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ABSTRACT OF DOCTORAL THESIS

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Title: Spatial distribution of cattle foraging behavior on contrasting landforms in Horqin Sandy Land of northern China
(中国北部ホルチン沙地の対照的な地形における牛の採食行動分布)

The overgrazing can alter ecosystem function and reduce vegetation nutrient and yield, es pecially in the arid and semi-arid land globally. Livestock grazing issues on rangelands are often the result of uneven distribution under the over-stocking. The management of fenced r anch has been widely used to reduce overgrazing by breaking large scale into several areas to increase the grazing densities and promote foraging patches uniformly over the ranch. In the contrast, the marginal effects contributed to restored herbage and soil property conditions decreased with increasing time of ranch management practices.

Alternatively, understanding livestock distribution is crucial to sustainable management in the grazing land. The critical driving factors related to the abiotic such as the settlement of watering points and topography, biotic factors such as pasture quality and quantity are strong ly determined the selective distribution pattern. The problem is determining trade-offs betwee n energy expenditure and cost of livestock selecting forage, and the efficient and cost-effecti ve method to modify grazing patterns and prevent animals from overusing preferred areas pa stures.

The religion of Horqin Sandy Land in northern China has suffered from serious desertifi cation and conducted the fence construction to reduce livestock number and grazing time per ranch, however, the desertification of semiarid grassland is still ongoing. The difference is t he landforms characteristic with rugged micro-topography enforce the complex interaction bet ween livestock distribution and landforms and relative herbage conditions. Previous studies a pplied grazing density directly on plant communities and soil properties to these areas, howe ver, it neglects the spatiotemporal dynamics of actual foraging pressure.

In this research, we conducted 3 experiments to reveal cattle behaviors distribution pattern on the contrasting landforms of fenced ranch and give available advises for the mana gement to prevent land degradation by overgrazing. To identify cattle different behaviors by GPS recording locations in the Random forest algorithm. To investigate the seasonal dynami cs of cattle foraging behaviors and distribution patterns and driving factors between lowlands and sand dunes areas. Develop models to predict probability of cattle behavior distribution based on resource availability and landforms characteristic over grazing season.

In study 1, The overall accuracy of GPS models was 85% to 90% when the time int erval was greater than 300–800 s, which was approximated to the tri-axis model (96%) and

GPS-tri models (96%). In the GPS model, the linear backward or forward distance were the most important determinants of behavior classification, and nongrazing was less than 30% when livestock travelled more than 30–50 m over a 5-min interval. For the tri-axis accelero meter model, the anteroposterior acceleration (–3 m/s2) of neck movement was the most acc urate determinant of livestock behavior classification.

In study 2, Over both low-land and sand-dune landforms, the proportion of time that livestock spent on foraging increased from 63% in July to 67% in August and 69% in Sept ember, and non-foraging behavior decreased correspondingly. In low-land, the log-transformed average foraging density significantly increased from 0.61 (i.e., total foraging behaviors in 5 days measured at 50-s intervals per 10 × 10 m grid) in July to 0.66 in August and 0.88 i n September, whereas there was no significant change on sand-dunes. From July to Septemb er, the relative area of low-land foraged by cattle accounted for 31%, 35%, and 36%, respec tively, and in sand-dunes the proportions increased from 45% to 47% to 51%. In low-land, the foraging density was negatively correlated with biomass ($P = .07$), total digestible nutrie nts ($P < .05$), and crude protein ($P = .06$) and positively correlated with acid detergent fiber ($P < .05$), whereas no such relationships were observed in sand-dunes.

In study 3, Cattle prefer to selection resource dominated by tress land, higher NDVI a nd closer to water resource, and avoiding areas higher elevation in both early and late grazi ng period. Regarding to the elevation, the conditional indirect effects of NDVI showed no si gnificant effect in early but reduce negative effect on cattle selection in late. For the distanc e to water, NDVI significantly reduce negative and increase positive effect of cattle selection in both early and late period.

These findings suggested that, (1) Using instantaneous acceleration of livestock body m ovement more precisely classified livestock behaviors than did GPS location-based distance metrics. When a tri-axis model is unavailable, GPS models will yield sufficiently reliable cla ssification accuracy when an appropriate time interval is defined. (2) The spent time of cattl e foraging was higher on lowland than dunes areas, and the increasing time was compensate d to both foraging density and areas on lowland otherwise just increased foraging areas on dunes as resource availability declined. (3) The development models support the ability to pr edict relative probability of cattle foraging distribution and revealed the explanation of cattle distribution change from early to late foraging time was that resource availability moderate the cattle move far from water and up areas of dunes as resource availability declined.

“* In addition, some of the figures, etc., have been omitted.”