Australian Government
Department of Agriculture, Fisheries and Forestry

Future Drought Fund

CHRRUP
Advancing rural communities

CASE STUDY
PREPARING FOR DROUGHT

GLENSTAR

NICHOLE JAMES

JUNE 30, 2024

GLENSTAR SUMMARY OF RESULTS

Activity	Situation 2002	Situation 2024	Future plan
Number of stock water points	3 water points	38 water points	48 water points
Number of paddocks	5 paddocks	22 paddocks	25 paddocks
Number of cattle sustainably supported	200 head	600 head	800 head
Landscape Rehydration	Severe scalding and erosion	Just completed	Expect 800ha recovered pasture (cost of $25 ha)

The owners of Glenstar emphasize that best management practices are crucial in this sandy, low-rainfall region, and that management must be flexible according to the seasons. Predicting drought is challenging, and they have had to destock three times in the last 20 years due to a lack of infrastructure, water and severe lack of rainfall.

2018

Over the last 20 years, the focus has been on building drought resilience by enhancing cattle rotation. This strategy has gradually rehabilitated eroded areas and transformed undesirable spinifex and wire grass into high-quality native and buffel grass and improved soil quality.

Livestock never have to walk more than 1 km for water. This is especially crucial during the summer season when temperatures often exceed 40°C.

2023

The increased number of paddocks optimizes fodder utilization and facilitates regular rotation, allowing grasses time to recover., with further improvements expected to boost this figure even more.

The new management system at Glenstar reduces workload through the selection of cattle for temperament, quiet handling techniques, and smaller paddocks for efficient pasture management and easier cattle movement.

Glenstar has initiated a landscape rehydration program aimed at reducing erosion. The project area was targeted for its restoration potential and to give the greatest results. The storm surge safety from episodic wetland functions has been lost due to erosion prematurely draining and or denying overland water flow that historically maintained them. These developing erosion features in key drainage points and or glazed/dehydrated landscapes that have lost function are common problems

throughout Australia. It is expected that the project will return natural function to the landscape after one or two significant rainfall events.

Hydration will effectively irrigate 800 hectares of bare land at a cost of $25ha. The restoration of episodic wetland function of this area has a very high environmental value both for flora and fauna.

GLENSTAR

BACKGROUND

Glenstar, is 7,772ha cattle property managed by Nichole for her father, Dick James, located 30km West of Jericho in the Desert Uplands Bioregion and purchased by the James Family in 2002. A Droughtmaster cross breeder herd is currently rotationally grazed across 22 paddocks on the property that is dominated by Ironbark, Box and Yellow Jacket country with wattle understory. Soil types on the property include sandy, sodic, with gigyea with patches of heartleaf, which is poisonous to cattle.

The owners prioritize animal welfare by implementing low-stress cattle handling techniques and using a set of well-designed cattle yards with extensive covered areas installed in 2017. This yard protects the cattle from rain and reduces the temperature by 15°C in the summer, leading to reduced stress, improved meat quality, and higher meat prices.

Previously, Glenstar relied on three water points - a river, turkey nest, and a tank - with one bore near the house. Over the past twenty years, Glenstar has undergone a series of steady improvements to enhance carrying capacity and productivity. This includes the planting of buffel grass and legumes such as wynn cassia and secca stylo to improve pasture quality and productivity.

One of the most significant improvements at Glenstar was the increase in paddocks from 5 to 22, with plans to further increase to 25. The 120-day paddock rotation has improved soil quality and helps maintain the long-term health and productivity of the property, making it an essential part of sustainable management. The management and infrastructure improvements have enhanced carrying capacity from 200 to 600 head, improved meat quality, and boosted the welfare of the stock while promoting the health of natural resources

In terms of biodiversity, the Western area of the property has seen the development of thick wattle patches, leading to a decrease in ground cover and an increase in erosion risk. However, the wildlife population appears to be in balance with feral pig numbers under control. Wild dogs can pose occasional challenges, which are managed through trapping efforts.

The Future Drought Fund (FDF) project at Glenstar supported changes in grazing management and infrastructure to mitigate landscape degradation risks. A key strategy was to spread grazing pressure evenly across paddocks by reducing paddock size and minimizing the distance to water for cattle. Ms. James has undergone training in forage budgeting using and now uses the Maia Grazing program. This will enable her to develop a comprehensive grazing management plan and make informed decisions regarding stocking rates in alignment with the property's carrying capacity.

The project has supported the development of a landscape hydration plan aimed at improving production and restoring wetland functions. Additionally, it has funded stage one of hydration works as a demonstration. Restoration efforts targeting the landscape's hydrological function can significantly enhance agricultural productivity.

Landscapes with impaired water functions are more susceptible to flooding and prolonged droughts. In Glenstar's case, restoring historical wetlands and flood out zones also holds significant environmental value as major carbon sinks and biodiversity habitats.

PRACTICES – BEFORE AND AFTER

Questions	
Grazing management system	When purchased in 2002, the property had 5 paddocks. Now have 22 paddocks. A 120 day rotation is used depending on grass and rainfall. Plan to increase to 25 paddocks and reduce the grazing period further.
Water management strategies	In 2002, there were 3 water points: the river, a turkey nest dam and a tank. One bore near house. River water is only available after significant rainfall. Now have 28 water points. This number still needs to be increased to about 38.
Cattle numbers	In 2002, ran 200 head. Now, the average carrying capacity is 600 head, depending on the season this has risen to over 800 head.
Pasture species	Most soil is sandy. There are some patches of heartleaf (poison to cattle). Planted buffel grass, wynn cassia secca stylo. Wynn cassia grows very well in sandy soils. It is not palatable when green but cattle eat when it dries off.
Land use by area - grazing, forest.	Total area 18,000ac. About 3000ac had already been pulled when purchased. Now, approximately 56% has been pulled.
Sale of cattle	Weaners/steers are private sale or Blackall saleyards
Time of joining bulls	October – April.
Burning regime	Burn in Jul-Aug if conditions are right. Only burn when needed. eg. It has been too dry last 7 years (drought). Will burn this year after two good seasons. We burn to control the fuel load. It is particularly important to have cool burns in wattle country.
Biodiversity	Western area - wattle is thick and there is no ground cover. There is also some erosion in this area. Wildlife is in balance with no major problem with feral pigs. Dogs can cause problems they are managed by trapping.
Grazing management strategy	Have destocked 3 times in 20 years due to drought. Bought the property in 2002 drought and then had to destock 3 times for 2-3 months. At that time there was no infrastructure and no water. In good seasons buy or agist more animals.
Shortcoming of this management practice	In this sandy, low rainfall country we need to be flexible and manage according to the seasons.

	It is difficult to predict drought eg in 1990 there was a flood and drought in one year. There was no nutrition in the grass and there was shortage of supplement lick due to the large demand. Cattle starved and died.
Key infrastructure	Cattle yards built in 2017 are an excellent facility for animal welfare compliance. Covered cemented area with curved race and crush and 4 way draft off end. Allows cattle to be branded, castrated, pregnancy tested, vaccinated. Calves and cattle are in shade reducing the temperature by 15C; and protected from rain.

TRANSITION TO DROUGHT PREPAREDNESS

Why did you take part in the project?	Had plans to improve stock water efficiency. The project provides both technical and financial assistance to do this. Chance to visit other properties.
What do you need to see - to consider the project a success?	That increased access water improves pasture cover, reduces stress to animas in hot and drought conditions. Cattle rotation allows better utilisation of pasture.
What financial benefits do you expect from taking part in this project?	Allow us to better manage cattle and the land much sooner than would have been possible without the project. We will be better prepared for the next drought. The project allows better utilisation of land and introduces water that allows paddocks to be divided for better rotation and production.
Do you plan to continue to expand the project activities into the future?	Yes. Intend to continue to divide paddocks and provide water. We want to add 6 new paddocks for rotation.
What additional activities do you plan to implement in future	Install woa boys to prevent erosion along roads, fences and cattle pads; Restore a claypan by ripping and seeding; Pull invasive wattle and build contours with timber to slow water velocity - erosion
How long do you think it will take to improve the drought preparedness of all your property?	Continuous improvement and maintenance will be needed, especially with climate change presenting new challenges. Key activities will be to maintain regrowth and pasture, maintain infrastructure

REGENERATION IN ACTION

What are the main degraded areas on the property	Clay pans Wattle areas (tree thickening)

GLENSTAR

	Erosion – scaled areas and eroding gullies
What are your main pests/weeds and how do you control them	Heartleaf – poison; Parkinsoina – poison. Constant treatment is required. Horcia Cactus seems under control by poison. There is a lot on the Jericho common.
Do you have a farm plan and/or grazing charts	Yes, for management decisions on transfer to next paddock; sale of animals
Are you using technology to assist in your management, eg drones, satellite imagery and monitoring software or programs, water control?	Drone to photo grass check sites; looking for cattle in the scrub. Use of Maia grazing software to decide on the need to move cattle or sell.
Have you made any improvement in water retention and management?	Woa boys along roads and fences and cattle pads; Filled gullies with logs Developed spreader banks to distribute water
Change in workload	Since 2002 the workload has decreased - cattle are selected for temperament - smaller paddocks - cattle are easier to manage
In what way have the changes you have made met your expectations?	Grazing pressure is more even – better production. Better grasses are not outcompeted by less desirable grasses. Woa boys have slowed erosion.

The funds provided by the project prompted Glenstar's owners to implement long-delayed plans. They cited the cash incentive and technical advice as crucial to their decision to act. Their additional significant cash contribution demonstrate the owners' commitment to the project activities and its success, serving as a model for change in remote grazing systems

RESULTS OF GOOD SEASONS AND MANAGEMENT CHANGE

Since 2002 production has increased from 200 head to 600 head.

Since 2002 paddock number has increased from 5 to 22 and water points from 3 to 38.

New fodder species have been introduced (Left. Example. Wynn Cassia. Right. Buffel grass)

LANDSCAPE HYDRATION

Opportunities have been identified to control deepening erosion features, and to spread and slow floodwaters. Currently any floodwaters drain quickly down artificial drainage features such as cattle pads, fence lines, drains, roads and new erosion features that have developed over the last 150yrs. Goals of the demonstration:

1 Rehydrate the landscape in a controlled environment by addressing unnatural drainage features.

2 Create demonstration to display the agricultural and environmental potential of restoring landscape function.

3 Restoring what should be some of the most productive country, allowing for management change to take grazing pressure off the larger area.

4 Reduce flood damage.

5 Increase drought resilience through improved pasture cover and water function in the landscape.

6 Mitigate erosion features and in particular restore natural episodic wetland functions.

Overview of the site for landscape hydration demonstration on Glenstar.

The completed project showing earth dam, spreader channels and ripped bare areas.

Left. Example of current gully erosion and scalding in an area selected for a landscape rehydration demonstration. Right: Note exposed tree roots how soil has eroded in the scaled areas. At the back of the tree is ripped soil and further back, an earthen bank to slow water flow. This area was once very productive with palatable grass and grain species and has been favoured by cattle, a major causal factor in the erosion.

THE PLAN

The plan is to build some small earth blocks such as low-profile contour banks to slow and spread the damaging overland flow velocities across bare soil sites. These will also be placed across old, abandoned fences, roads and small erosion features in conjunction with ripping of bare soils. Spreader channels and banks will be used to tackle sheet and larger gully erosion by helping to keep water in the landscape for longer.

Pipes in some of the small earth blocks will be used where necessary to maintain overland flow, particularly where water may be held up behind earth banks being used to silt up/drown out erosion features.

Above: The strategy is to slow water flow at large area. Fast flowing water will be slowed spreader channels constructed strictly along th

Above Right. Scaled areas are ripped on the contour to slow water velocity and allow the water to infiltrate to allow the natural grasses to recover and halt the gully erosion.

GLENSTAR

LINKAGE TO SOIL CARBON AND BIODIVERSITY CREDITS

Glenstar, one of five properties involved in the Future Drought Fund project, has adopted various drought-resilient strategies that align with the Clean Energy Regulator's 2021 soil carbon method for estimating soil organic carbon sequestration. These strategies include:

Altering Grazing Practices:

Adjusting the stocking rate, duration, or intensity of grazing to promote better soil health and carbon sequestration.

Land Remediation:

Modifying landscape or landform features to remediate and improve the land, thus enhancing its ability to sequester carbon.

Pasture Re-establishment:

Re-establishing or rejuvenating pastures through seeding efforts, contributing to improved soil organic carbon levels.

Although these activities could fit well with the soil carbon and proposed nature repair market, the owners of Glenstar are not interested in registering for carbon farming or biodiversity projects. This reluctance is common among local landowners, who doubt the value and profitability of such investments. As a result, no one in the area has signed up for carbon or biodiversity projects.

BASELINE SAMPLING FOR SOIL HEALTH

The project only runs for two years but has embarked on a soils health monitoring program to provide a baseline to inform future management. Soils were collected to depth of 30cm at four representative sites.

Sample Site Details

Sample 1. Hill top – near water.

Heavy clay soil. 98% native plants. 50% ground cover.

Area of great natural diversity. No clearing in the past. Compare soil natural system with buffel areas.

Broad leaf ironbark and desert oak with very diverse understory of native shrubs, grasses and legumes. Desert mitchell is dominent. Some spinafex, kangaroo grass with some buffel. Wynn cassia in bare areas - near car tracks.

Sample 2. Mid hill – near water.

Medium soil. 95% buffel. 70% ground cover.

Area was cleared in the 90's. Sample collected 10m adjacent to proposed pipeline; just into buffel dominated area. Area is near to existing water and in drought times is heavily grazed.

Area being grazed at time of sampling.

Sample 3. Flat – away from water. Light soil. 99% buffel. 70% ground cover.

Area was cleared in the 90's. Sampled 10m adjacent to proposed pipeline.

Buffel: some young mimosa and young blackberry present. Area is far from existing water and in drought times is less heavily grazed.

Area being grazed at time of sampling.

Sample 4. Flat – away from water. Sandy soil. 80% buffel. 75% ground cover.

Sampled on recovering sandy ridge. Shrubs present - ironwood, black wattle, cyprus pine. Grass dominated by buffell with some herbs. This is a recovered area and in the past was white spear, wire grass and spinafex. In the past it was common to get dry bogged in the sand - not now as soil structure has improved.

UNDERSTANDING SOILS

Total Organic Carbon

One of the major problems in continuous grazing systems is the depletion of Total Organic Carbon (TOC) in soils, which in turn runs down nutrient levels, particularly nitrogen (N).

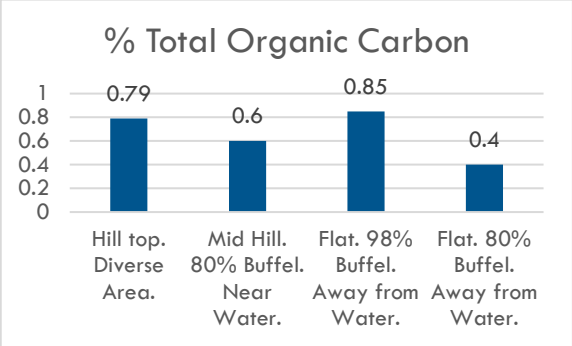
Understanding how much TOC is currently stored in the soils can be used as an indicator of soil health and will establish a basis for changed management practice. Carbon exists in two forms in soils – organic and inorganic. Organic carbon influences:

- soil fertility
- water relations
- aeration

On Glenstar, soil samples (30cm deep) were collected in a line from the top of a small hill with a diverse native plant community to a flat dominated by buffel grass. The samples set a baseline for change following a reduction in paddock size and increased water points across the project area.

Laboratory analysis was used to determine the % Total Organic Carbon (%TOC) the accepted measure of the organic carbon contained within soil (this measure excludes inorganic carbon = carbon from weathered parent material/rock).

In arid rangelands of Australia, the level of Total Organic Carbon (TOC) in the soil is generally low due to the harsh environmental conditions. The TOC levels are affected by factors such as low rainfall, high temperatures, and low nutrient availability, which limit the growth of vegetation and the accumulation of organic matter in the soil.



Typically, the TOC levels in arid rangelands of Australia are in the range of 0.1% to 2%, with some areas having even lower levels. The TOC levels can vary depending on the soil type, land use practices, and climate variability. Land management practices that improve vegetation cover, such as grazing management and fire management, can increase the TOC levels in the soil over time.

In comparison to the TOC levels found in the Arid Rangelands of Australia, Glenstar has relatively low Total Organic Carbon levels. This suggests there is good potential for uplift and for earning income from carbon credits.

The TOC levels at Glenstar range from a high of 0.85% in the Buffel monoculture area to a low of 0.4% in the recovering flat area away from water. These differences can be attributed to the high biomass (70% ground cover) of the Buffel monoculture area, which has low grazing pressure and is far from water sources. The mid hill area near with high grazing pressure has 0.6%.

The TOC levels in the diverse area at Glenstar were relatively high, as expected due to the highly diverse native plant community and 50% ground cover.

Overall, while Glenstar's TOC levels may be lower than those found in other areas of the Arid Rangelands of Australia, the improvements made to the property over the past 20 years have contributed to the recovery of soil health and the promotion of sustainable grazing practices.

Importance of soil microbiology

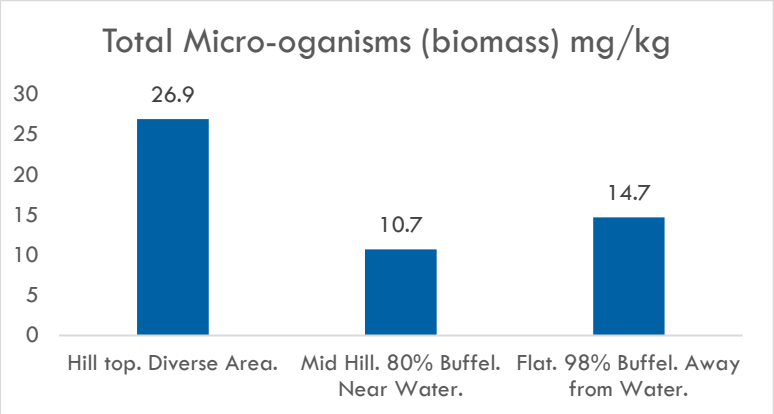
It is important to consider the soil biology since the health of the soil is directly correlated with profit and resilience of any agricultural enterprise.

Achieving balanced biology in the soil enhances the following key functions:

- Nutrient availability - optimal forms in the right place at the right time
- Root health, root depth, water retention, aerobic conditions in soil and improved soil structure - less watering needed, lessen your dependence on fertilizers.
- Decomposition of toxins - removes harmful residues
- Nutrient immobilization – reduces leaching.
- Disease protection - minimizes the need for pesticides.

Role of microbes in the soil:

- Mycorrhizal Colonization: Over 90% of all plants form symbiotic relationships with mycorrhizal fungi. Mycorrhizae increase the nutrient and water uptake capacity of the plant and protect it against pathogens. The laboratory determines what percentage of roots are colonized and look for signs of disease and other damage.
- Total Bacteria: the optimal bacterial biomass in the soil varies according to crop, climate and season.
- Total Fungi: the optimal range also varies according to crop, climate and season.
- Active Bacteria: are counted i.e. those currently metabolizing organic compounds and directly nourishing the plants.
- Active Fungi: are counted: only those fungi currently growing, and metabolizing are directly nourishing the plants.
- Protozoa are essential to healthy plant growth: they feed upon bacteria and excrete nitrogen in the plant available form of ammonium. One morphological group, the Ciliates are an important indicator of the aerobic conditions of the soil. They feed on anaerobic bacteria, so a high ciliate population may indicate anaerobic conditions which need to be addressed.
- Nematodes: some cause significant crop damage, some prey on other nematodes, and most graze on bacteria and fungi. Both the predators and bacterial & fungal feeders cycle nitrogen into a plant available form.



Soil samples were collected from different areas of Glenstar and analyzed for soil microbiology. The results showed significant variations in the total microorganisms present in each area. A graph representing the total microorganisms in mg/kg of soil revealed that the hilltop site had the highest level of microorganisms (26.9 per mg kg). This can be attributed to the diversity of the native

plant community and high ground cover in this area, which provides a conducive environment for microorganisms to thrive.

In contrast, the monoculture area near water, that has experienced overgrazing, had a lower total of microorganisms (10.7 per mg kg). Similarly, the undergrazed area away from water had a lower total of microorganisms (14.7 per mg kg). These variations in microorganisms can be attributed to differences in grazing pressure.

These findings provide a good baseline for monitoring soil health on Glenstar over time. Regular testing of soil microbiology can help property managers assess the effectiveness of their management practices in promoting soil health and fertility. It is crucial to maintain sustainable grazing practices and a diverse native plant community to promote healthy soil microbiology.

Importance of soil nitrogen and phosphorus

Nitrogen and phosphorus are essential nutrients for all living organisms. Phosphorus is bound to soil minerals, while nitrogen is converted by plants into protein. Plants use Nitrogen for leaf growth and good green colour, while Phosphorous helps form new roots, make seeds, fruit and flowers.

Legumes are able to form a symbiotic relationship with nitrogen-fixing soil bacteria called rhizobia. The result of this symbiosis is to form nodules on the plant root where the rhizobia convert atmospheric nitrogen into ammonia that can be used by the plant. Potassium is an essential nutrient for legumes. It is an activator for many enzymes, especially those involved in the synthesis of protein. Potassium also maintains water balance in the plant. In legumes, potassium is necessary for the proper development and functioning of root nodules.

Protein is a vital nutrient for maintenance, growth, health, reproduction and lactation in cattle. Nitrogen can be provided to cattle in the form of protein through grasses and legumes.

Phosphorus is a key component of bone health and cellular function. Cattle with the highest phosphorus requirements are growing stock, late-pregnant heifers and cows, and lactating cows.

The results of soil N and P analysis on Glenstar are depicted in the graphs with the blue showing the test result and the orange showing the expected result in similar soils. Full chemical analysis can be found in the Appendix.

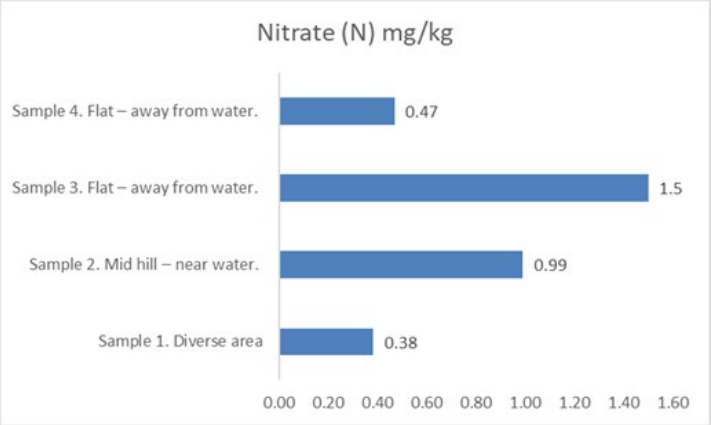
The average percentage of nitrate levels in arid rangelands can vary due to several factors such as soil type, vegetation cover, rainfall, grazing intensity, and management practices. Typically, nitrate levels in arid rangelands are lower than in areas with moderate to high rainfall due to the limited availability of water and the slower rate of nitrogen cycling in dry soils.

In general, nitrate levels in arid regions tend to be lower than those in more humid regions due to the limited availability of water for plants to take up nutrients. Studies have shown that the average nitrate level in Australian arid rangelands is around 1-2 mg/kg in the topsoil (0-10 cm) and slightly higher (around 3-4 mg/kg) in the subsoil (10-30 cm). It is important to note that the optimal nitrate level for plant growth varies

depending on the plant species. Some plants can tolerate low nitrogen levels, while others require higher concentrations for optimal growth.

Nitrate is a form of nitrogen that is readily available for plant uptake from soils. Nitrate (NO3-) is an important nutrient for plant growth and development, as it is a key component of amino acids and proteins. Nitrate is formed in soils through the process of nitrification, whereby microorganisms convert ammonium (NH4+) to nitrite (NO2-) and then to nitrate (NO3-).

Glenstar Nitrate results



On Glenstar Sample 3, the lowest grazed area with 70% ground cover away from water has a high nitrate concentration of 1.5mg/kg. This may be due to the presence of plant roots that absorb nitrate from the soil, as well as the absence of grazing animals that may consume the plants and remove the nitrogen from the system.

Sample 2, the area near water with 60% ground cover has a lower nitrate concentration of 0.99mg/kg. This may be due to the concentration of cattle and their urine deposition in this area, which can contribute to nitrogen loss through leaching or volatilization. Additionally, the lower ground cover may indicate a higher rate of erosion, which can remove soil and nutrients from the system.

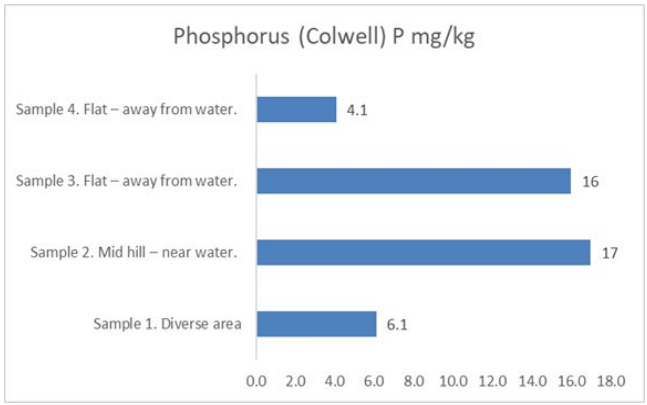
Sample 1, the natural ungrazed area has the lowest nitrate concentration at 0.38mg/kg, which may be due to the absence of plant roots to absorb the nitrogen and the lack of external inputs such as fertilizer or animal manure.

Finally, Sample 4, the recovering area with 70% ground cover has a nitrate concentration of 0.47mg/kg. This suggests that the recovery of plant cover in this area is still in progress and that the nitrate concentration is likely to increase as more plants establish and begin to absorb nitrogen from the soil. Overall, these results suggest that grazing intensity, ground cover, and proximity to water can all have significant impacts on soil nitrate levels.

Activities such as livestock grazing, and land-use change can also significantly impact soil nitrogen dynamics in arid rangelands. Therefore, it's crucial to consider the specific context and management practices of a particular rangeland system when assessing nitrate levels and their effects on plant growth and ecosystem functioning

Glenstar Phosphorus results

The average P levels in Australian arid rangelands using the Colwell test method can vary depending on the location, soil type, and vegetation cover. However, research studies have reported a wide range of P levels in Australian arid rangelands, typically ranging from less than 1 mg/kg to around 20 mg/kg.



Soil P levels in Glenstar were measured using the Colwell analysis method, which measures the concentration of available P in soil. The results showed that the areas dominated by buffel grass had the highest P levels. Sample 1 having 17 mg/kg and sample 2 having 16 mg/kg.

This is consistent with the idea that buffel grass has a high demand for P and can efficiently acquire and use it from soil.

In contrast, Sample 1, the natural diverse ecosystem had a lower P level of 6.1 mg/kg. This may be due to the absence of nutrient-demanding grasses in this area, which could limit the cycling of P in the ecosystem. Sample 4, the recovering area had the lowest P level of 4.1 mg/kg, indicating that the nutrient cycling processes are still in progress and that P availability may increase as the ecosystem recovers and becomes more diverse.

Overall, the results suggest that the distribution of P in Glenstar is influenced by the dominance of buffel grass and the diversity of the ecosystem. Understanding these patterns of P availability can be important for managing rangeland ecosystems and promoting the growth of desired plant species.

The reasons for low P levels include:

- P is often tightly bound to mineral particles or organic matter, making it less available for uptake by plants.
- low and unpredictable rainfall can limit the weathering of rock and mineral particles, which is an important source of phosphorus for many ecosystems.
- the removal of vegetation through grazing can further reduce the amount of phosphorus in the ecosystem, as plants are the primary source of phosphorus in many ecosystems.

Management practices that promote the conservation and accumulation of organic matter and the reduction of soil erosion can help to improve phosphorus availability and promote the health and productivity of pastures.

Pasture, Nutrition, Rotation Grazing, Supplements

When selecting improved pasture species, consideration should be given to the annual cycle of feed demand and supply as well as ensuring there is an appropriate mix of grasses and legumes. It is desirable to maintain at least 30% of the pasture composition as legume species, and 70% grasses.

When maintaining a productive pasture, it is necessary to consider the needs of the animal and the plant at the same time. Plants that have been grazed require a period of recovery before being grazed again.

- Rotation grazing is a key management strategy for maintaining a productive and sustainable pasture system. It helps to ensure adequate nutrition for the cattle, improve soil quality and fertility, and reduce the risk of diseases and parasites:
- The more uniform grazing ensures that all areas of the pasture are utilized and not overgrazed. This helps to prevent underutilization of some areas of the pasture, which can lead to weed infestations and decreased productivity.
- Soil quality and fertility is improved by allowing for adequate rest periods for the plants. The resting period allows the plants to develop stronger root systems, which in turn improves soil structure and water infiltration. This improves soil moisture retention and nutrient availability, which can lead to improved forage growth and quality.
- The risk of diseases and parasites in the cattle is reduced. Moving the cattle to different areas of the pasture breaks the life cycle of parasites and helps to prevent the build-up of pathogens in the soil.

Cattle grazing in the desert uplands are generally limited by protein during the dry season and phosphorus (P) during the wet season. Research has indicated that providing phosphorus in the wet season when cattle are growing and putting on weight gives the most benefit.

High-protein supplements can be provided during the dry season to help meet the protein needs of the cattle. Supplementing with phosphorus can help to improve weight gain and feed efficiency, increase reproductive performance, and reduce the risk of bone disorders such as rickets.

It is recommended to work with an expert to develop a balanced supplement program based on the specific needs of the herd and the local forage and soil conditions.

Water

Animals need water for biological functions such as excretion of waste in urine and faeces, transport of nutrients in the blood, milk production and the control of body temperature by sweating and panting. The body of an adult cow contains 70 per cent water. A 10 per cent loss of total body water can be life-threatening and on a hot day, loss of water in urine, faeces, respiration and sweat can amount to 15 per cent of liveweight. It is therefore necessary to provide an adequate supply of good quality water within walking distance, particularly during periods of high temperature and drought. Inadequate access to water can lead to dehydration, reduced feed intake, and decreased animal productivity.

BIODIVERSITY ASSESSMENT

Assessment Methodology and disclaimer: These assessments are solely based on available bioregional information without ground truthing at this time. These summaries are for general information and to inform the locations of future ground survey.

General Landscape descriptions for Glenstar

Desert Uplands Bioregion - Alice Tableland Sub-bioregion is dominated by sandstone ranges and deep red soils of intact Tertiary sand sheets and sandy alluvial fans derived from them. Alluvial clay soils are common along the major watercourses.

Desert Uplands Bioregion - Jericho Sub-bioregion is dominated by alluvial plains with clay and alluvial soils. The climate and vegetation show similarities with the adjoining Brigalow Belt Bioregion.

Glenstar Station

Local Government	Barcaldine Regional
Bioregion	Desert Uplands
Subregions	Jericho, Alice Tableland
Catchment	Cooper Creek

Glenstar Station is situated within the Jericho and Alice Tableland Sub-bioregions of the Desert Uplands Bioregion. The Alice River dissects the property from the Northeast boundary to the Southwest corner before draining to the Barcoo River and the Cooper Creek.

The property contains large, connected areas of intermittent wetlands and frontage to the Alice River that is of high biodiversity value to arboreal species along the riparian frontage including possums and koalas. Intermittent wetlands of these types can have high habitat values for nesting and seasonal nectar supplies. As for other riparian zones, this ecosystem has important values for stabilising stream banks and topsoils, providing corridors for wildlife including migratory waterbirds, and for trapping soil and maintaining water quality.

Species of note include: Black-throated finch, (*Poephila cincta cincta*); Gouldian finch, (*Erythrura gouldiae*); Australian painted snipe, (*Rostratula australis*); Painted honeyeater, (*Grantiella picta*); Glossy black cockatoo, (*Calyptorhynchus lathami*); Black-necked stork, (*Ephippiorhynchus asiaticus*); Grey falcon, (*Falco hypoleucos*); Square-tailed kite, (*Lophoictinia isura*); Cotton pygmy goose, (*Nettapus coromandelianus*); freckled duck, (*Stictonetta naevosa*); Two-toed fine-lined slider, (*Lerista wilkinsi*); Rufous bettong. (*Aepyprymnus rufescens*); Gould's wattle bat (*Chalinolobus gouldii*); Chocolate wattled bat, (*Chalinolobus morio*); Greenstripe frog, (*Cyclorana alboguttata*); Grassland collared frog. (*Cyclorana cultripes*).

The small portion of landscape in the northeast of the property includes the sandstone scarps and caves of the type found through the Alice Tableland Sub bioregion. The escarpments and cave habitats support species that are associated with bare stony ground, the mesic gorges or the caves and crevices in the sandstone rock. These provide significant roosting habitat for many bats species including significant species as well as roosts for owls in environments that may not otherwise have tall hollow-bearing trees.

Species of note include Little pied bat, (*Chalinolobus picatus*); Wood gecko, (*Diplodactylus vittatus*); Spectacled hare-wallaby, (*Lagorchestes conspicillatus*), White-eared honeyeater,
(*Lichenostomus leucotis*); Red-capped robin (*Petroica goodenovii*).

Most of the property is within the Jericho Sub-bioregion dominated by alluvial plains with clay and alluvial soils. These areas where largely intact support priority species including, Capricorn Ctenotus, (*Ctenotus capricorni*); Black-necked stork, (*Ephippiorhynchus asiaticus*); Squatter pigeon, (*Geophaps scripta scripta*); Pictorella

mannikin, (*Heteromunia pectoralis*); Lewin's rail, (*Lewinia pectoralis*); Square-tailed kite, (*Lophoictinia isura*).
Black-chinned honeyeater, (*Melithreptus gularis*); Black-throated finch, (*Poephila cincta cincta*); Australian painted snipe, (*Rostratula australis*); Rufous bettong, (*Aepyprymnus rufescens*); Brown tree-creeper, (*Climacteris picumnus*); Wood gecko, (*Diplodactylus vittatus*); Spectacled hare-wallaby, (*Lagorchestes conspicillatus*); White-eared honeyeater, (*Lichenostomus leucotis*); Red-capped robin, (*Petroica goodenovii*); Brown tree-creeper, (*Climacteris picumnus*); Desert mouse, (*Pseudomys deser*tor).

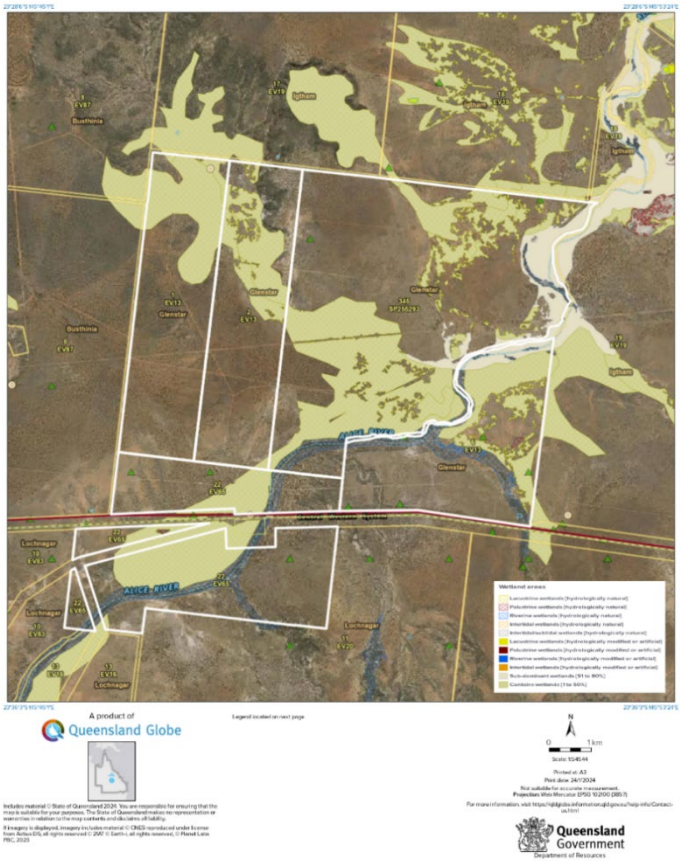








GLENSTAR

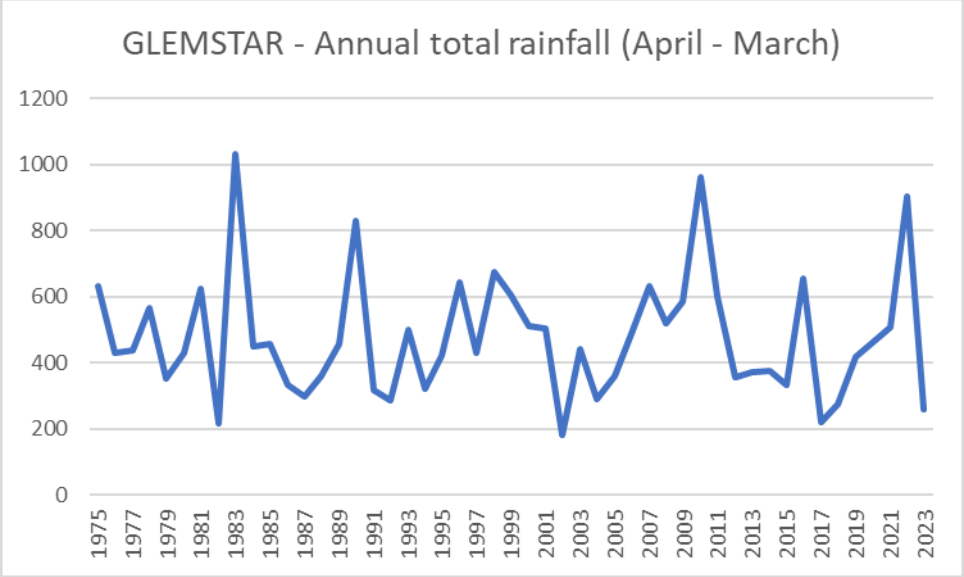


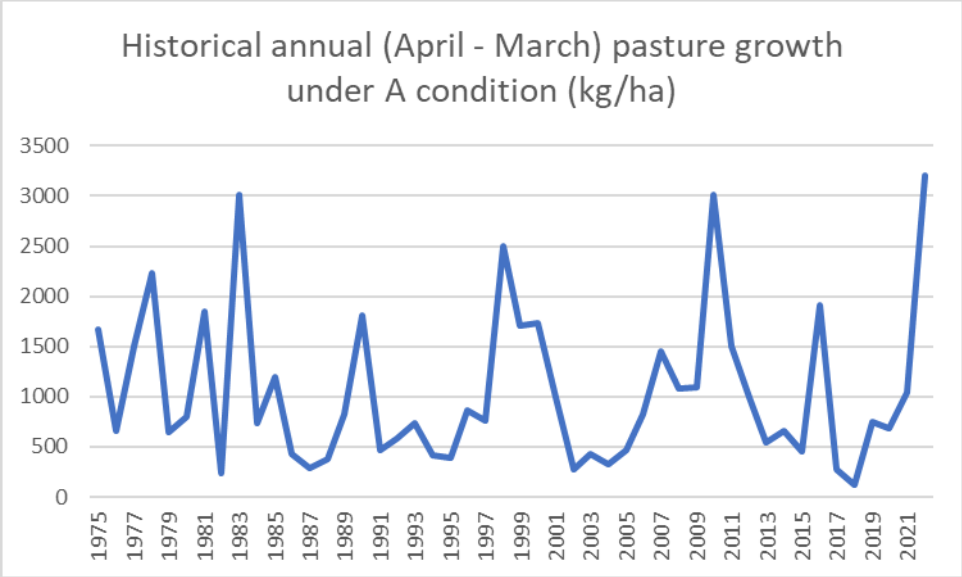
The Desert Uplands region boasts remarkable biodiversity, feature beautiful flowering plants and wildlife, including the sand goanna, kangaroos, and various bird species. Glenstar has intact areas that showcase the resilience and beauty of desert ecosystems.

Areas of the property have been modified however it still contains many areas of generally intact ecosystems. There is significant opportunity to recover the original wetlands and degraded waterways.

Refer to the map (left) that shows the property boundaries in white, water features in cream, and the Alice River in blue.

RAINFALL AND PASTURE GROWTH - GLENSTAR 1975 - 2023





The two graphs illustrate a clear correlation between rainfall and pasture growth. The crucial observation here is the upward trend in pasture growth over time since 1989. This indicates that despite the expansion of the herd size, the increase in pasture production is sustainable. This sustainability suggests effective management practices contributing to the resilience and productivity of the pasture system.

CONCLUSIONS

The continued implementation of cattle rotation has led to some recovery in erosion features, an improvement in soil quality and impressive 200% gain in production over 20 years.

A demonstration of landscape hydration on the property shows that the significant wetlands can be recovered at a cost of about $25 ha. In addition to the improved production, the historical wetlands and flood out zones also holds significant environmental value as major carbon sinks and biodiversity habitats.

The funds provides by the project inspired Glenstar's owners to implement delayed plans, with the cash incentive and technical advice being crucial. Their significant additional contributions show commitment and the suitability of this model for remote grazing systems.

In comparison to the Total Organic Carbon (TOC) levels found in the Arid Rangelands of Australia, Glenstar has relatively low levels. The owners of Glenstar are in the enviable position to use its agricultural assets to sequester carbon to offset whole of company emissions and participate in the evolving carbon credit and natural capital markets in Australia and internationally.