Land Development Optimization, a Literature Review

An investigation into low-intensity land development of non-cultivated agriculture lands in Whitehorse area.

Prepared for: Circle D Ranch and Growing Forward 2

Prepared by: Treharne Drury

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Acknowledgements & Project Partners

Growing Forward 2

The intent of Growing Forward 2 is to achieve a profitable, sustainable, competitive and innovative agri-culture, agri-food and agri-products industry that is market-responsive, anticipates and adapts to chang-ing circumstances, and is a major contributor to the well-being of Canadians.

Circle D Ranch

Circle D Ranch is a Yukon based business focusing on growing and raising healthy food and animals. The ranch prides itself on producing a healthy and responsibly raised product that consumers can feel proud of purchasing. Circle D Ranch is interested in innovating northern agriculture practices and developing new methods of agricultural diversity and income.

Summary

Work Completed

This project investigated current and traditional methods to improve private forested agriculture lands for enhanced grazing and forage. This project conducted a comprehensive literature review of pertinent materials, produced a list of reviewed materials and a list of recommendations. The proponent, Circle D Ranch, hopes to implement one or more of these techniques to improve grass production for increased livestock grazing capacity on non-cultivated (forest and bush) areas of their land. It is the hope of the proponent that this project might identify a development method that is; low cost, requires non-specialized equipment, has low impact, and does not eliminate the trees. The proponent wishes to "better utilize" the non-cultivated areas of their land for cattle grazing.

What we Found

This report found that there are a multitude of low impact ways to increase productivity on forested agriculture lands. Methods range from passive to mechanized techniques with varying degrees of effectiveness depending on many factors. It was found that specific considerations must be made to ensure effective implementation on a farm by farm basis. The research clearly indicates that not all enhancement techniques produce positive results and few generalizations can be made. With that said, there are some common themes that can be predicted to succeed in our region.

Forest stand thinning is reported to increase understory growth in a linear manner. Forest thinning is a simple technique and there are several low tech ways to accomplish this discussed in the paper.

Multispecies Grazing is another commonly implemented technique to fully utilize forested lands. This technique also holds promise for our region, however, specific stocking rates were not available and would need to be researched.

Potential Benefits

Potential benefits of this project include; additional knowledge regarding land enhancement, which could provide options to agriculturalists looking for new ways to increase land productivity. Implementation of these techniques may increase productivity on existing ag. lands, improve farm resiliency through diversification, reduce environmental impact of cultivation and soil disturbance, reduce soil erosion and runoff, reduce development costs to farmer, and reduce wind disturbance to livestock by keeping "tree islands".

Project Communication

Copies of the report were printed, submitted to and can be found at; YAA, Yukon Ag. Branch, and GF2 (Growing Forward 2).

Introduction

Background

Globally, the Yukon is unique in its agricultural and industrial infancy. Some form of agriculture has been occurring for about 100 years, however, industrial scale agriculture has never been a part of the Yukon landscape. The Yukon is home to about 150 farms and products are (almost exclusively) available to the local market. The Yukon faces challenging conditions in agriculture, growing conditions are difficult, distances to larger markets are vast, production costs are high, the industry is young and supporting infrastructure is lacking. Considering these hurdles there persists a vibrant agricultural community with strong connections to the land and commitment to sustainable production.

Agricultural land in the Yukon was traditionally obtained through a spot land application process. Today there is a second method for ag. land dispersal which is through planned agricultural subdivisions. In spot land dispersal, the applicant applies to the Agriculture Branch for a suitable piece of crown land. The application is assessed by branch staff and, following consultation through YESSA, a decision is made to either allow the application to proceed or not.

In the case of a favourable decision towards the applicant, the applicant has 7 years to complete the farm developments and take "title" of the new farm. Amongst other requirements, the applicant must "clear and break" just over half of the granted lands.

Farm development is a considerably expensive undertaking; many developers must hire specialized equipment and operators to have their land cleared and broken. These services can run as high as $100 per hour. This considerable cost, as well as all other development costs, influences farmers to clear the minimum amount of land necessary to gain title.

High development cost has manifested in many agriculture lands containing about 50% cleared/cultivated land and 50% forested or uncleared land. The grazing capacity of the undeveloped land is dependent on many factors, however, it is never as productive as the cultivated land. The question that this report is trying to answer is; What are some low-cost methods of enhancing the grazing capacity of those uncleared lands?

Why Choose Enhancement?

There are several key reasons that a farmer would choose to enhance forage and grazing as

opposed to simply clearing and cultivating the land.

1. Cost - it is very expensive to clear and cultivate. This will give you the highest yields, however, it comes at a significant upfront cost and may require irrigation and fertilizer to maintain good growth. For farmers looking for a low-cost option this will not work.
2. Shelter Belts - providing shelter from wind and weather is very important for the overwintering of livestock. Sheltered areas allow animals to get out of the wind in winter, provide shade in summer and provide a mixture of herbatious plants to supplement the diets.
3. Biodiversity - this might not be of concern to farmers or producers but it plays a vital role in the larger ecosystem, providing islands of habitat within a larger cleared area allows smaller mammals to migrate between feeding and breeding sites and to relocate.
4. Land Management - there are considerable monetary and time costs associated with up keeping and managing cultivated land. Without intervention cultivated lands can quickly become weed infested, overgrown with trees and shrubs or become saline. Most agriculture lands throughout the Takhini and Yukon river valleys require irrigation and fertilizer to maintain decent yields. All these interventions come at a high cost.

This literature review was initiated by Bill Drury of Circle D Ranch. The Drury ranch is predominantly a cattle and elk ranch raising animals for meat. The Drury ranch is considered large for the Yukon, it measures approx. 500 ha of which about half is cleared. This represents a significant area of land that is uncultivated and underproducing. The Drury ranch is not typical of farms and ranches in the Yukon, however, the results of this review can easily be transferred to smaller operations.

This report will focus on two aspects of forage enhancement;

1. investigate methods to thin existing tree stands, reduce sapling recruitment within existing stands, and reduce sapling encroachment onto cultivated lands.
2. Investigate methods of introducing and promoting the growth of forage grass species within the forest ecosystem.

Results

Reviewed Literature

- Hester, A.J., |Edenius, L., Buttehschon, R.M., and Kuiters, A.T., 2000 Interactions between forests and herbivores: the role of controlled grazing experiments. J. Forestry, Vol. 73, No. 4, 381-391.

This paper assesses and reports on the controlled grazing experiments used to study large herbivore interactions with the forest ecosystem. This paper acknowledges a lack of available information in this regard particularly with respect to forest grazing and tree species recruitment. This paper concludes that more experimental investigation is required to fully understand the effects of large herbivores on forest systems. The paper tries to understand grazing thresholds with respect to animal assemblage and densities. It finds that reduced deer densities result in increased sapling survival and recruitment. Within this paper some working numbers appear, reference is made to a paper (Beaumont et al., 1994) that finds rowan and birch sapling recruitment and survival becomes suppressed when sheep densities rise above 1 sheep per hectare. Suppression of tree species appears highly dependent upon the tree species in question and the herbivores that are grazing upon them. Regional experimentation is necessary to determine grazing effects on local tree species. It should also be noted that depending on the grazing intensities within the forest system and the herbivores used, the forest species assemblage can become drastically altered. Perhaps an important point raised by this paper is the difference between browsers and grazers, browsers seek and eat woody material occasionally eating herbaceous plants. Grazers on the other hand target herbaceous plants and occasionally eat woody plants, such as saplings and branches. This is an important distinction for land owners looking to reduce sapling recruitment and survival.

Furthermore, specific grazers can increase the presence of unwanted vegetation. Austin et al., (1994) found that horse grazing in spring and summer led to increased shrub growth within grazed areas. Without the presence of browsers on this type of system, good pastureland can quickly transition towards forest.

- Coffey, L., 2001 Multispecies Grazing. Appropriate Technology Transfer for Rural Areas. P 1-6.

This paper discusses the benefits of multispecies grazing within an agribusiness setting. The author posits that grazing cattle with sheep and goats will better utilize the available plant

matter yielding more meat production for a given pasture size. This method of grazing also reduces weeds and brush from outcompeting the grasses. The author estimates that one goat can be added to the pasture for every cow present without impacting cattle performance. Similar stocking rates apply to sheep, however, sheep will not have the same effect on controlling woody shrubs and saplings. Coffey continues on to explain that this method of management requires more effort and expertise, however, the payoffs to pasture improvement and income diversity are significant.

- Austin, D.D., Urness, J.P., Durham, S.L., 1994 Impacts of mule deer and horse grazing on transplanted shrubs for regeneration. J. Range Management, 47:8-11.

This paper provides the reader with information pertaining to range use by game and horses and the impacts that can be measured. The impacts of grazing horses serve to increase the available browse for deer. The impacts of browsing deer render the shrubs less competitive enabling the grasses and herbaceous plants to grow more plentiful in the following season.

- Thomas, H.S., Multi-Species Grazing of Cattle and Goats Makes Sense, 2010 BEEF Magazine, http://beefmagazine.com/mag/multi-species-grazing-goats-cattle-0801

This article focuses on the benefits of multi-species grazing on rangeland, benefits include; better utilization of available biomass, heavier stocking rates, weed and invasive control by goats and sheep, as well sheep and goats can eat plants toxic to cows reducing cow mortality.

- Briske, D.D., 1993 Grazing Optimization: A Plea For a Balanced Perspective. Ecological Applications, 3(1) pp. 24-26.

This paper discuses compensatory plant growth in response to herbivory and the effects of overgrazing and unbalanced systems. Briske explains that, "compensatory growth may be a significant ecological process that minimizes the reduction of primary production in some species and systems, given the appropriate combination of environmental variables." Briske stresses the importance of controlling the number of animals and the duration of time they spend on each pasture and that compensatory growth should not be used as an excuse to overgraze. This has potential implications in local systems, however, research needs to be done to determine which plant types might be suitable.

- Gordon, I. J., Facilitation of Red Deer Grazing By Cattle and its Impacts on Red Deer Performance. Journal of applied ecology, 1998, 25, 1-10.

This article explores grazing facilitation in a mixed graze ecosystem in northern Scotland. Cattle were re-introduced onto areas of a remote island where red deer were the only grazers for nearly 20 years. When the cattle were removed (1957) a vegetation monitoring program was introduced to track changes. This program discovered that species diversity and richness were in decline due to the highly selective grazing habits of the red deer. It was decided in the 1970s to reintroduce cattle and monitor vegetation and red deer population change.

It was found that the cattle improved grazing by triggering compensatory plant growth, trampling the leaf litter allowing light and heat to penetrate the ground, and fertilizing the ground through defecation and urination. This increased the availability of green plant material in areas the cattle grazed. The red deer responded by spending significantly more time in the areas that had been grazed by the cattle. Red deer were also noted to have a higher cow calf ratio in the regions grazed by the cattle.

This paper provides yet another example of how a mixed grazing system can improve pasture and grazed lands. The authors postulate that the benefits to red deer would be similar for sheep grazing in the same system. Research would be needed in order to positively state whether this type of grazing management practice would work in our region.

- Belsky, A.J., Blumenthal, M.D., Effects of Livestock Grazing on Stand Dynamics and Soils in Upland Forests of the Interior West, Conservation Biology, Vol. 10, No. 5, April 1996.

In this paper, Belsky and Blumenthal discuss the results of their findings following an investigation into the effects of grazing on forests of the western interior of the United States. Their findings differ from the findings discussed thus far.

Belsky and Blumenthal claim that livestock (livestock is not differentiated here) alter forest dynamics in two ways; they reduce the competition between grazed species and seedlings resulting in greater seedling recruitment, this in turn reduces the density of fine fuels in the understory which eliminates the presence of low intensity fires. They conclude by stating, live-

stock densify and alter tree species composition within western forests.

This paper clearly illustrates that generalities are difficult to make when predicting the results of management decisions. Direct comparisons are difficult to find and inferences must be made. These results support the need to conduct research specific to a management area.

- Cole, C.E., Hanley, A.T., Newton, M., Influence of pre-commercial thinning on understory vegetation of young-growth Sitka spruce forests in south eastern Alaska. Can. J. For. Res. 40:619-628, 2010.

Cole et.al., investigate the effects of pre-commercial thinning of forest understory in stands of Sitka spruce over a 7 year study period. The purpose of this investigation was to assess how forest thinning (for commercial forestry purposes) impacted food availability for the Sitka black-tailed deer. Research areas were aggressively thinned and stands were reduced from between 5000-29000 trees/ha to between 250-750 trees/ha. Researchers found that understory vegetation responded immediately to the thinning treatment and greatly increased, peaking at year 4 of the trial and slowly declining by year 7. Understory biomass was much greater in all treatment areas compared to untreated areas in year 7. This increase in shrub and forb productivity directly translated into productivity increases in the deer populations. Thinned areas were found to be more than twice as productive as un-thinned areas.

It is reasonable to surmise that similar (perhaps not to the same degree) results could be expected from forest thinning on local ag. lands.

- Green, L.R., Newell, L.A., Using Goats to Control Brush Regrowth on Fuelbreaks. Pacific Southwest Forest and Range Experimentation Station, Sept 1982.

This paper describes the usage of goats for controlling vegetation regrowth in fire breaks. It also discusses management practices, stocking rates, misconceptions about goats, their effects on the ecosystem and consequences of mismanagement. The key message of this document is that under proper management goats are able to consume large amounts of woody and non-woody materials (not palatable to other livestock) and remain productive. This paper also claims that properly managed goats can be the least destructive grazers (when compared to other grazers such as cows, sheep and horses) so long as proper stocking rates are maintained. This paper recommends that goats be confined (using herders or fences) to smaller

pastures in order to maximize the available biomass. Left to their own devices goats will preferentially feed upon tender new growth and leave the rest, however, if they are kept in smaller areas for short periods they will better utilize all available feed stock.

Discussion/Conclusion

While researching for this project I was unable to find analogous articles investigating similar solutions in similar geographic regions. It seems that due to our unique land development requirements, the Yukon is atypical in its abundance of non-developed agriculture lands. I was, however, able to find many articles dealing with partial aspects of this question which are presented in the results section.

Fortunately, there are many successful enhancement options that have been shown to work in other regions that can be tried locally. Unfortunately, because there has been little northern based research pertaining to this topic, this report is unable to recommend definitive techniques that will guarantee success.

It is important to remember and reiterate the goal of this project, to enhance grazing capacity on private forested ag. lands without resorting to expensive cultivation practices.

Enhancement techniques can be broken down into two basic categories; animal based enhancement, and mechanical based enhancement.

Animal based enhancement of these forested lands is accomplished through a number of techniques. The most important of which is through multispecies grazing.

For this discussion we will define multispecies grazing as, the practice of allowing more than one species of large herbivore with different forage preferences (grasses, forbs, shrubs) to graze a common forage resource (Walker, 1994). The benefits of grazing a combination of livestock animals is many fold and well understood. It has also been demonstrated to be effective in many regions and with several combinations of livestock. The key benefit of multispecies grazing is through efficient utilization of the available graze and browse found in the forest ecosystem. Browsing animals such as goats and deer do not compete with grazing animals such as cattle and horses. In many regions it is considered safe to add an equal numbers of browsers to an existing herd of grazers without negative consequences. As you can see this immediately increases the utilization and profitability of the land.

In many studies the benefits do not stop there. Researchers have noted that by adding browsers to rangelands, sapling encroachment onto pastures is reduced (browsers feed on the small tender saplings at the margins of grasslands

which maintains the grassland area), sapling recruitment (seedling survival within the forest) is reduced through cropping mortality and grasses are thus enabled to compete for space in the forest understory more successfully.

Mechanical based enhancement comes in many flavours as well. The two basic enhancement types are forest stand thinning followed by application of grass seed. Throughout the literature search, several innovative methods of low-cost (or profit generating) mechanical thinning practices were presented. Depending on forest type some or all of these methods could be adopted. These included;

- Woodcutting
- Christmas tree harvesting
- Selective timber harvesting
- Brush clearing/thinning/mulching

These methods (to varying degrees) are all effective at reducing stand density and increasing light and heat to the forest floor. Several studies have measured a linear relationship between a reduction in canopy density with a corresponding increase in understory proliferation. With proper management this proliferation could be either tree saplings or palatable grasses.

Several papers report success following the application of grass seed to opened areas of forest. Success in this case will vary considerably according to many factors; forest type, exposure, drainage, etc. and many considerations must be taken into account to ensure favourable results.

Perhaps the most effective and rapid method to reduce stand density is through selective mulching. A variety of mulching heads are available to be mounted on skid steer tractors. These heads are efficient and versatile, able to mulch everything from saplings to trees up to 12 inches in diameter. In heavy stands of regrowth or stands with high densities of small trees this tool would be highly effective. Industry literature through Bobcat claim, "We can clear half-an-acre of the big stuff—the Viney Maple—in 8 hours, for medium brush, we can clear an acre in 8 hours, whereas with lighter brush we can remove as much as 4 acres in a day."

Not only does this method of stand reduction open the canopy and allow more regrowth, because the trees/brush is chipped, nutrient and carbon is not removed from the system.

After having looked into renting a skid steer mulcher, I was disappointed to learn that they

are no longer available through our local rental companies.

Based on findings of a recent study conducted by the Yukon Agriculture Branch, this method of enhancement should prove highly effective for local producers. Following the non-conventional development of Agriculture Agreement 61-3, the ag branch studied the resulting growth of forage and compared it to native forest forage. 61-3 was developed in a similar manner to the methods discussed in this paper, trees were knocked down (it should be noted that the forest was cleared not thinned as proposed by this paper, however the clearings were small and simulated natural meadows) and grass seed was applied through a no-till process.

The branch found that all the modified sites produced significantly more palatable forage than the poplar and pine forest adjacent. It was determined that these sites produced substantially less forage than traditionally prepared ag lands. The results, however, strongly support this papers position that forest enhancement could significantly increase the productivity of forested ag lands.

Based on the results of the ag. Branch study the increase in grazing capacity is substantial. The study found that native forests in the study site produced between 16 and 30 ha/AMU, following modification productivity increased to 1.9-1.01 ha/AMU. It should be noted that the branch was calculating AMU based on traditional grazer palatability, considering browsers in the calculations would increase these numbers again.

With these results the economics of enhancement start to look attractive. By modifying a significant area of forested lands, producers could vastly increase productivity without incurring significant expense.

It is the recommendation of this report that agriculture managers utilize a combination of mechanical and animal based interventions to maximize productivity of their forested lands. It is understood that to truly maximize productivity, lands need to be cleared and cultivated, irrigated and fertilized and intensively managed. As we covered in the introduction, however, maintaining some forested lands on ag. properties is important and for many reasons necessary. This does not mean that they need to be unproductive. This report clearly shows that there are numerous cost effective ways to increase the productivity of forested ag land.

There seems to be great potential for implementation of both multispecies grazing and stand thinning on local forested ag lands. Fully understanding the implications of adding browsers to an existing grazing herd is needed in order to compile best practices for Yukon. As we learned from Belsky and Blumenthal, in certain instances, adding livestock to forest systems can have undesirable impacts such as forest densification and an elimination of palatable grasses. Understanding and designing a grazing regime for specific ag. lands is needed for sustainable agriculture.

For livestock producers, utilizing forest based graze and browse at specific times of year may have profound impacts on overall farm productivity. In spring, when cattle and horses are placed onto pastures, they are utilizing grasses during a most critical time.

Grasses are investing huge energy stores in early springtime growth. If heavy grazing pressures are present at this time it can have negative impacts on yields. If sufficient pressures are placed on the grasses year after year, grass mortality and unpalatable weed dominance can occur.

Keeping livestock on large areas of productive forested land might be a good alternative to spring pastures. Assuming sufficient enhancements can provide the necessary feed supply, this brief reprieve to pastures might pay significant dividends.

In closing, it is recommended that along with location specific research, field scale trials be conducted in Yukon to better understand how these management options might change range productivity. This research would benefit producers in several ways;

- it would provide some numbers on stocking rates in a mixed grazing system
- it would provide an opportunity to measure forest system primary productivity changes in a mixed graze environment
- it would verify the effectiveness of forest stand thinning on increased grass production
- and it would be able to measure the effectiveness of browsers on combating pasture and field encroachment by trees and shrubs

Future Research

Circle D Ranch is interested in seeing some field scale trails conducted on their property, they are willing to commit a newly developed parcel of ag. land for this purpose, as well, they are willing to provide livestock, labourers and some capital. The parcel of land that would be utilized

is a mixture of pasture and open forest which would be perfect for trials. They also have a parcel that is game-fenced with an existing herd of elk. This land could potentially serve to study mixed grazing of elk (browser) and cattle (grazer).

If there is expressed interest for further research from the Agricultural Research Committee, Circle D Ranch and GF2, I would be happy to submit a research proposal for consideration.

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