Otago Regional Council

**Document Id:**

# MEMORANDUM

**To:** Dolina Lee

**From:** Mark Crawford

**Date:** 20/11/2023

**Re:** Stocking Rate definitions and threshold values:

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| Name | Role | Date Completed |
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| Sam Thomas | Reviewer 1 | 19/12/2023 |

## Purpose

Questions posed by regional council policy for the proposed Land and Water plan were,

1. A blanket stocking rate limit/threshold is inappropriate for the region. Is there a rationale for FMU differences for stocking rate based on other risks?
2. Are we better to use stock units or liveweight as a measure and do you have a recommendation of numbers.

## Methods

To highlight the derivation of the stock unit system in New Zealand and the reason for change to the revised stock unit (RSU) system by reviewing the research on the subject matter. A blanket threshold stock value is then discussed for the region. Scientific literature is referenced where required.

## Discussion

### Stocking Rate

In New Zealand farm systems, stocking rate (SR) is the main definition for which farmers and other industry personnel can assess the intensity of the grazing system being used by the farm system. It is also a comparable metric used as a basis for analysis of productivity, inter and intra farm comparisons and business lending (Parker., 1998).

Pastures make up most of the livestock's feed supply in New Zealand (Morrison Consulting, 2017), and for the majority of pastoral farming systems the strategic aim is to develop stock policies that match animal requirements (feed demand) with the typical pasture supply profile in the locality and climate (feed supply) (Webby and Bywater., 2017) (Sondhage-Hofmann, 2016). Since the pasture feed supply can be variable both temporally and spatially, animal policy factors such as SR, timing of calving and dry off dates, lambing and weaning, sale and purchase dates, live weight gains, milk production, and reproductive performance are all key factors in altering animal demand as well as key determinants of farm productivity (Webby and Bywater., 2017). The ease of which these factors can be readily changed within a time period are variable, with some having a short time frame, whilst others have an annual cycle to consider. SR therefore is not a fixed constant and can vary both annually and seasonally. In general, the higher the variability of the feed supply the greater the need for farming flexibility to change grazing pressure and/or stocking rate in the short term. Whatever the decision, the degree of flexibility with SR and the outcome always involves a cost, either in direct cash terms or indirectly in either liveweight or production terms. For instance, drying off earlier which lowers autumn SR has implications with reduced milk production, perhaps improved cow condition and live weight, costs associated with the selling the dry cows and whether the cull cows after drying off are able to go to the freezing works or not at that time.

Stocking Rate (SR) is traditionally defined as the number of animals fed per unit area of land during a defined period (cows per ha or ewes per ha). It is widely accepted as the most important factor governing milk output per cow and per unit area from pasture (McCarthy, 2011). The sheep and beef industries are no different but do have the added complication of the ratio of cattle to sheep in addition to the other factors (Parker, 2013) (Hawkins, 2011).
The first main standardisation of the stock unit (SU) system was created by Professor Coop when he defined the "standard ewe" upon which the SU system was based (Parker., 1998). This ewe produced 1 lamb at a liveweight between 45.3 kg two tooth and a 59 kg 2-year ewe and shorn once in summer. The lamb was weaned between 23 and 27 kg liveweight at 14 weeks of age. It consumed around 595 kg dry matter (DM) per year. It was based on an indoor feeding trial, adjusted for foraging energy under a pastoral farm system. This was as Coop said a rough guide to determine the relative carrying capacity of different stock classes and for land valuation.

The New Zealand pastoral sector used this standard with some variation, however the dairy industry did not, given the fewer classes of stock and differing foraging features considered. To reconcile this Homes calculated an annual feed requirement based on Jersey and Friesian cows ranging from 350 to 425 and 400 to 550 kg liveweight respectively and producing between 244 to 383 kg milk solids (MS) per lactation. Following this Garrick calculated first an annual feed requirement for a base dairy cow for measuring genetic progress, which was defined as an average New Zealand cow of 403 kg liveweight in 1985 consuming 4500 kg DM (of feed value of 10.5 MJME[1]/kg DM) per year and producing 317 kg MS per lactation (Parker., 1998).

At this stage it is obvious that the standard SU based on the one ewe and one lamb was inconsistent and could not be used to compare between differing stock classes and farm systems. Garrick also explained why it was not a good measure of efficiency across the differing flocks within New Zealand. He established a base ewe assumed to weigh 55 kg liveweight weaning one lamb at 25 kg liveweight and consuming 550 kg DM per year. These stock units were adjusted for other ewe types and liveweight and lambs tailed plus the effect where seasonal variation existed within the SU system as ewe performance increased. Thus, between farm comparisons based on SU, which are based on kg liveweight/ha do not adequately show the economic effects of varying liveweight and productivity efficiencies and the response to

[1] MJME or Mega Joules of Metabolisable Energy is the proportion of feed energy absorbed from the digestive tract of an animal and retained for metabolic processes. All feeds can be ranked on their metabolizable energy content as a proportion of feed dry matter (MJME/kg DM)

various seasons with differing feed utilisation and quality, for example winter and spring (Parker., 1998).

Benchmarking also uses the SU system but is also not adequate. Using a standard of farm performance per SU for a farm type or region or farm discussion group cannot achieve the outcome of learning plus best management practice as the SU system relates to averages rather than best and it does not define the processes and resources through which above average performance is realised.

The true measure of the efficiency of an animal production system is the amount of feed required to achieve a kg of product. Generally, the higher the level of production the higher the efficiency and the less feed required per kg of product. The relationship between SR and output on an individual animal basis is different from that between SR and output on a per hectare basis (Webby and Bywater, 2017). Thus, the use of a SU or liveweight as an assessment for productivity is variable and simplistic. SR is best defined as feed demand (MJME/kg DM) and if SU values are adjusted to encapsulate this, then this is a more useful way of expressing stocking rate (Webby and Bywater, 2017). OverseerFM® developed the revised stock units (RSU) as a definition as a measure of animal ME requirements. 1 RSU is defined as being equivalent to 6000 MJME intake per year (Wheeler, 2018).The model is monthly based, enterprise specific and pasture quality based.

The above would lead one to conclude that liveweight as a measure is not accurate, nor is an animal metric. The better system is to use a model such as Farmmax or Overseer which account for the differing metabolic energies and production states to estimate the feed demand based on an average long term end of season standing biomass value for sustainable management (Sondhage-Hofmann, 2016) (McCarthy, 2011) (Parker., 1998) and as a proxy for farming intensity (McCarthy, 2011) (Silva-Villacorta et al, 2005).

## A blanket threshold:

Are there inter regional differences that should be accounted for in establishing a SR threshold? Having established that feed demand is a suitable proxy for stock intensity then it follows that even though there are differences within the various districts within the region, as seen by the averages, the variance is also high.

Farming within Otago is limited by the lower amount of high-class land when compared to the other regions in New Zealand that have the most developed rural land features within New Zealand (Moran, 2023). The region has more land class 3 and 4 and over 60% is classed as LUC classes 6 to 8, all which have biophysical limitations for intensive farming. Most of the sheep and beef sector in Otago are low input and low intensity given the spatial variability and portion of lower class land, with an average of 4 SU/ha as classed by Beef and Lamb (standard ewe SU and not RSU) The range is between 1.5 SU/grazing ha for High Country class 1 farms, to a little under 6 to 12 SU/ha on class 2, 6 and 7 class farms respectively (Burt, 2021). The losses are noted as low, as compared to the most intensive land use in Otago, dairying. Arable as already noted in previous memos have losses that are in between (Crawford, 2023). In addition, the mere fact of applying an average to a resource use and/or a freshwater issue creates a disconnect (Moran, 2023) (Parker., 1998)

Dairying and dairy support are likely to be the land uses that are to become restrictive within the proposed Land and Water plan. The focus will be on either a variable or blanket threshold for dairying and dairy support.

For dairying, Otago averages 1178 kg MS/ha and 409 kg MS/cow at an average of 2.9 cows/ha (or 26.7 RSU/ha) (DairyNZ & LIC, 2022). The district averages are tabulated below.

| District | No of Herds | Kg MS/ha | Kg MS/cow | Cows/ha | % change | RSU/Ha* | % change |
|---|---|---|---|---|---|---|---|
| Waitaki (North Otago) | 146 | 1346 | 413 | 3.26 | 23.9 | 30.4 | 25.6 |
| Dunedin City (Taieri) | 61 | 1283 | 422 | 3.04 | 15.6 | 28.1 | 16.1 |
| Clutha (South Otago) | 203 | 1053 | 389 | 2.71 | 3 | 24.9 | 2.9 |
| Central Otago/Lakes | 33 | 1057 | 403 | 2.63 | Base | 24.2 | Base |

* Average of 500 kg liveweight.

The higher stocking rates and higher farming intensity farms are situated in the North Otago and Taieri regions, reflecting the use of irrigation and freer draining plus higher fertility soils. The Taieri is also likely to have additional infrastructure advantages as it is a well-established dairying area. Added infrastructure generally results in higher cow numbers with added feed inputs, either directly from imported feeds or from extra feed grown from irrigation or additional fertiliser use (Silva-Villacorta et al, 2005).

The study by Moran for Otago Regional Council highlighted the average SR for self-contained farms within the South Otago region, highlighting the above generalisation but also the average SR to be lower given the self-contained nature of the businesses. Given they are lower SR they are also lower intensity. They were in the vicinity of 21 RSU/ha (2.1 cows/ha) based on 500 kg liveweight.

Defining a threshold for each region becomes problematic, in that each region has portions of soils, water availability and climatic variation which can mean that a threshold for one district is equally valid for another district, whatever the average for that district. This essentially confirms the adage that there is as much variation within the species as there is between species, in this case districts or farm systems. Some studies confirm this adage and explain this variation in terms of feed quality and the efficiency with which total feed available/supply is utilised. (Silva-Villacorta et al, 2005).

A differing threshold of intensity within a region introduces a complexity within the proposed Land and Water Plan that would have issues within the implementation of the plan. They are perhaps best left to Fresh water farm plans which are farm specific and address the unique features and risks of that farm system. Differing intra thresholds within the region may also have unintended consequences. The modelling for the proposed Land and Water plan did not define the differing farm systems based on districts within the region, they based their analysis on differing typologies around soil type, moisture levels and slope that were then used as a basis for analysing the various farm enterprises and land use pressures (Sise et al, 2022). This analysis did not use differing districts within the region as typologies, but based on the typologies, modelled 3 systems that best reflected the differences within the region. It was the prime basis for benchmarking contaminant loads within Otago. On this basis alone, one should not use a differing rule set that charts a different path than what was analysed initially to start the direction.

## Recommendation

The advice would then be to set a blanket threshold based on a revised stock unit which makes implementation of a set of rules easier and reflects the level of intensity of any farming system no matter where is exists within the region. An exception could perhaps be made for the Upper Lakes freshwater management unit, wherein both the within farming system variance is much likely to be smaller, and the sensitivity of the receiving environment plus the climatic variability would tend to demand a lower threshold value compared to the rest of Otago.

There is limited nutrient data to analyse to establish a threshold level of intensity. The level of intensity would be at best an estimation based on published averages and adjusted downwards to reflect the lower quartile. Both the Abacusbio and DairyNZ statistics reflect the average for dryland dairy farming on poorer draining soils as being 24 to 25 RSU/ha. If the Moran report indicated a 21 RSU/ha figure for self-contained units on this type of typology, ranging from 1.7 to 2.9 cows/ha then the bottom quartile in intensity would be equivalent to 21 to 22 RSU/ha for the DairyNZ statistics using the standard deviations from the Moran analysis and applying it to the DairyNZ statistics. This makes a figure of 21 RSU/ha as a blanket threshold based on reported figures from studies done and available statistics. For the Upper Lakes this would be a magnitude lower again.

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