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Checking for Change

A practical guide to checking whether sites newly managed for conservation are on track to improve

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Introducing Checking for Change

Why use this approach to check for change?

How will you know whether your work to improve the environmental condition of sites, such as changing timing of grazing or stock numbers to enhance the recovery of native plants, is actually making a difference? It's important to know whether you are on track, and knowing that sooner rather than later can help you adjust your management to try new things (if necessary) to achieve a better result faster.

Most monitoring at the moment focuses on simply reporting which management actions are performed, not what they achieve in terms of improving the environment. When we try to ask whether improvement is really happening, most of the indicators currently being used can take over a decade to reveal the answer and often involve hours of detailed data collection.

The indicators we share in this Guide will let you know if you're on track over much shorter timeframes (2 to 6 years), are straightforward to use, result in simple accurate data and are based on the latest scientific findings. You can use our BioCollect website http://tinyurl.com/checking4change which makes it easy to enter, store and share data so we can learn about improvement on properties, within regions, across states – even nationally.

Checking for Change will complement more detailed, longer-term monitoring methods and allow more people to participate in monitoring – including individual land managers, schools, and community groups.

Many of the indicators are common components of longer-term monitoring approaches but the way the information is collected has been modified to make it simpler and easier for 'citizen scientists' to do. The Checking for Change approach can thus help managers and funders of environmental management do more monitoring of real outcomes and quickly learn whether they are on track or need to keep experimenting with their management.

Changing focus – looking down beneath the trees

When we check a site we often look at the big picture – how do the trees 'look', are there any serious weed issues and is there 'new growth'? However, because positive improvements often happen at the ground level first (even below the plants and in the soil), the indicators in Checking for Change involve observing the ground layer – including leaf litter, bare ground, and even the bugs living there – not just the plants. By shifting your focus down to the ground, you can more effectively track a site's progress in the early years after you have changed management.

Assessing tree health in box gum woodlands

Native Common Buttercups (Ranunculus lappaceus)

Getting close to it all and discovering the native orchid amongst the grasses

Checking for change typically requires a shift in perspective from looking up at the trees (above left) down to the soils, grasses and wildflowers in the ground layer (above right and below)

What are the indicators?

There are 4 simple, easy-to-use indicators which do not require the ability to identify any plants or animals. These are:

Not Bare Ground

- the amount of ground that is not bare because it is covered with plants, leaf litter, mosses, fallen timber, rocks, animal dung etc.

Litter Depth

- how deep the leaf litter layer is

Litter Break-down

- the degree to which the litter is broken down and starting to become soil

Plant Types

- the number of different types of plants

There are two extra indicators and a more detailed version of Plant Types for people who have some plant and bird identification skills:

Cover of Native Perennials

- how much ground is covered by native perennial (long lived) plants

Bird Types

- the number of different types of birds in the site

Native Plant Types

- the number of different types of native plants (a version of 'Plant Types' above)

Lastly, there is one indicator that we are still learning about. It's easy to use and any information you collect could help us understand how much it might be a sign of improvement:

Number of Bugs

- number of bugs found on the ground, including in the litter

The science behind the indicators

The indicators in this handbook have been specifically designed to detect changes in ecological condition within just 2 to 6 years after altering land management practices for conservation purposes. They were originally developed and tested by CSIRO for the Box Gum Grassy Woodlands of south-eastern Australia but are likely to be useful in a range of grassland, woodland and open forest systems. They are not likely to be suitable for rainforests, heaths, or freshwater or coastal wetland systems.

All of the features that the indicators measure have been shown through prior research to be different between high quality (or 'reference') grassy woodlands compared to areas that have been impacted by grazing and other human activities. Thus, we can be confident that changes in these indicators represent actual *improvement*, not just change.

In the research that motivated this Guide, we specifically tested whether these indicators would improve following a change to a conservation management regime. The usefulness of the indicators was tested after two years following a change in management and then at six years following the change in management.

We also tested whether the indicators were easy to measure by land managers themselves and whether they yielded data that was as accurate as the data collected by ecological experts – and, the good news is, it was very similar!

Some of the indicators are not new and are already used in more detailed monitoring programs. But we modified the way the information is collected to make them more suitable for use by a wide range of people, not just experts. Only the indicators that either fully or mostly met those criteria are included in this Guide.

For more detailed information on the science, please see the companion guide '**Checking for Change: the science behind practical monitoring of ecological improvement**' (available under the Resources tab at our website: http://tinyurl.com/checking4change).

FOR PROFESSIONALS AND OTHER EXPERTS:

This Guide is written to enable a wide variety of people with different skill levels to participate in monitoring improvements in ecological condition. Yet the indicators themselves and in most cases the specific ways in which they are measured have been rigorously tested using a before-after-control-intervention (BACI) experimental design and formal statistical analysis over two time periods in the box-gum grassy woodlands of south-eastern Australia. For in-depth information on the peer-reviewed science, please see the companion guide 'Checking for Change: the science behind practical monitoring of ecological improvement' (available under the Resources tab at our website: http://tinyurl.com/checking4change).

Who is this Guide for?

Land Managers

Most of these methods have been selected and designed to be used by landholders with no specialist knowledge and limited time available. There are three additional indicators then available for land managers with a moderate level of plant and bird identification skills. Thus, land managers can use this Guide to track conservation improvements on their own properties. It can also help managers identify opportunities to innovate and try new management approaches to give a better result (for example, reduce kangaroo grazing, try mulching, or undertake revegetation).

Schools and Community Groups

Schools and community groups, including Landcare, are increasingly looking for opportunities to participate in 'citizen science'. The non-technical nature of these indicators means that they can be used by citizen scientists to provide insights into environmental improvement. Applying these indicators across multiple sites (e.g. across a Landcare district, in a rural/regional school district, or in a series of newly established urban parks) can give the added benefit of learning about regional improvement, not just individual sites. Schools or volunteer groups can coordinate with the types of organisations listed below to find multiple sites to work on.

Non-Governmental Organisations

Non-governmental organisations (NGOs) like Greening Australia work with private land owners to restore and manage sites for environmental improvement. They are often looking to improve their processes, so the early detection of improvements (or not) can help make that goal of 'adaptive management' a reality. There is also often a desire to involve land managers in monitoring and these indicators are very appropriate for fostering collaboration between NGOs and the individual land owners and managers they work with.

Natural Resource Management Organisations

Regional natural resource management (NRM) organisations often work with private land owners to restore and manage sites for environmental improvement, usually through education/extension services or through funding management agreements. Parks managers also often work to restore or improve areas within parks that have been degraded by various human activities. Checking for Change could help support adaptive management in these circumstances. By using these methods across multiple sites, these indicators could also provide highly cost-effective ways of reporting on program-level outcomes within the time frame of a funding or management program and its reporting, thus helping to meet increasing accountability requirements.

State and Federal Governments

State and federal governments may run environmental improvement programs themselves or provide the funding for programs administered by others (like NGOs and regional NRM organisations). These indicators are simple and inexpensive to apply, so could become part of mandated reporting. As most mandated reporting at the moment is focused on reporting on the management activities conducted, these types of simple methods to add *outcomes*-based reporting can potentially improve the accountability of publicly-funded programs.

State and federal governments are also responsible for State of the Environment reporting and are increasingly looking for simple yet quantitative ways to gain insights into the overall condition of the environment at larger scales. It would be possible to use these simple approaches to create widespread on-ground data collection that could very usefully complement the remotely sensed and modelled data typically used at these scales.

FOR PROFESSIONALS AND OTHER EXPERTS:

This Guide is written in plain English, with active voice to make the methods accessible to many potential users. As a result, it doesn't conform to the style that might be expected of a professional monitoring guide. But the indicators and methods are based on traditional transect and point-intercept sampling techniques so they are still suitable for use by experts and professionals including field officers, park managers, and ecological consultants. Because the Checking for Change indicators eliminate the extensive effort required to assess ecological variables that are not expected to change very quickly, Checking for Change may in fact provide a particularly cost-effective alternative for professionals in situations where short-term improvement needs to be assessed. To judge that for yourself, please see the companion guide 'Checking for Change: the science behind practical monitoring of ecological improvement' (available under the Resources tab at our website: http://tinyurl.com/checking4change).

Does this approach work with other monitoring methods?

If there is no monitoring or measurement of improvement/outcomes currently being undertaken, these methods provide a way to do it simply and cost-effectively for the first few years after a change in management.

However, what if other monitoring methods are currently being used? Remembering that the Checking for Change indicators are specifically designed to show change in the first 2-6 years, it means there are a few possible options:-

Add the indicators to your longer term monitoring scheme

If time and resources allow, add the Checking for Change approaches to a longer-term more detailed monitoring scheme to see what they can tell you specifically about short-term change in that broader monitoring context.

Use Checking for Change first

Use the Checking for Change indicators for about the first 6-8 years after a change in management, and then switch to the more detailed monitoring methods that are expected to show change after longer time frames. Remember to collect baseline data at the start (before or soon after a change in management) using the more detailed monitoring methods too, but then don't spend the time and money collecting those detailed data again until your Checking for Change program is over (6-8 years).

Do long-term monitoring opportunistically, across programs

Checking for Change fits within the time frames of most funding programs and management agreements. Long-term monitoring may be more aspirational with lack of clarity about how it will be funded. Thus, Checking for Change can be incorporated as the formal monitoring approach for a program and resourced as part of that program. Longer-term, more detailed monitoring could then be applied more opportunistically as funding allows.

What about photo points?

Land managers are often encouraged to monitor by using photo points – photos taken from the same point repeatedly over time. These are very useful for *illustrating* long-term change. Unfortunately, photo points cannot demonstrate that change is due to conservation management, adequately show short-term improvements, or provide data for larger regional or state assessments. Thus, don't hesitate to take photos alongside Checking for Change to provide a visual record, but do not consider photos from photo points to provide useful monitoring data.

Using in tandem with longer-term indicators

To ensure all of these choices are viable options, the Checking for Change indicators have been designed to be collected along a 50m 'survey line', which is also used in most longer term monitoring approaches. Thus, the preparation required to use Checking for Change also supports the transition to, or simultaneous use of, other monitoring methods.

How to use this Guide

If the Introduction to Checking for Change above has convinced you to give the indicators a try, here are some tips for how best to use the rest of this Guide.

1st

- ***First, simply look through the Guide*** so you are more familiar with the overall process, its objectives and your options for indicators. You will need to choose which indicators you want to use during the 'Preparation' step, so it's wise to learn a bit about them first.

2nd

- ***Read through the 'Preparation' section in detail*** - Preparation is critical as it helps you establish exactly where and how you will be collecting and interpreting the information. It then supports your use of the indicators for years to come so a bit of extra time spent at the start will be well worth it in the long run.

3rd

- ***Complete your Preparation work*** - This involves selecting your sites, setting up your survey lines, choosing which indicators you will use, planning your surveys, and gathering your supplies.

4th

- ***Use our Indicator Factsheets and Data Sheet to support you in collecting the information on your chosen indicators in spring*** - Each indicator is shown on a separate page so you can print (and laminate) separate pages and thus take only the information you need out into the paddock with you. Data sheets are also provided at the end of this Guide to make it easy for you to record the information.

5th

- ***As soon as possible after you have collected the information, follow the instructions in 'Making Sense of the Numbers' to know what they are telling you about improvement (or not) at your site(s).*** This will involve a small amount of simple maths and graphing on gridded paper (or more if you have the capacity). This may seem like the most foreign part of the process to you, but it is absolutely critical for learning from the information you collect. These results can be entered into the project's BioCollect website to make interpretation easier and help build a bigger regional picture of improvement.

Preparation

Choose a 'control' site to match your conservation site

One of the most critical aspects of detecting improvement in sites managed for conservation involves also collecting the information on sites that are *not* managed for conservation – 'control' sites.

This may be rarely done especially since it seems like twice as much work, but it actually provides the most important insights. This is because nature changes all the time in response to local and seasonal conditions. For example, when rainfall has been good, many more plants will pop up in spring to flower and seed, and the opposite is true after particularly low rainfall. Thus, if we only collect information at management sites, we can be misled and accidentally interpret natural seasonal changes as successes or failures of management.

To get a clear understanding of whether management is resulting in improvement of a site, we need to compare each management site with a 'control' site (one that is continuing to be managed for other purposes, not primarily for biodiversity conservation) and do so over time. What we actually expect to see is an increasing *difference* between the managed site and the 'control' site over time.

How to match your site with a 'control' site

You will need to select one control site for every site being managed for conservation that you are trying to monitor (or see note to professionals).

You will need to collect information using the Checking for Change indicators at BOTH of the sites.

To choose a control site, find another spot on the same property or on an adjacent property that:

- was historically managed similar to the way the conservation site was in the past
- is going to continue to be managed as it was historically (more or less)
- has the same basic grass and tree types (hint: if you aren't sure, just make sure it's not in a different part of the landscape such as on a hillslope when the conservation site is on a valley bottom)

FOR PROFESSIONALS AND OTHER EXPERTS:

If you are using Checking for Change across many sites being managed for conservation as part of a larger program, it may be possible to have fewer control sites than a strict one-to-one matching. The key thing is to ensure that the set of control sites capture the amount and nature of the variation present across conservation sites and that sample sizes will be sufficient for statistical analysis. In general, we recommend no less than half as many control sites as conservation sites.

Select a control site that roughly matches the past management and current condition of your conservation site. For example, in these images, a conservation site on the lower flats with little tree cover should be matched with a control site on the flats as well. A conservation site on the mid-upper slopes should be matched with a control site on the mid-upper slopes with similar tree cover. (bottom image © Mark Jekobsons)

Set up your survey lines

The information needs to be collected along one 50-metre-long survey line in your conservation site and one 50-metre-long survey line in your control site, like the one in the photo-diagram to the right. In each site, select a point at which to start your survey line that is inside the site rather than at its edge. Try to be at least 30 metres away from the edge, and preferably 50 metres away. Install a star picket or dropper (or similar permanent marker) at this beginning point of the survey line. Walk 50m in a straight line through the site and install

another star picket or similar marker at this end point of the survey line.

It's best to use a tape measure or rope already measured out to 50m, but you can also estimate the distance with your own steps or paces if you know how far you normally step. Your markers at the beginning and end will need to stay in place over time and be easily found again. Each time you collect information on the indicators, you will walk a straight line between these markers. These types of survey lines are often used in other more detailed monitoring approaches, where they are sometimes referred to as 'transects'.

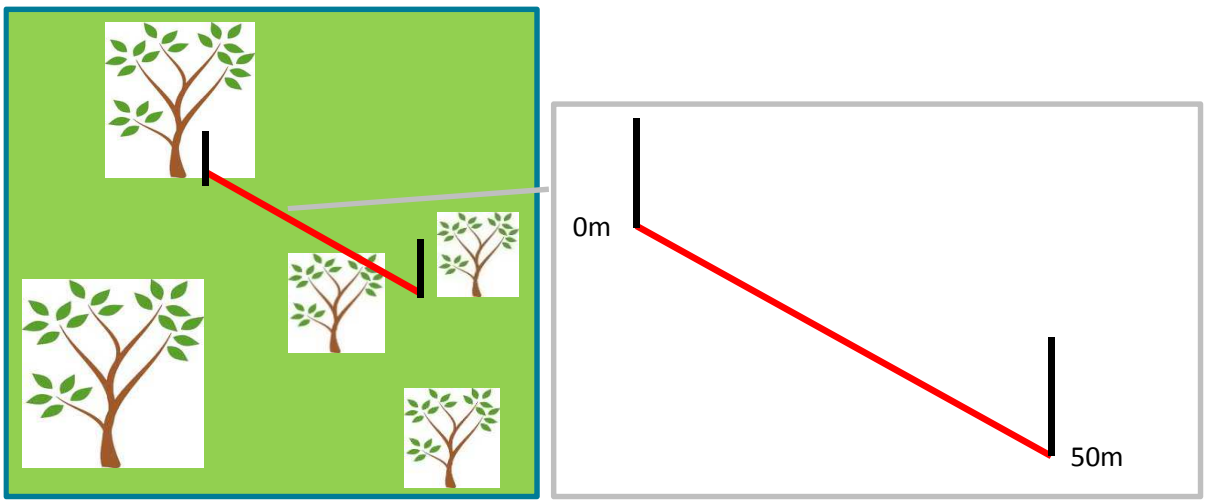
You will want to record the latitude and longitude of the beginning point of your survey line (Step 0). You can do this with a handheld GPS or a GPS enabled mobile phone. Ensure the datum is set to GDA94/WGS84 and record the latitude ^{o}S and longitude ^{o}E in degrees, minutes, and seconds using the format DD MM SS.SSSS.

Representing your site - where should the survey line be set up?

Each 50 metre survey line should run through a 'representative' part of each site (see diagram below). This means that you should try to run it through a part of your site that has a bit of everything in about the same relative amounts as you have across the whole site. Have a look and think about the whole site in order to consider its overall characteristics. Look at individual elements such as groundcover, shrubs, and trees and both their abundance and the spacing between them.

For example much of the sheep wheat belt from Queensland, through NSW and into Victoria, was covered by Box Gum Grassy Woodlands and there is often a mix of regrowth and older remnants, a sparse shrubby layer, and a ground layer varying from exotic annual grasses to a good cover of native perennial (long lived +2 years) grasses and native wildflowers.

The 50 metre survey line selected should contain those key elements of the site (see the diagram above). For example, avoid selecting an area with the only patch of shrubs and the one big old tree or because it "looks good" or is easy to walk through.



Stylised diagram showing a 50m survey line running through a 'representative' part of the site – with a bit of a big tree, a bit more of a small tree, and mostly grass.

Pick your indicators

Select which of the Checking for Change indicators you wish to use

You can use any or all of these indicators, depending on your preferences and levels of expertise (for example identifying native perennial grasses, all native plants, and/or recognising different birds). In general, the more of the indicators you use, the more complete a picture you will get. If your time is extremely limited and you want to use just a subset of the indicators, we suggest using at least three.

You should use the same indicators each time you collect information/conduct a 'survey' and don't change indicators partway through your monitoring. Thus, it's important to make your key decisions now.

Have a think or a chat about how many and which indicators you will use – in general using more indicators will provide a more complete picture but if your time is very limited make sure you use at least three

Confirm the order in which you will measure your indicators

When using multiple indicators, you want your sequence of measurements to be quick and efficient. Also, you don't want to accidentally damage your ability to get useful data (for example by trampling back and forth along the survey line before trying to count bugs in the leaf litter).

If you choose to use all the indicators, specific instructions for collecting all the data in one pass down your 50m survey line can be found after the factsheets, in the section 'Using Multiple Indicators'. If you are choosing to use only some of the indicators, look at the guidance in 'Using Multiple Indicators' to consider the most efficient way to tackle the set you have chosen.

To make sure your measurement of indicators is quick and efficient you will find some useful tips by reading the 'Using Multiple Indicators' section

Plan when to survey and how to record and understand the numbers

When is the best time to collect the information?

Typically in south-eastern Australia monitoring is undertaken in spring when annual plants are present. Thus, it is probably most useful to collect information on each of these indicators in spring, at about the same time each year. Information should be collected from your conservation site and your control site (by the same person) within a few days of each other in fine weather conditions. Your work should preferably be done in the morning if you are using the **Bird Types** indicator.

So for example, you might plan to collect your information on two consecutive mornings (one for the conservation site and one for the control site) sometime in the second half of October each year. The amount of time required each year will depend on how many indicators you choose to work with, but each site should take less than 1 hour once you are there and set up.

How often should you collect the information?

Just one survey is needed each year, but it should preferably be done by the same person each time. Some of the Checking for Change indicators have been shown to be most effective within just the first 2-3 years after a change in management while others continue to be helpful at least until 6 years after a change in management (and possibly longer). These differences are described on the factsheets for each indicator. The number of years you collect data may therefore differ depending on the indicators you have chosen, or depending on reporting responsibilities or your own motivation and curiosity. We suggest you collect the information at least three times (at the start of a change in management, one year after, and two years after) so you will be able to start to see trends over time (see 'Understanding the numbers').

Recording the information

Most of the information is collected for multiple 'sample points' along the survey line and later summarised for the whole site. Thus, it is particularly useful to have a formal data sheet that you take out in the paddock with you to write down all the numbers (or ticks to indicate 'yes') and then summarise them at home. We have provided a sample data sheet at the end of this Guide that can be printed and used each time.

Understanding the numbers

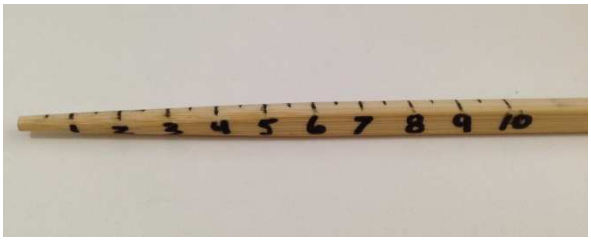
Each of the indicators includes a description of how to calculate a single summary number for the site based on the information collected. In most cases, this is an average or a simple percentage.

The key is assessing whether your conservation site is improving is to look at changes in the numbers over time at *both* the control site *and* the conservation site and look for a better trend at the conservation site. More detailed information about using simple graphs to make this easy is provided in the section 'Making Sense of the Numbers'. Just be sure to plan a small amount of time after collecting the information each year to do these simple calculations, share the information on our BioCollect website, and update your graphs.

Gather your supplies

Finally, it will be useful to have a small box prepared with the few supplies you need to use the indicators, which you can then store and use again each year. The supplies you will need are:

- A GPS or GPS enabled mobile phone to confirm the latitude and longitude of the start of your survey line
- Chalk or a permanent marker to put marks at the tips of each of your boots
- A pen or pencil

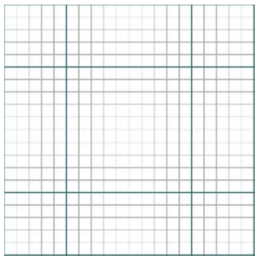


- A ruler (best if it has a pointy end – can make one using a chopstick or similar)

A chopstick can be turned into a homemade pointy-ended ruler, which is easier to push into leaf litter to measure its depth.

- Factsheets for the indicators you are using (preferably laminated)
- Datasheets on a clipboard or in a notebook

- Graph paper (or at least lined paper) to help make sense of the numbers (or software like Excel for advanced users)



Optional supplies

- rope or measuring tape to string between the two end markers to create a more precise survey line that could be easier to walk
- gloves to protect your hands from spider bites if measuring **Number of Bugs**
- binoculars to help you see birds if counting **Bird Types**

Your planning and preparation is now complete and you should be ready to 'Check for Change'.

Indicator Factsheets

The following pages contain the factsheets for each of the Checking for Change indicators with two pages per indicator. Print the pages for the indicators you have chosen to use. If you are able to laminate them, they will be more durable for using each year in the paddock. Here is a summary, showing the order in which the factsheets are presented:

First the 4 simple, easy-to-use indicators which do not require the ability to identify any plants or animals:

Not Bare Ground
– the amount of ground that is not bare because it is covered with plants, leaf litter, mosses, fallen timber, rocks, animal dung etc.

Litter Depth
– how deep any leaf litter layer is

Litter Break-down
– the degree to which the litter is broken down and starting to become soil

Plant Types
– the number of different types of plants

Then the two extra indicators and a more detailed version of Plant Types above for people who have some plant and/or bird identification skills:

Cover of Native Perennials
– how much ground is covered by native perennial (long-lived) plants

Bird Types
– the number of different types of birds in the site

Native Plant Types
– the number of different types of native plants (a version of above 'Plant Types')

Lastly, there is one indicator that we are still learning about. It's easy to use and any information you collect could help us understand how much it might be a sign of improvement:

Number of Bugs
– number of bugs found on the ground, especially in the litter

Not Bare Ground

What is 'Not Bare Ground'?

This indicator is the percentage of places where you look at the ground and do NOT find it bare – it has anything but bare soil, such as plants (including mosses and lichens), leaf litter or rocks.

Why is 'Not Bare Ground' important?

Plants and litter help to hold soil and soil moisture in place and litter helps to return nutrients back to the soil. So when the soil is bare, it is not getting those benefits. However, be aware that some bare soil is to be expected in Australian woodland systems and provides opportunities for new plants to establish and for wildlife to forage in.

However if the amount of bare ground is high and/or is increasing over time, your soil development and function is in decline. This may be because there are not enough ungrazed live plants to deposit litter in the first place, or because litter is being blown and washed away through erosion.

How long does it take to measure?

Less than 10 minutes per site

When is it useful?

0 - 6+ years after change in management

How do I measure it?

Mark the toe of each boot with something a marker pen or chalk then start at the beginning of your survey line. Take steps toward the end marker of the line that are approximately 1 metre apart (so you should aim to take about 50 steps in total along the line). At each step, record whether there is NOT bare ground directly under the mark at the tip of your boot (by making a tick mark in the box on the data sheet if you see anything except bare ground).

At the end, to record the summary value for the whole site, calculate the % of Not Bare Ground by adding up the number of ticks (or 'yes' answers), dividing by the number of steps you took, and multiplying by 100.

When litter is sparse, you need to be precise about recording what you find directly under the mark on your boot – in this picture, it could be bare ground or it could be leaf litter

So if you recorded 10 ticks and took 50 steps, the % of bare ground would be 10/50 x 100 = 20%.

Remember, if you use the Checking for Change BioCollect website to record and share your data (see 'Making Sense of the Numbers'), some of these calculations will be done for you.

Tips for success

Remember to look directly at the very small bit of ground exactly under the mark on the toe of your boot. If this is bare, even if there is leaf litter just a tiny distance away, do not put a tick mark on the data sheet.

Although there is leaf litter just to the left of the white mark at the toe of this boot, and some grass leaves to its right, the mark itself is directly above bare ground and so will be recorded as such and thus a tick mark will NOT be recorded on the data sheet.

Litter Depth

What is 'Litter'?

Plant litter is any non-attached piece of a plant lying in contact with the ground. Mostly plant litter consists of stems, twigs and leaves from grasses and trees but occasionally includes bark and other plant material from the site. Litter Depth is a measure of how thick the layer of litter is.

This leaf litter primarily consists of eucalypt leaves

Why is Litter Depth important?

As plant litter builds up and decomposes, it contributes to soil health by returning nutrients back to the soil. Depth is important because the amount of plant litter (deeper = more) affects how much carbon, nitrates and other nutrients are going back into the soil. It also helps to provide habitat for bugs that aerate the soil and thus allow water to filter down where it can be absorbed by the roots of plants.

How long does it take to measure?

Approximately 10 minutes per site

When is it useful?

0 - 6+ years after change in management

How do I measure it?

Mark the toe of each boot with a pen or chalk and start at the beginning of your survey line. Take steps toward the end marker of the line that are ~1 metre apart (so you should aim to take about 50 steps in total along the line). At each step, check to see if there is litter directly under the mark at the tip of your boot. If so, measure how deep it is by gently pushing a ruler all the way through the litter until it hits the firmer soil layer. (This is why a pointy-ended ruler of some sort is helpful – easier to push through.) Record how thick the litter layer is at that step to the nearest half-centimetre by writing the number in the box on the data sheet.

This leaf litter at the tip of the boot consists of a mixture of grass, twigs, bark and eucalypt leaves

At the end, you need to calculate the average Litter Depth for the whole site. Do this by adding all the numbers you recorded and divide by the number of times you found litter to measure. So if you recorded 3, 8, 2, 4, and 2 centimetres along your survey line, the average litter depth would be 19 centimetres (3+8+2+4+2) divided by 5 measurements = 3.8cm.

Remember, if you use the Checking for Change BioCollect website to record and share your data (see 'Making Sense of the Numbers'), some of these calculations will be done for you.

When measuring Litter Depth, put your ruler (or chopstick marked with centimetres and half-centimetres) straight down into the litter then read the depth to the nearest half-centimetre. In this picture on the right hand side this litter is 3cm deep. If you like to check that the measuring stick is sitting on the top of the soil surface you can gently move the litter aside to check

Tips for success

Remember to look directly at the very small bit of ground exactly under the mark on the toe of your boot. If there is litter there, try to measure its depth, even if it's just half a centimetre. You can also try practicing a few times first, as it's a bit fiddly to feel when you have pushed all the way through the litter and hit the soil.

Litter Break-down

What is 'Break-down'?

'Break-down' is the same as 'decomposition' – when dead plant material rots and breaks apart and thus goes through the process of becoming soil.

Why is Litter Break-down important?

When plant litter decomposes, it contributes to soil health by returning nutrients back to the soil. This break-down process happens in part because bugs, fungi and tiny animals in the soil eat the plant litter and excrete it out again. If this isn't happening, and litter is just sitting on top of the soil without breaking down, it is a sign that those other parts of a healthy ground layer aren't present or abundant enough, or perhaps the soil is too compacted to provide habitat for them, and the nutrients in the litter are not being returned to the soil.

How long does it take to measure?

About 10 minutes per site

When is it useful?

0 - 6+ years after change in management, though it may mostly respond early, and thus be most useful in the first 0-3 years.

How do I measure it?

Mark the toe of each boot with a pen or chalk and start at the beginning of your survey line. Take steps toward the end marker of the line that are ~1 metre apart (so you should aim to take about 50 steps in total along the line). At each step, check to see if there is litter directly under the mark at the tip of your boot. If so, rate how well the litter is broken down. Use the numbered rating table and the associated guidance photos on the next page, and record the rating (that best represents the amount of Litter Break-down) in the box on your data sheet.

At the end, you need to calculate the average Litter Break-down for the whole site. Do this by adding all the numbers you recorded and divide by the number of times you found litter to rate. So if you recorded 1, 0, 2, 2, 3, 1 along your survey line, the average Litter Break-down score would be 9 (1+0+2+2+3+1) divided by 6 = 1.5.

Remember, if you use the Checking for Change BioCollect website to record and share your data (see 'Making Sense of the Numbers'), some of these calculations will be done for you.

Tips for success

You may feel uncertain of your judgements at first. Consider investigating litter away from your survey line first to help you have confidence in your ratings. Remember, what matters most is that you make the same judgements in your conservation and control sites so that they can be compared, not that you are 'accurate' or 'perfect'.

Rating	Description
0	Litter is loosely spread on the surface with few signs of decomposition and incorporation
1	Litter is broken down into small fragments and intimately in contact with soil; some fragments may be partially buried
2	Litter is in several distinct layers; some fungus is visible; the layer next to the soil is somewhat decayed
3	Litter has at least 3 layers or stages in decomposition ranging from fresh material on top to 20 mm or more of comprehensively decayed (very dark, with no identifiable fragments) next to the soil

Rating = 0 This leaf litter is loosely spread on the surface with few signs of decomposition or incorporation

Rating = 1 Litter is in the process of being broken down into small fragments - some fragments are partially buried

Rating = 2 Distinct layers - some fungus is visible (the white stuff on the underside of the top leaf layer) and the layer next to the soil is somewhat broken up into smaller pieces

Rating = 3 For 3 layers: fresh material on top and 20 mm + of comprehensively decayed material (very dark, with no identifiable fragments) next to the soil

These litter decomposition classes are from a monitoring procedure developed by CSIRO called Landscape Function Analysis (Tongway and Hindley 2004). Other indicators such as litter cover and bare ground are also used in LFA providing a framework for assesing the functionality of the soil and groundlayer processes.

Plant Types

Remember - If you CAN do some plant identification and feel confident you can recognise native from exotic species in the ground layer, you may choose to use the alternative indicator 'Native Plant Types'.

What are 'Plant Types'?

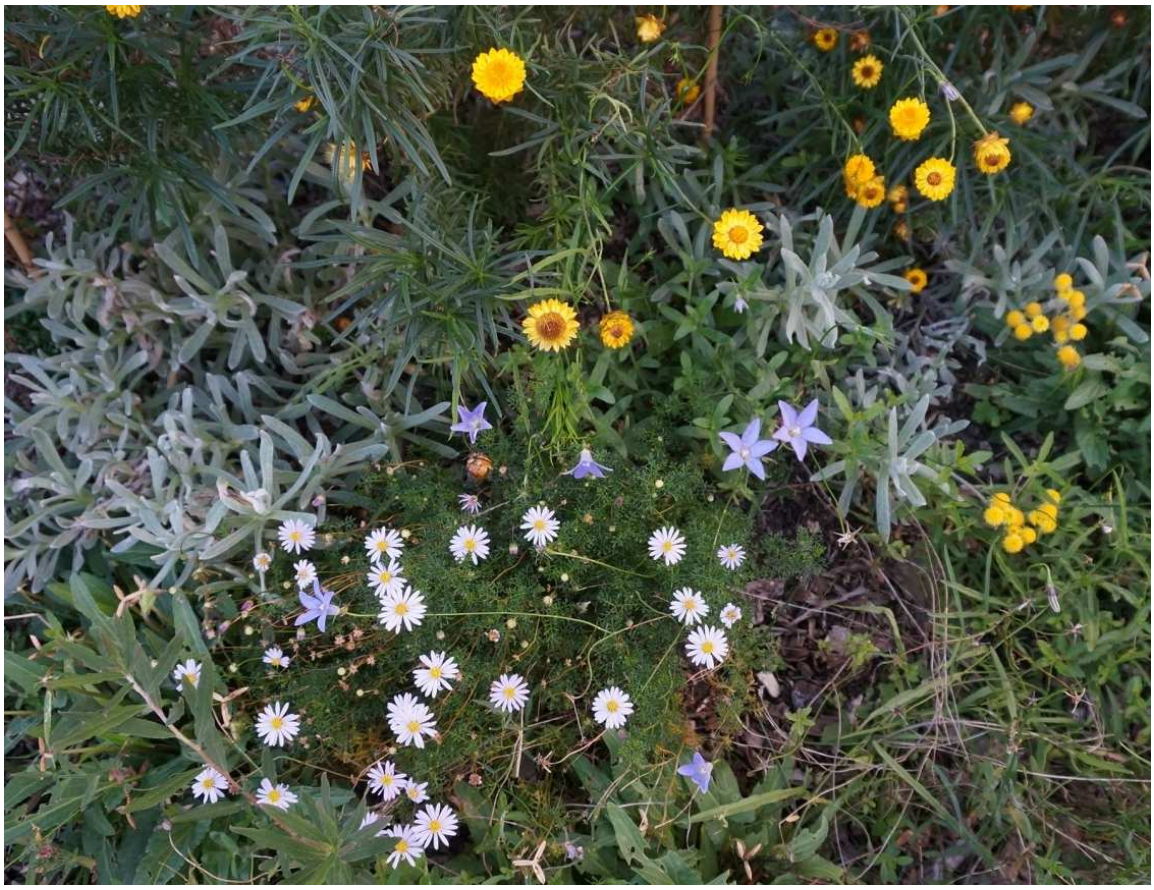
This is similar to the number of different species but is designed for people who aren't botanical experts and don't know how to precisely identify all the hundreds or even thousands of plant species they might find. Thus, a 'Plant Type' is simply a plant that looks different than the others based on the colour of the flower, the size and shape of the leaf, or maybe even how the plant grows (tall or short, many or single stemmed).

Why are 'Plant Types' important?

The number of plant species is a well-established indicator of a healthy site. Some species are very sensitive and will disappear from a site if it declines in health. Thus, more species generally means less disturbance and more natural processes. Native species are more important than exotics, but this kind of simple total count has still been shown to be useful.

How long does it take to measure?

About 20 minutes per site



There are 4 different native Plant Types in this picture based on flowers alone, and probably about 8 native Plant Types in total. See if you can count them yourself – this will help you 'get your eye in' for doing this on your own sites.

When is it useful?

Mostly 5-6+ years after a change in management, but measure it sooner than that too to help show trends that may become apparent by 5-6 years.

How do I measure it?

At the start of your survey line, touch your hands to your opposite elbows and lift your arms until they are in front of you, making a circle that you hold parallel to the ground. Tip your head just enough to allow you to look down through your arm circle at the ground. Within the circle you see through your arms, count the number of different Plant Types that are growing as part of the ground layer. Record that number on your data sheet.

At every 5th step after that (so 9 more times on a survey line), make the same circle with your arms and count any *new* Plant Types you didn't see in your previous circles. Record the number of new Plant Types on your data sheet.

At the end, to calculate the number of Plant Types for the whole site, simply add the numbers recorded at every 5th step along the whole survey line.

Tips for success

Without knowing the names of plants, it can be a bit hard to remember which plant types you saw along previous parts of your survey line. It can help to give them informal names and potentially scribble them down on a piece of scrap paper as you go. For example:

- "small yellow daisy-like flower"
- "tall wide-leaved grass"
- "big swishy grass with the spikey top"

It can be hard to see all the different Plant Types while you are standing up, so you may need to crouch down to look at the ground more closely. Before you crouch down, look through your arm circle and make a note of where the edges of your view actually are on the ground. This will help to ensure that even as you crouch down, you still know the boundaries within which you are counting Plant Types.

Put your hands on your elbows to make a circle to look through. This helps you define a small area you will look through in detail to count the number of Plant Types. Just make sure you do it the same way every time.

Cover of Native Perennials

Remember – This indicator is suitable for people who feel confident they can recognise native perennial grasses, even if they can't identify all the individual plant species

What is 'Cover of Native Perennials'?

When you look at the ground, how much of it is covered by native perennial grasses? These are grasses that persist throughout the year, often for many years and thus often have both old dry leaves and fresh new leaves together on the same plant.

This is in contrast to short lived annual grasses that usually only grow through spring and into summer then die off. You can view cover in two ways – based on the butt of the plant (the base where all the leaves sprout from) or based on the foliage (in which you imagine all the leaves form a dome over the ground and any part of the ground underneath that dome is 'covered'). You can use either of these versions, or both.

Weeping Grass (Microlaena stipoides) is a long-lived (perennial) native grass with a well-developed root system. In contrast an exotic annual grass has small roots and can easily be pulled up. The red arrow indicates foliage cover while the yellow line is the 'butt' or base of the plant.

Why is it important?

Most of Australia's grassy ecosystems (grasslands, woodlands, savannas, etc.) are dominated by perennial grasses. Perennial grasses help protect soil from eroding, particularly during dry times. Agricultural activities often lead to a reduction in perennial grasses and a shift in the system toward annual plants – which exposes soils to drying and erosion. Thus, the functionality of natural systems is restored if native perennial grasses increase after human disturbance has reduced them. In general, 15% cover of butts and 70% cover of foliage (the 'domes') is considered ideal.

How long does it take to measure?

About 10 minutes per site

When is it useful?

The 'foliage' version is useful any time from 0-6+ years after a change in management. The 'butt' version (technically 'basal cover') changes more slowly and is thus more useful 5-6+ years after change in management but is arguably a better measure of true recovery. That's why both can be helpful.

How do I measure it?

Tip – have a look at the next page at the images which demonstrate the following guidelines.

Mark the toe of each boot with a pen or chalk and start at the beginning of your survey line. Take steps toward the end marker of the line that are ~1 metre apart (so you should aim to take about 50 steps in total along the line). At each step, record whether there is native perennial plant cover directly under (for the butt version) or either under or over (for the foliage or

'dome' version) the mark at the tip of your boot (by making a tick mark in the box on the data sheet).

At the end, to record the summary value for the whole site, calculate the % of Cover by Native Perennials by adding up the number of ticks (or 'yes' answers), dividing by the number of steps you took, and multiplying by 100. So if you recorded 15 ticks and took 50 steps, the % of Cover by Native Perennials would be 15/50 x 100 = 33.3%.

This is a tricky one! Here the boot has flattened the native Wallaby Grass (Austrodanthonia spp) foliage but is not yet directly over the butt. Just another 5mm further and the butt would have been recorded!

Remember, if you use the Checking for Change BioCollect website to record and share your data (see 'Making Sense of the Numbers'), some of these calculations will be done for you.

Here the Weeping Grass foliage is quite short and lawn-like and growing directly up out of the butt or basal cover. So this point will be recorded as a 'yes' for both the butt and the foliage cover versions of this indicator.

Tips for success

The butts of perennial grasses are often quite solid and stick up out of the ground a bit, making them awkward to step on. Ensure when you take steps along your survey line, you put your boot down wherever your step takes you, even if the ground is uneven because you are stepping on a native perennial plant. If you don't, you will end up unconsciously avoiding this 'rough' ground and under-estimating perennial cover.

This boot step point would be recorded for 'foliage cover' only, as the boot is actually on bare ground beneath the leaves. Remember - don't avoid stepping on grasses, even if they are bulky and tall, as that will influence your results and under-estimate perennial cover.

Bird Types

Remember – This indicator is suitable for people who feel confident they can listen and look for different birds on their sites, even if they can't identify all the different species.

What are 'Bird Types'?

This is similar to the number of different species but is designed to be a bit simpler – for people who may have an eye or ear for birds but aren't expert birdwatchers. Thus, a 'Bird Type' is a bird that you believe is a different species because it looks or sounds different than the others.

Why are Bird Types important?

Birds depend on healthy plants and insect populations to provide habitat and food. Because many species are relatively mobile, they may be among the first animals to return to a site after the resources they need improve. Birds are also relatively easy to see and hear and different species often look and sound quite different. So they are ideal for a wide range of people to monitor.

How long does it take to measure?

Approx. 10 minutes

A good pair of binoculars will help you see birds better, though many birds will only be heard.

When is it useful?

Mostly 5-6+ years after a change in management, but measure it sooner than that to help show trends that may be apparent by 6 years.

How do I measure it?

The best time for finding birds is early in the morning shortly after dawn until around 9.30am in calm clear weather. Go to the centre of your site and count all the different types of birds you either see or hear within the site over a 10 minute period. Record the total number of Bird Types you counted on your data sheet.

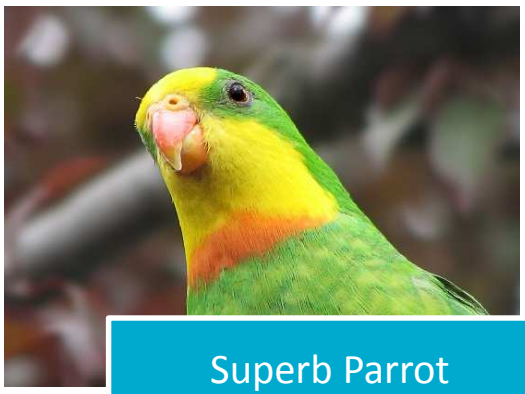
Tips for success

Remember to look and listen high up in the trees and on the ground as well as around your eye level.

It's important NOT to count birds you see or hear *outside* of the site. So don't just count everything – take a moment to think about whether it was in or out.

One challenge with recording Bird Types instead of species is that males and females, and adults and juveniles often look different so you may count the same 'type' more than once because of this. That's OK – remember that accuracy is less important than making the *same types of decisions* in the conservation and control sites each year so they can be compared.

Of course, if you are a good birdwatcher, you can record the actual species present on your site.



Superb Parrot

Spotted Pardalote

Galah

Sacred Kingfisher

Superb Fairy-wren

Sulphur-crested Cockatoo

These Australian birds are coloured very differently, however from a distance it is often difficult to see colour very well. So instead, pay attention to the fact they have different body and bill sizes and shapes and different length tails to help recognise the different 'types'. Bird identification guides can also be purchased at most bookstores and online and many birding websites have online free identification guides and images as well.

Native Plant Types

Remember – This indicator is suitable for people who feel confident they can recognise native plant species relative to exotics/weeds, including wildflowers and other annuals, even if they can't identify all the individual plant species.

What are 'Native Plant Types'?

If a 'Plant Type' is a plant that looks different than the others based on the colour of the flower, the size and shape of the leaf, or maybe even how the plant grows (tall or short, many or single stemmed), then a 'Native Plant Type' is simply a plant which looks different than the others that you feel fairly confident is a native plant.

Why is it important?

The number of plant species is a well-established indicator of a healthy site. Some species are very sensitive and will disappear from a site if it declines in health. Thus, more species generally means less disturbance and more natural processes. Increases in Native Plant Types are a stronger indicator of improvement than Plant Types, which can include increases in the number of different weeds as well as native plants. If you feel confident you can distinguish between native and exotic plants, this is the better indicator to use.

How long does it take to measure?

About 20 minutes per site

When is it useful?

0 - 6+ years after change in management.

How do I measure it?

At the start of your survey line, touch your hands to your opposite elbows and lift your arms until they are in front of you, making a circle through which you can look down at just part of the ground. Within the circle you see through your arms, count the number of different Native Plant Types that are growing as part of the ground layer. Record that number on your data sheet.

At every 5th step after that (so 9 more times on a survey line), make the same circle with your arms and count any NEW Native Plant Types you didn't see in your previous circles. Record the number of new Native Plant Types on your data sheet.

At the end, to calculate the number of Native Plant Types for the whole site, simply add the numbers recorded at every 5th step along the whole survey line.

Tips for success

Many of the exotic plants present will be common weeds such as Paterson's Curse, flatweed or annual grasses such as Brome and Wild Oats. In contrast, many of the native plants are uncommon so a native plant and weed ID book is helpful. If you know your common weeds, you could just assume that an uncommon unknown plant is native, as long as you do that at both your conservation and control sites.

Many ground layers are covered in weedy exotic annual grasses such as brome, wild oats, rye grass and silvergrass. Annual exotic grasses are often bright green, only present in spring and have small roots that can easily be pulled out, unlike perennial grasses.

Put your hands on your elbows to make a circle to look through. This helps you define a small area you will look through in detail to count the number of Native Plant Types. Just make sure you do it the same way every time.

Note that if you aren't sure about recognising the difference between native and exotic plants, you should use the simpler 'Plant Types' indicator. You could also invest in a native plant and weed identification book or seek identification resources online.

Number of Bugs

What is 'Number of Bugs'?

It is the number of individual bugs we can see with our naked eyes found living in the leaf litter. 'Bugs' includes spiders, ants, cockroaches, beetles, millipedes, worms, etc. Note that we mean total number of individuals, not the number of different types.

Counting the number of individual ants, spiders, beetles, and other 'bugs' may provide some indication of whether a site's capacity to capitalise on good rainfall years is increasing. Spider image © Bryce McQuillan.

Why is Number of Bugs important?

As they reproduce rapidly, and at least some of them are very mobile in the landscape, and they are a group that can recover faster than most. Also they play a key role in breaking down leaf litter and thus maintaining soil structure and health. Many also help control pests and serve as food for many other species.

How long does it take to measure?

About 10-15 minutes per site

When is it useful?

This may be most useful in particularly good rainfall years. We currently think that sites that are improving show a greater short-term increase in bugs (compared to control sites) when conditions are relatively wet, suggesting greater functionality in the system. But numbers appear to return to low levels during dry periods. Collecting information on this each year and adding a note about whether it's a wet, average, or dry year could help us learn more.

How do I measure it?

At the starting marker of your survey line and at every 5th step along the survey line, bend down, reach in front of your boots, and scrape any leaf litter toward you from an area about the size of both your boots (approx. 25cm x 20cm). As you scrape, count the number of bugs seen scurrying away. Replace any litter afterwards.

Tips for success

Even if there isn't much or any leaf litter, you should still scrape the ground because it will disturb any bugs that might be hiding there, giving you a chance to count them.

It's important to use your fingers to really move the litter and plants and properly disturb the bugs all the way down to the soil layer. So don't be squeamish. If you are concerned about bites, wear thin gloves like rubber kitchen gloves.

Also, if you are using this indicator along with a few others, just make sure you don't do it after doing something else that might have already disturbed your bugs. See 'Using Multiple Indicators' for some ideas on how to avoid this.

Gently scrape leaf litter toward you across an area about the size of both of your boots to count the number of bugs you see scurrying way. Wear light rubber kitchen gloves if you wish to protect your hands.

Using Multiple Indicators

Chances are, you will want to use more than one of these indicators. Because most of them are done along your 50 metre survey line, it doesn't make sense to walk the line separately to collect information on each indicator. Instead, you can walk the line once and end up with all the information you need at the end. Here are our suggestions about how to do that most efficiently.

Note that if you are using a few but not all of these indicators, you can still follow these suggestions for the indicators that are relevant to you. The instructions below are intended to be used in combination with the more thorough information provided for each indicator in the previous factsheets.

1. If using **Bird Types**, do that first from the middle of your site. If your survey line runs through the middle of your site, be careful not to trample the plants you will be looking at later. Instead, just stand a bit off to the side of the survey line.

2. Start the survey line work from step 0 (the marker at the start). If using all the indicators, do the boot mark measures first at step 0:
   - ✓ Is there **Not Bare Ground** under the tip of your boot mark (in other words, anything except bare ground)? If so, mark it on your data sheet with a tick or a 'yes'
   - ✓ If there is litter under the tip of your boot mark, gently measure and record **Litter Depth**, then determine the rating for **Litter Break-down** and record that on your data sheet (take care not to disturb the litter too much if you plan to count Number of Bugs later)
   - ✓ If there is a native perennial grass butt under the tip of your boot mark, note that on your data sheet for **Cover of Native Perennials (butts)**
   - ✓ If there is any foliage of a native perennial grass hanging over your boot such that the tip of your boot mark would be under an imaginary dome, encompassing an individual perennial grass, place a tick or a 'yes' on your data sheet for **Cover of Native Perennials (foliage)**

3. If using the Plant Type indicators or Number of Bugs, do these next at step 0 (the start of your survey line):
   - ✓ Make your arm circle and count either the number of **Plant Types** or the number of **Native Plant Types** you can see within it and record on your data sheet
   - ✓ Reach down and scrape the litter in front of your boots to count **Number of Bugs**, return the litter, and record the number of bugs you counted on your data sheet

4. Take your next step along the survey line and repeat the instructions in #2 above. Keep doing this for each of your ~1 metre long boot steps until you reach the end marker.

5. If using the Plant Type indicators or Number of Bugs, repeat the instructions in #3 above only at every fifth boot step along your survey line (so steps #5, 10, 15, 20, etc.).

Recording and Sharing Data using BioCollect

Why use BioCollect?

BioCollect (www.ala.org.au/biocollect/) is a tool developed by the Atlas of Living Australia to support data storage and sharing for anyone working with field data, especially citizen scientists. It is free to use. To help you, we have set up a project at http://tinyurl.com/checking4change, provided resources to help you contribute, and provided a place for you to enter survey data. This allows the data to be securely stored and accessed across the whole project. We encourage you to take advantage of what BioCollect has to offer.

Specifically, by entering your data in BioCollect, you will be able to:

- have BioCollect calculate some of the whole site values for you
- have your data safely stored somewhere
- look at your own data anytime so your monitoring efforts can help you make decisions about your management
- share your data with other Checking for Change users to gain insights into regional or state-scale improvement

At the Checking for Change BioCollect website, you can click on 'Resources' to access this Guide, helpful videos of how to use the methods, and access our companion guide on the scientific research that underpins these methods ('**Checking for Change: the science behind practical monitoring of ecological improvement**'). You can also click on 'Blog' to read any news or updates from us.

We encourage all Checking for Change users to make use of BioCollect, as the more users we have, the more regional and state-scale data we will have. This ensures your monitoring efforts have the potential to make a difference not just to your own management but to the decisions and actions taken at regional, state, and even federal levels. The more we participate, the more potential understanding and benefit we can gain.

FOR PROFESSIONALS AND OTHER EXPERTS:

The Checking for Change BioCollect site is also a valuable resource for you, even though it is listed under 'Citizen Science' projects. By catering for the most basic user (but still making it suitable for all users), we are able to collate data from all users in one location, making it much more likely that sufficient data for reporting at regional, state and even federal levels may be available. Thus, there are compelling reasons for professionals to enter their data in BioCollect, not just citizen scientist landholders.

It is also easy to set up a project in BioCollect. So if you are running a program in which you are encouraging or requiring all your landholders to use Checking for Change, you could choose to set up your own Checking for Change BioCollect project. The data forms and resources would all be duplicated, greatly reducing your work in setting up systems to receive and collate data. This would automatically give you a single, safe repository for all your program-specific Checking for Change data, which could be used all by itself or combined with data from other programs entered in the general Checking for Change project.

How to enter and share data in BioCollect

Everything you need can be found at the Checking for Change BioCollect website: http://tinyurl.com/checking4change. You will need to sign up as a registered user. This is easy to do by clicking on 'Get Started' or trying to log in to the Atlas of Living Australia.

You should then be able to use the 'Blog' tab to access any news or updates from us. The 'Resources' tab provides access to videos, data sheets, indicator factsheets, etc. to support your monitoring. The 'Survey' tab is where you will find electronic data forms to enter your monitoring data. Collect the information on paper out in your paddocks and then enter the basic information requested on the electronic form as soon as you can. The form will automatically calculate some of the basic whole-of-site numbers for you and additional functions may be added in the future. The 'Data' tab then allows you to search for and see any data you have entered as well as data entered by other users in the project.

As the numbers are best interpreted through graphs (or statistical analyses for professionals), you may then need to copy or download data from BioCollect to be able to graph or analyse it (see 'Making Sense of the Numbers' below.

Making Sense of the Numbers

Compare conservation and control sites over time

The key to understanding the numbers is to look at changes over time at ***both*** the control site and the conservation site and look for a better trend at the conservation site. There are a few reasons why this is a good thing to do, rather than just look at the trend at your conservation site:

1. Differences in the numbers from year to year might be fairly large due to recent rainfall, temperature, changes in regional populations of kangaroos, etc. As a result, looking at just one site could tell you much more about this year to year variation than about the effects of your management. But because these yearly differences will affect the control site as well as the conservation site, you need to look at differences in the trends between the two sites to really see the effect of your management.
2. By making comparisons between conservation and control sites, you don't need to worry as much about being perfectly accurate and precise in the numbers you collect. You just need to ensure that the same methods, judgements and decisions are being used at both conservation and control sites, because what is important is the differences between them not the absolute values. This means we can still have confidence in the information even if it is collected by citizen scientists who don't have much specialist training.
3. Finally, the other important reason to compare conservation and control sites is because 'improvement' may take many different forms. Conservation sites could be improving more than control sites, or they could be holding steady in their condition while control sites decline. In addition, all sites may be in decline (perhaps due to regional pressures beyond your ability to influence) but conservation sites could be declining more slowly than control sites. In all of these situations, there is evidence that management is working, at least to some degree, and you want to be able to learn about all of these from your monitoring.

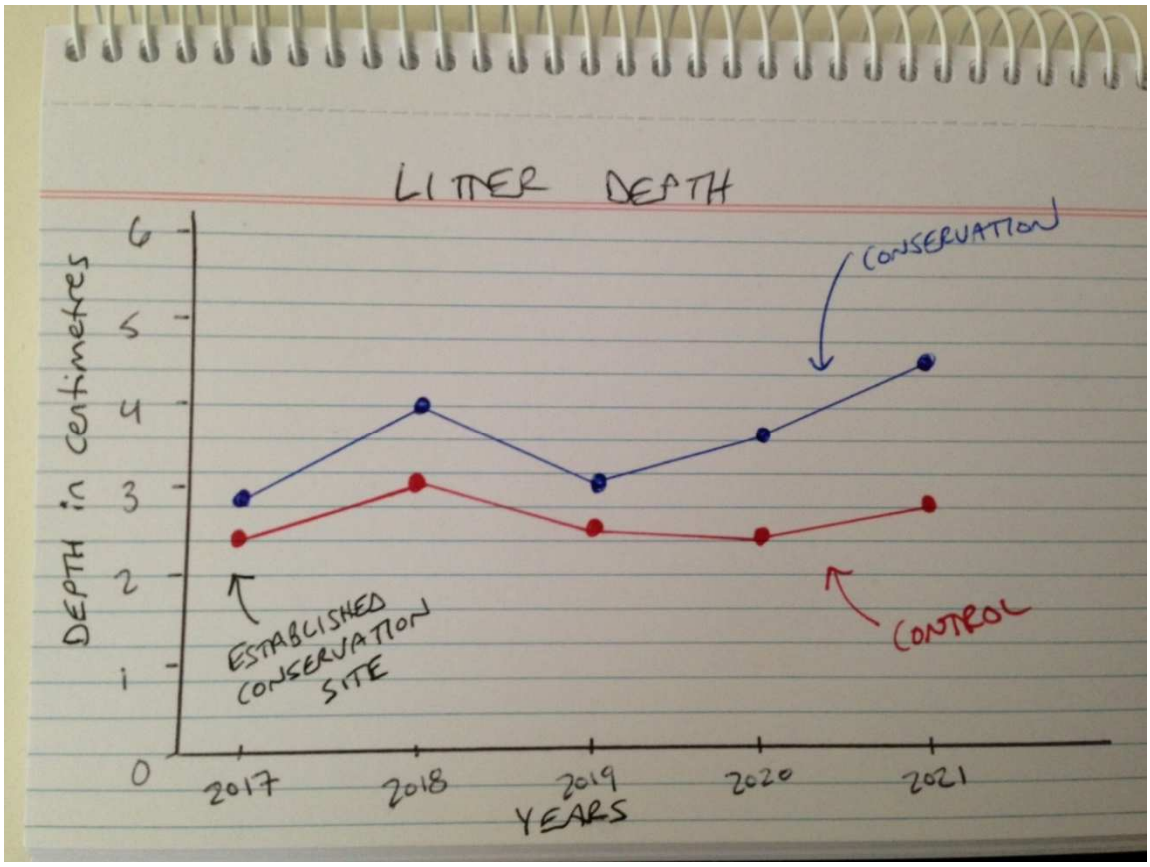
Best options depend on the number of sites and your love (or not) of maths

To help make these comparisons and judge for yourself whether conservation management is working, we suggest a few different ways to turn your information into graphs and, if you are an advanced professional, to conduct statistical analyses. These methods differ depending on whether you are looking at just a few pairs of conservation/control sites or whether you are looking at many pairs (for example, as part of a larger funding program or state-wide monitoring approach). They also differ depending on your willingness to do some maths. Thus, pick the section heading below that best describes your situation to get the most targeted advice on making sense of your numbers.

Option 1: If you have data from just one or a few conservation/control site pairs and prefer to avoid maths at all costs…

The simplest solution to understand whether your management is working is to graph the numbers you collect each year. Use graph paper or just lined paper if you can't find graph paper. (Of course, you can also use software like Excel to make pretty graphs but if you avoid maths, you probably don't use software to make graphs!) Across the bottom of the graph, put the years from left to right and be sure to space them evenly. On the left side going from bottom to top, write numbers for a given indicator, trying to show the range of different numbers you might end up with each year for both conservation and control sites. Again, be sure to space them evenly. You will need a graph for each indicator you are using (and each pair of conservation and control sites).

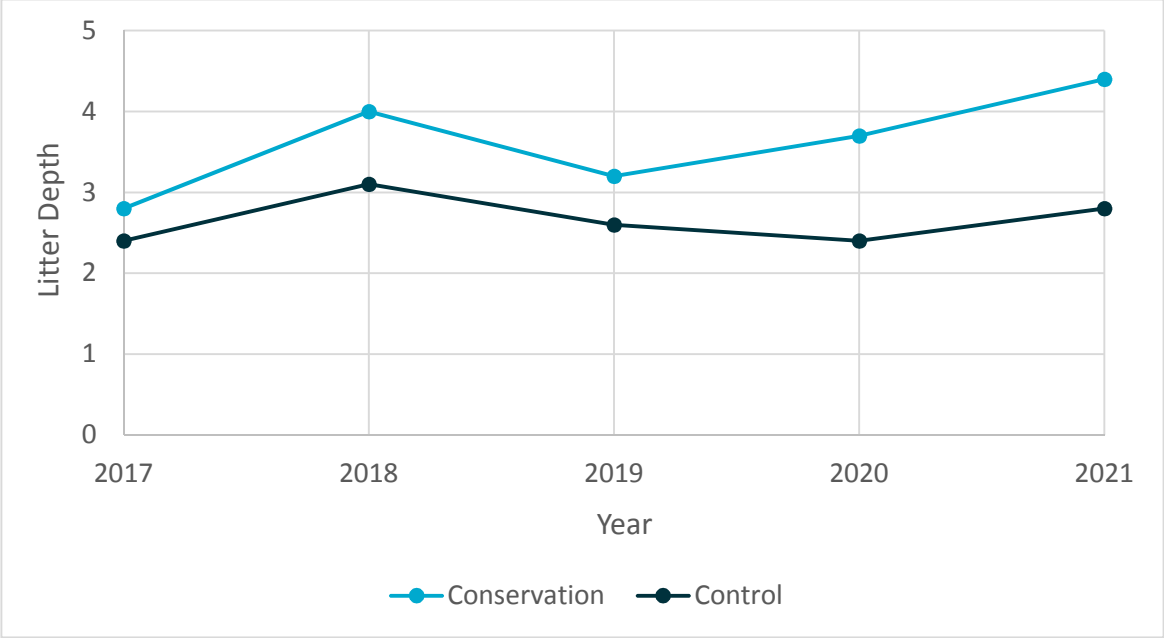
Each year you collect information, put a dot directly above the year and directly to the right of the number you calculated for the whole site (from the bottom of your data sheet – see the Data Sheet section below). Use different colour pens for conservation and control sites. As you add dots each year, draw a straight line from the previous dot for that site to the new dot for that site. The picture below shows an example of one of these hand-drawn graphs with information from five years of Checking for Change.



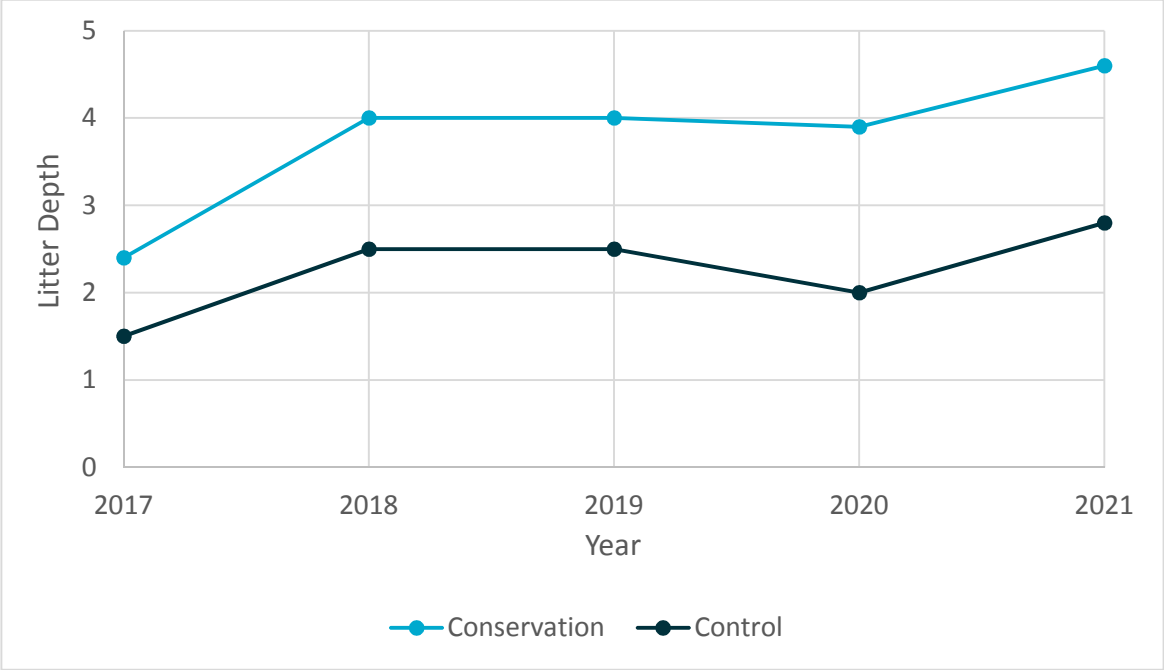
Once you have a few dots, you can begin to look for differences in the direction of the lines for conservation vs. control sites. In this hand-drawn graph above, the control site is staying about the same while the conservation site is improving (deeper litter).

Here are some examples of the different types of trends that indicate your management is helping:

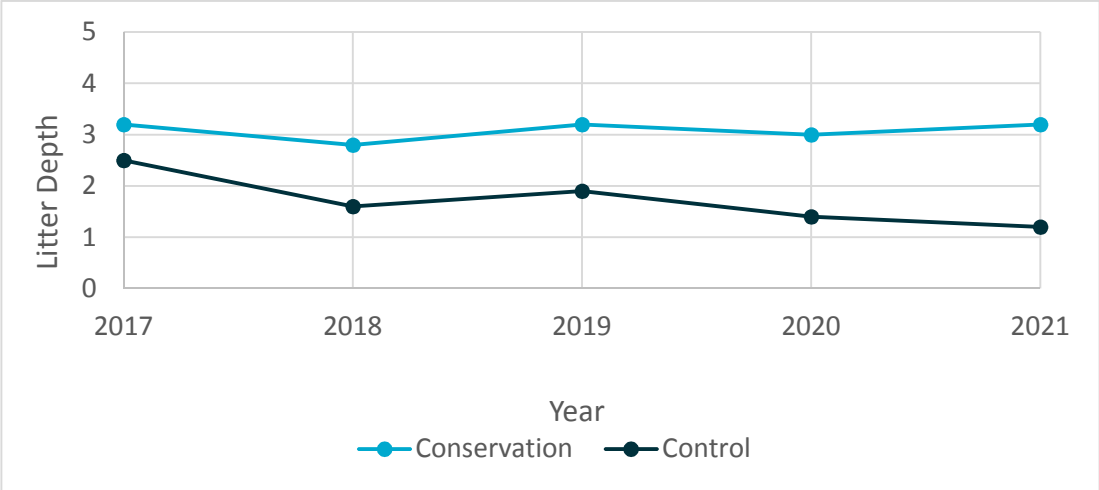
Conservation site improving while control is not



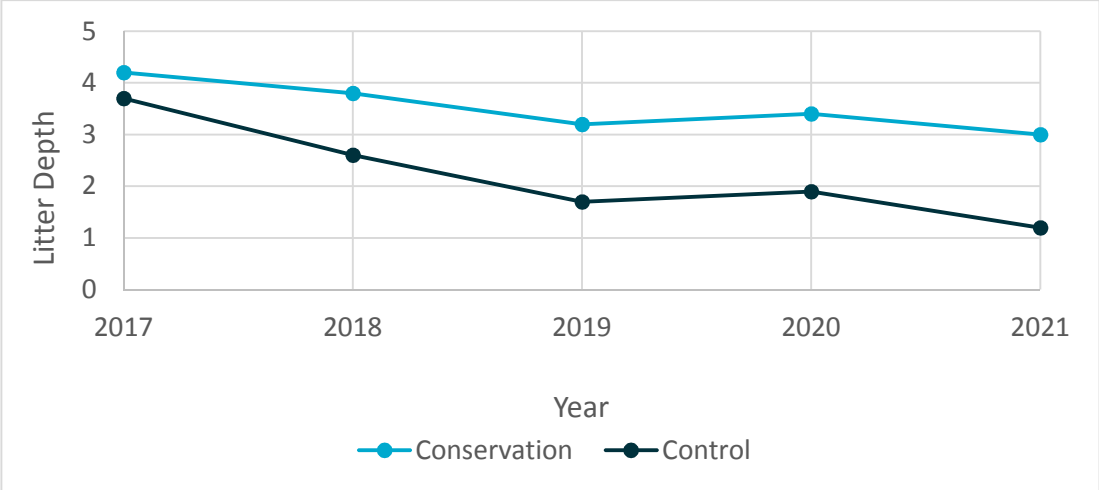
Conservation site improving more than control



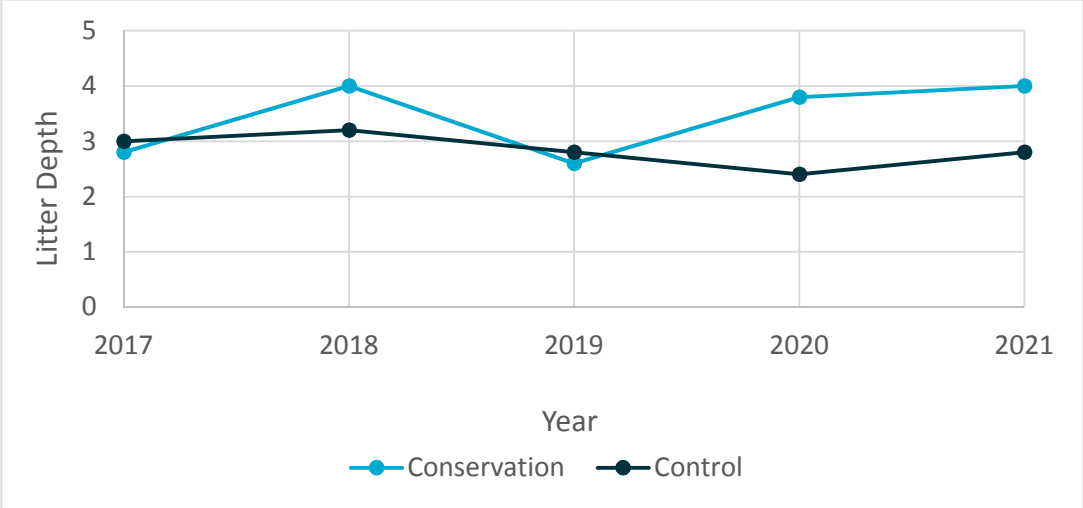
Conservation site holding steady while control declines



Conservation site declining but less than control

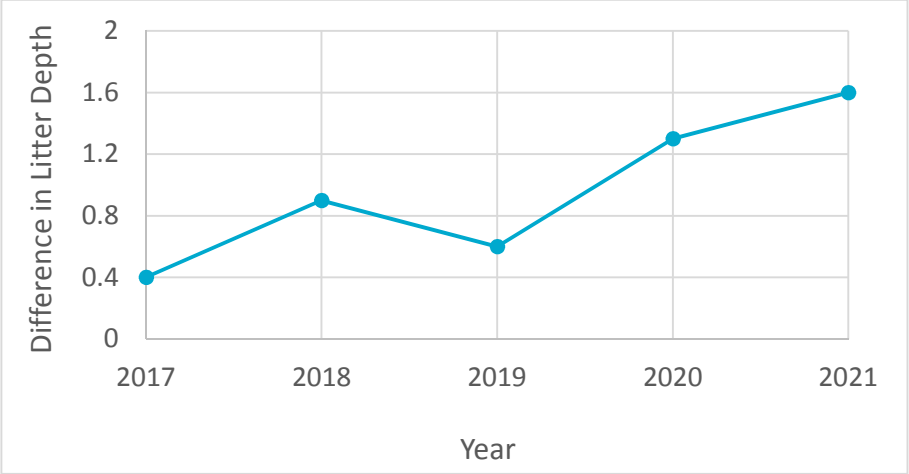


Note also that the **trends may look messier** than the example graphs shown above, and may be harder to judge. In the example below, the conservation site is improving while the control is not, but you have to look closely to see that.



Option 2: If you have data from just one or a few conservation/control site pairs and don't mind simple maths…

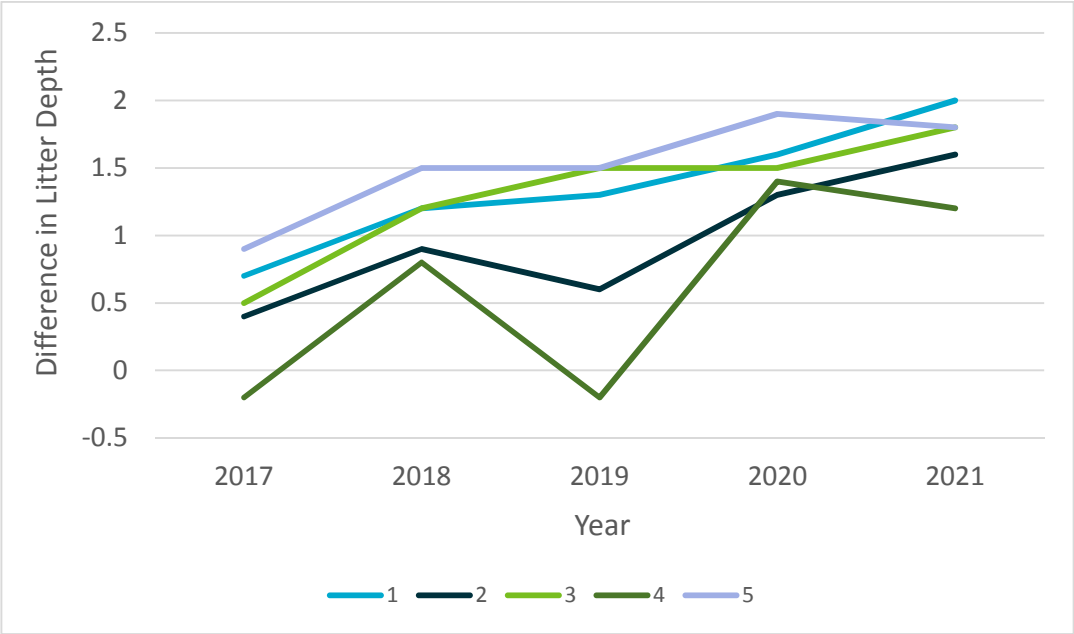
It can be easier to see the difference between conservation and control sites if you first calculate the difference in an indicator between each pair of sites each year (or use BioCollect to calculate it for you), and then graph that difference (instead of graphing conservation and control sites separately as above). Be sure to always subtract the value of the control site from the conservation site, and not the other way around. If you follow the instructions for graphing in Option 1 above (but just graph the one set of numbers – difference between each pair of conservation and control sites over time), you should end up with a graph that is quite easy to interpret. The only trend that indicates your management is helping to improve your conservation site is one in which the graph shows an upward trend in the difference between your conservation and control site over time, like this:



Option 3: If you have data from many conservation/control site pairs and like to avoid anything more than simple maths…

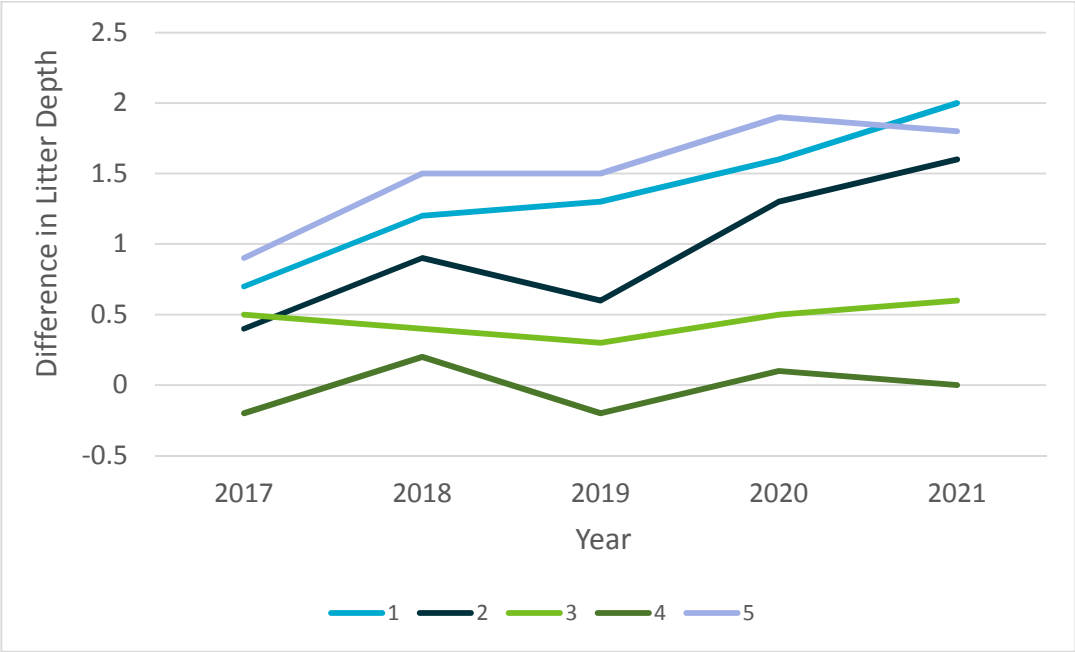
If you are looking at information from many site pairs, you may want to know overall, across the many sites, is the general management approach working? Thus, you don't want a separate graph for each pair of sites. Instead, you'd like to be able to see the trends and patterns revealed by the information from all sites at once. In this case, you will want to include the numbers from all sites in one graph (for each indicator). Unfortunately, this is too messy to do without at least calculating the difference between each pair of conservation and control sites each year first.

So begin by following the instructions above for Option 2. Then graph the differences each year for each conservation/control site pair, using a different colour to represent each site pair (or another kind of clear label). The result might look something like this:



This example graph only shows five site pairs and you may have many more, but this is the type of graph you might be looking to create, either by hand (a bit tedious, but possible) or using a software program like Excel.

The example graph above also shows the situation in which all conservation sites are improving relative to their associated control sites, thus giving a very clear indication that the conservation management approach is working in general. However, it may be more common to see a situation in which the approach appears to be working well on some sites, but less well or possibly not at all on others. Here is an example of what that might look like:



In these cases, you may decide that your conservation management is working overall as long as a majority of the site pairs show a trend toward improvement (greater difference over time between conservation and control sites). You might also use this kind of graph to identify the

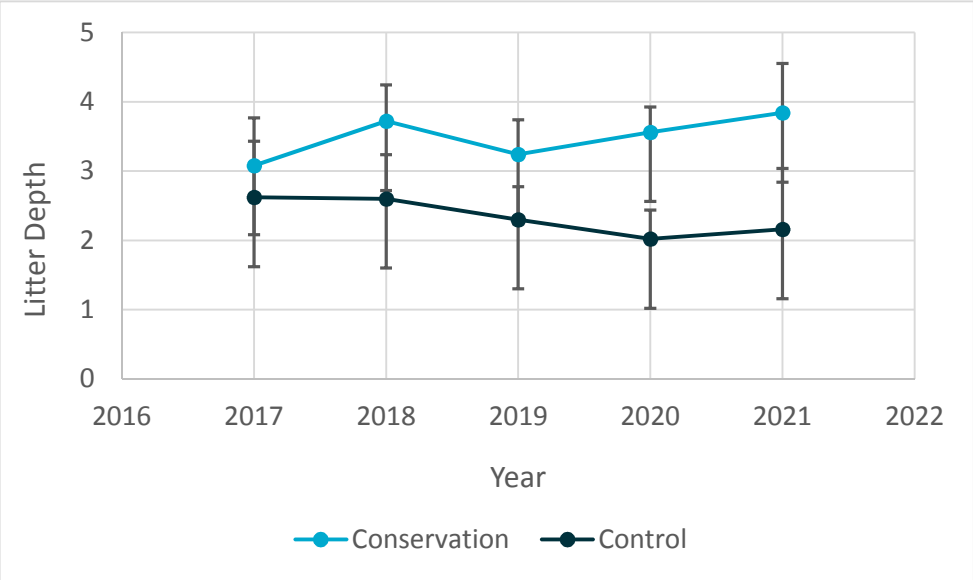
particular conservation sites that aren't improving relative to their controls (in the example graph above, numbers 3 and 4) and consider whether they differ in some consistent way from those that are improving. This can give you insight into the particular conditions under which your conservation management actions do or do not work.

FOR PROFESSIONALS AND OTHER EXPERTS:

Option 4: If you have data from many conservation/control site pairs and are happy calculating summary statistics…

If you have data from many sites, then you may get a clearer picture of overall trends by calculating and graphing some simple summary statistics. For each year and each indicator, you will want to calculate a mean value across all of the control sites and a mean value across all of the conservation sites.

However, looking at mean values on their own can be misleading depending on the amount of variation you have among your sites. Therefore, you should also calculate standard deviations for each mean (which Excel and other software programs can do for you). By graphing these means with standard deviations across time you should be able to roughly assess whether differences in the means of conservation and control sites are increasing over time and whether that is truly a consistent pattern across sites because the standard deviations of conservation and control sites are becoming non-overlapping. The example graph below shows means (dots) and error bars (standard deviations) of conservation and control sites, with the standard deviations of the two becoming non-overlapping in 2020.



If you have access to some simple statistical software, then an even better approach is to produce box plots (also known as box-and-whisker diagrams) which provide an even better representation of the "noise" around mean values.

FOR PROFESSIONALS AND OTHER EXPERTS:

Option 5: If you have data from many conservation/control site pairs and are skilled in statistical analysis…

You will still want to begin by graphing your data to look for trends of change (see Option 4), but can then go further by calculating the statistical significance of these trends.

During the early years of your monitoring, you will not have enough data points across time to allow proper time-series analysis. One option at this stage is to use non-parametric tests (e.g., Wilcoxon rank sum tests) to test whether conservation and control sites differ in terms of the observed changes (data points would be differences within each site across years – i.e., most recent value of an indicator minus the original value of the indicator when you started monitoring for each of your sites).

A stronger approach is to use parametric analysis of covariance (ANCOVA) which has the advantage of allowing you to incorporate and control for the effects of other environmental factors which may vary across your sites – including things like average rainfall, temperature, vegetation types, etc. For our own analyses in testing these indicators, we used the most recent data for each indicator as the response variable with the first year of data included as a baseline predictor. We then performed all subsets regression for each indicator using site covariates (we had four of these) as candidate predictor variables plus the first year of baseline data as a forced predictor (i.e., always included). We then selected as the best model the one with the lowest Akaike Information Criteria scores corrected for small sample size (AIC_C). We then performed analysis of covariance (ANCOVA) to test for differences between conservation and control sites including all of the variables from this best model as covariates.

[Note: to satisfy some of the assumptions of these parametric tests, we had to transform data for some indicators. Transformations may not always fully deal with violated assumptions so a combination of ANCOVA and Wilcoxon rank sum tests can be helpful if the ANCOVA is not always possible to do appropriately.]

Once you have more than a few years of data, you can begin to employ other statistical approaches to model the observed changes in the different indicators over time and to test whether these changes differ between treatment and control sites.

Data Sheet for recording information

The following two pages provide a separate printable data sheet designed specifically for recording information on these indicators while out in the paddock. One two-page sheet will be needed for each site (conservation and control) each year.

Full instructions on completing the data sheet are provided on the individual indicator factsheets. Note that 'Step 0' is the marker at the start of your survey line. Ideally, you then take 50 steps to reach the marker at the end of your survey line, but additional spaces are provided in case your steps are shorter than 1 metre and you end up taking a few more than 50. If you end up taking fewer steps than 50, that's OK too – just record data for however many steps you take before reaching the end marker of your survey line.

Checking for Change – Data Sheet

Site Name: _____Recorded by: _____Date :_____

Lat/Long of Step 0 (in DD MM SS.SSSS): _____ºS _____ºE

Control or Conservation Site? (circle)

If a conservation site, what year did conservation management start?_____

Name(s) of matching control or conservation site?_____

*Greyed out areas of columns without internal borderlines can be used for a description of the 'type' eg. small yellow flower or large black bird. The summary tally of numbers can be written at the bottom of the 2nd page of the data sheet

Step #	Bare Ground	Litter depth (in mm)	Litter Break-down	* Plant Types (or Native Plant Types)	Cover of Native Perennials (Butts)	Cover of Native Perennials (Foliage)	* Bird Types	Number of Bugs
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								

24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								
51								
52								
53								
Whole site	%	(average)	(average)	(sum)	%	%	(total #)	(average)

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