



Managing pastures in saline areas

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There are at least 30,000 ha of salt-affected land in the Glenelg Hopkins region, and a further 21,000 ha in Corangamite. These areas typically have carrying capacities of less than 5 DSE/ha, and are dominated by undesirable plants such as barley grass and spiny rush. Yet with appropriate management, carrying capacities on some saline areas can be increased 2- to 4-fold. Furthermore, stock can gain weight during summer, because high water tables allow pastures in saline areas to remain green while other pastures are dry.

Challenges of saline land

Saline land presents three challenges to plants, making growth and survival difficult:

- salinity – salt in the soil water
- waterlogging – lack of oxygen for root function
- flooding – water above the soil surface.

Plants often face more than one of these challenges simultaneously, and a combination is particularly difficult. For example, plants that actively exclude salt from the root surface in well-aerated soils cannot do this when the soil is waterlogged, because the roots do not have sufficient oxygen.

The farm manager also faces challenges on saline land:

- Animal welfare may be compromised because saline areas can have surface water for up to 3 months each year.
- Vehicle access may be limited for even longer periods, reducing options for cultivation, sowing and herbicide application.

Key points

- Saline land is often an under-utilised resource, which has potential to grow pasture for summer weight gains for stock
- Sowing adapted pasture species into mildly saline land can increase carrying capacity 2- to 4-fold
- For small areas of saline land, or where land is strongly saline, it is preferable to fence the area separately and manage to encourage native summer-growing species

- Many saline areas are small (less than 5 ha), and it may not be worthwhile managing them for production.

Salinity classification

In Victoria salinity is classified on the basis of visual symptoms such as the presence of indicator plants, and salinity readings obtained by soil tests.

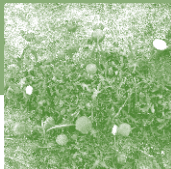
By determining the class to which a piece of saline land belongs, decisions about management options are easily identified.

Class 1 – mild salinity

- Isolated areas of patchy growth
- Productive annual and perennial species thin and die out, and are replaced by species tolerant of Classes 1, 2 or 3 salinity (salt tolerant species are described on pages 91–93)
- No salt crystals or bare patches can be seen
- Soil test salinity (ECe) 2–10 dS/m



Land of Class 1 salinity



Class 2 – moderate salinity

- Small areas of bare ground up to 1 m²
- Only species tolerant of Classes 2 and 3 salinity are present
- Leaves of buckshorn plantain turn a reddish colour adjacent to bare areas
- Virtually no legumes are present
- Soil test salinity (ECe) 10–25 dS/m



Land of Class 2 salinity

Class 3 – severe salinity

- Large areas of bare ground
- Often only 2–3 species, such as salt couch and buckshorn plantain
- Only species tolerant of Class 3 salinity are present
- Bare ground may be covered with a dark organic stain, or a white salt crust
- Soil test salinity (ECe) 25–40 dS/m

A list of the species tolerant to each class can be found in the publication *Spotting Soil Salting – A Victorian Guide to Salt Indicator Plants*, listed at the end of this chapter. The main plant indicators of saline land in south west Victoria are described in the next section of this chapter. In addition to the three classes described above, there is Class 0 (non saline) and Class 4 (extreme salinity).



Land of Class 3 salinity

Plant indicators of saline land

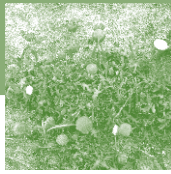
Plants are the best indicators of salinity throughout the year. A paddock walk is a quicker and cheaper way of assessing salinity than soil testing or electromagnetic (EM) surveys.

Some plant indicators of salinity are depicted and described in the following text.

Buckshorn plantain (*Plantago coronopus*) is a low-growing introduced perennial tolerant of flooding, waterlogging and Classes 2 and 3 salinity. It is a good indicator of salt stress, having leaves of a dull grey-green colour at low salinity and dark red at higher salinity. Sheep will readily graze buckshorn plantain.



Buckshorn plantain



Yellow buttons (*Cotula coronopifolia*) are introduced annual plants tolerant of Classes 2 and 3 salinity, flooding and waterlogging. They colonise disturbed areas. Yellow buttons are readily grazed by sheep in the vegetative phase, but after flowering starts in November, sheep prefer other components of the pasture.



Yellow buttons

Sea barley grass (*Hordeum marinum*) is an introduced annual grass tolerant of Classes 1 and 2 salinity, but it also grows widely in non-saline areas. It is readily grazed by sheep until mid spring, when it grows a spiky seed head.



Sea barley grass

Measuring salinity

Salinity is measured by the ability of water to conduct an electric current. Therefore salinity readings are referred to as **EC** – electrical conductivity. Increasing salt in water or soil increases conductance. Distilled water has an EC of less than 0.0001 decisiemens per metre (dS/m), and sea water 55 dS/m. Some laboratories report conductivity in different units, and conversions are shown in Table 10.1.

EC 1:5 is reported as part of standard soil analyses. It is the most routine measurement of salt content, but is affected by any particles in the water suspension including dispersed clay and organic matter.

ECe is the electrical conductivity of water within the soil when the soil is saturated with water, and is thus a more direct measure of soil salinity. However it is a more difficult procedure than obtaining a EC 1:5 and not carried out routinely. Approximate conversions between EC 1:5 and ECe are shown in Table 10.1.

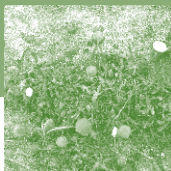
EM: Electromagnetic signals provide an indication of where in a paddock a salt problem is likely to arise in the future, and are useful for fencing saline areas. An EM38 held horizontally detects salts in the top 0.4 m, and if held vertically, to 1.0 m. An EM31 in horizontal mode senses the top 2.0 m, and vertically the top 6.0 m.

Table 10.1 Conversion table for salinity units

To convert	to	multiply by
millisiemens per centimetre (mS/cm)	decisiemens per metre (dS/m)	1
millisiemens per metre (mS/m)	decisiemens per metre (dS/m)	0.01
microsiemens per centimetre (µS/cm)	decisiemens per metre (dS/m)	0.001
EC 1:5 sandy loam	ECe	14
EC 1:5 loam	ECe	10
EC 1:5 medium clay	ECe	8

Salinity varies through the year

Values of EC 1:5 and ECe values change about 3-fold during the year. Salt concentrations in the topsoil are highest at the end of summer, because soil evaporation concentrates salts toward the surface. Salinity drops during winter as rainfall flushes the salts deeper. Winter-growing plants thus avoid the highest levels of salinity. The best time to measure soil salinity is between November and March, because it is relatively stable, and indicates the highest levels the plants will be exposed to.



Salt couch (*Sporobolus virginicus*) is a summer-growing native perennial couch grass, tolerant of Classes 2 and 3 salinity. It is green during summer, readily eaten by sheep, and its stolons are able to grow across scalded areas.



Salt couch

Native puccinellia (*Puccinellia stricta* var *perlaxa*) is a perennial grass able to colonise scalded areas of Classes 2 and 3 salinity. Its flower head has more widely spreading branches than the introduced *Puccinellia ciliarta*. Its feed quality and preferred growing conditions are similar to its introduced cousin.



Native puccinellia

Where is the salt?

A study on the Dundas Tableland near Hamilton investigated soil salinity under bare ground, pasture and trees. The graph below shows the level of soil salinity in the profile, to a depth of 1 m, for each of these situations.

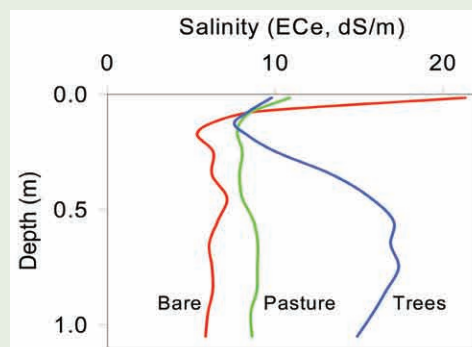


Figure 10.1 The level of salinity in the soil profile under bare ground, pasture and trees

Bare ground

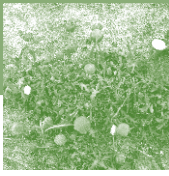
Salts are concentrated close to the soil surface, making it difficult for new plants to colonise the area. The soil acts like a wick, bringing moisture and salts up from water tables as deep as 1.5 m below the surface. Salt scalds can start by anything that removes plants or surface cover, such as sheep tracks, vehicle tracks, or following through cultivation or herbicide application. Mulches can ameliorate the problem by reducing soil evaporation but allowing rainfall to wash the salts deeper into the profile.

Pasture

Salts are distributed evenly down the soil profile. Plant roots take up moisture from upper layers of the soil (0.0–0.5 m), allowing salts to concentrate in these layers, while surface cover reduces soil evaporation. A land use with this salt profile should be sustainable in the long term, because flushing of salts from the soil surface during winter balances those concentrated from groundwater during the summer.

Trees

Salts are concentrated deeper in the profile (0.3–0.9 m). Both rainfall and upward seepages of groundwater are fully utilised by the trees, and salts build up within the root zone. This is not sustainable in the long term, because after the trees are harvested, a short period of bare ground will allow salts to rise to the surface. If not harvested, excessive salts will kill the trees, again causing salts to come to the surface. A lower density of trees may reduce the salt build-up and allow more flushing.



Pasture management for saline land

Saline land can be managed as pasture, to improve ground cover and maintain productivity. Separate fencing of saline land is the first step to improving the growth and utilisation of pasture. Unless the area is fenced, sheep tend to overgraze it. The next step is to either manage the native and volunteer species already present, or sow a new pasture.

Native pastures for saline land

Better management of existing volunteer plants on saline land, including natives, is worth serious consideration when desirable plant species are already present and:

- saline areas are too small to justify sowing and separate management
- salinity is mainly Classes 2 or 3
- the landholder has an interest in native pastures.

The saline areas should be fenced separately, and grazed as part of the overall farm rotational grazing system. Deferment of grazing in early summer can be used to thicken up native species that flower at that time of the year. Sheep weight gains of 60 g/d between December and March have been recorded on a volunteer pasture that consisted of buckshorn plantain and salt couch. This was achieved on Class 2 saline land, but only at a stocking rate of only 4 sheep/ha. Sowing native herbaceous species is not yet a practical option at the paddock scale, but research into low-cost methods of propagation is continuing.

Sown species for saline land

A range of introduced grass and legume species can be established as pasture on saline land.

Tall wheatgrass (*Thinopyrum ponticum*) is a productive perennial grass tolerant of Classes 1 and 2 salinity. It is the dominant sown pasture species on saline land in south west Victoria. The cultivar Dundas, released in 2000, was selected for improved leafiness and digestibility over the previous cultivar Tyrrell. Tall wheatgrass grows thick stems to about 1 m tall if there is insufficient grazing pressure in late spring. Seed is set in

autumn, and can spread by water movement. To avoid it becoming a weed in non-target areas, tall wheatgrass should only be sown where sufficient grazing pressure can be applied to consume all the seed heads.

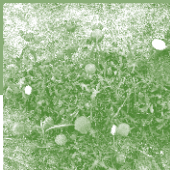


Tall wheatgrass

Puccinellia (*Puccinellia ciliata*) is a fine-stemmed perennial grass tolerant of Classes 1 and 2 salinity, and more tolerant of flooding than tall wheatgrass. It is easily established and grows mainly during winter and spring, but will stay green during summer if there is subsoil moisture.



Puccinellia



Tall fescue (*Festuca arundinacea*) is a productive perennial grass tolerant of Class 1 salinity. Saline areas should be sown to cultivars that are summer-active.



Tall fescue

Persian clover (*Trifolium resupinatum*) is an annual clover tolerant of Class 1 salinity similar to balansa, but it is more tolerant of flooding. Cultivar Nitro flowers about 2 weeks later than the Bolta variety of balansa.



Persian clover

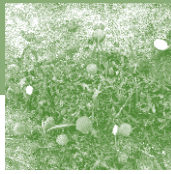
Balansa clover (*Trifolium michelianum*) is an annual clover tolerant of Class 1 salinity. It has good tolerance to flooding because its stems are hollow, allowing oxygen to move down to the roots when the plant is partially submerged. The most popular cultivar, Bolta, flowers in mid November.



Balansa clover



Strawberry clover



Sowing and establishment of introduced species

Sowing pasture on saline land requires more planning and preparation than sowing pasture on any other land. Pasture sowing principles are discussed in Chapter 4, *Sowing pastures*.

The first step for sowing a pasture on salt-affected land is to control annual grasses by spraying in October. Summer-growing perennials such as salt couch and buckshorn plantain will not compete strongly with the new pasture, and their transpiration will reduce salts rising to the surface over summer.

Late spring is the best time to determine the severity of salting by observing indicator species. Two soil samples (0–10 cm) should be collected – one from a good area of the paddock and one from a poor area – and analysed for EC, pH, phosphorus (Olsen P) and available potassium.

Because saline sites are spatially variable, a mixture of pasture species should be sown. Suggested sowing rates are shown in Table 10.2.

The pasture mix should be sown April–May after opening rains. If there have been no sowing rains by late April, the pasture can be sown dry. However, dry-sown pastures have more weeds than those cultivated or treated with herbicide between the autumn break and sowing. Alternatively, sowing can be delayed until spring.

If cultivation is required prior to sowing, the length of fallow should be minimised to reduce salts rising to the surface, and the number of passes minimised to reduce damage to soil structure.

Spraying for red-legged earth mite is necessary to ensure successful legume establishment.

General agronomy

There are important differences in the agronomy of land at different salinity levels.

Class 1

Weed control is critical for these areas, and cultivation or a second spraying may be required between opening rains and sowing. Balansa and Persian clovers will be strong competitors to the sown grasses and should be sown at a low sowing rate. Alternatively, these legumes can be drilled in the following year, once sown grasses have established.

Class 2

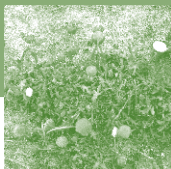
Plant germination is slower in Class 2 than Class 1, and tall wheatgrass may take longer to establish in these soils. There are fewer weeds that compete with the pasture, and these emerge slowly. Because legume growth is poor, tall wheatgrass is more dependent on applied nitrogen to maintain vigour.

Class 3

These are often primary saline sites (i.e. saline prior to European settlement), and difficult to develop reliably with tall wheatgrass-based pastures. Cultivation should be avoided. Separate fencing followed by deferment of grazing from December to mid January will encourage the existing summer-growing species such as salt couch.

Table 10.2 Sowing rates (kg/ha) for pastures on saline land

Salinity class	Class 1	Class 2	Class 3
Summer–autumn ECe (dS/m)	2–10	10–25	25–40
Year 1			
Tall fescue	15.0	-	-
Tall wheatgrass	7.0	10.0	15.0
Puccinellia	3.0	4.0	8.0
Strawberry clover	2.0	3.0	-
Balansa clover	0.5	1.0	-
Persian clover	0.5	1.0	-
Year 2			
Balansa clover	1–2	-	-
Persian clover	1–2	-	-



Fertiliser management

Pastures established on saline sites require adequate nutrition, either from the soil or from fertiliser, to achieve satisfactory production rates.

Phosphorus

Productive tall wheatgrass-based pasture requires soil phosphorus levels of 12–15 mg/kg (Olsen P). If levels are lower than this, a phosphorus fertiliser application will be necessary.

Potassium

During wet years, potassium leaches out of saline soils. Fertiliser applications of 10–20 kg K/ha may be required after years of high water movement. Regular soil testing will enable objective assessment of potassium levels, as well as other soil nutrients. See Chapter 5, *Fertilising pastures*, for guidelines to interpret soil potassium tests.

Nitrogen

Tall wheatgrass often responds well to applied nitrogen, particularly on Classes 2 and 3 land where legume growth is poor. Nitrogen levels can be raised with applications of 100 kg/ha of MAP (mono-ammonium phosphate) or DAP (di-ammonium phosphate) (10–18 kg N/ha) in the year of sowing. Moderate to high levels of salinity restrict subsequent legume growth, and good responses can be expected from 50 kg N/ha as urea in late autumn or early spring.

Sulphur

Discharge areas are nearly always high in available sulphur. High-analysis fertilisers such as MAP, DAP and TSP (triple superphosphate), which have low sulphur content, can be used in saline areas.

Grazing management

During the first growing season of a tall wheatgrass pasture, grazing should be light until November, to ensure plants are well anchored. After this, the pasture should be grazed when it reaches a height of 15 cm, and grazed down to 3 cm. Rotational grazing, a small paddock size, and large mob sizes are necessary to maintain the pasture in a vegetative state.

Small areas should be fenced and managed separately to avoid under or over-grazing.

Control of spiny rush

Spiny rush (*Juncus acutus*) is an introduced weed that grows on Classes 1 and 2 saline land, and is not readily eaten by livestock. It can dominate saline and waterlogged areas, reducing the carrying capacity of those areas. Landowners are required to take reasonable steps to control it and prevent its spread.

Control can be mechanical (mouldboard ploughing or mulching) or by using recommended herbicides. Control programs need to last 2 years to deplete the soil seed reserves, followed by planting of a vigorous salt-tolerant pasture to act as a strong competitor to any remaining seedlings. For more information look up the DPI Agnote on spiny rush at www.dpi.vic.gov.au/notes/

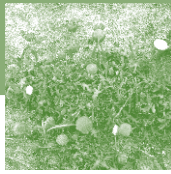


Spiny rush

Drainage

Drainage of surface runoff reduces the stress on plants caused by flooding and waterlogging, and at the same time improves animal welfare by creating drier areas for stock to stand and camp. Construction of drains that discharge surface runoff directly into waterways requires the permission of the local Catchment Management Authority. However, minor earthworks that discharge onto one's own property are permitted.

Effective options for managing surface water are described as follows.



Interceptor drains divert surface water coming from higher up the slope.

Raised beds allow plants such as tall wheatgrass with less flooding and waterlogging tolerance to perform well, while the drains favour puccinellia. Raised beds also allow greater flushing of salts from the topsoil. The beds limit vehicle access, but allow livestock to avoid flooded ground during winter.

Ploughlands can be made by opposing passes of a one-way disc plough, followed by cross-harrowing. These are more easily trafficable than raised beds, but are not as effective as beds in waterlogging control or salt flushing. Care needs to be taken that not all the topsoil is removed from the drain areas, otherwise achieving pasture cover will be difficult.

Drainage should not be contemplated on land of Class 3 salinity unless the surface is already bare, because it will be difficult to restore vegetative cover after earthworks.

Further reading

Spotting Soil Salting – A Victorian Guide to Salt Indicator Plants (1995)

by J. Matters & J. Bozon

www.dpi.vic.gov.au then search for Spotting Soil Salting

Saltland Pastures in Australia – A Practical Guide (2003)

by EG Barrett-Lennard,

Published by Land, Water and Wool Initiative, Land and Water Australia, Canberra, Australia

Productive pastures on saline land

Michael Blake, Hamilton A 40 ha paddock of Classes 1 and 2 salinity, which carried 2.5 DSE/ha year-round, was sown to tall wheatgrass and annual clovers, and subdivided to allow rotational grazing.

Carrying capacity the first year after sowing averaged 5 DSE/ha (10 DSE/ha during the 6 months of grazing), then increased to 10 DSE/ha in the second year and 15.5 DSE/ha the third year after sowing. Tall wheatgrass was only grazed during the 8 drier months of the second and third

years. A financial analysis showed that after allowing for sowing and subdivision costs, the investment had a payback period of 4.1 years.



Michael Blake, Hamilton

Les Payne, Victoria Valley A 35 ha area of Classes 1 and 2 salinity was sown to a tall wheatgrass-based pasture. Tall wheatgrass is productive over summer, allowing pregnant ewes to maintain weight with virtually no supplementary feeding between January and April.



Les Payne,
Victoria Valley

Peter Hayes, Dunkeld Summer carrying capacity on Class 1 land increased from 12 sheep/ha on a volunteer pasture to 16 sheep/ha with a tall wheatgrass-based pasture. On Class 2 land, summer carrying capacity increased from 7 to 13 sheep/ha. This site had an unusually strong volunteer pasture, consisting of buckshorn plantain and salt couch. Sheep gained weight over summer on all these pasture types.

Peter Hayes, Dunkeld

Photo: Land, Water & Wool Initiative

