BRIEF COMMUNICATION: The behaviour and impact of sheep accessing a natural waterway in summer

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Introduction

In New Zealand (NZ) during summer sheep likely have a greater need to drink water than in other seasons due to higher dry matter content of pasture and warmer environmental conditions. On many farms in NZ water is provided to sheep from reticulated water troughs as well as natural sources such as creeks, streams and dams. In hot environments sheep show a preference for grazing close to water sources (Lynch 1972; Turner 1979). Thus, in summer in NZ sheep may have a greater motivation to access natural waterways to drink than in other seasons. While in winter, ewes have shown minimal interaction a stream and access to a water trough, or not, had no effect on ewe behaviour within 3m of a stream (Bunyaga et al. 2023).

Farming activities in NZ can potentially affect water quality due to contamination of waterways with sediment and the deposition of faecal matter (Ledgard et al. 1996; Monaghan et al. 2005). Indeed, cattle have been shown to have a significant impact on water quality of natural waterways (Cournane et al. 2011; O'Callaghan et al. 2019). Cattle are natural swimmers and will cross waterways to access grazing areas whereas sheep generally avoid entering waterways voluntarily (Ekesbo and Gunnarsson 2018). There is sparse information on the behaviour of sheep around natural waterways and their impact on water quality in New Zealand.

The aim of the current study was to examine ewe behaviour and interaction with a natural waterway during summer.

Materials and methods

Procedures in this study were carried out with the approval of the Massey University Animal Ethics Committee (MUAEC 19/62). The study was conducted over two weeks from the 15th of February (D1) to the 28th of February 2020 (D14; Table 1) at Massey University's Tuapaka farm, 15 km north-east of Palmerston North, New Zealand (40.3345° S, 175.7390° E.).

A crossover study was conducted with 40 ewes grazed in a single paddock that contained a discrete natural stream which was 233m in length, <1 m wide and <30 cm deep for two weeks (Figure 1). Ewes were offered access to a reticulated water trough (unrestricted) in the first week which was then covered in the second week to prevent access (restricted). Ewe movement within the paddock and interactions with the waterway was monitored using GPS, accelerometer and video surveillance footage as per Bunyaga et al. (2023). Pasture moisture was determined from pasture grab samples collected on study days 1, 8 and 13 (D1, D8 and D13). Weather data including rainfall (mm), relative humidity (%), air temperature (ºC), solar radiation (MJ/mÂ²) and wind speed (m/s) was downloaded from a weather station located 800m from the study site.

GPS data were analysed using mapping software (ArcGIS Pro 2.2.4, 2018). An optimized hot spot analysis (z-score) was conducted to identify statistically significant spatial clustering of ewe GPS location fixes. Ewe behaviour data were checked for normality. Behavioural data including proportion of time ewes spent grazing, drinking, and walking when in the stream zone (within 3 m of the stream) were analysed using a 2-factor analysis of variance. A linear regression was also used to determine if any ewe behaviours were associated with time of the day or environmental temperature.

Results

Rainfall was recorded on 4 days of the two-week study period, with volumes ranging from 0.6 to 13.8 mm/day (Fig. 1). Maximum daily temperatures ranged from 17.4 to 26.6 °C, and the minimum temperature from 10.0 to 18.6 °C. Relative humidity ranged from 63.9% to 87.9%.

Animal density and spatial distribution

When ewes were restricted from accessing the water trough the optimized hot spot analysis identified one statistically significant spatial clustering of ewe GPS location fixes (hot spot; $p<0.05$) in the eastern area of the paddock which contained 46% of all fixes (Fig. 2A). When trough access was unrestricted, however, there was an additional hot spot in the north area near the trough which, when combined with the east hotspot, contained 61% of all the fixes.

The stream zone constituted 9% of the entire paddock area and contained 4.3 and 4.6% of all ewe GPS fixes during periods when the trough was restricted and unrestricted, respectively. When the stream zone was analysed in isolation there were seven and six hot spots

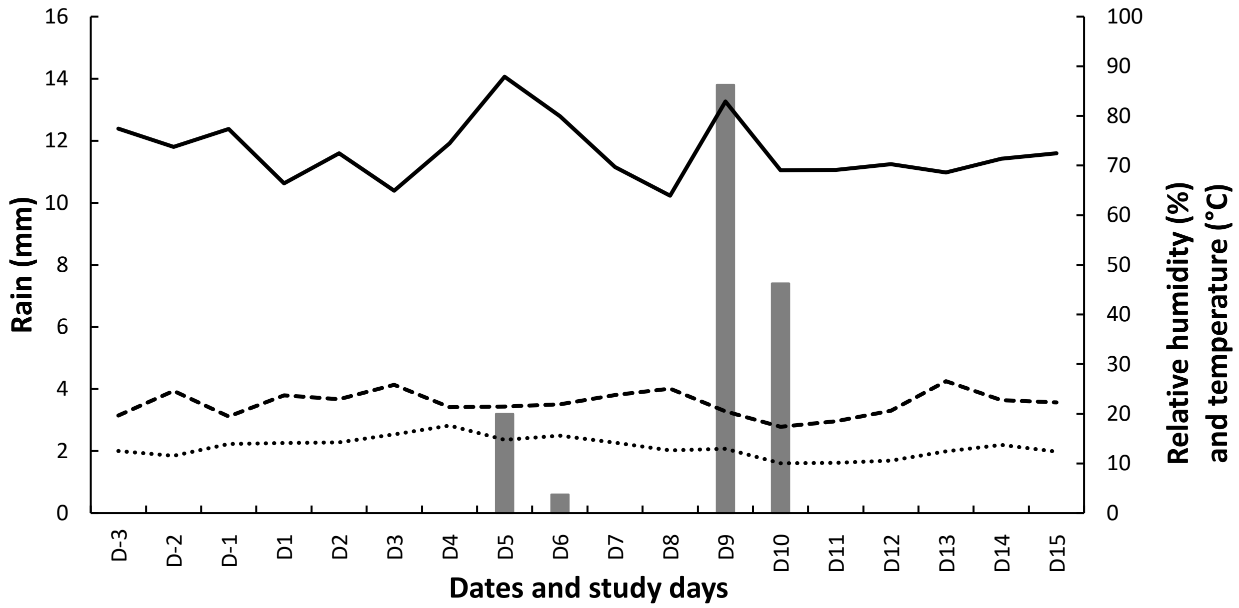

Figure 1: Daily mean rainfall (mm, bar), relative humidity (% solid line), minimum temperature (ºC dotted line) and maximum temperature (ºC, dashed line) during the study period. D-3 to D15 indicate number of days relative to the start of the study (D1;15 Feb 2020).

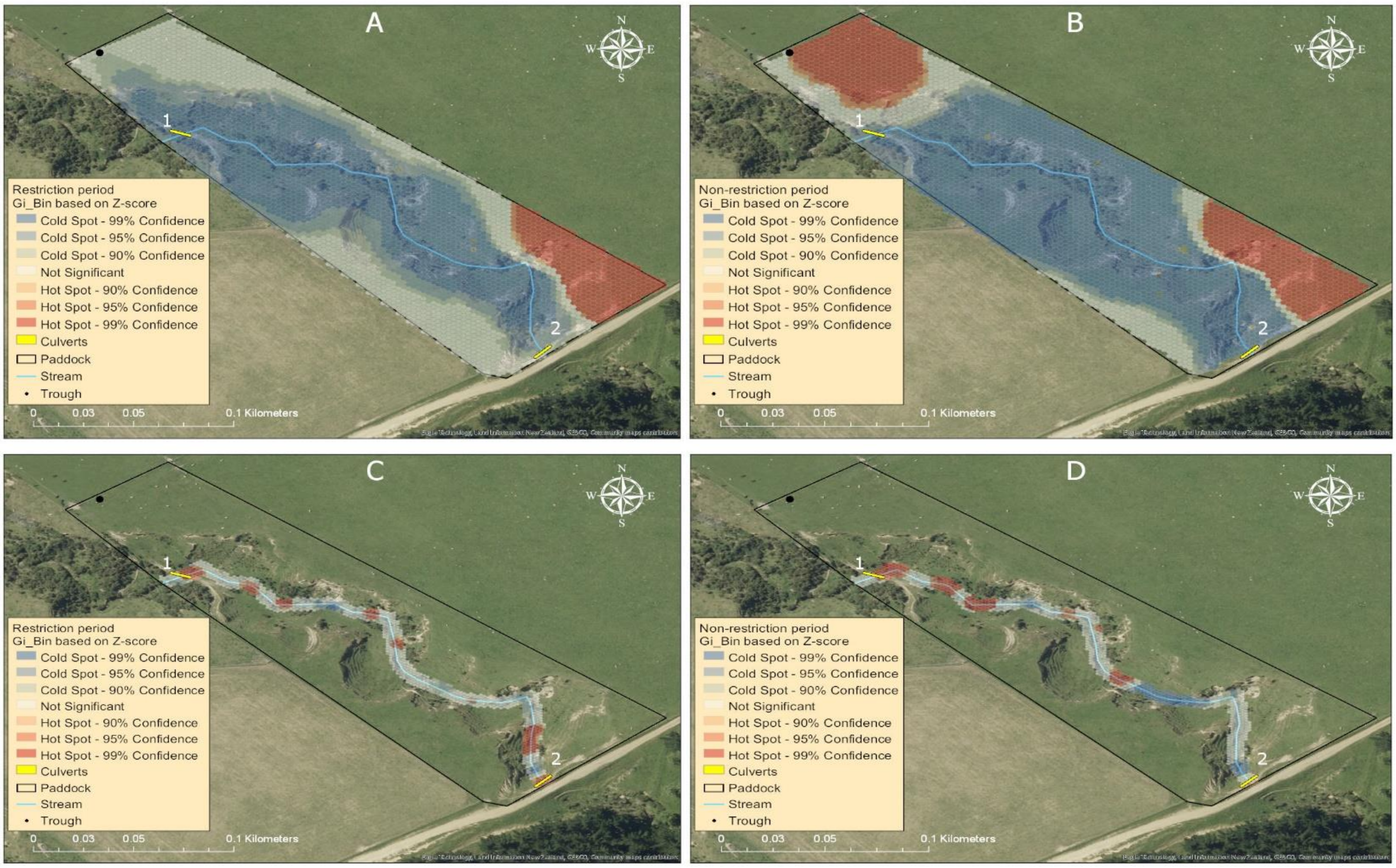

Figure 2: Maps showing the spatial distribution of ewes (magnitude per unit area) study paddock (A and B) and stream zone (within 3m, C and D) when access to the water-trough was restricted (panel A and C) or unrestricted (panel B and D) using optimised hot spot analysis. Blue areas indicate spatial clusters of low values ($p<0.05$; smaller negative z-score) representing low ewe density. Red areas indicate spatial clusters of high values ($p<0.05$; larger positive z-score) or high ewe density. White indicates random distribution or no spatial clustering.

containing 40 and 42% of fixes during the restricted and unrestricted periods, respectively ($p<0.05$; Fig. 2D). There were three cold spots (low ewe density) in the stream zones in both treatment periods.

Time spent in the stream zone

The duration that ewes were detected within 3m of the stream differed by time-of-day ($p<0.05$), with greater durations during day time periods followed by evening, and night (Table 6). Time spent within 3m of the stream did not differ ($p=0.81$) between the period the trough was restricted (13.3 ± 4.4 min/ewe/day) and unrestricted (10.3 ± 2.0 min/ewe/day).

Table 1: The daily duration (min/ewe/day mean ± SEM) that each ewe spent within 3m of any camera location by time of day during the entire study

Time of day *	n	Duration (min/ewe/day)
Night	126	6.6 ± 1.11[a]
Morning	84	11.8 ± 0.90[b]
Day	70	22.7 ± 1.02[d]
Evening	56	17.3 ± 1.38[c]

[abcd] superscripts with different letters are significantly different ($p<0.05$). * Night = 2000 to 0500 h, morning = 0600 to 0800 h, daylight = 0900 to 1600 h and evening = 1700 to 1900 h.

Behaviour within the stream zone

Observations from video footage over the 14 days of the study showed that in the stream zone ewes spent 41.9% of the time grazing (n=2304 of 5496 occasions), 26.9% stationary (n=1476) and 21.0% walking (n=1152). Ewes were observed to sniff and drink from the stream on 72 (1.3%) and 396 (7.2%) individual ewe occasions, respectively. On twelve individual occasions ewes were observed to walk in the stream (0.2%). Ewes spent more time grazing and drinking when the water trough was restricted than when access was provided ($p<0.05$; Fig. 3). The frequency of stationary and walking behaviours were unaffected by treatment ($p>0.05$).

Discussion

The aim of the current study was to examine the behaviour of sheep around a natural waterway in summer when access to a water trough was provided or unrestricted. It was hypothesised that in the summer, in the Manawatū region of NZ, access to a reticulated water trough would influence the frequency of ewe interactions with the natural waterway.

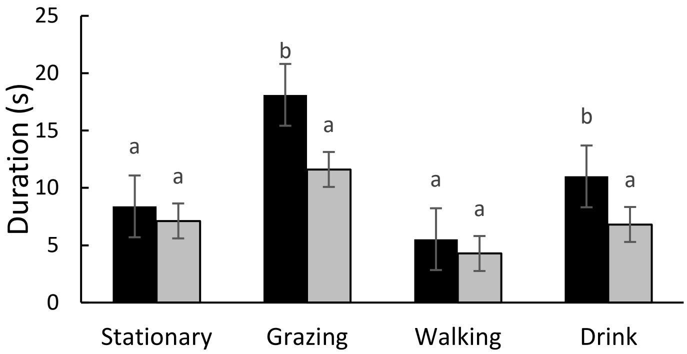

Figure 3: The average duration (time in seconds ± SE) ewes were observed to be stationary, grazing, walking, or drinking in the stream zone during periods of restricted access to water trough (black bars) or when access was not restricted (grey bars). Within each behavioural event, means with different letters are significantly different ($p<0.05$)

When in the stream zone, ewes were observed to graze and drink more frequently during the period when the water trough was restricted compared to when access was provided. The time grazing in the stream zone, regardless of trough access, was similar to the 49.5% of time grazing reported by Filipčík et al. (2020). Ewes in the current study spent 7.2% of their time when within the stream zone drinking from the stream. Observations of the behaviour of extensively managed sheep in West Africa during day light hours reported that in 4.4% and 3.4% of observations sheep were drinking in the dry and cool seasons, respectively (Ouédraogo-Koné et al. 2006). This difference in findings was likely due to the opportunistic recording of ewes when near the stream utilised in the current study rather than continuous monitoring.

When ewes had access to the water trough in the current study there was a significant clustering of ewes (hotspot) close to the trough that was not seen during the restricted period. This suggests that when the water trough was available the ewes utilised it. In winter, when access to the trough was unrestricted, there was no clustering of ewes near the trough (Bunyaga et al., 2023). Markwick (2007) reported that the consumption of free water by sheep was 40% greater in summer than winter. This increase in water consumption is likely to be a combination of warmer environmental conditions and the lower moisture content of pasture. The moisture content of the pasture offered in the current study was 56% compared with 77% in winter (Bunyaga et al. 2023). This likely necessitated the need for sheep to seek water. (Macfarlane et al. 1966; MacFarlane and Howard 1972) demonstrated that when pasture contained more than 60% water the water requirements of sheep could be met through forage consumed alone.

In the current study the duration ewes spent within 3m of the stream was greater during the hours of daylight (morning and day) than in the evening, with the least at night. It was expected that fewer ewes would be observed during the day as sheep tend to be inactive or avoid grazing during the middle of the day (Shinde et al. 1997; Evangelou et al. 2010). This finding was contrary to previous studies which reported that most of activity was during midday and evening (McGranahan et al. 2018; Filipčík et al. 2020).

In conclusion, sheep spent proportionally less time in the stream zone than would be expected based on its area. Ewes were observed to interact directly with the waterway, although, this was not influenced by the availability of the reticulated water trough. Further long-term studies are required to verify these results when ambient temperatures are greater than experienced in the current study and across varying environments.

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