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HEALTHY FARMING

LANDHOLDER SERIES

PROPERTY PLANNING GUIDE

ACKNOWLEDGEMENTS

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DISCLAIMER

Information sources have been provided in this document as appropriate and full references may be found in NRM South's 'Healthy Farming & Environment Reference Guide'. While information is considered true and correct at the time of publication it should be acknowledged that changes post publication may affect the accuracy of content.

This guide is designed as an aid to property planning, users of this guide must consider their own personal circumstances and seek further advice as appropriate.

FURTHER INFORMATION CONTACT:

NRM South
313 Macquarie Street
South Hobart Tasmania 7004
Tel: 03 6221 6111
Fax: 03 6221 6166
Email: admin@nrmsouth.org.au
www.nrmsouth.org.au

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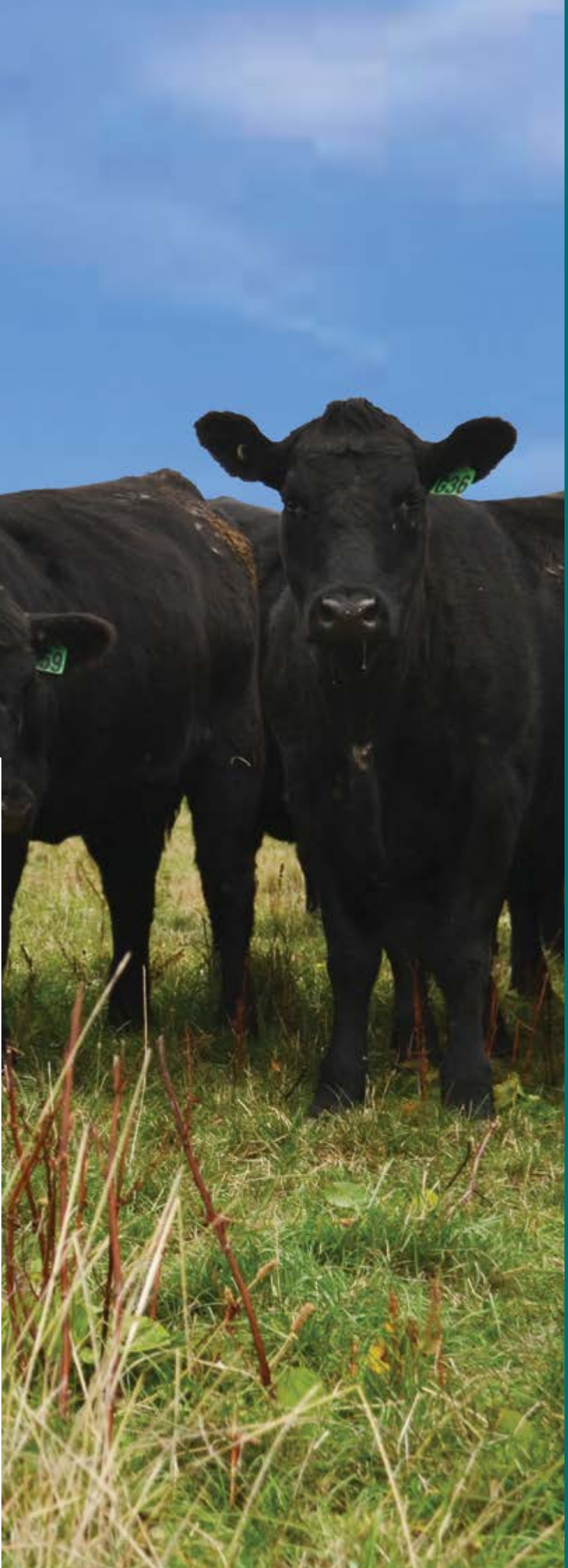

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Photo: S. Folder

HEALTHY SOILS

Soil health refers to the condition of the soil and its potential to sustain biological functioning, maintain environmental quality, and promote plant and animal health.

A healthy soil is one that is productive and easy to manage under the intended land use. It has physical, chemical and biological properties that promote the health of plants, animals and humans while also maintaining environmental quality.

- *Land and Water Australia*

Soils are described according to the following attributes;

PHYSICAL (soil type, texture, structure, compaction, erosion, water holding capacity & permeability)

CHEMICAL (salinity, pH, fertility and nutrients)

BIOLOGICAL (soil organic matter, beneficial organisms such as microbes and living organisms and pathogens)

CHARACTERISTICS OF A HEALTHY SOIL

Characteristic	Description
Physical	
Good soil tilth	Soil tilth refers to the overall physical character of the soil in the context of its suitability for production.
Sufficient rooting depth	Sufficient depth refers to the extent of the soil profile to which roots are able to grow and function. A soil with a shallow depth as a result of a compaction layer or past erosion is more susceptible to extreme fluctuations in the weather, thus predisposing the crop to drought or flooding stress.
Good soil drainage	Even after a heavy rain, a healthy soil will drain more rapidly as a result of good soil structure and an adequate distribution of different size pore spaces, but also retain adequate water for plant uptake.
Resistant to degradation	A healthy soil is more resistant to adverse events including erosion by wind and rain, excess rainfall, extreme drought, vehicle compaction etc.
Resilience when unfavourable conditions occur	A healthy soil will rebound more quickly after a negative event such as harvesting under wet soil conditions or if land constraints restrict or modify planned rotations.
Chemical	
Sufficient but not excess supply of nutrients	An adequate and accessible supply of nutrients is necessary for optimal plant growth and for maintaining balanced cycling of nutrients within the system. Excess nutrients can lead to leaching and potential ground water pollution, high nutrient runoff and greenhouse gas losses, as well as toxicity to plants and microbial communities.
Free of chemicals and toxins that may harm the crop	Healthy soils are either devoid of harmful chemicals and toxins or can detoxify and/or bind such chemicals making them unavailable for plant uptake.
Biological	
Small population of plant pathogens and insect pests	Plant pathogens and pests can cause diseases and damage to a crop. In a healthy soil, the population of these organisms is low and/or inactive. This could result from direct competition from other soil organisms for nutrients or niche habitats, hyper parasitism, etc. Also, healthy plants are better able to defend themselves against a variety of pests.
Large population of beneficial organisms	Microbes are important to the functioning of the soil. They help nutrient cycling, decomposition of organic matter, maintenance of soil structure, biological suppression of plant pests etc. A healthy soil will have a high and diverse population of beneficial organisms to carry out these functions and thus help maintain a healthy soil status.
Low weed pressure	Weed pressure is a major constraint in crop production. Weeds compete with crops for water and nutrients that are essential for plant growth. Weeds can interfere with plant establishment, block sunlight, interfere with harvest and cultivation operations, and harbour disease-causing pathogens and pests.

SOURCE: *Cornell Soil Health Assessment Training Manual, Edition 1.2.2*

HOW TO MEASURE SOIL HEALTH

1. Physical Inspection

Digging with a spade provides a simple way to assess the physical aspects of your soil. Record your thoughts on the following;

- What does it feel and smell like?
- What is the texture of your soil (sand, loam or clay)?
- How easily does it break up and how hard is it to dig?
- What plants are growing in it and how deep are the roots?

Photo: Cradle Coast NRM

SIGNS TO LOOK FOR WHEN EXAMINING THE HEALTH OF YOUR SOIL

	Good	Poor
Soil surface	✓ Textured, rough ✓ Good water drainage ✓ Good plant cover & growth	× Crusted, surface sealing × Water sheets/ runs off/ ponds × Moss/algal growth
Soil aggregates (structure)	✓ Rough faces on surface of aggregates ✓ Assorted-sized aggregates (ideal is 1-5mm) ✓ Friable ✓ Crumbly ✓ Lots of pores	× Sharp angles, “clean” faces × Larger aggregates × Falls to powder (no crumbs) × Clods × Few or no pores × Compacted, layers parallel to surface (at any depth) × Settles to blocks/bricks
Rusty colours/ mineral deposits in topsoil (water logging)	✓ Few/ small/ not noticeable	× Many/ noticeable
Plants	✓ Lots of roots in the soil	× Few or no roots in the soil

2. Chemical Soil Testing

A soil test will give you an indication of the chemical properties of your soil.

There are many soil testing laboratories that can undertake soils tests for you, local agronomists and fertiliser reps will be able to advise you on these.

When choosing a lab it is preferable to use one that is Australian Soil and Plant Analysis Council Inc (ASPAC) and National Association of Testing Authorities (NATA) accredited. It is advisable to take samples at the same time of the year and to use the same lab over time so that you can compare your results. Not all laboratories use the same testing methods and procedures.

Photo: Ag Vita Analytical

WHAT CAN BE FOUND ON A SOIL TEST?

Test	Description
Organic Matter (OM) & Organic Carbon (OC)	Organic Matter / Organic Carbon are essential for soil structure and nutrient retention. They are measured as percentages and the amount of OM is roughly twice the amount of OC. Ideal OC levels will depend on soil type and generally range from 2.5 – 4 %.
pH	pH refers to a soil's acidity or alkalinity. pH affects nutrient availability. pH is measured on a scale of 1 -14, with 7 being neutral, <7 is acidic and >7 is alkaline. Most plants prefer a soil with a pH range of 6 – 7.
Electrical Conductivity (EC)	EC is the soil's electrical conductivity. The more ions present, the greater the conductivity. EC is often used to indicate salinity. EC <0.15dS/m is safe for most crops on most soil types.
Chloride	Chloride (Cl) levels are related to salinity, and may become elevated when using fertilisers that contain Chloride.
Macronutrients	Macronutrients (Nitrogen (N), Phosphorous (P), Potassium (K), Sulphur (S), Calcium (Ca), Magnesium (Mg)) are required by plants in large amounts. P and K may become "locked up" in some soil types.
Cation Exchange Capacity (CEC)	CEC is related to soil texture (sand, clay, loam etc). The higher the CEC, the higher the nutrient holding capacity (sand < loam < clay)
Sodium	Sodium (Na) interferes with plant nutrient and water uptake and soil structure. Sodic soils have Na levels >6% CEC. Maximum recommended levels vary depending on soil type.
Ca / Mg, Ca / K & P / Mg ratios	Calcium / Magnesium, Calcium / Potassium and Potassium / Magnesium ratios indicate whether the soil's cations are balanced. Major cations are Ca, Mg, K, H, Na and Al. They have a positive charge.
Trace Elements	Trace elements (=micronutrients such as zinc, iron, manganese, copper, boron) are important for plant health, but required in small amounts.

SOURCE: *Serve-Ag/NLP Sustainable Agriculture Project*

3. Biological Soil Testing

A soil test will give you an indication of the chemical properties of your soil.

Soils with good physical and chemical condition usually have good soil biology. Some laboratories offer soil biological testing. Ask your local agronomist for details of labs that offer this service.

Soil organic matter is an essential food source for soil microbes and organisms and therefore soils with high organic matter will have higher soil microbial populations.

Healthy Root System
Photo: D. Blaesing

SOIL ISSUES TO LOOK OUT FOR

Erosion

Erosion is the loss of soil due to water or wind, which can result in the loss of valuable top soil, increase sediment and nutrient loads in waterways and destabilise the banks of rivers, streams and gullies.

Keeping good ground cover especially during winter and maintaining riparian vegetation will help to reduce the risk of erosion.

Erosion on a dam bank

buck's horn plantain - a common indicator of salinity

Salinity

Soil salinity is the accumulation of salts in a soil profile such that it limits plant growth. Salinity can be identified by;

- Plant and soil symptoms in affected areas eg. salt scalds, surface crusting of salt, poor areas within crops often in lower lying areas, yield losses, stunted plants or burnt leaves
- The presence of plant species that like salty conditions in affected areas (eg. sea barley grass, buck's horn plantain, water button)
- Measurement of the electrical conductivity (EC) in soil and or water samples

Saline areas can be managed by maintaining deep rooted vegetation in the landscape, ensuring effective drainage, planting salt tolerant plants, building soil organic matter and applying soil treatments.

Sodicity

Soil sodicity refers to an excess of sodium in the soil. It is measured by the proportion of sodium in the cation exchange capacity (CEC) and expressed as % sodium (Na) or exchangeable sodium percentage (ESP).

Sodicity affects the uptake of potassium (K), calcium (Ca), and magnesium (Mg). Sodic soils are usually poorly structured, hard setting when dry and sticky when wet and can be susceptible to water erosion due to their dispersive nature. Sodicity can be managed by building soil organic matter, and applying soil treatments eg. gypsum.

Erosion in a sodic clay soil

Compaction due to traffic

Compaction

Compaction occurs from frequent traffic over soils especially when wet. Compaction restricts rooting depth of plants, impedes drainage and leads to soil structure decline.

Using designated roadways (controlled traffic) and not working soils when wet will reduce the risk of compaction.

SOIL ISSUES TO LOOK OUT FOR

Acidification

Acidification is a decrease in soil pH that usually results in a reduction in plant vigour.

Acidification of topsoils, and more seriously, subsoils will lead to lower yields, reduced pasture and crop options and contribute to wider catchment problems such as weed infestations, salinity and erosion.

In acidic soils, aluminium, iron and manganese can reach concentrations toxic to the roots and there may be deficiencies in molybdenum, boron, calcium, magnesium and potassium. (DPI, Victoria)

Acidity can be managed through the application of lime.

Measuring Soil pH
Photo: S. Folder

Waterlogging
Photo: S Folder

Waterlogging

Waterlogging occurs when soil pores are saturated with water for significant periods of time because of impeded drainage due to poor soil structure or in low lying areas.

Drainage work to take water away from the area and building good soil structure can reduce the impact of waterlogging on plant and crop health.

Soil Structure Decline

Soil structure describes how individual soil granules bind together and aggregate, and therefore, the arrangement of soil pores between them.

Compaction and loss of organic matter, surface crusting, increase of surface run-off, poor infiltration, poor water holding, loss of drainage, hard setting, cloudiness, poor workability and low resistance to erosion are signs of poor or degraded soil structure. (*RMCG*)

Soil structure can be maintained through good soil management practices including, minimal tillage, not working when wet, using designated roadways, building soil organic matter and good crop rotations with pasture phases.

Poor Soil Structure
Photo: S Folder

PASTURE & GRAZING

Pastures are an essential component of agricultural properties throughout Southern Tasmania. They provide feed for livestock, incorporate atmospheric nitrogen into the soil (legume species), are an important break in cropping rotations and provide ground cover to protect soils from erosion.

There are a number of methods that can be used to improve pasture management, but important outcomes should include;

- Having adequate feed to meet livestock requirements
- Having good pasture quality to meet livestock requirements for energy, protein and fibre
- Controlling weed growth and establishment
- Controlling pasture pest populations
- Ensuring adequate ground cover to avoid soil loss through wind or water erosion
- Encouraging pasture species diversity to build more resilient pastures and to provide livestock with a wider range of nutrients
- Increasing water infiltration and decrease nutrient loss by reducing water runoff from bare ground
- Providing a fibrous root system which adds organic matter into your soil

MOST PASTURES ARE MADE UP OF A MIX OF GRASS AND LEGUME PASTURE SPECIES. THESE CAN INCLUDE THE FOLLOWING COMMON TASMANIAN PASTURE SPECIES;

Mixed pasture with grass and legume species.
Photo: S Folder

Grasses
annual ryegrass
perennial ryegrass
cocksfoot
tall fescue
phalaris
prairie grass (broome)

Perennial legumes
white clover
red clover
strawberry clover
caucasian clover
lucerne
birdsfoot trefoil
greater lotus

Perennial herbs
plantain
chicory

Annual legumes
sub clover
arrowleaf clover
persian clover
balansa Clover
biserrula

IMPORTANT POINTS TO CONSIDER IN MANAGING DIFFERENT PASTURE SPECIES

- Annual pasture species need to set seed in order to re-emerge the following season.
- Perennial grass species re-grow using tillers which grow from the base of the plant. Managing pastures in spring and autumn to avoid them growing too long is important as it allows sunlight to reach the base of the plant for setting up tiller establishment for the following season.
- Grasses provide good year round production and will provide more feed than legumes in late autumn, winter and early spring. They are also more tolerant to grazing.
- Legumes are important as they have higher levels of digestible protein, greater concentrations of calcium compared to grasses and significantly increase the nutritional value of pasture.
- Legume species have the ability to fix nitrogen from the atmosphere into the soil. They can provide at least 100kg /ha/year of nitrogen, which is essential for the growth of all pasture plants.

ANIMAL HEALTH CONSIDERATIONS FOR DIFFERENT PASTURE SPECIES

- In spring, legumes (eg. clovers and lucerne) can cause bloat in ruminant animals. It is important to regularly monitor livestock when grazing legume rich pastures. Bloat oil can be used to treat animals and pastures when conditions are bad.
- Some grass species can have animal health effects such as ryegrass staggers or phalaris toxicity.
- Ryegrass staggers is caused by an endophyte in the ryegrass. It can be more of a problem when pastures are short as new growth appears in late summer and autumn. Avoid stock management practices that encourage animals to graze close to the ground. Maintain a close watch on stock whenever feed is in short supply. Choose low endophyte species when renovating pastures.
- Phalaris toxity can occur in young green shoots of phalaris based pastures. It is due to the presence of an alkaloid. It is more of a problem with sheep than cattle and can be managed by avoiding hungry stock grazing regenerating phalaris pasture after rain. It can be exacerbated by stress caused by frost or moisture stress.

PASTURE ASSESSMENT

Why assess pastures?

- To better match animal requirements and pasture production
- To know how much feed you have - how different classes of animals will perform & to allocate stock accordingly
- To reduce supplementary feeding
- To enable accurate feed budgeting
- To meet livestock production targets

Visual Pasture Assessment
Photo: S Folder.

Pasture species selection is region and site specific. Local agronomists can provide you advice on what pasture type is best suited to your property and enterprise.

PASTURE QUANTITY

Pasture quantity is described in kilograms of dry matter per hectare (kg DM /ha). The dry matter component of a pasture is the part from which animals derive their protein, energy and fibre needs.

Pasture 'rulers' or sticks are an easy way to measure pasture height which can then be converted into an estimate of the kg of green dry matter/ha using height density tables. The table demonstrates the difference in kilograms of dry matter per hectare (Kg DM/ ha) according to pasture height between a dense (typically sheep grazed) pasture and an open pasture. Green refers to new vegetative growth of the pasture as opposed to dry standing feed. For typical sheep pastures use the 'dense pasture column' for typical beef pastures use the 'moderately dense column'.

Height (cm)	Kg DM/ ha		
	Lightly Grazed 50% green	Moderately dense pasture 100% green	Dense pasture 100% green
1	250	400	500
2	500	700	800
3	600	1000	1100
4	800	1200	1400
5	1000	1400	1700
6	1150	1600	2000
7	1300	1750	2300
8	1450	1900	2600
9	1600	2000	2800
10	1700	2100	3000

SOURCE: *Prograze manual*

A pasture ruler, used to measure pasture quantity

Matching the pasture quantity available (kg DM/ha) with livestock requirements will enable you to determine grazing rotations for your pastures and to determine if supplementary feed is required. It is also a critical tool to ensure that the soil is protected from overgrazing and livestock targets are achieved.

PASTURE QUALITY

Pasture quality refers to the feed quality of the pasture, or the amount of energy and protein it contains.

Pasture quality is affected by the species composition of the pasture, pasture growth stage (fibre content) and the percentage of green verses dead matter in the pasture.

Pastures are generally at their highest feed quality in spring when they are actively growing, in their vegetative growth stage (when fibre content is low) and when the legume content is high.

Once a pasture moves into the reproductive phase, begins to flower and send up its seed head (mid to late spring) the amount of fibre in the pasture increases and the feed quality declines.

A FEEDTEST can be used to measure pasture feed quality in a laboratory and will give you measures of energy, protein, fibre and digestibility of your pasture.

Feed testing can also be useful in determining the feed quality of hay and other supplementary feed products. The quality of different pastures and supplementary feeds can vary considerable, which in turn will influence the health and wellbeing of your livestock and overall farm productivity.

For more information on feed testing seek advice from an agricultural consultant or an accredited laboratory.

PASTURE GROWTH

The following elements are essential for pasture growth

SUNLIGHT

For plants to produce carbohydrates from sunlight through the process of photosynthesis.

WATER

Irrigating pastures at dry times of the year will increase the amount of pasture growth and provide more feed for livestock.

NUTRIENTS

Pasture plants derive most of their nutrients from the soil. Soil testing establishes what nutrients are potentially available to the plants. Plant sap tests are needed to determine what nutrients are actually taken up and are present in the plants. Data from both soil and sap tests can show whether there are deficiencies or over-supply of particular nutrients.

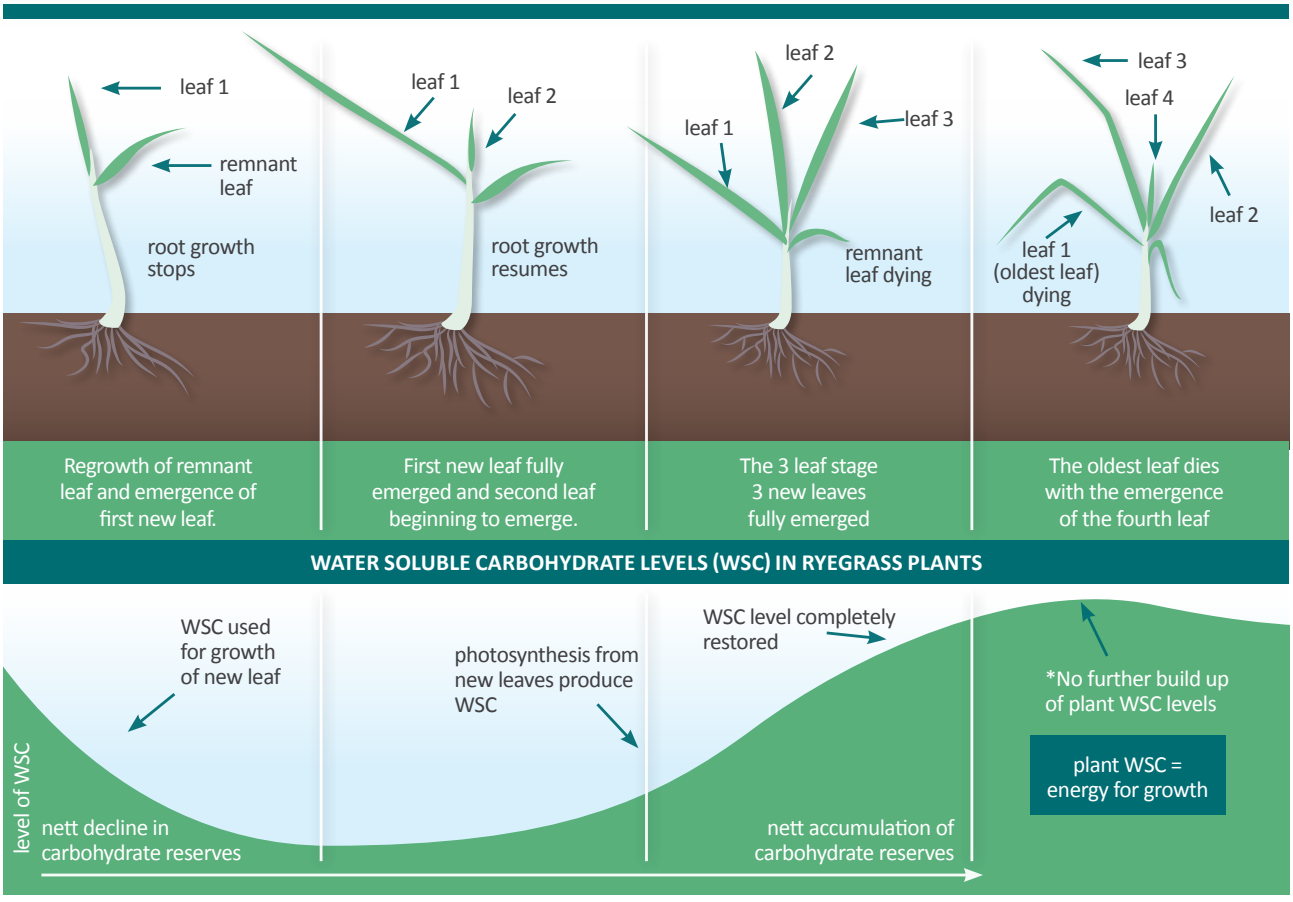
TEMPERATURE

Pastures will have faster growth in warmer temperatures and slower growth in cooler temperatures.

MANAGEMENT

Grazing, weed pressure and pest control in pastures will affect pasture growth potential.

STAGES OF GROWTH & GRAZING



MODIFIED FROM: *MLA More Beef From Pastures Manual*

Figure 1. How a perennial rye grass plant grows.

*However, while plants at the 4 leaf stage are no longer building WSC, the older leaves provide a good source of fibre for animals and when pushed into the soil surface by livestock will add beneficial organic matter to the soil, helping build soil carbon and in turn improving soil and pasture health.

GRAZING MANAGEMENT

Grazing management gives property managers the ability to manage when a pasture is grazed according to the best time for the plant and the animal.

The best time for grazing depends on the condition of the pasture, common practice is to graze when pasture grasses are at the 3 leaf stage when full photosynthetic potential of the plant is reached and when there is the most feed available for the livestock.

Pasture plants that are continually grazed at the one leaf stage do not have the opportunity to replenish root carbohydrate reserves required for re-growth. They will have smaller root systems and therefore a reduced ability to access water and nutrients from the soil than plants grazed at the 2 or 3 leaf stage (Figure 2).

Alternative grazing techniques such as Holistic Management® Planned Grazing focus on grazing at the 4 leaf stage, when dead leaf litter is formed. Feed for livestock is balanced with feed for the soil, as the dead plant material is trampled into the ground by grazing livestock. This process allows organic material and carbon to enter the soil, which in turn promotes nutrient cycling. The fundamental principle behind this management technique is to use livestock to improve the long-term health and resilience of pastures.

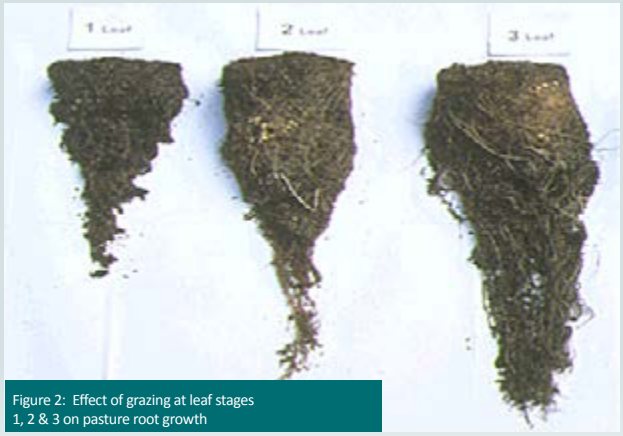


Figure 2: Effect of grazing at leaf stages 1, 2 & 3 on pasture root growth

There are a number of grazing systems that can be used on your property. Here are a few examples:

SET STOCKING

Livestock are usually grazed in the same area on the farm and there is minimal stock movement between paddocks through autumn and winter.

INTENSIVE ROTATIONAL GRAZING

Stock are moved frequently (every 1 to 3 days) through a large number of paddocks (eg. 15 – 30) on the farm.

SIMPLE ROTATIONAL GRAZING

Stock moved according to a set grazing schedule (5-14 days) through a small number of paddocks eg. (4-8 paddocks) on the farm.

HOLISTIC MANAGEMENT® PLANNED GRAZING

Stock are moved regularly through a large number of small paddocks based on regular assessment of pasture health and livestock performance, recently grazed paddocks are typically rested for long periods (6-9 months) on the farm.

Photo: S Folder.

Paddock ready for grazing (front)
Photo: S Folder.

SELECTIVE GRAZING

Livestock will selectively graze the pasture species that they prefer within a pasture.

Sheep have a greater ability to selectively graze than cattle. In a set stocking situation livestock can continually graze the new growth as it emerges (first leaf stage), in which case the pasture does not have the opportunity to replenish root carbohydrate reserves and may lead to weaker plants and less persistent pastures. Weed species that are less desirable to livestock will be given more opportunity to flourish under situations where selective grazing can occur.

CONSIDERATIONS FOR ROTATIONAL GRAZING

A simple rotational grazing system is proven to be a good way of managing pastures and controlling weeds. Setting your property up into several small paddocks is generally a good idea for all types of livestock.

The benefit of rotational grazing is that the pasture is given time to re-grow and replenish root reserves before the next grazing.

Rotationally grazed pastures have greater root mass and are therefore better able to access water and nutrients stored in the soils and lead to more healthy soils.

Many perennial pasture species favour rotational grazing and therefore these desirable species will flourish under rotational grazing systems.

Rotational grazing systems require a greater labour input than set stocking systems as stock need to be moved according to your rotation length.

It is essential to ensure that there is adequate stock water in all paddocks in your rotation to meet livestock requirements at all times of the year. Stock water requirements will be greater in the warmer months of summer when it is hot and pastures are free from dew.

Whilst the proven benefits of good rotational grazing are widely known, there are different schools of thought as to what types of rotational grazing techniques work best.

As a land owner it is important that you look at what your goals are for your property and to match these with your lifestyle to see what type of grazing technique works best for you. Regardless of the technique you decide to employ, it is essential that you have a grazing plan for your property.

Examples of different rotational grazing techniques previously mentioned include Holistic Management® Planned grazing and Time Based Rotational Grazing.

HOLISTIC MANAGEMENT® PLANNED GRAZING

Holistic Management® Planned Grazing commonly referred to as 'planned grazing' is a structured way of using animals to regenerate pasture, and to improve soil health and grazing profitability. This approach builds on the general principles of good rotational grazing described in this fact sheet and involves putting a large mob of animals into a small area for a short time (as little as a few hours), then remove them and letting the area recover (which can take from several months to over a year) before returning the animals again.

Planned grazing has the potential to significantly reduce costs while improving the land's ability to respond to seasonal and climate changes; international and mainland trials show that it can be extremely effective. NRM South is currently trialling the technique in southern Tasmania. For more information on Planned Grazing, please refer to NRM South's Guide to Planned Grazing or contact NRM South directly.

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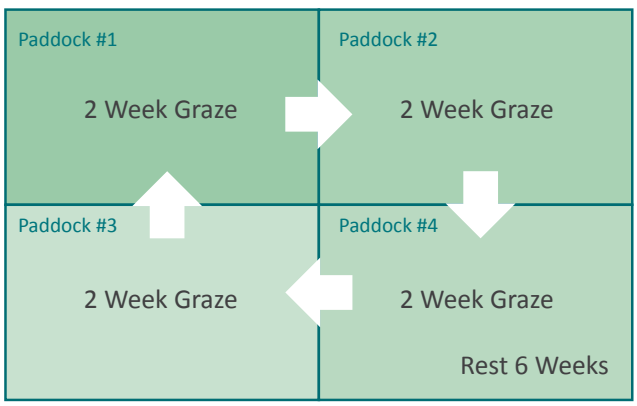
Time Based Rotational Grazing

Meat and livestock Australia recommend a rotation length that is managed so that pastures are grazed at the three leaf stage and when there is adequate pasture quantity to meet livestock requirements for a set period of time.

Time Based Rotations (4 Paddocks)

DURING MODERATE GROWTH



DURING FAST GROWTH (SPRING)

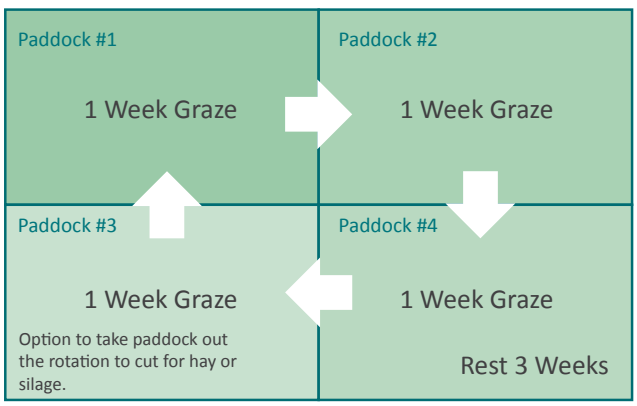


Figure 3: Simple Time Based Rotations (4 paddocks)

SOURCE: *Meat & Livestock Australia*
Tips & Tools, Getting started on a simple time based rotation

PASTURE PESTS

Watch out for pasture pests such as red legged earth mite and lucerne flea which will feed on pasture leaves in the spring and autumn.

Pasture grubs such as black headed cockchafer, red headed cockchafer and corbie grubs will feed on pasture roots and are often detected by bare patches in your pasture in the autumn and winter months. Grubs can be found in the soil of affected pastures.

Pasture pests can be controlled using an integrated pest management approach by applying a range of methods including application of selective sprays (chemical control), cultural control and biological control. Cultural methods can include selecting pest resistant cultivars when re-sowing, not letting pastures grow long in summer as it will be less attractive to corbie moths laying eggs and use of soil cultivation to expose grubs and disrupt their life cycle. Biological control involves the use of natural enemies that prey on pasture pests. Most are naturally occurring so it is important to monitor for beneficial pest insects as well as pest ones. If using chemical controls make sure that you get advice on sprays that will target pests and not affect beneficial insect populations (selective insecticides).

Red legged earth mite damage on clover leaves.

PASTURE WEEDS

Weeds will compete with pasture plants for space, light, water and nutrients and therefore it is important to manage weeds as they can significantly reduce the production and persistence of your pastures.

Some weeds can also be toxic to grazing livestock and therefore should be controlled immediately eg. Ragwort, Foxgloves and Patterson's Curse.

Good grazing management (use of rotational grazing) can be very effective in controlling pasture weeds. Spray grazing is a technique that can be effective for controlling weeds such as cape weed. It involves the application of a low dose of herbicide to bring the sugars into the leaves and make the plant very palatable to stock. This is then followed by heaving stocking to graze out the weeds.

Seek the advice of a local agronomist when deciding on herbicide programs for your pastures.

CARRYING CAPACITY & DSE

SUPPLEMENTARY INFORMATION ON STOCKING RATES FOR PROPERTIES

The term DSE (Dry Sheep Equivalent) is used to describe the amount of feed or dry matter (kg DM) required to maintain a wether or non lactating ewe per day (weighing 45-50 kg).

It is used as a standard to compare between different classes of livestock and to determine stocking rates and carrying capacity of a property. A table comparing the different DSE values attributed to different livestock classes is included in the animal husbandry fact sheet.

One DSE requires 1kg of DM per day to maintain body weight. When expressed in metabolisable energy or megajoules/day one DSE is equivalent to 7.6 MJ/day.

To work out the number of DSE's currently on your property, adapt the following example to your holding:

Holding size is: **25 hectares**
Amount of useable pasture is (exclude infrastructure & bush areas): **21 hectares**


Photo: K Johnson

STOCK ON HAND			
Sheep	**Number**	**Value of DSE**	**Total**
Sheep			
Ewes with Lambs at foot	8	3.3	26.4
Dry Sheep	8	1	8
Cattle			
Rising 2 year old beef steers	14	10	140
Weaned 9 month old beef steers	4	8	32
Horse			
	1	10	10
		Grand Total DSE	**216.4**

Divide the total DSE by the useable area of the holding: 216.4/21 = 10.3 DSE/ha.


Photo: D Blessing

CALCULATING THE CURRENT STOCKING RATE

Another way of calculating the current stocking rate of a property is to divide the average liveweight per hectare by 50.

At certain times of the year when pasture quality or quantity might be limiting supplementary feed maybe required to help you meet livestock feed requirements.

The soil type, fertiliser history and pasture quality all affect the carrying capacity of a property.

EXAMPLE.

10 dry sheep @ 60 kg each in a 2 hectare paddock. The paddock is carrying 10 x 60 = 600kg/(2 hectares) which equates to 300 kg per ha and divide by 50 (DSE value) giving you 6 DSE per hectare.

Working out potential sustainable carrying capacity is complex and neighbours who may have been in the district for a long period may be able to assist with locally relevant advice. Local agronomists can also provide further advice on the DSE rating per hectare for your region to also help you determine your property's most sustainable stocking rate.

ESTIMATING PASTURE GROWTH RATES

The following growth rates are for a typical pasture mix of perennial ryegrass and cocksfoot with white and red clover in the high rainfall areas, grading to sub clover in the lower rainfall areas. The measurements were taken over 4 years (1992–1995) at trial sites.

These figures are the kg DM/ha/day of feed produced at the trial sites. This information can be a guide for the landholder to start from, and the figures highlight seasonal variation in pasture growth. However once again be aware that the figures can only be used as a guide, each property and management regime is different

Estimated daily pasture growth rate (mid-month) of specific pasture types (kg DM/ha/day)

Month	North West – 900mm rainfall (Elliot Research Station)	North Central – 700mm rainfall (Cressy Research Station)	Southern Midlands – 500 mm rainfall (Jericho)	
			Barley grass sub clover pasture with annual fertiliser P&K	Cocksfoot, phalaris and clover with annual fertiliser P&K
January	25	14	0	7
February	9	5	0	1
March	5	2	0	2
April	14	8	3	8
May	9	6	3	7
June	8	7	3	6
July	8	6	3	4
August	7	6	5	6
September	19	31	15	16
October	54	65	45	36
November	51	46	35	47
December	35	22	15	20

SOURCE: *DPIW data, as cited by Making more from Sheep (AWI & MLA)*

ANIMAL HUSBANDRY

Domestic livestock is a term which covers animals traditionally used in farming to produce food and fibre or labour.

Farming pursuits can be carried out either for commercial purposes or by individuals aiming to be as self-sufficient as possible. Traditionally domestic livestock covered a range of animals including sheep, cattle, horses, pigs, poultry and bees, whereas today more exotic animals such as alpacas, fallow deer, camels, ostriches and fish are also farmed.

An animal is considered domesticated when their breeding and living conditions are controlled by people. The result of domesticating animals, or raising livestock for human benefit, is that we then become responsible for the animals welfare.

Photo: A. Renkin

General animal welfare covers:

- Food and water
- Shelter
- Health and wellbeing
- Handling and injury
- Companionship
- Reproduction

The following points are general; this factsheet does not have the capacity to cover all points of care necessary for all animals which may be farmed.

NUTRITION

The Department of Primary Industries, Parks, Water and Environment (DPIPWE) states that the most common problem for small landholders running cattle on their holding is poor nutrition, usually caused by overstocking.

The landholder may see lots of grass in the height of spring or because the property has perhaps been de-stocked for a period of time, and it is easy to overestimate the carrying capacity of the holding. Carrying capacity – often talked about in dry sheep equivalent (DSE), is a tool to help work out the correct number of animals for a given area. One DSE is rated at the amount of feed (kg of dry matter) required for an adult 45 - 50 kg wether or non-lactating ewe to maintain its weight. It is used as a standard to compare between different classes of livestock and to determine stocking rates and carrying capacity of a property. One way calculate your average stocking rate (DSE/ha), divide the average liveweight per hectare by 50.

TABLE 1: HOW MUCH FEED DOES MY STOCK REQUIRE?

This table gives the DSE rating of different livestock. Local agronomists can advise you on the DSE rating per hectare for your region to help you determine your property's stocking rate. At certain times of the year when pasture quality or quantity might be limiting, supplementary feed maybe required to help you meet livestock feed requirements.

CLASSES OF LIVESTOCK	VALUE OF DSE
SHEEP	
Dry sheep: wethers, ewes, hoggets (45kg)	1.0
Merino ewe: Spring lambing	1.5
Merino ewe: autumn lambing	1.8
Ram	2.0
Dairy Cattle	
Cows: milking or double suckling (350kg to 500kg)	14.0 – 16.0
Yearling steer or heifer	6.0 – 7.0
Weaner (3-6 months)	3.0 – 4.0
Beef Cattle	
Dry cow or steer (350kg – 450kg)	8.0 – 10.0
Yearling steer: fattening (250kg – 400kg)	8.0 – 10.0
Yearling steer: store (250kg – 350kg)	5.0 – 7.0
Fattening cattle: 20 to 32 months (350kg – 550kg)	9.0 – 12.0
Cow with calf at foot (up to 8 months)	12.0 – 14.0
Bull (800kg)	14.0
Alpacas (65kg)	
Dry adult	0.9
Deer	
Fallow dry female or castrate	1.5
Fallow breeding female with fawn	2.2
Goats	
Dry Angora	1.0
Breeding Angora	1.5
Dry milk or meat goat	1.5
Milk or meat goat lactating	3.0
Horses	
Pony	8
Large horse	10

FOOD & WATER

Some pastures are more nutritious than others; environmental factors such as annual rainfall, seasonal conditions, soil type and soil fertility as well as pasture composition affect the amount of pasture produced, which directly equates to the number of animals a property can carry.

Photo: A. Renkin

In addition the amount of weeds and fertiliser history of pasture impact on productivity. Farming methods also affects the number of stock which can be carried. Rotational grazing practiced by dairy farmers results in a property carrying more stock because the pasture is rested between grazing rotations, as opposed to properties that are set stocked, where animals are grazing in the same paddock for most of the time. Adequate feed results in less health problems. The best (and cheapest) feed for cattle is good pasture. Most cattle need some supplementary feeding during late winter and, in some areas and seasons, late summer as well. Make sure you buy only good quality hay as many people bale rubbish pasture that stock will not eat.

Clean water needs to be readily available at all times for domestic animals, and understandably in the summer all animals drink more. Water requirements range between animals, sheep may need approximately 2 litres per head per day, horses can drink 40-50 litres a day, while a lactating cow can need up to 100 litres a day.

SHELTER

Animals need access to shade and shelter. For larger livestock this is usually provided by trees, hedges or shelterbelts.

Besides the fact that it is a requirement under the *Animal Welfare Act 1993* to provide shelter for livestock, an animal which does not have shelter, particularly in times of bad weather, will require a much greater food intake to keep warm. Therefore providing shelter also lessens the demand on pasture or hay.

HEALTH & WELLBEING

Most livestock need periodic drenches or vaccines. Common problems are intestinal worms and lice which are treated with drenches, and clostridial diseases which need a prophylactic vaccination.

Clostridial diseases are caused by bacteria and include black leg, black disease, pulpy kidney and tetanus. There are many different products available on the market, so whenever you use a drench, vaccine or other chemicals, always read the label.

It is very important to follow the instructions about dosage rates and withholding periods. These will vary between different products.

Also if you use herbicide or insecticide in a paddock, check the label for information about how long the paddock must be destocked. Many people want to reduce the amount of chemical they use in the environment, but be aware that if you spread poultry manure or compost onto your paddocks, you need to destock the paddock for three weeks.

It is possible for soils to be deficient in minerals necessary for optimal livestock health. An example is copper – coast soils are generally considered to be low in copper. Selenium is another trace element necessary for animals to thrive, and is locally deficient in parts of Tasmania. A local agronomist or vet can provide advice.

Livestock diseases impact on animal welfare, reduce productivity, and can infect humans. Animal diseases may be reduced through good animal husbandry and good nutrition because healthy animals are more resistant to disease.

Worms are a common problem on many small farms and are commonly found in cattle, sheep and goats. Sheep and goats are more susceptible to worms than cattle. Young animals are at higher risk of infection and you should avoid grazing young stock on higher risk pastures e.g. short pastures, set stocked pastures. Rotating pasture grazing to allow for rest periods and rotating grazing between different stock types (e.g. sheep and cattle) can help to reduce worm burdens. A strategic drenching program is also an effective way of managing worms. Worm faecal egg counts can be undertaken by Department of Primary Industries Parks, Water and Environment (DPIPWE) to help you understand what type of worms you might have and the level of infection on your property.

All livestock owners are required by law to report any signs of an emergency animal disease. If you think your animal is showing the signs, please contact your local vet.

HANDLING & INJURY

Using low stress stock handling practices are very important when handling livestock. This will reduce stress on the animal, reduce the risk of injury to you or others and will impact on livestock temperament and performance.

Low stress stock handling training courses are offered by some training providers. Techniques such as yard weaning, feeding stock in the yard and having well designed handling facilities / yards will have an impact on your livestock's temperament and ease of handling. Poor temperament is a hereditary trait and therefore it may not be best to breed from poor tempered animals.

Specialised facilities are required for a number of domestic livestock. Most sheep, alpacas and some goats require a shed or at least yards for shearing, crutching and drenching. A cattle crush or headbail in cattle yards is essential for most handling of cattle, for example drenching.

Paddocks provided for stock need to have good fences to protect both the animals and the general public. If livestock stray onto a road and are hit by a car, the owner of the livestock is legally responsible. Public liability insurance is essential.

For the safety of livestock the fences must not have loose wire where the animals can get caught or cut themselves. All but minor injuries need to be attended to by a vet, as soon as possible.

Be aware that the male of the species can become territorial, dominant or aggressive. This is partly due to inherited genes which encourage the male to protect "his flock" but aggression can also come about through familiarity and lack of respect for people. It is best to handle males which you intend to keep for a long time with respect, demand respect in return, and don't become too familiar with them. You are actually helping the male animal establish a "correct code of conduct".

Times of bad weather, will require a much greater food intake to keep warm. Therefore providing shelter also lessens the demand on pasture or hay.

COMPANIONSHIP

Most domestic animals are also herd animals, and are much happier with others of their own kind for companionship.

Photo: A. Renkin

REPRODUCTION

Breeding animals whether they are sheep, cattle, horses, pigs or goats have special needs, so consider carefully before planning a breeding program.
A pregnant female requires a rising plane of nutrition as her pregnancy progresses.

In the case of sheep, if the female doesn't have enough nutrition in the last 4-6 weeks before lambing she is at risk of pregnancy toxaemia (also called twin lamb disease).

The name twin lamb disease is explicit because if the ewe is going to have twins or triplets, her nutritional requirements are greater than a ewe carrying a single lamb. Ewes will die from pregnancy toxaemia.

There are also particular risks for cows associated with the quality of feed available; grass tetany and milk fever can cause death, and these conditions relate to a lack of calcium (milk fever) or magnesium (grass tetany) in the pasture. Difficult births do occur, and may need vet assistance. A basic rule of thumb to help decide if a sheep or cow is having difficulty giving birth, is not to let more than 4 hours elapse from the time the water bag or feet of the foetus are showing until the lamb/calf is born. If it takes longer the unborn lamb/calf will be in distress and it is time for immediate vet assistance. For cattle, a cattle crush will be needed to restrain the cow to prevent disease.

SPECIFIC ANIMAL TREATMENTS

SHEEP & GOATS

Sheep and goats have some very similar animal husbandry needs, and they are often considered easier than cattle to handle because they are smaller. However they do require specific facilities for handling.

Unless the sheep is a shedding sheep breed such as Dorper or Wiltshire, it will need to be shorn once a year, and Angora goats need shearing twice per year. At least on one other occasion during the year both breeds will need to be crutched, which means removing the wool from around the face and rear end. They need to be drenched for internal parasites, so yards and a holding race are essential, and a working dog may be needed to get the sheep into the yards, because sheep quickly learn that the yards are like the dentist chair to most of us!

If carrying lice, sheep and goats will need treatment, usually after shearing, and in the summer the owner needs to keep a close watch for fly strike, particularly in unshorn sheep. Fly strike will kill animals, slowly and very painfully.

Flies generally strike in humid weather, often around a dirty tail or pizzle, so if an animal is seen kicking or biting at a part of its body, closer inspection is urgent. It is possible to use preventative measures against fly strike, again facilities for handling are necessary. Sheep and goats need hoof paring (trimming) to assist good foot health. The bacteria that causes scald and footrot is spread by infected sheep or goats, the condition is painful to the animal and can be quite debilitating. Some breeds are more resistant than others but purchasing clean stock will avoid the problem.

Johnes disease is becoming a major issue in Tasmania and purchasing vaccinated stock from reputable breeders is advisable. Both sheep and goats are herd animals, and are much happier in company. Fences need to be especially good to keep goats at home.

ALPACAS

These social animals like to be kept in flocks, and require shearing once a year.

They do not produce lanolin in the fleece like sheep, so in Tasmania alpacas require protection from cold, wet conditions when their fleece is waterlogged. They drink around five litres of water a day, and need routine toenail trimming and their teeth should be periodically checked. Alpacas are susceptible to clostridial diseases such as tetanus and pulpy kidney, and are also vulnerable to Rye grass staggers, Vitamin D and Selenium deficiencies, and Johne's Disease.

PIGS

Pigs can live up to 25 years, and need a clean shed to shelter from the weather, in particular the sun, because pigs suffer from sunburn. They also need clean water at all times.

All pigs over 10 weeks of age must have a tattoo which is registered to the property, and is obtained from DPIPWE. Pigs also require a number of vaccinations against diseases such as parvo, leptospirosis and erysipelas. In Australia it is illegal to feed pigs swill – food waste containing meat, bone or meat products or some dairy products such as soft cheeses because swill feeding can potentially lead to Foot and Mouth disease or Swine fever. As with poultry feed, most pig feeds contain Restricted Animal Material or RAM. If you are planning to purchase pigs, contact your local council first to check if you need any approvals.

It is most important that ruminants such as cattle, sheep, alpacas, deer or goats cannot access pig feed.

HORSES

Horses are an expensive undertaking because they require specific gear and regular care, often supplementary feeding, and possibly farrier and vet fees.

Although temperament varies between different animals, overall horses can be more excitable than other domestic livestock and seem to be more accident prone. Horses require dental checks as they age, because their teeth are continually growing and over time chewing will wear sharp edges on molars. They also need periodic drenches for intestinal worms, and their hooves will need trimming, or shoeing if the horse is in regular work. The condition of horses needs to be monitored because serious animal health problems will arise if they get too fat, or too thin. As previously mentioned they also need access to good water always because they can drink a lot in summer particularly after strenuous exercise. Shade and shelter from the elements needs to be accessible, and be aware that horses are very selective grazers, the pasture in a paddock set stocked with only horses will degrade over time. Resting paddocks and putting sheep in the paddock with the horses will keep pasture in a better condition.

POULTRY

Photo:
T. Ackroyd

External and internal parasites can be a problem for free range birds, and poultry does need to be protected from predation from dogs, feral cats and spotted-tailed quolls.

DPIPWE has a design for a "quoll proof hen-house" on their website. Poultry need access to clean water at all times and be aware when feeding chickens that they can eat products which are illegal to supply to cattle, sheep and goats. Processed poultry feed usually contains Restricted Animal Material (RAM) which is illegal to feed to ruminants (cattle, sheep and goats). The feed bag should state if it contains RAM, also, if you feed your poultry kitchen scraps containing even small amounts of meat or bone, make sure that ruminant animals cannot share these scraps. If you sell or give away eggs, there are hygiene and labelling standards set under the *Tasmanian Food Act 2003.*

NATIONAL LIVESTOCK IDENTIFICATION SCHEME

The National Livestock Identification System (NLIS) was established to facilitate the rapid tracing of animals if there was a major disease outbreak.

Each animal has a device attached to the ear which can be read or scanned. It is a permanent, whole-of-life identification system that enables individual cattle to be tracked from property of birth to slaughter. Before ordering NLIS devices, you need a Property Identification Code (PIC). The PIC will be recorded on each animals ear tag. Whilst NLIS provides the facility for cattle to be electronically identified at the time of transaction, in saleyards and at the time of slaughter (a unique number for each animal), sheep and goats are identified with non-electronic tags which include the PIC. Cattle movements between properties are also logged on the secure central NLIS database.

DUTY OF CARE

"Under the Animal Welfare Act, persons who have the care or charge of animals have a legal "duty of care" for the welfare of those animals, and must take all reasonable measures to ensure their welfare."

Animal Welfare Guidelines-Sheep, DPIW, 2008.

Source: http://dpipwe.tas.gov.au/biosecurity/animal-biosecurity/animal-welfare/legislation-standards-guidelines/animal-welfare-act

The Duty of Care is yours - you must take it seriously! If you have animals, own animals or look after animals, you are responsible for their welfare. This applies whether your animals are pets or livestock.

You may be deemed to have the care or charge of an animal if you are:

- The animal's owner
- A person with control, possession or custody of the animal
- An operator or manager of commercial premises involving the animal
- A share farmer
- A chief executive officer or a director of a company that owns the animal

Employers are liable for the actions, or inactions, of their employees in relation to the welfare of an animal.

NEGLECT IS CRUELTY

There is a legal requirement that animals unable to provide for themselves must be given appropriate and sufficient food, water, shelter and exercise.

It is most important, not just for the hobby farmers themselves but also for everyone else in the community, that all hobby farmers take their biosecurity and animal welfare responsibilities seriously. Biosecurity is the protection of industries, the environment and public well-being, health, amenity and safety from the negative impacts of pests, diseases and weeds.

WELFARE GUIDELINES

Photo: A. Renkin

Animal welfare guidelines published in accordance with the *Animal Welfare Act 1993* are available for sheep, cattle, horses, pigs, alpacas and poultry at FarmPoint.

The other side of the animal welfare issue is that ALL farmers will warn newcomers to animal husbandry that "If you have livestock, you have deadstock". Some stock losses, even with the best care, are unavoidable.

This section has provided information about some of the pitfalls and responsibilities of animal husbandry, but essentially the advice is care for them, have fun and enjoy them.

Canary broom Genista monspessulana

Photo: C. Strain

WEED MANAGEMENT

Australia's National Weed Strategy defines weeds as a plant that requires some form of action to reduce it's harmful effects on;

1. The economy
2. The environment
3. Human health and amenity

A weed is a plant growing in the wrong place. Tasmania contains some of the most productive agricultural land in Australia; the climate, soils and rainfall are good for growth and the weeds benefit from these conditions too.

We want to protect our agricultural industries and the environment, by keeping weeds to a minimum.

"Weeds reduce farm and forest productivity, displace native species and contribute to land degradation. The cost of weeds to agricultural industries is estimated at about $4 billion a year. The cost of weeds to the environment is difficult to calculate but could be greater than the estimated cost to agricultural industries"

- Department of Agriculture, Fisheries and Forestry

There are different types of weeds:

DECLARED listed under the *Tasmanian Weed Management Act 1999*, these weeds MUST be controlled under the law.

AGRICULTURAL invades crops and pasture and costs money, time and control measures can impact on the natural environment.

ENVIRONMENTAL often garden plants which escape and multiply in the natural environment and out compete native plants.

Currently there are approximately 115 weeds declared under the *Weed Management Act 1999* in Tasmania. Particular plants become listed as declared weeds because of the level of threat they present.

There are a number of declared weeds that are widespread and common in the region / state such as gorse, brooms, blackberry, Spanish heath, and willows. Control measures for these weeds should be implemented to ensure that further spread in the state / region is prevented and their impacts on the environment and Tasmania's agriculture are reduced.

These are listed on the Department of Primary Industries Parks Water and Environment (DPIPWE) website.

It is important to be able to recognise different weeds and the DPIPWE website is very helpful with many photos.

The declared weeds which create our biggest problems in Southern Tasmania include:

- gorse *Ulex europaeus*
- ragwort *Senecio jacobaea*
- pampas *Cortaderia* spp.
- blackberry *Rubus fruticosus agg.*
- broom *Genista monspessulana* and *Cytisus scoparius*
- spanish heath *Erica lusitanica*
- californian thistle *Cirsium vulgare*
- willows *Salix* spp.
- african boxthorn *Lycium ferocissimum*
- boneseed *Chrysanthemoides monilifera*
- St John's Wort *Hypericum perforatum*'

Like all plants, different weeds have particular preferences for habitat. For example amongst the declared weeds you will mainly find Boneseed, African boxthorn and Asparagus species near the coast.

A weed management plan (WMP) has been written for all Tasmanian declared weeds. The WMP will state according to each municipality whether a particular declared weed is widespread or isolated in occurrence, and therefore if the goal is eradication or control.

Environmental Weeds

Environmental weeds are often common garden plants and usually spread by birds or garden waste dumped inappropriately. Coastal properties and bush areas can be particularly vulnerable to environmental weeds such as:

- asparagus fern (also declared)
- cotoneaster
- fuchsia
- agapanthus
- holly
- ivy
- mirror bush
- foxglove
- sweet pittosporum
- perriwinkle

Gorse *Ulex europaeus*
Photo: N. Crane

weed control

When controlling weeds a big decision is what method to employ, and the options include mechanical, chemical, biological or manual removal. By far the best outcome though is covered by the saying "prevention is better than cure" so good hygiene is very important. Ensure contractors only bring clean machinery onto your property because "one year's seeds makes seven years of weeds".

Weed Spread

Weeds spread in the environment as plant material or through seed dispersal. Plant material might be dumped garden waste, whereas seeds are naturally dispersed by:

- animals and birds
- wind and water
- soil movement
- seed pod actions

Unintentional spread of weeds occurs with:

- topsoil on machinery moved from one area to another;
- gravel and quarried materials contaminated with seed such as gorse and broom;
- soil on peoples' boots;
- along roadsides where vehicles produce air currents which move wind blown seed;
- hay making machinery or hay bales moved from one area to another;
- fodder, grain or birdseed.

Agricultural Weeds

Some agricultural weeds are also declared weeds, such as ragwort and californian thistle. Other agricultural weeds, for example, wild radish and capeweed, are not declared but can be costly to control, and in many cases are toxic to stock. These include:

- spear thistle
- capeweed
- wild radish
- dock
- cumbungi
- *Glyceria maxima (Poa aquatia)* reed sweetgrass

PLANNING WEED CONTROL

When planning weed control consider:

- Which method or combination of methods – mechanical, chemical, biological or manual
- Mechanical control may result in weed heaps which need to be burnt, therefore the placement of the heaps needs to be thought out, and whether a fire permit will be necessary
- Special precautions if using chemicals in waterways
- Estimate a patch size that you can manage to control, and only take on an area where you know you can carry out **follow up** work. A lot of time, effort and money is wasted in weed control by not being able to **follow up**
- Making your plan site specific
- New weed incursions which may result from drought, fire, flood, contaminated vehicles and farm equipment, imported feed and other materials
- Practicing strict bio-security measures and designating specific vehicle and equipment wash-down areas, monitor for new weed incursions, for example in new feed out areas for livestock
- Start with smaller, outlier patches and work into the largest patch
- Time of year is critical for successful weed management, herbicide treatment should only be employed on actively growing plants before they flower and set seed
- The mantra for effective weed control is **follow up follow up follow up**
- All plants are like us and need a space to live. Weeds are often plants which rapidly colonise bare ground and out compete other plants. When planning weed management, don't leave bare ground for more weeds to re-colonise. The timing for re-planting with beneficial plants is critical though, not too soon in case soil stored seed germinates, but before other weeds take over the bare ground.

HEAVY MACHINERY

Heavy machinery such as an excavator or dozer can be used for raking up dense woody weed infestations, for example gorse, or removing willows from rivers and streams in conjunction with the cut stump and paint method.

A mulching machine or meri-crusher attached to a tractor is another method of gorse control which mulches the gorse material.

Heavy machinery can be a good, initial option if weed infestations such as gorse or broom are large and dense. However, mechanical control creates soil disturbance, so landholders need to be aware that after the initial control, a mass germination will occur from soil stored seed, and the mantra **follow up** control, is imperative.

An excavator can also be used for the removal of riparian and aquatic weeds *Glyceria maxima (Poa aquatia)* and cumbungi *Typha* spp. The benefits of mechanical control mean that less chemical is being applied, particularly if the target weeds occur in a waterway. However the machine operator needs to be very careful not to alter the structure of the waterway. Also consider that the excavated material (gorse or Glyceria or willows) still needs to be disposed of, which may require burning the heap.

Mulching machine at work on a dense gorse infestation

Photo: N. Crane

Mass germination of soil stored seed after gorse removal

Photo: A. Fergusson

MANUAL REMOVAL

The Bradley method was pioneered by two sisters in Sydney who wanted to remove weeds from bush areas.

The method revolves around minimal disturbance, hand weeding if possible, and allowing native vegetation to re-establish naturally. Importantly start with the outliers, small isolated patches and work into the thickest patch of weeds. Also don't clear large patches of weeds at one time which results in bare ground and weeds recolonising; give natives a chance to germinate and establish ground cover before removing the next patch of weeds.

Hand pulling can be very successful as long as it is followed up. Other manual removal methods are: cut and paint method where the stem or trunk of the weed (gorse for example, is cut with a saw and then Glyphosate is applied to the cut stump, within 30 seconds of cutting). This method results in much less chemical in the environment, the chemical is not applied with a sprayer so is safer for the operator and results in targeted application. The cut material will still need to be disposed of appropriately.

Controlling weeds in or near waterways is especially challenging. By law a person must not apply chemicals within 0.5 km up-stream of potable water intake in flowing water (a river or stream), or within 0.5 km of a potable water intake in a standing body of water such as a lake, pond or reservoir. Roundup Bioactive® or Weedmaster 360® without added surfactants are the only safe option for infestations near waterways (these are the only herbicides registered for use near waterways).

Remember to correctly identify your target weed. There are several native plants which are similar to some target weeds such as:

gorse *Ulex europaeus* - native gorse *Daviesia ulicifolia*

spanish heath *Erica lusitanica* - common heath *Epacris impressa*

cumbungi *Typha* spp. - 2 species are introduced, 1 species is native

Currant bush *Coprosma quadrifida* - spiny and may look a worry, but is a native and produces berries for native birds

Ragwort and blackberry

Photo: D. Lucas

BIOLOGICAL

A number of different biological control agents are used in Tasmania. For example, the gorse spider mite lives in colonies on the host, covered by a web and feeds on the gorse plant. Often biological control weakens the host, or interferes with the fertility of the plant, but may not kill the host.

CHEMICAL

We would all like to use fewer chemicals in the environment, but sometimes the careful use of chemicals can result in less physical disturbance to a site.

Spraying in a sensitive area an operator is using correct personal protective equipment as well as a dye in the spray
Photo: J. Cooper

In a particular situation it may be possible to use the cut and paint method, or drill and fill which are very target specific applications, rather than spraying which has the potential to harm non-target plants. The most important message for chemical use is to READ THE LABEL, and mix only at the rates as directed. Use the correct chemical for the task and please consider your own safety and biodiversity. It is possible to look at chemical labels and Material Safety Data Sheets (MSDS) on line before purchasing chemicals, and guidelines are also given on DPIPWE weed website under the chemical control link for specific weeds.

ChemCert courses are run periodically in all states; these courses are accredited and cover safe chemical handling and use. For more information visit their website: **www.chemcert.com.au**. Wearing the correct protective equipment is essential, and can include gloves, face mask, long sleeved shirt and trousers as a minimum.

Californian thistle and hemlock
Photo: A. Hughes

INVASIVE SPECIES

The Australian Pest Animal Strategy identified that 11 of Australia's major invasive animal species "are conservatively estimated to have impacts valued at over $720 million annually".

Invasive species are one of the biggest threats to biodiversity and agriculture in Tasmania. They have the potential to harm not only our environment but also our economy, lifestyle and even human health. Invasive species currently cost the state millions of dollars each year in lost production and management costs, and have far reaching impacts across all sectors of the community.

Currently Tasmania is free from many invasive species that, on mainland Australia, damage crops, spread disease, threaten the survival of native animals and disturb ecosystems. Without community action, the situation in Tasmania could change rapidly and we need to be vigilant and prepared to rapidly respond to the threat posed by new and emerging invasive species. We also need to work together to manage the impacts of invasive species already established in Tasmania.

Feral Cat
Photo: D. Marshall
Courtesy of Invasive Animals CRC

The number of naturalised species that become pests (those species that pose a threat to human health, primary production and/or the natural environment) and environmental pests (those pests that specifically impact on environmental values) in Tasmania, 2001 is shown in Table 1 on page 2. *The State of the Environment Report* notes that "Not all naturalised species become pests and not all pests become environmental pests."

TABLE 1: EXAMPLES OF THE IMPACT OF SOME OF THE MAJOR & POTENTIAL INVASIVE SPECIES IN TASMANIA

The table below gives examples of the impact of some of the major & potential invasive species in Tasmania

INVASIVE SPECIES	ENVIRONMENTAL /ECONOMIC IMPACTS
LAND	
European Red Fox	Predation of native mammals and ground nesting birds. Many marsupials are already extinct due to fox predation on mainland Australia. The economic losses of livestock from fox attacks could equate as a much as $20 million per annum in Tasmania's sheep industry alone (wool and slaughter). Foxes are a major contributor to Australia's world highest extinction rate.
Feral Cat	Prey upon native mammals, birds, reptiles (particularly skinks), frogs, fish and invertebrates. Economic losses of livestock through disease.

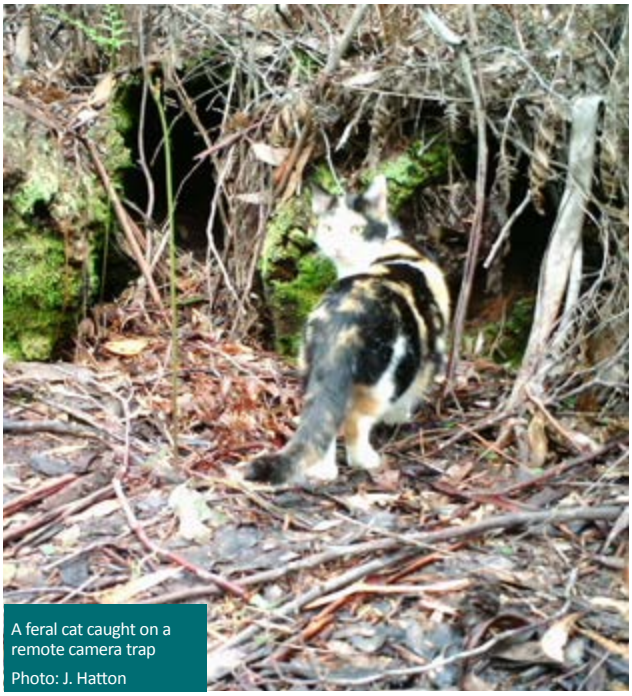
INVASIVE SPECIES	ENVIRONMENTAL /ECONOMIC IMPACTS
	LAND
Rat	Prey upon native birds, reptiles (e.g. skinks) and invertebrates. They have the potential to introduce disease. They have particularly devastating impacts on smaller sea bird populations (e.g. fairy prions and diving petrels) as they predate on the eggs, babies and adults.
Ferret	Ferrets are very successful predators. They prey on for example ground nesting and burrowing birds and native mammals. They also have the potential to introduce disease.
European Rabbit	Over-grazing, changes to vegetation structure, habitat losses to flora and fauna, soil erosion from burrows.
European Starling	Occupy and degrade nesting hollows needed for breeding of native birds, such as the already threatened orange-bellied parrot.
European Wasp	Prey upon many native invertebrates with as yet unstudied consequences.
	INLAND WATERS
European Carp	They destroy fragile water plants, destablise banks resulting in habitat loss for native fish and trout. Do not predate on native fish. However, they predate on invertebrates, thus competing with native fish for food.
Goldfish	Do not predate on native fish. However, they predate on invertebrates, thus competing with native fish for food.
Eastern Gambusia	The eastern Gambusia is listed as a controlled fish under the *Inland Fisheries Act 1995*. They out compete native fish especially in degraded systems and attack small native fish.
Mainland Yabby	They impact native habitats as they destroy aquatic vegetation, destablise banks resulting in habitat loss for native fish and troutand have the potential to introduce disease. Due to their burrowing nature they also damage farm dams, which may cause leakage problems.
Freshwater turtles	Tasmania has no native freshwater turtles and any freshwater turtle spotted in Tasmania is an invasive species. It is also illegal to import or keep turtles as pets in Tasmania and severe penalties apply. DPIPWE's Wildlife Management Branch has responsibility for managing the response to sightings of freshwater turtles in the wild in Tasmania.
Didymo	Didymo, also called rock snot, is a freshwater algae that is widespread in the Northern Hemisphere and New Zealand. Although not currently in Australia, it is highly invasive and is considered a significant risk. Didymo poses a significant threat to Tasmania because of the potential transfer from NZ via contaminated fishing and boating equipment.

SOURCE: *State of the Environment Tasmania (2003), Animals Pests*

CATS *FELIS CATUS*

Cats are known to prey on at least 50 Tasmanian species including 15 threatened species. The cat competes directly with native carnivores and impacts on wildlife through predation, competition and the spread of diseases such as Toxoplasmosis. Toxoplasmosis can be transmitted to humans and other mammals; it kills native animals and can cause abortions in sheep and goats.

It is believed that the population is rising in response to the decline in population of the Tasmanian devil through the Facial Tumour Disease. New legislation came into effect on July 1st 2012 which permits only registered breeders to breed cats. "Cats sold or given away must be more than eight weeks old, desexed and microchipped."



A feral cat caught on a remote camera trap
Photo: J. Hatton

CATS *FELIS CATUS (CONT)*

The Cat Management Act 2009 came into effect of 1 July 2012 to helps landowners better manage the impacts of feral cats and regulate breeding of domestic cats. The Act provides statutory powers for primary producers, land owners and land managers to trap, seize or humanely destroy stray and feral cats in certain circumstances. Councils can also declare cat management or prohibited areas in their municipality after a public notification process.

It is important that the domestic cat population does not provide a source of recruitment for the feral cat population and, with responsible pet ownership, this can be achieved. Microchipping and desexing domestic cats not only helps prevent unwanted kittens from becoming feral cats but also has important animal welfare benefits. Desexed cats are less likely to wander and be injured in traffic or fights; microchipping a cat allows more rapid return to the owner if a cat has wandered (reducing the stress on cat and owner alike). Cat owners can further assist in reducing the environmental impact of their cats by confining them to their properties, particularly if they live near bushland.

Further details about cat management can be found on the invasive species section of Department of Primary Industries, Parks, Water and Environment website or by contacting your local council.

Factsheets Courtesy of Department of Primary Industries, Parks, Water and the Environment

EUROPEAN RABBIT *ORYCTOLAGUS CUNICULUS*

With the ability for a pair of rabbits to produce 30-40 offspring in a year, the population of rabbits can increase rapidly when conditions are right.

On farms they compete with livestock for pasture (8 rabbits can eat the equivalent pasture of 1 sheep), impact on native vegetation and can change the composition of the vegetation communities. At high levels they can eat the grass down to bare soil, leaving it open to erosion and weed infestation.

High population levels also result in a rise in predator numbers which allows populations of species such as the feral cat to increase with a flow on effect on wildlife from higher predation levels and spread of disease.

Control measures for rabbits should aim to reduce the resident population by more than 90% otherwise, with the rabbits breeding rate, the population will return to pre-control levels within one breeding season. Usually several methods are required to make an impact on the population. Where rabbit numbers are excessive and causing significant impacts, DPIPWE can advise landowners on management options.

EUROPEAN STARLING *STURNUS VULGARIS*

European Starling

Photo: B. Lukins Courtesy of Invasive Animals CRC

Released in the 1880s to control insect pests eating European and pasture plants, the European starling is now so common in Tasmania it is hardly noticed any more.

It will compete with native birds for food, will destroy habitat and competes with native hollow dependent fauna for nest sites. It is known to "directly impact on Orange-bellied Parrots by using tree-hollow nest sites and by killing incubating females at nest" (*State of the Environment Tasmania 2009*). Starlings build nests in a wide range of sites including roof spaces, protected areas in wood piles, old guttering and pipes, hollows in trees as well as nesting boxes put up for native fauna.

MAINLAND YABBY *CHERAX DESTRUCTOR*

Hardy and quick maturing, the Mainland Yabby will start breeding from 6 months of age (compared to 14 years for female Giant Freshwater Lobster) and can spawn 2-4 times a year (every 2 years for giant freshwater lobster).

Tolerant of higher temperatures and able to burrow to survive drought, this species will outcompete native species, displacing endangered burrowing crayfish, reducing water quality, encouraging algae blooms, eroding stream banks and damaging dam walls. It may also carry diseases and parasites to which our native species have no resistance. Mainly found in farm dams at present, the Inland Fisheries Service needs community support to eradicate this species before it invades all our natural waterways.well as nesting boxes put up for native fauna, are used by these birds.

FERRET *MUSTELA FURO (POLECAT)*

The Ferret is another species to be alert for - a few small populations are known in Tasmania. It is a ferocious hunter of anything small enough to tackle (small ground-dwelling birds, reptiles, amphibians, mammals and invertebrates).

EUROPEAN RED FOX *VULPES VULPES*

Tasmania has a long history of fox introductions, with foxes being introduced for recreational hunting in the 1800s.

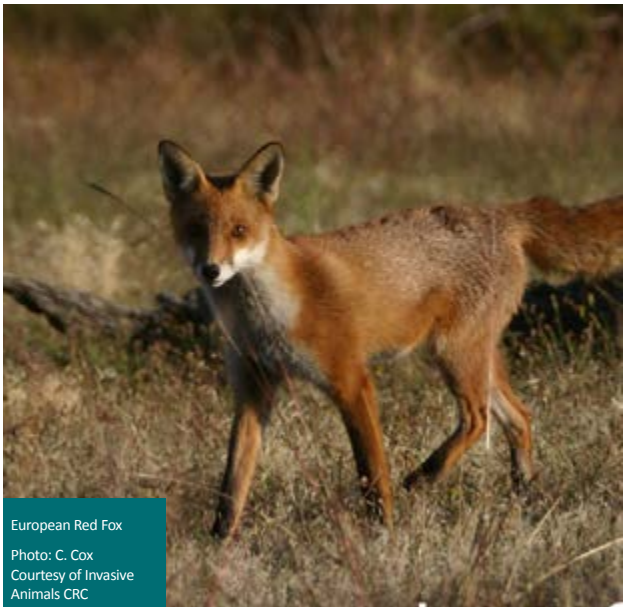
More recently, a range of evidence indicating fox activity in Tasmania triggered the start of an eradication effort aimed at ensuring that foxes were not able to establish in the state.

As at July 2014, no evidence of fox activity has been collected in Tasmania since July 2011, which is a positive sign that establishment has been prevented.

However, the presence of large numbers of foxes on mainland Australia means that the threat from fox incursions remains. Ongoing vigilance for fox activity is needed to ensure Tasmania does not risk suffering the same impacts from foxes as mainland states.

Foxes are a significant factor in the decline and extinction of many small and medium-sized mammal species in Australia. They also prey on many bird species. 78 species of native vertebrates (birds, mammals, frogs and reptiles) would potentially be impacted in Tasmania, not to mention the impact foxes would have on farming and the economy. Foxes may also compete with Tasmania's native carnivores and occupy niches usually held by quolls or the Tasmanian Devil.

Biosecurity Tasmania monitors for foxes in Tasmania through a strategic vertebrate pest monitoring program that searches for evidence of threats using a variety of measures, including scat (animal poo) collection surveys with the use of scat detector dogs.



European Red Fox

Photo: C. Cox
Courtesy of Invasive Animals CRC

It is important that all members of the public are vigilant and report fox sightings or any possible evidence of fox activity to DPIPWE's Invasive Species Branch.

INTRODUCED WASPS

VESPULA GERMANICA (EUROPEAN WASP)
VESPULA VULGARIS (ENGLISH COMMON WASP, YELLOW JACKET)

Accidental introduction, probably of hibernating queens to Tasmania in 1959 for the European Wasp and 1995 for the English Wasp.

These species can cause major economic losses in vineyards and orchards, and will also actively hunt invertebrates. They are thought to be implicated in the decline of the Ptunnara Brown Butterfly found in native grasslands. They are known to rob beehives, kill bees and fledgling birds, and will compete with native birds and bees for nectar. With a painful sting, which can cause allergic reactions in some, the wasps can deter people from enjoying outdoor activities where they are at high densities.

Factsheets Courtesy of Invasive Animals CRC

NATIVE PESTS

MACROPUS RUFOGRISEUS RUFOGRISEUS - BENNETTS WALLABY

THYLOGALE BILLARDIERII - PADEMELON

TRICHOSURUS VULPECULA FULIGINOSUS - BRUSHTAIL POSSUM

The Pademelon and Bennetts Wallaby (and Brushtail Possum in some areas) are abundant in Tasmania and their numbers and distribution have expanded over the past 30 years.

Land clearance in conjunction with improved pastures and water supply, along with reduced hunting pressure, have provided ideal conditions for increasing populations of these species.

Land clearance has resulted in a mosaic of pastures and remnant bushland which has provided ideal habitat enabling wallabies to feed at night on improved pasture and retreat to adjacent bushland to shelter by day. Studies have shown an average of 65% of pasture production is lost from rested paddocks near bushland (and within 20 metres of bush, up to 90% of pasture production can be lost) to wildlife browsing. If the landholder believes that there is a problem with wildlife browsing, this can be quantified by measuring pasture loss using exclusion cages as outlined in the Measuring Pasture Loss to Browsing Animals sheet (See References). If the losses are confirmed there are a few options to reduce the problem.

Wallaby-proof fencing has been shown to be one of the most successful methods to control browsing, however this is expensive and should

Bennetts Wallaby

be planned in conjunction with neighbouring properties so that the problem isn't merely shifted or populations isolated. Reducing the population before fencing remnant bush can avoid high-density wallaby populations impacting on the understory

A permit is required to "take" (which covers to kill, injure, catch, damage, destroy or collect) wallabies and Brushtail Possums, which are classified as "Partly Protected Wildlife" under the Wildlife Regulations 1999 of the *Nature Conservation Act 2002*. Game Management Services Unit (See References) will assist in developing a Property-based wildlife Management Plan with control options which include using wallaby proof fencing as a control measure.

HEALTHY WATERWAYS

BENEFITS OF HEALTHY WATERWAYS ON YOUR PROPERTY

Healthy waterways support a healthy environment and are vital for our social and economic wellbeing. They play a key role in agriculture, industry and recreation and provide essential habitat for wildlife including many rare and threatened species.

The land that immediately surrounds waterways is some of the most productive fertile land we have and is known as riparian land. Riparian land is described as the part of the landscape adjoining rivers and streams that has a direct influence on the water and aquatic ecosystems within them ,so it is important to manage this land sensitively, as down stream effects impact on both production and biodiversity". It includes the stream banks and a strip of land of variable width along the banks.

The benefits of riparian vegetation in good condition include:

Biodiversity

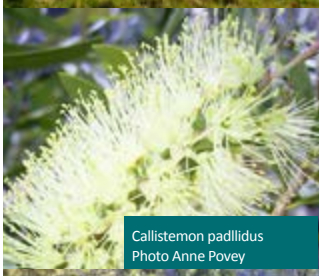
- Landscape refuge for native flora and fauna
- Corridors for wildlife to move through the landscape
- Habitat for rare and threatened species
- Contributes to water availability and nutrients cycling on a property and landscape scale
- Healthy aquatic life including fish: riparian vegetation creates shade therefore regulating water temperature and sheds timber into waterways that is used by fish for shelter, feeding and spawning

Productivity

- Water resources used in agriculture and industry
- Stock management and shelter: riparian vegetation creates shade and acts as a wind break
- Supports biological agents, such as predatory species that control pests of crops and pasture
- Increase in capital values
- Opportunities for diversification such as ecotourism, fishing tours, amenity for accommodation

Soil and water conservation

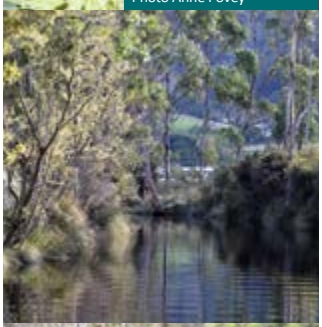
- Reduces erosion and retains sediment by physically slowing water and wind movement
- Maintains river courses: stabilises soil surfaces through the action of roots, organic matter and increased infiltration
- Lowers the water table through root action reducing water logging and salinity
- FIlters pollutants from surface water flows: ground cover plants and the litter layer help filter out pollutants before they reach the waterways



Callistemon padllidus
Photo Anne Povey

Aesthetics and well being

- Provide a connection to place
- Support recreation (bird-watching, bush walking, fishing)
- Provide landscape values
- Preserving original landscape
- "Spiritual, therapeutic effect"



CHARACTERISTICS OF RIVERS

The characteristics in the following table are based on a river* typically found in the mid to upper reaches of a catchment, immediately downstream of a mountainous area or hilly bedrock dominated headwater. This type of river is classified as a 'partially confined' river under the River Styles Framework and is commonly found in Tasmania's Huon Valley.

The characteristics of rivers will vary among different river 'styles' depending on where they are situated in the landscape. This will have a direct bearing on their short to long term management. Clearly a mountain river tumbling though a narrow bedrock valley is different to a slow-flowing, meandering river on a flat plain.

Partially confined rivers as the name suggests are able to move to some limited extent within their valley setting compared to the headwaters of a catchment where movement of the channel is restricted by the existing bedrock.

* The generic term "river" is used here to include all watercourses e.g. steams, gullies etc.

Figure: The River Styles Framework has been developed by Macquarie University to classify the character and behaviour of different river systems.

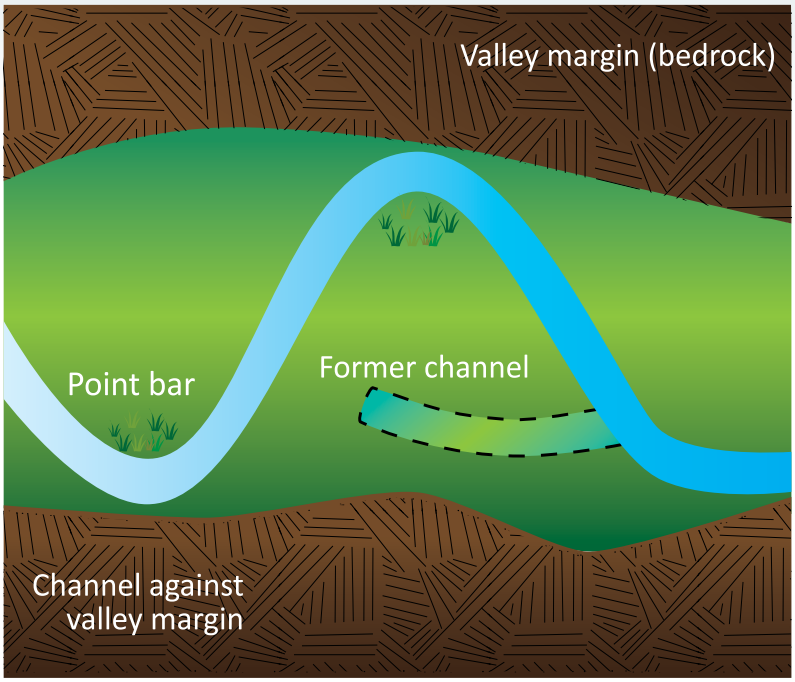
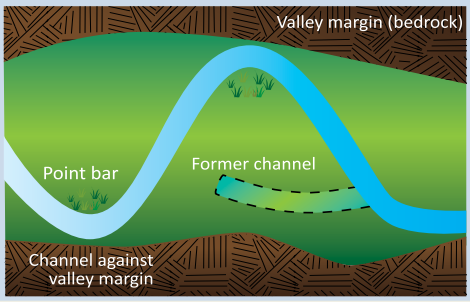


Illustration of a partially confined river

Examples of partially confined River Styles are common in the Huon Valley.

CHARACTERISTICS OF A OF A TYPICAL RIVER IN TASMANIA'S HUON VALLEY - MID TO UPPER CATCHMENTS

CHARACTERISTIC	GOOD CONDITION	POOR CONDITION
Shape of the channel zone 'Partially Confined' river style	A single meandering asymmetric channel with 10% to 50% of the channel against the valley margin. Channel has pools, riffles, point bars (sediment bar on inside bend) and benches (abandoned floodplain). Behaviour: In wider reaches, bends migrate down-stream. Phases of bed lowering are normal. 	Partially Confined rivers in poor condition exhibit straightened channels. Behaviour: Accelerated bed and bank erosion giving rise to channel expansion. Sudden changes in channel position (avulsions).
Floodplain 'Partially Confined' river style	Irregular floodplain surfaces. Presence of former sections of curved channel. Sections of bend cut off when new, shorter channels short cut during high energy floods) Sections of remnant floodplain no longer connected to the river. Some naturally formed ridges (levees)	Short cutting of bends. Lateral movement of the channel that erodes the floodplain. Localised scouring of surface material from the floodplain (floodplain stripping).
Large Woody Debris	Plenty of large wood debris, including large logs, occupy over 10% of the cross section of the river bed. Large woody debris helps trap sediment & helps to "lock" the bed of the river together, which means it plays a key role in erosion control. It also provides habitat and food for aquatic life. 	A river that has been cleared of large woody debris (de-snagged) is vulnerable to erosion (bed lowering) from fast flowing water. 
Riparian Vegetation Photo Rick James	The presence of a range of native riparian plants shrubs and trees growing at the top of a river bank to rushes and sedges (e.g. *Lomandra*) growing on the toe of the bank, will help minimise bank erosion. Native riparian vegetation helps trap soil and nutrients that 'run off' from the surrounding land, preventing them from entering adjoining waterways. Native riparian vegetation provides shade which regulates water temperature. This shading provides the right conditions for aquatic flora and fauna to thrive and prevents the excessive growth of algae and certain aquatic plants (macrophytes). Native riparian vegetation provides an essential refuge and habitat for native plants, animals and birds many of which are threatened. It also provides food and habitat for in-stream life. 	Bank covered in exotic grasses only. Regular areas of bank erosion evident. A bank with little or no vegetation can be subject to four times the erosive force during floods compared to a bank with a good cover of native riparian vegetation. Destabilisation of banks often resulting in massive increases in channel width, channel incision and gully erosion. Significant quantities of nutrients and sediment can enter waterways and adversely affect water quality. Increased nutrient levels (e.g. nitrogen and phosphorus), combined with increase temperatures from a lack of shade, stimulate weed and algal growth. A lack of shade, created by an absence of native riparian vegetation can lead to fluctuating and usually high water temperatures encourage growth of green algae and certain aquatic plants (macrophytes). This may cause major changes in aquatic habitat, reduce oxygen levels in the water column causing a reduction in aquatic fauna, including fish. Significant in-stream vegetation can also lead to slowing of the stream flow and the watercourse becomes broader and shallower, leading to bank erosion. The absence of native riparian vegetation means there is a lack of suitable habitat for native plants, animals and birds including threatened species.

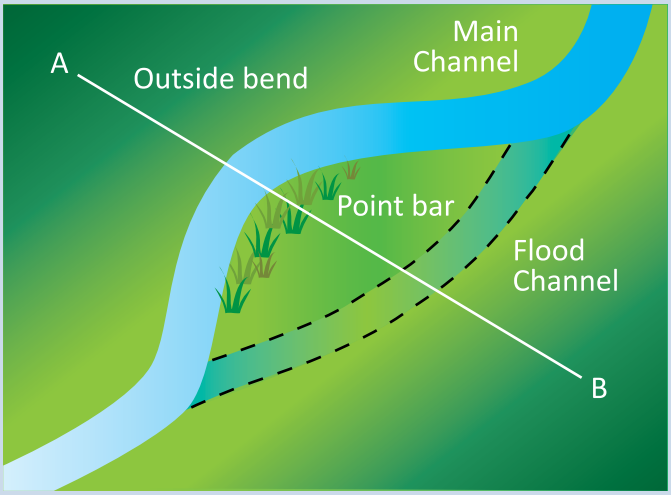
CHARACTERISTICS OF A OF A TYPICAL RIVER IN THE TASMANIA'S HUON VALLEY - MID TO UPPER CATCHMENTS)

CHARACTERISTIC	GOOD CONDITION	POOR CONDITION
Weeds	Few, if any, exotic plants (weeds) occur. If weeds are present, then they are low impact species only that will not affect the regeneration of native plants.	River bank more or less covered with exotic plants including many high threat weeds that will prevent the natural regeneration of native plants. Willow trees can gradually encroach into the centre of a waterway creating a shallower wider water course, which in turn leads to flooding and bank erosion.
Livestock	Livestock should have restricted or controlled access to riparian areas through adequate fencing. If access is occasionally given, this should only be to areas that are not erosion prone e.g. the inside of a bend. Stock should be prevented from entering the water course.	Livestock have free access to riparian areas including erosion prone sections of the channel e.g. outside bends, for water and grazing. This causes baring or pugging of waterlogged areas and watercourse banks, leading to soil compaction and erosion. Livestock will also foul waterways leading to water quality and public health issues.
Landscape health	The surrounding landscape, both native and productive contains little of no bare ground; soils are healthy with good physical structure. These conditions allow rain to easily penetrate the soil profile, vegetation traps sediment and the lack of bare ground means soil is retained in the landscape and is prevented from entering a water course. 	The presence of bare ground and compacted soil resulting from activities such as retaining fallow ground for extended periods, overgrazing and land clearance can lead to significant soil erosion, this can result in soil, nutrients and harmful chemical entering waterways. 
Connectivity	Intact riparian vegetation (along a watercourse) provides connectivity for wildlife, enabling species to access essential resources and new habitat in the landscape. Example below: 	Fragmented riparian vegetation (containing large areas of exotic vegetation and/or cleared land) can prevent native wildlife from accessing essential resources and colonising new habitat in the landscape. Example below: 

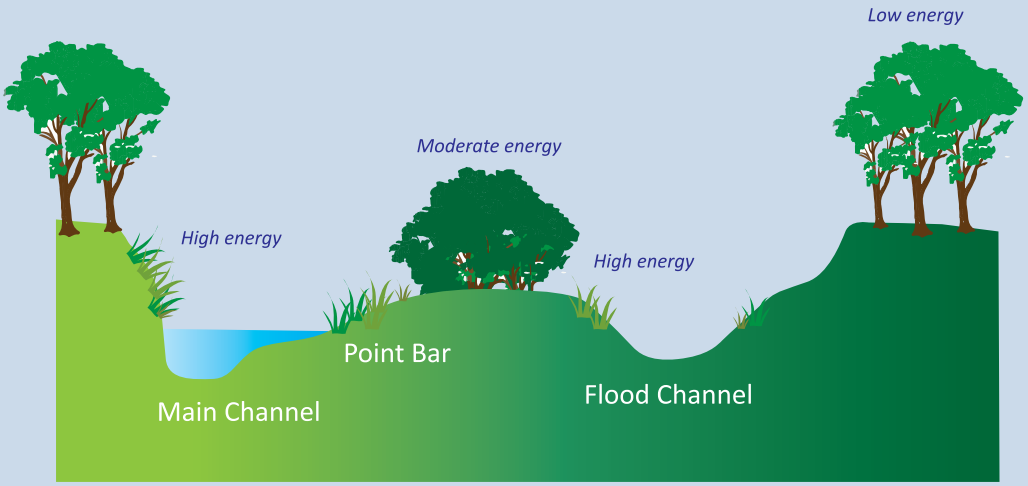
RIVER DYNAMICS AND RIPARIAN VEGETATION

Waterways are dynamic systems, which mean they constantly erode, transport sediment, change course, and flood their banks in natural and recurring patterns. Across the channel zone and river floodplain of a watercourse, the flood energy experienced varies greatly. That is, the energy exerted by the flowing water changes from place to place, with higher energy experienced where the water is deeper and faster flowing, and lower energy where the water is shallow and slower flowing.

Riparian plants differ in their ability to cope with different levels of energy flow and this creates distinct vegetation communities within waterways. The type of vegetation present can often be representative of species that can withstand high or low energy flows. (See 'Managing Waterways' factsheet for revegetation considerations including what to plant where). The following diagrams show the typical variation in water energy flow across the channel of a partially confined watercourse.



River Bend on a Partially Confined River



A. Outside bend Cross Section B

Diagram showing typical bend configuration for rivers in the partially confined River Style family rivers typically found in Tasmania's Huon Valley. In addition to the main channel, a flood channel is located across the back of the point bar feature. As its name suggests, this channel conveys flood flows taking some of the pressure off the main channel. The cross section A – B shows how the energy rating changes across the channel zone. High flow energy is experienced on the outside of the bend in the main channel and within the flood channel. Only plants with the ability to survive high flood energy will grow in these areas. The moderate energy zone between the two channels will have a distinct vegetation community too, while the lower energy bank top and flood plain areas can support a wider range of plants i.e. those that only have a low tolerance of flood forces. See 'Managing Waterways' factsheet for information about planning revegetation work in and around waterways.

MANAGING WATERWAYS

MANAGING WATERWAYS ON YOUR PROPERTY

Waterways and the riparian land surrounding them have undergone significant modification as a result of human activity. In many areas waterways are in poor condition. The modification of waterways has many unintended consequences that can severely impact productivity, social wellbeing and the environment; examples include the loss of productive farm land through erosion, and the loss of biodiversity and clean drinking through contamination of waterways by agri-chemicals, nutrients and chemical fertilisers.

Clearing riparian vegetation to make way for farm land and development, stream channel straightening, gravel extraction and de-snagging of waterways are some example of activities that can lead to widespread bank erosion, lowering of stream beds, localised flooding and the spread of willow and other invasive weeds. It is important to consider the long-term consequences of undertaking activities in and around waterways, which may be well-intended, but can adversely affect the health of waterways further along the catchment, either upstream or downstream.

SIGNS OF AN UNHEALTHY WATERWAY

Bed Lowering

Bed lowering, or bed incision, is erosion of the bed of a river resulting in a deeper channel. Bed lowering can be a natural process (we wouldn't have the Grand Canyon without it!), but accelerated bed erosion i.e. incision at a rate faster than what is considered "normal" for any given river, is viewed as an undesirable erosion problem. Bed lowering is often a precursor to bank erosion as a lowered bed leaves banks unstable. The most common process by which bed lowering takes place is the formation and upstream progression of a head cut. In essence, a head cut is a small waterfall that moves upslope as its face is undercut from the action of falling water. Head cuts are a common feature of gully erosion but can also occur in the bed of a river. Successive waves of head cut progression can significantly lower the bed of a river quickly resulting in bank collapse and channel expansion.

Head cut in top of gully, rock used to slow erosion. Photo Rick James

Two head cuts up degrading creek. Photo Rick James

Bank Erosion

Depending on the river bank erosion can be a natural process. Accelerated bank erosion is erosion above and beyond what would be normally expected for any given river. There are a number of mechanisms by which bank erosion can occur and correctly identifying the cause is essential if effective treatment is to be employed. Some causes include:

- Bed lowering: As the bed drops the "foundation" of the bank is lost. This is usually followed by bank slumping.
- Fluvial scour: The direct scouring of an exposed bank, typically on an outside bend.
- Hydraulic pressure: Groundwater seeping through the face of the bank causing destabilisation followed by slumping.
- Surcharge: The weight on top of the bank that causes collapse e.g. a large tree or building.

Depending on the site, some or all of the above may be operating.

Obvious bank erosion. The underlying cause of bank erosion must be identified if effective action is to be taken. Photo Rick James

DEALING WITH THE PROBLEMS

ISSUE	CAUSES	MANAGEMENT OPTIONS *Permits may be required to carryout certain works . For more information please see section on 'Works in and Around a Watercourse' on page 5 of this fact sheet.	PRO's and CON's
Bed Lowering	1. Disturbance of the bed e.g. de-snagging, excavating holes (gravel extraction, to create a pump hole etc.), moving gravel with an excavator or bulldozer, excessive stock access that breaks the natural armouring of bed materials. 2. Because head cuts in the bed of a river tend to migrate upstream, undisturbed reaches, or entire tributary systems, can be affected by downstream disturbance. 3. It is common for gully systems to be initiated by drainage works e.g. the channel-ization of a valley-fill swamp. Minor "plough lines" pulled through swampy valley-fill have often led to the formation of extensive gully systems. 4. Channel straightening. Cutting off a bend by creating a new straighter channel will result in the water flowing faster (as it now has to travel a shorter distance). Fast flowing water through a created channel with unarmoured bed material often triggers bed lowing.	1. Rock ramp bed controls are typically installed after bed lowering has taken place. The crest of the structure is built above bed level with the intention of trapping sediment upstream thereby raising the bed over time. 2. Rock lined scour pools are typically used to arrest a head cut in a gully system. 3. Timber V-weir bed control. 4. Timber or rock girdles (structures installed at bed level). 5. Re-snagging. 6. On narrow streams, stream-bank revegetation can provide effective bed control over time as the tree & shrub roots spread across the channel.	Rock structures can be expensive if suitable material is not available nearby. Construction is relatively straight forward but does require an excavator or backhoe machine. The materials for timber bed controls are usually cheaper but they are often harder to install. Re-snagging creates natural habitat as well as helping to stabilise the bed. Re-snagging will not by itself stop the upstream progression of an aggressive head cut.
Bank Erosion	Multiple potential causes any one of which, or combination of, may be operating at a particular site. The removal or damage of native riparian vegetation on the bank is usually a prerequisite factor. • Fluvial scour • Slumping • Surcharge • Bed lowering See previous section on Signs of an Unhealthy Waterway for terminology descriptions	1. Realignment & the construction of a log front wall. Revegetation of the bench created between the front wall & the eroding bank. 2. Direct protection of the bank e.g. rock revetment (sloping rock structure), log walls, pinning large woody debris against the toe of the bank etc. 3. Groyne deflection structures e.g. rock groynes, pin groynes (low wall or sturdy timber barrier), log groynes. 4. Gabion (cage containing aggregates such as rock, often used as a retaining wall) baskets. 5. Regeneration of native riparian plants by planting or facilitating natural regeneration e.g. by excluding stock.	Where severe erosion has taken place resulting in a poor bend alignment log or rock front walls can be very effective but are expensive to install. Direct bank protection is typically much cheaper. Using tree trunks with the root ball still attached can be very effective as the root ball acts as a groyne-type structure while the trunk provides direct protection. Gabions are expensive & have a limited life span. As they break down rusty wire is washed into the channel. In all cases, the long term viability depends on the successful establishment of bank-holding native vegetation. In some instances revegetation work on its own is not enough to prevent further head-cut and bank erosion and control structures (as outlined above) will need to be installed to support revegetation or regeneration of native plants. (also see section on Energy Zones in Riparian Zones)


Assessing the causes will assist in developing a plan to address the problems

NATIVE VEGETATION AND WATERWAYS

Native vegetation plays a vital role in maintaining the health of waterways. Existing native species should be maintained and where appropriate actively encouraged to recolonise areas along waterways. This can be achieved by reducing grazing pressure using livestock fencing, allowing early colonising plants such as Silver Wattle to establish particularly in erosion prone areas. In some cases natural re-colonisation by native species is likely to be hindered by the presence of ongoing disturbance and invasive weeds. Revegetation work may need to be carried out in such circumstances and often plays an integral role in restoring the health of waterways. Establishing suitable native vegetation is particularly important in erosion-prone areas where bare ground requires immediate stabilisation. Revegetation should be carried out in conjunction with the removal of weeds, such as willow, and to support newly established erosion control structures. However it is essential that certain factors are taken into consideration when planting native plants along waterways, including the choice of species and where they are situated in and around the channel zone.

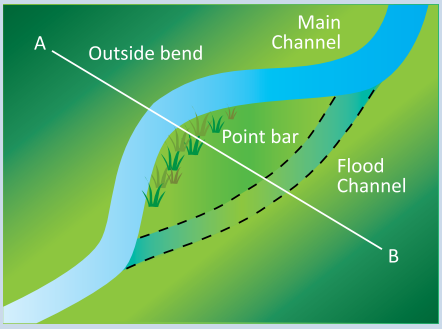
REVEGETATION CONSIDERATIONS

It is important that any revegetation work carried out within the stream channel zone takes the different energy settings into account (see 'Healthy Waterways' factsheet for more information). Some key considerations to look for are:

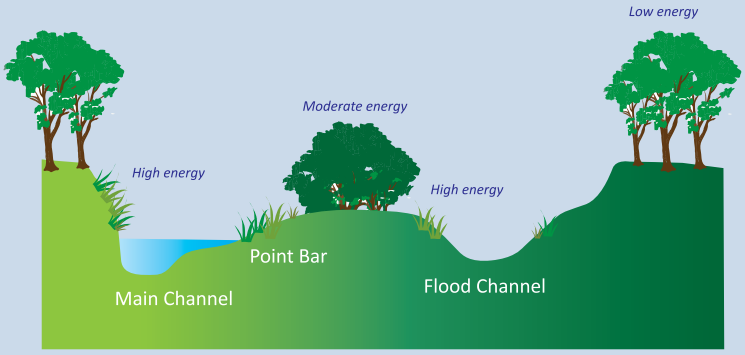
- Before carrying out revegetation works find a section of river similar to the one you propose to carry out works on, but with a good cover of native vegetation. Look carefully to work out what native plants grow where e.g. which ones seem to be able to tolerate high tractive stress? What plants only seem to grow in areas of low tractive stress?
- Plan your revegetation works around your observations – only put plants with a high tractive stress tolerance in high energy areas e.g. on the face of an outside bend.
- It is important to maintain a sufficient width of channel without the restrictions caused by larger shrubs or trees. This is required for the channel to retain its hydraulic efficiency e.g. its ability to convey flood flows. Planting large shrubs and trees on point bars, or within the flood channel zone is not a good idea as this will restrict the channel width over time.

WHAT SHOULD I PLANT WHERE?

Some plant species can hold on in the highest energy areas e.g. on the outside of a bend, while others can only grow where the energy level is low. The following diagrams show the typical variation in water energy flow across the channel of a partially confined watercourse (see 'Healthy Waterways' factsheet for more information).



River Bend on a Partially Confined River



A. Outside bend Cross Section B

The following table provides examples of Tasmanian native plants that are suitable for revegetating land adjacent to and within creeks lines and indicates where particular species should be planted, based on their ability to cope with different levels of energy flow within a waterway (see 'Healthy Waterways' factsheet for more information on river dynamics and vegetation).

ENERGY LEVEL	TYPICAL CHANNEL ZONE LOCATIONS	TYPICAL RIPARIAN PLANTS
High	• The outside of bends. • Flood channels. • Some bank attached bars. • Some mid-channel islands.	woolly tea tree (*Leptospernum lanigerum*) river tea tree *(Leptospernum riparium)* bottlebrush (*Callistemon* spp.) mat rush (*Lomandra* spp.) rushes (*Juncus* spp.) sedges (e.g. *Carex* spp.)
Medium	• Banks along straight river reaches. • The back of point bars.	blackwood (Acacia melanoxylon) silver wattle (Acacia dealbata)
Low	• Upper bank locations. • Floodplains.	black gum *(Eucalyptus ovata)* white gum *(Eucalyptus viminalis)*

*Plant Tasmanian native plants that grow in your local area. Some native plant nurseries may be able to grow native plants with longer root systems on request; these plants are grown in deep tube pots, specifically for the purpose of revegetating riparian areas.

Many species of mat rush (*Lomandra* spp.) are able to grow in areas of a stream channel that experience high energy water flows. The leafy crown offers little resistance to flood flows while the extensive, fibrous root network is highly effective at binding soil together. Lomandra longifolia can often hold fast as the bank it was growing on has eroded. It can sit in the channel in a supporting column of soil that its roots still hold firm. This is an ideal plant for revegetation work in high energy flow areas of the channel.

Stock fencing protecting new riparian plantings

LIVESTOCK AND LANDSCAPE

Livestock should be managed sensitively around waterways. Maintaining good ground cover in surrounding pasture and riparian land is key to improving the health of waterways.

- Over-use of land within a catchment can contribute to a decline in waterway health, particular where over-grazing results in poor ground cover (areas of bare ground) and compacted soil, leading to increased run off and soil erosion.
- Set a grazing regime around waterways that improves perennial vegetation cover and soil health using targeted grazing.
- Where possible use a flexible fence design, such as temporary electric fencing, near waterways. This helps to influence when and where you can graze and how long you rest the site for and can also assist planning for possible flood events.
- Knowing where your stock need to be in the next six months can influence how your riparian zone is managed as part of a planned grazing system.
- Holistic Management® Planned Grazing is one example of a management technique that can help improve ground cover and assist in reducing run off and soil erosion.
- Provide off-stream watering points for livestock. Stock should be prevented from accessing waterways, particularly in erosion prone areas.
- Retain native riparian vegetation to provide a minimum 10 metre width (buffer) upslope (away from) the top of the bank. Where no native vegetation is present, replant suitable native species, especially ground cover plants (see previous section: Revegetation Considerations). For maximum trapping of sediment, nutrient and other contaminants, combine a 10 metre riparian vegetation buffer with a grass filter strip.
- Livestock can be used to manage vegetation near waterways, for example to control woody weeds in a revegetation site, but this requires sensitive forward planning.

Top Left: Eroding banks from stock access
Bottom Left: Cattle excluded by fencing,
Right: grazing paddocks, non grazed top paddock with weed growth.

WORKS IN AND AROUND A WATERCOURSE

A "watercourse" is defined in the *Water Management Act 1999* as:
'watercourse means a river, creek or other natural stream of water (whether modified or not) flowing in a defined channel, or between banks, notwithstanding that the flow may be intermittent or seasonal or the banks not clearly or sharply defined'.

STEP BY STEP PROCESS FOR WORKS

For low impact works such as tree planting and fencing, steps 1 and 2 would normally suffice. For more complex activities such as the removal of willow using machinery or the construction of erosion control structures it's advisable to follow all 5 steps below. In-stream works may require a permit from your local council or from the Department of Primary Industries Parks Water and Environment (DPIPWE).
The *Water Management Act 1999* does provide powers to require landowners to remove works from a watercourse if it is found to be done without a permit when a permit would have been required. The Water Management Branch at DPIPWE is more than happy to review proposed works and provide guidance to landowners.

Step 1: Establish Land Tenure boundary prior to works

Step 2: Seek advice from Natural Resource Management (NRM) Agencies and Local Councils

Step 3: Seek advice from a river specialist required prior to in-stream works

Step 4: Consultation with the Water Management Branch of DPIPWE
Permits may be required for the following types of works:
*Construction of battens, rock walls on banks or any structures placed in waterways, particularly those that may impede/alter current water flow, use of machinery in watercourses (including management options referred to in this factsheet)

Step 5: Consultation with your local Council planners and Environmental Health Officers to establish if a planning permits required

*Any activities that are likely to have a negative impact on native wildlife, in particular Platypus and their burrows, need careful planning and advice should be sought from DPIPWE's Policy and Conservation Assessment Branch.

In the unlikely event that disturbance or destruction (taking) of a Platypus burrow is unavoidable, a permit is required. Permits are unlikely to be issued for the taking (destruction) of a Platypus and any works must be under¬taken in such a manner that taking of a Platypus does not occur. Avoid major earthworks near or within waterways between December and April (breeding season for Platypus). If this is not practical, further advice should be sought from the Policy and Conservation Assessment Branch.

Please refer to the DPIPWE Wetlands and Waterways Works Manual for further details on working in watercourses and relevant legislation.

Willow and blackberry control at Mountain River, before and after works

MYTHS ON RIVER MANAGEMENT

Myth: Trees cause erosion

The inter-relationship between riparian vegetation and channel form is a complex one. Overall, a river with a healthy community of native riparian plants will be less erosion prone than a similar system where the plant community has been disturbed. It is true that sometimes large trees falling from the bank can leave a large area of exposed bank. Where trees lodge in the channel and deflect flows into the bank erosion can also be triggered. However, these situations where trees are implicated in the cause of erosion are more than offset by the work they do to prevent erosion.

Myth: Bank erosion can be fixed by battering the bank

Battering a steep eroding bank will do nothing to stop the erosion. The only case where this may work is when the battered bank is immediately revegetated with suitable riparian plants and these plants have sufficient time to establish before the next large flood.

Myth: Pushing gravel up against an eroding bank from the bar opposite will protect it from further erosion.

Moving gravel from the low energy side of the channel e.g. a point bar, to the high energy side – an eroding outside bend – will offer temporary protection at best. If the river had sufficient energy to move the material to the point bar then it certainly has sufficient energy to move it away from the higher energy environment on the opposite bank. The gravel will simply be washed away.

Myth: Using concrete for bed controls or bank protection is the best method.

Concrete may be hard, but it's inflexible. Water will always find a way of working around the edges of concrete structures i.e. out-flanking them. Rock structures are more flexible. The overall structure can move to fill any localised scouring while maintaining overall integrity.

Myth: Builder's rubbish, old car and truck tyres and car bodies are all cheap ways of providing bank protection.

Apart from being illegal in many cases, simply dumping rubbish over the bank is unlikely to be effective. However, clean builder's rubble can be used in the core of revetment work and is then "faced-off" with quarry rock.

Myth: Willows and other exotics are better than native plants at providing bank protection.

Willows were used extensively for river bank protection in the past. Many species e.g. Crack Willow (Salix fragilis), strike easily from simple green canes which made establishing them along river banks easy. However, this same feature also means that they can spread quickly throughout the entire system including in places where they're not wanted e.g. in the middle of the channel. In the absence of suitable native riparian plants, willow can temporally protect against erosion and stream bed lowering, but in the long-term is likely to accelerate bank erosion and cause localised flooding. Carefully selected native plants can do the same job in terms of protecting banks from erosion without any of the unintended consequences associated with the use of exotics. Develop a strategic plan for managing willows and consider factors discussed in this factsheet such as where they are positioned along a water course, such as an outside bend.

Myth: Straightening out the channel will solve the bank erosion problems.

Except in rare cases rivers don't flow in straight lines. Straightening a river increases its bed gradient as it now has to travel over less distance per unit drop in elevation. Increased gradient means faster flowing water in a created channel with disturbed bed material. The result is almost always bed incision which leads to further bank erosion.

Willow on inside bend, impacting on erosion on opposite bank

MORE MYTHS ON RIVER MANAGEMENT

Myth: Building levee banks to stop flooding is a good idea.

Levee banks trap more water in the channel during floods. This increases the energy within the channel itself and can trigger bed and bank erosion. As water leaves the channel and spreads out over a floodplain it loses energy and deposits sediment (this is how the floodplain was formed in the first place).

Myth: Vegetation and large woody debris within the channel block it up and cause flooding.

More than 10% of the channel cross-sectional area needs to be blocked before any discernible backwater effect is evident. Many "messy" or "overgrown" sections of channel are well below this figure and as a consequence the vegetation is having very little impact on the hydraulic efficiency of the channel.

Myth: Removing large woody debris(de-snagging) will help high flows get away and reduce flooding.

See comments above regarding the clearing of channels. In addition, large woody debris in the bed of a river often acts like the reinforcing bars in concrete providing extra strength to the overall bed matrix of timber, sand, gravel etc. Removing this reinforcing can lead to bed lowing problems.

Myth: Clearing trees and shrubs off the bank will help the water get away better during high flows so will help reduce flooding.

Water will flow along the face of a well vegetated river bank at approximately half the speed of a cleared one. Or put another way; if you clear the trees and shrubs from a river bank the water flowing along the bank will move twice as fast. Because of the mathematical relationship between water velocity and the energy it contains, doubling the speed (velocity) will result in the moving water having four times as much energy. No wonder cleared river banks tend to erode.

Myth: Planting trees on top of the bank will stop it eroding.

This is partly true, but if the bank is higher than about 2 meters then trees on the top of the bank are unlikely to do much to stop the toe (bottom) of the bank undercutting. Vegetation on the bank face, and at the toe of the bank are required. The one exception to this is where bank erosion is being caused by water seeping through the bank from under the floodplain. In this case trees planted back from the top of the bank can help reduce bank moisture and thus improve stability.

Myth: Allowing stock to graze river banks doesn't do any harm.

As outlined above re. the clearing of vegetation along river banks, banks kept "clean" by stock are prone to attack by fluvial scour. This process works on all the bare areas that stock cause e.g. stock tracks down the bank face, resulting in erosion problems on relatively straight reaches of a riverbank.

Large woody debris providing stability to river bed

Photo: Rick James

313 Macquarie Street (PO Box 425) South Hobart Tasmania 7004
TEL: 03 6221 6111 FAX: 03 6221 6166
FACEBOOK: www.facebook.com/nrmsouthTas TWITTER: www.twitter.com/nrmsouth
WEB: www.nrmsouth.org.au