Contaminant Assessment in Devilbend Natural Features Reserve

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1. Introduction

Devilbend Natural Features Reserve was established in 2006. A series of research phases have been undertaken since 2008 to determine the freshwater ecology of the system, including a desktop summary of existing data (Phase One); a detailed ecological survey of all aquatic habitats in the Reserve (Phase Two); and a study to design a community-based monitoring program to measure any impacts resulting from changes in management practices (Phase Three). Based on this, a community-based Water Watch initiative has been established for ongoing monitoring of water quality in the Devilbend Reserve. The last Phase of the program (Phase Four) outlined a Toxicology Study, to assess if metals or pesticides may be an issue in the Reserve due to historic agricultural activities prior to the establishment of the reserve. Due to constraints with being able to assess bioaccumulation in fish flesh, an alternative toxicology program was proposed by the AQUEST research group.

We have conducted a sediment toxicity test with freshwater amphipods using sediments collected from four different locations in the Devilbend Reserve. Toxicity tests are designed to determine if any contaminants present in the collected sediment are having adverse effects on biota (i.e., reduced growth or survival). Tests run for 5 days (d) using standard testing procedures. We also conducted comprehensive chemical screening of sediments for metals, pesticides and petroleum hydrocarbons.

1.1. Aims and Objectives

The aims of this study are to measure concentrations of sediment bound contaminants in samples collected from four different locations within the Devilbend Reserve and assess the toxicity of these sediments to freshwater amphipods using a standard 5 d sediment toxicity test.

2. Study Area

Sites were selected in collaboration with Devilbend Foundation Inc. and Parks Victoria staff (Table 1; Figure 1).

Table 1: Study sites

Site Number	AQUEST code	Description	Latitude	Longitude
REFERENCE	43	Glynns Reservoir, North Warrandyte (control site)		
DEV1	2191	Devilbend Reservoir (NW section) at boat ramp; Tuerong	-38.279888°	145.101579°
DEV2	2194	Devilbend Reservoir (SW section) off Derril Rd; Tuerong	-38.289911°	145.092025°
DEV3	2193	Devilbend Reservoir (SE Section) at Orchid Track; Tuerong	-38.295546°	145.111878°
DEV4	2192	Devilbend Reservoir (NE section) off Reservoir Circuit Trail, near Graydens Rd; Tuerong	-38.283908°	145.110583°

Figure 1. Sampling sites around Devilbend Reservoir, Tuerong.

2.1. Collecting Sediment

Sediments were collected and filtered through 64 µm mesh at 4 sites in Devilbend Reservoir, and at one uncontaminated site in Glynns Reservoir, North Warrandyte (reference site) in August 2022. Sediments were returned to AQUEST laboratory, RMIT University and stored at 4°C before using in the toxicity test. Sediment holding time was less than 4 weeks.

2.2. Sediment Chemical Analysis

Filtered sediment samples were sent to Australian Laboratory Services (ALS) and National Measurement Institute (NMI) Port Melbourne laboratories for comprehensive chemical analyses, including pesticides, petroleum hydrocarbons and metals.

2.3. Toxicity Test Species: *Austrochiltonia subtenuis* (Freshwater Amphipod)

Austrochiltonia subtenuis used for the experiment were maintained at AQUEST (RMIT University, Australia), and were originally collected from Bittern Reservoir, Victoria. The culture was maintained under a 16:8 h light: dark cycle at 21 ±1°C in aerated culture medium. Amphipod were fed *ad libitum* with commercial fish food (TetraMin, Germany) and mixture of yeast, cerophyll, and trout chow (YCT).

Four replicates of a 250 mL beaker were used for Devilbend Reservoir site sediments and eight replicates were used for reference site sediments (Glynns Reservoir). Each beaker contained 50 g of sediment (wet weight) and 200 mL artificial water. The beakers were covered with plastic wrap to avoid water evaporation and were aerated during the experiment. Sediments were allowed to settle in beakers for 24 hours prior to exposure. Ten juvenile amphipods (pass 300 µm and retain on 212 µm sieves) were added to each replicate and were exposed to sediments for 5 days in an incubator under a 16:8 h light: dark cycle at 21 ±1 °C (Figure 2). Amphipods were fed at the start, on day 3, and at the end of the test. After the 5-d exposure, amphipods were removed from each replicate by sieving the water and sediment through a 250 µm sieve, survival was recorded.

Figure 2. Freshwater amphipods (*Austrochiltonia subtenuis*) and a laboratory- based toxicity test underway.

2.4. Water Quality

Dissolved oxygen (% saturation), pH, ammonia (mg/L) and electric conductivity (µS/cm) were measured at the start and at the end of the experiment using a water quality meter (Smartchem - Lab, TPS, QLD, Australia).

2.5. Data Analysis

Sediment toxicity test analyses were performed using SPSS (IBM SPSS Statistics 28). Parametric tests were applied (one-way ANOVA with *post hoc* Turkey HSD) to determine significant differences among sites. All data were checked for normality and homogeneity of variances and transformations were applied to normalize distributions where necessary. The level of significance for all statistical tests was $p < 0.05$.

3. Results

3.1. Sediment Chemistry

Sediment metal and total petroleum hydrocarbon (TPH) concentrations were compared to the sediment toxicant guideline values outlined in the Australian and New Zealand Guidelines for Fresh & Marine Water Quality (ANZG, 2018). The guidelines use two values for each toxicant: Default Guideline Value (DGV), which is the concentration of a toxicant below which adverse ecological impacts are not expected; and the Guideline Value-High (GV-High), which is the upper guideline limit whereby if values exceed this level, they are expected to be highly toxic to biota and cause adverse ecological effects.

Comprehensive pesticide screening for 109 different compounds was done, and none were detected in any of the sediment samples. Some metals and petroleum hydrocarbons were detected in Devilbend sediment; however all concentrations were below ecological guidelines, and were comparable to concentrations observed in the sediments collected from the reference site (Table 2).

Table 2. Metals and petroleum hydrocarbons in filtered sediments from Devilbend Reserve and the Glynns Wetland reference site. All concentrations were below ecological guideline values.

Site Code	Site Name		Total Organic Carbon %	C10-C36 Fraction (Sum) (1.0% TOC)	Arsenic	Barium	Chromium (III+VI)	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Vanadium	Zinc
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
43	Glynns Reservoir, North Warrandyte (reference site)		2.75	210	<5	160	29	6	14	15	121	<0.1	15	30	56
2191	Devilbend Reservoir (NW section) at boat ramp; Tuerong		2.56	110	7	120	18	2	30	19	336	<0.1	6	33	36
2192	Devilbend Reservoir (NE section) off Reservoir Circuit Trail; Tuerong		2.08	120	<5	50	7	<2	9	10	285	<0.1	3	15	12
2193	Devilbend Reservoir (SE Section) at Orchid Track; Tuerong		2.04	<50	<5	70	16	<2	16	14	168	<0.1	5	28	21
2194	Devilbend Reservoir (SW section) off Derril Rd; Tuerong		2.22	140	<5	40	10	<2	11	10	33	<0.1	3	18	15
	Sediment toxicant guidelines (ANZG, 2018) – default guideline value (DGV)			**280**	**20**		**80**		**65**	**50**		**0.15**	**21**		**200**
	Sediment toxicant guidelines (ANZG, 2018) – guideline value-high (GV-High)			**550**	**70**		**370**		**270**	**220**		**1.0**	**52**		**410**

3.2. 5 d Amphipod Toxicity Test

All water quality parameters were within acceptable ranges for sediment toxicity tests, as described by Simpson and Batley (2016). Dissolved oxygen concentrations were above 95% of the air saturation level at the temperature used in the test. The pH of the overlaying water was between 7.39 – 8.27 (Table 3). Water temperature was maintained within the prescribed ranges. Electrical conductivity was similar among sites. Ammonia was at low levels for all sites.

Table 3. Water quality parameters for 5d sediment toxicity tests.

Site	pH		DO (%S)		EC (uS/cm)		NH3 (mg/L)	
	Start	End	Start	End	Start	End	Start	End
43 (REF)	8.27	7.39	95	98.3	1342	1043	0	9
2191	8.27	8.29	95	97.6	1342	1353	0	0
2192	8.27	8.16	95	98.1	1342	1290	0	0.25
2193	8.27	8.11	95	95.9	1342	1259	0	0.25
2194	8.27	7.94	95	97.7	1342	1249	0	0

The survival percentage of the amphipods in the reference site sediment (Glynns Wetland) exceeded the minimum criteria of 70% (Simpson and Batley, 2016), thus the test is considered valid.
There was no significant difference in amphipod survival among sites (ANOVA; $F_{4,18}$ = 1.16, p = 0.360) (Figure 3). The Devilbend sediments had no impact on amphipod survival, all study sites have high survival percentage (> 90%).

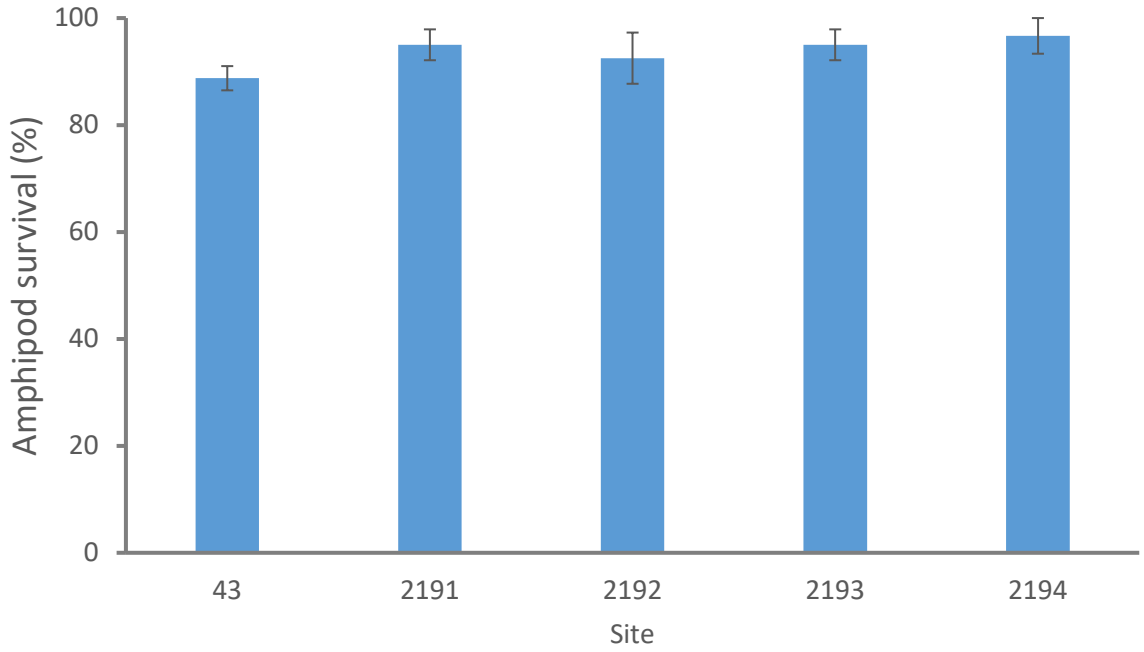

Figure 3: Percent survival (mean ± SE) of the *A. subtenuis* in 5d sediment toxicity test. There were no significant differences between the reference site and any Devilbend Reserve sites.

4. Discussion

This study has determined that sediments collected from four different locations within the Devilbend Reserve are clean, and not contaminated with metals, petroleum hydrocarbons or pesticides. Comprehensive screening of 109 pesticides showed zero detections and whilst low levels of some metals and petroleum hydrocarbons were detected, they were all below ecological guideline values and were comparable to the clean, reference site sediments.

Similarly, the 5-d amphipod toxicity test showed no indications of toxicity in any of the sediment samples. Based on these findings, we conclude that sediments from Devilbend Reserve do not present any risks of impacts to resident organisms within the Reserve.

5. References

ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.

Simpson, S., & Batley, G. (2016). Sediment quality assessment: a practical guide (No. Ed. 2). CSIRO Publishing.