EPA Information

Monitoring the recovery of the Tod River following the Eyre Peninsula bushfire of January 2005

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EPA 799/08: This information sheet provides the results of the monitoring study performed in the Eyre Peninsula following the 2005 bushfire. The Environment Protection Authority studied the effects of the bushfire on the water quality and aquatic invertebrates of the Tod River.

Background

On 11 January 11 2005 a bushfire on the Eyre Peninsula burnt more than 80,000 hectares of land north of Port Lincoln (Figure 1). The fire was thought to have been started when a car stopped in long grass, and the exhaust pipe caused the grass to ignite. Strong winds fanned the fire leading to the deaths of nine people, the destruction of more than 70 homes and thousands of livestock.

The fire swept through the Tod River catchment. The Tod River is the only permanently flowing waterway on the Lower Eyre Peninsula and has been one of the main sources of potable water for the region. Most river and bank vegetation was destroyed in the fire, resulting in bare river banks and large amounts of ash left on the land, some of which was then blown into the river.

Plate 1 The bushfire destroyed much of the vegetation

Plate 2 The landscape in some areas became bare with burnt vegetation bordering the river

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Plate 3 Scum and ash on the water surface of the Tod River near Koppio

Plate 4 Vegetation along the river bank was destroyed

The Environment Protection Authority (EPA) carried out a monitoring study of four sites on the Tod River throughout 2005 to:

- assess the impact of the bushfire on water quality and ecosystem health, and
- investigate the recovery of the stream in the months after the bushfire.

Sites were distributed so that three were within the fire-affected zone and one was located further upstream outside of the zone to act as a reference site (Yallunda Flat, site 7466).

Two of the monitoring sites—Tod River at White Flat (3683) and Tod River at Koppio (3684) were already being sampled as part of the EPA's Ambient Monitoring Program.

Both chemical and biological characteristics (eg aquatic invertebrates) of the river were measured:

- Water samples were collected once a month and tested for nutrients (oxidised nitrogen, total Kjeldahl nitrogen (TKN), soluble and total phosphorus and total organic carbon (TOC)), colour, turbidity, suspended solids and conductivity. Dissolved oxygen was measured in the field. Based on other studies, a number of chemical parameters, particularly nutrients, were expected to increase following the fire.
- Aquatic invertebrate samples were collected every three months to assess the ecological health of the river. This information was gathered to complement the water chemistry data and to allow comparison with previous invertebrate surveys of the river to determine the impact of the fire.

The first visit to the sites following the bushfire occurred on 12 January 2005, the day after the bushfire had swept through the catchment.

Figure 1 **Sites monitored in the Tod River catchment following the bushfire in January 2005**

Water chemistry

The direct effects of the bushfire

There were some immediate changes in water chemistry seen the day after the fire went through the Tod River catchment. In particular a rise in colour, total phosphorus and TKN concentrations were observed, at both Koppio and White Flat. A rise in soluble phosphorus concentrations was also evident at the site near White Flat. The increase in nutrients and colour may have been due to smoke and ash, with ash clearly visible on the surface of the river throughout the catchment. The ash was presumably carried to the river by wind as there was no rain immediately following the fire. Debris, fallen from bank vegetation burnt in the fire, may also have contributed to the increase in nutrients. However, all of these peaks were very short-lived with water quality returning to normal background levels after a few weeks.

Dissolved oxygen (DO) at Koppio and White Flat was very low following the fire (Figure 2). The site near Koppio had experienced low DO the previous summer, however, the DO reached an all-time low in February 2005. At White Flat, the DO was much lower than it had previously been measured. The decline at these two sites was probably due to natural seasonal variation in the river, although this may have been exacerbated by the effects of the bushfire. DO did recover at each site after a few months.

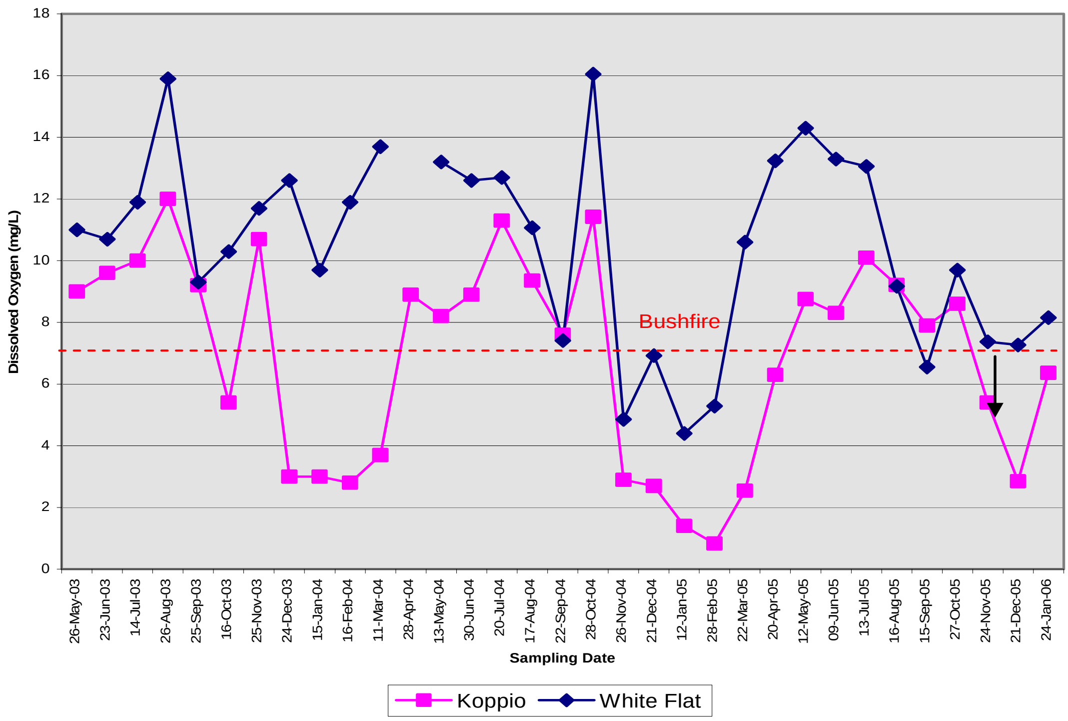

Figure 2 **Dissolved oxygen in the Tod River before and after the bushfire. The red line represents the guideline for freshwater ecosystems (ANZECC 2000).**

The indirect effects of the bushfire

The first decent rainfall for 2005 in the region occurred in June. Runoff during this rainfall is likely to have washed debris and loose top soil from the dry, bare catchment into the Tod River. This resulted in increases in colour and TOC at each of the impacted sites (Figures 3 and 4). The rise in concentrations increased as distance down the catchment increased, with White Flat showing the greatest rise in both colour and TOC.

In the first half of the year, the reference site (Yallunda Flat, site 7466) usually had much higher colour and TOC measurements than the impacted sites. This is probably because water at this site is largely confined to a series of pools, with considerable input of leaves and bark from the surrounding vegetation.

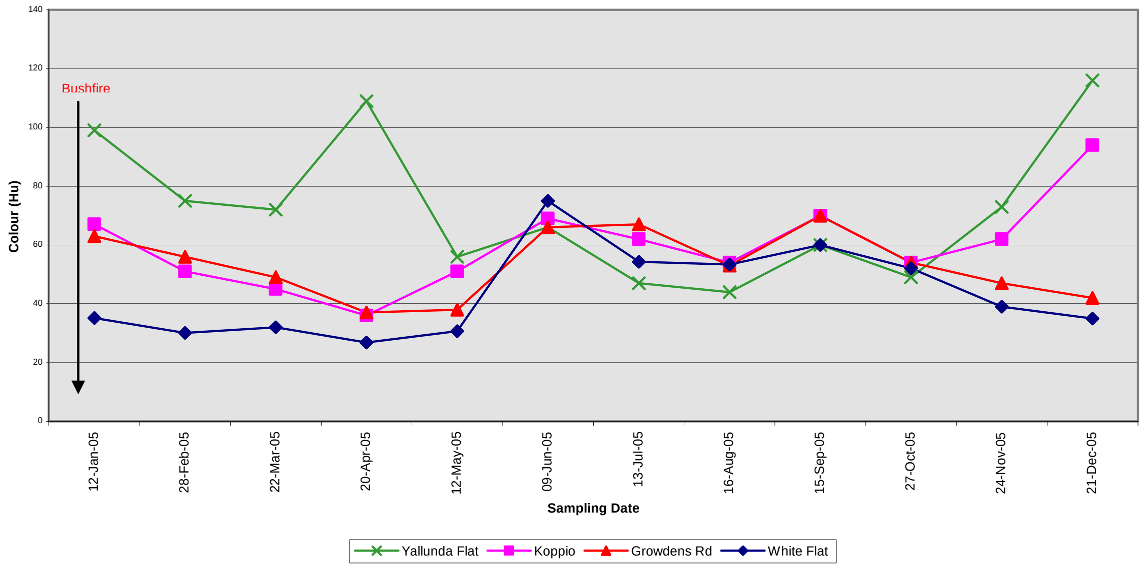

Figure 3 Colour in the Tod River following the bushfire in January 2005

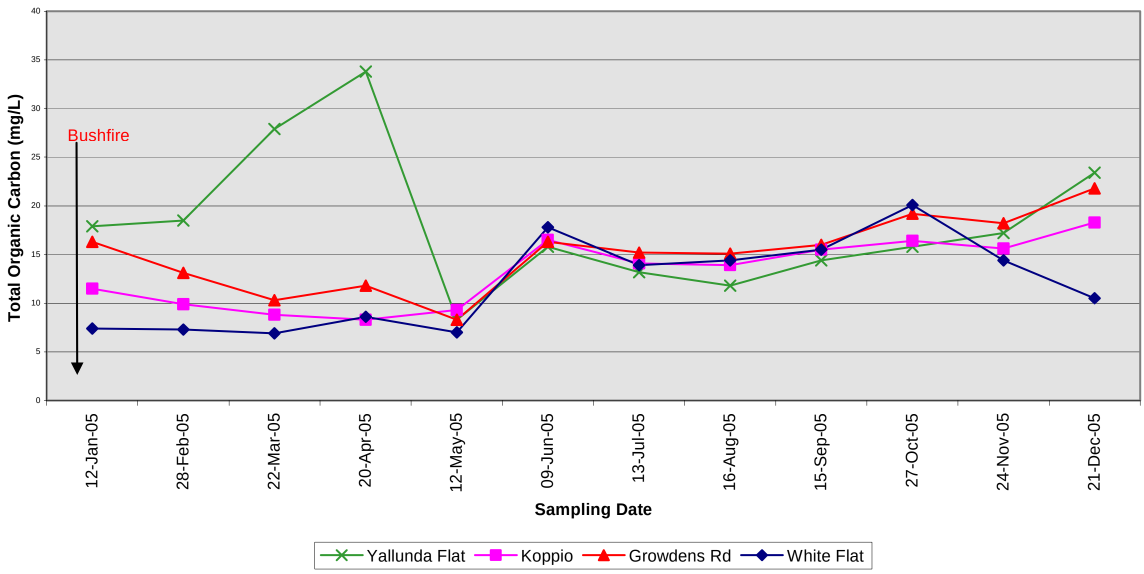

Figure 4 Total organic carbon in the Tod River following the bushfire in January 2005

In January 2006, soluble phosphorus and turbidity were measured at concentrations much higher than previously recorded. These increases occurred at impacted sites and not at the reference site, however, they did not occur at every impacted site. The increases may indicate a more long-term change in the water quality of the river, possibly linked to soil erosion and sediment transport associated with runoff in the catchment. As the fire burnt much of the catchment, most of the vegetation and crops within the region were destroyed. This left much of the landscape bare with little or no vegetation available to prevent the top soil from being washed or blown away. Periodic increases in nutrient concentrations following a bushfire were also documented by Spencer *et al* (2003) who studied the effects of a bushfire in the United States. They found similar increases that persisted for several years after the fire had occurred, especially during spring rains. However, results for the following summer suggest these increases might just be one-offs as concentrations of soluble phosphorus and turbidity were measured at similar levels to those seen before the fire occurred.

Pre-fire versus post-fire concentrations

As two sites (Koppio and White Flat) were monitored as part of the EPA's Ambient Monitoring Program for 18 months prior to the fire, the pre-fire condition of the river can be compared with its condition following the fire.

With the exception of total phosphorus, there were no obvious differences between pre- and post-fire concentrations measured at these sites. Total phosphorus concentrations at White Flat were significantly higher for the whole year following the fire (Figure 5). However, there was no significant difference recorded at the site near Koppio. This may reflect the drainage features at these sites where White Flat is further down the catchment and therefore receives more runoff than the site at Koppio. Furthermore, Koppio is also more channelised with a greater number of trees and large shrubs bordering the river than White Flat, which includes some floodplain habitat. The trees and large shrubs at Koppio might help to reduce the amount of runoff and pollutants associated with that runoff from entering the river. Comparison between pre- and post-fire conditions could not be made at the other two sites as monitoring only began at these sites after the fire had occurred.

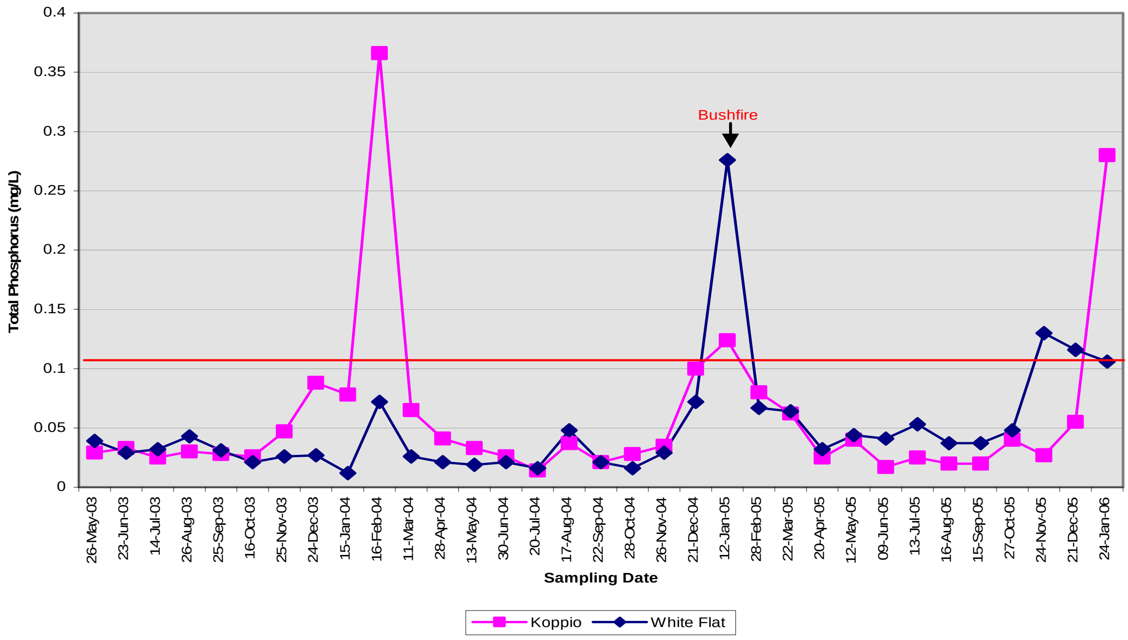

Figure 5 **Total phosphorus concentrations in the Tod River, before and after the bushfire. The red line represents the guideline for freshwater ecosystems (ANZECC 2000).**

Water chemistry measurements at the impacted sites compared to the reference site

Concentrations at the reference site were compared with those at the impacted sites to investigate any ongoing changes in water quality in the Tod River associated with the bushfire. There were no significant differences between the reference site and all three impacted sites for any of the parameters measured between January 2005 and January

2006. There were higher concentrations of TOC and colour at the reference site in comparison to White Flat and lower concentrations of oxidised nitrogen to those measured at Koppio. As these differences only occurred for one impacted site, they may have simply been due to natural processes in the river and not related to the bushfire.

Ecological health

The aquatic invertebrate community of the Tod River is typical of a brackish, ephemeral stream (see the EPA brochure *River Health on Eyre Peninsula* <www.epa.sa.gov.au/pdfs/river_health_eyre.pdf>. Most of the invertebrates found in the river are tolerant of a wide range of pollutants and moderate to high salinity.

Pre- versus post-fire community structure

There were no significant differences in the aquatic invertebrate composition or diversity between pre- and post-fire conditions at either Koppio or White Flat. The number and type of aquatic invertebrates found at a site will vary naturally during the year due to seasonal changes, and changes in flow and water level in a river. This was also found to be the case for the Tod River and changes in community structure seen in the river were considered to be due to seasonal variation rather than any obvious impact of the bushfire.

Ecological health at impacted sites compared to the reference site

There were no significant differences in the aquatic invertebrate communities when comparing the impacted sites with the reference site. However, the number of families collected from the site near White Flat was greater than the other three sites on all sampling occasions following the fire. This may have been due to better habitat availability for invertebrates, with more aquatic vegetation available within the channel.

Direct and indirect effects of fire on aquatic ecosystems

Other studies around the world that have looked at the effects of bushfires on streams have found that the direct effects of the fire are generally only minor. However, the indirect effects, which can result from increased rates of sediment runoff and channel alteration, will have greater impacts on aquatic invertebrate communities and on food webs. These changes can last from one to 10 years following fires (Minshall 2003). No obvious direct or indirect effects on the aquatic invertebrate community of the Tod River were evident during 2005, however, channel alteration was apparent with bank erosion occurring, presumably related to the removal of burnt vegetation and deposition of sediment and ash within the channel. There is potential for this channel alteration to lead to changes in the aquatic invertebrate community in the long-term.

Recovery of aquatic vegetation

While the amount of aquatic vegetation present at each site was not measured, those plant species starting to show signs of significant regrowth were noted, and regular photos were taken of the site to monitor recovery and re-growth along the river bank and within the channel. The plant life was largely destroyed by the fire, as can be seen in the following photos. However, regrowth was rapid and six weeks after the fire a significant amount of emergent aquatic vegetation had returned, especially at the site near White Flat. This rapid re-growth may have been aided by the release of nutrients from the ash and debris that entered the river during and after the fire. By the end of the year, much of the smaller bank vegetation had returned, with the larger trees and shrubs also starting to show signs of significant regrowth.

The site at White Flat

The day after the fire (January 12 2005)

Six weeks later (February 28, 2005)

12 months later (December 21, 2005)

The site at Koppio

The day after the fire (January 12 2005)

Six weeks later (February 28, 2005)

12 months later (December 21, 2005)

Conclusions

Monitoring aquatic invertebrates in the Tod River has shown that the majority of species found in this stream are quite tolerant and able to withstand the brackish and ephemeral nature of this river. Not surprisingly, the minor changes in water quality that were observed in the river following the fire did not appear to impact on the ecological health of the river.

Other studies into the effects of bushfires on streams have also found that overall changes to water quality are minor and short-lived (Spencer *et al* 2003 and Beche *et al* 2005). It is possible that more long-term changes to the river may occur in the future, such as changes in water chemistry, particularly during the summer months, or changes in the aquatic invertebrate community resulting from alterations in the channel morphology .

Glossary

Aquatic invertebrates	Small animals without backbones that have a lifecycle that is either partially or completely in water. They are usually visible with the naked eye and include insects, crustaceans, snails, worms and mites
Colour	A measure of water clarity. Water can be coloured due to degrading organic matter releasing tannins and other organic substances into the water, or from algae
Conductivity	The concentration of dissolved solids in water. Conductivity is a measure of salinity
Dissolved oxygen	The amount of oxygen dissolved in the water column that is available to organisms so they can respire. Dissolved oxygen may vary throughout the day and is influenced by the amount of aquatic vegetation producing oxygen and organisms consuming the oxygen
Emergent aquatic vegetation	Plants that are rooted in the stream bed but the stems, leaves and flowers grow above the surface of the water. These plants may also grow entirely out of the water when water levels fall
Oxidised nitrogen	The sum of the soluble forms of nitrogen, mainly nitrate and nitrite, which are highly available forms of nitrogen, which can be taken up by biological organisms very readily
Phosphorus (total and soluble)	Phosphorus, like nitrogen, is essential for the growth of plants and animals. It is readily available to organisms in soluble form, however can easily adsorb to particulate matter and is often bound to sediments
Suspended solids	Particulate matter that is suspended in the water column and can affect turbidity levels. This particulate matter can include fine clay and silt particles or microscopic living organisms
Total Kjeldahl Nitrogen (TKN)	A measure of the soluble and particulate organic nitrogen and ammonia nitrogen. The organic portion is not immediately available to biological organisms but can provide a store of nitrogen which may be broken down and released later. Ammonia is readily available
Total Organic Carbon (TOC)	A measure of the amount of organic carbon dissolved in the water as well as fine organic particulate matter from both plant and animals sources
Turbidity	A measure of the transmission of light through water as it is scattered by suspended particulate matter, such as clay and silt particles or living organisms

References

ANZECC (2000), *Australian and New Zealand guidelines for fresh and marine water quality*, Volume 1 and 2, Canberra, Australia.

Beche LA, Stephens SL and Resh VH (2005), Effects of prescribed fire on a Sierra Nevada (California, USA) stream and its riparian zone, *Forest Ecology and Managament* 218: 37–59.

Minshall, GW (2003), Responses of stream benthic macroinvertebrates to fire, *Forest Ecology and Management* 178: 155–161.

Spencer, CN, Gabel, KO, Hauer, FR (2003), Wildfire effects on stream food webs and nutrient dynamics in Glacier National Park, USA, *Forest Ecology and Management* 178: 141–153.

FURTHER INFORMATION

Legislation

Legislation may be viewed on the internet at: <www.legislation.sa.gov.au>
Copies of legislation are available for purchase from:

Service SA Government Legislation Outlet	Telephone:	13 23 24
101 Grenfell Street	Facsimile:	(08) 8204 1909
Adelaide SA 5000	Internet:	<shop.service.sa.gov.au>

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