SUBMISSION TO: LEGISLATIVE COUNCIL GOVERNMENT ADMINISTRATION COMMITTEE 'A'

INQUIRY INTO PLANNING, ASSESSMENT, OPERATION AND REGULATION OF FINFISH FARMING IN TASMANIA.

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27 November 2019

To whom it may concern:

I am a scientist with over 35 years' experience in water quality management, with a focus on southeastern Tasmanian rivers, estuaries and coastal waters. In particular, I established and managed the award-winning Derwent Estuary Program from 1999 to 2018 - a partnership between the three tiers of government, industries, scientists and the community to restore and promote the Derwent. I am a well-respected professional and am not ideologically opposed to salmon farming, or indeed any other primary industry. However, I strongly support the principles of sustainable development and believe that the current growth plan and associated regulatory processes will not achieve this without substantial modifications.

On the positive side, there have been a number of proactive steps taken over the past few years, including separation of approval and regulatory functions, greater investment in science, and some improvements in access to information.

However, I am very concerned that the scale and pace of development is now well ahead of the science that is needed to guide sustainable growth, and that the regulatory framework and processes are also struggling to catch up. It is essential that the community is consulted in a genuine and respectful way, and that the full range of interests is considered in this matter. Our coastal and freshwater resources are too valuable to risk for short-term profits, and there are serious biosecurity risks that also need to be addressed in the industry's own self-interest. A pause in further expansion of approximately 2-3 years is needed to address these issues.

My submission below is organised in accordance with the Terms of Reference. Please contact me if you have any questions about the matters raised in my submission – I am happy to provide further details and references.

I request an opportunity to address the committee members in person during the planned hearings.

Sincerely

Christine Coughanowr, BSc, MSc

[redacted]

Attachments

A **Port Arthur letter**

B **Derwent Estuary program submission on Storm Bay expansion**

C **Mercury Talking Point editorial – May 2019**

D **Salmon hatchery submission to EPA and Southern Midlands Council**

TERMS OF REFERENCE

To inquire into and report on the planning, assessment, operation and regulation of finfish farming in Tasmanian, with particular reference to:

1) The implementation of the Sustainable Industry Growth Plan for the Salmon Industry and its impact on commercial finfish farming operations and local communities, including:

Is the Growth Plan in fact sustainable? What information and consultation was used in its development?

The implementation of the Sustainable Industry Growth Plan (SIGP) has been problematic from a number of perspectives. First and foremost, the Plan was not developed in consultation with the community, with commercial fisheries, or even with the scientific community. The SIGP appeared as a draft for comment in August/Sept 2017, and there is no description in the plan about how it was drafted, or even the rationale for the proposed expansion target of $2 billion by 2030. Consultation occurred afterwards, not as part of the process, and many of the valid concerns raised were proposed to be addressed through regulatory change, improved science and information, and/or adaptive management. Unfortunately this has not yet eventuated.

There is no evidence that the SIGP was based on scientific, environmental or socio-economic investigations. In particular – what was the basis for the grow and no-grow areas? What was the basis for the expansion targets and timelines, and why are they considered to be sustainable? Were any other considerations included, such as the value and location of prime recreational and commercial fishing areas and potential impacts on areas of high biodiversity?

Furthermore, the growth plan does not address the full scope of sustainable salmon growth. This must include the freshwater end (water use, smolt production), wellboats, and downstream processing.

The plan also requires an unbiased/independent review of employment estimates, as this appears to be a key motivation for growth from the government's perspective. However major expansion involves significant levels of automation, and it is unclear if this has been included in the rosy employment figures.

1(a) Data collection and publication

The current situation with respect to both data collection and publication is very mixed and inconsistent.

Data collection: *Has the necessary data been collected to support sustainable operation and growth of the industry?*

Many of the older Marine Farm Development Plans (MFDPs) and leases were approved and operated with very limited baseline information on local water quality, habitats or biodiversity. On-going monitoring has typically involved monitoring of sediment condition beneath the lease and at the 35m compliance limits. While this provides useful information about organic loading (fish poo and uneaten food) in the immediate vicinity of fish pens, it is not a good indicator of nutrient loading, which can impact a much wider area.

Too many nutrients in the wrong places can result in growth of nuisance algae, with serious impacts on water clarity, seagrass and fringing reef communities, and subsequently on biodiversity and fisheries. Sheltered, poorly flushed bays are particularly vulnerable to fouling by filamentous green algae, and communities around the state are increasingly concerned about impacts of this algal load on their local coastal environments. Algal blooms in Port Arthur/Long Bay are one recent example of this problem (see Attachment A for details).

Most MFDP regions now require some form of Broadscale Environmental Monitoring Program (BEMP), which typically involves monthly water quality monitoring at sites located some distance away from individual leases. This includes measurements of nutrients, phytoplankton, oxygen and other standard parameters. While this provides some useful background information for the region as a whole (and is particularly useful for model development), sampling sites do not typically include the sheltered, poorly flushed bays where impacts are most likely to occur. Monitoring of filamentous algae is also not routinely collected. The assumption of the BEMP seems to be that as

long as water quality across a region does not exceed specified 'trigger levels', environmental harm cannot be demonstrated. While the BEMPs were considered to be fairly advanced when first implemented in the 2009, there has been little change in the methods or targets since then, and a comprehensive review/update is urgently needed. The new Storm Bay BEMP should provide a better model, but the contract for this is yet to be signed and the design has not been made publicly available.

Some of the newer MFDPs and leases/licenses have more stringent requirements, including baseline surveys. However, requirements for baseline surveys are not consistent and most do not include information about key habitats, such as seagrass beds and fringing reef communities, which are of particular interest to recreational and commercial fishers. Some regions have set biomass or nutrient limits (e.g. the Channel/Huon area, Macquarie Harbour, Storm Bay), however the basis for these limits are also not consistent. Some are based on 'adaptive management' guestimates, others on the development of carrying capacity models. However, it is important to remember that models are not a substitute for reality or for rigorous monitoring. (Hence the frequent quote 'All models are wrong, but some are useful'). It is essential that models are regularly tested and improved, using updated operational and monitoring data. Furthermore, the current models being used are not designed to simulate or predict growth of filamentous green algae or to predict impacts on seagrass and reef communities, which is a serious gap.

The EPA's planned Salmon Standard should provide greater consistency and rigour around requirements for baseline surveys, monitoring and modelling. This is strongly supported. However, the Standard is still under development and unlikely to be completed for another 1 to 2 years. Meanwhile, expansion is well underway.

Recommendations:
Set consistent and rigorous standards for monitoring and investigations. These should include:

- More comprehensive baseline surveys – including extent & condition of key habitats, extent and persistence of nutrient indicator algae
- BEMPs also need major overhaul – include more focus on sheltered/vulnerable areas, nuisance algal growth, any changes in the extent and condition of sensitive reef and seagrass habitats
- Nuisance algal growth beyond 35m should be included as an impact, and included in both monitoring and modelling designs
- Carrying capacity models should be required as a precursor to the assessment and approval of all new and significantly expanded MFDPs

Data publication: *Have the data, reports and other information been made available?*

Again, this is a very mixed bag. Information is variously collected by industry consultants, the EPA and IMAS scientists. Associated reports are then published in various places and formats, and in many cases are not publicly available at all. Older MFDPs/leases typically have less available information, newer ones have more, but this is still very inconsistent between sites and operators.

Information on salmon biomass, pollutant loads (e.g. bioavailable nitrogen) and localised impacts (impacts at 35m compliance boundary) is rarely available, and requests for this information have been denied on the basis of Commercial-in-Confidence, or diverted through onerous Freedom of Information processes. These are public waterways, and as such, the community should have a right to this information.

The proposed Salmon Farming Data Portal website has been significantly delayed, and finally went on-line in late Oct/early Nov 2019. This has been hosted by DPIPWE, rather than through an independent portal hosted by IMAS, as intended. Despite several enquiries, no input was sought/welcome from the community about what information they would like to have access to on this portal. While the new portal provides some information about compliance, this is mostly in the form of Y/N answers, which does not address community concerns about such issues as nutrient overloading, loss of amenity and biodiversity, etc. Links to Environmental Licenses (ELs), BEMP reports and other scientific reports are not provided directly, but must be accessed through other platforms (e.g.

the LIST, EPA Water Section, IMAS). The proposed Salmon Scorecard seems to be missing in action altogether. Altogether, this is a very disappointing outcome.

Publicly available Annual Environmental Reports (AERs) should be required for all fish farms, as is normally required for other large-scale premises, including industries, tips and sewage treatment plants. These AERs should include information on operations, pollutant loads and their management, plans for future improvements, as well as monitoring results. Information should also be provided on e.g. antibiotic and chemical use/discharges, in situ net-cleaning, discharges from desalination operations, as well as fish mortalities and escapes.

Finally, an independent science/technical body is needed to routinely audit and review industry sponsored research and development outputs. Most aquaculture-related studies in Tasmania are funded through the industry-sponsored Fisheries Research and Development Corporation (FRDC) and are not generally peer-reviewed. Furthermore, many of the scientists who are contracted to do this work are dependent on industry and government funding and good will, which can make it difficult to maintain independence or express alternative views. Indeed, to do so in Tasmania is generally considered to be, at best a career-limiting move, and at worst professional suicide. I have a high level of respect for the scientists at IMAS and CSIRO involved in this work, however it is essential that they have greater autonomy and independence.

1(b) Progress in the development of an industry wide biosecurity plan;

Clearly this is a major risk for the Tasmanian salmon industry, and ignoring or postponing the necessary biosecurity planning and implementation has decimated industries around the world. The combination of multiple operators in close proximity, farming fish of different cohorts is a recipe for disaster. Tasmania has already experienced severe disease outbreaks such as the POMV outbreak in Macquarie Harbour that killed an estimated 1.35 million fish in 2018. More recently, a disease outbreak in salmon pens off Bruny Island resulted in the transfer of fish from Storm Bay to 'hospital pens' in Norfolk Bay, under emergency provisions. This caused widespread community concern and anger and has fuelled the increasingly polarised debate about the rapid expansion of the salmon industry in Tasmania.

Nonetheless, biosecurity management to date has been largely voluntary, and a comprehensive State Government mandated biosecurity plan has not been completed. While this may be in part the result of incremental/uncoordinated past development, the recent approval of three new/expanded operations in Storm Bay is of particular concern.

Previous investigations and preliminary modelling results by IMAS suggests that salmon diseases could travel significant distances across Storm Bay during strong winds, and conservative separation distances have not been adhered to, particularly with respect to the Storm Bay North MFDP, off Betsey Island. Furthermore, the pilchards that carry the POM virus are not limited in their movements and can travel long distances, mingling with salmon within their cages.

In addition to diseases, biosecurity planning should include other likely causes of salmon mortality, including toxic algal blooms (e.g. *Noctaluca*), jellyfish, and warming ocean temperatures/ocean heat waves that reduce salmon resistance to disease.

While this issue may seem to be primarily related to industry-driven self-interest, there are important implications for the wider community. In particular:

- 'Emergency' transfer of sick or vulnerable salmon into 'hospital pens' in clean and sheltered waterways. This occurred in Norfolk Bay (Aug 2018) in an area critical to survival of the endangered Red Handfish, and with essentially no public consultation.
- Disposal of large fish kills. This has not yet been adequately planned for, as illustrated by the problems associated with disposal of fish from Macquarie Harbour following the 2017/18 fish kills there. Proactive planning is required to address this contingency, rather than an ad hoc response.

- Planning and management of disease and marine pests associated with movement of gear and water (wellboats)

Further expansion of salmon aquaculture should be postponed until rigorous biosecurity planning has been completed and implemented for all existing leases. This plan should be reviewed by independent experts, and should include clear prior arrangements for emergency pen movements (in consultation with the community), disposal of morts, and broader biosecurity management to prevent spread of introduced marine pests.

2 Application of the Marine Farming Planning Act 1995 relating to:

2(a) Preparation and approval process for marine farming development plans, including modifications and amendments to marine farming development plans;

The separation of the assessment/approval and regulatory processes is a positive development, with the EPA now responsible for the licensing and regulation fish farm operations, once the leases have been granted. The relevant legislation and regulations have also recently been modified to integrate this with EMPCA, and a new salmon section has been established within the EPA. However, there are still a number of outstanding legislative and regulatory gaps, that require further work. In particular:

- Too much power is invested in the Minister to approve/reject Marine Farm Development Plans (Marine Farm Planning Act 1995, Section 16), MFDP amendments (Section 42) and Emergency Plans (Section 45). This should be the role of a fully independent Board.
- The Marine Farming Development Review Panel (MFDRP) should be fully independent and include community and broader environmental interests. Term limits should also be set for Board members to ensure regular renewal – this is considered to be standard good governance practice for a variety of reasons. Further discussion about the Panel is provided below.
- Sections 33 and 35(2) of the MFP Act 1995 should be changed such that once the Panel has agreed to accept an application for a MFDP amendment, they are not then obliged to approve it, should the amendment be determined to be unsuitable. As currently written, the Act allows the Panel to alter the amendment, or require further changes, but they cannot refuse it. This is unacceptable if the Panel is genuinely independent.
- Modifications and amendments to existing plans can avoid full assessment/scrutiny, if they are deemed to be 'not of a substantial nature' by the MFDR Panel. A recent example of this (Nov 2019) was the combination of two major MFDPs (Huon River and Port Esperance Marine Farming Development Plan 2002 and D'Entrecasteaux Channel Marine Farming Development Plan 2002) into a single MFDP. These two plans are now nearly 20 years old, and this would have been an important opportunity for the community to have some input on how these two plans have been operating, and areas for improved management. However, the Panel apparently deemed this to be an insubstantial modification, thus bypassing the need for community consultation.
- Too much power is invested in the EPA Director for a wide range of decisions, including the ability to significantly increase biomass limits without public consultation or notification. The EPA Board should play a greater role in the review and decision-making associated with finfish operations.
- License conditions are highly variable between leases. All leases for example, should be required to provide annual monitoring reports and annual environmental reports. The regulatory salmon standard should resolve this problem, but is still under development and unlikely to be completed for another 18+ months. Nonetheless, approvals continue to be given
- Monitoring and compliance data are not readily available. For example, in order to obtain video documentation of sediment conditions at the 35m compliance boundary, I have been told that I must submit a FOI request. This is outside the lease area, in a public waterway, and should be provided as a matter of course.
- Most of the review and approvals processes relating to salmon farming are not subject to third party appeal rights. Why should the aquaculture industry be given special treatment? This should be brought into line with other industries.

The Marine Farming Development Panel (the MFDP) is neither fully independent nor broadly representative. In particular, there are no community or environmental representatives. Furthermore, a number of the current panel

members have uncomfortably close relationships with the aquaculture industry and/or state government; others have sat on the Panel for over 10 years and are accustomed to past regulatory practices. Several well-respected panel members with strong scientific backgrounds and independent views have not been welcome on the MFDP when their views have not been 'operationally convenient' for the salmon industry. Most recently, two members (Dr Barbara Novak and Dr Louise Cherrie) resigned in protest when their concerns about the Storm Bay expansion were not addressed. Previously, another respected scientist (Dr Lois Koehnken) was not reappointed to the Panel after her concerns about ecological impacts of a proposed lease in the Channel area resulted in perhaps the only instance where the Panel has ever knocked back an application. Shortly after this, the legislation was changed such that the Panel no longer had decision-making powers; this was transferred to the Minister and the Panel was demoted to an advisory role. Is it any surprise that the public has lost confidence in the Panel and its 'independent' role?

Public representations to the Panel are not taken seriously, and very few of their concerns and recommendations are incorporated into final MFDPs or Environmental Licenses. This process appears to be largely run a box-ticking 'consultation' exercise. For example, 220 submissions were made on the recently approved West of Wedge expansion in Storm Bay, and many people took the time to travel significant distances to present their concerns to the MFDRP in person. Virtually all of these were dismissed, including my own which was based on over 35 years of directly relevant scientific expertise (see Attachment B). The effort to review and assess the information provided in the EIS documentation is enormous; for Storm Bay this consisted of three massive documents with dozens of appendices, adding up to literally thousands of pages of material, all to be completed over the Christmas holiday period.

2b. Allocation of leases, applications for and granting of leases;

2c. Management of finfish farming operations with respect to the prevention of environmental harm;
There is widespread concern within the community that aquaculture operations to date have not been managed to prevent environmental harm. This includes the full range of operational activities and inputs. In particular:

Hatcheries & smolt production
There are over a dozen hatcheries and smolt production facilities located along rivers throughout Tasmania. The original hatcheries were relatively small-scale, flow-through systems, with rudimentary wastewater treatment and limited regulatory oversight. As the salmon industries have expanded, these facilities have also grown but in many cases without improved wastewater treatment. At the same time, there has been a move towards producing much larger smolt, resulting in major increases in both biomass and associated pollution loading. Water use is extremely high: for example, in 2011 fish hatcheries in the Derwent catchment had a combined allocation of over 150,000 ML/year (39% of all allocated water), which was greater than allocation for irrigation (30%) or public water supply (21%) (Eriksen et al, 2011). More recent information is not readily available.

As a result, nutrient loading to our rivers has increased significantly over the past 20 years, including in areas directly upstream of major drinking water supplies. In the River Derwent catchment, for example, there are five large hatcheries; one on the Florentine, one at Wayatinah, two on the Tyenna, and a fifth located at Meadowbank – directly upstream from Hobart's main drinking water supply at Bryn Estyn. These industrial-scale fish farms discharge nutrient loads that are equivalent to those of small to mid-size sewage treatment plants, with maximum discharges typically occurring during late summer when river levels are low and waterways are at their most vulnerable. Wastewater treatment is generally poor, particularly with respect to nutrient removal, and nutrient levels below outfalls have been recorded at over 100 times the upstream levels. (Proemse et al, 2018)

Consequences include high levels of algae and bacterial growth in downstream waterways, and loss of ecologic and amenity values. Of perhaps greater concern is the risk of toxic or nuisance blue-green algal blooms in downstream Hydro lakes and public water supplies. The combination of increasing nutrients + still reservoirs + warming temperatures is a perfect recipe for nuisance and toxic algal blooms. Indeed, the on-going taste and odour issues experienced at the Bryn Estyn water treatment plant (Hobart's main water supply) started in the summer of 2015, following the construction of the large new hatchery at Meadowbank. This also coincided with severe filamentous

algal blooms in the seagrass meadows of the upper estuary, that also commenced in the summer of 2015. Freshwater fish farms are known sources of the bacteria that produce taste and odour compounds (MIB/Geosmin), and this is a common internal management concern as it can taint the flesh of their products. Elevated nutrient levels may also stimulate production of these taste and odour compounds in the wider environment.

The on-going taste and odour issues at Bryn Estyn have required installation of additional carbon filtration systems, costing millions of dollars to TasWater (and their customers). This has also significantly reduced the rate at which potable water can be produced, meaning that less water is also now available for irrigation in the southeast region during summer months when demands are high. The need for additional filtration has clearly contributed to the recent (November 2019) water crisis experienced in southern Tasmania, with an unprecedented 50% reduction in irrigation flows, and threats of municipal water restrictions for the Hobart metropolitan area. See TasWater media release and ABC media release for details. Clearly, further investigations into the source of these taste and odour problems are warranted, both by TasWater and the EPA.

Recirculating aquaculture systems (RAS) have been promoted as a means to reduce water use and pollution from hatcheries/smolt production facilities, and in principle should be able to achieve this. However, a recent review of the RAS system proposed for Hamilton (immediately adjacent to Meadowbank Lake) found that water quality discharged from the facility was surprisingly poor – particularly with respect to salt and nutrients. Nitrate levels, for example were far higher than in effluent discharged by the worst-performing sewage treatment plants in Hobart. Surely we can expect better than this?! The proposal to manage this effluent is to transfer responsibility to an adjacent landholder for irrigation (improved grazing), however it is unclear that the soils can accommodate this level of effluent (sandy soils underlain by clay). The combined Environmental Impact Assessment/Development Application received 85 submissions, many concerned with potential impacts on Lake Meadowbank. However, rather than requiring a higher level of treatment and/or additional information to demonstrate that irrigation run-off would not enter Lake Meadowbank, the proposal was rushed through and approved with conditions. This is disappointing, and also raises questions about previously approved RAS systems at Ranelagh and Judbury. Are they in fact 'best practice' or have we been given false assurances? Furthermore, are existing license conditions even being met? Indeed, it appears that the effluent standards set in the EL for the RAS system at Ranelagh are being exceeded by a factor of 3. See Attachment D for my submission on this matter to the EPA and Southern Midlands Council.

Use of scarce freshwater resources

Salmon aquaculture uses vast quantities of freshwater, both for smolt production and to limit amoebic gill disease (AGD) in sea cages. The salmon industry has stated that caged fish typically need to be bathed about 7 times, particularly when the smolt are first introduced to saltwater. How much water is required for this, and where does it come from? What does the industry pay for this valuable resource? Freshwater sources used include rivers, dams, groundwater and desalination plants, however no comprehensive audit or review has been undertaken. There does not appear to be any information available on this from the State Government, and requests for information from the industries has not been forthcoming. This is clearly a major concern both for the industries themselves as well as for water-poor coastal communities in the southeast and eastern Tasmania. Conflict over water access is brewing and is likely to increase in the absence of a clear and equitable water strategy. The recent water pipeline fiasco at Orford is a perfect example of this, with a small council left holding the bag for a poorly planned water pipeline to benefit big industry. See ABC media release for details.

Impacts of new well-boats

HAC has operated a large well boat in Tasmania since 2015, and two more of the world's largest wellboats have recently arrived or are en route. These wellboats serve multiple purposes, including improved biosecurity, more efficient use of freshwater and production of desalinated water if required. These vessels have also been designed to streamline bathing, transportation and harvesting processes – significantly reducing labour costs. However it is unclear whether the potential impacts of these wellboats have been fully assessed by the EPA, and questions asked of Tassal at a recent community information session remain unanswered. Specifically:

- Where will the freshwater for the wellboat be sourced from? What volumes from each source? How much water will be sourced from land-based sources vs desalination?
- What is the salinity of the desalination brine, how will this be managed/disposed of, and what are the potential impacts?
- What is the quality of effluent to be discharged following bathing, and how will this be managed? Please provide a copy of the Environmental Management Plan (currently being finalised with the EPA), along with monitoring data confirming the quality of the discharged water.
- What types and quantities of chemicals will be used, including disinfectants (e.g. Virkon) and ozone, and how might these impact local waterways?
- How will biosecurity issues by managed to prevent spread and transfer of marine pests and disease, including northern Pacific seastars, POMS and toxic dinoflagellates?
- Will fish be harvested on board? If so, how will harvesting wastes be managed?

Pollution from sea cages

Sea cages can cause widespread organic and nutrient pollution in our coastal waterways, particularly in poorly flushed bays, estuaries and harbours. Consequences of organic pollution can include accumulation of fish faeces and uneaten food in the vicinity of the pens, resulting in sludgy, low-oxygen 'dead zones' with bacterial mats and loss of bottom-dwelling fauna. In Macquarie Harbour, this oxygen depletion has extended up into the water column, causing or contribution to massive fish kills in 2015 and 2018, along with impacts on native species such as the protected Maugean skate.

Impacts resulting from nutrient overloading can extend to larger areas and are known to cause a whole cascade of problems, including run-away algal blooms, damage and loss of reef and seagrass communities, low oxygen levels, fish kills and rotting algae on beaches. The scale of nutrient loading associated with existing and proposed fish farms is enormous, increasing rapidly, and is not widely known. To put this in perspective: nitrogen loading from the 30,000 tonnes of salmon produced in 2010 was equivalent to approximately twice the nitrogen discharged by all sewage treatment plants in Tasmania; the current production of 55,000 tonnes is equivalent to nearly four time this sewage load. If the full Storm Bay expansion is implemented, this would bring the state total up to 135,000 tonnes, or nearly nine times the sewage load from the entire state – this is the equivalent of the sewage load produced by over 4 million people. These are massive loads, and both the existing and potential impacts deserve careful and independent scrutiny.

Concerns about nutrient impacts have been raised many times by the community as well as by recreational and commercial fishing interests, particularly in poorly flushed embayments of the Huon/Channel, Nubeena Harbour and Port Arthur/Long Bay. The planned expansion into Storm Bay also carries significant risks, particularly for the shallow, sheltered bays, fringing reefs and seagrass meadows of Norfolk and Frederick Henry bays, which are particularly vulnerable to nutrient damage. See photos below and Attachment A for a recent summary of issues associated with Long Bay/Port Arthur.

In the Derwent estuary, this is further compounded by heavy metal contamination. Studies have shown that when oxygen levels drop, heavy metals are released from contaminated sediments, and mercury can be converted to more toxic forms. See the 2015 State of the Derwent Report, Chapter 10 for details. Storm Bay sets the overall water quality for the Derwent, which is already nutrient-stressed. Over 100 million dollars has been spent in recent years to reduce nutrient loads to the Derwent from sewage treatment plants – will this now be cancelled out by salmon production in Storm Bay? See Attachment B for the submission I wrote in January 2018 while Director of the DEP to the Marine Farm Development Review Panel on impacts associated with Storm Bay, or for a shorter version, my editorial on this matter published by the Mercury in May 2019 (Attachment C).

Why 'Adaptive Management' is not the answer.

The regulators and salmon industries are working on the assumption that our coastal and marine waters can absorb massive organic and nutrient loads, and that risks can be addressed using 'adaptive management' – which seems to be interpreted as dealing with any problems if and when they arise. This is simply not credible, as has been demonstrated via the Macquarie Harbour debacle. The production cycle from smolt to harvest is too long, and the value of the product is too high; no-one is going to pull the plug halfway through.

Adaptive management is not a substitute for careful planning. To be successful, adaptive management first requires good system understanding, including comprehensive baseline surveys. The baseline cannot be set after the expansion is already underway. This should then be coupled with predictive models that have been validated, and which can be used to estimate the system's carrying capacity. As production levels increase, a detailed monitoring program must confirm that the system can cope with the inputs as predicted, and that the models are accurate. This information needs to be shared with the community in a transparent and timely fashion, so they have confidence in the process. And finally – and most importantly – adaptive management must set the criteria, triggers and management response for when things go wrong. This cannot be done on an ad hoc basis.

In summary, this major expansion needs to be based on robust science, which is still several years away. In the meantime, the precautionary principle should prevail, and further expansion should be postponed until the necessary monitoring, modelling and management controls are in place. Without this – it is at best an educated guess, and at worst another exercise in crisis management.

3) Any other matter incidental thereto.

The major incentive for supporting further expansion of salmon aquaculture in Tasmania appears to be based on the mantra of 'jobs & growth', particularly in regional areas. This needs to be critically examined, both with respect to the actual number of full-time jobs created and where these jobs are located. Furthermore, the basis for the commonly cited 5:1 multiplier effect is opaque and requires further justification. Finally, expansion is clearly leading to automated systems and reducing labour requirements, particularly with respect to feeding, bathing and transporting fish in the new well-boats. The consequences of this automation needs to be included in the calculation of employment benefits, particularly in regional communities.

An alternative view of the economic benefit of the salmon industry is provided by the Australia Institute report 'Making mountains out of minnows', which suggests that Tasmania is not getting good value on the lease of our public assets. The auction of leases – as in done in Norway – could raise far more funding that could be directed to regional community support and marine conservation projects.

Finally, the Tasmanian brand is based on a foundation of clean air, clean water, clean food and wilderness. Let's make sure we don't kill the golden goose.

SUMMARY OF RECOMMENDATIONS

In summary, expansion of the Tasmanian salmon industry is progressing well beyond the scientific, biosecurity and regulatory frameworks necessary to ensure its long-term sustainability. Furthermore, as expansion involves increasing levels of automation, the standard argument that this will deliver regional jobs and growth may not apply. The three major companies are making handsome profits at current production levels, so this seems unlikely to result in serious hardship.

It is recommended that a 2 to 3 year pause on further expansion be established, until the following have been addressed:

- Rigorous science to inform management, including comprehensive baseline surveys, on-going monitoring and fully-tested nutrient response models. Sheltered bays should be included in monitoring and modelling designs, as these are particularly vulnerable. Seagrass beds, fringing reefs and growth of nuisance filamentous algae should also be included. Much of this work is currently underway at IMAS and CSIRO but will not be completed until at least 2021.
- A comprehensive biosecurity plan is needed to underpin the long-term sustainability of the industry. This should not be left to the discretion of three competing companies, or the issuance of emergency permits to move cages to new areas when disease outbreaks occur.
- Tighten up and address legislative and regulatory gaps, including the need for a truly independent Marine Farming Development Panel and excessive decision-making power invested in the Minister and EPA Director.
- Complete the EPA's Salmon Standard and apply this to all existing leases before new leases are approved. The Standard is currently underway but will not be finalised for another 12 to 24 months.
- Public consultation needs to be valued as more than a box-ticking exercise by both government and industries. These are public waterways with high amenity, economic and biodiversity values, and the community has a right to be both heard and included in decision-making.
- Information on polluting activities in public waterways should be readily available. This is standard practice for large industrial activities regulated by the EPA, including sewage treatment plants. Why should the salmon industry receive special treatment? The recently launched Salmon Portal could eventually deliver this, but does not currently provide important numerical information such as biomass levels, nutrient loads, number of fish escapes, etc.
- A full audit of freshwater resource requirements for the salmon industry is urgently needed, along with a policy/strategy as to how these will be allocated and managed (keeping in mind the needs of other water users).
- A detailed review of the impacts of hatcheries/smolt production facilities on inland waterways is also urgently needed. Substandard facilities should be required to treat wastewater in accordance with Accepted Modern Technology before new facilities are approved, or required to decommission. Current and proposed Recirculating Aquaculture Systems should be reviewed to ensure that these are actually being designed and operated in accordance with the most advanced modern technologies.
- Existing leases should be reviewed and improved before new leases are approved. Offshore expansion should also be accompanied by a reduction in nearshore sites, with a priority given to removing fish pens from sensitive, sheltered and biodiverse areas.
- Adaptive management cannot succeed until the necessary framework has been established (e.g. strong science, validated models, performance monitoring, clear triggers for management, regular review and transparent reporting). Until this time, the precautionary principle should prevail.

OPEN LETTER – TO WHOM IT MAY CONCERN

14 September 2019

Re. Impacts of salmon pens at Port Arthur/Long Bay

As a scientist and resident of the Tasman Peninsula, I am writing to express my concerns about the condition of Long Bay/Port Arthur following the introduction of multiple salmon pens into this system in 2017. I have heard similar concerns raised by the local community, and have raised some of these concerns with both EPA and Tassal representatives in person and in writing. While this letter primarily focusses on the Port Arthur lease, many of these concerns are also relevant to the leases at Nubeena.

Having spent considerable time reviewing available documents, including the 2017/18 Tasman BEMP, the current Environmental License, as well as previous baseline reports commissioned by Tassal, I am setting out a number of specific concerns and recommendations which I hope you will respond to in order to ensure sustainable use of this system.

Long Bay/Port Arthur is a narrow, N-S oriented embayment extending approximately 10 km into the middle of the Tasman Peninsula. Given the limited development and low density population in this area, water quality should be good, and previous surveys (Barrett et al, 2001) have documented healthy/diverse ecosystems, including temperate reef communities and seagrass beds. These provide valuable habitat for fish and invertebrates, and the bay is highly valued/used by the recreational fishing community. There are few waterways discharging to the bay, and their flow tends to be ephemeral; in particular, the northern end of the bay is not well-flushed.

As you are aware, a series of 14 large fish pens were installed at the Pt Arthur lease in about August 2017 with a maximum estimated biomass of 3200 tonnes, from which 2682 tonnes of salmon were harvested in late 2018 (Tassal, pers comm). This biomass of fish would have released at least 150t of DIN and considerably more organic matter to the bay. This nutrient load is equivalent to that of the Macquarie Point and Blackmans Bay sewage treatment plants combined, and represents an extremely high nutrient and organic load into the head of a poorly flushed and nutrient sensitive embayment.

Impacts associated with large-scale salmon aquaculture in this bay include:

- Altered hydrology and reduced circulation due to physical effects of pens, nets, feed barges, etc (baffle effect). This would result in longer residence times, increased sediment deposition and a change in nature of the sediments (finer, organic rich) and associated benthos
- Deposition of organic matter in vicinity of pens derived from uneaten feed, fish faeces and net-washing debris, leading to change in sediment character and benthos
- Release of bioavailable nutrients leading to increased phytoplankton, nuisance/drift algae and epiphytes. This is particular a concern for both nearby temperate reef communities and seagrass beds
- Potential effects of hypersaline emissions derived from desalination plant on land and/or well-boat (particularly in deeper channels). This could affect both flora and fauna
- Capture/mortalities of native fish and fish larvae during freshwater bathing and desalination operations
- Other (e.g. use of antibiotics, fish escapes, attraction of seals and sharks)

While kayaking in Long Bay/Port Arthur on multiple occasions in 2018 and 2019, I have observed extensive growth of filamentous algae in subtidal areas around lease (particularly *Chaetomorpha billiardii*), as well as fouling/epiphytic growth and some die-off of seagrass beds in Stingaree Bay and further north in Long Bay. This has persisted in some areas even after the harvesting of fish in late 2018, suggesting that nutrient enriched sediments may be an on-going source. I have kayaked extensively in the Tasman region and have never seen this level of persistent nuisance algal fouling, with exception of areas around the large salmon leases off Nubeena.

Science-based management and regulation

I am concerned that the initial stocking of Long Bay/Port Arthur has been far too intensive for this system, and that no efforts have been made to establish the carrying capacity or to set limits on the allowable maximum biomass or TPDNO. Indeed, the only compliance requirements I can find in the current Environmental License are:

- G1.1 That benthic sediment conditions meet specific criteria within the lease area and at the 35m boundary. This does not address impacts associated with dissolved pollutants which are likely to affect areas well beyond 35m.
- G2 That copper and zinc levels thresholds within the lease area are not exceeded, and
- G3 That indicator values set for the 'compliance site' off Nubeena (NUB-4) not exceed specified limits. How can this possibly be relevant for the Port Arthur lease, which is over 25 km away?

Monitoring and reporting

While the EL requires a significant level of monitoring it does not include key areas and communities, and it is unclear how the results will be used to inform production limits. The baseline survey and on-going monitoring were not designed to address impacts on broader ecosystem health, particularly with respect to rocky reef and seagrass communities, and the BEMP does not include water quality monitoring sites most likely to be impacted.

While there is a fairly extensive set of reporting requirements, much of this information is not made available to the public. In particular, I believe it is in the public interest to be advised of nutrient loads, compliance at the 35m boundary, release of chemicals and antibiotics, fish escapes and other matters that may impact on the use and enjoyment of this shared waterway. A further concern is that Tassal has recently withdrawn this site from ASC certification (due to shift to smolt grow-out), reducing the incentive for stakeholder consultation about operations in this bay.

In my professional opinion, the following steps are needed to improve the health of Long Bay and ensure salmon aquaculture can be undertaken sustainably:

- Major reduction in allowable biomass and set clear TPDNO limits, until the carrying capacity and robust monitoring systems have been established
- Undertake investigations and modelling to determine carrying capacity
- Extend monitoring to include additional BEMP sites to the north of the lease, as well as monitoring of reef and seagrass communities (including nuisance algal growth)
- Provide more comprehensive reporting to confirm that aquaculture operations are not impacting the wider system, including compliance results at the 35m limit, use of antibiotics, fish escapes, and other aspects of concern to the community. Much of this information may be included in the Annual Environmental Report, which should be made available to the public.
- Consult with stakeholders and the wider community in good faith about this site. I would suggest that an annual briefing from the EPA and Tassal to review regulatory compliance, present monitoring results, advise on production plans and address community concerns would be a good starting point.

I look forward to your response to these recommendations, and am available to meet in person to discuss my concerns and recommendations in further detail. I have also attached some more specific feedback and recommendations specific to the 2017/18 BEMP report (which can hopefully be incorporated into future monitoring and reports) as well as additional monitoring activities that are needed to protect this valuable asset.

Yours sincerely,

Christine Coughanowr

Attachments:

- Comments on 2017/18 BEMP for Tasman Peninsula and Norfolk Bay
- Additional monitoring recommendations for Port Arthur/Long Bay

ATTACHMENT 1: COMMENTS ON 2017/18 TASMAN PENINSULA & NORFOLK BAY BEMP.
Annual Broadscale Monitoring Report for the Tasman Peninsula and Norfolk Bay Marine Farm Development Plan Area (June 2017 to May 2018). Prepared by Aquenal, 2018

This publicly-available report covers the regulatory period from June 2017 to May 2018, but also includes water quality data back to 2013. Monitoring results for water quality, sediments and biota are provided at nine sites: 4 at Port Arthur and 5 at Nubeena, including the compliance site NUB-5.

Water quality monitoring is monthly at 9 sites, 3 depths for phys/chem parameters, nutrients and phytoplankton (chl a and cell counts). Water quality at Port Arthur sites has been monitored from Aug 2013 to present. Nubeena sites have been monitored from Feb 2014 to present.

Sediment samples were collected at each BEMP site (triplicate cores) in March 2018, which was 6+ months after fish were introduced to the Port Arthur system. Basic analyses (visual appearance, redox & sulphide) are done annually; benthic infauna, stable isotopes and grain size are four-yearly 1st round provided here (samples to be archived in between).

The report includes considerable information and numerous graphs, and clearly represents significant investment in effort and resources. However, the material as presented is difficult to review and interpret, and does not clearly evaluate if there have been impacts associated with the leases at Port Arthur or Nubeena.

In particular, several additional BEMP sites are needed in the less well-flushed ends of the Nubeena and Port Arthur systems, as this is where impacts are most likely to occur. Without this information, the BEMP cannot rule out significant impacts. Information on water clarity is also needed (e.g. Secchi Depth) to better evaluate potential impacts on benthic vegetation.

The figures are very difficult to review and interpret. Some provide data for all of the Nubeena and Port Arthur BEMP sites on single graph (lines run together and overlap), others combine data across the entire region. It is essential that the data for Port Arthur and Nubeena be presented separately, as these are spatially and ecologically separate systems, and have different operational activities. Also, the text size on many graphs is too small to read. While there is some interpretation of water quality results in Section 4, potential impacts resulting from aquaculture activities are not clearly assessed. To my eye, there are a number of trends which may well be related to increasing aquaculture in Nubeena and Port Arthur, as noted below:

- Fig 17: Lower DO at Nubeena than at Port Arthur. Bottom DO levels at NUB1 are particularly low, and have declined over several years.
- Fig 21: increasing bottom water ammonia levels at Nubeena, particularly at NUB1 during 2017/18.
- Fig 27: phosphate levels at Nubeena increasing over past few years, particularly at NUB1 and at depth
- Fig 33: chla levels at both Nubeena and Port A have increased in 2017/18, with progressively higher values towards the more intensively farmed areas of the bays. In Pt A, several high chla spikes (>5 mg/L) have been measured since smolt were introduced, that were not previously observed.

Furthermore, no information about operations/biomass is provided during this period. This information is needed to interpret results, and particularly whether changes may be attributable to marine farming activities. I am aware that smolts went in @Pt A in Aug 2017, so this report would cover the first 8-10 mos of production, when biomass was building up. Presumably Nubeena would have had higher levels of production.

The use of the 'compliance site' at NUB-5 does not make any sense to me as it is too far away from the Port Arthur lease, and may also be influenced by nutrients from the nearby Creeses Mistake lease at Nubeena. Instead, I would suggest that a reference site be established for Port Arthur (e.g. PA-4 or PA-3) and that seasonal water quality criteria are set using this, against which the Port Arthur BEMP results can be compared. Same goes for Nubeena.

I am actually quite confused about the rationale behind the 'compliance site' based on the EL and Section 4.5 of the BEMP report. It seems that as long as the rolling annual medians at NUB-5 are below the specified trigger levels, then the operations at both Nubeena and Port Arthur are considered to be in compliance. Is this correct? There does not seem to be any requirement to compare water quality results at the other BEMP sites with these trigger levels. If I have misunderstood this, I would appreciate some clarification. As noted above, it would be more appropriate to select a unimpacted reference site for Nubeena and Port Arthur, set seasonal water quality criteria, and then compare the BEMP data to these trigger values.

Finally, the report does not provide an executive summary, discussion, conclusions or recommendations. Have there been any observable effects associated with the fish farms in these two systems?

The sediment/benthic invertebrate data is also difficult to interpret, as it is based on samples collected in March 2018. This is some 6+ mos after fish were introduced to Pt A, and as such it is difficult to evaluate/attribute change. Was prior baseline sediment work done at the BEMP sites to provide a comparison? Or are there baseline or 35m compliance results that can provide better information on change. Where is the information on impacts at 35m published and have the compliance standards in the EL been achieved?

ATTACHMENT 2: PORT ARTHUR/LONG BAY MONTORING REVIEW AND RECOMMENDATIONS
(prepared by C. A. Coughanowr – Sept 2019)

The following additional monitoring and investigations are needed at Port Arthur/Long Bay to evaluate impacts on environmental condition, including sensitive receptors.

- Additional water quality sites (inner bay and meaningful compliance site) and parameters (Secchi depth)
- Additional sediment quality sites (inner bay)
- Seagrass monitoring (inner bays plus reference sites)
- Rocky reef monitoring (areas adjacent to lease plus previous baseline & reference sites)
- Intertidal monitoring (areas adjacent to lease plus previous baseline & reference sites)
- DEPOMOD and carrying capacity modelling and assessment

It is particularly concerning that baseline surveys and subsequent monitoring at Pt A were not designed to assess/track impacts on reef or seagrass communities, and furthermore that the BEMP design did not include likely areas of impacts to the north of the lease. Specific recommendations include the following:

Water quality (monthly)

- Extend BEMP to include at least 3 additional sites in sheltered areas to the north of the lease (e.g. 1 in channel, 2 on either side)
- Collect nutrient samples at surface and at depth where water column is stratified (e.g. channel)
- Include a reference site (PA-4, near the mouth of Pt A may be suitable; NUB-5 is not)
- Include Secchi depth (or another water clarity indicator) at all sites

Sediment/benthic monitoring (annual) Monitor changes in sediment quality (grain size, % organic carbon, redox, sulphide) and associated invertebrates at the above sites

Seagrass monitoring (seasonal/annual)

- Start with aerial photographic analysis/history to provide baseline and interannual variability
- Delineate major seagrass banks and channels – map distribution and maximum depth of seagrass
- Conduct seasonal monitoring (e.g. quarterly, possibly more during summer/high fish biomass periods)
- Set up fixed transects/quadrants or set points within specific areas
- Take photos of quadrants and record key attributes (e.g. sediment composition, % cover, species composition, canopy height, epiphyte abundance, algal % cover, macrofauna)
- Measure temperature, salinity and DO, particularly if stratified - including at depth in the central channel

Reef monitoring (seasonal/annual)

- Baseline mapping of reef type and distribution is needed
- Set up reef monitoring at @ 4 to 6 representative sites plus reference site(s); include/re-visit sites previously monitored by Tassal in 2013
- Monitor reef health/biodiversity using Edgar/Barrett method
- Monitor nuisance algae using IMAS RVA method (quarterly) – 12 fixed quadrants/site, or another well documented method

Intertidal monitoring (seasonal/annual)

- Set up series of fixed quadrants (mid & lower intertidal) and/or photo points. May need multiple transects/quadrants at each site, as variability is high. Also need reference site(s).
- These could be just on-shore from reef monitoring sites above; should also include/re-visit sites previously monitored by Tassal in 2013

DERWENT ESTUARY PROGRAM LTD SUBMISSION ON STORM BAY MARINE FARMING DEVELOPMENT PLANS/ENVIRONMENTAL IMPACT STATEMENTS:

Environmental Impact Statement to accompany Draft Amendment No 3 to the Storm Bay off Trumpeter Bay North Bruny Island, Marine Farming Development Plan, July 1998 (Huon Aquaculture)

Environmental Impact Statement to accompany Draft Amendment No 5 to the Tasman Peninsula and Norfolk Bay, Marine Farming Development Plan, November 2008 (Tassal)

Environmental Impact Statement for draft Storm Bay North Marine Farming Development Plan (Petuna)

17 January 2018

The Derwent Estuary Program (DEP) considers Storm Bay to be a single system, and thus addresses the potential cumulative impacts of all three proposals (HAC, Tassal and Petuna) in this combined submission, with a particular focus on the Derwent estuary.

The DPIPWE overview notes an aspirational target for salmon production in Storm Bay of 80,000 tpa, but that in light of robust scientific information, a combined limit of 40,000 tpa for the three proposals is currently under assessment. Further, that a staged 30,000 tpa limit will apply while monitoring and modelling systems are being established.

In addition to the comments provided below, the DEP requests a hearing to discuss these in more detail with the Marine Farming Planning Review Panel.

ABOUT THE DEP AND THE DERWENT ESTUARY

The DEP is a partnership between government, business, scientists and the community to restore and protect our waterway. Established in 1999, the partnership has been nationally recognised for excellence in reducing water pollution, protecting nature, monitoring river health and promoting greater use and enjoyment of the Derwent. In 2010, the DEP was awarded Australia's most valuable prize – the National River*Prize*.

Our major sponsors include: Brighton, Clarence, Derwent Valley, Glenorchy, Hobart and Kingborough councils, the Tasmanian Government, Nyrstar Hobart, Norske Skog Boyer, TasWater, TasPorts and Hydro Tasmania. Since March 2017, the DEP has been operating as a registered company, with an independent board.

The Derwent estuary lies at the heart of the Hobart metropolitan area and is home to 40% of Tasmania's population, as well as a major centre for commercial, industrial and tourism activities. The estuary has a long-standing history of heavy metal pollution – with some of the highest reported levels of zinc, mercury and lead in the world. In recent years, there has been significant investment to reduce metal inputs by both the zinc smelter and the state government, with considerable success. However, the legacy pollution in the estuary sediments will require careful management for many years to come.

More recently, the estuary has shown increasing signs of nutrient stress, including nuisance algal blooms, seagrass loss and persistent low oxygen levels in some areas. Previous research has shown a strong link between nutrient loading, low oxygen and release of heavy metals from sediments. Therefore, a key element of our long-term management strategy for the estuary is to manage and reduce nutrient loads, particularly during summer months, when the risks are highest. The marine waters of Storm Bay and the D'Entrecasteaux Channel drive the overall circulation of the estuary, and set the background nutrient levels for the system as a whole. Therefore, a significant change in nutrient inputs from Storm Bay could have far-reaching impacts on the Derwent estuary.

GENERAL COMMENTS

1. **Need for a combined assessment**

   Given the size and scale of the proposed expansion, and the connectivity of Storm Bay, it is essential that these three proposals be planned, assessed and managed together, as a cumulative impact assessment. Development of an 'Area Management Agreement' is also recommended by the Aquaculture Stewardship Council as an important aspect for certification.

   It is very difficult to understand the scale and timing of the three proposed developments when they are presented as separate proposals. Without this information, it is difficult to evaluate potential impacts. Therefore, the DEP has attempted to extract information on proposed biomass and nutrient loads from the three documents, as presented in the table below. Feedback on the accuracy of this combined table would be welcome, as comparative information was difficult to find.

   Other information that should be compiled and assessed as part of a combined regional assessment includes the location of sensitive or threatened communities/species including seagrass meadows, giant kelp, spotted and red handfish, and other relevant communities and species.

2. **Large scale, rapid development and the precautionary principle**

   The proposals indicate that an initial combined maximum biomass of 40,000 tpa is being considered for Storm Bay, with a staged approach (starting with 30,000 t as first stage). However, information is not presented in a consistent manner between the proposals. In particular, the HAC proposal presents a case for the 40,000 tpa scenario, while the Tassal and Petuna proposals provide information for the 30,000 tpa scenario.

   In either case, this is a very large biomass in comparison with current salmon production across Tasmania as a whole (50,000 tpa), and as compared to production in individual systems (e.g. 12,000 to 14,000 tpa in Macquarie Harbour, >24,000 tpa in the Channel/Huon (based on 2010 figures; current data was not available); or by individual producers (HAC: 20,000 tpa; Tassal 25,000 tpa; Petuna: not available).

   Estimated nutrient loads associated with these production levels are very large, as set out in the table figure below. An estimate of nutrient loads associated with the longer-term aspiration of 80,000 tpa is also presented.

Current and proposed production and Dissolved Nitrogen Outputs (DNO) to Storm Bay under different production scenarios (in tonnes/year):

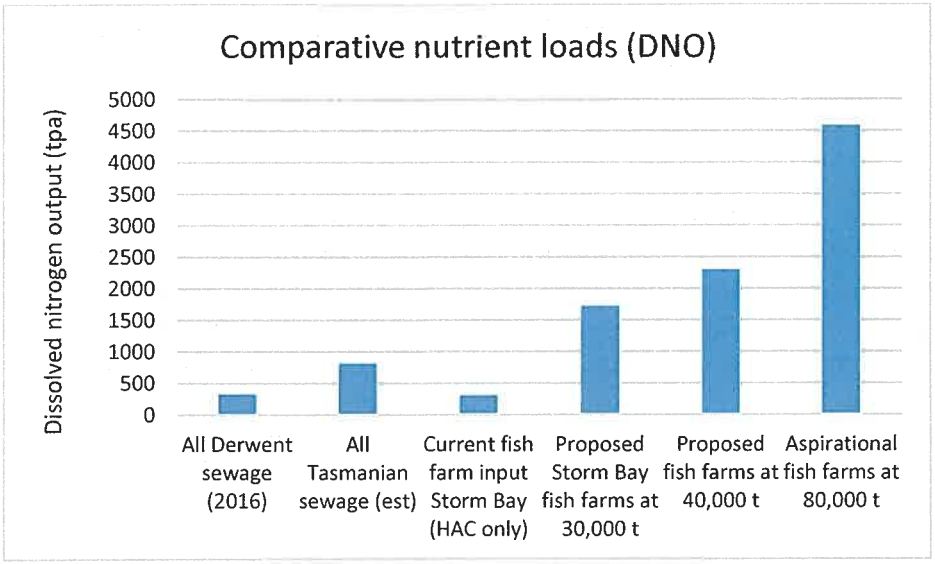
Source	Current production & load	Interim production - 30,000t **1722t TPDNO**	Proposed production - 40,000t **2296t TPDNO**	Aspirational production - 80,000 tpa **4592t TPDNO**
Storm Bay off Trumpeter lease (HAC)[1]	6000t 300 – 400 t (based on Fig 4)	*15,000 t biomass* *861 t DNO* *by ???*	20,000 t biomass 1148 t DNO by May 2019	
West of Wedge lease (Tassal)	??[2]	9000 t biomass 514 t DNO (Staged over 3 years) • Yr 1: 150 • Yr 2: 300 • Yr 3: 400	12,000 t biomass 689 t DNO	
Storm Bay North lease (Petuna) 35-39 m	0	6000t (@75%) 344t DNO (@75%) No info on staged approach	8000 t biomass 459 t DNO	

(1) HAC EIS proposes 20,000 t biomass, and notes the 30,000 t interim limit for Storm Bay as a whole, but does not provide DNO values at this level in the EIS. Values in italics are pro rata estimates based on 75% production. Of concern is the plan to stock

the Yellow Bluff site with smolts by April 2018, as this would lead to a very rapid increase in biomass and nutrient loads before monitoring & modelling systems are fully operational. See Fig 4, p17.

(2) Could not find Tassal current production at Nubeena in EIS

To provide some context, the DNO from all sewage discharged to the Derwent estuary is estimated at 327 tpa, and the sewage-derived DNO for the entire state would be under 1000 tpa (pro rata, assuming similar treatment levels). By comparison, the estimated DNO as set out in the three proposals at 40,000 t production is 1892 tpa (ie nearly six times the Derwent sewage load), and would be more than 14 times the Derwent sewage load at the 80,000 tpa production level.



The proposed rate of development is also very rapid, particularly for the Trumpeter Bay lease, which proposes to reach a DNO of 1147t by mid 2019 (Figure 4a, p 17).

'Offshore' is a relative term, and while the Storm Bay environment is relatively exposed, it is still considered to be a bay with variable degrees of exposure to prevailing winds and storms.. Given the scale and pace of the proposed expansion, and the proximity of several potentially sensitive receptors to nutrient loading – specifically the Derwent estuary and Frederick Henry Bay – it is recommended that a staged, precautionary approach be taken, based on good science, monitoring and reporting.

3. Need for good system understanding, including monitoring, modelling and process studies

Storm Bay is a unique system, with processes and patterns that are unlike other areas of Tasmania. This is an area of high variability, both within and between years, and has been identified as a climate change hotspot. Previous studies of Storm Bay have shown that nutrient processes and algal blooms are strongly influenced by wind and storm events (Harris et al, 1991). Assumptions based on steady state conditions are therefore risky, as are comparisons with other systems, and monitoring and modelling designs need to take this into account.

The nutrient assimilation capacity of Storm Bay is unknown, but likely is likely to vary seasonally, and from year to year. Furthermore, major southerly storm events could stir up nutrient-enriched bottom water and sediments with unanticipated consequences. Finally, the benthic system may not respond as anticipated as this system may not be adapted to high levels of nutrient and organic loading.

While there has been some baseline monitoring done for Storm Bay and some early stage modelling, these results are indicative and should be interpreted with caution. Furthermore, while there are a number of scientific investigations currently underway (e.g. FRDC), these have not yet been completed.

The intention to develop and implement a regional BEMP monitoring program, together with development of a BGC model (and associated process studies), would provide a good scientific basis for science-based management of aquaculture in Storm Bay. However, it is anticipated that this work will take a minimum of 2 to 3 years. We believe this work should commence, before significant expansion, and that future stages should be linked to completion of specific milestones.

4. Regular public reporting and access to data

Publications of annual environmental reports on the state of Storm Bay should be an integral part of this plan to ensure timely and transparent reporting on conditions and trends. It is essential that this include robust interpretation, and that funds be allocated to complete this (non-trivial) task. Monitoring data should also be made available via an on-line portal, as well as on request.

DETAILED COMMENTS

Issues of particular concern for the Derwent estuary

The Derwent has shown increasing signs of nutrient stress, including nuisance algal blooms, seagrass loss and persistent low oxygen levels in some areas. Previous research has shown a strong link between nutrient loading, low oxygen and release of heavy metals from sediments. Therefore, a key element of our long-term management strategy for the estuary is to manage and reduce nutrient loads, particularly during summer months, when the risks are highest. The marine waters of Storm Bay and the D'Entrecasteaux Channel drive the overall circulation of the estuary, and set the background nutrient levels for the system as a whole. Therefore, a significant change in nutrient inputs from Storm Bay could have far-reaching impacts on the Derwent estuary.

Of particular concern is the potential for increased nutrient levels in bottom water, which drives the overall circulation of the Derwent estuary and subsequent ecological response. This is not fully represented in the model, nor is the potential for large-scale resuspension following storm events. Ecological responses to eutrophication could present as changes in phytoplankton production (algal blooms and/or changes in community structure) and/or increased macroalgae production (attached or drift). Sensitive receptors could include:

- Ralphs Bay (shallow, poorly flushed, may be susceptible to drift algae growth and accumulation)
- Spotted handfish in lower Derwent/Ralphs Bay (spawning substrate susceptible to algal fouling)
- Derwent temperate reef communities (including EPBC-listed giant kelp communities), particularly those along the Kingborough shoreline
- Seagrass and macrophyte communities (susceptible to algal overgrowth, shading and loss)
- Heavy metal contaminated sediments – low oxygen levels can remobilize toxic metals (including mercury) with potential impacts on humans, fish, birds and other biota.

Comments on Nutrient Dispersion Modelling (Hadley et al, 2017) and proposed biogeochemical model

This report provides an interesting representation of predicted nutrient dispersion from the proposed developments at a combined biomass of 40,000 tpa, however, as stated on page 14 'this is early stage modelling is only indicative of the system conditions, and as such the results should be interpreted with the relevant degree of caution.' The DEP has a number of questions about the model, and would be concerned if it was used as a basis for decision-making without further validation, and indeed without the development of the full biogeochemical model. In particular:

- What hydrodynamic model underpins the dispersion model? If Herzfeld 2008, this is a relatively early-stage model (Stage 1 –INFORMD), and requires further development, particularly with respect to boundary conditions.
- The assumptions used in the model require further testing and validation, particularly the 4-day decay rate.
- Decay is not the same as removal – both ammonium and nitrate will stimulate phytoplankton and other algal growth, and the nutrients removed will return to the system when the algae breaks down (along with

oxygen depletion). This is what we are really interested in understanding, and a full biogeochemical model is needed to evaluate nutrient impacts more broadly.

- The assumptions used for dispersion at depth are hard to follow, and the dispersion model does not seem to include nitrogen release from sediments (e.g. breakdown of faecal matter and feed)
- It is unclear what period of data were used to generate the background percentiles – was this a single year or multiple years?
- The model seems to reflect steady-state conditions, but how would the system respond to a major storm event?

The biogeochemical model is an important tool to assess ecological responses to nutrient loading. The model should identify sensitive receptors and the conditions/times when these are most likely to be impacted – e.g. during summer months, following major storm events, during EAC dominated periods. Scenarios to be tested should include 'worst case scenarios'. Growth and accumulation of drift algae may be an important symptom of eutrophication in shallow bays such as Ralphs Bay and Frederick Henry Bay, and should be also be included in model development. Given the time required to develop and test the model – including process studies – the BGC model should be funded and well underway before significant expansion

Comments on Indicative Storm Bay Environmental Monitoring Program (DPIPWE, 2017)

This report provides an overview of an indicative BEMP monitoring program for Storm Bay, to be implemented as part of an adaptive management regime. The Storm Bay BEMP would include a range of water quality, benthic and reef monitoring sites. The DEP is very supportive of broadscale monitoring and reporting, and would strongly encourage coordinated and integrated monitoring between the Derwent and Storm Bay systems. Our recommendations include the following:

- Deployment of sensors at key sites to better inform model development, and to assess storm-related effects (it will not be practical or safe to collect water samples during major southerlies!).
- Include resources needed for the preparation/publication of annual reports. While the Huon/Channel BEMP is cited as a model for Storm Bay, lack of timely and regular public reporting has been a real concern. To date, only one BEMP report has been publicly released (for the period from 2009 to 2013), and it is therefore not possible to assess the merits of this monitoring program, or the current state of the Huon/Channel system.

Other comments

- Frederick Henry Bay / Norfolk Bay: these are shallow, clear and biodiverse systems, which are highly valued by the recreational fishing community. These bays are poorly flushed, and could be seriously impacted if nutrients were to be entrained. Some areas also provide critical habitat for the endangered red handfish (sensitive to biofouling), and there may also be important seagrass meadows and giant kelp communities. Thus, this area should be assessed with particular care, including potential impacts of storm events.
- Implications for Harmful Algal Blooms (HABs) – the increasing prevalence of the EAC suggests that this development may essentially be adding nutrients to a warm water, nutrient poor system that has seen severe increase in HABs over the past few years. Could further addition of nutrients exacerbate this?
- Marine pests: could nutrient and organic enrichment of previously coarse, sandy sediments encourage settlement and migration of marine pests? For example, the invasive Japanese seaweed *Undaria pinnitafolia* has been shown to grow more prolifically in nutrient enriched conditions.
- Handfish – where are current handfish populations (spotted and red), and could nutrient enrichment/biofouling pose a risk to their breeding success?
- Seagrass: as noted, seagrass is adversely impacted by nutrient enrichment. Existing seagrass beds should be mapped, baseline surveys (condition & extent) carried out and regular monitoring be implemented as part of this development.
- The estimated nutrient loads for Storm Bay are based on Food Conversion Ratios and associated nutrient yields that were derived from studies that are now over 15 years old; these also assumed zero loss of feed

(Wild-Allen, 2005). Given recent advances in feeds, feeding technologies and new cage designs, a review of these conversion rates is recommended to ensure the models are based on correct load estimates.

RECOMMENDATIONS

1. **Science-based management**
   Storm Bay should be managed as a single system, including integrated assessment and management of salmon production. It is important that potential impacts on adjacent nutrient-sensitive systems (Derwent and Frederick Henry Bay) also be fully assessed, and included in modelling and monitoring programs.

2. **Staged and precautionary growth**
   Given the scale of the proposed expansion, a staged and precautionary approach is recommended based on good system understanding. This should include determination of the Bay's carrying capacity under a range of conditions, as well as an understanding of how the system responds to major storms.

   A series of milestones and deliverables should be established that are clearly linked to each stage, and stocking levels should allow for the completion of each stage before the next production level is approved. It is particularly important that environmental triggers be established early on, and that there is clarity about the required management response, should the monitoring program demonstrate that these have been exceeded. A possible growth scenario could progress as follow:

   Pre-expansion
   - Commence BEMP and BGC model development; map location of / conduct baseline surveys of sensitive receptors (e.g. seagrass meadows, giant kelp, handfish populations)

   Stage 1 (e.g. 10,000 tpa)
   - Complete first BEMP report and stage 1 modelling

   Stage 2 (e.g. 20,000 tpa)
   - Complete second BEMP report and BGC modelling, including scenario-testing under worst case conditions

   Stage 3 (e.g. 30,000 tpa)
   - Consider further expansion based on successful completion/assessment of above.

3. **Regular public reporting and access to data**
   Publications of annual environmental reports on the state of Storm Bay is requested to ensure timely and transparent reporting on conditions and trends. Monitoring data should also be made available both via an on-line portal, as well as on request.

4. **DEP actively engaged**
   Given the potential sensitivity of the Derwent estuary to eutrophication, the size of the regional population, and the importance of the Derwent to tourism, we request that the DEP be actively engaged in the development and coordination of Storm Bay monitoring, modelling and process studies. We have over 20 years of water quality and other environmental data that could inform and value-add to these activities, and are widely respected by the regional and scientific community for our scientific understanding and expertise.

   In particular, the DEP would welcome regular meetings and workshops with colleagues at EPA, DPIPWE, IMAS, CSIRO and the marine farming companies to facilitate exchange of information, coordination of scientific investigations and constructive review and feedback on reports.

talking point

Don't dive t

'DON'T DIVE TOO DEEP IN STORM BAY'

Much more work is needed before salmon expansion in Storm Bay, which sets the overall water quality for the Derwent, says **Christine Coughanowr**

AS a scientist with more than 25 years' experience in water quality management in southern Tasmania, I am very concerned about the expansion of salmon aquaculture in Storm Bay for the reasons I outline here.

SCALE AND RATE OF DEVELOPMENT

The planned expansion of salmon aquaculture in Storm Bay at 40,000 to 80,000 tonnes a year will more than double production for the entire state (currently at about 55,000 tonnes).

This comes with a very large nutrient load, estimated at 2300 to 4600 tonnes a year of bioavailable nitrogen. To put it in perspective, this is six to 12 times the current nutrient load from all sewage treatment plants in the city of Hobart, or two to four times the estimated load for all sewage generated in Tasmania.

RISKS ASSOCIATED WITH NUTRIENT OVERLOAD

Too many nutrients are known to cause a whole cascade of problems, including run-away algal blooms, damage and loss of reef and seagrass communities, low oxygen levels, fish kills and rotting algae on beaches. In the Derwent estuary, this is further compounded by heavy-metal contamination.

Studies have shown that when oxygen levels drop, heavy metals are released from contaminated sediments and mercury can be converted to more toxic forms. Storm Bay sets the overall water quality for the Derwent, which is already nutrient-stressed.

More than $100 million has been spent in recent years to reduce nutrient loads to the Derwent from

systems that support recreational and commercial fishing, tourism, and a number of protected and endangered species. The shallow, sheltered bays, fringing reefs and seagrass meadows of Norfolk and Frederick Henry bays are particularly vulnerable to nutrient damage.

ROBUST SCIENCE TO GUIDE MANAGEMENT IS STILL SEVERAL YEARS AWAY

Our understanding of the Storm Bay system is not yet well developed, and we have no idea of what the carrying capacity of the system may be. While there is a large body of scientific work undertaken by reputable scientists at the Institute for Marine and Antarctic Studies (IMAS) and CSIRO, this has not yet been fully compiled or completed and there are a number of missing pieces. In particular:

Valuable habitats and sensitive areas have not been clearly identified or mapped;

Baseline monitoring has not been completed, particularly for reefs and seagrass meadows;

The comprehensive whole-of-Storm Bay monitoring program has not yet been funded or commenced;

Work on predictive 'carrying capacity' models is just beginning and will take several years; and

Public reporting is limited and in many cases access to important data is blocked.

ADAPTIVE MANAGEMENT VS PRECAUTIONARY PRINCIPLE

The regulators and proponents are working on the assumption that Storm Bay can absorb a massive nutrient load, and that risks can be addressed using 'adaptive management' – which seems to be interpreted as dealing with any

long, and the value of the product is too high; no-one is going to pull the plug halfway through.

Adaptive management is not a substitute for careful planning. To be successful, adaptive management first requires good system understanding, including comprehensive baseline surveys. The baseline cannot be set after the expansion is already underway. This should then be coupled with predictive models that have been validated, and which can be used to estimate the system's carrying capacity.

As production levels increase, a detailed monitoring program must confirm that the system can cope with the inputs as predicted, and that the models are accurate. This information needs to be shared with the community in a transparent and timely fashion, so they have confidence in the process.

And finally – and most importantly – adaptive management must set the criteria, triggers and management response for when things go wrong. This cannot be done on an ad-hoc basis.

In summary, this major expansion needs to be based on robust science, which is still several years away.

In the meantime, the precautionary principle should prevail, and further expansion should be postponed until the necessary monitoring, modelling and management controls are in place. Without this – it is at best an educated guess, and at worst another exercise in crisis management.

Christine Coughanowr (BSc, MSc) is an independent scientist with 35 years' experience in water quality science and management. She was the founder and director of the Derwent Estuary

COMMENTS ON ENVIRONMENTAL IMPACT STATEMENT FOR HAMILTON RECIRCULATING AQUACULTURE SYSTEM HATCHERY (SEPTEMBER 2019)

Prepared by Christine Coughanowr – Water Quality Scientist

17 October 2019

General comments

While I am pleased to see this move towards Accepted Modern Technology (AMT) in Derwent catchment hatcheries, it is important not to lose sight of the fact that there are five existing flow-through facilities that are operating at a relatively low standard and require further upgrades. In particular, the hatcheries at Wayatinah, Florentine and Russell Falls have only recently installed drum filters/screens to remove solids and continue to discharge high nutrient loads. Karanja has little treatment beyond an undersized settlement pond. Meadowbank has drum filters/screens to remove solids and a wetland system, which removes some nutrients, but is still a major nutrient source and may pose a risk to Hobart's main water supply at Bryn Estyn, as well as the seagrass beds of the upper Derwent estuary, both of which are located immediately downstream. I would suggest that if this proposal is approved, it be conditional on reducing biomass at some of these other facilities, until they have been upgraded or closed down.

I was prepared to be favourably impressed by this proposal, having heard much about the benefits of Recirculating Aquaculture Systems (RAS). Consequently, I was very surprised at the relatively high concentrations of salt (median EC 1782uS/cm) and nitrates (median 68 mg/L) in the effluent, as set out in Table 13 (p 83). Waterways in this part of Tasmania tend to have very low conductivity (e.g. EC <100 uS/cm in Lake Meadowbank – see Proemse et al, 2018), and irrigation with saline water is a known risk that can be difficult to manage. The anticipated median nitrate-N concentration of 68 mg/L is high – considerably higher than typical secondary-treatment sewage effluent. For example, the worst-performing sewage treatment plants in the Hobart municipal area rarely exceed 20 mg/L of nitrate, and tertiary treated effluent is well under 5 mg/L (Coughanowr et al 2015). Given the multiple biofiltration systems involved, I was expecting that the RAS effluent would be similar to tertiary treated effluent. *Is this really 'world's best practice', or can additional treatment be included to further reduce nutrient and salt concentrations?* This is something the EIS needs to address. In any case, the *EIS should include more specific information about the wastewater treatment system components, including how effluent quality changes after each major step, and provide some justification as to why this represents best practice. Additional information is also needed on other contaminants in effluent, including disinfectants, antibiotics, etc*.

The overall water intake volume of 650ML/yr is clearly lower than that of a flow-through system, but is still a large volume, of which 158 ML (about 25%) of this will be discharged for re-use. This represents 10,744 kg/yr of bioavailable nitrogen and 300 kg/yr of phosphorus. Nitrate is extremely mobile in groundwater and can accumulate to high levels, which is a risk both for nearby waterways and local water supplies. Anything over 10 mg/L nitrate- nitrogen is considered to be a drinking water health risk (US EPA guidelines), particularly for babies and young children ('blue baby syndrome'). While presumably this groundwater will not be used for drinking, this guideline does provide some context on standards and risks.

Lake Meadowbank is an important and sensitive water body. It provides water supplies for regional landholders (including nearby drinking water supplies). Furthermore, Meadowbank is the last hydro storage lake upstream of the Bryn Estyn water treatment plant which is Hobart's main drinking water supply. There are also a number of large industrial water supplies downstream, including the HAC hatchery just below Meadowbank, and the Norske Skog paper mill, as well as multiple irrigation offtakes. In addition, Lake Meadowbank is highly valued for recreational boating, swimming and fishing. Water quality in the lake is very high, and the clear, shallow and still/stratified characteristics of this lake could make it very susceptible to algal blooms, including toxic blue-green algal blooms. Clearly, this would be a disaster both for the lake itself, as well as for local and downstream users. It is therefore essential that effluent from the hatchery and

associated irrigation scheme **does not enter the lake**. Furthermore, I would argue that a treatment standard of Class B irrigation water is not adequate to protect a sensitive waterbody of this nature. The Class B recycled water standards are primarily focussed on faecal bacteria, and do not include specific criteria for nutrients or salinity (see EPA Reuse Guidelines, Table 2-1, p 16).

While irrigation is clearly a good option for managing nutrient-enriched effluent, success requires complex systems and careful oversight. I am very concerned that Tassal appears to be handing over responsibility for their large effluent stream to a third party, with no clear review, audit or reporting requirements. While the Irrigation EMP is clearly an important first step, successful implementation of this Plan needs to be monitored and fully documented. Furthermore, the proposed area for irrigation has a number of challenges, including a difficult soil profile (sandy soils over clay) and a complex pre-existing drainage system, including numerous dams and connecting drainage channels, including a long, shallow drain parallel to the lake margin (Lawrenny Channel). Unless very carefully managed, this could lead to accumulation of nutrient-enriched irrigation water along this sand/clay boundary, capture within the existing drainage systems and discharge to the lake. The geological report also refers to faults and ancestral river channels, which could act as preferential pathways for drainage. Indeed, the apparent lack of observed groundwater in the various test pits and bores is puzzling and should be further explored. Is this due to rapid run-off along clay surface? Preferential drainage pathways along faults? Interception by shallow drains? *Considerable supplemental work is needed to characterise the surface and sub-surface run-off characteristics of this site (including on-site tests using the existing pivot irrigator systems and monitoring following heavy rainfall events).*

Furthermore, there is *little information provided in the EIS about how changes in land practices may affect run-off quality from the irrigated area. In particular, a higher stocking rate of cattle and sheep plus the recommended addition of superphosphate fertilisers, could result in significant discharge of faecal bacteria and nutrients to Lake Meadowbank if not carefully managed. What is the current livestock stocking rate, and how will this change? Will there be fencing and a vegetated buffer to prevent livestock access and run-off to the lake?* Finally, the proposed buffer zone of 50m to the lake edge is too small to prevent spray drift and relies too heavily on operator/equipment. *Further justification is needed as to why this buffer is considered to be adequate.* While development of an Irrigation EMP is clearly an important management control, considerable up-front documentation is needed to ensure that this can be successfully implemented.

Further investigation and monitoring of subsurface groundwater, soil water and surface water is needed to confirm that effluent from this proposal will not enter Lake Meadowbank. Given the extent of clays in this area, soil water testing is particularly important, as this is the more likely path for excess irrigation water. The existing drains should also be monitored, as should Lake Meadowbank itself, particularly along the lake margin adjacent to the properties. Lake monitoring should include algal indicators of enrichment. Baseline monitoring prior to development, under varying climatic conditions, is essential. Finally, an independent annual audit of the irrigation system should be included in the plan, as part of a regular Annual Environmental Report (AER) for the RAS facility. Both of these reports should be publicly available.

Given my concerns about transfer of responsibility to third party irrigators and the need for independent reuse monitoring and audits, I spent some time looking at the conditions in the current Environmental Licenses for the existing RAS facilities at Rookwood and Forest Home (dated September, 2018), anticipating that this issue would be fully addressed. Much to my surprise, there do not appear to be any requirements in the ELs for EPA review, audit or monitoring of the irrigation systems, nor is there any requirement for annual environmental reporting for the RAS facilities themselves. This is a major omission and should be addressed both for the currently licensed RAS facilities as well as the Hamilton RAS, if approved.

I would strongly recommend that supplementary information as described above be requested before this proposal can be fully assessed, and that risks and management controls be assessed for the entirety of this operation, including the effluent reuse scheme. For a proposal of this scale, it is essential that Tassal fully owns their effluent, rather than handing it off to a third party.

Additional comments:

- 'Hatchery' is not really an accurate term/reflection of the activities at the site, given that production of large smolt (over 8 million 500g+ fish) appears to be the primary objective and will constitute the major biomass. *Further discussion about how this will change sea cage production is needed. Will there be a reduction in biomass/wastes discharged to coastal waters as a result? Or could this result in further intensification, for example by increasing production at each lease (increased number of shorter grow out periods using larger fish).*
- The effluent reuse dam appears to be located on two different properties. *Who is responsible for it, and how will this be managed?*
- It is not acceptable to transfer smolt to other hatcheries with poor treatment systems in the event of unanticipated problems with effluent reuse. This should not be included as an option.
- This project should *include a second emergency overflow dam/storage system*, to store wastewater that does not meet specs until it can be re-treated, or should the effluent storage dam exceed the 80% storage capacity. Reliance on a single dam runs the risk of contamination of the entire storage.
- *Further information is needed on how blue-green algal risks will be managed*. Monitoring needs to be tightened up (e.g. regular lab as well as visual testing in summer), and conditions set for response in the event of a bloom. This is a significant risk for the lake and downstream users.
- Stormwater run-off should be treated and minimised by collecting run-off from roofs and impervious areas. This should either be reused and/or treated using *Water Sensitive Urban Design* features such as vegetated swales. The DEP has excellent resources for WSUD, including specific engineering guidelines.
- Community consultation appears to be sparse at best. As part of the EIS, why was no consultation undertaken with local recreational users, Landcare or environmental groups – e.g. angers, boaters, Derwent Catchment NRM, Derwent Estuary Program, Greening Australia, etc?
- Please provide a *reference or other evidence for the 5:1 job multiplier*.
- The values in the recycled effluent quality table (Table 13, p 83) do not add up. In particular, the nitrate value (68 mg/L) is higher than the Total Nitrogen values (51 mg/L), which is physically impossible. Presumably this is due to the use of different monitoring periods/data to generate each value. *If these values are to be used, the rational for use of different monitoring periods should be provided.*
- Effluent from the Rookwood RAS (which is the model for the proposed Hamilton system) is well above the required water quality criteria set out in the current Environmental License (9922/1). Specifically, the EL criteria for Total Nitrogen is set at 20 kg/ML (equivalent to 20mg/L), while the actual effluent levels are at least 3 times this (68 mg/L). Is the EPA aware of this, and how is it being managed?
- When is the public meeting for this EIS, and how has/will it be advertised?
- *Publicly available Annual Environmental Report (AERs) should be required* as an Environmental License condition for all hatcheries. This is a standard requirement for most large EPA regulated premises, and should also be required for aquaculture activities.

I hope these comments are useful and will be carefully considered in the review process. In particular, I believe that considerable supplementary information is required before this proposal can be accurately assessed. I have highlighted in blue italics above some of the key information gaps. While I support the move towards RAS in Tasmania, it is important that these systems incorporate the best available technologies and that any effluent discharged to land or water is fully assessed, managed, monitored and reported on.

Sincerely,

Christine Coughanowr, BSc, MSc
Water Quality Specialist (and co-author of multiple Derwent catchment water quality monitoring reports)

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