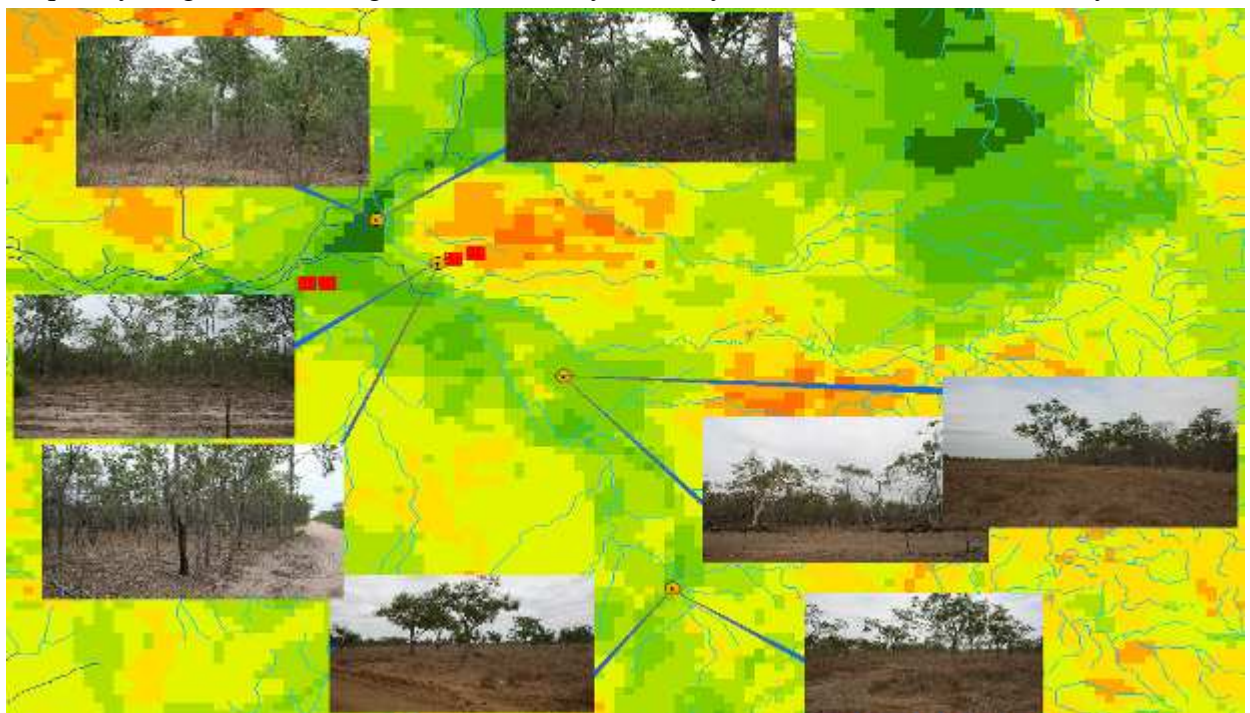
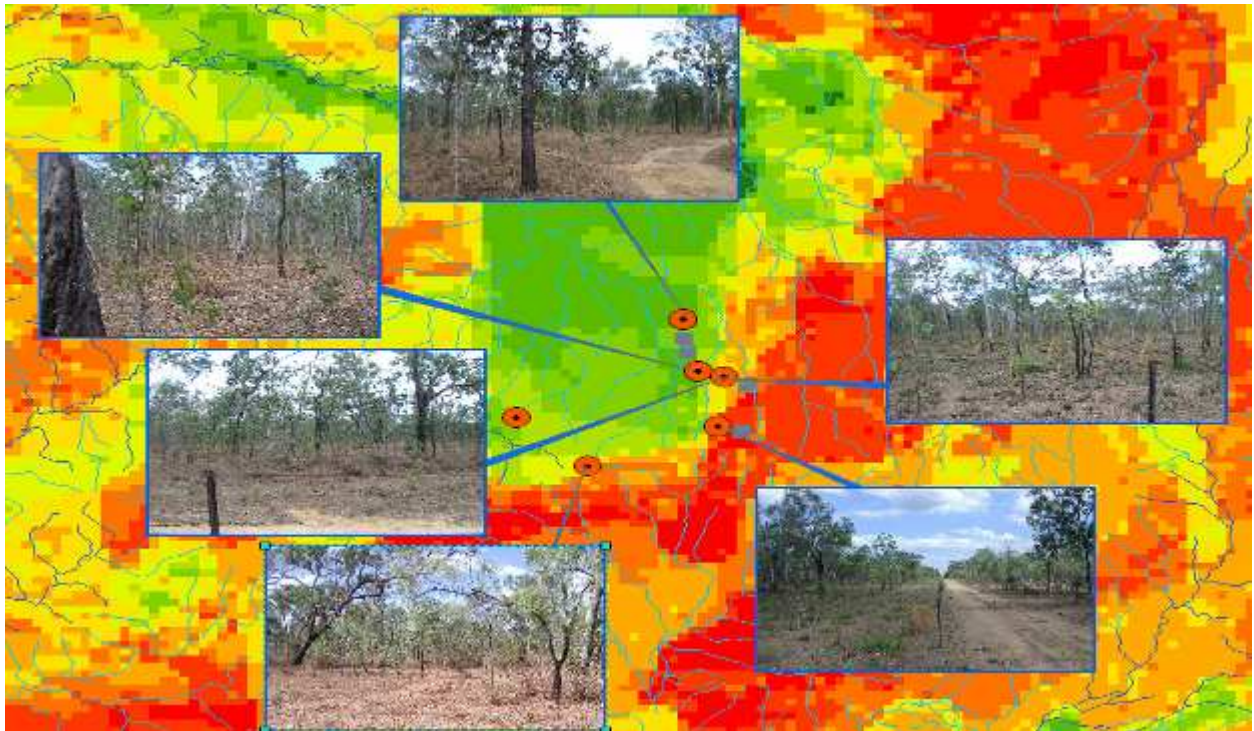


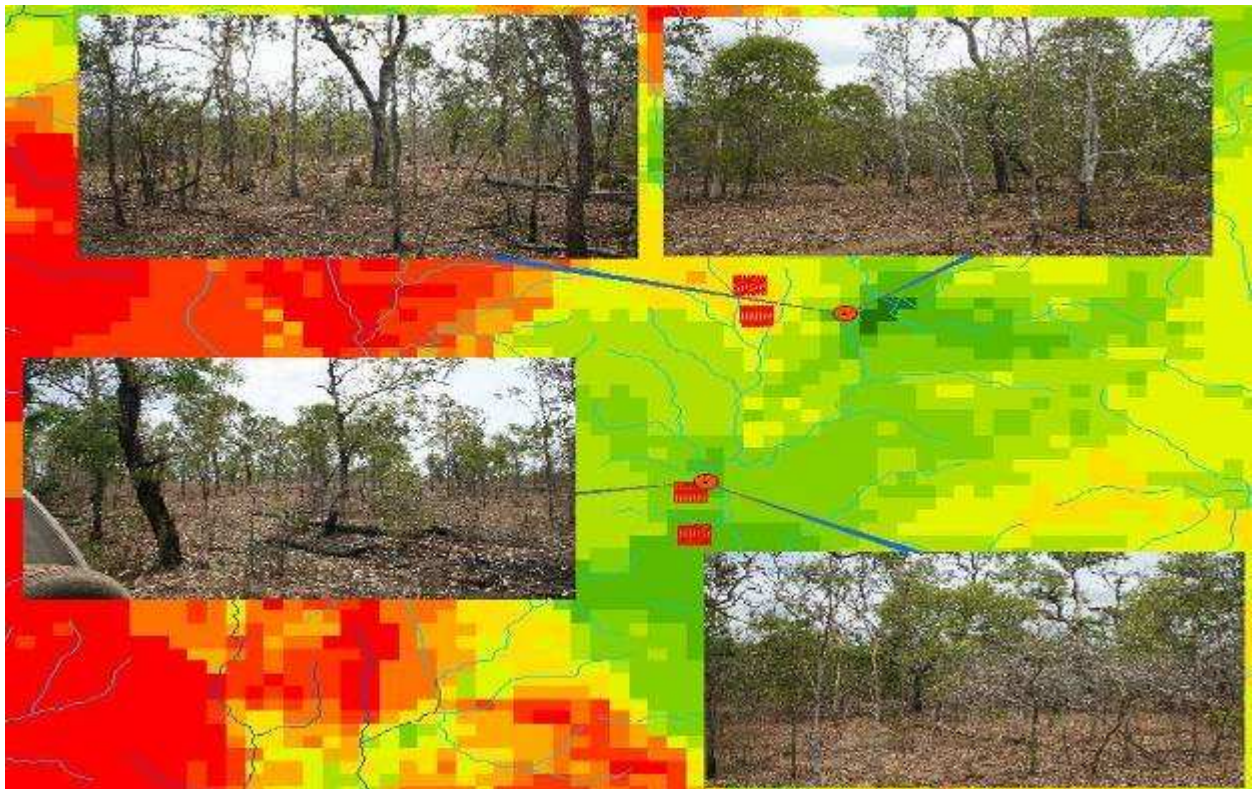
**Figure 2.3:** The fire frequency layer in relation to suspected woody thickening points (orange) and woody vegetation grid count locations (red squares) on Property 2. Fire frequency ranges from dark green (0 out of 9 years) to yellow to dark red (9 out of 9 years).



**Figure 2.4:** The fire frequency layer in relation to suspected woody thickening points (orange) and woody vegetation grid count locations (red squares) on Property 6. Fire frequency ranges from dark green (0 out of 9 years) to yellow to dark red (9 out of 9 years).



**Figure 2.5:** The fire frequency layer in relation to suspected woody thickening points (orange) and woody vegetation grid count locations (grey squares) on Property 7. Fire frequency ranges from dark green (0 out of 9 years) to yellow to dark red (9 out of 9 years).



**Figure 2.6:** The fire frequency layer in relation to suspected woody thickening points (orange) and woody vegetation grid count locations (red squares) on Property 8. Fire frequency ranges from dark green (0 out of 9 years) to yellow to dark red (9 out of 9 years).

### 2.3.2. Comparison of grid counts in locations of 'Frequent' and 'Infrequent' fire regimes

Changes in woody vegetation in the period from the mid to late 1950's up until 2008 were assessed in relation to fire frequency by comparing the grid counts conducted on historical aerial photography with grid counts conducted on contemporary photography flown in July 2008. On each property, 'woody' or 'non-woody' vegetation presence was counted within grid squares on sites classified as having a 'Frequent' fire regime (2 sites; n = 200) and an 'Infrequent' fire regime (2 sites; n = 200).

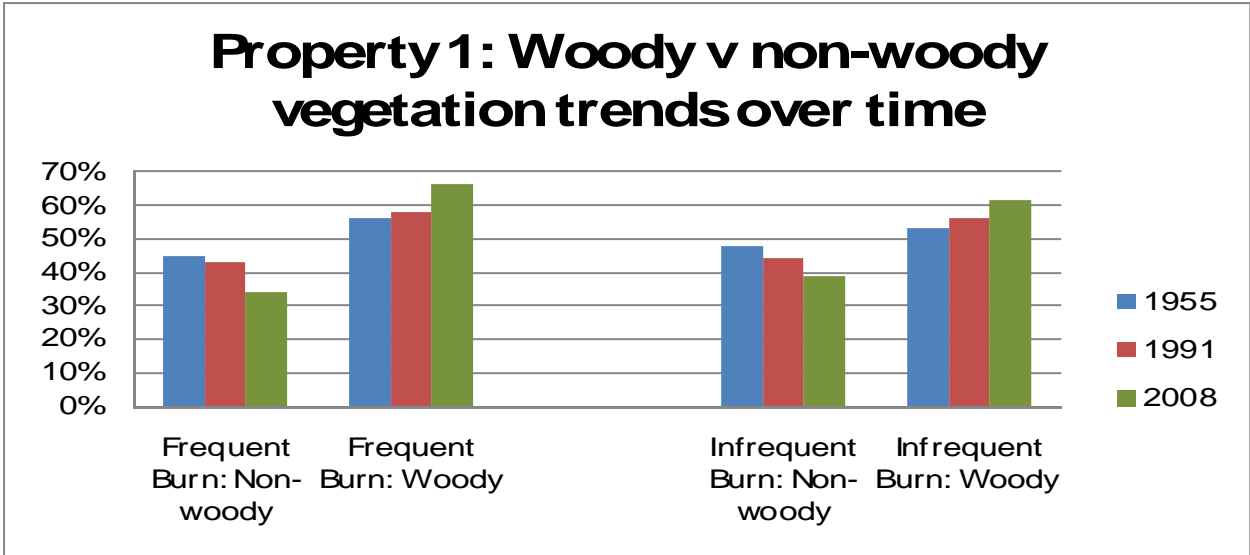
The timing and frequency of the fires for each of these regimes on each property is summarised in Table 2.3. By definition, early season fires were mapped as occurring before August 1 in any year. Dry season fires occurred between August 1 and November 15. Storm season fires were mapped as occurring after November 15 in any year. Although not the classic definition of storm-burning as per Crowley and Garnett (2000)<sup>3</sup>, an indication of the closeness of the fire date to the 'normal' wet season commencement was required.

**Table 2.3:** The timing and frequency of 'Frequent' and 'infrequent' fire regimes on properties where grid counts were conducted for woody cover change assessment.

Property code	Average 'Frequent' Fire Regime - timing and number of fires in 9 years	Average 'Infrequent' Fire Regime - timing and number of fires in 9 years
1	Mainly storm season burnt - 2.9 of the 3.4 fires	Burnt once in dry season, 0.5 times in the storm season
2	Mainly storm season burnt - 2.9 of the 5.3 fires	Burnt once in storm season
6	Half storm season burnt - 2.6 of the 5.6 fires, 2 early season and 1 in the dry season	Burnt once in storm season
7	Mainly early and dry season burnt - 6.6 out of 7.5	Burnt 1.8 times in storm season
8	Mainly early and dry season burnt - 3 out of 5	Mainly storm season burnt - 1 out of 1.3 fires

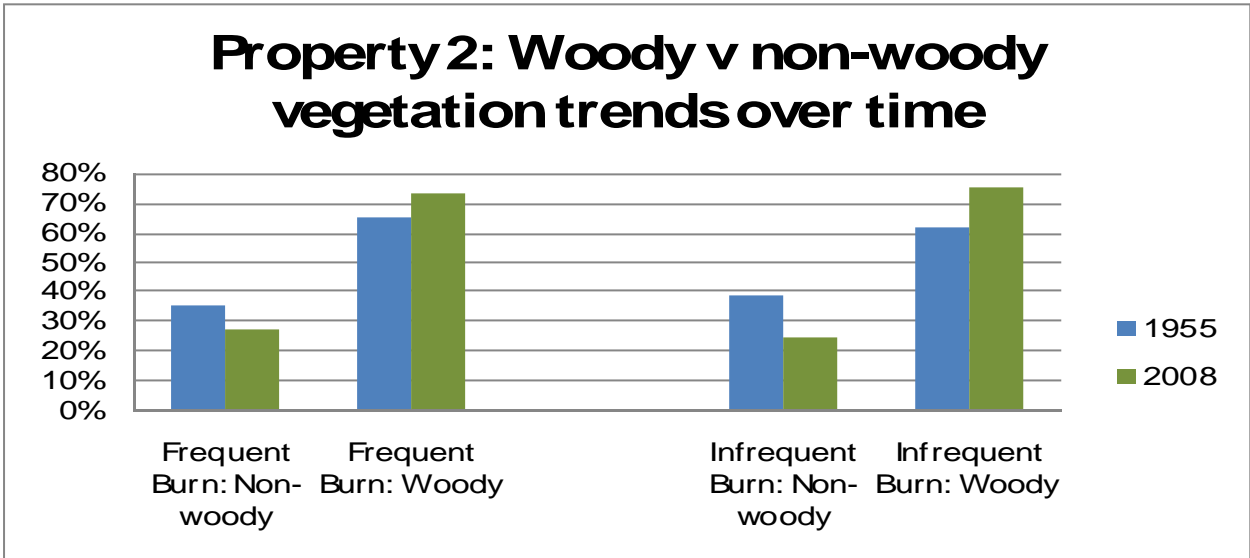
Figure 2.7 shows that the woody vegetation % has steadily increased in both the 'Frequent' and 'Infrequent' burn regime sites on Property 1 over the past 50 years. The fire frequency does not appear to have greatly affected the rate of woody thickening. The woody vegetation at sites examined on Property 1 has generally 'thickened' in the past 50 years, with most of this occurring in the past 17 years. The past 17 years have seen a decade of increased rainfall leading up to a 5-year period of reduced rainfall.

<sup>3</sup> North Australia wide publications on fire refer to fires before Aug 1 as "early dry season fires" and fires after this as "late dry season fires". "Storm burns" are not storm-burns unless they are lit within three days of the first heavy storms [Crowley GM and Garnett ST (2000). Changing fire management in the pastoral lands of Cape York Peninsula: 1623 to 1996. *Australian Geographical Studies* 38, 10-26].

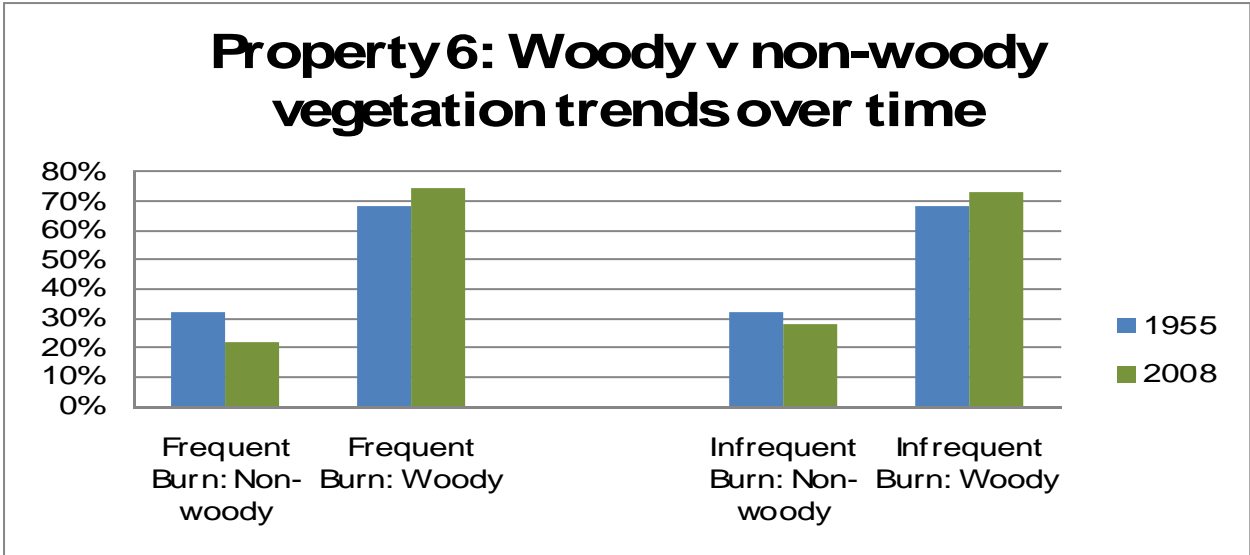


**Figure 2.7:** Change in woody vegetation % cover over time at two ‘Frequent’ and two ‘Infrequent’ burn sites on Property 1.

The same steady trend in woody thickening independent of fire frequency was seen on Property 2 sites (Figure 2.8) and Property 6 sites (Figure 2.9), though the scale of the increase was not as pronounced on Property 6 as it was for Properties 1 and 2.



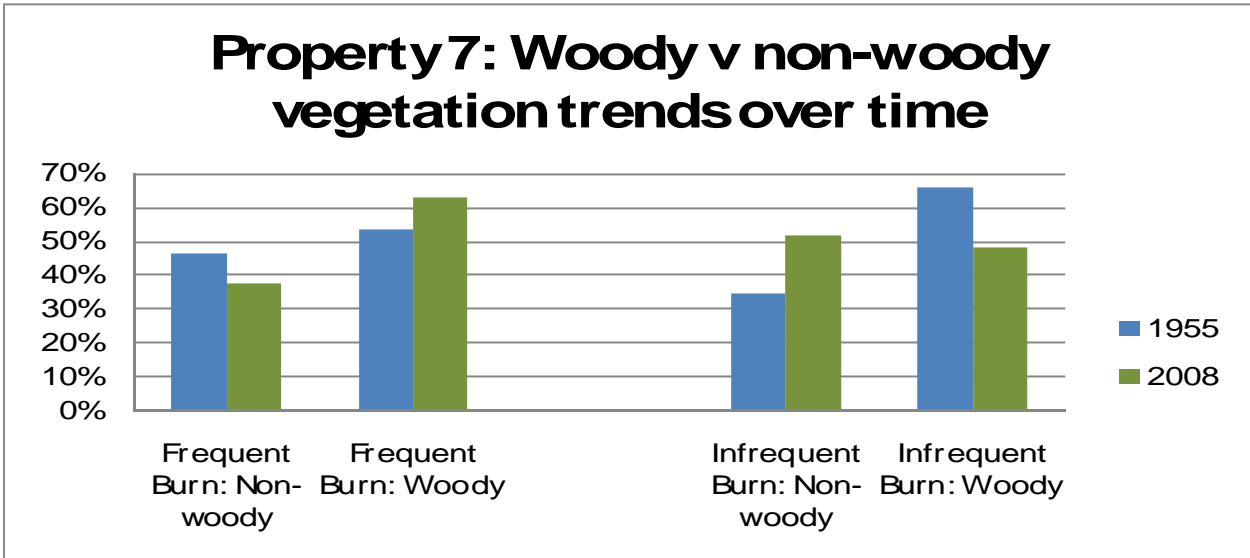
**Figure 2.8:** Change in woody vegetation % cover over time at two ‘Frequent’ and two ‘Infrequent’ burn sites on Property 2.



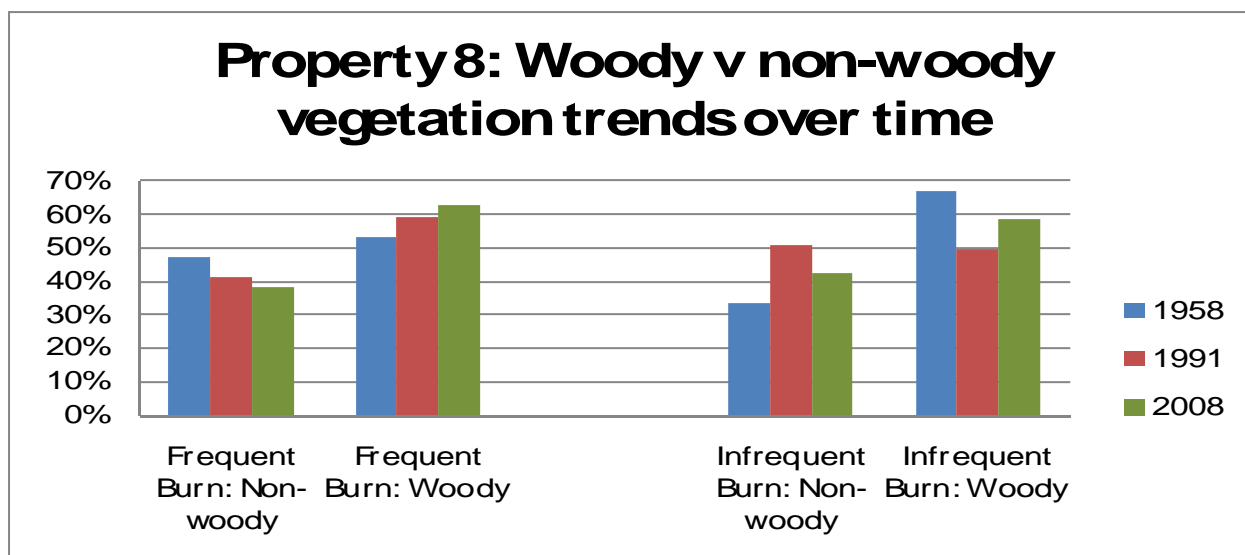
**Figure 2.9:** Change in woody vegetation % cover over time at two ‘Frequent’ and two ‘Infrequent’ burn sites on Property 6.

Inexplicably, the grid count sites on Properties 7 and 8 have shown a different trend (Figures 2.10 and 2.11). Although the ‘Frequent’ burn sites showed an increase in woody vegetation cover in line with the other 3 property sites, the ‘Infrequent’ burn sites on both Properties 7 and 8 experienced a reduction in woody vegetation cover.

The reduction in woody tree and shrub count between 1955 and 2008 in the ‘Infrequent’ burn areas at Property 7 may be real, or may be a function of exaggerated ‘woody’ cover estimates arising from the 1:50,000 scale 1955 photos (as described in 2.1.3.1.).



**Figure 2.10:** Change in woody vegetation % cover over time at two ‘Frequent’ and two ‘Infrequent’ burn sites on Property 7.



**Figure 2.11:** Change in woody vegetation % cover over time at two ‘Frequent’ and two ‘Infrequent’ burn sites on Property 8.

The data from woody vegetation grid counts is inconclusive and does not allow us to draw any conclusions as to the relationship, if any exists, between fire frequency and woody vegetation cover. The diversity of responses we have encountered emphasises the need to investigate the causes of these differences.

The trend of woody vegetation cover increasing in the past 50 years seen on all frequently burnt sites and on 3 of the 5 infrequently burnt sites substantiates anecdotal evidence that Cape York Peninsula is ‘thickening up’.

The small increase in woody cover apparent in Property 1 (Figure 2.7) at both ‘Frequent’ and ‘Infrequent’ burn sites, and the large decrease in woody cover measured on Property 8 at the ‘Infrequent’ sites (Figure 2.11) in between the late 1950’s and 1991 shows that the current thickening trend may not be long term and may be driven in part by climatic conditions. A general decline in rainfall was seen for almost two decades from the early 1970’s leading up to the 1991 sampling date (Figure 2.1).

### 2.3.3. Comparison of tree basal area, canopy cover and ground cover in ‘Frequent’ and ‘Infrequent’ fire regimes

On-ground measurements of tree basal area, canopy cover and ground cover in ‘Frequent’ and ‘Infrequent’ fire regime sites has been examined to ascertain whether any vegetative trends can be associated with fire history on each property.

Correlation of on-ground woody cover measurements from each property with fire frequency showed no apparent relationship. In order to determine if this lack of relationship was purely due to a small sample size the measurements from all properties were pooled and correlated with the mapped fire frequencies for each measurement site.

Correlations show that even when using a larger sample size ( $n = 310$ ) fire frequency could not related to either tree basal area ( $r^2=0.039$ ), canopy cover ( $r^2=0.002$ ) or the amount of ground cover ( $r^2=0.004$ ).

The data from the on-ground vegetative measurements and the aerial photo grid counts are complimentary and point to the conclusion that fire frequency is not having a significant effect on woody vegetation dynamics. This lack of relationship is not surprising as the factors affecting the sites are so variable, particularly vegetation type, stocking rate and season of burn which may be more important than frequency.

#### **2.4. Conclusions drawn from linking fire history to environmental state and change**

No relationship could be established between fire frequency and the apparent woody thickening that has occurred particularly in the last 2 decades measured through aerial photo analysis.

No relationship could be established between fire frequency and the on ground measurements of woody cover – basal area, canopy cover and ground cover.

The lack of relationship may be because the factors affecting the sites are so variable, particularly vegetation type, stocking rate and season of burn.

It is likely that the intensity of a fire is more important than frequency of fire in determining the effect on landscape ‘woodiness’. Grazing pressure in each of the study sites may have reduced fire intensity.

The diversity of responses emphasise a need to further investigate the causes of the causes of woody thickening and thinning.

It would appear that medium term rainfall trends may also be an important factor affecting landscape ‘woodiness’.

There is the possibility that the relationships are clouded because the fire frequency data, mapped in the past 9 years, is not representative of a longer time period. (However, strong relationships between fire frequency and underlying landscape features such as soil, regolith, landform etc suggest that the mapped fire frequency is representative of a long term period).

Elevated levels of carbon-dioxide in the atmosphere may also be contributing to increased woody species growth.

Fensham et al. (2005) conclude that fire could not be related to woody cover change and that correlation of biodiversity measures with fire frequency and landuse must also take into account historical rainfall which has been positively related to changes in woody cover.

This relationship is disputed by Verlinden and Laamanen (2006) who found differences in tree occurrence, regeneration and stem diameter distributions between areas of low and high fire frequencies.

#### **References**

- Fensham, R.J., Fairfax, R.J. and Archer, S.R (2005). Rainfall, land use and woody vegetation cover change in semi-arid Australian savanna. *Journal of Ecology* **93**, 596-606
- Verlinden, A. and Laamanen, R. (2006). Long term fire scar monitoring with remote sensing in northern Namibia: relations between fire frequency, rainfall, land cover, fire management and trees. *Environmental Monitoring and Assessment* **112**, 231–253

### **OBJECTIVE 3 - Model Development**

#### **KEY PERFORMANCE INDICATORS FOR OBJECTIVE 3**

1. Incorporation of financial and environmental information into model of economics of fire management.
2. Model testing and review.
3. Assess predictive capacity of the model.

#### **OUTPUTS FOR OBJECTIVE 3**

1. Incorporation of financial and environmental information into model

Time frame – 08/2007 to 03/2008

Financial and environmental information has been incorporated into tailored spreadsheet models for 8 individual properties.

2. Model testing and review

Time frame – 04/2008 to 05/2008

A model incorporating the information from all properties has been produced and testing has been conducted relating its outputs to financial data collected from the 8 real cattle properties.

3. Assess predictive capacity of the model

Time frame – 06/2008 to 07/2008

A project team “model predictive capacity assessment” visit was carried out on 6<sup>4</sup> of the 8 properties involved in the survey during October 2008. Overall, the landholders agreed with the model findings and a few inaccuracies were addressed. Landholders will be free to make further adjustments to their models (included in their post-project “information pack” – see below) to reflect current revenues and expenditures.

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<sup>4</sup> Of the remaining two, one landholder was unavailable and the other (P7) too busy actually fighting fires.

## **MILESTONES FOR OBJECTIVE 3**

### **3.1. Model of economics of fire management produced**

#### *3.1.1. Model development methods*

The CYP fire management property-level tool developed for this project is a spreadsheet model that allows landowners to input their specific situations in order to get financially compiled information. The tool itself is based on the integration of two approaches to modelling (Clewett *et al.* 1991), one perspective, relying upon user inputs for their accuracy, and a scientific perspective whose accuracy depends on reliable knowledge of biological relationships describing climate, soil, plant and animal interactions.

The property level tool draws on the adaptation of a more generic tool or model for estimating private benefits and costs from fire management on a hypothetical property in CYP. Prior to this project a workshop was organised to draw on the knowledge of as wide a selection of the CYP pastoral community as possible, particularly those with long experience of fire management in the region. The approach had four elements: maximise attendance, elicit information freely, transparently situate information in the region and ensure information ownership. A workshop was organised at minimal cost to participants at a readily accessible property in a central location on the Peninsula. The workshop was organised by the CYP Landcare Group whose network includes landowners from all the relevant properties. Also, included among those running the workshop were two ecologists and two pastoral advisors, who had each been interacting with the pastoralists for at least 15 years and had built up high levels of trust in the community. The workshop was held at the homestead of a pastoral property whose owners are well-respected on CYP for both their fire and pastoral-related knowledge. As a result the workshop was well-attended and included pastoralists with more than ten years fire management on CYP (43% of attendees, two of whom each had more than 50 years experience), Indigenous pastoralists (14%), and pastoralists with fewer than 5 years' experience (33%). Participants travelled an average of 1.5 hrs return (range 0-20 hours).

To elicit information for the generic tool about costs in ways that did not reveal private information relating to individual properties, participants at the workshop were asked to provide information for a fictional property of approximately 1,100 km<sup>2</sup>, "Pretend Plains", set in the centre of the study area. Pretend Plains had characteristics of many of the properties of the region without being identical to any of them. This included a variety of infrastructure including the homestead itself, holding yards for cattle, tracks, fenced and unfenced country and, as can be seen in Table 3.A, a putative herd size of 2,830 AE based on optimal stocking densities previously estimated for each of the vegetation types characteristic of the region (following Cotter 1994).

In order to encourage full consideration of all factors influencing fire management and its costs, as well as ownership of the information, participants were told that they were neighbours to Pretend Plains and were providing advice to a new owner who had not lived in the region before. This was personified at the meeting by a Canadian economist who attended the workshop with his wife and family. This enabled local people to display their knowledge not just of the financial aspects of property management, but also to pass on some of the local traditions, including roles that different members of the family might be expected to play in the running of the property.

The workshop was facilitated by a well-respected pastoral extension officer. Introductory sessions described the history of fire on CYP and the objectives of the

workshop. The property and its new owner were introduced and a broad framework for valuations of fire management presented.

The model was based on parameters and estimates that were provided by participants. Participants proffered costs of the full range of activities that take place on a cattle property. Subsequent to the workshop, quantification of some parameters identified as important by workshop participants but unavailable to them (e.g. probability distribution of timing of rainfall events) were derived from published data. Full details of the generic modelling outcomes can be found in Drucker *et al.* (2008).

The model seeks to account for interactions between land, pasture, trees and livestock within the context of climatic variability. This is achieved through analyses of the costs and benefits of a baseline (no wildfires) against alternative fire management regimes representing cumulatively increasing levels of fire management intensity. Further development of the model took place once an analysis of the economic data for each property was complete. The property gross margin analyses were also undertaken at that time.

Figure 3.1 shows a draft diagrammatic representation of a general structure for estimating the financial returns associated with a given fire management regime<sup>5</sup>.

Once an estimated probability of a station burn<sup>6</sup> has been calculated, it is possible to explore the impact of the burn in terms of yearly forage availability and hence changes in benefits between the different regimes. The estimated probability and area of station burns will also impact a number of cost variables such as cattle and fence replacement, and suppression costs. Net Present Values (NPVs)<sup>7</sup> will be calculated for each of the alternative management regimes<sup>8</sup>.

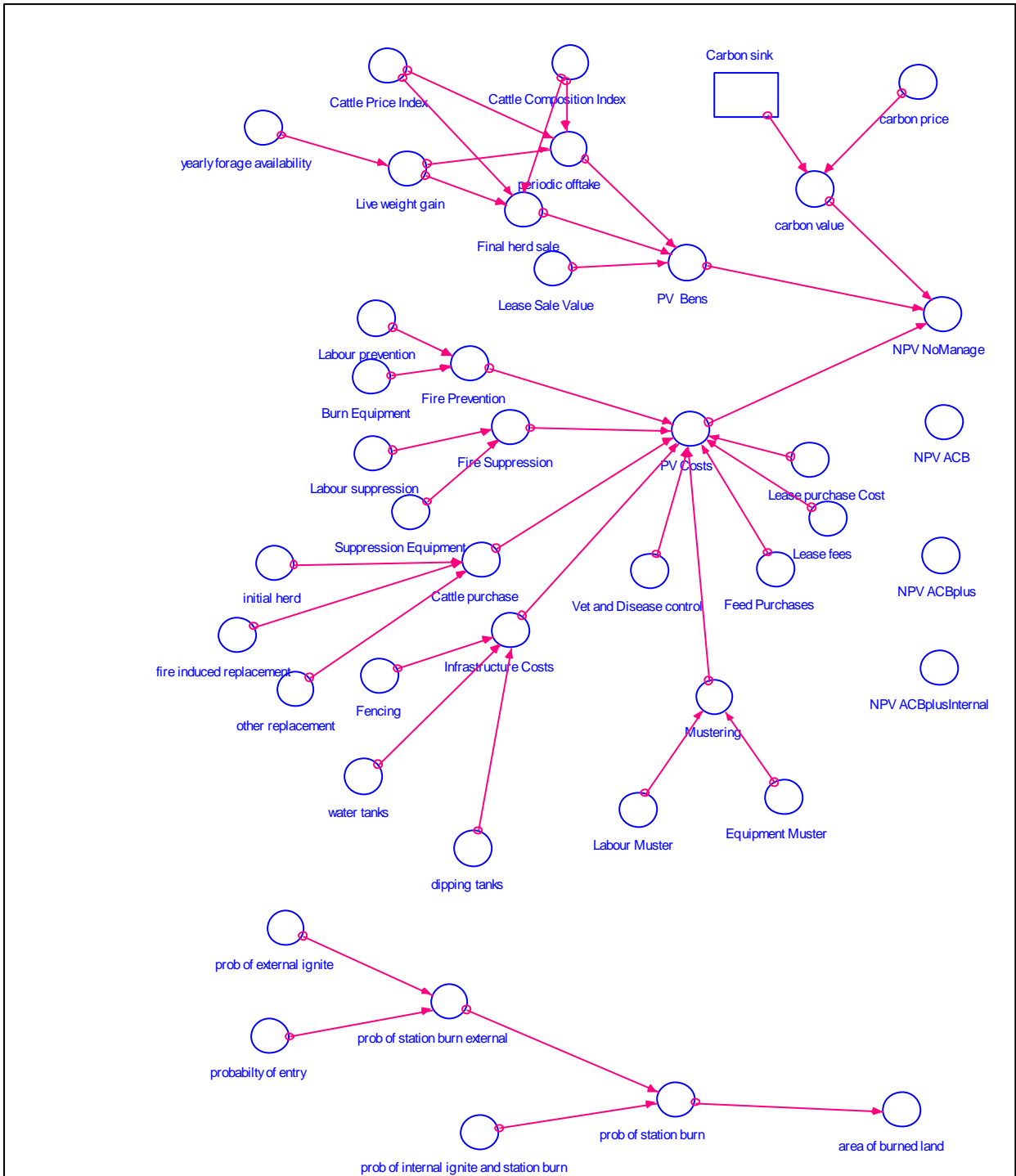
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<sup>5</sup> All circles that do not have an arrow entering them are data variables. All circles that have arrows entering them are calculated values based on the data variables.

<sup>6</sup> Note that the probability of ignition and station burn model is not linked to the NPV calculations in the diagram. The links are too numerous to show diagrammatically.

<sup>7</sup> NPV is a measure of the economic returns of a given activity and is calculated by discounting the various benefit and cost streams into present values (PV Bens and PV costs in the diagram) and adding them together. The differences between the net present values will permit an assessment of the relative financial performance of each management regime.

<sup>8</sup> The diagram currently shows how the NPV is calculated for the “no fire management” alternative (NPV NoManage). A similar diagram can be constructed for the other alternatives, which are listed but, for simplicity, not linked in this diagram.



**Figure 3.1:** Diagram of a Draft General Structure of Variables Influencing Financial Returns of a Fire Management Regime.

As part of the current project and drawing on the resulting generic model, specific economic survey questions were drawn up (see APPENDIX ONE) for eight individual CYP landholders, selected across a range of fire frequency locations, land quality locations and degrees of production intensity. This individual property data was then used to adapt the generic model to a set of individual property level models or tools.

The results arising from these eight individual property models and a comparable version of the generic model are the subject of the comparative analysis carried out below.

### *3.1.2. Description of the decision-support tool*

The structure of the financial analysis model within the spreadsheet was based on five components: the baseline scenario and four alternative fire management regimes. The baseline scenario estimated the financial costs and benefits assuming *no considerations for wildfire*. We then add the consideration of wildfire to the baseline scenario with four fire management responses, each cumulatively increasing the level of fire management investment. Costs and benefits were determined for: regime 1, where wild fires occur but no action in response to these fires is taken; regime 2, which adds the fighting of fires (i.e. reactive fire suppression); regime 3, which includes the costs and benefits of EDS burning for the prevention of wildfire spread; and regime 4, which adds the costs and benefits of storm-burning. Each of the model components, and the resulting financial implications, are described below. On the benefit side, they include the periodic off-take of cattle minus sale and transportation fees. On the cost side they include variable costs related to regular livestock management activities (e.g. supplements and feed, veterinary care and supplies, tags, horses/dog feed and replacement, labour and helicopter use). Fire suppression, prevention and/or storm-burning expenditures (labour and equipment costs for implementation of a given fire management regime) are also considered together with costs related to the replacement of fire damaged infrastructure (e.g. fences); supplements/feed costs due to forage loss resulting from fire; additional post-fire mustering costs (labour and equipment); and reduced carrying capacity due to vegetative thickening in the absence of storm-burning.

Fixed or (quasi-)fixed costs related to annual lease fees, insurance and legal costs, office expenditures, vehicles/grader repairs and maintenance, fuel, infrastructure maintenance – yards, dams, lick sheds, traps, etc. and weed control were not included in the calculations. This is because the model assumes that stocks of capital to run the operation (i.e. land, machinery, animals, knowledge, etc.) are already in place and need only maintenance, not purchase. Although much of this capital has an opportunity cost, in that it could be used in other economic endeavours, it is assumed that, despite low financial returns, the capital will stay in cattle management because of personal attachment to country, a desire to maintain a way of life, and the appreciating values of cattle properties. Hence, opportunity costs of capital are not included. Gross margins (including in present value terms) can subsequently be calculated and compared over a range of different fire management regimes, time horizons, discount rates, wildfire probabilities and season (dry/wet) lengths.

Given the uncertainties involved in estimating herd sizes (due to the existence of feral animals and limited information regarding existing herd sizes and structures, etc.), stated herd sizes and structures were adjusted to be consistent with the stated number of cattle sold each year. Furthermore, in the absence of any regular cattle purchases, herd sizes and structures were designed to be consistent with self-replication. Income figures based on the number of cattle sold were determined by taking an average over the survey period.

### 3.1.3. Findings

As can be seen in Table 3.A, the properties surveyed varied in terms of area used from 30,360 (property 7 = P7<sup>9</sup>) hectares to 126,000 hectares (P1)<sup>10</sup>. The number of animal equivalents (AE) estimated to be on each property varied from just under 1,000 (P3) to just under 5,000 (P7), resulting in stocking rates (ha/AE) of 6.1 (P7) to 120.4 (P3). For “Pretend Plains”, the hypothetical property (P0) on which the generic model is based, these numbers are 113,800, 2,829 and 40.2, respectively, indicating that Pretend Plains is broadly representative of the properties actually surveyed.

**Table 3.A:** Production characteristics of the pastoral properties that participated in the model development.

Property Code	0	7	4	1	6	2	5	8	3
<b>CYPastoral Property Production Characteristics</b>									
Area on which cattle are run (ha)	113,800	30,360	77,200	125,786	124,000	31,390	145,000	71,126	115,231
AE(number)	2,830	4,961	2,458	3,170	3,589	1,666	2,483	3,263	957
Stocking Rate	40.2	6.1	31.4	39.7	34.5	19.0	58.2	21.8	120.4

#### 3.1.3.1. Property Gross Margin Analyses (Milestone and Output 1.3)

As can be seen in Table 3.B, the numbers of cattle (head) sold p.a. varied between 228 (P2) and 1,010 (P7), generating income (\$ p.a.) varying from approximately \$40,000 (P3) to \$496,000 (P7). Total variable costs were made up of feed, supplements and veterinary care, labour and mustering (including helicopter use and horses and dogs). In addition, a measure of reduced productivity in the absence of storm burning in ti-tree flats was also included (ranging from \$766 - \$3660, see below). Gross margin (GM) per property thus ranged from a loss of approximately \$26,500 (P3) to positive returns of \$248,000 (P7), leading to a baseline (GM/AE) in the absence of wildfires of -\$27.68 (P3) to +\$49.90 (P7). The respective figures for the generic property P0 are 579 head, \$236,000, \$98,000, \$136,000 and \$48.02. Despite P0 having an average stocking rate and cattle sales, its total variable costs are relatively low compared to the actual properties surveyed. Hence, only P7 and P4 have similar GM/AE (as can be seen in Table 3.E.).

**Table 3.B:** Variable costs and revenues of the pastoral properties that participated in the model development.

Property Code	0	7	4	1	6	2	5	8	3
<b>CYP Pastoral Property Variable Costs and Revenues (\$)</b>									
Cattle sold (head p.a.)	579	1,010	350	496	450	228	234	300	100
Income (\$ p.a.)	236,317	495,905	170,800	191,104	232,750	71,464	59,454	79,750	40,000
Feed/Supp/Vet Costs	79,800	147,538	42,473	68,064	115,524	47,443	27,149	67,011	17,470
Non-Family Labour Costs	4,000	49,920	-	27,300	12,800	-	-	-	-
Mustering	10,080	36,000	8,000	16,200	55,440	14,175	22,174	8,400	45,360
Helicopter	-	-	7,200	12,600	18,000	3,000	-	-	-
Horses and Dogs	3,700	14,150	3,950	3,649	1,200	1,566	5,350	10,000	750
Total Variable Costs	97,580	247,608	61,623	127,814	202,964	66,184	54,673	85,411	63,580
Loss in Absence of Stormburning	2,872	766	1,949	3,175	3,130	792	3,660	1,795	2,908
Gross Margin	135,866	247,531	107,228	60,116	26,657	4,488	1,121	- 7,457	- 26,488

<sup>9</sup> In accordance with project ethics and confidentiality agreements, all property names have been coded and are only identifiable to the principal investigators.

<sup>10</sup> This is the area actually used, although physical land areas were twice this size at the top end of the range.

The reasons for negative returns on two of the properties (P8 and P3) are various but include low income and/or high feed/supplement costs and/or high helicopter/mustering costs. P8 is considered to have fairly poor quality land, while P3 has the lowest stocking rate of the survey sample.

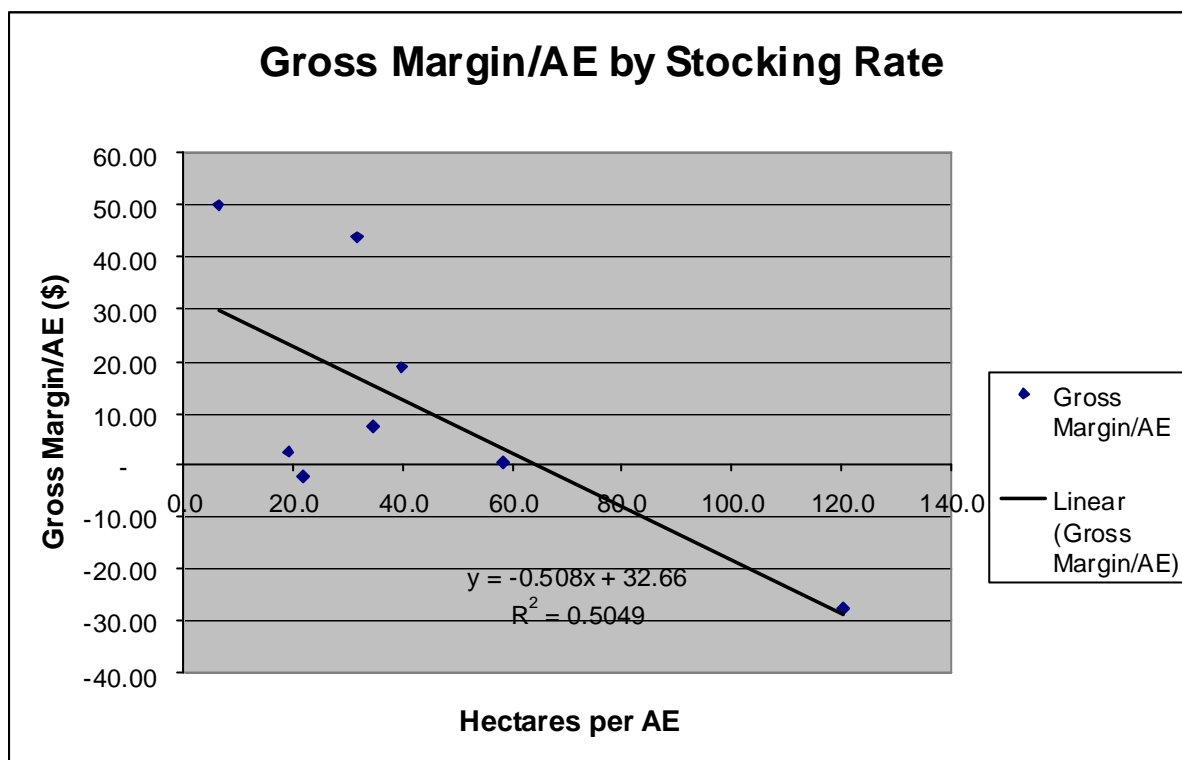
Overall, the baseline financial situation is broadly in line with stocking rate (ha/AE) with the exception of P4 and P6, both of which do better financially than would be otherwise suggested by their stocking rate. P2 and P8 do worse than might be expected. 6 out of 8 of the properties have stocking rates superior (i.e. fewer ha/AE) to that of P0.

Figure 3.2 reveals the negative relationship between gross margin/AE and the stocking rate. Higher gross margins/AE are associated with lower land requirements per AE according to the following relationship (t stats in parenthesis<sup>11</sup>) where y is gross margin/AE and x is the stocking rate expressed as hectares required per AE.

$$y = 32.66 - 0.508x \quad R^2 = 0.5049 \quad (1)$$

(2.998)\*    (-2.473)\*

Hence, every hectare less of land that is required to support an AE results in an increase of \$0.51 in gross margin.

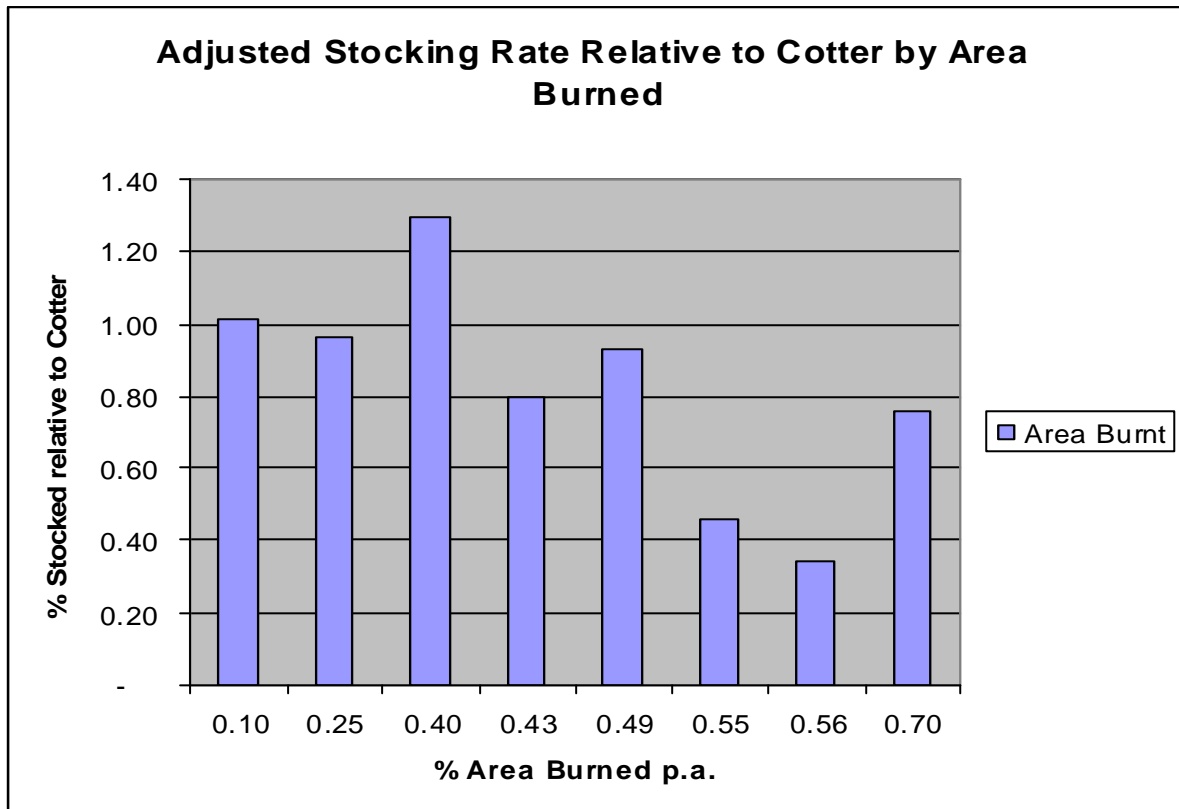


**Figure 3.2:** Gross Margin per Adult Equivalent (AE) as affected by stocking rate (ha/AE)

By contrast the relationship between land type (based on Cotter carrying capacities) and stocking rate was found not to be significant, possibly as other factors related to infrastructure

<sup>11</sup> \* = significant at 95% confidence level

(watering points and paddock fencing) play a greater role. Nevertheless, as can be seen in Figure 3.2a, 6 of the 8 properties were found to be understocked in absolute terms (once adjustments for partial property use had been made), with those properties (P6, P3 and P5) with the highest percentage areas burned each year (55%-70%) being the most understocked relative to Cotter carrying capacities (having only 34% -76% of cattle numbers compared to Cotter predictions); and those properties being burned the least (10% - 40%) being the most highly stocked relative to Cotter predictions.



**Figure 3.2a:** Adjusted actual stocking rate relative to estimated stocking rate as affected by area burned.

Gross margin/AE is also closely related to the percentage of the property area burned each year, as can be seen in Figure 3.3<sup>12</sup>.

Higher gross margins/AE are negatively associated with the average percentage of the property that gets burned each year according to the following relationship (t stats in parenthesis):

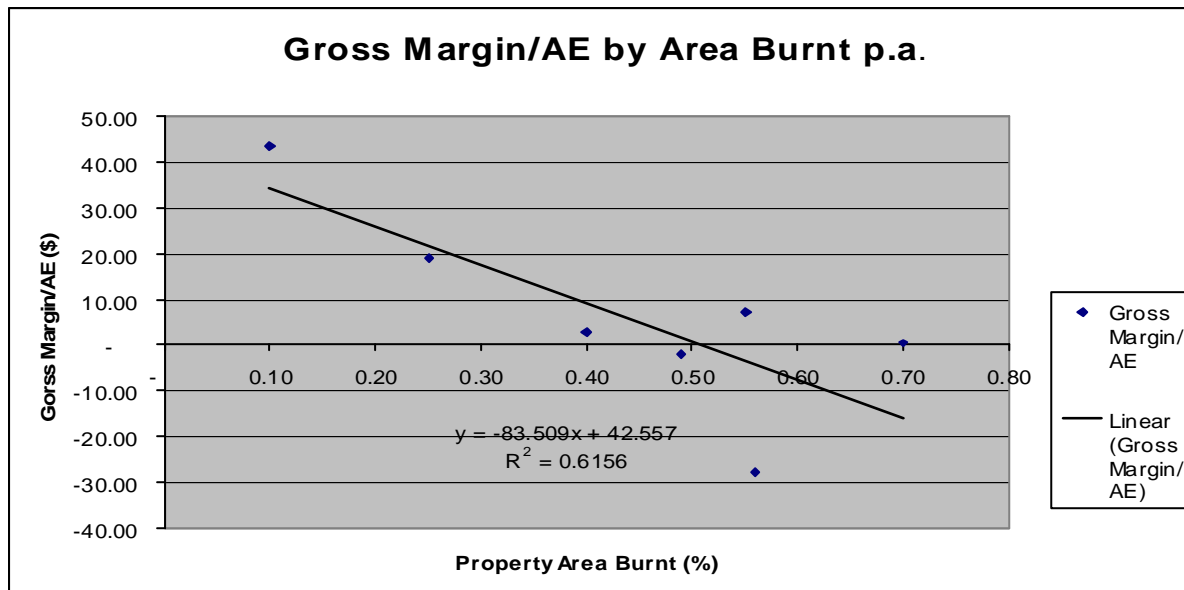
$$y = 42.56 - 83.51x \quad R^2 = 0.6156 \quad (2)$$

$$(3.036)^* \quad (-2.829)^*$$

where y is as above and x is the average percentage of the property burned p.a.

<sup>12</sup> P7 was excluded as an outlier, based on its particularly high intensity of management relative to the other properties.

Hence, every percentage increase in property area burned results in a decline in gross margin of \$0.83/AE.



**Figure 3.3:** Gross Margin per Adult Equivalent (AE) as affected by the average % of the property burned each year.

3.1.3.2. *Incorporation of fire frequency and management costs (Milestone and Output 3.1)*

A summary of the survey data related to wildfire frequency, probability of control under alternative fire management regimes and probability of getting burned out is presented in Table 3.C. A “fire year” is one during which one or more wildfires occur. Depending on whether these are controlled or not, they may result in a “burn year.” A “burn year” is one in which a significant proportion of the property (in the region of 60%, but can vary depending on landholder perceptions) gets burned out and results in increased supplemental feeding, mustering and/or infrastructure damage repair costs.

Based on the original workshop data provided by a group of CYP pastoralists, the P0 model assumes that fires will occur and burn out the property nearly every year (18/20) under regime 1 (do nothing) and in 11/20 years under regime 2 (fire suppression only). Under regimes 3 (fire suppression plus early dry season preventative burning) and regime 4 (regime 3 plus storm burning in ti-tree flats) fire years only occur in 2/20 years and only one of those burns out the property.

The individual property models suggest that, under regime 1, fires would burn out 5 of the properties every year, which is very much consistent with the P0 assumption (18 years out of 20). In the remaining 3 cases (P4, P1 and P2), fires would occur only half the time (10 years in 20) but would burn out the property on each occasion. As these 3 properties are in low to low-medium fire frequency areas, this finding is also broadly consistent with our expectations.

**Table 3.C:** Survey data summary related to wildfire frequency, the probability of wildfire control under alternative fire management regimes and the probability of getting burned out.

Property Code	0	7	4	7	6	2	5	8	3
<b>CYP Pastoral Property Fire and Burn Years+A2 under Alternative Management Regimes</b>									
<b>Regime 1</b>									
Fire years	18	20	10	10	20	10	20	20	20
Burn Years	18	20	10	10	20	10	20	20	20
Non-burn years	0	0	0	0	0	0	0	0	0
% fires controlled	0	0	0	0	0	0	0	0	0
<b>Regime 2</b>									
Fire years	18	20	10	10	20	10	20	20	20
Burn Years	11	20	0	9	10	0	20	20	20
Non-burn years	7	0	10	1	10	10	0	0	0
% fires controlled	0.4	0	1.00	0.1	0.5	1	0	0	0
<b>Regime 3</b>									
Fire years	2	13	5	5	20	10	10	13	6
Burn Years	1	2	0	3	0	0	8	0	5
Non-burn years	1	11	5	2	20	10	2	13	1
% fires controlled	0.50	0.88	1.00	0.50	1.00	1.00	0.25	1.00	0.17
<b>Regime 4</b>									
Fire years	2	13	5	5	20	10	10	10	6
Burn Years	1	2	0	3	0	0	8	0	5
Non-burn years	1	11	5	2	20	10	2	10	1
% fires controlled	0.50	0.88	1.00	0.50	1.00	1.00	0.25	1.00	0.17

Under regime 2 (which under P0 assumptions has fire fighting leading to a 40% chance of controlling fires), 5 of the properties have no or almost no success fighting fires, one has a 50% probability and the remaining 2 have total or near total success. Three of the five properties with zero fire fighting success (P7, P5 and P3) are in high fire frequency locations, while the two with total or near total success (P4 and P2) are in low to medium fire frequency locations. These findings are therefore also broadly in line with expectations.

Under regime 3 (which under P0 assumptions has fire fighting and preventative burning leading to a reduced number of fire years [2/20] and a 50% control probability), all but two (P6 and P2) have a reduced number of fire years relative to regimes 1 and 2. However, the extent in the reduction in wildfire years is not to the same extent as for P0. Nevertheless, this is partially balanced out by the fact that the probability of controlling a fire increases (from 0.17 to 1.0) to a somewhat larger extent than under the P0 assumptions ( $[(0.5-0.17)/0.4] = 0.25$ ). Overall, only P5 and P3 continue to have a very high number of burn years (8 and 5, respectively) compared to P0 (1 year), but both are in high fire frequency areas.

We also note that the above data helps to explain why those properties which are very successful in fighting fires under regime 2 still bother to engage in preventative burning as well. The reason would seem to lie with the impact that preventative burning has on the number of years in which wildfires occur and need to be fought. For all but two properties (P2 and P6) a substantial decline in fire years can be observed.

Regime 4 fire/burn results are by definition identical to those of Regime 3 (as it is broadly accepted that storm burning in ti-tree flats has no impact on wildfire frequency or control), with the exception of P8 who consider that storm burning can reduce fire years.

### 3.1.3.3. *Fire Management Regime Economics*

Fighting and controlling wildfires has an economic cost arising from the labour, fuel and equipment required. These are summarised in Table 3.D, both in terms of the undiscounted cost of getting burned out, as well as in terms of an annualised equivalent over a 20 year time horizon.

**Table 3.D:** The economic costs arising from fighting and controlling wildfires.

Property Code	0	7	4	1	6	2	5	8	3
<b>TABLE E: CYP Pastoral Property Fire and Burn Costs (Regime 1)</b>									
Annualised Average cost of fire, over time period	25,533	2,933	600	50	440	-	300	-	860
Total fire costs p.a. if burned	28,370	2,933	1,200	100	440	-	300	-	860
<b>Regime 3</b>									
Annualised Average cost of fire, over time period	6,764	9,297	913	900	2,020	850	394	4,735	6,211
Total fire costs p.a. if burned	42,811	14,174	4,850	3,640	2,460	1,400	848	5,140	10,018

In annualised terms, only P7 (\$2,900 has any significant costs associated with burn years. However, although never having incurred such costs, P4 would potentially have costs similar to that of P0, as it was stated that cattle would have to be fed for up to 2 months should the property be ever be burned out in October<sup>13</sup>.

Consequently, as there are seemingly few significant costs directly associated with getting burned out, there are only minimal costs (mostly related to fence repair) involved in doing nothing (regime 1). The resulting marginally lower gross margin/AE than the baseline for 6 of the 8 properties is not to the same extent as predicted by P0 assumptions (see Table 3.E). The differences between the best and worst case scenarios (which depend on whether fire and burn years happen early or late within the analytical period) for each regime are also small.

As under the P0 assumptions, 5 of the 8 properties have lower GM/AE for regime 2 than regime 3, showing that just fire fighting on its own is not sufficient. Furthermore, Regime 3 always has a lower GM/AE than the baseline, which is also consistent with the P0 assumptions, even if that difference is somewhat smaller. Regime 3 annualised control costs (Table 3.D) are also of a similar order of magnitude to those of P0 given that the frequency of burn years is much lower relative to the baseline and supplemental feeding is only one component of the costs.

Storm burning in ti-tree flats (regime 4/Table 3.E) avoids a loss of carrying capacity worth \$760 - \$3,660 p.a. depending on the property size. Given the relatively low costs of storm burning, gross margin under regime 4 is superior to that under regime 3<sup>14</sup>.

<sup>13</sup> To be strictly comparable with P0, it would be necessary to calculate the probability of a fire occurring in October or earlier. Hence, the above calculation for P4 is likely to result in an over-estimation of its annualised feeding costs.

<sup>14</sup> While more accurate data regarding stocking rates on different land types within a property remain to be determined, together with the degree to which open flats (15 ha/AE) may transform to lower carrying capacity ti-tree flats (60 ha/AE) in the absence of storm burning, a general figure based on P0 assumptions is used. This assumes that 1% p.a. of a given property, up to a maximum of 10% of the total property may be transformed over time in the absence of stormburning, costing the landholder \$0.025/ha.

**Table 3.E:** Pastoral property Gross margins/AE under alternative fire management regimes.

Total fire costs p.a. if burned	42,811	14,174	4,850	3,640	2,460	1,400	848	5,140	10,018
Property Code	0	7	4	1	6	2	5	8	3
CYP Pastoral Property Gross Margin per Animal Equivalent Under Alternative Fire Management Regimes									
<b>Baseline Financial Situation</b>	<b>48.02</b>	<b>49.90</b>	<b>43.62</b>	<b>18.96</b>	<b>7.43</b>	<b>2.71</b>	<b>0.45</b>	<b>- 2.28</b>	<b>- 27.68</b>
<b>4.1 Fire regime 1 (no suppression or management)</b>		-		-					
a) Annual Expected Net Present Value of Costs (AENPVC) A	38.99	49.31	43.37	18.95	7.30	2.71	0.33	- 2.28	- 28.58
b) Best Case Net Present Value of Costs B	39.49	49.31	43.43	18.95	7.30	2.71	0.33	- 2.28	- 28.58
c) Worst Case Net Present Value of Costs C	38.61	49.31	43.31	18.94	7.30	2.71	0.33	- 2.28	- 28.58
<b>4.2 Fire regime 2 (suppression but no management)</b>		-		-					
d) Annual Expected Net Present Value of Costs (AENPVC) D	39.22	47.88	42.87	18.39	7.23	2.38	0.11	- 2.62	- 34.58
e) Best Case Net Present Value of Costs E	40.60	47.88	43.05	18.53	7.25	2.46	0.11	- 2.62	- 34.58
f) Worst Case Net Present Value of Costs F	37.91	47.88	42.70	18.25	7.22	2.30	0.11	- 2.62	- 34.58
<b>4.3 Fire regime 3 (suppression and early burning)</b>		-		-					
g) Annual Expected Net Present Value of Costs (AENPVC) H	45.63	48.02	43.24	18.68	6.86	2.20	0.29	- 3.74	- 34.17
h) Best Case Net Present Value of Costs I	45.88	48.14	43.37	18.77	6.83	2.26	0.33	- 3.81	- 33.53
i) Worst Case Net Present Value of Costs J	45.03	47.76	43.10	18.57	6.83	2.10	0.25	- 3.86	- 35.54
<b>4.4 Fire regime 4 (suppression and early burning and storm-burning)</b>		-		-					
j) Annual Expected Net Present Value of Costs (AENPVC) L	46.64	48.18	44.04	19.68	7.74	2.67	1.76	- 3.14	- 31.14
k) Best Case Net Present Value of Costs M	47.00	48.93	44.40	19.85	7.83	2.98	1.82	- 3.09	- 30.27
l) Worst Case Net Present Value of Costs N	46.04	47.91	43.89	19.57	7.70	2.58	1.72	- 3.28	- 32.51

### 3.1.4. Assessment of predictive capacity of the individual models

A project team visit to 6<sup>15</sup> of the 8 properties involved in the survey was carried out during October 2008. The purpose of these visits was to allow the landholder to assess the predictive capacity of the individualised models following the above incorporation of the individual property data into the framework provided by the generic model. Furthermore, the visit provided an opportunity to correct any inaccuracies in the data used and explore together with the landholder how sensitive some of the findings were to particular cost factors.

Overall, the landholders agreed with the model findings, particularly with regard to the relatively low gross margins/AE that had been identified, as well as the high proportion of production costs related to licks, supplements, vaccines and mustering (with or without helicopter). A number of landholders did however note that the stocking rates calculated, which had been based on whole property land areas, tended to overestimate the true hectare/AE stocking rate on the actual areas used. Furthermore, the variability of annual cattle sales and the existence of only rough estimates regarding herd numbers (in some cases up to 30% of the whereabouts of the herd is unknown) meant that determining average costs over the period in question was extremely difficult.

It was nonetheless possible to address some of these issues in the individual models described above and landholders will be free to make further adjustments to their models (included in their post-project “information pack”) to reflect current revenues and expenditures.

<sup>15</sup> Of the remaining two, one landholder was unavailable and the other (P7) too busy actually fighting fires.

### 3.1.5. Conclusions

In general, the above findings per fire management regime are determined by both i) the stated costs of a burn year (supplemental feeding, fence repair and post-burn mustering) and; ii) the number of fire years and control probabilities (determining actual burn years) under alternative management regimes.

The relatively small differences between regimes, together with the observation that landholders are presumably acting rationally by putting plenty of effort into fire management (all operate under regimes 3 or 4), suggests that, in contrast to P0 assumptions, the costs of being burned out do not principally show up in terms of supplemental feeding. Instead the costs of fire and getting burned out tend to manifest themselves in the form of lower “safe” stocking rates, particularly on properties where large areas are burned each year. This was observable in Figures 3.1 and 3.2, where declining gross margin/AE was clearly associated both with increasing average annual burn areas and lower stocking rates. Figure 3.2a showed similar results relative to Cotter carrying capacity predictions.

Using such a finding to bring the P0 model assumptions more in line with actual property findings, we note that reducing post-burn feeding costs to zero (i.e. assuming that this would never be needed) would be equivalent in gross margin terms to a 14% reduction in the stocking rate (from 40.22 to 46.74 ha/AE) under Regime 1.

### 3.1.6. References

Clewett JF, Cavaye JM, McKeon GM, Partridge IJ and Scanlan JC (1991) Decision support software as an aid to managing pasture systems *Tropical Grasslands* 25, 159–164.

Cotter GF (1994) ‘A Study of the Pastoral Industry of Cape York Peninsula.’ Queensland Department of Lands (Brisbane).

Drucker, A.G., Garnett, S. T., Luckert, M., Crowley, G.M. and Gobius, N. (2008). Manager-based valuations of alternative fire management regimes on the Cape York Peninsula, Australia. *International Journal of Wildland Fire* 17, 660–673.

## MILESTONES FOR OBJECTIVE 3

### 3.2. CD copies of model available for distribution

Individualised information packs for each landholder are currently being prepared and will be posted to participating landholders by the end of the month. The information packs contain a summary of the overall project findings, an explanation of the results of the individual property model (MS Excel-based spreadsheet) and instructions on how to update cost and revenue data for future use.

An example of an information pack accompanies this report. A generic version of the model is also included (see APPENDIX FIVE - **Individualised information packs**).

## **OBJECTIVE 4 - Awareness and communication**

### **KEY PERFORMANCE INDICATORS FOR OBJECTIVE 4**

1. Project awareness seminars.
2. Detailed report of the outcomes of the project.
3. Project team presentation.
4. Project outcome seminars and publicity.

### **OUTPUTS FOR OBJECTIVE 4**

1. Awareness seminar flyers.

Time frame – 06/2007 to 08/2007

2. Report writing

Time frame – 04/2008 to 08/2008

3. Team presentation day program.

Time frame – 08/2008

4. Project outcome seminars and publicity.

Time frame – 08/2008

### **MILESTONES FOR OBJECTIVE 4**

#### **4.1. 3 awareness seminar held**

Three project awareness seminars were held with landholders in Cape York Peninsula to advise them about the commencement of the project and call for volunteers to be part of the project. These seminars were held at:

- Lakeland Downs on the 23<sup>rd</sup> of April 2007,
- Musgrave Roadhouse on the 24<sup>th</sup> of April 2007 and
- Weipa on the 1<sup>st</sup> of May 2007.

Unfortunately, attendances were not up to expectations as the time conflicted with cattle station work being undertaken just after the wet season finish. However, we did manage to secure commitments from several properties.

To view the PowerPoint presentation delivered at these seminars see:

**APPENDIX TWO –Economics of Fire project Presentation Apr-May 07**

At these seminars and at other opportune moments a brochure describing the project's aims and objectives has also been distributed. This brochure also calls for volunteers to be part of the project and describes the requirements for volunteer involvement and the benefits they would receive from being part of the project.

To view the 2 page brochures we distributed see: **APPENDIX THREE – Economics of Fire Project Brochure**

#### **4.2. Team presentation seminar held**

On the Sunday the 12<sup>th</sup>, Monday the 13<sup>th</sup>, Tuesday the 14<sup>th</sup> and Wednesday the 15<sup>th</sup> of October, 2008 six presentation seminars were held throughout Cape York

#### **4.3. 3 project-outcome seminars held**

As 6 presentation seminars have already been held throughout Cape York Peninsula no other seminars are planned. Instead we plan to distribute the Project Outcome Brochure at a Queensland Grazing Symposium to be held in Cairns on the 26<sup>th</sup>/27<sup>th</sup> November, an initiative of the Queensland Regional Collective. This meeting will have representatives of the grazing industry from all Regional NRM Groups in Queensland.

We will also have an attendance at the Northern Gulf Annual General Meeting where a short presentation will be given and brochures distributed.

Project outcome brochures will also be sent to the Grazing Land Officer of the Southern Gulf Regional NRM Group at Mt Isa.

#### **4.4. Brochures distributed**

Project awareness brochures were disseminated in 2007.

In October 2008 a brochure outlining the main findings of the project was been produced and will been sent to all Cape York pastoral properties.

To view the 2 page brochures we distributed see:  
**APPENDIX FOUR – Economics of Fire Project outcomes brochure**

#### **4.5. Web-site upgraded**

Brochures, results and the final report for the project will be uploaded to the CYPDA website upon approval of the final report by DAFF.

#### **4.6. Final report received by 31 August 2008**

As per the extension granted on the 7<sup>th</sup> August 2008, DAFF will receive an electronic copy of the Final report on Friday the 24<sup>th</sup> October 2008. A printed copy will be sent by post the same day.

## DISCUSSION AND CONCLUSIONS

The discussion and conclusion will deal with the issues relating to the objectives the project wished to accomplish. These objectives are stated again below.

1. Develop a model capable of identifying the financial and environmental economic costs and benefits of fire management regimes on different parts of Cape York Peninsula.

The CYP fire management property-level tool developed for this project is a spreadsheet model that allows landowners to input their specific situations in order to get financially compiled information. It draws on the adaptation of a more generic tool or model for estimating private benefits and costs from fire management on a hypothetical property in CYP which was developed following a CYP pastoral community workshop just prior to this project.

The generic model is based on parameters and estimates that were provided by the workshop participants. Full details of the generic modelling outcomes can be found in Drucker *et al.* (2008). The model seeks to account for interactions between land, pasture, trees and livestock within the context of climatic variability. This is achieved through analyses of the costs and benefits of a baseline (no wildfires) against alternative fire management regimes representing cumulatively increasing levels of fire management intensity (i.e. fire fighting only; fire fighting plus early dry season [EDS] burn prevention; and fire fighting, EDS burn prevention and stormburning).

As part of the current project, the generic model was adapted to generate individual property models following the analysis of the specific economic data from each property.

In general, the findings per fire management regime are determined by both i) the stated costs of a burn year (supplemental feeding, fence repair and post-burn mustering) and; ii) the number of fire years and control probabilities (determining actual burn years) under alternative management regimes.

The project has highlighted the differences between the outputs of a generic model and that from individual properties that differ in management, fire proneness, land type etc. The model clearly highlights where the actual and importantly, the hidden costs and benefits of fire management in CYP arise.

2. Use current and historical individual pastoral property financial records, environmental trend records, and remotely-sensed fire scar imagery to model the economics of fire management in Cape York Peninsula, for further application throughout northern Australia.

Individual property 8-year financial record surveys provided real data to link with the satellite mapped fire scar records and statistics. Woody thickening trend data from previous research was also incorporated into the model to account for vegetation thickening and thinning due to early season and storm season fires, respectively.

This data formed the basis of the “economics of fire management model” that was produced and the background for interpretation of its results.

This project attempted to draw relationships between the mapped fire scar information and on-ground vegetation trends. This was largely unsuccessful probably due to a number of reasons:

- An 8-year fire scar mapping period was assumed to be indicative of the fire pattern resulting in the vegetation change observed over a 50+ year period between aerial photo images.
- The 8-year fire scar mapping period was a time period not long enough to observe a realistic seasonal fire frequency to verify the season fire effects on vegetation dynamics.
- In most instances the only aerial photos that could be sourced for the vegetation change analysis were captured at a different stage of the dry season to those images captured in 2008. Canopy appearance can be very different at different stages of the season due to leaf drop or growth.
- Factors affecting different sites are so variable, particularly vegetation type, soil type, stocking rate/fuel load interactions and the season of burn.
- It is likely that mid-term rainfall trends, the intensity of a fire and when it takes place is more important than frequency of fire in determining the effect on landscape 'woodiness'.

Fensham *et al.* (2005) conclude that fire could not be related to woody cover change and that correlation of biodiversity measures with fire frequency and landuse must also take into account historical rainfall which has been positively related to changes in woody cover. This relationship is disputed by Verlinden and Laamanen (2006) who found differences in tree occurrence, regeneration and stem diameter distributions between areas of low and high fire frequencies.

3. Investigate the cost effectiveness and efficacy of: no management; 'early dry' season fire management burns (2 months after wet season), 'dry' season wildfire fighting, and 'storm season' fire management burns; and various fire regimes.

The model has enabled investigations into the cost effectiveness of various fire management regimes. In general, the cost effectiveness of fire management regimes are determined by both i) the stated costs of being burnt out (supplemental feeding requirements, fence repair and post-burn mustering costs) and; ii) the number of years wildfires occur and fire control probabilities (determining actual burnt-out years) under alternative management regimes.

In contrast to the generic model findings, only relatively small differences in GM/AE between fire management regimes were identified. Given that landholders are presumably acting rationally by putting plenty of effort into fire management (all intensively manage fire, albeit largely using "unpaid" family labour), this suggests that, in contrast to the generic model assumptions, the costs of being burned out do not principally show up in terms of the need to incur post-burn supplemental feeding costs. Instead the costs of getting burned out tend to manifest themselves in the form of lost carrying capacity and the adoption of a lower "safe" stocking rate i.e. the choice of a stocking rate such that there is hardly ever any reason to feed cattle after a major burn as there will always be sufficient pasture for the cattle to move to.

Properties which are very successful in fighting wildfires in the 'dry' season still bother to engage in preventative burning because preventative burning appears to impact on the number of years in which wildfires occur and need to be fought. For some properties it leads to a substantial decline in the number of years in which fires need to be fought.

Storm burning in ti-tree flats avoids a loss of carrying capacity worth \$760 - \$3,660 p.a. depending on the property size. Given the relatively low costs of storm burning, gross

margins when conducting storm burning are superior to when just early season firebreaks are implemented.

4. Assist land holders and government to assess the economic costs and benefits of fire management on Cape York Peninsula pastoral properties.

The costs of being burnt out are not obvious as a large part of the costs associated with successful fire management are related to the use of “unpaid” family labour (which can nonetheless be assumed to involve significant opportunity costs). Furthermore, replacing burnt infrastructure appears to not generate significant costs and supplementary feeding is generally not carried out even when most of the property is burnt out; instead the costs of fire and getting burned out tend to manifest themselves in the form of lower stocking rates. Declining gross margin/Adult Equivalent (AE) was clearly associated both with increasing average annual burn areas and lower stocking rates.

Collective data from the 8 properties surveyed indicate that for every percentage increase in property area burned a decline in gross margin of \$0.83/AE results.

If land is being sacrificed to burning each year, rather than having to purchase expensive supplementary feed, less land is available to support livestock. In effect, properties that annually burn a greater percentage of their area have lower carrying capacities ie. more land is required to support and AE.

Again, the collective data from the 8 properties surveyed indicate that for every hectare more of land that is required to support an AE, a decrease of \$0.51 in gross margin results.

Cotter (1994) in a study of the pastoral industry of Cape York Peninsula assigned a livestock carrying capacity to all landtypes in CYP. The estimated carrying capacities of the properties involved in this study were calculated using the Cotter data. 6 of the 8 properties had stocking rates lower than that predicted by Cotter’s (1994) land type carrying capacity estimates. These lower stocking rates were particularly noticeable on those properties with the highest percentage areas burned each year (55%-70%), where only 34% - 76% of predicted cattle numbers were carried. Lower stocking rates and increasing average annual burn areas, as noted above, are also clearly associated with declining gross margin/AE.

One particular property in the study, with an excellent fire management record, has managed to dramatically reduce the amount of fire on the area of land they manage compared to its surroundings and the stocking rate and GM of their business is accordingly high.

The results are important for landholders and government agencies assessing the cost effectiveness of preventive burning regimes such as the aerial incendiary program conducted through the Rural Fire Service.

5. Create awareness of fire management costs and benefits on Cape York Peninsula and northern Australia, via a communications strategy developed in association with stakeholder organisations.

The individual property models will be of interest to the specific landholders surveyed, allowing them to update the model with data from current and future years, as well as permitting them to identify those factors that play a significant role in determining their gross margin. The generic model, having now been shown to be sufficiently flexible to

cover a range of individual situations, will be of interest at a more regional level, providing the basis for additional landholders to adapt it to their specific situations.

The principles of the results obtained from this project in CYP are likely to be transferrable across northern Australia.

The project has already created discussion amongst the CYP grazing community. Awareness seminars and an awareness brochure advised landholders of the project and the CYPDA newsletter published regular updates about the project.

Presentation seminars have been held on six of the participating grazing properties to advise the participants of the major findings of the project and to double check their figures with them to ensure their satisfaction with the data and the results.

Now that the project is complete another brochure outlining the main conclusions of the project has been published and will be sent to all pastoralists in CYP (see APPENDIX FOUR).

The results will be further disseminated at fire management meetings in Cape York Peninsula at the start of the fire season in 2009.

The brochures will also be disseminated at a Queensland Grazing Symposium to be held in Cairns on the 26<sup>th</sup>/27<sup>th</sup> November, an initiative of the Queensland Regional Collective. This meeting will have representatives of the grazing industry from all Regional NRM Groups in Queensland.

We will also have an attendance at the Northern Gulf Annual General Meeting where a short presentation will be given and brochures distributed. Project outcome brochures will also be sent to the Grazing Land Officer of the Southern Gulf Regional NRM Group at Mt Isa.

## **ACKNOWLEDGEMENTS**

Cape York Sustainable Futures (formerly CYPDA) would sincerely like to thank the Cape York Peninsula pastoralists who freely contributed to this study and without their participation this project would have been nothing.

We would also like to thank Adam Drucker, Stephen Garnett and Gabriel Crowley at CDU and the Tropical Savannas CRC for their tireless work and advice regarding economic analyses as well as Cape York Peninsula land types and ecology.

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