Mallee soil erosion and land management survey

Late Summer 2012

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Contents

Purpose of Report

This report provides the results of the 'Mallee soil erosion and land management survey'. The report is divided into two parts. The first part of the report provides a summary of trends over time in soil erosion risk and land management practices for the Mallee sites surveyed. The second part of the report provides the results from the late summer 2012 survey.

Trend Summary

Background

Wind erosion occurs naturally in the landscape and is an important part of soil genesis; many soils in the Mallee have formed by aeolian processes. However wind erosion also causes adverse effects through the removal of large amounts of fine soil particles that result in a direct loss of nutrients from agricultural land as well as sandblasting emerging crops (Armbrust 1984 as cited in Leys et al 2007). Wind erosion also has considerable off-site impact, the airborne particulate matter can cause adverse health effects, and reduced visibility and the deposition of soil can smother native vegetation, bury or undermine infrastructure and increase nutrient loads in waterways (Clune, 2005).

Wind erosion has been a recognised issue in the Mallee since at least 1945 (Thomas as cited in Clune 2005) and as such has been a priority of natural resource management organisations for many years. This has resulted in extensive promotion and research of agricultural practices that minimise the risk of erosion.

In 1978 the Mallee fallow survey commenced after wind erosion became severe and widespread, particularly in areas with light soils (Boucher 2005a). The objective of this original survey was to assess actual erosion and land use practices in the Mallee region of Victoria. The survey has continued using a number of different methods (Wakefield 2008b).

In 2005-2006 the survey underwent a review and redesign. The results reported in the main component of this report are from the current methods which have been implemented since 2007.

The current survey is conducted three times annually, during late summer (February - March), post sowing (June - July) and spring (October). In-paddock assessments are completed at 157 sites, from across six land systems (Central Mallee, Millewa, Tempy, Hopetoun, Culgoa and Boigbeat) within the Mallee region. Refer to methods section in main report.

The Department of Primary Industries (DPI) Farm Services Victoria (FSV) in partnership with the Mallee Catchment Management Authority (Mallee CMA) conducts the Mallee Soil Erosion and Land Management Survey and manages the Mallee Soils and Land Management database with funding provided through the Victorian State Government.

The 2005/2006 review determined that the historical data (pre 2007) and the post redesign data can not be directly compared. The historical data has however been included in trend graphs (Refer to Figure 1 & 2) to capture all data collected over the survey's history, and although not comparable it is a valuable data resource.

The second part of this report documents the methods used in the surveys as well as analyses of the results of the late summer 2012 survey. The survey records, soil dry aggregate, vegetation cover and height (risk of wind erosion), land management practices and a centre point photograph.

The following graphs illustrate trends over time for the land management practices and risk of erosion at the sites surveyed.

Land management practices

The data presented in Figure 1 suggests that at the sites surveyed there has been a decrease in long conventional fallow since 1985, this is fallow that is started prior to spring. Figure 2 also suggests an increase in chemical fallow and a decrease in paddocks being conventionally fallowed during summer. However, this data needs to be interpreted with caution as the data collected prior to 2007 was collected using different methods compared to the post 2007 data. Also, the data collected prior to 2007 as part of the late summer survey was collected later during March, where as the current methods see data collected during February to early March.

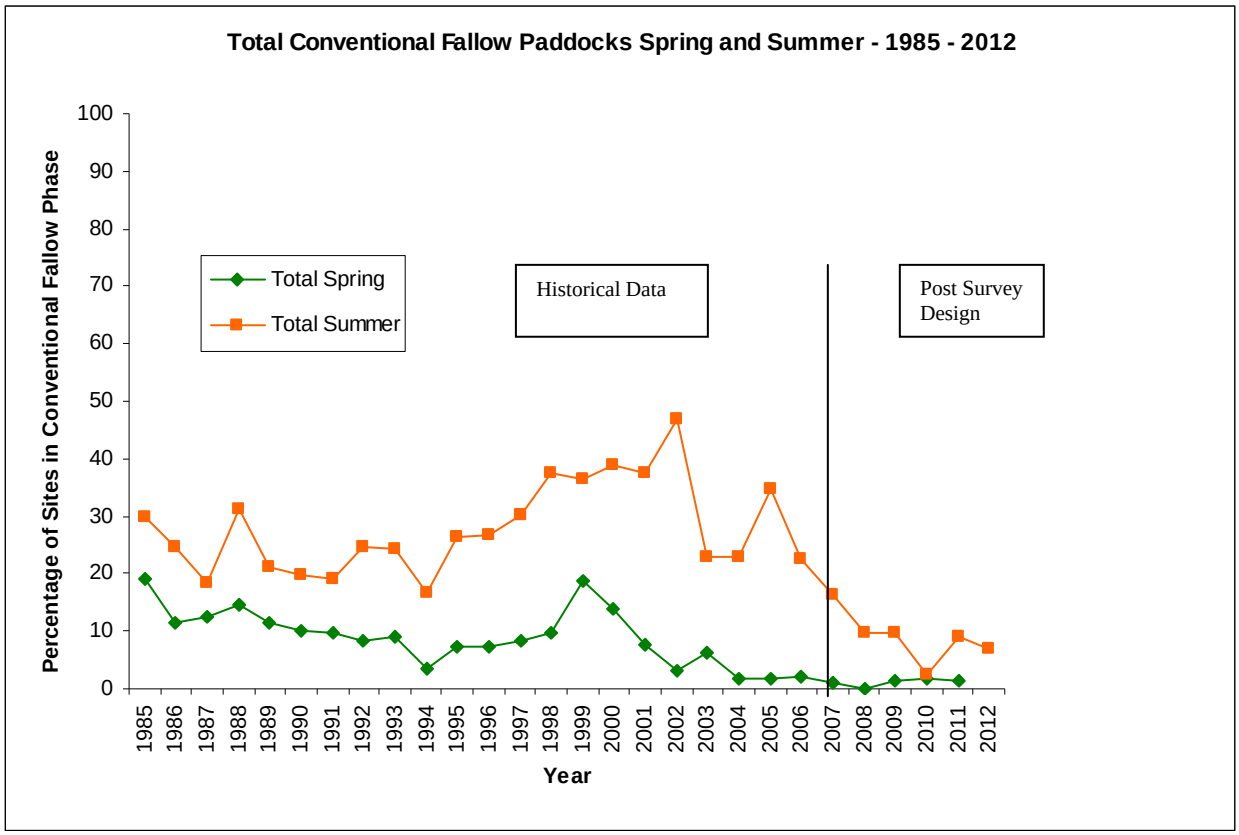

Figure 1: The percentage of sites surveyed in the Mallee under conventional fallow management since 1985. The historical data refers to data collected using the drive by methods from 1985 to 2006 (Wakefield 2008b). Since 2007 the method has been redesigned to include an in-paddock assessment of erosion risk and land management.

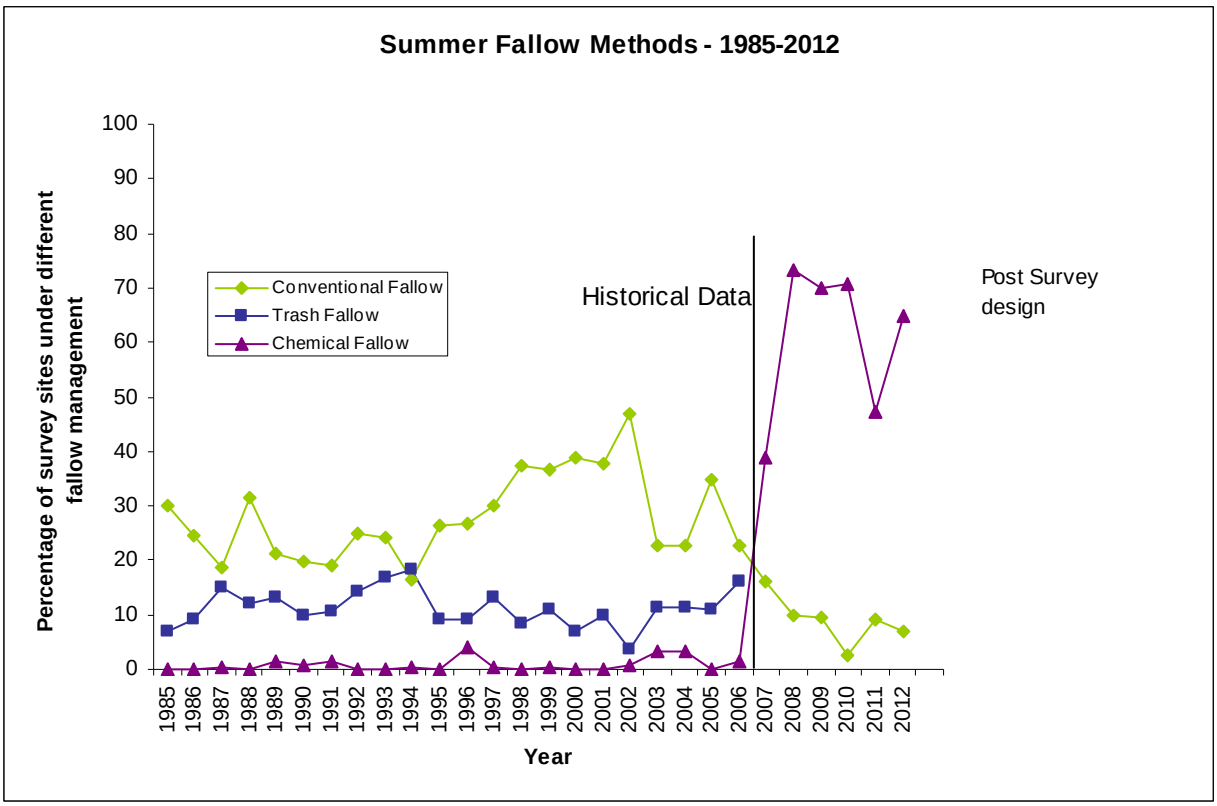

Figure 2: The percentage of sites surveyed in the Mallee under different fallow techniques during summer since 1985. The historical data refers to data collected using the drive by methods from 1985 to 2006 (Wakefield 2008b). Since 2007 the methods were redesigned to include an in-paddock assessment of erosion risk and land management. Note: The use of trash fallows have largely reduced in the Mallee (pers comm. Graham McKechnie) and have not occurred on the sites represented in the 2007 onwards survey.

In 2007 late summer survey, 38.97% of sites were recorded in a chemical fallow phase that had increased to 65% in 2012; however there was a decrease in 2011 to 47.4% that must be viewed with caution due to a one in two hundred year rainfall event (Figure 2). From 2009-2012, conventional fallow has remained below 10% of the sites surveyed during the late summer period (Figure 3).

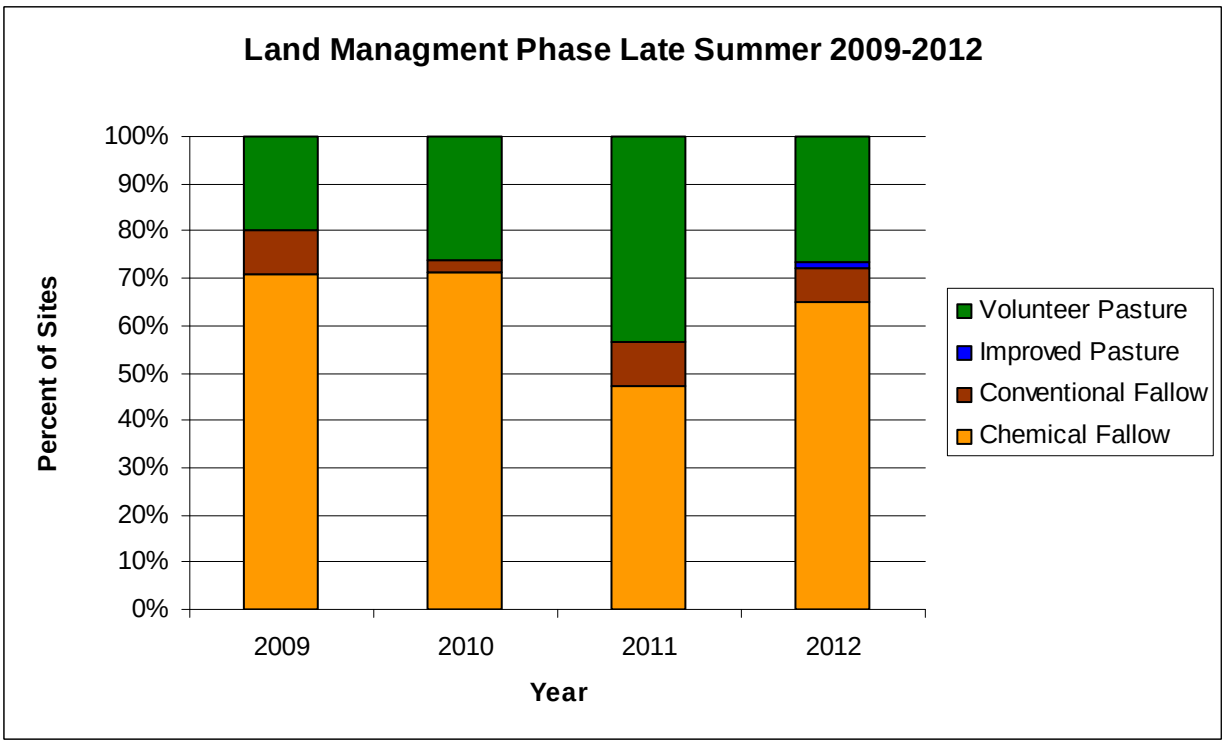

Figure 3: Percentage of sites surveyed in the Mallee under different management phases. This includes volunteer and improved pasture, conventional and chemical fallow methods during the late summer surveys.

Risk of erosion

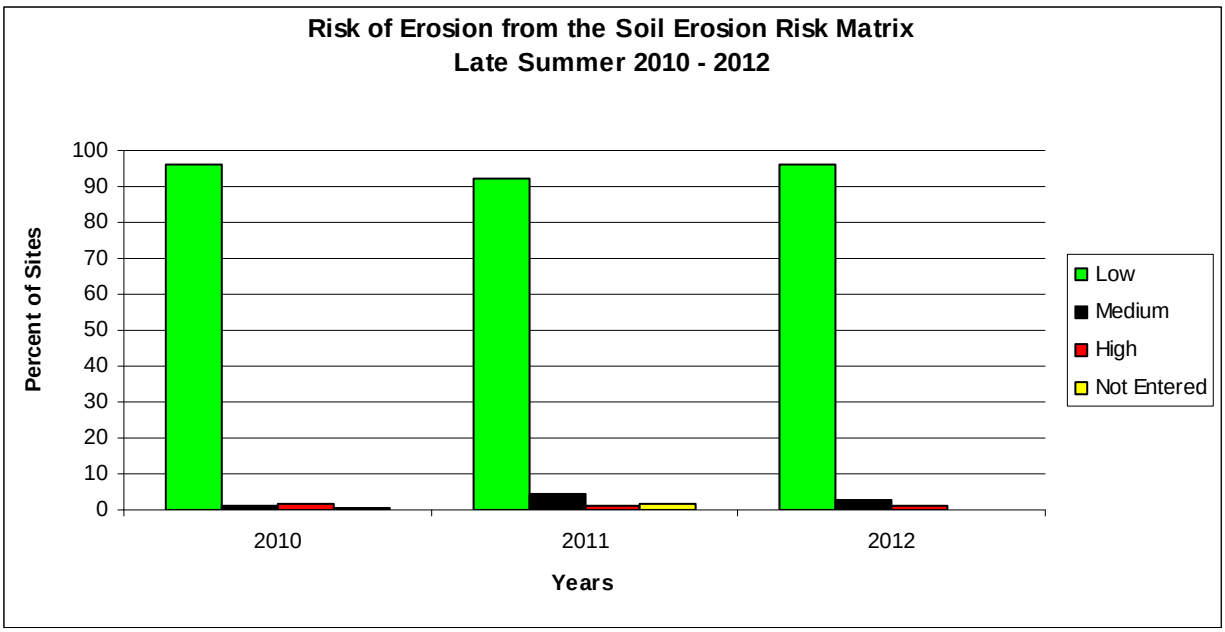

Figure 4: Risk of erosion calculated using the risk matrix for percentage of sites surveyed in the Mallee during the late summer survey.

In paddock measurements for risk of erosion of sites surveyed have been recorded in late summer since 2010. Greater than 92% of sites have recorded low risk of erosion across this three year period (Figure 4).

Conclusion

The survey over the late summer sampling period shows a consistent trend of decreasing conventional fallow for the sites surveyed.

From 2009-2012, conventional fallow has remained below 10% of the sites surveyed during the late summer period

Risk of erosion recorded at sites during the late summer sampling period has remained consistent with low risk of erosion being recorded at over 92% of sites surveyed.

Late Summer 2012 Report

Background

The Department of Primary Industries (DPI) Farm Services Victoria (FSV) in partnership with the Mallee Catchment Management Authority (Mallee CMA) conducts the Mallee Soil Erosion and Land Management Survey.

In 1978 the Mallee fallow survey commenced after wind erosion became severe and widespread, particularly in areas with light soils (Boucher 2005a). The objective of this original survey was to assess actual erosion and land use practices in the Mallee region of Victoria.

In 2005-2006 the survey underwent a review (Boucher, 2005a) and was redesigned using recommendations from the review (Wakefield 2008b). The focus of the survey now is on assessing risk of erosion and recording land management practices. The redesigned survey was first trialled in the summer of 2007. The survey is conducted three times annually during late summer, post sowing and spring.

The late summer 2012 survey of soil erosion and land management was conducted from February 27th to March 9th 2012. This report documents the methods used in the survey as well as analysis of the result of the survey.

Objectives

The objectives of this project (2011/12) were to:

- Undertake, analyse and report on the "Mallee Soil Erosion and Land Management Survey" three times annually (post sowing 2011, spring 2011, and late summer 2012).
- Deliver targeted communication activities to increase landholder awareness of erosion risk and management tools to mitigate both incidence and impact of wind erosion.

Methods

Survey Transects and Sampling Locations

From across six land systems within the Mallee region approximately 160 sites were selected randomly for continuous in-paddock assessments three times a year, late summer (February/March), post sowing (June/July) and spring (October). For the late summer survey 2012, 157 sites were surveyed.

Site selection was stratified based on land system. The proportion of sites from each land system was equivalent to the representation of the land system within the major agricultural regions of the Mallee (the area of the survey), for example the Central Mallee land system occupies 50 percent of the survey area (agricultural region of the Mallee), so 50 percent of the 160 sites were located within this land system. Within each land system the sites were also stratified based on land forms (hummock, plain and dune). Again the number of sites on each land form was based on the percent of area covered by that land form within the land system. The data on land systems area and land form area was based on the Rowan & Downes, 1963 report.

The following is a list of the land systems and transects within each land system where the soil erosion monitoring occurs (See Figure1).

Central Mallee

- Ouyen to Piangil
- Torrita North to Torrita South
- Tutye North to Tutye South
- Murrayville to Murrayville North

Millewa

- Meringur North to Meringur South
- Bambill North to Bambill South
- Karawinna North to Karawinna South

Tempy

- Gypsum to Gama

Hopetoun

- Hopetoun to Yaapeet
- Gama to Lascelles
- Hopetoun to Woomelang
- Hopetoun to Lascelles

Culgoa

- Swan Hill to Ultima
- Culgoa to Lalbert

Boigbeat

- Ultima to Sea Lake

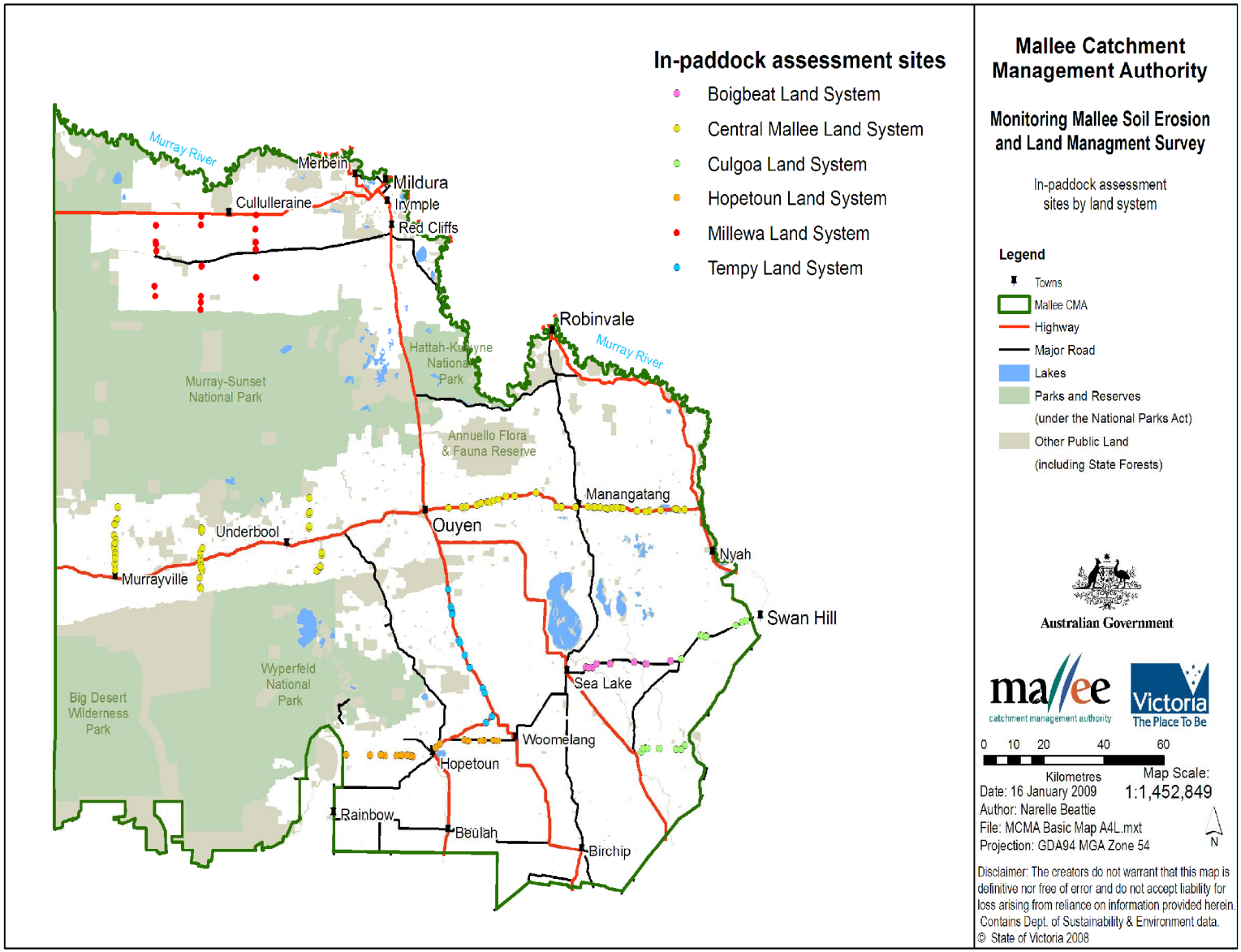

Figure 1: Map of the 157 sites where the soil erosion monitoring is being conducted.

Data Collection

At each site a one hectare area was used for collecting data, this was located 100m along the roadside fence line from the start of the paddock and 50m into the paddock (away from the roadside). At each site the following was recorded:

- Vegetation cover and height measurements.
- Soil dry aggregate measurements.
- The current management phase (i.e. conventional fallow, chemical fallow, crop, pasture).
- The current management practice (i.e. conventional farming or no-till/minimal till).
- The presence/absence of livestock.
- The presence of standing stubble reported during summer and post sowing surveys.
- Soil detachment rating.

Vegetation Cover and Height Measurements

Vegetation cover was measured using the levy point sampler (Levy & Madden, 1993) (refer to Figure 2). A total of 20 random sites in the one hectare area were sampled to record vegetation cover and vegetation height (200 points). The sampler was placed on the ground (i.e. without looking) 20 times within the one hectare sampling area. Five paces south/north then five paces east/west were taken then recordings taken, and repeated until 20 samples were completed. Vegetation height measurement was recorded by a 40cm ruler attached to the side of the levy point sampler. The height of the closest piece of vegetation (live or dead) to the ruler was measured in centimetres (rounding off to whole number). Vegetation measurements were achieved by counting dead or live vegetation touching the prongs on the levy point sampler.

Figure 2: Levy point sampler used for assessing vegetation cover.

Dry Aggregation

From within the one hectare sampling area at each site, three points were randomly located for collection of soil samples. Each soil sample was collected using a square nosed hand shovel (or hearth shovel). Approximately 2kg of soil was collected down to a depth of 10cm. It was important to ensure that minimal disturbance was made to the soil, and that the soil was dry when sampling. The soil sample was then placed in an 850µm hand sieve and gently shaken over a baking tray. Both the coarse and fine samples were then weighed and the proportion of coarse aggregates was calculated. This provided an indication of the protection dry aggregates provide against wind erosion (Leys et al 2002).

Land Management Practices

Table 1 – Management Practice Descriptions

Chemical Fallow	Is referred to where obvious detection of both weed and/or self- sown crop death (due to a chemical application) is observed. This is usually prior to any form of cultivation occurring, (but is not restricted to this) and is in preparation for the next crop. This "chemical fallow" could be for a relatively short duration (a matter of months) but in some instances may continue for as long as 18 months, i.e. a 2 year rotation where 18 month fallow period is practised.
Conventional Fallow	Land kept free of live vegetation with the use of mechanical cultivation. Visual of up turned earth.
Pasture -Volunteer	Land dominated by random grasses/cereal for grazing
Pasture - Improved	Land dominated by annual broadleaf and/or legume (i.e. clover/ vetch/ medic) used for grazing or green and brown manuring.
Hay	Pasture that has been prepared for hay by evidence of cutting, windrowing or baling. Obvious cut stems on vegetation or evidence of raked vegetation on ground.
Cereal Crop	Wheat, Barley, Oats, Triticale etc
Legume Crop	Field peas, Vetch, Lupins, Beans etc
Oilseed Crop	Canola, Mustard etc
Other	Saltbush etc

Land Management Practice

Table 2: Management Practice Descriptions

Conventional Farming	A system of multiple cultivation control. Passes before sowing for weed and/or seedbed preparation
No-Till/ Minimal Till	Sowing system aimed at minimising soil disturbance and retaining crop residues

Livestock Present

Livestock including sheep, cattle, horses and goats were recorded as present or absent within the site. They were determined to be present if visual evidence of stock, recent scats or hoof marks could be seen i.e. scats were soft, fresh or dark in colour; stock trails could often be seen throughout the area and around fence lines where stock had walked; and/or evidence of footprints and scats around watering points.

Centre Point Photograph

Paddock management practise and phase is documented by photographic evidence. A centre point photograph is taken at the site by walking twenty five metres into the site from the roadside fence line recording transect, site number, GPS coordinates and survey date.

Soil Stability Assessment

Table 3 was used as a guide to determine soil surface stability. Each site was assigned a detachment rating based on a visual assessment of soil disturbance. This was a method developed by the South Australian Department of Water, Land and Biodiversity Conservation and used as part of their soil erosion monitoring program (McCord 2008).

Table 3: Soil Detachment Rating (McCord, 2008).

Detachment Rating	Stability	Description
1	**Stable**	No significant disturbance
2	**Slightly to moderately Unstable**	Partial soil surface disturbance by: - No-Till (narrow point) sowing - first working with blade plough, prickle chain or harrow - or grazing livestock. Includes any land which has been cultivated at least once: - which has consolidated due to rain (on **loamy** NOT sandy soils) and/or new growth - which is very cloddy and has some residue present - which may have full disturbance but has moderate to heavy residue protection (eg. Cover Rating 4, 3, 2 and some is likely to be anchored) Also includes land with new crop, up until late tillering: - which has partially consolidated due to rain and/or new crop growth. Also includes crops beyond tillering stage - where cover is too poor for complete stability and consolidation is only partial or patchy (eg. drought or erosion affected crop).
3	**Very Unstable**	Complete soil disturbance by cultivation or heavy grazing (or both). - Includes sowing by full disturbance direct drilling Such disturbance by grazing alone would normally occur only on sand.

Personnel

To ensure timely completion of the sampling during each survey period a number of teams were setup to complete field work in specified areas. Six teams of two people (Table 4) were assembled and completed all measurements and observations allocated sites. Most teams completed field work in two days.

Table 4: Allocation of transects to teams

Team	Day	Transect	No of sites
1	1	Ouyen Piangil	12
	2	Ouyen Piangil	13
2	1	Torrita	13
	2	Ouyen Piangil	13
3	1	Tutye	13
	2	Murrayville	14
4	1	Millewa	10
	2	Millewa	10
5	1	Sea Lake – Ultima – Swan Hill	15
	2	Sea Lake – Ultima – Swan Hill & Culgoa - Lalbert	13
6	1	Gama - Yaapeet	14
	2	Gypsum – Gama & Hopetoun - Woomelang	19

Data Entry

Field measurements were recorded on hard copy data sheets (Appendix 1) and the data was entered into the database in the office.

A quality control check was completed on the data entered into the database. A 100% check was completed by a staff member not involved in the original entry of the data. A signed quality control form is included as Appendix 2.

Analysis

Erosion risk

For the purpose of comparison three types of assessments of soil erosion risk were completed. These were:

- Calculation of the 'Q value'.
- Assessment of soil stability.
- Determination of soil erosion risk using a risk matrix.

Q value

A formula has been derived by Leys (Leys et al 2002) to determine relative wind erosion risk. It uses the direct measurements of vegetation cover and soil dry aggregates to calculate a wind erosion risk for each site. The formula is as follows:

$$Q = 78.11375017 * \exp(-0.05172598 * SC\%) * \exp(-0.038989759 * DA\%)$$

Where Q is the calculated sediment transport rate (g/m/s) for an equivalent 65km/h wind measured at 10 m height; SC% is the vegetation cover percentage; and DA% is the level of dry aggregation greater than 0.85 mm as determined by gentle hand sieving.

A Q value of less than 5 g/m/s equates to low erosion risk, moderate risk is a Q value greater than 5 but less than 25 g/m/s and a high erosion risk is a Q value greater than 25 g/m/s.

Soil erosion risk matrix

The measurements of vegetation cover and soil dry aggregates were used to estimate a risk of erosion for each site. The rougher the soil surface the more stable the soil is, vegetation contributes to the roughness. It is recommended that vegetation cover remains above 50% cover to adequately protect from wind erosion (Agricultural Bureau of South Australia, 2002). Larger soil aggregates also protect soil from wind erosion. The larger the aggregates the less likely they are to be picked up and carried away by the wind, larger aggregates also contribute to surface roughness. Dry aggregation greater than 40% has been shown to greatly reduce erosion (Leys, Keon & McTanish, 1996). Table 5 is the matrix that was used to determine the erosion risk using the measurements of vegetation cover and soil dry aggregates.

Table 5: Matrix to determine erosion risk for sites where vegetation cover and soil dry aggregates has been measured (McIntosh, Leys & Biesaga, 2006).

dry aggregates	>50%	30-50%	10-30%	<10%
groundcover				
>70%	low	low	low	low
50-70%	low	low	low	medium
30-50%	low	low	medium	high
10-30%	low	medium	high	high
<10%	medium	high	high	High

Assessment of soil stability.

Completed in the field as described in the data collection.

Results and discussion

Data collection from one transect for the late summer 2012 survey was delayed by one working day of the designated period due to a rainfall events in the region. This did not appear to alter data collection results due to this delay and rainfall event.

Land Management Phase

Land management phase is recorded during each survey to determine what phases are occurring over the year at sites surveyed within the Mallee region and also to see whether they have any impact on wind erosion.

The survey of land management phase during the late summer sampling period showed 65% of the sites were in chemical fallow and 7% of the sites were in conventional fallow, and 28% in pasture (Table 6 and Figure 3). Conventional fallow was recorded in two of the six land systems.

Table 6. Survey of land management phase during the late summer 2012 survey sampling period.

LandSystem	Chemical Fallow	Conventional Fallow	Improved Pasture	Volunteer Pasture
Boigbeat	80.0% (8)	0.0% (0)	0.0% (0)	20.0% (2)
Central Mallee	62.3% (48)	9.1% (7)	1.3% (1)	27.3% (21)
Culgoa	64.7% (11)	0.0% (0)	0.0% (0)	35.3% (6)
Hopetoun	87.0% (20)	0.0% (0)	4.3% (1)	8.7% (2)
Millewa	35.0% (7)	20.0% (4)	0.0% (0)	45.0% (9)
Tempy	80.0% (8)	0.0% (0)	0.0% (0)	20.0% (2)
Total	**65.0% (102)**	**7.0% (11)**	**1.3% (2)**	**26.7% (42)**

Burnt stubbles were not recorded at any sites during the late summer sampling survey; however evidence of remains of burnt stubbles were present at some sites during the late summer sampling period. Further assessment of this indicates that this may not have been recorded due to the current layout of the monitoring sheet, that appears not to allow for the recording of more than one management phase at a given period therefore another option may have been chosen as more dominant. It is therefore recommended that the forms are modified to record presence of burnt stubble separately or as well as land management phase.

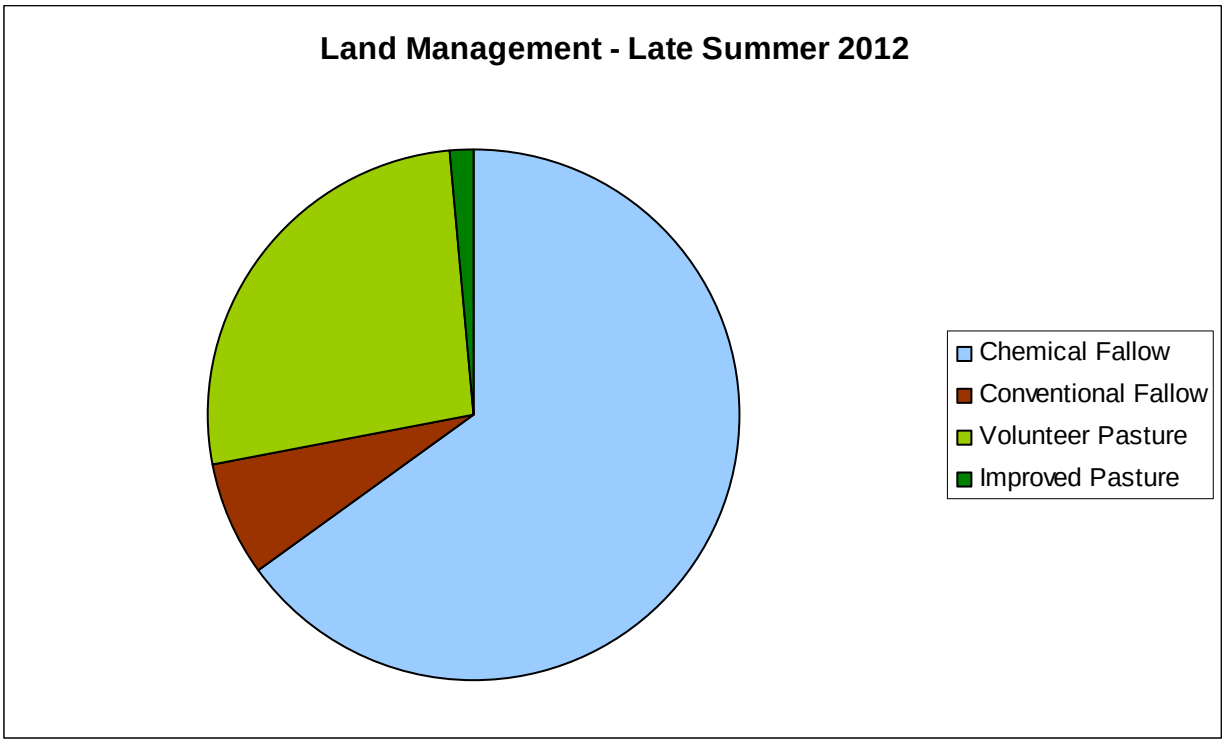

Figure 3: Percentage of the sites under different land management practices, observed during the late summer 2011 survey.

During the 2012 late summer sampling survey 14.65% of sites were observed to have livestock present (sheep and cattle) with 85.35% of the sites recording absence of stock (Figure 4).

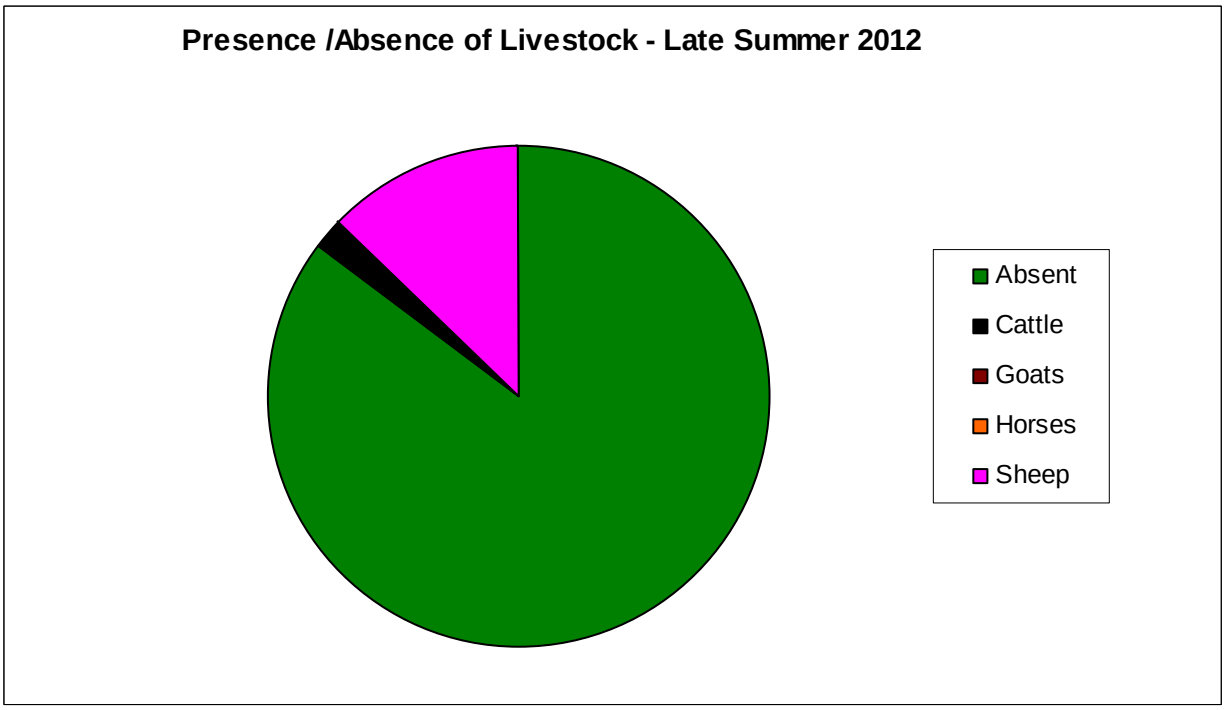

Figure 4: Percentage of sites with livestock absent/present, observed during the late summer 2012 survey.

Vegetation Measurements

The late summer 2012 survey reported that three sites (1.91% of sites) recorded less than 10% vegetation coverage and 5.74% or nine sites recorded between 10% - 30% vegetation coverage. The survey recorded 13.38% of sites with between 30-50% vegetation coverage; 40.76% or sixty four sites with between 50-70% vegetation cover; and 38.21% of sites with greater than 70% vegetation cover (Figure 5). Only one land system (Tempy) recorded 100% of sites with greater than 50% vegetation cover, significantly reducing the risk of erosion at these sites (Table 7).

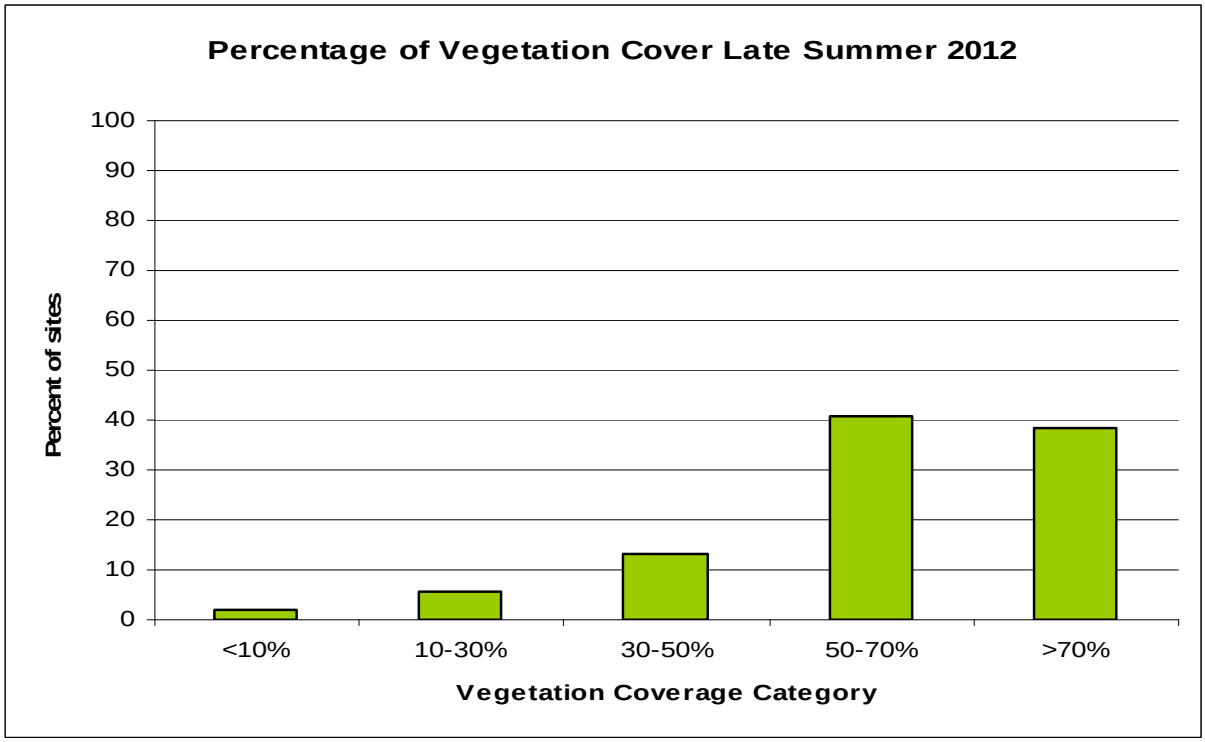

Figure 5: Percentage of vegetation cover at sites surveyed for the Mallee Soil Erosion and Land Management survey, results from the late summer 2012.

Table 7: The percent (and number) of sites by land system recorded vegetation cover during the late summer 2012 survey.

LandSystem	<10%	10-30%	30-50%	50-70%	>70%
Boigbeat	0.0% (0)	0.0% (0)	10.0% (1)	80.0% (8)	10.0% (1)
Central Mallee	2.5% (2)	6.2% (5)	12.5% (10)	37.5% (30)	37.5% (30)
Culgoa	0.0% (0)	5.6% (1)	27.8% (5)	38.9% (7)	22.2% (4)
Hopetoun	0.0% (0)	0.0% (0)	13.0% (3)	30.4% (7)	56.5% (13)
Millewa	5.0% (1)	15.0% (3)	10.0% (2)	45.0% (9)	25.0% (5)
Tempy	0.0% (0)	0.0% (0)	0.0% (0)	30.0% (3)	70.0% (7)
Total	**1.91% (3)**	**5.74% (9)**	**13.38% (21)**	**40.76% (64)**	**38.21% (60)**

Erosion Risk

Q Value

Table 8: The percentage (and number) of sites with low, medium and high erosion risk calculated using the formula derived by Leys (Leys et al, 2002)

Land Systems	Low	Medium	High
Boigbeat	100% (10)	0.0% (0)	0.0% (0)
Central Mallee	93.52% (72)	5.19% (4)	1.29% (1)
Culgoa	100% (17)	0.0% (0)	0.0% (0)
Hopetoun	100% (23)	0.0% (0)	0.0% (0)
Millewa	85% (17)	10% (2)	5% (1)
Tempy	100% (10)	0.0% (0)	0.0% (0)
Total	**94.90% (149)**	**3.83% (6)**	**1.27% (2)**

Soil erosion risk matrix

Table 9: The percentage (and number) of sites with low, medium and high erosion risk estimated using the soil erosion risk matrix (Table 5).

Land Systems	Low	Medium	High
Boigbeat	100% (10)	0.0% (0)	0.0% (0)
Central Mallee	92.22% (71)	5.19% (4)	2.59% (2)
Culgoa	100% (17)	0.0% (0)	0.0% (0)
Hopetoun	100% (23)	0.0% (0)	0.0% (0)
Millewa	100% (20)	0.0% (0)	0.0% (0)
Tempy	100% (10)	0.0% (0)	0.0% (0)
Total	**96.19% (151)**	**2.54% (4)**	**1.27% (2)**

Assessment of soil stability

Table 10: The percentage (and number) of sites with a detachment rating of 1, 2 or 3.

Land Systems	1	2	3
Boigbeat	100% (10)	0.0% (0)	0.0% (0)
Central Mallee	94.82% (73)	3.89% (3)	1.29% (1)
Culgoa	94.11% (16)	5.89% (1)	0.0% (0)
Hopetoun	100% (23)	0.0% (0)	0.0% (0)
Millewa	80.00% (16)	15.00% (3)	5.0% (1)
Tempy	100% (10)	0.0% (0)	0.0% (0)
Total	**94.28% (148)**	**4.45% (7)**	**1.27% (2)**

The results from all erosion risk methods record similar results with some minor differences particularly in the Millewa land system. The Q value (Table 8), soil erosion risk matrix (Table 9) and the assessment of soil stability (Table 10), all indicate greater than 94% of sites in the low risk category of erosion.

Conclusion

During the late summer 2012 survey:-

- Soil erosion matrix resulted in 96.19% of sites surveyed recording a low risk of erosion
- 78.97% of sites surveyed had greater than 50% vegetation coverage rating these sites as a low risk of erosion
- 28% of the sites surveyed were in pasture including volunteer and improved pastures.
- 7% of sites surveyed were in a conventional fallow phase.
- 65% of sites surveyed were recorded in a chemical fallow management phase

Recommendations

- Continue collaborating with NSW, SA and WA to continue to develop soil erosion monitoring protocols, in particular to develop methods to measure risk of erosion.

- Redesign the data collection sheets to capture further evidence of management practice phase through multi choice selection especially to capture evidence of burnt stubble.

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