Tactical Research Fund: Conduct a risk assessment for stocking Barramundi into Hazelwood Cooling Pondage in Churchill Victoria

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futurefish FOUNDATION

PHS PANAQUATIC

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OBJECTIVES:

1. To conduct a comprehensive risk assessment on the potential stocking of Hazelwood Cooling Pondage with Barramundi (*Lates calcarifer)*. This risk assessment will be conducted in accordance with the Victorian "Guidelines for the Translocation of Aquatic Organisms in Victoria".

NON TECHNICAL SUMMARY

OUTCOMES ACHIEVED TO DATE

This project forms part of the necessary requirements for the stocking of Hazelwood Cooling Pondage in Victoria with Barramundi to create a new recreational fishery

The risk assessment has been completed and has satisfied the Victorian Translocation Evaluation Panel's request for a risk assessment prior to consideration of stocking Barramundi in Hazelwood Cooling Pondage in Victoria.

Beneficieries of this total project will be Victorian recreational fishers and the local economies in surrounding areas.

Many impoundments in Queensland that are of similar size to Hazelwood Cooling Pondage are stocked annually with Barramundi. A recent study into the economic value of freshwater impoundment fisheries in Queensland's Bjelke-Peterson, Boondooma and Fairbairn Dams suggest that this project will contribute a significant boost to the local economy in the Latrobe Valley region. The total economic value from recreational fishing in Boondooma Dam which is most comparable with Hazelwood is valued at $3.2 million.

This is a rare chance to create a new recreational fishery with very little effort. The return to the local economy is significant and the fishery will be instantly recognised and predicted to be visited by many Victorians as well interstate visitors from New South Wales, South Australia and Tasmania.

The objective of this report was to provide a comprehensive risk assessment on stocking barramundi into Hazelwood Cooling Pondage following the risk assessment proforma supplied by Fisheries Victoria. This proforma requires the consideration of the disease and environmental issues surrounding a stocking of waterway in Victoria with a new fish species.

It requires consideration of the likelihood and consequences of escape or release of the stocked fish, the potential diseases that may accompany movement of the fish and the potential environmental impact that may results from releasing the fish into the waterway.

Hazelwood Cooling Pondage is a unique Victorian body of water in that it contains water which is heated to between 20 to 35 degrees Celsius all year round. The Pondage water is used to cool one of Victoria’s largest coal powered electricity generators, Hazelwood Power Station, situated in the Latrobe Valley region of Gippsland. For many years there has been interest in the potential for barramundi (a warm water highly prized angling species) to survive in this water and hence form the potential for a recreational fishery. Many impoundments in Queensland that are of similar size to Hazelwood Cooling Pondage are stocked annually with Barramundi.

In May 2009, Panaquatic Health Solutions Pty Ltd was engaged by Futurefish Foundation to conduct the risk assessment. It was completed in December 2009, and was submitted to the Translocation Evaluation Panel for consideration in providing advice to the Executive Director Fisheries Victoria.

The key findings of the risk assessment were that:

- It was considered highly likely that barramundi released into Hazelwood Cooling Pondage would survive. The water conditions in the Pondage are favourable and currently there is a suitable feed source in the pondage, although the full extent of this feed source was not assessed.
    - The consequences of the barramundi surviving is likely to be a reduction in the number of exotic fish species currently resident in Pondage due to the predatory nature of the species.
- It was considered unlikely that parasites or other pathogens would be introduced to Hazelwood Cooling Pondage with the barramundi, provided barramundi were sourced from a facility where the health status was known and provided that each batch to be translocated was certified as free from any evidence of clinical disease prior to translocation. Were any parasites or pathogens to be introduced inadvertently with the barramundi, then the consequences were considered to be minimal and limited to the confines of the Hazelwood Cooling Pondage, it being an artificially created environment.
- Barramundi will not be able to establish in the Hazelwood Cooling Pondage except for those individuals actually stocked. Translocated fish will not be able to breed due to the pondage being predominately freshwater.
- It was considered highly unlikely that barramundi would escape from Hazelwood Cooling Pondage and should they escape the chance of survival for also considered unlikely, due to the ambient temperature of the ponds into which they may escape being significantly below the barramundi’s preferred temperature range.
- Major positive social and community impacts are envisaged from the proposal to stock Hazelwood Cooling Pondage with barramundi. If the proposal is successful, it will be the only recreational barramundi fishery in the southern half of Australia. It is

expected that recreational anglers from all over Victoria as well as New South Wales, South Australia and Tasmania will visit Hazelwood Cooling Pondage.

- The social and community impacts will be increased holiday and tourism opportunities for the region and it is envisaged that membership in local fishing club and other local social club membership will significantly increase as a direct result of the fishery being established. It is also predicted that several fishing competitions and community events will be introduced as a direct result of this fishery being established.

Full details of the Assessment can be found in Appendix 2.

In February, 2010 the Translocation Evaluation Panel advised the Executive Director (Fisheries Victoria) that they approved the stocking of Barramundi into Hazelwood Cooling Pondage. Hence an initial major hurdle in the potential stocking of Hazelwood Cooling Pondage with barramundi has been overcome through the work conducted under this Project.

KEYWORDS: **Barramundi, Hazelwood Cooling Pondage, recreational fishing.**

ACKNOWLEDGMENTS

The authors would like to acknowledge the valuable assistance provided by David Kramer of Future Fish Foundation in preparing the Risk Assessment.

BACKGROUND

Hazelwood Cooling Pondage is a unique Victorian body of water in that it contains water which is heated to between 20 to 35 degrees celsius all year round. The Pondage water is used to cool one of Victoria's largest coal powered electricity generators, Hazelwood Power Station, situated in the Latrobe Valley region of Gippsland. For many years there has been interest in the potential for barramundi (a warm water highly prized angling species) to survive in this water and hence form the potential for a recreational fishery. Many impoundments in Queensland that are of similar size to Hazelwood Cooling Pondage are stocked annually with Barramundi.

A recent study into the economic value of freshwater impoundment fisheries in Queensland's Bjelke-Peterson, Boondooma and Fairbairn Dams suggest that the stocking of Hazelwood Cooling Pondage with barramundi is likely to contribute a significant boost to the local economy in the Latrobe Valley region. The total economic value from recreational fishing in Boondooma Dam which is most comparable with Hazelwood is valued at $3.2 million. Beneficiaries of the Hazelwood stocking will be Victorian recreational fishers and the local economies in surrounding areas.

Futurefish Foundation, a non profit charitable organisation dedicated to enhancing recreational fishing opportunities for all Victorians, has embarked on a project to establish such a public recreational barramundi fishery in Victoria. Futurefish Foundation is also a registered environmental organisation with the Australian Government. It has used public and corporate donations to conduct preliminary research into the establishment of the fishery.

After public consultation and discussions with International Power (the Pondage owners) and Latrobe City Council, Futurefish Foundation provided Fisheries Victoria with an initial screening application which is the first step in gaining approval from Government authorities to stock fish in waters previously not stocked.

NEED

Futurefish Foundation's mission is to protect and enhance recreational fishing for all Victorian's through a range of initiatives including environmental, educational and fish stocking projects as well as projects that improve fish habitat, access and facilities.

In line with this mission statement, Futurefish foundation is a registered environmental organisation and recieves a moderate level of corporate donations to invest in recreational fishing projects with an environmental component.

The Futurefish Foundation Board of Directors determined that the possible stocking of Barramundi into Hazelwood Cooling Pondage had significant potential to enhance recreational fishing opportunities in Victoria and initiated the the prefeasibility work to investigate this possibility.

However, Fisheries Victoria advised Futurefish Foundation that a comprehensive risk assessment would need to be conducted on this potential stocking. The risk assessment component of this project is neccessary for Fisheries Victoria's Translocation Evaluation Panel's consideration prior to providing advice to the Executive Director to approve the fish stocking. This process is outlined in the 2003 publication "Guidelines for the Translocation of Aquatic Organisms in Victoria”[1]

The objective of this report is to provide a comprehensive risk assessment on stocking barramundi into Hazelwood Cooling Pondage following the risk assessment proforma supplied by Fisheries Victoria.

OBJECTIVE

The objective of this study was to conduct a comprehensive risk assessment on the potential stocking of Hazelwood Cooling Pondage with Barramundi (*Lates calcarifer*).

This risk assessment will be conducted in accordance with the Victorian *"Guidelines for the Translocation of Aquatic Organisms in Victoria"*.

METHODS

In May 2009, Futurefish Foundation engaged the services of Drs Paul Hardy Smith and John Humphrey (Panaquatic Health Solutions Pty Ltd) to conduct the risk assessment. Drs Hardy-Smith and Humphrey are veterinarians with extensive experience in aquatic animal health and finfish production management. Both veterinarians have also prepared a number of other similar risk assessments. The method used to prepare the risk assessment included extensive consultation with stakeholders, a comprehensive review of diseases of barramundi and detailed examination of the environmental considerations concerning the movement of a fish species to a new area. This examination included visiting the Hazelwood Cooling Pondage area and extended to diving in the pondage to confirm the identification of some of the exotic fish species already resident in this body of water. Methodology is outlined in Appendix A.

The Risk Assessment was completed in December 2009 and is attached to this Final Report (Appendix A). This assessment has been submitted to the Translocation Evaluation Panel for consideration in providing advice to the Executive Director Fisheries Victoria.

RESULTS/DISCUSSION

The Risk Assessment Proforma is attached to this report as an Appendix. It contains full details of how each of the Proforma questions was addressed.

Major positive social and community impacts are envisaged from the proposal to stock Hazelwood Cooling Pondage with barramundi. It will be the only recreational barramundi fishery in the southern half of Australia. It is expected that recreational anglers from all over

[1] Version 2 of this document is available at http://new.dpi.vic.gov.au/fisheries/about-fisheries/Moving-and-stocking-live-aquatic-organisms/guidelines-for-assessing-translocations

Victoria as well as New South Wales, South Australia and Tasmania will visit Hazelwood Cooling Pondage.

The social and community impacts will be increased holiday and tourism opportunities for the region and it is envisaged that membership in local fishing club and other local social club membership will significantly increase as a direct result of the fishery being established. It is also predicted that several fishing competitions and community events will be introduced as a direct result of this fishery being established.

In February, 2010 the Translocation Evaluation Panel advised the Executive Director (Fisheries Victoria) that they approved the stocking of Barramundi into Hazelwood Cooling Pondage. Hence an initial major hurdle in the potential stocking of Hazelwood Cooling Pondage with barramundi has been overcome through the work conducted under this Project.

There are however many other factors that need consideration in the stocking of a new fish species into a privately owned body of water such as Hazelwood Cooling Pondage. Consideration of these factors is ongoing.

BENEFITS AND ADOPTION

This project not only achieved its primary objective of conducting a risk assessment, but that assessment was also successful by having the Victorian Translocation Evaulation Panel provide a recommendation to the Executive Director (Fisheries Victoria) to allow stocking of Hazelwood Cooling Pondage with barramundi.

This has ensured that the overall project of stocking Hazelwood Cooling Pondage has been able to proceed.

FURTHER DEVELOPMENT

There is still much to consider in stocking a waterway with a new fish species. Many other approvals need to be sort and provided. This process is ongoing but now has one major hurdle overcome.

PLANNED OUTCOMES

The eventual outcome of this project is to have a new recreational fishery in Victoria based on barramundi in Hazelwood Cooling Pondage.

The risk assessment component of this project has satisfied the Victorian Translocation Evaluation Panel’s request for a risk assessment prioir to consideration of stocking Barramundi in Hazelwood Cooling Pondage in Victoria.

Beneficieries of this total project will be Victorian recreational fishers and the local economies in surrounding areas.

Many impoundments in Queensland that are of similar size to Hazelwood Cooling Pondage are stocked annually with Barramundi. A recent study into the economic value of freshwater impoundment fisheries in Queensland's Bjelke-Peterson, Boondooma and Fairbairn Dams suggest that this project will contribute a significant boost to the local economy in the Latrobe Valley region. The total economic value from recreational fishing in Boondooma Dam which is most comparable with Hazelwood is valued at $3.2 million.

This is a rare chance to create a new recreational fishery with very little effort. The return to the local economy is significant and the fishery will be instantly recognised and predicted to be visited by many Victorians as well interstate visitors from New South Wales, South Australia and Tasmania.

CONCLUSION

This project was successful in achieving its objective which was conduct a comprehensive risk assessment on the potential stocking of Hazelwood Cooling Pondage with Barramundi (*Lates calcarifer*).

In February, 2010 the Translocation Evaluation Panel advised the Executive Director (Fisheries Victoria) that they approved the stocking of Barramundi into Hazelwood Cooling Pondage. Hence an initial major hurdle in the potential stocking of Hazelwood Cooling Pondage with barramundi has been overcome through the work conducted under this Project.

APPENDIX 1 - STAFF

Paul-Hardy-Smith (Panaquatic Health Solutions Pty Ltd)

John Humphrey (Panaquatic Health Solutions Pty Ltd)

David Kramer (Future Fish Foundation)

APPENDIX 2 - RISK ASSESSMENT PROFORMA FOR THE POTENTIAL TRANSLOCATION OF BARRAMUNDI (*LATES CALCARIFER*) INTO HAZELWOOD COOLING PONDAGE

Risk Assessment Proforma for the potential Translocation of barramundi (*Lates calcarifer*) into Hazelwood Cooling Pondage

Prepared by Panaquatic Health Solutions Pty Ltd for Futurefish Foundation

December 4th, 2009

1. Proponent and Risk Assessor Details.

1.1 Proponent

The proponent is the person, business or organisation who is responsible for the translocation. If a business or organisation name is supplied, additional details must be provided in Contact name. Where applicable, it is recommended that e-mail and or facsimile be provided as such forms of communication may reduce time-lines for communication with the proponent.

Proponent Name **Futurefish Foundation**

Contact name (if proponent is a business or organisation name) **David Kramer**

Postal address **P.O Box 734, Patterson Lakes**

State **Vic** Post Code **3917**

Telephone **(03) 9773 8613 or 0428170091** Facsimile ( )

E- mail **David.Kramer@futurefish.com.au**

1.2 Risk Assessor

In the case where a proponent (or applicant on behalf of a proponent) is contracting an independent risk assessor to conduct the risk assessment, details of the risk assessor should be provided. Where applicable, it is recommended that e-mail and or facsimile be provided as such forms of communication may reduce time-lines for communication with the proponent.

Name **Drs. Paul Hardy-Smith and John Humphrey**

Postal address **Panaquatic Health Solutions Pty Ltd, 26A Liddiard St, Hawthorn**

State **Vic** Post Code **3122**

Telephone **(03) 98185100** Facsimile (**03) 98181200**

E- mail **paul@panaquatic.com.au**

Relevant Qualifications ***BVSC, MACVSc, PhD***

2. Escape or Release - Likelihood

2.1 Will the transport medium and equipment be treated before transport?

The transport medium and equipment used to transport the proposed species for translocation, organisms can harbour infectious organisms and unwanted pests. Appropriate disinfection procedures and appropriately designed transport vessels may reduce the load of infectious organisms or reduce the likelihood of spillage en-route. International standards of procedures can be found as Appendix A the full manual can be located on the Office International des Epizooites (OIE) website www.oie.int in the Manual of Diagnostic Tests for Aquatic Animals 2003.

Barramundi will be transported live in a tanker containing fresh, aerated water which has been sourced from an underground aquifer ("bore" water). The container in which the barramundi will be transported will have been cleaned, disinfected with sodium hypochlorite (at 50mg/l) and rinsed prior to loading.

Discharge of any transport water into the Hazelwood cooling pond (HCP) will be minimised. Fish will be netted out of the tanker. Excess water will be drained from the tanker and placed in a holding tank on site for subsequent disinfection with sodium hypochlorite. Following delivery, the tanker will be returned to the farm of origin and disinfected internally using sodium hypochlorite solution at a minimum concentration of 50mg/l, which is above the concentration recommended in Appendix A of this proforma.

2.2 Will the transport medium be treated using appropriate methods after the translocation?

Refer instructions of 2.1

The transport medium, i.e., fresh water, will be disinfected using sodium hypochlorite following the translocation as indicated in Section 2.1. The disinfectant will be sodium hypochlorite. The concentration will be 50mg/l in the water. This will be allowed to sit for at least one hour before neutralisation with sodium thiosulfate.

Important note for questions 2.3 - 2.8

Questions 2.3 -2.8 applies to closed and semi-closed systems only. If your translocation event is the stocking of organisms into a system that is defined as an open system please disregard questions 2.3 -2.8 and proceed to question 2.9. A definition of each system is provided in the Glossary of terms.

2.3 How close and accessible are nearby watercourses?

The risk of escape from closed or semi-closed systems can be heightened where the facility is in close proximity to a waterway. In addition, infectious organisms found in untreated effluent water may be transported via a watercourse to larger waterways that contain susceptible species. Please estimate the distance from the nearest waterway and identify the potential watercourses that could transport organisms, including fish, pathogens or other pests. Please also clarify the height of the proposed stocking area in relation to the 1 in 100 year flood level. Seasonal waterflows should also be considered. This information can be found on the Department of Sustainability and Environment website: www.dse.vic.gov.au.

This is not applicable (N/A) as by definition Hazelwood cooling pondage (HCP) is defined as an open system as there is little (no) control over the movement of organisms and water flow within HCP. It should be pointed out though that there is control over the movement of fish escaping from the pondage (section 2.16).

2.4 Is the facility fully enclosed and secure from unauthorised access?

Fully enclosed and secure systems can effectively reduce the risk of escape of aquatic organisms. The level of physical security is also important as it prevents unauthorised access to the property. Provide details of the security measures in place or proposed to be in place at the site.

N/A – open system

2.5 Based on knowledge of the facility's waste water treatment and disposal, and the capability to contain all life stages of the organism, are any life stages likely to be released from the facility during normal operations?

Effective screening of waste water outflow is an important mechanism to prevent escape of stocked species. However, such screening needs to take into account all life stages of the stocked species including eggs, larvae, fingerling, sub-adult and adult forms. For both closed and semi closed systems describe the mechanisms in place to control organism and water movement throughout the system. In the case of semi-closed systems please also provide details of the containment mechanisms used to control outputs of water or organisms from the system with particular focus on measures to restrict over filling.

N/A – open system

2.6 Based on knowledge of the facility's waste water filtration, sterilisation and disposal, are any diseases present in the facility that are likely to escape?

It is imperative to consider the diversity of unwanted organisms that may harbour in wastewater and, recognise that some life stages of infectious organisms are well adapted to withstand unfavourable conditions. It is therefore appropriate that wastewater treatment methods are well designed to eradicate all infectious organisms. Provide details of treatment systems with reference to OIE disinfection standards where possible.

N/A – open system

2.7 Does the facility have adequate contingency plans in the event of a technical failure?

Technical failures of fish farms may result in unplanned release of water and or stock from the facility. In some cases, facilities are unable to cope with such events and water and or stock are discharged to the surrounding environment. Please provide details of the contingencies and design elements that will be used to contain any stock and water in the case of technical failure.

N/A – open system

2.8 Have local environmental issues (e.g. flooding) been considered in containment planning?

In the first instance, local environmental issues may be discovered and responded to when applying for a planning permit. Examples of local environmental considerations may include, but not be limited to the properties tendency to flood, environmental overlays in the local planning scheme, the proximity to threatened species, international governmental agreements eg. Ramsar wetlands or, other important national or state wetlands. Consult with your local council or Department of Sustainability and Environment office for further information about important environmental sites and environmental issues in your area.

N/A – open system

2.9 What is the nature of any disease surveillance programs in the source area and/or facility?

Understanding the health status of organisms in an aquaculture facility is an important economic and environmental consideration. Programs to monitor fish mortalities and disease can include the regular screening of fish and or wastewater. Monitoring of fish and wastewater can also allow an aquaculture to measure the effectiveness of their treatment system. Provide details of any monitoring programs that are undertaken in the source area or facility.

The proposed source facility is a fully enclosed recirculation system operating under license in Victoria. Source water for this facility is from a bore (i.e. underground aquifer) and does not present a risk of pathogenic organisms or parasites. The proposed source facility has had regular veterinary health inspections for at least the past 5 years. Any mortality event occurring during that time has been investigated and where necessary samples have been taken and submitted to a veterinary diagnostic facility for analysis.

The proposed source facility only farms barramundi and no other fish species.

The facility had previously received translocated fingerlings from a number of hatcheries located in different states once the fingerlings were at least 42 days Days After Hatch (DAH) to comply with Victorian translocation requirements. After submission of a Risk Assessment proforma and successful acceptance of the proposed translocation modification by the Executive Director, Fisheries Victoria, the facility now translocates barramundi fingerlings at approximately 25-28 days DAH only from one interstate hatchery every 30 days (approx.) into a secure quarantine area within the facility. These fingerlings have been subject to health screening by the state's government veterinary pathology services. This screening is primarily aimed at exclusion of evidence of Viral Nervous Necrosis (VNN, commonly referred to as nodavirus). If there is any evidence of VNN in a batch, the batch is destroyed in the source hatchery and not translocated into the facility in Victoria.

At around 48 days DAH, an on-site veterinary inspection is required in order to release these fish from the quarantine area. The veterinary inspection includes examination of the health screening results conducted while the fingerlings were still at the hatchery, examination of all mortality records while fingerlings are in the quarantine area in Victoria and a final examination of the fingerlings themselves. Such an inspection is conducted, on average, once monthly.

Generally a veterinary inspection of the production fish in the facility is conducted at the same time as the quarantine inspection.

The proposed source facility has not had fish showing evidence of any of the diseases of concern as identified in the Risk Analysis conducted as part of this application (Appendix B) for at least the previous two years.

The facility did have the disease Streptococcosis first diagnosed in 2005. It is thought that this disease originated in fish translocated from an interstate hatchery from which the farm was sourcing fingerlings at the time. Farm management initiated an immediate health management plan to control and eradicate the disease from the facility. This involved such procedures as vaccination of all fish while in the nursery and before entering the production area, stopping sourcing fish from the interstate hatchery that is suspected of having infected fingerlings but rather sourcing fish from another interstate hatchery that they have control of (and know is not a potential source of *S. iniae*), paying strict attention to reducing stress on fish at all stages of the production cycle and maintaining close liaison with an experienced aquatic veterinarian to assist in understanding the disease and managing it. Control and eradication was successful - the last time Streptococcosis was diagnosed at this facility was in early 2007 i.e. over two years ago.

2.10 Are there any disease, parasite or unexplained mortality issues in the source area?

Mortalities of the stocked organisms can occur for a range of reasons. In closed and semi closed systems poor husbandry and diet amongst other causes can lead to stress, decreasing the organisms' ability to fight infection and allowing secondary infections to affect the animal. Facilities may also harbour parasites such as flukes and tapeworms and other species, and the translocation of these must also be restricted. Open system mortalities may arise from water quality problems such as deoxygenation. Provide details as to whether there have been any disease, parasite or unexplained mortalities in the source area or facility.

As discussed in Section 2.9, there are currently no disease, parasite or unexplained mortality issues in the proposed source area or facility based on detailed knowledge and on-going health monitoring of this facility. The fish currently present in this facility are considered to be in very good health. As also mentioned, the proposed source facility for the barramundi to be translocated to HSP (if this application is successful) is visited by an aquatic veterinarian at least once monthly.

2.11 Will the consignment be reliably certified free of known diseases, and if so by whom?

While a health certificate is not a requirement for translocation it can minimise the risk of disease transfer. Certification can generally be arranged with the source hatchery. Certification should be provided by a competent authority, which may include a registered veterinarian or a person nominated by the relevant state. International translocations require AQIS approval. In the case where a health certificate will accompany the consignment please provide details of the competent authority and tests to be conducted.

An important element of this application was the conducting of a comprehensive disease risk analysis (RA) on barramundi (Appendix B). This was to identify what potential diseases of concern would need to be considered as potential risks should translocation occur. It also allowed consideration of risk mitigation measures that may be applied as controls if diseases of concern were identified.

There were seven diseases of concern identified in the RA. These were:

Viral Nervous Necrosis (VNN)
Lymphocystis
Streptococcosis
Epizootic Ulcerative Syndrome (EUS)
Virulent *Vibrio harveyi*
Trypanosoma sp.
Neobenedenia melleni

Currently, as far as the proponents are aware the proposed source facility has none of these diseases of concern. However, as an additional safeguard (risk mitigation measure) if this application is successful additional testing will be conducted immediately prior to any consignments of barramundi being translocated from the proposed source facility to HCP. This health testing will include both the submission of selected fish for laboratory testing (microbiology, histology) and examination of the fish by a suitably qualified aquatic veterinarian prior to shipment. The purpose of this testing and examination will be to ensure the fish to be translocated have no evidence of any of the diseases of concern.

2.12 What is the OIE disease zoning status of the source and destination areas?

According to OIE guidelines, there are three classes of disease zoning: free, surveillance and infected. The OIE has generally classed disease zones at a country level rather than by state. Australia currently has not developed disease-zoning classifications for a number of aquatic animal diseases however in the case where organisms are to be translocated from international sources, the point of origin may be an area with a particular zonal classification. Information of these zones can be obtained from the relevant countries export approval authority or through the OIE.

The disease agents, or strains of select disease agents identified as being of high quarantine importance and subject to risk mitigation measures in the accompanying disease Risk Analysis have been deemed to be absent from Victorian fish, i.e, they are exotic. As such, Victorian waters, i.e., as far as is known, the destination waters, may be considered a free zone for these agents. All 7 disease agents are, however, endemic in one or more regions of Australia where barramundi may be sourced. Based on on-going health monitoring and surveillance, the proposed source facility can also be considered to be a free zone. Effectively, therefore, the barramundi to be translocated should this application be successful will be moved from a specified disease free zone to a zone where there is no evidence of the diseases of concern, although as far as the proponent is aware there has been little if any testing of fish currently resident in Hazelwood cooling pondage.

2.13 What quarantine processes and/or treatments will the consignment be subject to?

Quarantining of new stock is an established best practice approach for many aquaculture facilities. Quarantine provisions are best developed to manage the risks associated with particular species and source areas. Australian standards for quarantining stock should be used in each case. Pre export and post export quarantine procedures can be obtained from AQIS at www.aqis.gov.au Alternatively quarantine procedures may be customised for the species. Provide details of the quarantine and treatment processes that you intend to subject the consignment to.

The barramundi will be released directly into the Hazelwood cooling pondage (HCP) hence will not be subject to any quarantine processes. There are though currently no barramundi resident in the HCP as far as the proponent is aware. It is also important to note that each consignment of barramundi will come from a source facility which is considered to be free of any of the diseases of concern as identified in the attached Risk Analysis. Additionally, health testing will be conducted on each consignment as an added risk reduction exercise and the batch certified as free of any evidence of the diseases of concern prior to translocation.

2.14 Are undesirable species (e.g. parasites, blue green algae, fish) likely to be translocated with the consignment that are not currently found in the target location?

Translocating the target species may cause parasites or diseases present in the source area to also be translocated. List parasites and diseases species present in the source area and provide details as to whether any of these species are likely to be transported with the consignment. Refer 2.1. Various publications on fish diseases and parasites may assist the proponent in answering this question.

The proposed source facility only farms barramundi and no other fish species. It is a fully enclosed and biosecure facility hence there is no possibility of any other fish species inadvertently gaining entry. All source water comes from an underground aquifer, hence the chance of blue-green algae being present in the facility is considered very low.

As a precaution however, the proponent can ensure that any barramundi to be translocated are first dipped in a bath of fresh, clean aquifer water prior to being loaded onto the transport vehicle. This will reduce the possibility of any algal species resident in the production tanks being translocated with the fish.

Although there is no evidence of parasitic diseases in the source facility, it is not possible to completely remove any parasite that may be present on the barramundi at the proposed source facility. None of the parasites identified as diseases of concern are present – typically, parasites like *Trichodina* species may be present in very low numbers. These parasites are relatively ubiquitous across Australia and are not considered to be a high risk. It is also quite possible that exotic fish species currently resident in Hazelwood cooling pondage may have low parasite burdens.

2.15 Will the consignment be reliably certified free of undesirable accompanying species? If so, by whom?

A competent aquatic veterinarian authority can provide a level of assurance that the translocated species are correctly identified and that the consignment is free of any undesirable species. Provide details of the competent authority that will certify the consignment free of undesirable species. Refer 2.11.

Clean bore water will be used to transport the fish in. The fish are also being sourced from a fully enclosed recirculation aquaculture facility and can be dipped in fresh, clean bore water prior to loading on the transport vehicle. Visual inspection of the consignment may be conducted. Hence the consignment(s) can be reliably certified as free of undesirable accompanying species. This can be done by the aquatic animal veterinarian at the same time as the consignment is certified as free of any evidence of the diseases described in 2.11.

2.16 Based on the answers to Questions 2.1 to 2.15, what is the likelihood of escape?

This question asks the proponent to consolidate responses to all questions in this section and provide a summary argument on the likelihood of escape with particular reference to the effectiveness of proposed control measures at managing the risk of escape or release, including the threat of disease and parasite transfer

Summary argument:

If this application is successful the translocated barramundi from the proposed source facility will be released directly into the waters of the Hazelwood cooling pondage (HCP). They will come from a facility considered to be free of any of the diseases of concern identified in this application. They will also be subject to health testing prior to being translocated.

HCP is a man-made structure, with a single outfall point located at the point of the old Eel Hole Creek (identified with a red star in figure 1). Eel Hole Creek only flows intermittently. The distance from the outfall area to a more substantial rivercourse (Morwell River) is approximately 2 kilometres.

There are two routes that water (and escaped fish) may take when flowing out of HCP. The power stations preferred route is that water is pumped from a concrete bund, via a pipe approximately 30 cm in diameter (see figure 2), to a cooling tower 100 m away from the bund (see figure 3). The water is pumped to the top of the cooling tower, where it disperses through two large bladed rotating fans that air-cool the water. The water is spread over an area approximately 20 m by 10m and cascades down a series of timber baffles. It is unlikely any escaped fish would survive being hit or cut by the fans and then the consequent 15m fall through the series of timber baffles. The water then lands in a concrete floored bund area and flows into a drain leading to a concrete spillway. The water flows for approximately 20m along the spillway at a depth of approximately 5 cm eventually ending up in a series of ponds prior to flowing into Eel Hole Creek.

The alternative route to the cooling tower, is that water can overflow over a concrete wall which has a chain link fence along the top (figure 2). Water then flows along a concrete spillway for approximately 100m before entering the ponds before Eel Hole Creek. The depth of water along the 100m concrete spillway is unlikely to exceed 3 cm.

Hazelwood Power must ensure that the temperature of the water entering Eel Hole Creek is reduced by at least 10°C; hence the cooling tower route is the preferred overflow from the HCP. It is quite likely that the water temperature in Eel Hole Creek would not rise above 15-20°C at any point in the year.

Hence for barramundi to escape from HCP, they would need to satisfactorily pass through the screens over the outflow, through the cooling tower and then survive in water that is at a temperature well below their preferred tolerance range for over 2 kilometres along a creek that only flows intermittently. If they were to reach the Morwell River, they would still be exposed to water temperatures well below their optimum range.

Hence escape is considered highly unlikely. In the highly unlikely event of a fish escaping, the possibility of it surviving for anything more than a day or so is again considered highly unlikely. It is worth noting that there was no evidence of escaped fish in the area when inspected on 5 November 2009.

Figure 1 - HCP showing outfall area into Eel Hole Creek (Red Star)

Figure 2 - Outfall area from HCP

Figure 3 - Cooling tower at outfall area HCP

3. Escape / Release - Consequences

3.1 What species (including diseases and parasites) are likely to escape?

This question requires the proponent to provide details of species that are likely to escape from the area where the translocation is to occur. Please provide details of any parasites and diseases that may also be translocated in the transport medium or in or on the subject species of the translocation. Refer 2.14.

The consignment(s) of barramundi that will be released into Hazelwood cooling pondage (HCP) if this application is successful will:

i. Be sourced from a fully enclosed recirculation facility which only holds barramundi
ii. Be certified as free of evidence of a number of diseases that have been identified to be of concern in the Risk Analysis report that is attached (Appendix B).
iii. Be certified as free of any evidence of any undesirable accompanying species.

The barramundi will be released directly into the HCP and hence will have the ability to move to any area within the 550ha of pondage. There will be no control over this movement once the barramundi are released.

The ability to escape from this pondage has been discussed in 2.16.

3.2 In the event of an escape, what life stages (e.g. gametes, fertilised eggs, juveniles, adults, etc.) are likely to escape?

Certain events may make it possible for the translocated species to escape from the system it is held in, eg Flood, transport via waterfowl and vermin. However these transport vectors may only make it possible for certain life stages to be released. Provide details of the life stages that may be released during an escape event.

Barramundi of approximately 300mm in length will be released into the pondage. The pondage is freshwater. Barramundi cannot breed in freshwater which is further discussed in Section 6. Hence the only life stages which could possibly escape will be barramundi with a minimum length of 300mm. The only means of escape will be out through the overflow channel into Eel Hole Creek as has been discussed previously (Section 2.16).

3.3 In the event of an escape how many individuals are likely to escape?

The consequence of a handful of species being released during an escape event may be less than that of an event where thousands of the one species are released, however both escapes may constitute a risk. Please provide details of the number of organisms likely to escape during an escape event.

A total of approximately 10,000-16,000 fish are proposed to be released initially. The amount of fish that could possibly escape from the pondage will be a proportion of this number, depending on:

i. How many fish have been removed from the pondage since stocking through fishing or attrition (mortality)
ii. How long the escape event lasts
iii. How many fish are in the neighbourhood of the outflow of water through which the escape occurs.

Any escape of fish that does not result in fish being released into Eel Hole Creek will result in fish dying relatively quickly i.e. if there is a breach of the pondage wall (which would be catastrophic for the Power Station), fish may be released into pasture land. The temperature of the release water would rapidly cool even in summer. As the water level fell, the fish would be stranded on pasture land.

3.4 Based on the answers to Questions 3.1 to 3.3, what are the consequences of escape?

The proponent must provide a consolidated response to all questions in this section and provide a summary argument on the consequence of escape with particular reference to the effectiveness of proposed control measures for managing these risks.

Summary argument:

In the unlikely event of barramundi escaping out of the HCP at the outfall area and travelling through the cooling tower it is likely that they would end up residing in the small ponds below the cooling tower at the outfall area. The ambient temperature of these ponds is significantly below the water temperature in the HCP and also below the barramundi's preferred temperature range.

If any escapees were to move further down Eel Hole Creek the water will get cooler and cooler. It is likely that the barramundi will become more and more lethargic as the temperature cools. It is quite likely that if they were left in the confines of Eel Hole Creek they will die. If necessary though, another possibility is to capture any escapees – this will not be difficult considering the lethargic nature of the fish.

Hence the consequences of any escape would be negligible and confined to a very well defined area.

4. Survival - Likelihood

4.1 Is the natural and/or current range of the species/genetic stock known?

A species' natural range is an area where that species is found prior to any translocation events occurring. The current range of a species may differ to its natural range through a number of reasons including habitat degradation or over-fishing. Genetic homogeneity of a species may also differ between areas due to separation of a species through physical barriers. The proponent should provide details of both the natural and current range of the species and where information is available on the genetic homogeneity of the species describe if meta-populations of the species occur.

In Australia, the natural range of barramundi is considered to extend across the top of Australia from Shark Bay in Western Australia to about Mary River in Queensland (Pusey et al 2004). Hence Hazelwood Pondage is well outside the natural range of barramundi. The only reason that barramundi will survive in the pondage outside of its natural range is because of the artificially warm conditions created in the pondage because of the heating of water by the adjacent power station.

As far as the proponent is aware there are no other natural populations of barramundi within thousands of kilometres of Hazelwood cooling pondage.

4.2 Are the temperature and water quality requirements for survival known and are they available in the potential receiving waters?

If the water quality requirements of the species to be translocated exist in the receiving waters the likelihood of survival is increased. The proponent should provide information demonstrating water quality requirements of the species to be translocated and those that are found in the potential receiving waters. Parameters that may be provided include temperature, dissolved oxygen, pH and salinity.

Adult barramundi are found across a range of temperatures. The natural distribution of barramundi is limited by the winter water temperature – the lower temperature limit has been cited as 15.5°C (Pusey et al 2004). Feeding activity is greatly reduced below 24°C. Barramundi have been recorded in waters as warm as 35°C.

Heated water from the power station has been reported to raise the ambient temperature of water in the Hazelwood cooling pondage (HCP) from 14°C to 27°C in winter and from 21°C to 35°C in summer (Cadwallader et al. 1980). A survey of the HCP conducted by the proponents on November 5th, 2009 showed that the surface water temperatures across the HCP ranged from 25.3°C to 31.7°C. This is shown in figure 4. These temperatures are considered ideal for barramundi.

Any water flowing out of the pondage flows down Eel Hole Creek until it reaches the Morwell River. The water temperature in the lower reaches of Eel Hole Creek have been recorded as being around 17°-18°C in winter as shown in Figure 1. This is close to the lower temperature limit of barramundi. While barramundi may survive in this water temperature, they would likely be subdued, not eating and immunosuppressed. In studies conducted on barramundi moving upstream during their natural lifecycle, it has been found on at least one occasion that no movement occurred when water temperatures were below 20.5°C (Pusey et al 2004). The water temperature in the Morwell River is much closer to ambient – in winter this has been recorded as 8°C. It is highly unlikely that barramundi would survive many hours in water at this temperature.

However, one report has noted that the maximum temperature value for water in Morwell River was 25°C. It is likely that this temperature was recorded in summer. In this particular survey it was noted that the 90th percentile was 20°C (Harasymiw 1989). There are no reports of water temperature this high in Eel Hole Creek. If temperatures did rise above 20°C escaped barramundi may survive for a period of time. They would however be still in water that is at a temperature below their preferred range and it is unlikely the barramundi would eat of travel far. It is considered unlikely that the water temperature in Eel Hole Creek, if it did rise above 20°C, would remain at this level for very long.

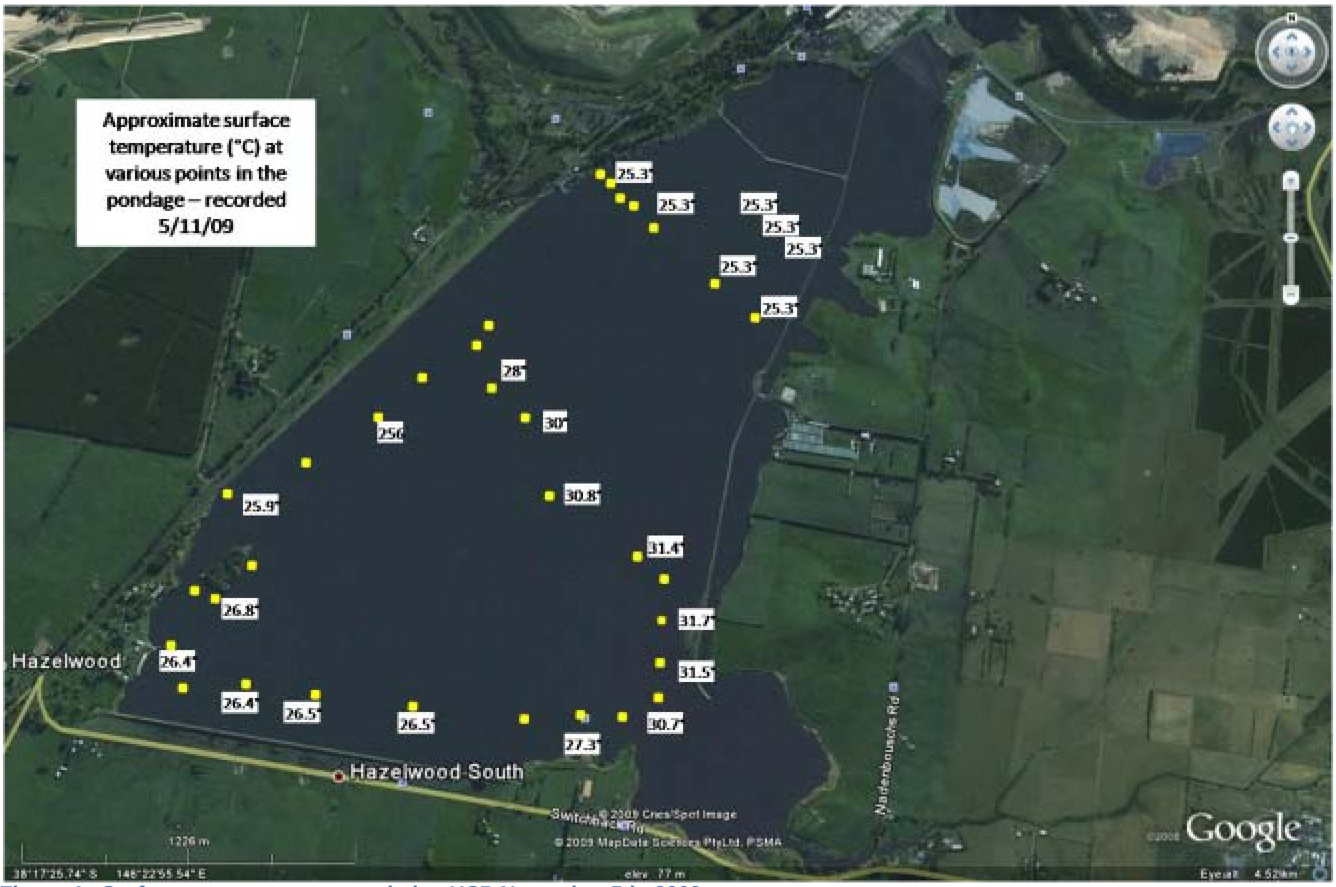

Figure 4 - Surface temperatures recorded at HCP November 5th, 2009

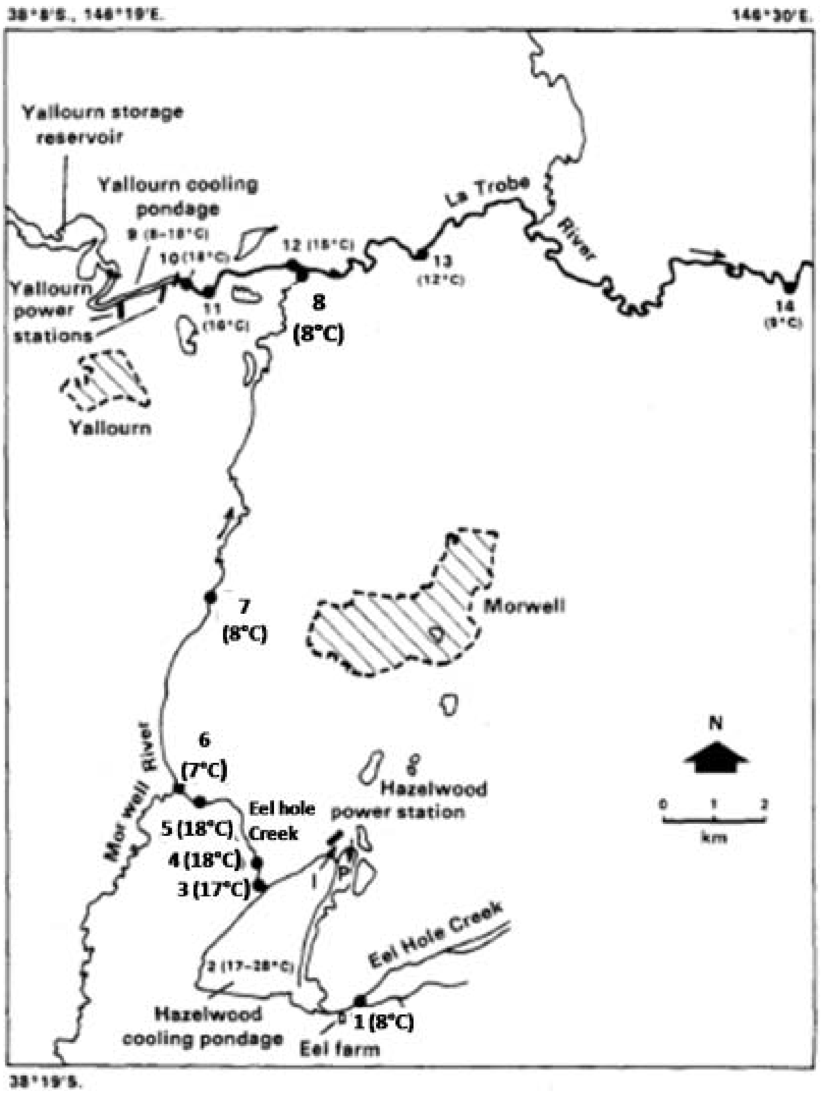

Figure 5 - Hazelwood pondage and associated water showing water temperatures as recorded at various stations in July and August 1979 (from Cadwaller et al, 1980)

4.3 Are the habitat requirements for survival known and are they available in the potential receiving waters?

Habitat requirements of species are also important for survival in the potential receiving waters. Some species require rocky substrates to graze algae from others are pelagic and can adapt to a range of open water habitats such as streams or lakes. Please describe whether the habitat required for survival of the target species, potential diseases or parasites to be translocated is known and whether that habitat is present in the potential receiving water.

Barramundi are very widely distributed throughout their natural range, and have been found in a number of different habitats. The most suitable habitat though changes through the life stages of the barramundi (Pusey et al 2004). When fish are approximately 250-350mm (i.e. the potential size of the fish to be translocated) they move upstream into a range of freshwater habitats including billabongs and floodplain lagoons and wetlands where they can remain for 3-5 years.

The proponents visited HCP on November 5th, 2009. At a number of sites the bottom of the pondage was physically examined. It was found to consist mainly of silt and mud, with little evidence of bottom weed. There were also numerous sites around the edges of HCP where there was tree limbs and water weeks extending into the pondage. This is likely to make excellent cover for barramundi – indeed, on examining these areas there were large populations of exotic fish species (predominately cichlids) identified (figures 2, 3, and 4)

Figure 6 - Example of habitat along edge of island in HCP

Figure 7 - Close up of overhanging tree branches in which numerous wild exotic species of fish were found – the red star identifies where figure 8 photo taken

Figure 8 - Underwater photo of some of the exotic fish species seen at the location marked with a red star in figure 7.

Based on this evidence, it is likely that the habitat of the HCP is suitable for survival of barramundi.

4.4 Are the food requirements of the species known and are they available in the potential receiving waters?

Certain species have specific food requirements for survival, which if not met the likelihood of survival may be reduced. Provide details of any specific food requirements that the species may have and details as to whether these are found in the potential receiving waters.

The food requirements of barramundi are known (Pusey et al 2004). There are changes in the make up of the typical diet of barramundi as they get older. Barramundi up to 400mm in length have a diet similar to adult fish i.e. more than half the diet is composed of macrocrustaceans such as prawns and crabs, with around 36% of the diet being fish. Barramundi greater than 400mm predominately rely on fish as their main food source.

It is currently unknown exactly how many different fish species are present in Hazelwood Pondage as no stock assessment fishery surveys have been conducted there. Credible evidence of at least 5 species of African cichlid has been recorded along with eels and carp (State Government of Victoria 2008) and two fish stockings have been attempted, but establishment of populations is unknown. The proponents physically identified at least two different species when visiting the HCP on November 5th, 2009.

In 1978 the African cichlid spotted tilapia (*Tilapia mariae*) and convict cichlid (*Archocentrus nigrofasciatus*) - 2 exotic species of tropical African Cichlid, were documented to have established self sustaining populations in the system, presumably from unlawful release of aquarium fish (Cadwallader et al 1980). Since then the South American blue acara (*Aequidens pulcher*), Central American Red Devil (*Amphilophus labiatus*) and a potential cross between African Lake Malawi cichlids *Labeotropheus* sp. and *Pseudotropheus* zebra have also become established in the pondage (Raadik 2001, Koehn 2002). Published (Cadwallader et al 1980) and anecdotal evidence (angler reports) suggest other species of tropical aquarium fish may have also been released into the system.

Two fish stockings have been attempted in the system. Fingerling rainbow trout (*Oncorhychus mykiss*) were unsuccessfully stocked in 1997 and 10,000 Australian Bass were released into Hazelwood pondage in 2003 (DPI website, Ainsworth and Jones 2003).

The barramundi which will be stocked into Hazelwood will have been supplied a commercial pelleted ration for most of their life. It is though likely that on release into the pondage the barramundi will quickly revert to being predatory in nature and will consume fish and any crustaceans that are currently present in the lake.

Hence at least initially there will be a suitable food source for the barramundi stocked into the HCP.

4.5 How `natural` is the target area (some species colonise disturbed areas more effectively)?

Target areas, which are undisturbed, may not be suitable for some species that prefer a more disturbed environment. Alternatively a disturbed area may reduce the likelihood of species survival for species requiring pristine habitats. The level of disturbance of the target area should be provided. Also provide details as to whether the receiving waters demonstrates a level of disturbance that is suitable to the translocated species.

For Closed and Semi-Closed Systems, applicants are also encouraged to consider how 'natural' the potential receiving waters are.

The target area is wholly man made due to the damming of Eel Hole Creek in 1962. The water in the pondage is significantly and unnaturally warmer than any ambient water of this area. It is only because of these disturbances to the natural habitat that the translocation of barramundi is being considered.

As noted before, the outfall of the HCP flows into Eel Hole Creek. After approximately 2km, Eel Hole Creek flows into the Morwell River. A survey of the Morwell River at the point where it Eel Hole Creek runs into it noted that the area “was rather barren, with no shelter that was reflected in the fact that no fish were caught at this site. In general, the data...indicate that the Morwell River, from the Morwell Diversion down, was degraded as a fish habitat (Harasymiw 1989).

4.6 For diseases and parasites, are suitable hosts likely to be available in the target area?

Many diseases and parasites are opportunistic and can infect a range of hosts in the target area. Others are species specific and can only affect a particular host. Please provide details as to whether a suitable host species is likely to be found in target area. Also refer 4.2. If the receiving water is not suitable for host species survival then the likelihood of survival of diseases and parasites may also be reduced.

For Closed and Semi-Closed Systems, applicants are also encouraged to consider availability of suitable hosts in the potential receiving waters.

It is quite possible that suitable fish hosts for some of the diseases and parasites identified in the Risk Analysis (Appendix B) are available in the target area. These fish though are exotic species released without authority into the HCP.

4.7 Based on the answers to Questions 4.1 to 4.6, what is the likelihood of survival?

In consideration of the responses made to questions 4.1-4.6 provide a detailed summary describing the likelihood of survival of the target species, parasites and pathogens in the target area and potential receiving waters.

Summary argument:

It is highly likely that barramundi, when released into HCP, will survive. The water conditions are favourable and currently there is a suitable feed source in the pondage. The full extent of this feed source is however not known.

As the barramundi are likely to survive, any parasites or pathogens that accompanied the barramundi during the translocation phase would also likely survive. Hence the need to source barramundi from a facility with a known health status and the additional mitigation step of health testing barramundi prior to translocation.

5. Survival Consequences

5.1 Is the species endemic to the target area?

A species endemic to the target area poses a lower risk to the environment than non-endemic species eg Golden perch in the Murray-Darling. Provide historical evidence demonstrating the target species is endemic to the target area.

For Closed and Semi-Closed Systems, applicants are also encouraged to consider if the species is endemic to the potential receiving waters.

The target species is not endemic to the target area – the target area is a man-made pondage with an unnaturally elevated water temperature. This is the only reason this non-endemic species is being considered for this area.

5.2 Is the species currently found in the target area?

The presence of the target species in the target area indicates that survival of the species in those receiving waters is highly likely. However the presence of that species may not mean that all stages of the lifecycle can be supported in that system. Please provide details as to whether the target species is currently found in the target area. Information that may be able to assist in this response, in the case where a species to be translocated is a recreationally targeted species, can be located on the DPI website in the Guide to the Inland Angling Waters of Victoria.

For Closed and Semi-Closed Systems, applicants are also encouraged to consider whether the species is found in the potential receiving waters.

Not as far as the proponents are aware.

5.3 Is the species likely to be a significant competitor/predator in the target area?

The impact of a species on the target area can be measured in a number of ways. Two potential impacts are predation on species within the target area and competition for food and/or habitat. Provide details on whether the species to be translocated are likely to be a predator or competitor with other species endemic to the target area.

For Closed and Semi-Closed Systems, applicants are also encouraged to consider if the species is likely to be a significant competitor/predator in the potential receiving waters.

Barramundi are a known predatory species of fish. Their presence in the pondage is likely to have an important effect on the structure of the freshwater aquatic community of the pond. However, currently the most abundant species in the pondage are exotic fish species, including some that are declared noxious species to Victoria. The presence of barramundi is likely to reduce the abundance of these exotic and noxious species.

5.4 Is the species likely to alter the physical environment?

Some species habits may have an effect on the physical habitat in which they live, eg yabbies are known for burrowing potentially causing seepage of ponds. The proponent must provide details of the species habits and whether those habits could have a physical effect on the environment in the target area and potential receiving waters.

It is unlikely that barramundi will alter the physical environment. As European carp (*Cyprinus carpio*) have been detected in the pondage it is possible that barramundi may prey on this species. If so, reduction of the carp could potentially decrease the potential for increased turbidity in the water column. European carp are known to feed along the bottom stirring up sediments.

5.5 Is the species likely to destabilise local plant communities?

Further to 5.4 the habits of some species may destabilise local plant communities. Please provide details of the species behavioural characteristics and evidence as to whether the target species is or is not likely to cause an effect on local plant communities in the target area and potential receiving waters.

No, it is unlikely that the introduced barramundi will destabilise local plant communities if they were present. Examination of the bottom of the pondage in a number of areas failed to detect any significant communities of benthic plants.

5.6 What effects are any released diseases or parasites likely to have in the potential receiving waters without completing their full life cycle?

Some diseases and parasites may be able to effect species within the potential receiving waters without completing their life cycle. Provide details of the effects that potential diseases or parasites identified in 3.1, could have on species that are found in the potential receiving waters even without them completing their full life cycle.

The risk analysis conducted as part of this application (Appendix B) has identified the following diseases of concern:

Viral Nervous Necrosis (VNN)
Lymphocystis
Streptococcosis
Epizootic Ulcerative Syndrome (EUS)
Virulent Vibrio harveyi
Trypanosoma sp.
Neobenedenia melleni

Risk mitigation measures which will be put in place to minimise the risk of these diseases being present in translocated barramundi have been discussed (Section 2.11) and include testing at the source facility prior to translocation.

It is possible that should these disease agents be released into the receiving water they may affect species currently present including the exotic and noxious species. The possibility of release of any pathogens from the HCP through escaped barramundi is considered very low – it would require the barramundi and pathogens to survive in the much cooler waters of Eel Hole Creek. While very low, it is not zero so again the proponents stress that a condition of this proposal is to source fish from a facility with a known health status and ensure fish are certified as free of any evidence of the above seven pathogenic agents prior to translocation into the HCP.

5.7 Based on the answers to Questions 5.1 to 5.6, what are the consequences of survival?

In consideration of the responses made to questions 5.1-5.6 provide a detailed summary describing the likely consequences of survival of the target species, parasites and pathogens in the potential receiving waters.

Summary argument:

If the translocated barramundi survive in the target water (which is to be expected) then any parasites or pathogens they may carry would also survive. The consequences of the barramundi surviving is likely to be a reduction in the number of exotic fish species currently resident in HCP due to the predatory nature of the species.

The consequences of the parasites and pathogens surviving (if introduced with the barramundi) is likely to be limited to the confines of the HCP and to any of the fish living in the HCP. This is because the HCP is an artificially created environment. It is considered that the consequences would be minimal. However, as mentioned previously the barramundi to be translocated will be sourced from a facility with a known health status and which maintains strict biosecurity. Any barramundi translocated will be certified as free from any evidence of clinical disease prior to translocation.

6. Establishment - Likelihood

6.1 Are the environmental requirements for the completion of all stages of the life cycle known and are they available in the potential receiving waters?

Many species require certain environmental conditions to successfully complete all stages of their life cycle. For example many warm water natives require a temperature increase to spawn. The proponent should demonstrate the environmental conditions required for the completion of all life stages of the target species and identified parasites or diseases and whether or not they are present in the potential receiving waters.

No, larval barramundi require waters of elevated salinity (upwards of 30 g/litre) to develop (Pusey et al). From Hazelwood Power annual reports, salinities have risen to 1.2g/litre in the HCP, which is well below what is required for the larval barramundi. Hence any barramundi introduced to the HCP will not breed.

6.2 For diseases and parasites, are carriers and hosts required for the completion of all stages of the life cycle known; and are they available in the potential receiving waters?

Refer instructions to 6.1.

Although the pondage currently contains a range of non-endemic warm-water fish species which likely carry a range of parasites or other disease agents, as far as the proponents are aware there are no records of disease monitoring or surveillance on these fish.

It is proposed that if barramundi are stocked in the pondage, regular monitoring of the health of these barramundi will be conducted. This will be through:

(a) observations on behaviour including feeding behaviour; and

(b) regular post-mortem examinations on captured fish.

6.3 Is the ability of the species to hybridise with local species known?

Hybridisation of species may occur where two separate species interbreed and produce offspring. Viable offspring such as in some abalone species or unviable offspring may be produced from this cross breeding. If a species can interbreed with another species in the potential receiving water, then the likelihood of a hybrid population in that waterway increases. Please provided details as to whether or not the target species will be able to interbreed with species in the potential receiving waters and in the case that this may occur, will the offspring be viable or unviable.

Barramundi will not hybridise with local species primarily as they will not be able to sexually mature due to an inability to reach salt water.

6.4 Based on the answers to Questions 6.1 to 6.3, what is the likelihood of establishment?

In consideration of the responses made to questions 6.1 -6.3 provide a detailed summary describing the likelihood of establishment of the target species in the potential receiving water

Summary argument:

Barramundi will not be able to establish in the HCP except for those individuals actually stocked. Translocated fish will not be able to breed due to the pondage being predominately freshwater.

7. Establishment - Consequences

7.1 How `natural` are the potential receiving waters (in unique or pristine areas, the consequences of establishment are likely to be considered to be more important)?

The consequences of a non-endemic species establishing itself within a pristine area may be considered a greater risk that an area where the waterway is degraded or has a number on non-endemic species already within it. Please indicate in your response the level of disturbance the waterway has been subject to and what these disturbances are, eg snag removal, bank erosion etc.

The potential receiving waters are contained in a man-made impoundment maintained at a temperature well above that of natural bodies of water in the surrounding environment. The receiving waters also contain a range of exotic warm-water fish species. As such, the receiving waters cannot be considered pristine and may be considered degraded as a consequence of its exotic fish fauna. It is highly probable that the barramundi will establish in these waters, which is the intention of the proposal.

7.2 Are there any endangered or rare species in the potential receiving waters?

A list of threatened species can be obtained from the Department of Sustainability and Environment web page. The proponent must consider whether the species proposed to be stocked will pose a risk to other aquatic fauna/flora, which may include invertebrates, amphibians and reptiles. In the case where threatened species are located in the potential receiving waters demonstrate whether the target species will have an effect on them.

As far as the proponent is aware there are no endangered or rare species in the Hazelwood cooling pondage, which as already discussed is maintained at a water temperature considerably greater than is ambient for this area.

The outfall from HCP flows into Eel Hole Creek, which then flows for approximately 2km before flowing into the Morwell River. A fish sampling survey was conducted just below the point at which Eel Hole Creek joins the Morwell River. No fish were caught at this area, which was noted to be barren (Harasymiw 1989). In the upland zone of the Morwell River, the following species of fish were caught using gill nets:

- Blackfish (*Gadopsis marmoratus*)
- Brown trout (*Salmo trutta*)
- Non-parasitic lamprey (*Mordacia praecox*)
- Short finned eel (*Anguilla australis*)

In the lowland zone, just upstream of where Eel Hole Creek enters the Morwell River, the following species were caught:

- Blackfish
- Pygmy perch (*Nannoperca australis*)
- Short finned eel

In the lowland zone downstream of where Eel Hole Creek enters the Morwell River, the following species were caught

- Australian smelt (*Retropinna semoni)*
- Pygmy perch.

As far as the authors are aware none of these species are threatened or endangered species.

In addition, in December 2002 research staff from Marine and Freshwater Resources Institute (MAFRI) surveyed 5 sites on the Morwell River, at and upstream of Yinnar (i.e. well upstream of where Eel Hole Creek joins the Morwell River) using electro-fishing equipment. All the above species were captured during this method, except the non-parasitic lamprey. The short headed lamprey (*Mordacia mordax*), the Pouched lamprey (*Geotria australis*) and the Gippsland Spiny Crayfish (*Euastacus kershawi)*, were also caught (Ainsworth and Jones, 2003).

Conceivably, some or all of these species may be present in part or all of Eel Hole Creek. As noted previously, it is considered highly unlikely that a barramundi will escape out of the Pondage and survive passage through the cooling tower or down the concrete spillway. However, if they did it is also considered highly unlikely they will survive in Eel Hole Creek for very long and are unlikely to be highly predatory in the short time they potentially could survive. Hence it is considered doubtful that any of these species, if present in Eel Hole Creek, will be at risk in the unlikely event of barramundi escaping and hence the consequence of this is considered very low.

7.3 Is the species subject to an eradication or minimisation program in the target area?

It is important to ensure that where a species is subject to an eradication program in a particular area that the translocation will not re-introduce the species into the area. Information as to whether the species in subject to such a program can be obtained through your local DPI / DSE office.

For closed and semi-closed systems consideration should be given to eradication programs in the potential receiving waters.

Barramundi are not subject to eradication programs in the target area.

7.4 Is the organism genetically modified?

Species that have been genetically modified may be more suited to an environment than species endemic to that area and may therefor displace these species through competition for food and habitat. Please provide details as to whether the species has been genetically modified and what are the implications of the modifications.

The barramundi proposed for introduction are not genetically modified.

7.5 Should the species establish in water bodies, is it likely that it can be eradicated?

There are many examples of animal translocations that have resulted in the establishment of feral populations. In most of these cases attempts to prevent their spread or eradicate the species has not been successful. Please provide details as to whether it is likely that the species to be translocated could be eradicated from the potential receiving waters.

Barramundi will be retained in the impoundment for life. Breeding populations will not occur due to the need for a saltwater phase in the life-cycle of barramundi. Thus over time and without additional stocking the population of barramundi over time will decrease.

7.6 Based on knowledge of the species' growth, reproductive characteristics and behaviour, is the species likely to displace local species in similar ecological niches?

The displacement of species through competition for similar ecological niches can be as damaging to biodiversity as predation or habitat destruction. Provide details as to whether any life stages of the species proposed to be translocated may displace species found in the potential receiving waters.

Barramundi are likely to be predatory on local exotic species already established in the HCP.

7.7 Based on knowledge of the species' behaviour and physical characteristics, is it likely to be a significant predator in the potential receiving waters?

The possibility of predation by the species proposed for translocation on species found in the potential receiving waters must also be considered. Refer 5.3. Noting that most recreational species in Victoria are predatory by nature provide details as to whether any life stages of the species proposed for translocation may predate on species found in the potential receiving waters.

Yes.

7.8 Based on knowledge of the species' behaviour and physical characteristics, is it likely to alter the physical environment in the potential receiving waters?

Some species through behaviour or physical characteristics may cause damage to the environment. This damage can alter the physical environment, which in turn can reduce available habitat and food for endemic species in that area. Provide details as to whether the species proposed for translocation could alter the physical environment of the potential receiving waters. Also Refer 5.5

Barramundi are unlikely to alter the physical environment of the potential receiving waters, which are essential man-made. The proponents have dived a number of points in the pondage and found the bottom to be predominately a silty mud bottom with little weed growth.

7.9 Based on knowledge of the species' behaviour and physical characteristics, is it likely to destabilise plant communities in the potential receiving waters?

Provide details, based on knowledge of the target species, as to whether the species is likely to destabilise plant communities within the potential receiving waters. Also Refer 7.8, 5.5.

No, barramundi are unlikely to destabilise plant communities in the receiving waters.

7.10 Is the consignment of the same genetic stock as local populations?

The mixing of genetic stocks can reduce the genetic integrity of species and in turn may reduce it's resistance to disease or certain environmental conditions. It is therefore important that genetic stocks are not mixed in order to maintain genetic integrity within natural populations. Provide details describing the source of the stock and whether there are genetic differences between those stocks.

As far as the proponent is aware there are currently no local populations of barramundi in the HCP.

7.11 What effects are any released diseases or parasites likely to have in the potential receiving waters?

Some diseases and parasites are host specific. Therefore the effect of these on the receiving waters will alter depending on the inhabitants of those waters. Provide details of the potential effects that any diseases or parasites that may be transported could have on species found in the potential receiving waters.

A number of pathogens and parasites have been identified as being of significance to the potential translocation of barramundi (Appendix B). These are:

- Viral Nervous Necrosis (VNN)
- Lymphocystis
- Streptococcosis
- Epizootic Ulcerative Syndrome (EUS)

Virulent Vibrio harveyi
Trypanosoma sp.
Neobenedenia melleni

It is possible that these parasites and pathogens could affect the fish species currently established in HCP. However, as far as the authors are aware most of these species are introduced species exotic to the area. The consequences of any of these pathogens or parasites entering HCP may be to cause morbidity or mortality in these local established populations. This is not considered desirable, hence the mitigation measures that have been proposed to minimise the risk of any of these parasites or pathogens being translocated with the barramundi.

7.12 Based on the answers to Questions 7.1 to 7.11, what are the consequences of establishment?

Based on questions 7.1-7.11 what are the consequences of establishment of the target species or diseases and parasites that may be transported with the species on the potential receiving waters.

Summary argument

Any barramundi translocated into the HCP will be unable to establish breeding populations due to the fact that the HCP is predominately freshwater. The only barramundi that will be present in the HCP will be those that have been translocated there.

This is different from the other species present in the pondage. As noted previously, at least 2 exotic species have been documented as establishing self sustaining populations in the pondage. Introducing barramundi, an Australian native fish into the HCP may assist in reducing the numbers of the exotic species present there.

8. Socio-Economic

8.1 What are the social or community impacts associated with your proposal to translocate?

Describe the social benefits that may be gained from the proposal to translocate an organism e.g fish for tourism. Detail whether these social benefits will "out weigh" any of the social aspects of other activities in the proposed receiving waters e.g damage to other recreational fisheries.

Major positive social and community impacts are envisaged from the proposal to stock Hazelwood pondage with barramundi. If this proposal is successful, it will be the only recreational barramundi fishery in the southern half of Australia. It is expected that recreational anglers from all over Victoria as well as New South Wales, South Australia and Tasmania will visit Hazelwood Pondage.

The social and community impacts will be increased holiday and tourism opportunities for the region and it is envisaged that membership in local fishing club and other local social club membership will significantly increase as a direct result of the fishery being established.

It is also predicted that several fishing competitions and community events will be introduced as a direct result of this fishery being established.

There are no perceived social disadvantages from the proposal. There is no competing recreational or commercial fishery.

8.2 What are the estimated economic impacts associated with your proposal to translocate?

Provide details of the economic impacts of the proposal. These may be positive effects such as regional employment and tourism or negative effects such as eradication and or recovery programs.

In 2006, an economic impact study (Rolfe et al 2005) was conducted on three Queensland impoundments which are stocked with fish for recreational fishing purposes. During the 1980's Boondooma dam in South East Queensland was established to supply the needs of the Tarong Power Station. The study revealed that an estimated $3.5m in economic activity is generated from recreational fishing at this dam.

While Boondooma dam is approximately 3.5 times larger than Hazelwood Pondage, it is likely that a recreational barramundi fishery may contribute more than $2m to the local economy by way of accommodation, meals, fuel, fishing equipment and other local tourism activity.

It is envisaged that employment in the local accommodation sector will be increased as a direct result of this fishery being established.

References

Ainsworth M, Jones G (2003). Fisheries Management Report. Year 2003 Consultations with DPI Regions on Fish Stocking, Fish Population Surveys and other Recreational Fisheries Management Issues. F. Victoria. East Melbourne, Department of Primary Industries.

Cadwallader PL, Backhouse GN and Fallu R (1980). Occurrence of Exotic Tropical Fish i9n the Cooling Pondage of a Power Station in Temperate South-eastern Australia. Australian Journal of Marine and Freshwater Research, 31:541-546

Harasymiw BJ (1989). Fish survey of the Morwell River and biota comparison with Traralgon Creek. Report No. SO/88/150 State Electricity Commission of Victoria.

Hazelwood Power (2001) - Hazelwood Power Environmental Report 1st July 2000 – 31st December 2001. Available at http://www.ipplc.com.au/_modules/Uploader/_uploaderBin/jbrinkworth/4f83e98e0cecd1ab82c03fcd2869dd242001AnnualReport.pdf

Koehn J. (2002). Freshwater invaders in Victoria. Under Control - Pest Plant and Animal Management News DPI. 22.

Pusey B, Kennard M and Arthington A (2004). Freshwater fishes of north-eastern Australia. CSIRO publishing.

Raadik T (2001). Hazelwood Pondage rivals Lakes Victoria and Nicaragua for cichlid diversity? Australian Society For Fish Biology newsletter. 31: 27.

Rolfe J, Prayaga P, Long P and Cheetham R (2005). The Economic Value of Freshwater Impoundment Fisheries in Queensland: The Bjelke-Petersen, Boondooma and Fairbairn Dams. Project funded by the Queensland Department of Primary Industries and Central Queensland University.

APPENDIX A

Disinfection of Fish Farms

Disinfection and Method of use as per OIE, International Aquatic Animal Health Code 2003.

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Process	Indications	Method of Use*	Comments
Physical			
Desiccation, Light	Fish pathogens on earthen bottoms	Dry for 3 months at an average temperature of 18^oC	Drying period can be reduced by the use of a chemical disinfectant
Dry Heat	Fish pathogens on concrete, stone iron, ceramic surfaces	Flame-blower, blow-lamp	
Damp heat	Fish pathogens in transport vehicle tanks	Steam at 100^0C for 5 minutes	
Ultra -violet rays	Viruses and bacteria *Myosporidian* spores in water Infectious pancreatic necrosis (IPN) and nodavirus (VNN/VER) in water	$10mJ/ cm^2$ $35mJ/ cm^2$ $125\text{-}200mJ/cm^2$	Minimum lethal dose
Chemical			
Quaternary ammonia	Virus, bacteria, hands Gill bacteria, plastic surfaces	1mg/ L for 1 minute 2mg/ L for 15 minutes	Infectious Pancreatic Necrosis virus resistant.
Calcium[a] oxide	Fish pathogens on dried earthen-base	$0.5kg/m^2$ for 4 weeks	Replace in water and empty disinfected pools keeping the effluent at pH <8.5
Calcium (Hypochlorite)	Bacteria and viruses on all clean surfaces and in water	30mg available chlorine / litre left to inactivate for several days	Can be neutralised with sodium thiosulfate
Calcium[a] cyanamide	Spores on earthen bottoms	3000 kg/ ha on dry surfaces; leave in contact for 1 month	
Formalin	Fish pathogens in sealed premises	Release from formogenic substances, generally trioxymethylene. Comply with instructions	
Iodine (iodophors)	Bacteria Viruses Hands, smooth surfaces Eyed eggs Gametes during fertilisation Nets, boots and clothing	 >200mg iodine/ litre a few seconds 100 mg iodine / litre for 10 minutes 25 mg iodine/litre for several hours 200 mg iodine / litre	

Ozone	Sterilisation of water, fish pathogens	.2-1mg / litre for 3 minutes	Costly
Sodium[a] (hydroxide)	Fish pathogens on resistant surfaces with cracks	Mixture: Sodium hydroxide 100g, Teepol® 10 g, Calcium hydroxide 500 g, Water 10 litres. Spray, 1 Litre / $10m^2$ leave for 48 Hours.	The most active disinfectant $Ca(OH)_2$ stains the surfaces treated; Teepol® is a tensio-active agent Turn Water on, checking pH
Sodium[a] (hypochlorite)	Bacteria and viruses on all clean surfaces and in water	30 mg available chlorine / litre. Leave to inactivate for a few days or neutralise with Na thiosulfate after 3 hours	
Sodium[a] (hypochlorite)	Nets, boots and clothing	200 mg available chlorine / litre for several minutes	
Sodium[a] (hypochlorite)	Hands	Rinse with clean water or neutralise with thiosulfate	

a. Dangerous. Personnel must be protected. Protect skin, eyes and respiratory tract with a suitable barrier.

* The concentrations indicated are those for the active substance. NB Chemicals must be approved for the prescribed use and used according to the manufacturer's specifications

<u>Appendix B</u>

Stocking of Barramundi into Hazelwood Pondage: A FutureFish Foundation Initiative

Disease Risk Analysis

and

Management Options Paper

Table of Contents

Introduction and Background

Futurefish Foundation was incorporated in 1999, with a mission to protect and enhance recreational fishing for all Victorian's through a range of initiatives including environmental, educational and fish stocking projects as well as projects that improve fish habitat, access and facilities. A recent initiative of Futurefish Foundation is to promote the establishment of a recreational barramundi fishery at the Hazelwood Pondage, the cooling waters for the Hazelwood power station in the Latrobe Valley, Victoria, which maintain a water temperature supportive of barramundi normally restricted to tropical waters. It is envisaged that the establishment of the fishery will bring significant economic and recreational benefits to the region.

In order to achieve the recreational barramundi fishery, Futurefish Foundation has collaborated closely with International Power (Hazelwood), the Latrobe City Council and Fisheries Victoria. An initial application to Fisheries Victoria for consideration and approval of the proposal has initiated an assessment of the ecological and health risks associated with the proposal to introduce barramundi to the pondage. This document describes the assessment process used to determine the disease risks to endemic Victorian species associated with the introduction of barramundi into the Hazelwood pondage, the nature of the disease risks and mechanisms or strategies whereby such risks may be minimised.

Methods

Fish fauna of Hazelwood pondage

As a basis for the risk assessment process, a list of native and endemic fish species identified in Hazelwood pondage was compiled and is shown in Table 1.

Risk Assessment Process

This assessment of risk of disease incursion into Victorian waterways as a result of the importation of barramundi into the Hazelwood cooling ponds has been based on the guidelines in Biosecurity Australia (2009) and on the risk assessment process modified from published examples of import risk Analyses (Kahn et al 1999).

The risk assessment process comprised the following three components:

Part 1. Hazard identification

Hazard identification, i.e., those diseases presenting a threat to Victorian endemic fish species was determined as follows:

i. Definition of criteria used for identifying diseases of concern
ii. Listing of all known disease agents in Australian barramundi
iii. Ranking of disease agents according to criteria defined in i. Above
iv. Identification of disease agents for further consideration

Part 2. Risk assessment

Risk assessment was determined according to three factors

i. Release assessment
ii. Exposure assessment
iii. Consequence assessment

Part 3. Risk management

Measures to mitigate against disease incursion associated with the introduction of barramundi into the Hazelwood pondage were developed, based on the hazards identified and the risk presented by these agents.

Part 1. Hazard identification

The diseases, pathogens and parasites addressed in this import risk assessment (IRA) were those identified in barramundi in Australia and which are potentially infectious, i.e., are capable of being transmitted within barramundi populations or to other species of finfish and which, should they establish in Victorian waters may result in result in high mortality and/or morbidity in endemic Victorian fish species.

Disease agents or strains of disease agents recorded in barramundi in Australia were assessed against the following criteria to determine their level of quarantine concern given unrestricted entry to Victoria:

- Exotic to Victoria, and;
- An infectious primary pathogen or parasite, and;
- Notifiable under Victorian legislation, and/or
- Capable of causing disease with significant potential adverse impact on commercial fisheries, aquaculture or the environment

This IRA does not address non-infectious (nutritional, toxic, genetic, environmental) diseases reported in Australia and does not address exotic diseases that have been reported in barramundi elsewhere.

In order to identify hazards for the IRA, a comprehensive review of all microbial and parasitic agents recorded in barramundi in Australia was undertaken and tabulated (Table 2). Those agents meeting the criteria for diseases of concern were identified for further consideration in the IRA (Table 3). Disease agents that are endemic in Victorian waters, that are of low pathogenic and/or economic significance and disease agents regarded as being secondary or opportunistic invaders were excluded from further consideration at this point.

Part 2: Risk assessment

Subsequent to the identification of disease agents of concern in barramundi, each agent was subject to further consideration in relation to the specific risk presented by the unrestricted importation of barramundi into Victoria from elsewhere in Australia, the unrestricted importation being defined as imports of barramundi irrespective of origin with no disease testing or health certification.

Disease agent summaries

To assist in the evaluation of the probability of disease establishment and to assess the consequences of such establishment in Victorian waters, the clinico-pathological features of the disease, its pathogenesis and its important epidemiological characteristics were summarised for each disease agent of concern (Table 3) according to the following headings:

- ***Background and pathogenic significance***
- ***Geographic distribution, host range and prevalence in Australia***
- ***Detection methods***
- ***Stability of disease agent***
- ***Transmission***

Release, Exposure and Consequence Assessment

Based on the approach used by Biosecurity Australia, quarantine risk relating to the unrestricted importation of barramundi into Victorian waters was considered from two aspects:

1. The probability of the disease agent (1) entering (***Release assessment***) and (2) becoming established (***Exposure assessment***) in Victorian waters which combined gives a measure of the risk of disease establishment.
2. The expected impact or significance of such establishment of the disease agent, i.e., the consequences or ***consequence assessment***.

Measure of risk

The probability of these event occurring, ie., the risk, was made in a semi-quantitative manner according to Kahn et al (1999) thus:

Probability	**Criteria**
High	Event would be expected to occur
Moderate	There is less than an even chance <50%) of the event occurring
Low	Event would be unlikely to occur
Very low	Event would occur rarely
Extremely low	Event would occur very rarely
Negligible	Chance of event occurring is so small it can be ignored in practical terms

Release assessment

The probability that the agent will enter Victorian waters as a consequence of the unrestricted importation of live barramundi.

Exposure assessment

The probability of susceptible fish being exposed to a dose sufficient to cause infection if the disease agent enters Victorian waters in live barramundi.

Probability of disease establishment

The probability that a disease agent will enter the pondage and establish in susceptible Victorian fish species was determined by combining the release assessment and exposure assessment above.

Consequence assessment

The consequence assessment was determined to be the assessment of the adverse biological, social and economic impacts should the disease agent establish in the Hazelwood cooling ponds or the wider Victorian freshwater or marine environments. Specifically, the following four criteria were considered:

- *Potential adverse impacts on species of commercial or recreational importance*
- *Potential adverse impacts on species of aquacultural importance*
- *Potentail adverse ecological and environmental impacts*
- *Potential adverse socio-economic impacts*

Unrestricted risk estimate

The unrestricted risk estimate was determined by combining the probability of disease establishment with the consequence assessment for each specific disease agent. Where high, the unrestricted risk estimate was used to justify the implementation of specific risk management measures.

Details of risk assessments for each disease agent are shown in Appendix 1.

Part 3: Risk management

Two general mechanisms exist by which the risk of disease agents entering and establishing concurrent to the importation of live finfish may be minimised:

- Imposing conditions on the population from which the fish are sourced and/or on the fish to be imported

- Reducing the likelihood that susceptible host species in the receiving areaa would be exposed to imported barramundi or derived waste likely to transmit disease, by imposing conditions on the imported fish and/or on the materials imported with them.

Mechanisms whereby the risk of disease agents identifies in Part 2 were developed for imported barramundi, specifically in relation to the proposal to hold fish in the Hazelwood cooling ponds.

Results

Fish fauna of Hazelwood pondage

The fish species identified in the Hazelwood pondage comprises both endemic species and introduced tropical species (Table 1).

Table 1. Fish fauna identified in Hazelwood pondage

Species	Common name	Reference
Tilapia mariae	Black mangrove or Niger cichlid	Cadwallader et al 1980
Archocentrus (Cichlasoma) nigrofasciatum	Convict cichlid	Cadwallader et al 1980
Cichlasoma octofasciatum	Jack Demsey cichlid	Cadwallader et al 1980
Cyprinus carpio	Carp	Raadik 2001
Carassius auratus	Goldfish	Raadik 2001
Gambusia holbrooki	Gambusia	Raadik 2001
Anguilla australis	Native short-finned eel	Raadik 2001
Retropinna semoni	Australian smelt	Raadik 2001
Aequidens pulcher	South American blue acara	Raadik 2001
Labeotropheus sp. x *Pseudotropheus zebra*	African Lake Malawi cichlids	Raadik 2001
Amphilophus (*Cichlasoma*) *labiatus*	Central American Red Devil	Raadik 2001

Part 1. Hazard identification

Each of the infectious disease agents identified in Australian barramundi is shown in Table 2, together with criteria for identifying agents of high quarantine importance and the ranking of agents to be considered further.

Table 2. Listing of disease agents of barramundi in Australian and identification of disease agents for further consideration

Agent	Considered Exotic to Victoria	Considered a Primary Pathogen	Notifiable under Victorian legislation	Disease of significant adverse impact	Considered further in IRA
Viruses					
Viral nervous necrosis virus	Yes	Yes	Yes	Yes	Yes
Lymphocystis virus	Yes	Yes	No	Yes	Yes
Bacteria					
Aeromonas spp. (Not *A. salmonicida*)	No	No	No	Yes	No
Alcaligenes sp.	No	No	No	No	No
Citrobacter werkmanii	No	No	No	No	No
Clostridium spp.	No	No	No	No	No
Corynebacterium spp.	No	No	No	No	No
Edwardsiella tarda	No	No	No	No	No
Enterococcus sp.	No	No	No	No	No
Flavobacteraceae (*Flavobacterium* / *Tenacibaculum* group)	No	No	No	Yes	No
Fusobacterium sp.	No	No	No	No	No
Klebsiella pneumoniae	No	No	No	No	No
Mycobacterium spp.	No	Yes	No	No	No
Pasteurella multocida	No	No	No	No	No
Phenon 53	No	No	No	No	No
Photobacterium damselae subsp. damselae	No	No	No	No	No
Pleisomonas shigelloides	No	No	No	No	No

Prevotella sp.	No	No	No	No	No
Pseudomonas spp.	No	No	No	No	No
Rickettsia (Epitheliocystis)	Yes	Yes	No	Yes	Yes
Shewanella spp	No	No	No	No	No
Streptococcus dysgalactiae	No	No	No	No	No
Streptococcus iniae	Yes	Yes	No	Yes	Yes
Streptococcus sp. group D	No	No	No	No	No
Vibrionaceae (Excluding virulent V. harveyi)	No	No	No	Yes	No
Vibrio harveyi	Yes (?)	Yes	No	Yes	Yes
Fungi					
Branchiomyces – like *sp.*	Yes	Yes	No	No	No
Oomycetes – Saprolegniales group	No	No	No	No	No
Aphanomyces invadans	Yes	Yes	Yes	Yes	Yes
Pleistophora-like *sp.*	Yes	Yes	No	No	No
Protozoa					
Chilodonella spp.	No	Yes	No	Yes	No
Cryptocaryon irritans	No	Yes	No	Yes	No
Ichthyophthirius multifiliis	No	Yes	No	Yes	No
Trichodina spp.	No	Yes	No	Yes	No
Epieimeria – like sp.	Yes	Yes	No	No	No
Cryptosporidium – like sp.	Yes	Yes	No	No	No
Ichthyobodo (Costia) necator	No	Yes	No	Yes	No
Cryptobia sp.	Yes	Yes	No	No	No
Amyloodinium spp	No?	Yes	No	Yes	No
Henneguya sp.	Yes	No	No	No	No
Kudoa sp.	Yes	No	No	No	No
Trypanosoma sp	Yes	Yes	No	Yes	Yes
Cestodes					
Metacestodes - unidentified	No	Yes	No	No	No
Monogenea					
Neobenedenia melleni	Yes	Yes	No	Yes	Yes
Diplectanum sp.	Yes	Yes	No	No	No
Laticola paralates	Yes	Yes	No	No	No
Digenea					
Metacercaria - unidentified	No	No	No	No	No
Prototransversotrema steeri	Yes	No	No	No	No
Erilepturus hamati	Yes	No	No	No	No
Paracryptogonimus sp.	Yes	No	No	No	No
Sanguinicolidae gen sp.	Yes	No	No	No	No
Nematoda					
Nematode larvae - unidentified	Yes	Yes	No	No	No
Eustrongylides sp. larvae	No	Yes	No	No	No
Terranova type ll larvae	No	Yes	No	No	No
Copepods					
Ergasilus sp.	Yes	Yes	No	No	No
Ergasilus ogawai	Yes	Yes	No	No	No
Lernanthropus latis	Yes	Yes	No	No	No
Lernanthropus sp.	Yes	Yes	No	No	No
Isopods					
Nerocila barramundae	Yes	Yes	No	No	No
Branchiurans					
Argulus sp.	No	Yes	No	No	No
Annelids -leechs					
Unidentified	Yes	Yes	No	No	No

Disease agents of concern identified for further consideration

Eight disease agents meeting the criteria for diseases of concern were identified and are shown in Table 3.

Table 3. Disease agents of concern identified in barramundi

Viruses	Viral nervous necrosis virus
	Lymphocystis virus
Bacteria	Rickettsia (Epitheliocystis)
	Streptococcus iniae
	Virulent *Vibrio harveyi*
Fungi	*Aphanomyces invadans*
Protozoa	*Trypanosoma sp*
Metazoa	*Neobenedenia melleni*

Part 2. Risk Assessment

Each disease agent identified as a disease agent of concern in Table 3 was evaluated against the risk assessment criteria (Appendix 1) and the results summarised in Table 4 as follows:

Table 4. Probability of disease establishment in Victorian waters and potential consequences as a result of the unrestricted importation of live barramundi

Agent	Release Assessment	Exposure Assessment	Disease Establishment	Consequence Assessment	Risk Management Measures
Viral nervous necrosis virus	High (H)	Moderate (M)	High-Moderate	High	Yes
Lymphocystis virus	Low	Low	Low		
Streptococcus iniae	High	High	High		
Virulent *Vibrio harveyi*					
Rickettsia (Epitheliocystis)	Moderate	Moderate	Moderate		
Aphanomyces invadans	Moderate	Moderate	Moderate		
Trypanosoma sp	Low	Negligible	Low - Negligible		
Neobenedenia melleni,	Low	Negligible	Low - Negligible		

Part 3. Recommended Risk Management Measures

VNNV

- Stocks of fish to be derived from hatchery-reared fish
- Seedstock tested for freedom for VNNV, including absence of clinical disease
- Life-long maintenance in quarantine situation with no introductions of fish from untested sources

Aphanomyces invadans

- Stocks of fish to be derived from hatchery-reared fish
- A minimum of 12 months health monitoring on fish destined for translocation
- No history of clinical disease or lesions consistent with *A. invadans*
- Life-long maintenance in quarantine situation

Streptococcus iniae

- Stocks of fish to be derived from hatchery-reared fish
- A minimum of 12 months health monitoring on fish destined for translocation
- No history of clinical disease or lesions consistent with streptococcosis
- Life-long maintenance in quarantine situation

Epitheliocystis

- Stocks of fish to be derived from hatchery-reared fish
- A minimum of 12 months health monitoring on fish destined for translocation
- No history of clinical disease or lesions consistent with epitheliocystis
- Life-long maintenance in quarantine situation with no introductions of fish from untested sources
- Prolonged (>12mth) maintenance in fresh water

Virulent *Vibrio harveyi*

- Stocks of fish to be derived from hatchery-reared fish
- A minimum of 12 months health monitoring on fish destined for translocation
- No history of clinical disease or lesions consistent with primary vibriosis
- Life-long maintenance in quarantine situation with no introductions of fish from untested sources
- Prolonged (>12mths) maintenance in fresh water

Trypanosoma sp.

- Stocks of fish to be derived from hatchery-reared fish
- A minimum of 12 months health monitoring on fish destined for translocation
- No history of clinical disease or lesions consistent with trypanosomiasis
- Life-long maintenance in quarantine situation
- Prolonged (>12mths) maintenance in fresh water

Neobenedenia melleni

- Stocks of fish to be derived from hatchery-reared fish
- A minimum of 12 months health monitoring on fish destined for translocation
- No history of clinical disease or lesions consistent with epitheliocystis
- Prolonged (>12mth) maintenance in fresh water

Appendix 1: Risk assessment for disease agents of concern

As described in Methods above, based on:
Release Assessment: The probability that the agent will enter Victorian waters as a consequence of the unrestricted importation of live barramundi.
Exposure Assessment: The probability of susceptible fish being exposed to a dose sufficient to cause infection if the disease agent enters Victorian waters following unrestricted entry of live barramundi.
Disease Establishment: Combination of Release Assessment and Exposure Assessment, i.e., the probability that a disease agent will enter Victorian waters and establish in susceptible Victorian fish species
Consequence assessment: The consequences of the disease agent establishing in Hazelwood cooling ponds or in the wider Victorian freshwater or marine environments.

Viral nervous necrosis virus (VNNV)

Background and pathogenic significance

Viral nervous necrosis (VNN) is the disease caused by infection with members of the Betanodaviridae named viral nervous necrosis virus, commonly referred to as "nodavirus". The disease has emerged over the past two decades as a major global health problem in diverse species of finfish (Munday et al 2002). The disease in barramundi is reported in juvenile fish up to approximately 6 weeks, although typically it is fish 2-4 weeks that are affected. In Australia, the disease may be a significant limiting factor in the hatchery production of barramundi for aquaculture or stock enhancement. Mortalities may reach 100% in affected stock. Recovered fish may continue to carry the virus in the brain and retina (J. Humphrey – unpublished data).

Geographic distribution, host range and prevalence in Australia

VNN was first recorded and described as a picorna-like virus in Australia in a hatchery in Mourilyan in north Queensland in early 1989 and was subsequently detected in other hatcheries or farms in northern and southern Queensland and the Northern Territory (Anderson et al 1993, Glazebrook and Heasman 1992, Glazebrook et al 1990, Munday et al 1992, Overstreet 1990). The virus is now well recognised in Australia, being reported from diverse geographic locations in New South Wales, Northern Territory, Queensland, Western Australia, South Australia and Tasmania (FRDC 2007).

The virus is well recognised in a number of Australian finfish species including Barramundi *Lates calcarifer,* Australian bass *Macquaria novemaculata*, barramundi cod *Cromileptes altilevis*, goldspotted rockcod or estuary cod *Epinephelus coioides*, flowery cod *Epinephelus fuscoguttatus,* mullaway *Argyrosomus hololeptidotus,* sleepy cod *Oxyeleotris lineolatus,* archer fish *Toxotes jaculotrix* , snapper *Pagrus auratus,* striped trumpeter *Latris lineata* , trumpeter whiting *Sillago maculate*, sea mullet *Mugil cephalus*, sea bream *Acanthopagrus australis*, flat-tailed mullet *Liza argentea*, luderick *Girella tricuspidata* and yellowtail kingfish *Seriola lalandi* (Anderson and Oakey 2008, FRDC 2007).

Although there appear to be no records of nodavirus in the fish fauna of Hazelwood pondage, nodaviral disease is recognised in tilapia in freshwater environments (Bigarre et al 2009) and the possibility that species present in the pondage are susceptible cannot be excluded . Experimentally, further species including species endemic to the Murray Darling water catchment have been reported to be susceptible (Anderson and Moody 2005 Glazebrook 1995)

The prevalence of nodavirus in non-captive fish remains uncertain. Assays on stocks of captive broodstock barramundi predominantly captured from the wild ranged from approximately 5% to 30% positive (Anderson and Oakey 2008). Studies on growout barramundi derived from hatchery reared populations have demonstrated up to 50% carriers (Paul Hick – unpublished data).

Detection methods

Clinical VNN is readily diagnosed on the basis of typical clinical signs and histopathology. The detection of latent carriers is more difficult. PCR assays have been used for some years for the confirmation of VNN and to attempt to detect carrier fish or confirm of freedom for VNNV in populations of seed-stock for distribution to farms.

A commercial kit was one of the first assays adopted in Australia (IQ2000™ VNN Detection and Prevention System. Farming Intelligene Technology Corporation). More recently, a nested RT-PCR has been adopted (Moody et al 2004) which has shown to have greater sensitivity that the kit test. Currently, a real-time PCR assay developed by the University of Sydney is being validated for adoption as the preferred assay, with increased sensitivity, rapid assay time and reduced opportunity for false positive reactions through contamination.

Stability of disease agent

Piscine Betanodavirus is relatively resistant to physical and chemical agents, including UV irradiation, ozone disinfection in seawater, high and low pH, seawater and heating (Frerichs et al 1996, 2000; Liltvet et al 2006).

Transmission

Mature barramundi have been identified by PCR assay as latent carriers of VNNV with virus detected on occasions in ovarian fluid, seminal fluid and in the brain and retinae (Paul Hicks – unpublished data) and viral antigen has been demonstrated in ovarian tissue of broodstock fish and in the progeny derived therefore (Azad et al 2006a).

Although vertical transmission may occur, Azad et al (2006b) demonstrated integument and muscle infection in fish co-habited with diseased fish supporting a strong case for horizontal transmission. Further, Hick (unpublished) found compelling evidence of horizontal transmission via hatchery intake waters in populations of barramundi fry that tested negative following spawning, hatching and early development.

It appears likely that both means of infection occur under differing circumstances, with horizontal transmission from virus or virally infected planktonic organisms appearing to be a major mode of transmission to juvenile barramundi.

No cases of clinical disease due to VNN have been recorded in barramundi over approximately 6 weeks of age (J. Humphrey unpublished data). Thus fish older than 6 weeks of age are refractory to clinical infection

Fish recovered from clinical VNN are known to carry virus in a latent state. PCR assay of 20 fingerlings recovered from VNN at DAC showed a 90% incidence in eyes/ brain at approximately 4 months of age (J. Humphrey - Unpublished data). Although these fish may act as a source of infection, the mechanisms whereby virus may be shed from such fish remain unknown. It is not implausible that barramundi latently infected in the brain and retina are dead end hosts for the virus and do not shed virus at all.

Release assessment

The following key points are relevant to the likelihood of VNNV entering Victorian waters as a result of the unrestricted importation of barramundi.

- Although the geographic distribution of VNNV is not fully established, the virus appears to be widespread in certain populations of wild barramundi in Queensland waters and in farmed barramundi which have recovered from clinical disease
- Barramundi are known to carry VNNV in a subclinical or latent form. The virus appears to localise in the central nervous system and retina.
- There is evidence that the virus may be shed in ovarian or seminal fluids at or near spawning.
- Only juvenile fish up to about 6 weeks of age show clinical disease
- The clinical signs of VNN are characteristic and a positive diagnosis can readily be made using histopathology and molecular diagnostic methods which are readily available.

Exposure assessment

The following key points are relevant if VNNV entered the Hazelwood cooling ponds and the wider Victorian aquatic environment:

- The route of transmission is uncertain. Some evidence suggests the possibility of vertical transmission. Horizontal transmission has been demonstrated experimentally as a result of bath immersion to juvenile fish. Compelling evidence now exists demonstrating horizontal infection from sources other than known infected barramundi, ie, plankton or water-born virus.
- A range of native fish have been shown to be susceptible to natural or experimental infection, including species commonly found in the Murray Darling system.
- Latently infected mature barramundi appear unlikely to shed virus other than possibly at spawning.

On the basis of the above, the exposure assessment for VNNV is considered to be moderate

Risk of Disease establishment

On the basis of the release assessment and the exposure assessment, the risk of the establishment of VNNV is considered high-moderate

Consequence assessment

Effects on species of commercially or recreational importance

The effect of VNNV in commercially or recreationally important species would appear to be minimal. There are no examples of outbreaks of disease due to VNNV in non-captive populations of fish, however, the possibility of cryptic infections and disease in juvenile fish cannot be excluded.

Effects on species of aquacultural importance

The consequence of establishment or occurrence of VNNV in aquaculture hatcheries may be severe, with numerous examples of adverse impacts of VNNV in hatcheries. Occurrence of VNNV in hatcheries may result in high mortalities, accompanied by loss of market access for seedstock and discontinuities in the production grow out cycle.

Ecological and environmental effects

As noted, although there are no known adverse ecological and environment effects, the possibility of disease in juvenile stocks of fish cannot be excluded.

On the basis of the above, the consequence assessment for VNNV is considered to be high

Unrestricted risk estimate

For the unrestricted importation of barramundi, the probability of VNNV establishing in Victorian waterways is assessed as being high to moderate. The consequences of VNNV establishing in fish population in Victorian hatcheries is considered to be high.

Thus, for VNNV, the risk associated with the unrestricted importation of barramundi into Victoria and specifically into the Hazelwood cooling ponds is considered sufficiently high to justify the implementation of specific risk management measures.

Lymphocystis virus

Background and pathogenic significance

Lymphocystis virus is an iridovirus and is the cause of the disease lymphocystis. Infection results in massive enlargement of infected cells and causing nodular wart-like masses or discrete nodules principally in the skin, fins and gills. Lesions are readily visible to the unaided eye. The disease is recorded world-wide. Although the disease is disfiguring and may result in market rejection, infection is usually benign and lesions frequently regress spontaneously. Mortalities are reported, however, especially in juvenile fish and in ornamental species. A large number of higher-order teleosts fish are recorded with the virus worldwide.

Geographic distribution, host range and prevalence in Australia

Lymphocystis has been detected in Australia from imported ornamental fish in quarantine prior to release (Ashburner 1975, Langdon 1988) and has been described from South Australia, Queensland, New South Wales and the Northern Territory (Durham *et al* 1996, Pearce et al 1990, QDPI 2001a, Reddacliff and Quartararo 1992).

Lymphocystis disease has been confirmed in a number of captive and non-captive native Australian finfish species, including snapper *Pagrus auratus,* kingfish *Seriola lalandi* and barramundi *L. calcarifer* (Durham *et al* 1996, Pearce et al 1990, QDPI 2001a, Reddacliff and Quartararo 1992). It appears that lymphocystis virus is endemic in Australian finfish.

Detection methods

The virus is diagnosed on gross and histopathological findings.

Stability of disease agent

There is little data on the stability of lymphocystis virus

Transmission

Transmission is believed to occur following degeneration and lysis of the virally-transformed cells

Release assessment

The following key points are relevant to the likelihood of lymphocystis entering Victorian waters as a result of the unrestricted importation of barramundi.

- Lymphocystis has been recorded on one occasion in captive barramundi in Australia, despite widespread observation of farmed and non-captive fish over many years.

On the basis of the above, the release assessment for disease agent is considered to be extremely low

Exposure assessment

The following key points are relevant if lymphocystis virus entered the Hazelwood cooling ponds and the wider Victorian aquatic environment:

- A wide range of fish species are susceptible to infection
- Transmission is known to occur from spread of virus from clinically affected fish

On the basis of the above, the exposure assessment for lymphocystis virus is considered to be moderate

Risk of Disease establishment

On the basis of the release assessment and the exposure assessment, the risk of the establishment of lymphocystis virus is considered to be low.

Consequence assessment

Effects on species of commercially or recreational importance.

The effect of lymphocystis virus on commercial or recreational species appears to be very low

Effects on species of aquacultural importance

Lymphocystis virus has been associated with low-grade mortalities and market rejection. The disease is generally considered to be self limiting in aquaculture

Ecological and environmental effects

None reported

On the basis of the above, the consequence assessment for lymphocytsis virus is considered to be low

Unrestricted risk estimate

For the unrestricted importation of barramundi, the probability of lytmphocystis virus establishing in Victorian waterways is assessed as being low. The consequences of disease agent establishing in fish populations in Victorian waters is considered to be low.

Thus, for lymphocystis virus, the risk associated with the unrestricted importation of barramundi into Victoria and specifically into the Hazelwood cooling ponds is not considered sufficiently high to justify the implementation of specific risk management measures.

Epitheliocystis

Background and pathogenic significance

Epitheliocystis is caused by Chlamydial –like bacteria and is a disease recognised globally. Infection may result in high mortality, especially in juvenile stock. Infection is commonly subclinical. The organism typically affects gills, and may cause extensive hyperplasia of the gill lamellar epithelium. Histologically, the organisms are characterised by focal or multi-focal large basophilic inclusions.

Geographic distribution, host range and prevalence in Australia

Epitheliocystis is a common disease in Australian finfish, being recorded in a number of Australia species including silver perch (Read et al 2007), leafy sea dragon (Langdon et al 1991) and barramundi (Anderson and Prior 1992).

Detection methods

Infection is detected by histological examination.

Stability of disease agent

There appears to be no data on the stability of the epitheliocystis organism.

Transmission

There appears to be little information on the transmission of the disease. It is assumed that direct transmission occurs as a result of breakdown of epitheliocystis bodies.

Release assessment

The following key points are relevant to the likelihood of Disease agent entering Victorian waters as a result of the unrestricted importation of barramundi.

- Commonly reported in farmed barramundi – growout and juveniles
- Likely present in wild fish
- Commonly carried as latent infections in barramundi - gills

On the basis of the above, the release assessment for epitheliocystis is considered to be high to moderate

Exposure assessment

The following key points are relevant if the epitheliocystis agent entered the Hazelwood cooling ponds and the wider Victorian aquatic environment:

- Many fish species are potentially susceptible
- Infection appears to be direct via dissemination in water
- Shedding by clinically diseased and latently infected barramundi
- Low infectious dose likely

On the basis of the above, the exposure assessment for the epitheliocystis agent is considered to be high

Risk of Disease establishment

On the basis of the release assessment and the exposure assessment, the risk of the establishment of the epitheliocystis agent is considered high-moderate

Consequence assessment

Effects on species of commercially or recreational importance

Not recognised as a significant cause of disease.

Effects on species of aquacultural importance

May cause high mortalities in farmed seedstock and growout fish.

Ecological and environmental effects

No adverse impacts recorded

On the basis of the above, the consequence assessment for the epitheliocystis agent is considered to be high-moderate

Unrestricted risk estimate

For the unrestricted importation of barramundi, the probability of the epitheliocystis agent establishing in Victorian waterways is assessed as being high to moderate. The consequences of the epitheliocystis agent establishing in fish population in Victorian waters is considered to be of high-moderate severity.

Thus, for the lymphocystis agent, the risk associated with the unrestricted importation of barramundi into Victoria and specifically into the Hazelwood cooling ponds is considered sufficiently high to justify the implementation of specific risk management measures.

Streptococcus iniae

Background and pathogenic significance

S. iniae has emerged globally as a significant cause of mortalities in a diverse range of fish species (Austin and Austin 2004).

Geographic distribution, host range and prevalence in Australia

Streptococcosis caused by strains of *Streptococcus iniae* has emerged as a major disease in farmed barramundi in Australia. Aspects of the epidemiology, pathogenesis, treatment and control have been reviewed by Agnew and Barnes (2007). In Australia, the disease appears to be under reported, at least in intensive systems of barramundi production. Streptococcosis is recorded in farmed barramundi in both freshwater and marine environments (Bromage et al

1999; Creeper and Buller 2005; QDPI 2000, 2001b), and in silver perch (Read et al 2007).. Although the disease has been reported in Victorian farmed fish, multiple strains of the agent are known to occur in barramundi in Australia. These strains are considered exotic to Victoria.

Detection methods

S. iniae may be detected by bacterial culture, by PCR assay and by serological assays. A presumptive diagnosis may be made on histopathological examination of diseased fish. Detection in asymptomatically infected fish may also be achieved by culture and by PCR assay.

Stability of disease agent

There appears to be little specific data on the stability of S. iniae.

Transmission

Transmission appears to be direct.

Release assessment

The following key points are relevant to the likelihood of S. iniae entering Victorian waters as a result of the unrestricted importation of barramundi.

- Commonly reported in farmed barramundi – growout and juveniles
- Carried as latent infections in barramundi - meninges

On the basis of the above, the release assessment for S. iniae is considered to be high

Exposure assessment

The following key points are relevant if S. iniae entered the Hazelwood cooling ponds and the wider Victorian aquatic environment:

- Many species potentially susceptible
- Infection via dissemination in water
- Shedding by clinically diseased barramundi
- Low infectious dose
- Suspected of being spread with infected seedstock
- Multiple strains present in Australia

On the basis of the above, the exposure assessment for disease is considered to be high

Risk of Disease establishment

On the basis of the release assessment and the exposure assessment, the risk of the establishment of disease agent is considered high

Consequence assessment

Effects on species of commercially or recreational importance – No major effects identified

Effects on species of aquacultural importance– Major pathogen of farmed finfish with losses incurred through mortalities, chemotherapy and vaccination.

Ecological and environmental effects – No major effects identified

On the basis of the above, the consequence assessment for S. iniae is considered to be high

Unrestricted risk estimate

For the unrestricted importation of barramundi, the probability of exotic strains of S. iniae establishing in Victorian waterways is assessed as being high to moderate. The consequences of disease agent establishing in fish population in Victorian waters is considered to be high.

Thus, for S. iniae, the risk associated with the unrestricted importation of barramundi into Victoria and specifically into the Hazelwood cooling ponds is considered sufficiently high to justify the implementation of specific risk management measures.

Virulent *Vibrio harveyi*

Background and pathogenic significance

Geographic distribution

Host range and prevalence in Australia

Detection methods

Stability of disease agent

Transmission

Release assessment

The following key points are relevant to the likelihood of virulent V. harveyi entering Victorian waters as a result of the unrestricted importation of barramundi.

- Rarely reported in farmed barramundi – growout and juveniles
- Associated with antibiotic use & selection for virulent species

On the basis of the above, the release assessment for disease agent is considered to be very low.

Exposure assessment

The following key points are relevant if virulent V. harveyi entered the Hazelwood cooling ponds and the wider Victorian aquatic environment:

- Many species potentially susceptible
- Infection via dissemination in water
- Shedding by clinically diseased and latently infected barramundi
- Low infectious dose likely
- Marine / estuarine pathogen

On the basis of the above, the exposure assessment for disease is considered to be moderate

Risk of Disease establishment

On the basis of the release assessment and the exposure assessment, the risk of the establishment of Virulent V. harveyi is considered low

Consequence assessment

Effects on species of commercially or recreational importance – no adverse impacts known

Effects on species of aquacultural importance– Major adverse impacts resulting from mortalitie, l;ost production, chemotherapy and vaccination

Ecological and environmental effects - no adverse impacts known

On the basis of the above, the consequence assessment for virulent V. harveyi is considered to be high

Unrestricted risk estimate

For the unrestricted importation of barramundi, the probability of virulent V. harveyi establishing in Victorian waterways is assessed as being low. The consequences of virulent V. harveyi establishing in fish population in Victorian hatcheries is considered to be high.

Thus, for virulent V. harveyi, the risk associated with the unrestricted importation of barramundi into Victoria and specifically into the Hazelwood cooling ponds is considered sufficiently high to justify the implementation of specific risk management measures.

Aphanomyces invadans

Background and pathogenic significance

Epizootic Ulcerative Syndrome (EUS), a syndrome of dermal ulceration, erosion and necrosis, frequently accompanied by fungal invasion, necrosis and granulomatous inflammatory changes in underlying collagenous and muscle tissues occur world-wide in diverse families of fish from freshwater and estuarine environments spanning tropical, subtropical and temperate environments (Sindermann 1988). EUS has emerged as a major disease over the past 15-20 years in Australia and South-East Asia (FAO 1986, Langdon 1986, Roberts et al 1986, Roberts et al 1992, Tonguthai 1985) and was recorded as a distinct syndrome in Papua New Guinea (Uwate 1983, Coates 1984).

Geographic distribution, host range and prevalence in Australia

In Australia, syndromes described as ulcer disease, red spot, Bundaberg disease, ulcerative syndrome, ulcerative mycosis and epizootic ulcerative syndrome have been used to describe the erosive, ulcerative and necrotising lesions associated with the invasive fungus *Aphanomyces invadans* (McKenzie and Hall 1976; Fraser et al 1992), and are all considered to be EUS. EUS has been described in a diverse range of species from coastal Queensland (Burke and Rodgers 1981, McKenzie and Hall 1976, QDPI 2001b, Rodgers and Burke 1981), central Australia (JD Humphrey unpublished), coastal New South Wales, (Callinan 1988, Read et al 2007), Tasmania (Munday 1985), Western Australia (Callinan 1986), and Northern Territory (Gray 1987, Pearce 1988). One isolated report of a mycotic myositis has been reported from Victoria (JASCOFD 1990). Although in the majority of cases, fungal isolation has not been conducted, in Queensland, New South Wales and the Northern Territory at least, the condition is recognised as EUS with *Aphanomyces invadans* considered to be the invasive fungus.

Detection methods

Stability of disease agent

Transmission

Release assessment

The following key points are relevant to the likelihood of Disease agent entering Victorian waters as a result of the unrestricted importation of barramundi.

- Reported in wild and grow-out barramundi – endemic northern and eastern rivers
- Seasonally recurrent disease – latent infections

On the basis of the above, the release assessment for A. invadans is considered to be high

Exposure assessment

The following key points are relevant if disease agent entered the Hazelwood cooling ponds and the wider Victorian aquatic environment:

- Many species susceptible
- Infection via motile spores from environment or infected fish
- Unlikely to be carried by fish with no lesions, however, early lesions may be difficult to detect
- Factors facilitating infection not totally understood: acid pH, parasitism, environment

On the basis of the above, the exposure assessment for A.invadans is considered to be moderate

Risk of Disease establishment

On the basis of the release assessment and the exposure assessment, the risk of the establishment of A. invadans is considered high-moderate.

Consequence assessment

Effects on species of commercially or recreational importance – major adverse impacto on commercially and recreationally important species with lesions, deaths

Effects on species of aquacultural importance – recognised in farmed fish

Ecological and environmental effects – Unknown but possibly adverse impacts on recruitment through high losses.

On the basis of the above, the consequence assessment for A. invadans is considered to be high

Unrestricted risk estimate

For the unrestricted importation of barramundi, the probability of A. invadans establishing in Victorian waterways is assessed as being high to moderate. The consequences of A. invadans establishing in fish population in Victorian hatcheries is considered to be high.

Thus, for A. invadans, the risk associated with the unrestricted importation of barramundi into Victoria and specifically into the Hazelwood cooling ponds is considered sufficiently high to justify the implementation of specific risk management measures.

Trypanosoma sp.

Background and pathogenic significance

Geographic distribution, host range and prevalence in Australia

Detection methods

Stability of disease agent

Transmission

Release assessment

The following key points are relevant to the likelihood of Trypanosoma sp. entering Victorian waters as a result of the unrestricted importation of barramundi.

- Reported on one occasion as severe clinical disease in marine farmed barramundi
- Possibly carried as asymptomatic infections in wild barramundi or other species

On the basis of the above, the release assessment for disease agent is considered to be extremely low.

Exposure assessment

The following key points are relevant if disease agent entered the Hazelwood cooling ponds and the wider Victorian aquatic environment:

- Possibly direct transmission for heavily infected fish at high stocking densities in clinical outbreak
- Intermediate blood-sucking host generally considered necessary
- Marine / estuarine pathogen

On the basis of the above, the exposure assessment for disease is considered to be very low

Risk of Disease establishment

On the basis of the release assessment and the exposure assessment, the risk of the establishment of disease agent is considered very to extremely low.

Consequence assessment

Effects on species of commercially or recreational importance- no impacts reported

Effects on species of aquacultural importance- Cause of high mortalities on one occasion

Ecological and environmental effects - no impacts reported

On the basis of the above, the consequence assessment for VNNV is considered to be low

Unrestricted risk estimate

For the unrestricted importation of barramundi, the probability of Trypanosoma sp. establishing in Victorian waterways is assessed as being very to extremely low. The consequences of disease agent establishing in fish population in Victorian hatcheries is considered to be low.

Thus, for Trypanosoma sp. the risk associated with the unrestricted importation of barramundi into Victoria and specifically into the Hazelwood cooling ponds is not considered sufficiently high to justify the implementation of specific risk management measures.

Neobenedenia melleni

Background and pathogenic significance

Geographic distribution

Host range and prevalence in Australia

Detection methods

Stability of disease agent

Transmission

Release assessment

The following key points are relevant to the likelihood of N. melleni entering Victorian waters as a result of the unrestricted importation of barramundi.

- Reported from marine farmed barramundi from Queensland
- Asymptomatic or low-grade infections in barramundi or other species likely
- May readily be carried subclinically

On the basis of the above, the release assessment for N. melleni is considered to be low

Exposure assessment

The following key points are relevant if N. melleni entered the Hazelwood cooling ponds and the wider Victorian aquatic environment:

- Possibly direct transmission to other fish species in marine or estuarine environment
- Direct life cycle – no intermediate host necessary
- Marine / estuarine pathogen – unlikely to survive in freshwater environment

On the basis of the above, the exposure assessment for N. melleni is considered to be extremely low

Risk of Disease establishment

On the basis of the release assessment and the exposure assessment, the risk of the establishment of disease agent is considered low-extremely low

Consequence assessment

Effects on species of commercially or recreational importance – No known impact

Effects on species of aquacultural importance– Major potential pathogen of marine farmed species

Ecological and environmental effects – No known impact

On the basis of the above, the consequence assessment for N. melleni is considered to be moderate

Unrestricted risk estimate

For the unrestricted importation of barramundi, the probability of N. melleni establishing in Victorian waterways is assessed as being low-extremely low. The consequences of disease agent establishing in fish population in Victorian hatcheries is considered to be moderate.

Thus, for N. melleni, the risk associated with the unrestricted importation of barramundi into Victoria and specifically into the Hazelwood cooling ponds is not considered sufficiently high to justify the implementation of specific risk management measures.

References

Agnew, W. and Barnes, A.C. (2007). *Streptococcus iniae*: An aquatic pathogen of global veterinary significance and a challenging candidate for reliable vaccination. *Veterinary Microbiology 122*: 1-25

Anderson, I., Barlow, C., Fielder, S., Hallam, D., Heasman, M. and Rimmer, M. (1993). Occurrence of the picorna-like virus infecting barramundi. *Austasian Aquaculture 7*(2):42-44

Anderson, I.G. and Prior, H.C. (1992). Subclinical epitheliocystis in barramundi, *Lates calcarifer*, reared in sea cages. *Australian Veterinary Journal* 69:226-227

Anderson, I.G. and Moody, N. (2005). The effect of barramundi nodavirus on inmportant freshwater fishes. FRDC Project 1999/205 Final Report: 98pp

Anderson, I.G. and Oakey, H.J. (2008). The production of nodavirus-free fish fry and the nodaviruses natural distribution. Final Report, FRDC Project No 2002/043

Ashburner, L.D. (1975). Lymphocystis in paradise fish (*Macropodus opercularis*) in Australia. *Australian Veterinary Journal* 51:448-449

Austin, B. and Austin, D.A. (2007). Bacterial Fish Pathogens. Diseases of Farmed and Wild Fish. 4th Edition, Springer-Praxis Chichester, UK: 552pp

Azad, I.S., Jithendran, K. P. Shekhar, M. S. Thirunavukkatasu, A. R. and Pena L. D. (2006a). Immunolocalisation of nervous necrosis virus indicates vertical transmission in hatchery produced Asian sea bass (*Lates calcarifer* Bloch) - A case study. *Aquaculture 255*: 39-47

Azad, L.S., Shekhar, M.S., Thirunavukkarasu, R.A. and Jithendran, K.P. (2006b. Viral nervous necrosis in hatchery-produced fry of Asian seabass *Lates calcarifer*: sequential microscopic analysis of histopathology. *Diseases of Aquatic Organisms 73*: 123-130

Bigarr, L., Cabon, J., Baud, M, Heimann, M., Body, A. Lieffrig, F. and Castric, J. (2009). Outbreak of betanodavirus infection in tilapia, *Oreochromis niloticus* (L.), in fresh water. *Journal of Fish Diseases* 32: 667–673

Biosecurity Australia (2009). Australian Government Department of Agriculture, Fisheries and Forestry 2009, Import Risk Analysis Handbook 2007 (update 2009), Canberra.

Bromage, E.S., Thomas, A. and Owens, L. (1999). *Streptococcus iniae*, a bacterial infection in barramundi *Lates calcarifer*. *Diseases of Aquatic Organisms 36*:177-181

Burke, J. and Rodgers, L. (1981). Identification of pathogenic bacteria associated with the occurrence of 'red spot' in sea mullet, *Mugil cephalus* L., in south-eastern Queensland. *Journal of Fish Diseases 4*:153-159

Cadwallader, P.L., Backhouse, G.N. and Fallu, R. (1980). Occurrence of exotic tropical fish in the cooling pondage of a power station in temperate south-eastern Australia. *Australian Journal of Marine and Freshwater Research* 31(4) 541 – 546.

Callinan, R.B. (1988). Diseases of Australian native fishes. In Fish Diseases. Refresher Course for Veterinarians. Proceedings 106, Post-Graduate Committee in Veterinary Science, University of Sydney, May 23-27: 459-473

Coates, D. (1984). An ulcer-disease outbreak amongst the freshwater fish population of the Sepik River system, with notes on some freshwater fish parasites. Report 84-02, Fisheries and Research Branch, Department of primary Industry, Port Moresby, papua New Guinea: 21pp

Creeper, J.H and Buller, N.B. (2005).An outbreak of Streptococcus iniae in Barramundi (*Lates calcarifer*) in freshwater cage culture. *Australian Veterinary Journal 84*:404-411

Durham, P.J.K., Allanson, M.J. and Hutchinson, W.G. (1966). Lymphocystis disease in snapper (*Pagrus auratus*) from Spencer Gulf, South Australia. *Australian Veterinary Journal 74* (4):312-313

FAO (1986). Report of the Expert Consultation of Ulcerative Fish Diseases in the Asia-Pacific Region. Food and Agriculture Organisation of the United Nations, Regional Office for Asia and the Pacific TCP/RAS/4508 Project:1-38

Fraser, G.C., Callinan, R.B. and Calder, L.M. (1992).*Aphanomyces* species associated with red spot disease: an ulcerative disease of estuarine fish from eastern Australia. *Journal of Fish Diseases 15*:173-181

Frerichs, G.N., Rodger, H.D. and Peric, Z. (1996). Cell culture isolation of piscine neuropathy nodavirus from juvenile sea bass, *Dicentrarchus labrax*. *Journal of General Virology* 77:2067–2071.

Frerichs, G.N., Tweedie, A., Starkey, W.G. and Richards, R.H. (2000). Temperature, pH and electrolyte sensitivity, and heat, UV and disinfection inactivation of sea bass (*Dicentrarchus labrax*) neuropathy virus. *Aquaculture* 185:13–24.

FRDC (2007). National Nodavirus R&D Planning Workshop, 6-7 September, 2007. Aquatic Animal Health Subprogram, Fisheries Research and Development Corporation.

Glazebrook, J. (1995). Disease risks associated with the translocation of a virus lethal for barramundi (Lates calcarifer) Bloch. Research dissertation submitted for Master of Environmental Management at the Graduate School of Environmental Science and Engineering, Griffith University, Brisbane, Queensland.

Glazebrook, J.S., Heasman, M.P. and de Beer, S.W. (1990). Picorna-like viral particles associated with mass mortalities in larval barramundi, *Lates calcarifer* Bloch. *Journal of Fish Diseases 13*:245-249

Glazebrook, J.S. and Heasman. M.P. (1992). Diagnosis and control of picorna-like virus infections in larval barramundi, *Lates calcarifer* Bloch. In Diseases in Asian Aquaculture I.

M. Shariff, R.P. Subasinghe and J.R. Arthur (eds) Fish Health Section, Asian Fisheries Society, Manila, Philippines:267-272

Grey (1987) Ulcerative disease ('Red Spot') in Northern Territory Fish. The NT Marine and Fisheries Magazine March 1987:4-5

JASCOFD (1990). Joint Advisory SubCommittee on Fish Diseases, Sixth Meeting, April 6, 1990. CSIRO Australian Animal Health Laboratory, Geelong:7pp

Kahn, S.A., Wilson, D.W., Perera, R.P., Hayder H. and Gerrity, S.E. (1999). Import risk analysis on imported ornamental fish. AQIS, Canberra.

Langdon, J.S. (1986). Ulcerative Syndromes in Fish in the Indo-Pacific Region. Position paper: Joint Technical Subcommittee on Fish Disease

Langdon, J.S. (1988). Diseases of introduced Australian fish. In: Fish Diseases. Refresher Course for Veterinarians. Proceedings of the Postgraduate Committee in Veterinary Science, University of Sydney, 106: 228-276

Langdon, J.S., Elliott, K. and Mackay, B. (1991). Epitheliocystis in the leafy sea-dragon. *Australian Veterinary Journal 68*:244

Liltved, H., Vogelsang, C., Modahl, I and Dannevig, B.H. (2006). High resistance of fish pathogenic viruses to UV irradiation and ozonated seawater. *Aquacultural Engineering* 34:72-82.

McKenzie, R.A. and Hall, W.T.K. (1976). Dermal Ulceration of Mullet (*Mugil cephalus*). *Australian Veterinary Journal 52*:230-231

Moody, N.J., Horwood, P.F. and McHardy, S. (2004). Aquatic Animal Health Subprogram: development of diagnostic tests for the detectiuon of nodavirus. FRDC Project 2001/626 Final Report. 127 p

Munday, B.L. (1985). "Ulcer Disease" in cod (*Pseudophycis bachus*) from the Tamar River. Tasmanian Fisheries Research 27:15-18

Munday, B.L., Langdon, J.S., Hyatt, A. and Humphrey, J.D. (1992). Mass mortality associated with a viral-induced vacuolating encephalopathy and retinopathy of larval and juvenile barramundi, *Lates calcarifer* Bloch. *Aquaculture 103*:197-211

Munday, B.L., Kwang, J and Moody, N. (2002). Betanodavirus infections of teleost fish: a review. *Journal of Fish Diseases 25*:127-142

Osbourne, A. 1980. Ichthyofauna of the Hazelwood pondage with emphasis on the introduced tropical cichlid *Tilapia mariae*. B.Sc. (Honours) thesis, Department of Zoology, La Trobe University, Melbourne.

Overstreet, R.M. (1990). Antipodean aquaculture agents. *International Journal for Parasitology 20*:551-564

Pearce, M. (1989). Epizootic ulcerative syndrome. Technical Report Dec. 1987 - Sept 1989. Northern Territory Department of Primary industry and Fisheries. Fisheries Report 22:82p

Pearce, M., Humphrey, J.D., Hyatt, A.D. and Williams, L.M. (1990). Lymphocystis disease in captive barramundi *Lates calcarifer*. *Australian Veterinary Journal* 67:144-145

QDPI 2000 Fish Disease Report No 2 May 2000. (Eds Webb, R and Townsend, W). Queensland Department of Primary Industries: 4pp

QDPI (2001a). Fish Disease Report No 1 March 2001. (Eds Webb, R., Anderson, I. and Townsend, W.) Queensland Department of Primary Industries: 8pp.

QDPI (2001b). Fish Disease Report No 2 July 2001. (Eds Webb, R., Anderson, I. and Townsend, W.) Queensland Department of Primary Industries: 6pp.

Raadik, T. (2001). Alien Fishes Committee Report - May 2001. Hazelwood Pondage rivals Lakes Victoria and Nicaragua for cichlid diversity? Australian Society for Fish Biology. http://www.asfb.org.au/research/exotic/escr200105.htm

Reddacliff, G.L. and Quartararo, N. (1992). Lymphocystis in cultured snapper (*Pagrus auratus*) and wild kingfish (*Seriola lalandi*) in Australia. *Australian Veterinary Journal 69*:116-117

Read, P., Landos, M., Rowland, S.J. and Mifsud, C. (2007). Diagnosis, Treatment and Prevention of the Diseases of the Australian Freshwater Fish Silver Perch (Bidyanus bidyanus). NSW Department of Primary Industries: 81pp

Roberts, R.J., Macintosh, D.J., Tonguthai, K., Boonyaratpalin, S., Tayaputch, N., Phillips, M.J. and Millar, S.D. (1986). Field and Laboratory Investigations into Ulcerative Fish Diseases in the Asia-Pacific Region. Techical Report of FAO Project TCP/RAS/4508, FAO Bankok: 214pp

Roberts, R.J., Frerichs, G.N. and Millar, S.D. (1992). Epizootic ulcerative syndrome - the current position. In Diseases in Asian Aquaculture l, eds. M. Shariff, R.P. Subasinghe and J.R. Arthur, Fish Health Section, Asian Fisheries Society, Manilla, Philippines:431-436

Rodgers, L.J. and Burke, J.B. (1981). Seasonal variation in the prevalence of 'red spot' disease in estuarine fish with particular reference to the sea mullet, *Mugil cephalus* L. Journal *of Fish Diseases 4*:297-308

Sindermann, C. (1988). Epizootic ulcerative syndromes in coastal/estuarine fish. OAA Technical Memorandum NMFS-F/NEC-54, United States Department of Commerce, 37p

Tonguthai, K. (1985). A Preliminary Account of Ulcerative Fish Diseases in the Indo-Pacific Region. (A comprehensive study based on Thai experiences). National Inland Fisheries Institute FAO TCP/RAS/4508:39pp

Uwate, K.R. (1983). A report on the "Fish Disease" situation in the Sepik River, Papua New Guinea. Pacific Islands Development Program, East-West Centre, Hawaii 56 p