

**WATER QUALITY MONITORING UPSTREAM AND DOWNSTREAM OF SMOLT PRODUCTION FACILITIES ON
THE UPPER DERWENT AND FLORENTINE RIVERS**

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Client: Environment Tasmania

Samples were collected on 24 March 2019 at sites upstream and downstream of the hatchery/smolt production facilities at Wayatinah and Florentine. Samples were also collected at outfalls from the two facilities, at the point where they enter the rivers.

Conditions on the day were clear and dry, and river flows were relatively low. However, on-line hydrographs available through Hydro Tasmania indicated that there had been higher flows 5 to 10 days prior to sampling, which would have flushed out any stagnant water.

Samples at each site were collected for dissolved nutrients: ammonium plus ammonia nitrogen (NH₄-N); nitrate plus nitrite nitrogen (NO_x-N) and dissolved reactive phosphorus (DRP). These nutrients are immediately bioavailable for algal growth, with phosphorus generally considered to be a limiting nutrient in freshwater systems, and nitrogen more of a concern in marine systems. In addition, outfall samples were collected for coliform/E coli bacteria. All samples were maintained at cold temperatures and delivered to NATA accredited labs (Analytical Services Tasmania and Public Health Laboratory) the following day for analysis.

Results for Wayatinah hatchery

	NH₄-N	NO_x-N	DIN*	DRP	Coliforms	E Coli
<i>Units</i>	<i>µg/L</i>	<i>µg/L</i>	<i>µg/L</i>	<i>µg/L</i>	<i>MPN/100 ml</i>	<i>MPN/100 ml</i>
Derwent above hatchery	<5	39	<44	4		
Hatchery outfall	290	100	390	50	63	31
Derwent below hatchery	200	720	920	73		

*calculated by adding NH₄-N plus NO_x-N

These results document excellent water quality in the Derwent River directly above the hatchery and demonstrate that high nutrient levels are entering the river at the hatchery, as shown by both the results for the outfall sampled as well as the river further downstream. There appeared to be 4 or 5 outfalls discharging from the hatchery and the largest of these, which is also furthest downstream, was sampled. However, the results for NO_x-N and DRP in the sample downstream of the outfall were even higher than those in the outfall itself, indicating that there must be additional sources of nutrients – presumably from one or more of the other outfalls that were not sampled. Dissolved phosphorus and nitrogen levels in the river downstream of the hatchery ranged from 18 to more than 40 times upstream levels. Significant levels of fouling were also observed on the rocks and river bed downstream. Coliform and E coli bacteria levels in the outfall did not appear to be particularly high, however the status of other outfalls is unknown.

Results for Florentine hatchery

	NH₄-N	NO_x-N	DIN*	DRP	Coliforms	E Coli
<i>Units</i>	<i>µg/L</i>	<i>µg/L</i>	<i>µg/L</i>	<i>µg/L</i>	<i>MPN/100 ml</i>	<i>MPN/100 ml</i>
Florentine above hatchery	<5	33	<38	4		
Hatchery outfall	780	670	1450	110	>24,196	886
Florentine below hatchery	640	160	800	59		

*calculated by adding NH₄-N plus NO_x-N

These results document excellent water quality in the Florentine River directly above the hatchery and demonstrate that high nutrient levels are entering the river at the hatchery, as shown by both the results for the outfall sampled as well as the river further downstream. Dissolved phosphorus and nitrogen levels

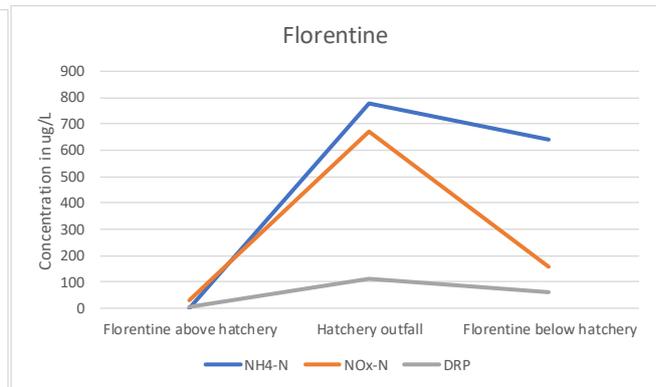
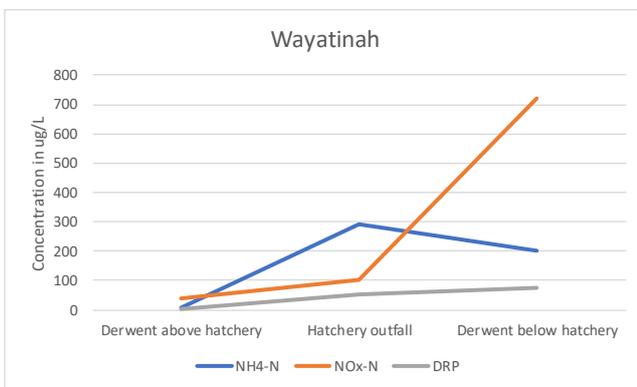
in the river downstream of the hatchery ranged from 5 to more than 128 times upstream levels. Significant levels of fouling were also observed on the rocks and river bed downstream. Coliform and E coli bacteria levels in the outfall were very high, and there was a strong odour and visible slick in the area.



Approximate sample locations: Wayatinah



Approximate sample locations: Florentine



Concentrations of dissolved nutrients at sites sampled (to provide some context, Australia's national water quality guidelines for slightly disturbed ecosystems recommend a concentration of 15 ug/L for NOx-N and NH4-N, and 5 µg/L for DRP)



Biofouling downstream of outfalls

Discussion:

The results demonstrate that these two facilities are discharging high concentrations of nutrients, and potentially bacteria into high quality rivers. While these levels are disturbingly high, they were not unexpected: similar results for nutrients on the Florentine have been documented over a period of two-years (2015 – 2017) by the Derwent Estuary Program's Derwent catchment monitoring program (see Proemse et al 2018 for details). Both sites are located directly upstream of Hydro lakes (Wayatinah and Catagunya). These lakes are part of a series of reservoirs, which are widely used for recreation, fishing and as drinking water supplies to local communities. Further downstream – at Bryn Estyn – the Derwent supplies the majority of Hobart's drinking water.

The bacteria results for the Florentine outfall (coliforms >24,196 MPN/100 ml) were unexpectedly high, and merit further investigation. Coliform bacteria include sixteen sub-groups, some derived from faecal material, others from soil and vegetation (MFE, 2003). Which are present here, and could this pose a risk to downstream ecology – including native fish? Are there specific groups of bacteria associated with smolt production facilities that may be of particular concern? And why was the E coli count (886 MPN/100 ml) so high, given that this is normally associated with warm-blooded animals? Alert levels for E coli in recreational waters are in the range of 126 MPN/100 ml (USEPA, 2012) to 260 MPN/100 ml (MFE, 2003), and elevated E coli levels are of particular concern in drinking water supplies (Tasmanian and Australian Drinking Water Guidelines).

Finally, while the bacteria levels at the outfall sampled at Wayatinah were not particularly high, it appears that there are other significant outfalls discharging in this area which may contain higher bacteria levels – these other outfalls should be investigated as well.

Risks and recommendations:

- The smolt production facilities at Wayatinah and Florentine are discharging high concentrations of nutrients, and potentially bacteria, into high quality rivers, near the headwaters of the River Derwent.
- These outfalls are located directly upstream of a series of Hydro lakes, that supply local communities with drinking water, provide water for irrigation and livestock, and are valued for fishing and other recreation.
- In addition to the two facilities monitored on 24 March, there are three other large-scale hatcheries located within the catchment (two on the Tyenna, one directly downstream of Lake Meadowbank) that also merit further scrutiny.
- The combination for high nutrients, low water flows and warming water temperatures is a common trigger for algal blooms, including toxic species. Algal blooms in any one of the Derwent lakes could readily spread downstream and – once established – be difficult/impossible to eradicate. This could have severe consequences for water supplies and the users that depend on these. Taste and odour problems associated with blue-green algae have already been experienced over the past few summers at TasWater's Bryn Estyn water treatment plant, requiring expensive additional treatment.
- It is recommended that smolt production facilities located in the Derwent catchment either implement best management practices (e.g. full recirculation) or that smolt production be moved to facilities with modern wastewater treatment processes.

References

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USEPA, 2012. Recreational Water Quality Criteria. Office of Water, United State Environmental Protection Agency.