# *Impacts of rehabilitating degraded lands on soil health, pastures, runoff, erosion, nutrient and sediment movement. Part IV: The Kimberley rehabilitation programs and lessons for the Great Barrier Reef catchments*

## RRRD.024 Final Report for the Australian Government's Caring for Our Country Reef Rescue Water Quality Research and Development Program

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Queensland Government

CARING FOR OUR COUNTRY

Reef & Rainforest RESEARCH CENTRE

# *Impacts of rehabilitating degraded lands on soil health, pastures, runoff, erosion, nutrient and sediment movement*

**Rehabilitation of the Ord River and Fitzroy River catchments of the Kimberley, Western Australia, 2014: Lessons for the Great Barrier Reef catchments**

## Project RRRD.024 Final Report Part IV

**1962**

**2014**

**Trevor J. Hall**
**Department of Agriculture and Fisheries, Toowoomba**
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# Lessons from the Kimberley for regeneration of degraded grazing lands of reef catchments of Queensland

*The Ord River catchment of Western Australia was severely overgrazed over about four to six decades in western areas, initially by sheep grazing and later by uncontrolled cattle grazing. Grazing locations and stock numbers were not managed so the best landtypes near permanent waters in rivers were degraded to D-condition by extensive surface sheet erosion. This situation of uncontrolled grazing is not a practice followed in Queensland, however, a combination of heavy grazing and droughts can produce similar land condition results on a smaller scale. This type of erosion can be avoided by improved landholder knowledge in pasture management, resulting in better forward planning of stock numbers and grazing pressure, as part of drought planning strategies. Improved accuracy of climate forecasting will assist this management approach.*

*Initially the Ord River Regeneration Reserve (ORRR) regeneration developed very slowly, while total grazing pressure was not managed, resulting in continuing over-grazing of the native pasture and the new sown exotic pastures. Successful regeneration required complete removal of cattle, donkeys and camels, and restricting native fauna grazing by reducing the spread of water supplies. To obtain grazing control the WA Government eventually had to resume full control of the land. In Queensland, similar effective grazing control can be obtained on the smaller degraded areas while the land remains under private ownership. Financial support from the Government (both State and Federal) may be required in some circumstances and can be justified by the wider benefit to the whole community by regenerating degraded patches to improve water quality flowing into the Great Barrier Reef (GBR).*

*In the Ord River scheme, mechanical disturbance methods for establishing pastures were tested during the 1960s and selected for the soil types and slopes. The off-set twin disc machinery that was widely used in the ORRR was not successful in some environments of the Fitzroy catchment in a recent rehabilitation program. Much of the degraded Ord River catchment was flat to gently undulating which provided the opportunity for shallow banks and cultivation on the contour to contain most of the water, and allow infiltration in the seeding zone. The friable clay and clay loam oil types of the original grasslands of the Ord River were also more suited to pasture establishment and production than are some of the hard-setting red earth soils supporting spinifex at the Fitzroy sites. As the Ord river areas were extensive and bare, the contour marking out, and disturbance and seeding passes were relatively rapid and straight forward. The steep gully erosion areas were avoided and not treated, but eventually they stabilised after the surrounding country was revegetated. In the Queensland GBR catchments, most soils of the grazing lands or 'hillside' eroded areas are now considered treatable with current mechanical disturbance methods and existing exotic pasture species. Severe gully and streambank erosion requires a different management approach; however, with successful rehabilitation of bare areas across the grazing lands, these water courses may become more stable and lose less sediment into the Reef Lagoon. Grazing management education, followed by improved grazing practices, and mechanical disturbance treatments are both required to achieve higher ground cover levels and to maintain better condition pastures across the landscape. This will result in a reduction in sediments and nutrients leaving grazing country over the longer-term.*

*Professional input into the design and construction of any water holding systems, such as horseshoe ponds, is necessary to have the best opportunity of collecting maximum water and maintaining structures for many years. Poorly designed structures can fail and concentrate water which can create more serious erosion and even gullying. Using larger machinery, such as a G16 grader, has been most effective and economic in constructing water-ponding banks in the WA Fitzroy. Qualified surveying staff and large machinery are available in Queensland to conduct these designs and structures where necessary. Shallow ponding with some ripping or disturbance, without seeding exotic pastures, has produced varying degrees of herbage cover from early seral native species colonisers within one or two good summer seasons. Converting this initial cover into useful grazing pastures is the next challenge.*

*Native and feral animal grazing management was necessary, as the fresh pasture protected from cattle grazing is selectively grazed by marsupials, both kangaroos and wallabies, and their populations can quickly grow to plague proportions. This will destroy any pasture seedlings establishing in the regeneration area as is occurring close to the Fitzroy River in the West Kimberley. This problem of high marsupial populations will arise throughout Queensland and will require managing for successful rehabilitation of degraded areas. Kangaroos have proven a problem by grazing and killing new pasture plants in the Spyglass rehabilitation experiment.*

*Pasture species were evaluated for the Ord catchment soil types with the best adapted exotic tropical grasses Cenchrus ciliaris (buffel grass) and C. setiger (Birdwood grass) and the forb Aerva javanica (kapok bush) being selected. Experiments testing potential species, seeding rates and depths, combined with surface disturbance and shallow ponding banks were conducted to develop the methods most likely to be successful. In Queensland, the Reef Rehabilitation Project (RRRD.024) has evaluated some commercial mechanical disturbance methods and pasture species with potential to rehabilitate degraded D-condition landtypes in the two major reef catchments of the Burdekin and Fitzroy Rivers. There is an established seed industry capable of supplying adequate quantities of quality seed of the best adapted grasses and legumes. The pasture species suitable for rehabilitation of degraded soil types are also productive grazing pastures. Sowing and species recommendations are included in the Reef Rehabilitation Technical Report. Queensland does not have the restrictions on sowing proven exotic pasture species in grazing lands, as is a limitation in the WA rangelands.*

*A good rainfall summer season in the first year is a great assistance in achieving a successful base pasture to start the rehabilitation process. This first year pasture will then develop much faster if it receives a run of good seasons. In the Ord, regeneration was slow for the first two to three decades and then made rapid progress during the run of higher rainfall years in the 1990s, to produce the 'spectacular' recovery reported in 2002. By this time total grazing was controlled and there had been widespread establishment of plants to produce a seed supply, which allowed the good seasons to produce dense, well grown and seeding pastures across much of the regeneration area. Soil surfaces are now soft, not scalded, and have extensive cryptogam cover, indicating their good health. For rehabilitation of degraded areas in Queensland, these extended time periods and cycles of consecutive good seasons will need to be considered. Rehabilitating D-condition landscapes is not always successful and is not a short, several years, process and can take decades under less favourable circumstances.*

# Abstract

There were extensive areas of bare, eroded and scalded soils and clay pans, all D-condition land, on the properties of Ord, Turner, Fox Rivers and parts of Flora Valley, Elvire, and Ruby Stations in the Ord River catchment covering some 46,700 km$^2$. Some of these properties were eventually resumed and amalgamated by the Government as the Ord River Regeneration Reserve (ORRR). The aim was to reduce sedimentation of Lake Argyle on the Ord River, which was built for irrigation of down-stream flood plain areas from Kununurra. Government ownership allowed full control for new fencing, artificial water points and cattle management, so all grazing was prevented, with the removal of cattle, donkeys, and camels. On-ground mechanical disturbance and seeding with predominantly *Cenchrus* spp. and *Aerva javanica*, began in the early 1960s to revegetate these eroded plains. Artificial water sources were closed to reduce potential grazing influences, although there are water holes present in major rivers, most of the area has no grazing to the present. Marsupials are confined to a limited distance from natural water holes in creeks and rivers. The ORRR is now rehabilitated by *Cenchrus* species pastures, with *C. setiger* being a dominant grass, and it is managed by the WA Department of Parks and Wildlife. The original native pasture species have not become dominant at this time. Any feral animal grazing and cattle incursions from neighbours are managed and animals may be shot. The undulating to flat, D-condition country was successfully rehabilitated over some four decades by aggressive mechanical disturbance, sowing well adapted tropical exotic pasture grass and forb species, total grazing control, and a run of consecutive above average rainfall seasons. There are similar issues and many lessons from this rehabilitation program that are relevant for rehabilitating degraded landscapes in the grazing lands of reef catchments in Queensland.


# Introduction

The Kimberley Region of Western Australia is between 14-20$^0$S latitude, in the tropics, with a strongly summer dominant rainfall in an arid to semi-arid monsoonal climate. Poor grazing control of sheep in the West Kimberley from about 1883, and cattle in the East Kimberley from about 1884, caused extensive overgrazing of the more favourable pasture types with peak livestock numbers declining from around 1920 (Fitzgerald 1975). Severe degradation and erosion occurred throughout the Kimberley Region due to overgrazing by uncontrolled cattle at high stocking rates along rivers and water courses, as well as by increasing numbers of feral animals, particularly donkeys and camels. A mechanical intervention and reseeding program to rehabilitate this extensive D-condition land started in 1960, and a series of permanent photo marker sites were established in 1962. These sites have continued to the present in the ORRR which is now managed as a stock-free reserve by the WA Parks and Wildlife Department.

There were three main successful exotic species sown in the regeneration program that produced the ground cover and eventually the stable pasture required to rehabilitate the extensive degradation. These species were kapok bush (*Aerva javanica*) as the initial pioneer, with buffel grass cultivars (*Cenchrus ciliaris*) and Birdwood grass (*C. setiger*) eventually becoming dominant. In the early regeneration phase, the kapok bush provided cover with leaf and seed litter to collect dust and assist in the perennial grass establishment. As the regeneration period progressed, the kapok bush was replaced by the two exotic grasses and an increasing population of native grasses. Ribbon grass (*Chrysopogon fallax*) was a desirable and wide-spread native grass across the region before being destroyed by overgrazing. This

species is expected to eventually increase and could become dominant again; however, this has not occurred to date, after some 50 years.

The landtypes of the Kimberley and their original pasture species and land systems have been well described and reviewed by Payne and Schoknecht (2011). The Nelson, Gordon, Antrim and Elder land systems were extensively degraded and have been successfully rehabilitated by the processes used across the ORRR. A shrub weed, rubber bush or calotrope (*Calotropis procera*) was absent at the start of the regeneration program, but became wide-spread in the middle period and now occurs widely as scattered plants across large areas. This species has a short lifespan so the populations have varying ages and sized plants. The native *Eucalyptus* and *Corymbia* species, particularly the bloodwoods, and *Acacia* species (wattles), are still regenerating amongst the dense pasture.

Initial regeneration was very slow and not always successful while there was not good grazing control when the stations remained under private ownership, mainly by the Vestey Company. To gain full management control the WA Government resumed entire stations and parts of stations, and assumed their management in the 1980s. This allowed for new fencing to control and cull the cattle, and provided opportunities for clearing all animals. Some 55 000 cattle and thousands of donkeys and camels were culled over the next 20 years. The areas cleared of livestock could then be maintained grazing free. It was not until this period of total grazing control and a run of good seasons during the late 1990s that the regeneration became widely successful. By 2002 most of the ORRR was considered successfully regenerated, and in recent years the WA Parks and Wildlife Department has maintained the nil grazing policy, and has initiated some patch burning programs to reduce problems with wildfires.

In 1976 an assessment of the main Ord River Station regeneration areas, Ryan (1981) found that 'the majority of the erosion had been halted by the regeneration program and new vegetation cover had established over large parts of the area.' It was 'in good condition and that judicious stocking would do little harm.' However, the total grazing protection policy has continued to the present time. Ryan (1981) suggested three main causes of the original massive erosion. These factors were:

1. Palatable pastures were removed by heavy continuous grazing leaving the soil bare to erosive influences.
2. Erodible soils with small particle size and even soil profiles allowing wind and water erosion.
3. The slope was often greater than $1^0$ producing accelerated water flow from the unprotected soil.

The success of the regeneration program is summarised in a publication "Spectacular recovery in the Ord River Catchment" by Payne *et al*. 2004. The main conclusions are:

1. Fencing was required to control grazing;
2. Reduction of cattle grazing to near zero (over 30 years);
3. Removal of feral animal grazing (particularly donkeys); and
4. Cultivation of degraded country and sowing adapted perennial plant seed (kapok bush, buffel and Birdwood grasses being most successful). A decade of well above average rainfall produced the most extensive pasture improvement.

# Review of Ord River Regeneration Reserve and Fitzroy River catchment regeneration, 2014

A field inspection across the Ord River Regeneration Reserve and the recent rehabilitation works in the Fitzroy River catchment (WA) was conducted in September 2014. The locations of the ORRR South of Kununurra, and the Fitzroy River properties inspected, Go Go Station, Christmas Creek Station and Larrawa Station, where large-scale regeneration works have been conducted, are shown in Figure 1.


**Figure 1. Property map showing locations of the ORRR and three Stations visited with regeneration programs in the Fitzroy Catchment of the West Kimberley Region of WA.**

A review of the on-ground inspection of these D-condition land rehabilitation programs is reported below.

## Ord River Regeneration Reserve

The field inspection across the ORRR showed extensive areas of good perennial grass pastures, Birdwood and buffel grasses, and a large number of small areas either not regenerated, still D-condition patches, or only partially recovered. There are extensive areas with evidence of large moribund tussock grass plants with dying centres, indicating the lack of grazing and no recent fires. The soil surface in the well-established pastures is healthy and soft, with very extensive cryptogam cover.

The large areas of gravelly and stony hilly country supporting hummock pastures of spinifex (*Triodia* species) with Eucalypts, such as snappy gum (*E. brevifolia*), have little other plant cover between the spinifex in the late dry season. These soils were not the focus of the regeneration program. The mechanical disturbance concentrated mainly on the red earth type

soils. Examples of the type of bare, eroded plains and gullies, partial rehabilitation and early rehabilitation attempts using tyres to reduce water flow are shown in Figure 2.

**Figure 2. Ord River Regeneration Reserve – regeneration not complete everywhere-September 2014.**

***Site 1*** *(top left). Typical eroded bare red earth soils of ORRR prior to regeneration. This site in the ORRR is used as a private cattle station, is still grazed and remains bare and scalded.*
***Site 2*** *(top right). Partly regenerated site with buffel and Birdwood grasses and weed species of* Calotropis procera *(rubber bush) and* Ptilotus exaltatus *(pink mulla mulla or lambs tails).*
***Site 3*** *(bottom left). Typical breakaway gully erosion with partially regenerated patches of buffel and Birdwood grasses.*
***Site 4*** *(bottom right). Early attempt at regeneration of breakaway gully erosion with linked tyres and pasture seeding; method was unsuccessful in this environment.*

A successful method of rehabilitation was to cultivate between low banks built by a twin off-set disc plough, along the contour.

Figure 3 and
Figure 4 show early 1960s methods used in regeneration trials of the ORRR and established strips of kapok bush with buffel/birdwood grass plants. These landscapes were relatively flat. This twin off-set disc cultivation strip method has not proved successful in the recent Fitzroy River region rehabilitation trials where exotic species could not be sown. Larger ponded banks collecting and holding water have been selected as a better method. *(Photos of early regeneration sites were provided by the WA Department of Agriculture and Food).*

**Figure 3. L. Twin off-set disc seeder with contour level indicator; and R. Pattern of surface disturbance and seeding 1963.**

**Figure 4. L. Ripping between twin off-set disc banks; and R. Early strip establishment of kapok bush-mid-1960s.**

## Successful pasture regeneration across the ORRR

Rehabilitation of sites on different landtypes within several land systems (e.g. Nelson) was monitored from the start of the mechanical rehabilitation phase in the early 1960s. Some of these sites were re-photographed in September 2014 to evaluate the long-term regeneration of the ORRR. The following Figures 4-12 represent the regeneration of various landtypes across the ORRR mainly in the Kelly paddocks and Turner Plains regions.

**Figure 5. ORRR monitoring site H01: L. Prior to rehabilitation disturbance in 1963; and R. Rehabilitated pastures in Sept. 2014.**

**Figure 6. ORRR monitoring site H04: L. 5-chain transect site in Kelly paddock in Sept. 1963; R. Rehabilitated pasture with dead Acacia farnesiana in Sept. 2014.**

**Figure 7. ORRR monitoring site H05 (West of Duncan Road): L. Kelly paddock in Sept. 1963; and R. Grazed pasture in Sept. 2014.**

**Figure 8. ORRR monitoring site ORD H07: L. Rehabilitated pasture in August 2002; and R. Good condition pasture in Sept. 2014.**

## Permanent monitoring sites photograph sequence *(Site ORD H08)*

There has been regular monitoring of the ORRR with fixed photograph sites located across different landtypes of the regeneration areas. The following sequence of photographs is from Site H8 in Kelly paddock on Ord River Station, showing the extent of the eroded plains in 1962 through the early regeneration of forbs, including kapok bush, and small scattered grass plants in 1963, with scattered kapok bushes and perennial grasses of buffel grass and Birdwood grass in 1977, to extensive perennial grass by 2002, which have retained perennial grasses to the present (Sept. 2014), but more forbs have established, probably due to recent drier years or fires. Sites that were once white with kapok bush dominance even up to 1977 now have grass dominance. The monitoring shows there was a long lag period from the initial treatments in

1962 to grass dominance, to 40 years at some sites. The first 15-20 years, when grazing was not totally eliminated had limited perennial grass cover. The dense grass pasture has developed over the last 20-odd years.

The following series of five photographs (
Figure 9;
Figure 10;
Figure 11) show the pasture regeneration rate and process at fixed monitoring site ORD H08 in Kelly Paddock of the ORRR, from bare condition in 1962 to a mature pasture 2014.


**Figure 9. ORRR Site Ord H08 (Kelly Paddock): Landscape prior to rehabilitation in Sept. 1962; and R. Site in 1963.**

**Figure 10. ORRR site Ord H08: L. Regeneration in July 1974; and R. Dense pasture rehabilitation August 2002.**

**Figure 11. ORRR Site Ord H08: Mature pasture rehabilitated in Sept. 2014.**

Rubber bush was not present at the monitoring sites in the first 20 years, but is now well scattered across the ORRR, but not usually in dense populations. The relatively short lifecycle of this species ensures a periodic turnover of mature plants.

The flat Turner plain in the Nelson lands system was an extensive area of eroded red earth soil in D-condition in the early 1960s and has been successfully revegetated to a *Cenchrus* dominant pasture with scattered rubber bushes and Eucalypts (
Figure 12).

**Figure 12. ORRR Turner Plain site Ord H12: L. Bare eroded surface in 1962; and R. Regenerated *Cenchrus* pasture with scattered woody species in Sept. 2014.**

Pasture monitoring sites were established across the ORRR as the new pastures developed. A photographic example from Site Ord 122 between 1989 and 2014 is reported in
Figure 13.

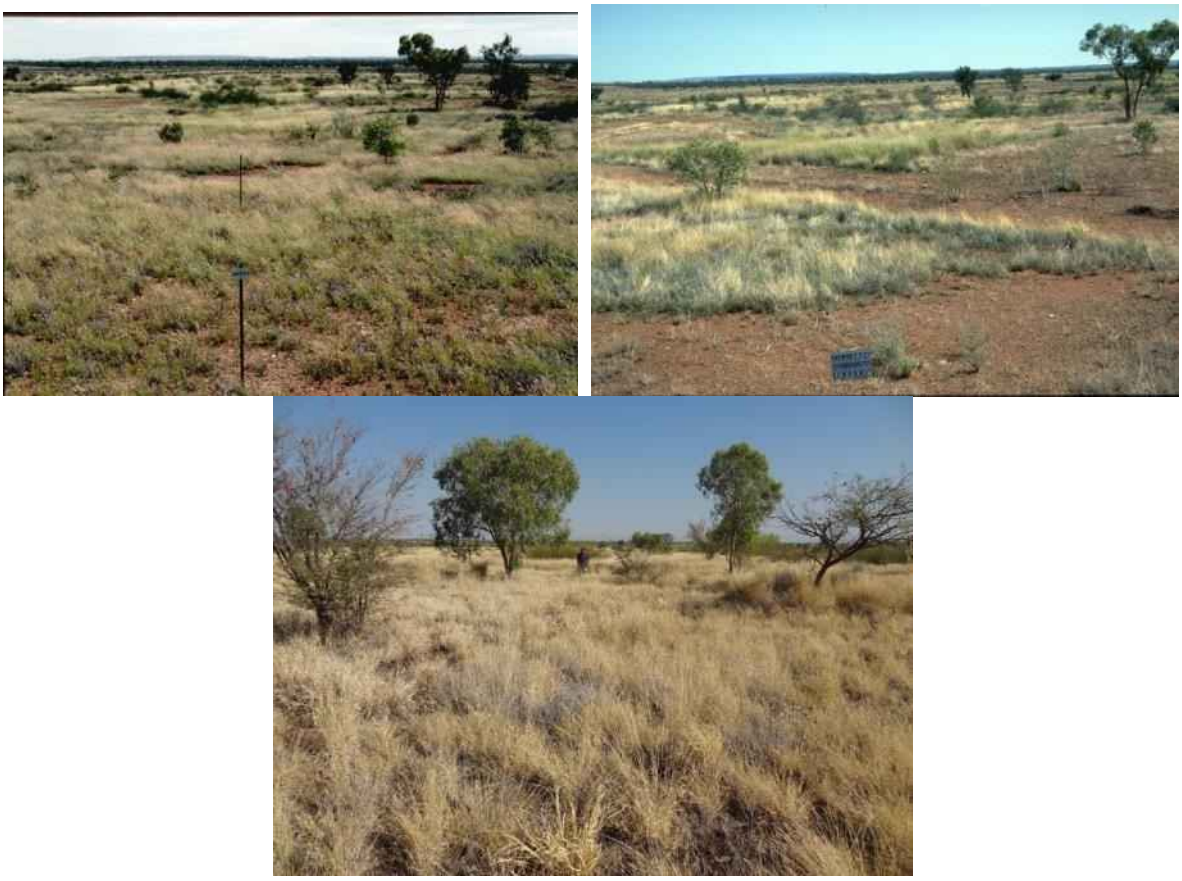

**Figure 13. ORRR Pasture monitoring site Ord 122: top left: Partially rehabilitated site in 1989; top right: Patchy pasture in 1992; and bottom left rehabilitated pasture across site in Sept. 2014.**

## Regenerated pastures in 2014

The original vast, degraded, bare D-condition plains of the 1960s are now covered with dense perennial grass, predominantly *Cenchrus* species, interspersed with native grasses such as ribbon grass and *Enneapogon* species. Heavier soil areas have increasing patches of Gulf bluegrass (*Dichanthium fecundum*) and silky browntop (*Eulalia aurea*), that are useful native grasses. These two grasses dominate the cracking clay plains of the Balbirini land system of the southern Gulf in Queensland, and are ideal grazing pastures.

While there is no grazing permitted on the ORRR, the accumulated fuel load available for fires can be a problem late in the dry season. Controlling wild fires with the limited road and track access system presents an annual problem. There are few fences remaining and only limited permanent water so managing cattle grazing in the foreseeable future, a suggestion by local producers, is not a current option. One area, adjacent to the nil grazed ORRR, was inspected where cattle grazing still occur. These paddocks have retained large areas of D-condition scalds and extensive areas of low-cover native pasture patches (
Figure 14).

**Figure 14. L. Eroded bare D-condition patches in grazed paddocks; and R. Heavily grazed pastures. Both images are adjacent to the ORRR regenerated plains (sites ORD H05 and H04 respectively).**

As the area of irrigation from Lake Argyle expands, there is an option of increasing the height of the dam wall to hold a greater volume of water. This would reduce the impact of future sediment accumulation in the Lake from the ORRR and surrounding grazed lands.

## *Fitzroy River catchment regeneration, West Kimberley*

Shallow-water ponding systems have been evaluated in clay pan regeneration projects conducted on four properties in the Fitzroy River catchment of the West Kimberley, with the assistance of the WA Agriculture Department and the local NRM group and MLA PDS funding. Professional surveyor input (R. Thompson, NSW Government) was used for the design and surveying of the shallow ponds. Project details and initial results from one property (Larrawa Station) are presented in a MLA Final Report on project B.NBO.0616.A by Fletcher (2013). An inspection of three properties involved in the project show a good initial establishment of early colonisers, such as native weeds (*Portulaca, Sclerolaena, Boerhavia, Ptilotus* species) and annual grasses (*Brachyachne convergens, Dactyloctenium radulans* and *Cynodon* species). Unfortunately, producers were not allowed to sow the proven regeneration exotic species for the Ord region, i.e. buffel grasses and Birdwood grass with kapok bush, on leasehold land in the Kimberley rangelands (WA Government restrictions). They have to rely on the invasion by native pasture and weed species from surrounding areas. This does not guarantee a successful rehabilitation and any progress towards a useful grazing pasture will take and extended period. Commercial seed of any potential native grass grazing species is not economically available.

Payne *et al.* (1979) reported that some 30% of the West Kimberley area surveyed, which included the Fitzroy catchment, was in a degraded to poor or very poor condition and that moderate to severe erosion was widespread. These authors said drastic remedial action was required to facilitate rehabilitation. The worst areas of degradation and erosion were the most valuable pasture lands, the best soils that were readily accessible, close to permanent waters and supported attractive pastures. Continuous, unrestricted, preferential over-grazing since the early days of settlement was responsible for their degraded state. To prevent further degradation, some areas were recommended to be removed totally from grazing and others to have a 50% reduction in cattle numbers.

Three properties in the Fitzroy River catchment, Go Go, Christmas Creek and Larrawa Stations, were inspected where on-ground works aimed at pasture regeneration had been undertaken as a Catchment Project in recent years. A brief summary is presented below. The Stations are located between Fitzroy Crossing and Halls Creek in the West Kimberley region surveyed by Payne *et al.* (1979). Shallow ponding on a fourth station, Bulka, was not inspected.

***'Go Go' Station***, at Fitzroy Crossing on the Fitzroy River in the Kimberley Region of WA participated in the regeneration project on ponding for rehabilitation of degraded river frontages. Aerial photos of the pond banks at establishment and with water during the first summer are shown in
Figure 15.

**Figure 15. 'Go Go' Station rehabilitation pond banks: Top L. At bank establishment; Top R. First filling with water in the first wet season; and Bottom L. and R. Ponds with water during the first wet season (Photos: Rick Ford).**

The ponds and pasture at the end of the 2014 dry season show the litter and grass tussocks remaining from pastures that established during the last three summers (
Figure 16). There was negligible *Sclerolaena* on the loamy soils at this site.

**Figure 16. 'Go Go' Station regeneration ponding banks with pasture remaining at the end of the dry season Sept. 2014 (four images).**

***'Christmas Creek' Station,*** Fitzroy River Catchment WA also participated in the shallow ponding regeneration project on scalded red soils surrounded by spinifex.
Figure 17 shows images across the ponded site and pastures at the end of the dry season in 2014. Strips of grass, including *Eragrostis* species, and forbs such as *Sclerolaena* and *Salsola* species, established both along the banks and in cultivated strips between the banks. Undisturbed areas between the banks remain largely bare. There are still bare eroded areas surrounding the regeneration trial site. The paddock is grazed by cattle.

**Figure 17. 'Christmas Creek' regeneration area: Top and Centre L and R. Pond banks with established pasture in water collection zones; Bottom L. Pasture in cultivated strips between banks; and Bottom R. Surrounding areas remaining bare, in Sept. 2014.**

***'Larrawa' Station*** in the upper Fitzroy catchment to the east of the other two properties in the West Kimberley has conducted ponded regeneration trials since 2009 when four circular ponds were constructed. The Station also participated in the Catchment regeneration PDS project. Larrawa Station has tested various soil disturbance implements including a twin off-set disc plough with seed box and a heavy crocodile plough (
Figure 18) and two sized graders, Cat G12 and G16, for regeneration work. The banks from the off-set disc plough were too small to hold sufficient water over several years to encourage plant establishment and the crocodile plough pits were too small to be effective on these hard soils in this environment. Well designed and well-constructed 70 cm ponded banks built by a large grader were the most successful regeneration method (Fletcher 2013).

**Figure 18. Regeneration machinery: L. Twin off-set disc cultivator with seeding roller; and R. Crocodile cultivator, both were evaluated in 'Larrawa' trials (neither was effective on their own).**

Indicators of historical surface soil loss from water and wind erosion on well grazed creek frontage areas of the West Kimberley are shown in
Figure 19.

**Figure 19. Indicators of historical erosion at two locations near creeks in the West Kimberley: L. Elevated dying *Acacia* bush; and R. Exposed tree roots.**

The design layout of the pond banks and early establishment of pasture in the flooded ponds is shown in
Figure 20.

**Figure 20. 'Larrawa' contour regeneration pond banks: L. At establishment before any rain; and R. Early plant establishment along banks and in the inter-bank disturbed strips (Photos: Larrawa).**

Examples of the continuing lack of pasture surrounding the ponds and pastures inside the flooding zone of ponds at several sites on 'Larrawa' in September 2014 are shown in Figure 21. There was negligible plant establishment in the disturbed strips on a flat surface from the twin off-set disc plough, due to the low height of banks which didn't collect and hold sufficient water for plant establishment.

Exotic pasture seed could not be sown on this lease. However, there are buffel and Birdwood grass plants well scattered along the highways through the region providing a potential source of seed for more favourable environments in the longer-term.

**Figure 21. 'Larrawa' Station regeneration projects at various locations: Top L. and R. Monitoring sites inside and outside treated area; Pastures in the pond banks (four images), at the end of the dry season in Sept. 2014.**

Not all methods or sites were successful in growing early seral weed species after the rehabilitation works. The banks from the twin off-set discs did not hold sufficient water for a long enough period to establish any worthwhile cover at one site and ripping strips in an alternating pattern only provided some temporary vegetation cover
Figure 22.

**Figure 22. Negligible vegetation cover from two disturbance methods: L. Low banks from off-set discs; and R. Cultivated strips on an alternating pattern.**

The design, layout and construction of the ponding banks across the clay pans require professional design and specific construction consideration. The design areas, bank length, bank height and a construction method have been developed for the Fitzroy region. For example the larger machine, a Cat G16 grader, has been shown to be the most cost effective machine to build 70 cm high banks with two passes on the upside of the bank and one pass on the lower side. The grader blade angle and depth are set so the soil slides along the blade maintaining the topsoil at the top and the passes on both side of the bank must ensure it does not leave a furrow on the top which could allow water accumulation and cause the bank to collapse (
Figure 23).

**Figure 23. Bank design and construction by professional survey staff and a large grader (Cat G16) is recommended (Photos: Larrawa and Ray Thompson).**

***'Bulka' Station.*** A fourth property involved in shallow ponding regeneration project in the Fitzroy catchment was 'Bulka' Station. This site was not inspected; however, the bank layout and good establishment of native plants in the first high rainfall summer can be seen in Figure 24.

**Figure 24. Plants growing in 'Bulka' Station water ponds in the first wet season (Photo: Felicity Brown).**

## *Native / feral animals*

Marsupials, especially wallabies, are a serious problem for regeneration of eroded and scalded country along major rivers, such as the Fitzroy in the West Kimberley. They are very effective at grazing grass seedlings, causing the death of young plants. Wallabies and kangaroos can also cause furrows across pond banks by their pads from the river to pastures within and beyond ponded bank regeneration areas (
Figure 25). Cattle grazing can be controlled easily by fencing, but wallaby control is more difficult, very expensive and often not practical. High wallaby populations have potential to degrade the pond banks and contribute to their failure to retain water, and the consequent failure of the pasture regeneration program. A failure to establish pastures in the ponds has potential to cause further land degradation and a total loss of the original regeneration investment. The early problem of overgrazing on regeneration areas in the Kimberley by donkeys and camels has been solved by their total removal by mustering and shooting

programs. This is not feasible with native animals. Without a means of controlling marsupial grazing, the regeneration of degraded Fitzroy River frontages, on 'Go Go' Station for example, by any means, including by ponding banks, is not likely to be successful in producing a permanent perennial palatable grass pasture. No proven wallaby control measures were suggested.

Below are examples of marsupial pads across ponds and pond bank damage caused by marsupial grazing in and around the regeneration trial area on 'Go Go' Station (
Figure 25).

**Figure 25. Wallabies are damaging pond banks near the Fitzroy River: L. Wallaby pads over banks across ponds; and R. Degradation of a pond bank ('Go Go' Station) in Sept. 2014.**

## *Exotic species for regeneration*

The prevention, by the environmental Departments of WA, of planting exotic pasture grasses with a proven regeneration record in the Ord River catchment, such as Buffel and Birdwood grasses, in these new regeneration programs is not conducive to rapid successful regeneration on a cattle grazing property. After their success in rehabilitating the Ord River Regeneration Reserve it is difficult for landholders in the Fitzroy catchment to understand why the Rangeland Board has chosen to prevent the use of these proven exotic grasses in their scald rehabilitation work. They are much more suitable species for regeneration and subsequent cattle grazing than any local native pasture species, with no commercial seed supply. The buffel grasses and Birdwood grass already occur within the Fitzroy Catchment. There is no seed of any adapted native grass available in quantity and at an economic cost to sow as alternatives in this environment. The current restriction on use of exotic pasture species for rehabilitation of degraded D-condition lands puts these landholders at a huge disadvantage to the Governments own earlier rehabilitation program in the Ord River Catchment.

Ribbon grass (*Chrysopogon fallax*) is a major desirable native pasture grazing grass for the Kimberley Region, and also in the dry tropics of Queensland, but there is not a supply of cheap seed for regeneration to replace the adapted exotic grasses, which cannot be sown. Even the spreading, native black speargrass (*Heteropogon contortus*) seed is not available economically or in significant quantity. Therefore ponding for regeneration without sowing any aggressive, well adapted pasture species will require an extended time period to produce recovery, if

successful, which is not guaranteed, while relying on local native plants invading. Even with species of *Portulaca* (pig weeds), *Sclerolaena* (e.g. soft roly poly burrs), *Eragrostis (love grasses), Eriachne* (wire grass), *Aristida (kerosene, feather top and wire grasses)* and *Xerochloa laniflora (*rice grass) establishing in the first season from the recent soil disturbance, there is no assurance that desirable native grasses will invade eventually. The Ord River regeneration areas have not yet reverted to the original native pasture composition after some 50 years from rehabilitation works for the early sites. A series of above average rainfall seasons will also be required during the regeneration period to assist palatable plant establishment and seeding. The continued control and management of all grazing will be required for many years, perhaps decades, when regeneration relies on invading local native species. These scalded clay pan areas will have no or negligible soil seed reserves and any seed must be blown, carried or washed in from surrounding areas.

This situation of Government Departments preventing the sowing of proven adapted exotic pasture species for regeneration of grazing lands is not a problem in the Queensland rangelands at present. One casualty is Gamba grass (*Andropogon gayanus*) which is the most suited exotic grass for northern Cape York Peninsula and it has been banned due to fire problems in the northern NT. Sown exotic grass species including buffel grasses, Sabi grass (*Urochloa mosambicensis*), Rhodes grass (*Chloris gayana*), Indian bluegrass (*Bothriochloa pertusa*) and creeping bluegrass (*B. insculpta*), and tropical legumes including the stylos (Seca, Amiga, Verano, Caatinga – *Stylosanthes* spp.), butterfly pea (*Clitoria ternatea*) and desmanthus (*Desmanthus* spp.) are suited to assist in rehabilitation of grazing lands in Queensland.

The shallow ponding system used on the relatively flat eroded Fitzroy River region in the West Kimberley is best suited to extensive flat sites where soils are not highly sodic. The horse-shoe pond bank design method using graders to build the structures has been used successfully for revegetating scalds on flat plains in south-west Queensland. In many eroded and scalded locations in the Burdekin and Fitzroy reef catchments of Queensland, the sites are on more undulating slopes that are not usually suited to this ponding method of regeneration. Also, some sub-soils are highly sodic and can inhibit grass establishment. However, the principles of surface disturbance, water holding and increased infiltration, pasture species seed supply, total grazing control, good summer seasons and time (over years), that support successful ponding regeneration in the Kimberley, are equally valid for rehabilitation of eroded bare areas in the reef catchments of Queensland.

# Conclusions

There are many similarities and also differences between the rehabilitation sites, landscapes and methods used in the Kimberley of WA and across the reef catchments of Queensland. There are similar soils and climates, however, in WA the extent of D-condition land was much greater and the long-term WA Government involvement in on-site rangeland management is not an issue in reef catchment areas of Queensland. The important rehabilitation lessons from WA are equally valid to degraded patches that occur throughout the Burdekin and Fitzroy River reef catchments of Queensland. Lessons from three broad areas directly apply to reef catchments:

1. Manage total grazing over the long-term,

2. Research to select strongly adapted pasture plants, and
3. Develop reliable establishment techniques.

Some broader Kimberley issues relevant to protecting the reef from nutrient and sediment runoff include: total grazing pressure (domestic livestock, native and feral grazers) must be eliminated or managed for an extended period of many years; aggressive mechanical disturbance that retains water on the surface for maximum infiltration is required; well adapted pasture plant species must be selected; quality seed is necessary to provide rapid establishment, cover and a potential grazing pasture in a shorter time period; allowing the sown plants to produce seed in the first few years is required for surface cover development during the initial growing seasons; and successful rehabilitation requires a dedicated and long-term labour and funding commitment, as successful rehabilitation can take many years, even decades.

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