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PRIMARY INDUSTRIES

BETTING ON RAIN

MANAGING SEASONAL RISK IN WESTERN NSW

RON HACKER, YOHANNES ALEMSEGED, PAUL CARBERRY, BOB BROWNE & WARREN SMITH

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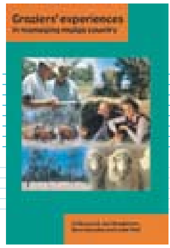

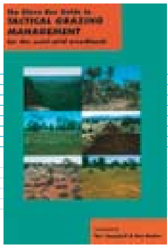

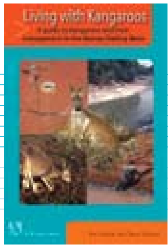

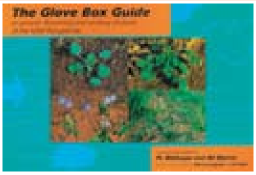

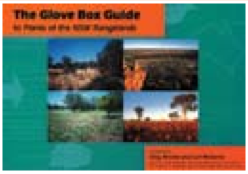

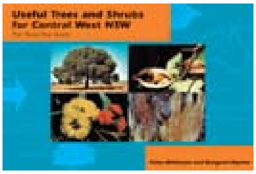

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R B HACKER, Y ALEMSEGED, P M CARBERRY, R H BROWNE, W J SMITH

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FOREWORD

Farmers and graziers in western NSW face special challenges in managing their businesses and their land for long-term viability. Not the least of these is posed by the extreme variability and non-seasonal distribution of rainfall. In such an uncertain environment decision making can be particularly difficult and the management of seasonal risk is a key to both business success and astute environmental stewardship. This guide will provide practical assistance with this important task.

Betting on Rain draws together basic information on weather and climate systems, and recent research on the development and application of seasonal risk assessment tools, in the specific context of western NSW. The guide provides both informative insights into the factors that determine regional weather patterns and practical tools that will allow landholders to utilise what predictability does exist to improve management decision making.

The research team worked with a network of over 300 landholders across western NSW. Their feedback has helped shape this booklet and I expect that they and others will find it a valuable addition to the earlier rangeland publications in the **glove box guide** series.

Climate science can not yet provide answers to all the questions that landholders ask about future seasonal conditions. But it can make a practical contribution when the available tools are understood and properly applied. This publication will make a substantial contribution to that process. It should reward frequent reference whenever landholders grapple with the climatic uncertainties that confront primary production and land management in western NSW.

B D Buffier

Director-General

NSW Department of Primary Industries

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INTRODUCTION

This guide describes the physical forces that drive weather and climate in western NSW, and tools that can be practically applied to help manage seasonal risk in this highly variable and uncertain environment. It presents the results of the project **Improved seasonal forecasts for wool producers in western NSW**, funded by Land and Water, Australia and Australian Wool innovation Limited through the Land, Water and Wool program, and NSW Department of Primary Industries (NSW DPI).

As part of this project a team from NSW DPI worked in conjunction with colleagues from the Queensland Department of Natural Resources and Mines to analyse the value of seasonal risk assessment systems in western NSW, and with a network of some 330 producers to determine how the results might best be used in practical management.

The research component evaluated the usefulness of seasonal risk assessments for both rainfall and pasture growth derived from the Southern Oscillation Index and Sea Surface Temperatures. It also developed the concept of 'trigger points' – key dates for management decisions – and identified these dates for a range of locations throughout the region.

The interaction with the landholder network, both through project newsletters and face to face workshops, was invaluable in identifying those management decisions that are most dependent on seasonal outlooks, as well as the background information on climate and weather systems which would be of practical value to managers. That information has been included in this guide.

HOW TO USE THIS GUIDE

This guide is intended to be used as a working manual. It contains seven major sections. While an initial reading of the whole book would be useful, practical application will generally require reference to specific sections. The colour coding and the description of each section below will assist this quick-look application.

Part 1 – What drives climate and weather?

Basic drivers of weather and climate in western NSW; seasonal outlook indicators; El Niño and La Niña. (If you have previously attended a NSW Department of Primary Industries climate workshop you might skip this section although a refresher could be useful).

Part 2 – Managing climate risk

Some basic issues in managing climate risk using a probability or 'odds' based approach.

Part 3 – Using historical rainfall data

Understanding and using long-term climate records; long-term climate data for locations in western NSW.

Part 4 – Seasonal risk assessment

When are seasonal risk assessments useful?; maps showing the probability of exceeding median pasture growth in various SOI phases at these times.

Part 5 – Trigger points

What are trigger points?; pasture growth profiles for various locations in western NSW.

Part 6 – Sources of climate and weather information

Web sites and other sources of weather and climate information.

Part 7 – Some producers' views

Some producers' opinions about seasonal risk management and use of the tools described in this book.

PART 1 –
WHAT DRIVES CLIMATE AND WEATHER?

- Global circulation and weather – high and low pressure belts, global wind patterns
- What makes it rain? – sources of moisture and the processes that can trigger the formation of rain
- Major weather systems that deliver moisture to eastern Australia or act as triggers – satellite images and synoptic charts, reading weather maps
- Seasonal outlook indicators – the Southern Oscillation Index, sea surface temperatures, El Niño, La Niña and other factors – how these works to influence the seasonal potential

Note – if you have already attended a NSW Department of Primary Industry climate workshop you might wish to skip this section.

Global circulation and weather

Local weather is driven by the major global circulation systems. These in turn are driven by heat, provided almost exclusively by the sun. The sun provides most heat to the part of the earth which is closest, near the equator, and creates warm water and land in this strip around the globe (Figure 1.1). This, in turn, creates warm air which expands and rises resulting in a low pressure belt at the earth's surface in the equatorial region. At altitude, this air cools and falls in a belt at about 30º S latitude, over Australia, resulting in a belt of high pressure at the surface. To forecast weather in Australia you need to watch the closest of the six to eight high pressure systems formed around the globe in this belt where the air is falling.

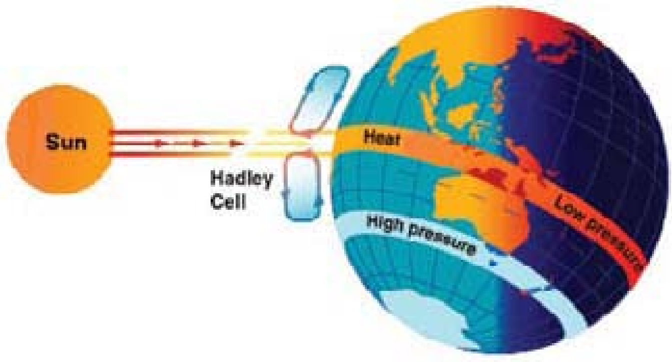


Figure 1.1 Atmospheric wind and pressure systems

As air in the high pressure belt flows towards the low pressure belt in an attempt to reach equilibrium, the Hadley Cell is completed. With the continuous heating and cooling occurring in the atmosphere, equilibrium is never reached. Movement of air in the pressure systems as they try to balance out is the basic force that creates the global wind patterns. These patterns are also influenced by the rotation of the earth from west to east, resulting in the apparent deflection of the air flow and the characteristic south-easterly direction of the trade winds in the southern hemisphere. The rotation of the earth around the sun produces the seasons, and also a north–south shift in the position of the low and high pressure belts.

Figure 1.2 shows the actual wind speed and direction as it was on one specific day. Such measures are continually recorded to ensure accurate starting conditions for forecasting. Note the five large anticlockwise high pressure circulations in the southern hemisphere and the region of east to west 'trade winds' along the equator.

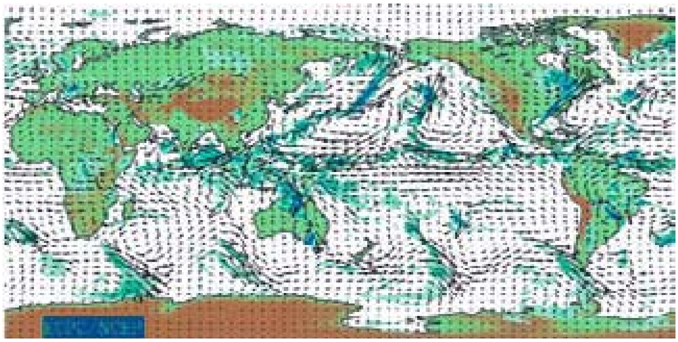
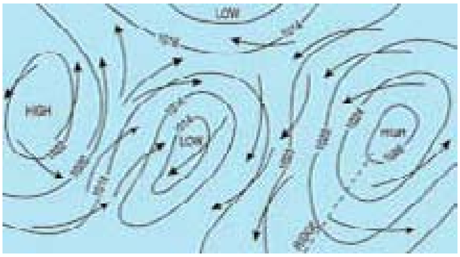


Figure 1.2 Wind circulation map – the size and direction of arrows indicate strength and direction of winds

How do these pressure systems work?

In the southern hemisphere the air spirals clockwise, and upwards, in a low pressure system and anticlockwise, and downward, in a high (Figures 1.3a and 1.3b). The amount of difference in the pressures and the closeness of the systems determine the wind speed. This is seen by the closeness of isobars on synoptic maps. Larger pressure differences will create faster wind speeds and will show up as closer isobars. The general movement patterns are shown in the diagram.



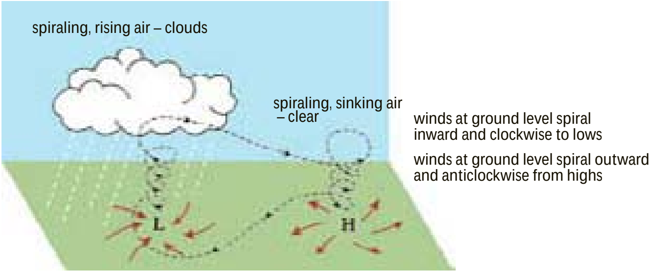


Figure 1.3a (left) Directions of air flow, Figure 1.3b (right) A side view of how highs and lows behave

The location of the pressure systems can give a good guide to what will come with the wind. It is most likely that air coming off the ocean, particularly the warmer parts of the ocean, will bring moisture. Air from central Australia (no free water, few plants) will be dry. Air coming from the Antarctic will be cold. Air from the north will be warm.

Air moving downward in a high spirals outward at an angle of about 15º to the lines of pressure, and air moving upwards into the lows spirals inwards at a similar angle. This will vary slightly with terrain and there will be local effects from hills, valleys, forests or agricultural activity such as large fallow areas or irrigation.

It is important to recognise that the air is moving up or down as well as round and either in or out, all at the same time. It is a very dynamic, three dimensional system.

The air going into lows can contain moisture and as it rises it cools and can form rain. Descending air pushing out from the highs is usually dry, the moisture condensed out when the air rose. While lows are often triggers for rain, it is the air pushing out from the highs that determines the surface wind direction and thus whether it will blow over a good moisture source or not, before it gets to a trigger. Look to the highs for future weather. Where you are in relation to the centre of the high provides a guide to what is coming.

Also, highs tend to be big, slow moving systems while lows are smaller and faster. Frosts and fog often form in the central regions of these slow highs in the colder months.

What makes it rain?

Two factors are required to make it rain: a source of moisture and a trigger.

As a general rule evaporation from the warmer ocean waters provides the major source of moisture. Cooler air originating from the Southern Ocean will have less moisture available for precipitation, although these systems still produce good falls from time to time in regions which are closest to where the system comes onshore.

Unfortunately, having a good source of moisture is not sufficient to produce rain. A number of other conditions must also be met for this to occur. The most important is that moist air needs to cool. As the temperature drops the evaporation rate decreases faster than the condensation rate, until they cross over at the 'dew point' and water droplets form and grow. The temperature at the dew point depends on the relative humidity. Anything that causes air to cool can act as the trigger for rain. Without a trigger no rain will occur even if the air contains plenty of moisture.

The most common triggers are things that cause air to rise, resulting in cooling of about 0.65ºC for each 100 m in elevation. Air rises because of

- Hills and mountains – Orographic lift. The air must rise to get over the hills. The hills must be high enough to cause significant cooling and wide enough so the air can not simply flow around them without rising.
- Irregularities on the earth's surface – mechanical or frictional turbulence. If there are things which create enough turbulence, some air will get pushed up enough to cause some cooling. This mechanism often results in showers from systems that otherwise would not rain.
- Collision of air pressure systems e.g. cold fronts undercutting warmer air as shown in Figure 1.4 below. These generally produce widespread rain.

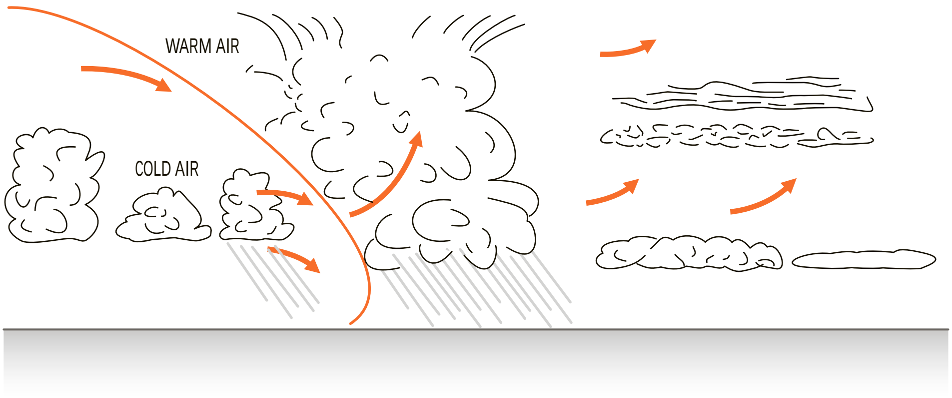


Figure 1.4 An example of warm air uplift by a cold front

- Hot air uplift – local convection, resulting in storm rain in summer. Sufficient heat is required to create a local hot spot which can produce a pool of warm, rising air. Most storms occur in the afternoon, following the hottest part of the day.
- A circulating low – convergence pushing air up. As explained earlier, the air in a low pressure system is rising, with air converging into it from surrounding systems. If the air is moist, the rise within the low can trigger rain.

Other causes of cooling can be

- Mixing with cooler air as two circulating systems interact. Both systems need to be moist to produce rain. This combination can result from the interaction of a slow moving high in the Bight and a Tasman high but as a trigger this mechanism is less effective than an undercutting cold front pushed in from the south west.
- Sunset, where the source of heating is removed allowing the air to cool.
- A trough of lower pressure where the air expands as it flows out of the region of high pressure to a zone where pressure is less, spreading the heat it contains and thus cooling slightly. This can be just the region between two highs but a more significant trough with strong air flow is usually necessary to produce substantial rain. Figure 1.5 shows a modest trough (dashed line) through the north east of NSW.

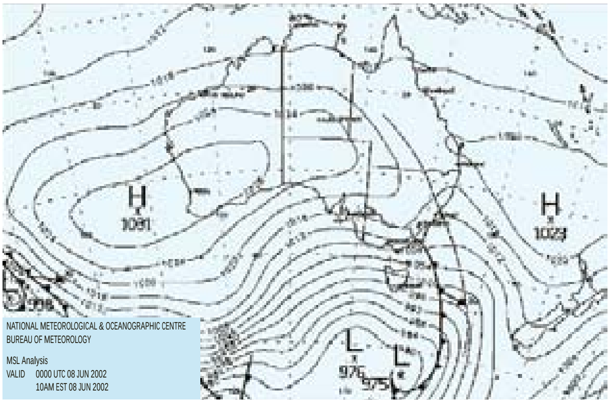


Figure 1.5 Synoptic chart showing trough through north east NSW

Several major weather systems deliver moisture to eastern Australia or act as triggers.

1. Monsoons and cyclones in the tropical regions – November to April

These summer phenomena originate in the tropical seas where warm temperatures result in huge volumes of moisture entering the atmosphere. Some falls as rain within the system but some remains after the monsoon or cyclone breaks down and can interact with other triggers to produce rain elsewhere (Figure 1.6), typically as storms. These often result in patchy rain and sometimes strong wind or hail in quite small areas. Some storms produce very little or no rain but may have lightning which can cause fire. On rare occasions this moisture will interact with a front to produce more general rains.

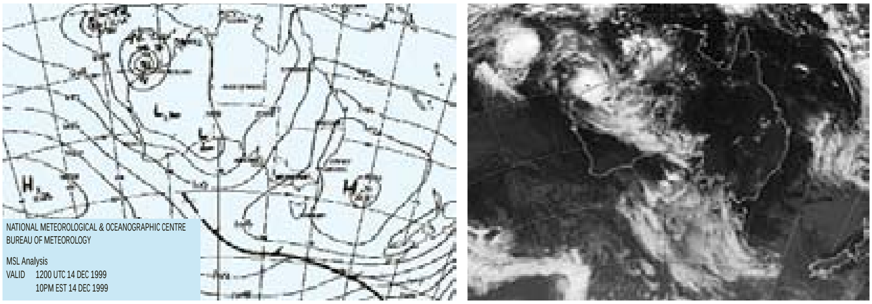


Figure1.6 A typical summer cyclone pattern with cloud from the cyclone off the north west coast over north west and central Australia. As these systems break down, moisture often drifts over to western NSW, even when it has become vapour which does not show on the pictures. This vapour can develop into thunderstorms.

Source: Satellite image originally processed by the Bureau of Meteorology from the Geostationary Meteorological Satellite (GMS-5) of the Japan Meteorological Agency.

2. North west cloud bands from the northern Indian ocean – April to August

Usually an autumn / winter source, they originate in the northern Indian Ocean. The band forms off the coast of Western Australia, moves southeast and rises (Figure 1.7). This broad scale ascent is a mechanism that may, in itself, produce widespread rainfall. Interaction with other features such as an undercutting front will increase the chances of rain. They sometimes bring extensive rain to inland, southern and eastern Australia.

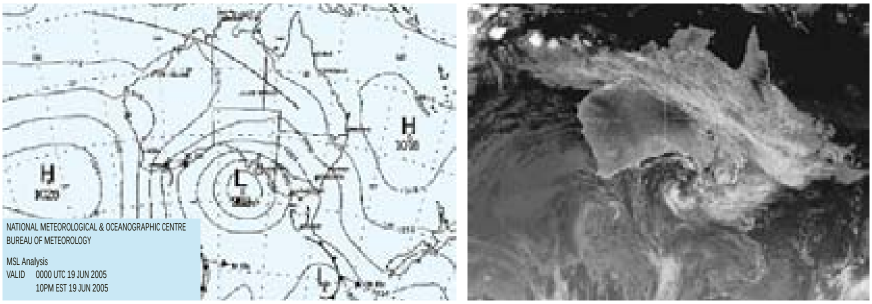


Figure 1.7 A strong north west cloud band streaming in from near Indonesia

Source: Satellite image originally processed by the Bureau of Meteorology from the Geostationary Meteorological Satellite (GOES-9) of the Japan Meteorological Agency.

3. The Tasman high/cold front system – May to October

High pressure systems in the Tasman Sea (Figure 1.8) bring moist easterlies onto south eastern Australia throughout the year. However, from May to October these systems frequently interact with cold fronts over southern Australia to produce widespread 'frontal' rain. The cold fronts circulate continuously but it is only in winter, when the global circulation pattern moves to the north, that they intersect the Australian land mass. How far they move to the north is an important determinant of winter rainfall in northern NSW.

The fronts themselves are poor sources of moisture but the uplift they create when they interact with the warmer air circulating from the Tasman high is the trigger which produces the rain. Although this rain moves through from the west, the moisture has actually originated in the Tasman and Coral seas and has been brought over the land mass by the easterly and north-easterly air streams produced by the high pressure system. Rainfall is often widespread through amounts may vary.

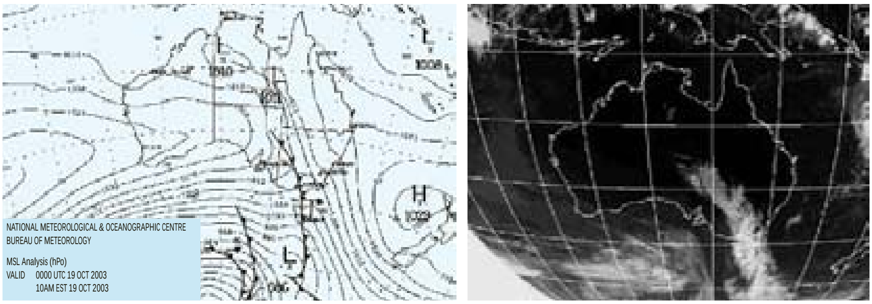


Figure 1.8 Cloud pattern and synoptic chart showing a typical Tasman high/cold front system at work

Source: Satellite image originally processed by the Bureau of Meteorology from the Geostationary Meteorological Satellite (GMS-5) of the Japan Meteorological Agency.

4. Tasman lows – any time but mostly June to September

These systems affect rainfall only on the mid coast and in the south east, often in association with cold southerly winds. These lows can bring intense rain and strong winds but do not affect inland areas (Figure 1.9).

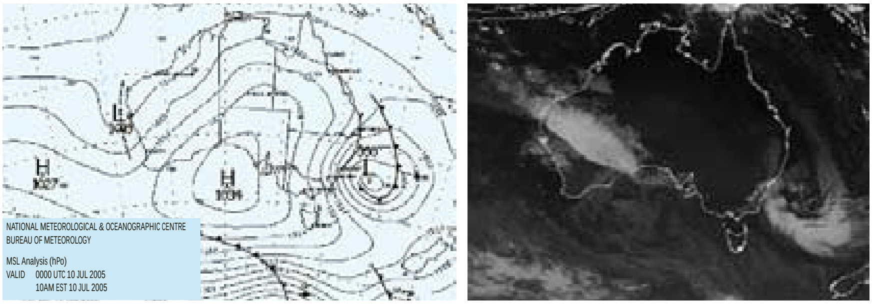


Figure 1.9 Cloud drawing into a Tasman low off the southern NSW coast.

Source: Satellite image originally processed by the Bureau of Meteorology from the Geostationary Meteorological Satellite (GOES-9) of the Japan Meteorological Agency.

Clouds

Clouds do not contain all the water which falls from them. They are just a visible sign that condensation activity is taking place. Only about 1 part per million of the volume of a cloud is condensed water or ice, though there is a larger portion which is uncondensed vapour. This means that all the visible water in a cloud 1 kilometre high would only be 1 mm deep on the ground. To produce rainfall in amounts useful to agriculture requires the inflow of moist air to continue for some time, and the conditions inducing condensation to remain in force, to turn more vapour into rain.

Reading ‘weather maps’

Cloud pictures and weather maps (as shown in newspapers, on TV or in fax services) can be used to find out where the moisture is and what triggers are potentially active in your region. Look for indicators of moisture in the atmosphere which could come your way in the next few days and for some trigger mechanism to interact with it while it is in your region.

The ‘cloud’ picture provides the clues to the moisture. While it is just an infrared image of the Australian region, the cold parts (shown as white) are usually the tops of high clouds. This usually means a good depth of moisture at a concentration which is already producing condensation – a potential source of rain.

The synoptic chart (with the isobar lines drawn on it) provides the clues to any triggers. Cold fronts and strong trough zones are good triggers for inland regions.

Seasonal outlook indicators

A variety of indicators can be used to look a bit further out than just the next week or so, which is all that can be done with weather forecasting systems at the moment.

These indicators are known to be connected to major shifts in weather patterns but are not usually specific enough to predict exactly what will happen. They are used to get a guide to the chance – or **probability** – of specific things occurring, thus providing a good basis for risk assessment but not a definitive prediction. One is the Southern Oscillation Index or SOI.

The SOI is based on measures of the difference in air pressure between Darwin and Tahiti. The difference is compared to the long-term mean difference at the same time of year and is expressed as a number which ranges from about -30 to +30. It is a method of getting an indication of what is happening with the atmospheric circulation across the Pacific.

When the SOI is positive the trade winds typically blow strongly across the warm western Pacific Ocean and pick up plenty of moisture which can then lead to rain over eastern Australia. In years with a positive SOI rainfall is commonly above average. When the SOI is negative the trade winds are usually weakened and the rainfall in eastern Australia can often be below average.

The SOI is just an indicator and does not include all the factors influencing rain in eastern Australia so while the general relationship between SOI and rainfall is useful – as can be seen from Figure 1.10 – there is considerable variation that is not simply determined by the SOI.

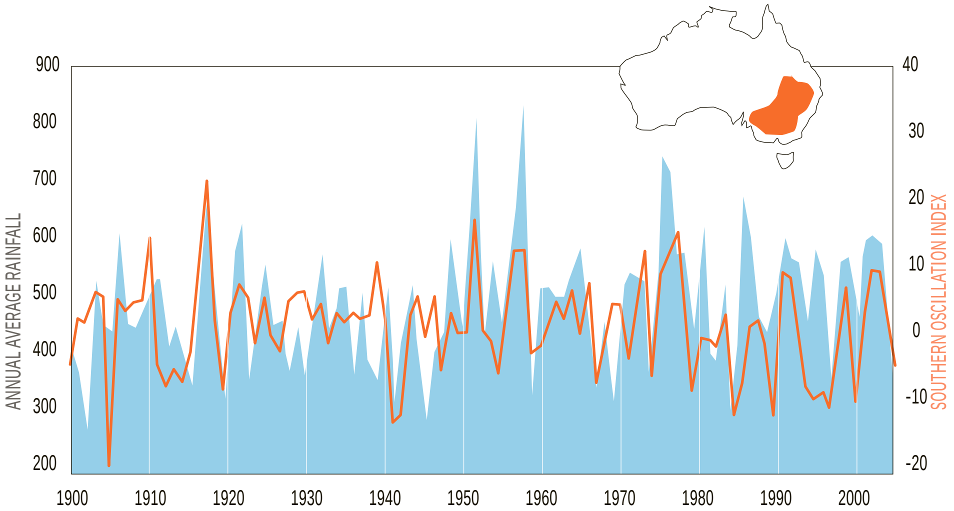


Figure 1.10 Studying the El Niño Southern Oscillation phenomenon: Annual average rainfall for the Murray-Darling Basin (solid grey) is highly correlated with values of the Southern Oscillation Index (orange line).

Source: Australian Weather Calendar 2004, Commonwealth Bureau of Meteorology and Australian Meteorological and Oceanographic Society.

Figure 1.11 shows two important features of the behaviour of the SOI:

1. the SOI tends to jump each autumn and settle into one of three patterns – high, low or wobbling about the middle;
2. once it has jumped it tends to remain in the same pattern for many months.

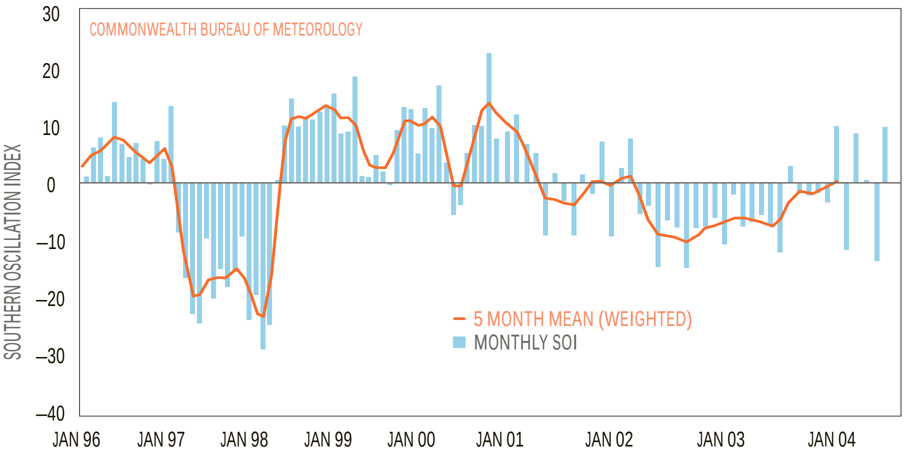


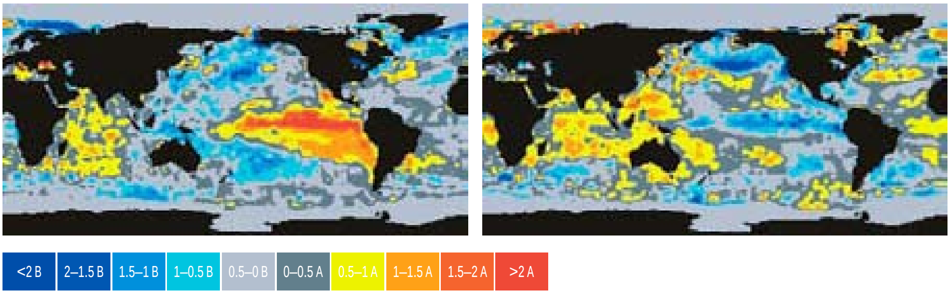
Figure 1.11 SOI from 1996 to 2004. The graph shows the end-of-month values of the 30-day moving average of the SOI.

These two features, when added to the tendency for rain to be higher when the SOI is high and lower when the SOI is low, mean that it can be a useful guide to the potential for rain in the following few months once it has settled after a jump. It should not be used in the late summer or autumn as it may jump in the immediate future and settle into a vastly different pattern, associated with different rainfall probabilities. Furthermore, local effects may make the correlation between SOI and rainfall in your region different from elsewhere.

Another seasonal outlook indicator is **Sea Surface Temperature** or SST. Sea surface temperatures have been measured since 1982 when satellites were put in place to collect worldwide data. The oceans supply the moisture from which the atmospheric systems create rain and this supply is largely dependent on water temperature. In addition, the atmospheric systems themselves are modified by changes in the oceans. While a number of different atmospheric systems may trigger rain over any season, the state of the oceans can be a guide to both the potential moisture supply and the interacting atmospheric systems that produce the rain.

Figure 1.12 shows one period when the SSTs in the central and eastern Pacific were high and one when they were low. These are known, respectively, as the El Niño and La Niña conditions, which are explained further in the next section.

El Niño conditions (September 1982) La Niña conditions (September 1988)



B – below average, A – above average

Figure 1.12 Variation of sea-surface temperature from average

Source: www.LongPaddock.qld.gov.au

In these images the yellow to red areas indicate above-average temperature, the blue tones are areas of lower than average temperature, remembering that the average can only be derived from data between 1982 and 2004. This is not a long time in geological history and we may not have seen all the natural variation yet but the images do give us a look at the current SST in relation to the recent past and therefore a guide to the potential for moisture to come our way, relative to this recent past.

In contrast to atmospheric indicators, SSTs change fairly slowly, because the ocean is a huge mass of water with high thermal density. They can therefore provide an indication of the likely moisture supply for several months ahead.

'Seasonal climate outlooks' from the Bureau of Meteorology are based on the relationship between the Australian climate and the oceans, particularly ocean temperatures. As with all such outlooks they are not absolute predictions but are given in terms of probability – the percentage chance of getting rainfall above the median.

What are El Niño and La Niña?

Each year around Christmas time the waters off the Peruvian coast warm a little. The locals noticed that at intervals of around 3 to 6 years the water became unusually warm. This produced flooding rain and poor anchovy catches (Anchovy prefer cooler water). They called these events El Niño, meaning the 'boy child' as the event occurred near Christmas time. These same conditions that bring heavy rain to the Americas are associated with reduced rainfall or drought in Australia, particularly eastern Australia.

The process works like this. Normally, SSTs in the central and eastern equatorial Pacific are colder than at the western end, to the north east of Australia. This temperature gradient results in a corresponding air pressure gradient at the surface, with higher pressure in the east over the colder water and lower pressure in the west. The cool, dry air above the eastern waters thus flows westward along the surface toward the warmer western Pacific, creating the trade winds, which pick up moisture as they move over the warmer water. If this moisture is brought over the Australian land mass (e.g. by the action of a Tasman high) it can produce rain.

During an El Niño, sea surface temperatures in the central and eastern equatorial Pacific rise, and those in the western Pacific fall. The associated change in the pressure gradient reduces or even reverses the flow of the trade winds, while the reduced temperature also reduces the amount of moisture they can pick up in the western Pacific. The result is a reduction in the amount of moisture fed into weather systems over Australia, particularly by the Tasman highs, and rainfall is often less than average, especially in eastern Australia. The typical circulation pattern during an El Niño is shown in Figure 1.13.

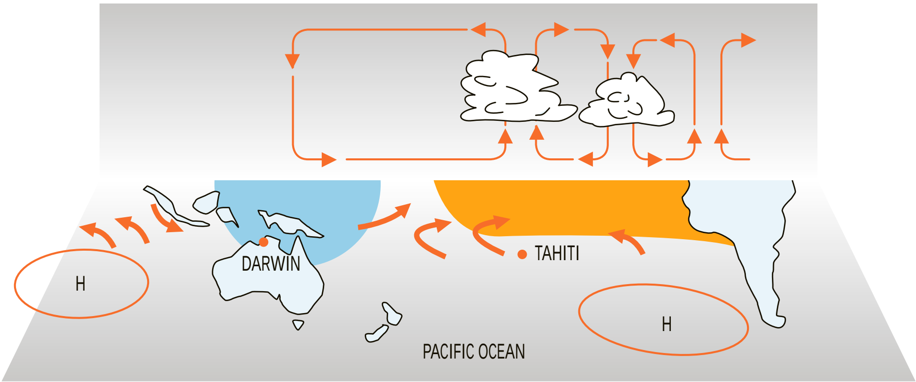


Figure 1.13 Circulation pattern during an El Niño event

Source: Climate Variability and El Niňo, Bureau of Meteorology 1994, Commonwealth of Australia.

After an El Niño event, weather conditions usually return to normal. However, in some years the easterly trade winds can become extremely strong and an abnormal accumulation of cold water can occur in the central and eastern Pacific. This event is called a La Niña and can be associated with above average rainfall in eastern Australia. The typical circulation pattern during such an event is shown in Figure 1.14.

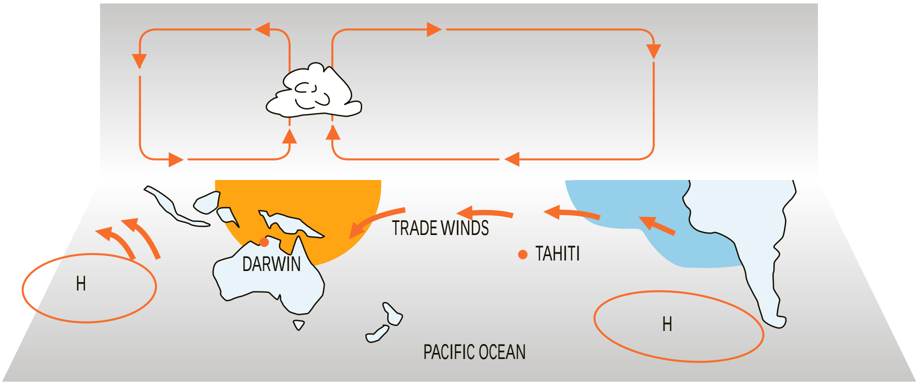


Figure 1.14 Circulation pattern during a La Niña event

Source: Climate Variability and El Nińo, Bureau of Meteorology 1994, Commonwealth of Australia.

Not all major droughts in eastern Australia have been associated with an El Niño but the majority have been. Equally, many but not all periods of high rainfall have been associated with La Niña.

The major impact of these events can be seen from Figure 1.15a and b. Note that the impact on western NSW can be high – the influence of El Niño and La Niña is certainly not restricted to northern Australia as some seem to believe.

Some other influences on seasonal conditions

The Madden-Julian Oscillation (MJO)

The MJO (also commonly known as the 40-day wave) is a tropical atmospheric phenomenon first recognised in the early 1970s. It is a small region of comparatively low pressure which develops over the Indian Ocean and travels east across the tropics with a timescale ranging from 30 to 60 days, and a frequency of 6–12 events per year.

It does not show up as a clear low in synoptic charts and can only be detected with sophisticated measuring and calculating techniques but it appears to assist the lifting of tropical moisture to where it can feed into Australian weather systems.

The location of the MJO can be linked with rainfall patterns, particularly in north eastern Australia. Although other synoptic factors ultimately determine rainfall, the relative position of the MJO can help forecast increased or decreased chance of rain, through its contribution to moisture supply as it traverses the tropics. Unfortunately the phenomenon has very little identified influence in western NSW as it rarely feeds systems which are the most common sources of rain in these regions.

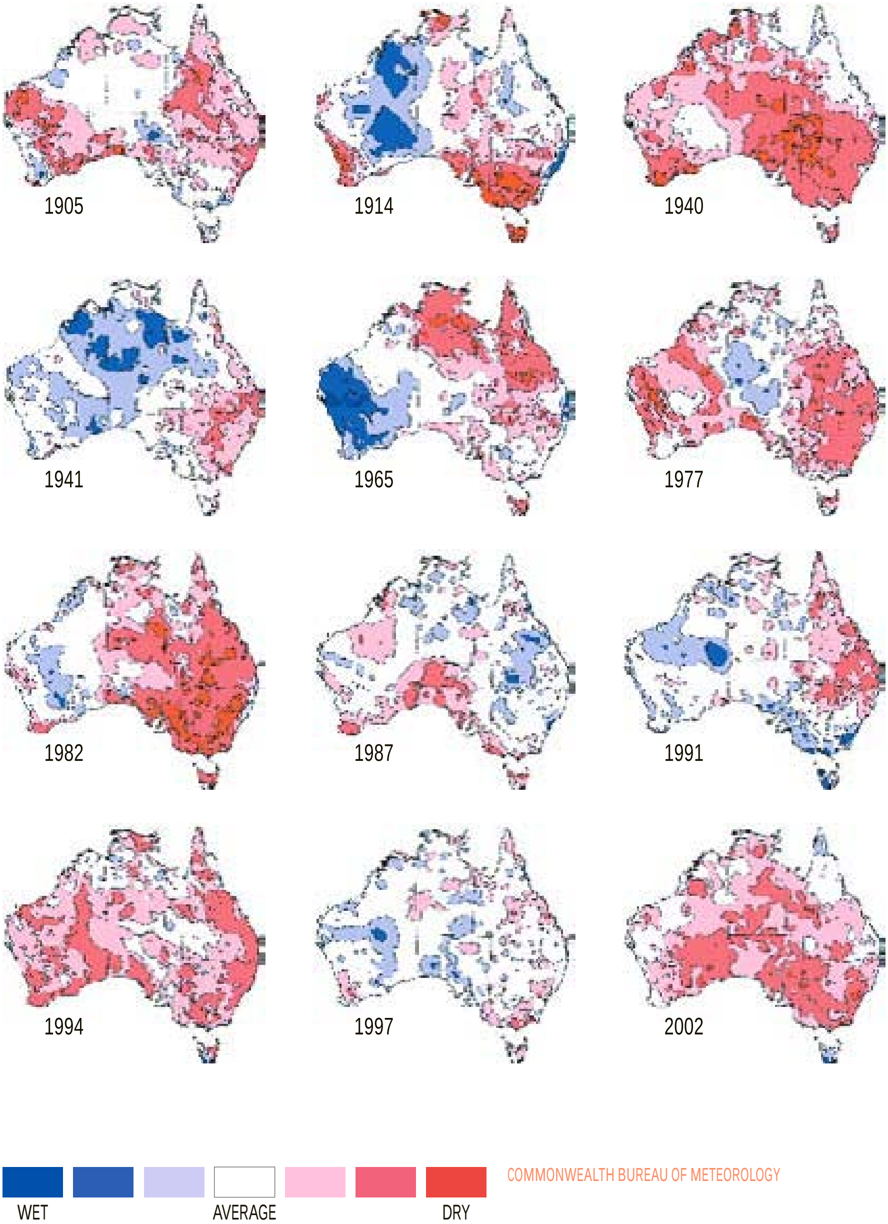


Figure 1.15a Impact of major El Niño events on Australian rainfall

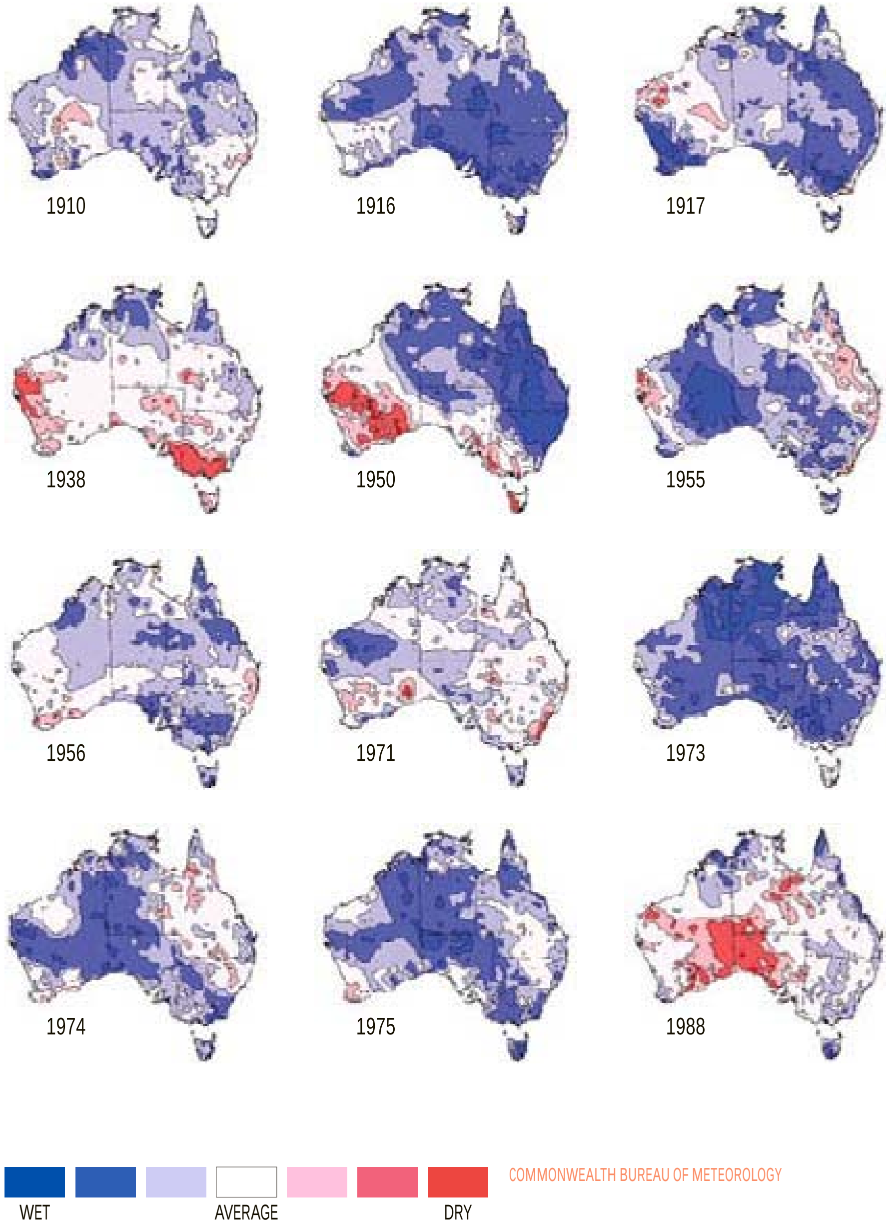


Figure 1.15b Impact of major La Niña events on Australian rainfall

Interdecadal Pacific Oscillation (IPO)

The IPO was first named in 1999 and is currently the subject of much research interest in Australia and New Zealand. The phenomenon is related to sea surface temperature changes on roughly decadal time scales. Indications are that the effects of the El Niño and La Niña phenomena on Australian rainfall may be modified depending on whether the IPO is in a 'warm' or 'cool' phase. In north west NSW the coincidence of El Niño with a cool phase of the IPO seems to produce particularly severe drought. However, other regions have different relationships between El Niño and the IPO so the overall situation is complex.

Unfortunately, while the current understanding of this phenomenon allows its influence to be demonstrated, it does not allow its fluctuations to be forecast. A more complete understanding may eventually lead to improved seasonal risk assessments but no account of its influence was possible in the preparation of this guide.

PART 2 – MANAGING CLIMATE RISK

- How do seasonal risk assessments fit into management? – tactical stocking decision or in-crop management decisions will benefit most
- Some basic concepts for interpreting weather records and understanding climate risk assessments – mean, median, deciles and probability
- Probability-based assessments and the accuracy question – probability-based assessments are neither right nor wrong, they just provide the odds
- What level of probability will change a decision? – many people would like at least 70% but smaller shifts could still be useful
- Using seasonal risk assessments in management – they're only one part of the jig saw but they can help make progressive adjustments
- Taking a calculated risk – even relatively small shifts in the odds may make a difference; its worth doing a simple calculation to find out

As part of the project we conducted surveys of wool producers in the Western Division and adjacent parts of the Central Division to determine how seasonal risk assessments might be incorporated into practical management. We also obtained feedback from our co-operators in response to newsletters, and from workshops. Some of the key issues raised by this interaction are discussed in this section.

How do seasonal risk assessments fit into management?

For livestock enterprises we found that the annual cycle of husbandry operations (e.g. time of joining, shearing etc.) was not likely to be influenced by assessments of medium term (3–6 months) climatic conditions. These dates are determined by other major factors in the production system such as the need to have lambs at a certain age by shearing, or the need to have sheep in short wool when grass seeds are likely to be a problem. Understandably, these major strategic decisions are not influenced by medium term seasonal outlooks. However, tactical decisions – particularly those related to livestock sales and other drought management decisions, and livestock purchases – are potentially very open to influence by seasonal outlook assessments.

For mixed farmers, major cropping decisions at the start of the season (e.g. the area to be planted) were found to be more influenced by actual conditions such as the depth of soil moisture or the quality of the seasonal break than by medium term climate outlooks. However, in-crop management decisions e.g. whether to apply additional nitrogen or to graze off a crop headed for failure could be influenced by seasonal outlooks.

For both crop and livestock operations then, tactical decisions are those most likely to benefit from medium term seasonal risk assessments. The tools that are discussed in the remainder of this booklet are particularly directed at these decisions

Some basic concepts

Risk is a mathematical or statistical concept and statistical terms inevitably crop up in any discussion about risk management. A few of these basic terms need to be understood. These include **average** (or mean), **median**, **decile** and **probability**.

The **average** is simply the sum of a set of figures divided by the number of figures in the set. It's the number we tend to think of most readily when trying to describe the 'typical' or 'expected' value. However, with some sets of numbers the average can be misleading. A common example is the average wage. You may notice that the average wage exceeds the wage of many people you know. The reason is that one individual with a very high income can distort the average. The same is true for the annual rainfall. One year of flooding rain in a dry climate can result in a misleading average.

A better way of describing annual rainfall is to use the **median**. This is the value that has 50 percent of years above it and 50 per cent below. For annual rainfall at most locations in Australia, the median is about 10 per cent less than the average and the difference can be much greater for individual months.

The number of years on which the average or median is based is very important. A few years can produce misleading figures. To have confidence in the figures it is desirable to have at least 50 years of records.

Deciles give an even better idea of how dry or wet a month, or year, has been relative to the historical record. All the rainfalls received (by year or month) are ranked in order from lowest to highest. The lowest 10 per cent are in decile range 1, the next 10 per cent are in decile range 2, and so on. The value that represents the top of the 5th decile range is the median. (Note that you can't simply add up all the monthly values in any decile range to get the yearly value – each analysis has to be done separately).

The concept of **probability** is fundamental to any discussion of risk management. This is simply the chance of some event occurring, usually expressed as a percentage from 0–100%, and is calculated by expressing the number of times a particular event is observed as a percentage of the total number of observations. In any set of numbers, the probability that any randomly selected number will be greater than the median is 50%. Likewise the probability that any randomly selected number will be equal to or less than the top of the 3rd decile range is 30%. The concept of probability – which only has meaning before the event occurs – inevitably embodies the idea of uncertainty for unless the probability is 100 % (absolute certainty of success) or 0% (absolute certainty of failure) there is always a chance that either success or failure may be the result of any trial, just as there is no way of guaranteeing that an odds-on favourite will win. In fact, it may be useful to think of probabilities as 'bookmaker's odds', which is essentially what they are. If, for example, there is a 20% chance of some event occurring, and therefore an 80 per cent chance that it will not occur, the odds of success are 1:4. The odds you would get from a bookmaker for a 'win' would be at best 4:1.

Probability-based assessments and the accuracy question

The seasonal risk assessments discussed in Part 4 are 'probability-based assessments'. They simply provide the probability of certain seasonal conditions being experienced in a given time period. In our case, they are expressed as the probability of exceeding median rainfall or median pasture growth for that period. When these probabilities are derived from historical records i.e. actual rainfall records or the modelled pasture growth profiles derived from historical rainfall and other environmental data, they are 'accurate' in the sense that they have been correctly calculated.

However, at any specific time there is no way of guaranteeing that a particular result will materialise even if the probability is high, These risk assessments are not predictions that can be assessed with hindsight as 'right' or 'wrong'. They simply provide the chances, based on history, of a particular result occurring.

During the project, many producers expressed concern about the 'accuracy' of the forecasts or risk assessments. But the discussion above makes it clear that the question is not really about 'accuracy' but the level of probability necessary for you to feel confident in making or changing a management decision.

For example, if the probability of exceeding median pasture growth in the next three months is around 50% (or in practice between 40 and 60%), you could not very confidently take a decision that depended on getting above-median growth even though the probability is correct. The historical record is simply telling us that the particular state of the SOI has very little influence on pasture growth for the time and place we are considering. You might as well flip a coin or better still look at the long-term rainfall records (see Part 3) to work out the probability of certain amounts of rain.

However, if the probability is above 70%, or less than 30%, we can feel a lot more confident in making a decision than we could be if we just flipped the coin. It is under these circumstances that probability-based forecasts really have something to offer.

Remember, failure of the favourite to win, or the failure of good seasons to eventuate despite a high probability, does not mean that the odds were 'wrong' or 'inaccurate' – even with a 90% chance of exceeding the median there is still a 10% chance that you won't get the result you want. Nevertheless, making a decision on the basis of known probabilities is a lot better than just flipping a coin – unless you know that the probability really is about 50 per cent.

What level of probability will change a decision?

During the project co-operators were asked 'if you could get a forecast showing probabilities for a more extreme year, what level of probability would be necessary before you changed your management?' The response shown in Figure 2.1 indicates that the majority of respondents would like to know that the probability of an extreme year (in this case a year in either the top or bottom 20 per cent of the historical record) is about 70% to 80% before they would change tack from normal management.

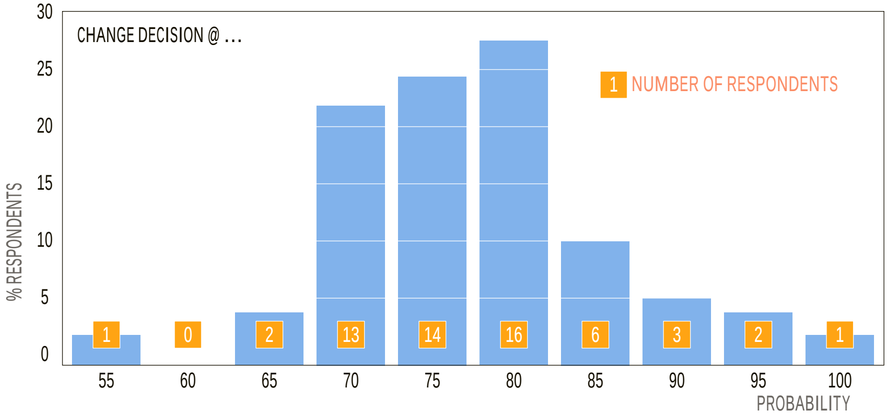


Figure 2.1 Effect of seasonal risk probability on the proportion of wool growers willing to change management decisions

The risk assessments provided in this booklet are based on the probability of exceeding the median value (i.e. the 50th percentile), not the 20th or 80th percentiles. We expect therefore that the majority of producers would like to see probabilities of at least 70–80% before management would be changed, although some recent evidence suggests that those who are familiar with seasonal risk assessments are prepared to act on lower probabilities (P. Leith, *personal commumication*, 2004) . Given the current risk assessment capability, probabilities of this magnitude are not going to occur very often. When they do, some early management changes and intense monitoring of stock, soil moisture and plant health would be very wise. We would suggest that managers look for small changes that may be implemented at lower probabilities (about 65%) as this level still has odds of 2:1.

Using seasonal risk assessments in management

Probability-based seasonal risk assessments are only one piece of information in the jigsaw of data that determines most management decisions. Furthermore, using probabilities is much more difficult than using predictions (assuming these were possible for medium range climatic outlooks) since there is always a (known) chance that the result we don't want will occur.

Nevertheless, managers in other industries use these sorts of outlooks by making small adjustments to management early and by increasing the monitoring of the production system to get early warning of when things are being stressed, making further adjustments to reduce the stress when it shows up and getting updated outlooks as they go along.

These managers also accept that sometimes their decisions will turn out to be wrong – that the early management changes were really not necessary and that they have probably missed an opportunity for extra production and profit. They are ready to accept this because they know that if you adjust things according to the outlooks you will be right more often than you are wrong and you will save much more by not having to prop up or repair the production system than you will pass up in lost opportunities.

Agricultural managers can use the same techniques. You need to carefully assess the actual situation in the paddock, add in the chance of the coming season being wet or dry and, if reasonable, make a small adjustment to your plans. Monitor both the paddock and the updated outlooks and revise the plans regularly.

While it would be nice to always have probabilities of at least 70–80 per cent, many small but important changes could sensibly be made at slightly lower probabilities These may include things like selling a portion of normal annual sales at earlier times, changing shearing date, if possible, to have stock in a condition which will allow sales if this becomes necessary, purchasing and storing some fodder while it is relatively cheap, talking to your financier about the possibility of accessing more funds or rescheduling payments, de-stocking small areas to allow pasture or browse to freshen up, harvesting feral animals to reduce grazing pressure or finding agistment for your core stock.

Taking a calculated risk

Almost everyone uses this phrase but few people have actually taken a calculated risk.

To do so you need to estimate the likely net returns from each of the possible outcomes and the odds of each of those outcomes.

Using a livestock example, say the SOI Phase is indicating a 65% chance that the next three months will be dry and you look at the choice between carrying on normally or selling half your usual sale stock early.

If you carry on normally and the season turns out OK you expect a net income of $20,000 from sales but if the season turns out dry it will cost you $10,000 in feed, lower growth and poor reproduction from retained stock so the net income is only $10,000.

Lets assume, for the sake of simplicity, that if you decide to sell early and it turns out to be the right decision your net income will be same as if you carried on normally and that was the right decision. However, if you sell early and it turns out to be the wrong decision then you will incur a cost of $15,000 and end up with a net income of only $5000.

So the possibilities you are facing are:

OPTION	NET INCOME $	PROBABILITY
Carry on, correct decision	20,000	0.35
Carry on, incorrect decision	10,000	0.65
Change, correct decision	20,000	0.65
Change, incorrect decision	5,000	0.35

The 'expected benefit' of *carrying on* is
(20,000 x 0.35) + (10,000 x 0.65) = $13,500.

The 'expected benefit' of *changing* is
(20,000 x 0.65) + (5000 x 0.35) = $14,750.

So even though it would be tempting to take the risk on a smaller cost by carrying on as normal ($10,000 compared with $15,000) when you consider the chances of the various outcomes the least risky decision is still to make the change.

The shift in odds from an assumed base of 50% to 65% doesn't seem very great but in fact the change is from 50:50 to 65:35. This is from evens to about 2:1. This shift in odds is big enough to outweigh the difference in costs.

As this shift in odds increases, so the benefit of the change increases rapidly, For example if the probability of a dry season is 75% then the relative benefits in the above example would be $12,500 (carry on normally) and $16,250 (change).

To take a truly calculated risk you need to estimate the expected benefit, or risk, on each side of the alternative actions and compare them. The result might surprise you.

PART 3 –
USING HISTORICAL RAINFALL DATA

- Analysis of historical rainfall data is particularly useful when other seasonal indicators are unreliable
- For the moment historical data still provide the best means of describing the climatic characteristics of a location despite the evidence for global climate change
- Diagrams and tables summarising historical rainfall data for 12 locations in western NSW

Background

Historical rainfall data can provide a useful guide to the range and variability of weather in the medium-term future; especially at those times when the seasonal assessments discussed in Part 4 are unreliable. A history of 100 years or more will probably encompass almost the entire range that will be experienced over the next 10 years. While we need to be mindful of the possible effects of climate change (see below) a record of this length provides the best indication we have of the likely frequency and magnitude of extreme events, though it can not provide any real clues about when they might occur.

Monthly median values provide a good description of the long-term climate at any location and provide a reference point for seasonal forecasts that are expressed in terms of probability of exceeding the median (though remember that the median for a period of several months is not the same as the sum of the monthly medians). Monthly medians are summarised for 12 locations in western NSW in Figure 3.1.

Monthly deciles are particularly useful as they allow you to estimate the probability – the 'bookmaker's odds' – of receiving any amount of rain in any month of the year. If you feel inclined you might even adjust the odds slightly according to the SOI at times of the year when it is a good indicator (as discussed in Part 4). The tables in this section provide monthly rainfall deciles, and other information, for the 12 locations shown in Figure 3.1. The decile values are presented as the % of years in which rainfall has been equal to or greater than the figure shown. At Bourke, for example, January rainfall has been equal to or greater than 29 mm in 40% of years. In other words there is a 40 per cent chance of getting 29 mm or more of rainfall in January, based on the historical record. The standard deviation given in the tables is a measure of the variability of rainfall from year to year – the higher the figure the more variable the rainfall. The standard deviation expressed as a percentage of the mean (called the Coefficient of Variation) is a good way of comparing the relative variability from month to month.

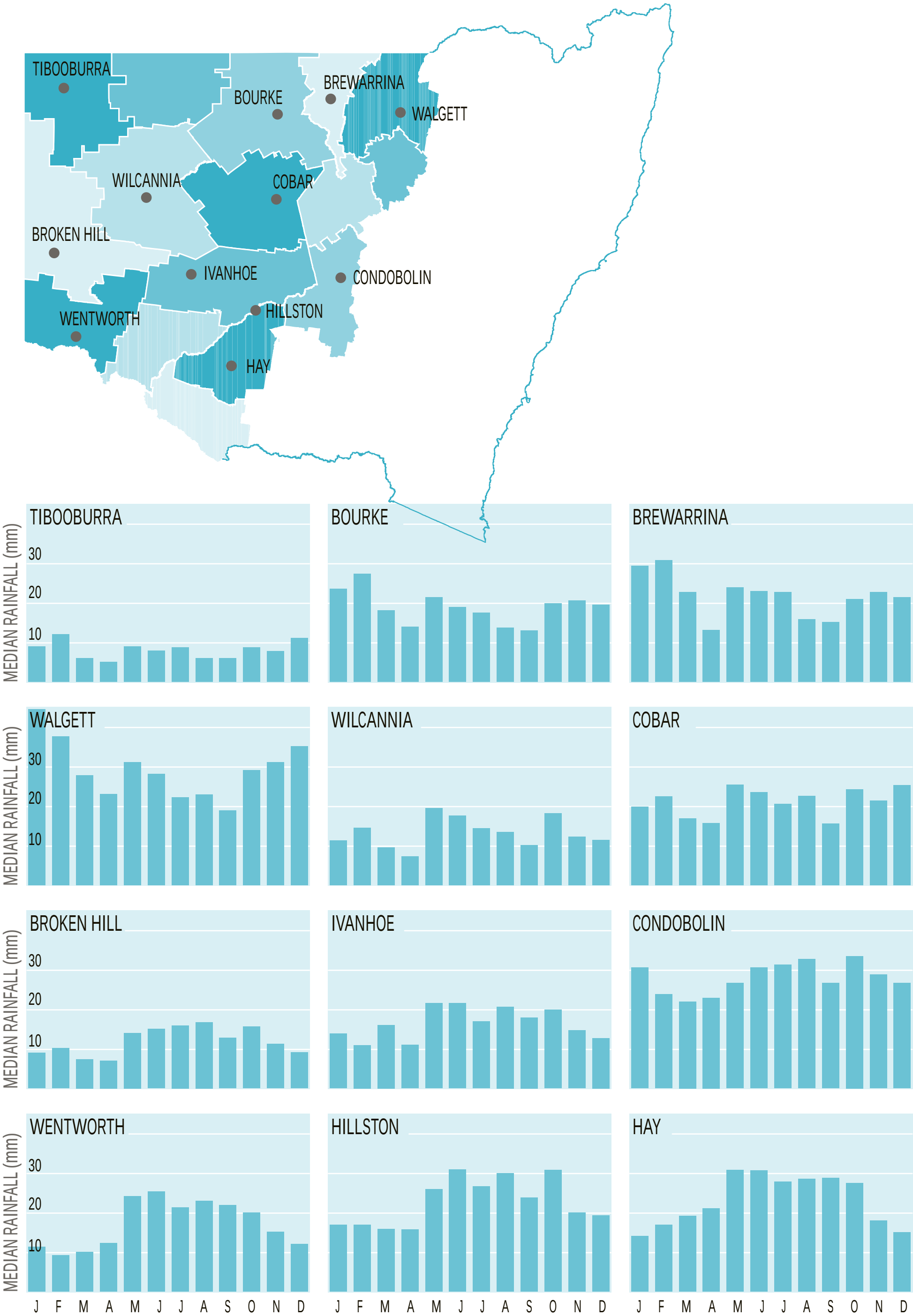


Figure 3.1 Median monthly rainfall for locations in western NSW

Table 3.1 Monthly rainfall deciles for 12 locations across the project area. Tables have been reproduced from *Rainman Streamflow Version 4.3* (The State of Queensland, Department of Primary Industries, June 2003)

Probabilities of monthly rainfall recorded at BOURKE POST OFFICE
Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	0	0	0	0	0	0	0	103
90% yrs at least	1	1	0	0	1	2	1	1	1	3	1	1	172
80% yrs at least	5	5	3	1	3	6	2	3	3	5	5	5	207
70% yrs at least	7	10	5	3	10	9	8	6	5	11	9	10	258
60% yrs at least	13	17	10	6	15	14	13	9	10	17	13	17	286
median, 50% yrs at least	24	28	18	14	21	19	18	14	13	20	21	20	338
40% yrs at least	29	37	24	21	27	27	21	18	18	27	28	34	374
30% yrs at least	40	51	37	35	41	34	28	25	27	34	35	41	419
20% yrs at least	55	68	47	47	47	45	42	36	38	41	47	51	487
10% yrs at least	95	94	101	77	62	58	54	49	51	59	83	76	583
Highest on record	206	283	224	205	196	128	169	99	106	154	159	169	856
Mean	37	41	35	28	30	27	24	20	20	27	30	32	353
Standard Deviation	48	49	48	40	32	25	26	21	21	26	33	33	152

Probabilities of monthly rainfall recorded at BREWARRINA POST OFFICE
Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	0	0	0	0	0	0	0	115
90% yrs at least	4	1	1	0	0	4	2	0	1	2	1	2	218
80% yrs at least	7	6	4	2	5	8	6	2	3	6	6	6	256
70% yrs at least	13	14	9	5	11	13	11	6	6	10	11	10	323
60% yrs at least	22	21	16	9	16	18	18	11	10	15	16	17	372
median, 50% yrs at least	30	31	23	13	24	23	23	16	15	21	23	22	393
40% yrs at least	39	45	32	25	30	30	29	22	19	28	31	30	422
30% yrs at least	50	60	39	36	36	42	35	26	27	37	39	47	452
20% yrs at least	80	83	63	56	51	52	45	36	42	50	52	63	559
10% yrs at least	129	123	97	86	80	74	68	57	60	68	74	82	634
Highest on record	354	324	274	304	194	192	153	97	169	220	229	206	941
Mean	51	49	39	31	32	33	30	22	25	30	33	36	410
Standard Deviation	63	54	50	42	34	31	29	23	30	31	37	38	161

Probabilities of monthly rainfall recorded at BROKEN HILL (PATTON STREET)

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	0	0	0	0	0	0	0	57
90% yrs at least	0	0	0	0	1	2	2	3	2	2	1	0	135
80% yrs at least	2	1	1	1	3	5	4	6	4	7	2	2	166
70% yrs at least	3	4	2	2	6	8	7	8	7	10	4	4	188
60% yrs at least	5	6	4	4	9	10	10	12	11	13	8	6	221
median, 50% yrs at least	9	10	7	7	14	15	16	17	13	16	11	9	242
40% yrs at least	16	17	13	14	21	20	20	18	16	25	16	15	258
30% yrs at least	26	25	18	20	30	25	24	24	25	32	23	19	296
20% yrs at least	37	41	30	31	40	37	31	29	33	44	31	32	319
10% yrs at least	72	73	57	45	59	46	39	41	46	56	48	61	393
Highest on record	216	112	259	219	93	149	89	91	155	129	122	180	839
Mean	23	24	19	18	23	21	19	19	20	25	20	21	254
Standard Deviation	34	30	32	28	24	22	17	16	23	24	24	31	111

Probabilities of monthly rainfall recorded at COBAR MO COMPOSITE

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years (1881–1965 Cobar PO, 1962–2004 Cobar MO)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	0	0	0	0	0	0	0	101
90% yrs at least	3	1	0	0	1	4	2	4	3	4	3	3	183
80% yrs at least	5	4	2	2	8	8	6	10	6	8	5	8	241
70% yrs at least	7	8	5	5	11	13	11	15	9	13	10	10	272
60% yrs at least	12	14	10	8	15	17	17	17	13	20	16	17	313
median, 50% yrs at least	20	23	17	16	26	24	21	23	16	25	22	26	354
40% yrs at least	31	30	28	20	32	30	26	27	22	32	26	32	391
30% yrs at least	41	46	40	30	38	36	31	39	27	43	37	43	434
20% yrs at least	60	59	50	44	50	46	42	49	35	51	54	58	497
10% yrs at least	97	116	74	69	65	64	54	63	51	78	69	86	593
Highest on record	240	281	238	201	144	104	102	114	105	131	157	158	800
Mean	37	39	32	27	30	29	26	29	23	32	31	35	372
Standard Deviation	47	48	42	35	27	24	22	24	22	28	32	35	156

Probabilities of monthly rainfall recorded at CONDOBOLIN POST OFFICE

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	2	0	0	0	0	0	0	210
90% yrs at least	3	2	1	2	7	10	6	8	9	8	5	4	287
80% yrs at least	7	5	4	6	14	14	12	15	12	16	9	8	319
70% yrs at least	14	9	10	11	18	17	19	21	14	22	13	15	339
60% yrs at least	23	15	16	15	23	24	24	27	20	29	20	20	384
median, 50% yrs at least	31	24	22	23	27	31	32	33	27	34	29	27	424
40% yrs at least	38	40	29	30	36	37	36	37	31	44	35	35	462
30% yrs at least	50	48	39	41	47	43	42	46	35	52	45	55	523
20% yrs at least	71	68	58	54	55	51	54	55	44	64	60	68	579
10% yrs at least	96	91	88	76	76	74	71	69	66	88	79	96	641
Highest on record	255	255	254	256	138	125	111	125	121	155	127	197	904
Mean	45	39	37	35	36	36	34	36	32	42	35	40	448
Standard Deviation	49	42	45	41	28	26	24	24	24	33	30	39	144

Probabilities of monthly rainfall recorded at HAY POST OFFICE

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	2	1	0	1	0	0	0	157
90% yrs at least	1	1	0	2	7	9	7	9	8	9	3	2	221
80% yrs at least	3	2	2	6	13	17	13	15	11	13	7	4	268
70% yrs at least	7	6	7	9	17	21	17	20	17	18	11	7	290
60% yrs at least	11	9	13	13	23	26	22	25	22	23	13	10	333
median, 50% yrs at least	14	17	19	21	31	31	28	29	29	28	18	15	363
40% yrs at least	22	24	24	27	37	36	34	34	33	31	22	20	389
30% yrs at least	33	32	32	35	44	47	39	42	38	42	27	29	416
20% yrs at least	48	43	42	48	53	56	45	48	43	63	38	42	450
10% yrs at least	69	71	71	72	68	68	59	61	62	80	49	67	490
Highest on record	191	204	200	151	134	116	101	108	106	150	152	152	837
Mean	27	28	29	30	36	36	31	33	31	36	24	26	369
Standard Deviation	32	36	37	31	29	23	22	20	22	30	25	30	127

Probabilities of monthly rainfall recorded at HILLSTON POST OFFICE

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	1	0	0	0	0	0	0	102
90% yrs at least	1	0	0	1	3	6	5	6	8	6	3	3	218
80% yrs at least	4	2	4	4	10	11	10	13	11	12	5	6	264
70% yrs at least	8	5	5	9	16	18	16	18	16	16	8	10	305
60% yrs at least	13	12	11	13	20	25	21	25	19	24	13	15	330
median, 50% yrs at least	17	17	16	16	26	31	27	30	24	31	20	19	358
40% yrs at least	24	21	24	26	35	38	32	36	28	36	28	27	393
30% yrs at least	31	30	39	35	45	46	39	42	32	46	34	40	421
20% yrs at least	52	43	59	47	56	54	50	50	37	55	48	52	475
10% yrs at least	83	73	88	65	74	62	61	60	49	70	63	73	533
Highest on record	213	184	218	182	106	123	103	84	151	128	149	107	712
Mean	31	28	32	28	33	34	30	31	28	36	27	29	370
Standard Deviation	39	35	41	32	26	24	23	20	21	28	27	27	126

Probabilities of monthly rainfall recorded at IVANHOE POST OFFICE

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	0	0	0	0	0	0	0	69
90% yrs at least	1	0	0	0	1	4	3	3	4	5	1	1	163
80% yrs at least	2	2	2	2	7	9	6	7	7	10	3	3	208
70% yrs at least	5	5	6	4	10	13	11	11	9	13	6	7	232
60% yrs at least	8	8	10	8	14	18	14	17	13	18	9	11	257
median, 50% yrs at least	14	11	16	11	22	22	17	21	18	20	15	13	290
40% yrs at least	18	19	21	17	31	27	23	25	21	27	20	18	323
30% yrs at least	30	32	27	22	37	31	27	30	25	35	29	33	349
20% yrs at least	48	46	39	28	43	42	35	41	31	45	41	47	378
10% yrs at least	80	76	73	46	59	57	50	53	49	63	58	74	471
Highest on record	210	217	187	179	124	144	108	71	95	132	120	151	880
Mean	29	27	28	19	27	26	22	24	22	28	23	27	305
Standard Deviation	41	35	37	26	24	22	19	18	20	25	25	32	129

Probabilities of monthly rainfall recorded at TIBOOBURRA POST OFFICE

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	0	0	0	0	0	0	0	48
90% yrs at least	0	0	0	0	0	0	0	0	0	0	0	0	97
80% yrs at least	1	1	0	0	0	1	0	1	0	2	1	2	126
70% yrs at least	3	3	1	0	3	3	2	2	1	3	3	4	146
60% yrs at least	5	7	3	2	5	5	4	4	3	5	5	7	165
median, 50% yrs at least	9	12	6	5	9	8	9	6	6	9	8	11	201
40% yrs at least	15	21	11	8	15	13	11	8	9	14	12	18	223
30% yrs at least	29	26	18	16	25	21	18	14	14	20	16	25	281
20% yrs at least	45	45	38	31	33	30	30	22	21	34	27	37	322
10% yrs at least	78	79	61	58	45	42	44	28	33	52	46	58	393
Highest on record	385	178	398	125	95	127	92	59	140	110	87	124	757
Mean	29	29	24	16	18	17	16	11	12	18	15	21	228
Standard Deviation	51	43	50	25	23	21	21	13	19	22	19	26	129

Probabilities of monthly rainfall recorded at WALGETT POST OFFICE

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	0	0	0	0	0	0	0	172
90% yrs at least	10	5	1	1	1	5	3	2	2	4	4	4	267
80% yrs at least	17	11	5	4	7	10	8	5	6	13	11	11	334
70% yrs at least	27	18	11	8	14	15	13	12	10	20	16	17	365
60% yrs at least	34	26	19	14	22	20	18	17	14	25	23	25	408
median, 50% yrs at least	45	38	28	23	31	28	22	23	19	29	31	35	491
40% yrs at least	64	50	43	30	41	34	32	27	23	35	38	43	521
30% yrs at least	76	63	52	40	53	43	44	32	32	42	49	54	554
20% yrs at least	98	95	65	53	64	59	56	42	42	58	59	67	609
10% yrs at least	148	139	90	87	95	82	73	66	59	82	79	81	673
Highest on record	345	239	216	233	182	125	178	137	191	231	177	201	921
Mean	64	56	40	34	40	35	33	29	27	38	39	41	476
Standard Deviation	60	55	40	40	38	29	31	28	28	35	36	34	159

Probabilities of monthly rainfall recorded at WENTWORTH POST OFFICE

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	0	1	0	0	0	0	0	104
90% yrs at least	0	0	0	0	4	4	6	5	6	4	2	1	182
80% yrs at least	2	1	1	2	7	9	11	9	9	10	5	3	215
70% yrs at least	4	3	4	5	11	13	13	14	14	12	9	6	240
60% yrs at least	8	6	6	7	17	18	17	18	19	17	12	8	262
median, 50% yrs at least	11	9	10	12	24	25	21	23	22	20	15	12	278
40% yrs at least	17	16	15	16	29	30	27	31	27	27	20	16	301
30% yrs at least	25	23	20	21	34	34	31	35	31	32	28	25	320
20% yrs at least	34	39	30	26	43	38	35	42	38	42	40	33	347
10% yrs at least	60	57	53	39	69	61	48	50	55	62	56	52	395
Highest on record	106	222	145	118	150	90	85	92	109	121	107	198	705
Mean	21	22	19	18	28	27	24	26	27	28	24	21	287
Standard Deviation	25	32	26	21	25	21	16	18	21	25	23	27	100

Probabilities of monthly rainfall recorded at WILCANNIA POST OFFICE

Amounts of rain (mm) received or exceeded in 100%, 90% … 0% of years

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lowest on record	0	0	0	0	0	0	0	0	0	0	0	0	67
90% yrs at least	0	0	0	0	0	2	1	1	2	1	0	0	133
80% yrs at least	1	1	1	1	4	5	3	3	3	5	2	2	166
70% yrs at least	3	4	3	2	9	8	6	6	5	10	4	4	183
60% yrs at least	6	6	5	4	13	11	10	10	7	14	8	7	213
median, 50% yrs at least	11	14	9	7	19	17	14	13	10	18	12	11	251
40% yrs at least	15	20	16	13	25	22	18	18	14	21	19	15	275
30% yrs at least	23	28	21	19	34	27	22	22	18	30	26	28	298
20% yrs at least	39	43	34	27	43	36	29	28	30	42	33	44	354
10% yrs at least	68	80	45	53	53	49	44	43	38	67	48	71	407
Highest on record	236	185	325	181	113	102	84	84	86	126	95	252	680
Mean	25	26	23	28	24	22	18	18	16	26	20	26	261
Standard Deviation	40	34	43	25	22	20	17	18	17	25	22	40	117

A comment on climate change

There is increasing evidence that the global climate is in a state of rapid change, influenced strongly by 'greenhouse' gasses produced by human activity. These changes are likely to continue for at least the next 100 years.

The result has been rapidly increasing temperatures and, as discussed in Part 1, temperature strongly influences the processes that create rainfall, as well as evaporation and the biological activity of plants and animals. This means that climate change needs to be considered when making long-term plans (ten years or more) as future temperature and rainfall conditions may vary from the ranges experienced in the past. Nevertheless, for the moment, the historical record provides the best means we have of describing the climatic characteristics of a location. Managing the impact of climatic variability will continue to be essential for sustainable business practice. Informed analysis and use of historical data will be an essential component of this management.

PART 4 –
SEASONAL RISK ASSESSMENT

- The SOI Phase system is the best currently available for western NSW but it is more reliable in winter and spring than at other times
- The SOI Phase system is more reliable for (simulated) pasture growth – essentially 'effective rainfall' – than for actual rainfall
- It's worthwhile checking the SOI phase in June, July, August and September in particular. Enter the 'LongPaddock' website **http://www.LongPaddock.qld.gov.au/RainfallAndPastureGrowth/NSW** as a favourite in your browser to ensure that you know the current SOI phase (click on **SOI Phase**).
- Probabilities of exceeding median pasture growth will tend to be low in phase 1, and high in phase 2; probabilities around 50% don't mean you should expect average conditions, just that the SOI phase is not telling you much about likely future conditions
- Maps showing the **historical** probability of pasture growth exceeding the median for 3 month periods, with lead times up to two months, based on the SOI Phase observed in June, July, August and September.

  Note that **current** probabilities for risk assessments with zero lead time are preferable to the **historical** probabilities and maybe accessed through the LongPaddock site **http://www.LongPaddock.qld.gov.au/RainfallAndPastureGrowth/** (follow the links to **NSW/PastureGrowth SeasonalProbability**)

Background

In western NSW the **SOI phase system** provides the best seasonal risk assessments currently available. Testing of this system during the project, and the alternative **SST (sea surface temperature) phase system**, in terms of the association between the indicator and future rainfall or (modelled) pasture growth based on historical records, supports this conclusion. In undertaking this testing, however, rainfall or pasture growth is not expressed in absolute terms but simply as being above or below the median value for the particular time, place and assessment period.

Risk assessments provided by the system are therefore expressed in terms of the **probability of exceeding the median**.

SOI phases

There are five recognised phases of the SOI

PHASE 1	Consistently negative	PHASE 2	Consistently positive
PHASE 3	Rapidly falling	PHASE 4	Rapidly rising
PHASE 5	Consistently near zero		

The current phase is determined on the first day of each month, based on the trend in SOI over the previous two months. The current phase can be found at **http://www.LongPaddock.qld.gov.au/RainfallAndPastureGrowth/NSW** (click on SOI Phase)

More detailed SOI numbers can be found at: **http://www.LongPaddock.qld.gov.au/SeasonalClimateOutlook/SouthernOscillationIndex/SOIDataFiles/**

Importantly, the strength of the SOI phase system in western NSW is actually greater for pasture growth than for rainfall. The data used to test this association were derived from a computer simulation model (called GRASP, for Grass Production) that calculates daily pasture growth from daily inputs of rainfall, temperature, evaporation and solar radiation. These calculations may be carried out for any particular location – defined by soil type and vegetation characteristics – and for as long as climate records are available.

The relationships that are encapsulated in the GRASP model are shown in Figure 4.1. An example of the results is shown in Figure 4.2, taken from the model output for Hillston.

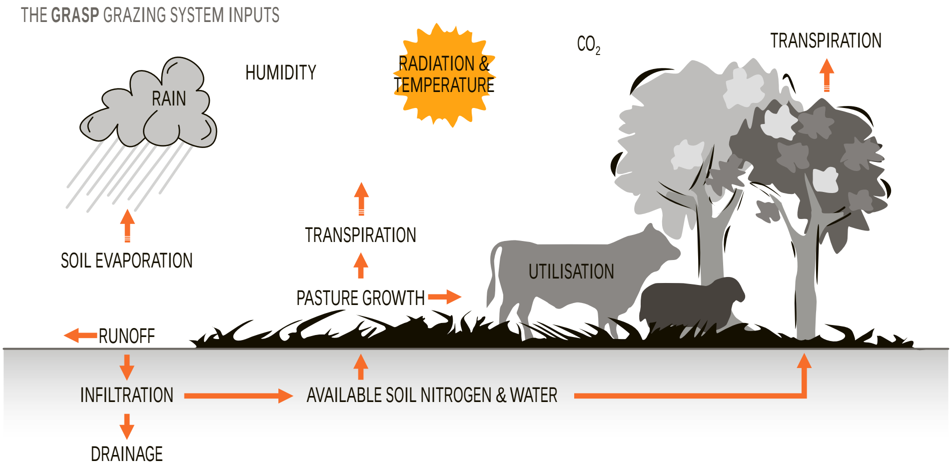


Figure 4.1 Schematic representation of the GRASP pasture model
Source: Queensland Department of Natural Resources and Mines

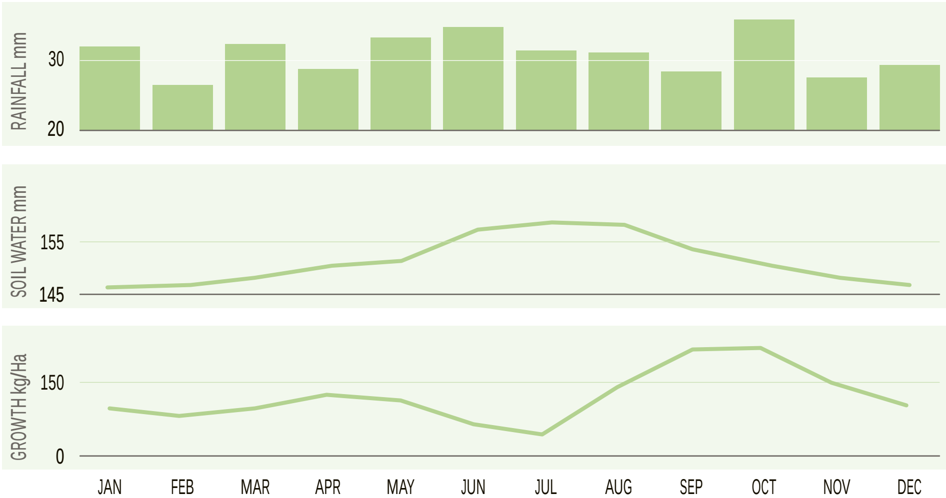


Figure 4.2 An example of long-term (1889–2004) monthly averages of rainfall (from the historical record) and soil moisture and pasture growth derived from the GRASP model. Soil moisture and pasture growth averages are derived from the daily output of the model over the entire historical record. On average, pasture growth drops in winter allowing soil moisture to rise which in turn allows rapid growth in spring. Soil moisture drops in late spring to early summer despite high rainfall in October due probably to increased evapotranspiration.

The stronger association with pasture growth means that the SOI phase is more strongly related to **effective rainfall** than to actual rainfall because calculated pasture growth, taking into account the factors shown in Figure 4.1, is the best measure of effective rainfall.

Unfortunately, the strength of this association, and hence the value of the risk assessment that can be provided, is not uniform across western NSW or at all times of the year. It also varies depending on the how far in advance the assessment is made i.e. the lead time or the number of months between the **SOI phase period** and the **outlook period**. The relationship also varies depending on the length of the outlook period but this is usually standardised to three months.

Generally, the association is strongest:

- in the winter-spring period, particularly from June to September and
- for outlook periods that immediately follow the indicator period (i.e. zero lead time) although some useful relationships exists for lead times out to two months.

At other times the relationship is weaker and/or less coherent over extensive areas. While it may still be useful at particular times or places it is not considered sufficiently strong or spatially uniform to be include here. The pattern of variation in the strength of the relationship over the year can be seen in Appendix 1.

(Note that when pasture growth is the variable of interest 'skill' scores similar to those shown in Appendix 1 cannot be calculated for risk assessments with lead times longer than zero months. The inclusion of some risk assessments with longer lead times in this section is based on other measures of the relationship between SOI phase and pasture growth. All risk assessments based on pasture growth are currently regarded as experimental prototypes.)

The stronger association in winter and spring is understandable when we consider the major sources of moisture discussed in Part 1. In winter and spring the Tasman highs are the major systems feeding moisture into western NSW. Their capacity to do so will be related to surface temperatures in the Coral Sea and adjacent waters, which in turn will be reflected, albeit indirectly, in the SOI.

Even in winter and spring the probability of exceeding median pasture growth will not be high, or low, in all years. The probability tends to be low in phase 1 (consistently negative) and high in phase 2 (consistently positive). In the other three phases the probabilities are often around 40–60 per cent. While probabilities of this order are not as high as most people would like it is still useful to know what the figure actually is. Note that when the probability of exceeding the median is about 50% it **does not mean that we can expect average conditions**. Pasture growth could be well above or well below the median – it's just that the SOI Phase is not providing a strong indication one way or the other. Under these conditions it will be useful to consult the historical climate data given in Part 3.

The figures numbered 1 to 45 at the end of this section show the seasonal risk assessments – the probability of exceeding median pasture growth – for each phase of the SOI and for those three monthly outlook periods where the relationship between pasture growth and SOI phase is reasonably strong. Only the area covered by the project is shown in these figures.

Table 4.1 shows how these figures can be used to obtain the **historical probability of exceeding median pasture growth**. Simply look up the figure – given by the number in the table – corresponding to

- the current month
- the 3-month outlook period of interest and
- the current SOI phase.

For example: If the SOI is in phase 1 in August (based on the SOI pattern in June-July), the historical probability of pasture growth exceeding the median in the 3-month period October-December is given by Figure 26.

Make sure the site **http://www.LongPaddock.qld.gov.au/RainfallAndPastureGrowth/NSW** is entered as a favourite in your browser so you can readily determine the current SOI Phase.

Table 4.1 Index of figures showing the probability of exceeding median pasture growth for various outlook periods and SOI phases.

CURRENT MONTH	OUTLOOK PERIOD (CALENDAR MONTHS)	SOI PHASE				
		1	2	3	4	5
JUNE	J J A	1	2	3	4	5
JULY	J A S	6	7	8	9	10
	A S O	11	12	13	14	15
AUGUST	A S O	16	17	18	19	20
	S O N	21	22	23	24	25
	O N D	26	27	28	29	30
SEPTEMBER	S O N	31	32	33	34	35
	O N D	36	37	38	39	40
	N D J	41	42	43	44	45

SOI PHASE
1 – consistently negative
2 – consistently positive
3 – rapidly falling
4 – rapidly rising
5 – consistantly near zero

Similar information for rainfall is not presented in this guide because, as explained earlier, the relationship between SOI phase and rainfall is weaker than for pasture growth although the variation in the relationship throughout the year is similar. If you wish to obtain comparable information for rainfall refer to **http://www.LongPaddock.qld.gov.au/SeasonalClimateOutlook/RainfallProbability/**

In figures 1 to 45 the boundaries correspond to the Rural Lands Protection Boards included within the project area, as shown in Figure 4.3.

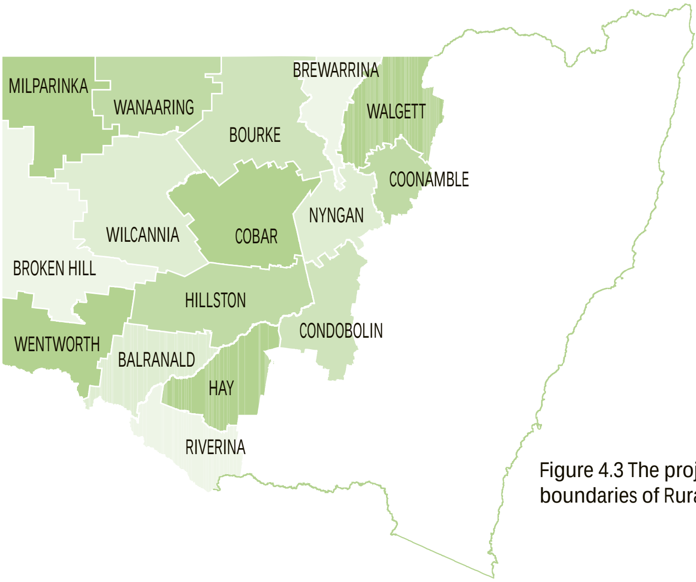


Figure 4.3 The project area, showing boundaries of Rural Lands Protection Boards

Important note

Although the following figures indicate the **historical probability of exceeding median pasture growth**, based on long-term growth simulation, the actual pasture growth outlook for the next three months is also influenced by the amount of pasture actually on hand and the amount of soil moisture available for plant growth at the start of the period. In particular, the probability of exceeding median growth may be lower than the historical figure following a prolonged dry spell, and may be higher than the historical figure if a good flush of growth is already present. Landholders should make some allowance for these effects when interpreting the historical probabilities.

For assessments with zero lead time, it is possible to calculate the **current probabilities**, (i.e. accounting for current growth conditions), by running the GRASP model forward from the present date, using actual rainfall data from each of those years in the historical record having the same SOI phase as the current year.

These probabilities are preferable to the historical figures for **zero lead time** assessments.

They can be found at **http://www.LongPaddock.qld.gov.au/RainfallAndPastureGrowth/** and are updated monthly. Follow the links to **NSW/PastureGrowth SeasonalProbability**.

You can see the skill associated with these probabilities by following the link to **NSW/PastureGrowth_SeasonalProbability_SkillScore**.

No **current probabilities** are available for 1 or 2 month lead times, and for these assessments the historical probabilities shown here are the best available.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

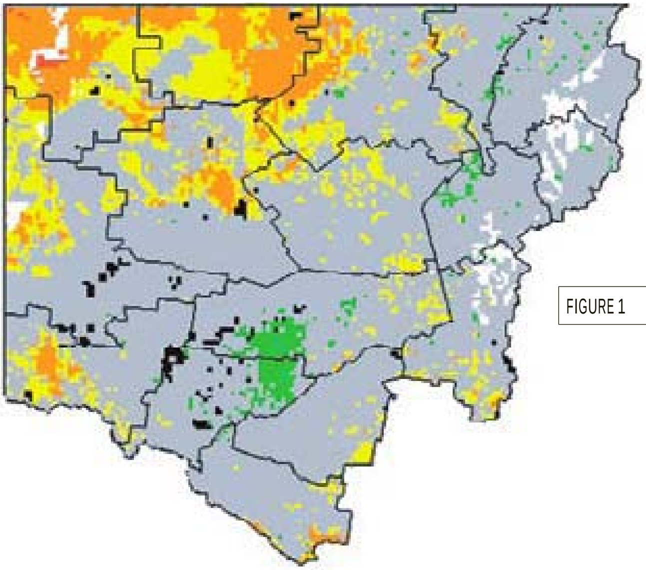


FIGURE 1	CURRENT MONTH	June
	OUTLOOK PERIOD	June, July, August
	SOI PHASE	1

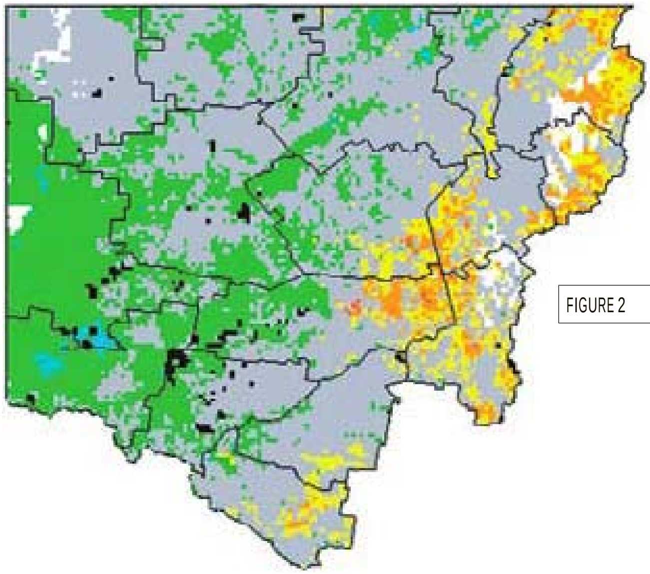


FIGURE 2	CURRENT MONTH	June
	OUTLOOK PERIOD	June, July, August
	SOI PHASE	2

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

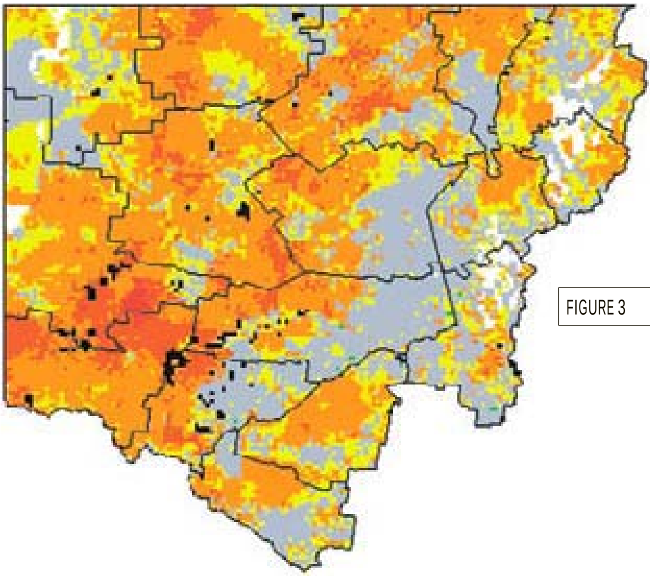


FIGURE 3	CURRENT MONTH	June
	OUTLOOK PERIOD	June, July, August
	SOI PHASE	3

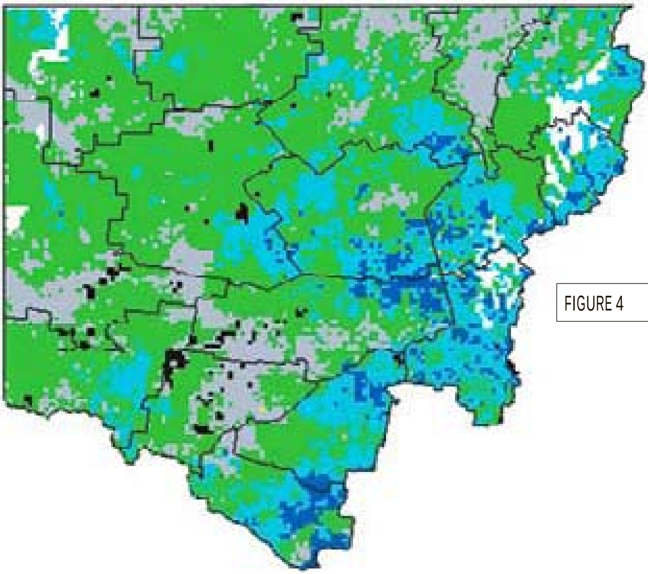


FIGURE 4	CURRENT MONTH	June
	OUTLOOK PERIOD	June, July, August
	SOI PHASE	4

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

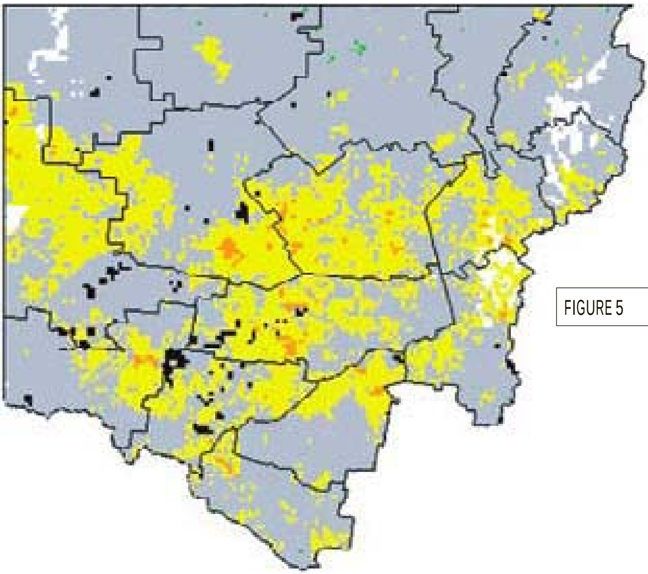


FIGURE 5	CURRENT MONTH	June
	OUTLOOK PERIOD	June, July, August
	SOI PHASE	5

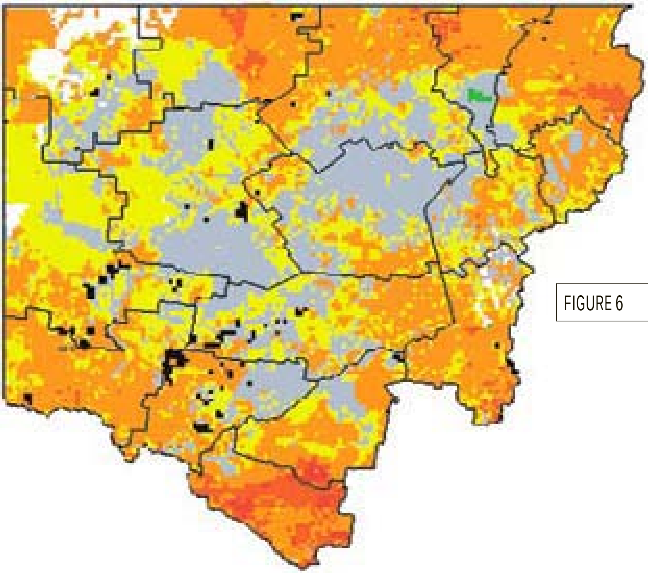


FIGURE 6	CURRENT MONTH	July
	OUTLOOK PERIOD	July, August, September
	SOI PHASE	1

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

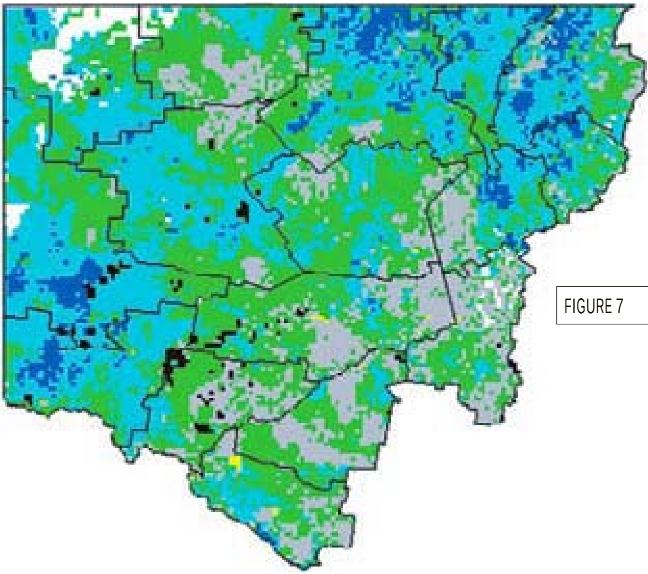


FIGURE 7	CURRENT MONTH	July
	OUTLOOK PERIOD	July, August, September
	SOI PHASE	2

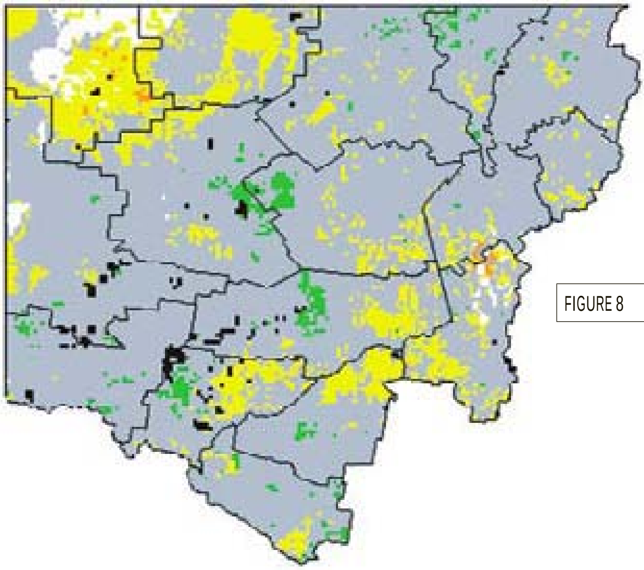


FIGURE 8	CURRENT MONTH	July
	OUTLOOK PERIOD	July, August, September
	SOI PHASE	3

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

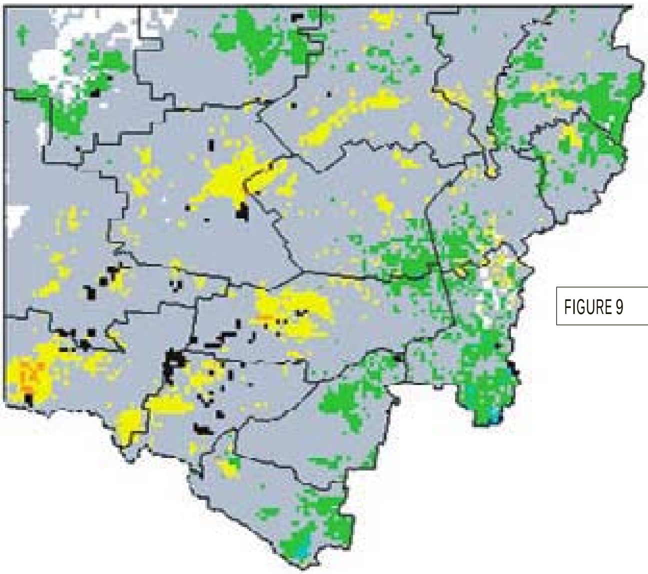


FIGURE 9	CURRENT MONTH	July
	OUTLOOK PERIOD	July, August, September
	SOI PHASE	4

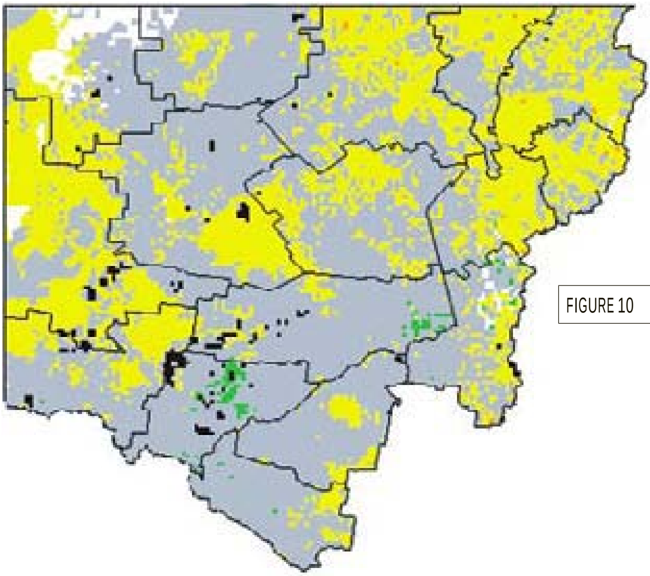


FIGURE 10	CURRENT MONTH	July
	OUTLOOK PERIOD	July, August, September
	SOI PHASE	5

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

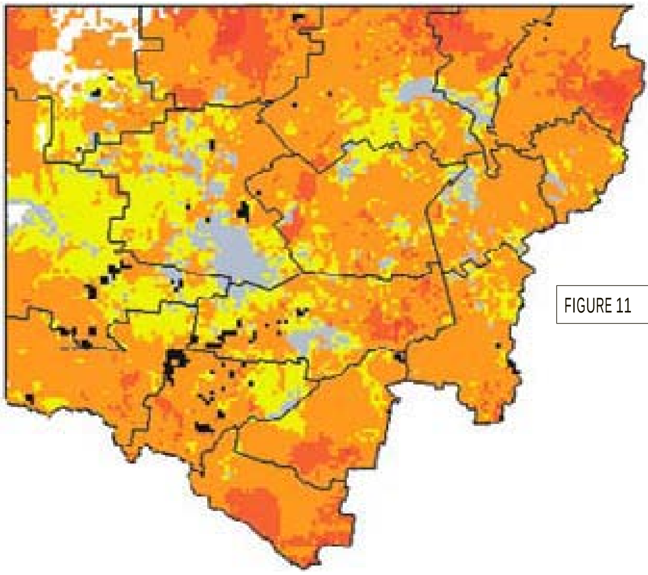


FIGURE 11	CURRENT MONTH	July
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	1

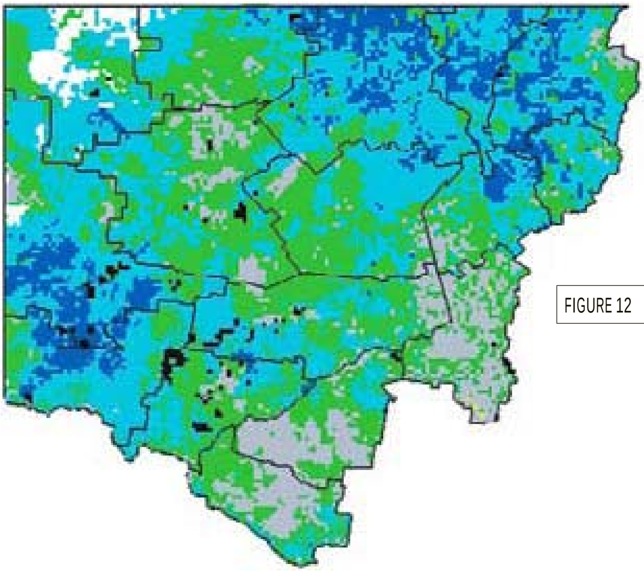


FIGURE 12	CURRENT MONTH	July
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	2

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

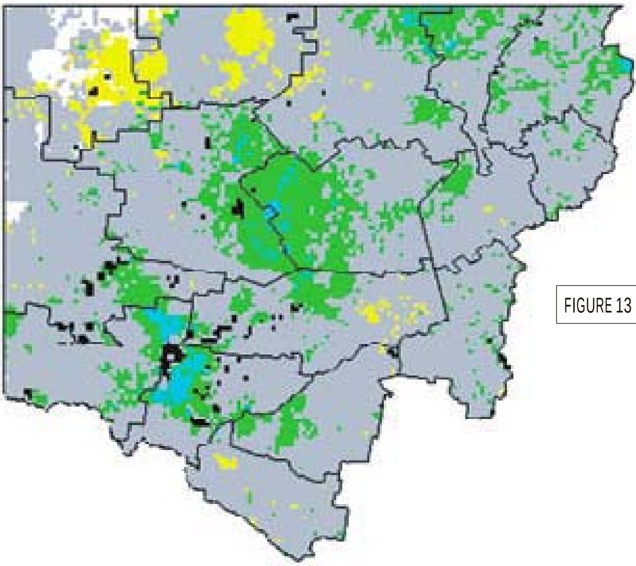


FIGURE 13	CURRENT MONTH	July
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	3

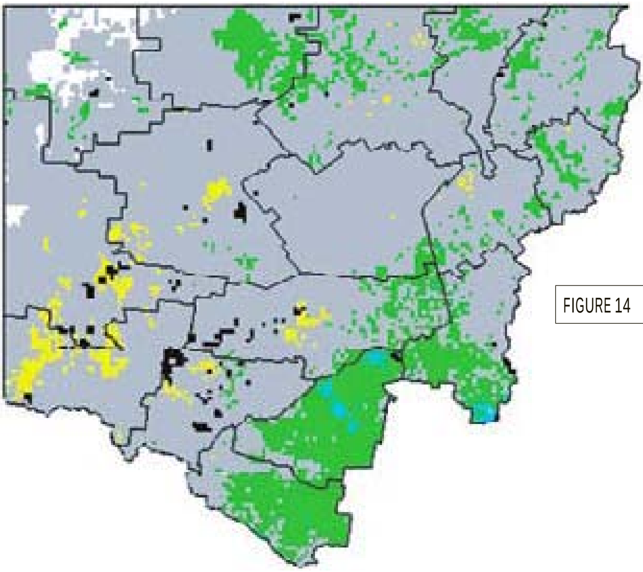


FIGURE 14	CURRENT MONTH	July
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	4

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

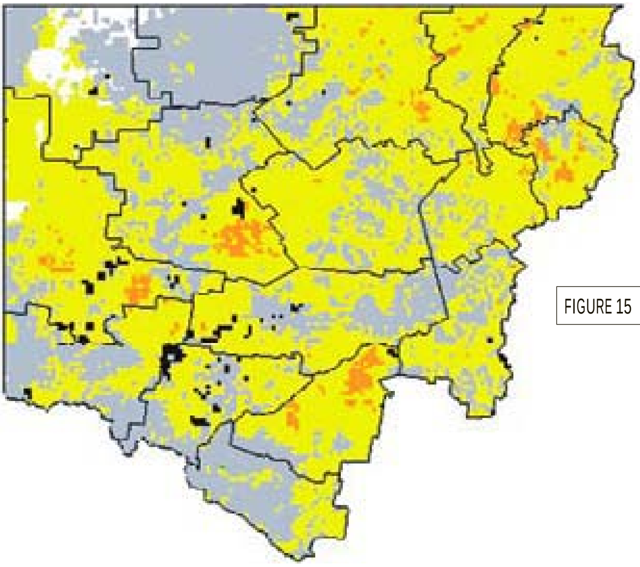


FIGURE 15	CURRENT MONTH	July
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	5

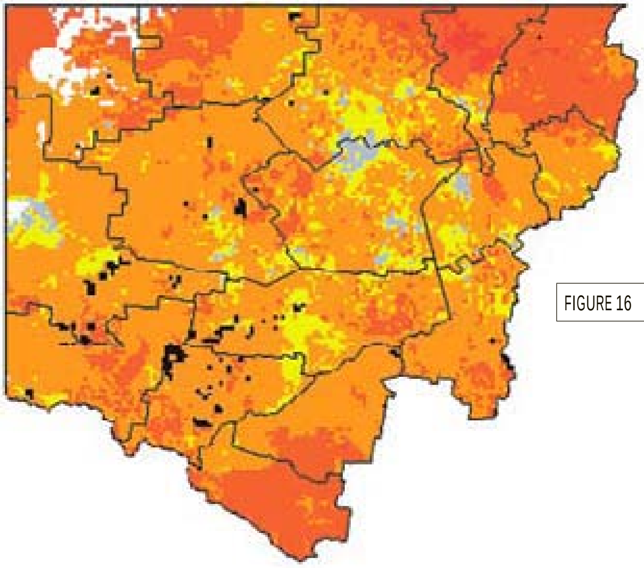


FIGURE 16	CURRENT MONTH	August
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	1

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

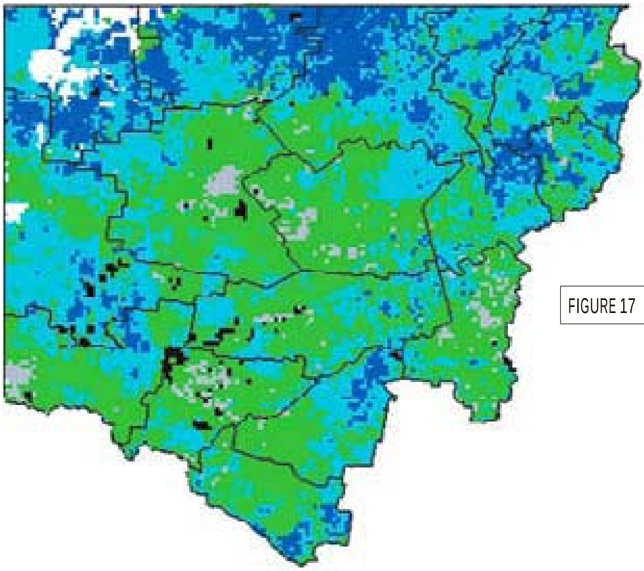


FIGURE 17	CURRENT MONTH	August
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	2

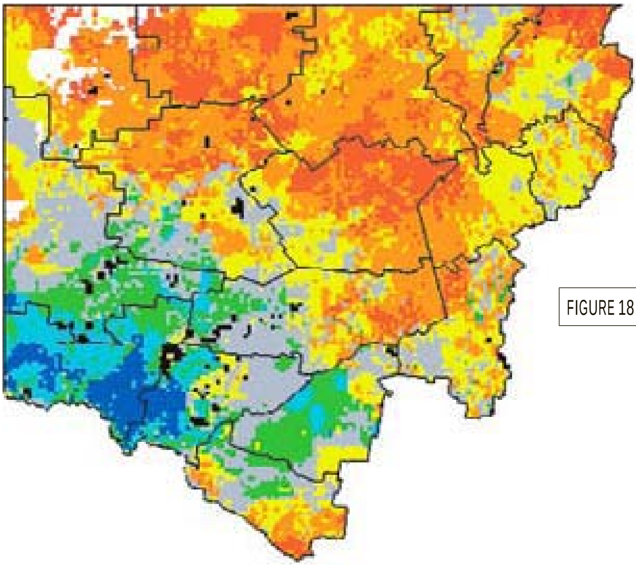


FIGURE 18	CURRENT MONTH	August
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	3

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

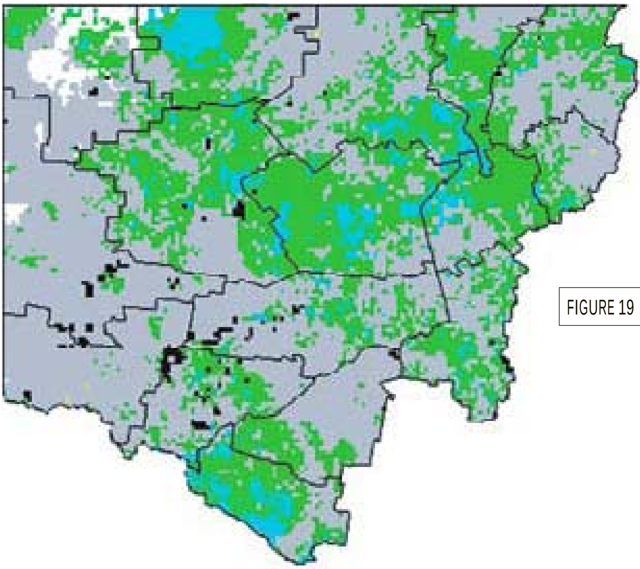


FIGURE 19	CURRENT MONTH	August
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	4

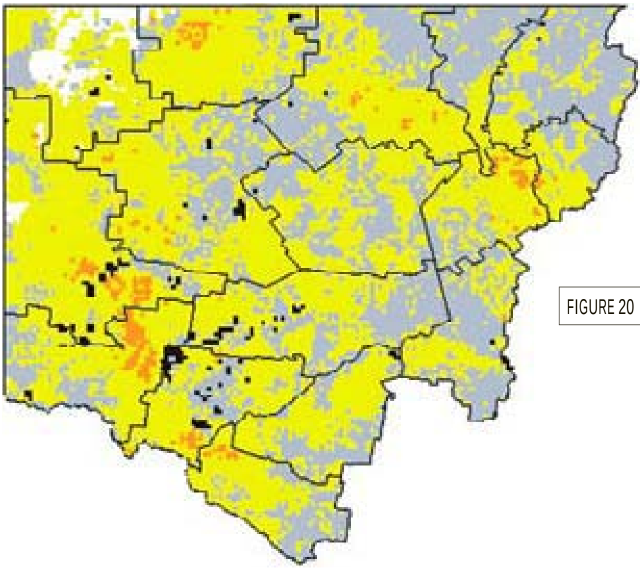


FIGURE 20	CURRENT MONTH	August
	OUTLOOK PERIOD	August, September, October
	SOI PHASE	5

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

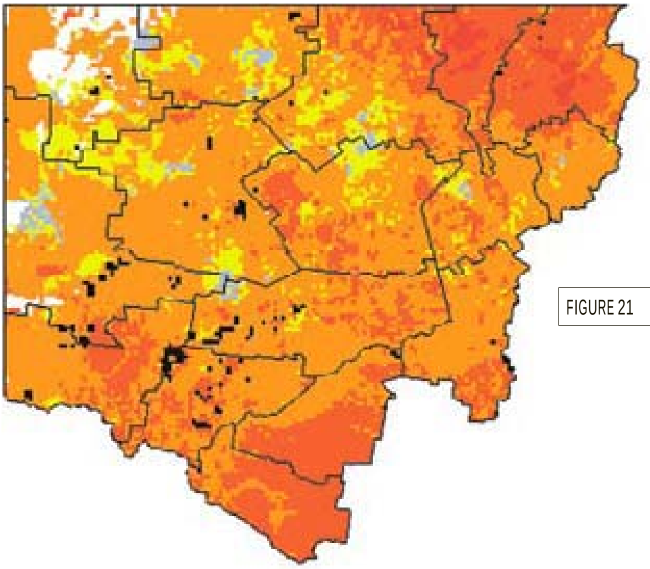


FIGURE 21	CURRENT MONTH	August
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	1

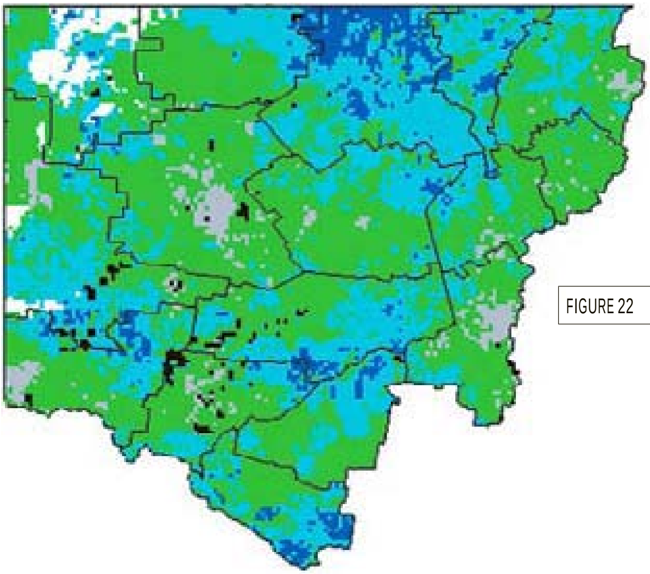


FIGURE 22	CURRENT MONTH	August
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	2

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

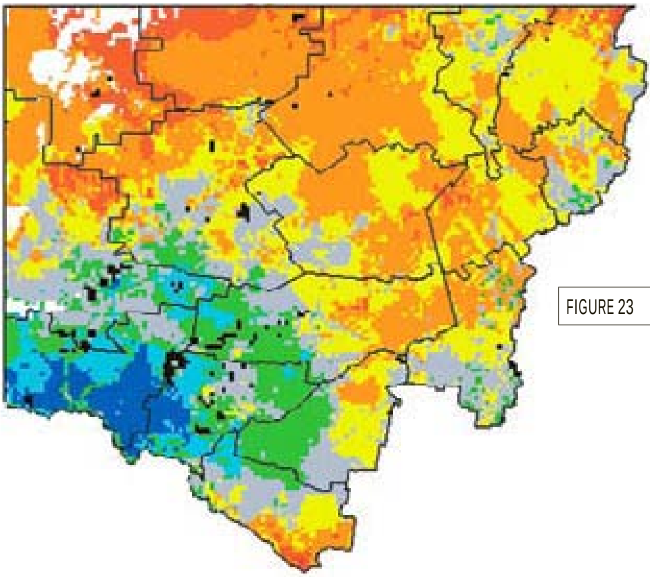


FIGURE 23		
	CURRENT MONTH	August
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	3

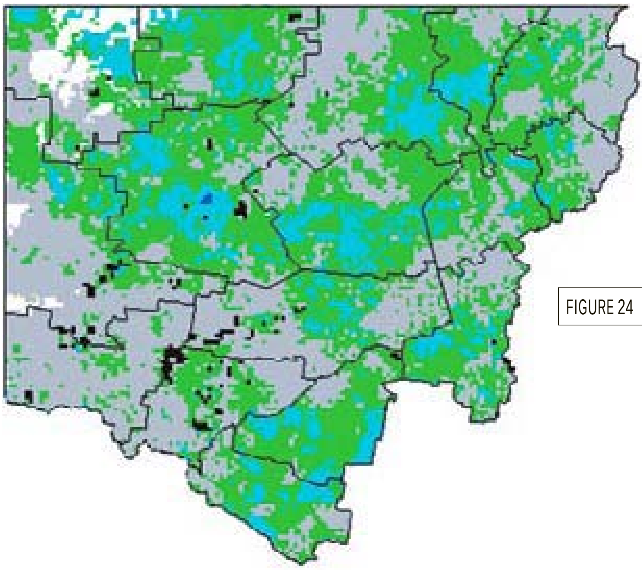


FIGURE 24		
	CURRENT MONTH	August
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	4

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

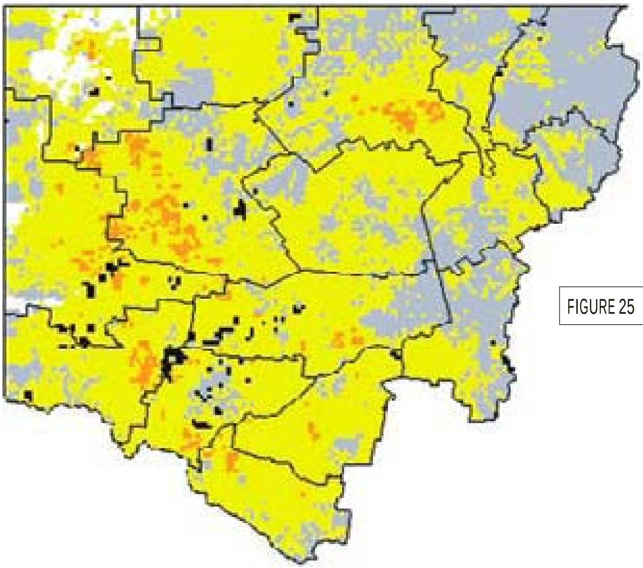


FIGURE 25	CURRENT MONTH	August
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	5

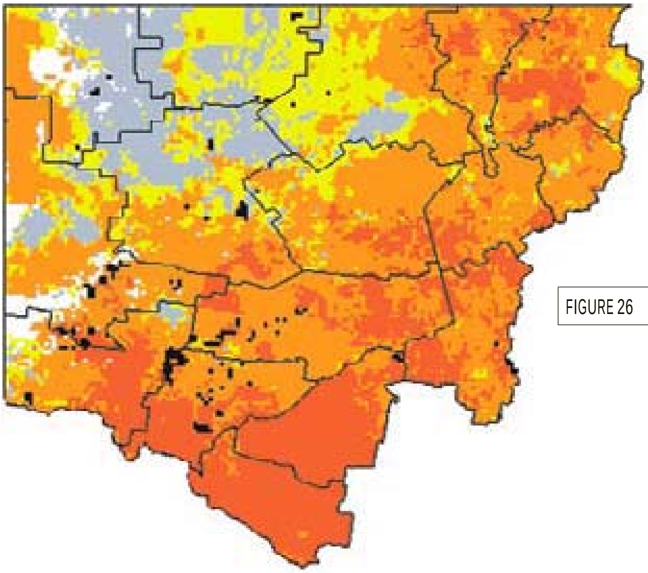
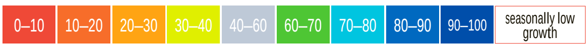


FIGURE 26	CURRENT MONTH	August
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	1



Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

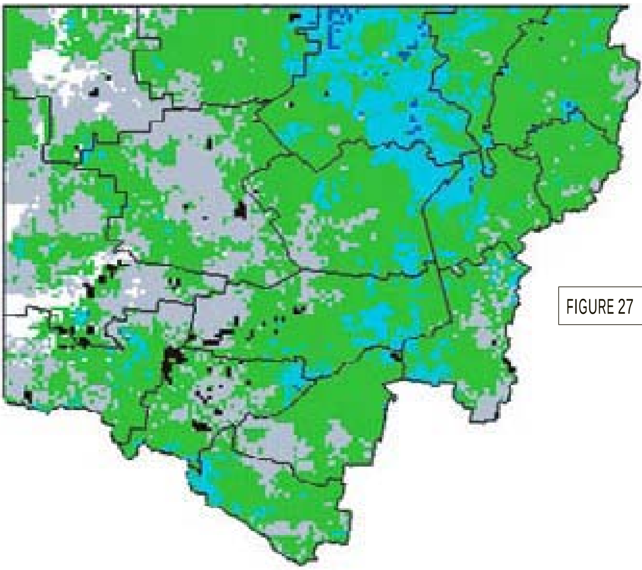


FIGURE 27	CURRENT MONTH	August
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	2

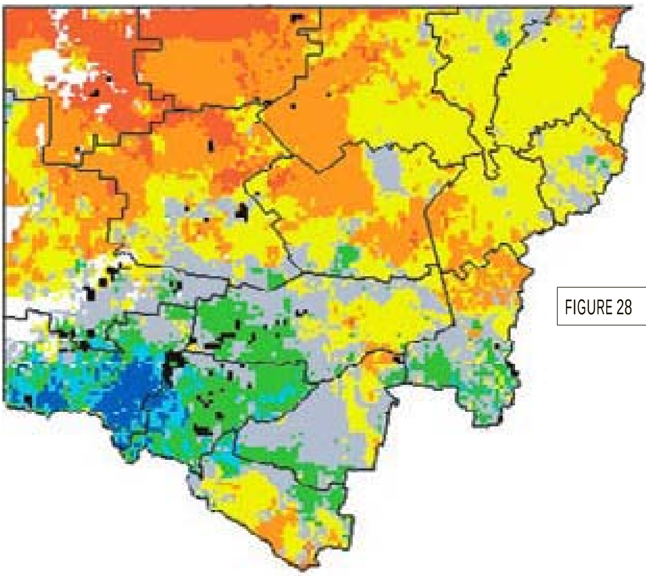


FIGURE 28	CURRENT MONTH	August
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	3

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

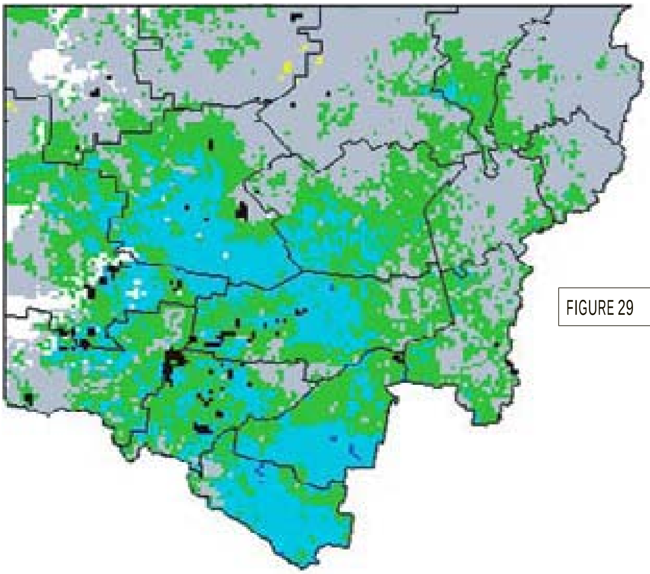


FIGURE 29	CURRENT MONTH	August
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	4

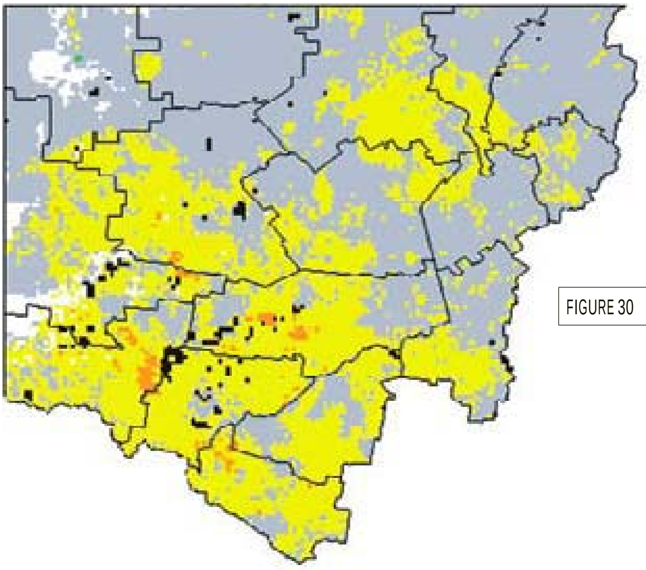


FIGURE 30	CURRENT MONTH	August
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	5

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

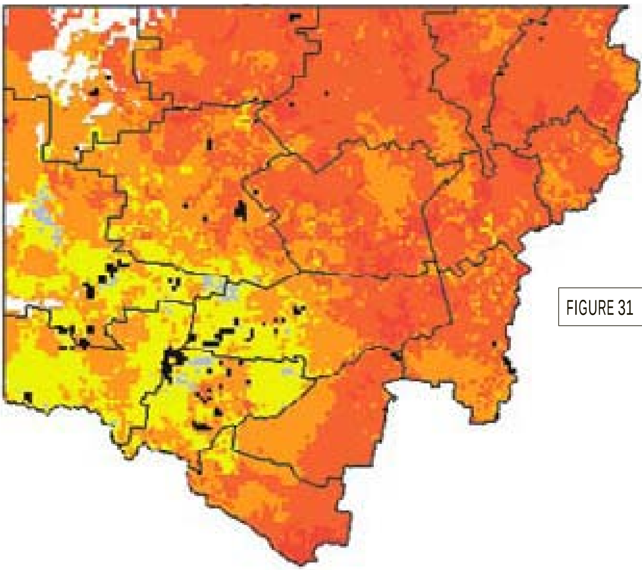


FIGURE 31	CURRENT MONTH	September
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	1

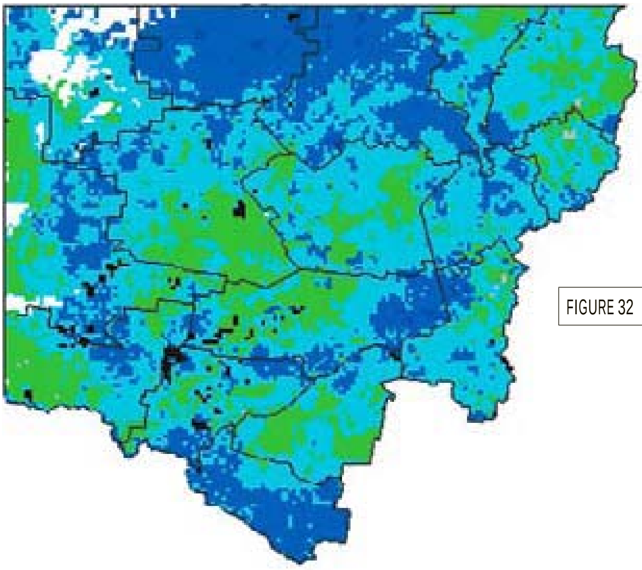


FIGURE 32	CURRENT MONTH	September
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	2

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

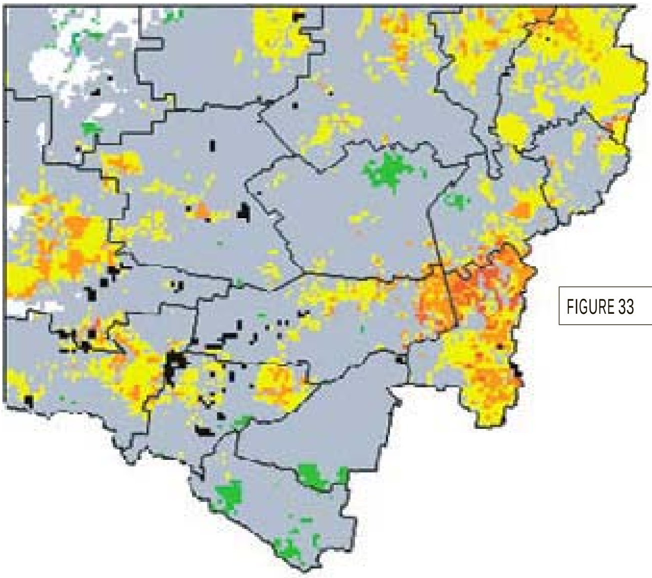


FIGURE 33	CURRENT MONTH	September
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	3

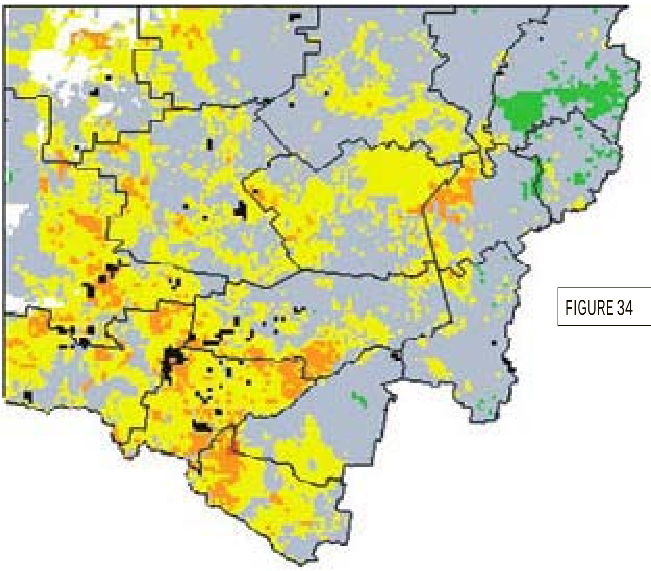


FIGURE 34	CURRENT MONTH	September
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	4

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

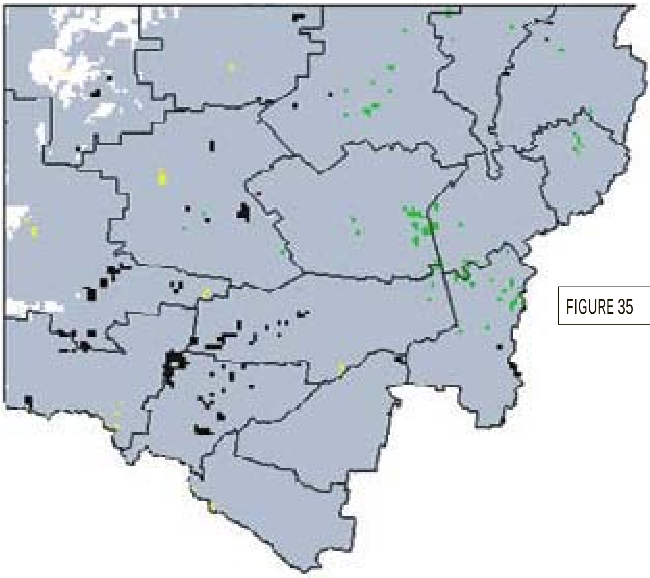


FIGURE 35	CURRENT MONTH	September
	OUTLOOK PERIOD	September, October, November
	SOI PHASE	5

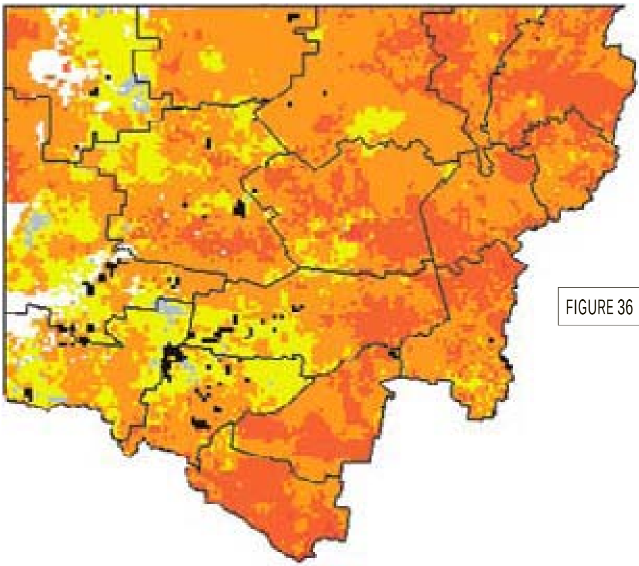


FIGURE 36	CURRENT MONTH	September
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	1

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

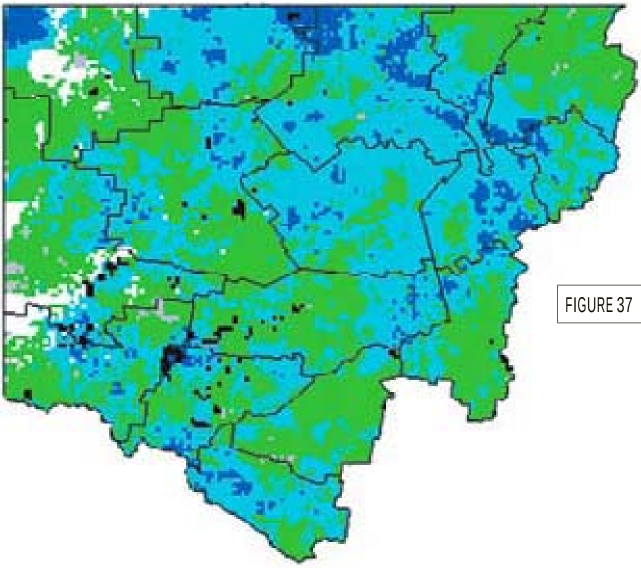


FIGURE 37	CURRENT MONTH	September
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	2

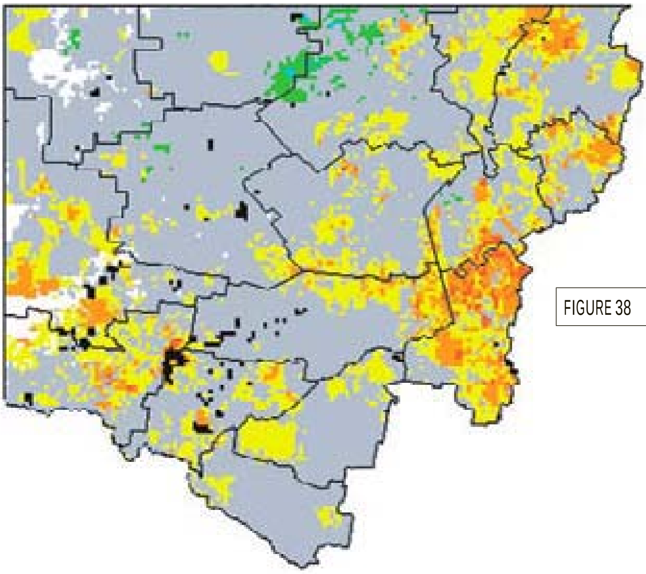


FIGURE 38	CURRENT MONTH	September
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	3

0–10 | 10–20 | 20–30 | 30–40 | 40–60 | 60–70 | 70–80 | 80–90 | 90–100 | seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

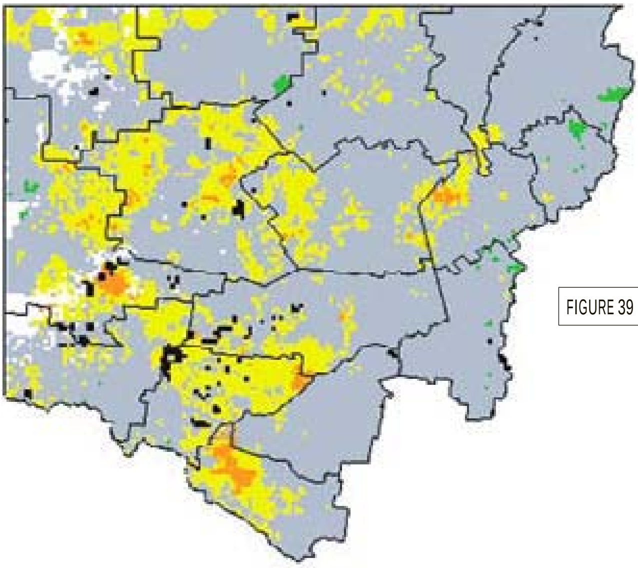


FIGURE 39	CURRENT MONTH	September
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	4

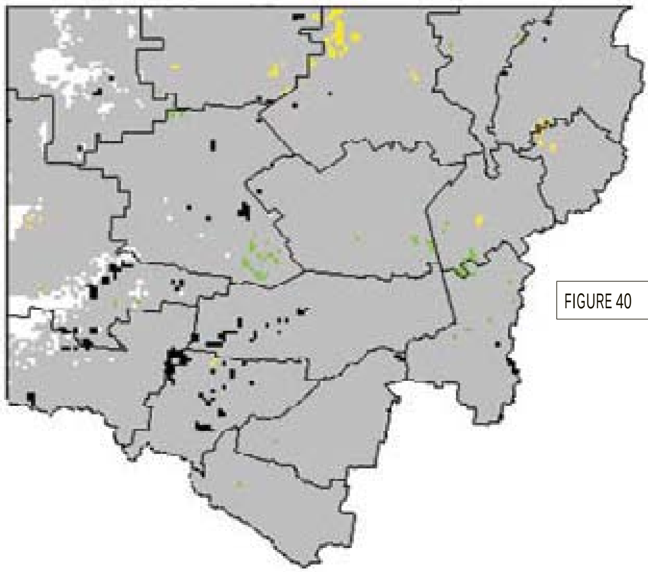


FIGURE 40	CURRENT MONTH	September
	OUTLOOK PERIOD	October, November, December
	SOI PHASE	5

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

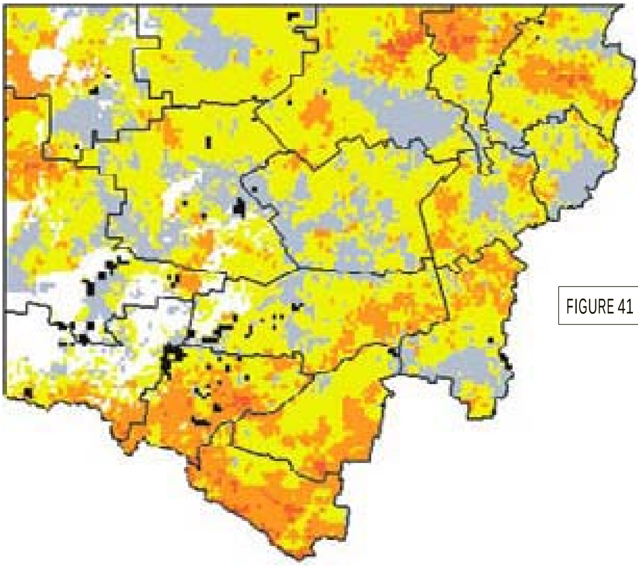


FIGURE 41	CURRENT MONTH	September
	OUTLOOK PERIOD	November, December, January
	SOI PHASE	1

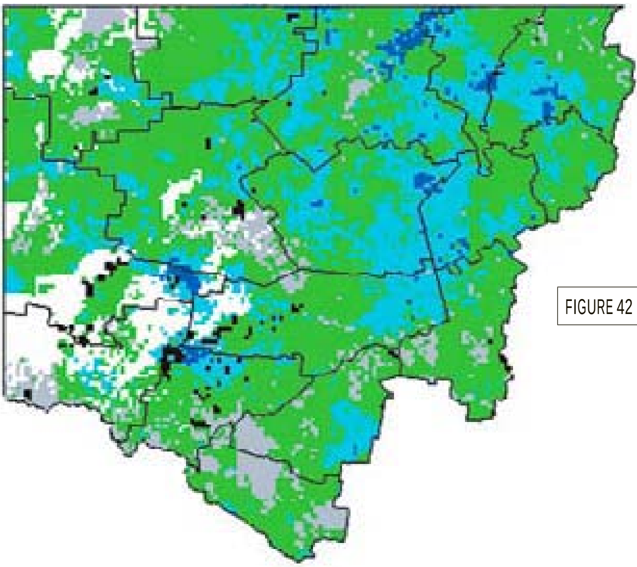


FIGURE 42	CURRENT MONTH	September
	OUTLOOK PERIOD	November, December, January
	SOI PHASE	2

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

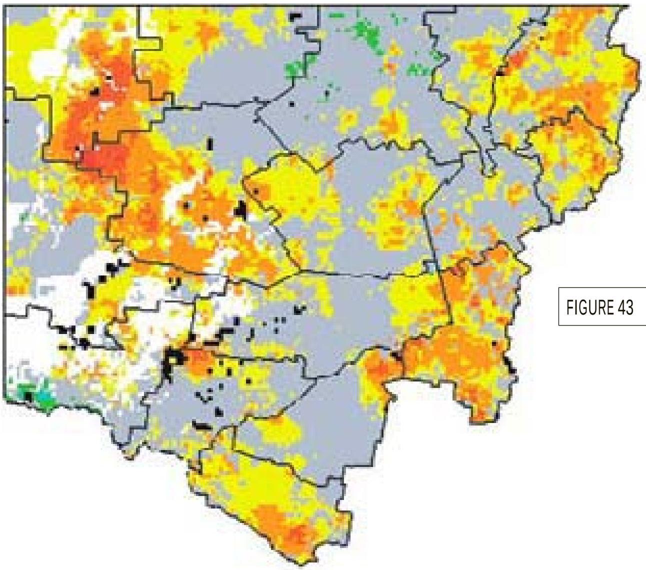


FIGURE 43	CURRENT MONTH	September
	OUTLOOK PERIOD	November, December, January
	SOI PHASE	3

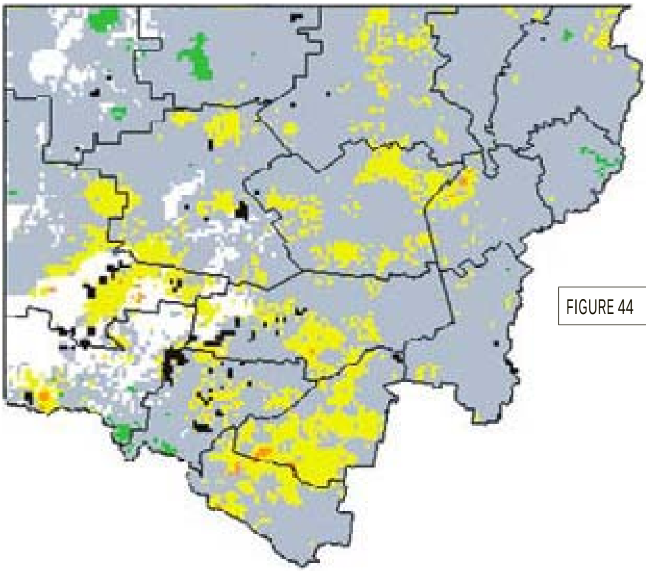


FIGURE 44	CURRENT MONTH	September
	OUTLOOK PERIOD	November, December, January
	SOI PHASE	4

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PROBABILITY OF EXCEEDING MEDIAN PASTURE GROWTH

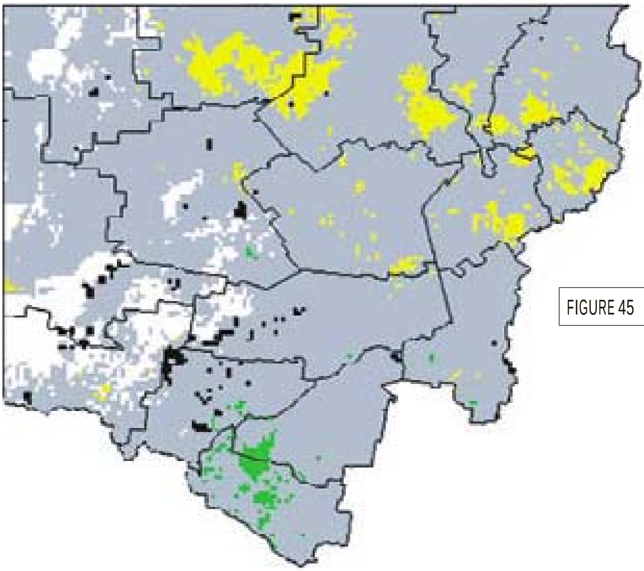


FIGURE 45	CURRENT MONTH	September
	OUTLOOK PERIOD	November, December, January
	SOI PHASE	5

0–10	10–20	20–30	30–40	40–60	60–70	70–80	80–90	90–100	seasonally low growth

Experimental prototypes from AussieGRASS (www.LongPaddock.qld.gov.au) produced for the Land Water and Wool Managing Climate Variability Project.

PART 5 – TRIGGER POINTS

- Trigger points are calendar dates beyond which decisions to buy or sell livestock should not be delayed
- They can be identified by summarising the long-term (simulated) pasture growth record to show when the prospects for pasture growth for the next three months are highest or lowest, and the variability in growth from year to year
- Pasture growth profiles and country type descriptions for 27 locations across western NSW based on feedback from graziers
- How to use this information to identify trigger points for your own property and to complement or enhance seasonal risk assessments based on SOI Phase

Background

Making management decisions that involve taking a chance on future climatic conditions is always difficult – and more so when rainfall is not strongly seasonal, as in western NSW. Understanding the seasonal risk assessments provided by the SOI phase system will be useful during winter and spring but at other times of the year this system is not very helpful.

Having a rule of thumb about how long destocking decisions can reasonably be delayed in the hope that the season may improve should assist with these difficult decisions; alternatively, a rule of thumb about when might be the best time to buy if the season already looks promising might assist in getting the best productivity consistent with prudent risk management.

In this section we have tried to encapsulate this idea of 'rules of thumb' in the form of 'trigger points'. Trigger points are times of the year – calendar dates – when the prospects of future pasture growth are high or low based on the long-term record. Understanding this long-term growth pattern should be useful, when combined with first hand knowledge of the current season, in deciding whether its time to buy or sell. If in doubt, a decision to sell should not be delayed beyond the autumn trigger point and a decision to buy, while probably less critical, beyond the spring trigger point.

Identifying trigger points requires the same long-term (> 100 years) record of simulated daily pasture growth used to produce the historical probabilities described in the previous section. From this information, we can identify trigger points by the following process:

1. Calculate, for each year of the record, the amount of growth produced in 3 month periods starting at fortnightly intervals throughout the year i.e. for 3 month periods starting 1 January, 15 January, 29 January etc. in each year;

2. Summarise the set of data for each starting point in a way that allows maximum and minimum values – i.e. trigger points – to be identified among the 26 starting points.

In the figures at the end of this section we have summarised the raw data derived from step 1 in two ways:

- **Growth potential index** – this index summarises the historical growth data for each starting date as a single figure. Technically, the index is equal to the area under the cumulative probability curve i.e. the curve that gives the probability of exceeding any given level of pasture growth. This area, and thus the value of the index, will be high for those starting dates associated with generally high growth periods, and low for those that commence periods of generally low growth. (Using this index has certain advantages over simply using the average growth for each starting point but the pattern of index values over the year would be similar).
- **Critical percentiles** – this approach summarises the historical data by specifying the growth values that correspond to the 20th, 50th (median) and 80th percentiles (i.e. the levels of growth that define the lowest 20%, 50% and 80% respectively of historical values, or the upper limits of the 2nd, 5th and 8th deciles).

Defining trigger points from this information is straight forward for the growth potential index as the highest and lowest values are easily identified although in some instances, where the index values are similar for a number of starting dates, there may be no strong reason to choose one date over another.

Defining trigger points using critical percentiles has the advantage of providing an indication of the historical variability of pasture growth associated with each starting date – indicated by the difference between the 20th and 80th percentile values. This information may lead to some adjustment of the trigger points that would otherwise be identified from the 50th percentile (median) values (or the growth potential index) alone.

Identifying trigger points for your property

Identifying trigger points in the way we have described depends on having pasture growth profiles that are acceptably accurate for any particular location. Several different versions of the GRASP model are available for western NSW. These have either been calibrated for particular locations based on experimental data or represent an 'average calibration'. To identify the best profile for particular locations, we provided graziers across the region with growth potential and critical percentile profiles from likely alternative versions, based on climatic data from the most appropriate long-term weather station. We then sought their advice on which version, if any, provided a good description of the local pasture growth pattern.

The numbers shown in the location diagram (Figure 5.1) represent the properties that participated in this analysis. They correspond to the numbers in Table 5.1 and to the numbers in Figure 5.3, at the end of this section, which show the profiles that graziers felt best described the local pasture growth pattern. (The combinations of model version and climatic record that were used to generate these profiles are given in Appendix 2). The type of country on each property is described in the table.

In some instances, graziers in relatively close proximity selected somewhat different profiles. Their choice has been allowed to stand. In a few cases, graziers thought that none of the alternatives was quite right and they adjusted the profiles to better reflect their understanding of the local situation. These profiles have also been included but identified as a modified pattern.

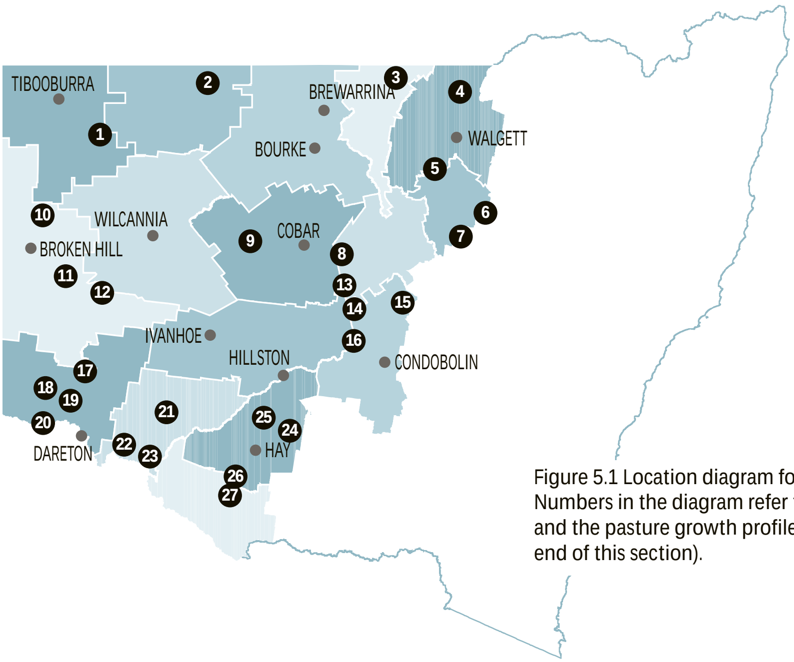


Figure 5.1 Location diagram for trigger point analysis. Numbers in the diagram refer to numbers in Table 5.1 and the pasture growth profiles in Figure 5.3 (at the end of this section).

Table 5.1 Descriptions of the country types that make up the properties identified in Figure 5.1. Shaded entries indicate that the modelled growth pattern was modified to reflect the co-operator's perception of local conditions.

SITE NO.	COUNTRY TYPE DESCRIPTION
1	Mulga
2	80% northern flood plains and riverine woodlands, 15% mulga and 5% bimble box-pine
3	40% gidgee and brigalow, 30% northern floodplains and 30% Mitchell grass
4	Northern flood plains
5	A mixture of northern flood plains and Mitchell grass with bimble box/pine and gidgee/brigalow
6	Bimble box-pine
7	Bimble box-pine
8	About 70% bimble box-pine and 30% mallee
9	About 50% mulga and 40% bimble box-pine with small areas of belah-bluebush and mallee
10	About 50% saltbush slopes and 25% ridges with copperburr, smaller areas of mulga, belah bluebush, Mitchell grass and local flood plains
11	60% bluebush, 30% flood plains, 10% Mitchell grass
12	60% flood plains, 25% belah-bluebush, 15% bimble box-pine
13	80% bimble box 20% mallee
14	Bimble box-pine
15	Box-pine
16	30% bimble box-pine, 30% riverine woodlands, 25% belah-bluebush, 15% 'plains grass'.
17	Belah-bluebush
18	60% belah-bluebush, 20% saltbush plains, 20% southern riverine woodlands
19	40% mallee, 30% belah-bluebush, 15% saltbush plains, 10% southern riverine woodlands, 5% pine.
20	Saltbush and saline flood plains
21	Saltbush plains
22	50% mallee, 50% belah-bluebush
23	Mallee
24	Open grassy plains with scattered black box, rosewood, boree and river red gum
25	50% saltbush plains, 50% cottonbush grassland
26	60% whitetop grassland, 30% saltbush plains, 10% riverine woodlands
27	Southern riverine woodlands

To identify trigger points for your property:

- Select the site likely to be most similar to your property from the location diagram and the country type descriptions in Table 5.1; generally the closest will probably be the best choice but there may be exceptions. You may feel that none of these sites is similar to your property in which case you should stop now.
- Turn to the corresponding graphs in Figure 5.3; again, if you feel the growth pattern described there does not fit your property stop now.
- Consider the growth potential and critical percentile profiles and determine trigger point dates as shown in the example below (Figure 5.2). Note that no critical percentiles can be provided for those locations where graziers altered the original graphs to reflect their assessment of pasture growth pattern.

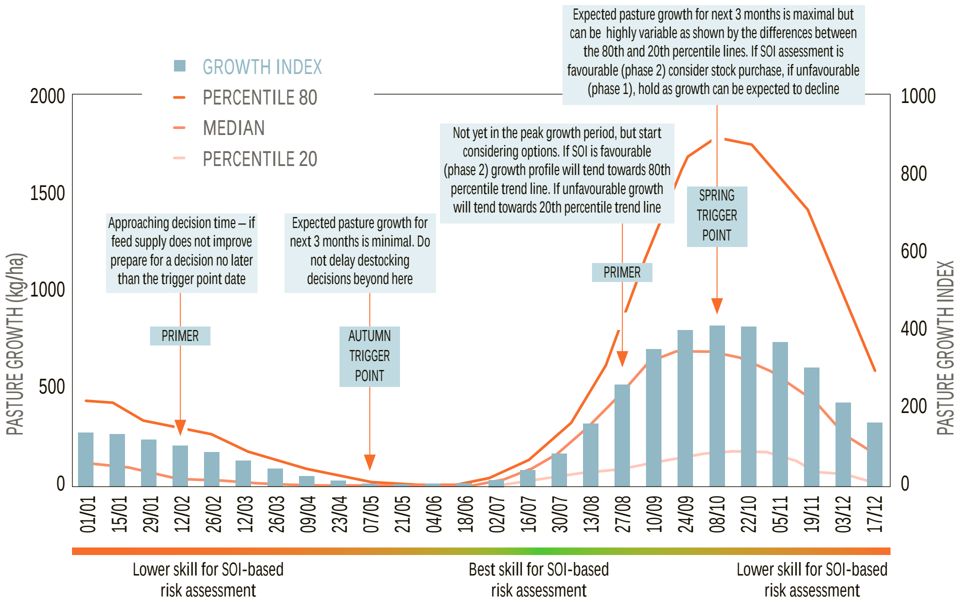


Figure 5.2 Example of how to use the pasture growth profiles and critical percentile values to determine trigger points beyond which decisions that depend on future growth should not be delayed. Note the 'primer' point, some time before the trigger point, when preparation for a decision and consideration of options should start.

Using trigger points and pasture growth profiles

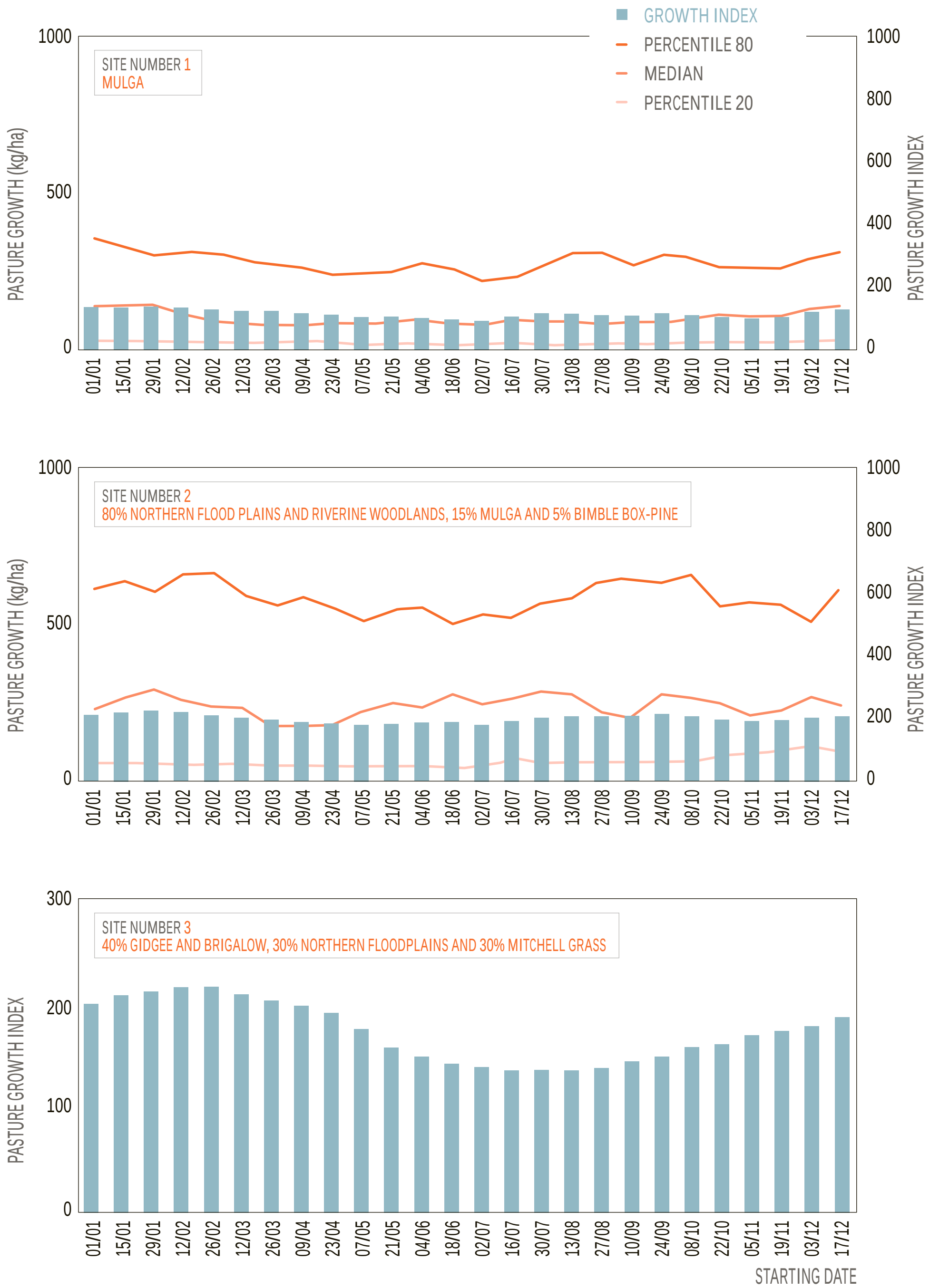
Understanding trigger points can both complement and enhance the use of SOI-based seasonal risk assessments in management decision making.

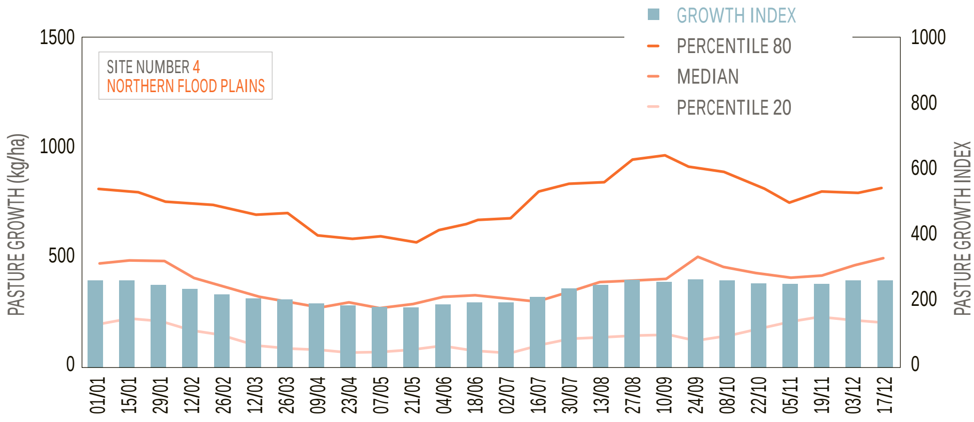
Periods of minimal pasture growth in western NSW commonly occur in late summer and autumn, when the value of seasonal risk assessments based on the SOI phase is low. Identifying a trigger point at this time – i.e. the calendar date after which pasture growth potential for the next 3 months is minimal – can support management decisions, particularly sale decisions, at a time when little assistance is provided by the SOI. If seasonal conditions are deteriorating, for example, a decision to sell should not be deferred beyond the trigger point. Preparation for such a decision should begin sometime before the trigger point, around the time identified in Figure 5.2 as the 'primer' point.

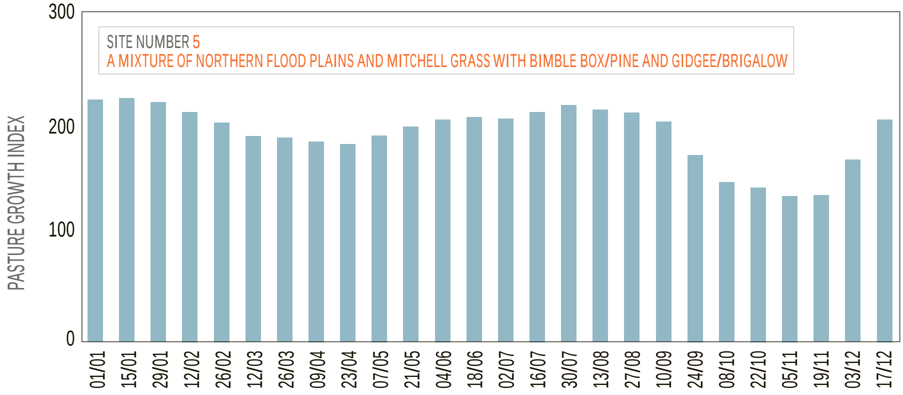
At the other extreme, the trigger point that defines the period of highest growth expectation will often occur in spring-summer, at a time when the value of SOI-based seasonal risk assessments is relatively high. Decisions to buy at this time could sensibly be made around the time of the trigger point – i.e. going into the period of highest growth expectation – but that decision could be modified by the current risk assessment provided by the SOI phase system.

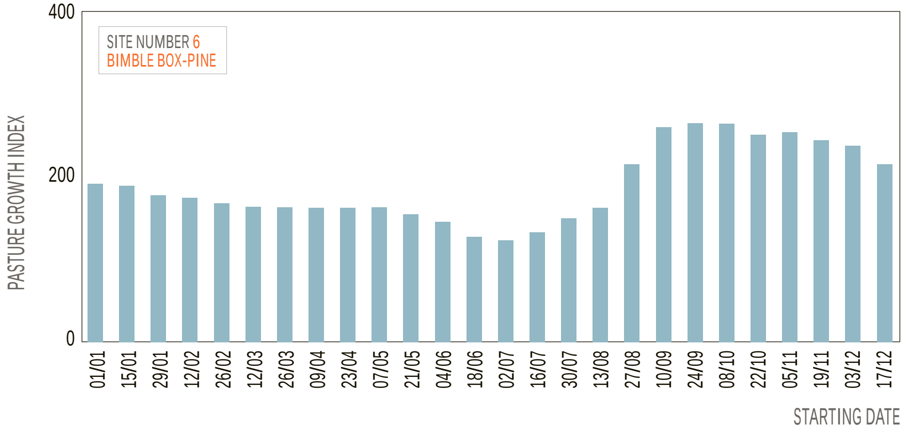
In addition to these tactical decisions, strategic decisions may also benefit from an examination of the pasture growth profiles even though these are often driven by other considerations. Calving and lambing, for example, may be timed to coincide with periods of high growth potential, or to avoid periods when growth is low or highly variable.

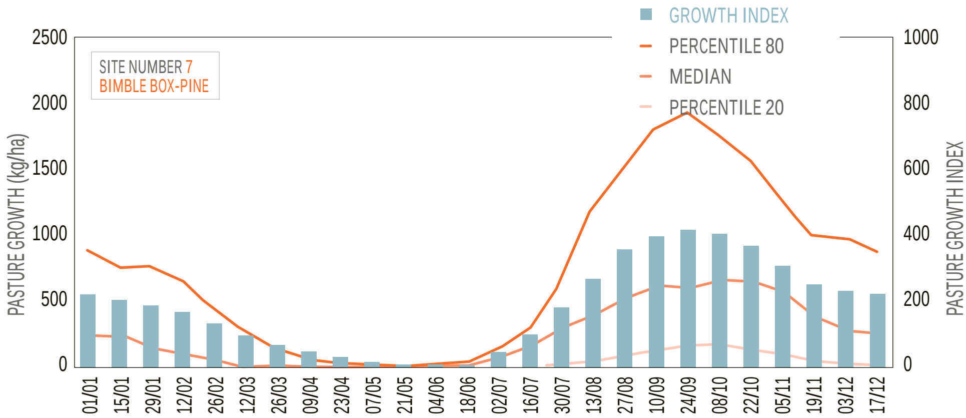
Figure 5.3 Pasture growth profiles for the 27 sites identified in Figure 5.1 and Table 5.1.

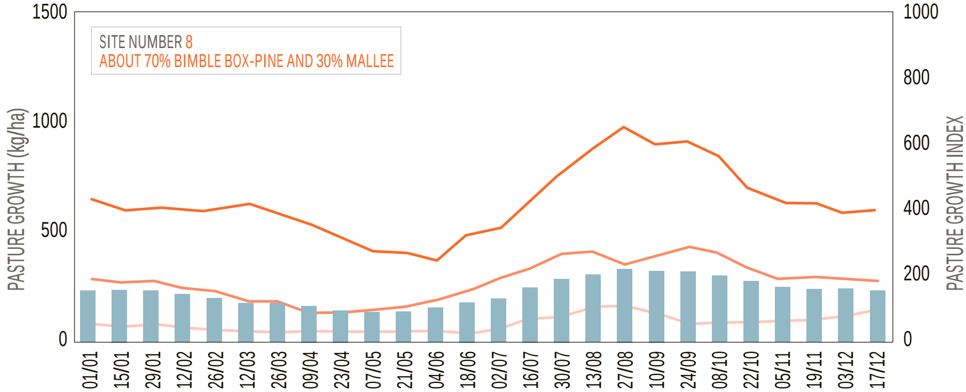


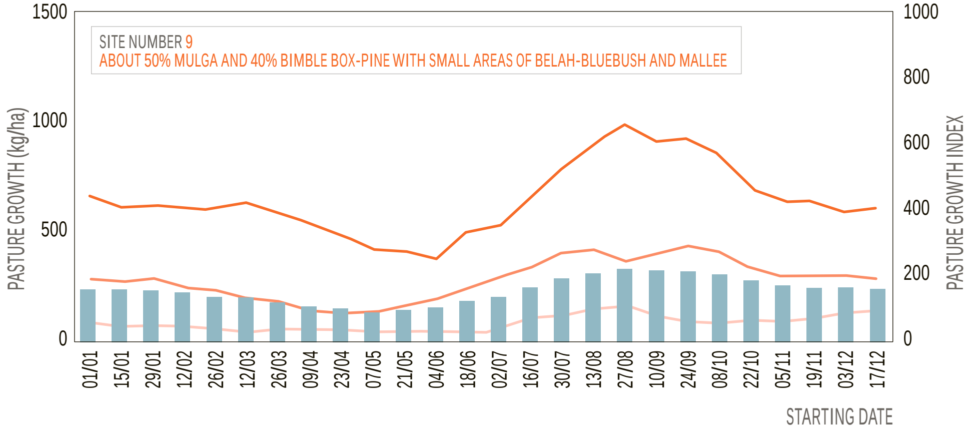

GROWTH INDEX
PERCENTILE 80
MEDIAN
PERCENTILE 20
SITE NUMBER 4
NORTHERN FLOOD PLAINS
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
1500
1000
500
0
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12

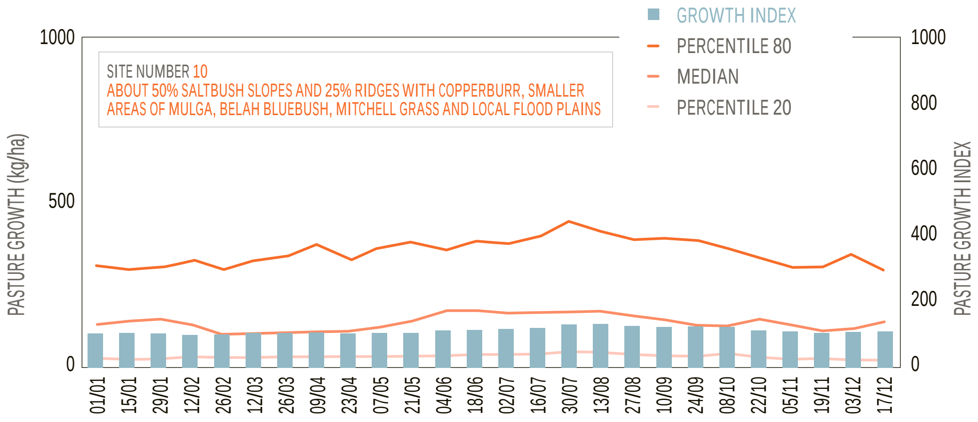

SITE NUMBER 5
A MIXTURE OF NORTHERN FLOOD PLAINS AND MITCHELL GRASS WITH BIMBLE BOX/PINE AND GIDGEE/BRIGALOW
PASTURE GROWTH INDEX
300
200
100
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12

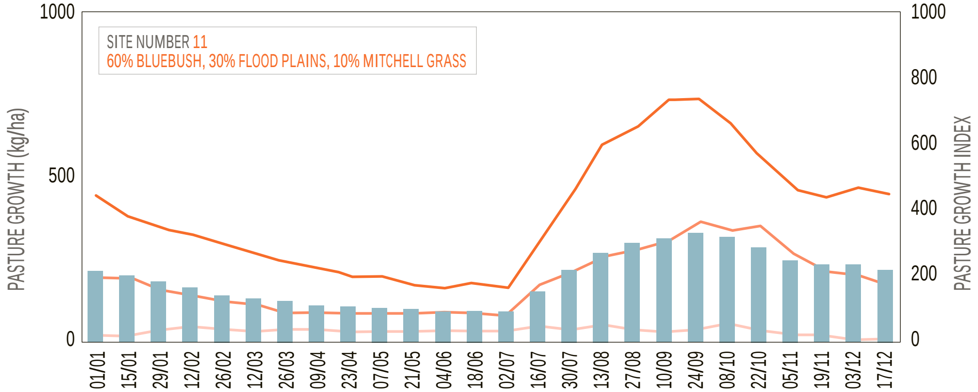

SITE NUMBER 6
BIMBLE BOX-PINE
PASTURE GROWTH INDEX
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12
STARTING DATE

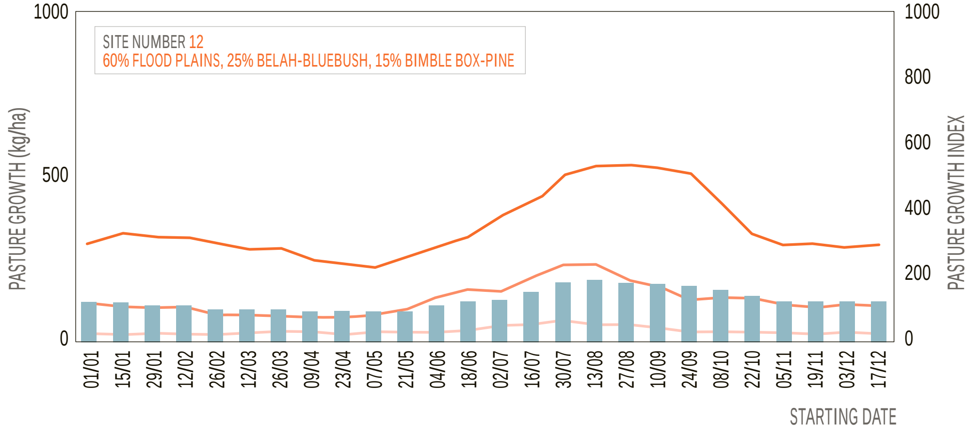

GROWTH INDEX
PERCENTILE 80
MEDIAN
PERCENTILE 20
SITE NUMBER 7
BIMBLE BOX-PINE
PASTURE GROWTH (kg/ha)
2500
2000
1500
1000
500
0
PASTURE GROWTH INDEX
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12

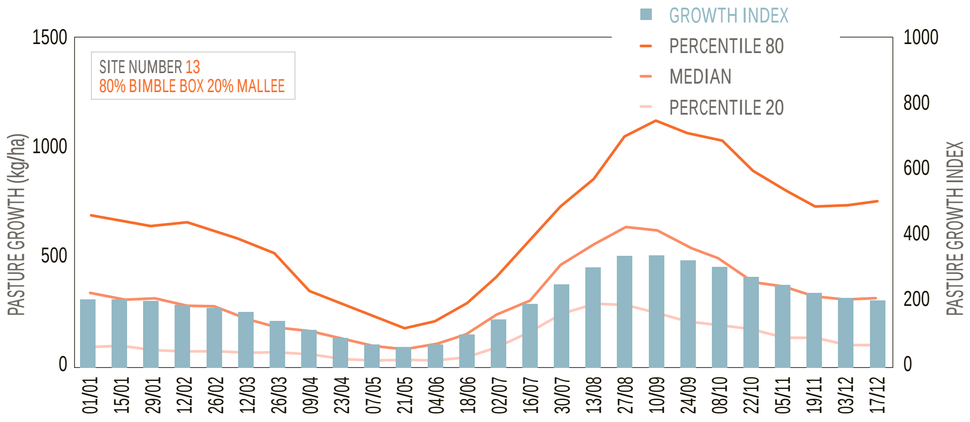

SITE NUMBER 8
ABOUT 70% BIMBLE BOX-PINE AND 30% MALLEE
PASTURE GROWTH (kg/ha)
1500
1000
500
0
PASTURE GROWTH INDEX
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12

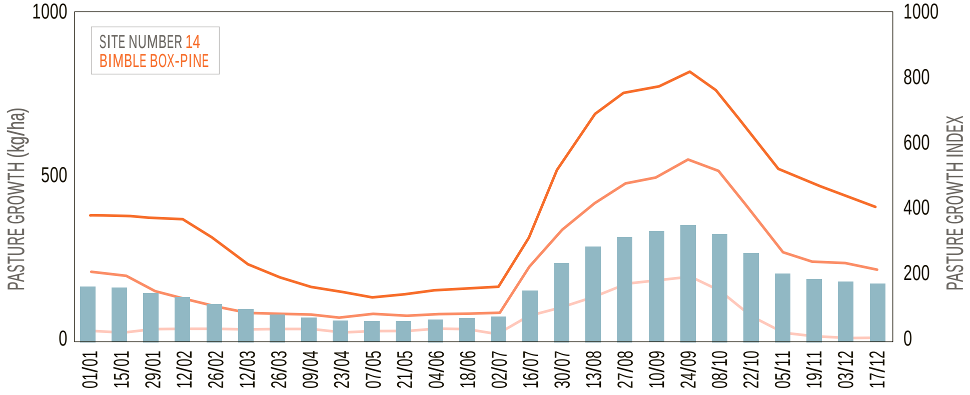

SITE NUMBER 9
ABOUT 50% MULGA AND 40% BIMBLE BOX-PINE WITH SMALL AREAS OF BELAH-BLUEBUSH AND MALLEE
PASTURE GROWTH (kg/ha)
1500
1000
500
0
PASTURE GROWTH INDEX
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12
STARTING DATE

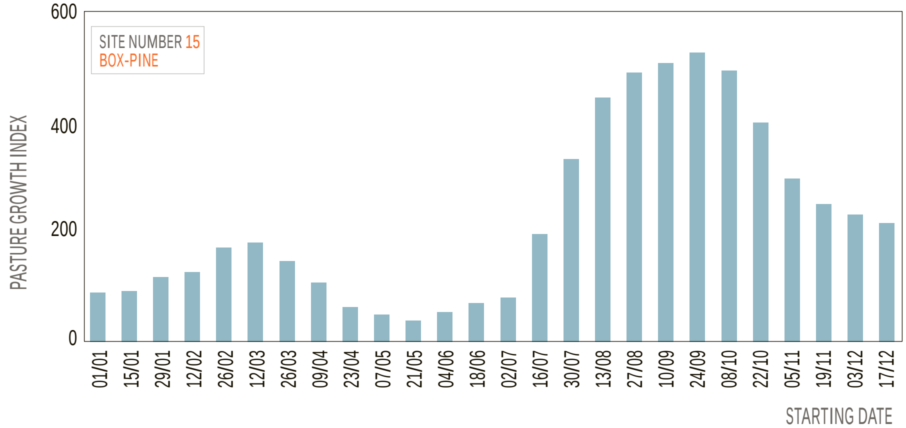

GROWTH INDEX
PERCENTILE 80
MEDIAN
PERCENTILE 20
SITE NUMBER 10
ABOUT 50% SALTBUSH SLOPES AND 25% RIDGES WITH COPPERBURR, SMALLER AREAS OF MULGA, BELAH BLUEBUSH, MITCHELL GRASS AND LOCAL FLOOD PLAINS
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12

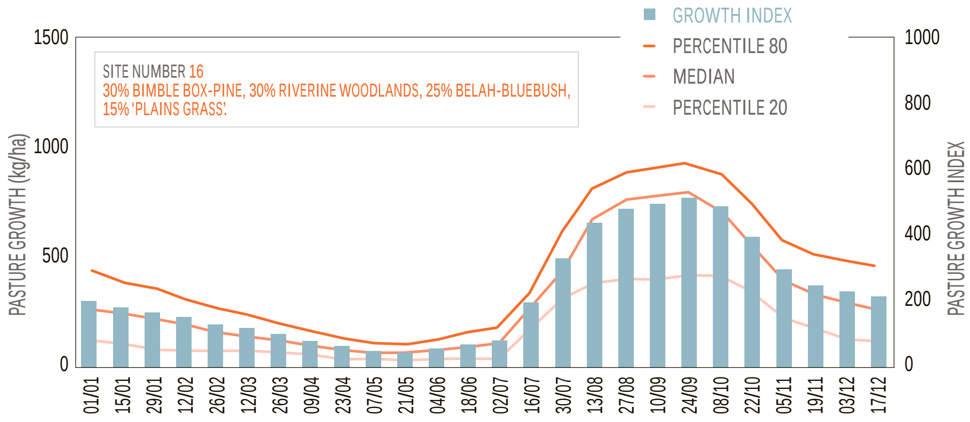

SITE NUMBER 11
60% BLUEBUSH, 30% FLOOD PLAINS, 10% MITCHELL GRASS
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12

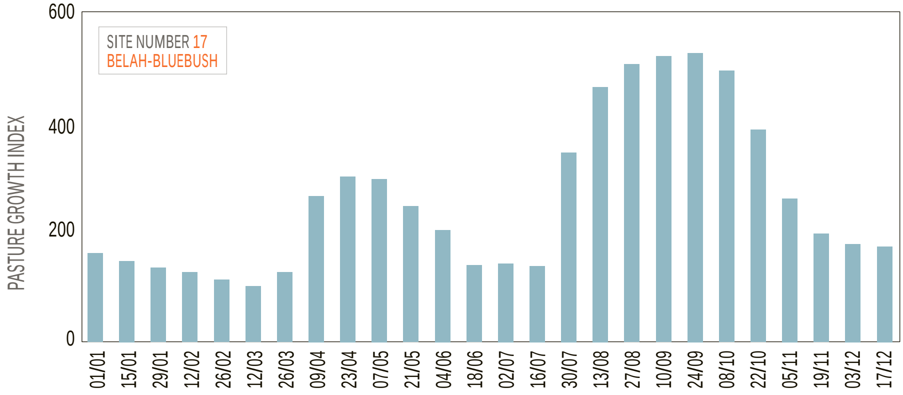

SITE NUMBER 12
60% FLOOD PLAINS, 25% BELAH-BLUEBUSH, 15% BIMBLE BOX-PINE
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12
STARTING DATE

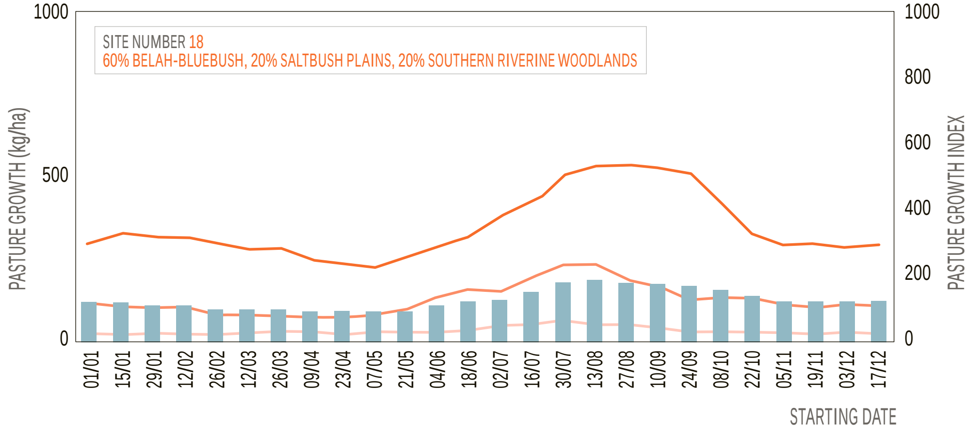

GROWTH INDEX
PERCENTILE 80
MEDIAN
PERCENTILE 20
SITE NUMBER 13
80% BIMBLE BOX 20% MALLEE
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12

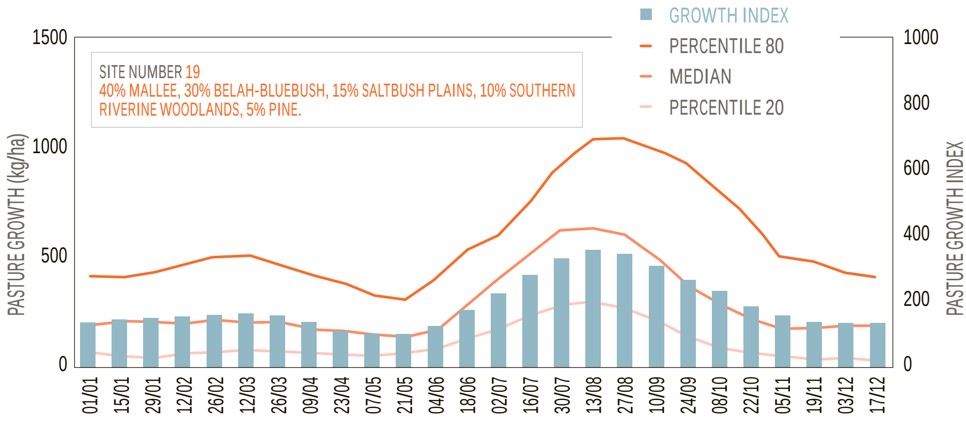

SITE NUMBER 14
BIMBLE BOX-PINE
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12

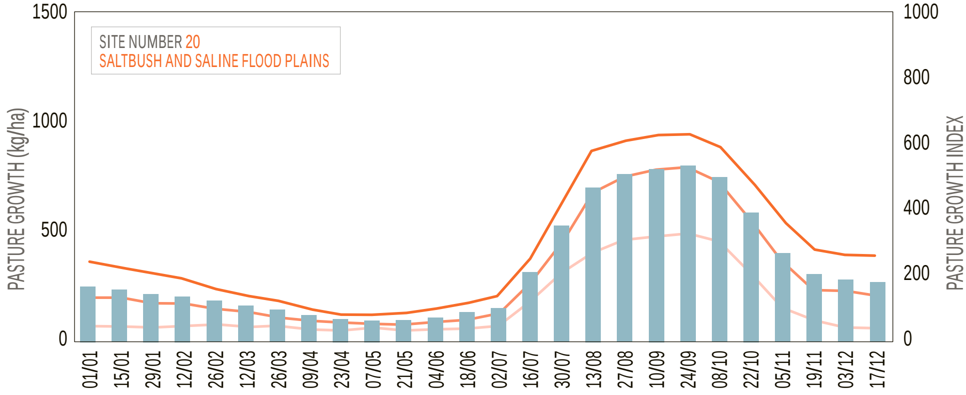

SITE NUMBER 15
BOX-PINE
PASTURE GROWTH INDEX
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12
STARTING DATE


GROWTH INDEX
PERCENTILE 80
MEDIAN
PERCENTILE 20
SITE NUMBER 16
30% BIMBLE BOX-PINE, 30% RIVERINE WOODLANDS, 25% BELAH-BLUEBUSH, 15% 'PLAINS GRASS'.
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
1500
1000
500
0
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12


SITE NUMBER 17
BELAH-BLUEBUSH
PASTURE GROWTH INDEX
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12


SITE NUMBER 18
60% BELAH-BLUEBUSH, 20% SALTBUSH PLAINS, 20% SOUTHERN RIVERINE WOODLANDS
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
1000
500
0
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12
STARTING DATE


GROWTH INDEX
PERCENTILE 80
MEDIAN
PERCENTILE 20
SITE NUMBER 19
40% MALLEE, 30% BELAH-BLUEBUSH, 15% SALTBUSH PLAINS, 10% SOUTHERN RIVERINE WOODLANDS, 5% PINE.
PASTURE GROWTH (kg/ha)
1500
1000
500
0
PASTURE GROWTH INDEX
1000
800
600
400
200
0
01/01
15/01
29/01
12/02
26/02
12/03
26/03
09/04
23/04
07/05
21/05
04/06
18/06
02/07
16/07
30/07
13/08
27/08
10/09
24/09
08/10
22/10
05/11
19/11
03/12
17/12


SITE NUMBER 20
SALTBUSH AND SALINE FLOOD PLAINS
PASTURE GROWTH (kg/ha)
1500
1000
500
0
PASTURE GROWTH INDEX
1000
800
600
400
200
0
01/01
15/01
29/01
12/02
26/02
12/03
26/03
09/04
23/04
07/05
21/05
04/06
18/06
02/07
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22/10
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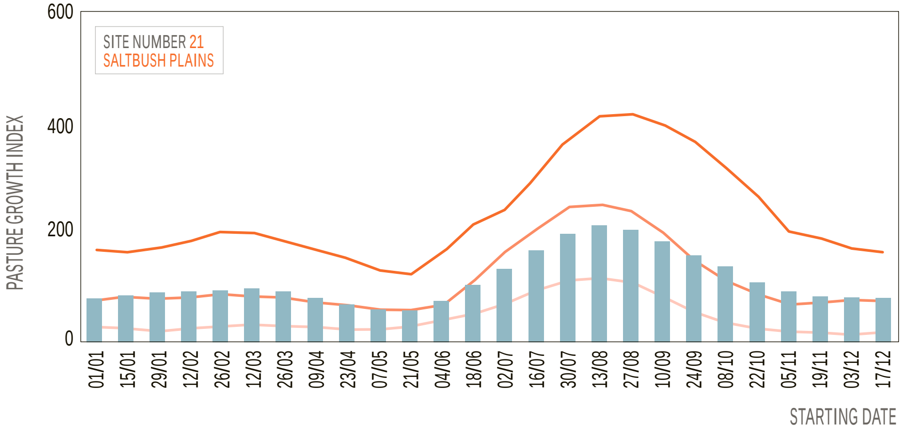
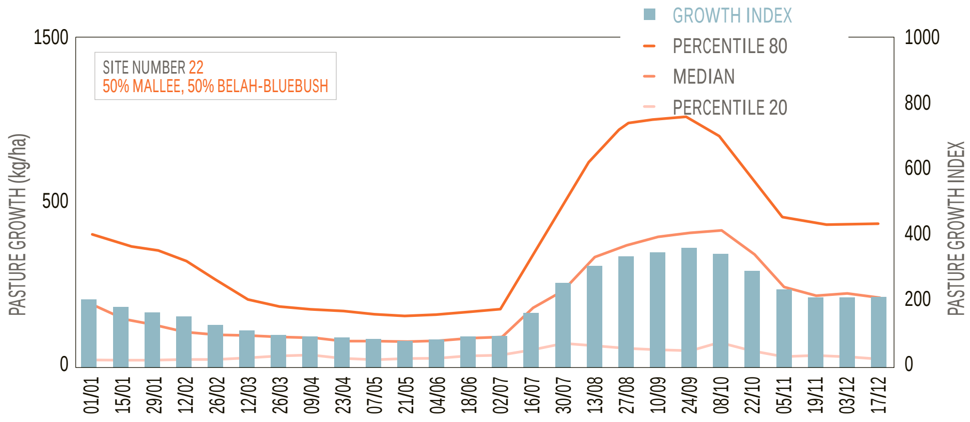
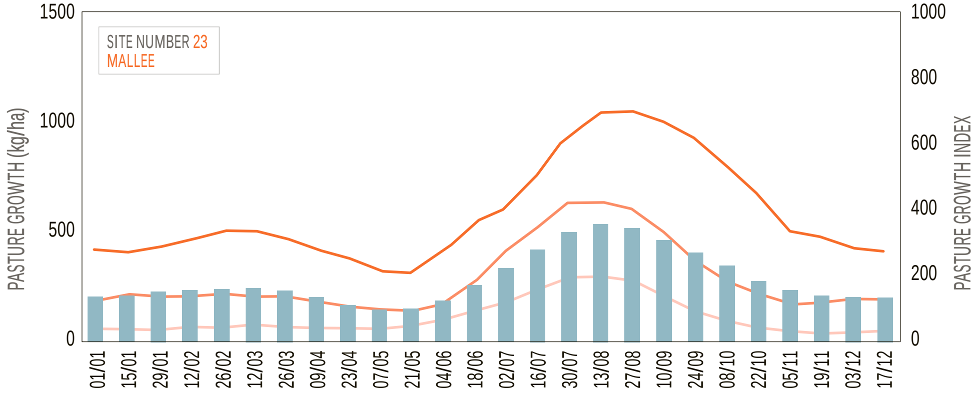
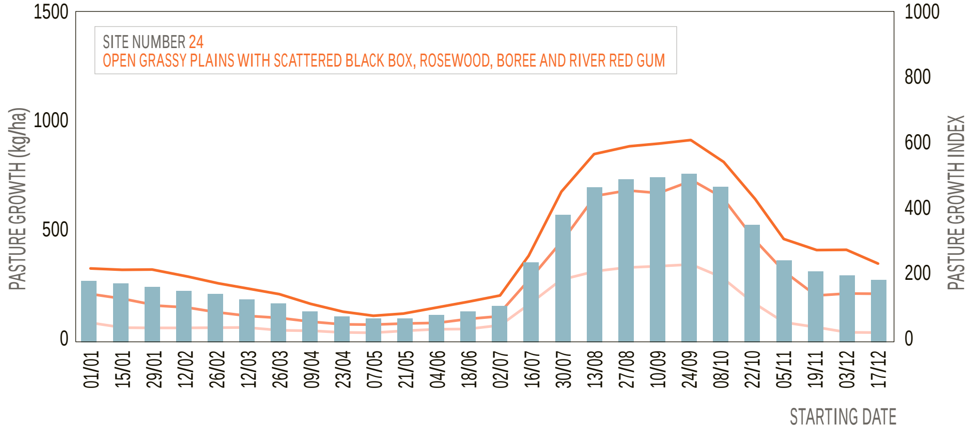
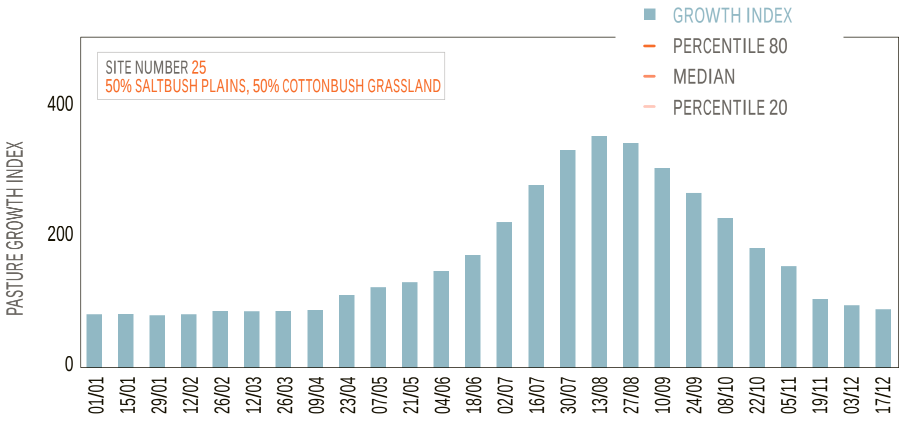
19/11
03/12
17/12

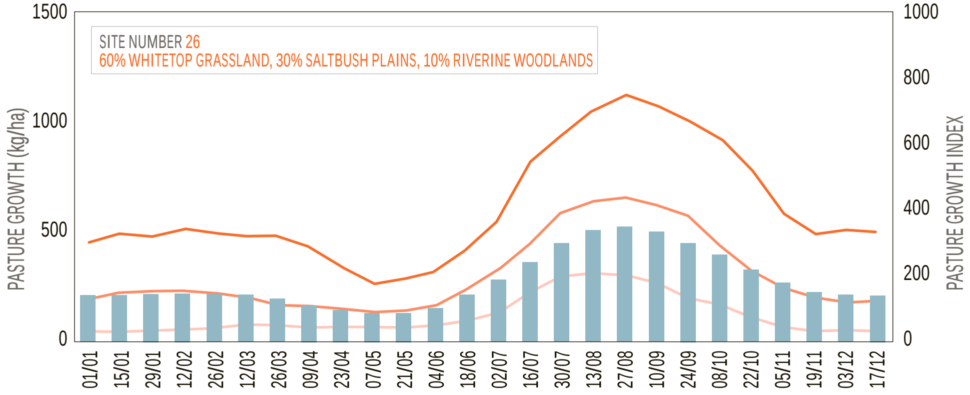

SITE NUMBER 21
SALTBUSH PLAINS
PASTURE GROWTH INDEX
600
400
200
0
01/01
15/01
29/01
12/02
26/02
12/03
26/03
09/04
23/04
07/05
21/05
04/06
18/06
02/07
16/07
30/07
13/08
27/08
10/09
24/09
08/10
22/10
05/11
19/11
03/12
17/12
STARTING DATE

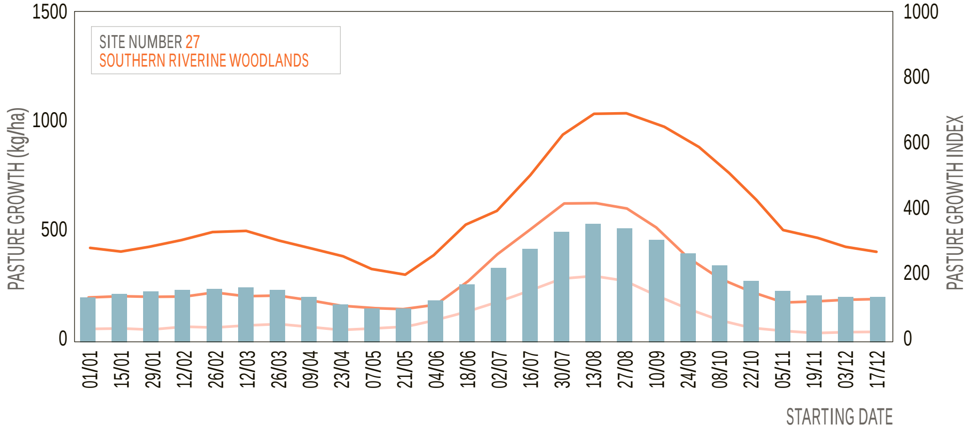

GROWTH INDEX
PERCENTILE 80
MEDIAN
PERCENTILE 20
SITE NUMBER 22
50% MALLEE, 50% BELAH-BLUEBUSH
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
1500
500
0
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12


SITE NUMBER 23
MALLEE
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
1500
1000
500
0
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12


SITE NUMBER 24
OPEN GRASSY PLAINS WITH SCATTERED BLACK BOX, ROSEWOOD, BOREE AND RIVER RED GUM
PASTURE GROWTH (kg/ha)
PASTURE GROWTH INDEX
1500
1000
500
0
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12
STARTING DATE


GROWTH INDEX
PERCENTILE 80
MEDIAN
PERCENTILE 20
SITE NUMBER 25
50% SALTBUSH PLAINS, 50% COTTONBUSH GRASSLAND
PASTURE GROWTH INDEX
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12


SITE NUMBER 26
60% WHITETOP GRASSLAND, 30% SALTBUSH PLAINS, 10% RIVERINE WOODLANDS
PASTURE GROWTH (kg/ha)
1500
1000
500
0
PASTURE GROWTH INDEX
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12


SITE NUMBER 27
SOUTHERN RIVERINE WOODLANDS
PASTURE GROWTH (kg/ha)
1500
1000
500
0
PASTURE GROWTH INDEX
1000
800
600
400
200
0
01/01 15/01 29/01 12/02 26/02 12/03 26/03 09/04 23/04 07/05 21/05 04/06 18/06 02/07 16/07 30/07 13/08 27/08 10/09 24/09 08/10 22/10 05/11 19/11 03/12 17/12
STARTING DATE

PART 6 –
SOURCES OF CLIMATE AND WEATHER INFORMATION

Where to go for

- short term weather information, on the Internet or by fax
- seasonal climate outlooks (next 3 months), on the Internet or by fax
- historical climate data

As agriculturalists we have rapidly moved from having too little climate and weather information to a problem of information overload. Links provided here will readily source relevant information. The challenge in using the information is to be clear about the uncertainty in short term forecasts and longer-term seasonal outlooks, and to use the information for risk assessment.

Short term weather forecasts

The following are some of the most relevant sites (with brief comment on their use and interpretation provided by NSW Department of Primary Industries, Tamworth).

Bureau of Meteorology 4 day forecast

http://www.bom.gov.au/products/IDG00074.shtml

Note that the hashed areas only indicate a chance of rain, not an expectation.

The Bureau of Meteorology forecast information is available in text form at http://www.bom.gov.au/weather/nsw/forecasts.shtml.

The notes on the weather are particularly helpful in interpreting the synoptic events.

Australian Weather News forecasts

http://www.australianweathernews.com/forecast_OCF.htm

This provides a link to a map of Australia showing all the Bureau of Meteorology weather zones, where you can get a 7-day forecast for specific sites within any zone. They all include maximum/minimum temperature forecasts as well as rainfall and some have potential evaporation and sunshine hours.

IGES COLA forecast for Australia

http://wxmaps.org/pix/prec7.html

This forecast is produced by the Centre for Ocean–Land–Atmosphere studies in the USA. It indicates the amount and location of rain that could fall in Australia in each of two five day blocks. Forecasts are updated daily and changes indicated in the day 6–10 block should be monitored for developments as information is updated.

The same model can be examined for each of the next 6 days individually at **http://wxmaps.org/pix/aus.vv.html**

Central & Southern Tablelands Weather

http://members.ozemail.com.au/~sjhop/c&stw.html

This site contains links to a large number of both short and long-term forecasts useful Australia wide.

Weather forecasts on fax

A range of weather forecasts and base information is available on Poll Fax (consult your fax manual for instructions on polling). The Bureau of Meteorology Fax numbers directory can be obtained on 1800 630 100 (free). It includes the following that may be of special interest:

- Mean Sea Level Prognostic analysis chart (the synoptic chart) and latest cloud picture – 1902 935 252
- Australian region 4 day forecast – 1902 935 002
- 48 hr forecast chart – 1902 935 007
- 2/3 day forecast chart – 1902 935 728
- 4/5 day forecast chart – 1902 935 003
- 6/7 day forecast chart – 1902 935 004
- Rain radar – maps of currently falling regional rain; the directory provides specific numbers for rain radar pictures from each site
- Farmweather – includes latest cloud picture, 4 day forecast, written description of the weather systems and how they are expected to develop as well as probability estimates of forecast rain times and amounts within each region. The directory provides specific poll fax numbers for tailored forecasts for 30 agricultural regions throughout Australia.

Seasonal Climate Outlooks

Seasonal climate outlooks provide as assessment of likely rainfall conditions for the next three months. **While short term weather information is provided as forecasts or predictions, seasonal climate outlooks are always stated as probabilities.**

Bureau of Meteorology Seasonal Outlook

http://www.bom.gov.au/climate/ahead/rain_ahead.shtml

This outlook shows the probability of exceeding median rainfall for the next three months. It is issued about the middle of each month and is derived from the pattern of sea surface temperatures in both the Indian and Pacific Oceans. Temperature forecasts are also available on the BoM site.

Queensland Centre for Climate Applications

http://www.LongPaddock.qld.gov.au/SeasonalClimateOutlook/RainfallProbability/

This site uses historical records of rainfall and SOI to estimate the probability of exceeding median rainfall in Australia over the next three months, based on the SOI phase over the last two months. You need to scroll down and select the 'Australia' map.

El Niño/La Niña summary and background

http://www.bom.gov.au/climate/enso/

This Bureau of Meteorology site provides a good summary of conditions and why they are important to Australia – worth a look to see what impact El Niño can have, and the variability as well as the current risk.

Current NSW conditions

http://www.dpi.nsw.gov.au/reader/drt-area

This site provides a series of maps showing areas where conditions are assessed as Drought, Marginal or Satisfactory; updated monthly; maps are available back to June 1998.

Seasonal outlooks on fax

Bureau of Meteorology Fax numbers directory (free) – 1800 630 100

The directory includes the following that may be of special interest

- 3 month climate outlook – 1902 935 251
- Southern Oscillation Index & Sea Surface Temperature update – 1902 935 432
- Australian Drought Statement (by the Bureau of Meteorology) – 1902 935 259
- 1 & 3 month Australian rainfall maps – 1902 935 262

Accessing historical climate data

Despite the short history of agriculture in Australia, we have historical rainfall records that are the envy of most other countries. For example Pooncarie has records from January 1878 and Bourke from 1877. Most centres have records for almost as long. They can be useful in preparing long-term plans where the frequency and magnitude of extreme events are important and the medians and probabilities describe the local climate.

For a basic analysis of past climate data, the Bureau of Meteorology web site **http://www.bom.gov.au/climate/map/climate_avgs/clim_avg1.shtml** has average monthly rainfall, rain days, max. and min. temperature and humidity for 1000 sites in Australia. Just click on the map and you can download the data into a spreadsheet. The same information is available in printed form in most public libraries in 'Climatic Averages'.

The Bureau of Meteorology web site **http://www.bom.gov.au/climate/austmaps/** has excellent maps of rainfall and temperature over the past day, week, month or three, six, nine 12, 18, 24 or 36 months.

PART 7 – SOME PRODUCER'S VIEWS

All of the graziers who worked with us on this project have their own experience of managing climate variability and their own philosophies of management. We asked a few to give us a snapshot of their approach, an opinion on the importance of seasonal risk assessment and a response to the information provided by the project.

Hugh McLean, Booligal

In general most people's expectations of weather or climate forecasting would be, when is it going to rain and how much will we receive? I must admit that before becoming involved in the Land, Water & Wool Seasonal Forecasting project in July of 2003 this was also my expectation.

I manage, in conjunction with my parents, a family owned merino grazing operation in the Booligal district of south western NSW. In a normal year we would join 4,500 merino ewes to merino rams, however since the 2002 drought this has been reduced to 3,000. The key principle of our grazing system is set stocking of paddocks at conservative rates.

The seasonal forecasting project has improved my understanding of two major principles. First, the effect of the Southern Oscillation Index and Sea Surface Temperature on the Australian climate. Second and more importantly is understanding forecast probabilities of achieving median rainfall. Farming like all business enterprises is about taking a risk today to hopefully receive a reward at some point in the future. As in all dry area farming one of our greatest inputs is rainfall. Forecast probabilities allow a risk level to be put on the potential of a future event, therefore allowing for a more meaningful decision to be made.

Into the future seasonal forecasting will be used to make decisions more for the upside. Meaning that when there is a forecast probability of achieving above median rainfall of greater than 70% (particularly in the period May to October) greater business risks will be taken. This could mean trading stock, taking on agistment or holding over sale stock to achieve greater per head returns.

Ed Fessey, Brewarrina

Good management in grazing industries usually entails the following features:

- Some experience and knowledge of the past
- Ability to continually access the future availability of feed
- The courage to make decisive decisions and not deliberate once the decision has been made

- Plan to always have the next sale mob ready for sale
- Spend time on local rainfall records and try to get a feel for the ebb and flow of seasons in relation to experience of what feed grows in these seasons
- Look at as many different long range forecasts as possible and be ruthless in deciding to agree or disagree with the trend.

The Land Water & Wool project is based on better managing climate variability in western NSW and about making trigger points for livestock numbers. Basically Anzac Day to May Day is the most critical period of the year because all of our successful seasons have usually had a major rainfall event in the January to April period. Consequently, if that rainfall event has not occurred by Anzac Day or is not likely to occur by the 1st of May, then you must get busy about making decisions.

At the end of the day, all good management involves good planning, decision making and a healthy dose of good luck!

Peter Bevan, Broken Hill

Farmers and graziers in nearly every area of Australia watch the weather closely, more so at critical times of the year, and have not enough indication of how the season will pan out. I believe we have a long way to go before long-term forecasting is good enough to rely on, but it is improving. Great strides have been made in the short term forecast.

I have learnt, at the climate forum, that our moisture tends to come from the east coast when a high is well north up the coast, and rain falls when the moist layer is acted upon by a trigger event from a westerly direction. There is many a slip, over the large distance involved, between good indications and actual useful rain.

We graze merino sheep and Murray Grey cattle on 75,000 ha of Barrier Range, footslope, and floodout country north of Broken Hill, some 5,000 ha is conservation land under the West 2000 Plus pilot scheme. Over the last 50 years, our country has changed from grass to bush, with a lot more trees, saltbush, bluebush, prickly acacia, etc. Access is a problem, with sandier creeks, deeper gutters, bush mounds, and very dense old-man saltbush and acacia. Woody weeds are not a problem. The bush helped us survive the drought. It means we have months longer to consider our options now, before we need to take drought action. A storm on the range can give the cattle quality feed for weeks.

We take an interest in SOI and some people use it as a good guide when deciding what stock, and how many, to turn off. This linkage gives a fairly reliable trend in weather patterns. When I was young, there was no SOI, we made do with fresh cow's milk! (Graziers need a sense of humour).

ACKNOWLEDGEMENTS

This guide is the result of input from numerous colleagues and collaborators. We thank particularly the 320 wool growers who participated in the project in various ways, many of whom provided valuable feedback in response to surveys or newsletters, or participated in workshops. Our colleagues in the Queensland Department of Natural Resources and Mines, led by Dr Beverley Henry, were always extremely obliging and prepared to expend whatever effort was required to undertake the major computing tasks required of the project, answer our questions and provide whatever data and images were required. Further analysis of the imagery provided by the Queensland group was undertaken proficiently by Mr Ian McGowen of NSW DPI as part of the analysis phase of the project.

We express our appreciation to Dr Barry White, Coordinator of the Managing Climate Variability Sub-Program of Land Water and Wool for his dedication to the cause of improved seasonal risk management over many years and for his guidance throughout this project. Finally we gratefully acknowledge the funding provided by the NSW Department of Primary Industries and the Land, Water and Wool partners, Land and Water, Australia and Australian Wool innovation Limited.

GLOSSARY

This glossary contains terms used in the text as well as others likely to be encountered in the literature of climate science and seasonal risk management.

Analogue year	A year with a similar pattern of the SOI, or some other indicator, to the current year.
Anticyclones	Cells of high pressure associated with dry air, resulting in mainly cloud-free skies and little or no rainfall. Anticyclones move from west to east across Australia at 25–40°S.
Aspect	Direction faced (e.g. east or west).
Atmosphere	The envelope of gases, bound by gravity, which surrounds the earth.
Atmospheric pressure	The pressure at a point due to the weight of the column of air above it.
AussieGRASS	Australian Grassland &. Rangeland Assessment by Spatial Simulation. A system operated by the Queensland Centre for Climate Applications that computes pasture growth in 5X5 km grid cells across Australia and provides monthly updates.
Average	See mean.
Cell	A vertical circulation of the atmosphere in which warm air rises and cools, flows laterally at high levels, then descends.
Climate	The weather experienced by a site or region over a period of many years.
Cold front	The boundary between a mass of advancing cold air and a mass of warm air.
Cyclones	Areas of low pressure (depressions) associated with rising warm air and clockwise air circulation in the southern hemisphere. A tropical cyclone is an intense depression fed by very warm (28°C) waters, and by release of latent heat energy as water vapour condenses to form rain.
Deciles	These divide a set of recorded rainfalls (monthly, seasonal or annual) into 10 equal groups. The lowest 10 per cent of falls belong in decile range one, the next lowest 10 per cent in decile range two and so on up to the highest 10 per cent of recorded

falls, which belong to decile range 10. The value between decile range five and decile range six is the median. Decile ranges give a better indication of how dry or wet a period has been than departure from the mean (or average).

Drought — Meteorological drought occurs when rainfall (for a period of at least three months) falls within the lowest 10 percent of all totals for that period (decile range one). The Bureau of Meteorology calls this a 'serious deficiency'. Droughts in New South Wales are often associated with strongly negative Southern Oscillation Index (SOI) values, commonly referred to as El Niño events.

El Niño — Originally this term referred specifically to a warming of the sea surface off the coast of Peru. It is now more generally used to describe the unusual warming of a large area of the eastern equatorial Pacific Ocean. This warming is strongly linked to negative phases of the Southern Oscillation.

ENSO — El Niño-Southern Oscillation – a composite term referring to the range of events associated with changing SOI phases.

Evapotranspiration — Moisture lost to the atmosphere from plants, soil and bodies of water.

GRASP — A computer model that calculated daily grass production (hence GRASP) from daily rainfall and other meteorological data. The model has been extensively validated for numerous vegetation types and locations in inland Australia, including western NSW, and is the basis of the AussieGRASS system.

Humidity — The water vapour content of the air.

IPO — Interdecadal Pacific Oscillation. The phenomenon is related to sea surface temperature changes on roughly decadal time scales. Indications are that the effects of El Niño and La Niña on Australian rainfall may be modified depending on whether the IPO is in a 'warm' or 'cool' phase.

Isobar — A line on a weather map joining places with the same mean sea level barometric pressure.

ITCZ — The Intertropical Convergence Zone where the moist south-east trade winds of the southern hemisphere meet the north-east trades of the northern hemisphere. It is a zone of heavy rain and thunderstorms, and a main source of tropical rain.

JMA — Japanese Meteorological Agency. Satellites operated by this agency provide the cloud images of Australia.

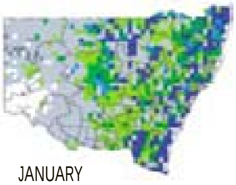
La Niña	This term is now used to refer to the opposite of an El Niño (the opposite phase of the Southern Oscillation). La Niña refers to cooler than average sea surface temperatures in the eastern Pacific which are accompanied by positive SOI values.
Mean (average)	The mean is calculated by adding all the numbers in a series (e.g. annual, monthly or daily rainfalls) and dividing the total by the number of observations.
Median	The median value is determined by ranking a set of numbers from highest to lowest. The value which has 50% of the numbers above it and 50% below is the median. Monthly means may be well above the median, especially in arid regions where the mean is distorted by rare, but torrential rainfall events (see mean).
MJO	Madden-Julian Oscillation, also known as 30–60 day waves, or intra-seasonal oscillations. These periods are low pressure waves that sweep west-east across the north of the continent irregularly every 30–60 days (average 40 days), triggering rainfall events.
NCC	National Climate Centre of the Bureau of Meteorology located at the Melbourne Head Office (GPO Box 1289K, Melbourne, Victoria 3001).
NOAA	National Oceanic and Atmospheric Administration.
NSW DPI	NSW Department of Primary Industries.
Orographic rain	Rain caused by terrain standing in the way of moisture-laden air, forcing it to rise and cool resulting in condensation and rain.
Precipitation	Deposits of water, (rain, ice, snow) reaching earth from the atmosphere.
Probability	Probability of an event happening can be expressed as a percentage. A probability of 70 per cent means there are 70 chances in 100 (seven in 10) of the event occurring.
QDPI	Qld Department of Primary Industries.
Rainman	A computer package developed by the QDPI that provides historical rainfall information for numerous locations across Australia and allows relationships between rainfall and SOI to be determined. The most recent version of the package Rainman Streamflow also provides correlations between SOI and flow of many Australian rivers

Relative humidity	The water vapour content of the air as a percentage of the amount needed to saturate it at the same temperature.
SCO	Seasonal Climate Outlook. Issued by climate meteorologists at the National Climate Centre.
Skill	The extent to which the use of an indicator (e.g. SOI Phase) improves the prediction of a variable (e.g. rainfall or pasture growth) compared with the use of historical data alone. It is related to the strength of the relationship between the variable and the indicator (see also Appendix 1).
SOI Phases	The five phase of the SOI – consistently negative (1), consistently positive (2), falling (3), rising (4) and neutral (5) – used for seasonal risk assessment. The phases are determined by the pattern of the SOI over the previous two months.
SOI	Abbreviation for Southern Oscillation Index, the index that measures the strength and sign of the Southern Oscillation. The index is based on a mathematical formula that expresses the standardised difference in air pressure between Darwin and Tahiti.
SST	Sea Surface Temperature. SSTs play an important role in Australian rainfall variability, particularly the temperatures across the tropical Pacific Ocean.
Trade winds	The south-east winds blowing across the southern Pacific Ocean are referred to as trade winds. They weaken in an El Niño event.
Trigger Points	As used in this booklet, calendar dates that should prompt tactical management decisions when used in conjunction with other observations of seasonal conditions.
Troposphere	The lowest layer of the Earth's atmosphere in which our weather occurs. It extends to a height of about 20 km at the equator, and 10–15 km at mid-latitudes.
Trough	An extension of a low pressure system.
Warm episode	This refers to a sea surface temperature anomaly in the eastern Pacific; a warm episode is the same as an El Niño and corresponds with a negative phase of the Southern Oscillation.

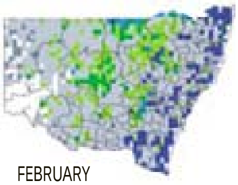
APPENDIX 1

Variation over the year in the relationship between SOI phase and the probability of exceeding median pasture growth.

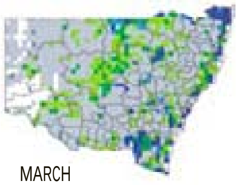
The strength of the relationship is expressed as a 'skill' score calculated using a statistical procedure (LEPS; linear error in parameter space) which measures the improvement in the probability of exceeding median growth obtained by using the SOI phase compared with long-term history. LEPS scores greater than 10 are considered to indicate 'significant' skill. All assessments are based on 3-month pasture growth and zero lead time i.e. growth is related to the SOI phase in the two-month period to the end of the indicated month. Months shown in capitals correspond to the 'current month' for making an assessment as used in Table 4.1.



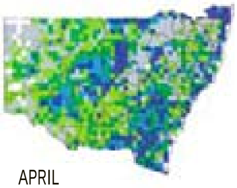
JANUARY
SOI phase – December
Growth – January to March



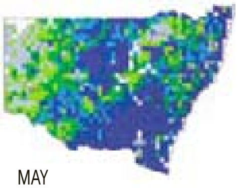
FEBRUARY
SOI phase – January
Growth – February to April



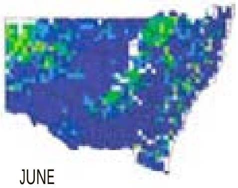
MARCH
SOI phase – February
Growth – March to May



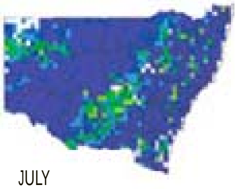
APRIL
SOI phase – March
Growth – April to June



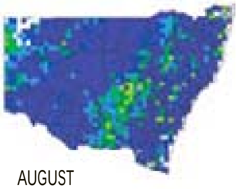
MAY
SOI phase – April
Growth – May to July



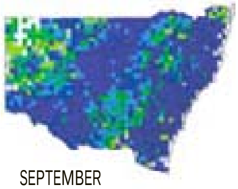
JUNE
SOI phase – May
Growth – June to August



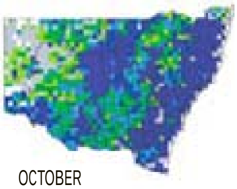
JULY
SOI phase – June
Growth – July to September



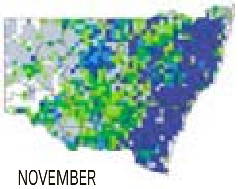
AUGUST
SOI phase – July
Growth – August to October



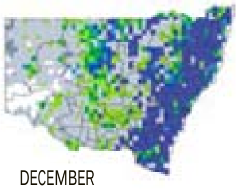
SEPTEMBER
SOI phase – August
Growth – September to November



OCTOBER
SOI phase – September
Growth – October to December



NOVEMBER
SOI phase – October
Growth – November to January



DECEMBER
SOI phase – November
Growth – December to February

<0 | 0–10 | 10–15 | 15–20 | 20–25 | 25–30 | >30 | seasonally negligible

LEPS Forecast Skill, www.LongPaddock.qld.gov.au

APPENDIX 2

Model versions (either the location for which the GRASP model was calibrated or an 'average' calibration) and the climate record used to produce the pasture growth profiles included in Part 5.

SITE NO.	MODEL VERSION – CLIMATE STATION
1	Lake Mere (Louth) – Tibooburra
2	Lake Mere (Louth) – Bourke
3	NSW average – Bourke with grazier modification (Modified graph with pasture growth index only)
4	Lake Mere (Louth) – Walgett
5	Lake Mere (Louth) – Brewarrina with grazier modification (Modified graph with pasture growth index only)
6	NSW average – Walgett with grazier modification (Modified graph with pasture growth index only)
7	Gilruth Plains (Cunnamulla) – Brewarrina
8	NSW average – Cobar
9	NSW average – Cobar
10	NSW average – Wilcannia
11	Kinchega (Menindee) – Wilcannia
12	NSW average – Broken Hill
13	NSW average – Condobolin
14	Kinchega (Menindee) – Ivanhoe
15	Kinchega (Menindee) – Condobolin with grazier modification (Modified graph with pasture growth index only)
16	Kinchega (Menindee) – Condobolin
17	Kinchega (Menindee) – Deniliquin with grazier modification (Modified graph with pasture growth index only)
18	NSW average – Broken Hill
19	NSW average – Hay
20	Kinchega (Menindee) – Deniliquin
21	NSW average – Hay
22	Kinchega (Menindee) – Broken Hill
23	NSW average – Hay
24	Kinchega (Menindee) – Hay
25	NSW average – Hay with grazier modification (Modified graph with pasture growth index only)
26	NSW average – Deniliquin
27	NSW average – Hay

For further information or to organise activities related to the material contained in this booklet contact:

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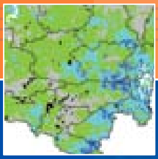
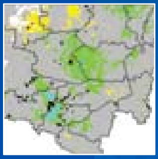
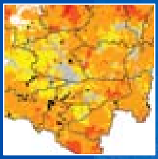

BETTING ON RAIN

MANAGING SEASONAL RISK IN WESTERN NSW

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