

Development of Preliminary Receiving Water Quality Guidelines Values for Wayatinah Hatchery and Florentine Hatchery.

Introduction

Water quality has been monitored upstream and downstream of the Wayatinah and Florentine Hatcheries since May 2015. Water quality of the settlement ponds has also been monitored during this period. Water quality data collected from upstream sites provides an opportunity to calculate site-specific trigger values that can set a benchmark against which downstream water quality can be assessed. This document outlines the data available and assigns preliminary water quality guideline values for the two hatcheries. Water quality monitoring at these sites has been intermittent with several changes in frequency of monitoring events since 2015.

The Water Quality Dataset

There have been 24 sampling events upstream of the Wayatinah and Florentine Hatcheries since May 2015 (Table 1). The frequency of sampling was approximately quarterly between May 2015 and March 2018, then changed to fortnightly between March 2018 and September 2018.

Nineteen parameters were measured from the water samples. Not all parameters were sampled and/or analysed for each sampling event. Sixteen analytes were sampled twenty or more times between 2015 and 2018. Temperature, DO (mg/L) and DO (%) were only measured on 10, 13 and 5 occasions, respectively. Data available for parameters were unevenly spread across years (quarterly sampling between 2015-2017; fortnightly samples for 2018; Table 2) and seasons (autumn and winter well represented; summer and spring poorly represented; Table 2).

Values for some parameters often fell below lab detection limits. The laboratory analysing water samples reported these parameters with a prefix '<' (e.g. <0.005 mg/L). In these cases, the upper value of the detection limit was used in calculations. For example, a value of <0.005 mg/L was converted to 0.005 mg/L. An alternative approach is to halve values that reach detection limits of laboratories (e.g. <0.005 mg/L = 0.0025 mg/L) and the effect of this approach could be trialled upon request.

Table 1: List of upstream sampling events from 2015, 2016, 2017, 2018. Note that not all parameters were sampled and/or analysed during each sampling event.

2015	2016	2017	2018
8-May	29-Mar	11-Jan	13-Mar
7-Jul	28-Jul	27-Apr	26-Mar
18-Aug	18-Oct	27-Jul	11-Apr
16-Dec		18-Oct	19-Apr
			3-May
			16-May
			5-Jun
			21-Jun
			17-Jul
			16-Aug
			18-Sep

Table 2: Number of data points for each parameter by year and by season. Parameter 1 refers to labels in the AST water quality sampling reports . Parameter 2 refers to equivalent label in Water Quality Default Guideline Values for the Upper Derwent (Appendix 2)

Parameter 1	Parameter 2	2015	2016	2017	2018	Autumn	Winter	Spring	Summer	Total
Florentine										
Alkalinity		4	3	4	12	9	9	2	3	23
Ammonia		4	3	4	12	9	9	2	3	23
BOD		4	3	4	12	9	9	2	3	23
Coliforms		4	3	4	12	9	9	2	3	23
DO (%)	DO (% sat)^	0	1	1	11	6	3	2	2	13
DO (mg/L)	DO (mg/L)^	0	1	1	3	1	0	2	2	5
EC	Cond^	4	3	4	13	9	9	3	3	24
Hardness		4	3	4	12	9	9	2	3	23
Nitrate	NO ₃ as N^	4	3	4	12	9	9	2	3	23
Nitrite	NO ₂ as N^	2	3	4	12	8	8	2	3	21
pH	pH^	4	3	4	12	9	9	2	3	23
Phosphorus	DRP as P^	4	3	4	12	9	9	2	3	23
TDS		4	3	4	12	9	9	2	3	23
Temperature	Temp (°C)^	0	1	4	5	2	3	3	2	10
Total Mg		4	3	4	12	9	9	2	3	23
Total Nitrogen	TAN as N^	4	3	4	12	9	9	2	3	23
Total Phosphorus	Total P as P^	4	3	4	12	9	9	2	3	23
Total Zinc		4	3	4	12	9	9	2	3	23
TSS	TSS* (1.5 µm)	4	3	4	12	9	9	2	3	23
Wayatinah										
Alkalinity		4	3	4	12	9	9	2	3	23
Ammonia		4	3	4	12	9	9	2	3	23
BOD		4	3	4	12	9	9	2	3	23
Coliforms		4	3	4	11	9	8	2	3	22
DO (% sat)	DO (% sat)^	0	1	1	5	1	2	2	2	7
DO (mg/L)	DO (mg/L)^	0	1	1	3	1	0	2	2	5
EC	Cond^	4	3	4	13	9	9	3	3	24
Hardness		4	3	4	12	9	9	2	3	23
Nitrate	NO ₃ as N^	4	3	4	12	9	9	2	3	23
Nitrite	NO ₂ as N^	2	3	4	12	8	8	2	3	21
pH	pH^	4	3	4	12	9	9	2	3	23
Phosphorus	DRP as P^	4	3	4	12	9	9	2	3	23
TDS		4	3	4	12	9	9	2	3	23
Temperature	Temp (°C)^	0	1	4	6	2	4	3	2	11
Total Mg		4	3	4	12	9	9	2	3	23
Total Nitrogen	TAN as N^	4	3	4	12	9	9	2	3	23
Total Phosphorus	Total P as P^	4	3	4	12	9	9	2	3	23
Total Zinc		4	3	4	12	9	9	2	3	23
TSS	TSS* (1.5 µm)	4	3	4	12	9	9	2	3	23

Calculation of Receiving Water Quality Guidelines Values

The National Water Quality Management Strategy considers that the 80th percentile provides an upper limit for stressors that cause problems at high values, while the 20th percentile provides a lower limit for stressors that cause problems at low values. These site-specific trigger values set a benchmark against which future variation in water quality at sites can be assessed.

It is considered that sufficient information should be available from historical upstream sampling of hatcheries to calculate guideline values for receiving water quality. The water quality default guidelines values for the Upper Derwent provide a set of relevant parameters (Appendix 1: see Parameter 2 column in Table 2) and these default guideline values that can be referred to when data is insufficient.

Annual guideline values

The annual trigger values for 20th and 80th percentiles were calculated using all available data (i.e. all water samples collected between 2015-2018) in using the following formula in Excel (Table 3):

=PERCENTILE.INC(J2:J25,0.2) for the 20th percentile, where J2: J125 is the array of parameter values and 0.2 stipulates the percentile value

=PERCENTILE.INC(J2:J25,0.8) for the 80th percentile, where J2: J125 is the array of parameter values and 0.8 stipulates the percentile value

It is important to note that the annual trigger values derived from this data (Table 3) will be subject to yearly and seasonal bias because of (a) unbalanced sampling across years (see Table 2) and (b) unbalanced sampling across seasons (see Table 2). This may have an effect on parameters with a strong seasonal cycle, for example, the over-representation of cold water in autumn and winter samples compared to spring and summer samples (see Table 2) will result in temperature trigger limits that may be considerably cooler than true conditions.

Seasonal guideline values

The water quality default guidelines values for the Upper Derwent include seasonal values (Appendix 1). The 20th and 80th percentiles were calculated for each season for Florentine and Wayatinah hatcheries (Table 4). These values should be treated with caution given the low sample numbers, particularly for spring and summer where only two or three samples were often available.

Interpretation and caveats

Derived guideline values were calculated using upstream water quality information for the Florentine and Wayatinah hatcheries. Relevant parameters were based on the water quality default guidelines values for the Upper Derwent and the 20th and 80th percentiles were used to set a benchmark against which future variation in water quality at sites can be assessed. Annual and seasonal guideline values were derived (Table 3; Table 4).

Two important points should be noted when using and interpreting guideline values presented in Table 3 and Table 4: (1) sample collection was unbalanced across years and seasons and annual guideline values may be skewed toward winter and autumn conditions; and (2) guideline values for some seasons (i.e. Spring/Summer) and some parameters (i.e. dissolved oxygen; temperature) are based on very small sample sites. In these cases, it may be prudent to defer to default guideline values for the upper Derwent (Table 3; Table 4; Appendix 1).

Appendix 1: Water Quality Default Guideline Values for the Upper Derwent.

Table A1: Water Quality Default Guideline Values for the Upper Derwent. NB: Where Site Specific Data is available that is to be used instead.

SMD	Physico-chemical indicators and Protection of Aquatic Ecosystems guideline values																	
	DO (mg/L)^		DO (% sat)^		Cond^	pH^		Turb^	Temp (°C)^		TAN as N^	NO ₃ as N^	NO ₂ as N^	Total N as N^	DRP as P^	Total P as P^	TSS* (1.5 µm)	TSS^ (0.45 µm)
	lower	upper	lower	upper	(µs/cm)	lower	upper	NTU	lower	upper	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Annual	9.4	11.8	90.3	103.8	123.4	6.2	7.4	8.3	6.5	13.5	0.012	0.020	0.003	0.394	0.004	0.022	5.00	11.00
Summer	8.9	10.5	90.3	103.1	140.4	6.5	7.8	6.7	11.2	16.9	0.011	0.008	0.003	0.370	0.004	0.023	5.00	15.20
Autumn	9.7	11.7	89.5	103.8	124.4	6.3	7.6	6.0	7.6	12.2	0.011	0.020	0.004	0.323	0.004	0.016	5.00	12.00
Winter	11.1	13.0	90.5	105.1	116.5	6.0	7.0	13.0	4.5	7.0	0.016	0.071	0.005	0.529	0.004	0.028	10.00	7.00
Spring	9.5	11.8	90.5	103.7	114.6	6.2	7.3	9.1	7.0	11.7	0.012	0.009	0.004	0.392	0.004	0.022	5.00	8.20

Appendix 2: Raw Data for upstream water samples

Table A2: Raw data for upstream samples at Florentine and Wayatinah Hatcheries.

Region	Date	Season	Temp	pH	EC	DO_mgL	DO_per	TDS	TSS	Alkalinity	Hardness	BOD	Coliforms
Florentine	8-May-15	Autumn		7.3	72			92	12	17	28	<5	50
Florentine	7-Jul-15	Winter		7.7	158			112	<2	62	72	<5	<10
Florentine	18-Aug-15	Winter		7.6	99			90	4	32	39	<5	10
Florentine	16-Dec-15	Summer		8.1	168			125	4	73	77	<5	30
Florentine	29-Mar-16	Autumn		8.4	295			202	<2	141	143	<5	40
Florentine	28-Jul-16	Winter		7.5	94			92	4	29	35	<5	20
Florentine	18-Oct-16	Spring	7.7	8.1	112.6	11.3	99.7	91	<2	41	45	<5	40
Florentine	11-Jan-17	Summer	15.2	8.09	346	10.3	98.2	182	<2	157	12	<5	10
Florentine	27-Apr-17	Autumn	7.4	8.22	341			190	2	161	161	<5	60
Florentine	27-Jul-17	Winter	5.2	7.6	91.7			84	4	33	37	<5	20
Florentine	18-Oct-17	Spring	9.6	7.74	217.7			138	<2	94	105	<5	<10
Florentine	23-Feb-18	Summer	13.2	8.2	229	12.27	117.1	151	2	100	107	<5	50
Florentine	13-Mar-18	Autumn		8.5	326			115	195	157	166	<5	<10
Florentine	26-Mar-18	Autumn		7.8	139			109	101	55	58	<5	60
Florentine	11-Apr-18	Autumn		8.2	216			101	149	93	99	<5	50
Florentine	19-Apr-18	Autumn		7.6	112			106	106	34	43	<5	140
Florentine	3-May-18	Autumn		8.1	222			105	148	99	105	<5	20
Florentine	16-May-18	Autumn	7	7.9	170	12.99	106.8	115	<2	67	73	<5	50
Florentine	5-Jun-18	Winter		8.1	194			102	130	81	80	<5	20
Florentine	21-Jun-18	Winter	4	7.8	139			100	118	58	63	<5	10
Florentine	17-Jul-18	Winter	6.7	8	199			102	122	84	87	<5	10
Florentine	30-Jul-18	Winter		7.7	121			85	<2	44	52	<5	30
Florentine	16-Aug-18	Winter		7.4	80			72	3	26	29	<5	10
Florentine	18-Sep-18	Spring	8.3		139	12.8	108.8						
Wayatinah	8-May-15	Autumn		5.5	42			62	12	<2	7	<5	20
Wayatinah	7-Jul-15	Winter		7	50			47	2	7	11	<5	<10
Wayatinah	18-Aug-15	Winter		6.9	42			39	<2	5	9	<5	<10
Wayatinah	16-Dec-15	Summer		7.3	55			57	<2	15	14	<5	<10
Wayatinah	29-Mar-16	Autumn		7.77	54			72	<2	12	17	<5	20

Wayatinah	28-Jul-16	Winter		8.19	34			47	2	6	10	<5	10
Wayatinah	18-Oct-16	Spring	8.2	8.45	29.3	11.9	100.2	30	<2	3	6	<5	10
Wayatinah	11-Jan-17	Summer	15.7	8.5	69.3	10.2	98.3	48	<2	16	17	<5	<10
Wayatinah	27-Apr-17	Autumn	7.4	8.4	62.7			57	<2	16	18	<5	60
Wayatinah	27-Jul-17	Winter	3.9	8.02	35.3			39	2	4	7	<5	10
Wayatinah	18-Oct-17	Spring	11.7	7.71	51			47	4	10	12	<5	<10
Wayatinah	23-Feb-18	Summer	14.3	4.81	62	10.8	106.1	56	<2	17	18	<5	40
Wayatinah	13-Mar-18	Autumn		7.4	73			62	<2	21	22	<5	10
Wayatinah	26-Mar-18	Autumn		6.5	42			64	8	5	10	<5	230
Wayatinah	11-Apr-18	Autumn		7	58			67	<2	12	14	<5	130
Wayatinah	19-Apr-18	Autumn		6.7	43			47	<2	5	9	<5	130
Wayatinah	3-May-18	Autumn		7.3	56			51	<2	12	15	<5	50
Wayatinah	16-May-18	Autumn	6.2	6.9	47	13.21	106.5	44	<2	7	10	<5	30
Wayatinah	5-Jun-18	Winter	6	7.1	52			41	<2	9	10	<5	
Wayatinah	21-Jun-18	Winter	5.1	6.9	44		101	47	<2	7	10	<5	<10
Wayatinah	17-Jul-18	Winter	5.2	7	56		102	44	<2	9	11	<5	10
Wayatinah	30-Jul-18	Winter		6.4	33			41	3	3	7	<5	30
Wayatinah	16-Aug-18	Winter		6.6	28			30	3	3	6	<5	20
Wayatinah	18-Sep-18	Spring	8.1		23	12.9	109.5						

Table A2 continued: Raw data for upstream samples at Florentine and Wayatinah Hatcheries.

Region	Date	Season	Ammonia	Nitrate	Nitrate_Nitrite	Nitrite	Phosphorus	Total_N	TKN	Total_P	Total_Ca	Total_Mg	Total_Zn
Florentine	8-May-15	Autumn	0.018	0.037		0.008	0.007	0.8		0.02	8.8	1.37	6
Florentine	7-Jul-15	Winter	<0.005	0.066		0.003	0.006	0.31		<0.01	24.7	2.47	4
Florentine	18-Aug-15	Winter	0.007	0.038	0.043	0.005	0.004	0.35	0.31	0.01	13.2	1.58	3
Florentine	16-Dec-15	Summer	0.006	0.032	0.036	0.004	0.005	0.31	0.28	<0.01	27	2.38	<2
Florentine	29-Mar-16	Autumn	<0.005	0.063	0.064	<0.002	0.004	0.33	0.26	<0.01	50.4	4.1	6
Florentine	28-Jul-16	Winter	0.006	0.079	0.084	0.005	0.004	0.39	0.3	<0.01	11.6	1.39	3
Florentine	18-Oct-16	Spring	0.01	0.047	0.05	0.003	<0.003	0.3	0.25	<0.01	15.3	1.65	<2
Florentine	11-Jan-17	Summer	<0.005	0.084	0.086	<0.002	0.004	0.31	0.23	<0.01	3.02	1.01	52
Florentine	27-Apr-17	Autumn	<0.005	0.067	0.069	<0.002	0.005	0.16	<0.1	<0.01	57.3	4.43	<2
Florentine	27-Jul-17	Winter	0.01	0.032	0.038	0.006	0.005	0.41	0.37	0.02	12.3	1.42	3
Florentine	18-Oct-17	Spring	<0.005	0.12	0.13	0.002	0.004	0.29	0.17	<0.01	37.5	2.81	2
Florentine	23-Feb-18	Summer	0.008	0.047	0.049	0.003	<0.003	0.34	0.29	<0.01	37.7	3.09	2
Florentine	13-Mar-18	Autumn	0.005	0.059	0.061	<0.002	0.003	0.21	0.15	<0.01	59.1	4.58	<2
Florentine	26-Mar-18	Autumn	<0.005	0.031	0.034	0.003	0.004	0.31	0.28	0.01	19.6	2.25	3
Florentine	11-Apr-18	Autumn	0.007	0.055	0.059	0.003	0.004	0.32	0.26	<0.01	34.7	3.03	4
Florentine	19-Apr-18	Autumn	0.012	0.046	0.052	0.006	0.007	0.66	0.61	0.02	14.5	1.61	4
Florentine	3-May-18	Autumn	0.007	0.07	0.073	0.003	0.005	0.3	0.23	<0.01	36.8	3.23	<2
Florentine	16-May-18	Autumn	0.008	0.096	0.099	0.003	0.004	0.4	0.3	0.01	25.3	2.36	<2
Florentine	5-Jun-18	Winter	0.005	0.088	0.09	0.002	<0.003	0.32	0.23	0.01	27.8	2.5	3
Florentine	21-Jun-18	Winter	0.009	0.11	0.12	0.003	0.003	0.42	0.31	0.01	22.2	1.93	<2
Florentine	17-Jul-18	Winter	0.007	0.14	0.14	<0.002	0.004	0.3	0.15	<0.01	30.5	2.58	8
Florentine	30-Jul-18	Winter	0.008	0.074	0.077	0.003	<0.003	0.3	0.23	<0.01	17.9	1.74	4
Florentine	16-Aug-18	Winter	0.01	0.044	0.049	0.005	0.003	0.45	0.4	0.01	9.62	1.2	2
Florentine	18-Sep-18	Spring											
Wayatinah	8-May-15	Autumn	0.009	0.028		0.006	0.005	0.51		0.03	1.35	0.99	18
Wayatinah	7-Jul-15	Winter	0.009	0.094		0.003	0.005	0.27		<0.01	2.23	1.42	4
Wayatinah	18-Aug-15	Winter	<0.005	0.079	0.081	0.002	0.003	0.24	0.16	0.01	1.69	1.17	3
Wayatinah	16-Dec-15	Summer	0.008	0.04	0.044	0.004	0.005	0.27	0.23	<0.01	2.83	1.78	<2
Wayatinah	29-Mar-16	Autumn	0.017	0.02	0.029	0.009	0.005	0.6	0.57	0.01	3.41	2.05	4
Wayatinah	28-Jul-16	Winter	0.007	0.16	0.17	0.005	0.056	0.75	0.58	0.09	2.39	0.91	4
Wayatinah	18-Oct-16	Spring	0.007	0.059	0.061	<0.002	0.005	0.2	0.14	<0.01	1.09	0.72	4

