Scaling grazing trial results upwards to a whole property level – a case study using the Wambiana grazing trial.

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Abstract

Grazing trials are used to quantify and demonstrate the biophysical impact of grazing strategies, with the Wambiana grazing trial being one of the longest running trials in northern Australia. Previous economic analyses of this trial suggest that there is a major advantage in stocking at a fixed, moderate stocking rate or in using decision rules allowing flexible stocking to match available feed supply.

The present study developed and applied a modelling procedure to use data collected at the small plot, land type and paddock scale at the trial to simulate the property-level implications of a range of fixed stocking rates for a breeding-finishing enterprise. The best economic performance was achieved at a moderate stocking rate of 10.5 adult equivalents/100 hectares. Model outcomes are consistent with previous economic analyses using actual trial data.

Further modelling of the Wambiana trial data is warranted and similar analyses should be applied to other major grazing trials to allow scaling up of results to the whole-property level.

Key words: GRASP model, ENTERPRISE model, economic performance

Introduction

Stocking rate is the key management factor determining pasture condition, animal production and economic performance on rangelands (O'Reagain *et al.* 2011). Accordingly, grazing trials have been established to assess appropriate stocking rates for different regions. However, such trials are expensive and the results are often restricted to particular locations, land types and climate periods.

Simulation models allow extrapolation of trial results in time and space. GRASP, a point-based, biophysical model has been used extensively to estimate long term carrying capacity (McKeon *et al.* 2009) and to predict the impacts of different stocking rates on pasture condition, animal production and soil loss. Simulation results from GRASP have recently been incorporated with a dynamic herd model (ENTERPISE), and used to examine the property-level implications of different grazing management strategies (MacLeod *et al.* 2011).

This paper aims to demonstrate how detailed plant and animal data collected at the plot and paddock level can be linked to an economic model to assess the potential impacts of different stocking rates at the property level. Data drawn from the Wambiana trial are used for this case example.

Methods

The Wambiana grazing trial (20° 34' S, 146° 07' E; mean annual rainfall ~ 640 mm) was established in 1997, ~70 km SW of Charters Towers, north Queensland. There are 10 experimental paddocks of 93–117 ha, with two blocks of five grazing strategies - two fixed stocking rates, a rotational spelling system and two variable stocking strategies. The dominant land type is box (*Eucalyptus brownii*) (O'Reagain *et al*. 2009).

Detailed pasture production data were collected on two small plots within the box land type. Pasture total standing dry matter (TSDM) data were collected twice per year at the land type and whole paddock level. The analytical schema is shown in Figure 1.

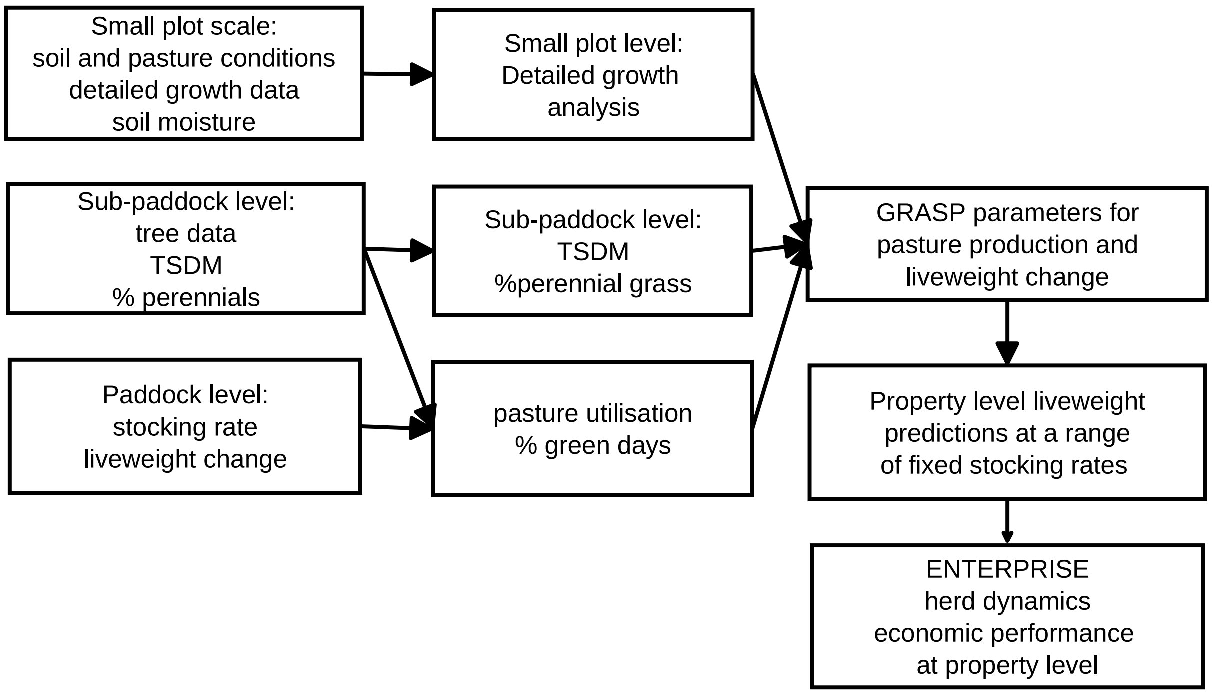

Figure 1. Key steps in evaluating the effect of stocking rate on property-level biophysical and economic performance.

Results

Once calibrated for the site, GRASP represented the pasture production on small plots (R^2 = 0.94) and the pasture condition on the box land type within paddocks well (R^2 = 0.53), with no significant bias. This is the first time that recent modifications to GRASP to estimate changes in pasture condition (Scanlan *et al.* 2011) have been tested against grazing trial data.

GRASP was then used to estimate TSDM in each paddock, using the box land type to represent the whole paddock. This achieved a good match between observed and predicted TSDM (R^2 = 0.82; no significant bias). Figure 2 presents an example.

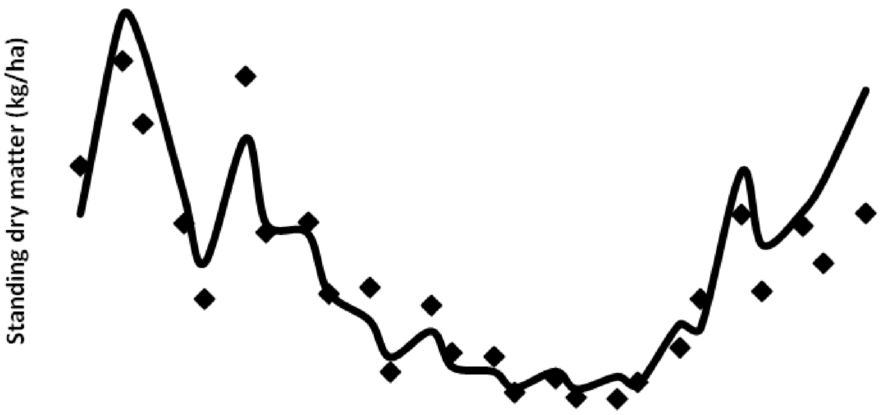

Figure 2. Predicted (——) and observed (◆) total standing dry matter for one of the moderate stocking rate paddocks at Wambiana.

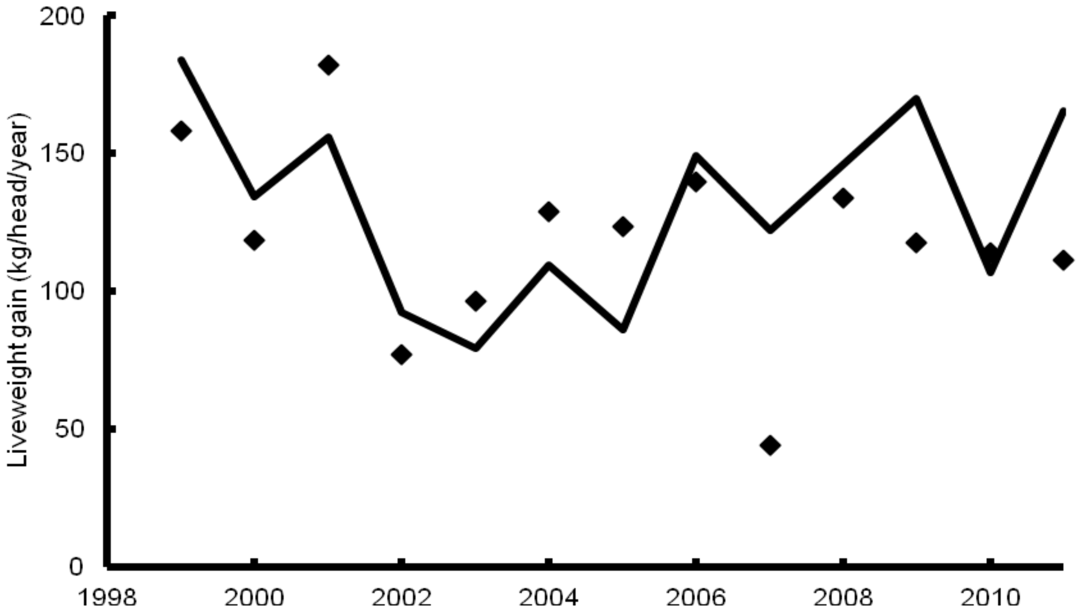

Figure 3. Predicted (——) and observed (◆) annual liveweight gain for one of the moderate stocking rate paddocks at Wambiana.

GRASP also predicts annual liveweight gain (LWG) from pasture utilisation and the percentage of green days in each year (Mayer *et al.* 2011). There was a good fit of predicted LWG (without any calibration necessary) to observations (R^2 = 0.64) when data from 2005 and 2007 were excluded and there was no significant bias (Figure 3 provides an example). The two years that did not fit the general relationship were drought years, with very low pasture availability (< 600 kg/ha).

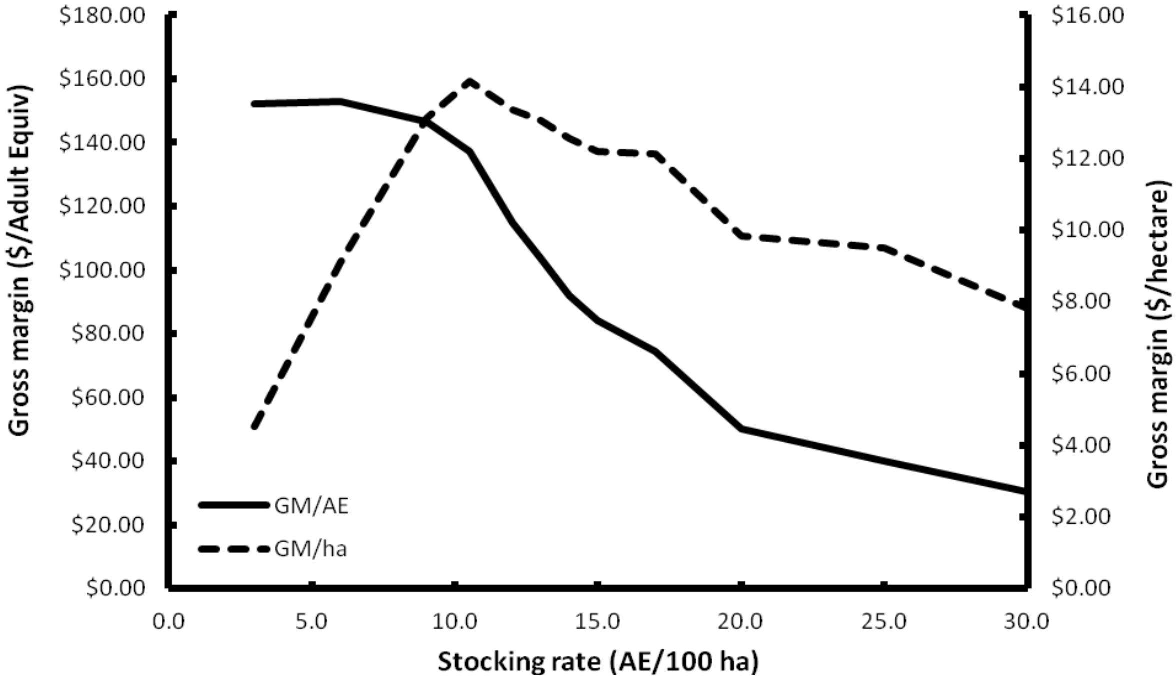

Figure 4. Gross margin (GM) per adult equivalent (AE) and per ha (from simulation of a range of fixed stocking rates over 1981-2011 for a property composed of the box land system.

ENTERPRISE estimates of the gross margin (GM) per adult equivalent (AE) tended to remain high (about $150) at stocking rates up to 8 AE/100 ha (Figure 4). Above this stocking rate, GM/AE declined almost linearly. This largely reflects the decline in LWG/head with increasing stocking rate. The GM/ha increased rapidly to $14/ha at a stocking rate of 10.5 AE/100 ha and then declined almost linearly to $8/ha at the highest stocking rate simulated.

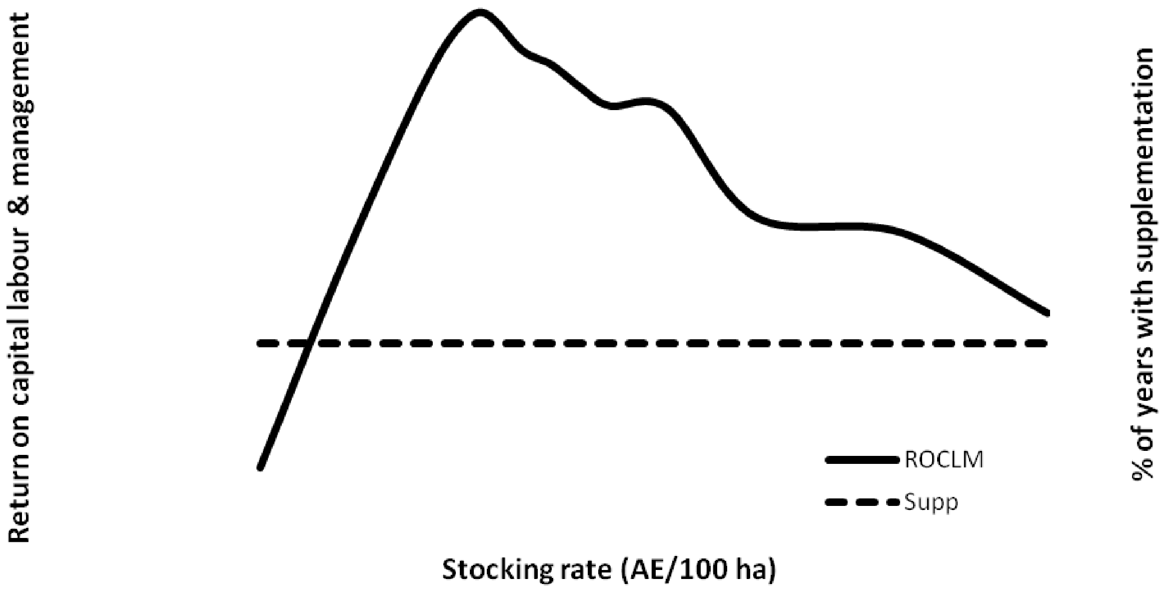

Figure 5. Return on capital, labour and management and percentage of years with supplementation required from simulation of a range of fixed stocking rates in 1981-2011.

When overheads are deducted, return on capital, labour and management (net profit) peaked ($164,400) at 10.5AE/100 ha (Figure 5). The decline above this figure was associated with supplementary feeding increasing to above 55% of years at the highest stocking rate.

Discussion

The procedure outlined in this paper shows how experimental data collected at a wide range of spatial scales can be used to explore biophysical and economic performance of whole properties. Despite the simplifications made during the analyses (especially assuming all paddocks could be represented by one land type), the fit between predictions and observations was very good. Provided the appropriate data were collected, this process could be applied to all grazing trials as a means of understanding the individual treatment dynamics, as well as scaling results up to the property-level.

Recent enhancements to GRASP have modified the way in which pasture condition changes are modelled (Scanlan *et al*. 2011) and this is the first major study to apply these changes in grazing trials. Further analyses of other grazing trials should be undertaken to provide estimates of the model parameters to represent condition changes in other locations and land types.

The annual LWG predictions based on parameters derived from the Kangaroo Hills grazing trail (Gillard 1979) in north Queensland (Eq. 1 in Mayer *et al.* 2011) produced a good match between observed and predicted LWG. Nevertheless, further detailed analysis is warranted to determine why the general relationship did not fit trial observations in 2005 and 2007.

Economic analysis of the Wambiana trial (O'Reagain *et al.* 2011) showed that moderate stocking (~ 10 AE/100 ha) gave a net present benefit of about $120/ha, far higher than the $70/ha under heavy stocking rate treatment (~ 20 AE/100 ha). These values are lower than those presented here with the differences due to the approach taken in the respective studies. First, the present simulations spanned a 30-year period (1981-2011) whereas the trial results covered only 1997-2011. Second, the price penalty applied in the present study for livestock sold in poor condition was less severe than recorded by O'Reagain *et al.* (2011). The model also operated at the property scale and naturally included other herd dynamic and economic inputs. In particular, the model simulated a breeding-finishing enterprise compared with the steer-only analysis of O'Reagain *et al.* (2011). These steer data nevertheless provide a critical foundation for predicting the performance of breeding animals. Further modelling analyses will be conducted to investigate the potential impact of some of these factors on results.

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