

Catchment to coast planning: summary of key environmental management issues and activities undertaken by land managers in the Gilbert River catchment, Queensland, Australia

Report prepared for the Northern Gulf Resource Management Group

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CONTENTS

1.	Acknowledgements.....	1
2.	Background.....	2
3.	Data management	2
4.	Collected information	2
5.	Information about surveyed stations.....	3
6.	Weeds	8
6.1.	Weed management plan	8
6.2.	Weed management goals.....	8
6.3.	Occurrence and extent of weeds	9
6.4.	Production and environmental impacts of weeds	9
6.5.	Observed changes in the abundance of weeds	11
6.6.	Current management of weeds	12
6.7.	Weed management outcomes.....	13
7.	Pests.....	15
7.1.	Pest management plan.....	15
7.2.	Pest management goals.....	15
7.3.	Occurrence and extent of pests	16
7.4.	Production and environmental impacts of pests	16
7.5.	Observed changes in the abundance of pests	19
7.6.	Current management of pests	20
7.7.	Pest management outcomes	21
8.	Fire	23
8.1.	Fire management plan.....	23
8.2.	Fire management goals	23
8.3.	Occurrence and extent of fires	24
8.4.	Production and environmental impacts of wildfires.....	24
8.5.	Observed changes in the occurrence of wildfires and use of prescribed fires	25
8.6.	Current fire management activities	26
8.7.	Fire management outcomes	27
9.	Erosion.....	28
9.1.	Erosion management plan.....	28
9.2.	Erosion management goals.....	28
9.3.	Occurrence and extent of erosion.....	29
9.4.	Production and environmental impacts of erosion	29
9.5.	Observed changes in the occurrence of erosion processes	30
9.6.	Current erosion management activities	31
9.7.	Erosion management outcomes	33

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Very special thanks to all of survey respondents for participating in the study.

2. Background

The study is a joint research project between James Cook University and the Northern Gulf Resource Management Group (NGRMG). The goal is to understand key environmental management problems (i.e. weeds, pests, erosion, altered fire regimes) and how land managers deal with these problems, as well as how grazing practices contribute to land condition. We collected information about their property and production system, the costs of managing the property, the expenditure in terms of individual management activities, and their opinion on how important these land management problems are. The study will provide information relevant to develop a management plan for the Gilbert River catchment that reflects landholders' perspectives and knowledge.

Designing effective natural resource management (NRM) plans require good understanding of the environmental and production problems affecting the region (e.g. loss of natural vegetation, species declines, poor land condition, decreased productivity, reduced water availability and quality), and the management activities required to prevent or mitigate these problems. Effective management requires allocating limited resources efficiently to address the most pressing problems (e.g. feral animals, weeds, erosion, overgrazing) affecting valuable areas. Inefficient allocation of management resources can thus compromise the land values and the long-term sustainability of production systems in the region.

Efficient allocation of management resources requires understanding the distribution, magnitude, and impacts of environmental problems, as well as the activities required (and being undertaken) to prevent or mitigate these problems. Likewise, it is important to estimate the costs of individual management activities (e.g. fire, weed and pest control) needed to mitigate the production and environmental problems within budgetary constraints. Collecting local knowledge on the environmental problems and ongoing management activities is critical to understand the problems and vision of land managers, as well as to estimate management costs, which is necessary to develop feasible NRM plans.

3. Data management

All the information collected during the interview will be managed following NGRMG data management standards and confidentiality agreements. None of the data collected will be disclosed to third parties and all information will be aggregated and summarized, thus information on individual properties will not be reported.

4. Collected information

We collected general information about each property, including: ownership, tenure, expertise/knowledge and business structure, as well as primary activities, land use (past, current, future) and grazing system (type, cattle type, livestock numbers/production). This information will help us characterize the production system and conditions under which different threats occur, and some will be used as predictor variables (drivers) for modelling management costs.

We also collected information regarding property-level management costs. In some contexts, it will be difficult to accurately attribute all financial costs to individual management activities or management units (e.g. paddocks) as there are likely to be some centralised (system-level) costs associated with managing the property as a whole and jointly incurred across more than one management activity or unit. For this we collected information on expenditure in management infrastructure and equipment, including capital and any other one-off spending ('non-recurrent costs') and annual operating budget ('recurrent costs').

Finally, we collected data on individual management activities happening in each property and tried to identify the areas where these are applied (and/or needed) and quantify as far as practicable the costs of implementing them. A critical part of this section was also to: identify the main management problems in the region (i.e. invasive species, erosion and modified fire regimes); document the perceived occurrence and impact/importance from a production and environmental point of view; whether these threats are being managed and how; and to what extent the stated management objectives have been achieved with current expenditure (see [Table 1](#) for standards).

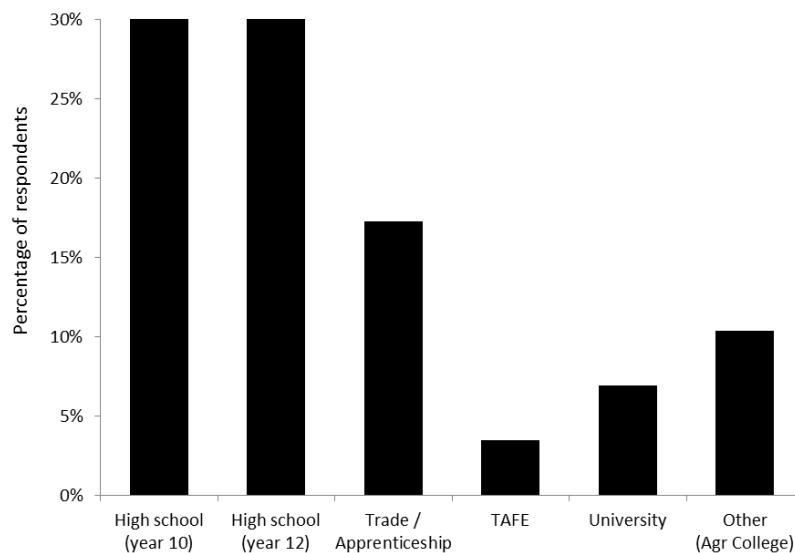
Table 1. Definitions of outcomes for weed, pest, fire and erosion management

STANDARD	DEFINITION
Poor	Management objectives are not being met: problems continue to expand and land values are under risk/compromised
Fair	Management objectives are partially met: impacts are mitigated and land values are prevented from deteriorating further
Good	Management achieves desired outcomes: problems are under control or eliminated and land values are secured

5. Information about surveyed stations

We surveyed 28 cattle stations covering ~17,840 km², mostly within the Gilbert River catchment (14,550 km²: 82%), with smaller portions within the Norman (1,218 km²: 7%), Staaten (1,976 km² – 10.5%) and Mitchell (96 km²: 0.5%) catchments. This roughly represents 31.5% of the total area of the Gilbert catchment (46,288 km²). We interviewed 48 managers, with about 85% of interviewees being owners or co-owners of the grazing enterprise, in all cases a family business (e.g. company, trust). The type of education varied across managers, but was dominated by high school (year 10 and 12, 30% each), followed by trade/apprenticeship ([Figure 1](#)).

Figure 1. Education types of interviewed land managers



In average, managers reported having managed the property for over 20 years, but ranged between 2 and 35 years ([Figure 2](#)). In most cases, managers are second or third generation and properties have been under the family management for 55 years in average (but up to 150 years) and 44 years under current management ([Figure 3](#)). Land tenure of most properties (70%) was rural/grazing lease, which in most cases included most of the property area (average: 95%). Other types of tenure included Perpetual lease (e.g. GHPL) and freehold land; about 7% of the properties reported having 'Nature Refuges' within their property ([Figure 4](#)).

Figure 2. Number of years that respondents have managed their land

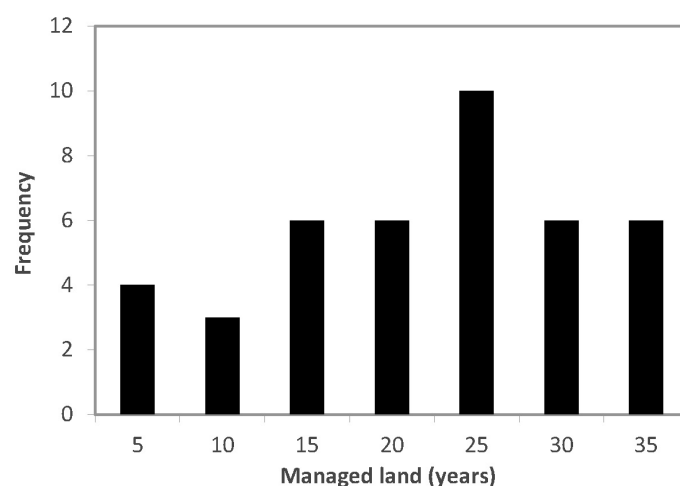


Figure 3. Average number of years that properties have been under current and family ownership

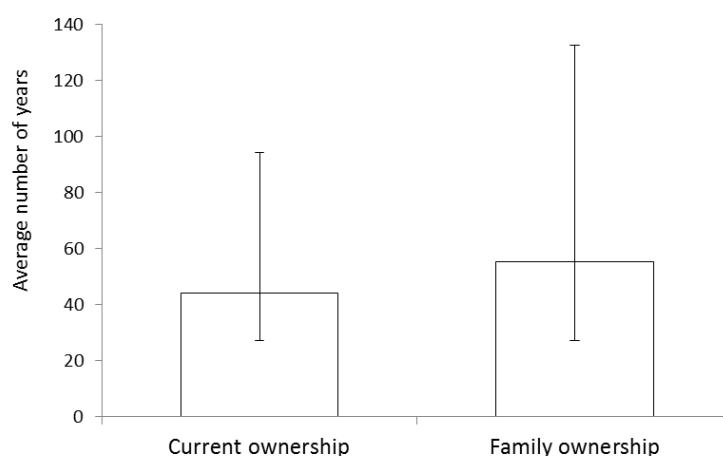
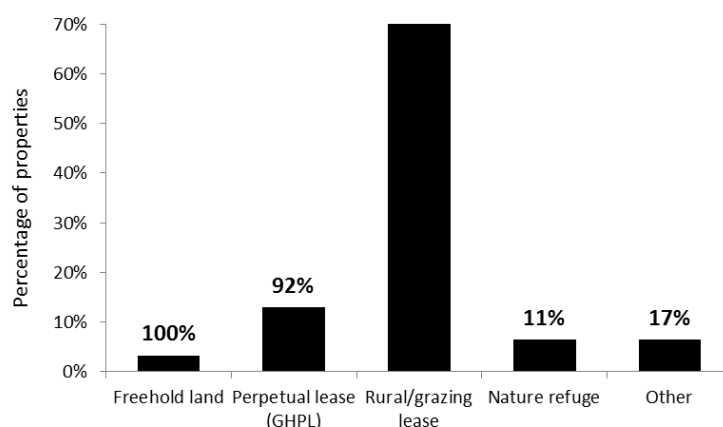
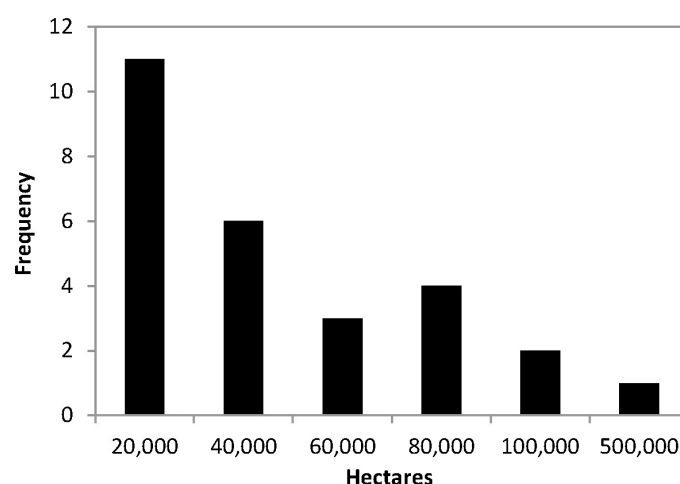


Figure 4. Types of land tenure of surveyed properties



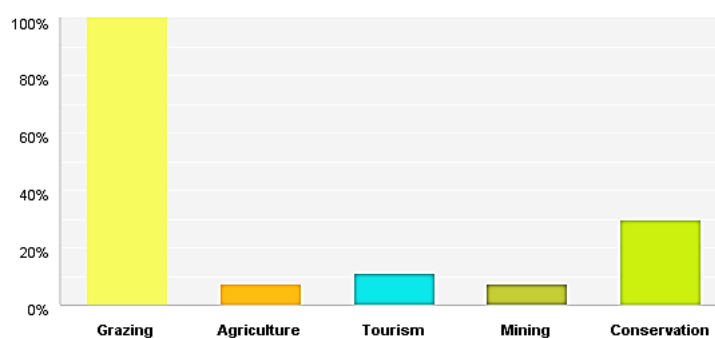
We surveyed properties of varying sizes, ranging between 6,000 and 475,000 hectares ([Figure 5](#)). Almost 80% of properties were predominantly under rural/grazing lease, but we also surveyed properties under perpetual leases (15%) and freehold land (one property). The number of people working in each property varied between 1 and 10 (mean: 5). Properties have an average of 3 part-time workers, 2 of which are seasonal employees. In average, full-timers work 64 hours per week (median: 70), while part-timers work 36 hours (median: 40) and seasonal workers 44 hours (median: 50); seasonal employees work 6 weeks per year on average, but up to 36 (median: 4).

Figure 5. Distribution of property size across participating stations



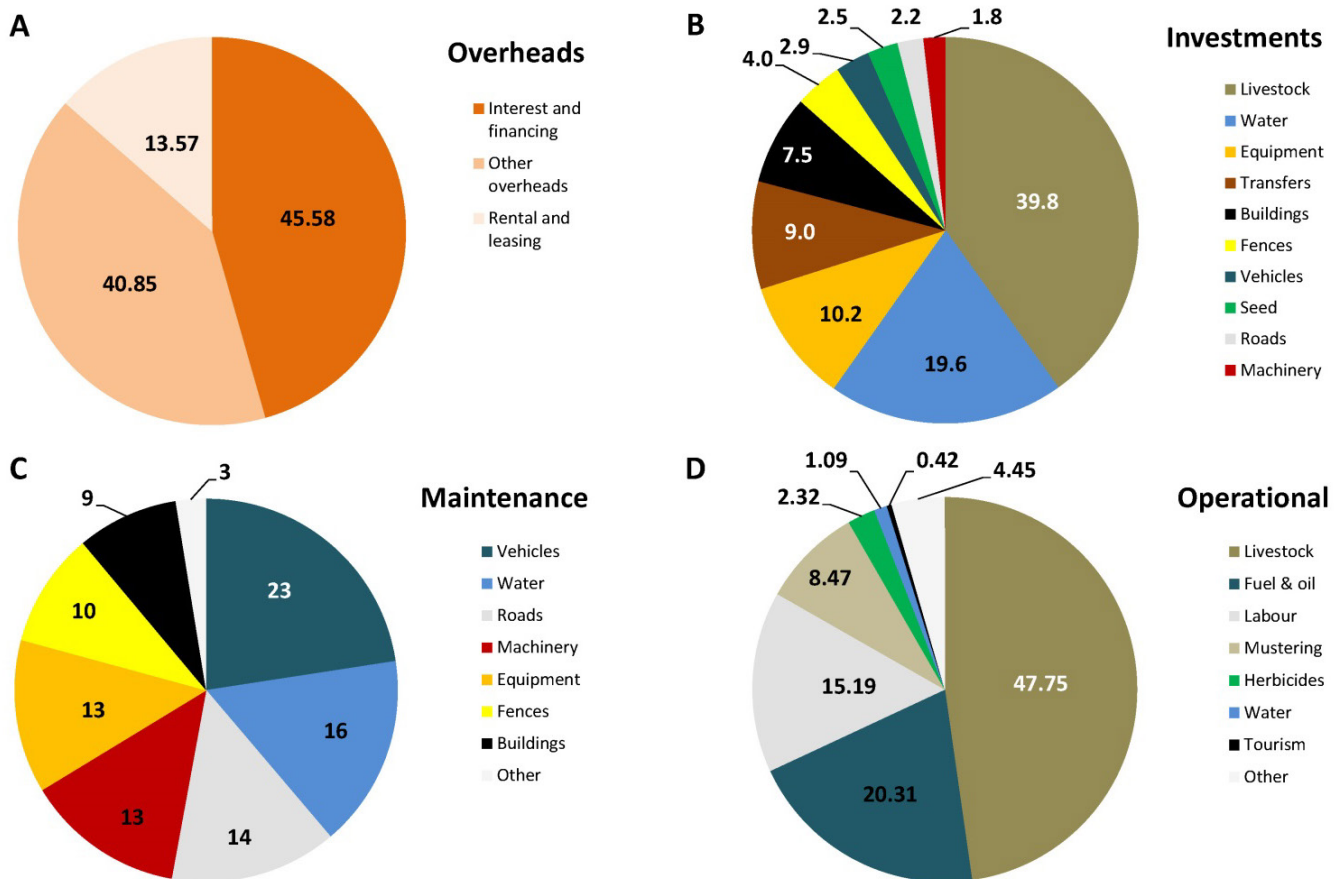
The primary activity across all properties was grazing, but some also reported agriculture (mainly hay associated with cattle), tourism, conservation (e.g. nature refuge, un-grazed areas) and mining ([Figure 6](#)). In average, 86% of the income is derived from cattle (median: 98.5%), but labour is a significant source of income for ~20% of the properties (mean: 21%, but ranging from 1 to 50%). Other sources of income included mining, tourism and grants, but were significantly smaller (~1%).

Figure 6. Percentage of properties participating in different land use/activities



Land management expenditure was dominated by operational costs (e.g. livestock costs, mustering, labour, fuel and oil) and overheads (e.g. interest and financing expenses, rental and leasing of machinery, equipment, vehicles, buildings and land, and taxes, rates and services), corresponding on average 39% and 32% of total expenditure, respectively. Longer-term investments and capital expenditures (e.g. livestock purchases and transfers, seed, construction of buildings, roads, fences and water infrastructure, purchase of machinery, vehicles and equipment) accounted for ~17% of total expenditure, and about 12% was dedicated to maintenance and repair expenses (e.g. vehicle, water infrastructure, roads). Distribution of costs within each type of expenditure varied across properties, but in average the most prominent expenses were, for (A) overheads: interest and financing expenses (e.g. loan or mortgage repayments); (B) investments: livestock purchases, followed by construction of water infrastructure and purchase of equipment; (C) repairs and maintenance: vehicles, water infrastructure, roads and machinery; and (D) operational: livestock costs, fuel and oil, and labour ([Figure 7](#)).

Figure 7. Average distribution of land management expenditure across properties



Managers consistently reported that very small portion of their property has been cleared of native vegetation, mainly for house, cattle squares and airstrips (mean: 70 hectares) and no recent changes over the past 5 years; thinning was mentioned by 10% of managers. Most managers indicated they would like to be able to clear additional small portions (mean: 300 has), mainly for hay production, silage and/or improved pasture (within land types with good soil, e.g. frontage) and planting of *Leucaena sp* (related to grazing) was also mentioned.

Active Mining Leases
Airstrip
Hay Production
Hectares Dedicated
Improved Pasture
Land
Management Thinning

As an important element describing the context of land management, we asked managers to indicate if there been any significant events (e.g. flood, wildfire, cyclone, live cattle bans, disease, pests) affecting their land (e.g. making it less productive or less 'healthy' than it would normally be) in recent years. All respondents mentioned a few factors, including natural (e.g. fires, droughts) and economic (e.g. market, prices, live cattle ban).

Affected
Failed Wet Season
Fences
Followed Income
Land
Live Export Ban
Market
Move Cattle
Paddock
Property
Reduced Prices
Took

Regarding the natural values on their land, 70% of land managers indicated a diversity of areas or sites on their land where they consider they have different natural values. For example, areas where they can find wildlife (particularly birds), waterbird migratory stopovers, springs, or unique vegetation types. Some of these areas are already designated as Nature Refuges and/or fenced-off (or have the intention to do so). Over 85% of managers also identified different areas within their property that they regard for their recreational value (e.g. gorges, streams, billabongs) and are visited by their family/friends and/or tourists for fishing, bush walking, etc. In many cases, these were closely associated with water (e.g. river, waterfalls, billabongs).

About 60% of respondents consider there are some areas with agriculture (e.g. good for improved pasture) potential within their property. Only a small proportion (15%) indicated there could be potential for carbon farming (e.g. abatement of carbon emissions by modifying fire regimes, store carbon in vegetation and soil through best fire and land management practices) on their property, but the grand majority (70%) did not know enough to make an informed opinion.

Alluvial Flats Country House Improved Pasture
Paddocks Sandy Loam Soil Water

Finally, we asked them if there are any areas on their land with potential for mining. About 45% responded positively, 25% negatively, and 30% indicated they are not aware of any mining potential within their property. Of those responding positively and unsure, the most commonly mentioned activity was exploration, but some also indicated active mining.

Active Mining Aware Exploration Leases
Findings Map Ongoing Exploration
Specific Areas Uranium

Following we summarise the main results regarding the four key management issues (i.e. weeds, pests, fire and erosion) in the Gilbert River catchment. This information will be refined and validated through further consultations with graziers during feedback sessions planned to be undertaken during August 2014. Based on revised data, further analysis and interpretation will be provided, which will also serve as a basis for the modelling of management costs and for the prioritisation exercise.

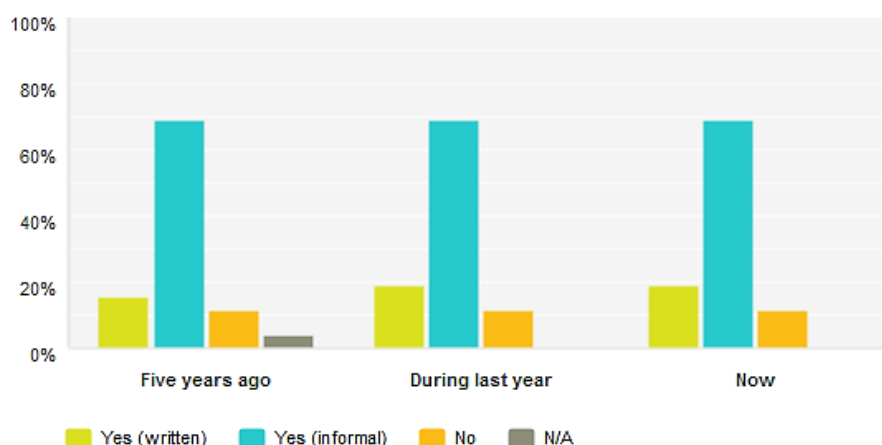
6. Weeds

We collected information for weeds of management priority in the region, identified based on their status as Weeds of National Significance (WoNS) or according to Queensland's pest classes. The list of potential weeds was compared with available spatial data and reports of weeds of concern in the region (e.g. Northern Gulf NRM Plan). The list was presented to land managers, but they were asked to supplement the list if there were other weeds of management concern. The full list of weeds considered in this study is presented in [Appendix 1](#).

6.1. Weed management plan

The first question we asked to managers was whether they have and use a 'weed management plan' to prevent and/or control weed problems on their property. Most managers indicated having an 'informal plan', which in some cases was part of a larger management plan for the property. Only ~10% of the properties reported having a 'written management plan' ([Figure 8](#)); one of the managers, who recently developed a written management plan, reported not knowing whether they had or not a plan five years ago. Managers reporting not following a management plan indicated money and time as main concerns, and also reported weed management actions.

Figure 8. Properties using weeds management plans



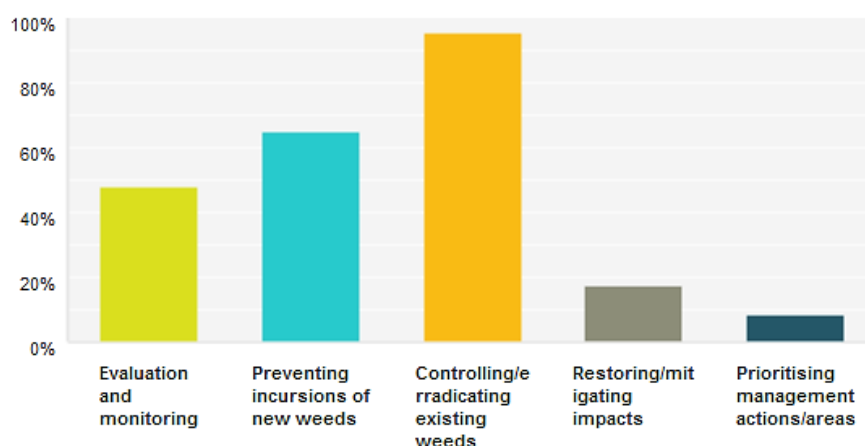
Land managers also shown some level of agreement on the broad management goals for weeds, including paying particular attention to some weeds (e.g. Rubber vine, Calotrope, Thorn apple) and focusing management on some paddocks, maintaining good ground/grass cover as part of their management strategies (see word cloud below).

Apple Calotrope Cover Identifying Monitoring Treatment
Management Paddocks Plan
Rubber Vine Weeds

6.2. Weed management goals

Most land managers (95%) indicated that their 'weed management plan' (informal or written) considered controlling and/or eradicating weeds, but a majority (65%) also considered the prevention of incursions of new weeds as a management priority ([Figure 9](#)). Evaluating and monitoring the occurrence and impacts of weeds (mainly as part of routine land management activities) was also common across stations and few considered restoration/mitigation of weed impacts (e.g. pasture regeneration). Only one property reported prioritising management actions/areas.

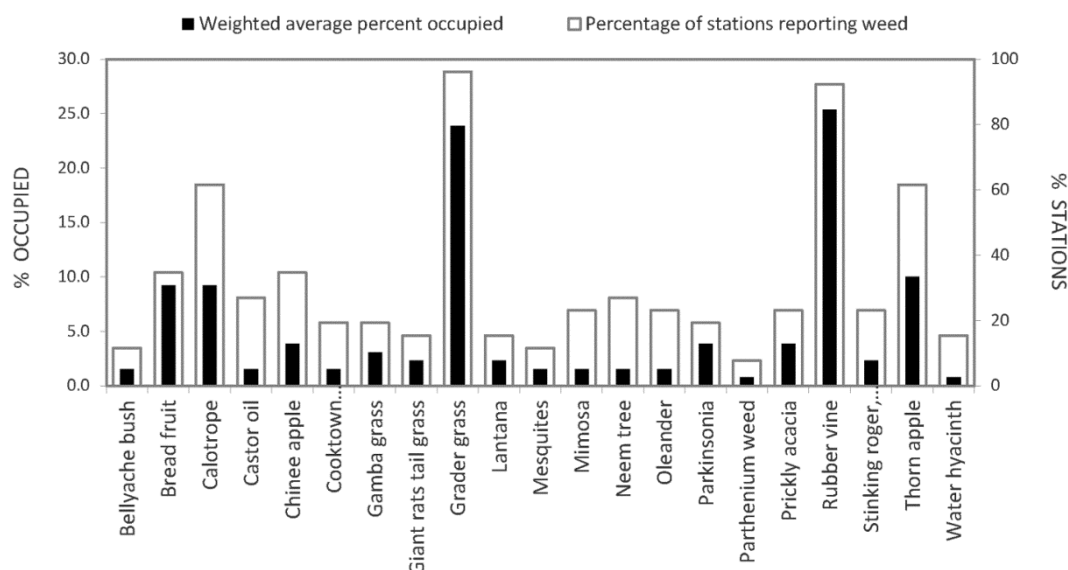
Figure 9. Weed management goals reported by managers



6.3. Occurrence and extent of weeds

We also asked managers to indicate if the weeds from the list were present on their property and, if they were, to estimate the affected area (percent of property), independent of density/infestation level. The two most prominent weeds identified by land managers as occurring on their property were grader grass and rubber vine (Figure 10). Both rank high both in terms of the number of properties the reported their presence within their property and the percentage of the land where it has been observed. Following is a weighted average, indicative of the number of stations reporting the weed and the proportion of land affected per property.

Figure 10. Occurrence and extent of weeds reported by managers



6.4. Production and environmental impacts of weeds

For those weeds occurring on their property, we also asked managers how they are affecting their production system (grazing) and/or the environment (e.g. wildlife, natural vegetation, wetlands, soil, water). For those weeds present in most properties, thus with enough information to identify patterns, we generated 'word clouds' indicative of the views of land managers regarding weed impacts. Following are a few examples for the most prominent weeds.

For **grader grass** there was a general perception that although cattle can eat it (when young), it has low nutritional value, takes over good country, has the potential to spread (hence it is difficult to control), and is a problem for other grasses (native and introduced) and soil, hence is a concern for both production and the environment.

Cattle Eat Country Difficult to Control
Grasses Grazing Low Nutritional Value Nutritious
Problem Soil Spread **Takes over Native**

Likewise, many land managers agreed that **rubber vine** is a major concern and costly from a production and environmental point of view, it is difficult to control, negative for grasses, creates access problems, thus making land management harder (particularly around riparian areas), and it affects good country and stream systems.

Costs Country Difficult **Grass** Habitat Harder
Land Management Not a Major Concern
Not Allow Potential Riparian **River**

Thorn apple was also mentioned by many managers as a concern in terms of access and because it seems to occupy better (fertile) country, although it seemed to be mainly restricted to areas highly used by cattle.

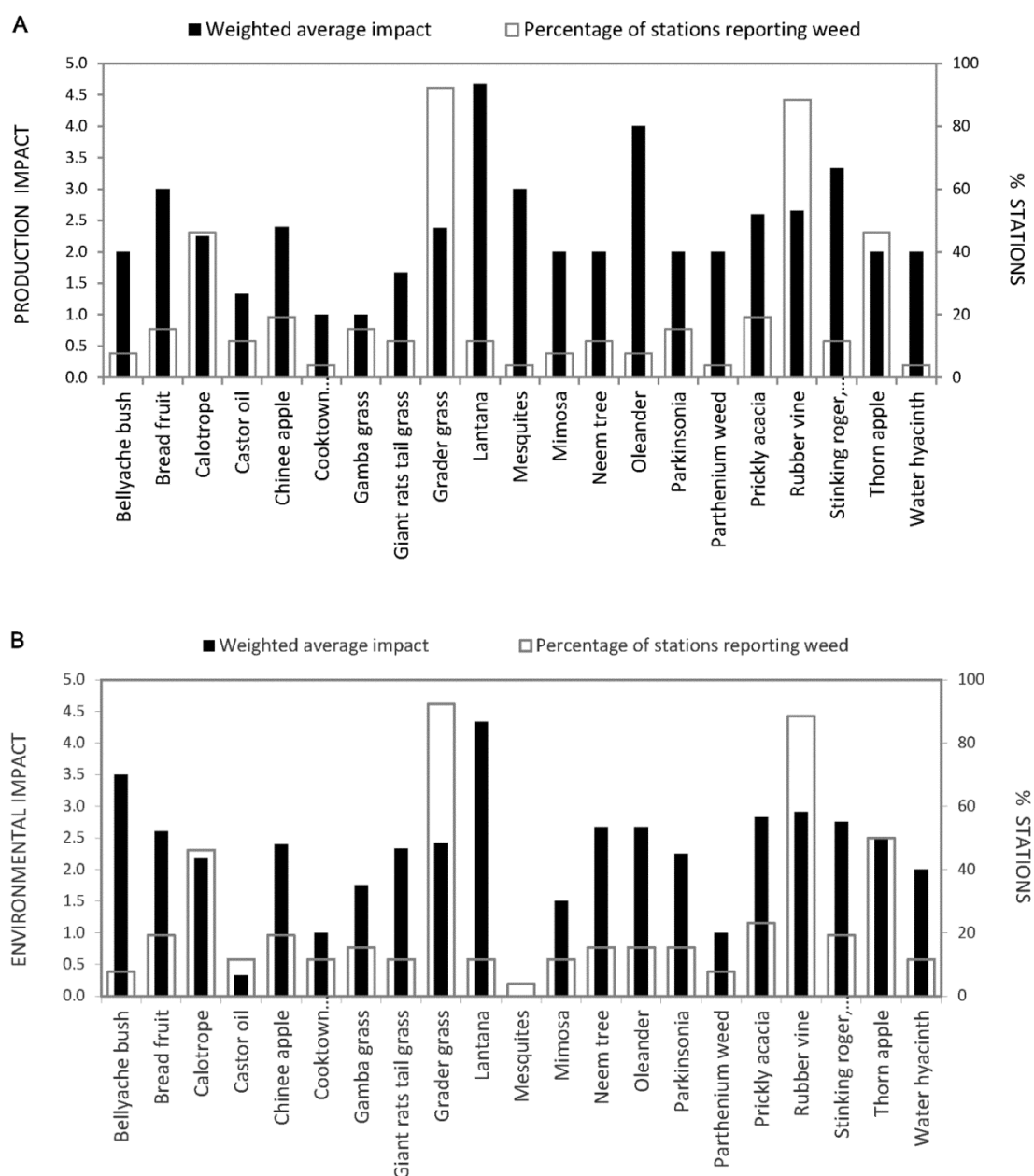
Access Problems Better Country **Cattle**
Concern Fertile

Other weeds with sufficient information to identify some consistent (but less common) statements included:

Prickly acacia	Calotrope
Costs Country	Cattle Country Problem Spreading
Bread fruit	Chinee apple
Reduces Grass Cover	Big Grows

Having collected their thoughts on the impacts of weeds, we asked managers to rate how problematic weeds are for their production system and the environment, using a five-point scale, from negligible (0) to extreme (5). Very few respondents identified a weed as extremely problematic, either for production or the environment ([Figure 11](#)). In some cases, mainly for low/moderate impacts, managers indicated that their rating considered management efforts, i.e. impacts would be higher if weeds were not controlled. This was particularly the case for grader grass and rubber vine, the most commonly found and managed weeds. Following is a graphic summary of the ratings given by land managers for (A) production and (B) environmental impacts. There is some level of agreement between the ratings for production and environmental impacts, but the correlation for the weighted average values between both is moderate (Pearson correlation coefficient: 0.528).

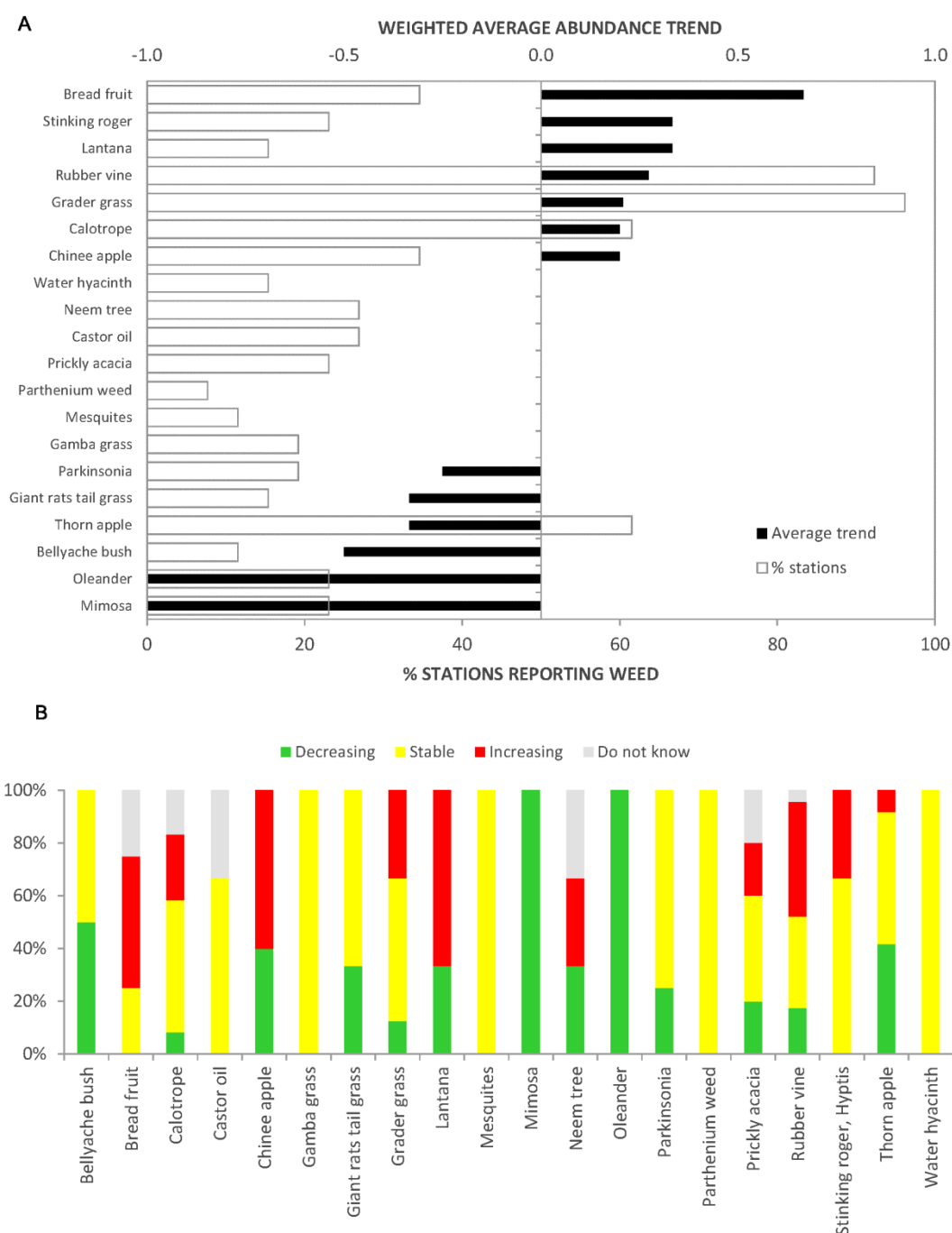
Figure 11. Rating of production and environmental impact of weeds



6.5. Observed changes in the abundance of weeds

For weeds occurring on their property, we asked managers if they have observed any change in abundance over the past five years. They indicated if they have seen an increase or decrease on their property, or if they have observed no changes. A couple of managers have not managed the land for at least 5 years, in which case we documented trend as 'unknown'. For all the weeds that we had information, we summarised the provided data as the weighted average trend, which basically indicates the general trend across those properties reporting a given weed (Figure 12). However, some weeds were only reported by some managers, hence we also present the percentage of properties reporting the weed for further reference. Managers reported an overall increasing trend for seven weeds, stable for another seven, and decreasing for six weeds (A); but see percentage of reporting properties (B). Three of those are worth noting, because they were reported by >90% (i.e. grader grass, rubber vine) and 60% (Calotrope) of properties and despite management they continue to increase, indicating the need to increase or improve/optimize management investments. In contrast, thorn apple was reported for 60% of stations, but had an average decreasing trend across reporting stations (mainly due to management). Another worth noting is bread fruit; thickening was reported by almost 40% of managers and an average increasing trend.

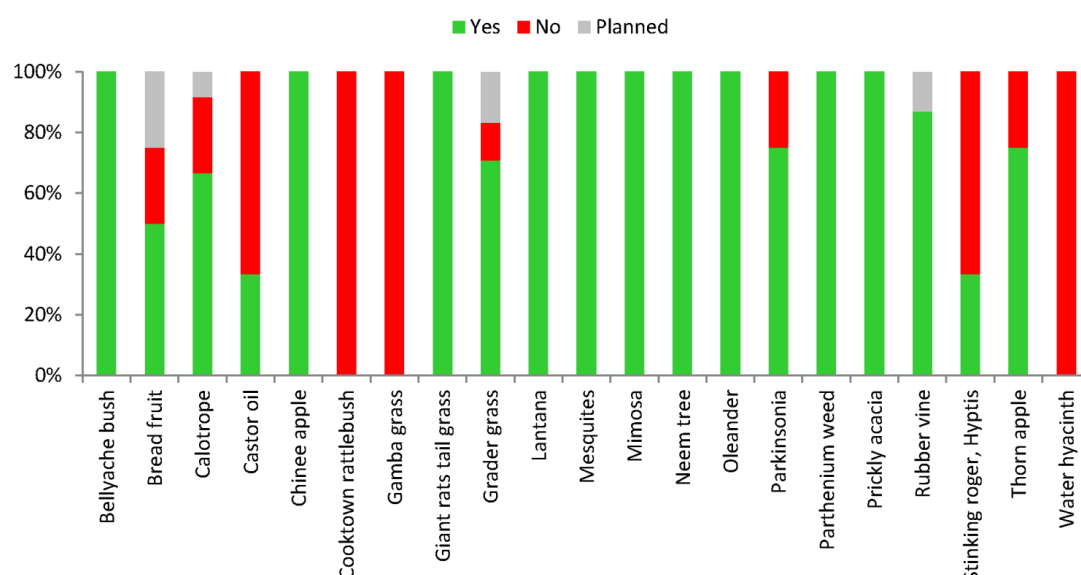
Figure 12. Trend in the abundance of weeds over the past five years



6.6. Current management of weeds

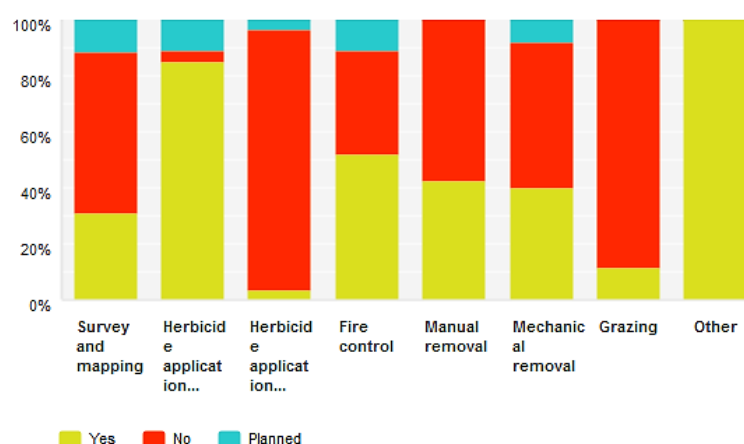
Regarding management actions, we asked managers for each of the weeds occurring on their property, if they have implemented any activities to prevent and/or mitigate their impacts on their production system and/or the environment (Figure 13). Only three weeds were noted as not being managed by any of the reporting stations, but two of them (Cooktown rattlebush and Water hyacinth) were only reported by one station. The other, Gamba grass, was not considered a problem (some managers indicated they would not mind having more if it, if it grew) and was mainly a type of grass that generally did not seem to expand much in the region, and kept under controlled by cattle/horses. For the rest of the weeds, most stations reported having undertaken some type of control.

Figure 13. Percentage of properties managing weeds



Regarding the type of activities undertaken by managers, herbicide application (on-ground) was the most common activity, followed by the use of grazing practices (part of routine land management) and then fire control, mainly directed to Rubber vine and Bread fruit control (Figure 14). The main strategy referred by managers was the use of rotational grassing and/or spelling, mainly to control Grader grass, allowing native grasses to overgrow the weed (in other words, to avoid overgrazing to allow good ground/grass cover). Manual and mechanical removals were less common, and aerial herbicide application was seldom reported. More than 30% of properties reported undertaking some sort of survey and monitoring, although only in a few cases this was a systematic exercise (e.g. monitoring sites, photographs) and, in general, this was undertaken along other routine land management activities.

Figure 14. Percentage of properties undertaking different weed management activities

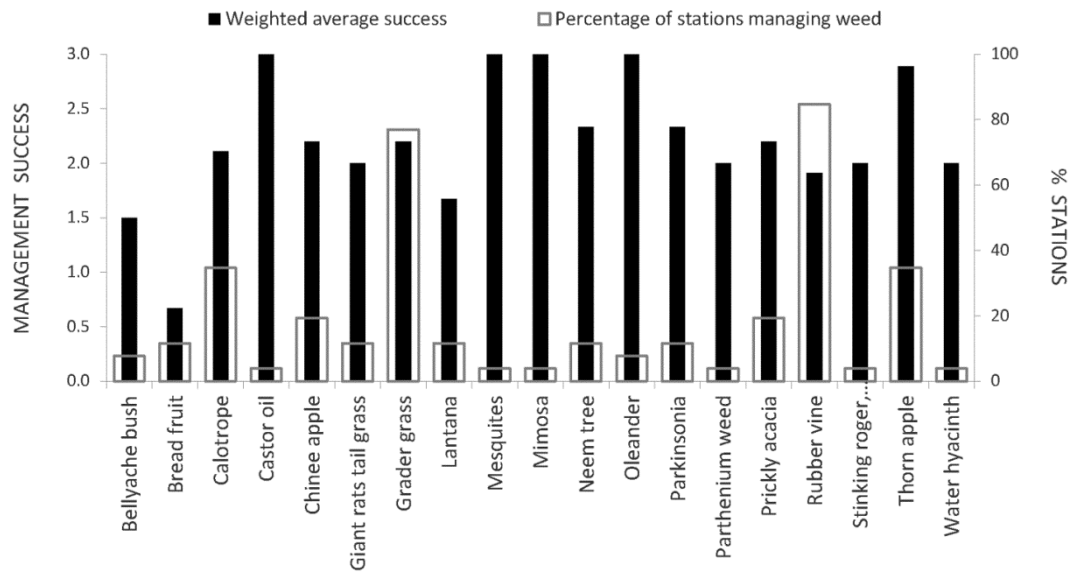


6.7. Weed management outcomes

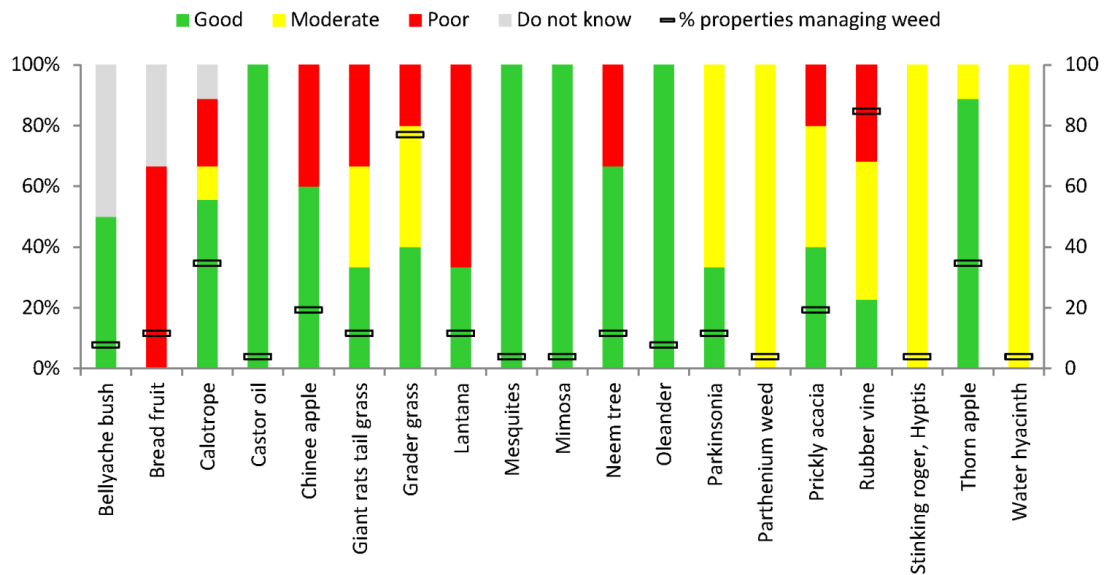
For those weeds identified as being managed by each property, we asked managers to rate the management outcomes in terms of preventing/minimising their impacts on their property. We used a three-point scale to rate success: poor (1), moderate (2), and good (3). Management success varied across properties (Figure 15), but in most cases it was reported as 'moderate' or 'good' for most weeds, with a weighted average of 2.2 across all weeds and properties. Bread fruit, reported to be managed by two properties, was consistently indicated as having 'poor' management outcomes.

Figure 15. Management outcomes of weed management activities

A



B



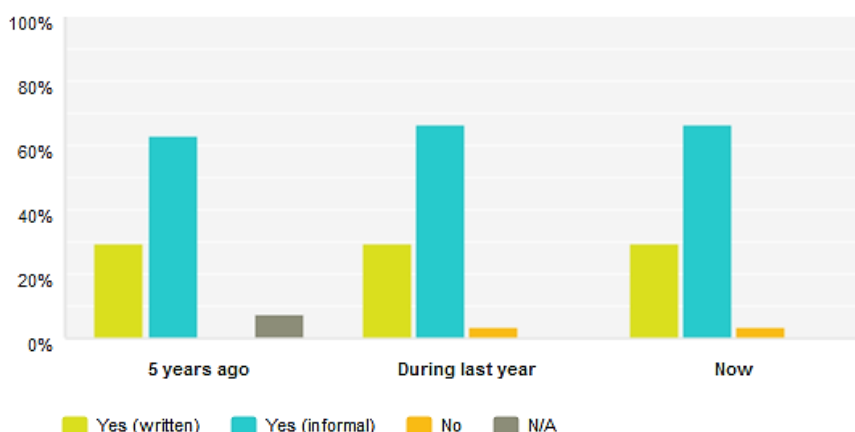
7. Pests

We collected information for pest of management priority in the region, identified based on their status as invasive species in Queensland (pest class) and/or concerns raised by the pastoral community and the NGRMG. The list of potential pests was compared with available spatial data and reports of pests of concern in the region (e.g. Northern Gulf NRM Plan). The list was presented to land managers, but they were asked to supplement the list if there were other pests of management concern. The full list of pests considered in this study is presented in [Appendix 2](#).

7.1. Pest management plan

The first question we asked to managers was whether they have and use a ‘pest management plan’ to prevent and/or control pest problems on their property. Most managers indicated having an ‘informal plan’, which in some cases was part of a larger management plan for the property ([Figure 16](#)). About 15% of the properties reported having a ‘written management plan’, but some indicated the need to update it. Land managers reporting not following a management plan indicated they did not have major problems with pests (mainly due to lack of water), but also reported pest management actions.

Figure 16. Properties using pest management plans



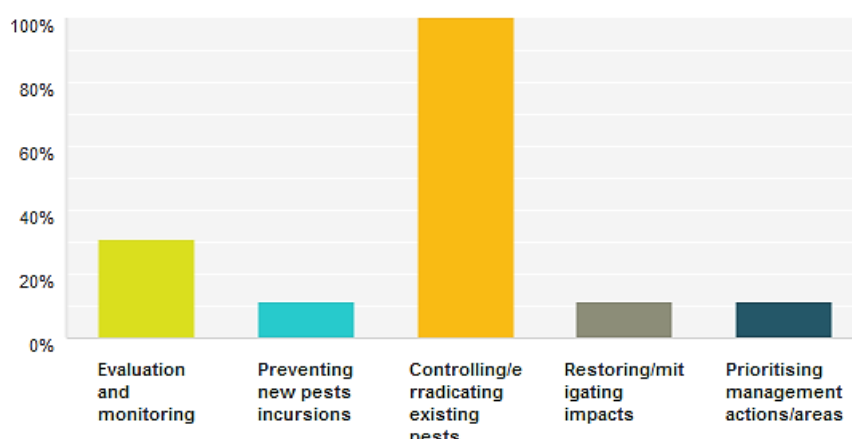
Land managers also shown some level of agreement on the broad management goals for pests, including paying particular attention to some pests (i.e. wild dogs and feral pigs), the need to increase coordination of management across properties, and – contrary to weed management – they tend to manage the whole property rather than focusing their efforts on a few paddocks (see word cloud below).

Focus on Wild dog Control Management Needs
Pigs and Wild Dogs

7.2. Pest management goals

All land managers indicated that their ‘pest management plan’ (informal or written) considered controlling and/or eradicating pests (mainly wild dogs and feral pigs). About 30% indicated they undertake some form of monitoring and only 10% also considered preventing the incursion of new pests, restoring impacts (including spelling areas to allow for recovery) and prioritising actions/areas as management priorities ([Figure 17](#)).

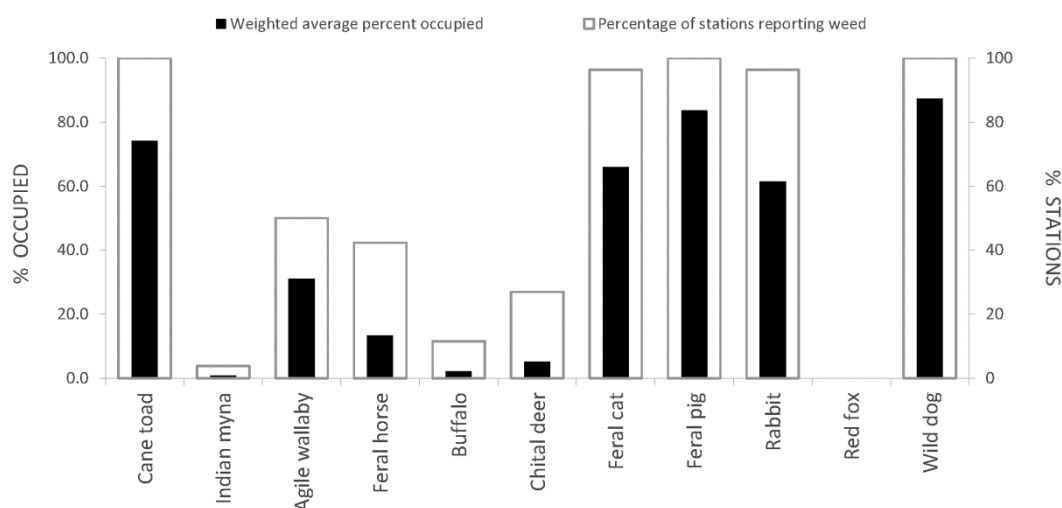
Figure 17. Pest management goals reported by managers



7.3. Occurrence and extent of pests

We also asked managers to indicate if the pests from the list were present on their property and, if they were, to estimate the affected area (percent of property), independent of abundance. The three most prominent pests identified by land managers as occurring on their property were cane toads, feral pigs and wild dogs (Figure 18). The three pests were reported by 100% of land managers and occupy the largest weighted average percent of properties (>75%). Feral cats and rabbits were also reported by most managers, who indicated they have been observed in at least 60% of their property. According to 50% of managers, agile wallabies (and in some cases, other macropods such as wallaroos) are present in high numbers, but the weighted area affected is about 30% of the properties. Following is a weighted average, indicative of the number of stations reporting the pest and the proportion of land affected per property.

Figure 18. Occurrence and extent of pests reported by managers



7.4. Production and environmental impacts of pests

For those pests occurring on their property, we also asked managers how they are affecting their production system (grazing) and/or the environment (e.g. wildlife, natural vegetation, wetlands, soil, water). For those pests present in most properties, thus with enough information to identify patterns, we generated 'word clouds' indicating the views of land managers regarding pests impacts. Following are a few examples for the most prominent pests.

For **cane toad** there was a general perception that they are more a concern around the house and around water (e.g. dams, troughs) and they can have some environmental impacts on the environment, particularly on wildlife (e.g. affecting beetles, snakes, frogs and birds), but overall are not considered a major issue. In contrast, the species is not considered to have significant production impacts.

Concern_{House} Impacts Not an Issue_{Problem}

Land managers had multiple concerns regarding **feral pigs**, both in terms of production and their environmental impacts. In most cases, there was a consistent association to water (including creeks and watering points) and good country. They were repeatedly mentioned as potential carriers of disease and major soil disturbance factor (particularly in good country and along creek, where they dig-up roots and damage country). Other direct production impacts include eating cattle feed and dirtying watering points.

Country_{Creeks} Damage_{Dams} Dig-up_{Disease}
Feed Ground_{Production} River_{Rooting} Soil_{Water}

Most managers indicated **wild dogs** are a big problem (but difficult to quantify) and impacts were strongly associated with production, in terms of killing and damaging calves (and sometimes adult animals). Some indicated their impacts are low because they are under control. Only two managers mentioned they could have a moderate impact on wildlife and they predate on wallaroos.

Big Problem Concern Damage
Kill and Bite Calves_{Kill Cattle Low}

In contrast, **feral cats** were clearly associated with environmental impacts and no mention to any production impact was recorded. Overall, feral cats were identified as a major environmental concern because they predate on wildlife (mainly birds, lizards and small mammals). Some indicated feral cats are not a problem (mainly because they are in low numbers) and hence not considered a management priority.

Big_{Birds} Environmental Concern_{Impact}
Problem

Despite their apparent low numbers in the region, **rabbits** were of concern to some land managers and reported to be increasing in some areas. Reported impacts were localised (mainly due to burrowing) and only in some types of country where they can dig.

Concern_{Impact} Low Numbers_{Minimal}
Not an Issue Not Burrow Problem Starting

Agile wallabies (and other macropods) were mentioned by many managers are having some production and environmental impacts, mainly around riparian and frontage areas, and close to the house. Competition for grass

and damage of soil (and erosion) through digging were the most common impacts reported by managers. Some indicated that they are not a problem at the moment, but could be if they are in large numbers.

Cattle Compete for Grass Damage

Digging Eat Grass Land Not a Problem at the Moment

Pasture River Frontage

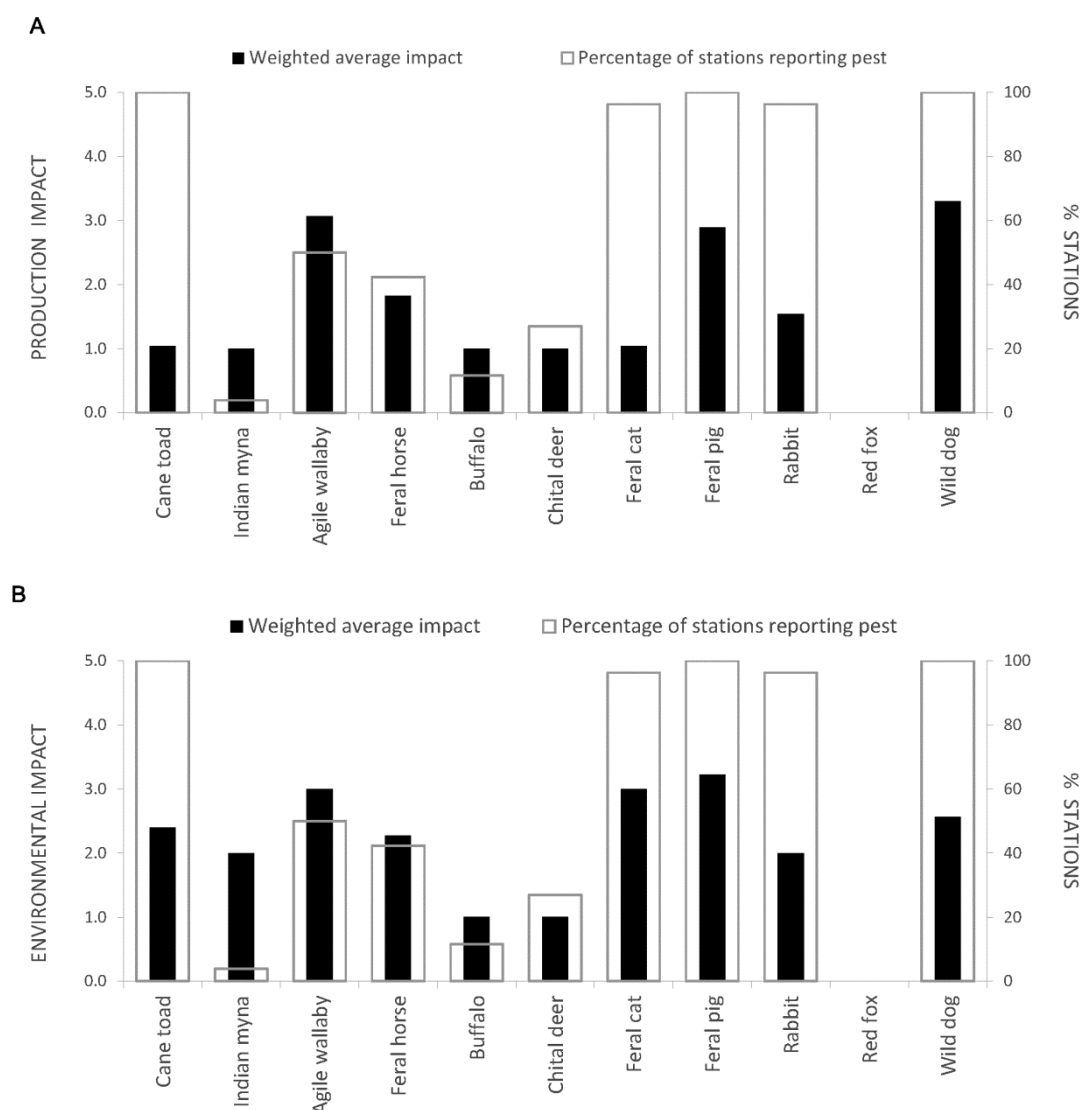
Feral horses were identified as a management problem by many managers because they eat grass and damage fences. Other impacts mentioned included spreading weeds, dirtying waters and damaging water infrastructure. Therefore, there was a general agreement in the need to keep them under control where necessary.

Control Damage Eat Grass Fences

Having collected managers' views on the impacts of pests, we asked them to rate how problematic pests are for their production system and the environment, using a five-point scale, from negligible (0) to extreme (5). Very few respondents identified a pest as extremely problematic for production, i.e. agile wallabies and feral pigs (7%), and wild dogs (11%). From an environmental point of view, the same percentage of managers (7%) identified wallabies and feral pigs as problematic, but only 4% identified wild dogs as an environmental problem. In contrast, some managers indicated that feral cats (8%) and cane toads (4%) can have extreme environmental impacts (**Figure 19**). In some cases, mainly for low/moderate impacts, managers indicated that their rating considered management efforts, i.e. impacts would be higher if pests were not controlled. This was particularly the case for wild dogs, feral pigs and brumbies.

Following is a graphic summary of the ratings given by land managers for (A) production and (B) environmental impacts. We found a relatively good agreement (i.e. high correlation) between the weighted average values for production and environmental impacts (Pearson correlation coefficient: 0.608). Notable exceptions to this agreement are the cane toad and feral cat, which had very different production (both rated as 'very low') and environmental (moderate and high, respectively) ratings.

Figure 19. Rating of production and environmental impact of pests

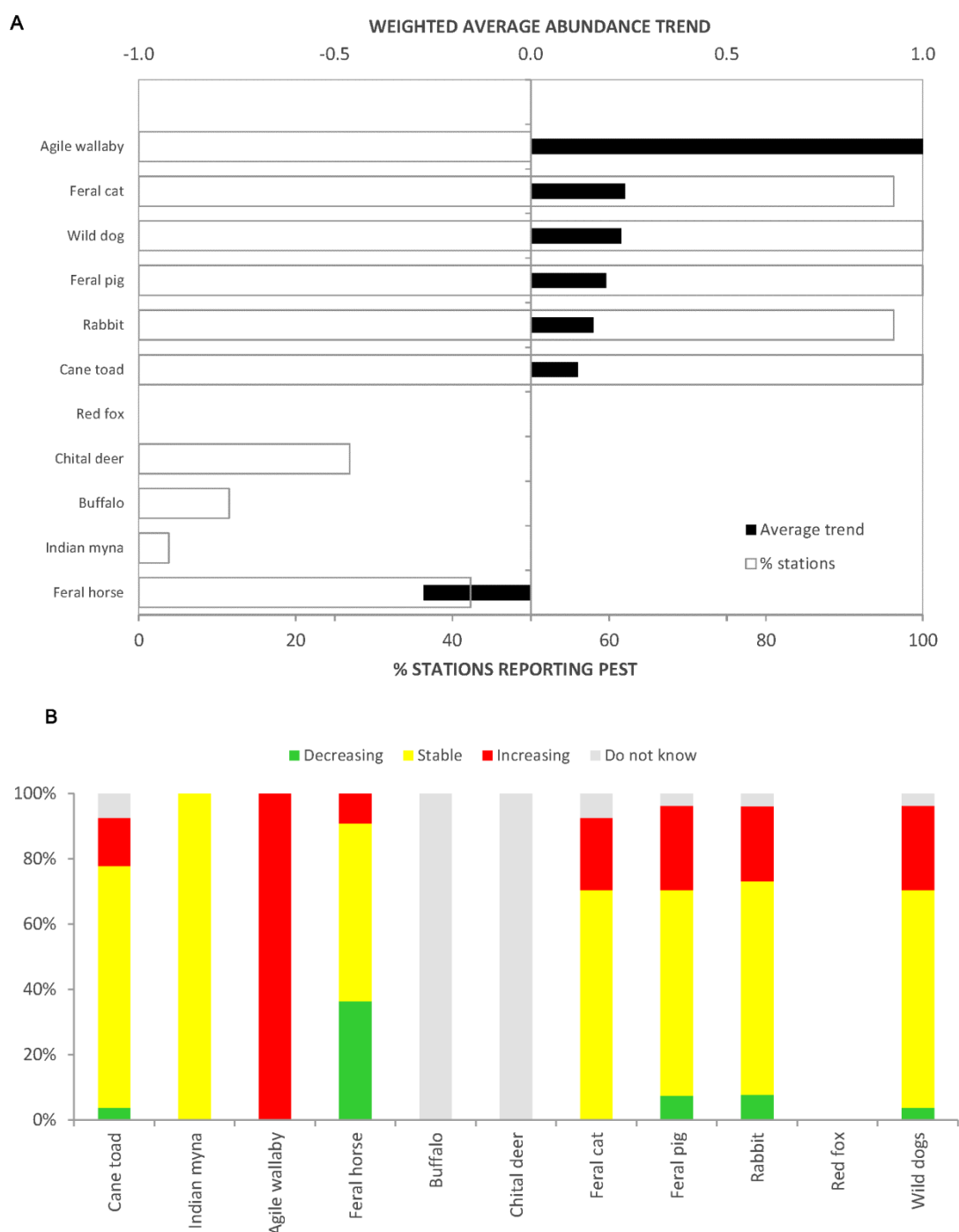


7.5. Observed changes in the abundance of pests

Following we asked managers to indicate, for pests occurring on their property, if they have observed any change in their abundance over the past five years. They indicated if they have seen an increase or decrease on their property, or if they have observed no changes ([Figure 20](#)). A couple of managers have not managed the land for at least 5 years, in which case we documented trend as 'unknown'. For all the pests that we had information, we summarised the provided data as the weighted average trend, which indicates the general trend across those properties reporting a given pest (A). Some pests were only reported by some managers; therefore, we also present the percentage of properties reporting the pest for further reference (B).

In average, managers reported a moderate increase in abundance of five pests (i.e. feral cat, wild dog, feral pig, rabbit, cane toad). Only in one case (agile wallaby), there was consensus about an increasing trend in abundance across properties reporting the species as highly abundant and problematic (50% of properties). In contrast, the moderate increasing trend identified for other five species is based on reports from >90% of land managers. The increasing trend in agile wallaby populations needs to be interpreted cautiously because it includes cases of uncertain taxonomic identification (overabundant macropods included wallaroos and kangaroos). The population of feral horses in most properties were considered to be in decline (mainly due to management). Information for the other reported pests (i.e. buffalo, deer and common myna) was insufficient to determine a trend.

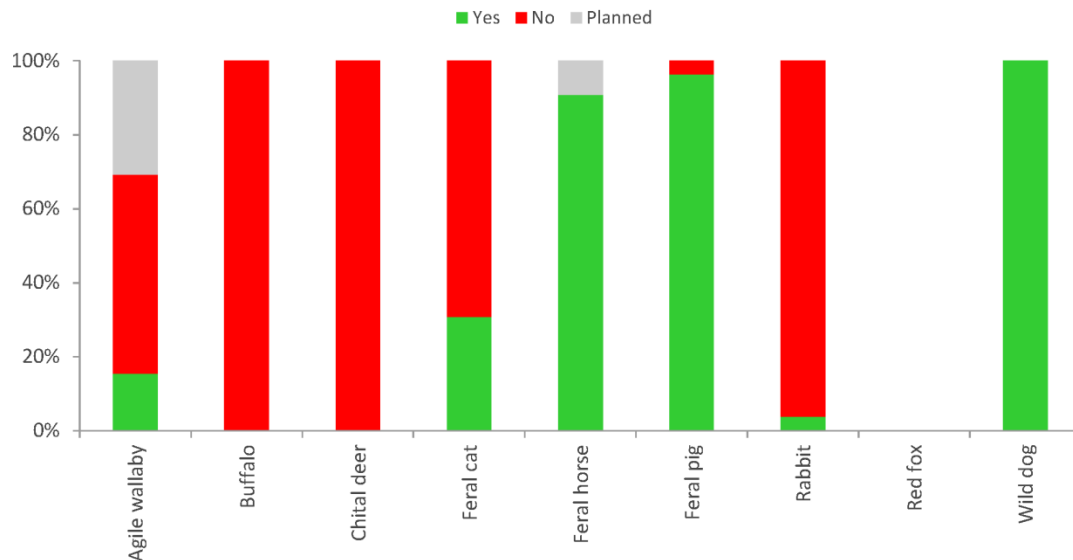
Figure 20. Trend in the abundance of pests over the past five years



7.6. Current management of pests

Regarding management actions, we asked managers for each of the pests occurring on their property, if they have implemented any activities to prevent and/or mitigate their impacts on their production system and/or the environment ([Figure 21](#)). Only three pests were managed in all (wild dogs) or most properties (feral pigs and feral horse). About 30% of land managers reported some form of management of feral cats, but this was mainly opportunistic, and only one property reported having managed rabbits. Some properties also reported some control activities of macropods on their property. The rare occurrence of buffalo, deer and common myna was reflected in the absence of management of these animals. Despite their wide distribution, increasing trend and notable environmental impacts, cane toads are not controlled; only one manager indicated their intention to control them.

Figure 21. Percentage of properties managing pests



Regarding the type of activities undertaken by managers, ground shooting (95%) and baiting (90%) were the most common activities, although ground shooting was mainly undertaken opportunistically along other routine land management activities (Figure 22). Aerial shooting and baiting were also common activities, undertaken in almost 40% of properties, mainly directed to control brumbies and wild dogs, respectively. Trapping is undertaken by 30% of managers to control feral pigs and/or wild dogs, but is also generally opportunistic. While trapping was considered by some managers as an effective management tool, its unsystematic application prevents assessing its cost-effectiveness for controlling feral pigs and wild dogs. None of the managers reported undertaking surveys, systematic monitoring or any other pest management activities (e.g. fencing against feral pigs).

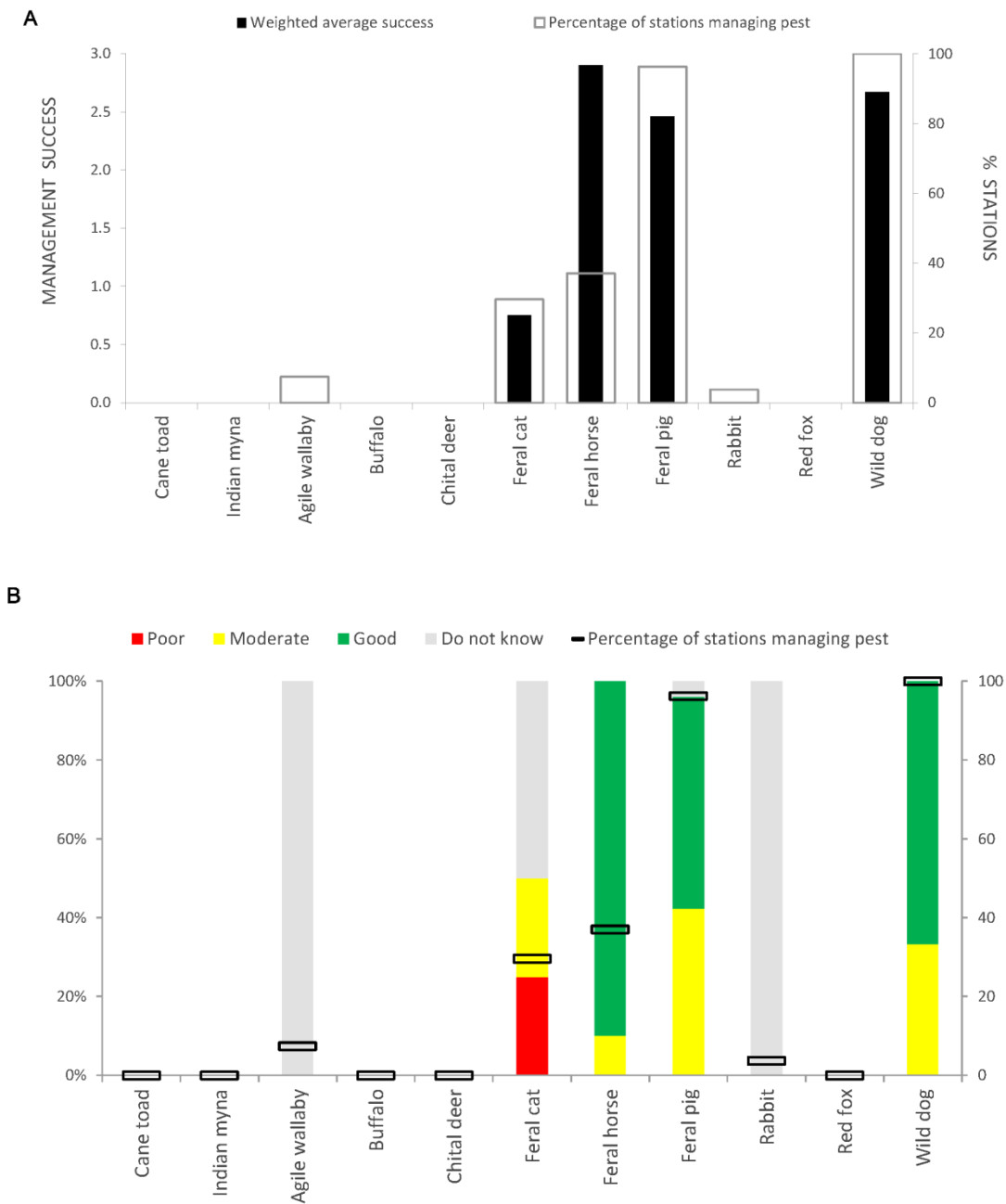
Figure 2.2. Percentage of properties undertaking different pest management activities



7.7. Pest management outcomes

For those pests identified as being managed by each property, we asked managers to rate the management outcomes in terms of preventing or minimising their impacts on their property. We used a three-point scale to rate success: poor (1), moderate (2), and good (3). Management success varied across properties, but it was considered to be generally good for the three main target pests (i.e. brumbies, feral pigs and wild dogs) and poor for feral cats (Figure 23). Management of rabbits and macropods was non-systematic and only undertaken by <10% of properties, thus assessment of effectiveness was not possible. Among the three main target pests, outcomes were generally better for brumbies and wild dogs; about 50% of properties reported only moderate results for feral pigs, thus suggesting further (systematic) effort is required to achieve good outcomes in feral pig control.

Figure 23. Management outcomes of pest management activities

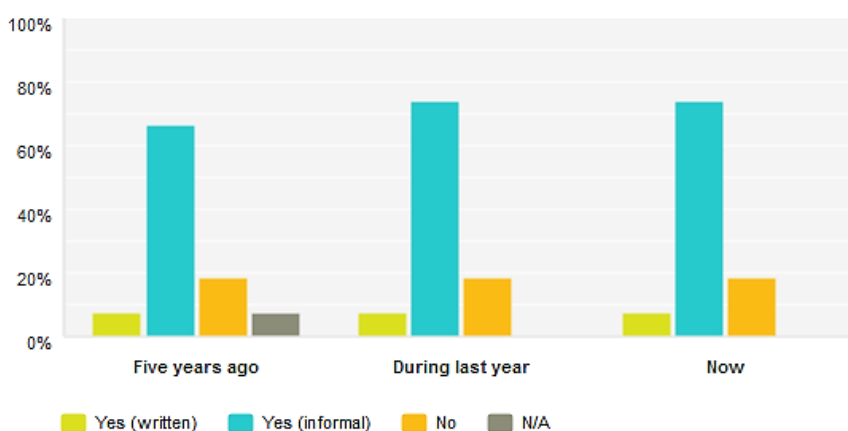


8. Fire

8.1. Fire management plan

We collected information regarding fire management for two broad goals: preventing and controlling wild fires and using fire for management purposes (e.g. weed control, grass management). The first question we asked to managers was whether they have and use a 'fire management plan' to help them make decisions about fire management/control on their property. Similar to weed and pest management, most managers indicated having an 'informal plan', which in some cases was part of a larger management plan for the property. Less than 10% of the properties reported having a 'written management plan' and almost 20% indicated not following a plan to make decisions about fire management (**Figure 24**). However, 20% of the managers not following a plan expressed their intention to have one in the next 5 years. Also, even those managers reporting not following a formal or informal fire management plan did report some fire management actions.

Figure 24. Properties using a fire management plan



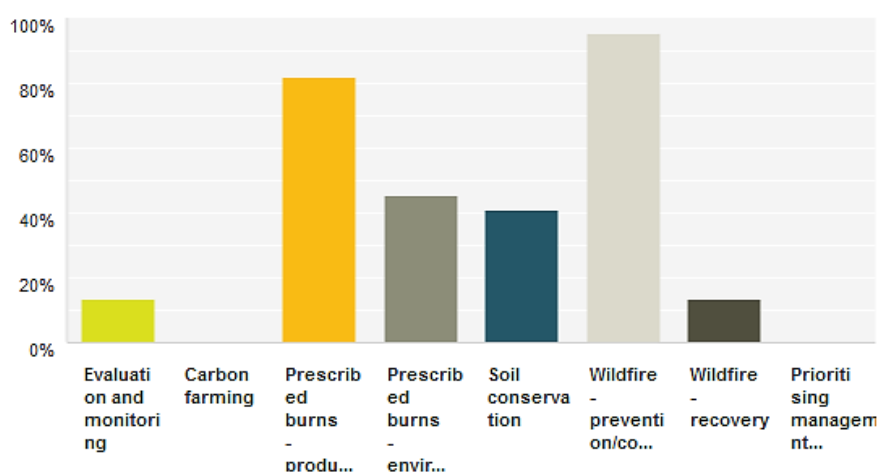
There was some level of agreement on broad fire management goals, including maintaining fire breaks and prescribed burns to reduce wild fire risk, control some weeds (e.g. Rubber vine; but this requires good grass management and there is a potential tradeoff with production) and reduce woodland thickening. Other broad goals of fire management were maintaining grass quantity and quality. Also important was the need for further resources for fire brigades to respond to wild fires (see word cloud below).

Brigade **Focused** Land Management
Maintain Prescribed Burns Rubber Vine
Weed Control Woodland Thickening

8.2. Fire management goals

Most land managers (95%) indicated that their 'fire management plan' (informal or written) main goal is prevent and control wildfires, but a majority (80%) also considered the use of prescribed burns for production (grass management) purposes (**Figure 25**). Over 40% of managers indicated the use of prescribed burns for environmental purposes (i.e. weed management) and soil conservation. Only 10% of properties indicated that part of their fire management goals was to actively promote recovery after wildfires and none reported prioritising management actions/areas. Evaluating wildfire risk is part of routine land management activities, but few reported a systematic monitoring approach (e.g. using NAFI fire monitoring system).

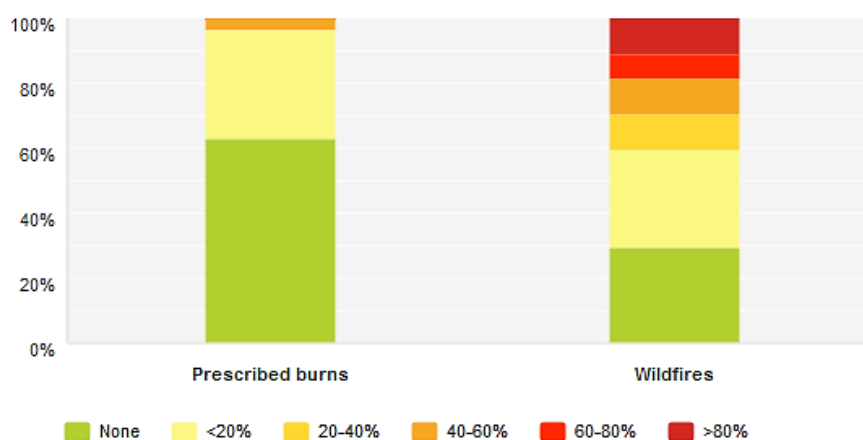
Figure 25. Fire management goals reported by managers



8.3. Occurrence and extent of fires

We also asked managers to indicate – roughly – what percentage of their property was burned (independent of their intensity and frequency) the previous year (2012-2013). Differences in the percentage between prescribed and wildfires is notable, with >60% of managers reporting no use of prescribed fires, in contrast with >70% of properties reporting the occurrence of wildfires on their property. Another important difference was the percentage of burned area; most managers reporting having used prescribed burns specified the area was <20% (only one reporting 40-60%), while the extent of wildfire was generally larger; over 40% of properties reported fire affected >20% of their property (Figure 26).

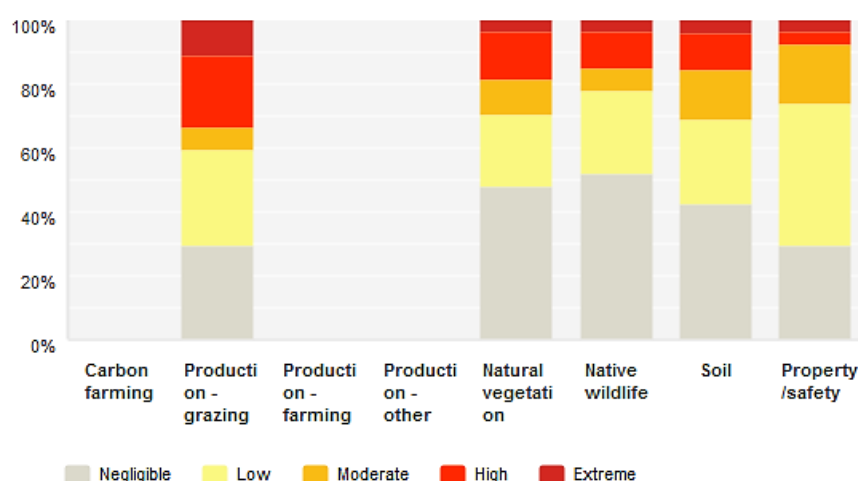
Figure 26. Occurrence and extent of prescribed and wildfires reported by managers (2012-2013)



8.4. Production and environmental impacts of wildfires

We also asked managers how wildfires are affecting their production system (grazing) and/or the environment (e.g. wildlife, natural vegetation, wetlands, soil). Their responses indicated that impacts tend to be higher on production, namely grazing), with over 70% of managers reporting some impact and 35% rating impacts between high and extreme (Figure 27). In contrast, most managers (>60%) rated the impact of wildfires on their property (e.g. fences and other infrastructure) and safety as low or moderate. Perceived impacts to natural vegetation, wildlife and soil were very similar, with about half of the managers reporting low and moderate impacts and <20% high to extreme. Overall, managers indicated having a lower confidence in their rating of environmental impacts and/or the need for long-term monitoring to have reliable assessments. Some managers mentioned that adjacency to National Parks increased the risk of wildfires on their property.

Figure 27. Rating of production and environmental impact of wildfires



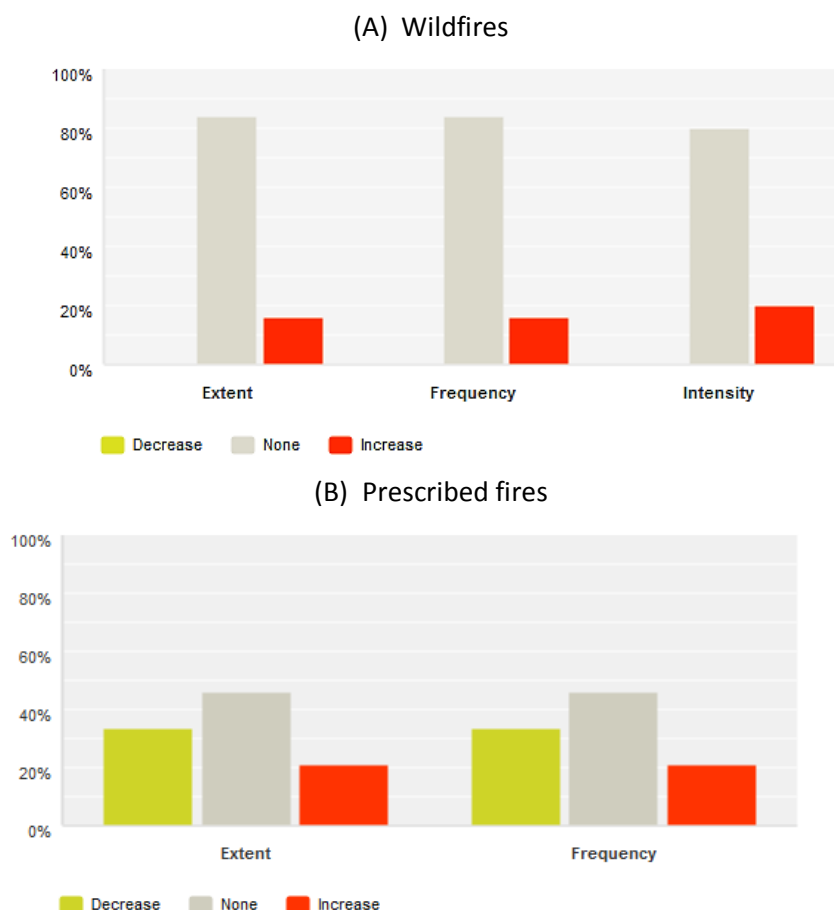
Based on their responses, we also generated a ‘word cloud’ (below) indicating common perceptions on wildfire impacts on their property, thus reflecting their views on relevance of undertaking wildfire management actions. Lack of good conditions for country/grass to recover (i.e. big wildfires followed by a poor wet season) was mentioned as some of the criteria used by managers to rate impact. Indirect production and environmental impacts associated with wildfires include reduction in the area that managers were planning to spell.

Fires Poor Wet Property Recover Soil

8.5. Observed changes in the occurrence of wildfires and use of prescribed fires

Following, we asked managers to indicate if they have noticed any change in the occurrence (in terms of extent, frequency and intensity) of wildfires on their property over the past five years. The vast majority (>80%) have observed no changes in the extent, frequency or intensity of wildfires (Figure 28). The recent big fires were mainly attributed to the natural cycle, but in particular to the preceding three good wet seasons. Some managers indicated that spelling and rotational grazing has also resulted in the accumulation of more fuel. Overall, there is a perception that there is good commitment by land managers to keep fires under control. In contrast, most managers (35%) reported a reduction in the use of prescribed burning, both in terms of area and frequency over the past five years. However, opinions were more divided because about 20% of managers indicated an increasing trend in both extent and frequency of prescribed burns within their properties.

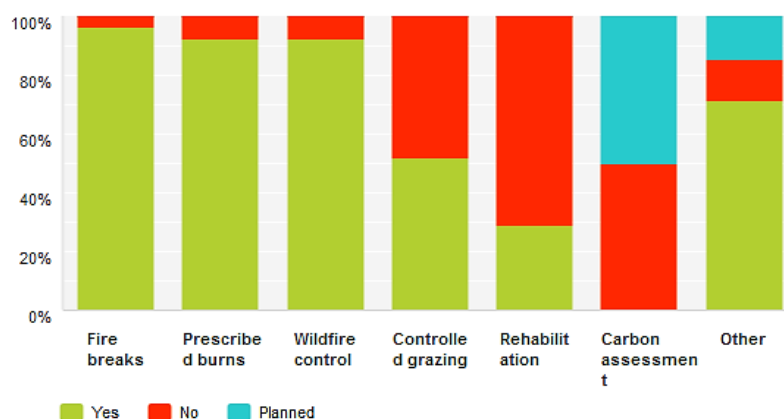
Figure 28. Trends in the extent, frequency and intensity of fires over the past five years



8.6. Current fire management activities

Regarding the type of fire management activities reported by managers, fire breaks (96%), prescribed burns (93%) and wildfire control (93%) were the most common (Figure 29). Over 50% reported the use of controlled grazing as a strategy to manage fire (both to reduce fire risk and/or increase fuel for prescribed burns); in some cases, it was considered an indirect or “side effect” of their grazing system. About 30% of managers reported undertaking some activities to rehabilitate areas after wildfires (mainly spelling, but sometimes also as part of their rotational grazing system). Interestingly, half of the managers indicated interest in undertaking an assessment of carbon storage/emissions associated with fires on their properties. While most managers were not familiar with the methods and guidelines regarding current carbon farming initiatives, some are interested in knowing more about it and think some areas within their properties have potential value for carbon farming.

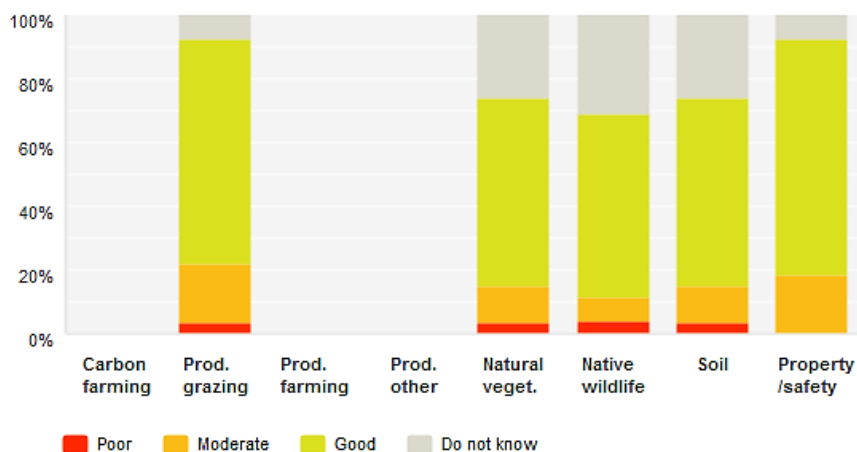
Figure 29. Percentage of properties undertaking different fire management activities



8.7. Fire management outcomes

We asked managers to rate the management outcomes in terms of achieving their fire management goals on their property. We used a three-point scale to rate success: poor (1), moderate (2), and good (3). Management success varied across properties, but it was considered to be generally good and very similar across the five broad management goals (i.e. grazing production, natural vegetation, wildlife, soil and safety), perhaps more uncertain in terms of the outcomes for vegetation, wildlife and soil ([Figure 30](#)).

Figure 30. Outcomes of fire management activities

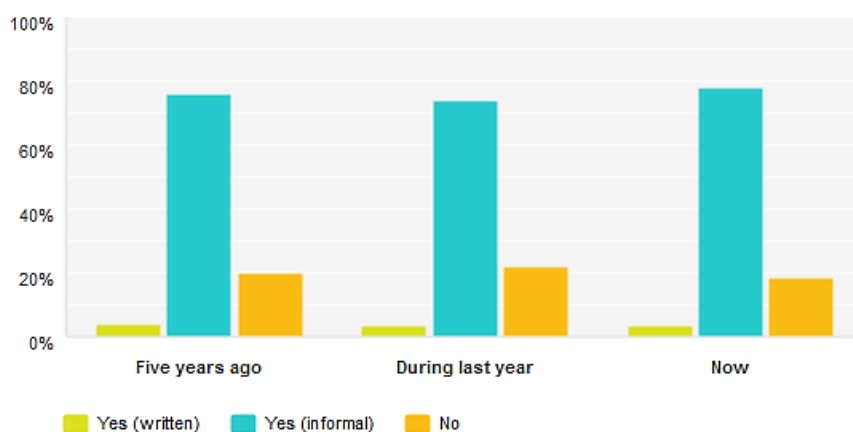


9. Erosion

9.1. Erosion management plan

We collected information regarding erosion management for two broad goals: preventing and controlling erosion. The first question we asked to managers was whether they have and use a management plan to help them make decisions about erosion management/control on their property. Similar to weed, pest and fire management, most managers indicated having an 'informal plan', which in some cases was part of a larger management plan for the property. In this case, less than 5% of the properties reported having a 'written management plan' and like fire management, almost 20% indicated not following a plan to make decisions about erosion management ([Figure 31](#)). However, almost 35% of the managers not following a plan expressed their intention to have one in the next 5 years and some managers indicating not following a management plan, also reported management actions.

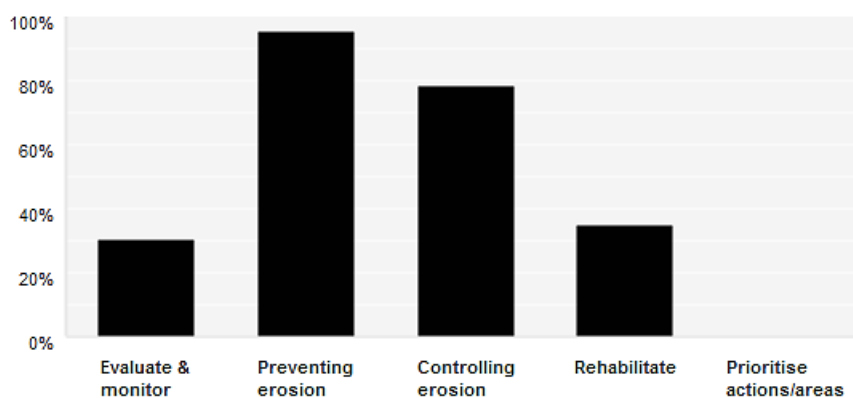
Figure 31. Properties using erosion management plans



9.2. Erosion management goals

Most land managers (95%) indicated that their 'erosion management plan' (informal or written) main goal is prevent erosion (mainly through maintaining good grass cover as part of their grazing management system), but a majority (80%) also considered the need to control or reduce ongoing erosion on their properties ([Figure 32](#)). About 35% of managers mentioned rehabilitation is one of their erosion management goals and 30% also put emphasis on evaluating and monitoring soil cover and ongoing erosion. None of the managers considered prioritising actions/areas as part of their erosion management plan.

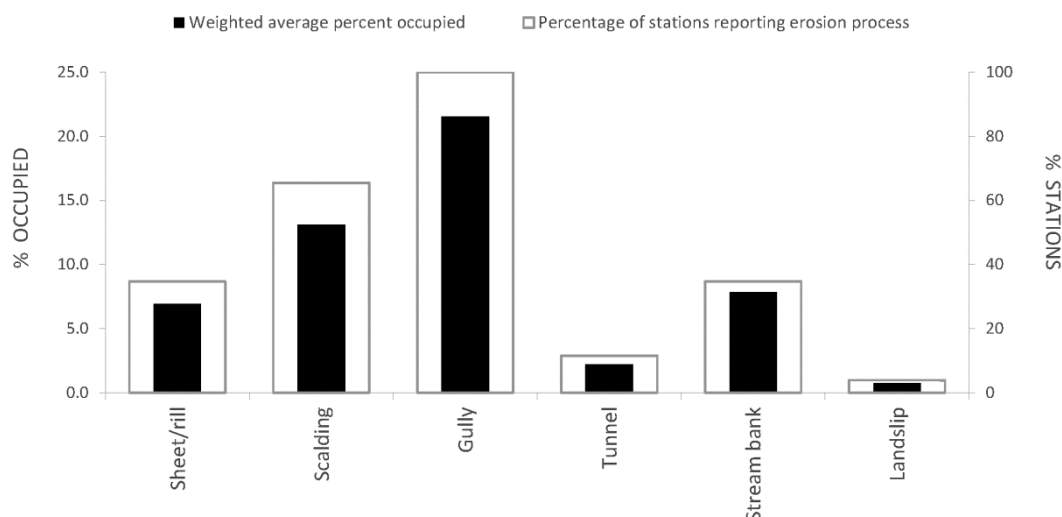
Figure 32. Erosion management goals reported by managers



9.3. Occurrence and extent of erosion

We also asked managers to indicate which erosion processes have been observed in their properties and, if they were, to estimate the affected area (percent of property), independent of the severity. Following is a weighted average, indicative of the number of managers reporting each type of erosion and the proportion of the property affected ([Figure 33](#)). The two most prominent erosion processes identified by land managers as occurring on their property were gully erosion and scalding, with 100% and 65% of managers reporting them, respectively. Both processes were also the more extensive, with about 22% and 13% weighted average percent of properties. Stream bank and sheet-rill erosion were also mentioned by 35% of managers, but their weighted percentages were 8% and 7%, respectively. Only a few managers reported the occurrence of tunnel erosion (specifically in some soil types) and one indicated having observed localised landslips.

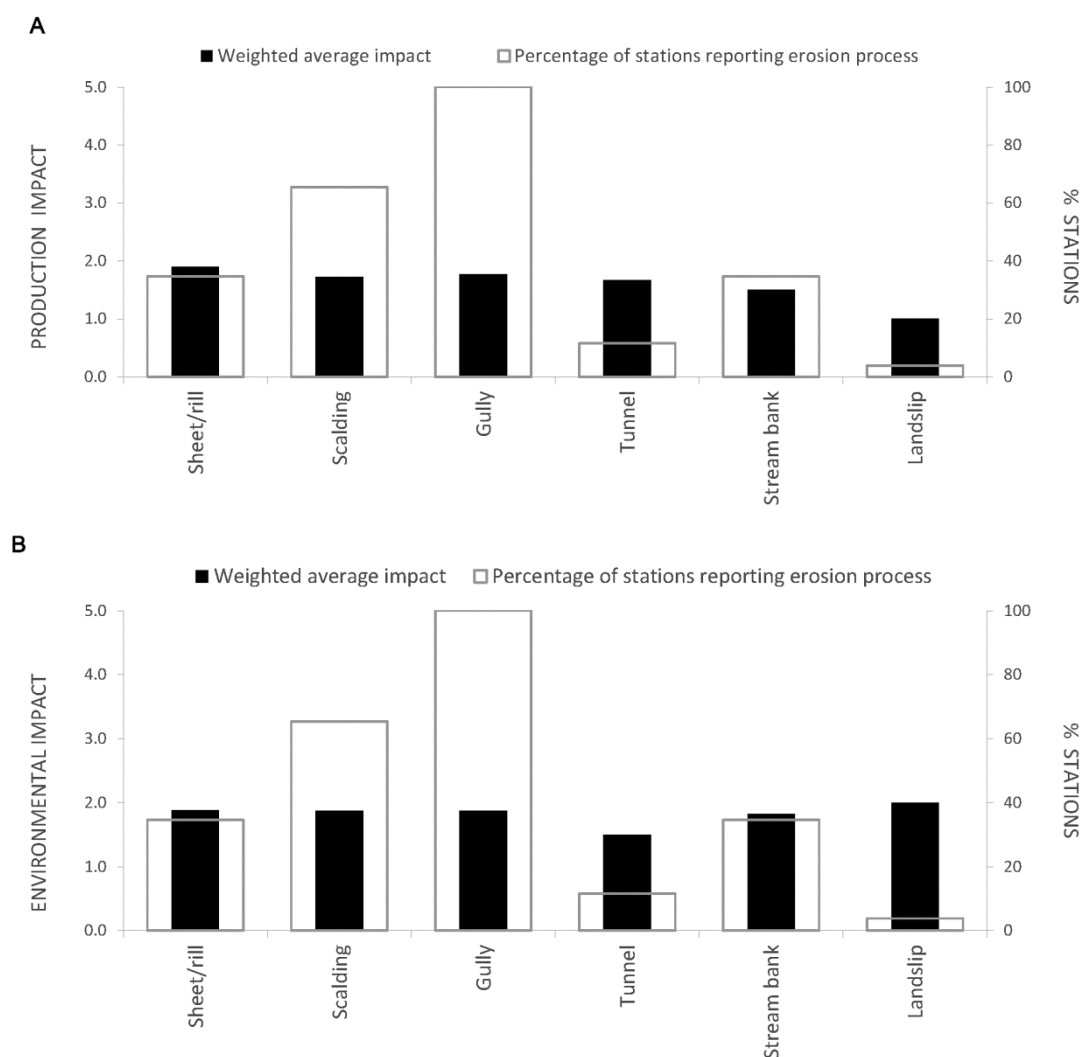
Figure 33. Occurrence and extent of erosion processes reported by managers



9.4. Production and environmental impacts of erosion

For those erosion processes observed on their property, we asked managers to rate how problematic these are for their production system (grazing) and the environment (i.e. wildlife, natural vegetation, wetlands, soil, water), using a five-point scale, from negligible (0) to extreme (5). Following is a graphic summary of the ratings given by land managers for (A) production and (B) environmental impacts ([Figure 34](#)). None of the respondents rated any of the erosion processes as having a high or extreme impact on their production or the environment. Overall, they rated the impact of all erosion processes as low to moderate. However, there were some differences between perceived production and environmental impact, which is reflected in the weak negative correlation between the weighted average values for production and environmental impacts (Pearson correlation coefficient: -0.362); both landslips and stream bank erosion were rated notably higher for their environmental impacts.

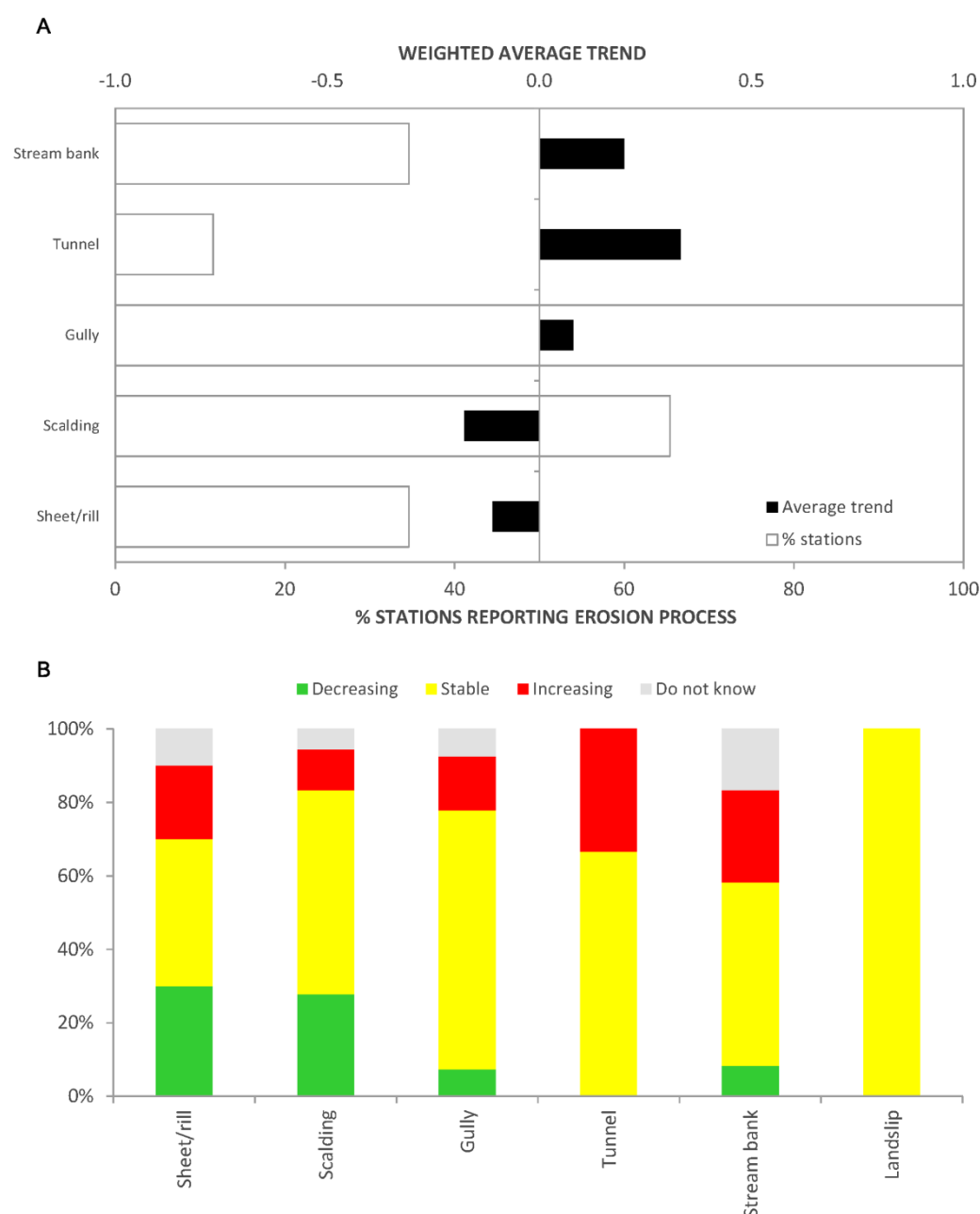
Figure 34. Rating of production and environmental impact of erosion



9.5. Observed changes in the occurrence of erosion processes

Following, we asked managers to indicate if they have noticed any change (in terms of extent and severity) of the observed erosion processes on their property over the past five years (Figure 35). There was an overall agreement that gully erosion (reported by 100% of the managers) was not getting worse (70%) and – in average – marginally increasing; 15% reported that some gullies are actively advancing and 8% indicated good progress in slowing down or reversing gully erosion in some areas due to management (i.e. grazing system and some active restoration). Despite the overall trend, some indicated that gully erosion has the potential to get worse if not managed. In contrast, more managers reported improvements (28%) in scalded land (the second most common erosion process), mainly associated with management, including destocking, spelling and seeding. Some managers mentioned that some areas seem to be “naturally scalded” with little opportunity to improve in grass cover. Reported trends in sheet/rill erosion were divided between managers reporting decrease (30%), increase (20%) or no change (40%); in average, we observe a slight improving trend. A moderate increasing trend was observed for stream bank erosion (reported by 35% of managers), but there was some uncertainty in their responses. Very few managers identified tunnel erosion (12%), with 33% indicating increases and 66% no change.

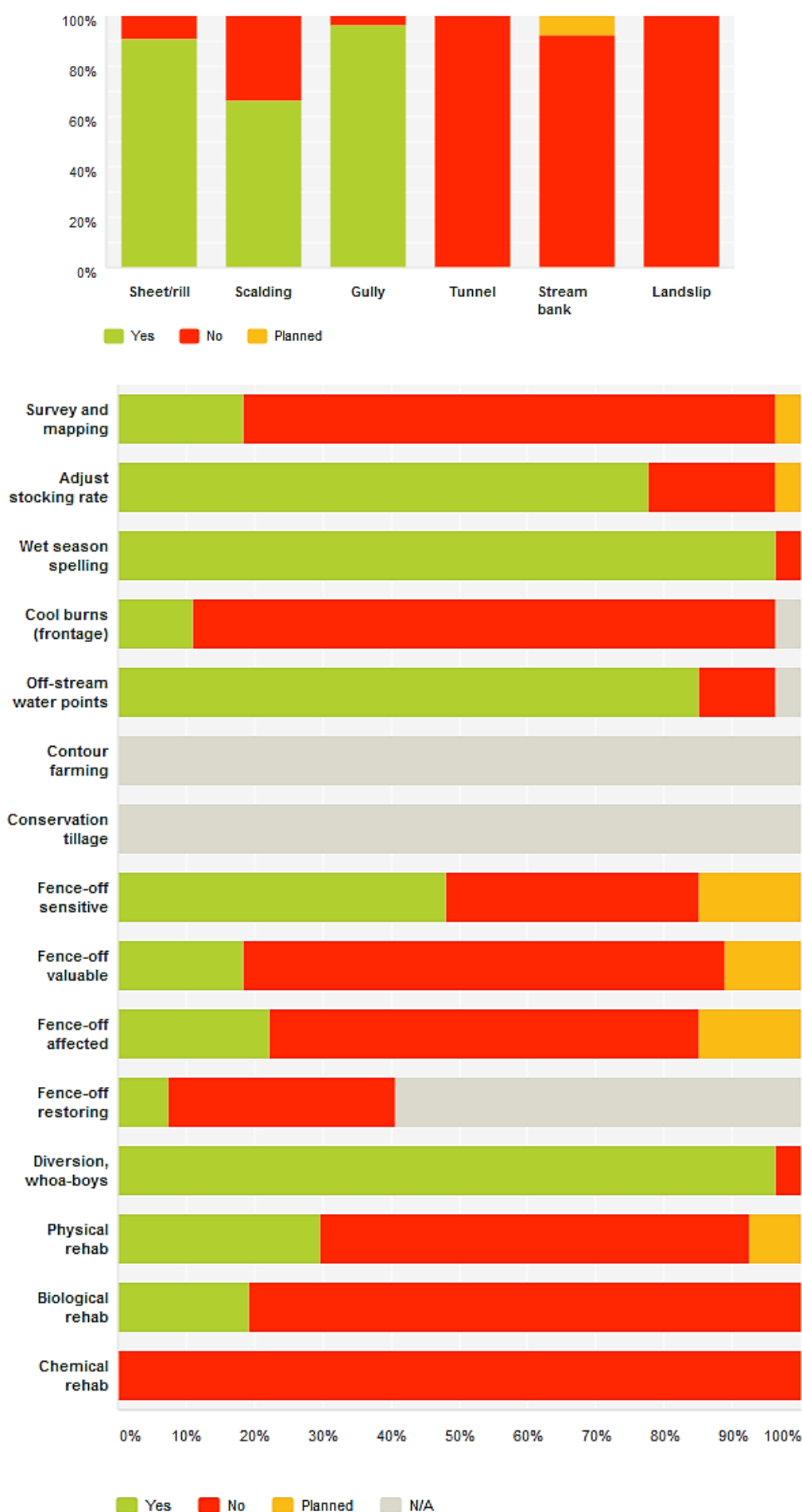
Figure 35. Trends in the extent and severity of erosion processes over the past five years



9.6. Current erosion management activities

Of the erosion processes occurring in the region, only gully erosion, scalding and sheet/rill erosion were actively managed. Among the properties reporting the occurrence of these erosion processes, 96% manage gully erosion, 91% sheet/rill erosion, and 67% scalded land ([Figure 36](#)). One manager mentioned the intention to do something about the observed stream bank erosion happening on their property. The two main strategies to manage erosion were maintaining good grass cover (e.g. through spelling/rotation and matching stocking rate to carrying capacity) and water diversion. Many managers mentioned that a significant part of effort in road works goes into erosion control activities, mainly through water diversion (e.g. whoaboys); this was complemented by good planning on how and where to place roads and fences. Managers also mentioned they try keeping cattle away from areas that erode easily (particularly during the wet season) and using low impact vehicles on erodible areas to minimise disturbing the soil. Other strategies mentioned were spelling and fencing of sensitive areas (e.g. wetlands), using lick for herd effect (scalded land), seeding of degrade/overgrazed areas or after prescribed burns (e.g. Buffel grass, stylos), and physical rehabilitation to stabilise gullies (e.g. diversion banks on top of gully head). One manager explicitly indicated the importance of feral pig control as an activity to prevent/minimise erosion.

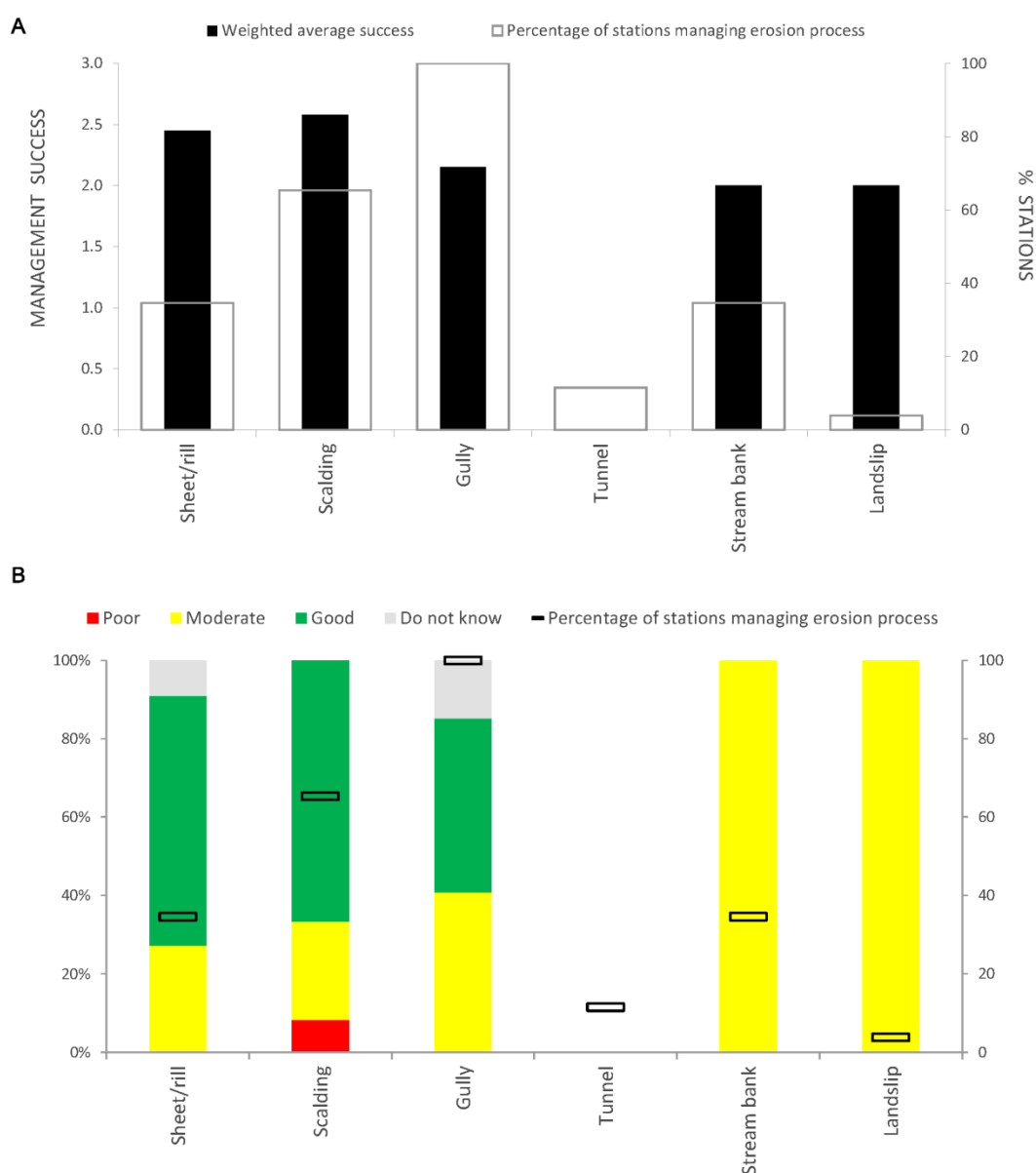
Figure 36. Percentage of properties undertaking activities to manage different erosion processes



9.7. Erosion management outcomes

We asked managers to rate the management outcomes in terms of achieving their erosion management goals on their property. We used a three-point scale to rate success: poor (1), moderate (2), and good (3). Management success varied across (and within) properties and erosion processes (Figure 37). The perceived success for two main processes occurring in the region, was in average moderate (gully erosion, reported for 100% of properties) and moderate-to-good (scalding, reported for 65% of properties). Limited resources and the need for additional technical guidance (regarding physical rehabilitation in particular) were mentioned as factors contributing to sub-optimal results. For gully erosion in particular, there is uncertainty in this average because about 15% of managers were unsure of the outcomes of their efforts; the rest was divided between moderate and good outcomes. One manager explicitly indicated the poor outcomes despite significant efforts to reduce scalded areas on their property, but the majority indicated good results. While sheet/rill erosion was notably less common (reported for 35% of properties), outcomes were generally good (64%), mainly attributed to improved grazing practices (e.g. maintaining good ground cover is helping to prevent erosion of new areas). Despite not being actively managed, managers reported moderate outcomes for stream bank and landslip erosion (although, only one manager reported observing landslips). Stream bank erosion was difficult to assess, but exclusion of cattle from streams was reported as an activity that could be contributing to preventing or reducing this process. Over 35% of managers indicated the need for further fencing to mitigate ongoing erosion processes.

Figure 37. Outcomes of erosion management activities



Appendix 1. Plant species of potential management concern in the Gilbert River catchment

Common	Scientific	WoNS	QLD	Notes on distribution
Bellyache bush	<i>Jatropha gossypifolia</i>	Yes	Class 2	Widespread across northern Australia; naturalised in various areas of North QLD; smaller infestations occur throughout QLD.
Bread fruit, Gardenia ¹	<i>Gardenia vilhelmii</i>	No	No	Breadfruit is thickening up in large areas of the Northern Gulf, particularly in the Georgetown district; commonly found on red earths, granites and gravelly soils.
Calotrope, rubber bush	<i>Calotropis procera</i>	No	No	Calotrope can readily become established in disturbed areas associated with clearing vegetation, road making or heavy grazing; naturalised in semi-arid north (e.g. Gulf of Carpentaria); extensive infestations on some Gulf islands, particularly sandy foreshore.
Castor oil plant/bush	<i>Ricinus communis</i>	No	No	Abundant along watercourses and floodplains, disturbed or waste land and roadsides
Chinee apple, Indian jujube	<i>Ziziphus mauritiana</i>	No	Class 2	Widespread in North QLD, mainly around the areas associated with mining early last century; densest areas around Charters Towers, Mingela, Ravenswood and Hughenden; occurs in towns in drier parts of North and Central QLD.
Gamba grass	<i>Andropogon gayanus</i>	Yes	Class 2	Currently exists as scattered populations (estimated total of 60,000ha) across the north, with most sites on Cape York Peninsula and the Atherton Tablelands.
Giant rats tail grass	<i>Sporobolus</i> spp.	No	Class 2	Modelling suggests it is suited to conditions in 30% of Australia and 60% of QLD (108 million ha), including areas with as little as 500mm mean annual rainfall; current distribution: <i>S. natalensis</i> : Rockhampton (QLD) to Port Macquarie (NSW); and <i>S. pyramidalis</i> : Cooktown (QLD) to the NSW central coast
Grader grass	<i>Themeda quadrivalvis</i>	No	No	Grader grass is considered to be in the top 200 most invasive plants of south-western QLD; found throughout coastal, sub-coastal and seasonally dry tropical regions of QLD and NT.
Lantana	<i>Lantana camara</i>	Yes	Class 3	Covers 5 million ha throughout most coastal and sub-coastal areas of eastern Australia, from North QLD to southern NSW; spread into the NT and WA and has the potential to invade Victoria.
Mesquites	<i>Prosopis</i> spp.	Yes	Class 1	Mesquite, once a favoured shade tree around homesteads, has spread significantly in QLD;
Mimosa bush	<i>Acacia farnesiana</i>	No	No	Naturalised in Australia and widespread in QLD; withstands drought well, is readily eaten by stock, and has good regrowth after grazing;
Neem tree	<i>Azadirachta indica</i>	No	No	Found across northern Australia in the NT and WA; it is planted throughout QLD and is growing wild in sandy river beds of the Gulf region.
Oleander, Yellow oleander	<i>Cascabela thevetia</i>	No	Class 3	In Australia naturalised near old habitations or along creeks. Established infestations near Mingela and Ingham.
Parkinsonia	<i>Parkinsonia aculeata</i>	Yes	Class 2	Found along watercourses in subhumid and semiarid areas of QLD; infestations in the Gulf of Carpentaria Region and Fitzroy catchment are up to several kilometres across.
Parthenium weed	<i>Parthenium hysterophorus</i>	Yes	Class 2	Invades disturbed bare areas along roadsides, heavily stocked areas around yards and watering points; well-established in Central QLD, west to Longreach and northern and southern QLD.
Prickly acacia	<i>Acacia nilotica</i>	Yes	Class 2	About one-third of QLD is adequate for prickly acacia growth; several million hectares of the Mitchell grass plains are infested; infestations occur from Barcaldine to Hughenden, west to Longreach, Winton and Julia Creek; also along the coast (e.g. Home Hill, Bowen, Rockhampton).
Rubber vine	<i>Cryptostegia grandiflora</i>	Yes	Class 2	Infestations found throughout river systems of southern Cape York and the Gulf of Carpentaria, south along the coast to the Burnett River; common in Central QLD.
Stinking roger, Hyptis	<i>Hyptis suaveolens</i>	No	No	A major weed in northern QLD and in the NT; commonly found along roads, watercourses and overgrazed areas. Plants not eaten by stock.
Thorn apple	<i>Datura</i> sp.	No	No	Widely distributed weed of disturbed land.
Water hyacinth	<i>Eichhornia crassipes</i>	No	Class 2	Infestations mostly in coastal QLD and NSW.

¹ Native species identified as weed by some land managers; one of the main species linked to woody thickening.

Appendix 2. Animals of potential management concern in the Gilbert River catchment

Common	Scientific	QLD	Notes on distribution
Cane toad	<i>Bufa marinus</i>	Class 2	Established in Queensland and also present in Northern Territory, New South Wales and north-east Western Australia
Common myna	<i>Acridotheres tristis</i>	No	Found throughout eastern Australia, from western Victoria to Cairns. There is some concern that this highly invasive bird could be reaching some areas in the Northern Gulf region.
Agile wallaby²	<i>Macropus agilis</i>	No	Native to Australia and found throughout Queensland, but reported overabundant and in high density in some areas and causing soil damage
Chital deer	<i>Axis axis</i>	Class 2	The established chital range in Queensland is in the area north of Charters Towers, where they were released in the late 19th century and in defined pockets throughout Queensland including near Townsville, Barcaldine and Texas. Climate analysis suggests that much of Queensland is suitable for Chital deer as long as water requirements are met.
Feral cat	<i>Felis catus</i>	Class 2	Thrives under all climatic extremes and in vastly different types of terrain; present Australia wide.
Feral horse	<i>Equus caballus</i>	No	There may be as many as 200,000 feral horses in Queensland, mainly in semi-arid western and north-western areas of the state; widespread and abundant across western and north-western parts of the state, with smaller populations scattered across bushland areas in eastern Queensland.
Feral pig	<i>Sus scrofa</i>	Class 2	The feral pig is one of the most widespread and damaging pest animals in Queensland; greatest concentrations on the larger drainage basins, and swamp areas of the coast and inland; found in most areas of Queensland; estimated up to 24 million feral pigs in Australia.
Rabbit	<i>Oryctolagus cuniculus</i>	Class 2	Rabbits are spread throughout Queensland, with high populations found in the granite belt, and the southwest. Moderate populations are located in the southwestern and northwestern Darling Downs, Maranoa, southern Warrego, north Burnett and on the Atherton Tableland with isolated populations in the remainder of the State; within Queensland, rabbit distribution correlates well with particular soil types, especially those soil types that can be burrowed.
Red fox	<i>Vulpes vulpes</i>	Class 2	Are widespread throughout most of mainland Australia.
Water buffalo	<i>Bubalus bubalis</i>	No	Most found in the 'Top End' of the Northern Territory; introduced between 1825 and 1843 to provide remote settlements with meat; current population in the Northern Territory now estimated at 80,000.
Wild dog	<i>Canis familiaris dingo</i>	Class 2	Found throughout Queensland.

² Agile wallaby was the macropod most commonly identified as overabundant and problematic in some areas, but other species mentioned include wallaroos and kangaroos, thus our results should be interpreted cautiously because of uncertain taxonomic identification by managers.