2021

RECOMMENDED MONITORING PROTOCOLS FOR TARGETED GRAZING PROJECTS

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ACKNOWLEDGEMENTS

The authors thank the Nature Conservancy of Canada (Conservation Science Impact Fund), and the Ranchers Stewardship Alliance Inc. for providing funding to undertake this project.

This project was made possible through the cooperation and input of numerous organizations implementing targeted grazing projects including Antelope Creek Habitat Development Area, the City of Calgary, the City of Edmonton, the City of Lethbridge, Meewasin Valley Authority, the Nature Conservancy of Canada, and SODCAP Inc. /Frenchman – Wood River Weed Management Area.

A number of individuals assisted us by providing recommendations for monitoring protocols and by reviewing the draft report. Those individuals include Amanda Miller, Ross Adams, Sarah Kellet, Jackie Cardinal, Katelyn Ceh, Qiting Chen, Renny Grilz, Craig Harding, Nicole Fraser, Patricia Striker, Melanie Toppi, Shannon Wagner and Neal Wilson.

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INTRODUCTION

Targeted or prescriptive grazing can be defined as the use of a specified kind of livestock at a determined season, duration and intensity to accomplish defined vegetation and landscape goals (Launchbaugh and Walker 2006). Targeted grazing is used to address numerous conservation issues including but not limited to: noxious weed and non-native plant species invasion, woody vegetation invasion of grasslands, grass and broadleaf woody vegetation invasion of regenerating forests, and manipulation of vegetation and litter to reduce fire hazard or enhance habitat for species at risk and other wildlife.

Targeted grazing with livestock to reduce weeds and undesirable vegetation has increased over the last decade as land managers look for options to facilitate integrated vegetation management plans. Research regarding the effectiveness of targeted grazing treatments in western Canada is lacking and projects are often not monitored in any consistent manner. This project engaged urban park ecologists, livestock producer organizations and stewardship organizations to discuss existing projects and to review monitoring programs.

Most of the published research regarding targeted grazing has been conducted in the United States and other countries, often in specific ecological settings that are very different from western Canada. Currently, there is considerable promotion of the methods used in the United States. However, research has not been conducted to determine the effectiveness of the methods when applied in western Canadian ecosystems.

In some cases, targeted grazing projects may achieve reduction of the unwanted vegetation, but at the expense of other components of ecological integrity such as litter abundance or impact to non-target vegetation. In addition, there remains considerable scepticism of the effectiveness of targeted grazing as an ecological service, and therefore many organizations and agencies are reluctant to facilitate implementation on conservation lands. Monitoring programs can help address these issues.

Targeted grazing projects include a wide array of logistical components, ranging from knowledge of plant ecology, to animal husbandry, to communications with public and enforcement agencies. The implementation of sound monitoring protocols and effective use of monitoring information are key to the success of targeted grazing projects (Bailey et al 2019).

This component of our targeted grazing investigation is aimed at developing suitable protocols for monitoring the effects of targeted grazing projects. The project engaged a variety of partners from both urban and rural landscape management with common stewardship goals, providing an opportunity for dialogue, education and a connection to the livestock industry.

Monitoring programs can be designed to address the following questions:

1. Is the livestock species sufficiently grazing the targeted vegetation?

2. Is the targeted grazing program having the desired impact?
3. Is the targeted grazing program having any unintended or undesirable consequences on other values such as ecological integrity?

The results of a monitoring program can be used for many purposes (adapted from Newman 2020) such as:

- Determining the effectiveness of a targeted grazing project.
- Identifying and mitigating impacts to other values.
- Adapting or designing targeted grazing projects.
- Evaluating or ranking sites or grazing options (e.g., livestock species, grazing intensity) with a goal of determining how and where targeted grazing might be most successful.
- Providing information for technical transfer of knowledge or public awareness / outreach.
- Providing baseline data and a sampling framework for incremental research.
- Contributing data for associated assessments such as economic evaluation, wildfire risk reduction, forage and timber productivity, and wildlife habitat quantification.

Our goal for this phase of the project was to evaluate the effectiveness of current and recent targeted grazing projects in Alberta and Saskatchewan and recommend appropriate monitoring protocols that land managers and municipalities can use to assess their own targeted grazing projects. This resource helps guide the use of targeted grazing to enhance the success of outcomes and to minimize or eliminate any negative consequences.

METHODS

Ten organizations or municipalities implementing targeted grazing programs were identified as potential candidates for evaluation. Several of these entities were implementing targeted grazing programs at more than one location. Projects were chosen to reflect both urban and rural programs as well as a variety of target vegetation, livestock species, and natural subregions/ecoregions in at least two jurisdictions (Alberta and Saskatchewan). Seven projects were ultimately chosen for evaluation purposes (Table 1).

Due to the risks and restrictions associated with the COVID-19 pandemic during the field season of 2020, it was necessary for us to adjust our methodology and obtain more information remotely. We interviewed project managers from all seven programs, and completed field visits to four locations.

Monitoring protocols had been developed for most of the projects, and were implemented with varying degrees of success. Only one of the monitoring programs was able to statistically demonstrate a positive impact from the targeted grazing program. Although the other projects were not able to demonstrate success, it was most often due to insufficient data which was lacking for a variety of reasons.

Monitoring protocols varied widely and included the following methods:

- Range health
- Vegetation transects measuring foliar cover by species or species groups based on range inventory protocols
- Stem counts of the targeted vegetation species
- Density of targeted plants
- Area of infestation (measured using GPS)
- Biomass sampling
- Permanent photo points

We evaluated each monitoring program in consultation with the project managers. During interviews with project managers, we obtained information on the grazing prescription used, monitoring protocols (if any), effectiveness of the project, lessons learned (what might have made implementation more effective), and what information or protocols is/are lacking with respect to targeted grazing design and implementation.

We viewed the project sites for four of the projects to verify results and assisted with monitoring on one of those sites. Several of the projects shared monitoring reports and/or data. A summary of the projects evaluated is presented in Appendix A.

Using the results from all projects, whether or not they were able to demonstrate success, we developed a recommended monitoring protocol to assist users of targeted grazing in evaluating their projects.

Table 1. Projects chosen for evaluation.

Targeted Grazing Project	Location	Urban / Rural	Natural Subregion / Ecoregion	Type of Property	Livestock Used	Targeted Vegetation	Written Grazing Prescription Prepared	Site Monitoring Occurs[1]
Antelope Creek Ranch	Brooks AB	Rural	Dry Mixedgrass	Conservation Area	Beef Cattle	Crested wheatgrass invasion into native prairie	Yes	Intensive
City of Lethbridge	Lethbridge AB	Urban	Mixedgrass	Natural Area Park	Goats	Leafy spurge and absinthe, and fire hazard reduction	No	Light
City of Calgary	Calgary AB	Urban	Foothills Fescue / Foothills Parkland	Natural Area Park	Goats	Noxious weeds and woody plant invasion	Yes	Intensive
City of Edmonton	Edmonton AB	Urban	Boreal Dry Mixedwood	Natural Area Park	Goats	Leafy spurge and Canada thistle in river valley	Yes	Intensive
Meewasin Valley Authority	Saskatoon SK	Urban	Aspen Parkland (Fescue Prairie)	Natural Area Park	Sheep	Woody vegetation and Kentucky bluegrass invasion into native prairie	No	Light
Nature Conservancy Canada	Edmonton, AB	Rural	Boreal Dry Mixedwood	Conservation Area	Goats	Common tansy, Canada thistle and sow thistle invasion into a restoration site	No	Light
SODCAP / Frenchman-Wood River Weed Management Area	Cypress Hills SK	Rural	Cypress Uplands	Community Pasture	Goats	Leafy spurge infestation into native prairie	No	Intensive

[1] Intensive monitoring = numerous data points measuring vegetation attributes suitable for the determination of trends supported by statistical analysis.
Light monitoring = photo monitoring; limited number of data points; site or community level measurements; and/or measurements not suitable for statistical analysis.

LESSONS LEARNED

Most projects have designed a monitoring program that requires intensive sampling of the target vegetation species. For example, stem counts along transects through patches of invasion are commonly used. But few of these projects have the funds required to implement such monitoring, and therefore the data gathered was insufficient to determine whether or not targeted grazing is having an impact.

In addition, while stem counts may be appropriate for annual weed species and short-lived perennials, they do not work well for long-lived perennials with multiple reproductive strategies (Sharrow and Seefeldt 2006). For example, several of the projects we reviewed targeted leafy spurge, a long-lived perennial with prolific seed production as well as the capability to sprout vegetatively from an extensive lateral root system. Stem counts were employed as a monitoring method for two of these projects. Despite having an adequate number of samples to detect change, the number of stems did not change significantly after grazing. However, the shepherds and project managers indicated that leafy spurge was utilized by the livestock, and further noted that there were fewer flowering stems and a decline in the vigour of plants grazed. The monitoring protocols did not include these variables; therefore the observed results are anecdotal. If using intensive surveys of this type for long-lived perennial plant species, it is important to include measurements of reproductive structures such as flowers and seeds as well as an assessment of vigour. Measuring percent foliar cover of plants is likely more cost-effective and would provide a better estimate of the abundance and extent of a species regardless of whether it is short or long-lived.

Use of intensive monitoring which is focussed on measuring only the targeted vegetation does not allow for an assessment of the impacts on non-target vegetation, or on ecological integrity of the site as a whole. With any grazing program, there is a risk of negative impacts to various components of ecological integrity if sites are overutilized. Including range health assessments in monitoring protocols can address this need.

In one case, funding for monitoring was sufficient, but the sampling design failed to include a control site (i.e., untreated / ungrazed) for comparison. Control sites strengthen the power of the statistical analysis of data by controlling for variables not related to the treatment (e.g. grazing), making it easier to determine statistically significant impacts from the treatment. Without a control site, it is not possible to determine and control for impacts such as annual climatic variation. As a result, this project was unable to statistically analyze the results.

Most sampling designs were unique to a single targeted grazing project, and sampling protocols were neither standardized nor sufficiently described in monitoring reports to facilitate repeatability. Therefore, when different individuals undertook field sampling in different years, sampling methodology tended to vary. For example, when using vegetative cover

measurements, it's important to know whether you are estimating canopy, foliar or basal percent cover. Using standardized sampling methodology can help. For example transects used to sample vegetation composition and cover in rangeland science are standardized for Alberta, and used widely to assess range condition, range health and wildlife habitat. There is a standardized, published sampling design and associated measurement protocols making comparison of data gathered by different individuals reasonably accurate. In addition, annual training opportunities are available and affordable for range health and range condition monitoring.

In one case, there was concern that the livestock used for the targeted grazing project were not actually consuming the target vegetation to a substantial degree. When designing a targeted grazing prescription, it is important to choose a livestock species suited to consuming the target vegetation. Goats, sheep and cattle have varying natural preferences for, and tolerances of, grass versus forbs versus woody vegetation, as well as toxic compounds in plants. All these species can be trained to select for any type of vegetation, however in most cases flocks and herds have not been trained. Some level of monitoring of the utilization of the targeted vegetation is critical. This can range from a simple estimate of percent utilization during a range health survey, to establishing exclosures to compare utilization between grazed and ungrazed sites.

In order to make monitoring data useful from a management perspective, it is important to measure the intensity and season of grazing. There were many approaches to measuring grazing intensity. The simplest was to track the amount of time (e.g., hours or days) by date, and the number of animals using a given discrete location. The most costly method which provides the most accurate and detailed information is to GPS-collar the animals. In one of the projects, the evidence of livestock presence did not match the reported information from the shepherd. The concern in this particular case was that the control site had been grazed. GPS tracking via collars alleviates these types of issues. Any of these livestock tracking measurements can be used to design or adapt a grazing prescription using animal units per area. Biomass sampling using exclusion cages is another method used to determine intensity of grazing. Biomass measurements can be used to design or adapt a grazing prescription by prescribing a certain level of desired utilization of forage, rather than prescribing the intensity and duration of grazing.

In many of the projects, external contracts were in place for monitoring. In two cases, although the field sampling occurred, the contracts were never completed. In both cases, the field data was lost and the project managers were not able to recover that data. Only in situations where data was retained in house, were monitoring programs able to survive a change in personnel. When contracting monitoring to an external organization, the deliverables of the contract should include the raw data and the detailed monitoring protocol and monitoring timeline.

It is important to note that many of these issues could be avoided by having a targeted grazing prescription and a land management plan in place before beginning a project. These documents should have clearly defined goals and objectives for the property and the targeted grazing project, which helps determine what should be monitored.

WHAT TO MEASURE?

At minimum, primary variables relating to a targeted grazing project should be monitored. If funding or partnerships allow, secondary variables can also be measured.

Primary Variables

The primary variables measured for a monitoring project relate directly to the primary goals of the targeted grazing project. Primary variables (Table 2) are most often an invasive plant species or group of species, but depending on the program the target could include such variables as native vegetation species, tree regeneration, or fine fuels relating to fire hazard. An example of primary variables to measure would be the abundance and extent of the targeted vegetation species.

Overall ecological integrity of a site should also be considered a primary variable. There are both potential risks and benefits associated with focusing a targeted grazing project on reducing unwanted vegetation. Components of ecological integrity can be altered in either negative or positive ways. For example, a carefully managed targeted grazing program can increase the amount of desirable vegetation such as native plants. Conversely, untended livestock or inexperienced herders/shepherds can result in unintended consequences such as overutilization of non-target and desirable vegetation. In either situation, it is important to know the impacts so that grazing prescriptions and livestock management can be adjusted to reverse or avoid negative impacts, or to take advantage of opportunities for positive impacts.

Table 2. Purpose of monitoring primary variables.

Primary Variable	**Purpose**
Target vegetation	Determine efficacy of grazing treatment on target vegetation- e.g., Invasive species of concern or fuel loads
Non-target vegetation	Determine impact(s) of grazing treatment on non-target vegetation- e.g., Tree regeneration, changes in herbaceous species composition, shrub cover, etc.
Ecological Integrity	Determine impact of grazing treatment on ecological integrity of site – e.g., Range health

Secondary Variables

Secondary variables are those related to secondary goals of a targeted grazing project, or values not specifically related to the control of a single vegetation species or group of species. Secondary variables often include grazing intensity, forage production, wildlife habitat requirements, riparian health, water quality, fire hazard or rare plants.

HOW TO MEASURE?

A sampling design should be chosen based on the following considerations (adapted from Newman 2020):

- Standard / accepted methodology,
- Repeatability,
- Value for communicating results,
- Value for comparing with other projects or over time,
- Accuracy, and
- Cost effectiveness.

Table 3 presents a summary of sampling design strategies that can be used to achieve a scientifically valid and cost effective monitoring process.

Table 3. Summary of Recommended Sampling Design Strategies (adapted from Newman 2020).

Strategy	Rationale
Site stratification followed by selection of key strata (e.g. vegetation communities, fields or invasion patches).	Reduces the area required for sampling. Reduces the number of plots required to achieve enough statistical power to detect change.
Randomize selection of sites within key strata.	Selected sites will be random and dispersed across the project area. Reduces bias of sampling and reduces the chance of poor representation.
Choose plot / transect location representative of the key strata.	Increases representativeness of sampling.
Include control (ungrazed / untreated) sites within key strata	Allows for identification of impacts due to annual variation such as climate. Improves the power of statistical analysis to detect change due to grazing.
Use of permanent plots	Reduces the impact of annual variance. Improves the power of statistical analysis to detect change due to grazing.
Use of permanent photo points	Provides limited quantitative data, but provides an effective communication product using readily available equipment and is very cost effective.
If sampling biomass, randomly select cage locations within key strata, then select pairing for uncaged biomass sampling based on similarity in site characteristics.	Reduces variation between caged and uncaged biomass samples. Reduces the number of plots required to achieve enough statistical power to detect change.

RECOMMENDED MONITORING PROTOCOLS FOR ALBERTA AND SASKATCHEWAN

Measuring Primary Variables

Measurements of size of infestation and density of plants within an infestation are suitable for monitoring small invasions of plants in the order of tens of m^2. Monitoring will measure changes in the size of the infestation as well as changes in the distribution and density of the invasive plant within a small infestation area. However, there is too much variability in density, and too much difficulty in determining infestation boundaries when a plant species, or group of species has invaded larger areas. Large areas of invasion are the most common situation where targeted grazing is employed as a control technique.

A suitable monitoring system for large invasions that meets the criteria for selecting a sampling design already exists in both Alberta and Saskatchewan. Both jurisdictions have developed standardized vegetation inventory protocols and range health assessments supported by classifications of plant communities based on ecosite classifications (Table 4). Plant communities developed from ecosite classification are more suitable for rural than urban landscapes. Urban landscapes are more likely to support modified vegetation communities that are ubiquitous across a project site. In this situation it is important to stratify the site based on features such as management unit, soil type, slope and aspect. Range health guides for each province include assessment options for grasslands, forest and tame grasslands. The tame grassland assessment is suitable for sites that have been converted, either intentionally or unintentionally, from native vegetation to anthropogenic vegetation.

Vegetation transects used in range inventories are suitable for monitoring both target and non-target vegetation in prescribed grazing projects. Range health assessments are suitable for monitoring ecological integrity of the overall site. The range health methodology is designed to assess five ecological functions: site productivity, site stability, capture and beneficial release of water, nutrient cycling/carbon storage and plant species diversity. One component of the range health assessment is specifically designed to measure the density and distribution of noxious weeds.

The cover data from vegetation transects is suitable for evaluating the extent and abundance of unwanted vegetation over time and has been designed to support statistical analyses, particularly if transect locations are permanent and have an untreated control for comparison. The range transect methodology is standardized and widely used, making it relatively accurate, repeatable and useful for comparing results between different projects.

Alberta's sampling design process is well researched and well documented (Alberta Environment and Parks 2021). Saskatchewan's system is similar, but less well documented. Alberta's range health assessment protocols can be found in Adams et al (2016), and Saskatchewan's range health assessment protocols can be found in Saskatchewan PCAP

Greencover Committee (2008). These methodologies are documented, easily repeatable and cost-effective. Additionally, training and certification in implementing these monitoring methods are readily available.

Table 4. Protocols and contacts for monitoring primary variables.

Primary Variable	Recommended Monitoring Protocol	Protocol Contact Information	Training Contact Information
Target and Non-target Vegetation	Alberta: Range Inventory Manual; Range Plant Community Guides Saskatchewan: Ecosite Plant Community Guides	Alberta: Search Alberta Government's Open Data Saskatchewan: Prairie Conservation Action Plan www.pcap-sk.org	Alberta Environment & Parks, Rangeland Resource Stewardship Section
Ecological Integrity	Alberta: Range Health Assessment for Grassland, Forest & Tame Pasture Saskatchewan: Native grassland and forest Rangeland Health Assessment	Alberta: Search Alberta Government's Open Data Saskatchewan: Prairie Conservation Action Plan www.pcap-sk.org	Alberta Environment & Parks, Rangeland Resource Stewardship Section Saskatchewan Prairie Conservation Action Plan www.pcap-sk.org


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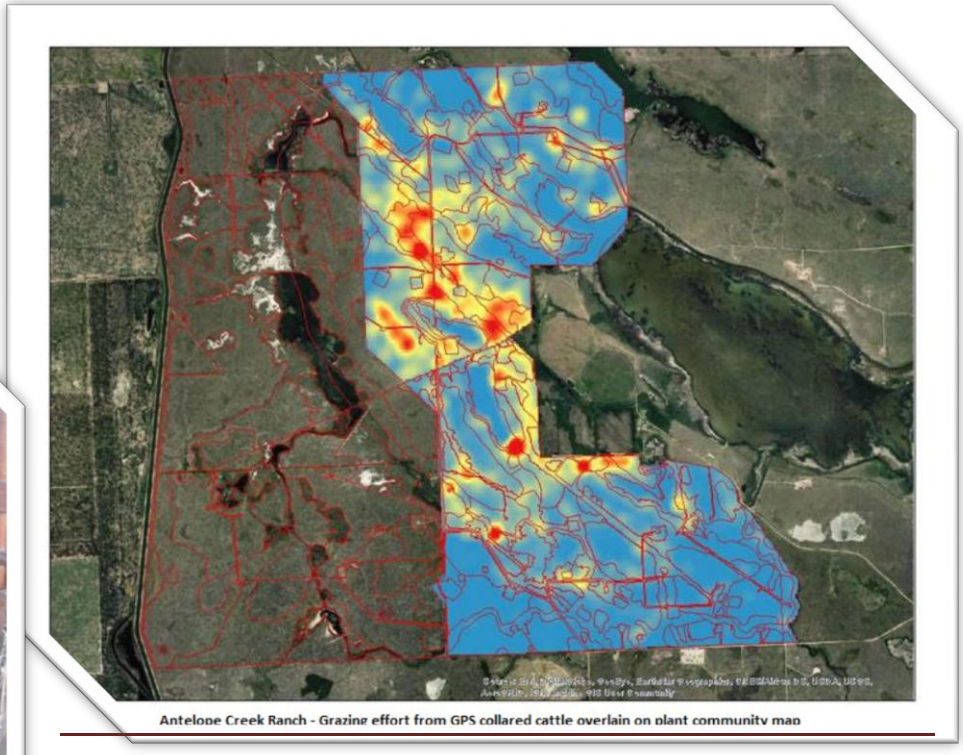
Antelope Creek Ranch - Grazing effort from GPS collared cattle overlain on plant community map

Measuring Secondary Variables

There can be many secondary variables associated with targeted grazing projects. For some of the more common secondary variables (Table 5), there are accepted monitoring protocols available. For example, there are standard protocols for riparian assessments for Alberta (Ambrose et al 2009; Fitch et al 2009) and Saskatchewan (Saskatchewan PCAP 2008a; 2008b), and for rare plant surveys (Henderson 2009; Alberta Native Plant Council 2012; Saskatchewan Ministry of Environment 2015).

Table 5. Protocols and contacts for monitoring secondary variables.

Secondary Variable	Recommended Monitoring Protocol	Protocol Contact Information
Fuel Loading	Newman (2020)	B.C. Cattlemen's Association
Riparian Health	Alberta: Riparian Health Assessment for Lentic, Lotic and Large Rivers Saskatchewan: Riparian Health Assessment for Lakes, Slough & Wetlands and Streams & Small Rivers	Alberta: Cows & Fish www. cowsandfish.org Saskatchewan: Prairie Conservation Action Plan www.pcap-sk.org
Rare Plants	Henderson (2009) Alberta Native Plant Council (2012) Saskatchewan Ministry of Environment (2015)	Environment & Climate Change Canada www.anpc.ab.ca www.environment.gov.sk.ca
Biomass Sampling	Cooke (2017)	Samuel Roberts Noble Foundation

Newman (2020) has designed an intensive and extensive monitoring protocol for fine fuel loadings which can guide targeted grazing projects where reduction of fire hazard is the primary goal. Some of the measurements of primary variables outlined in Newman's monitoring protocol could be adapted for monitoring of fine fuels as secondary variables. As a secondary variable in grasslands and shrublands, litter loadings measured during range health surveys may be sufficient in situations where cost of monitoring is a major consideration. In addition, if biomass sampling is also occurring, impacts on fuel load can be determined from that data.

Biomass sampling using grazing exclusion cages or exclosures is the most suitable method for determining grazing intensity, but may not be the most cost-effective. Estimates of animal units

or animal grazing days/hours are surrogate measurements that assume a given impact on vegetation due to the presence of livestock. Biomass sampling directly measures the impact of grazing. Standardized protocols exist (e.g., Cook 2017) for biomass sampling using grazing exclusion cages /exclosures. If funding for monitoring is limited, utilization of vegetation, or of target vegetation, can be estimated by visually assessing the percent of current year's growth that is consumed or destroyed by livestock and other grazing animals on a site. However, to be a useful measure, the timing of assessing utilization is critical. Utilization should be estimated immediately following the removal of livestock. Estimating utilization before livestock are removed can substantially underestimate grazing intensity. Postponing utilization estimates for long after livestock are removed allows for vegetation regrowth which will also result in underestimation of utilization.

Other Monitoring Recommendations

An often overlooked, but very useful monitoring method is the use of permanent photo points. Photos are cost-effective and easily repeatable when using permanent photo points. The results are not statistical data, but are priceless for demonstrating change in communication products. Photo points should be part of any monitoring protocol and should be used for targeted grazing projects even if, and perhaps especially if, no other form of monitoring will occur. There are many resources available to guide photo point monitoring (e.g., Hall 2002). A good resource on establishing photo points has been developed by Hamilton (2005).

Intensity, Timing and Frequency of Monitoring

Once a project site has been stratified into vegetation communities, or by some other variables as may occur in situations where the natural vegetation has been replaced with anthropogenic vegetation, a representative number of vegetation transects need to be established on the site. Alberta's range inventory manual (Alberta Environment and Parks 2021) suggests at least one transect should be established per unique vegetation community. On sites where vegetation and soil variability is low (e.g., smaller or heavily modified sites), more than one transect per community or strata may be necessary. A good rule of thumb is to establish a minimum of 10 transects (Sharrow and Seefeldt 2006). However, it should be noted that statistically significant results have been obtained on targeted grazing projects in Alberta with as few as four transects.

It is important to monitor at roughly the same time each year throughout the life of the monitoring program so that plants are in the same growth stage making comparison of measurements between years more accurate. Monitoring at different growth stages can impact the variable to be measured sometimes to such an extent that the impact of grazing is eclipsed by the variation between plant growth stages. Normally, vegetation transects should be monitored at later in the growing season before the target plant species have gone dormant for the winter. A good guideline is to monitor prior to mid-September. Timing of monitoring may need to be adjusted based on the variables to be measured. For example, if flowering stems of

the target plant species are one of the primary variables to be measured, then monitoring should occur when the target plant species is flowering.

Ideally, monitoring would begin the year prior to the implementation of the targeted grazing project to provide a baseline against which to compare. Monitoring should occur at least once per year over the life of the project. Continuing to monitor post-project can provide useful information such as if and how many years it takes for the targeted vegetation to recover to pre-treatment levels, and provides an indication of when treatments should be re-applied. This kind of long-term monitoring provides data suitable for research-level analyses that can be used to determine how long the benefits of a targeted grazing program last, in cost-benefit analyses of targeted grazing programs, and ultimately to provide the decision-making information for program design and program justification.

If the targeted grazing program is likely to be short-term (i.e., five years or less), intensive monitoring should be repeated annually. If the targeted grazing program is long-term (i.e., greater than 5 years), intensive monitoring may only need to be repeated every two to three years. In this situation, monitoring could be restricted to range health measurements in the intervening years, and data analysis and reporting could be associated with intensive measurement years.

Monitoring Reporting

Monitoring reports should be written with the following objectives in mind:

- Assessing whether or not the primary goals of the targeted grazing project have been met,
- Identifying impacts to other specifically identified values of interest,
- Recommending ways to adapt the targeted grazing prescription to mitigate negative impacts or improve positive impacts,
- Recommending additional land management activities such as weed control methods to complement targeted grazing or land restoration activities,
- Providing results for communications purposes, and
- Ranking or evaluation sites as a means of prioritizing projects (if appropriate).

Anecdotal observations should also be included in the monitoring report as it will not always be possible to obtain significant results from statistical analysis. Raw data, photos, the monitoring protocol, and a timeline of monitoring efforts/activities should be included as deliverables with the report.

REFERENCES

Abouguendia, Z.M., J.P. Thorpe, and R.C. Godwin. 1990. An Assessment Procedure for Saskatchewan Rangeland. Saskatchewan Research Council Publication No. E-2520-2-E-90. Saskatoon, SK.

Adams. B. W., G. Ehlert, C. Stone, M. Alexander, D. Lawrence, M. Willoughby, D. Moisey, C. Hincz, A. Burkinshaw, J. Richman, K. France, C. DeMaere, T. Kupsch, T. France, T Broadbent, L. Blonski, and A.J. Miller. 2016. Rangeland Health Assessment for Grassland, Forest and Tame Pasture. Alberta Environment and Parks, Rangeland Resource Stewardship Section. ISBN No. 978-1-4601-2784-1.

Alberta Environment and Parks. 2021. Range Inventory Manual. ISBN: 978-1-4601-3948-6

Alberta Native Plant Council. 2012. ANPC Guidelines for Rare Vascular Plant Surveys in Alberta – 2012 Update. Alberta Native Plant Council, Edmonton, AB.

Ambrose, N., G. Ehlert, K. Spicer-Rawe. 2009. Riparian Health Assessment for Lakes, Sloughs, and Wetlands - Field Workbook. Second Edition. Modified from Fitch, L., B. W. Adams, and G. Hale, 2001. Riparian Health Assessment for Streams and Small Rivers - Field Workbook. Lethbridge, Alberta. Cows and Fish program. 96 pgs. ISBN Number: 978-0-9688541-5-0

Bailey, D.W., J. C. Mosley, R. E. Estell, A. F. Cibils, M. Horney, J. R. Hendrickson, J. W. Walker, K. L. Launchbaugh, E. A. Burritt. 2019. Synthesis Paper: Targeted Livestock Grazing: Prescription for Healthy Rangelands. Rangeland Ecology & Management. Volume 72, Issue 6, Pages 865-877

Cooke, R. 2017. How to Use Exclusion Cages to Better Manage Cattle Stocking Rates. IN: AG News & Views, Volume 35, Issue 1. A Monthly Publication from the Samuel Roberts Noble Foundation. 2 pp. https://www.noble.org/globalassets/images/news/ag-news-and-views/2017/01/use-exclusion-cages-to-manage-stocking-rates.pdf

Fitch, L., B.W. Adams and G. Hale. 2009. Riparian Health Assessment for Streams and Small Rivers - Field Workbook. Second Edition. Lethbridge, Alberta: Cows and Fish Program. 94 pages. ISBN Number: 978-0-9688541-4-3.

Hall, Frederick. 2002. Photo Point Monitoring Handbook. U.S. Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-526. Portland, Oregon.

Hamilton, R.M. 2005. Photo Point Monitoring, A Weed Manager's Guide to Remote Sensing and GIS — Mapping & Monitoring. U.S. Department of Agriculture, Forest Service, Remote Sensing Applications Center, Salt Lake City, UT. https://deq.nd.gov/publications/WQ/3_WM/NPS/SWCBinder/Riparian/Photopoint_monitoringUSFS.pdf

Henderson, D. 2009. Occupancy Survey Guidelines for Prairie Plant Species at Risk. Canadian Wildlife Service Prairie and Northern Region. 37 pp.

Launchbaugh, K. and J. Walker (Eds.). 2006. Targeted Grazing: A natural approach to vegetation management and landscape enhancement. American Sheep Industry Association, Denver, Colorado.

Newman, R. F. 2020. Targeted grazing draft standardized monitoring protocol. Prepared for the B.C. Cattlemen's Association. Unpublished Report. 39 pp.

Saskatchewan PCAP. 2008a. Riparian Health Assessment: Lakes, sloughs and wetlands. Prairie Conservation Action Plan. Regina, SK.

Saskatchewan Ministry of Environment, 2015. Rare Prairie Plant Survey Protocol. Fish & Wildlife Branch Technical Report 2015-20. Regina, SK. 8 pp.

Saskatchewan PCAP. 2008b. Riparian Health Assessment: Streams and small rivers. Prairie Conservation Action Plan. Regina, SK.

Saskatchewan PCAP Greencover Committee. 2008. Rangeland Health Assessment: Native Grassland and Forest. Prairie Conservation Action Plan. Regina, SK.

Sharrow, S.H. and S.S. Seefeldt. 2006. Monitoring for success. Chapter 5 IN: Launchbaugh, K. and J. Walker (Eds.). Targeted Grazing: A natural approach to vegetation management and landscape enhancement. American Sheep Industry Association, Denver, Colorado.

Thorpe, J. 2014. Saskatchewan Rangeland Ecosystems, Publication 1: Ecoregions and Ecosites. Version 2. Saskatchewan Prairie Conservation Action Plan. Saskatchewan Research Council Pub. No. 11881-1E14.

APPENDIX A: SUMMARY OF PROJECTS

City of Lethbridge

Jackie Cardinal
Natural Resource Coordinator, City of Lethbridge Parks Department

Onsite interview, September 10, 2020
The City of Lethbridge in 2019, contracted a targeted grazing pilot project with goats in portions of Indian Battle Park and the Alexander Wilderness Park to reduce the spread of Leafy spurge (*Euphorbia esula*) and Absinthe (*Artemisia absinthium*). The pilot project contract, awarded to Creekside Goat Company, has been extended from one to three years, renewable to five years.

Two hundred goats are herded for 50 days in targeted areas within the parks primarily along the Oldman River and adjacent uplands. The goats are herded within specified areas by an experienced herder. Two grazing periods are implemented: June to early July to reduce flowering and seed set and again in August/ September to defoliate and weaken the perennial plants. Treated areas are mapped as polygons by trained city parks staff and permanent photo reference points have been established. Density and distribution of Leafy spurge and Absinthe within the polygon is established using Figure 11 from Alberta's Range Health Assessment Field Workbook (Adams et al 2016). Photos are taken every two weeks and kept on file. An annual report is prepared and kept on file.

In the fall of 2019 the goats were also used as part of a Fire Smart project by the Lethbridge Fire Department. The goats were used to reduce the accumulated fuel load in the shrub and grassland plant communities along the coulees adjacent to Scenic Drive and Scenic Heights.

Craig Harding
Director of Conservation Science and Planning
Katelyn Ceh
Director of Conservation Parkland and Grassland
Nature Conservancy of Canada/ Alberta Region

September 23, 2020
Interview conducted through web meeting

NCC implemented a three year trial targeted grazing project in 2018 on the Fleming Property west of Edmonton. Since 2015 a portion of the property is in the process of being restored from cultivation to native mixedwood boreal forest, through the planting of native trees and native grass species. Targeted grazing with goats was implemented to reduce weeds invading the site such as common tansy, Canada thistle and sow thistle.

Short duration, high density grazing management was implemented by Baah'd Plant Management with approximately 500 goats on site for one day, with repeat treatments occurring in late June, August and September. Monitoring information includes: recording weed density and distribution evaluated at permanent reference locations, identifying and mapping any areas of concern such as bedding sites and photos taken before and after treatment.

Resources:

Nature Conservancy of Canada. 2020. Targeted browsing with goats: NCC Fleming Property. 2018-2020. Project Summary. 16 pp.

City of Edmonton

Nicole Fraser, Travis Kennedy, Shannon Wagner and Qiting Chen
City Operations/ Parks and Road Services
City of Edmonton

October 30, 2020
Interview conducted through web meeting

The "GoatWorks" targeted grazing pilot project was initiated 2017 by the City of Edmonton's Parks and Road Services in an effort to manage regulated noxious weeds on City owned lands response to a need to eliminate non-essential use of herbicides. The project also sought to provide public education related to herbicide policy changes.

The three year pilot project was implemented in Rundle Park located in the river valley where the use of herbicides is problematic. Leafy spurge (*Euphorbia esula*) and Canada thistle (*Cirsium arvense*) were targeted noxious weed species. Baah'd Plant Management was contracted and worked closely with the Goat Program Coordinator to implement grazing prescriptions including the area, timing and frequency of treatment, and the number of goats. Over the three year trial target areas were treated three times during the grazing season for 5 to 7 days at a time. Number of goats per treatment varied from 200 to 400.

Monitoring methods include pre and post treatment photos and data collection along 200 meter permanent line transects where stem count and percent cover estimates were collected every five meters. Analysis of the results was unable to show any significant trends in numbers or cover of weeds monitored.

Resources:

Bishop, K. 2019. Engaging the public with Edmonton's GoatWorks program. Sustainability Scholar Final Report. Prepared for the City of Edmonton. University of Alberta. 96 pp.

City of Edmonton. 2019. GoatWorks pilot project 2017-2019 summary report. City Operations. Parks and Road Services. 82 pp.

City of Edmonton. 2020. GoatWorks Pilot Research Method. 4 pp.

City of Edmonton. GoatWorks Research Data Collection Form.

Hall, J. 2018. Edmonton GoatWorks. Prepared for the City of Edmonton by Baa'd Plant Management and Reclamation. 13 pp.

Chavarria Sanchez, M. 2020. Evaluation of the use of goats for weed control in naturalized park areas. Final Report. Prepared for the City of Edmonton. Olds College Centre for Innovation. 20 pp.

City of Calgary

Sarah Kellet and Patricia Striker
Park Ecologists
City of Calgary Parks

November 19, 2020
Interview conducted by conference call

The City of Calgary has six targeted grazing projects. Three projects with long term monitoring programs were discussed during the interview. Targeted grazing guidelines were established by the City of Calgary in 2017 to facilitate contract management.

A pilot project was conducted Confluence Park in 2016 to assess the feasibility of using goats as a tool for managing the occurrence and spread of invasive or undesirable plant species. Baah'd Plant Management was contracted to conduct the targeted grazing with goats. Fiera Biological Consulting was contracted to design and implement a long term monitoring program. Four focal vegetation species were identified: Canada thistle (*Cirsium arvense*), perennial sow thistle (*Sonchus arvensis*), yellow toadflax (*Linaria vulgaris*), and buckbrush (*Symphoricarpos occidentalis*). While the outcomes of the pilot program suggested that goats offer great promise for controlling invasive or undesirable species in City parks, further research was required to document and evaluate the effectiveness of browsing as a tool for controlling the occurrence and spread of target species in the short term (e.g., within the same growing season) and over the longer term (e.g., regrowth or recurrence patterns over a number of years). Subsequently the project was extended in 2017, 2018 and 2019. Annual monitoring reports were prepared by Fiera Biological Consulting and the monitoring methods discussed in this report.

At McHugh Bluff Park, Tannas Conservation Services Ltd. (TCS) was contracted in 2018 to provide range management recommendations that would provide guidance for project management. The goal was to set up a sustainable grazing program to re-introduce grazing to the park for the purpose of improving ecosystem function and health as well as maintaining plant communities and biodiversity within the park. The report provided guidance regarding the carrying capacity for sheep or goats, the timing and frequency of treatments.

In 2019, TCS was contracted to provide a status report on the grazing program based on weed suppression and range health. The density and distribution of noxious weeds and invasive non-native plant species was assessed prior to introduction of grazing by the goats and again at the completion of grazing. Prominent species of concern throughout McHugh Bluff include: common burdock (*Arctium minus*), creeping bellflower (*Campanula rapunculoides*), nodding thistle (*Carduus nutans*), yellow clematis (*Clematis tangutica*), Canada thistle (*Cirsium arvense*), leafy spurge (*Euphorbia esula*), black henbane (*Hyoscyamus niger*), Himalayan balsam (*Impatiens glandulifera*), scentless chamomile (*Matricaria perforata*), perennial sowthistle (*Sonchus arvensis*), thesium (*Thesium arvense*), and tufted vetch (*Vicia cracca*).

Range health was assessed both pre-and post- treatment following the protocol for tame pasture (Adams et al 2016) as there were virtually no native species on site. Recommendations based on the findings included methods for improving the distribution of the livestock within the site to improve the reduction of targeted species and to decrease overgrazing in specific high use areas.

Ralph Klein Park has multiple constructed wetlands and a number of reclaimed open native grasslands. The entire area has been historically disturbed through tillage at some point or another. Baah'd Plant Management and Reclamation was contracted to conduct targeted grazing with goats in 2019. Temporary fencing and the water's edge were used to contain goats to targeted weed areas. Tannas Conservation Services Ltd. was contracted to design a monitor program to assess the long-term effectiveness of goat grazing on controlling target invasive species, and impacts on non-target native species within the park. The program compared a variety of treatment plots with control plots using grazed and non-grazed treatments. Three noxious weeds: Canada thistle (*Cirsium arvense*), perennial sow thistle (*Sonchus arvensis*), yellow toadflax (*Linaria vulgaris*), were the focus of the study. A detailed report with recommendations was provided to the City of Calgary.

Resources:

The City of Calgary. 2017. Targeted Grazing Project Guidelines. Prepared by Calgary Parks, Urban Conservation Policy. 10 pp

Fiera Biological Consulting. 2019. Targeted browsing monitoring program in Confluence Park. Prepared for City of Calgary. 27 pp

Tannas Conservation Services Ltd. 2019. McHugh Bluff Park grazing management: grazing results and recommendations. Prepared for the City of Calgary. 54 pp

Tannas Conservation Services Ltd. 2019. Ralph Klein Park targeted grazing study to control invasive species: study methodology, statistical analysis, cover and density results. Prepared for the City of Calgary.

Antelope Creek Ranch

Neal Wilson
Ranch Manager
Ross Adams
Range Management Specialist, Alberta Environment & Parks

September 16, 2020
Site visit and subsequent communications

Antelope Creek Ranch initiated a targeted grazing program in 2015 using beef cattle with a goal of reducing the predominance of crested wheatgrass (CWG) in two fields, each approximately 1200 ac in size with significant CWG invasion. Vegetation communities were identified and mapped. Four permanent vegetation transects were established on large CWG infestations in two fields for long-term monitoring. Some CWG infested sites were mowed in an attempt to make regrowth more palatable and more attractive to cattle. The grazing prescription involves a skim graze in mid-May when crested wheatgrass is growing but native range plants are largely dormant. Cattle are removed once native vegetation begins to grow, and are then rotated back into the fields anywhere between June to October for approximately 21 to 28 days.

In 2016, some of the cattle were GPS-collared to determine how much time they were spending in various locations. Vegetation transects and range health (Adams et al 2016) on CWG infestations were reassessed in 2018 to evaluate changes in CWG dominance after several years of skim grazing. Analysis of monitoring results indicate there was a clear preference by cattle for uplands dominated by CWG compared to uplands dominated by native vegetation by both electivity and forage ratio measures, although cattle appeared to have no preference for mowed sites versus unmowed sites. Between 2015 and 2018, CWG cover was reduced on infested sites and native grass cover increased. Three species of native grasses - western wheatgrass, blue grama, and sandberg bluegrass - that were not recorded in 2015 were found to have re-established on infested sites. Range health assessments have shown no change over time.

Resources:

Adams, Ross. 2019. Spreadsheets and notes from GPS collar and vegetation transect analysis.

Antelope Creek Technical Committee. 2018. Antelope Creek Habitat Development Area 2016 GPS Collar Analysis. 10pp

Antelope Creek Habitat Development Area. 2015. Summer Range Technician Report. 4 pp.

Baker, H. and K. Rushton. 2020. Range Management Review for Antelope Creek Habitat Development Area. Prepared by Keefer Ecological Services. 35 pp.

Dyck, A. 2017. Summer Range Technician Report: Antelope Creek Habitat Development Area. 13 pp.

Pettybone, M. 2016. Summer Range Technician Report: Antelope Creek Habitat Development Area. 12 pp.

Rushton, K. 2018. Summer Range Technician Report: Antelope Creek Habitat Development Area. 16 pp.

Renny Grilz
Resource Management Officer
Meewasin Valley Authority

September 18, 2020
Interview conducted by phone call
Previous site visits in 2017 and 2018

Meewasin Valley Authority has one of the longest-running targeted grazing programs in Canada. Meewasin began using sheep to combat invasive plants in the natural areas they manage within the City of Saskatoon more than a decade ago. They target an array of invasive plants from woody vegetation such as buckbrush to noxious weeds such as Canada thistle and sow thistle to non-native plants such as Kentucky bluegrass using an integrated vegetation management approach that includes targeted grazing, mowing, controlled burning and herbicides. The overall ecological goal is to have a mosaic of disturbance on the landscape.

The primary long-term monitoring Meewasin has in place is the measurement of biomass, using grazing exclusion cages, before and after grazing each year. Photos of the sampling sites are also taken before and after grazing. This information helps Meewasin determine if they have met the goals of the grazing prescription and helps refine future grazing prescriptions. Results indicate that there is a reduction in the targeted plant species, primarily Kentucky bluegrass, for about two years and by the third year post-grazing the target plant species is back to full production.

A graduate student looked at plant biodiversity on grazed and burned sites and found that the biodiversity index was high with grazing than without, higher with burning than without, and even higher when a site was treated with a combination of grazing and burning.

Other monitoring that has occurred on an adhoc basis includes structural vegetation measurements for wildlife habitat; range health and vegetation composition measurements; and some wildlife species monitoring. Vegetation monitoring indicated that wildflowers and native grasses increased following grazing. No results are available from the range health monitoring as the data was never analyzed and the raw data was never received.

Meewasin found that without disturbance their bird species and vegetation communities were shifting from grassland species to woodland species. With burning and grazing, or with repeated grazing, thirteen lined ground squirrels and raptors increased. Some breeding bird monitoring was undertaken, but not for enough years to define trends.

Social goals are very important in Meewasin's grazing program. They strive to make connections between rural and urban cultures and livestock can play a big role. Being able to

share the results of their grazing and burning programs is important to gain public support and funding. To that end they are developing interpretive signage with positive messaging about the role of grazing and burning in land management.

In future, they hope to be able to implement some multi-species targeted grazing with cows, sheep and goats.

Melanie Toppi
AgriEnvironmental Group Plan Biologist
SODCAP Inc. / FWRWMA

September 25, 2020
Site visit and conducted monitoring for 2020

SODCAP supports two targeted grazing projects on privately managed properties. One projects began in 2018 and the second in 2019, and both use goats to target leafy spurge invasion. In 2019, one of the sites had both sheep and goats. Initially, both landowners contracted a goat herder (Lee Sexton). In 2020, one of the landowners bought their own goats so they could target the spurge for the whole grazing season. Having their own goat herd will also allow them to continue to target graze once funds to supplement the practice are no longer available. In Saskatchewan, there are currently funds available for targeted grazing of noxious weeds through the Ministry of Agriculture's Environmental Farm Plan program.

In 2019, SODCAP developed a monitoring protocol adapted from a monitoring program developed for the Elbow Community Pasture in Saskatchewan by the University of Saskatchewan. 12 permanent transects were established in the larger of the two targeted grazing projects, including one control transect. At intervals along the transect the following measurements were taken: stem counts of leafy spurge, height of the nearest leafy spurge plant, percent cover of leafy spurge, percent bare ground and litter (lbs/ac).

Funding for monitoring was limited. However, the larger site was monitored in 2019 and a partial monitoring was conducted in 2020. Based on the analysis of the data, there were significant reductions in number of stems and percent cover of leafy spurge between 2019 and 2020. However, the control transect was not remeasured. Therefore, it is not clear that the reduction is due to targeted grazing of spurge. It may be climate-related. Bare ground showed no significant change. Litter decreased substantially on some transects, but this was not a consistent trend across transects. Leafy spurge heights were not measured in 2019, therefore no comparison could be made between years. Photos were taken in each cardinal direction at each transect.

The shepherds indicate that they noticed a decline in the vigour and number of flowering heads of leafy spurge due to targeted grazing. However, as this was not measured it could not be verified.

Resources:

SODCAP. 2019. Leafy spurge assessment standard operating procedure. Prepared by Melanie Toppi. South of the Divide Conservation Action Plan. 3 pp

SODCAP. 2019. Template data sheet

Toppi, Melanie. Spreadsheet with 2019 and 2020 measurements and analysis.