Water Quality Monitoring of the Upper Lindsay River

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mallee
catchment management authority

The Murray-Darling Freshwater Research Centre

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Introduction

The Murray Darling Basin Commission (MDBC) in 2003 reported a considerable deterioration in River Red Gums (*Eucalyptus camaldulensis*) on the semi-arid zone Murray River floodplain in South Australia and Victoria below Euston. In some locations, this decline is regarded by the MDBC as irreparable. The 2003 MDBC report illustrates that the observed symptoms of the Red Gums are consistent with changed flooding regimes causing prolonged water stress and soil salt accumulation. This situation is also believed to be exacerbated by extended drought conditions in the region.

Re-surveying of Victorian monitoring sites during March 2004 indicated that the health of River Red Gums had substantially deteriorated since the 2003 survey. The re-survey included sites at Lindsay and Wallpolla Islands and Neds Corner Station, between Mildura and the South Australia border.

In the March 2004 survey, 90% of survey sites had a majority of trees stressed or dead, compared with 56% of sites in 2003. 63% of survey sites in 2004 had more than 80% of trees stressed or dead compared with 7% of sites in 2003 (Lane and Associates 2004).

Through DSE (Department of Sustainability and Environment) 7 GL of water from Victoria's Murray Flora and Fauna Entitlement became available for use to relieve Red Gum stress. Several watering sites were chosen in the Lindsay and Wallpolla Island vicinity where Red Gums were in a critical condition. One such site was the Upper Lindsay River.

The objectives of this investigation were to monitor changes in water quality, as water was pumped from the Murray River into the Upper Lindsay River.

Water quality monitoring at the trial was primarily undertaken as a mechanism for risk management, however it also served to improve knowledge and understanding of the likely response of water quality to emergency pumping operations.

It was identified that water quality decline during the trial may have an adverse impact on in stream habitat and riparian vegetation. In particular, the potential impact of increased salt loading on River Red Gums, and a decrease in dissolved oxygen. Decreases in dissolved oxygen concentrations in the River subsequent to inflow were a concern, as microbial breakdown of organic matter in the river channel (primarily leaf litter) upon inundation of flood water may create anaerobic in-stream conditions, which may have implications for aquatic flora and fauna.

Subsequently, an operational plan was developed, which included temporal and spatial checks, to manage water quality throughout the trial.

Methods

The Upper Lindsay Section that was monitored was divided into two reaches by a natural sill. The upstream reach (reach 1) was 430 m, the downstream reach (reach 2) was 1300 m (Figure 1; Table 1)
Water quality, water level readings and cross-sectional river profiles were taken at thirteen sites within the two reaches.

Reach 1 - Sites	Distance from Murray River (m)	Reach 2 - Sites	Distance from Murray River (m)
1	73	7	571
2	162	8	731
3	217	9	916
4	299	10	1104
5	358	11	1370
6	427	12	1570
		13	1734

Table 1: Distance of individual transects from the Murray River.

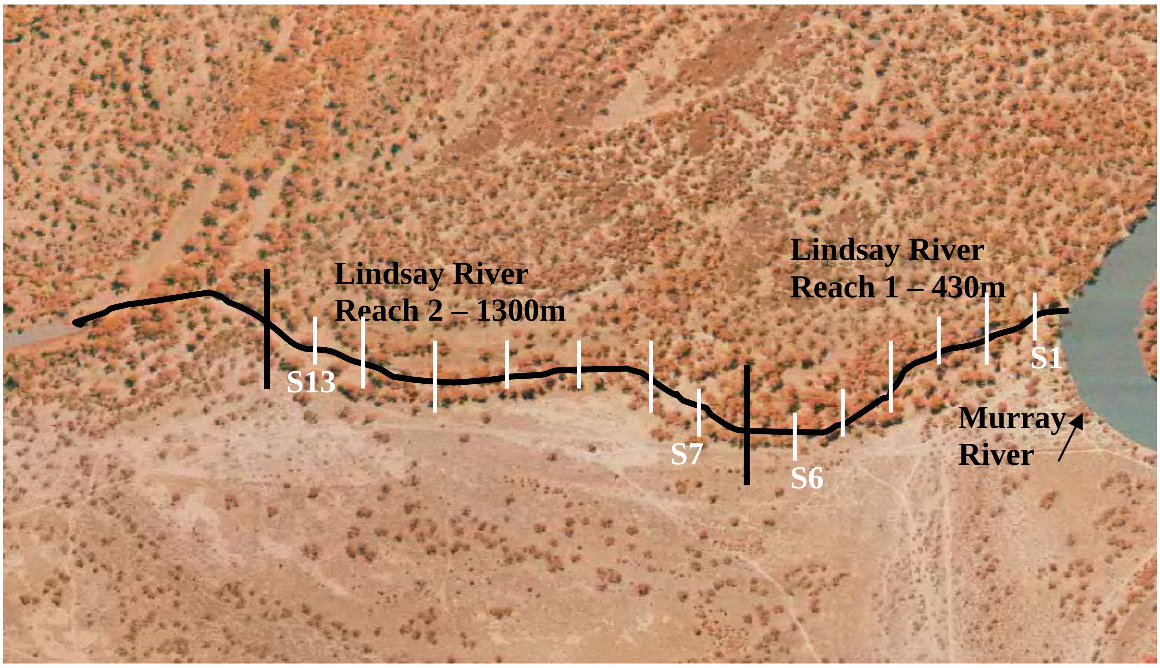


Figure 1: Aerial image of Pumping site at Lindsay River. White lines represent sites 1-13.

The pumping of water into the Upper Lindsay River Pumping commenced on the 26th of May 2004. Pumping was discontinuous and total pumping time was a total of 32.66 hours until the 1st of June. Final channel volume was measured at this stage using cross-sectional profiles (see appendix) as shown in Fig. 1 and Table 1.

There was some conjecture over the pumping capacity, with two estimates of 1 $ML.h^{-1}$ and 60 $L.s^{-1}$. Additionally we measured water velocity at the pump outlet and used all three measures to calculate total volume pumped (TVP), according to the following equations:

Estimate 1: TVP = Pumping time (hrs) * 1 ML
Estimate 2: TVP = Pump velocity * pipe diameter * pumping time (hrs)
Estimate 3: TVP = 60L * 60secs * pumping time (mins)

When compared to the final volume contained in the river it became clear that estimates 1 and 2 provided the most accurate estimate total volume, and were consequently used to calculate total volume pumped and total seepage.

Total seepage (TS) and Total seepage as a percentage of water pumped (TS%), were calculated using the following equations:

TS = Total volume (TVP) – channel volume (CV)
(TS%) = Total seepage (TS) / Total volume (TVP) * 100

Water column electrical conductivity (EC), pH, dissolved oxygen (DO), temperature and turbidity were recorded using a U/10 water quality probe (Horiba Ltd. Australian Scientific). Water quality was measured at sites in reach 1 as the flood pulse arrived at each site and then daily until the cessation of pumping. Water quality was measured at all 13 sites across both reaches on day 7 and day 21.

As an estimate of the potential amounts of carbon entering the system, organic matter density was measured using $1m^2$ quadrats in randomly selected areas along the channel bed prior to inundation. Organic matter from within the quadrat was collected, dried and weighed.

The development of high salinity and anaerobic conditions posed a potential risk to native aquatic species that may have been present in the ephemeral wetland situated 200m downstream of site 13. The wetland was seine netted at four sites prior to water reaching it from Reach 2, to establish if any threatened native fish species, specifically Murray Hardyhead (*Craterocephalus fluviatilis*), resided in the wetland.

Results/Discussion

Organic matter

The organic matter collected ranged from a weight of $19g/m^2$ to $2374g/m^2$ (see appendix 2) and had an average weight of $554g/m^2$. Observations showed that there was an accumulation of organic matter where deep holes occurred within the channel.

Fish Survey

The only species recorded in the wetland was the introduced species Gambusia (*Gambusia holbrooki*).

Volume and Seepage

- Total volume pumped for reach 1 was 7.29 ML. Reach 2 had a TVP of 23.81 ML. Total seepage for reach 1 was 4.03 ML, and total seepage for reach 2 was 12.63 ML. In reach 1 and 2 seepage expressed as a percentage was 50% and 57% respectively.

Electrical Conductivity

- The Electrical conductivity of water pumped in to the Upper Lindsay River from the Murray River was 174 µS.cm^{-1}. In a more impervious system it might be expected that water at the front of the flood pulse would increase in EC due to the mobilization of surface salts. Electrical conductivity in this case however did not increase as the flood pulse moved down stream (Figure 2).

- At site 1 EC was initially elevated to 241 µS.cm^{-1} (Figure 2) but decreased after 24 hours, suggesting water at the 'front' was continually absorbed into the sediment and replaced by fresh river water.

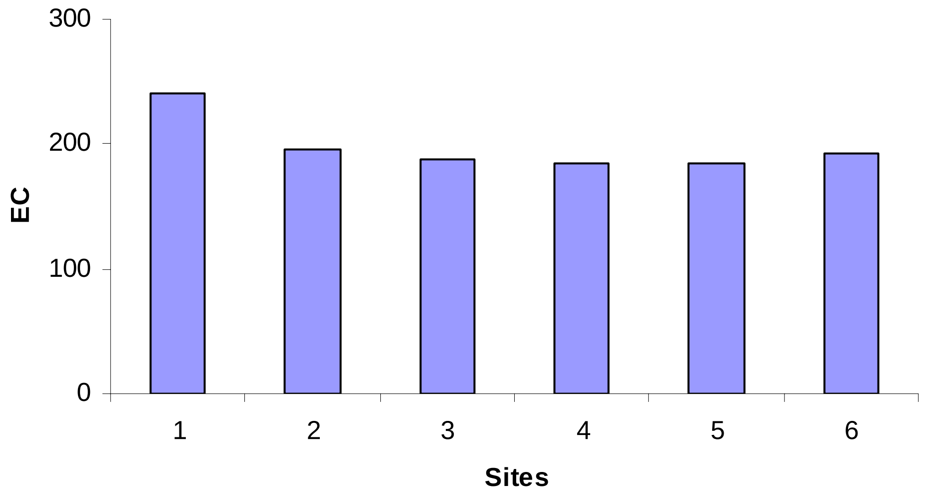


Figure 2: Electrical conductivity readings taken at the front of the flood pulse as it reached each site in reach 1.

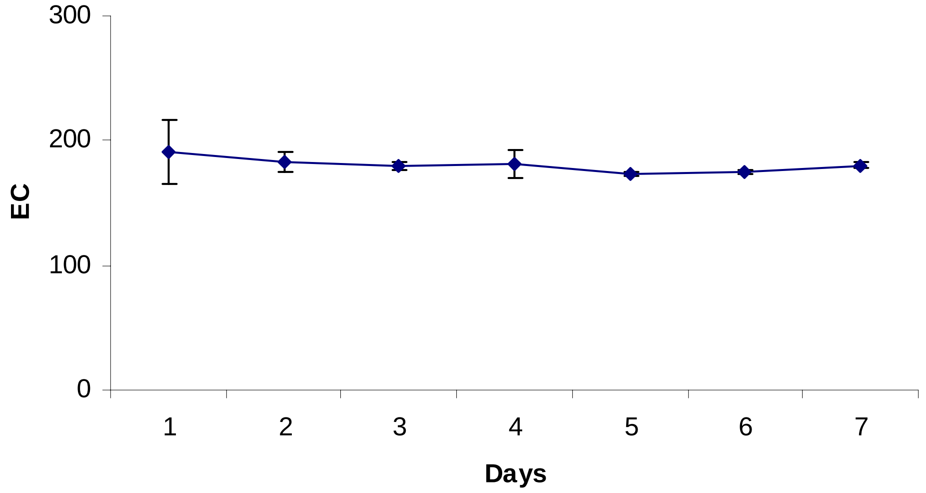


Figure 3: Electrical conductivity for reach 1 averaged across sites for the seven days of inundation.

- Electrical conductivity within section one did not vary considerably over 7 days (Figure 3).

- No salt loading was evident.

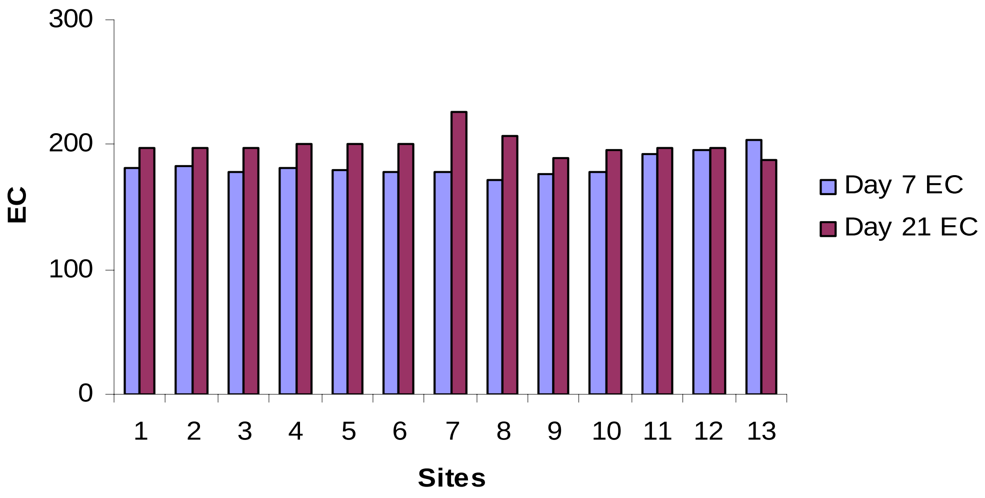


Figure 4: EC readings across all sites upon cessation of pumping on day 7 (1/6/04) and day 21 (17/5/04) two weeks after the cessation of pumping.

- 27 days after the channel was filled, EC readings were notably higher than two weeks previous (Figure 4). Average EC across both reaches increased from 170 µS.cm^{-1} to 200 µS.cm^{-1} by day 21. This increase was most likely a result of absorption of salts from the sediments due to the residency time of the water.

Dissolved Oxygen (DO)

- Dissolved Oxygen concentrations during pumping on day 1 didn't vary across sites and day 2 varied markedly between sites and ranged from 5-8 mgO.L^{-1}. On day 3 the pump had been off for 12 hours and the DO range across sites in reach 1 decreased, now ranging from 4- 7 mgO.L^{-1}.

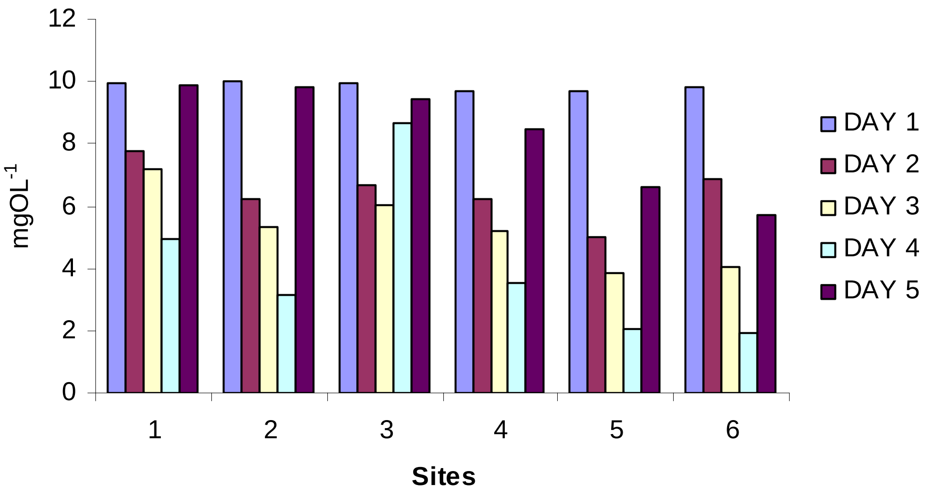


Figure 5: Dissolved oxygen concentrations across all sites for reach 1 on days 1-5.

- Dissolved oxygen concentrations decreased as low as 2 mgO.L^{-1} at sites 5 and 6 on day 4 when the pump had been off for 36hrs (figure 5). Flooding of dry sediments has been shown to stimulate the release of nutrients and carbon from the sediments and leaf litter (Boulton and Brock 1999). These inputs encourage aerobic activity of bacteria, and the decomposition of organic matter, this process is exacerbated by low or no flow, and has the capacity to decrease DO and pH.

- At the recommencement of flooding on day 5 DO levels increased again to a range of 6-10 mgO.L^{-1} (figure 5).

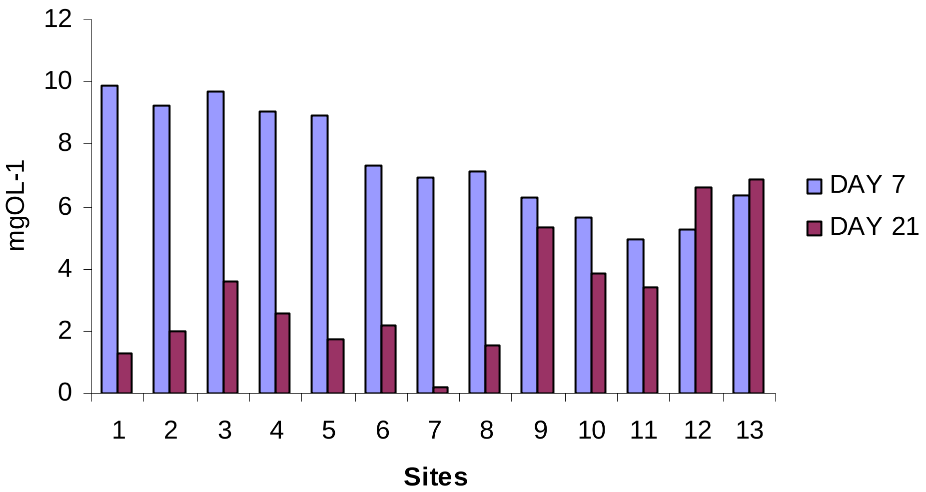


Figure 6: Dissolved oxygen concentrations across all sites upon cessation of pumping on day 7 (1/6/04) and two weeks after the cessation of pumping on day 21 (17/5/04).

- Dissolved Oxygen concentrations taken on day 7 during pumping varied considerably across sites, ranging from 5-10 mg.L^{-1} (Figure 6). A general decrease in DO concentration occurred downstream (Figure 6), due to the cumulative removal of oxygen from the water column by the aerobic activity and decomposition.

- Dissolved oxygen readings taken two weeks after the cessation of pumping on day 21, were considerably lower at sites 1-8 and 10-11 than two weeks earlier (Figure 6). DO at site 9 only slightly decreased between day 7 and 21 and DO actually increased at sites 12 and 13 over the same period.

- Observations indicate that DO is lowest in areas where deep holes were present with high organic matter and longest residence time of water. Higher DO at sites 9,12,13 where the observed channel bed characteristics were sandy and shallow, with less organic matter, and hence less removal of DO through biological composition.

pH

- As a consequence of the water pooling for 36 hours (day 2 – day 4), considerable leaching of the leaf litter occured. The Leached compounds include polyphenols, tannins and terpenoids and caused an increase in acidity and a decrease in pH from day 1-4.

- At the re-commencement of flooding on day 5, pH increased from an average of 6 to an average of 7 across reach 1(Figure 7). pH was higher at sites where water had a longer residency time and where organic matter was dense.

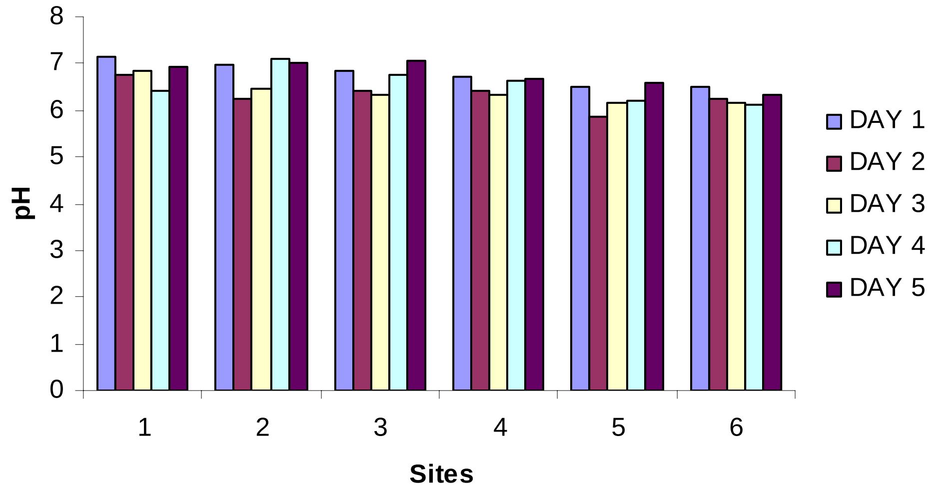


Figure 7: pH readings across sites in reach 1 on days 1- 5.

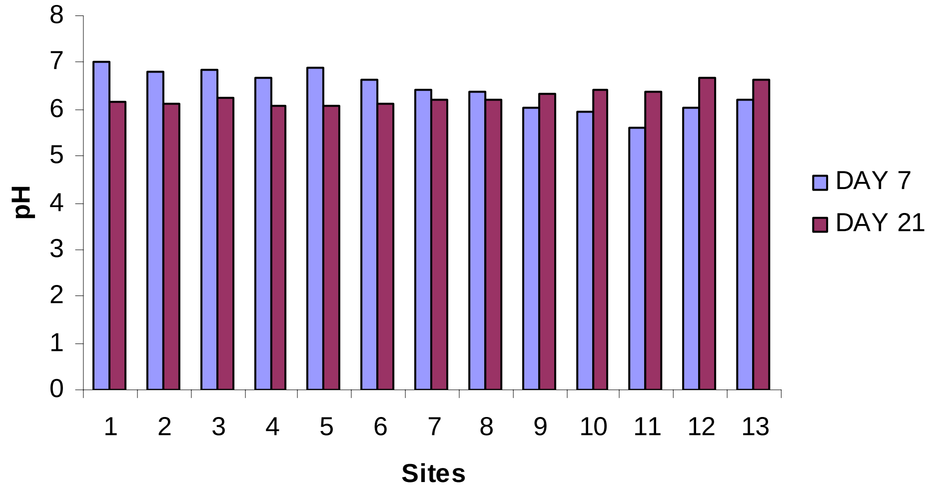


Figure 8: pH across both reaches on day 7 (1/6/04) and day 21 (17/6/04) two weeks after the cessation of pumping.

pH decreased between days 7 and 21 at sites where deep holes were present (Appendix 1), containing snags and a build up of litter (sites 1-8). pH increased at sites 9-13 which contained shallow open areas of sandy soil and less leaf litter (Figure 8).

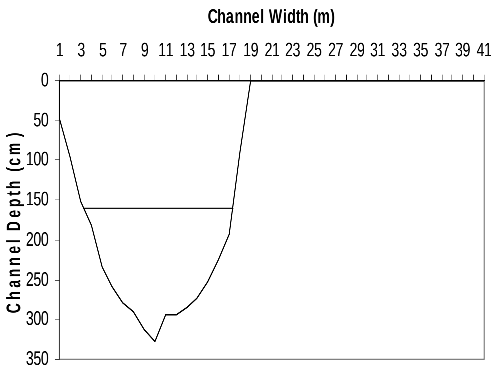
References

Boulton, A.J. and Brock, M.A. (1999). Australian Freshwater Ecology Processes and Management. Gleneagles Publishing: Australia.

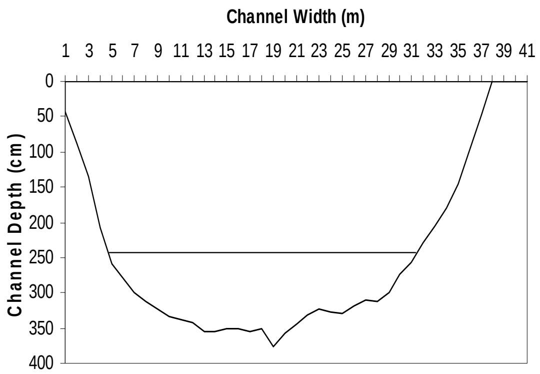
Brett Lane and Associates (2004) as cited in Cooke (2004).

Preliminary Investigations into observed River Red Gum decline along the River Murray below Euston. Murray Darling Basin Commission Technical Report (2003).

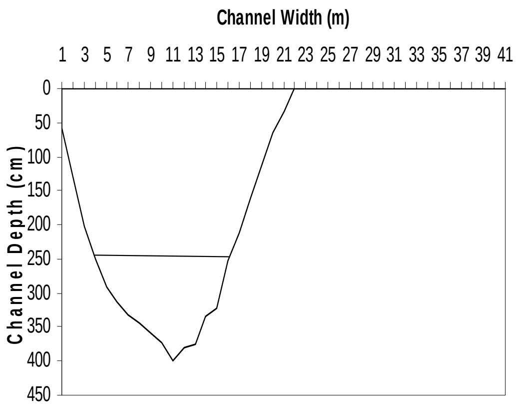
Appendix



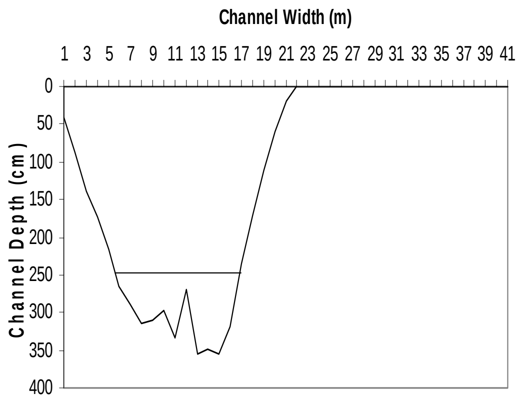
Transect 1 channel profile.



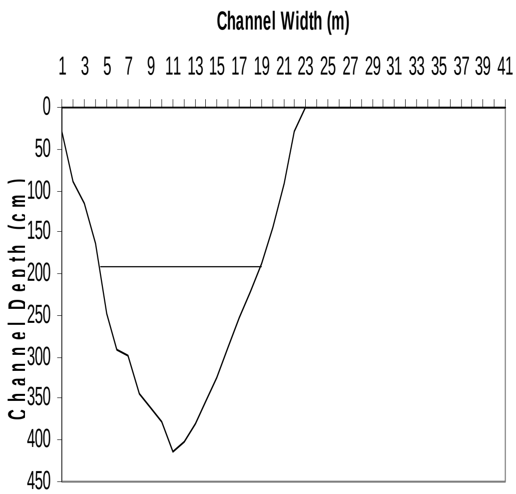
Transect 2 channel profile.



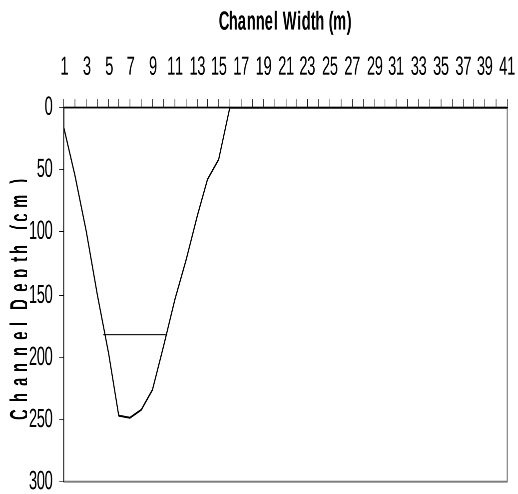
: Transect 3 channel profile.



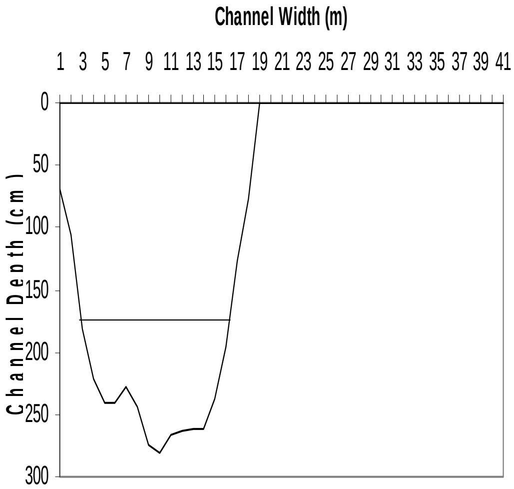
Transect 4 channel profile.



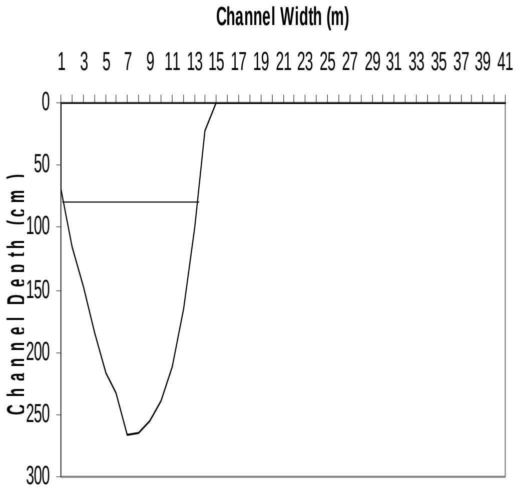
Transect 5 channel profile.



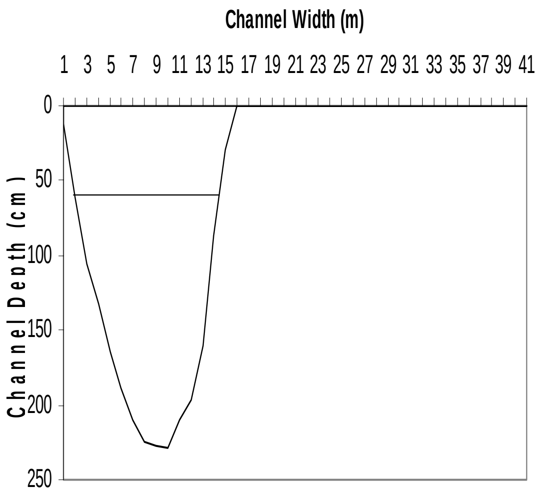
Transect 6 channel profile.



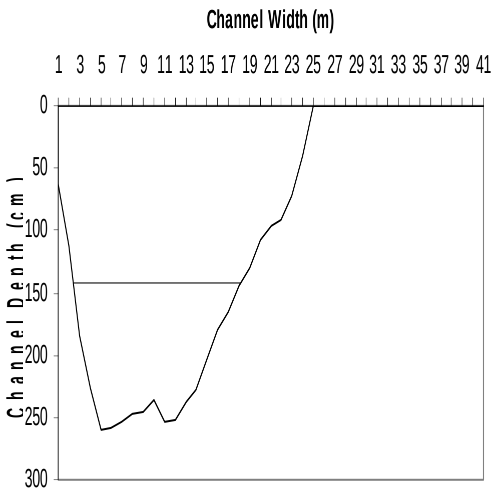
Transect 7 channel profile.



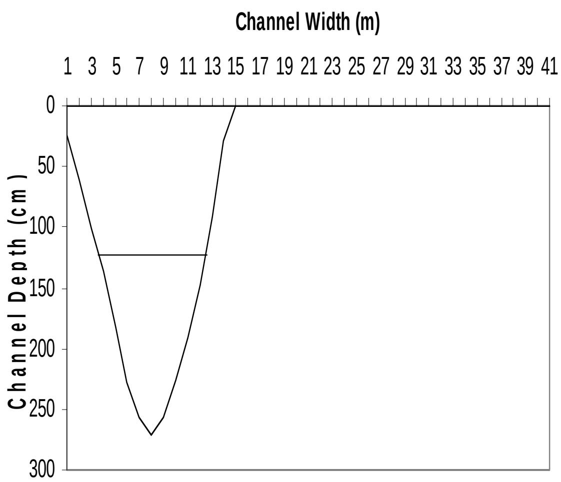
Transect 8 channel profile.



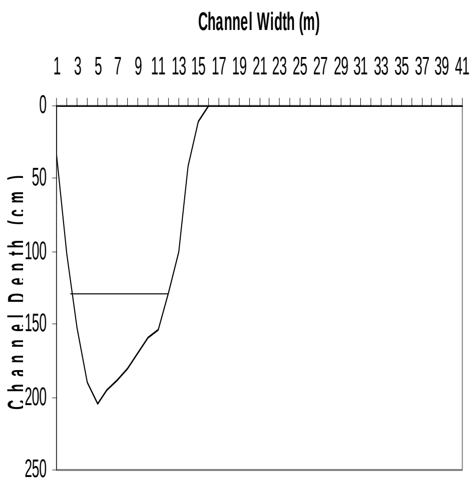
Transect 9 channel profile.



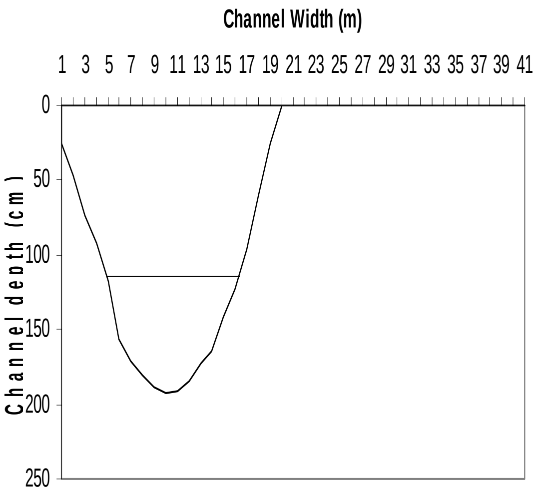
Transect 10 channel profile.



Transect 11 channel profile.



Transect 12 channel profile.



Transect 13 channel profile.

Quadrat Number	Dry Weight (g)
1	239
2	380
3	328
4	52
5	89
6	41
7	69
8	194
9	265
10	19
11	447
12	576
13	397
14	647
15	678
16	1269
17	2374
18	1343
19	873
20	794

Appendix 2: 20 randomly selected dry weight of surface leaf litter for 1m^2 quadrats in the Upper Lindsay River.