Recommendations for the Control of Invasive Plants

AT THE LAURIE GUICHON MEMORIAL GRASSLAND INTERPRETIVE SITE

ACKNOWLEDGEMENTS

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SECTION 1

Background

The Laurie Guichon Memorial Grasslands Interpretive Site (LGMGIS) was established in 2001 by the Nicola Watershed Community Round Table (NWCRT) in partnership with the Grasslands Conservation Council of BC (GCC). The 102 hectare area is located approximately 11 km southeast of Merritt, British Columbia, east of highway5A/97C at the junction with an access road to Lundbom and Marquart Lakes.

The goal of the GCC within the LGMGIS is to represent a healthy grassland ecosystem.

The site was established to honour Laurie Guichon, a fourth generation rancher in the Nicola Valley and founding member of the NWCRT and GCC. Laurie was passionate about creating a grasslands interpretive site and the site was part of his vision to bring people together to share knowledge and responsibility for the land.

On April 1 2012, the NWCRT entered into a "Recreation Sites and Trails BC Partnership Agreement" with the province under the Forest and Range Practices Act. The primary purpose of the agreement is to have the land managed and maintained for the purposes of recreational and/or conservation activities. Volunteer members of the NWCRT have been crucial stewards of this land, maintaining cleanliness, as well as adding interpretive signs and trails to educate visitors about the grasslands' history, use, and biodiversity. The site also lies within a grazing tenure managed by the Ministry of Forests, Lands, and Natural Resource Operations and Rural Development, that experiences varying levels of annual cattle grazing. The NWCRT convened a stakeholder meeting in 2017 to address the general state of ecological deterioration within the LGMGIS. Following that meeting, the GCC and NCWRT engaged Iverson and MacKenzie Biological Consulting Ltd. who in concert with Dennis Lloyd, a GCC Director, conducted a thorough baseline ecological assessment of the area.

In 2019, The Grassland Conservation Council of BC released the baseline inventory report (GCC, 2019) that included many assessments of the ecological conditions of the LGMGIS.

Cheatgrass is often found in the understory of densely infested knapweed patches.

Figure 1 – An example of excellent bluebunch wheatgrass community within the Laurie Guichon Memorial Grassland Interpretive Site

The 102 ha LGMGIS is ecologically diverse and includes four grassland, five forest, four wetland, one rock outcrop and one shrubland ecosystem type. Spotted knapweed (*Centaurea biebersteini*) is the dominant invasive species of concern on the grasslands and 5 cover classes have been mapped.

The purpose of this report is to summarize the current invasive plant species distribution, with a focus on spotted knapweed; and make recommendations for the prevention of spotted knapweed into healthy areas, the control of existing knapweed populations, the prevention of cheatgrass (*Bromus tectorum*) as a replacement invader, and restoration of sites to a diverse bunchgrass ecosystem.

General Site Description

The site description outlined below comes from the ecological inventory produced by the GCC (2019).

The site occupies 102 ha at an elevation of 1120 to 1200 meters. Annual precipitation is 35-40 cm, of which 30% falls as snow. The site occurs on Provincial crown land on the SW corner of the 5000 ha Lundbom Commonage. The site is an unfenced portion within the larger Marquart West pasture. The gently rolling landscape is dominated by grasslands with small aspen patches occurring in moist depressions and Douglas-fir dominated forests occupying cool north aspects. There are scattered ponds and associated wetland plant communities in shallow basins from which there are no outlet streams.

ASSESSMENT OF ECOLOGICAL CONDITION AND INVASIVE SPECIES

Grassland plant communities make up 66% of the area and were historically dominated by rough fescue and bluebunch wheatgrass. These 'upper' grasslands are considered to be the most productive grasslands in British Columbia; however, heavy use of these sites has lead to an increase in the invasive species – in particular, spotted knapweed and cheatgrass.

The baseline inventory (GCC, 2019) concluded that approximately 80% of the grasslands within LGMGIS are in an early- or mid-seral condition reflective of a history of heavy use, followed by an invasion of primarily spotted knapweed, with an understory of cheatgrass.

RESULTS OF INVASIVE SPECIES MAPPING

Figure 2 displays the distribution of spotted knapweed by percent cover class, Table 1 describes the cover class codes, and Table 2 summarizes the abundance (ha) of each cover class within the LGMGIS.

Figure 2 – Distribution of spotted knapweed by cover class within the Laurie Guichon Memorial Grassland Interpretive Site

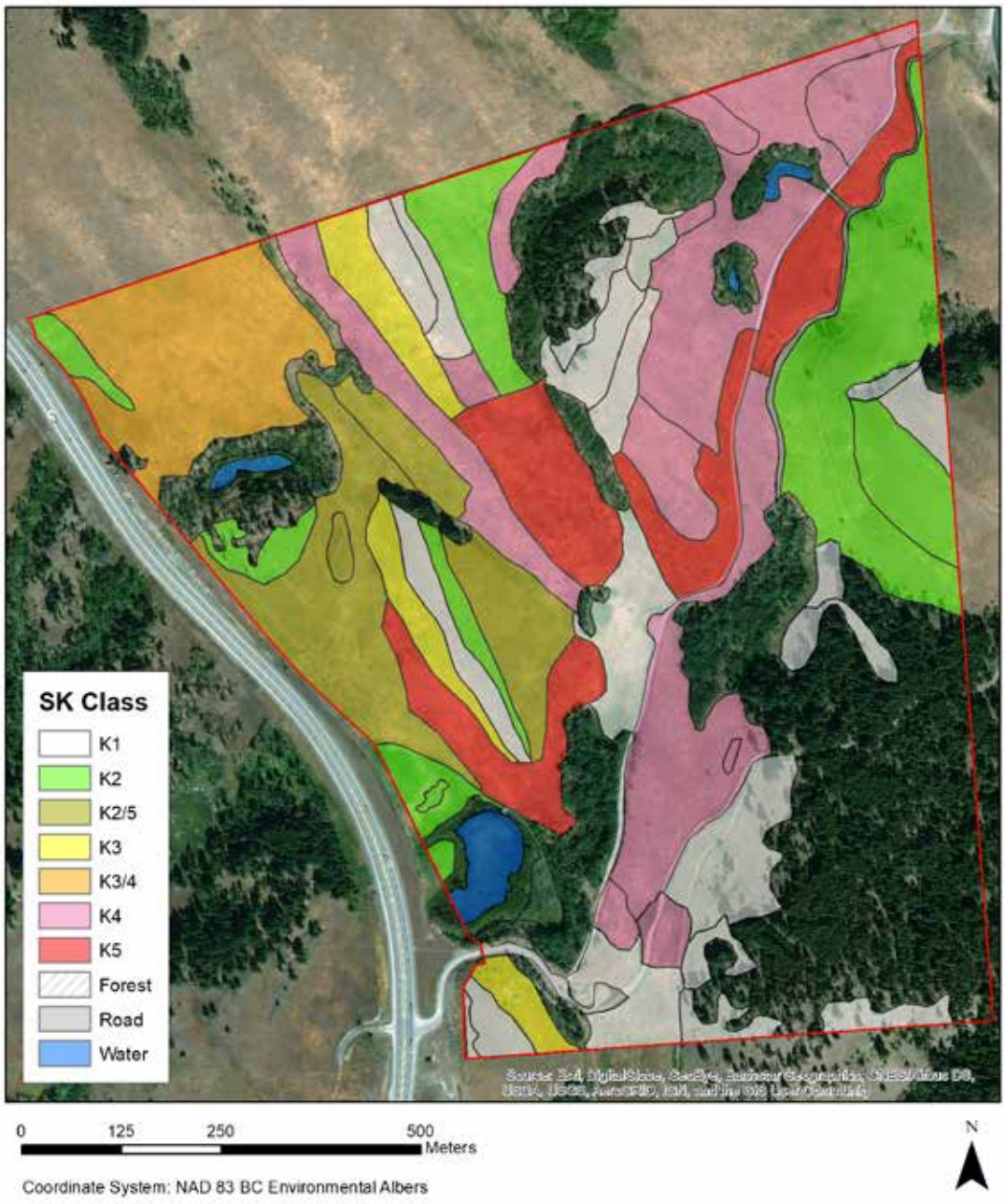

Table 1 – Description of cover class code as abundance (% cover) spotted knapweed

Cover Class Code (% cover of spotted knapweed)				
K1	K2	K3	K4	K5
0-<1	1-5	6-25	26-50	>50

Table 2 – Abundance of each cover class within the Laurie Guichon Memorial Grassland Interpretive Site

Class	Area (ha)
K1	13.0
K2	12.3
K2/5	18.9
K3	3.1
K3/4	6.1
K4	16.4
K5	15.3
Forested	28.7
Water	1.2
Road	0.7

SECTION 2

Integrated Pest Management

Within rangeland ecosystems, the practice of IPM must begin long before problem weeds arrive.

Integrated Pest Management (IPM) is an approach to managing weeds using a combination of practices that are the most environmentally and economically appropriate. The purpose of IPM is to combine as many practices as possible in order to maximize weed control and minimize weed adaptation and spread.

IPM is an iterative process; a land manager should never stop practicing IPM, as such, the model below is circular.

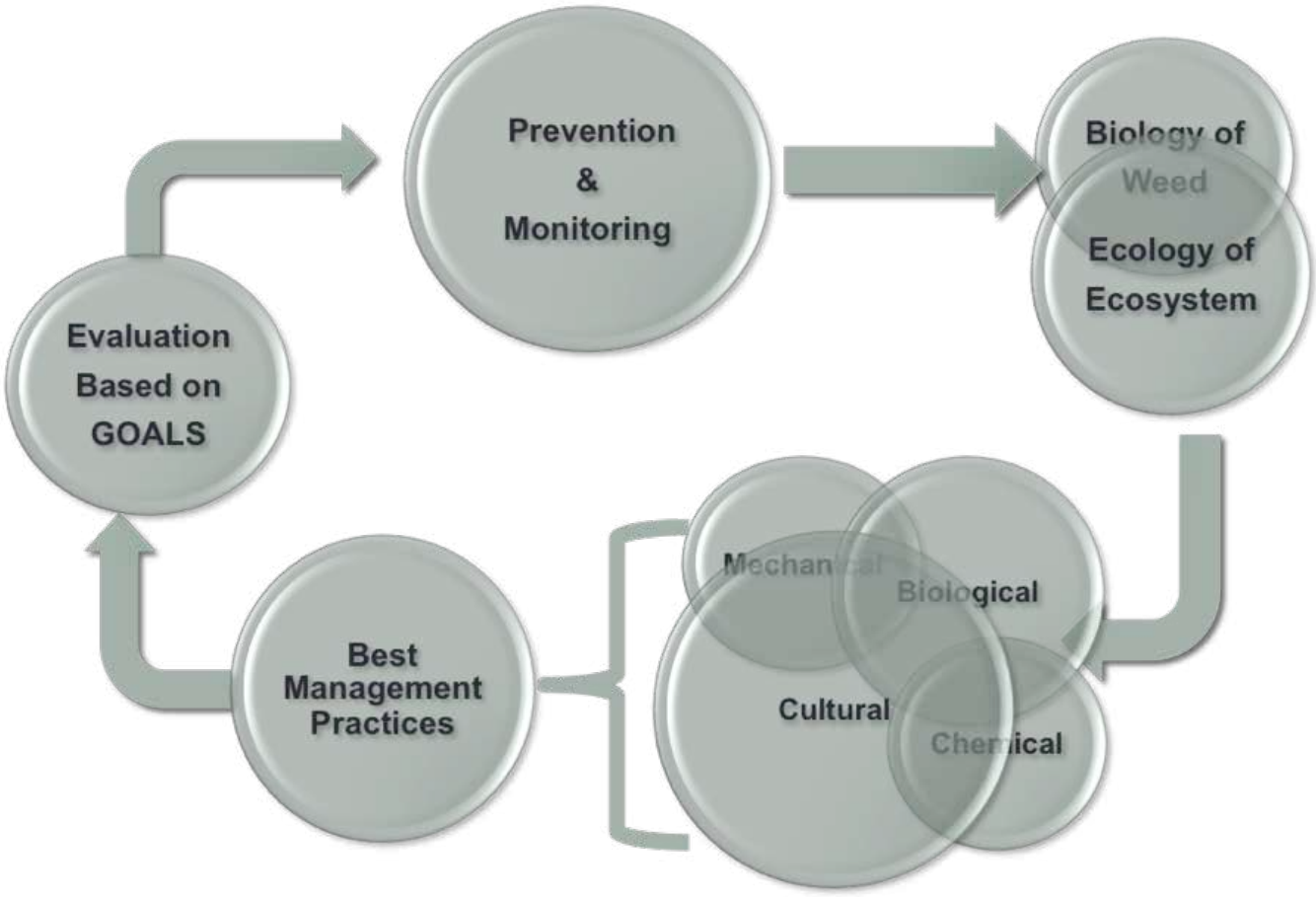

Figure 3 – Schematic of the cyclical process of Integrated Pest Management

Stages of Integrated Pest Management

PREVENTION AND MONITORING

The most critical component of a successful IPM program is effective prevention and monitoring.

Keeping healthy areas healthy and weed free is the easiest, most cost effective and environmentally sound practice. Within LGMGIS, approximately 13 ha have less than 1% spotted knapweed; and 25 ha have less than 5% spotted knapweed.

UNDERSTANDING THE BIOLOGY OF THE WEED

Spotted knapweed

An aggressive perennial that easily invades disturbed rangelands (Figure 4). Plants produce showy dark pink flowers and each plant can produce up to 1,000 seeds per year. The viable seeds may remain on the site for 5-8 years following deposition. Perhaps more challenging than the abundant seed production is the fact that spotted knapweed is allelopathic, meaning it exudes chemicals from its roots that are toxic to other plant species. This allelopathy inhibits germination and growth of other species.

Cheatgrass

Cheatgrass is fast growing winter annual grass that can also germinate in the spring when fall moisture is limited. Cheatgrass grows quickly in the spring, depleting soil moisture to the permanent wilting point (4-8% soil moisture) before native perennials break dormancy; this trait allows cheatgrass to gain a competitive advantage in cold, semiarid environments similar to those found at LGMGIS. Cheatgrass tends to form dense monocultures, averaging 6,450 plants/m2. Cheatgrass produces abundant litter, resulting in an increased vulnerability to fire, which perpetuates cheatgrass dominance.

Figure 4 – Example of densely (K5) spotted knapweed infested area within the Laurie Guichon Memorial Grassland Interpretive Site.

UNDERSTANDING THE ECOLOGY OF THE ECOSYSTEM

In general, grassland ecosystems are quick to degrade and slow to recover due to seasonal soil moisture deficits.

A thin veneer (2-20 cm deep) of windblown fine sands and silts blankets most of the area. The climate is characterized by hot dry summers, cold winters and four distinct seasons. The area receives about 35-40 cm of precipitation annually, 35% percent of it as snow (Ryan and Lloyd 2018). Accumulations of snow rarely exceed 50 cm in depth and snowmelt is generally complete by late March, although there is considerable variability in snow accumulation patterns depending on the slope, aspect and shade on individual sites. The thin veneer of sandy-silt soil combined with limited snow accumulation and low liquid precipitation results in poor water holding capacity and dry soil conditions for most of the growing season.

Historical site disturbance combined with climatic limitations has resulted in patches of very dense spotted knapweed, typically on mid and gentle slopes bordered by relatively healthy grassland ecosystems, typically on wetter sites, steep upper slopes, or forested communities. Cheatgrass is also commonly present on many historically disturbed sites.

Management Tools

CHEMICAL

While there are a host of chemicals that are effective against spotted knapweed, Milestone® is considered the most environmentally sound option and has a 2 year residual effect. Even so, it is imperative that chemicals are used judiciously. Recall the overall goal for the GCC within the LGMGIS is to support healthy grassland ecosystems. Herbicides that remove spotted knapweed will also remove all dicot species. Additionally, most land managers observe that heavy spotted knapweed infestations often have an understory of cheatgrass. In heavily infested stands relying solely on herbicides often results in weed community shifts (from spotted knapweed to cheatgrass) rather than an increase in biodiversity. The cost for broadcast chemical control of spotted knapweed is estimated to be ~$450/ha (FLNRORD). If cheatgrass is in the understory, then an additional herbicide treatment will be needed. Table 3 outlines herbicide options for spotted knapweed and cheatgrass, their active ingredient, application rates, timing of application, approximate cost/ha and general comments.

Table 3 – A comparison of a variety of herbicides for spotted knapweed and cheatgrass control, their trade name, active ingredient, application rate, application timing, estimate of cost/hectare, and comments.

Invasive Species	Trade Name	Active Ingredient	Amount/ ha	Application Timing	Cost / ha	Comments
Cheatgrass	Kerb SC	Propyzamid	2.2 l/ha	Fall applied Pre Emergence	~$450	Will remove all annual and perennial grasses
Spotted knapweed						
	Milestone*	Aminopyralid + 2,4-D	.25 - .5 l/ha	Post Emergence During active growth	~$450	Least expensive per acre for chemical. Excellent control, low mobility in soil, and good soil residual (2 yr)
	Reclaim	Metsulfuron + Aminopyralid + 2,4-D		Post Emergence During active growth	~$450	More expensive than Milestone, broader spectrum, 2 yr soil residual
	Grazon	Picloram		Post Emergence During active growth	~$450	Most expensive, can move through soil profile (mobility), 3 yr residual, higher off-target risks

** Recommended herbicide by Lisa Jarrett (Corteva AgriSciences)*

Note: reseeding within all herbicide options for spotted knapweed should be after 8 months of herbicide treatment

In general, spot spraying is the recommended treatment method but hand-pulling is a good option for low density spotted knapweed sites when volunteer crews are utilized.

MECHANICAL

Mechanical weed control is typically mowing or hand pulling. Mowing is only practical along flat areas - roads and landing sites. While it is relatively quick, multiple treatments in a season are necessary to prevent seed production and spotted knapweed will adapt to the mowing pressure by flowering below the mower blade. Mowing is a short-term treatment option to reduce seed production for 1 or 2 years but should not be relied upon for eradication. Hand pulling is a highly effective form of mechanical treatment. Hand pulling is labour intensive and best utilized in low-density sites (K1 and K2) when spot spraying is not an option (ie – volunteer work crews). The benefit of hand pulling is that the plant is selectively removed and there is no opportunity for the plant to adapt to the treatment pressure. Since regrowth can occur from root crowns, the entire crown portion of the plant (from soil surface to a depth of about 3 inches) must be removed. Plants can be pulled most effectively following a rain or when the soil is moist. While this control method is effective on single plants or relatively small infestations, it is not economically feasible on large, well-established knapweed infestations. Hand-pulling is not feasible on cheatgrass sites due to the density of the plant.

BIOLOGICAL

Biological weed control is the use of insects or animals to selectively target invasive species.

Insects

There are a number of insect biocontrols available for spotted knapweed although the root boring weevil *Cyphocleonus achetes* is thought to be the most effective because it targets the vigour of the plant – the root. Eradication is not the goal of insect biocontrol, at best the insects will reduce spotted knapweed to a point where the plant represents 20% of the whole plant community and seed production is drastically reduced.

A key consideration for *Cyphocleonus achetes* is that the insect is very slow to disperse on the landscape; averaging about 1 meter/year. Therefore, insect biocontrol must be combined with other IPM tools to prevent the weed infestation from expanding faster than the biocontrol insect can disperse.

Additionally, the density of spotted knapweed needs to be quite high (>10 plants/ m2) and continuous so that the insects can readily move from plant to plant. Insect biocontrol is best suited for heavy infestation levels and needs to be combined with perimeter weed control tools. Consult with FLNRORD on current locations of biocontrol insects and augment existing insect populations with additional insects as needed.

Goats

Goats will require quite a lot of maintenance in the form of fencing, herd safety from predators, monitoring and moving.

Animal biocontrol is an excellent option for LGMGIS. Goats are a very effective and readily eat spotted knapweed. Grass typically makes up 20% of a goat's diet so any remnant perennial grasses will not be over grazed. Goats can readily be combined with insect biocontrol because Cyphocleonus achetes spends the majority of its life underground; only emerging for 6-8 weeks (August – September) to mate and lay eggs. Research by Prather and Williams, 2019 found that grazing spotted knapweed at the bloom stage of development resulted in significantly less cover and biomass than grazing at the rosette, or even rosette and bloom (Twice grazed) stages over a 3-year period. During this experiment the number of grazing days (for 250 does and kids on 17 acres) declined from 10 days, to 7, to 4 days, indicative of the reduced spotted knapweed availability.

However, the use of portable panel electric fencing, combined with a full-time shepherd could work quite well at LGMGIS because there are natural breaks in the infestation levels provided by K1 and K2 sites, forested areas, roads and water.

Cattle

Cattle can be trained to eat spotted knapweed, especially when training is combined with a high-intensity grazing system. Spotted knapweed tends to have 15-20% crude protein, presenting an excellent source of forage.

Additionally, early spring grazing with cattle has been shown to reduce cheatgrass stands.

Because cheatgrass initiates spring growth before native perennial grasses, grazing in the spring can be an effective cheatgrass control technique without harming the native bunchgrasses.

Cheatgrass has relatively high biomass, nutritional value and palatability early in the spring. The use of cattle to control cheatgrass requires additional herd management as the cattle are moved through an area relatively quickly. As well, intensive grazing should lead to a more uniform distribution of cattle across the landscape through the use of fencing.

The challenge with utilizing cattle is that an adjustment to the current grazing schedule needs to be made with invasive species control in mind. Additionally, the practice of intensive grazing management requires additional fencing and additional herd management.

CULTURAL

Range Management Practices

The foundation of cultural weed control under rangeland management is to maintain a healthy, diverse, robust native plant community that is resistant to weed invasion. The tools within rangeland management to maintain or promote a healthy community are Frequency, Intensity and Opportunity for regrowth (F, I, O). In order to achieve sustainable restoration of LGMGIS an assessment of available Animal Unit Months (AUM) should be compared to the AUM demand. Additionally, electric fencing, adding stock watering sites, salt and other tools could be used to control dispersal of cattle within the LGMGIS.

> ***Assuming the forage availability meets the demand a weed control and restoration program can begin.***

Transplanting Native Plugs

The fastest way to create a healthy native plant community is to transplant plugs. Research by Huddleston and Young (2014) demonstrated greater than 98% survival rates for bluebunch wheatgrass and Idaho fescue plugs transplanted at 18 cm spacing at a restoration site in Oregon. Plugs can be readily grown on contract through N.A.T.S. Nursery in Langley. The plants are grown under a seedling management service contract, if seed is supplied, in 50P styroblock containers. Seedlings plugs are 5 cm wide by 11.5 cm long and have a volume of 142 ml. Seedling transplant spacing should be approximately 100 cm, for a transplant density of 10,000 plants/ha. The challenges with transplanting native plugs are the high cost to purchase the plugs and the labour to transplant. Additionally, there would need to be fencing or other protective measures to prevent grazing of transplants for at least one year.

Direct Seeding

If possible, consider using a no-till drill to seed agronomics where the slope is less than 20°.

Reseeding spotted knapweed treated areas can have inconsistent results. The competition pressure from the rapid establishment of fall-germinated cheatgrass can greatly affect germination of seeded species. The most competitive species against cheatgrass is crested wheatgrass (*Agropyrum cristatum*) which should be seeded at ½ inch or less. Crested wheatgrass is suitable for areas with <14 inches of precipitation (LGMGIS is approximately 14 inches of precipitation), with 'Hycrest' being the best option on sites with heavy weed competition. Crested wheatgrass typically produces 1.5-1.0 times more forage per unit area than native grass stands; obviously more so on knapweed infested sites, and can tolerate very high levels of grazing (65-70% utilization).

Direct seeding crested wheatgrass on flat areas may be suitable as a 'sacrifice' forage area to try to limit grazing in the native grass stands.

Dormant late fall seeding is recommended at rates of 10 pounds PLS/acre.

Best Management Practices

The development of best management practices based on the utilization of the IPM toolbox (chemical, cultural, biological and mechanical) is critical to adaptive management. All treatments must be critically assessed for their ability to achieve the land management goals outlined for the LGMGIS – "to represent a healthy grassland ecosystem". Best management recommendations are outlined in Section 3.

Evaluation Based on Land Management Goals

A comprehensive monitoring program must be initiated prior to the start of an integrated pest management program.

Through the use of photopoint monitoring and permanent transects, success or failure of best management practices can be critically evaluated. Once best management practices have been put in place and initiated the ultimate test of these practices is whether or not they are leading the site towards the land management goals established by land managers. In the case of LGMGIS the goal is "to represent a healthy grassland ecosystem". The critical assessment of best management practices is an iterative process and long-term monitoring tools (photo point monitoring, rangeland health monitoring) should be conducted on a regular basis to help land managers critically assess the effects of their treatments.

SECTION 3

Recommendations Based on Spotted Knapweed Density

Because the cheatgrass distribution was not mapped at the time of the inventory, this report makes the assumption that cheatgrass is abundant, though distribution is uncertain, in the understory of K3-K5 spotted knapweed classes.

All knapweed cover classes should have at least 2 photopoints and 2 permanent vegetation transects (50 meters long) installed as soon as possible. The photopoints and transects should be randomly located and identified with permanent stakes. Because one of the goals of the LGMGIS is to provide education and outreach opportunities, all treatments should be established as demonstration sites.

VERY LOW-DENSITY (K1 AND K2)

K1 and K2 classes have less than 5% cover of spotted knapweed. These two classes make up approximately 25 ha. The first priority for management of this area should be spot treatment of the individual spotted knapweed plants. There are a number of low-density infested areas (mapped as K1 and K2) that are bordered by high-density infested areas (Mapped as K5). These border regions should be high priority sites for herbicide application. A protection buffer needs to be created along borders where K1/K2 condition borders K4/K5 condition.

There are two treatment recommendations for these very low-density sites:

1. Monitor the sites annually, during flowering, and spot spray spotted knapweed. Use GPS to map sites where knapweed was sprayed; this will facilitate rapid revisits in subsequent years for continued treatments.

2. Use Milestone, during the active growing period, to create a 3 meter wide buffer along the perimeters of K1/K2 classes that border K3-K5 classes. Monitor the K1/K2 buffer areas closely for spotted knapweed invasion and spread. The treated buffer should be restored as per recommendations outlined for K3-K5 (below).

INCONSISTENT DENSITY (K2/5)

K2/5 classes are characterized by a highly heterogenous distribution of spotted knapweed; patches of high-density knapweed surrounded by healthy communities of grassland species. This density class makes up approximately 19 ha.

There are two treatment recommendations for these patchy sites:

1. Monitor the sites annually and spot spray (Milestone) patches of spotted knapweed during the active growing period.
2. Monitor the uninvaded areas of K2/5 class and hand-pull or spot spray individual or small groups of spotted knapweed plants.

As with the low-density sites (K1 and K2) using GPS waypoints to mark treatment locations will facilitate rapid relocation, treatment, and monitoring in subsequent years.

PATCHY YET CONTINUOUS DENSITY (K3 AND K3/4)

These areas typically range from 6-25% density of spotted knapweed but may have patches of higher density – upwards of 50%. These sites make up 9.2 ha. These areas fall between low-density and high-density condition and therefore can utilize treatment options outlined for all density conditions, depending on individual polygon conditions.

HIGH DENSITY (K4 AND K5)

Management of large-scale knapweed infestations is more effective with a combination of treatments rather than using any one treatment method alone.

The goal for the LGMGIS is to represent a healthy grassland community; therefore the high-density areas will require a long-term commitment. The K4 & K5 density classes make up approximately 31.6 ha and will require multiple tools, to be utilized for a number of years, outlined chronologically below:

Year 1

- **Ensure monitoring program is established and pre-treatment, baseline data is collected across all sites regardless of scheduled treatment date.**
- Initiate greenhouse partnership to grow bluebunch wheatgrass and rough fescue plugs. Start grass plugs in greenhouse early in the season.
- Mid-season, treat buffer strips with a combination of the herbicides Milestone and Kerb SC to control both spotted knapweed and cheatgrass. These buffer strips will protect the low-density (K1 and K2) areas from the higher density areas.
- Mid-July (after weaning and during bloom stage), initiate rotational goat grazing on the K3 through K5 sites to prevent seed production, knapweed expansion, and reduce the presence of mature, wolfy knapweed plants.

- Late season (August), after consultation with FLNRORD on current locations of biocontrol, augment existing insect populations with additional *Cyphocleonus achetes* biocontrol releases.
- Fall, on steeper sites, after treating with Milestone and KerbSC, transplant native grass plugs into buffer strips in trial areas. Allow grass plugs to establish through fall and into the following Spring.
- Late Fall, on flatter sites (<20°) conduct no-till dormant seeding of crested wheatgrass. Consider a trial of native seed in addition to crested wheatgrass.

Year 2

- Continue greenhouse native grass propagation program.
- Early spring, protect native grass plugs from grazing through electric fence exclosure. Monitor native grass plugs for winter survival. Monitor understory community for cheatgrass establishment. If cheatgrass has emerged in the understory, map cheatgrass locations and prepare for a second fall application of KerbSC.
- Continue rotational goat grazing to prevent seed establishment and knapweed expansion.
- Monitor biocontrol releases to ensure establishment is successful.
- Monitor native grass transplants and fill-in plant in areas where mortality has occurred.
- Monitor no-till seeding of crested wheatgrass and native seed to determine establishment rates.

Year 3

- Decide if greenhouse propagation of native bunchgrass is meeting expectations and restoration goals; if so, continue program and consider expanding treatment areas to being compressing infested areas through step-wise treatment moving into densely infested areas.
- Continue rotational goat grazing program
- Consider initiating high intensity cattle grazing within the K3 – K5 density areas.

Year 4 and onwards

- **Critically evaluate successes** using the in-depth monitoring program installed prior to Year 1.
- **Decide which portions of program are meeting Goals and expand accordingly.**

SECTION 4

Summary of Recommendations by Priority

The recommendations outlined below are strategically prioritized based on ease of implementation, likelihood of success and cost of implementation. Recommendations can be implemented independently or concurrently.

1. Assessment of AUM Supply versus AUM Demand

    a. Use standard range management techniques to assess AUM supply in the LGMGIS and compare AUM supply to AUM demand.

2. Utilization of grazing management tools to reduce grazing pressure in areas to be restored, and in areas which are still KI and K2 condition

    a. Consider installing temporary fencing or other techniques to reduce grazing frequency or intensity in the K1 and K2 knapweed condition.

3. Monitor and prevent weed establishment in low-density infested areas (K1 and K2)

    a. Spot spraying with Milestone® using certified pesticide applicator.

    b. Hand pull if using volunteer groups

4. Protect low-density areas from invasion from neighbouring higher density areas through the creation of buffers

    a. Broadcast herbicide buffer zones using a combination of Milestone® and KerbSC®

    b. Use 9 foot no-till drill to dormant direct seed less steep locations with crested wheatgrass 'Hycrest'. Also consider direct seeding with bluebunch wheatgrass and other native species. Consider purchasing improved varieties if good quality native seed cannot be sourced

5. Use rotational goat grazing to reduce spotted knapweed seed production and reduce vigour of existing knapweed plants

    a. A herd of 30 goats can graze a half-acre section in 1-2 days. Use Gallagher electric poultry netting to contain goats.

6. Use high intensity, targeted grazing by cattle to reduce cheatgrass

    a. Consider working with local range tenure holder to initiate high intensity spring grazing of cheatgrass.

7. Distribute more *Cyphocleonus achetes* biocontrol releases as needed

8. Use a system of herbicide/transplanting to begin restoring heavily infested knapweed areas (K3-K5) that are on sites too steep to herbicide and reseed. Assume cheatgrass invasion is a risk at all K3-K5 sites.

    a. Broadcast herbicide restoration areas using a combination of Milestone® and KerbSC®

    b. Source native seed and grow plugs to be fall transplanted

Budget Estimates of Treatment Options

Treatment	Timing of Treatment	Applicable Sites	Cost/ha
Broadcast herbicide (knapweed)	Active growing season	K3-K5	~$450
Hand pulling**	Early flowering stage	K1 & K2	$30-$200
Spot spraying	Active growing season	K1-K3	~$300
Goat grazing	Bloom stage	K3-K5	~$2500
High intensity grazing for cheatgrass	Grazing schedule	K3-K5	need to coordinate with tenure holder
Broadcast herbicide (cheatgrass)	Fall preemergence	K3-K5	~$450
Bunchgrass plug Propagation**	Seedling management contract	K4 & K5	~$10,000
Bunchgrass plug planting**	Fall transplant	K4 & K5	~$5,000
Cyphocleonus achetes	Mid-August	K4 & K5	$200/release

** Treatment options that have an excellent potential for partnership with community groups/organizations to reduce costs

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