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MONITORING OF CATTLE IN STREAMS AND WET AREAS ON A HILL COUNTRY FARM

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Abstract

Grazing livestock are an important source of contamination of freshwater, particularly when they have direct access to streams. Cattle in particular contribute to riparian habitat deterioration through stream bank destruction and direct defecation and urination in streams. Exclusion of stock or planting of riparian areas, are the most common catchment management methods used to protect waterways. Given the relatively low returns from beef and sheep farming, both of these strategies are very expensive and often logistically prohibitive in steep hill county landscapes. Despite this, policy trends indicate that fencing of streams in agricultural catchments may become mandatory in the future. It is important that we understand how much time cattle spend in and around hill country streams and wet areas (wetlands and hill side seeps), in order to quantify the likely environmental benefits from such policies.

The current study examined cattle movement data obtained using Global Positioning System (GPS) collars from experiments undertaken at Massey University's hill country research farm, Tuapaka, near Palmerston North, to investigate the amount of time beef cows spent in and around streams and wet areas. Animal movement data were collected from one herd in winter 2012 and two separate herds in 2013 and 2015. Permanent streams and wet areas were identified using a digital elevation model derived from 1m LiDAR data and ground-truthing.

Cattle spent 3.3 – 6.0% (48 – 87 mins/day) of their day in streams and wet areas consistently across the 7 data collections. Cattle spent more time in streams and wet areas during the afternoon than at other times of day. There were differences in the median amount of time individual animals spent in non-risk areas. Further research is necessary to evaluate how we can influence the amount of time cattle spend in riparian areas on hill country and how stream bank behaviour varies at different times of the year.

Introduction

Pastoral cattle grazing systems can have significant impacts on the quality of riparian habitats and fresh water streams. Cattle in the United States of America (USA) with unrestricted access to streams are often associated with defecation and urination into the waterway, as well as destruction of the riparian vegetative cover, bank erosion and changes in soil properties (Osmond et al. 2007, Franklin et al. 2014). The contaminants most commonly associated with cattle grazing are nutrient, bacteria and sediment (Osmond et al. 2007, Franklin et al. 2014). Of these, faecal coliform bacteria and sediment have been identified as the more problematic contaminants (Osmond et al. 2007).

There is growing concern by both the general public and government agencies to improve the quality and management of fresh water in New Zealand. This has seen livestock grazing and the agricultural community placed under increased scrutiny. The Ministry for Environment (2016) indicated livestock exclusion from waterways on hill country pastures may become mandatory by 2025. Currently, there is a lack of material from New Zealand studies on the impacts of cattle waterways, most research on the behaviour of cattle in and around waterways has been carried out in the USA.

Exclusion fencing of riparian areas and waterways is widely regarded as the best management option in the USA (Osmond et al. 2007), the other preferred method for protection of waterways in New Zealand is riparian planting (McKergow et al. 2016). However, the low returns from sheep and beef farming in New Zealand, the large number of water courses and wet areas which intersperse hill country farms and the need for stock to access water and traverse paddocks means that these strategies are not financially or practically feasible on many properties.

The aim of this experiment was to investigate the amounts of time cattle spend in hill country streams and wet areas on in an effort to quantify the likely environmental benefits of livestock exclusion policies in a hill country setting, and to determine whether this time varied with time of day and between different animals.

Materials and Methods

Four paddocks (Fig 1.) were selected on Massey University’s hill country research farm, Tuapaka, north-east of Palmerston North.

Animal movement data was recorded from 47 randomly selected mixed-age beef cows fitted with GPS collars. Data was collected from one herd in winter 2012, and two separate herds in winter of 2013 and 2015. Animal movement data was recorded on two separate occasions from herds in 2015. Each of these periods of data have been labelled as an event (Table 1). Cows were Angus, Angus-cross-Friesian or Angus-cross-Jersey.

Table 1. Summary of the different periods of data collection.

Event number	Year	Paddock number	Number of cows	Breed
1	2012	11	11	Angus x Friesian
2	2013	10	13	Angus x Friesian
3	2013	11	10	Angus x Jersey
4	2015	9	8	Angus
5	2015	9	7	Angus
6	2015	12	7	Angus
7	2015	12	8	Angus

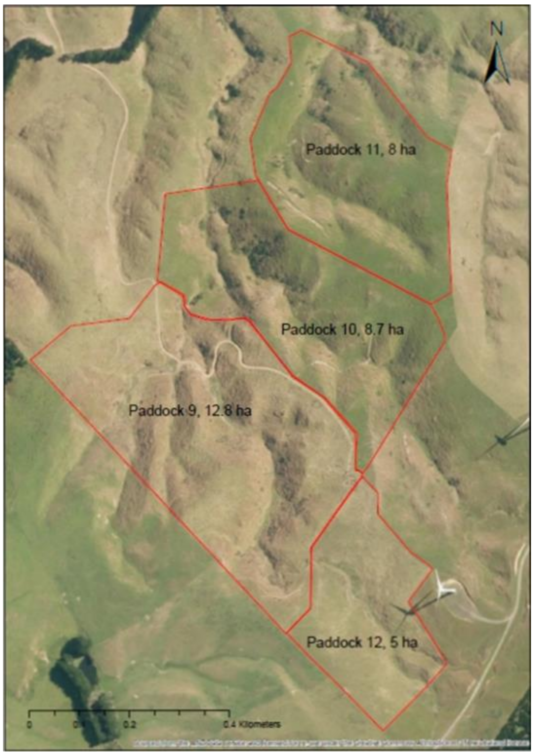

Figure 1. Tuapaka farm study site showing paddock outlines in red

GPS Collars

The GPS collars were custom-made using Trimble® Lassen GPS modules (Draganova 2012), programmed to allow for continual tracking of satellites and logging of animal positions whenever a cow moved ≥4 m, or every 1 min, if the cow did not move during that time. The GPS units were powered by one 3.6-V, 19-Ah Tadiran battery with a life under continuous GPS use of 8 – 10 days. The GPS unit was enclosed in a plastic box and attached to an adjustable leather collar. A Trimble® Active antenna was also attached to the leather collar. The collar was placed around the neck of the cow in such a position that the antenna was situated at the nape of the neck and the GPS unit under the animal's neck (Fig 2).

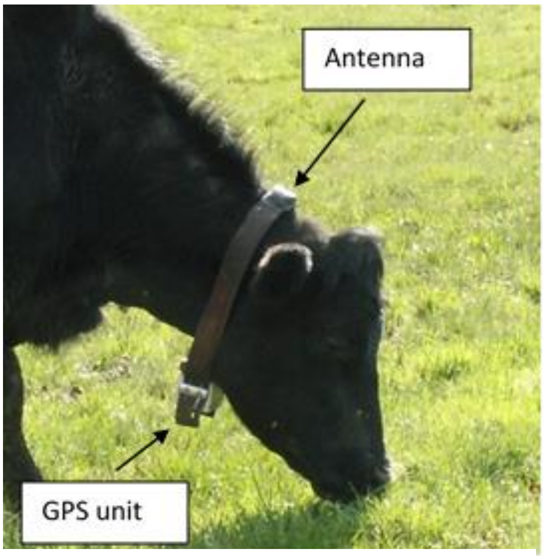

Figure 2 Cow wearing GPS collar with antenna and GPS unit.

Mapping of streams and wet areas

Permanent streams and wet areas were identified using a digital elevation model derived from 1m LiDAR data and Real Time Kinematic (RTK) GPS ground points taken on farm. Paddock twelve, for data collection events 6 and 7 had no wet areas within the paddock.

Definitions

Streams - Stream order relates to the size of the streams or where the stream is situated within a catchment. The streams highest in the catchment are first order streams (i.e. very small streams) and the stream order increases as water flows down through the catchment and joins with other streams and rivers. The first order streams on Tuapaka are ephemeral, meaning they only flow when there is rainfall which generates surface runoff. Therefore, for this study, we have excluded first order streams from our classification. The remaining streams that fall within the paddocks of interest are 2nd, 3rd and 4th order streams.

Wet area – naturally occurring wetlands and areas where water seeps out of the side of a hill and creates a wet boggy area.

Non-risk – all other areas within the paddock that have not been classed as a stream or wet area.

Data Processing and Analysis

GPS point data were used to investigate the spatial preference of animals for locations within each paddock. These data were used to create a Geographic Information System (GIS) layer of spatial animal distribution using ArcGIS Pro 1.4. A five-meter buffer was created around each stream and wet area using data management functions (ArcGIS Pro 1.4). The 5m buffer was applied to account for the level of precision associated with GPS collars.

Data was exported into Microsoft Excel® workbooks and data was excluded for days where the GPS collar had not recorded for a full 24 hours. At each recorded point, cows were classified as being in a stream, wet area or non-risk area. When an animal was recorded as being in a stream and a wet area for a location, this was recorded as a 'stream'. Pivot tables were used to calculate the number of times each cow was recorded in a 'stream', 'wet area' and 'non-risk' area on both a daily and hourly basis. The nature of the GPS data meant there was a variable number of points per hour depending on how far the cow moved. Within an hour, each point was assumed to represent equal time and the proportion of points per hour in ana area classification was assumed to represent the percentage of time in that hour spent in that area type These data were used to calculate the percentage of the day and hour spent in the different areas, for each cow.

Raw means were calculated in SAS for percentage time spent in 'stream', 'wet area' and 'non-risk' for each cow, hourly period throughout the day, day and event.

Results

Time per day

The percentage of time spent in streams, wet areas and non-risk areas over a 24 hr period varied between the 7 events. However, cattle spent the largest percentage of their day in non-risk areas of the paddock (Fig 3).

Cattle in Event 5 spent the least amount of time in streams and wet areas, while the cattle in Event 2 spent the most time, spending almost 1.5 hr per day in streams and wet areas combined (Table 2). The mean amount of time spent in streams across all 7 events was 67.5min/day.

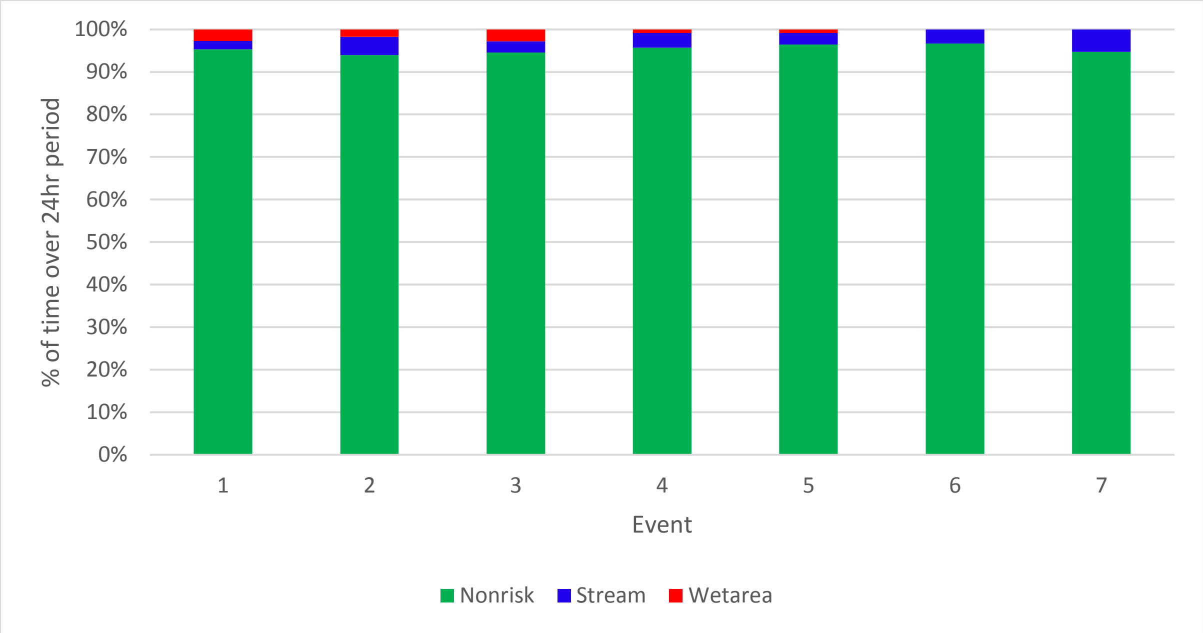

Figure 3. Mean percentage of time spent in non-risk, stream and wet areas over a 24hr period for each data collection event.

Table 2. Mean number of minutes per day cattle spent in streams and wet areas combined for each data collection event.

Event	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7
Mean Time (minutes/day)	68	87	79	62	52	49	76

An examination of the mean percentage of time spent in non-risk areas for the 31 days of data collection shows that most of these days' cattle spent between 94-98% of their time in non-risk areas, However, there were a number of days were cattle spent less time in non-risk areas (Fig 4).

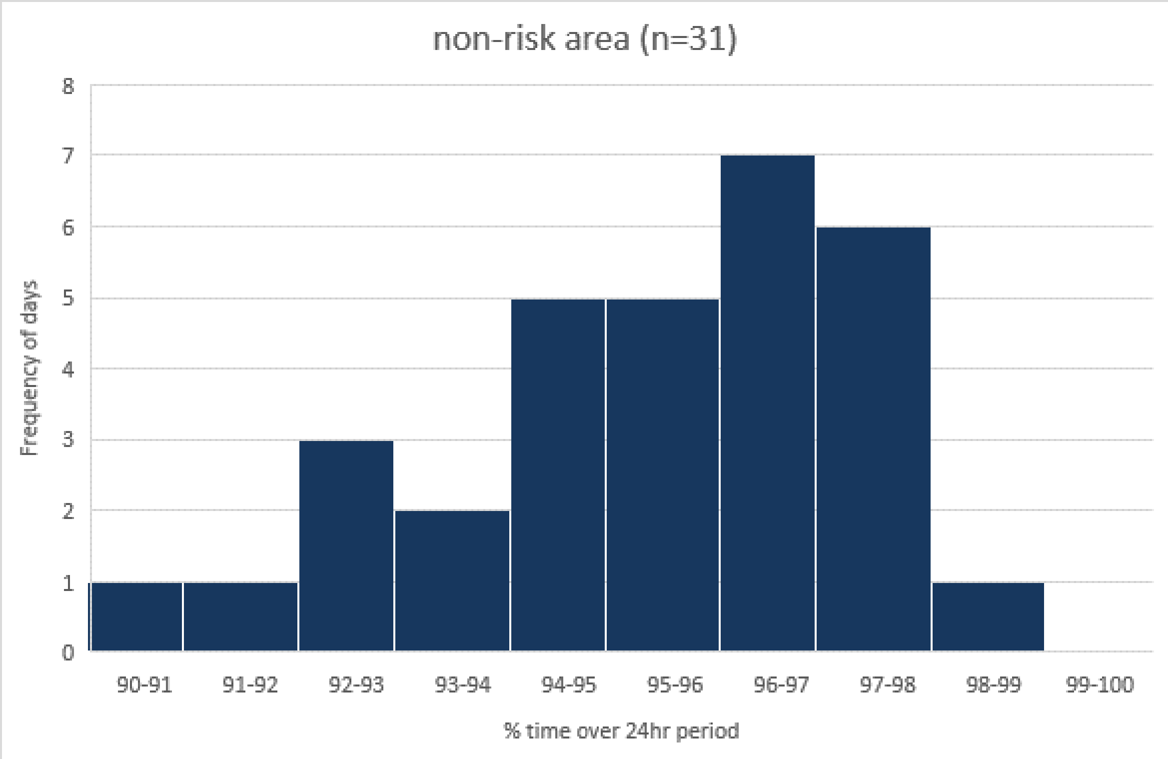

Figure 4. Frequency distribution of the mean percentage of time spent in non-risk area per day.

Time of Day

Cattle spent the greatest percentage of time within the streams and wet areas combined from 1pm to 7pm, peak time spent within these areas was at 4pm (Fig. 5).

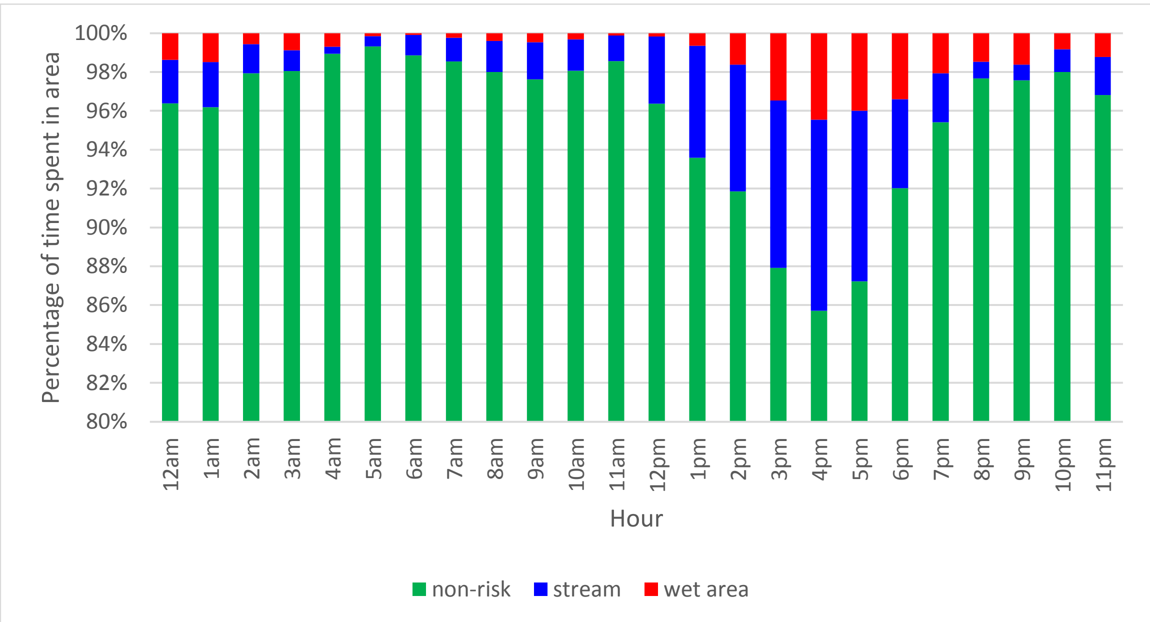

Figure 5. Mean percentage of hour spent in different areas progressing over the course of 1 day, averaged across the 7 events.

Individual animals

The amount of time individual cattle spent in non-risk areas varied greatly, with one cow spending 100% of her time in non-risk areas. In contrast, another cow spent a median percentage of 88.8% of her time in non-risk areas (Fig 6). Figure 6 also illustrates the large spread in the percentage of time individual cows spend within the non-risk area. Despite this large spread, 35 out of 47 cows measured a median of ≥95% of time spent in non-risk areas.

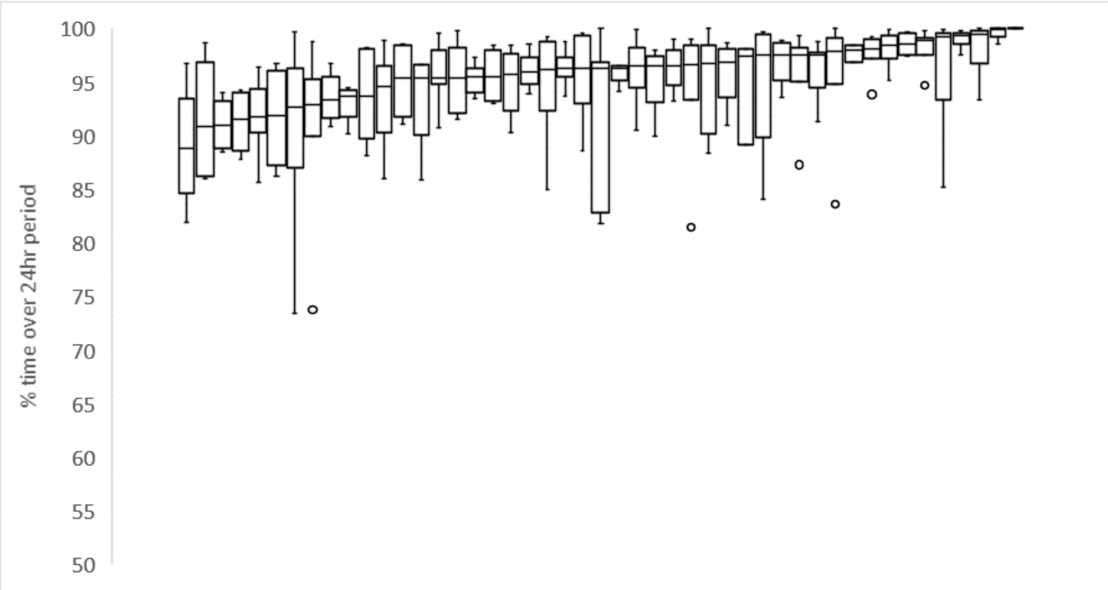

Figure 6. Percentage of time spent in non-risk area for individual cows. Each boxplot represents a cow in the study displaying the median, upper and lower quartiles and range of data collected for that cow. The small circles are outliers, as these values are more than 1.5 times the interquartile range.

Discussion

Cattle in our study spent a mean of 67.5 mins/day across 7 events in streams and wet areas. When comparing our observations of mean mins/day spent in streams and wet areas with those documented in other studies, there is a large difference between this study and previous studies, where 2 studies observed beef cattle spending only 6 mins/day (Osmond et al, 2007) in streams, while other studies recorded cattle spending 25 mins/day and 60mins/day (Osmond et al, 2007) in the waterways. Possible reasons for these differences include that the reviewed studies were carried out in USA on relatively flat terrain, in areas where there were only one or two water access points and in a climate that has a much colder in winter than New Zealand. Our study was conducted on medium to steep hill country with multiple streams and wet areas within the paddocks, providing much more opportunity for cattle to enter these areas. Another possible reason is that previous studies were human observational studies over shorter periods of time and our study used GPS data to quantify when cattle were in streams or wet areas over a 31-day period. Our study also included a 5m buffer zone around streams and wet areas meaning for some data points the cow may not have truly been in the stream or wet area.

It is important to consider how this time is likely to impact on water quality. The number of defecations into the stream is important when evaluating faecal coliform bacteria concentrations in a stream. A USA study reviewed by Osmond et al (2007) estimated the average number of defecations into a stream for individual cows during winter was 0.17/day, with cattle spending an average of 6 mins/day in the stream. These figures increased to 0.41/day and 11.2 mins/day respectively, in the summer. In contrast to previous studies, cattle spent more time in streams and wet areas in the current study, therefore it is plausible that the average number of defecations by cattle into the stream and wet areas, was also higher than those previously reported.

The observation of increased time spent in streams and wet areas during the afternoon is consistent with existing overseas literature (Bond et al, 2012, Franklin et al, 2014 and Osmond et al, 2007) and may reflect the pattern in daily temperatures, with cattle spending more time in riparian areas when temperatures were at daily highs (Osmond et al, 2007). It is important to consider that this daily cycle of activity trend may vary at different times of the year. Our study only observed the time cattle spent in streams and wet areas during the winter months. However, our experience and observations at the study site suggest that during summer and autumn, when stream water flows are low and air temperatures are higher, we observe our biggest issues associated with riparian damage by cattle. Low water flows and elevated air temperatures are conductive to more active periphyton growth, which reduces water quality (Biggs 2000). Therefore, it is important that we undertake further research to collect animal data movement around hill country streams and wet areas during these critical risk periods. Bond et al (2012) observed that cattle spent more time in waterways during summer and that there was a difference in the use of riparian areas between the months of Autumn and Spring, concluding there was a positive correlation between air temperature and the amount of time cattle spent in waterways.

We do not understand why the time individual cows spend in streams and wet areas varies. Existing literature suggests that animals may develop preference or aversion to riparian areas via social or learned behaviour (Osmond e al, 2007, Bond et al, 2012). It is also possible that cattle breed and genetics can influence the amount of time cattle spend in waterways and this aspect appears to require further research.

Conclusions

This study provides insight in to the amount of time cattle spend in and around streams and wet areas on NZ hill country landscapes. Our results indicate that cattle with unrestricted access spent slightly over 1hr/day in streams and wet areas. Cattle spent more time in and around streams and wet areas during the afternoon.

Further research is necessary to evaluate how management strategies other than fencing or planting of riparian areas, can be implemented to reduce the time cattle spend in and around streams and wet areas. In addition, future studies should also evaluate the seasonal differences on the amount of time cattle spend in and around streams and wet areas, as summer and autumn can be a critical time in terms of water quality.

Acknowledgements

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References

Biggs, B J (2000) New Zealand periphyton guideline: Detecting, monitoring and managing enrichment in streams. Report from NIWA. Ministry for the Environment.

Bond, T. A., Sear, D., & Edwards, M. (2012). Temperature-driven river utilisation and preferential defecation by cattle in an English chalk stream. Livestock Science, 14659-66.

Draganova I. 2012. Nutrient distribution and behaviour of livestock in an intensively managed dairy herd: a thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy. Massey University, Palmerston North, New Zealand.

Franklin, D., Cabrera, M., Byers, H., Matthews, M., Andrae, J., Radcliffe, D., & Calvert, V. (2014). Impact of water troughs on cattle use of riparian zones in the Georgia Piedmont in the United States. *Journal of Animal Science, 87*(6), 2151-2159.

McKergow, L. A., Matheson, F. E., & Quinn, J. M. (2016). Riparian management: A restoration tool for New Zealand streams. Ecological Management & Restoration, (3), 218 – 227.

Ministry for the Environment. 2016. Next steps for fresh water: Consultation document. Wellington: Ministry for the Environment.

Osmond, D.L., D.M. Butler, N.N. Ranells, M.H. Poore, A. Wossink, J. T. Green. 2007. Grazing Practices: A Review of the Literature. North Carolina Agricultural Research Service, Technical Bulletin 325-W. North Carolina State University. Raleigh, NC.