Controlling azolla in farm dams

Strzelecki hills 2018

Demonstrating Sustainable FARM PRACTICES

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Background

In 2015, Bob and Robyn Gray applied for a grant through the Demonstrating Sustainable Farming Practices project supported by the Western Port Catchment Landcare Network. Located in the Strzelecki hills south of Warragul, they wanted to investigate different strategies to control the growth of azolla on farm dams as the excessive growth and then death of the azolla was causing problems including fish kills.

Azolla is an aquatic weed /fern that can spread rapidly and choke dams and stock water troughs. It can reproduce asexually and, under ideal conditions, double in size (area of water covered) in less than two weeks. There are two species found in Australia, Azolla pinnata and Azolla filiculoides. It appears on dams as both a green and reddish form, as a consequence of its exposure to sunlight.[1] In shaded conditions the leaves are usually green, whilst in direct sunlight they become reddish.

Figure 1: Red azolla

Figure 2: Green azolla

Azolla thrives where surface water dams collect nutrients, especially Nitrogen and Phosphorous from runoff or stock access. The dispersible, grey clay soils of the Strzelecki ranges favour the growth of azolla as the nutrients are carried into surface water storage dams on the soil particles, especially the clay. The plant supports nitrogen fixing bacterium, which allows it to use nitrogen from the water and air for its own growth.

Azolla can survive within a water pH range of 3.5 to 10, but optimum growth occurs in the pH range of 4.5 to 7 and temperature range of 18 – 26c.[2]

Azolla can reproduce to the extent that it effectively smothers itself and suffers a total perish, which leaves a large quantity of biologically active material into the water, depleting oxygen and fouling the water. This can result in the death of fish and other life in the water that requires oxygen. When this occurs we have called it a 'perish event'

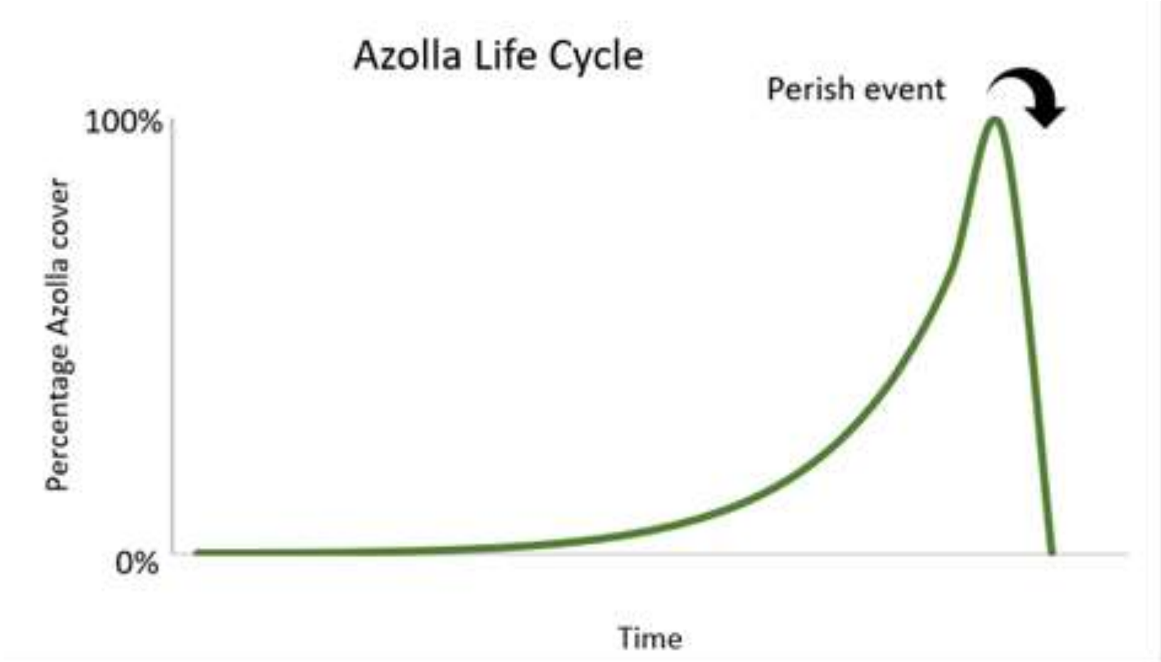

Figure 3. An example of the life cycle of azolla displaying coverage leading up to a 'perish event'

Preparing the demonstration site

This project attempted to control the growth of azolla through two activities:

1. **First, by treating the dam water with agents (Alum - Aluminium Sulphate and Gypsum – hydrated Calcium sulphate) to remove the nutrients by flocculating the water borne sediments.** Two dams were treated at the rate of 50 Kg of Alum and 50 Kg Gypsum per Megalitre of dam water volume. This was applied to the surface of the water by being thrown out of a rowing boat. It was mixed into the water as thoroughly as possible while rowing around the dam. Both dams were treated in autumn of 2016. The two dams were located in different drainage lines, both were fenced to exclude stock and revegetated. This provided two replicates of the treatments. A third dam was left untreated and used as a control.

- **Second, was to construct silt traps across the gullies leading to the dams in an attempt to limit the sediment entering the dams through runoff.** All three dams had been fenced to exclude stock, and revegetated some years earlier. The traps were built in three different ways to see which one was the most effective (see Methods 1, 2 and 3 below).

**Figure 5: Method 1.	Hay bales staked down and covered with shade cloth**

Figure 6: Method 2.   Shade cloth covering a thick layer of hay with bales staked down and covered in a geotextile

Figure 7: Method 3. A packed "sausage" of hay wrapped in shade cloth

Measurements of water quality and macro – fauna present in each of the dams were taken before these treatments (Table 1), with a follow-up two years later (Tables 2 and 3) to determine the effect of the treatments on water quality and the aquatic life within the dams.

Figure 8: B & R Gray farm map with location of dams

Results

1. Effect of Flocculation treatment

The immediate effect of the application of the Alum and Gypsum was to clear the water, and cease the development of the azolla present at the time. Extensive surveys in each of the three dams established a baseline for macro- invertebrate populations as well as base levels of major nutrients and other measures of water quality. These are presented in Table 1. (pre–treatment), Table 2 (after 9 months), and Table 3 (after 21 months).

2. Effectiveness of sediment traps

The initial results from the sediment traps were very positive. They slowed the flow of water runoff and appeared to be filtering the water as it passed through.

Figures 9: Sediment traps filtering the water as it passes through

Figures 10: Sediment traps filtering the water as it passes through

Figure 11: Sediment traps filtering the water as it passes through

Figure 12: However, the excitement was relatively short-lived as heavier rain events overwhelmed the sediment traps and they were found to be largely ineffective under such conditions

Figure 13: The heavier rain events overwhelmed the sediment traps and they were found to be largely ineffective under such conditions

Figure 14: Another example of the heavier rain events that overwhelmed the sediment traps and they were found to be largely ineffective under such conditions

In Treatment Dam 2, the effect of flooding the silt traps was clearly seen by a demarcation between the dirty water entering the dam which had water cleared by the chemical treatment. Treatment Dam 2 was located in a gully with a larger catchment than Treatment Dam 1. It also had a considerable population of wombats whose excavations added substantially to the sediments entering the water course.

Therefore, whilst the chemical treatment was effective in cleaning the water, it was a relatively short-lived result especially in Treatment Dam 2. Longer term control suggests the need for actions which control water inflows and allow sediment to be filtered out.

Figure 15: the demarcation can be seen with the dirty water entering the dam

The design for Method 1, where a thick layer of hay was covered in shade cloth, worked well under high flow conditions. The runoff flowed onto the shade cloth and was progressively trapped and filtered through the underlying hay. This design is also very easy to refurbish each year and is the easiest and cheapest to construct.

Figure 16: the preferred silt trap design method

Method 1 – the preferred silt trap design. There appears to be no benefit from including the barrier hay bales.

Bob said "The cost of building this silt trap is very little and also relatively easy. 70% shade cloth can be purchased from Hardware stores. It comes in widths of about 3.6m for a cost of about $8 per linear metre. If the 3.6m width spans the watercourse, about 4 - 5m would be adequate. The upstream edge of the cloth is dug into the ground and also secured with wooden pegs. Poorest quality hay is used at a depth of about 200mm and the shade cloth rolled down over the top and secured with wire loops pushed into the ground. Total cost, valuing the hay at $50 per roll (1/2 a roll) is therefore about $70. To renew the trap, simply remove the wire loops, roll up the shade cloth, replace the hay and relay the shade cloth."

Water Quality

The observations of the macro - fauna populations suggested that there was no detrimental effect on the numbers or distribution of the species. The major effect appeared to be the complete perish of azolla, which occurred in Treatment Dam 2 in both 2016 (Sept) and 2017 (May) after the treatments.

Table 1. Water Quality Measures 1/11/2015 (Pre-Treatment)

	Control Dam	Treatment Dam 1	Treatment Dam 2
Total P mg/l	0.46	0.1	0.33
Total N mg/l	2.15	0.95	1.39
Macro Invertebrates	Few Numbers	Large Numbers	Fewer Numbers than Dam 1
	Poor Diversity	Wide diversity	Less Diversity.
	Species found in poor environments	Species found in good quality water	Species found in poor quality water
Azolla Cover %	90%	100%	75%

Table 2. Water Quality Measures 1/11/2016 (11 months after treatment)

	Control Dam	Treatment Dam 1	Treatment Dam 2
Total P mg/l	0.11	0.051	0.26
Reactive P (available P)	0.008	0.003	0.12
Total N mg/l	1.6	0.7	1.6
TKN (soluble N)	1.6	0.7	1.6
Macro Invertebrates	Few numbers	Rich in numbers	Low numbers
	Only species found in poorer quality water	Diversity of Species	Poor diversity
		Mayflies indicate good quality water	Only pollution tolerant species
Azolla Cover %	90%	20%	10% (100% & perish in Sept)
Turbidity NTU	12.6	3.2	21.3
Dissolved Oxygen	6.6	9.4	4.1

Table 3. Water Quality Measures 1/11/2017 (21 months after treatment)			
	Control Dam	**Treatment Dam 1**	**Treatment Dam 2**
Total P mg/l	0.44	0.1	0.33
Reactive P (available P)	0.003	0.054	0.28
Total N mg/l	3.6	0.9	1.1
TKN (soluble N)	3.6	0.9	1.1
Macro Invertebrates	Few numbers.	Large numbers.	Fewer numbers than Dam 1.
	Species indicate poor quality water.	Large diversity.	Limited diversity.
		Mayflies indicate good water quality	Species indicate poorer water quality
Azolla Cover %	80%	30%	0% (perish in May 2017)
Turbidity NTU	3.1	6.9	2.6
Dissolved Oxygen	29	78	95

Discussion

Changes in the measures of Total P and Total N following the treatments (Table 2 compared to Table 1) does not show the full picture. Whilst decreases were suggested in Treatment Dam 1, they were not so clear in Treatment Dam 2. Also, the measures declined substantially in the Control Dam, so little can be inferred from these tests. This is not surprising, given the runoff events which occurred between the initial tests and the testing carried out after 9 months. Treatment Dam 2 measures would also have been impacted by the perish event which occurred in Sept 2016 (2 months prior to the second test).

By November 2017, 21 months after treatment, it is interesting to note that the figures for Total P and Total N are virtually identical to those taken prior to the treatments. This confirms the observations that the use of flocculating agents to improve water quality in an attempt to control azolla are a short-term solution only.

The measurements of Turbidity and Dissolved Oxygen are also indicators of water quality. The measures recorded in this trial were inconclusive, again having been influenced by the runoff events. However, a relationship can be detected, especially in Treatment Dam 1 between lower turbidity, higher dissolved oxygen and the better range of macro – invertebrate numbers and species.

The final measures taken in Treatment Dam 2, some 2 months after the azolla perish event of 2017, show low turbidity and high dissolved oxygen, suggesting that the water had been "cleaned" to some extent by the perish and was in the process of recovering. This is supported by anecdotal observations from the district that dams generally are clear of azolla blooms for several years following a perish event. This is presumably where large silt inflows do not occur immediately following the event.

Continuing observation, especially of Treatment Dam 1, has shown an on-going presence of azolla. However, it has not continued to develop and proceed to full coverage of the surface and ultimately a perish event. This had occurred several times in past years prior to the treatment and installation of the silt traps. It suggests that, despite being overwhelmed in storm events, the silt traps still work on normal flows and reduce sediment and nutrient inflow sufficiently to restrict the azolla growth – it effectively runs out of food and retreats. From 20% coverage in November 2017 azolla expanded to approximately 75% coverage in late January 2018 and then retreated to be about 30% in mid – March 2018 and by mid-April was negligible.

Conclusion

- Treatment of surface runoff dams with both Alum and Gypsum at 50 Kg/ megalitre of water volume can flocculate sediment and effectively clear the water.
- Treatment with these agents at these rates does not appear to have a detrimental effect on the Macro-fauna populations residing within the dams.
- Unless further inflows of sediment and nutrients can be prevented, such treatment is a very short – term solution to the problems caused by azolla infestation.
- Silt traps can be effective in reducing the inflow of particles and nutrients into surface dams but they have limitations in controlling the high flows associated with storm events.
- It appears that, in some applications, an effective silt trap may be able to trap sufficient sediment to control the rapid reproduction of azolla and prevent total coverage of the dam and a consequent perish event.
- A preferred design for silt traps was shown and described in the report. The design works by filtering the water as it flows across and through the materials rather than trying to slow the flow and allowing sediment to settle out

References

1. Agriculture Victoria, Technical Resources, “Azolla on Farm Dams.”
2. http://agriculture.vic.gov.au/agriculture/farm-management/soil-and-water/water/farm-water-solutions/technical-resources/azolla-growth-in-farm-dams

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