

2019

GLENELG CASE STUDY: SUMMARY ECOLOGICAL REPORT

Prepared by Greg Hosking and Matt Bolton

Key findings

Glenelg is a 4000 hectare grazing property which has been managed by the Chambers family since 1970, located to the south of Mungallala, Queensland. This ecological assessment commences in 1970 which is the year Harry Chambers purchased the first parcel of Glenelg.

Glenelg has been managed under a conservative stocking regime for much of the Chambers management period. Since acquiring the first parcel of Glenelg in 1970 the Chambers have extensively cleared vegetation on the property and established ground cover species. Glenelg has been managed to produce pasture for production and to maintain the ecological health of the property for much of the Chambers management.

The graphical summaries displayed in this report are composed of 10 ecological criteria, the graphical summaries for Glenelg demonstrate that there is a close relationship between the land manager's goals/ideals and the ecological outcomes in each of the four phases:

Phase 1: 1970-1984	Conventional non-regenerative regimes and practices
Phase 2: 1985-2004	Intensive conventional interventions and small-scale trials of revegetation projects
Phase 3: 2005-2014	Transition to broader scale regenerative grazing land management regimes and revegetation projects
Phase 4: 2015-2018	Increasing maturity of regenerative grazing land management regimes and revegetation projects

An assessment over time of the responses to 10 ecological criteria shows that, by phase 4, compared with the previous three phases, most ecological criteria have been assessed as nearly fully achieved or having achieved their reference state (i.e. a scores between 0.8 – 1.0). For example:

- Minimising effects of extreme climatic events across the whole property and its place in the broader catchment, including preparedness for drought and floods.
- Managing pastures for production and to maintain ecological health of the property. Ecological changes include: improving the reproductive potential of pastures and maintaining high levels of ground cover across the property.
- Improving soil health and function. Ecological changes include: soil nutrients and soil carbon, soil hydrology, soil biology and soil physical properties i.e. soil as a medium for plant growth.

Introduction

Glenelg is located 16 kilometres south of Mungallala, Queensland in the Maranoa Region. The average annual rainfall of Mungallala is 565 mm and it is summer dominant. Mungallala is 410 metres above sea level.

The first parcel of Glenelg was acquired by Harry Chambers in 1970, the final acquisition was made in 1978. Harry managed Glenelg with Graham from early 1980's with Jan joining in 1985. Graham and Jan took over Glenelg in 1994 and have been sole managers since then.

Glenelg comprises 4000 hectares with the original vegetation consisting of Poplar Box, False Sandalwood, Wilga and various acacias, notably Mulga, Bendee and Bowyakka. Much of the original vegetation was converted to Buffel grass pastures after acquisition.

After acquiring Glenelg, Harry Chambers ran 27 cattle on the property. In the years following acquisition, land clearing was conducted extensively across Glenelg to enable pasture growth. By 1978 Glenelg had 200 cattle on it, and the Chambers had started operating a merino wool enterprise.

Treatment of woody vegetation has continued to be carried out on Glenelg up until till 2018, the methods of treatment used have consisted of ringbarking, pulling, tordon herbicide and blade ploughing. The treatments have largely been carried out by the Chambers with machinery they own and repair.

In 1985 Harry Chambers cleared the large eucalypts from the banks of the Mungallala Creek which runs through Glenelg. Harry thought that removing the large eucalypts would raise the water table of the creek and enable water to be present in the creek year-round. Prior to this the Mungallala Creek would run dry each year. The treatments conducted by Harry Chambers were successful, water has been present in waterholes in the Mungallala Creek since 1985. To combat the issue of erosion damage occurring, the Chambers have maintained a high level of grass coverage on the banks of the creek. However, the process of clearing vegetation from waterways is contentious and carries the risk of increasing salinity.

In the 1980's buffel grass was established on Glenelg, Buffel grass is an African species of grass which is highly drought tolerant and nutritious for livestock. The establishment of buffel grass enabled the Chambers to sustainably increase the number of livestock on Glenelg. Roughly 4000 sheep and 200 cattle and 100 goats have been run on Glenelg consistently since the establishment of buffel grass.

Kangaroos and wild dogs have been the major issues facing the Chambers since the late 1990's. During the millennial drought kangaroo numbers on Glenelg increased dramatically due to Glenelg carrying pasture longer than the surrounding region. Wild dog attacks increased as well as much of the region moved from wool enterprises to cattle after the crash of the Australian wool market. In 2013 the issue of wild dog attacks on sheep and kangaroos exerting grazing were making operating a financially viable business on Glenelg near on impossible. To combat the problem the Chambers started constructing an exclusion/predator proof fence around the boundary of Glenelg. The Chambers erected the exclusion/predator fence themselves and completed the task in 2016.

Since the completion of the exclusion/predator fence in 2016 wild dog attacks have ceased. Kangaroo numbers inside Glenelg have also been controlled to a sustainable level, this has enabled the Chambers to control total grazing pressure and better manage their pastures for production and ecological health.

Glenelg has been drought declared since 2013, however they haven't had to supplementary feed their livestock since 2014/15. The exclusion/predator fence around Glenelg combined with their

traditionally conservative stocking rate has largely enabled the Chambers to continue operating normally throughout the drought.

Assessment of ecological and biodiversity outcomes

Regenerating pastures and vegetated areas to minimise effects of extreme climatic events

The ability of Glenelg to withstand extreme climatic events i.e. drought, has improved since 1970 (Figure 1).

Clearing woody vegetation and establishing pastures has increased the ability of Glenelg to cope with drought since 1975. The construction of the exclusion/predator fence in 2014/16 significantly improved the resilience to drought of Glenelg. The continued presence of water in the Mungallala Creek has also helped improve Glenelg's resilience to drought.

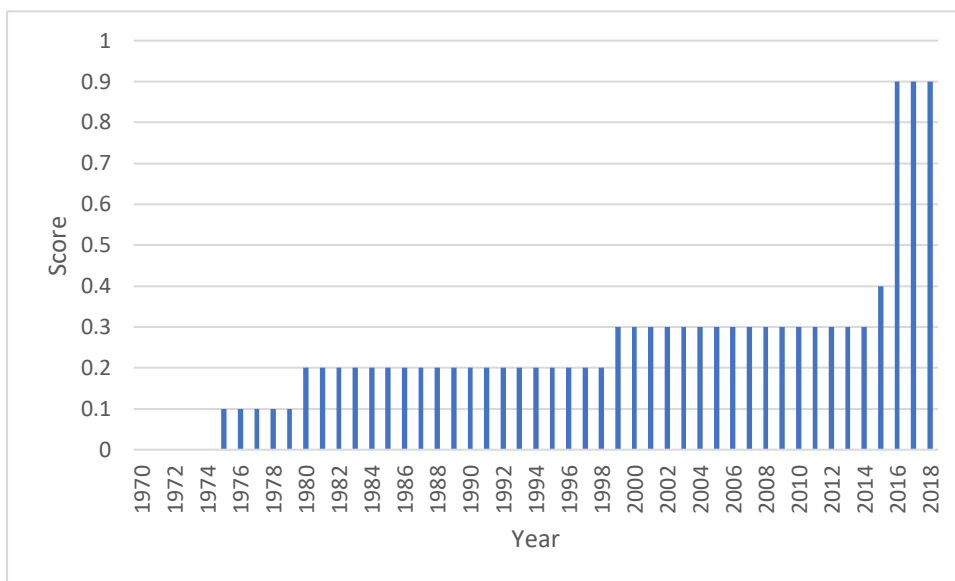


Figure 1. Minimising the effects of the extreme climatic event - drought - in response to changes in land management regimes.

Managing soils to prevent erosion, restore eroded areas and to maintain ecological health, productive capacity and water quality

Soil indicators have improved significantly on Glenelg since 1970 (Figure 2). The improvement is due to the management practices undertaken by the Chambers. Upon purchasing the first parcel of Glenelg in 1970 the Chambers commenced a management plan to improve ground cover and pasture growth on Glenelg. The soil indicators are directly tied to the health of the ground cover. Ground cover provides organic matter to the soil, reduces erosion and improves the percolation ability of the soil.

The Chambers have gradually improved ground cover across Glenelg since 1970, in the early years this coincided with the removal of woody vegetation and in recent times the completion of the exclusion/predator fence around the boundary of Glenelg.

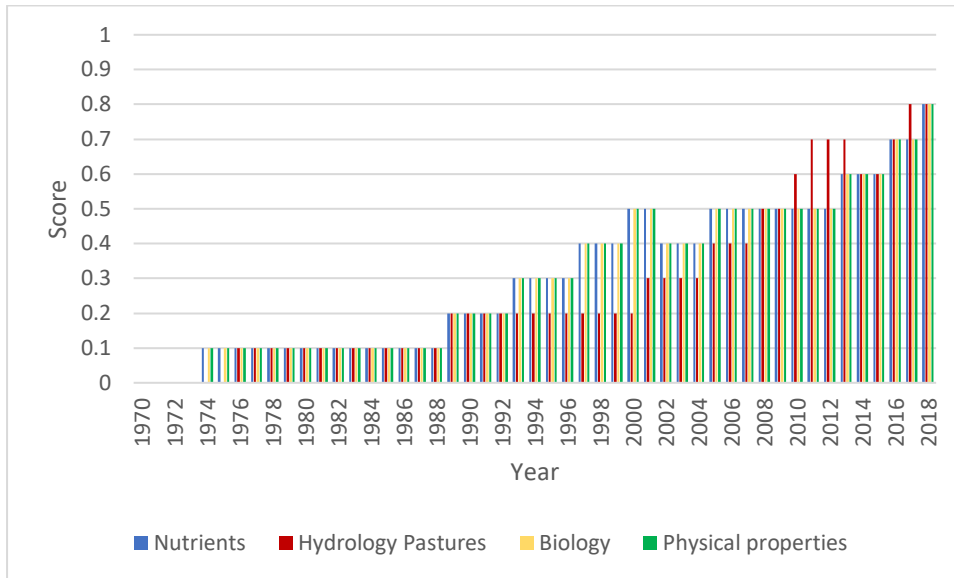


Figure 2. Status of soil indicators over time at Glenelg

Managing ground layer vegetation for production and to maintain ecological health

Prior to 1980 much of Glenelg was covered by dense woody vegetation, the presence of the woody vegetation stopped ground cover species from growing. The Chambers have conducted numerous woody vegetation treatments over the years to promote the growth of ground cover, due to these land management practices the number of ground cover species has increased significantly. The conservative stocking regime utilised on Glenelg and the construction of the exclusion/predator fence along with the woody vegetation treatments have significantly improved ground cover and its reproductive potential (Figure 3).

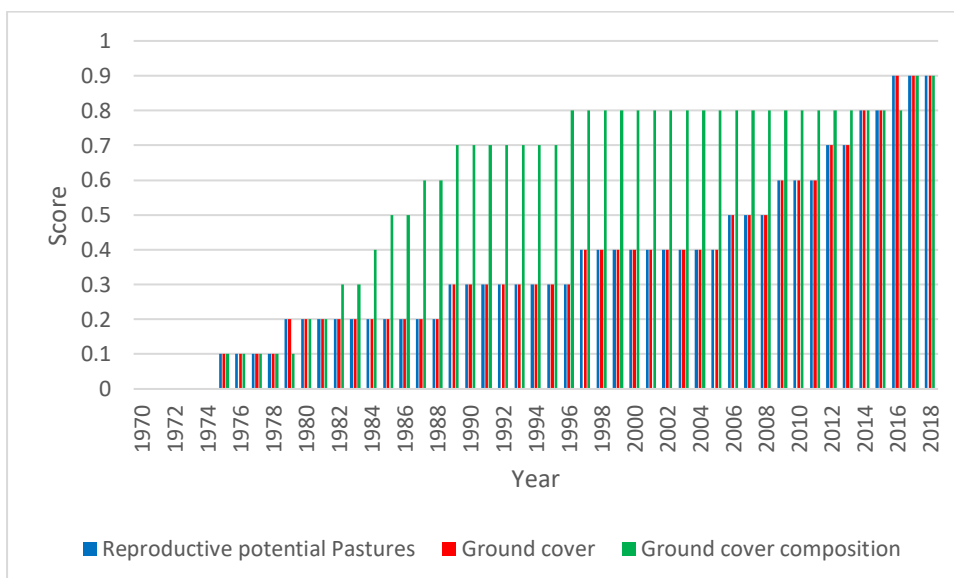


Figure 3. Status of ground layer vegetation for production and to maintain ecological health over time at Glenelg

Managing trees and shrubs for production and to maintain ecological health of the property and watershed

In 1970 Glenelg was entirely covered by woody vegetation and was unsuitable for agricultural purposes. Since 1970 woody vegetation has been controlled on the property to enable pasture growth for production and ecological purposes. The tree and shrub structure and the number of eucalypt species on Glenelg have significantly declined since 1970. The number of shrub species on Glenelg has only marginally declined.

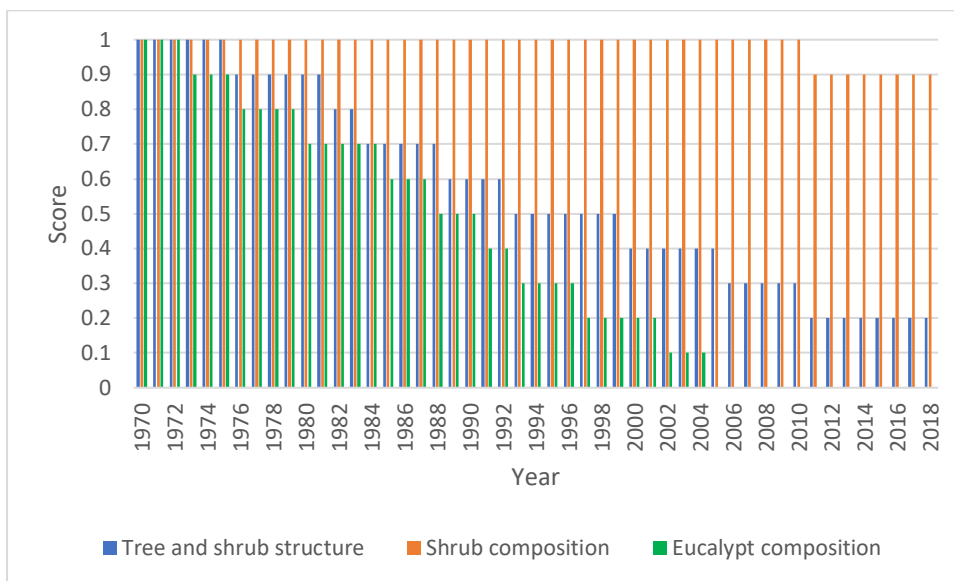


Figure 4. Status of trees and shrubs for production and to maintain ecological health of the property and watershed over time at Glenelg

Managing natural watercourses, riparian areas, natural lakes and wetlands, to protect ecosystems that are sensitive to agricultural land management.

The major watercourse running through Glenelg is the Mungallala Creek. The Chambers have experimented with removing trees from the watercourse and replacing the trees with grass. This land management regime has raised the water table of the Mungallala Creek and resulted in waterholes holding water year-round. Water birds and fish are now present in and around the waterholes permanently. By maintaining a good coverage of grass along the banks of the creek erosion risks are mitigated.

2019

GLENELG CASE STUDY: ECOLOGICAL SUPPLEMENTARY REPORT

Prepared by Matt Bolton and Greg Hosking

Key findings

Glenelg is a 4000-hectare grazing property which has been managed by the Chambers family since 1970. Glenelg is located to the south of Mungallala, Queensland. This ecological assessment commences in 1970. The date reflects the year Harry Chambers purchased the first parcel of Glenelg.

Glenelg has been managed under a conservative stocking regime for much of the Chambers management period. Since acquiring the first parcel of Glenelg in 1970 the Chambers have extensively cleared native woody vegetation on the property and established exotic ground cover species. Glenelg has been managed to produce pasture for production and to maintain the ecological health of the property for much of the Chambers management.

The graphical summaries displayed in this report are composed of 10 ecological criteria, the graphical summaries for Glenelg demonstrate that there is a close relationship between the land manager's goals/ideals and the ecological outcomes in each of the four phases:

Phase 1: 1970-1984	Conventional non-regenerative regimes and practices
Phase 2: 1985-2004	Intensive conventional interventions and small-scale trials of revegetation projects
Phase 3: 2005-2014	Transition to broader scale regenerative grazing land management regimes and revegetation projects
Phase 4: 2015-2018	Increasing maturity of regenerative grazing land management regimes and revegetation projects

An assessment over time of the responses to 10 ecological criteria shows that, by phase 4, compared with the previous three phases, most ecological criteria have been assessed as nearly fully achieved or having achieved their reference state (i.e. a scores between 0.8 – 1.0). For example:

- Minimising effects of extreme climatic events across the whole property and its place in the broader catchment, including preparedness for drought and floods.
- Managing pastures for production and to maintain ecological health of the property. Ecological changes include: improving the reproductive potential of pastures and maintaining high levels of ground cover across the property.
- Improving soil health and function. Ecological changes include: improved soil nutrients and soil carbon, soil hydrology, soil biology and soil physical properties i.e. soil as a medium for plant growth.

The transformation of Glenelg toward a regeneratively managed property has been achieved through a process of understanding landscape function and planning to manage the land accordingly. Consistent implementation of management ideals has enabled the land manager to reduce total grazing pressure on the property and to maintain water in their creek year-round.

In addition, the management of pastures to maintain ground cover and height has enabled many bird species to live and thrive on Glenelg. A field survey of birds conducted by Greg Hosking and Matt Bolton in December 2018 recorded 28 species of birds in a Buffel Grass (*Cenchrus ciliaris*) pasture. A species observed of particular note was the Grey Falcon *Falco hypoleucos*, the Grey Falcon is currently listed as “vulnerable” by the Queensland Government.

Independent scientific assessment

An independent assessment of the land manager’s self-assessment across all 10 ecological response criteria supports information presented by the land manager.

This independent assessment examined a measures of ecological response found inside and outside the Glenelg property boundary: 1) ground cover.

An assessment of ground cover information for Glenelg was derived from a standardised national ground cover dataset (Landsat satellite using a 30m resolution) between 1990 and 2018. This ground cover analysis supports the graphical ecological summaries provided by the land manager, showing an obvious transformation in ground cover at Glenelg. In the 90’s and early 2000’s the property had consistently high levels of ground cover compared to neighbours. In the mid 2000’s Glenelg had mid-low levels of ground cover compared to neighbours, this was due to drought conditions and kangaroo incursions onto the property. In the late 2000’s and early years of the current decade ground cover levels rose and fell on Glenelg in relation to drought. In normal to high rainfall years Glenelg produced more ground cover than much of the surrounding region, in drought years kangaroos invaded Glenelg in high numbers and reduced ground cover levels. In recent years Glenelg has had an exclusion fence constructed around its boundary to control kangaroo numbers. Whilst Glenelg is still drought declared ground cover levels have risen on the property due to a reduction in grazing pressure applied by kangaroos.



This independent ecological assessment highlights the importance of a local land manager understanding, and planning for, and implementing well-informed land management regimes that aim to achieve sustainable ecological outcomes. These results support the conclusion that Glenelg is an outstanding example of understanding ecological function and managing for it in an agricultural setting.

Assessing responses to land management regimes according to the ecological criteria

This Detailed Report is underpinned by the Soils for Life *Conceptual Model* and *Assessment Framework* that documents the responses of 10 criteria corresponding to ecosystem function, composition and structure.

Prior to undertaking a field visit to Glenelg in December 2018, the landowners, Graham and Jan Chambers, were asked to document the production systems that have been developed and implemented at Glenelg including land management regimes associated with the following: soil and vegetation condition (pastures, shrubs and trees); weeds and pests; surface and ground water and

animal production. That production history aimed to document land management phases which lead up to the current regenerative landscape management.

This included a collation of all relevant available published and unpublished ecological data and information about the farm and how it was managed (Attachment A).

Assessment of Response Criteria

This ecological assessment commences in 1970 when the Chambers family purchased the first parcel of Glenelg.

A. Resilience of landscape to natural disturbances – Drought/Flood Preparedness

Why track changes and trends in resilience to major natural disturbance/s?

Resilience to major disturbance/s includes the following factors depending on the agro-climatic region (wildfire, drought, cyclone, dust storm, flood). A major natural disaster or natural disturbance event can occur at any time. Some disturbances give a warning, such as a wind storm or electrical storm preceding a wildfire or a flood. Once a disaster happens, the time to prepare is gone. Lack of preparation can have enormous consequences on farm life including; social, ecological, economic and production.

Assumptions and definitions

Drought and flood are the major natural disturbance events affecting Glenelg.

Results and Interpretation

Phase 1 extended from 1970-1984 and was associated with high density set stocking causing overgrazing and clearing land for pastures. Much of this phase was dedicated to establishing pasture species and controlling woody regrowth. Water infrastructure was underdeveloped and stock watering points were few and far between, the ability of the property to cope with drought was severely limited by these factors.

During this phase the fencing on the property was not designed to cope with flooding events, when floods occurred damage to fencing was costly and extensive as well as time consuming to repair. The risk of erosion due to flooding events was also high. The properties ability to cope with flooding events was low and they posed a severe risk to the enterprise.

In Phase 2 the land manager started low density set stocking. Pasture establishment of Buffel Grass was conducted throughout this phase. Buffel Grass is a highly drought tolerant species with sufficient nutrients for livestock. The establishment of Buffel Grass marginally improved the capacity of the property to cope with drought events. Water infrastructure was also improved during this phase.

In 1985 the land manager started clearing large trees from a section of creek running through the property. The land manager theorised that the trees were consuming much of the water available in the creek and causing it to run dry frequently. After removing the trees from the creek banks the land manager established a ground layer of grasses to stabilise the creek banks from erosion. Permanent water holes appeared in the creek after the trees were removed causing the water table to rise and provide water for livestock, fish and other wildlife year-round.

In Phase 3 the land holder improved water infrastructure on the property.

In Phase 4 the land manager constructed an exclusion fence around the property to control total grazing pressure applied by kangaroos on the property. The ability to maintain kangaroo numbers at a

sustainable level on the property greatly improved its capacity to cope with drought events. Livestock were grazed to maintain and improve ground cover levels during this Phase. The exclusion fence erected around the property was designed with areas that had the capacity to lay flat on the ground when pushed over by a flood event. This reduced the damage a flood could cause on the property.

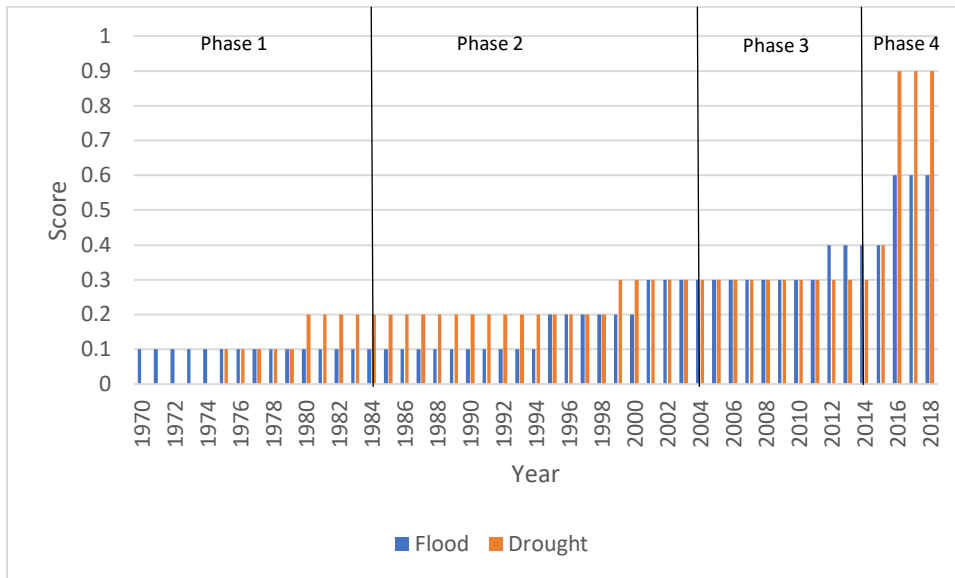


Figure 1. Resilience of Glenelg to severe climatic events- Drought & Flood.

B. Status of soil nutrients – including soil carbon

Why track changes and trends in soil nutrients – including soil carbon?

Soil organic matter (SOM) is the basis of soil fertility. As a general rule-of-thumb, for every tonne of carbon in SOM about 100 kilograms (kg) of nitrogen, 15kg of phosphorus and 15kg of sulphur become available to plants as the organic matter is broken down. Thus, SOM releases nutrients for plant growth, promotes the structure, biological and physical health of soil, and is a buffer against harmful substances.

Assumptions and definitions

Glenelg is situated within the Australian Rangelands (<http://www.agriculture.gov.au/ag-farm-food/natural-resources/vegetation/rangelands>), which is a low rainfall region with typically hotter and drier climate conditions. Due to the climate and the location and size of properties in the rangelands, soil testing and adding inputs such as compost to improve soil health have traditionally not occurred. According to the CSIRO maintaining and building a high ground cover level is critical to improving soil nutrients in the Rangelands.

Results and Interpretation

During Phase 1 the ground cover layer on Glenelg was being developed, at the time of acquisition the property could only support 27 head of cattle due to the lack of ground cover and the density of woody vegetation. Soil nutrient levels were low during this Phase due to a lack of regularly active photosynthesizing vegetation providing organic matter to decompose in the soil.

In Phase 2 the land manager successfully established a ground cover layer of vegetation. The presence of ground cover improved the soil nutrient levels of the property by providing a source of organic matter.

In Phase 3 the land manager maintained the ground cover layer as above.

In Phase 4 the land manager constructed an exclusion fence to keep kangaroo numbers at sustainable levels within the property. By managing kangaroo numbers, the land manager controlled total grazing pressure on the property, this improved soil nutrient levels on the property by increasing ground cover.

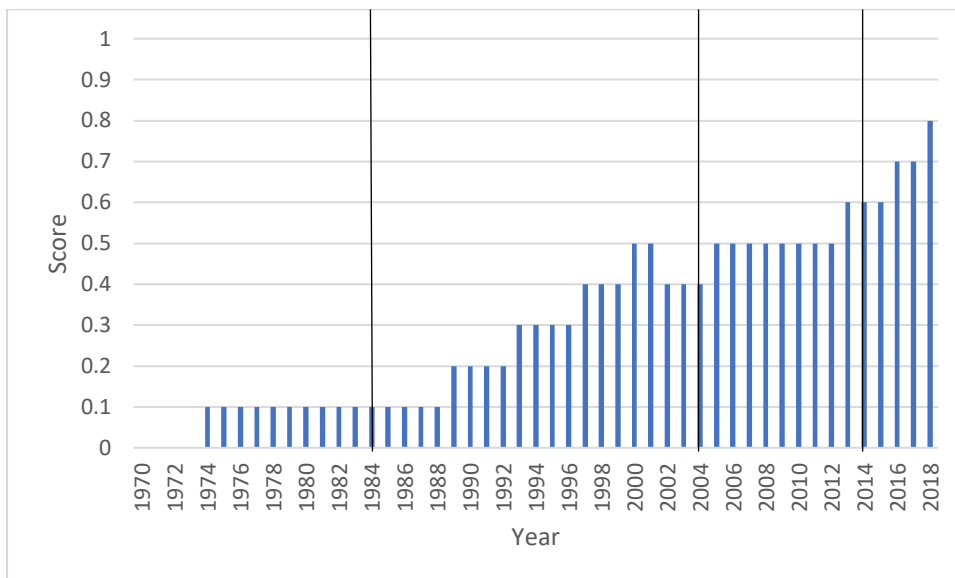


Figure 2. Status of soil nutrients.

C. Status of soil hydrology - Soil surface water infiltration

Why track changes and trends in soil surface water infiltration?

Soil physical properties have a direct relationship to soil moisture. Soil texture and structure greatly influence water infiltration, permeability and water-holding capacity. Of the water entering a soil profile, some will be stored within the root zone for plant use, some will evaporate, and some will drain away. In agro-ecological settings, by increasing water infiltration, permeability and water-holding capacity this will usually act as a stimulus to ecological function.

Assumptions and definitions

Ground cover was utilised as the key indicator of soil hydrology for pastures on Glenelg. Maintaining appropriate ground cover levels is essential for all the soil indicators within the Rangelands. Soil hydrology of the creeks of Glenelg was also assessed due to the innovative methods utilised on Glenelg to maintain water in their creeks year-round.

Results and Interpretation

Phase 1 – as above.

In Phase 2 the land managers started clearing vegetation from the creek banks and established a grass cover on the banks of the creeks. Water holes in the creek were also enlarged due to major flooding.

In Phase 3 the hydrology of the pastures improved due to the maturation of the ground cover level and the improving physical properties of the soil enabling water infiltration. Development of the creeks continued in the form of maturation of the ground layer on the creek banks and further enlarging of water holes due to flooding.

In Phase 4 the hydrology of the pastures suffered from an excess of kangaroos combined with drought conditions. After the construction of the exclusion fence and the subsequent controlling of kangaroo numbers the hydrology of the pastures improved due to a better ground cover vegetation layer.

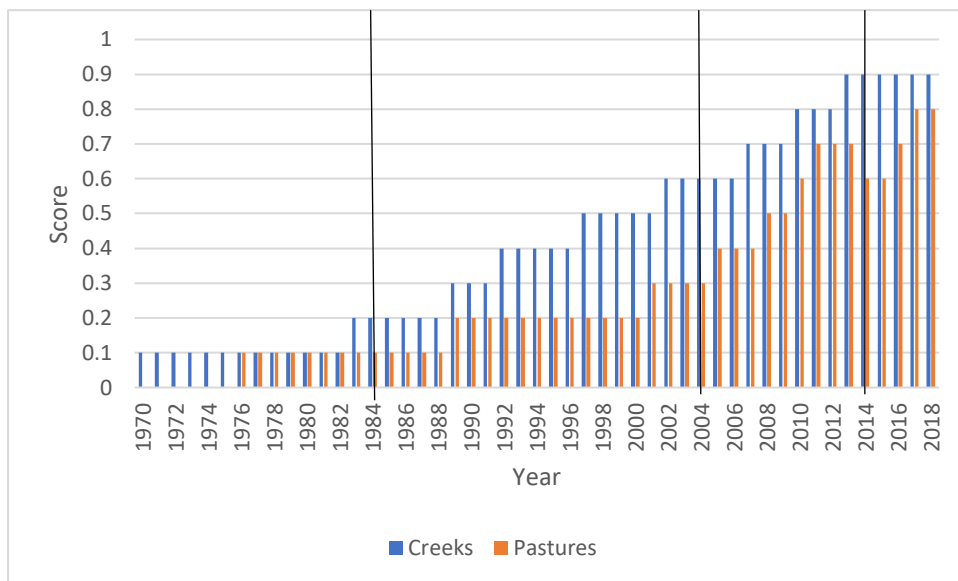


Figure 3. Status of soil hydrology – Creeks & Pastures.

D. Status of soil biology - Soil biology

Why track changes and trends in soil biological activity?

Soil biology affects plant (and animal) production by modifying the soil's physical, chemical and biological environment within which plants grow and persist. The ratio of fungi to bacteria is important for land managers to understand - too many bacteria can indicate an unhealthy and unproductive soil. Soil fungi contribute to:

- natural processes (litter transformation, micro-food web participation and soil engineering);
- the decomposition of organic material resulting from compost applications and disturbance from cattle grazing; and
- enhancing nutrient distribution for plant health and productivity.

In healthy soils, invertebrates including arthropods and worms also form a vital part of a soil food web.

Assumptions and definitions

Soil biology are reliant on plants to provide sugars as a food source. Groundcover layers were utilised as a surrogate to assess the status of soil biology on Glenelg.

Results and Interpretation

Phase 1- as above.

Phase 2- as above.

Phase 3- as above.

Phase 4- as above.

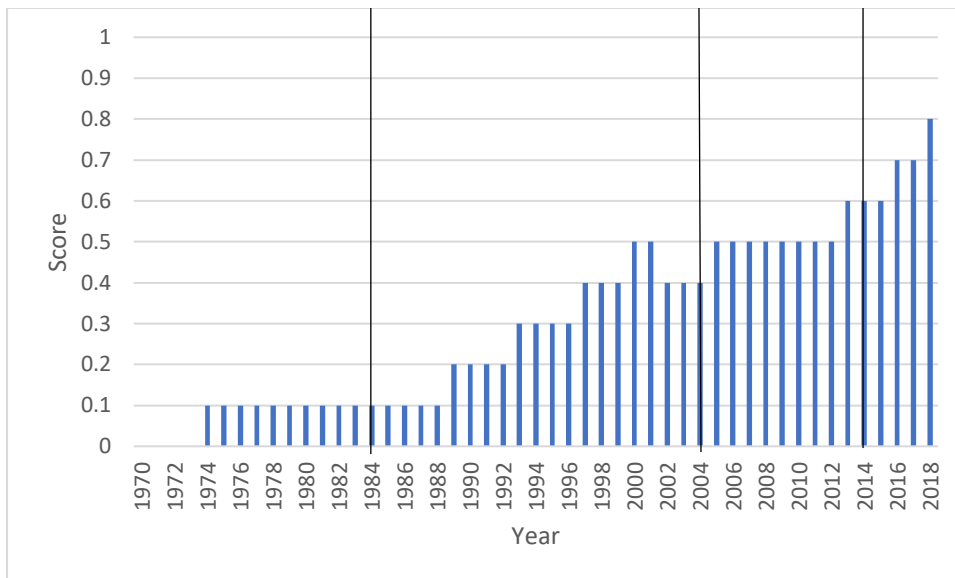


Figure 4. Status of soil biology.

E. Status of soil physical properties – as a medium for plant growth

Why track changes and trends in soil physical properties?

Declining soil surface condition involves the depletion of nutrients, soil organic matter and of key elements of the soil biology from the soils. Soil degradation is the result of high levels of bare ground, water erosion, wind erosion, chemical and physical deterioration. It is often associated with unsuitable land management regimes. Over time loss of the soil’s physical properties will have consequences on production, economic, other ecological criteria as well as social outcomes.

Assumptions and definitions

The physical properties of the soil are closely related with over grazing. Over grazing reduces ground layer vegetation which limits the potential root depth of plants. Over grazing can also cause compaction resulting in reduced rates of water infiltration and a deficit of soil moisture.

Results and Interpretation

Phase 1- as above.

Phase 2- as above

Phase 3- as above.

Phase 4- as above.

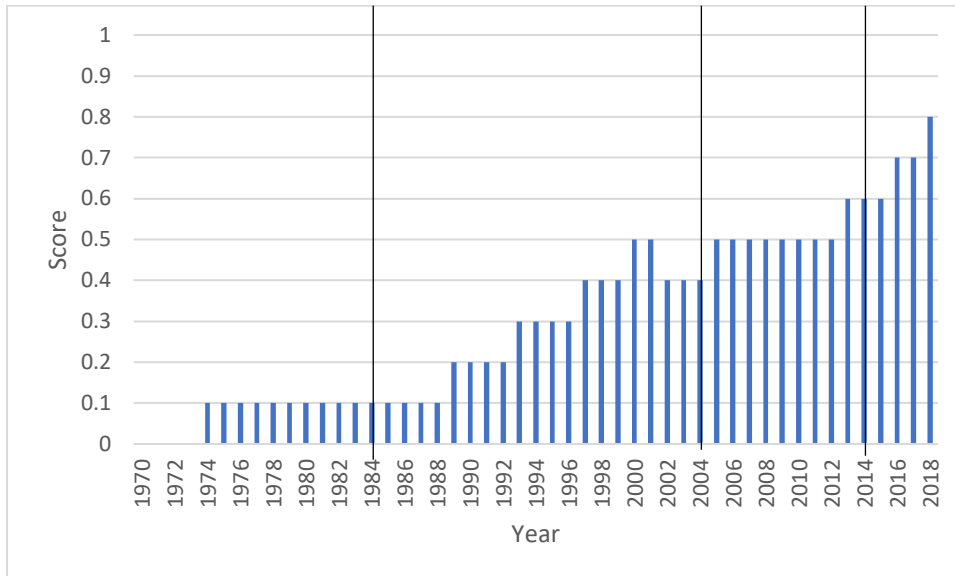


Figure 5. Status of soil physical properties.

F. Status of plant reproductive potential – reproductive potential of pastures

Why track changes and trends in reproductive potential of pastures?

An understanding of successful reproduction, germination, establishment and development of plants is important in managing agri-ecological ecosystems. This understanding of successful plant reproduction is vital for the manipulation of planned production outcomes - e.g. grazing regimes can prevent seed-setting by undesirable or invasive plants and for increasing the longevity of perennial pastures before they need to be resown.

Assumptions and definitions

Reproductive potential is the relative capacity of a species to reproduce itself under optimum conditions, including trees, shrubs and grasses.

Overgrazing can limit the reproductive potential of pasture species, if species are constantly overgrazed they will not have a chance to produce and set seed. If pasture species are stopped from setting seed regularly species suffer and bare ground will become more prevalent. A major issue currently facing land managers who conservatively stock to maintain ground cover, is the number of kangaroos invading their properties. Kangaroos move through the landscape looking for pasture, particularly in times of drought when feed is scarce. Traditionally land managers have not had the capability or the infrastructure to stop incursions of kangaroos onto their properties. This changed recently with exclusion fencing products becoming widely available. Exclusion fencing has given the land holders the ability to control animal incursions onto their properties.

The reproductive potential of pastures was split into two categories, Buffel Grass and native grasses. Buffel Grass has been actively established on Glenelg due to its drought tolerance and nutritional content. In some areas on Glenelg native grass pastures have been replaced by Buffel Grass affecting their reproductive potential.

Results and Interpretation

In Phase 1 woody vegetation had to be cleared to establish pasture species on Glenelg, native grasses replaced the woody vegetation in this Phase.

In Phase 2 buffel grass started to become established due to the management regimes of the land holder. The reproductive potential of native grasses declined when faced with competition from Buffel Grass.

Phase 3- as above.

In Phase 4 Buffel Grass had become firmly established due to the construction of the exclusion fence reducing total grazing pressure. The reproductive potential of native grasses also improved due to the exclusion fence.

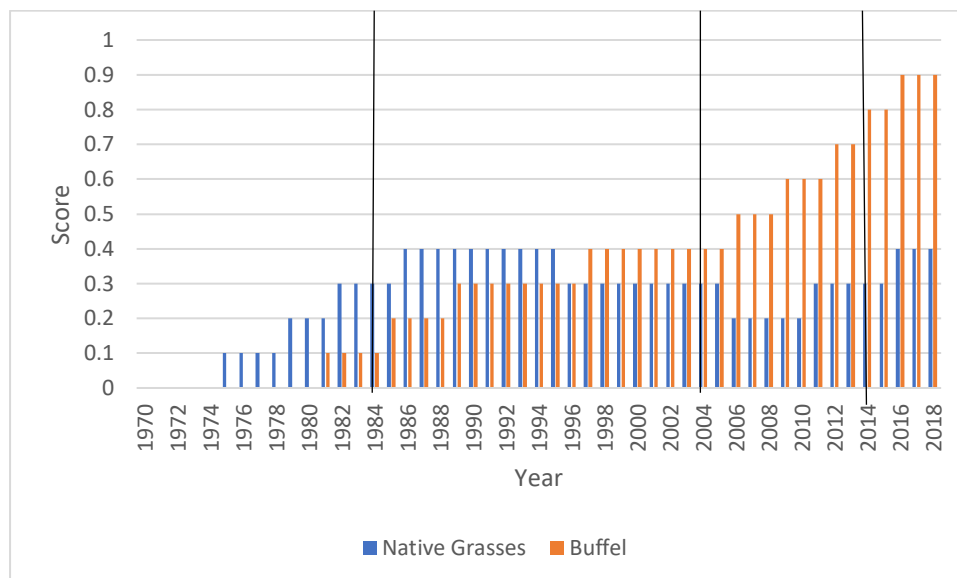


Figure 6. Status of reproductive potential of pasture species.

G. Status of tree and shrub structural diversity and health

Why track changes and trends in extent of tree cover?

Tree cover on grazing land in the Rangelands is actively monitored and controlled by graziers to maintain pastures in a productive state. Woody weeds in the Rangelands overshadow ground layer vegetation and severely affect its status. Controlling of woody weeds is required to maintain ground layer vegetation and enable grazing for production.

Assumptions and definitions

If woody weeds are not controlled ground layer vegetation will be outcompeted and the land would no longer be suitable for production.

Large paddock trees are left intact to provide habitat for biodiversity on the property.

Results and Interpretation

In Phase 1 Glenelg was entirely covered with woody vegetation, any form of significant ground layer vegetation was not present. The land manager commenced clearing of woody vegetation with the goal of establishing pasture species for production. Initially ringbarking was conducted and later vegetation was cleared by pulling with a chain.

In Phase 2 the land manager controlled the regrowth of woody weeds across the property using methods such as pulling, Tordon application and later blade ploughing.

Phase 3- as above.

Phase 4- as above.

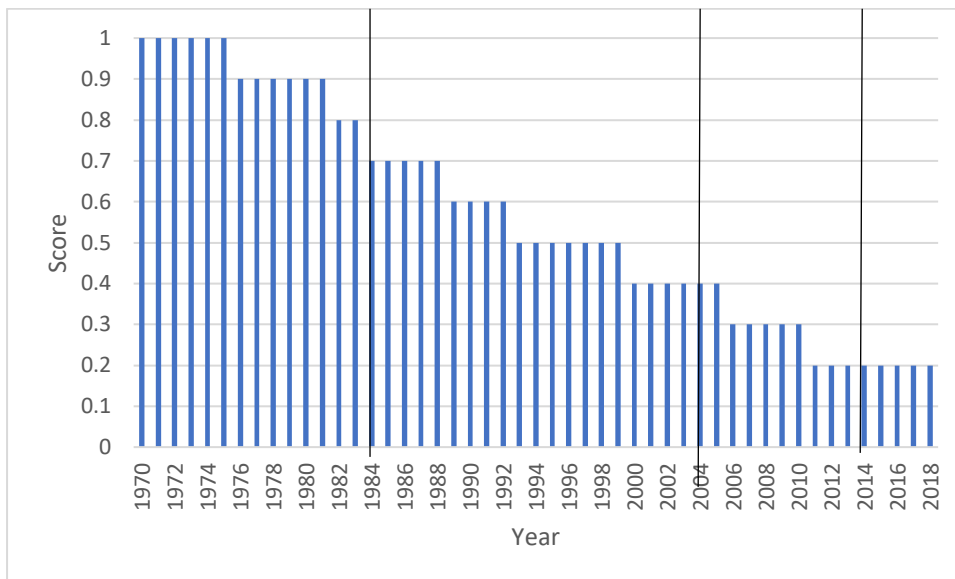


Figure 7. Status of tree and shrub cover.

H. Status of grass and herb structure - Ground cover

Why track changes and trends in ground cover?

Ground cover in the Rangelands is one of the key indicators of land health, it is closely related to the soil indicators outlined above. Maintaining healthy ground cover levels is a critical component of farming regeneratively in the Rangelands.

Definitions and Assumptions

Overgrazing by livestock and kangaroos is the biggest factor in harming ground layer vegetation on Glenelg. The land holders have acknowledged this and have stocked their property conservatively for many years to ensure overgrazing by livestock did not occur. However, since 2000 kangaroo incursions onto the property have been increasing, particularly in times of drought. The construction of an exclusion fence from 2014 has enabled the land holder to stop kangaroo incursions onto Glenelg.

Results and Interpretation

Phase 1- as above.

Phase 2- as above.

Phase 3- as above.

Phase 4- as above.

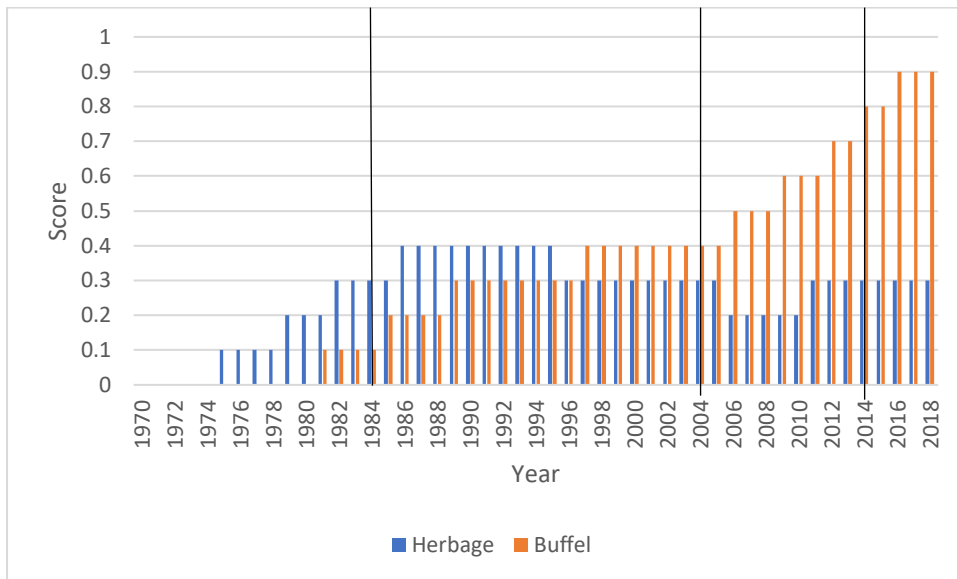


Figure 8. Status of ground cover.

I. Status of tree and shrub species richness and functional traits

Why track changes and trends in the status of tree and shrub species richness?

Tree and shrub species richness refers to the number and diversity of species present. It is a useful indicator to track the affects the land management regimes have had on the ecological health of the property.

Definitions and Assumptions

Eucalypts and shrubs were assessed on Glenelg. The species of eucalypt on Glenelg were seen as woody weeds and they have been actively controlled and removed from the landscape to promote pasture growth for production. Other species of trees which do not spread across the landscape at the same vigorous rate as the eucalypts have been retained on Glenelg as shade for stock.

Results and Interpretation

In Phase 1 the eucalypt species were actively removed from the landscape and their revegetation attempts were controlled. Shrub species were not an issue and were not targeted for removal.

Phase 2- as above.

In Phase 3 some species of shrubs were removed from the landscape by blade ploughing.

Phase 4- as above.

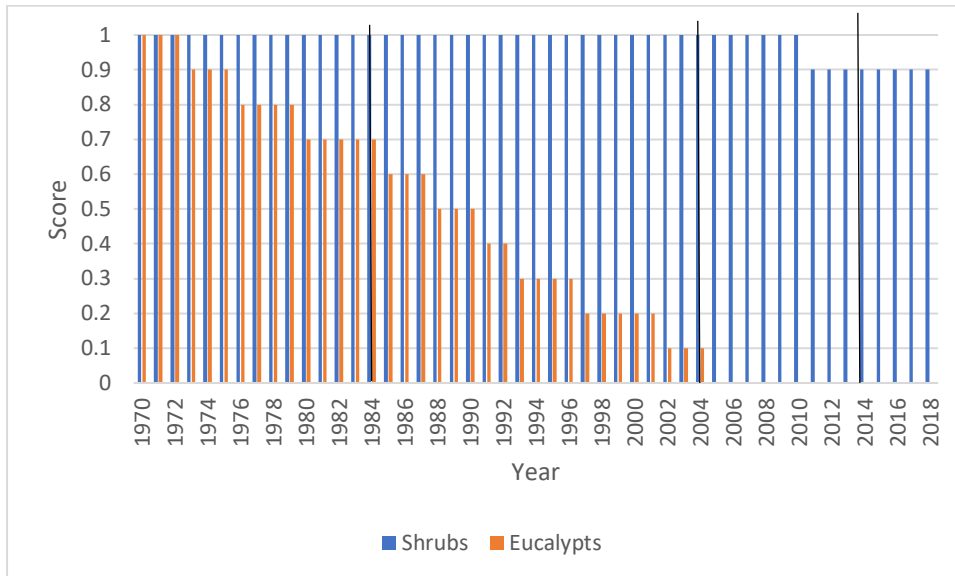


Figure 9. Status of tree and shrub species richness.

J. Status of grass and herb species richness and functional traits

Why track changes and trends in grass species diversity?

Functional richness refers to the number of species inhabiting a place and what is/are their roles in that place and functional diversity reveals how evenly the species are distributed in an area. Any decrease in functional richness and evenness decreases an ecosystem's productivity and stability. How an ecosystem is managed in a production setting will determine its productivity and stability.

In many grazing land management regimes, the variety of pasture plants (annuals and perennials) can improve production, protect natural resources (soil and water) and build the capacity of farming systems to adapt to future production and environmental challenges. The intensity of the grazing management system will determine the health and vitality of pastures and their longevity.

Results and Interpretation

In Phase 1 the number of grass and herb species increased as woody vegetation was removed from the landscape enabling understory growth.

Phase 2- as above.

Phase 3- as above.

In Phase 4 species of grass and herbs which had never been observed before appeared, due to the reduction of total grazing pressure caused by the construction of the exclusion fence.

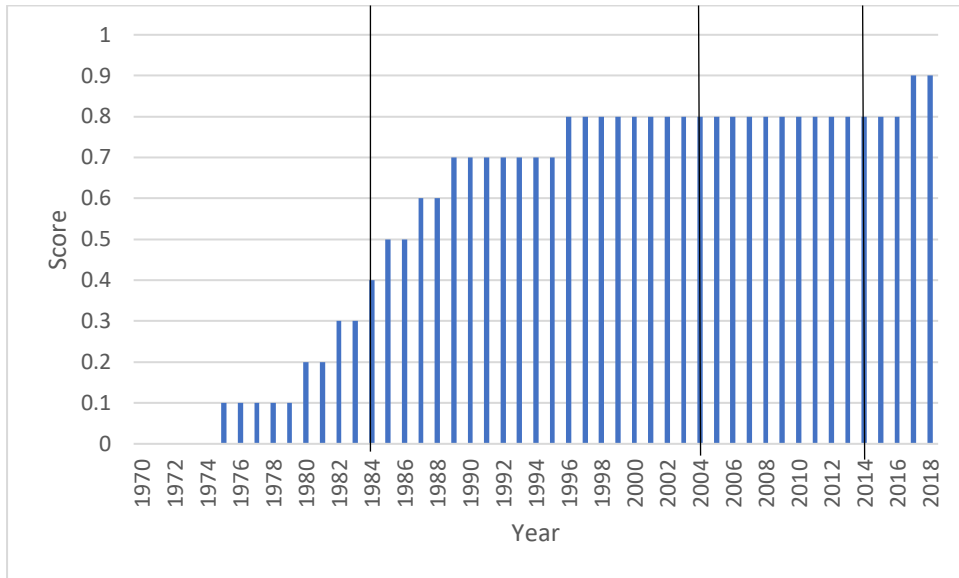


Figure 10. Status of grass and herb species richness.

Attachment A

Production systems

1970

- Harry Chambers acquired the first parcel of Glenelg
- Commenced woody vegetation treatments in the form of ring barking
- Half the property supported 27 head of cattle

1978

- Purchased the last parcel of Glenelg
- Woody vegetation treatments had occurred continuously from 1970 across the property
- 200 head of cattle were now run on Glenelg
- Started a merino wool operation on Glenelg
- Commenced scrub pulling as a wood vegetation treatment

1981

- Graham joined the partnership
- The entire property was scrub pulled

1985

- Jan joined the partnership
- The Mungallala Creek was cleared of trees

1989

- Pulled the entire property again
- 8000 sheep were shorn on Glenelg, they were fed on the pulled vegetation
- Pimelea poisoning was an issue throughout the 1980's; cattle were lost. Managed to mostly control pimelea by maintaining good ground cover levels
- Buffel grass took hold on Glenelg in the late 80's

1990

- Water holes in the Mungallala Creek were enlarged due to major flooding

1994

- Graham and Jan Chambers took over Glenelg

1997

- Woody vegetation removed entirely from the property

2002

- Kangaroos started to become a major problem during drought years

2005

- Blade ploughing commenced on Glenelg

2010

- Waterholes enlarged again on the Mungallala Creek, due to major flooding

2012

- Waterholes enlarged again on the Mungallala Creek due to major flooding

2013

- Glenelg was drought declared
- The most recent fire occurred on Glenelg
- Half the cattle were sold due to drought conditions
- Pulled mulga to feed sheep
- Galvanised burr came when ground cover levels were low

2014

- Mulga ran out on the property, no longer available to feed sheep in drought time
- Fed cotton seed to the sheep in 2013-2014 summer
- Commenced construction on the exclusion/predator fence

2016

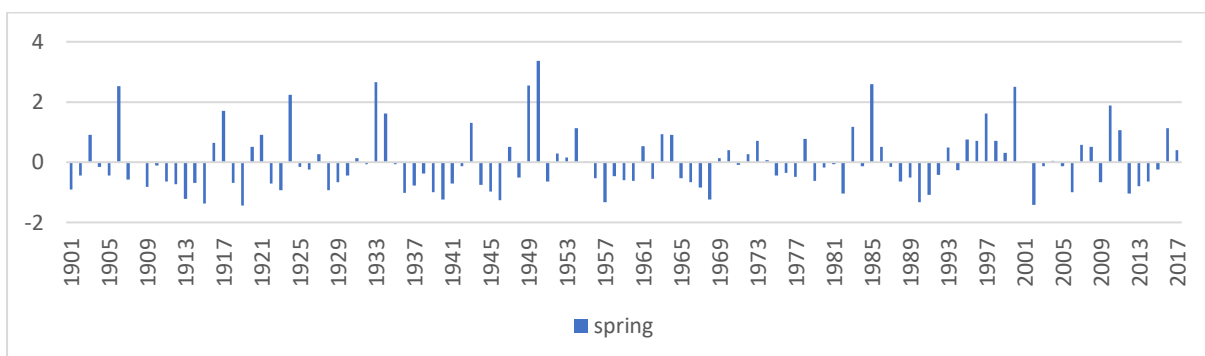
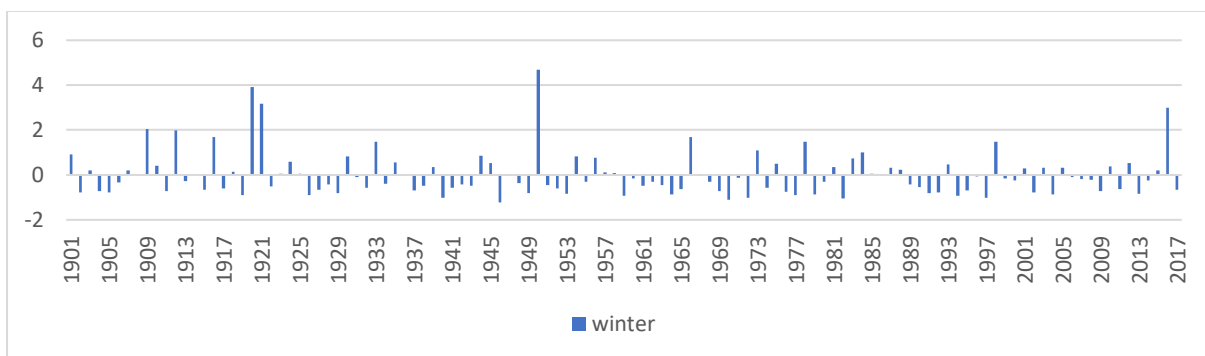
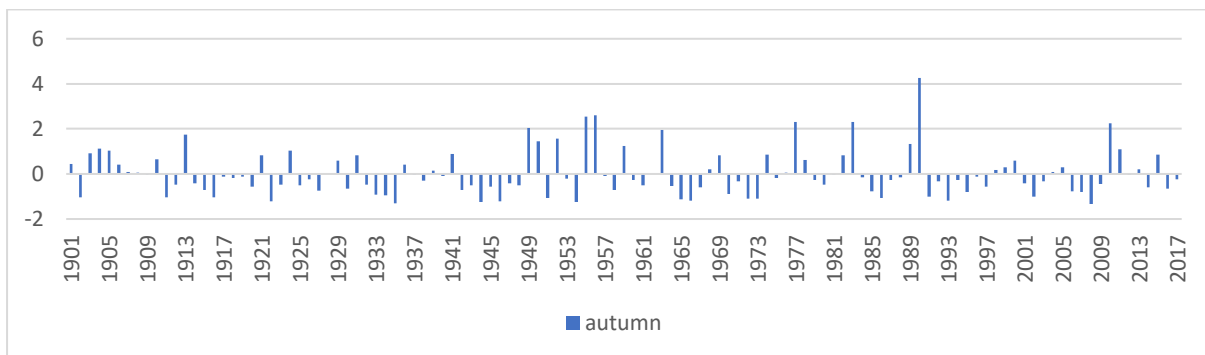
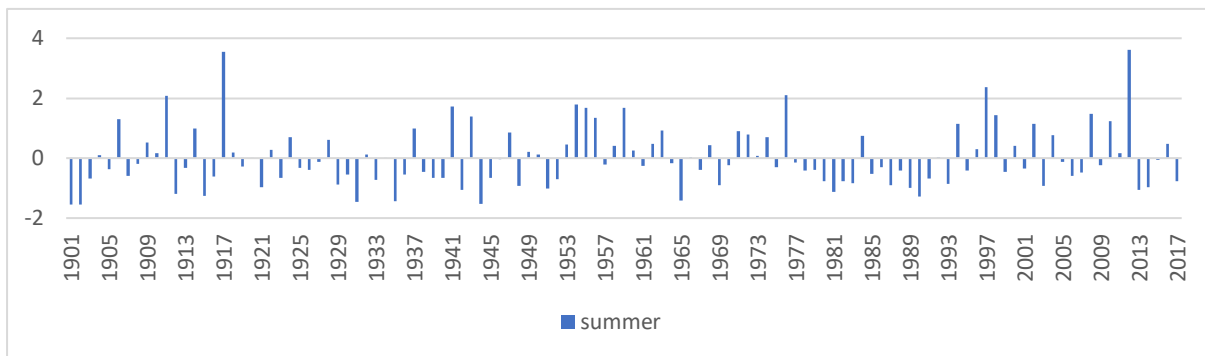
- 4-5000 kangaroos were driven off the property whilst construction of the exclusion/predator fence was underway
- Finished construction on the exclusion/predator fence

2017

- Kangaroos were shot in the 12 months after the exclusion/predator fence was completed

Attachment B

Patterns of seasonal rainfall derive from modelled monthly rainfall data for Glenelg showing variants around the mean.





Gleneig Case Study