

REPORT TO WESTERN ABALONE DIVERS ASSOCIATION OF
VICTORIA ON THE GANGLIONEURITIS OUTBREAK

Report From Judith Handler

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January, 2007

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1. EXECUTIVE SUMMARY

- The facts surrounding this outbreak and the response have been summarised and reviewed. Although the source of this outbreak and the current distribution of this viral disease is unknown, it is clear that a previously unknown disease of increasing international concern has become established in Western Victoria, displaying a pattern of disease spread indicative of a naïve population in this area. It appears highly likely that this has occurred due to poor biosecurity with regard to broodstock translocations and on-farm, though there are a number of possible alternatives with regard to source and route of introduction. Each of these possibilities has implications with regard to likely future spread or actions, highlighting the need for efforts to establishing the nature of the source (even if not the specific location). Nevertheless, regardless of the source of the infection, biosecurity and the opportunities and practicalities limiting the disease response are key issues leading to this outcome and need to be addressed.
- This outbreak unfortunately provides insights into areas of risk and possible improvements in biosecurity of Australian aquaculture and Fisheries generally. There is a national need to put in place opportunities to capture and consolidate knowledge regarding Australia's disease preparedness with regard to aquatic animal, and to respond to identified critical failure points such as the lack of a compensation mechanism for such disease responses.
- Improving biosecurity has been identified as an issue for all sectors, and is relevant to all States. Biosecurity regarding the selective breeding program must be reviewed. Apart from identification of specific risks (and possibly regulation regarding these), there is a need to markedly increase biosecurity awareness across both industries and to change the culture to embrace biosecurity. Achieving this is dependent on ensuring a framework and resources for disease surveillance; clarity of regulatory requirements such as having translocation policies in place for abalone; ongoing education components; and ways to capture and share knowledge regarding this and other abalone diseases. Biosecurity review for farms should, if a compensation mechanisms for disease responses is to be progressed, include consideration of measures that would improve the practicality and likelihood of success of disease control measure (official or farm generated), such as compartmentalisation of larger farms with regard to basic biosecurity. This step may be essential to ensure that stock destruction with compensation is a practical and likely response to a future disease outbreak. This would appear to be true for all aquaculture industries. This may be the single most effective step in improving Australia's ability to respond to similar incidents in the future.
- There is a recognised need for a national approach to consider the national and international implications to trade and quarantine issues, including issues of zoning for this disease. This is necessary to limit the further spread of the virus, optimise Australia's abalone market access, ensure consistency of quarantine and biosecurity policy, and protect Australia's reputation as a leader in animal biosecurity matters.
- Specific measures have been listed where possible that may assist in these processes. A list of the research needed (prepared in conjunction with the whole Expert Team) is also included. This includes continued international collaboration to establish the relationship of this virus to abalone viral diseases reported in Asia.

2. INTRODUCTION

I thank WADA for the opportunity to review and report on circumstances surrounding this viral disease outbreak and subsequent actions, and to be part of the recent review processes. This report is in addition to advice given in person and fed into responses such as the prioritisation of research and the Victorian risk analysis process. The delay in completion of this report has allowed this to be written after review of the reports prepared by Paul Hardy-Smith (P H-S), Anna Mouton (AM), and Carolyn Freidman (CF), and with knowledge of some information that has emerged subsequent to those reports, particularly with regard to the continued spread of the virus outbreak in the Western district of Victoria. I agree in general with the facts and the majority of the assessments of these reports, and have not therefore repeated these points. I have indicated below points where my opinion differs from these authors (in part reflecting the updated information), and where I see further issues that should be reconsidered for future planning.

The aim of this report is to maximise our understanding of the outbreak to date, and of the constraints on the response and disease control generally, as a guide to future actions. Areas of possible further action that will improve safeguards in the future, beyond those already in train have been highlighted where possible. Although this is primarily a report on the Western Victorian situation (farmed and wild), this outbreak has relevance to all sectors of the Australian abalone industry, and to a lesser extent to other aquaculture and wild fisheries sectors, and is therefore presented within a national perspective where relevant.

In order to provide a structured approach to the report and hopefully to assist Stakeholders, I have attempted firstly to tabulate and summarise the known facts regarding the virus disease and relevant disease control options. To ensure all the current gaps in knowledge and procedures are considered, I have included a table separating the facts, assumptions, and working hypothesis that were formulated to determine the initial response, and an analysis of gaps affecting the outbreak. The latter has already fed into the prioritisation of research and the Victorian risk analysis process. These are based on the best information available at the time, but I make no claim that any of these are necessarily complete, and recognise they may need updating as more information becomes available.

The latter part of the report considers actions required to correct critical failure points. It includes an attempted SWOT analysis relating to the whole of the abalone industry (and to some extent all aquaculture). I have also included general recommendations with regard to the international context of this viral disease that were prepared with Mike Hine during the WADA virus review workshops.

Many of the actions recommended have already been recognised are now under way in Victoria (and possibly other States), but are listed here to assist the process of review across all relevant sectors.

PART A – SUMMARISING THE FACTS

3. GENERAL SITUATION SUMMARY

- A previously unknown viral disease resulting in high levels of abalone mortality has been seen in Western Victoria, initially in farmed stock and then in wild stocks near an affected farm. Knowledge of the outbreak to that time is recorded in the by epidemiology report by Paul Hardy-Smith^{1,2}
- Further discussion on some of these points is now available from reports by A. Mouton³ and C. Freidman³, following the Victorian information tours and workshops.
- Some later information on initial spread in the wild is recorded in the Victorian Fisheries presentations to the joint WADA / Fisheries Victoria Workshop.
- Since that Workshop, further spread of the virus in the wild has been reported.
- There has been no reported infection in sentinel stock on de-stocked farms, which are aiming to re-stock as soon as practical.
- The initiatives by WADA and Fisheries Victoria have identified a number of failure points and risk situations, and an analysis of the relative risks is under way (*Victorian Risk Analysis Workshop report*⁵).
- The need to review and revise biosecurity measures on abalone farms (particularly the affected farms), has been recognised both at the policy level and by the farms. Current activities towards this objective include:
 - Review at the policy level includes completion of a draft Victorian Abalone Aquaculture Translocation Protocol that has been under development for some time. There is requirement that translocation for restocking would follow this protocol. [I understand this will also involve a formal farm risk assessment process – a Forster, pers com.]
 - A formal health surveillance program for all Victorian farms is under development. (Also true for other States, to varying levels, with conformity between these being considered. However progress has generally been slow.)
 - Farms have been alerted to the need to address both physical improvements (recognising the constraints of altering existing farms), and current practice, to improve biosecurity. This includes advice given during the information tour, written advice from C. Freidman, and (I understand) farm veterinary advice.
 - I am uncertain as to what extent this advice has been taken up, the extent of physical restraints on doing so, or the time-frame for completion, and am not therefore in a position to comment on progress with this process. Evidence of increased formal and written Standard Operating Procedures that address biosecurity was visible during the farm visits, and appears to be on-going. I am also aware of longer-term movements for the whole of Australia's abalone aquaculture to develop a formal EMS framework that includes biosecurity issues. However as physical improvements in particular may take some time to reach optimum standards, the area of farm biosecurity needs to be seen as a work-in-progress with an extended time-frame. As some types of improvements may only be possible to fully implement with re-development or further development of farms, it is important to keep this issue in the forefront of farm planning procedures.

- Issues of farm level biosecurity emerging from this outbreak have relevance to farms in all States.
- The Risk Analysis process under way in Victoria included a review of risks associated with practices of both the farmed and wild harvest sector. I am unaware of the extent of implementation of recommendations to reduce the risks associated with the wild sector, but consider it likely that this will also be an ongoing process, with a similar need to ensure a process for continued bio-vigilance including staff training with personnel turnover.
- This outbreak unfortunately provides insights into areas of risk and possible improvements in biosecurity of Australian aquaculture and Fisheries generally. There is a national need to put in place opportunities to capture and consolidate this emerging knowledge, and to respond to identified critical failure points such as the lack of a compensation mechanism for such disease responses.

4. ANALYSIS OF KNOWLEDGE REGARDING THIS OUTBREAK

Responses to disease outbreaks are almost always necessary to undertake without adequate information, and are therefore judgement based. This is based on a combination of working assumptions about the disease and its epidemiology, evaluation of possible consequences, and practicality and likelihood of an action achieving its objective. The most desirable actions are often not practical, or the window in which they might have worked has passed before action can be undertaken. This time-factor further increased the need to rely on best-fit assumptions.

Alternatively, a heroic response may be judged necessary if the potential consequences of even an unlikely scenario are judged to be severe and **action to prevent this is still possible**. Working assumptions regarding the disease and epidemiology are inevitable during the initial response period. However as these may contain errors, separation of these from known facts is an essential component of ensuring the best **long-term** response. Some may require further research until the facts can be confirmed. The following list is an attempt to separate working assumptions from known facts, and to provide an indication of the likelihood or significance of truth to ensure that relevant follow-up research is identified, and future decisions based on the best information. (It is in the nature of working assumptions that this list will need modification over time.)

Table 1: Separation of facts, working assumptions and critical unknowns with regard to the virus outbreak.

(Note: likelihood estimates are crude estimates only).

Status of knowledge	Fact	Working Assumptions	Possibility	False	Likelihood the assumption is correct	Critical unknowns	Comments / Significance
Disease occurrence & source							
High mortality has occurred in farmed & wild animals	X						
This disease has not previously been present in this area		X			High		Intense discussions during WADA expert tour sponsored + photos, strongly support the view of no previous occurrence with this presentation in this area & any such outbreaks would have been detected. <ul style="list-style-type: none"> Not seen in previously or in Disease Survey but was a 1 sampling snap shop with low numbers from any one area. AM considers previous presence in this area is a possibility (see comment below)
If the disease was present in this area previously it would have been detected.					Moderate / high		a) See above. b) The high level of mortality suggest naive population c) If carriers are a component, a level of previous exposure could be disparate (leaving both naive and carrier animals)
The disease was first detected on farms	X						
In this area, the disease first occurred on farms		X			High		<ul style="list-style-type: none"> The first observations were on farms, but limited data from nearby areas in the period preceding this. AM raised the possibility that farms could have been infected from local wild stock.
Infected abalone on the farm were the source of infection for wild stock in Western Victoria		X			High		<ul style="list-style-type: none"> (Related to above)
This disease has been brought into the farms area with broodstock for farm selection program		X			High	Status of source populations	<ul style="list-style-type: none"> Although there is considerable circumstantial evidence for this, alternate sources are possible, e.g potential for contamination of waters near farm from processing waste not excluded. If so, the broodstock may have been infected pre-movement, or in transit. Imported feed has also been considered & discarded.

At least one of the broodstock popns was infected	X			High.	Status of source pops.	<ul style="list-style-type: none"> Infection in transit has not been excluded, at processing plant used for rehydration, as processing plant had imported gastropod material on hand. No pre-movement testing of source pops. Limited follow-up testing of some source pops. (No test for pre-clinical infection)
<p>If present at the broodstock source, the disease would have been picked up:</p> <ul style="list-style-type: none"> at the source prior to the commencement of movement. 			X?	Did this occur? ? only afterwards		<ul style="list-style-type: none"> Suspicion of the SA movements as the source of the outbreak rests not just on the timing but on detection of mortalities in this region, the cause of which has not been satisfactorily resolved. As far as I am aware, these mortalities were only detected in January, though they could have commenced earlier.
If disease had been known at a source, current procedures would have prevented movement from this area			X?	V. Low / demonstrated false?		<ul style="list-style-type: none"> Movement protocols were either not in place or not followed. This removed official means of checking status of source. As far as I am aware, the researcher detecting the SA mortalities at Pt McDonald did not have a formal disease reporting / investigation protocol to follow and no timely investigation was initiated. (Academic regarding SA as these mortalities were not observed until January 2007)
If present in broodstock source populations, the disease would have been picked up at the time of transport				V. Low / demonstrated false?	Cause of mortalities seen post-transport, and in SA	<ul style="list-style-type: none"> No pre-movement testing. Sick abalone often difficult to detect due to inactivity, & introduced broods may have shown stress anyway Not all mortalities seen by farms were investigated. Signs of this disease can be non-specific Very limited data or follow up from SA Macdonald Range area A chronically infected source population may have included carriers & / or be partly adapted to the virus, which would have been more difficult to detect on farm.
If a Translocation Policy was in place, following national recommendations, translocation from an infected source would not have occurred.	X			Low*		<ul style="list-style-type: none"> Translocation policy varies between States and is determined by the States, although there is a national Ministerial policy that outlines Principals and Guidelines. An industry driven attempt to achieve a uniform translocation policy for abalone¹⁰ failed to reach agreement and would have failed to protect the industry had there been agreement on the identified risks as only known risks were considered.

<p>If the origin is not exotic (e.g. via processing plants, gastropods on hulls etc), the disease should be considered endemic in Australian abalone</p>		X?		<p>Low [Problem atic – too broad</p>	<p>Distribu tion in Australi a</p>	<ul style="list-style-type: none"> Behaviour in this area is that of a new disease in a naive popn. Similar native popns expected to exist in other areas: Australia is too large to consider as one zone for assessing impacts. Need to separate regulatory impacts and true biological ones.
<p>The virus is endemic in at least some areas of Australia</p>		X		High		<p>Either true, or the virus is of recent exotic origin. (Yet to be established)</p> <ul style="list-style-type: none">
<p>If entering this area through broodstock infected at source, the virus is endemic in at least some areas of Australia (apart from the area of the current outbreak),</p>					<p>Cause of the SA mortalities.</p>	<ul style="list-style-type: none"> This assumption is based on the lack of large abalone mortalities reports in other areas The other possibility is that entry to the area from which infected broodstock were sourced has been quite recent. Low levels of monitoring and fishing effort could result in mortalities being less obvious than in Western Victoria Recommend follow-up & monitor SA areas where wild mortalities were reported as available information suggests limited follow-up monitoring of this area.
<p>Stock from these areas are likely to be relatively adapted..</p>		X		High?	<p>Are the two viruses the same?</p>	<ul style="list-style-type: none"> Informal information that diversion of live product to farms has occurred in China, and may have occurred in Taiwan (or virus spread from China?). Given the large amount and diversity of shellfish imports to that region, this may be true for both Australian abalone or an alternate common source.
<p>Alternative theories as to source The disease is exotic, via processing plants</p>		X		Mod Low?	<p>Tests on remnant held imported product or similar. (Need</p>	<ul style="list-style-type: none"> Cannot be excluded, and consequences would be high if found to be true. Remnant product is unlikely to be available, but should be held for PCR tests if it is. If not (more likely), similar product should be tested by PCR when available, but a negative test would be inconclusive. Potential routes to the marine environment from other

							PCR)	processing plants (other than via rehydration and farms) should not be totally discounted, although the opportunity to gain more information is unlikely.
The disease is exotic, via an unidentified source.			X				Low	<ul style="list-style-type: none"> The behaviour of the outbreaks suggest a naïve population. The source of many disease introductions is not established. Marine animals have been translocated with shipping etc.
The disease has recently crossed over from a related species.			X				a) mod low b) v low	<ul style="list-style-type: none"> A) Includes the possibility (above) of infection from imported gastropod / mollusc product. In this instance a recent change to the virus is not implied (just exposure of another susceptible species) B) The likelihood of a recent viral change resulting in cross-over of the virus from another related species to abalone is diminished by the similarity (at least) to the viral disease in Taiwan which suggests these two diseases are either identical or share common ancestry.
Aetiology / cause								
This disease is caused by a herpes type virus	X							(Association, Experimental transmission.)
This virus is similar to the Taiwan virus	X							
This virus is the same as Taiwan virus		?					X	Need sequence comparison.
The Taiwan virus is same as "China Syndrome"							X	<ul style="list-style-type: none"> The OIE Ad Hoc Mollusc Group makes this assumption in the current recommendation to list "viral abalone mortality", based on the Chinese virus, with the expectation that the disease in Taiwan has spread from mainland China. In Mainland China 2 diverse conditions are described in 2 abalone species, which may or may not be due to the same virus. Both disease descriptions from China differ from those of Taiwan. There appears to be little current research in mainland China and therefore it is unlikely that these differences will be clarified.
This virus affects the nerves and ganglia	X							<ul style="list-style-type: none"> True for both the Australian and Taiwan virus diseases. Not described from mainland China.
This virus affects only the nerves and ganglia		X					Moderate	<ul style="list-style-type: none"> While disease is associated with degeneration in nerves and ganglia, mild lesions (which might be secondary or unrelated) have been found in other tissues. The range of cell types which may support the virus is unknown, but

<p>This virus affects all the abalone species to the same level</p>						<p>typically includes more than just nervous tissue for other herpes viruses.</p> <ul style="list-style-type: none"> Review of pathology slides by the Expert Panel pathologists confirmed lesions in the mouth epithelium of some abalone. Opinions differed as to the likelihood of some cells in these lesions showing virus-related nuclear changes (varying from moderate to high). Similarly, some degenerate cells were found in the interstitial tissue, but it was not possible to determine how many were simply degenerative changes secondary to the responses damage in nerves. It is possible that electron microscopy could resolve this issue, but <i>in situ</i> hybridisation tests are required for definitive investigation of cell types affected. (Both EM and <i>in situ</i> hybridisation needed together, if examining phagocytes, as these could contain virus particles / fragments from cell debris without necessarily supporting virus growth.) I note that ganglioneuritis has not been described from China, though the types of investigation undertaken (mostly electron microscopy, rarely pathology) suggests this could have been overlooked, and apparent spread to Taiwan has suggested the Chinese disease (or diseases), may be due to the same virus. If so, it is also possible that the tissue tropism varies between species, widening the definition of this viral disease and its potential expression.
<p>This virus affects only abalone (if</p>	<p>X?</p>	<p>High</p>				<ul style="list-style-type: none"> Both Victorian species are impacted, to a similar degree although there are some indication of minor differences between age groups and possible species. However these have not been confirmed: there may have been other possible modifiers (e.g density etc). So far information on these 2 commercial species and their hybrids. In the longer term may be useful to test other abalone species, as well as other molluscs. Note comments above raising the possibility of differences of expression in different abalone species Note wide recognition that adaptation to a herpes virus may include unapparent carriage or latency. <p>PCR (or similar) needed to test other gastropods for</p>
					<p>X</p>	

untrue, provides other means of introduction and / or spread)									infection / carrier status. (No observed mortality does not exclude infection.)
Source									
The virus was introduced to farms with broodstock	X							High	(See above for potential alternate routes)
Infected broodstock were introduced via Coastal Seafoods (with secondary infection of other farms through movements from CS)	X							v. high	<ul style="list-style-type: none"> Current evidence supports this view as the most likely scenario but is dependent on assumptions made regarding the likely timing of the first virus related deaths, and that the lack of infection at GSW reflects non-entry of the virus rather than good biosecurity and good luck. Should either of these assumptions be untrue, there is less certainty of entry point Includes possibility of either an endemic or exotic source
The source is likely to be From Pt Macdonald SA on Dec 2 From Carpenter Rocks SA (35 K from Pt MacD) Dec 10 Or Flinders + NW Tas, via rehydration facility Nov 23)	X								
These are the only broodstock shipments likely to have introduced the virus	X							Moderate?	<ul style="list-style-type: none"> Introduction with earlier broodstock shipments is possible if assumptions regarding GSW are incorrect. Uncertainty is increased as mortalities were not routinely investigated until recognised as high and unusual. Recommend that exclusion tests ultimately include all the broodstock sources unless data on health status is available.
Spread									
The virus is spread laterally from infected abalone	X*								But don't know if / how excreted from live animal. If excreted in mucus / from gut or urine etc, implies other cell types infected.
The virus is spread vertically?	X?							X	In the wild, true vertical transmission via gametes potentially more significant than pseudo-vertical transmission via ovarian / seminal fluids etc where a dilution & current effect could operate
The virus survives in water	X*								Duration unknown, especially when protected by mucus and tissue fragments etc.
Dilution ameliorates infection rate	X*								Dilution may be confounded by protective tissues / mucus. (dilution not achieved)
This virus can be carried by ingestion of dead abalone by fish or other mobile								?	(Transmission trials on digested ingesta)

species.										
The virus outbreak in the wild is diminishing	X		(X?)	Low	X					<ul style="list-style-type: none"> Diminished spread was given as a likely scenario at the Victorian meetings (joint WADA / DPI & Risk Analysis), but subsequent information suggests otherwise. Level of knowledge restricted by the constraints on monitoring wild sites.
The virus outbreak will eventually peter out?				V Low ?						<ul style="list-style-type: none"> No evidence to support this in the foreseeable future. Likelihood of latency and uneven fine-scale impact suggests will persist. (Opinion shared by CF report.)
The outbreak will continue to spread	X			High	X					Not quite the same as persistence of the virus as natural spread could be restricted by natural barriers (or not). See possible temp effects. As overseas experience suggests winter could be a greater risk period, need to ensure monitoring continues through all seasons.
Lack of evidence of further outbreaks over the next few months would be indicative that the disease is dying out	X			Low						
Susceptibility										
As wild abalone are considered the most likely source of virus, and healthy abalone have been seen near SOM discharge, wild abalone may have an inherent resistance to it		X		Low						Outbreaks to date suggest otherwise Source not actually established Disease in area in at least 1 suspected source area not well investigated (<i>or results have not been made available</i>)
Farm "stress" adds to magnitude of outbreaks on farms	X			Mod to high						Stress, age, and possibly non-stressful factors such as crowding or slow water flow may modify prevalence on farms compared to infected wild areas. Need to consider both.
There is concern that the effect may be greater at high temperatures.				Low?	X					Logic suggests "stress" to be a factor affecting severity of an outbreak. On farms (and possibly in the wild although animals are in their normal habitat), peak summer temperatures may constitute a stress. However experience with the mainland Chinese virus ⁶ , and the Taiwan ganglioneuritis outbreaks ⁷ , highest mortality and laboratory demonstrated susceptibility was highest at low temperatures. Temperature might influence susceptibility in either direction, or effects may reflect a combination of these two factors. Effects are most likely at extremes of temperature.
(It could be desirable to add to this table as more data becomes available.)										

5. GAP ANALYSIS:

(Events possibly leading to or accentuating the outbreak)

This analysis of gaps leading to or accentuating the recent outbreaks was initially prepared and discussed during the WADA technical workshops and subsequently fed into the Victorian Risk Analysis Workshop process.

5.1. FARMS

5.1.1. General Lack of biosecurity on farms

- Lack of understanding of biosecurity on farms
- Lack of established health surveillance program or routine monitoring
- Lack of a farm-vet relationship
- Lack of risk minimization on farms (disinfection, limiting movements, control of visitor footwear etc)
- Presence of uncontrolled abalone e.g. in settlement ponds, and lack of barriers to direct re-entry into the farm, and to different tanks.
- Lack of quarantine facilities (e.g. for wild stock)
- General lack of biosecurity separation of farm and shed sectors to limit spread of pathogens. (Lack of ability to isolate sectors of the farm or of a shed; general barriers to limit spread of potential pathogens. Farms are now considering these.)
- Lack of quarantine options regarding diseased stock.
- Outflows go direct onto floors etc, so easily contaminate boots.
- Location of harvest bins near stock
- Occasional presence of other marine species in tanks (from unspecified locations)

Recommendation 1: Review biosecurity & ensure in place before restocking [e. g. Lack of segmentation of farms to minimize spread increases the cost of remedial actions with disease. Not obvious prior to this outbreak.]

Recommendation 2: Suggest make this a formal process of review (with farm, veterinary, regulatory input)

[Note: I understand both these actions are now under way.]

5.1.2. Lack of biosecurity regarding wild stock brought onto farms for family line selection.

- Lack of knowledge of health status of stock brought onto the farm
- Lack of protocols or adherence (?) regarding movements of wild stock onto the farm
- Specifically, rehydration at uncontrolled (multi-species, multi-origin) facilities.
- Lack of quarantine facilities on some farms, in the face of unknown of health status.
- Even disregarding the lack of full quarantine facilities, spread once on farm was facilitated by incomplete primary separation from other stock. (Mingling with other broodstock (baskets in shared water), and incomplete separation of tanks for broodstock from production stock.

- Lack of standard operating procedures SOP (and / or full adherence to these), also facilitated spread once on farm
- Lack of protocol or options for health testing when wild (quarantined) stock disposed of once breeding completed.
 - Farms implied they were prevented from testing introduced wild broodstock when killed after use as were required to keep whole bodies, frozen, until collection and disposal by the Dept. Testing of broodstock and progeny post-use is an international recommendation (ICES) for quarantine protocol for introductions if health status of source is not available.
 - Recommend samples also collected from larvae / pst-larvae, as well as broodstock. [For this virus, collect – into ethanol and fixed 24 hours. Frozen samples at least -20°C or better -80°C better but frozen probably not required. Histopathology and / or samples for EM also in the initial post-viral stages. For EM recommend use glutaraldehyde 2.5% or Carson’s fluid to use for both histo & EM.]
 - Need for broodstock assessment post-use to be a practical procedures – work out for each farm.
- Gaps in research protocols.
 - Questions were asked regarding the extent of Risk Analysis in the Family Line program. (This is a normal FRDC project requirement: was it carried out for this project, and to what extent was this written or assessed with biosecurity in mind.)
 - The meeting noted claims that this program is at odds with previous guidelines about local sourcing of broodstock.
 - *This added to the general view of a lack of awareness of disease issues and services among researchers (who may be first on the scene, or involved in risk associated activities. JH)*

Recommendation: Review family lines program taking a risk analysis approach.

5.1.3. General issues regarding farms / placement/ license conditions / enforcement

- Placement of farms near productive wild fisheries
- Lack of effective barriers between (both intake and discharge)
- Shell dump from commercial processor
- Variable separation of intake and outlet locations.
- Questions were raised regarding the suitability of available site for mortality disposal on-site burial: sandy, readily draining soil was noted at the disposal site, which was adjacent to the farm and the wider marine environment. Need to consider whether this may provide a route for re-entry of virus to the sea. (Survival criteria for the virus may help determine this. Scavengers etc may also need to be considered.)
- General lack of clarity regarding movement protocols (within and between States/ Zones), how adherence to these can be verified (whether SOPs should be a license condition to ensure verification?). It is noted that an FRDC project is now under way to ensure this (MD)

5.2. GAPS REGARDING THE WILD FISHERY

5.2.1. Gaps re processing plants:

- Reports of discharge of viscera directly into the sea (now stopped – see P H-S report)

- Shell dump from commercial processor from multi-species, multi-origin operations at margins of sand-based site readily draining (along with farm outflow) into the sea. (This could result in similar contamination to direct discharge?)
- Multi-species – **multi-origin** processing, potentially exposing returning equipment.
- Reports of molluscs (including gastropods) of overseas origin being processed in the same facilities as local stock could also result in contamination of equipment returned to farms or wild harvesters.

5.2.2. Gaps regarding wild / harvesting operations.

- Lack of established disease investigation protocol.
- Lack of general biosecurity in wild industry. (RC).
- Lack of data collection / sampling for disease surveillance.
- Need for improved training / procedures across the whole wild sector to better involve them in becoming “the eyes and ears” for disease outbreaks (formal recognition as part of an “effective early warning system”).

5.3. GAPS IN REGARD TO THE RESPONSE

5.3.1. Lack of industry compensation mechanism

- Appears to have prevented early destruction of infected farm (eventually voluntary slaughter by farms)
- Note: current compensation mechanisms only for defined live stock disease (Live Stock Disease Control Act 1994 – Fisheries Victoria Management Report Series No 9, 2003)

5.3.2. Operational matters regarding the response

- An apparent failure to maintain good communication between the government and the wild fishery sector, especially those directly at risk and impacted by the disease.
- Perception of inadequate monitoring of at risk areas, and of the means to do so (e.g. what proportion of stock can be seen by snorkelling).
 - It was noted that this could in part be influenced by the communication issue as well as equipment / capacity issues.
 - Video cameras were suggested, where diving was not possible
 - Industry raised the issue of that there was no use of local divers, whose knowledge would allow them to locate more major abalone aggregations. It was noted (PA), that given the biosecurity issues and the need for independence of the divers, this was recognised as a situation where “*you are damned if you do and damned if you don’t*”.
- Lack of supervision of disposal operations? (Delays were reported, as well as concerns expressed regarding the ultimate disposal method.).
 - Is this a problem due to the voluntary nature of the kill-out – should there in general still be supervision built into this?

- Lack of familiarity of industry of the Aquaplan and State Response Plan process.
 - There was some confusion by Stakeholders as to the Action Plans used. While both State and National actions plans appear to have been utilised [eg State Response Plans and an initial Interstate and Federal (CCEAD) consultation], there appears to have been Stakeholder uncertainty regarding what plans could or should have been used. May need to consider if this is due to
 - lack of Stakeholder familiarisation and clarity regarding the relevant roles of each plan
 - or plans developed primarily with aquaculture focus, that did not adequately address a situation involving both wild and farmed stock?

5.3.3. What was right?

- **Response Plans were in place:** Aquaplan and Victorian. Noted that the Victorian plan, funded by FRDC was the plan specifically used (PA at WADA Technical Meeting)
- **The cooperation and forward thinking of WADA**
- **Cooperation of the farms.**

5.4. GAPS IN KNOWLEDGE OF THIS VIRUS / DISEASE

5.4.1. Source and current distribution – risks of further infections.

- Whether it is a localised endemic, erupting due to translocation; or widespread endemic that has reached critical dosage on the farm; or exotic in origin
- The source (if exotic or translocated).
- The current distribution (need PCR)
- The species range affected.
- What cell types are infected (mucus cells – are they infected and a source of virus?)
- How important is mucus and physical strands of decaying tissue in transmission
- How long does the virus survive in decaying abalone?
- Mechanisms of the disease – is the rapid time frame determined by rapid multiplication, or expression of some other response.

5.4.2. Similarity to the Taiwan virus.

- Summary of findings so far from separate investigations by Tristan Renault (France) and AAHL, using PCR primers developed for Pacific oyster herpes virus, indicate that so far no signals have been found from the Australian virus against these primers, but there has been some signal from the Taiwan virus. However the tests for the latter have used a wider range of sequences than carried out so far by AAHL.
- With the Taiwan virus, there was more success using the *in situ* test, with good signal in ganglia, but also some from other tissues. However this needs to be interpreted with caution until it can be determined whether the cells showing this signal contain a replicating virus infection, or have phagocytosed cell remnants containing the virus? This shows the need more specific genetic based tools. (The first step is to purify the virus, to enable these tools to be developed.

Meanwhile, results from the Taiwan virus suggest it may be useful to extend the range of oyster sequences used with local material.

- So far large % of Taiwan sequence does not have homology to known sequences. Need to purify the virus and analyse this (for both viruses). Could also try virus specific for herpes virus polymerase – but may not work as may be big differences between vertebrates and the few invertebrate ones so far studied.
- Re other Australian mollusc herpes viruses: *O. angasi*, the native flat oyster, has a herpes virus (Described from WA and occasionally from Tasmania, in haemocytes / interstitial cells of adult oysters. This is in contrast to the Pacific oyster virus, which is generally detected in larvae, which die at about 8 days of age). Sydney rock oysters have also shown massive larval losses, with some speculation that this may also be virus related (unconfirmed, but would be valuable to compare reactions with Tristans's primers to define the Australian mollusc herpes viruses generally). [A herpes virus has also been seen as a cause of mortality in *K. scalarina* clam larvae in Australia (J Handler⁸). This affects epithelial cells, and does not appear to cross react with the French virus *in situ* hybridisation test, suggesting this is not as closely related to the Pacific oyster virus found in Europe. Note that the EU oyster herpes may infect other clam species.]
- Expert Review Panel considered there was insufficient information to determine if the Australian viruses were the same or very similar, on current available data.
- The Panel did recognise the potential need to bring Taiwan's abalone virus into AAHL to further this work.

5.5. ANTICIPATED VICTORIAN RESPONSES TO GAP ANALYSIS

(As noted at the technical workshop of WADA and Victorian fisheries panels)

This section records (to the best of my ability as scribe) the responses indicated by Peter Appleford that are anticipated or now under way in Victoria to correct the above gaps, following discussion of the Gap Analysis (above) at the joint Technical. These should be taken into consideration in evaluating what **further** actions that may be required to correct these gaps, both within and outside of Victoria.

Victorian Fisheries:

- Recognised a need to establish a Response Plan for this disease, and the need for this disease to be managed on national basis.
- Recognised need to consider a compensation plan **that takes wild fisheries into account**.
- Acknowledged the communication / education problems, which are being addressed and were seen as more an understanding problem
- Noted that where Regional Fisheries Officers were being used, they were successfully getting samples to the laboratories.
- Noted that since this outbreak started, the laboratories are also getting samples (all types of disease) from processors.
- Commented on the Victorian initiative with FRDC for: Developing biosecurity processors for both wild and aquaculture sectors – and recreational (*Note it is suggested the industry related research community should be added to this -JH.*)
- Noted re the consideration of License conditions etc:

- The need to get industry ownership of this as regulation won't work. (Seen largely as an education issue).
- [Comments from the floor suggested there was also a role for someone independent to play both an education and audit role. I.e a QA system needed & needs to be owned.]
- Commented that the Director of Fisheries: Doesn't currently have ability to put conditions on licences with regard to the disease (*My notes are uncertain as to whether this was a general or specific comment.*)
- Recognised the need also to look at the issue of aquaculture conditions nationally.

The Director of Fisheries also commented on Steve Rodis presentation, which was presented to reference group as a basis of "*We think this is where industry should be.*" His comment was that there was not a great deal of divergence in thinking between government and industry on this issue.

6. POINTS OF DIFFERENCE

While in general accepting or agreeing with the summaries provided by the reports of Paul Hardy-Smith, Anna Mouton, or Carolyn Freidman, my interpretation of the facts does occasionally differ. Such differences in approach are expected and under lie the advantages and rationale of inviting multiple experts to review the outbreak. Rather than repeat those reviews (which largely I agree with) this section records significant differences of opinion or interpretation from those authors, or corrections on the basis of later information. The following points are raised with recognition that more information on this outbreak is now available than at the time those reports were written, and does not exclude the possibility that, at the time, I may have reached some of the same conclusions. These are similarly subject to possible changes based on later information.

6.1. Regarding the epidemiology report by Paul Hardy-Smith²:

a) Too much emphasis on the working hypothesis of the most likely timing or shipments for initial source?

While not disagreeing on the assessment of the *most likely* timing or shipments for initial source, I feel too much emphasis has been placed on these, to the exclusion of follow up on other possibilities. While In my opinion the evidence for this is not sufficiently strong for other possible shipments, or sources (such as overseas material in processing plants), to be ignored. The implications of other sources are significant. Therefore effort must include verifying the source of infection, or responding also to alternate scenarios. Uncertainties

b) Disagreement with the statement on P 6: "As the most likely source is wild abalone, wild abalone may have an inherent resistance to it".

Later information on the level of mortality in impacted micro-communities and continued spread, together with uncertainty and confounding factors regarding previously suspected age effects on farms, suggest this statement is untrue. Possibly this is reflection of the sweeping nature of the original statement.

- The wild abalone (of both species) in this area of Victoria show marked (but possibly not uniform) susceptibility to infection and disease at all ages so far studied. Once confounding factors such as density (and possibly stress etc) are taken into account, it remains to be established whether any age-effect on susceptibility is evident, but it appears likely that this is at best a matter of degree. **In this area at least the virus appears to be acting on a naïve population, which does not have resistance** (This applies to both farmed and wild).
- Australia has a very large coast line, and any virus relatively recently introduced will not be uniformly distributed. Any enhanced resistance through selection is likely to therefore be disparate across the Australian populations. It is also yet to be established whether this virus has been translocated with wild abalone from an area within Australia where it has been present for sufficient time for a selective pressure for resistance to this virus has been operating. The lack of previous reports or findings of a disease of this nature in Australia could reflect either:
 - A very recent introduction (either during the broodstock movement process or sufficiently recent into a wild site to allow no time for resistance, or for disease detection)
 - *Or* A reflection of poor wild industry disease surveillance.
 - The possibility of this is indicated by the reports of deaths in at least one South Australian broodstock source site. To date there is no information explaining these deaths.

6.2. Regarding A Mouton report³:

Firstly, I note that the aim of A Mouton's report was to advise on the disease investigation and response to the herpes virus outbreak, and did not therefore encompass biosecurity issues leading to the development of the outbreak.

a) Regarding her Statement that "the virus is most probably endemic in Australia" (p 1 and elsewhere)

This statement is understandable from an overseas perspective, but in my opinion is too simplistic to be useful to best protect Australian industry, as it ignores the large area Australia covers. The highly pathogenic nature in this outbreak suggests that this virus is a recent introduction to this area of Victoria, and that the impacted Victorian population in this area is naïve to this virus. It would appear highly likely, therefore, that if this virus originated in Australia or was introduced prior to this outbreak, that this event did not occur sufficiently long ago for the virus to become endemic in **all** areas of Australia. Australia is likely, therefore, to benefit from establishing a zoning policy and test program with regard to this disease, to minimise the overall impact, and the disease should be regarded as "exotic" from other areas until the current distribution of the virus is established.

- A reduced response to this virus due to a perception that the virus is endemic throughout Australia, and that abalone populations have survived despite this **would place all remaining naïve Australian populations at risk of infection.**
- A reduced response to define areas of Australia infected and free of this virus **may unnecessarily place in risk the markets for abalone from all areas** (ie – particularly with regard to live product).

Furthermore A, Mouton's statement suggesting this is "*probably endemic*" is not modified by her conclusion that the possible introduction from overseas via non-abalone product (into processing plants used for re-hydration of some brood-stock shipments), could not be excluded with currently available diagnostic tools.

- Note: even with improved diagnostic tools, this could be difficult to resolve unless there is positive findings in like material as I would expect the original material to no longer be available.
- Similarly, she recognised that an origin from other local gastropods would also be difficult to verify, as they would be subject to post-outbreak exposure. I agree with this statement, but consider that the finding of infection in another gastropod species would be considerable circumstantial evidence to support such an origin, warranting further investigation in areas outside Western Victoria. There would be a need, though, to establish that test results (eg detection by PCR) did reflect active infection and growth of the virus within these hosts, rather than just passive uptake of a virus signal from water or ingested tissue scraps.

Either of these two possibilities as a source of this outbreak would have implications for the risk level to other zones.

Perhaps of more concern is her statement (p8) that "*The official response to the disease outbreak appears to be based on the assumption that the responsible virus is endemic to **Australia** (bold marks mine)*" implying that distribution across the whole of Australia is accepted. In my opinion there is far too little information at this time to support such a position, and it seems to be inconsistent with Victoria's position (see section 4.5), that the need for a national approach and a Response Plan for this disease are needed.

b) Her assessment is consistent with her judgement that (at the time), "*Mortalities in the wild population have been relatively modest so far, with the exception of The Crags*". Like all such assessments, her recommendations need to be reviewed in light of subsequent information on the further spread of the virus. She acknowledges this fact (in a more general context for all of the assumptions), on page 2 of her report. Nevertheless, given the paucity of information, there appears to be undue weight given to this assessment in her overall judgement that this is an endemic Australian disease that (presumably) has impacted this area or previously (enough to influence the resistance level).

c) (Also on page 2) She has also indicated that "*it is tempting, but ultimately pointless, to speculate on outcomes resulting from decisions which were not taken*" (i.e possible due to lack of available information at the time, or lack of resources).

While her statement should generally be kept in mind, this **does** need to be reviewed in terms of ongoing response planning for responses to future outbreaks in this or other locations. Comprehensive unbiased debriefing is an important part of this process. The purpose of such an exercise should be not just to determine whether other action are likely to have been more successful, but whether there were restraints that prevented such actions being taken that can be avoided in the future.

d) P 3. The reservations above about considering Australia one “zone” with regard to disease needs to be kept in mind, in considering her statement that “*Whereas it is feasible to eradicate an exotic virus, or even one which has newly evolved to infect abalone, this will not be possible should the virus prove to be endemic.*”

The definition of *endemic* needs clarification here. In some disciplines *endemic* refers to a species / agent that has originated from and is found only in that area. In the disease control context it is used to refer to a species / agent that is established and would be expected to be maintained in an area (whether originating here or elsewhere).

Australia needs to differentiate between a disease that is widespread and endemic across Australia, from a disease that is either endemic in some but not all areas of Australia, or recently introduced to 1 or 2 areas. Unless we do so, other countries will consider the former situation to apply. (It is not possible to eradicate the disease from Western Victoria, so unless it should die out naturally it is considered now endemic to this area, regardless of its origin.)

Should this disease be found in another area of Australia with a history and presentation to suggest a translocation, the disease would need to be considered as a possible exotic **to that region** in determining an appropriate response (with hind-sight from the Western Victorian outbreak). In practice the level of containment is a major factor on the ability to eradicate a new pathogen from an area (or “zone”). The circumstances of the outbreak would determine both the practicality of a robust response, and judgement as to whether this could or could not prevent the disease becoming established in that area. Establishing the current distribution of the virus (and ideally the source for this outbreak), is critical to optimise such decisions. It is also necessary in the longer term to establish zoning for market access (e.g for live product).

e) I agree with her assessment (p 13), that if this proves to be the same virus as present in Taiwan (and possibly mainland China), it may well have come from Australia, due to the heavy one-way traffic of live abalone. However this does not **necessarily** follow. It is also true that if this had been introduced to Australia with (for example), frozen gastropod meat brought in for processing, these areas of Asia are very likely to have been exposed to the same source risk, due to the very wide range of product imported into those areas.

f) *Her arguments supporting a locally endemic origin appear unclear:*

Resistance of the wild population is put forward as an argument towards this, but is an assumption, not well supported by later information. The only discussion I can find regarding possible resistance is the consideration that wild population in some areas were exposed (via effluent from the farms) for several months without apparent disease being detected (p7). The reason for this delay may have nothing to do with resistance. Given the factors affecting the likelihood of infection being established in an exposed abalone (such as infectious dose and the dilution effect on this), there is a need to separate the likelihood of an initial wild infection from the question of resistance to the diseases once exposed to a large viral load from adjacent dying abalone. For example, the fact that effluent water from the farms would not be expected to contain dead abalone (or parts thereof) during most of this period could be a significant factor in the apparent disparity between the time to establish an initial wild infection and the speed of spread once established. **I note discussion while**

on this farm that pigging of the pipes (a routine twice-yearly event) may have occurred around the time affected wild animals were first noted near the intake. (Though there is some uncertainty as to the timing of the first wild infections due to low monitoring prior to this time.)

- It is stated that “*spread of virus to a new host species is, by definition, less likely than a virus infecting its primary host.*”, and yet at the same time the rapid spread on farm is said to support this theory. [In my opinion this neither supports nor refutes this theory.]

g) I have less difficulty in accepting *the spread patterns seen on farms* (top of p 5), in that these can be explained to some extent by differing levels of incomplete biosecurity between sectors of the farm, possibly coupled with retrograde migration of abalone from pipes draining multiple tanks which eventually would have included infected tanks. One would expect the hatchery to be one of the most biosecure areas of the farm, particularly with regard to water supply, and therefore affected late. The lack of mortalities in swimming larvae may have been influenced by the very short period to settlement compared to bivalve larvae, the lack of feeding during larval life, the cell types susceptible to this virus, and particularly to timing. (Most Australian abalone hatcheries hatch over a limited period, while in S Africa year round spawning has been practiced. Given that the genetics program broodstock were apparently timed to spawn after routine farm stock, it is likely that there were few if any larvae present during the major periods of virus spread on the farm - farms can verify whether this was the case.)

h) The statement in Section 7 (p6) that “*events appear to show that the virus may have been present in wild abalone, even causing some deaths, without drawing attention, for an unknown period prior to this outbreak*” is not supported with any presented evidence. This is contrary to the conclusion I drew after carefully questioning those in the wild catch sector during the WADA sponsored expert panel information visits, with regard to local Victorian stocks. A similar evaluation was given by members of the Tasmanian industry on the likelihood that this disease, if present in this form, would have gone undetected in the Tasmanian wild industry. This may be an oblique reference to the deaths occurring in SA prior to broodstock movements, underlying the need for further information or investigation of abalone health in this area.

i) on page 7 she question whether it is possible that the farms infected the wild stock, or vice versa “*Furthermore, it can be asked whether they have been affected in the past without attracting notice*”. I agree this is a legitimate question, but the responses from the wild fisheries sector, and from farms, when I asked this throughout the WADA information tour convinced me that this was very unlikely. Nevertheless the former is a well supported assumption, rather than confirmed fact.

j) P 13. A small point of clarification on her statement on p 8 that “*Although the first mortalities in farmed abalone are thought to have occurred in early December 2005, samples were not submitted for diagnosis until much later. In spite of this, ganglioneuritis was identified and the probable cause found to be a herpes like virus during January 2006.*” The first diagnosis was in fact made on samples submitted late December (so the delay in sampling time was less than implied). I agree with her statement that “*The speed with which this disease, previously unknown in Australia and elsewhere poorly described, was diagnosed is impressive*”. The time to reach a diagnosis was determined by the physical time to prepare and examine samples, time for interstate referral for a second opinion, a slight delay over the Xmas / New Year period, time to review on-farm data for

evidence of a new and infectious disease, time to prepare samples and examine by electron microscopy (time consuming), and review of literature which located the recently described similar Taiwanese herpes virus disease. (The earlier described Chinese virus disease may also be similar, but the described disease presentations were different and there was little information on pathology or virus nature.) Initial action was being taken on farm prior to the confirmation of the herpes-like virus, once the probable new and infectious nature of the disease was recognised. The only significant restraint on the initial diagnostic period would appear to be the lack of good farm data on their common diseases, and the lack of a culture of disease investigation.

k) p 8. Comments on the following (bold marks mine) that “It has been debated whether farms should have been encouraged to close when the diagnosis was first made. *“In the case of Coastal Seafarms, the presence of a herpes like virus was confirmed during January 2006. Abalone were dying on the farm at this time. Considering what was known about the disease then, an argument can be made that the farm should have depopulated immediately. **Abalone farms in general are not designed or managed in a way that permits the control of a highly infectious disease.** It is not probable that Coastal Seafarms would have been able to stop the disease from affecting the entire farm and subsequent events demonstrated this.*

In general I agree with these comments. The take-home message, though, is whether abalone farms can be better designed or managed. The management issues are being considered (within the existing resources). There is a case to take the issue of farm design to minimise disease spread as a serious issue for the whole industry. In considering the investment implications of such an approach farms should consider that no sector has probably been more affected by this outbreak than the directly impacted farms, and that the advantages provided would apply equally to locally propagating endemic diseases. Savings from the latter would off-set the cost.

Re the following comment: *“Immediate steps to harvest as many abalone as possible and destroy the remainder would have been the option of least risk.”* Arguments have also been made for destruction of all stock (without emergency harvest, to increase the speed of removal). The constraints on such an action need to be recognised:

- i) the cost
- ii) there would still have been the need to remove large quantities of decaying abalone, which may in itself have increased risks or this or other impacts.

And the further comment (p 9) that *(as there was at that time no mortalities on Southern Ocean Mariculture) “Therefore, there were no grounds on which to depopulate the farm”*

While such a point is always arguable, given the impact of the similar Taiwanese virus, there needs to be recognition that such events do develop slowly, the window for such action can be limited, and advantages are weighed against constraints. The constraints on such actions are always related to the magnitude of the necessary response – no factor would have been more likely to result in complete and rapid depopulation of the infected and exposed population than to have a smaller proportion of the farm in this category. (i.e. relates to the issue of farm design and management into smaller biosecure units) – TOO MANY EGGS IN ONE BASKET.

l) p 9. Regarding the section “*Mention was made of mortalities in wild abalone in the Port MacDonalld region of South Australia occurring in January 2006. It is telling that, although the existence of mortalities has apparently been confirmed, little has been done to establish the cause.*”
and

“*In addition, there does not appear to be any connection to abalone farming in this case.*” The latter statement I disagree with (or am not interpreting in the way she intended) as the information provided by P H-S indicates that there were wild-caught broodstock shipments from South Australia from quite close to this region.

Although reports of some minor investigations have been given verbally, I cannot find a written summary of what has been undertaken or planned to resolve the cause of those SA mortalities. If such reports exist, it would be an advantage to ensure they are more widely available. Unless there is solid information to the contrary, I consider that this area should be considered as a potential source of the virus for this outbreak until proved otherwise (although other sources should also be considered). As such, it should also be considered as a potential source of risk to other areas of Australian abalone, and the risk of movement of abalone or equipment from this area considered in this light. This status should remain until either there is sufficient evidence to the contrary, or an agreed Australia position that there is sufficient information to consider this a widely distributed, virtually ubiquitous, disease. Given the apparent naïve nature of the impacted farms and wild stock, and the failure to find any previous evidence of this disease in areas with a good history of abalone disease investigation, I do not believe that the current evidence supports such a position. Therefore any potential source of this outbreak should also be considered a risk for other areas.

Recommendation: That investigation of the SA Port Macdonald region be given a high priority, starting with a summary of information to date. Given the difficulties associated with disease surveillance in wild fisheries, and the paucity of current resources for this, the nature and extent of investigations appropriate to resolve issues of this nature should be considered as part of a national approach to this issue.

[Note: Given that the details surrounding this outbreak are public knowledge internationally, and that the above is regarded as “*telling*” it is likely that Australia’s reputation would be best served by ensuring there is a good summary of follow up information should this be told, either regarding this disease or during more general discussions relating to Australia’s approach to aquatic animal health.]

m) Finally: Her statement (with regard to improving biosecurity guidelines for the abalone industry, p10), her statement that “*Practically, these guidelines cannot be enforced and the continued commitment of all in the abalone industry will be required for success. Participation of processing and relay facilities is as important as cooperation from farms and commercial divers*” should be kept in mind. I agree wholeheartedly with this Statement, and remind Stakeholders of the need to ensure such guidelines are embedded within an industry structure that ensures these issues “remain on the table”, once the initial concern is passed, and take into account such issues as staff turnover.

6.3. Regarding C. Freidman's report:

Dr Freidman has provided an excellent summary of general biosecurity with particular reference to this outbreak, and advice for improving biosecurity on farms, as well as a valuable discussion of the nature of herpes virus infections and how this might influence future outbreaks.

a) Most of the biosecurity issues (p1) have been raised and recognised in previous discussions. Of note are her comments on the importance of regular removal of escapees from drains, air gaps between drains and the main floor to prevent re-entry of escapees, and the ability to sanitize walkways. All are relevant to include in any review of farm design and / or modification.

b) Her point that the family lines project provides an excellent opportunity to collect information on each family line is also worth considering in detail should the family line program be reviewed. [I note that this outbreak could have provided an opportunity to determine whether all lines were impacted equally, but can well understand the impracticality and low priority of this at the time!] Nevertheless, should this disease remain endemic in the area, information on the relative susceptibility to both infection (including sub-clinical / carrier /latent infection) and disease may be valuable. Once the current distribution of the virus is known, testing of potential wild parent stock for the level of susceptibility could be valuable. This is most likely to be worth considering if there is evidence of that the distribution is not uniform across Australia but may have been present in at least one area for a significant period.

Even if the findings do not suggest this scenario, inherent differences in the way abalone respond to viruses could be expected. We know very little of the way that molluscs respond to or prevent viral infections – there are some reports (from 1960's) of antiviral factors being produced by abalone, but there is still little information on their nature. The very rapid course of this disease and the dramatic inflammatory response suggests the possibility that the speed of mortality could be in part due to host responses (possibly including apoptosis or host initiated cell death), rather than just through rapid viral replication resulting in cell destruction. If so, differences between abalone in their response to infection could be exploited to increase survival if the disease remains in the area. (Potentially valuable to wild fisheries also, if the worst case long-term scenario of persistent outbreaks is found. In effect this would be accelerating the selection that may naturally occur over time.)

Such considerations highlight the need to maintain contact between academic study of the virus and host responses and those seeking long-term disease control. The forward thinking of WADA is to be congratulated on bringing these aspects forward at this time, but these interactions need to be maintained.

I note her recommendation (p3), that the recently processed Chilean limpets be examined. This is certainly desirable (as also for any other imported molluscan product in processing plants that may have a route to these farms or the local marine environment), although I suspect that the original material is no longer available, and the relevance of negative findings to similar but different shipments questionable. Moreover it is highly likely that effective tests would need to await the availability of a PCR test (as this would be frozen material, unsuitable for other types of test). The

most appropriate action at this time would appear to be to investigate the availability of this or similar material imported about this time, and to collect and hold samples as appropriate for PCR.

The research needs listed are similar to that given below (Appendix), though more specific as to suggested infectivity trials.

Regarding her advice to specific farms: I found her summary of the information provided during the expert tour to be accurate, and advice to farms thorough.

I note particularly her comment p (similar to comments made in gap analysis, above), of the imperative need to be able to collect health monitoring samples from wild-caught broodstock “*after use and prior to destruction*”, particularly where there is little information on the health status of source stock. There is little point holding such animals in quarantine (essential under those circumstances, as discussed above), if the only test to subsequently be applied is survival (and hopefully, progeny testing). Although it is possible to safely bring in broodstock from areas of unknown health status, but only if both quarantine and eventual testing prior to mixing of the progeny with other stock are used. (ICES guidelines).

I note also the discussion (p 13-14) of the apparent reduction in losses reported by Coastal Seafoods with high temperatures, and whether this could have been influenced by management changes used to reduce high temperature related losses such as vibriosis. This raises the question of whether the disease seen in Australia is like that Taiwan (and China) where major losses were associated with low water temperatures. I note WADA has concerns regarding possible losses over summer, but if losses are less than expected, vigilance needs to be maintained to verify whether outbreaks are more common again in winter.

THE WAY FORWARD
POSSIBLE ACTIONS FOR IMPROVMENT

7. GENERAL RECOMMENDATIONS AND IMPLICATIONS FOR AUSTRALIA

(prepared by J Handlinger and M. Hine during the WADA sponsored workshops).

Abalone viral mortality is a serious disease of *Haliotis discus* in China, Peoples Republic / Taiwan and the seriousness of this disease has recently been recognized by the OIE9 (www.oie.int). This will require cooperation between State and Commonwealth Authorities.

It is not certain if this stage whether the herpes viral infections in Australian abalone are the same disease, but it is apparent that they are very similar. Given this, and bearing in mind that the Australian disease has been apparent since Dec 2005, there is an urgent need for Australian authorities to implement controls within a national framework to stop the spread, and to minimize the effect on trade.

Within Australia such controls are vested in the State and commonwealth competent Authorities. There are currently 2 national framework for dealing with emergencies, AquaVetPlan and the CCEAD mechanism (*as well response plans within State frameworks*).

General Recommendation 1: Need to address the current situation through these mechanisms to minimize losses to trade but maximize biosecurity.

Western group have been forward thinking in the management of their fishery, and have demonstrated their support for biosecurity measures. There is also a need for adjoining abalone management organizations to be aware of the situation and to cooperate with control efforts. The history of this outbreak has shown that there is a lack of awareness and a lack of structure for the investigation of wild fisheries disease, and these also need to be addressed. (Similar barriers were exposed during the previous pilchard kill response, but have not been tested in wild fish since).

There has already been moved towards improved disease management in aquaculture sector, but (at the time of the information visits) this was clearly not at the rate required, and this is a glaring gap in the current situation. (Notwithstanding this history, there have been some movements to improve the situation in both groups since the WADA sponsored visits and Workshop.)

Action needs to be taken in a coordinated way between States as these boundaries are best drawn on geographic distribution and natural barriers (rather than jurisdictional).

This disease has impacted both the wild fishery and aquaculture industry. Whereas there is a temptation to blame one or both of these sectors, we do not yet understand the origin of this disease. While there is a need for at least some of the missing knowledge for long-term management, the immediate need is for forward and contingency planning. This is both a State and National issue, and may be best achieved between the State Authorities, the abalone diving industry, and aquaculture.

Unless action is taken to improve biosecurity, spread of the disease could see a regional problem develop into a State-wide problem, and will threaten the national industry. The trade issues are already likely to have national impact. There is a need to define the infected area, define a buffer

zone, and implement active surveillance of areas outside the buffer zone to demonstrate an uninfected status. After this, under OIE rules, the buffer zone must be under active surveillance.

Contingency planning must address the issue of compensation, should control of further disease outbreaks require this, to maximize the speed with which action can be taken. This need is urgent, and it is recommended that the Levy issue be revisited. Communication structures are also an issue. (The Federal Government should be made aware of these issues – *note – the Federal Government has been aware of the situation from the initial outbreak. Since this initial comment was made, these specific issues have been raised, though they are still on the agenda for action .*)

Urgency should be taken on the development of a sensitive PCR protocol to allow the rapid, efficient and cost effect detection of the virus to define infected zone. (*Now in progress?*) However the OIE also recognizes that an efficient early warning system is an essential component of disease surveillance, and this will require increased awareness and training of all industry sectors. Such a component will initially have to be based on existing diagnostic techniques. (This are more relevant to investigation of diseased abalone than defining the extent of low level infected populations.)

Zones: Defining zones must take into account the activities of other fisheries and aquaculture operations in the relevant zones.

Recommendation 2: It is recommended that each State collect samples for PCR and fixed for histology for current assessment of disease distribution. (*Note: This recommendation was put forward at the Workshop, with a recommendation from that Workshop that all States with abalone industries undertake this action.*)

8. SWOT ANALYSIS - OPPORTUNITIES & CONSTRAINTS FOR IMPROVEMENT

STRENGTHS

- Response plans in place and general awareness
- Cooperation and openness of farms
- Cooperation and proactive response of wild fishery sector
- Willingness of the wild sector to acknowledge and live with aquaculture into the future.
- Active response of Vic Dept
- Knowledge of normal abalone disease profile (normal background)
- Expertise available to Vic Dept & industry (*cf quality, not quantity*)
- Expertise and framework available for a national response
- Aquaculture ventures in Victoria already developing Standard Operating Procedures which concentrate on biosecurity (to varying levels of completion and implementation)
- The wider abalone aquaculture and research community has invested in “proforma” examples of integrated EMS systems. (Aim is to translate this into more specific SOP for individual farms. Health monitoring program is embedded within as part of the EMS.)
 - generic documents for Tasmanian abalone farms completed
 - a more national approach is being developed.
- High capital investment to date should be a driver to ensure effective biosecurity solutions are found and implemented to protect the investment.
 - Lack of alternative economic uses for these investments will increase this drive

WEAKNESSES

- Lack of resources to implement disease minimisation policies
- Failure to implement disease minimisation policies & stipulated conditions (eg where broodstock sourced)
- Lack of industry compensation mechanism
- Tendency to operate on assumptions as if they were facts: Estimating most likely scenario is useful to initiate appropriate responses, but a trap if other possibilities with severe consequences are ignored. Seen as an inherent difficulty which needs to be actively countered rather than a specific criticism, but reflects concerns raised.)
- Slow progress towards implementation of health surveillance, despite industry agreement that this was essential. (Refers to all Australian abalone sectors.)
 - Lack of industry drive & failure to follow through on commitments to research funding bodies (*should this be the major source of responsibility*)
 - Lack of Dept support (& reportedly, of farm condition? Policies)
 - Poor coordination of available resources to ensure effective health surveillance & some confusion of roles
 - Complacency (despite disaster): **still** a sense that not really important?
- Inherent high capital cost of farms & the consequent lack of flexibility to change systems to improve biosecurity.
- Poor awareness and adherence of research community to good health principals and to stipulated farm conditions.

- Lack of biosecurity awareness by researchers (e.g. selection program)
- Lack of risk analysis by funding bodies
- Failure of participants to “think biosecurity”
- Chronically low level of resourcing for aquatic animal health (*see other reports*).
 - Over the last 2 decades, aquaculture has grown at least 10-fold. Over the same period aquatic animal health resources have hardly moved (*they were close to double the initial level in some states a few years ago, but are again in decline with failure to replace retiring experienced staff. There has been no growth in the Govt sector in any State for some time (or negative growth) and very little opportunity for growth in the private sector.*)
 - Victorian resources available to respond to this outbreak appear to be less (or at least no more) than during the less impacting *Bonamia* outbreaks of 1992?
 - Low priority of aquatic health research, especially for research outside the area of test development.
 - Unresolved commonwealth perception that the bulk of background and health surveillance activity is a State responsibility, while States perceive much of this as research (especially in the area of previously unexplored species), or as an industry responsibility?
 - Unresolved issues of what constitutes appropriate levels of health surveillance to support Australia’s general claims to both disease status and a high biosecurity framework across all sectors?
- Loss of faith of some participants in the Victorian disease response structure.
- Resentment by industry participants that they are not getting the same level of assistance as others subject to adverse influences beyond their control, such as drought affected farmers.
- Cumbersome elements of a national response that may not take emerging facts into consideration in a timely manner
- Whatever weaknesses are apparent are already in the international arena, in detail (as will future responses to these).

OPPORTUNITIES

- Impetus to restart the industry compensation debate and increase biosecurity awareness
- Impetus to implement effective health surveillance for both aquaculture and wild abalone sector, and to raise awareness across all the aquatic animal industries.

THREATS

- Long-term to threat to a sustainable industry in the affected areas.
- Threat of disease spread to other areas of Australian abalone industry. Both sectors at risk.
 - Risk of a Victoria-centric response, which assumes this disease to be “endemic in Australia” despite evidence that it is acting as a new or “exotic” agent in this area, and presumably would also do so in other areas. Need to view Australia within a “regional” context (as a large area with potentially discrete bioregions), rather than “an infected country”.
 - Apparent failure to adequately investigate other areas of risk (minimal testing has been reported from the suspect SA area)
- Threats to abalone markets, and / or increased associated costs, particularly for live product, if this becomes recognised as an OIE listed disease (*relates to both the current proposal to list*

abalone viral mortality, and the question of the relationship between this and the Australian virus)

- Threats to the fragile reputation of aquaculture as a responsible and sustainable venture.
- **Whole of aquaculture at risk with regard to investment.** (*I note Tristan Renault's quoted remarks regarding investors and their likely concern regarding the lack of a farm health program*) Threats to future investment capital for aquaculture as a whole, consequent to the general question of perceived risk (due to direct losses), and to lost reputation as a responsible sector appear not unlikely.
- Threats to Australia's reputation as a country with high biosecurity standards (*cf GATT / WTO rules on consistency of quarantine and internal policies*)
- Setbacks to the previously successful fine scale management program that may adversely affect the uptake of similar management programs in other areas.

9. DISCUSSION AND RECOMMENDATIONS EMERGING FROM FACT ANALYSIS

It is recognised that at this point in time there is little that can be done to directly influence the outcome of this disease in wild stock in Western Victoria, or to limit the natural spread, other than to monitor the disease and stock sufficiently to facilitate good management for the long-term future of the industry. Research to provide both the diagnostic tools and the epidemiological information on the disease pattern is essential to achieve this. The other major area of future concern is to protect the rest of the abalone industry (both sectors), by preventing enhanced spread through human activity, and mapping the distribution of the virus to maximise market access. Improved biosecurity and disease surveillance is key to preventing spread through human activity.

The following are specific actions (other than those already under way), arising from the Gap Analysis or other discussions above, that could assist in this process.

9.1. SUGGESTIONS FOR CORRECTION OF CRITICAL FAILURE POINTS

9.1.1. Critical failure point – deficiencies in translocation procedures (&/or policies)

It is well recognised that Abalone Translocation Policies for each State are required (with as much consistency between States as possible, recognising that the actual risks do vary between different parts of Australia). A draft policy has now been completed for Victoria (A. Foster, pers com). I note that the recent attempt to write a single national translocation policy for abalone did not reach a consensus, partly for this reason. (Jones and Stephens, 2006¹⁰) Furthermore, examination for the diseases that were identified as those of greatest risk by this process (perkinsosis and mudworm infections), would not have protected the industry in this case if infected broodstock were indeed the source of the infection. This was a reflection that the preliminary risk assessment process undertaken considered only **known** risks. This is appropriate for well studied species with a well defined disease profile, and in line with international guidelines for risks identification as the first step in the Risk Analysis process. However the same OIE guidelines¹¹ also indicate that “*Certification of freedom from diseases based on purely clinical freedom and aquatic animal population history is of limited value*”. Knowledge of the actual health status (either by batch testing or well established disease surveillance history) is an essential component of any translocation policy.

This OIE Code also stresses evaluation of competent authorities for (among other things), an effective early warning system for disease outbreaks, and that where a pathogen is present within the country, a higher level of protective measure should not be applied on imports “than that provided for the same pathogens or diseases by the measures applied within that country or zone”.

States should therefore consider the international context in establishing conditions for translocation within Australia, with regard to this pathogen.

Discussion of specific concerns: I note that responses to this virus outbreak include a review of Victorian biosecurity policy (under way, with both input from and relevance to other States), and the updated (draft) abalone aquaculture translocation protocol, to be utilized during farm restocking.

Many of the identified failure points are being addressed through these processes. Nevertheless concern is still being expressed from the Victorian wild fishery sector with regard farm biosecurity, especially with regard to full implementation of policy. I note particularly concern regarding reports of restocking prior to the completion of the full Victorian risk assessment process. (I understand that farm specific Risk Analysis is part of this process also – these concerns need to be clarified through Victorian Fisheries.) The recently completed draft Victorian translocation protocol, which I understand includes a farm specific risk analysis step, goes a considerable way towards implementation of measures to address the most relevant risks and would require a high general standard of farm biosecurity as well as health certification of in-coming stock. It needs also to be recognised that operating according to that process, with current recognised standards of good biosecurity, would place these farms on a similar footing to other aquaculture and wild fisheries sectors that continue to operate at a similar level of biosecurity, despite other risks being identified that may take longer to rectify. The question of the level of risk that is acceptable for continued operation during the industry-wide risk assessment process is common to **all** sectors of the industry.

This does illustrate the need for implementation of the biosecurity review to be an active and continuing process, as it is unlikely that all identified changes to practice can be immediately put in place: some changes will be gradual. This highlights the need for a continued process of engagement of both sectors (wild fishery and aquaculture). By their nature, more effort may be needed in the wild sector to ensure involvement is ongoing, especially regarding those areas that may not perceive an immediate risk from this virus, as the direct effects on farms of these review processes will be more immediate.

It is well recognised that enforcement alone has limited effect in ensuring the implementation of a biosecurity policy. (This point has been made by both Victorian Fisheries and A. Mouton). (For example, staff ignorance is still a major reason for non-adherence to policy.) Policies that are well defined, well communicated and well understood by Stakeholders, so they become embedded in standard business operating systems provide greater gains. The large number of biosecurity risks identified across both industry sectors in the recent Risk Assessment workshop has highlighted failures in the past, particularly with regard to Stakeholder familiarity with biosecurity and inherent disease risks. It is very disappointing to one of a small band of dedicated people who have spent years trying to rectify this, to see failure due to the same unresolved issues that have been reported and discussed for over a decade: in particular the low level of resources devoted to aquatic animal health service provision, the lack of an effective framework for disease surveillance for most industries, a general paucity of veterinary services, and the lack of an emergency response compensation mechanism. While these issues are still, or again, on the national agenda, drive from industry sectors to have these supported could raise the level of urgency with which these issues are addressed.

9.1.2. Additional recommendations for improving biosecurity across the industry

The need for improved biosecurity in all sectors has been well recognised, with actions towards this under way by both Government and industry sectors, in Victoria and elsewhere. The Gap analysis above has highlighted areas of potential concern to be considered: this has already fed into the Victorian Risk Assessment process, where they will be formally considered. These recommendations are to capture issues that may not have been included in that process. This is in part in recognition that while some improvements can be expected to be rapidly implemented by

changed practices, other actions such as farm modification and planning of new farms or buildings to optimise biosecurity have a much longer time-frame.

9.1.2.1. Ensure there is a framework to ensure efforts to improve general biosecurity are industry wide and on-going

A: Given the potentially long-time frame, and inevitable staff turnover, effort also should be directed specifically to ensure that **mechanisms are in place to ensure this remains an ongoing active process**, rather than a one-round response to this specific outbreak.

B. As experience from this outbreak, and from implementation of corrective actions, are likely to be useful to other enterprises, **mechanism to share this experience** should also be developed.

- A permanent written report from a national de-brief process (e.g through Australian Animal Health Committee), would be useful to ensure Australia's aquatic animal health response strategies can be effectively implemented.
- Implementing enterprise level biosecurity has relevance to farms in all States: specific presentations from farms at the annual AAGA workshops and national abalone meetings on traps and triumphs should be useful to ensure farms in all States move forward. [e.g, for farms these may include solutions to achieve gaps in outlet pipelines, separation of farms into bio-independent sectors etc. The practicalities of biosecurity for the wild harvest sector may prove equally challenging. Industry bodies should consider putting this to organising committees.]

9.1.2.2. Review of family lines program

During the gap analysis presentation at the technical workshop, it was recommended that the family lines project be reviewed, taking a risk analysis approach before further translocations are undertaken. This is expected to include quarantine and farm biosecurity issues, coupled with appropriate levels of health testing.

- Review of the program by Stakeholders should give consideration as to whether all farms involved in this program actually need to hold, quarantine and spawn broodstock. If source areas and therefore risks are to be shared (as per the report by P H-S) some farms would be better served by contract holding of program broodstock at the best equipped quarantine facilities, bringing in only washed larvae, or older animals where health status has been verified. Untested larvae should still be held under quarantine until health status established (at least initially by observation time only, unless disease of any type occurs), but this should be more practical than providing full adult quarantine facilities.
- The need for a known health status (and / or quarantine) for wild broodstock movements to farms has been highlighted. The program (and individual farms), should also consider the issue of known health status of stock from this program shared between farms. It is noted that broodstock were moved between farms, despite knowledge of a disease problem of unknown nature.

- Review of the program should include **issues of researcher and research institution awareness of biosecurity issues**. These sectors need to be included in education / extension efforts to increase industry awareness of biosecurity.

9.1.2.3. Biosecurity and the response: consider suitability of on-farm disposal sites

Consider whether on farm disposal sites adjacent to the farm (the available sites, as used for routine mortalities, and in these cases in readily draining sandy soil) are suitable for this purpose.

9.1.3. Critical failure point – lack of effective disease surveillance

9.1.3.1. Critical failure point – lack of defined disease surveillance programs

The need for a disease surveillance programs for both wild and farming abalone sectors has been highlighted since at least the First National Abalone Convention, and agreed to formally by farms in supporting the application to FRDC for the disease survey project (FRDC 2002/201). Although this project was recognised as a preliminary step to this process, subsequent progress has been slow but program for farms are under development in all abalone farming States. This outbreak is likely now to accelerate that process, and must be implemented. However there is also a critical need to ensure that wild fisheries are included in this or a parallel process. A knowledge of the current distribution of this disease is critical for management decision not only to those areas where the disease is having an immediate impact, but also for areas currently free of this disease, to ensure decisions that best protect them from accidental spread and protect markets.

Note: While market protection (e.g for live abalone exports) may appear to have little relevance to the Western District at this time (which I would be expecting to target the processed abalone market), ensuring the good reputation of Australian abalone marketing would appear to be paramount. Ensuring that areas free of the virus have the data to confirm status as zones free of this disease would add both to the general reputation of the Australian abalone industry and ensure that there are no blanket restraints on Australian abalone marketing that would see all wild sectors targeting the processed market, with increased competition within that market.

The structure of such a program for wild fisheries should look beyond this disease alone. It should also be borne in mind that regardless of the origin or status of this disease, endemic diseases do occur in Australian abalone and may not be uniformly distributed. It is highly likely that further diseases currently present in wild stock will emerge and may pose a risk of infecting currently free areas. Concentration on obvious mortalities alone may overlook chronic diseases that predominantly affect productivity (such as the parasite in Bass Strait associated with poor productivity and stunting, and suspected to contribute to this). Areas of poor productivity have in general been poorly investigated with regard to disease, in part due to low harvest effort in these areas. (For example, I noted the presentation at the most recent National Abalone Convention on a stock reduction exercise in a stunted area from Victoria did not include a health check to establish if disease was a contributing factor.)

9.1.3.2. Critical failure point – aquatic animal health resources

(e.g – part of reason for lack of surveillance program – especially non-lab resources?)

The Victorian abalone aquaculture production has grown nearly 20-fold in the 4 years prior to this outbreak. Over the last 1-2 decades, the volume and value of aquaculture generally has grown at least 10 fold (4% / year for the past decade). Over this period, the number of veterinary and ancillary staff employed in servicing this industry has grown hardly at all. There had been growth in the government sector in some States, but this appears to have been negative in recent years, with general cost cutting issues and retirement of experienced staff. There has to date been little development of the private veterinary sector. Much of the effort with regard to aquatic animal health has so far been directed towards research. While the need to determine the disease profile and factors affecting disease control is both understandable and laudable, there is a corresponding need for an appropriate service provision sector to ensure this investment is utilised by both farms and governments.

The issue of an appropriate level and composition of veterinary and ancillary resources for provision of services to both farms and governments is complex, but is critical to improving the overall biosecurity practices of not only this industry, but of aquaculture and fisheries generally. An effective system requires an appropriate level of both private and government veterinary input as well as a laboratory system with appropriate background information and skills.

There appears to have been no recent assessment of the overall resources required to achieve aquatic animal health objectives, though current FRDC projects are reviewing some components such as the educational needs (Landos et al, in preparation, FRDC project 2005/641), and the needs for an aquatic animal health laboratory network (FRDC 2005/621).

In most States, most health resources have been within the government sector, reflecting the high proportion of work relating to new and developing diseases that emerge as new industries develop. There has been some concern that this may have somewhat impeded the development of a private service sector, and the need to develop this has also been recognised. However undue reliance upon the private sector alone would do little to advance industry health unless provision is made to ensure in-depth investigation of new and emerging disease situations which remain likely in this still relatively juvenile industry. (This ganglioneuritis outbreak is a good example of utilisation of a variety of resources to achieve this. However for aquaculture and fisheries to manage health issues effectively, provision needs to be made to ensure this opportunity outside of an emergency situation.)

The recent abalone disease survey project in which I was involved was based on the premise that this was to be the foundation for on-going comprehensive health surveillance and monitoring programs in all relevant States. The need for this had been agreed by all aquaculture sectors (and the need to include the wild fisheries sector recognised), prior to commencement of that project. However progress in putting such programs in place has been slow to perfunctory in all States (although the overall level of monitoring has probably improved).

This summary has so-far highlighted the need for both routine (profit-centric) veterinary services for farms, and the need for provision for in-depth investigations of new or problematic problems that benefit the whole industry that cost more than is appropriately borne by one farm. Another element that needs to be included in a comprehensive industry service program is the need for **education**.

This is relevant not only to farms, but also to the wild sector, and to others such as researchers who service these industries.

9.1.3.3. Education / industry familiarization component

The ganglioneuritis outbreak highlights the lack of biosecurity awareness among the more general **research community**, and was a critical factor in this outbreak. Despite the high profile of disease research in recent years, this has not been translated into researcher awareness. Nor are the results of research with regard to disease necessarily being taken on board. Failure points include failure of research leaders to properly consider the biosecurity issues when developing the selective breeding program; failure to ensure the program adhered to farm biosecurity regulations; failure of research funding body to undertake an effective risk analysis of the project; failure to consider advice from previous research projects in such a process; and failure of the farms themselves to detect these omissions.

While the impact of some of these points is well recognised, there are other less obvious examples of possible impact. From the information provided it appears some broodstock were may have been drawn from the Flinders Is area of Bass Strait despite advice against moving stock from this area until risks associated with the haemocyte parasite from those stocks are fully assessed. Some of these animals died, leading to some farm staff considering this shipment a possible source of ganglioneuritis. However these reported deaths could be due to reduced robustness associated with the parasite. In either of these cases it is perhaps fortunate, therefore, that these broodstock did not survive. (Alternately, the cause of these deaths could be simply stress and secondary vibriosis, as first considered.)

Available information also suggests increased researcher and industry awareness, and better defined protocols for wild disease investigation, would have improved the investigation of reported deaths from the South Australian wild brood-stock sources.

The previously provided advice to develop a formal framework for health surveillance for this industry was designed to enable all of these elements to be captured or coordinated, and appears still very relevant. It is recommended that these programs include health training workshops, as required. The steps taken so far to develop farm health surveillance programs in each State (preferably linked for information sharing through Australian Abalone Growers Association annual research meetings), are encouraging in that this should see researchers from other disciplines included in this process. (It may be advisable to consider formalizing this link.) A similar need exists regarding the wild fishery.

9.1.4. Critical failure point – on-farm biosecurity

Framework: This outbreak has highlighted the need for a high level of on-farm biosecurity. I note the efforts to develop EMS programs for abalone farms (starting with a generic framework for Tasmanian farms – completed – and currently being extended to all States), and recognition that health management is a component of such a program. This should provide an excellent framework for on-going review of biosecurity.

Specific measures: In terms of practical measures to increase Australia's ability to respond to such outbreaks in the future, perhaps no measure (other than a formal compensation mechanism) is likely to be as effective as introducing (where possible), effective biosecurity sub-division of large farms. Whether a decision to destroy or discard stock is subsequently made by a farm or by the State, and if stock losses directly due to a disease are high, the effect is much less likely to be enterprise threatening. As the Australian aquaculture industry becomes more complex, often with more than one available site / enterprise, this becomes a realistic option to consider. Such actions (including site or cage separation, all-in-all-out systems etc), would also reduce the spread of endemic diseases on farm, and help to prevent the build-up of pathogens that can accompany continued unbroken low level disease transfer. Inclusion of fallowing and dry-out between consignments of stock goes some way towards this, but direct cross-contamination between tanks and age groups was a factor in the farm outbreaks, so lateral spread needs also to be prevented.

9.1.5. Critical failure point – lack of an industry compensation fund for disease control.

A mechanism for cost-effective and equitable industry compensation for emergency actions has been a topic of deliberations for many years, without resolution. The lack of such a compensation mechanism almost certainly delayed vigorous response to this disease outbreak. While there is always a temptation during periods of tight budgets (currently especially evident in most State budgets, as well as no doubt many industry budgets) to maintain the *status quo* and avoid re-prioritization, the overall cost of this outbreak is high and growing and a return on the considerable investment by Australia in response planning appears to have been compromised by not resolving this issue. I understand that this issue has already returned to the national agenda and will be raised in interstate forums such as the Aquatic Animal Health Committee [and its subsidiary technical advisory group the National Aquatic Animal Health Technical Working Group (NAAHTWG)?]. It may be useful to consider lessons from this outbreak, to feed into renewed discussion of this issue.

Background: Despite the lack of a national agreed compensation mechanism for aquaculture / aquatic animal diseases, States are not without the ability to order destruction of stock, and have been able to do so for other classes of livestock. The mechanism to do so (for those industries) is with compensation from a collective fund to which industry contributes (mostly retrospectively). This is in place for immediate action for a specified small list of diseases, and can be rapidly put in place with industry agreement for other animal diseases. Note that compensation put in place for known diseases of national concern would **not** have covered a disease such as ganglioneuritis.

While States also have the ability to order destruction of stock with compensation by the State, or without compensation, there are complex legal issues that are likely to vary between the States that confound both these actions, making such actions unlikely or unrealistic.

Another major constraint on formation of a practical compensation mechanism is the effective size of many aquaculture systems. For many enterprises, compensation for destruction of stock across the whole farm is currently beyond the budget capability of State Governments, and there is a danger that the same may apply to a joint industry funded compensation mechanism. Destruction of all of a farms stock without compensation is also beyond the ability of that farm to bear. The aim is to ensure that the cost of destruction of any one unit is shared between a number of units that are

better protected by this action. The key to such a strategy is to ensure a relatively high number of protected units, compared to those killed out. Any re-engineering of farms or farm practices to provide biosecurity units that are smaller than the whole farm will help in achieving this.

During the initial outbreaks, an effort was made on at least one farm to overcome this outbreak by destruction of the affected part of the farm, a strategy that was shown by later events to be ineffective as this section was not independent with regard to biosecurity. Had this been a more bio-secure unit, the partially voluntary destruction may have been both biologically and cost effective. Indeed some staff at one unaffected Victorian abalone farm have expressed some uncertainty as to whether they were entirely free of entry of virus, but if such an event did occur the effective biosecurity measures in place prior to any known outbreak were effective in preventing this becoming established. The formation and financing of an industry compensation fund would be much aided by a review of practices on all farms to provide smaller units of disease exposure. This is true for all types of aquaculture, and may include practices such as age group separation and all-in all-out type of management as well as physical separation.

9.1.6. General issue – improving disease preparedness

Overall this outbreak should have highlighted to aquatic animal industries generally that the espoused risks from disease outbreaks, particularly translocated diseases, are considerable and that the slow progress in putting in place practical solutions to problems recognised for many years has resulted in an unpreparedness, despite considerable planning, resulting in a serious outbreak that could have been avoided. There is a perception that the division of responsibility between State and Commonwealth, and funding initiative that consider do not consider the whole spectrum have resulted in a disproportionate effort in the planning process, without follow-through with adequate resources to ensure good practice and adequate data collection to underpin the overall process, or that the most effective responses can be undertaken. These issues have national significance and relevance to all aquaculture and fisheries sectors and should be addressed at a national as well as State and local level.

9.2. THE VALUE OF ESTABLISHING THE SOURCE OF INFECTION

It is recognised that it may never be possible to establish the specific source of infection. However there is considerable value in establishing this if possible, or at least establishing the likely type of source - particularly whether translocated from a different area of Australia, from an exotic source, or a jump from another mollusc species. The implications for future management are different for each of these scenarios.

- If recently introduced to Australia (either by contact with overseas product during rehydration at a processing plant etc, via gastropods coming in on ships, or by movement of broodstock from an area of very recent introduction), most if not all Australian stocks could be expected to be highly susceptible to this virus. (As is the case in Western Victoria (farm and wild, both species), where the behaviour of the disease suggests a naïve population.)
- If relatively recent introduction to an area of Australia (with subsequent movement of broodstock from that area), identifying the area is essential to:

- Primarily to reduce risks to other areas (e.g. by movement for processing, passively with movement of boats or equipment, or through live trade) *and*
- Provide a better understanding of this disease outbreak, to improve overall diagnostic capability and contingency planning against similar outbreaks.
- If abalone in the source location are found to show inherent resistance (as suggested by P H-S), implying time for at least some selection pressure, this could provide a possible source of future genetic material partially selected for increased resistance to the virus.
 - **Note:** It needs to be recognized that such resistance will always be partial, and that this may allow the continued presence of the virus within an area as it is likely to increase the level of long term subclinical infection (carriers). This strategy is likely, therefore, to be useful only in a situation where the virus is endemic and cannot be eradicated. Because of international (and national) concern regarding this virus, there would be expected to be some market restraints on production under these circumstances (eg. Exclusion from live product market).
 - It also needs to be recognized that any translocation from such an area would need to be undertaken with due long-term quarantine to prevent re-introduction of the virus if a control program is in place (e.g. possibly via movement of larvae or very young stock, which can be washed and quarantined for a longer period).
 - A situation where this could be useful would be that a long-term impact continues in Western Victoria, and there is no rapid local development of a similar level of resistance. [Note: I am not therefore advocating that any such an action be undertaken lightly, or without due control.]
- If endemic to Australia (and therefore possibly the source of virus outbreak in Taiwan), the lack of previous detections by the industry and its researchers suggests that there are areas (or species), with a high level of resistance to disease (but not to infection), that are maintaining this virus. [Such species may or may not be abalone. If not, they are probably closely related.]

10. FINAL COMMENTS:

No amount of knowledge can undo the events leading to the emergence of this disease in Western Victoria, and any suggestions of eradication from this area are unrealistic. The major advantage of this review process is to ensure that there is sufficient knowledge and resources to provide the optimum conditions for the industry to continue to operate despite the presence of this virus, and to prevent human activity that may further spread the virus. Many of the risks and recommendations have already been recognised through related and other forums, and this disease is certainly on the national aquatic disease agenda. WADA is to be congratulated for their forward-thinking approach in organising the Expert Group visits and review process. The openness of farms to review of past mistakes leading to the high level of biosecurity risk has also been critical – as will be their openness to continued and collective review of progress to reduce such risks. I urge WADA to maintain their efforts to ensure a continued dialogue across all sectors of the industry. Hopefully, this report will assist that process.

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Current FRDC project referred to:

2005/621	Aquatic Animal Health Subprogram: Establishment of a national aquatic animal health diagnostic network Associated species: Multi-	Prof Richard Whittington University of Sydney Phone: 02 9351 1619 Email: richardw@camden.usyd.edu.au
2005/641	Aquatic Animal Health Subprogram: Current and future needs for aquatic animal health training and for systems for merit-based accreditation and competency assessments Associated species: Multi-	Dr Brian Jones Department of Fisheries, WA Phone: 08 9368 3649 Email: bjones@agric.wa.gov.au

12. APPENDIX: RESEARCH PRIORITIES IDENTIFIED.

This is a record of the research priority list developed during the technical discussions organised by WADA that has already been utilized. It has been modified only with regard to formatting and clarity of wording. This list was prepared jointly during the Expert Panel discussions and presented and discussed at the joint WADA/ VIC-DPI technical meeting of Wednesday 20 September. After initial prioritisation and assessment for practicality at this time, the shortened list of immediate priorities (below) was developed collectively by the technical participants and presented to the joint WADA / Vic DPI Scientific Forum (Sept 21), and agreed to by that meeting.

The expanded list was also forwarded to Mark Crane (who was a participant in this process), for use in planning by the FRDC Health Subprogram. It is included here as it captures the detail of suggested and agreed research as well as further desirable research which can be re-assessed for priority and practicality once further diagnostic tools are developed, and in the light of further field information.

12.1. Summary Of Immediate Research Priorities

The summary form of immediate research priorities was presented to the Scientific Forum and agreed to by meeting participants:

TO DO NOW:

- Develop & Implement Australia-wide sampling regimes – make bench mark collections, and long term system for collecting apparently diseased samples

A: Diagnostic Tools

- Initially Use Available non-specific tools
- Develop Specific Tools
 - Purification of Virus
 - PCR – polymerase chain reaction
 - Comparison with other Herpes and like viruses

B: Patterns of Disease (EPIDEMIOLOGY)

- Distribution of virus / disease in abalone
- Host range (other species – especially gastropods?)
- Agent Characteristics; (Transmission, Latency, Impact on Larvae, Stability, Disinfection)

12.2. Expanded Research Framework

12.2.1. Summary of research that can be currently undertaken:

- Further EM to define the actual distribution of the virus within the host, and the range of tissues that can be infected. (To be followed by *In situ* hybridization.
- Evaluate the existing PCR's for oyster virus, on abalone
- Use specific probe for OsHV-1 (the French oyster herpes virus tests) on experimentally infected animals (temporarily sampled experiments) and possibly link with TEM.
- Improve Disease Monitoring surveying protocols (use diver knowledge to direct surveying effort)
- Test the stability of virus in relation to temperature, disinfection, and detergents.
- Industry Based Monitoring of several infected populations over time to document progression of disease over time and eventual level of survivorship (u/w video and marked populations)
- Quantitative Surveying to prepare for documentation of impact of disease (Inside Disease, through buffer zone and in Distant disease free areas)
- Develop & Implement Australia-wide sampling regimes – make bench mark collections, and system for collecting apparently diseased samples

12.2.2. Longer-term research to systematically fill knowledge gaps

A: DIAGNOSIS

Purification is an initial step for each of these activities.

•PCR (most likely to be developed by AAHL)

- In situ hybridization (using PCR genetic information) – most likely developed in conjunction with IFREMER (e.g. possibly through International Scientific Linkages)
- Comparison of the herpes virus with the Taiwan herpes virus
- Collaboration where possible to help define the Chinese virus complex

B: EPIDEMIOLOGY

- Distribution of virus / disease
 - In abalone
 - In other gastropods
 - Age class, species effects (regarding impact on population make-up in impacted areas).
 - Density effects
- Control of disease
 - Transmission [source? Role of mucus?]
 - Experimental exposure of larvae / juveniles.
 - Latency / subclinical infection – does it exist?
 - Whether this is likely to change over time – will it attenuate
 - Stability of virus in relation to temperature, disinfection, and detergents.
- Origin of virus (see above + field studies)

C. FUNDAMENTAL RESEARCH (longer term)

- Host-virus interaction & mechanisms of disease: what determined the very short time-frame of this disease. E.g is cell destruction and host response mediated by the common mechanism of cell destruction following florid virus replication, or by other host-mediated factors? (Potentially this could lead to tests for previous exposure to a virus – e.g detecting enhanced reactions, or to aid selection for resistance.)
- Is the HOST changing – will the host become adapted
 - Even if it does, still an issue to live trade if OIE listed.
 - Probably easiest to study in farmed stock, but **related heavily to wild industry future.**
 - How does the host respond?
 - Is there variation between hosts in this response –
 - Epidemiology results
 - Genetic analysis of survivors (locus assisted selection etc, rather than continue Family Line program unchanged)
- Comparative virulence of this virus, compared to that from Taiwan.
- Relationship of rate of transmission to density

(Other gaps were not discussed in detail, as it was recognised that initial research to establish more diagnostic techniques and fundamental questions of epidemiology needed to precede these, and that they did not come within immediate priorities.)