clinical disease is detected. This risk assessment does not restrict itself to spread of disease within West Australian waters, but also takes into account potential for introduction from interstate, in particular Victoria. It is also assumed that the extent of infection within Victorian waters has been confirmed and all interstate imports or movements could potentially come from infected sources.

As such, West Australian waters are considered potentially infected.

Assignment of likelihood ratings
Potential for an infective dose of AVG to be established or distributed around WA waters is used as the basis for assigning a likelihood rating. This rating takes into account factors such as dilution of the pathogen in discharge waters, potential to survive off the host, potential for shedding and proximity to susceptible populations.

Likelihood also uses a specific type of activity undertaken by a group over time rather than a single event.

This rating takes into account:

- Potential for an infective dose [1] of the Victorian AVG to be established or distributed around WA waters.
- Potential for an infective dose [2] of the Tasmanian AVG to be established or distributed around WA waters.
- Dilution of the pathogen in discharge waters,
- Potential of the pathogen to survive off the host,
- Potential for shedding of the pathogen, and
- Proximity to of pathogen to susceptible populations.

Likelihood also uses a specific type of activity undertaken by a group over time rather than a single event.

Assignment of consequence ratings
The period between infection of a population and detection of clinical disease through routine surveillance and reporting systems can directly affect the overall consequence of an event (i.e. longer period would allow greater dissemination of the pathogen throughout WA In order to address this issue an infection to detection period of one month has been applied.
This assumes that infection could be present within WA waters for up to one month before disease was detected by normal surveillance activities and consequence is gauged against how far disease could spread during this period.

Although consequence uses geographic distribution over a one-month period as the primary basis for assigning ratings, natural environment and potential for establishment were also taken into account.

The infection to detection period applies only to consequence ratings and has not been applied to likelihood ratings.

This rating takes into account:

- The period between infection of a population and detection of clinical disease (i.e. a longer surveillance period would allow greater dissemination of the pathogen throughout West Australia In order to address

this issue an infection to detection period [3] of one month has been applied.

- The geographic distribution of abalone over a one-month period. Are closely aligned to current fishing zones, but also take into account geographic barriers, fishing patterns and landing ports.

- The natural environment, and
- Potential for establishment were also taken into account.

Potential Control Measures
Mitigation activities include any measures that may be put in place to inactivate or limit exposure to the pathogen.

- Where there is variation between particular facilities or activities due to their geographic location or infrastructure, a realistic worst-case scenario is used for as part of the assessment process.

- Where specific geographic conditions present a realistic natural barrier to limit spread of the disease, these were taken into account. Such geographic barriers could include a significant distance between abalone habitats e.g. 5nm.

Individual ratings for interstate movements
Similar activities that involve contact with interstate waters will vary in risk to those undertaken solely within WA waters.

Ability to detect pathogen
For the detection of the AVG virus, it is assumed that the PCR can detect virus when present at high levels as found in abalone with clinical disease or likely to develop clinical disease.
The PCR test has low sensitivity and is unlikely to detect low-level infections

Assessment of risks associated with virus amplification
Whereas the risks associated with disease entering processing or holding facilities and abalone farms can be considered using the assumptions previously outlined, the risks associated with the amplification of virus within stock held for periods of time within abalone farms or holding facilities has not been. The potential for amplification of AVG virus within facilities holding stock under intensive conditions has been identified as an important risk factor and therefore requires further discussion.
Amplification (increase in concentration) of virus within facilities holding abalone stock for extended periods of time has been demonstrated by the 2005 Victorian outbreak as a realistic risk of disease spread. It allows low levels of virus to build up within stock held in the facility (e.g. abalone farms or holding facilities) and be excreted at much higher levels in discharge waters. This results in the increased likelihood of abalone populations in close proximity to the facility outflow being exposed to an infective dose of AVG.

Within holding facilities, a large number of abalone from a range of areas are received but held within the facility for shorter periods of time. Here the likelihood of infected abalone entering the facility is much higher, but due the fact that abalone are held for shorter periods of time, the ability for the virus to amplify is in the abalone decreased. There is still potential for the disease to amplify within holding facilities, especially where a water circulation system is operational. Holding facilities may also have potential to discharge significant quantities of virus into the adjacent environment, dependent on the quantity of infected abalone.

Table below compares the relative risks of processors, holding facilities and farms. The table assumes that diseased stock will enter the facility at some time; there is no control of water outflow and the outflow discharges into viable abalone environment. An infection to detection period of 1 month has been applied.

Comparison of abalone farm and processor discharge taking into account potential for viral amplification (adapted from Anon, 2010)

	Likelihood of disease stock entering the facility	**Duration of abalone within the facility/ ability for virus to amplify**	**Expected discharge of virus from facility if diseased stock are present**	**Likelihood of disease being established in surrounding environment**	**Consequences of disease spread**
Processing facilities (Closed system)	High (High frequency of stock movement from a wide range of areas)	Short duration/ Low amplification	**Low** (Most processing facilities plumb into sewerage treatment systems)	**Low**	**Low to High** (Dependent on distance between fishing areas and processing facility; and significance of the fishing areas)
Holding facilities Category A [1] or B (closed system)	High (Due to high frequency of stock movement from a range of areas)	Medium duration/ moderate amplification	**Low** (Category A and B processing facilities plumb into treatment systems)	**Low**	**Low to High** (Dependent on distance between fishing areas and processing facility; and significance of the fishing areas)
Holding facilities Category C (Semi-closed system)	High (Due to high frequency of stock movement from a range of areas	Medium duration/ moderate amplification	**Moderate - high** (Initially discharge would be low but could build up to very high levels over time. This does not take into account discharge dilution.	**Low to High** (Depends on the frequency of diseased abalone passing though the facility and the dilution of virus in discharge water)	**Low to High** (Dependent on distance between fishing areas and processing facility; and significance of the fishing areas)
Aquaculture farms **Category A or B** Semi-closed system)	Very Low (Due to low frequency of stock movement from limited areas)	Long duration/ high amplification	**Low- Moderate - high** (Initially discharge would be low but could build up to very high levels over time. This does not take into account discharge dilution.	**Low to High** (Detection time of clinical disease at the facility, and the dilution of virus in discharge water, and level of connectivity with local reefs)	**Low to High** (Dependent on distance between fishing areas and processing facility; and significance of the fishing areas)
Aquaculture farms **Category C** (Semi-open system)	Very Low (Low frequency of stock movement from limited areas)	Long duration/ high amplification	**Low- Moderate - high** (Discharge uncontrolled. This does not take into account discharge dilution)	**Low to High** (Detection time of clinical disease at the facility, and the dilution of virus in discharge water, and level of connectivity with local reefs)	**Low to High** (Dependent on distance between fishing areas and processing facility; and significance of the fishing areas)
Stock Enhancement **Category C** (Open system)	Very Low (Low frequency of stock movement from farms with disease and pest free certification)	Long duration/ low amplification, due low stocking density.	**Low** (Discharge uncontrolled)	**Low** (Detection time of clinical disease at the site, and the dilution of virus in discharge water, and level of connectivity with local reefs)	**Low to High** (Dependent on distance between fishing areas; and significance of the fishing areas)

Appendix 5: Table 1 and 2 - descriptions definitions of likelihood and consequence, and Table 3: Risk Scores**.**

Table 1

Likelihood	Description Definition
Negligible (1)	Chances of event occurring so small as to be considered practically nil (0.1%)
Extremely low (2)	Event occurring only under exceptional circumstances (0.9-0.1%)
Very low (3)	Event possible but would be unlikely to occur (1-19%)
Low (4)	Event that may occur at some time but will be infrequent (20-45%)
Moderate (5)	Event likely to occur periodically (50:50%)
High (6)	Event would be expected to occur frequently. (>55%)

Table 2

Consequences	Description Definition Industry	People	Social	Environment
Negligible impact (1)	No perceivable consequences for either wild or farmed stocks. **No Financial Impact.**	No first aid required	No community complaint. No job losses	No perceivable consequences to the environment
Very low impact (2)	Minor impact, affecting only an individual tank or consignment of abalone. **Financial Impact of >$0.1 million and <$0.25 million**.	First Aid	Local public compliant. No jobs losses.	No lasting effect. Rectified by immediate corrective action
Low impact (3)	Localised disease outbreak restricted to a single farm, single processor or a single well defined area of water. **Financial Impact of >$0.25 million and <$0.5 million**.	Medical Treatment cases	Local Community complaint- written and phone. Visit by legislative body. Casual staff layoffs.	Minor incident, no significant impact. Monitoring result not in compliance,
Moderate impact (4)	Disease outbreak affecting multiple sites but restricted to a local area. Affecting several adjacent reefs, farms, holding facilities or processors within a small area. **Financial Impact of >$0.5 million and <$1 million.**	Irreversible disability/lost time injury	On-going social issues. Local public and media compliant, causing headline in local paper. Compliant lodged with legislative body, time and assets allocated to assist with investigation. Staff Layoffs.	Environmental incident requires clean up, large loss of stock.
High impact (5)	Regional consequences, disease outbreak spread across a single region within the state. **Financial Impact of >$1 million and <$2 million**.	Permanent total Disabilities/single fatality	Ongoing serious social issues. Public/media outcry causing headlines in major paper. Court Action and fine. Staff layoffs are >5% but <10% local employment market.	Significant damage requiring long-term restoration work. Impact to surrounding environment and restricted public access.
Extreme impact (6)	State-wide or interstate consequences, outbreak of disease. **Financial of greater >$2 million of GVP. Loss of international Market Access**	Multiple fatalities or irreversible effects to multiple persons	Ministerial Censure/loss of credibility. Class action and/or significant prosecution and fines. Staff layoffs are >10% local employment market. Closing of enterprise(s).	Very serious environmental impacts - irreversible pollution and widespread ecosystem damage.

Table 3: Risk Scores

		Consequence of establishment and spread					
		Negligible Impact	**Very Low Impact**	**Low Impact**	**Moderate Impact**	**High Impact**	**Extreme Impact**
Likelihood of establishment and spread	**High Likelihood**	Negligible Risk (6)	Very Low Risk (12)	Low Risk (18)	Moderate Risk (24)	High Risk (30)	Extreme Risk (36)
	Moderate Likelihood	Negligible Risk (5)	Very Low Risk (10)	Low Risk (15)	Moderate Risk (20)	High Risk (25)	High Risk (30)
	Low Likelihood	Negligible Risk (4)	Negligible Risk (8)	Very Low Risk (12)	Low Risk (16)	Moderate Risk (20)	Moderate Risk (24)
	Very Low Likelihood	Negligible Risk (3)	Negligible Risk (6)	Negligible Risk (9)	Very Low Risk (12)	Low Risk (15)	Low Risk (18)
	Extremely Low Likelihood	Negligible Risk (2)	Negligible Risk (4)	Negligible Risk (6)	Negligible Risk (8)	Very Low Risk (10)	Very Low Risk (12)
	Negligible Likelihood	Negligible Risk (1)	Negligible Risk (2)	Negligible Risk (3)	Negligible Risk (4)	Negligible Risk (5)	Negligible Risk (6)

Appendix 6: Risk Response Table

Table 4. Risk response table Qualitative Risk	Description	Appropriate response
Negligible	Acceptable	No response
Very Low	Acceptable – no specific control measures needed	No specific action needed to achieve acceptable performance
Low	Specific management needed to maintain acceptable performance	Review current arrangements
Moderate	Not desirable – continue strong management action. Further or new risk control measures may need to be introduced in the near future	Probable adaptation to current management needed
High	Detrimental – review management action. Further or new risk control measures need to be introduced	Urgent reassessment of the current management strategies and implementation of stronger controls or restrictions on the activity.
Extreme	Unacceptable – major changes required to management approach in near future	Substantial additional management controls needed or activity ceased.

Appendix 7: Risk Assessment Scores

RISKS ASSOCIATED WITH ABALONE RESEEDING/STOCK ENHANCEMENT OR RANCHING

Row Number	Category	Pathway	Risk Description	Expert Panel's Average Likelihood	Expert Panel's Average Consequence	Uncontrolled (Raw) Risk	Raw Risk Score	Tasmanian Unmitigated Risk Rating	Current Controls	Control Effectiveness (1= zero effectiveness; 0=100% effectiveness)	Controlled (Residual) Risk	Controlled (Residual) Risk Score	Risk Response	Proposed Additional Control Measures	(D) Av. Revised Control Effectiveness	Revised Controlled (Residual) Risk Score	Revised Controlled (Residual) Risk	Risk Response	Notes/Justification
				A	B	C	D	E	F	G	H	I			J	L			
						Columns A*B					Columns C*G					Columns C*J			
1	SE	23	Movement of equipment and personnel to other stock enhancement sites facilities.	3.1	4.6	14.3	LOW	Not assessed	Stock enhancement using hatchery seed stock covered under Biosecurity Management Plan.	0.5	7.8	NEGLIGIBLE	No response	Establish regulations, breaches and penalties under FRMA e.g. mandatory reporting of disease, Bio Security Plan, peer reviewed & independently audited. Improved compliance, especially at key risk periods. Set up biosecurity areas, based on equivalent health status of stock.	0.4	5.0	NEGLIGIBLE	No response	Consequence: it is assumed that impact is taken over ten a year time frame, within a part of the fishery were the catch is significant. This assumption has been used in all pathways below. Likelihood: Assuming 10 years of losses, AVG-1 (VIC) and high connectivity between reef systems. Populations with high levels of unidirectional water movement suffered lower mortalities. Evidence in Victoria is that disease was worst where the water was trapped and re-circulated, due to reef physiology (Gorfine pers comm). Also, the AVG stability is lower in higher temperatures (Corbeil 2011).
2	SE	24	Movement of live animals to stock enhancement sites	5.5	5.4	29.7	HIGH	Not assessed	Stock enhancement using hatchery seed stock covered under Biosecurity Management Plan and translocation approval. Mandatory reporting of disease.	0.5	15.1	LOW	Review Current Arrangements	Establish regulations, breaches and penalties under FRMA eg. Mandatory reporting of disease, Bio Security Plan, peer reviewed & independently audited. Improved compliance, especially at key risk periods. Establish active and passive surveillance determine the relative health status of abalone populations. Time and movement restriction implemented under an animal emergency response. Powers to impose quarantine area in the event of a disease outbreak and penalties for deliberate infection. Practice emergency response procedures. MOU with commercial & recreational fishers to control activities movement in the event of a disease. Complete policy to clarify Departmental position on restocking & stock enhancement, covering sea ranching, including distance between farms and fisheries stock. Analysis of risk behaviour and development of education awareness program. Set up biosecurity areas, based on equivalent health status of stock. Training of aquaculture and fisheries on clinical diseases of abalone.	0.4	12.8	LOW	No specific action needed to achieve acceptable performance	This risk appears equivalent to Commercial Fishing threat pathway No. 2. Control effectiveness, based on stock/reef connectivity, is a function of distance between related activities; for example, 1km vs. 10km will have different control effectiveness scores. It was noted that distance is very site specific, and that WA abalone stocks are an order on magnitude less intensity compared to VIC and TAS, i.e. less amplification risk i.e. low titre (concentration), if not detected This matter needs to be referred to the technical panel for advice. It was tabled that Dr Brian Jones will undertake a literature survey of the evidence on distance between farms and related activities. This may require a case-by-case assessment. Refer to Cameron (2004) Principles for the Design and Conduct of Surveys to show Presence or Absence of Infectious Disease in Aquatic Animals. The consequence is very site specific. The drivers of the likelihood are stocking density (host susceptibility); connectivity of reefs; frequency transfers; and use of broodstock and juveniles of unknown health status, and pre-conditioning of stock. Amplification of pathogen is low once density is lower. This score takes into consideration CSIRO regarding temp stability of the virus, and that WA has relatively high seawater temperatures (due to the Leeuwin Current) and sparse abalone populations. The strong recommendation is that, in the event of an outbreak the Minister should have the power to quarantine an area within a 10Km radius of the outbreak with no movement of any watercraft within the quarantine area without specific permission of the Department.
3	SE	24/25	Unintentional transfer of live animals from farm/stock enhancement site to the marine environment via feral or escaped stock	4.3	5.2	22.2	MODERATE	Not assessed	No controls	1	22.2	MODERATE	Probable adaptation to current management needed	Same risk pathway as commercial fishing pathway No. 2. Policy that all artificial structures to provide a sand barrier between it and reef.	0.4	8.0	NEGLIGIBLE	No response	All stock is from wild abalone parents so cannot be by definition be significantly genetically different to local abalone i.e. cannot be feral. Abalone do not cross sand barriers. See Misc. pathway No. 5 for risks related to water movement.
4	SE	25	Movement of live animals to other stock enhancement sites.	3.7	4.8	18.0	LOW	Not assessed	Stock enhancement using hatchery seed stock covered under Biosecurity Management Plan and translocation approval.	0.6	10.4	VERY LOW	No specific action needed to achieve acceptable performance	Same risk pathway as commercial fishing pathway No. 2. Establish regulations, breaches and penalties under FRMA eg. Bio Security Plan, peer reviewed & independently audited. Stock of must be in the same health status or from biosecurity status area.	0.4	6.8	NEGLIGIBLE	No response	Likelihood: Transfer of disease agent to other reefs is very low, due to lower stocking density i.e. equivalent to wild. On this basis, there is lower disease amplification and high dilution i.e. low titre (concentration), if not detected; plus an infrequency of movement of stock. Need data on frequency. May be higher risk upon immediate transfer, due to the stress of transport at higher density. May need to use quarantine areas prior to release, extra observation, however, weak animals will quickly be eaten. Control Effectiveness: need to understand the specificity of PCR test, as these are critical in the power of the surveillance program. Are there any technical limitations on the PCR that the panel should be aware of?
5	SE	26	Movements of live animals from stock enhancement sites into processing facilities.	5.2	4.0	20.8	MODERATE	Not assessed	Requires a translocation approval.	0.6	11.6	VERY LOW	No specific action needed to achieve acceptable performance	Establish regulations, breaches and penalties under FRMA eg. Facilities should be closed or effluent treated to prevent disease transmission of animals of unknown or different health status. Processing facilities and aquaculture farms or operations should be spatially separated.	0.1	2.6	NEGLIGIBLE	No response	Given the significantly higher amplification risk of live holding.
6	SE	27	Inappropriate disposal of shells and waste material (viscera) into the marine environment	4.9	5.2	25.3	HIGH	Not assessed	Shells have to be landed but viscera is still disposed of at sea.	1	25.3	HIGH	Urgent reassessment of the current management strategies and implementation of stronger controls or restrictions on the activity.	Same controls as commercial fishing pathway No. 1.4 Shucking at sea must be in the same locality (health status) as the point of harvest. Establish regulations, licence conditions, breaches and penalties under FRMA eg. Bio Security Plan, peer reviewed & independently audited	0.3	7.6	NEGLIGIBLE	No response	
7	SE	28	Inappropriate disposal of mortalities, shells and waste material such as viscera on land.	3.9	3.6	13.9	LOW	Not assessed	No controls	1	13.9	LOW	Review Current Arrangements	Use municipal landfill sites ensure waste is immediately covered.	0.2	2.8	NEGLIGIBLE	No response	
8	SE	29	Discharge of contaminated seawater infected by abalone from holding tanks	4.4	5.0	22.0	MODERATE	Moderate	No controls	1	22.0	MODERATE	Probable adaptation to current management needed	Similar to commercial fishing pathway No. 1. Establish protocols for preventing water being discharged into zones of different health status in the marine environment as a condition of licence.	0.4	8.0	NEGLIGIBLE	No response	
9	SE	30	Potential for domestic feed to transmit disease to farmed abalone.	2.2	5.4	11.9	VERY LOW	Very Low-Low Risk	No controls	1	11.9	VERY LOW	No specific action needed to achieve acceptable performance	Enhanced abalone are not fed pellets as a condition of licence.	0.1	1.2	NEGLIGIBLE	No response	The method of pellet extrusion results in high temperatures that result in the sterilisation of the feed.

Row Number	Category	Pathway	Risk Description	Expert Panel's Average Likelihood	Expert Panel's Average Consequence	Uncontrolled (Raw) Risk	Raw Risk Score	Tasmanian Unmitigated Risk Rating	Current Controls	Control Effectiveness (1= zero effectiveness; 0=100% effectiveness)	Controlled (Residual) Risk	Controlled (Residual) Risk Score	Risk Response	Proposed Additional Control Measures	(D) Av. Revised Control Effectiveness	Revised Controlled (Residual) Risk Score	Revised Controlled (Residual) Risk	Risk Response	Notes/Justification
RISKS ASSOCIATED WITH MISCELLANEOUS ACTIVITIES																			
10	Misc.	Other	Movement of the virus from an infected area to an uninfected area/reefs by human activity not mentioned in other threat pathways	3.8	5.0	19.0	MODERATE	Very low	No controls	1	19.0	MODERATE	Probable adaptation to current management needed	Ongoing awareness program. Time and movement restriction implemented under an animal emergency response. Powers to impose quarantine area in the event of a disease outbreak and penalties for deliberate infection.	0.7	13.3	LOW	Review Current Arrangements	
11	Misc.	Other	Movement of the virus from infected area to an uninfected area/reefs by other animals (carriers, vectors, predators, scavengers etc.)	3.7	5.0	18.4	MODERATE	Very low	No controls	1	18.4	MODERATE	Probable adaptation to current management needed	Uncontrolled - no realistic management or controls are available to mitigate the risk.	1.0	18.4	MODERATE	Probable adaptation to current management needed	Note sand barrier to movement from farm site to adjacent reefs
12	Misc.	Other	Movement of equipment and personnel by commercial fishers (other than abalone) from infected stocks/areas within WA to uninfected stocks/areas.	4.4	5.2	22.9	MODERATE	Not assessed	No controls	1	22.9	MODERATE	Probable adaptation to current management needed	Ongoing awareness program. MOU with commercial & recreational fishers to control activities movement in the event of a disease. Time and movement restriction implemented under an animal emergency response. Powers to impose quarantine area in the event of a disease outbreak and penalties for deliberate infection.	0.4	9.7	VERY LOW	No response	
13	Misc.	Other	Movement of equipment and personnel by commercial fishers (other than Abalone) from infected stocks/areas outside of WA to uninfected stocks/areas within WA	2.7	5.2	13.9	LOW	Not assessed	No controls	1	13.9	LOW	Review Current Arrangements	Ongoing awareness program. Provision of a wash-down facility at Eucla for trailered vessels. No controls on movement of vessels form SA.	0.8	11.1	VERY LOW	No specific action needed to achieve acceptable performance	
14	Misc.	Other	Movement of the virus through natural movement of abalone or via water currents	4.2	4.6	19.5	MODERATE	Very low	No controls	1	19.5	MODERATE	Probable adaptation to current management needed	Uncontrolled - no realistic management or controls are available to mitigate the risk.	1.0	19.5	MODERATE	No response	This risk is equivalent to Commercial Fishing threat pathway No. 2. Control effectiveness factor is a function of distance for example, 1km vs. 10km. Noting that this is very site specific, and that Western Australia's abalone stocks are an order on magnitude less in density compared to VIC and TAS, i.e. amplification risk, and therefore low titre (concentration), if not detected. This matter needs to be referred to the technical panel. It was tabled that Dr Brian Jones will undertake a literature survey of the evidence. This may require a case-by-case assessment, rather than one size fits all. Refer to Cameron, A (2004) *Principles for the Design and Conduct of Surveys to show Presence or Absence of Infectious Disease in Aquatic Animals*. The consequence is very site specific. The drivers of the likelihood are stocking density (host susceptibility); connectivity of reefs; frequency transfers; and use of broodstock and juveniles of unknown health status; Pre-conditioning of stock mitigates the risk. Amplification of pathogen is low once density is lower.; This score did take into consideration CSIRO regarding temperature stability of the virus (Corbeil *et al* 2012), and that WA has relatively high seawater temperatures (due to the Leeuwin Current) and sparse abalone populations. The strong recommendation is that, in the event of an outbreak the Minister should have the power to quarantine an area within a 10Km radius of the outbreak with no movement of any watercraft within the quarantine area without specific permission of the Department. Prevailing currents affects the transport of disease - no consistency between inshore and offshore drifts.
15	Misc.	Other	Illegal abalone fishing activities	3.4	5.2	17.6	LOW	Moderate	See "Notes & justification"	0.7	12.3	LOW	Review Current Arrangements	Uncontrolled - no realistic management or controls are available to mitigate the risk.	0.9	14.9	LOW	Review Current Arrangements	Department has surveillance and enforcement on illegal abalone fishing.
16	Misc.	Other	Movement of ballast water in maritime vessels	2.4	5.4	13.2	LOW	Very low	Protocols in place for ballast water exchange for international shipping	0.8	10.2	VERY LOW	No specific action needed to achieve acceptable performance		0.8	10.2	LOW	No response	This assumes that abalone are not present within ships ballast and ballast water.
17	SE	Other	Potential for abalone hybrids to create new disease. (KR)	0.9	2.2	2.1	NOT ASSESSED	Not assessed	Biologically highly unlikely. Never been recorded.	Not assessed	Not assessed	NOT ASSESSED	No response	The virological evidence does not support this.	Not assessed	Not assessed	NOT ASSESSED	No response	The virological evidence does not support this.
18	SE	Other	Potential for selective breeding programs to transmit diseases. (KR)	4.5	5.2	23.6	MODERATE	Not Assessed	See "Notes & justification"	Not Assessed	Not Assessed	NOT ASSESSED	Not Assessed	Domesticated stock may not be used for enhancement to be a condition of licence	0.3	7.1	NEGLIGIBLE	No response	This relates to the movement of stock and quarantine. These risk are managed under the abalone farming pathways.
19	Misc.	Other	High stocking rates impacts on incubation times for clinical disease (KR)	3.0	3.8	11.4	VERY LOW	Not assessed		0.2	2.0	NEGLIGIBLE	No response	See general assumptions (Appendix 4)	0.3	2.9	NEGLIGIBLE	No response	See general assumptions. Enhanced stock is not artificially fed the stock densities are unlikely to be higher than in the wild i.e. less amplification risk i.e. low titre (concentration), if not detected. This relates to likelihood of infection. Incubation time for AVG is 72 hours.
20	Misc.	Other	Potential for imported feed to transmit disease to farmed abalone	2.4	4.9	11.9	VERY LOW	Very low	AQIS import risk assessment of feeds & baits,	0.8	9.5	VERY LOW	No response	Pellets not used in enhancement - see above	0.2	2.1	NEGLIGIBLE	No response	The method of pellet extrusion results in high temperatures that result in the sterilisation of the fed. Assumes abalone product is not used in the feed. Meat meal component is heat-treated. Assumes feed is manufactures away from infected regions.

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