

Tobacco Plains Ecological Restoration

UKE-F17-W-1395

Prepared For: Fish and Wildlife Compensation Program

Prepared By: Myra Juckers, BSc, PAg

March 31, 2017



3816 Highland Rd.
Cranbrook BC V1C 6X7
(250) 489-4140
www.keefereco.com



3603 93 Hwy 93
Grasmere, BC V0B 1R0
(250) 887-3461

Acknowledgements

Keefer Ecological Services Ltd. (KES) and Tobacco Plains Indian Band (TPIB) would like to thank the Fish and Wildlife Compensation Program and the Interdepartmental Recovery Fund for their continued support of grassland and open forest recovery efforts on Tobacco Plains Indian Reserve (TPIR).

KES and TPIB would also like to thank Tracy Kaisner of West Fork Resource Management for conducting herbicide application on TPIR and the TPIB logging crew, led by Wally Gravelle, for conducting thinning efforts.

Further, KES would like to specifically thank Tom Phillips, Lands and Resources Manager of TPIB, for his assistance in project management.

Table of Contents

Acknowledgements.....	i
Executive Summary.....	iv
Introduction	1
Goals and Objectives.....	3
Invasive Plant Management	6
Leafy Spurge (<i>Euphorbia esula</i>)	6
Orange hawkweed (<i>Hieracium aurantiacum</i>).....	11
Spotted knapweed (<i>Centaurea stoebe</i>)	14
Field Bindweed (<i>Convolvulus arvensis</i>)	17
Monitoring	19
Ecological Restoration Forest Thinning.....	20
Treatment Unit Delineation	20
2015 Ecological Restoration (ER) Implementation	23
ER Implementation Workshop.....	23
Monitoring	23
2016 Thinning	24
Next Steps	29
References	31
Appendix A.....	34
Appendix B	37

List of Figures

Figure 1	Map of Tobacco Plains Indian Reserve.....	5
Figure 2	Location of the leafy spurge (<i>Euphorbia esula</i>) infestation on Tobacco Plains Indian Reserve.....	7
Figure 3	Photo documentation of the 2.7 ha leafy spurge (<i>Euphorbia esula</i>) infestation in 2015 (A) and 2016 (B) pre-treatment and post-treatment on Tobacco Plains Indian Reserve...9	
Figure 4	Dense leafy spurge (<i>Euphorbia esula</i>) patch within the 2.7 ha infestation area on Tobacco Plains Indian Reserve. Photo taken on June 13, 2016 prior to herbicide application.....	10
Figure 5	Locations of orange hawkweed (<i>Hieracium aurantiacum</i>) infestations on Tobacco Plains Indian Reserve identified in 2015 and 2016.....	13
Figure 6	Locations of spotted knapweed (<i>Centaurea stoebe</i>) infestations on Tobacco Plains Indian Reserve identified in 2015 and 2016.....	15
Figure 7	An example of a spotted knapweed (<i>Centaurea stoebe</i>) patch prior to the application of the herbicide Milestone in 2015 (A), taken on July 27, 2015, and the condition of the patch in 2016 (B), taken on September 1, 2016. The patch is located in the north western corner of the reserve, west of Edwards Lake (11U 636891E 5439447N).....	16
Figure 8	Location of the field bindweed (<i>Convolvulus arvensis</i>) infestation on Tobacco Plains Indian Reserve.....	18
Figure 9	Locations of areas thinned in the southern reach of Tobacco Plains Indian Reserve in 2014 – 2016 and proposed areas to be thinned in 2017.....	22
Figure 10	Representative photos pre- and post-treatment in CATCHFLY 14-17 taken in 2013 (A) and 2016 (B) respectively.....	24
Figure 11	Evidence of wildlife rubbing within a wildlife tree patch retained in in the 8.8 ha thinned area of CATCHFLY 14-17 in 2016. Photo taken on November 25, 2016.....	27

List of Tables

Table 1	Number of orange hawkweed (<i>Hieracium aurantiacum</i>) patches and their area of infestation, in hectares, identified within Tobacco Plains Indian Reserve in 2015 and 2016.....	11
Table 2	Spotted knapweed (<i>Centaurea stoebe</i>) patches and their area of infestation, in hectares, identified within Tobacco Plains Indian Reserve in 2015 and 2016.....	13
Table 3	Average density (sph) of ponderosa pine trees remaining and girdled following thinning within 8.8 ha of CATCHFLY 14-17 in 2016.....	24
Table 4	Average density (sph) of ponderosa pine (Py) and Douglas fir (Fd) seedlings within the 8.8 ha thinned area of CATCHFLY 14-17 in 2016.....	25
Table 5	Average density (sph) of ponderosa pine (Py) and Douglas fir (Fd) seedlings within the areas thinned in 2014, 2015, and 2016.....	25
Table 6	Average density (sph) of ponderosa pine (Py) and Douglas fir (Fd) poles, saplings, and seedlings present within wildlife tree patches retained in the 8.8 ha thinned area of CATCHFLY 14-17 in 2016.....	26

Executive Summary

Tobacco Plains Indian Reserve (TPIR) is located within the southern Rocky Mountain Trench and spans 5,261 ha of historically fire-regulated grassland and open forested ecosystems. The reserve provides winter range for mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), and elk (*Cervus canadensis*). As well, TPIR is home to several federally listed species at risk, including American badger (*Taxidea taxus*), Lewis's woodpecker (*Melanerpes lewis*), long-billed curlew (*Numenius americanus*), and the Spalding's campion (*Silene spaldingii*) plant. Forest encroachment and ingrowth threaten each of these species and invasive plant species directly threaten Spalding's campion and long-billed curlew habitat and also reduce habitat quality for ungulates.

Keefer Ecological Services Ltd. (KES) and Tobacco Plains Indian Band (TPIB) have been working to recover critical grassland and open forest habitat on Tobacco Plains Indian Reserve (TPIR) since 2006. Efforts in 2016/17 focused on continued recovery of grassland and open forest habitat through invasive plant management, including herbicide application and targeted goat grazing, forest thinning, a Lewis's woodpecker nesting survey, and the development of an environmental restoration (ER) prescription for long-billed curlew habitat. This report focuses on the invasive plant management (excluding sulphur cinquefoil) and forest thinning efforts conducted in 2016/17. Supplemental reports are included for targeted goat grazing, the Lewis's woodpecker nesting survey, and the long-billed curlew habitat ER prescription.

Invasive plant management involved spraying the 2.7 ha leafy spurge infestation for the second consecutive year with the herbicide Trillion, in mid-June and early September. A decline in the infestation was not observed between 2015 and 2016. As such, a new permit application has been submitted to Environment Canada requesting the use of the herbicides Tordon 22K and glyphosate to manage the leafy spurge infestation to improve control efforts. A comprehensive survey of orange hawkweed was conducted to determine the distribution of the invasive plant throughout the reserve. In addition to the two infestations identified in 2015, 13 more sites were found in 2016. All infestations identified in 2015 and 2016 were sprayed with the herbicide Milestone. The four spotted knapweed infestations identified during the 2015 invasive plant survey were monitored to assess whether re-application of herbicide was necessary. Of the four, only a portion of one was resprayed with Milestone as rosettes and small plants were observed. Five additional infestations found in 2016 were also sprayed with Milestone. The field bindweed (*Convolvulus arvensis*) infestation identified in 2015 was reassessed and a decline in the infestation was not observed. As such, the infestation was resprayed with Milestone. Further, the first year of a proposed five year targeted goat grazing program was initiated on 48 ha of grassland over an eight day period (see supplemental report) with the purpose of determining whether targeted goat grazing is an effective method to manage sulphur cinquefoil. During the first year of this program the average height distribution of the sulphur cinquefoil plants within the sample plots was found to decline following grazing. The seeds heads, number of seed clusters, and percent cover of sulphur cinquefoil were also observed to decline, indicating the goats impacted the plant. Continued monitoring of all managed infestations will be conducted to assess whether infestations are significantly

declining, if other invasive plants are invading sites and if the native plant community is successfully re-establishing or support through revegetation is needed.

Forest thinning efforts continued for the third consecutive year in the southern reach of the reserve. In addition to the seven hectares thinned in 2014 and the 16.4 ha thinned in 2015, approximately 8.8 ha were thinned in 2016. The goal is to restore this area of the reserve to an open forest, with the objective of maintaining 76 to 400 stems per hectare (sph) on site with a target of 150 sph while maintaining the largest trees on site, emphasizing trees greater than 20 cm dbh; and removing most small diameter trees (less than 20 cm), retaining an average of 10-20 sph of healthy poles for stand recruitment. In 2016, stand retention of trees equal to or greater than 20 cm was an average of 140 sph, which was just below the target of 150 sph. Pole retention averaged 80 sph, which exceeded the target of 10-20 sph. This past year, tree girdling was used as a tool by the logging crew to increase tree mortality within the thinned areas while increasing efficiency by reducing the need for cutting, piling, and burning. An enhanced girdling effort in following years will be conducted to increase pole mortality in order to achieve the target density of 10-20 sph.

The nesting survey conducted on TPIR in summer 2016 documented the presence/absence of nesting Lewis's woodpeckers on the reserve (see supplemental report). Two Lewis's woodpeckers were spotted near the reserve; however, nesting Lewis's woodpeckers were not observed on the reserve. Continued monitoring of nesting Lewis's woodpeckers is recommended to evaluate the response of Lewis's woodpecker to forest thinning efforts.

Assessment of long-billed curlew habitat further supported the need for invasive plant management and forest thinning efforts. As well, the ER prescription highlights the possibility of using grazing to manage long-billed curlew habitat and recommends the reintroduction of low-intensity fires to the landscape to maintain native grassland habitat for long-billed curlew.

Future work on TPIR will continue with invasive plant management efforts and forest thinning to further recovery of critical grassland and open forest habitat for ungulates and species at risk.

Introduction

Tobacco Plains Indian Reserve (TPIR) is located within the southern Rocky Mountain Trench and spans 5,261 ha of historically fire-regulated grassland and open forested ecosystems. As a result of fire-suppression practices which have been in place since the early 20th century, the region has experienced heavy encroachment of ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*; Crowley & Gall, 2011). Additionally, invasive species, such as leafy spurge (*Euphorbia esula*), spotted knapweed (*Centaurea stoebe*), sulphur cinquefoil (*Potentilla recta*), and orange hawkweed (*Hieracium aurantiacum*) are threatening grasslands and open forests on the reserve (Juckers and Moody, 2016).

As TPIR is federal land it has been excluded from the provincially led, highly-successful, Rocky Mountain Trench Ecosystem Restoration (ER) Program, which has been in effect since the late 1990s (Bond et al., 2013). Located adjacent to 10,466 ha of core grassland areas of the Provincial ER program (Harris, 2014), on the east side of the Koocanusa reservoir, TPIR represents a significant area of critical grassland and open forest habitat for many species. The reserve provides winter range for mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), and elk (*Cervus canadensis*). As well, TPIR is home to several federally listed species at risk, including American badger (*Taxidea taxus*), Lewis's woodpecker (*Melanerpes lewis*), long-billed curlew (*Numenius americanus*) and the Spalding's campion (*Silene spaldingii*) plant. Forest encroachment and ingrowth threaten each of these species (Environment Canada 2013, 2016a,b; Jeffersonii Badger Recovery Team, 2008) as it directly results in the loss of habitat which increases pressure on remaining habitat, reducing habitat quality. In addition to forest encroachment and ingrowth, invasive plants species directly threaten Spalding's campion and long-billed curlew habitat and also reduce habitat quality for ungulates.

Spalding's campion is threatened by invasive plants in four primary ways (Environment Canada, 2016a):

- 1) Alteration of the composition, structure, and function of the native bunchgrass communities which support Spalding's campion;
- 2) Increased thatch build up;
- 3) Alteration of microclimate and soil structure/chemistry; and
- 4) Direct competition for critical resources, including water, nutrients, pollinators, and germination safe sites.

Leafy spurge (*Euphorbia esula*) and spotted knapweed (*Centaurea stoebe*) have been identified as primary invasive plants which may threaten long-billed curlew (COSEWIC, 2002). These invasive plants are aggressive species, displacing native graminoid vegetation, and reducing visibility. Long-billed curlew breeds in areas with maximum visibility because of their co-operative anti-predator mobbing behaviours (Ohanjanian, 2004). During pre-laying and incubation curlews prefer vegetation less than 10 cm in height but up to 30 cm tall (Ohanjanian, 2004). During brood-rearing, vegetation up to 30 cm tall may be used (Ohanjanian, 2004). Leafy spurge grows 20-90 cm in height and spotted knapweed grows from 20-180 cm in height (Klinkenberg, 2015), which creates a vegetation profile that is likely beyond vegetation height tolerances for breeding long-billed curlew.

Keefer Ecological Services Ltd. (KES) has been working with Tobacco Plains Indian Band (TPIB) since 2006, conducting Spalding's campion recovery and ER efforts on critical grassland and open forest habitat on the reserve. Over the years, work has involved:

In 2006 (Keefer, 2009)

- Preliminary survey of high potential habitat on TPIR;
- Surveying individual Spalding's campion plants;
- Installing fencing over 2 ha to exclude horse and cattle grazing on Spalding's campion habitat;
- Removing invasive plants surrounding Spalding's campion; and
- Slashing conifers.

In 2007 (Keefer, 2009)

- Raising community awareness about Spalding's campion;
- Updating the TPIB Integrated Land Management Plan; and
- Thinning ponderosa pine on approximately 1.5 ha.

In 2008 (Keefer, 2009)

- Conducting a presence/absence survey of Spalding's campion populations in July and August.

In 2010 (Keefer and Kennedy, 2010)

- Establishing permanent monitoring transects;
- Conducting a randomized Spalding's campion survey of the reserve;
- Identifying habitat preferences for Spalding's campion;
- Recording new Spalding's campion occurrences; and
- Inventorying invasive plants threatening known Spalding's campion sub-populations.

In 2013 (Seher, 2014)

- Revisiting permanent transects established in 2010 in early summer (June) and late summer (August) to assess population dynamics;
- Conducting a reconnaissance in the southern Rocky Mountain Trench from TPIR northward to Skookumchuk to identify possible Spalding's campion locations off reserve;
- Development of prescriptions for designated grassland and open forest ER treatment units on TPIR to initiate a multi-year habitat recovery program for Spalding's campion; and
- Drafting the federal Spalding's campion recovery strategy.

In 2014-2015 (Carignan et al., 2015)

- Revisiting permanent transects established in 2010 in early summer (June) and late summer (August) to assess population dynamics;
- Securing a multi-year herbicide treatment permit from Environment Canada to treat the leafy spurge infestation present at a large Spalding's campion site;
- Implementing an open forest restoration prescription on 7 ha of land;
- Creating a 2014-2015 Site Action plan outlining the goals, priority areas, training and safety of ER prescription implementation;

- Developing and sharing a presentation on ER treatment objectives with TPIB crew members to facilitate effective treatment implementation and better understanding of the purpose of ER;
- Developing 11 additional prescriptions for treatment units on TPIR using data collected in 2013;
- Writing a 2015-2016 Site Action plan to outline next steps and coordinate collaboration with new funding partners (BC Hydro, Fish and Wildlife Compensation Program); and
- Presenting the project at the East Kootenay Invasive Species Council 2015 AGM.

In 2015-2016 (Juckers and Moody, 2016)

- Holding an invasive plant management workshop, led by the East Kootenay Invasive Species Council, at the TPIB office;
- Conducting an invasive plant survey of the reserve and developing an invasive plant management report based on survey results;
- Applying herbicide to various infestations on the reserve, including the 2.7 ha leafy spurge infestation identified in 2009, and small infestations of spotted knapweed, orange hawkweed, field bindweed, and yellow hawkweed.
- Implementing open forest ER prescriptions on approximately 16.4 ha of land on the southern part of the reserve;
- Conducting a site visit post-thinning to assess thinned areas and to determine whether prescriptions have been met;
- Creating a draft prescribed burn plan for prescription units that have received thinning treatment; and
- Writing a 2016-2017 Site Action Plan to outline next steps.

Goals and Objectives

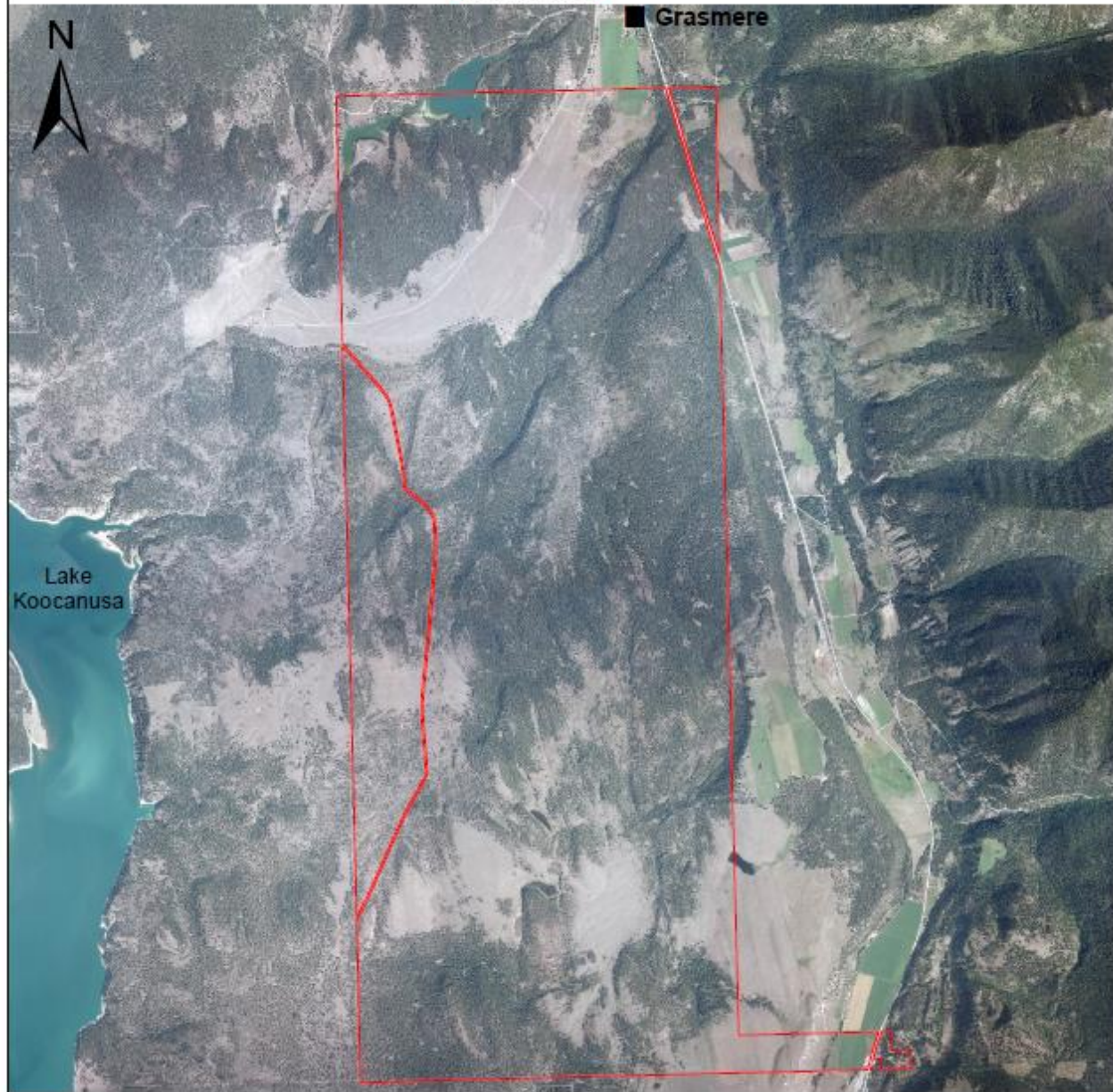
The goal in 2016/17 was to continue efforts to recover critical grassland and open forest habitat on TPIR (Figure 1). Objectives for 2016/17 included:

- Conducting a survey of orange hawkweed infestations throughout the reserve and mapping the extent of the infestations;
- Continued application of herbicide on the 2.7 ha leafy spurge infestation and small infestations (less than 1 hectare) of spotted knapweed, orange hawkweed, and field bindweed;
- Conducting targeted goat grazing on grassland habitat infested with sulphur cinquefoil;
- Conducting a Lewis's woodpecker nesting survey;
- Developing an ER prescription for long-billed curlew habitat;
- Continued implementation of open forest ER prescriptions within the southern part of the reserve; and
- Conducting a site visit post-thinning to assess the area thinned using five 5.64 m radius plots to gather data on tree species, stems per hectare (sph), and diameter at breast height (dbh) of saplings, poles, co-dominant and dominant trees remaining post-thinning. The density and species of seedlings was also determined within each radius plot. This information was used to determine whether the prescription for an open forest was being met.

The following report is a summary of the invasive plant management (excluding sulphur cinquefoil) and forest thinning efforts conducted in 2016/17 to restore critical grassland and open forest habitat on TPIR. Supplemental reports are included for the Lewis's woodpecker nesting survey, long-billed curlew habitat ER prescription, and targeted goat grazing of sulphur cinquefoil.

Tobacco Plains Indian Band Reserve Area

Grasmere, British Columbia



Legend

 Reserve Outline



Coordinate System: NAD 1983 UTM Zone 11N
Projection: Transverse Mercator
Datum: North American 1983

Figure 1: Map of Tobacco Plains Indian Reserve.



Invasive Plant Management

Invasive plants are a serious threat to grasslands and open forest systems throughout British Columbia, with over 100,000 ha of grasslands and open forests infested (Wikeem and Miller, 2006). Grassland and open forest systems on TPIR are not unique in this regard, with up to 10 invasive plant species invading grassland sites and up to 17 invasive plant species invading open forest sites (Juckers and Keefer, 2016). Invasive plants threaten biological diversity, rare and endangered species, and ecological processes, including succession, energy flow, and mineral and nutrient cycles (Wikeem and Miller, 2006). Invasive plant management is imperative to maintain the natural integrity of these systems and to reduce their threat to native plants and animals (Wikeem and Miller, 2006).

To address the threat of invasive plants on grasslands and open forests throughout TPIR, an invasive plant survey was conducted during the summer of 2015. Results from the survey were used to create an invasive plant management report (Juckers and Keefer, 2016). Herbicide was also applied to a 2.7 ha leafy spurge (*Euphorbia esula*) infestation, identified on TPIR in 2009, and to small infestations (less than 1 hectare) of spotted knapweed (*Centaurea stoebe*), orange hawkweed (*Hieracium aurantiacum*), yellow hawkweed (*Hieracium spp.*) and field bindweed (*Convolvulus arvensis*; Juckers and Moody, 2016). In summer 2016, invasive plant management continued. Management efforts involved surveying the reserve for orange hawkweed infestations and spraying infestations, as well as monitoring and spraying the leafy spurge infestation and small infestations of spotted knapweed and field bindweed. Treatment was led by Keefer Ecological Services Ltd. and West Fork Resource Management with assistance from TPIB members.

Leafy Spurge (*Euphorbia esula*)

The herbicide Trillion was applied to the leafy spurge infestation (Figure 2) in mid-June and early September. Photo documentation was conducted between years to visually observe changes in the infestation. Two photo documentation locations were established in 2015 within the leafy spurge infestation area. Trees were marked in order to relocate photo documentation points and a compass bearing was taken at each point to ensure photos were taken in the same direction. In 2015, photos were taken in mid-July prior to seed set of leafy spurge and in 2016 photos were taken in mid-June prior to seed set and in early September prior to the second application of herbicide. Photo documentation between year 1 (2015) and year 2 (2016) showed a decline in the infestation density at photo point 1, whereas changes at photo point 2 were not observed (Figure 3). Other patches within the infestation area remained quite dense (Figure 4). Overall, the infestation distribution has remained to be 5 (a few patches or clumps of a species) to 6 (several well-spaced patches or clumps) with a density of 2 (2 to 5 plants / m²) to 3 (6 to 10 plants / m²) in both 2015 to 2016, indicating no notable declines in the leafy spurge population. Further, a minimal expansion of the infestation was observed.

2015 & 2016 Invasive Plant Management Leafy Spurge (*Euphorbia esula*)

Tobacco Plains Indian Band Reserve Area
Grasmere, British Columbia

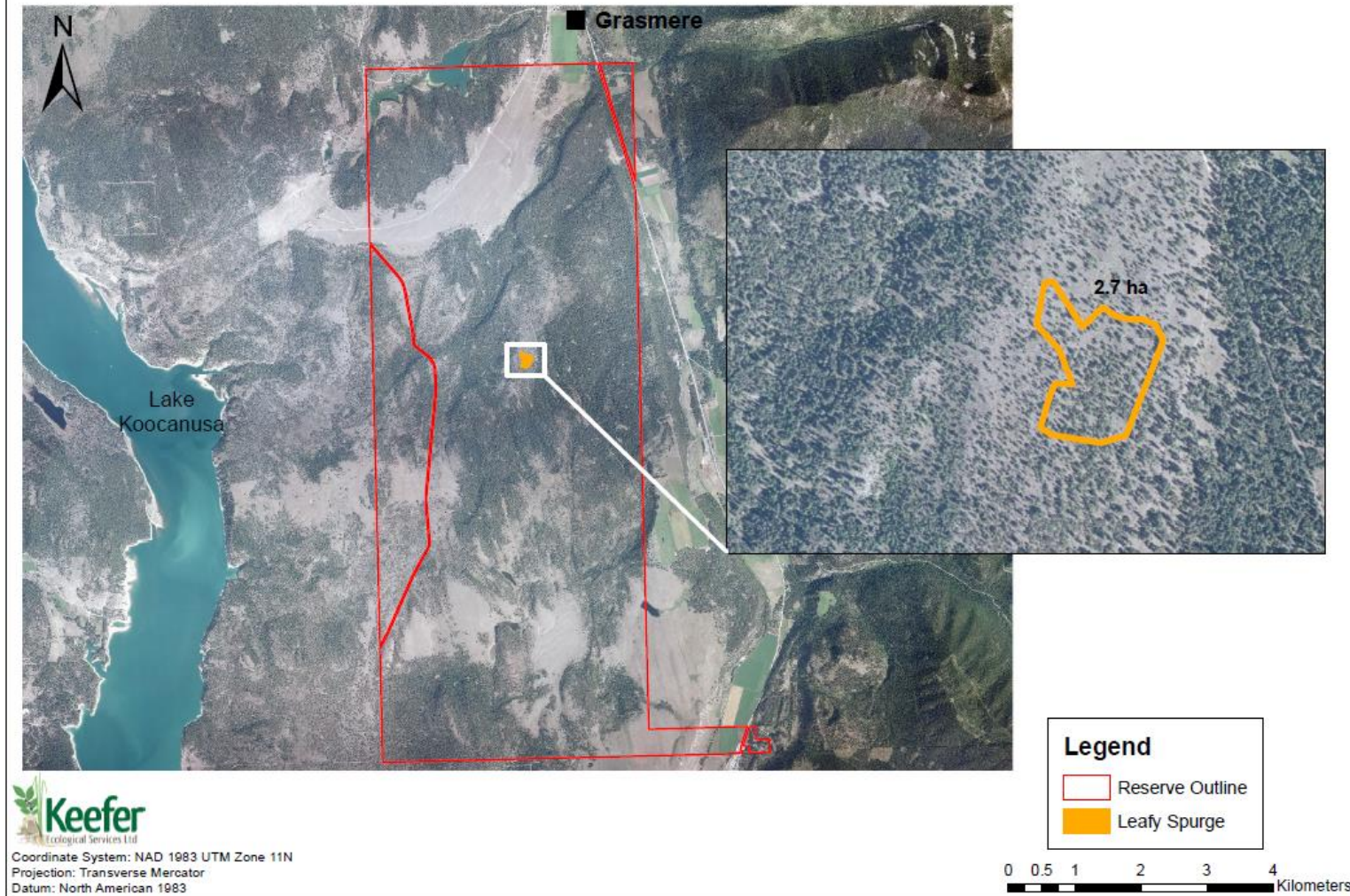


Figure 2: Location of the leafy spurge (*Euphorbia esula*) infestation on Tobacco Plains Indian Reserve.

A) Photo Point 1: 11U 638999E 5435233 N
Bearing: 329°

Pre-treatment 2015

Photo of a leafy spurge infestation patch within the 2.7 ha infestation area taken on July 13, 2015 prior to herbicide application



Pre-treatment 2016

Photo of a leafy spurge infestation patch within the 2.7 ha infestation area taken on June 13, 2016 prior to herbicide application



Post-treatment 2016

Photo of a leafy spurge infestation patch within the 2.7 ha infestation area taken on September 01, 2016 prior to the second application of herbicide



B) Photo Point 2: 11U 639011E 5435159N
Bearing: 035°

Pre-treatment 2015

Photo of a leafy spurge infestation patch within the 2.7 ha infestation area taken on July 13, 2015 prior to herbicide application



Pre-treatment 2016

Photo of a leafy spurge infestation patch within the 2.7 ha infestation area taken on June 13, 2016 prior to herbicide application



Post-treatment 2016

Photo of a leafy spurge infestation patch within the 2.7 ha infestation area taken on September 01, 2016 prior to the second application of herbicide



Figure 3: Photo documentation of the 2.7 ha leafy spurge (*Euphorbia esula*) infestation in 2015 (A) and 2016 (B) pre-treatment and post-treatment on Tobacco Plains Indian Reserve.



Figure 4: Dense leafy spurge (*Euphorbia esula*) patch within the 2.7 ha infestation area on Tobacco Plains Indian Reserve. Photo taken on June 13, 2016 prior to herbicide application.

As noted in 2015, leafy spurge die-off was observed subsequently following herbicide application (Figure 3; Juckers and Moody, 2016). However, similar to efforts in 2015, a second round of herbicide application in early September was necessary to treat plants which emerged following initial treatment.

The leafy spurge infestation is located within a substantial sub-population of Spalding's campion (*Silene spaldingii*; Keefer and Kennedy, 2010), a species listed as Endangered under the *Species at Risk Act* and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The application of mild doses of Trillion twice a year during the growing season was initially selected as the method of choice to address the leafy spurge infestation, rather than herbicides such as Tordon 22K and glyphosate, because Trillion was expected to reduce the risk of the herbicide to Spalding's campion plants. However, since a notable decline in the leafy spurge infestation was not observed between years 1 and 2, a revised herbicide application was submitted to Environment and Climate Change Canada requesting the application of Tordon 22K five meters from known Spalding's campion sites and the application of glyphosate by wicking within Spalding's campion sites.

Tordon 22K is recognized as a well-known, effective herbicide to manage small leafy spurge infestations (Scott and Robbins, 2000; Pachkowski and Thorton, 2011). Approximately 90% control of leafy spurge can be achieved in the first year (Pachkowski and Thorton, 2011). However, the herbicide can remain in the soil for 5 years because of the active ingredient picloram (Dow AgroSciences, n.d.). As such, a five meter buffer between Spalding's campion plants and the application of Tordon 22K is recommended to mitigate the risk of harming Spalding's campion plants. Within the five meter buffer, the application of glyphosate by wicking is recommended.

Glyphosate has been reported to reduce leafy spurge infestations by 80-90% (Lym et al., 2002). The major pathway of glyphosate is through the foliage and once absorbed glyphosate is translocated throughout all plant parts where it prevents regrowth (Schuette, 1998). Further, glyphosate has moderate persistence with a soil field dissipation half-life averaging 44-60 days (Schuette, 1998). Wick application of glyphosate on leafy spurge plants rather than broadcast spraying will reduce impacts of the herbicide on Spalding's campion plants and other plants in the area as glyphosate is non-selective, and will therefore harm grasses, forbs, shrubs, and trees. Further, covering Spalding's campion plants with temporary, impermeable plastic barriers, to protect them from the herbicide will also be employed to reduce the risk of glyphosate.

The use of Tordon 22K and glyphosate is expected to reduce the leafy spurge infestation more effectively than Trillion, resulting in a much greater reduction in the amount of leafy spurge germinating which will require less time to treat the area and thus less exposure to chemical on the landscape.

To continue assessing changes in the leafy spurge infestation, photo documentation will continue at the two photo points within the infestation area. As well, the density and distribution of the infestation will continue to be documented to assess changes. An efficacy rating of 1-10 will be given, as per the Invasive Alien Plant Program (IAPP) monitoring methods, to document the mortality achieved on the site (Ministry of Forests and Range, 2010). Further, the perimeter of the infestation will be walked using a hand-held GPS to document any changes in the infestation area.

Orange hawkweed (*Hieracium aurantiacum*)

The invasive plant survey conducted in 2015 found a few small (less than 1 hectare) orange hawkweed infestations throughout the reserve (Juckers and Keefer, 2016). The survey took place near the end of orange hawkweed's flowering period and thus the full extent of the invasive plant was unknown. To determine the distribution of orange hawkweed throughout the reserve, a more comprehensive survey of orange hawkweed was conducted in early summer 2016. In addition to the two sites identified in 2015 (Juckers and Moody, 2016), 13 more sites were found in 2016 (Figure 5), totaling an infestation area of approximately 1.34 ha (Table 1). All patches identified in both 2015 and 2016 were sprayed with the herbicide Milestone to control infestations and work towards eliminating infestations from the reserve. Patches identified and sprayed in 2015 were re-sprayed with a higher concentration of Milestone as initial treatment was unsuccessful.

The distribution of orange hawkweed was found to be sporadic throughout the reserve (see map) and patches were quite small, ranging from 0.00014 ha to 0.69 ha (Table 1). The majority of patches were identified near well-used roads; however, a few patches were found in more discreet locations (see map). Due to the sporadic nature of orange hawkweed throughout the reserve and locating infestations in less-accessible areas, educating band members on identification and ecology of orange hawkweed is critical. Education will bring awareness of the plant among the community and prompt band members to report sightings to the band office which will help in the eradication of orange hawkweed from the reserve.

Table 1: Number of orange hawkweed (*Hieracium aurantiacum*) patches and their area of infestation, in hectares, identified within Tobacco Plains Indian Reserve in 2015 and 2016.

Patch	Hectares	
	2015	2016
1	0.0025	
2	0.1697	
3		0.0109
4		0.0056
5		0.0747
6		0.00014
7		0.0103
8		0.00048
9		0.6937
10		0.0015
11		0.2554
12		0.0535
13		0.0682
14		0.00085
15		0.00084
TOTAL	0.1722	1.17611

2015 & 2016 Invasive Plant Management Orange Hawkweed (*Hieracium aurantiacum*)

Tobacco Plains Indian Band Reserve Area
Grasmere, British Columbia

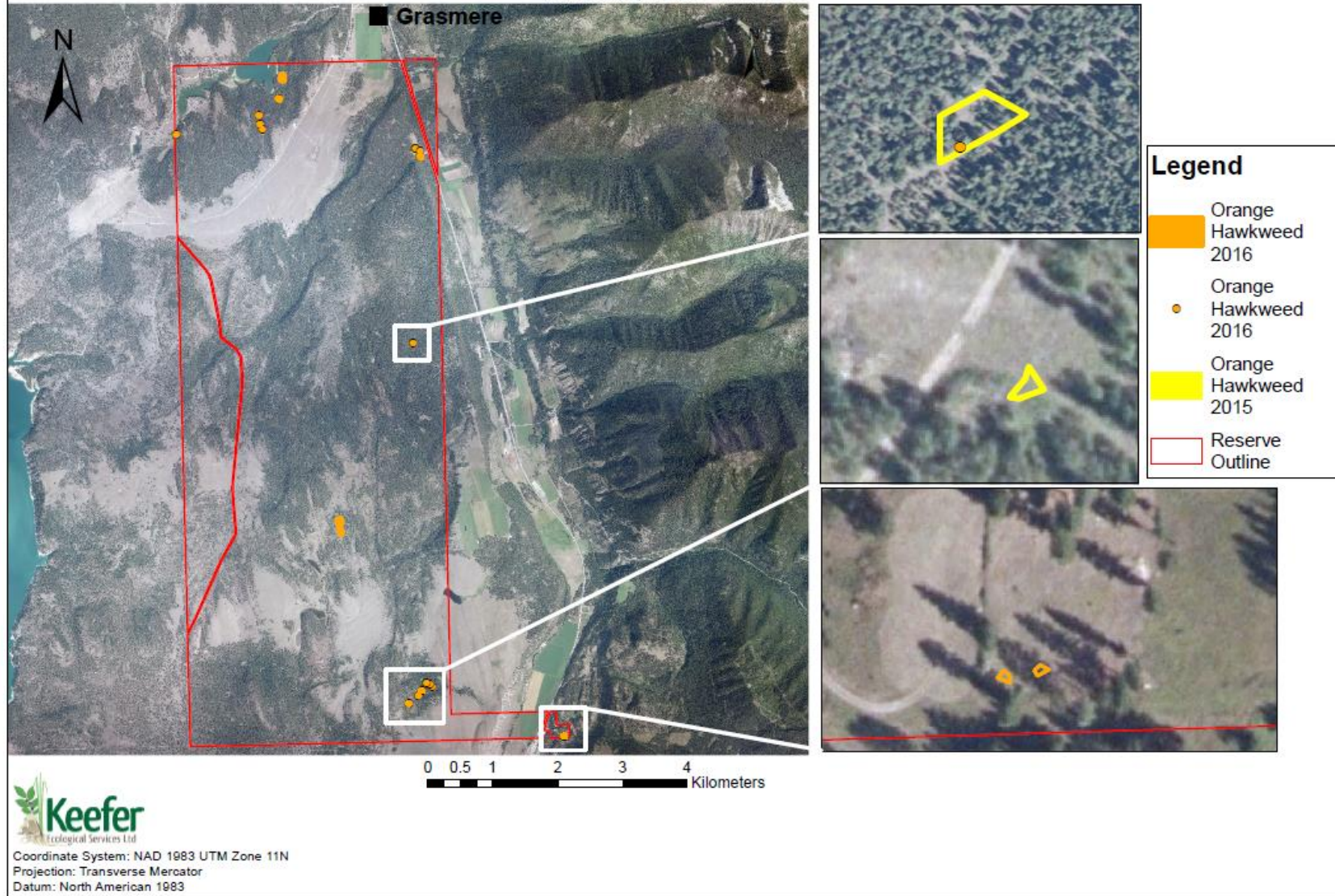


Figure 5: Locations of orange hawkweed (*Hieracium aurantiacum*) infestations on Tobacco Plains Indian Reserve identified in 2015 and 2016.

Spotted knapweed (*Centaurea stoebe*)

Large and small infestations of spotted knapweed were identified throughout TPIR during the invasive plant survey conducted in 2015 (Figure 6). In 2015, 4 infestations less than 0.34 each, totalling approximately 0.9 ha, were sprayed with the herbicide Milestone to manage the distribution of knapweed throughout the reserve. Of the 4 infestations, a portion of one was resprayed with the herbicide Milestone as rosettes and small plants were observed (Table 2). The remaining 3 infestations were assessed and knapweed was not observed to have re-emerged (Figure 7) and thus areas were not re-sprayed. Monitoring will continue in future years to assess sites for possible re-emergence of spotted knapweed.

Table 2: Spotted knapweed (*Centaurea stoebe*) patches and their area of infestation, in hectares, identified within Tobacco Plains Indian Reserve in 2015 and 2016.

Patch	Hectares	
	2015	2016
1	0.3326	
2	0.0271	
3	0.2903	
4	0.2915	0.0535
5		0.0035
6		0.0029
7		0.0115
8		0.0066
9		0.4025
TOTAL	0.9415	0.4805

2015 & 2016 Invasive Plant Management Spotted Knapweed (*Centaurea stoebe*)

Tobacco Plains Indian Band Reserve Area
Grasmere, British Columbia

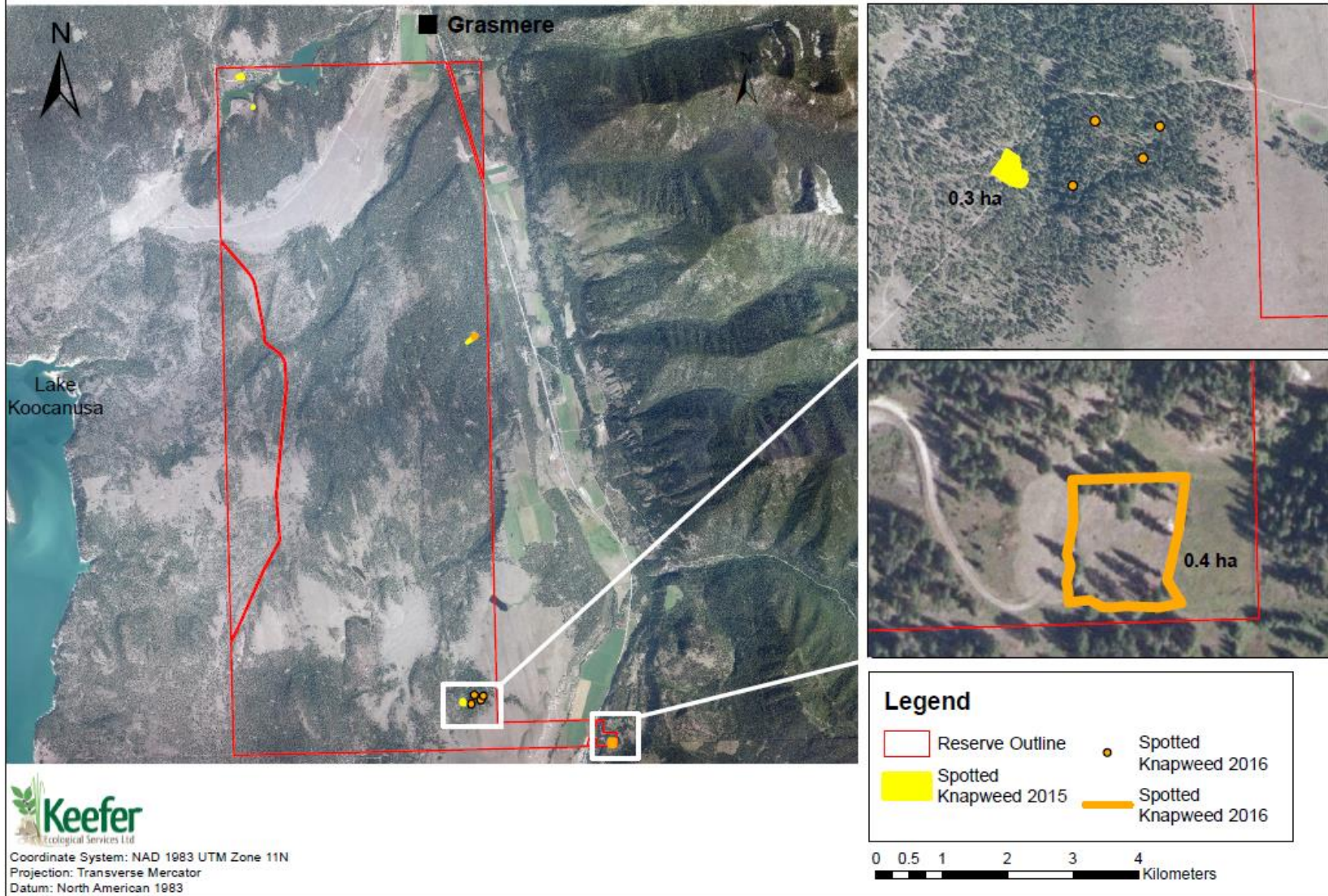


Figure 6: Locations of spotted knapweed (*Centaurea stoebe*) infestations on Tobacco Plains Indian Reserve identified in 2015 and 2016.



A



B

Figure 7: An example of a spotted knapweed (*Centaurea stoebe*) patch prior to the application of the herbicide Milestone in 2015 (A), taken on July 27, 2015, and the condition of the patch in 2016 (B), taken on September 1, 2016. The patch is located in the north western corner of the reserve, west of Edwards Lake (11U 636891E 5439447N).

Five additional infestations were sprayed with Milestone in summer 2016 (Figure 6). Four of the five were found while surveying for orange hawkweed. These infestations were less than 0.05 ha (Table 2) and located several meters from the road (Figure 6). The fifth infestation was located in and around the cemetery; the area sprayed within the cemetery was 0.4 ha (Table 2). The entire infestation in and around the cemetery was not sprayed because the cemetery is located adjacent to the State of Montana border which is heavily infested with knapweed. Future spraying is recommended along the road to the cemetery and the perimeter of the cemetery to control re-infestation. Further, these actions will aid in preventing the spread of knapweed throughout the reserve resulting from seeds adhering to vehicles, clothing, and boots of individuals visiting the cemetery.

Due to the expanse of knapweed infestations throughout the reserve (Juckers and Keefer, 2016) and the State of Montana as a substantial point source of knapweed (Duncan et al., 2011), eradicating the noxious weed from the reserve is not deemed feasible. However, containing large infestations and eradicating small infestations found throughout the reserve is imperative to managing the spread of knapweed into critical habitat. Biocontrol is abundant within large spotted knapweed infestations on the reserve (Juckers and Keefer, 2016). Monitoring and conducting inventory for spotted knapweed biocontrol species is important to ensure biocontrol populations exist at levels required to impact large knapweed infestations. Further, educating members on spotted knapweed identification and ecology, as well as biocontrol identification and ecology, are important aspects of long-term management of invasive plants on the reserve. Raising awareness of the plant and its biocontrol agents, and encouraging band members to report occurrences of new or established infestations to the band office are essential in effective invasive plant management for this community.

Field Bindweed (*Convolvulus arvensis*)

The small field bindweed infestation found during the invasive plant survey in 2015 was sprayed with the herbicide Milestone in 2015 (Figure 8; Juckers and Moody, 2016). The infestation was reassessed in summer 2016 and a decline in plant density was not observed. As such, the infestation was re-sprayed with Milestone. Continued monitoring is necessary to determine whether spraying efforts were successful in reducing infestation density and if further treatment is necessary to eradicate the infestation from the reserve. Educating band members on field bindweed identification is also critical to enable band members to report any potential occurrences to the band office, which can subsequently lead to treatment.

2015 & 2016 Invasive Plant Management Field Bindweed (*Convolvulus arvensis*)

Tobacco Plains Indian Band Reserve Area
Grasmere, British Columbia

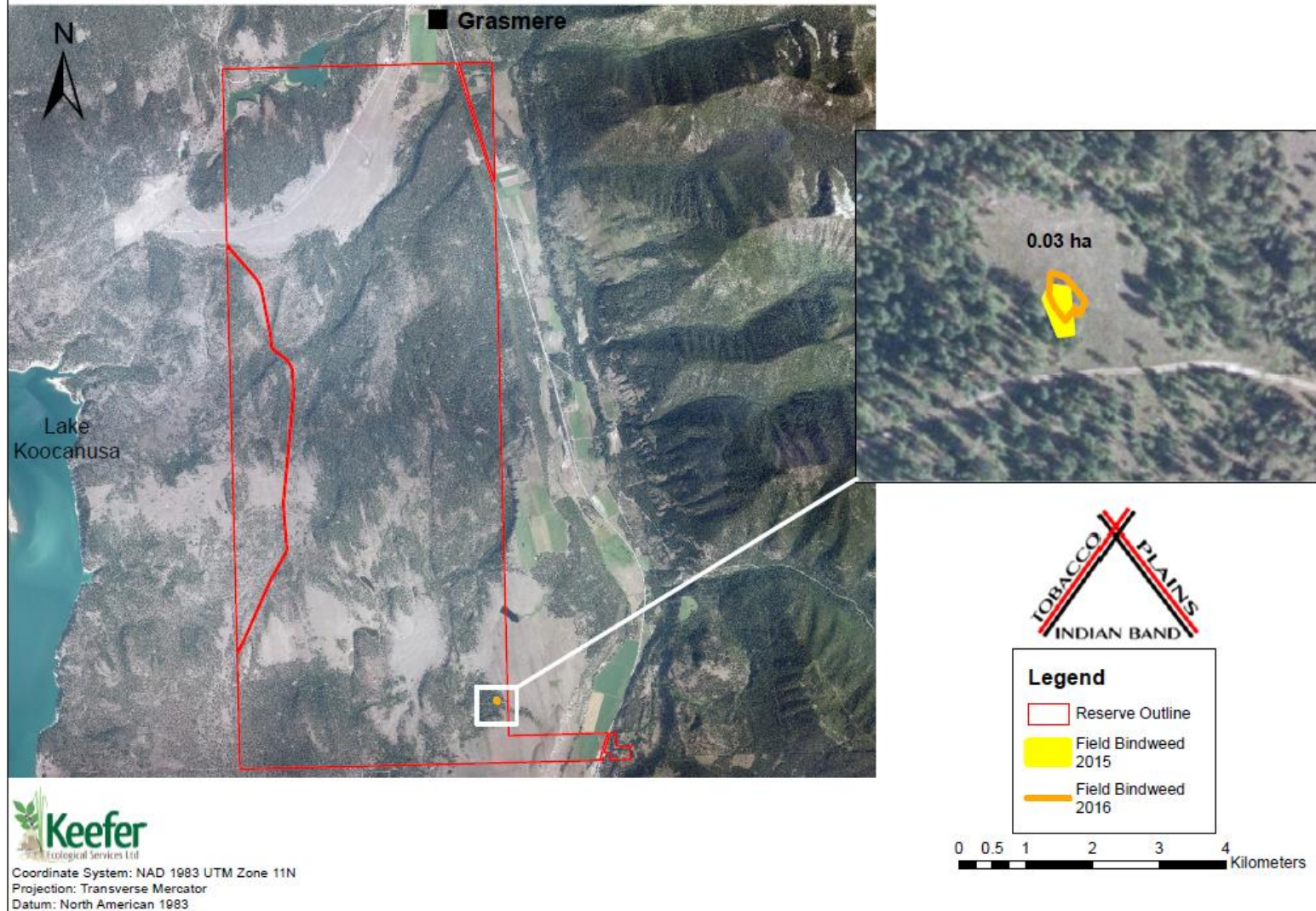


Figure 8: Location of the field bindweed (*Convolvulus arvensis*) infestation on Tobacco Plains Indian Reserve.

Monitoring

Monitoring is being employed using methods under the *Invasive Alien Plant Program Reference Guide, Part I, Module 1.5*, to determine whether invasive plant management efforts are successfully reducing and controlling invasive plant infestations to prevent re-invasion and expansion of infestations. As well, data on inventory, treatment and monitoring of invasive plants on TPIR is entered into the Invasive Alien Plant Program database in order to make the information available at a provincial level.

In 2015, the invasive plant survey inventoried the distribution and density of invasive plant infestations present within grassland/rangeland, past burns, cleared/logged areas, and areas of concern identified by TPIB members. Infestations were then prioritized and selected for treatment. All infestations treated in 2015 were re-visited in 2016 to determine whether the control method was successful. Monitoring will continue for the next four years to identify if re-treatment is necessary. Monitoring of infestations treated in 2016 will also occur 5 years following treatment to assess management success.

In addition to assessing changes in the invasive plant infestation, monitoring will assess whether other invasive plants are invading the site and if the native plant community is re-establishing. This is of particular concern within the grassland/rangeland areas on the reserve as native vegetation is present at these sites (Appendix A); however, they are dominated by sulphur cinquefoil and Canada bluegrass (*Poa compressa*). Further, exposed soil is prevalent throughout grassland/rangeland on the reserve due to historic cattle overgrazing and a large feral horse population on the reserve (Juckers and Keefer, 2016).

In the late 1990s, Tobacco Plains reserve lands were leased to a farmer for cattle grazing. Approximately 150 head of cattle grazed reserve lands until 2006 after which the majority of the herd was removed from the reserve. At present, approximately 25-30 head of cattle utilize the summer pasture which is located on the south side of the reserve. Poor grazing management resulted in overgrazing, causing the degradation of rangeland on reserve, particularly around the waterbodies located in the southern end of the reserve where the cattle concentrated. TPIB intends to move the remaining cattle off reserve onto crown land this summer (T.Phillips, pers.comm., Mar 27, 2017). As well, this past winter, 90 of the approximately 110 feral horses that roamed the reserve were rounded up and taken off reserve (T.Phillips, pers.comm., March 27, 2017). The removal of the feral horses, coupled with the proposed removal of cattle from the reserve, should greatly reduce pressure on the grasslands/rangeland, which should give native plant communities on the reserve the opportunity to rest from grazing pressure. Continued monitoring of the targeted goat grazing site (see supplemental report 2016 *Targeted Grazing of Sulfur Cinquefoil (Potentilla recta) Using Goats on Tobacco Plains Indian Reserve*) will provide insight into whether native plant species are re-establishing or if revegetation is necessary to speed recovery efforts. As well, TPIB is in the process of updating their Land Use Plan. Meetings will be held with the TPIB Lands and Resources Committee to identify their updated land use objectives and discuss grassland/rangeland recovery efforts on the reserve, including the possibility of revegetation.

Ecological Restoration Forest Thinning

Tobacco Plains Indian Reserve (TPIR) is located within the dry-hot ponderosa pine biogeoclimatic subzone which is one of the rarest biogeoclimatic zones in British Columbia (Biodiversity BC, 2010). Historically, fire played a significant role in the ecology of this zone. Specifically in the Tobacco Plains region, studies have indicated fire frequency ranged from 6 to 8.7 years which coincides with oral history regarding First Nations use of fire (Heyerdahl et al., 2008). Regular wildfire on the landscape created a mosaic of grasslands and open forest stands; however, decades of fire suppression has led to forest encroachment and ingrowth within these grassland and open forest ecosystems. The implications of forest encroachment and ingrowth include (Bond et al., 2013):

- A shift in tree density and tree age as grasslands are becoming open forests;
- Increased tree density in open forests and a shift to younger, smaller diameter trees which places competition on veteran trees;
- A shift in tree species from fire-tolerant ponderosa pine to less-fire adapted Douglas fir;
- Increased risk of severe fire as fuels build;
- Reduction and possible extirpation of native grassland plants as plants are out-shaded by encroaching trees; and
- Loss of forage for grazing animals, such as elk and mule deer, placing increased pressure on remaining grazing sites.

Tobacco Plains Indian Reserve is also home to several federally listed species at risk, including Spalding's campion, long-billed curlew, American badger, and Lewis's woodpecker. Forest encroachment and ingrowth is a threat to each of these at risk species. Removal of encroaching vegetation is imperative for improving and maintaining critical grassland and open forest habitat for these species.

Treatment Unit Delineation

Since 2006, Keefer Ecological Services Ltd. (KES) has worked with Tobacco Plains Indian Band (TPIB) to restore critical grassland and open forest habitat on the reserve. In 2013, KES delineated priority areas throughout the reserve to address tree encroachment on Spalding's campion habitat, which would also benefit other species at risk, including long-billed curlew, American badger, and Lewis's woodpecker, all of which thrive in grassland and open forest habitat. Prior to conducting field work, a desktop exercise was conducted to identify priority sites. GIS mapping work completed for KES in 2010 produced ecosystem units by cover type (grassland, open forest, closed forest; Keefer and Kennedy, 2010). The data were overlain with Spalding's campion point occurrences, highlighting encroached grasslands and overstocked forest sites containing, or in close proximity to, known Spalding's campion locations. Pre-treatment surveys in fall 2013 were targeted at these sites to characterize each treatment unit in its present state, develop appropriate stocking rates and describe the target plant community composition, post-treatment. Data were analyzed using MS Excel and subsequently used to create ecological restoration (ER) prescriptions using the Ministry of Forests, Lands and Natural Resource Operations

Rocky Mountain Forest District Ecological Restoration Prescription form (Appendix B). Prescription implementation began in 2014, in which approximately seven hectares (ha) of open forest habitat was thinned within treatment unit CATCHFLY 14-10 (Figure 9). In 2015, work continued within CATCHFLY 14-10, with approximately 3.4 ha of open forest thinned (Figure 9). Additionally, approximately 13 ha of open forest was thinned in and around CATCHFLY 14-17 (Figure 9). In 2016, work has continued within CATCHFLY 14-17.

Thinned Regions 2014, 2015, 2016 & Proposed 2017

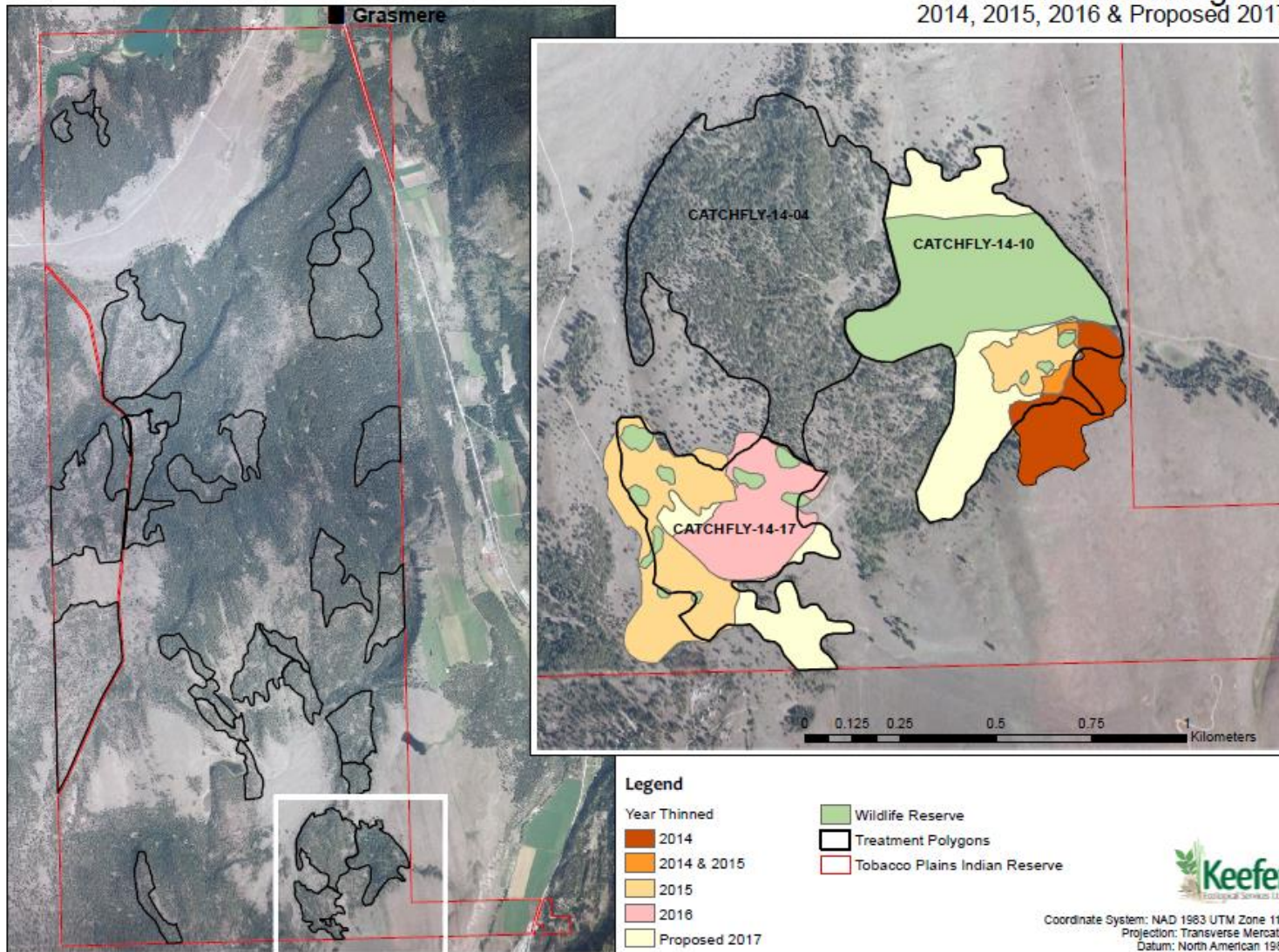


Figure 9: Locations of areas thinned in the southern reach of Tobacco Plains Indian Reserve in 2014 – 2016 and proposed areas to be thinned in 2017.

2015 Ecological Restoration (ER) Implementation

ER Implementation Workshop

A half day workshop was held on October 12, 2016 for the Tobacco Plains Logging Crew that would be conducting thinning efforts. The workshop involved a discussion on the importance of grassland and open forest habitat for species at risk on the reserve, including Spalding's campion, long-billed curlew, American badger, and Lewis's woodpecker. The logging crew was brought to an active invasive plant management site to demonstrate, that in addition to forest thinning efforts, restoration work has involved invasive plant management. Further, the importance of invasive plant management in accordance with thinning efforts was expressed.

The crew was then brought to CATCHFLY 14-17 and shown how to determine stocking density of seedlings, saplings, poles, co-dominant, and dominant trees using a 5.64 m radius plot. The use of the fixed-radius plots was explained to determine the quantity of trees needing to be removed from the treatment unit to meet the ER prescription. Tree girdling was also discussed with crew members as a tool to be employed to increase tree mortality while reducing effort to reach the ER prescription goal.

Monitoring

Monitoring of the thinned area within CATCHFLY 14-17 was conducted in November 2016. The extent of the thinned area within the treatment unit was determined by walking the perimeter with a handheld GPS. Five 5.64 m radius plots were conducted to gather data on tree species, stems per hectare (sph), and diameter at breast height (dbh) of saplings, poles, co-dominant and dominant trees remaining post-thinning. The density and species of seedlings was also determined within each radius plot. Additionally, tree density in two of the three wildlife tree patches retained within the thinned area was assessed using a radius plot.

The following definitions were used to characterize the trees (BC Government, 2000):

Seedling: A tree with a dbh less than 2.5 cm

Sapling: A tree of 2.5 cm to 12.4 cm dbh

Pole: A tree of 12.5 cm to 19.9 cm dbh

Co-dominant: A tree of 20.0 cm to 29.9 cm dbh

Dominant: A tree with a dbh equal to or greater than 30 cm

2016 Thinning

Results

Approximately 8.8 ha of land was thinned within CATCHFLY 14-17 in 2016 (Figure 9). The goal of CATCHFLY 14-17 was to restore the unit to an open forest. To reach this goal, the following was prescribed:

- Maintain 76 to 400 sph on site with a target of 150 sph while maintaining the largest trees on site, emphasizing trees greater than 20 cm dbh; and
- Remove most small diameter trees (less than 20 cm), retaining an average of 10-20 sph of healthy poles for stand recruitment.

Photo monitoring conducted at two representative permanent point locations pre- and post-treatment shows the encroachment on the landscape by ponderosa pine and Douglas fir, followed by the opening of the area through thinning to restore open forest habitat (Figure 10).

A) CAATCHFLY 14-17, Photo Point 1, North Facing: 11U 639909 E 5429647

Pre-treatment

Photo taken On November 22, 2013



Post-treatment

Photo taken on November 25, 2016



B) CATHFLY 14-17, Photo Point 2, North Facing: 11U 639795E 5429523 N

Pre-treatment

Photo taken On November 22, 2013



Post-treatment

Photo taken on November 25, 2016



Figure 10: Representative photos pre- and post-treatment in CATCHFLY 14-17 taken in 2013 (A) and 2016 (B) respectively.

Post-monitoring of the 8.8 ha thinned area found retention of an average of 80 dominant and 60 co-dominant ponderosa pines, totaling 140 sph of ponderosa pines equal to and greater than 20 cm in diameter (Table 3). The total is just below the target of 150 sph and is within the prescribed range of 76 to 400 sph maintained on site. Pole retention averaged 80 sph, which is above the objective to retain an average of 10-20 sph of healthy poles. The number of poles girdled averaged 80 sph (Table 3). Further, sapling density averaged 140 sph (Table 3).

Table 3: Average density (sph) of ponderosa pine trees remaining and girdled following thinning within 8.8 ha of CATCHFLY 14-17 in 2016.

Size	Density (sph)/Girdled Density (sph)
Sapling (2.5 – 12.4 cm)	140/0
Pole (12.5 – 19.9 cm)	80/80
Co-dominant (20.0 – 29.9 cm)	60/0
Dominant (≥ 30.0 cm)	80/0
Total sph	360/80

Average density of seedlings within the thinned area totaled 11,480 ponderosa pines and 60 Douglas firs, of which the majority were less than 10 cm in height (Table 4). Since 2014, seedling density has been found to be high in thinned areas, particularly within CATCHFLY 14-17 (Table 5).

Table 4: Average density (sph) of ponderosa pine (Py) and Douglas fir (Fd) seedlings within the 8.8 ha thinned area of CATCHFLY 14-17 in 2016.

Size (cm)	Density (sph)		
	Py	Fd	Total
0-9.9	11,080	60	11,140
10 - 24.9	140	0	140
25-50	120	0	120
>50	140	0	140
Total	11,480	60	11,540

Table 5: Average density (sph) of ponderosa pine (Py) and Douglas fir (Fd) seedlings within the areas thinned in 2014, 2015, and 2016.

Year	Treatment Unit	Density (sph)		
		Py	Fd	Total
2014	CATCHFLY 14-10	60	1,420	1,480
2015	CATCHFLY 14-10	83.3	333.3	416.6
	CATCHFLY 14-17	17,333	16.6	17,349.6
2016	CATCHFLY 14-17	11,480	60	11,540

Three wildlife tree patches, totaling 0.7 ha, were retained within the thinned area (Figure 9; Figure 11). Average density of poles, saplings, and seedlings found within the wildlife tree patches was 450 sph, 7,350 sph, and 1,900 sph respectively, of which ponderosa pine density was greater than Douglas fir (Table 6).



Figure 11: Evidence of wildlife rubbing within a wildlife tree patch retained in the 8.8 ha thinned area of CATCHFLY 14-17 in 2016. Photo taken on November 25, 2016.

Table 6: Average density (sph) of ponderosa pine (Py) and Douglas fir (Fd) poles, saplings, and seedlings present within wildlife tree patches retained in the 8.8 ha thinned area of CATCHFLY 14-17 in 2016.

Size	Density (sph)		
	Py	Fd	Total
Pole (12.5 – 19.9 cm)	400	50	450
Sapling (2.5 – 12.4 cm)	7,200	150	7,350
Seedling (<2.5 cm)	1,750	150	1,900

Discussion

Since 2014 and 2015, thinning efforts have improved. In 2014, the 7 ha of land thinned in CATCHFLY 14-10 had an average stand density of 200 sph equal to and greater than 20 cm in diameter post-treatment (Carignan et al., 2015). In 2015, average stand density equal to and greater than 20 cm in diameter post-treatment in the 3.4 ha area thinned in CATCHFLY 14-10 and the 13 ha area thinned in CATHCFLY 14-17 was 266.6 sph and 166.6 sph, respectively (Juckers and Moody, 2016). In both years, stand retention of larger trees exceeded the open forest target of 150 sph; however, the number of trees maintained on site was within the prescribed range of 76 to 400 sph (Harris, 2007). In 2016, stand retention of trees equal to or greater than 20 cm was 140 sph, which has been the closest achievement of the open forest target ER prescription to date.

Over the past three years, pole retention has exceeded the open forest ER prescription retention average of 10-20 sph (Harris, 2007). In 2014, pole retention greatly exceeded the target as the average pole density was 300 sph within the thinned area of CATCHFLY 14-10 (Carignan et al., 2015). However, improvements were seen in 2015 as average pole density in both CATCHFLY 14-10 and CATCHFLY 14-17 was 83.3 sph (Juckers and Moody, 2016). In 2016, pole density within the thinned area of CATCHFLY 14-17 averaged 80 sph, only slightly less than the average achieved in 2015. This past year, tree girdling was used as a tool by the logging crew to increase tree mortality within the thinned areas while increasing efficiency by reducing the need for cutting, piling, and burning. An enhanced girdling effort in following years is recommended to increase pole mortality in order to achieve the target density of 10-20 sph. Continued communication with the logging crew through workshops and site visits is critical to articulate the goal to be achieved and make recommendations on how thinning efforts can be performed more efficiently.

Seedling density was found to be high in treatment units, particularly CATCHFLY 14-17 (Table 5). A prescribed burn plan was drafted in 2016 that encompasses CATCHFLY 14-04, 14-10, and 14-17 (MAP; see Juckers and Moody, 2016 for draft plan). Implementation of the prescribed burn plan is critical to manage regeneration following completion of thinning efforts within this southern region of the reserve.

In 2015, the logging crew left patches of young Douglas fir and ponderosa pine (Juckers and Moody, 2016) and the practice was continued in 2016, with three wildlife tree patches, totaling approximately 0.7 ha, retained within the thinned area (see map). Community members expressed the importance of wildlife tree patches to provide cover and rubbing areas for wildlife, particularly ungulates. Based on this feedback, the practice will continue within open forest prescription areas.

In addition to thinning efforts, invasive plant management has been occurring on the reserve since 2014. Invasive plant management is critical to consider within these treatment units because of increased risk of establishment coinciding with site disturbance. Efforts must focus on monitoring invasive plant infestations to assess the species, distribution, and density present on site. Further, monitoring is imperative to ensure new infestations do not establish within these units. If infestations do establish, immediate action must be taken to control their spread within critical habitat.

Next Steps

In 2017, restoration efforts will continue within critical grassland and open forest habitat on Tobacco Plains Indian Reserve through invasive plant inventory, monitoring, and control measures and forest thinning. Specifically, efforts will include:

Invasive Plant Management

- *Spotted knapweed assessment and herbicide treatment*
Large and small infestations (less than 1 hectare) of spotted knapweed have been found throughout TPIR (Juckers and Keefer, 2016). The spread of spotted knapweed throughout TPIR is a primary concern of community members. Containing large infestations of spotted knapweed and eradicating small infestations throughout the reserve is critical to manage spotted knapweed. A thorough assessment of the extent of spotted knapweed throughout TPIR and treating small infestations is necessary to continue managing spotted knapweed. Monitoring of infestations treated in 2015 and 2016 will assess whether control measures were effective. Further, monitoring the assemblage and abundance of biocontrol in large spotted knapweed infestations will aid in determining whether large infestations are being effectively managed.
- *Leafy spurge herbicide treatment*
Monitoring of the leafy spurge infestation will be conducted to assess any changes in the infestation from 2016. As well, spraying will occur to continue efforts to eradicate leafy spurge from the reserve. An application has been submitted to Environment and Climate Change Canada to request the application of the herbicides Tordon 22K and glyphosate to manage the leafy spurge infestation in place of Trillion.
- *Orange hawkweed herbicide treatment*
Monitoring of orange hawkweed infestations identified in 2016 will be conducted to determine whether further spraying is necessary.
- *Sulphur cinquefoil treatment through target goat grazing*
Monitoring of the 48 ha of grassland grazed in 2016 will be conducted to assess any notable changes in the sulphur cinquefoil infestation. Monitoring will involve revisiting the control and sample plots to assess the size, phenology and coverage of sulphur cinquefoil plants and determine the percent cover of additional plants species within each plot. Target goat grazing efforts will continue within the area to manage sulphur cinquefoil.

Ecological Restoration Forest Thinning

- *Treatment prescriptions*
In 2013, 28 treatment units were identified throughout TPIR to conduct ecological restoration (ER) forest thinning. The treatment units were evaluated to gather data for the development of ER thinning prescriptions per treatment area using the Rocky Mountain Forest District ER

prescription template. To date, 7 ER thinning prescriptions have been developed and 7 have been drafted. Finalization of the 7 drafted prescriptions and development of the remaining 14 treatment units will be conducted.

- *Forest Thinning*
Forest thinning will occur on 30-40 ha of grassland and open forest habitat within the southern reach of TPIR to reduce the threat of forest encroachment and ingrowth.
- *Monitoring*
Monitoring of forest thinning efforts using radius plots will be conducted to determine whether ER thinning prescriptions were achieved in order to increase available critical habitat. Conducting an inventory of invasive plants present within areas thinned will also be conducted to identify the distribution and density of invasive plants within these sites. Collection of this data will be used to assess any changes in invasive plant populations over the years.

Community Engagement

A field tour of invasive plant management and forest thinning sites on TPIR will be offered to Tobacco Plains members, the East Kootenay Invasive Species Council, the Rocky Mountain Trench Natural Resources Society, the Kootenay Livestock Association, and the Rocky Mountain Field Naturalists. Also, upon project completion, a presentation will be given to Tobacco Plains Chief and Council. These outreach events will increase awareness not only among Tobacco Plains members but also among citizens of the East Kootenay regarding the importance of grassland and open forest habitat, the threat of invasive species and tree encroachment and ingrowth to these critical habitats, and efforts which have occurred on TPIR to address these threats.

References

- BC Government. 2000. Spatial and Temporal Themes: Successional Stages. Available: <https://www.for.gov.bc.ca/hfd/pubs/docs/srs/Srs05/Srs05-2f.pdf>.
- Biodiversity BC. 2010. BC's Natural Treasure: Will it Still be Here for Your Children? Available: <http://www.biodiversitybc.org/assets/Default/BBC-poster-Web-final1.pdf>.
- Bond, S., M. Gall, D. Gayton, R. Harris, B. Munroe, R. Neil, H. Page, W. Rockafellow and S. Witbeck. 2013. Rocky Mountain Trench Ecosystem Restoration Program: Blueprint for Action 2013, Progress and Learnings 1997-2013. Rocky Mountain Trench Ecosystem Restoration Program: Cranbrook, BC. Available: http://trench-er.com/images/uploads/Blueprint2013_booklet_web.pdf.
- Carignan, G., A. Burton, and M. Juckers. 2015. Spalding's Campion Inventory and Habitat Recovery: Tobacco Plains Indian Reserve 2014-2015. Keefer Ecological Services Ltd.: Cranbrook, BC.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. *COSEWIC Assessment and Update Status Report on the Long-billed Curlew Numenius americanus in Canada*. Committee on the Status of Endangered Wildlife in Canada: Ottawa, ON. Available: http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_long_billed_curlew_e.pdf.
- Crowley, S. & Gall, M. 2011. East Kootenay Grassland Ecosystem Restoration: Project Synthesis: 2005-2010. Habitat Conservation Trust Fund Project 4-299. BC Ministry of Environment. Available: <http://trench-er.com/public/library/files/east-kootenay-grassland-restoration.pdf>.
- Davies, K.W., G. Collins, and C.S. Boyd. 2014. Effects of Feral Free-roaming Horses on Semi-arid Rangeland Ecosystems: An Example from the Sagebrush Steppe. *Ecosphere*, 5(10): 127.
- Dow Agro Sciences. n.d. Tordon 22K for Industrial Vegetation Management. Available at: http://msdssearch.dow.com/PublishedLiteratureDAS/dh_094e/0901b8038094e800.pdf?filepath=/pdfs/noreg/010-23103.pdf&fromPage=GetDoc.
- Duncan, C., J. Story, and R. Sheley. 2011. Biology, Ecology, and Management of Montana Knapweeds. Montana State University Extension. Available at: http://msuinvasiveplants.org/documents/mt_noxious_weeds/knapweeds.pdf.
- Environment Canada. 2016a. Recovery Strategy for the Spalding's Campion (*Silene spaldingii*) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada: Ottawa, ON. Available: https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/rs_spalding's_campion_e_proposed.pdf.
- 2016b. Recovery Strategy for the Lewis's Woodpecker (*Melanerpes lewis*) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada: Ottawa, ON. Available: http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/rs_lewis%27s_woodpecker_e_proposed.pdf.

2013. Management Plan for the Long-billed Curlew (*Numenius americanus*) in Canada. Species at Risk Act Management Plan Series. Environment Canada: Ottawa, ON. Available: https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/mp_long_billed_curlew_e_final.pdf.
- Harris, B.J.R. 2014. 2014 Core Grassland Map: South. Ministry of Forests Lands and Natural Resource Operations (MFLNRO). Available: http://trencher.com/public/library/files/CORE_GRASSLAND_SOUTH.pdf.
- Harris, B.J.R. 2007. Rocky Mountain Trench Ecosystem Restoration Program Objective Matrix. BC MFLNRO Ecosystems – Rocky Mountain. Cranbrook, BC.
- Heyerdahl, E.K., P. Morgan and J.P. Riser II. 2008. Multi-Season Synchronized Historical Fires in Dry Forests (1650-1900), Northern Rockies, USA. *Ecology*, 89(3): 705-716.
- Jeffersonii Badger Recovery Team. 2008. *Recovery Strategy for the Badger (Taxidea taxus) in British Columbia*. Prepared for the B.C. Ministry of Environment: Victoria, BC. Available: http://www.env.gov.bc.ca/wld/documents/recovery/rcvrystrat/badger_jeffersonii_rcvry_strat18092008.pdf.
- Juckers, M. and M. Keefer. 2016. Invasive Plant Management on Tobacco Plains Indian Reserve. Keefer Ecological Services Ltd.: Cranbrook, BC.
- Juckers, M. and R. Moody. 2016. 2015-2016 Spalding's Campion Habitat Recovery: Tobacco Plains Indian Reserve. Keefer Ecological Services Ltd.: Cranbrook, BC.
- Keefer, M. 2009. Spalding's Campion Presence/Absence Study on Tobacco Plains Indian Reserve, Grasmere, BC. Keefer Ecological Services Ltd.: Cranbrook, BC.
- Keefer, M. and A. Kennedy. 2010. Spalding's Campion Inventory and Habitat Assessment Works 2010. Keefer Ecological Services Ltd.: Cranbrook, BC. Submitted to Environment Canada.
- Klinkenberg, B. (Editor). 2015. *E-Flora BC: Electronic Atlas of the Plants of British Columbia [eflora.bc.ca]*. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia: Vancouver, BC. Available: <http://ibis.geog.ubc.ca/biodiversity/eflora/>.
- Lym, R., C. Prosser, C. Duncan, D. Bangsund and G. Anderson. 2002. Herbicide Control of Leafy Spurge: A Comprehensive, Easy-to-Read Manual on Using Herbicide as an Effective Leafy Spurge Management Tool. USDA-ARS TEAM Leafy Spurge, Sidney, MT. Available at: <https://www.team.ars.usda.gov/herbicidemanual.pdf>.
- Ohanjanian, I.A. 2004. Long-Billed Curlew. In: Identified Wildlife Management Strategy. Accounts and Measures for Managing Identified Wildlife: Southern Interior Forest Region, Version 2004. BC Ministry of Water, Land and Air Protection (Ministry of Environment): Victoria, BC. pp. 268-275. Available: http://www.env.gov.bc.ca/wld/frpa/iwms/documents/Accounts_and_Measures_South.pdf.

Pachkowski, J. and J. Thorton. 2011. Integrated Pest Management (IPM): Leafy Spurge Prevention and Control. A Comprehensive Approach to Controlling Leafy Spurge for Landowners and Land Managers. Available at:

https://www.brandonu.ca/rdi/files/2011/03/IPM_Leafy_Spurge_Manual.pdf.

Schuette, J. 1998. Environmental Fate of Glyphosate. Environmental Monitoring & Pest Management Department of Pesticide Regulation, Sacramento, CA. Available at:

<http://www.cdpr.ca.gov/docs/emon/pubs/fatememo/glyphos.pdf>.

Seher, S. 2014. Spalding's campion Inventory and Habitat Recovery on Tobacco Plains Indian Reserve 2013. Keefer Ecological Services, Cranbrook, BC. Submitted to Environment Canada.

Wikeem, B. and V.A. Miller. 2006. Invasive Plants in British Columbia Protected Lands: A Strategic Plan. BC Ministry of Environment: Victoria, BC. Available: https://www.for.gov.bc.ca/hra/invasive-species/Publications/MoE_Invasive_plants_strategic_plan_Jan_2006.pdf.

Appendix A

Plant species identified within grassland areas throughout Tobacco Plains Indian Reserve.

		Plots																	
		A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	C4	C5	D1	D2	D3	E1	E2	E3
Invasive Species																			
Grasses																			
Bromus japonicus	Japanese brome					x					0.1		1	x	0.1				1
Bromus tectorum	cheatgrass					x		1	2		20		20	x	1			5	5
Poa compressa	Canada bluegrass	2	30		40	x	1	5	10		15		2	x	10	x	20	25	25
Poa pratensis	Kentucky bluegrass		1		1	x	1							x	2		10	2	5
Forbs																			
Hypericum perforatum	St. John's-wort					x	1	1	2	0.1	2	0.1	2	0.01	2	2	1	1	2
Potentilla recta	sulphur cinquefoil	25	25	20	40	0.1	40	1	40		5	5	1	1	15	20	15	5	5
Taraxacum officinale	common dandelion			0.1						0.1		0.1	0.1	0.01	0.01	0.1			
Tragopogon dubius	yellow salsify	1	1		0.1		0.1				1		0.1	x			0.1	1	0.1
Verbascum blattaria	moth mullein										0.1		1	x					0.01
Trees																			
Pinus ponderosa	ponderosa pine seedlings		1															0.01	0.01
	ponderosa pine saplings		0.01												0.01			0.1	0.01
Shrubs																			
Rosa sp.	rose									10	0.1								
Symphoricarpos albus	common snowberry		2	0.1						5			1				0.1	0.1	
Grasses																			
Achnatherum richardsonii	spreading needlegrass		5																

Grasses		A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	C4	C5	D1	D2	D3	E1	E2	E3
Calamagrostis sp.	reedgrass	0.01																	
Festuca campestris	rough fescue		0.1																
Festuca idahoensis	Idaho fescue										1		2						
Hesperostipa comata	needle-and-thread grass	35	1		0.01	x	15	15	5		15		15	x	15	x	1		
Koeleria macrantha	junegrass	10	1		0.01	x	5	5					1		1		2	2	
Forbs		A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	C4	C5	D1	D2	D3	E1	E2	E3
Achillea millefolium	yarrow	1	10	1	1			0.1		5	1	0.1	0.1	0.01	1	0.1	0.1	1	5
Agoseris glauca	short-beaked agoseris		0.01		0.01														
Anemone multifida	cut-leaved anemone								1		0.01								
Antennaria microphylla	white pussytoes	2	5		1	x		1	15		0.1		5	x		1	5	0.1	
Antennaria neglecta	field pussytoes		1																
Antennaria sp.	pussytoes	5	2			1	0.1	0.1	1	2	1	1	0.1	1	5	1	1	0.1	0.1
Arabis holboellii	Holboell's rockcress							0.01		0.01									
Arabis sp.	rockcress					x	0.01												
Aristida purpurea	red three-awn	0.01	5		0.01	x			1					x	1		2	2	
Arnica fulgens	orange arnica	2	0.1							1		2	1	1				1	
Astragalus miser	timber milk-vetch	1		7	1					2	0.1	2							
Astragalus sp.	milk-vetch					0.01												0.1	0.1
Calochortus macrocarpus	sagebrush mariposa lily	0.01		0.01	0.1		0.01	0.01			0.01				0.01		0.01		0.01
Castilleja sp.	paintbrush															0.01			0.01
Cerastium arvense	field chickweed																	0.1	1
Cirsium undulatum	wavy-leaved thistle								0.01										
Delphinium nuttallianum	upland larkspur		0.01	0.1		0.1	0.1	0.1	0.01		0.1		0.1						
Dodecatheon pulchellum	few-flowered shootingstar	4					0.1												
Drymocallis glandulosa	sticky cinquefoil		0.1	0.1	0.1												1		0.01
Erigeron pumilus	shaggy fleabane	0.1	0.1			1	0.01	1	1	1	0.1	1	1	0.01			0.01		0.1
Erigeron sp.	fleabane												0.1			0.01		1	
Erigeron speciosus	showy daisy																0.1		1
Eriogonum niveum	snow buckwheat	0.01														0.01			
Eriogonum ovalifolium	cushion buckwheat															0.01			0.01

Forbs		A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	C4	C5	D1	D2	D3	E1	E2	E3
Eriogonum umbellatum	sulphur buckwheat	1																	
Fragaria virginiana	wild strawberry								0.1										
Gaillardia aristata	brown-eyed Susan	1	5	1	0.1	x	1	0.1	0.01	1	1	1		1	0.1	0.1	1	1	
Galium boreale	northern bedstraw				5									1					
Geum triflorum	old man's whiskers		0.1	1	1			0.1											
Grindelia squarrosa	curly-cup gumweed								1								0.01		0.01
Heterotheca villosa	golden-aster	5				x		1			0.01			x	2	1	1		25
Lewisia rediviva	bitterroot					0.1	0.01	0.01			0.01				0.1	1			
Lithophragma parviflorum	small-flowered fringecup		0.1	0.1							0.1	0.1	0.1	0.01	0.1		0.01	0.1	0.1
Lithospermum ruderales	lemonweed																	1	0.1
Lomatium macrocarpum	large-fruited desert-parsley	1		0.1		0.1					0.1				1	0.01			
Lomatium triternatum	nine-leaved desert-parsley						0.01			0.01					0.01	0.01			0.01
Monarda fistulosa	wild bergamot		15								0.1			x	10		1	10	1
Oxytropis campestris	field locoweed								0.01										
Penstemon confertus	yellow penstemon		0.01							0.01	0.1					0.01	1		
Phlox diffusa	spreading phlox	5		0.1		0.01		30				1			1	0.1			
Plantago patagonica	woolly plantain		1		0.1	x	0.01	1			1				1	1			
Potentilla pensylvanica	Pennsylvanian cinquefoil		0.1								0.1								
Triteleia grandiflora	large-flowered triteleia	2		0.1		0.1	1	0.1	0.1		1	1	1	0.1	0.01	0.01	0.1	0.1	0.1
Viola orbiculata	round-leaved violet															0.01			
Viola sp.	violet				0.01														
Zigadenus venenosus	meadow death-camas	0.01				0.1	0.01			0.1	0.1	0.1	0.1			0.01	0.01	0.01	
Moss		A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	C4	C5	D1	D2	D3	E1	E2	E3
Selaginella densa	compact selaginella	10																	

x indicates the plant was found within the plot; however, a percent cover was not provided

Appendix B

ECOSYSTEM RESTORATION PRESCRIPTION

Rocky Mountain Forest District

Single **multi-area**

AREA IDENTIFIER: CATCHFLY-14-XX	<input checked="" type="checkbox"/> ORIGINAL <input type="checkbox"/> AMENDMENT	DATE Y / M / D
UTM 11N XE XN		
Location:		

GENERAL DESCRIPTION OF AREA

SU	TU	Treatment Regime	Gross Area (ha)	Reserve/No Treat Area (ha)	NP Area (ha)	Net TREATMENT AREA (ha)
OR	A,B..	Open Range				
Reserve	RES	Reserve from Treatment				
Totals						

FIELD WORK BY:	TOTAL TREATMENT AREA	DATE COMPLETED:
	TBD ON-SITE BEFORE TREATMENT IN YEAR ONE	

HIGHER-LEVEL PLANS

ARE THESE TREATMENT AREAS WITHIN LOCAL RESOURCE USE, TOTAL RESOURCE, INTEGRATED WATERSHED MANAGEMENT, OR OTHER SPECIFIC PLANNING AREAS? NO

ARE ANY OF THESE TREATMENT AREAS WITHIN A COMMUNITY WATERSHED? YES NO

SU number:

IF YES:	PLAN NAME
	No higher level plans applicable for reserve lands.
IF NO:	CONSULT WITH OTHER RESOURCE AGENCIES TO ASSIST IN DEVELOPING MANAGEMENT OBJECTIVES FOR THE PRESCRIPTION.

STAND-LEVEL OBJECTIVES

ARE CURRENT STAND-LEVEL OBJECTIVES AVAILABLE FROM SILVICULTURE PRESCRIPTIONS? Yes No

IF 'YES,' ARE CURRENT STAND-LEVEL OBJECTIVES STILL APPROPRIATE FOR THESE STANDS? NA

Summary of objectives from higher-level plans or for developing or clarifying stand-level objectives

TIMBER		MANAGEMENT OBJECTIVES
SU All	<ol style="list-style-type: none"> 1. Open Range stands are to maintain 0-75 stems/ha on site with a target of 20 stems/ha while maintaining largest trees on site emphasizing trees greater than 30cm DBH. 	
<p><i>Details on access, availability of merchantable timber.</i></p>		
UNDERSTORY (Grasses, Forbs, Shrubs)		MANAGEMENT OBJECTIVES
SU All	<ol style="list-style-type: none"> 1. Increase the native grass and forb plant cover by 25% within ten years of initial treatment. Initially, until better inventory data is available, the rough fescue/ Idaho fescue/ blue bunch wheatgrass is to be used as the default community to be increased. 2. Increase forage biomass production by 5% within 5 years of initial treatment. 3. Increase the forage biomass of valuable decreaser (e.g. Saskatoon berry, rose spp., ceanothus, chokecherry) shrubs by 25% cover in treated areas within 5 years. 	
<p><i>Details on potential for increase of native grasses, forbs, shrubs. Highlight any risk of increase in young regen.</i></p>		

RIPARIAN (Streams, Wetlands, Lakes, Fisheries)		MANAGEMENT OBJECTIVES
SU All	n/a	
<p>No treatments are prescribed for sites including or adjacent to riparian areas on TPIR in year one.</p>		
COMMUNITY WATERSHED		MANAGEMENT OBJECTIVES
SU All	n/a	
<p>Water license records show no consumptive use water licenses, water diversions or Community watersheds on this LBU.</p>		
STAND LEVEL BIODIVERSITY (Patch Size, Old Growth & Wildlife Trees, CWD)		MANAGEMENT OBJECTIVES
SU All	<ol style="list-style-type: none"> 1. Treatment will maintain and recruit 2 to 10 wildlife trees (over 30cm DBH, 40cm preferred) per hectare throughout treatment cycle on the treated area. Tree species in descending order of preference are Ponderosa pine, western larch, Douglas fir, trembling aspen and black cottonwood (the latter if available). 2. Maintain and recruit 3 cubic metres of CWD (over 30cm DBH and all rot stages not just sawlog grade) per hectare throughout treatment cycle on the treated area. Number and distribution shall, at least, meet minimums set by FPPR namely as minimum of 4 logs per hectare, greater than 5 metres long and 7.5cm diameter at small end. 	

Retention potential and targets (if any for Open Range). Details on existing CWD cover and amount to leave. Discussion of old growth retention.

WILDLIFE SPECIES AT RISK		MANAGEMENT OBJECTIVES
SU All	Maintain or increase the species richness and population density of endemic wildlife species in treated areas; with special emphasis in species listed as being red or blue listed by the Conservation Data Centre (CDC).	
RARE PLANT SPECIES OR PLANT COMMUNITIES		MANAGEMENT OBJECTIVES
SU All	Maintain or increase the species richness and population density of endemic plant species and plant communities in treated areas; with special emphasis in species listed as being red or blue listed by the Conservation Data Centre (CDC).	
UNGULATE CONCERNS		MANAGEMENT OBJECTIVES
SU All	Enhance richness of grassland forage species and increase hectarage of Open Range	
FOREST HEALTH		MANAGEMENT OBJECTIVES
SU All	n/a	
INVASIVE PLANTS		MANAGEMENT OBJECTIVES
SU All	<ol style="list-style-type: none"> 1. Invasive plant infestations of priority species should not increase from observations recorded and publicly available through the Invasive and Alien Plant Program (IAPP), managed by the BC MoFLNRO. New occurrences will be recorded in the IAPP database. 2. Prescription will address priority invasive plant infestations. 	
<i>Discussion of invasive species observations, current and recommended treatment efforts. Description of introduced species populations.</i>		
RECREATION		MANAGEMENT OBJECTIVES
SU All	n/a	
No official recreation sites or trails in this TU.		

ACCESS	MANAGEMENT OBJECTIVES
SU All	Access control is to be considered in each prescription and appropriate action prescribed and implemented.
<i>Description of access road.</i>	
ARCHAEOLOGICAL	Archaeological Assessment Required? No Completed? No
SU All	<p>1. All ER Prescriptions that overlay medium to high potential archaeological polygons will be considered for examination by an archaeologist acceptable to First Nations and recommendations for treatments (e.g. avoidance, treat only under sufficient snow pack) will be discussed with the archaeologist and incorporated into the ER Prescription.</p> <p>2. Notwithstanding the above an archaeological assessment shall be completed for any ER operation that requires the exposure of earth (i.e. the construction of new road, landing, fireguard or reopening an existing road) within a medium to high archaeological polygon prior to work commencing. Operations shall respect the recommendations of the assessment.</p>
CULTURAL AND HERITAGE CONCERNS	MANAGEMENT OBJECTIVES
SU All	<p>ER prescribers shall note, in the ER prescription the occurrence of plant species noted by experts as being culturally important food plants, including:</p> <ul style="list-style-type: none"> • Saskatoon • soopolallie • black gooseberry • choke cherry • nodding onion • arrowleaf balsamroot • sagebrush mariposa lily • wild strawberry • wild bergamot • bitterroot
<p>It should be noted that the timing of pre-treatment survey did not necessarily correspond with the emergence and active growth phases for all species listed above. Survey observations may not have captured all cultural target species occurring in the treatment units.</p>	
<i>Discussion of cultural species observations and potential for increase.</i>	

RANGE		CATTLE USE? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	IF 'YES,' RANGE UNIT: n/a	PASTURE: n/a
RANGE IMPROVEMENTS CATTLE PRIMARY ACCESS TRAILS? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		IF 'YES,' LOCATE ON ATTACHED MAP	SEEDED? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
SU All	MANAGEMENT OBJECTIVES			
	ER treatment shall not open up closed forests that would change the distribution of cattle and shall ensure that any fence damaged by ER practices is repaired to acceptable standards.			
PRESCRIBED BURN		MANAGEMENT OBJECTIVES		
SU All	n/a			

FUEL MANAGEMENT		MANAGEMENT OBJECTIVES		
SU All	Prescribers shall estimate fuel loading by TU and propose hazard abatement strategy for the fuel.			
	<i>Estimation of stems removed by class. Description of fuel management techniques.</i>			
SMOKE MANAGEMENT		MANAGEMENT OBJECTIVES		
SU All	Prescriber shall outline smoke control issue for information of burn plan and operations on site.			
OTHER RESOURCE VALUES/INTERESTS (Public Utilities, research plots etc.)		MANAGEMENT OBJECTIVES		
SU All	Conduct operations next to transmission and TELUS telephone lines as per attached "STANDARD OPERATING PROCEDURE FOR ECOSYSTEM RESTORATION PROJECTS CONDUCTED NEAR PUBLIC UTILITIES"			

SPECIAL AREAS

SPECIAL AREAS WITHIN STANDARDS UNIT? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		TYPE OF SPECIAL AREA; (e.g., Riparian Reserve Zone, Riparian Mgmt Zone, Lakeshore Mgmt Zone, FENs, research installations, other)	
AREA NO.	SIZE	<i>Description of special area and significant features</i>	
DESCRIBE HOW MANAGEMENT ACTIVITIES DIFFER FROM THE REST OF THE STANDARDS UNIT			
COMMENTS		INITIALS	
		PREPARED BY	SENIOR REVIEWER
			BAND MANAGER

FS68 HFP 98/6

PRESCRIPTION APPROVAL

PREPARATION

PREPARED BY (SIGNATURE)			
PRINTED NAME		DATE SUBMITTED	Y / M / D
PRESCRIPTION REVIEW		FINAL APPROVAL	
Senior Reviewer:		Band Manager:	
* SIGNATURE		* SIGNATURE	
PRINTED NAME	DATE SIGNED	DATE APPROVED	Y / M / D

FS68 HFP 98/6

- May be mandatory if activity part of license agreement



Tobacco Plains Ecological Restoration

Lewis's Woodpecker (*Melanerpes lewis*) Nesting Survey on Tobacco Plains
Indian Reserve

UKE-F17-W-1395

Prepared For: Fish and Wildlife Compensation Program

Prepared By: Myra Juckers, BSc, PAg

March 31, 2017



**Keefer**
Ecological Services Ltd
3816 Highland Rd.
Cranbrook BC V1C 6X7
(250) 489-4140
www.keefereco.com

**TOBACCO** **PLAINS**
INDIAN BAND
3603 93 Hwy 93
Grasmere, BC V0B 1R0
(250) 887-3461

Acknowledgements

Kefer Ecological Services Ltd. (KES) and Tobacco Plains Indian Band (TPIB) would like to thank the Fish and Wildlife Compensation Program for their financial support of the Lewis's woodpecker (*Melanerpes lewis*) nesting survey. As well, KES and TPIB would like to thank Dean Nicholson for leading the nesting survey.

Table of Contents

Acknowledgements.....	i
Background	1
Objective	1
Study Area.....	1
Methods.....	1
Results.....	3
Discussion.....	3
Recommendations	5
References	6

Background

Lewis's woodpecker (*Melanerpes lewis*) was assessed as Threatened under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2010 and was listed as Threatened under Schedule 1 of the *Species At Risk Act* (SARA) in 2012. Lewis's woodpecker is only found in western North America, breeding from southern British Columbia through the western United States to California and southern Mexico and east to western Oklahoma and Nebraska (Tobalske, 1997). The distribution of Lewis's woodpecker appears to be associated with ponderosa pine (*Pinus ponderosa*; Tobalske, 1997). Within British Columbia (BC), Lewis's woodpecker breeds in six geographic areas: Okanagan-Similkameen, Thompson-Nicola, Boundary, East Kootenay, West Kootenay, and Cariboo-Chilcotin (Environment Canada, 2016). The East Kootenay Rocky Mountain Trench is home to the second largest population of breeding individuals (Environment Canada, 2016), with birds found south of Invermere to Newgate and Tobacco Plains Indian Reserve (Gebauer, 2004).

Objective

As mentioned, Lewis's woodpecker's range in the East Kootenay Rocky Mountain Trench extends to Tobacco Plains Indian Reserve (TPIR). A nesting survey was conducted on TPIR in summer 2016 to document the presence/absence of nesting Lewis's woodpeckers on the reserve.

Study Area

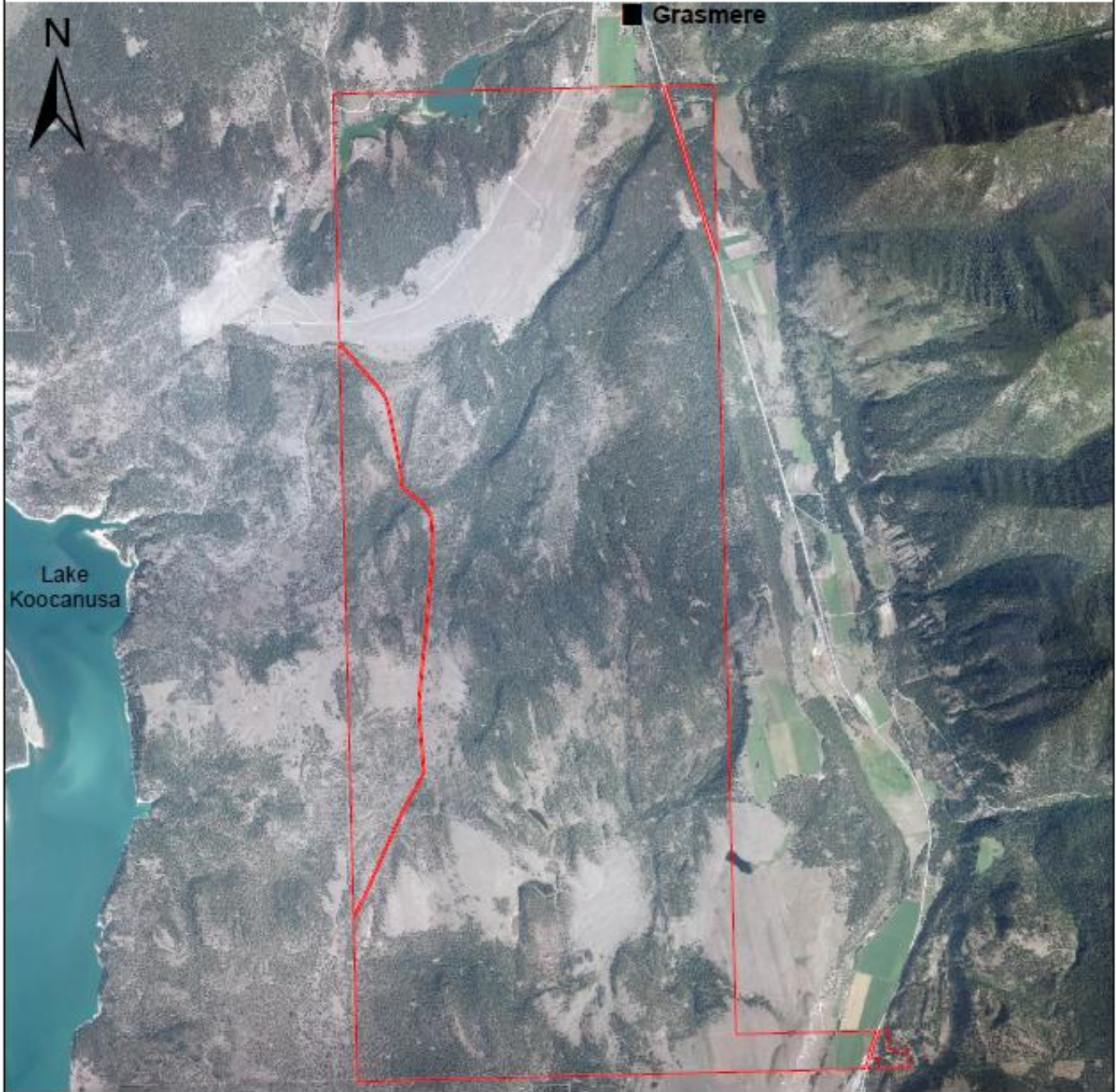
The survey was conducted throughout TPIR (see map). The reserve is located within the southern Rocky Mountain Trench and contains large areas of ponderosa pine dominated forest which has undergone forest ingrowth as a result of long-term fire suppression.

Methods


The nesting survey was conducted by Dean Nicholson, a local field naturalist. Two individual surveys were conducted, one in mid-June and the other in mid-July, to coincide with peak times the birds would be expected to be preparing a nest and/or feeding young. Following survey methods used in other Lewis's woodpecker studies (e.g. Jakkett et al., 2007), the survey involved driving throughout the reserve looking for suitable nesting trees and then spending approximately 5 to 10 minutes observing for Lewis's woodpeckers. Suitable trees were dead or near-dead large Ponderosa pine (*Pinus ponderosa*) and/or Douglas fir (*Pseudotsuga menziesii*). Trees were observed for signs of nesting activity (nesting holes) and the presence of woodpeckers coming to or leaving nesting holes, or in the general area of suitable trees.

Tobacco Plains Indian Band Reserve Area

Grasmere, British Columbia



Legend

 Reserve Outline

0 0.5 1 2 3 4 Kilometers



Coordinate System: NAD 1983 UTM Zone 11N
Projection: Transverse Mercator
Datum: North American 1983

Results

During the June survey, no Lewis's woodpeckers were observed. A significant observation was the relative lack of large dead or dying ponderosa pine trees, the preferred nesting tree for Lewis's woodpeckers in this area. A small stand of mature black cottonwood on the south-eastern edge of the reserve also did not show any woodpeckers.

In July, one Lewis's woodpecker was observed in a dead ponderosa pine approximately 25 m outside the reserve boundary at the northern reach of the reserve (see map). The bird was observed for 10 minutes during which it flew to a second tree about 30 m away. Potential nest holes were noted in the first tree; however, the woodpecker did not make any movements towards the holes.

It should be noted that in May, during a long-billed curlew habitat assessment, a Lewis's woodpecker was observed approximately 1.3 km east and 670 m north of the reserve boundary at the southern reach of the reserve (see map).

Discussion

Although Lewis's woodpecker was spotted near the reserve, nesting birds were not identified. These results coincide with a comprehensive Lewis's woodpecker study conducted by Harrison (2014) in summer 2013. The study completed baseline surveys for Lewis's woodpecker on Tobacco Plains, St. Mary's and Akisq'nuk Indian Reserves as well as baseline assessments of Lewis's woodpecker habitat conditions throughout the reserves. The study surveyed 43 locations and found no nesting Lewis's woodpeckers on any of the reserves.

In BC, the breeding habitat of Lewis's woodpecker includes (Environment Canada, 2014; Cooper and Beauchesne, 2000):

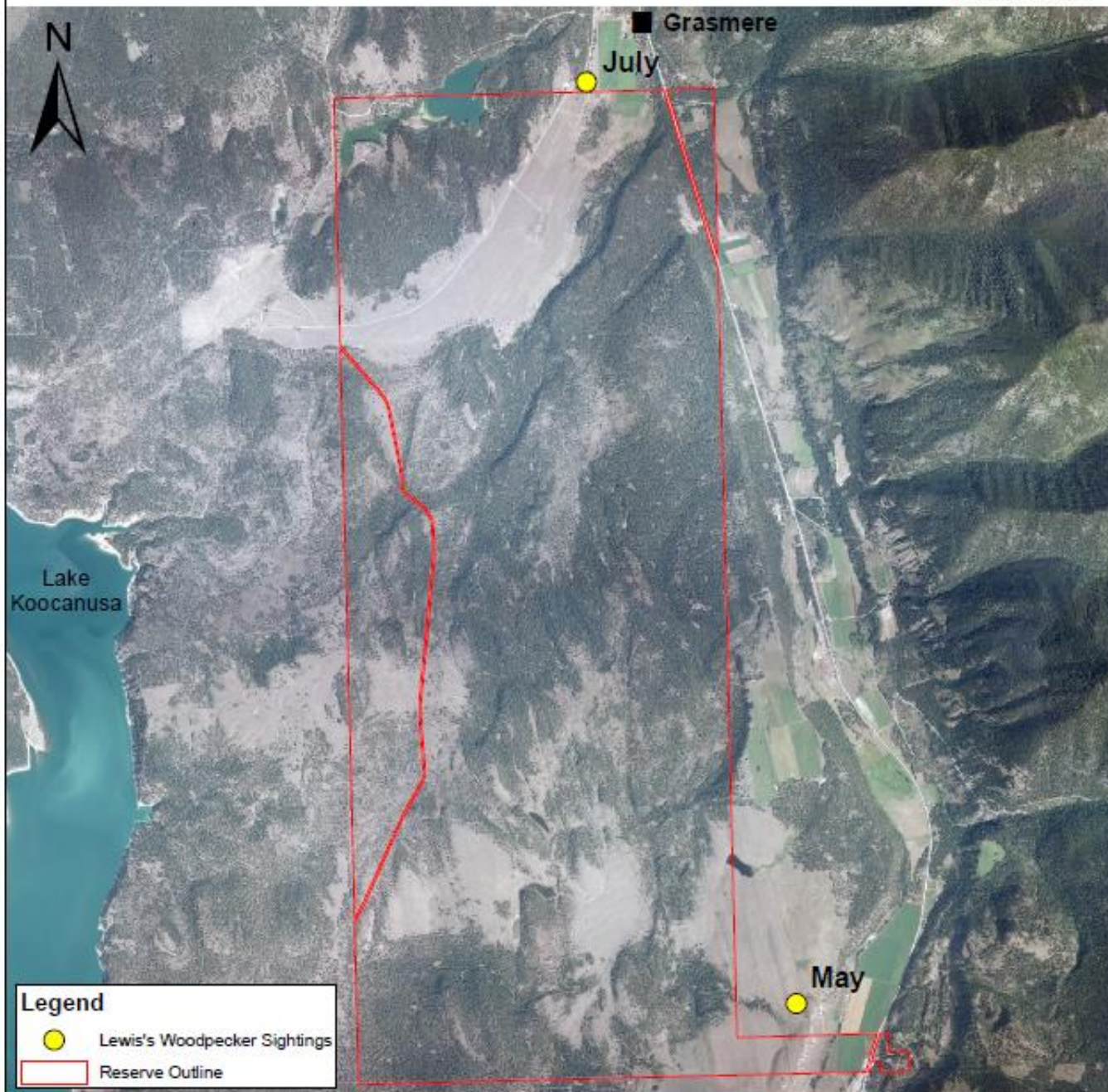
- Dry, open ponderosa pine or Douglas-fir forests and open grasslands with fire-maintained features, low stem densities, veteran ponderosa pines or Douglas-firs, abundant wildlife trees, and rich herb and shrub layers;
- Mature to old riparian cottonwood stands adjacent to grassland, agricultural field, shrub-steppe, or open woodland habitats; or
- Recently burned (<30 years) ponderosa pine and Douglas-fir dominated forests with standing snags caused by stand-destroying fires.

Generally, good breeding habitat is defined by an open canopy that has less than 25% crown closure, availability of suitable dead or dying trees greater than 30 cm diameter at breast height (dbh) for nesting, and understory vegetation with high availability of insects (Gebauer, 2004). In situations in which nesting occurs in closed canopy, riparian stands, trees along the edge of the stand are selected (Gebauer, 2004).

Lewis's Woodpecker (*Melanerpes lewis*) Sightings

Tobacco Plains Indian Band Reserve Area

Grasmere, British Columbia



Legend

- Lewis's Woodpecker Sightings
- Reserve Outline



Coordinate System: NAD 1983 UTM Zone 11N
Projection: Transverse Mercator
Datum: North American 1983



Suitable nesting habitat was not observed on TPIR. Tobacco Plains Indian Reserve spans 5,261 ha of historically fire-regulated grassland and open forested ecosystems. However, fire suppression since the 20th century has resulted in heavy encroachment and ingrowth of ponderosa pine and Douglas fir. Habitat is lost as grasslands are no longer fire maintained and fires that do occur in open forests burn too hot, destroying nesting habitat (Environment Canada, 2014). Specifically in the East Kootenay, the percentage of the Lewis's woodpecker population that occupies burns in comparison to other habitat types is disproportionately high in relation to other regions (Environment Canada, 2014). As such, fire plays a major role in creating and maintaining suitable nesting habitat for Lewis's woodpecker.

Recommendations

Since 2014, forest thinning has been conducted on the reserve to manage forest encroachment and ingrowth on critical grassland and open forest habitat for a variety of species, including Lewis's woodpecker. To date, approximately 31 ha of land has been thinned (Juckers, 2017). Continued forest thinning is important to increase available habitat for Lewis's woodpecker in the region. Based on the survey, Lewis's woodpecker is present in the area as two woodpeckers were observed just outside the reserve boundary; however, the birds are not nesting within the reserve. Continued monitoring every 2-3 years is recommended to evaluate the response of Lewis's woodpecker to forest thinning efforts.

References

- Cooper, J.M. and S. Beauchesne. 2000. Inventory of Lewis's Woodpecker Breeding Population and Habitat in the East Kootenay. BC Ministry of Environment (formerly Ministry of Environment, Lands and Parks), Victoria, BC. Available at:
<http://www.env.gov.bc.ca/wld/documents/techpub/wr100.pdf>.
- Environment Canada. 2016. Recovery Strategy for the Lewis's Woodpecker (*Melanerpes lewis*) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa, ON. Available at: https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/rs_lewis's_woodpecker_e_proposed.pdf.
- Gebauer, M. 2004. Lewis's Woodpecker. In: BC Ministry of Environment (formerly Ministry of Water, Land and Air Protection) (Ed.), Accounts and Measures for Managing Identified Wildlife: Southern Interior Forest Region, Version 2004, Victoria, BC. Available at:
http://www.env.gov.bc.ca/wld/frpa/iwms/documents/Accounts_and_Measures_South.pdf.
- Harrison, M. 2014. Lewis's Woodpecker Nesting Surveys in Ktunaxa First Nation Reserves of the East Kootenay Region. Available at:
http://www.env.gov.bc.ca/wildlife/wsi/reports/5200_WSI_5200_RPT_2013.PDF.
- Jackett, N., M. Traicheff, K. Vaino, and V. Young. 2007. Lewis's Woodpecker (*Melanerpes lewis*) Inventory, Okanagan Region, 2007. Prepared for BC Ministry of Environment, Penticton, BC. Available at: http://www.env.gov.bc.ca/wildlife/wsi/reports/4298_WSI_4298_RPT.PDF.
- Juckers, M. 2017. Critical Grassland and Open Forest Restoration on Tobacco Plains Indian Reserve. Keefer Ecological Services Ltd., Cranbrook, BC.
- Tobalske, B.W. 1997. Lewis's Woodpecker (*Melanerpes lewis*). In A. Poole and F. Gill (Eds), The birds of North America, No. 284. Acad. Nat. Sci., Philadelphia, Penn., and Am. Ornith. Union, Washington, DC.

Tobacco Plains Ecological Restoration

Lewis's Woodpecker (*Melanerpes lewis*) Nesting Survey on Tobacco Plains
Indian Reserve

UKE-F17-W-1395

Prepared For: Fish and Wildlife Compensation Program

Prepared By: Myra Juckers, BSc, PAg

March 31, 2017



 **Keefer**
Ecological Services Ltd
3816 Highland Rd.
Cranbrook BC V1C 6X7
(250) 489-4140
www.keefereco.com


3603 93 Hwy 93
Grasmere, BC V0B 1R0
(250) 887-3461

Acknowledgements

Kefer Ecological Services Ltd. (KES) and Tobacco Plains Indian Band (TPIB) would like to thank the Fish and Wildlife Compensation Program for their financial support of the Lewis's woodpecker (*Melanerpes lewis*) nesting survey. As well, KES and TPIB would like to thank Dean Nicholson for leading the nesting survey.

Table of Contents

Acknowledgements.....	i
Background	1
Objective	1
Study Area.....	1
Methods.....	1
Results.....	3
Discussion.....	3
Recommendations	5
References	6

Background

Lewis's woodpecker (*Melanerpes lewis*) was assessed as Threatened under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2010 and was listed as Threatened under Schedule 1 of the *Species At Risk Act* (SARA) in 2012. Lewis's woodpecker is only found in western North America, breeding from southern British Columbia through the western United States to California and southern Mexico and east to western Oklahoma and Nebraska (Tobalske, 1997). The distribution of Lewis's woodpecker appears to be associated with ponderosa pine (*Pinus ponderosa*; Tobalske, 1997). Within British Columbia (BC), Lewis's woodpecker breeds in six geographic areas: Okanagan-Similkameen, Thompson-Nicola, Boundary, East Kootenay, West Kootenay, and Cariboo-Chilcotin (Environment Canada, 2016). The East Kootenay Rocky Mountain Trench is home to the second largest population of breeding individuals (Environment Canada, 2016), with birds found south of Invermere to Newgate and Tobacco Plains Indian Reserve (Gebauer, 2004).

Objective

As mentioned, Lewis's woodpecker's range in the East Kootenay Rocky Mountain Trench extends to Tobacco Plains Indian Reserve (TPIR). A nesting survey was conducted on TPIR in summer 2016 to document the presence/absence of nesting Lewis's woodpeckers on the reserve.

Study Area

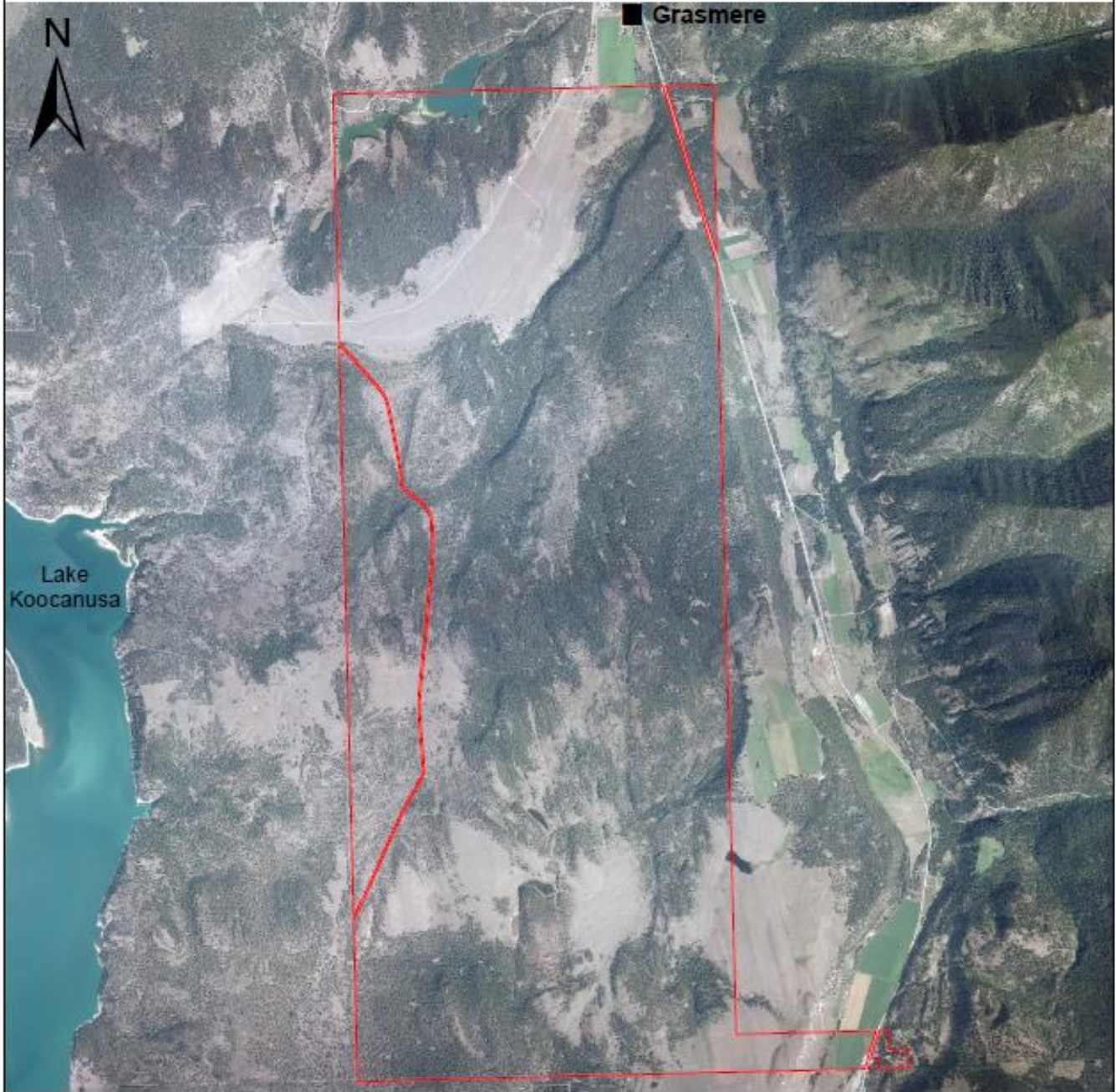
The survey was conducted throughout TPIR (see map). The reserve is located within the southern Rocky Mountain Trench and contains large areas of ponderosa pine dominated forest which has undergone forest ingrowth as a result of long-term fire suppression.

Methods

The nesting survey was conducted by Dean Nicholson, a local field naturalist. Two individual surveys were conducted, one in mid-June and the other in mid-July, to coincide with peak times the birds would be expected to be preparing a nest and/or feeding young. Following survey methods used in other Lewis's woodpecker studies (e.g. Jakkett et al., 2007), the survey involved driving throughout the reserve looking for suitable nesting trees and then spending approximately 5 to 10 minutes observing for Lewis's woodpeckers. Suitable trees were dead or near-dead large Ponderosa pine (*Pinus ponderosa*) and/or Douglas fir (*Pseudotsuga menziesii*). Trees were observed for signs of nesting activity (nesting holes) and the presence of woodpeckers coming to or leaving nesting holes, or in the general area of suitable trees.

Tobacco Plains Indian Band Reserve Area

Grasmere, British Columbia



Legend

 Reserve Outline

0 0.5 1 2 3 4 Kilometers



Coordinate System: NAD 1983 UTM Zone 11N
Projection: Transverse Mercator
Datum: North American 1983

Results

During the June survey, no Lewis's woodpeckers were observed. A significant observation was the relative lack of large dead or dying ponderosa pine trees, the preferred nesting tree for Lewis's woodpeckers in this area. A small stand of mature black cottonwood on the south-eastern edge of the reserve also did not show any woodpeckers.

In July, one Lewis's woodpecker was observed in a dead ponderosa pine approximately 25 m outside the reserve boundary at the northern reach of the reserve (see map). The bird was observed for 10 minutes during which it flew to a second tree about 30 m away. Potential nest holes were noted in the first tree; however, the woodpecker did not make any movements towards the holes.

It should be noted that in May, during a long-billed curlew habitat assessment, a Lewis's woodpecker was observed approximately 1.3 km east and 670 m north of the reserve boundary at the southern reach of the reserve (see map).

Discussion

Although Lewis's woodpecker was spotted near the reserve, nesting birds were not identified. These results coincide with a comprehensive Lewis's woodpecker study conducted by Harrison (2014) in summer 2013. The study completed baseline surveys for Lewis's woodpecker on Tobacco Plains, St. Mary's and Akisq'nuk Indian Reserves as well as baseline assessments of Lewis's woodpecker habitat conditions throughout the reserves. The study surveyed 43 locations and found no nesting Lewis's woodpeckers on any of the reserves.

In BC, the breeding habitat of Lewis's woodpecker includes (Environment Canada, 2014; Cooper and Beauchesne, 2000):

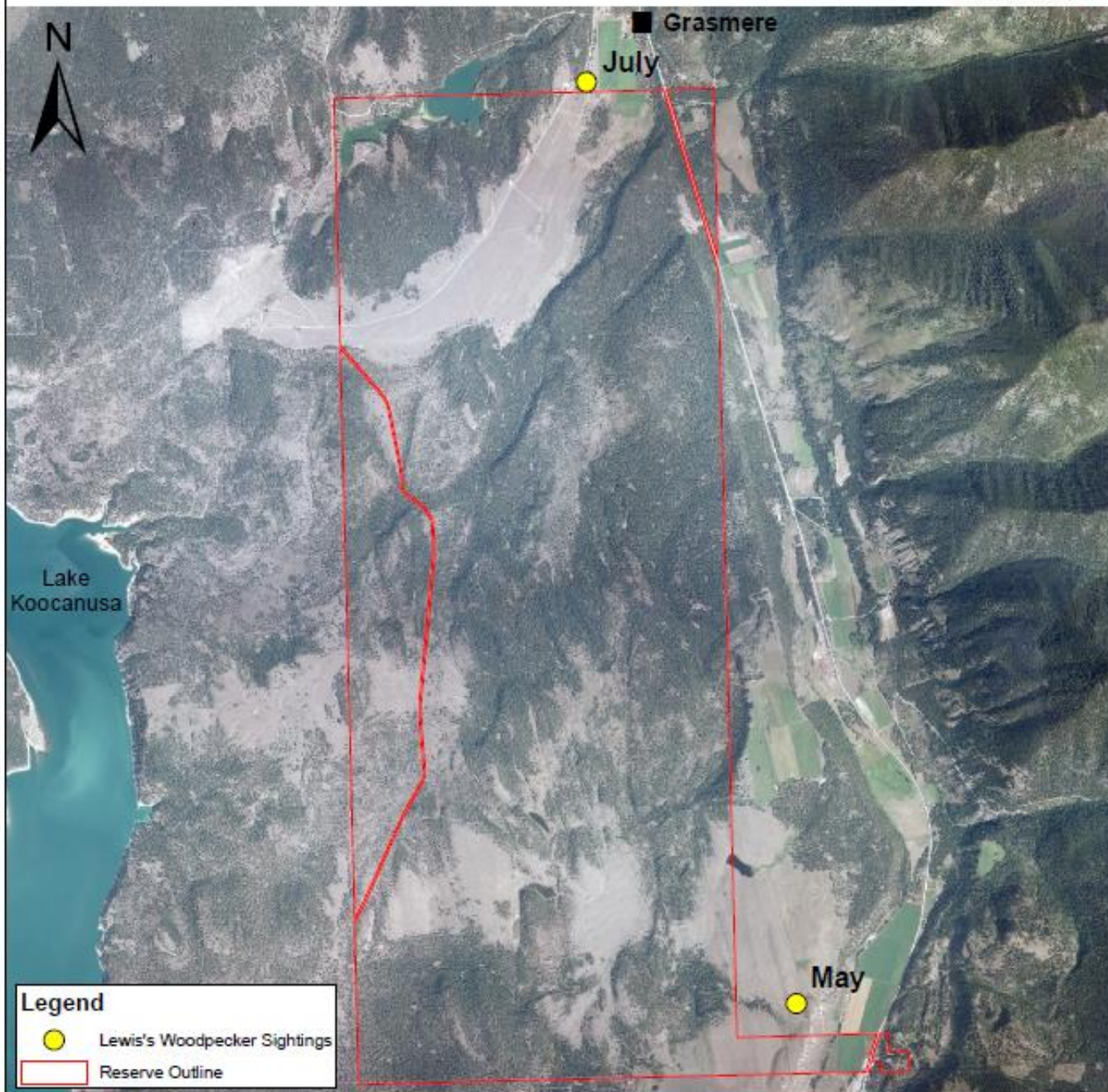
- Dry, open ponderosa pine or Douglas-fir forests and open grasslands with fire-maintained features, low stem densities, veteran ponderosa pines or Douglas-firs, abundant wildlife trees, and rich herb and shrub layers;
- Mature to old riparian cottonwood stands adjacent to grassland, agricultural field, shrub-steppe, or open woodland habitats; or
- Recently burned (<30 years) ponderosa pine and Douglas-fir dominated forests with standing snags caused by stand-destroying fires.

Generally, good breeding habitat is defined by an open canopy that has less than 25% crown closure, availability of suitable dead or dying trees greater than 30 cm diameter at breast height (dbh) for nesting, and understory vegetation with high availability of insects (Gebauer, 2004). In situations in which nesting occurs in closed canopy, riparian stands, trees along the edge of the stand are selected (Gebauer, 2004).

Lewis's Woodpecker (*Melanerpes lewis*) Sightings

Tobacco Plains Indian Band Reserve Area

Grasmere, British Columbia



Legend

- Lewis's Woodpecker Sightings
- Reserve Outline



Coordinate System: NAD 1983 UTM Zone 11N
Projection: Transverse Mercator
Datum: North American 1983



Suitable nesting habitat was not observed on TPIR. Tobacco Plains Indian Reserve spans 5,261 ha of historically fire-regulated grassland and open forested ecosystems. However, fire suppression since the 20th century has resulted in heavy encroachment and ingrowth of ponderosa pine and Douglas fir. Habitat is lost as grasslands are no longer fire maintained and fires that do occur in open forests burn too hot, destroying nesting habitat (Environment Canada, 2014). Specifically in the East Kootenay, the percentage of the Lewis's woodpecker population that occupies burns in comparison to other habitat types is disproportionately high in relation to other regions (Environment Canada, 2014). As such, fire plays a major role in creating and maintaining suitable nesting habitat for Lewis's woodpecker.

Recommendations

Since 2014, forest thinning has been conducted on the reserve to manage forest encroachment and ingrowth on critical grassland and open forest habitat for a variety of species, including Lewis's woodpecker. To date, approximately 31 ha of land has been thinned (Juckers, 2017). Continued forest thinning is important to increase available habitat for Lewis's woodpecker in the region. Based on the survey, Lewis's woodpecker is present in the area as two woodpeckers were observed just outside the reserve boundary; however, the birds are not nesting within the reserve. Continued monitoring every 2-3 years is recommended to evaluate the response of Lewis's woodpecker to forest thinning efforts.

References

- Cooper, J.M. and S. Beauchesne. 2000. Inventory of Lewis's Woodpecker Breeding Population and Habitat in the East Kootenay. BC Ministry of Environment (formerly Ministry of Environment, Lands and Parks), Victoria, BC. Available at:
<http://www.env.gov.bc.ca/wld/documents/techpub/wr100.pdf>.
- Environment Canada. 2016. Recovery Strategy for the Lewis's Woodpecker (*Melanerpes lewis*) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa, ON. Available at: https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/rs_lewis's_woodpecker_e_proposed.pdf.
- Gebauer, M. 2004. Lewis's Woodpecker. In: BC Ministry of Environment (formerly Ministry of Water, Land and Air Protection) (Ed.), Accounts and Measures for Managing Identified Wildlife: Southern Interior Forest Region, Version 2004, Victoria, BC. Available at:
http://www.env.gov.bc.ca/wld/frpa/iwms/documents/Accounts_and_Measures_South.pdf.
- Harrison, M. 2014. Lewis's Woodpecker Nesting Surveys in Ktunaxa First Nation Reserves of the East Kootenay Region. Available at:
http://www.env.gov.bc.ca/wildlife/wsi/reports/5200_WSI_5200_RPT_2013.PDF.
- Jackett, N., M. Traicheff, K. Vaino, and V. Young. 2007. Lewis's Woodpecker (*Melanerpes lewis*) Inventory, Okanagan Region, 2007. Prepared for BC Ministry of Environment, Penticton, BC. Available at: http://www.env.gov.bc.ca/wildlife/wsi/reports/4298_WSI_4298_RPT.PDF.
- Juckers, M. 2017. Critical Grassland and Open Forest Restoration on Tobacco Plains Indian Reserve. Keefer Ecological Services Ltd., Cranbrook, BC.
- Tobalske, B.W. 1997. Lewis's Woodpecker (*Melanerpes lewis*). In A. Poole and F. Gill (Eds), The birds of North America, No. 284. Acad. Nat. Sci., Philadelphia, Penn., and Am. Ornith. Union, Washington, DC.

Tobacco Plains Ecological Restoration

Long-Billed Curlew (*Numenius americanus*) HABITAT RESTORATION PRESCRIPTION

UKE-F17-W-1395

Prepared For: Fish and Wildlife Compensation Program

Prepared By: Myra Juckers, BSc, PAg

March 31, 2017



**Keefers**
Ecological Services Ltd
3816 Highland Rd.
Cranbrook BC V1C 6X7
(250) 489-4140
www.keefereco.com

**TOBACCO PLAINS
INDIAN BAND**
3603 93 Hwy 93
Grasmere, BC V0B 1R0
(250) 887-3461

Acknowledgements

Keefer Ecological Services Ltd. (KES) and Tobacco Plains Indian Band (TPIB) would like to thank the Fish and Wildlife Compensation Program for their financial support to develop a habitat restoration prescription for long-billed curlew (*Numenius americanus*), a species of Special Concern.

**Long-Billed Curlew (*Numenius americanus*)
HABITAT RESTORATION PRESCRIPTION**

Rocky Mountain Forest District

Single multi-area

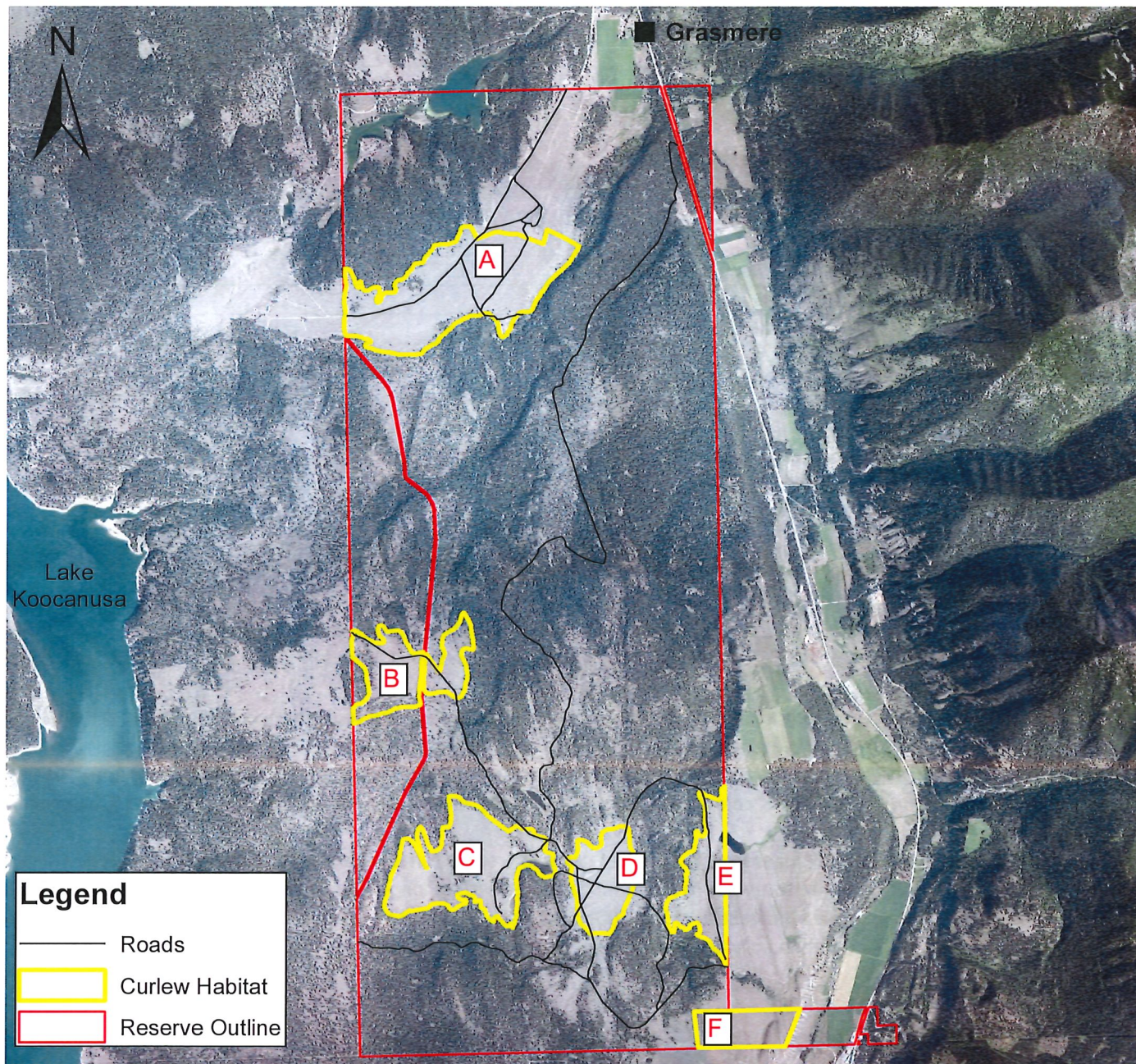
<input checked="" type="checkbox"/> ORIGINAL <input type="checkbox"/> AMENDMENT		Date: Y/M/D		
Location: Tobacco Plains Indian Reserve				
General Description of Area				
TU #	UTM	Treatment Regime	Treatment Area (ha)	Reserve/No Treatment Area (ha)
A	11U 637881E 5437443N	Rangeland	196	/
B	11U 637369E 5433200N	Rangeland	81	/
C	11U 638066E 5431127N	Rangeland	141	/
D	11U 639430E 5430917N	Rangeland	60	/
E	11U 640428E 5430740N	Rangeland	65	/
F	11U 640939E 5429399N	Rangeland	42	/
Field Work By:			Total Treatment Area: 585 ha	Total Reserve Area: 0 ha
Date Completed:				

Long-billed Curlew Breeding Habitat Requirements

SU All	<p>Summary</p> <ul style="list-style-type: none"> • In British Columbia, long-billed curlew breeds in dry, short grasslands and pastures between 280-1200 m elevation (Environment Canada, 2013). These grasslands are commonly glacio-fluvial features with coarse substrates. • During pre-laying and incubation, long-billed curlew prefers low vegetation, less than 10 cm tall to a maximum vertical coverage of 40% at 30cm tall (Ohanjanian, 2004). • During brood rearing, higher vegetation, up to 30 cm, and irregular spacing of taller grass clumps, to complement chicks' colouration and provide hiding and shading opportunities, is preferred (Ohanjanian, 2004). • Territory size ranges from 6-20 ha per pair and areas of suitable habitat should be approximately 3 times greater than territory size to accommodate the needs of long-billed curlew (Environment Canada, 2013). • An unoccupied buffer strip of 300-500 m has been observed between nesting territories and non-suitable habitat or human activities (Ohanjanian, 2004).
--------	---

Long-billed Curlew (*Numenius americanus*) Habitat Tobacco Plains Indian Band Reserve Area

Grasmere, British Columbia



Legend

- Roads
- ▭ Curlew Habitat
- ▭ Reserve Outline

0 0.5 1 2 3 4 Kilometers



Coordinate System: NAD 1983 UTM Zone 11N
Projection: Transverse Mercator
Datum: North American 1983

Stand-Level Management Objectives

<p>SU All</p>	<p>Background Tobacco Plains Indian Reserve (TPIR) is located within the southern Rocky Mountain Trench. Historically, fire played a significant role in the ecology of this region. Specifically in the Tobacco Plains area, studies have indicated fire frequency ranged from 6 to 8.7 years which coincides with oral history regarding First Nations use of fire (Heyerdahl et al., 2008). Regular wildfire on the landscape created a mosaic of grasslands and open forest stands; however, decades of fire suppression has led to forest encroachment and ingrowth within these grassland and open forest ecosystems. Specifically, forest encroachment in grasslands results in direct loss of breeding habitat for long-billed curlew and the reduction in quality of remaining habitat. Further, long-billed curlew have been found to avoid nesting in grassed areas that are close to surrounding shrublands or forests (Environment Canada, 2013).</p>
	<p>Objective</p> <ul style="list-style-type: none"> • Grassland stands are to be maintained at 0-10 stems per hectare (sph), emphasizing retention of trees greater than 40 cm diameter at breast height (dbh).
	<p>Implementation</p> <ul style="list-style-type: none"> • Focus of treatment efforts is the removal of all regeneration, saplings and poles and retention of trees greater than 40 cm dbh. • Removal of regeneration and saplings can be achieved through prescribed burn efforts (see <i>Prescribed Burn Management</i>). • Removal of poles and trees less than 40 cm dbh can be achieved through manual efforts. • Treed sites will target a density of 5-10 stems per hectare. The tree island sites will only be located in toe slopes and depressions, areas proximate to water bodies or near veteran, large diameter or high value wildlife trees. • Area between tree island sites in which no trees are present should be at least 10 ha.
	<p>Measurement</p> <p><i>Pre-treatment</i></p> <ul style="list-style-type: none"> • Delineate the treatment area. • Determine the average sph of regeneration, saplings, poles, and mature trees present on site. • Identify tree retention areas and measure average sph of regeneration, saplings, poles, and mature trees within the tree retention areas. <p><i>Post-treatment</i></p> <ul style="list-style-type: none"> • Determine the average sph following thinning efforts to determine whether the prescription was achieved. • Delineate the tree island sites and measure the area between tree islands to ensure more than 10 ha of area exists between tree islands. <p><i>Long-billed Curlew Surveying</i></p> <ul style="list-style-type: none"> • Conduct a survey of long-billed curlews during the nesting period (May) pre-treatment and consecutively for 5 yrs following treatment to assess whether the number of nesting curlews has increased since treatment implementation.
	<p>Notes</p>

Grassland Management Objectives	
SU All	<p>Background</p> <ul style="list-style-type: none"> • Long-billed curlews prefer open, level to gently rolling grasslands for nesting, and will also nest in wet meadows, sparse shrubsteppe, and some agricultural habitats (e.g. hayfields, pastures, fallow, stubble; Casey, 2015). • During pre-laying and incubation, long-billed curlew prefers low vegetation, less than 10 cm tall to a maximum of 30 cm tall (Ohanjanian, 2004). • During brood rearing, higher vegetation, up to 30 cm, and irregular spacing of taller grass clumps, to complement chicks' colouration and provide hiding and shading opportunities, is preferred (Ohanjanian, 2004).
	<p>Objective</p> <ul style="list-style-type: none"> • Restore native grass/forb cover to 85% within grassland habitat • Aim for 5% of grass and forb cover to be in tall condition (30-40 cm) for brood rearing
	<p>Implementation</p> <ul style="list-style-type: none"> • Invasive plant management is critical to reduce competition of non-native species on native grasses and forbs. See <i>Invasive Plant Management Objectives</i> for additional information. • Historic overgrazing and the feral horse population which roamed the reserve degraded grassland habitat. Sustainable grazing practises are necessary to ensure native grasses and forbs may re-establish and flourish. See <i>Grazing Management Objectives</i> for additional information. • Exposed soil is prevalent in grassland areas, which is believed to be due to historic overgrazing by cattle and feral horses that had roamed the reserve. Seeding native grasses or planting plugs, in conjunction with invasive plant and grazing management may be necessary to aid in enhancing presence of native grasses. Using a seed mix, or planting plugs, with the following grass species is recommended: <ul style="list-style-type: none"> - Needle-and-thread grass (<i>Hesperostipa comata</i>) - Idaho fescue (<i>Festuca idahoensis</i>) - Rough fescue (<i>Festuca campestris</i>) - Reedgrass (<i>Calamagrostis sp.</i>) - Spreading needlegrass (<i>Achnatherum richardsonii</i>) - Junegrass (<i>Koeleria macrantha</i>) Also consider using culturally important plant species in mix (see <i>Cultural and Heritage Concerns Management Objectives</i>).
	<p>Measurement</p> <ul style="list-style-type: none"> • Using 10 randomly located monitoring plots, determine the cover of native grasses and forbs using percent cover to assess whether an 85% cover of native grasses and forbs has been achieved. • Using 10 randomly located monitoring plots, measure whether 5% of grasses and forbs taller than 30-40 cm were retained on site using percent cover.
	<p>Notes</p> <ul style="list-style-type: none"> • If a native grass seed mix is used to revegetate grassland areas, obtain seed certificates for each species to ensure other non-native species are not introduced to the landscape. • Note that several of the native grass species mentioned for revegetation cannot be accessed commercially. As such, the implementation of a seed collection program will be necessary.

Grazing Management Objectives

SU All	<p>Background</p> <ul style="list-style-type: none"> • Long-billed curlew prefers short-growth grassland for nesting habitat (grasses and forbs <30 cm) (Ohanjanian, 2004). • Sustainable livestock grazing can be a great tool to control succession and maintain productive curlew habitat (Mueller, n.d.). • Grazing rotations can be used to maintain grasses at a height of 30 cm or less (Mueller, n.d.).
	<p>Objective</p> <ul style="list-style-type: none"> • Implement rotational grazing within long-billed curlew habitat to control succession and maintain grasses at a height of 30 cm or less.
	<p>Implementation</p> <ul style="list-style-type: none"> • Graze curlew habitat in the fall to remove tall, dense residual vegetation before the spring arrival/pre-laying period. • Adjust timing and intensity of grazing to leave grass cover 10-30 cm tall by the time of nest initiation. • Retain 5% of grasses and forbs in taller condition (30-40 cm) for broods. • Avoid grazing during the incubation and nesting period (April 15 – July 15) to prevent potential for trampling.
	<p>Measurement</p> <ul style="list-style-type: none"> • Using 10 randomly located monitoring plots, measure the height of grass and forbs to ensure their height is 10-30 cm. • Using 10 randomly located monitoring plots, measure whether 5% of grasses and forbs taller than 30-40 cm were retained on site using percent cover. • Conduct a survey of long-billed curlews during the nesting period (May) pre-treatment and consecutively for 5 yrs following treatment to assess whether the number of nesting curlews has increased since treatment implementation.
	<p>Notes</p> <ul style="list-style-type: none"> • Grasslands on the reserve have been historically overgrazed by cattle and feral horses. The recent removal of 90 of the approximately 110 feral horses that roamed the reserve, coupled with the proposed removal of the remaining 25-30 head of cattle from the reserve, should greatly reduce pressure on the grasslands. Allowing the grasslands to rest prior to implementing grazing management is recommended. • During grazing management, rotationally resting pastures and fencing livestock from nesting and brood-rearing habitat may be necessary.

Invasive Plant Management Objectives

SU All

Background

- Leafy spurge (*Euphorbia esula*) and spotted knapweed (*Centaurea stoebe*) have been identified as primary invasive plants which may threaten long-billed curlew (COSEWIC, 2002). These invasive plants are aggressive species, displacing native graminoid vegetation, and reducing visibility. Leafy spurge grows 20-90 cm in height and spotted knapweed grows 20-180 cm in height (Klinkenberg, 2015), which creates a vegetation profile too high for long-billed curlew. Both invasive plants have been identified on TPIR; however, leafy spurge is currently absent from grasslands on TPIR and spotted knapweed has only been found as a low occurrence in grasslands. Note that leafy spurge typically grows 20-40 cm in height on the reserve.
- Sulphur cinquefoil (*Potentilla recta*) and Canada bluegrass (*Poa compressa*) dominate many of the grasslands on TPIR. Both invasive plants grow around or below 30 cm, which does not inhibit the visibility of long-billed curlew.
- Although the visibility of long-billed curlew is not inhibited from the invasive plants that are widespread throughout grasslands on TPIR, management of invasive plants is critical to increase the abundance of native grassland species. This will allow sustainable grazing practises to be introduced to manage curlew habitat as forage will be available. As well, it will allow prescribed burning to be effectively utilized on the landscape. Canada bluegrass density and biomass is progressively reduced if burning occurs annually or biennially in late spring (Uchytel, 1993); however, fire favours seed germination and vegetative growth of sulphur cinquefoil (USDA NRSC, n.d.). As such, the reintroduction of fire on the landscape to support native grassland species requires management of sulphur cinquefoil through chemical or cultural methods.

Objective

- To reduce invasive plant species within grasslands on TPIR by 85%.
- Primary focus should be on sulphur cinquefoil reduction as it dominates grasslands throughout TPIR.

Implementation

- Conduct targeted goat grazing for 5 consecutive years to reduce the density of invasive plant species, particularly sulphur cinquefoil.
- Prior to initiating grazing efforts, collection of background information of the land is critical to place context to monitoring data as it provides a clear description of the present situation (Sharrow and Seefeldt, 2006). Background information that should be collected includes:
 - Identification of all plant species and their percent cover
 - Percent bare ground
 - Evidence of disturbance
 - Wildlife usage
- Obtain annual precipitation data from Environment Canada over the years targeted goat grazing occurs to assess whether changes in invasive plant species were a result of management efforts or weather patterns (Sharrow and Seefeldt, 2006).

Measurement

- Establish 10 randomly located monitoring plots within each site and conduct the following during the 5 years of targeted goat grazing and for 5 consecutive years following grazing efforts:
 - Photo monitoring
 - Percent cover of all plant species, litter, exposed soil, bryophyte, rock, and feces within a 1m x 1m quadrat
- Conduct a survey of long-billed curlews during the nesting period (May) pre-treatment and consecutively for 5 yrs following treatment to assess whether the number of nesting curlews has increased since treatment implementation.

	<p>Notes</p> <ul style="list-style-type: none"> • Since sulphur cinquefoil is widespread throughout the reserve and thus application of herbicide is not practical or recommended. Rather, targeted goat grazing is considered a viable option to manage sulphur cinquefoil (Juckers, 2016). • Consider integrating native plant seeding with invasive plant control to promote the establishment of native plant communities resistant to sulphur cinquefoil invasion (Endress et al, 2008). Using a seed mix, or planting plugs, with the following grass species is recommended: <ul style="list-style-type: none"> - Needle-and-thread grass (<i>Hesperostipa comata</i>) - Idaho fescue (<i>Festuca idahoensis</i>) - Rough fescue (<i>Festuca campestris</i>) - Reedgrass (<i>Calamagrostis sp.</i>) - Spreading needlegrass (<i>Achnatherum richardsonii</i>) - Junegrass (<i>Koeleria macrantha</i>) <p>Also consider using culturally important plant species in mix (see <i>Cultural and Heritage Concerns Management Objectives</i>).</p> <p>Note that several of the native grass species mentioned for revegetation cannot be accessed commercially. As such, the implementation of a seed collection program will be necessary.</p>
--	---

Rare Plant Species Management Objectives	
SU All	<ul style="list-style-type: none"> • A search of the BC Conservation Data Centre identified 8 blue listed plant species (<i>Calamagrostis montanensis</i>, <i>Glycyrrhiza lepidota</i>, <i>Helenium autumnale</i> var. <i>grandiflorum</i>, <i>Heterocodon rariflorum</i>, <i>Lupinus bingenensis</i> var. <i>subsaccatus</i>, <i>Orobanche corymbosa</i> ssp. <i>mutabilis</i>, <i>Physaria didymocarpa</i> ssp. <i>didymocarpa</i>, <i>Sphenopholis intermedia</i>) and 9 red listed plant species (<i>Chenopodium subglabrum</i>, <i>Gaura coccinea</i>, <i>Gayophytum ramosissimum</i>, <i>Hedeoma hispida</i>, <i>Helianthus nuttallii</i> ssp. <i>Rydbergii</i>, <i>Lupinus sulphureus</i>, <i>Senecio hydrophiloides</i>, <i>Silene spaldingii</i>, <i>Thermopsis rhombifolia</i>) that may potentially occur with the treatment area. Of these species, the red listed plant Spalding's campion (<i>Silene spaldingii</i>) has been identified as the highest priority species for protection as it is only found in Canada in and around Tobacco Plains Indian Reserve. • Spalding's campion is a long-lived, perennial herbaceous plant species that is considered endangered under federal COSEWIC and SARA designations (BC CDC, 2017). • Spalding's campion tends to inhabit northerly aspects of gently rolling kettle-moraine topography, encroached grasslands and shallow slopes (<10% slope; Keefer and Kennedy, 2010). Spalding's campion is not typically found on long-billed curlew habitat because it is on glacial-fluvial features with coarse substrates, whereas Spalding's campion requires finer substrates. However, to ensure restoration efforts do not harm or destroy Spalding's campion plants which may be present on long-billed curlew habitat, the following is advised: <ul style="list-style-type: none"> - Conduct a survey for Spalding's campion on long-billed curlew habitat, prior to implementing restoration efforts, and mark locations with pig-tails and flagging tape to expose the location of the plant. - Ensure restoration efforts, such as targeted goat grazing, do not harm or damage Spalding's campion plants onsite.

Cultural and Heritage Concerns Management Objectives	
SU All	<p>Background</p> <ul style="list-style-type: none"> • Culturally important food plants known to occur within long-billed curlew habitat include: <ul style="list-style-type: none"> - nodding onion (<i>Allium cernuum</i>) - sagebrush mariposa lily (<i>Calochortus macrocarpus</i>) - wild bergamot (<i>Monarda fistulosa</i>) - bitterroot (<i>Lewisia rediviva</i>) • Restoration of long-billed curlew habitat will also improve habitat quality for these culturally important food plants.
	<p>Objective</p> <ul style="list-style-type: none"> • Increase culturally important food plants within long-billed curlew habitat.
	<p>Implementation</p> <ul style="list-style-type: none"> • Conduct targeted goat grazing for 5 consecutive years to reduce the density of invasive plant species, particularly sulphur cinquefoil (see <i>Invasive Plant Management Objectives</i>). • Remove tree encroachment (see <i>Stand-Level Management Objectives</i>).
	<p>Measurement</p> <ul style="list-style-type: none"> • Establish 10 randomly located monitoring plots within each site and identify, using a 1m x 1m quadrat, percent cover of culturally important food plants prior to restoration treatment. • Assess and document any potential harm/damage to culturally important food plants post-restoration treatment. • Assess culturally important food plants within monitoring plots consecutively for 5 yrs following treatment to assess whether culturally important food plants have increased since treatment implementation.
	<p>Notes</p> <ul style="list-style-type: none"> • If seeding or planting plugs is used as a restoration treatment method, consider using culturally important plant species in the mix.

Riparian (Streams, Wetlands, Lakes, Fisheries) Management Objectives	
SU All	No treatments are prescribed for sites including or adjacent to riparian areas on TPIR

Community Watershed Management Objectives	
SU All	Water license records show no consumptive use water licenses, water diversions or Community watersheds on this LBU

Recreation Management Objectives

SU All	<p>Background</p> <ul style="list-style-type: none"> Recreational activities can disturb long-billed curlew, particularly during the nesting period, which can result in nest depredation, nest abandonment, and mortality of young (Downey, 2010).
	<p>Objective</p> <ul style="list-style-type: none"> Avoid recreational activities in suitable nesting areas during the breeding season from April 1 to July 15
	<p>Implementation</p> <ul style="list-style-type: none"> Post signs near suitable nesting areas during the breeding season (April 1 to July 15) to reduce disturbance to nesting sites. Educate band members about long-billed curlew and the importance of preventing disturbance during the breeding season to avoid nest depredation, nest abandonment, and mortality of young.
	<p>Measurement</p> <ul style="list-style-type: none"> N/A
	<p>Notes</p>

Access Management Objectives

SU All	<p>Description of Access Road(s)</p> <ul style="list-style-type: none"> Roads are known to fragment long-billed curlew habitat (Casey, 2015). Various roads are adjacent to and traverse long-billed curlew habitat (see map above).
	<p>Mitigation Efforts</p> <ul style="list-style-type: none"> Roads are an important access feature for labour crews conducting treatment but will not be altered for its purposes. No changes are projected to any existing access roads within treatment units. Road use should be limited during the breeding season (April 15-July 15). Additional roads should not be constructed to avoid habitat fragmentation.

Prescribed Burn Management	
SU All	<p>Background</p> <ul style="list-style-type: none"> • Fire played a significant role in the ecology of TPIR and the surrounding region. Specifically in the Tobacco Plains area, studies have indicated fire frequency ranged from 6 to 8.7 years which coincides with oral history regarding First Nations use of fire (Heyerdahl et al., 2008). • Fire suppression practices have been in place since the early 20th century (Bond et al., 2013) which greatly altered the landscape, increasing tree cover and reducing habitat for native grassland species.
	<p>Objective</p> <ul style="list-style-type: none"> • Reintroduce low-intensity fires to the landscape to maintain native grassland habitat for various species, including long-billed curlew.
	<p>Implementation</p> <ul style="list-style-type: none"> • Develop and implement a prescribed burn plan for each treatment unit.
	<p>Measurement</p> <ul style="list-style-type: none"> • Prior to implementing the prescribed burn plan, establish 10 randomly located 1m x 1m monitoring plots and document percent cover of all plant species, coarse woody debris, exposed soil, and feces. • For 5 yrs following the prescribed burn plan, monitoring will be conducted to assess success of native plant re-establishment. • Conduct a survey of long-billed curlews during the nesting period (May) pre-treatment and consecutively for 5 yrs following treatment to assess whether the number of nesting curlews has increased since treatment implementation.
	<p>Notes</p> <ul style="list-style-type: none"> • As mentioned, Canada bluegrass (<i>Poa compressa</i>) and sulphur cinquefoil (<i>Potentilla recta</i>) dominate grasslands within TPIR. Canada bluegrass density and biomass is progressively reduced if burning occurs annually or biennially in late spring (Uchytel, 1993); however, fire favours seed germination and vegetative growth of sulphur cinquefoil (USDA NRSC, n.d.). • Complementing prescribed burn efforts with targeted goat grazing and seeding with native plants can promote re-establishment of a native grassland community.

References

- Beever, E. A., R. J. Taush, and W. E. Thogmartin. 2008. Multi-scale Responses of Vegetation to Removal of Horse Grazing from the Great Basin (USA) Mountain Ranges. *Plant Ecology*, 196:163–184.
- Casey, D. 2015. Land Manager's Guide to Grassland Conservation and the Long-billed Curlew. American Bird Conservancy, The Plains, Virginia. Available at: <http://abcbirds.org/wp-content/uploads/2015/12/Land-Managers-Guide-to-Long-billed-Curlew-Conservation.pdf>.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. COSEWIC Assessment and Update Status Report on the Long-billed Curlew *Numenius americanus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. Available at: http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_long_billed_curlew_e.pdf.
- Davies, K.W., G. Collins, and C.S. Boyd. 2014. Effects of Feral Free-roaming Horses on Semi-arid Rangeland Ecosystems: An Example from the Sagebrush Steppe. *Ecosphere*, 5(10): 127.
- Downey, B. 2010. Long-billed Curlew Conservation Management Plan, 2010-2015. Alberta Species at Risk Conservation Management Plan No. 3. Alberta Sustainable Resource Development, Edmonton, AB. Available at: <https://open.alberta.ca/dataset/cbc00984-949d-498f-9f49-b6ed11bf5a5e/resource/3b2a6124-6822-48d2-8b50-c2f8e8585965/download/SAR-LongBilledCurlew-ConsManPlan-2010-15.pdf>.
- Endress, B.A., C.G. Parks, B.J. Naylor and S.R. Radosevich. 2008. Herbicide and Native Grass Seeding Effects on Sulfur Cinquefoil (*Potentilla recta*) – Infested Grasslands. *Invasive Plant Science and Management*, 1: 50-58.
- Environment Canada. 2016. Recovery Strategy for the Spalding's Campion (*Silene spaldingii*) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa, ON.
- Environment Canada. 2013. Management Plan for the Long-billed Curlew (*Numenius americanus*) in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. iii + 24 pp.
- Heyerdahl, E.K., P. Morgan and J.P. Riser II. 2008. Multi-Season Synchronized Historical Fires in Dry Forests (1650-1900), Northern Rockies, USA. *Ecology*, 89(3): 705-716.
- Juckers, M. 2016. Sulphur Cinquefoil Control Through Target Goat Grazing. Keefer Ecological Services, Cranbrook, BC.
- Keefer, M., and A. Kennedy. 2010. Spalding's Campion Inventory and Habitat Assessment Works 2010. Keefer Ecological Services, Cranbrook, BC. Submitted to Environment Canada.
- Klinkenberg, B. (Editor). 2015. E-Flora BC: Electronic Atlas of the Plants of British Columbia [eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia: Vancouver, BC. Available at: <http://ibis.geog.ubc.ca/biodiversity/eflora/>.

Mueller, J. n.d. Long-billed Curlew (*Numenius americanus*). Fish and Wildlife Habitat Management Leaflet Number 7. Natural Resources Conservation Services, United States Department of Agriculture, Washington, DC. Available at:

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_054095.pdf.

Ohanjanian, I.A. 2004. Long-Billed Curlew (*Numenius americanus*). In: BC Ministry of Environment (formerly Ministry of Water, Land and Air Protection) (Ed.), Accounts and Measures for Managing Identified Wildlife: Southern Interior Forest Region, Version 2004, Victoria, BC. Available at:

http://www.env.gov.bc.ca/wld/frpa/iwms/documents/Accounts_and_Measures_South.pdf.

Sharrow, S.H. and S.S. Seefeldt. 2006. Monitoring for success. In: K. Launchbaugh (Ed.). Targeted Grazing: A Natural Approach to Vegetation Management and Landscape Enhancement. Englewood, CO, USA: American Sheep Industry Association. pp. 40-49. Available at:

http://www.fs.fed.us/rm/pubs/rmrs_gtr292/2006_launchbaugh_k002.pdf.

Uchytel, R.J. 1993. *Poa compressa*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer).

Available at: <https://www.fs.fed.us/database/feis/plants/graminoid/pocom/all.html>.

United States Department of Agriculture, Natural Resources Conservation Service (USDA NRSC). n.d. Prescribed Burning for Sulphur Cinquefoil. Available at:

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mt/home/?cid=nrcs144p2_056743.

Tobacco Plains Ecological Restoration

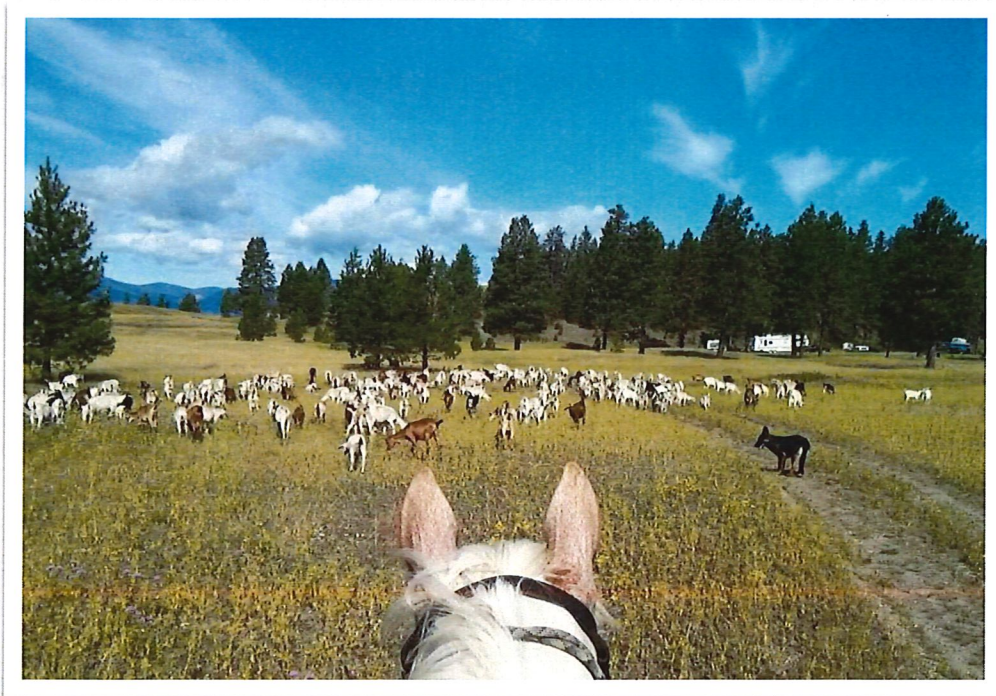
2016 Targeted Grazing of Sulfur Cinquefoil (*Potentilla recta*) Using Goats on Tobacco Plains Indian Reserve

UKE-F17-W-1395

Prepared For: Fish and Wildlife Compensation Program

Prepared By: Gaëtane Carignan, MSc, PAg

March 31, 2017



**Keefer**
Ecological Services Ltd
3816 Highland Rd.
Cranbrook BC V1C 6X7
(250) 489-4140
www.keefereco.com


3603 93 Hwy 93
Grasmere, BC V0B 1R0
(250) 887-3461

Acknowledgements

All data for this project was collected in cooperation with Natasha Murphy, a graduate student at the British Columbia Institute of Technology and Simon Fraser University, studying Ecological Restoration. Her thesis will provide some of the first multi-site research data in BC on the efficacy of targeted goat grazing.

Thank you to Donna and Conrad Lindblom, of Rocky Ridge Vegetation Control, for enthusiastically sharing their process and explaining what is involved in travelling to various sites across BC each summer with 300 goats, three horses, four dogs, and an employee, all trained to target invasive species, avoid predators, and get along amicably.

Thank you to Tobacco Plains Indian Band, especially Tom Philips, Melissa Carter, and Dan Gravelle, for your participation and willingness to bring this pilot project into reality.

Finally, thank you to the Fish and Wildlife Compensation Program for their financial support of the targeted goat grazing pilot project.

Table of Contents

Acknowledgements.....	i
Introduction	1
Methods.....	1
Goat Herd Management	1
Vegetation Survey.....	2
Plant Species Survey	4
Pre and Post Grazing Treatment Data on Sulphur Cinquefoil	4
Results.....	5
Goat Herd Management	5
Plant Species Survey	5
Pre and Post Grazing Treatment Data on Sulphur Cinquefoil	7
Discussion.....	8
Community Engagement	9
References	10

Introduction

The following report is a summary of the targeted goat grazing of sulphur cinquefoil (*Potentilla recta*) conducted for eight days from July 7th to July 14th, 2016 on approximately 48 ha of open grassland on the Tobacco Plains Indian Reserve (TPIR). The 48 ha is located in a place known to Tobacco Plains Indian Band (TPIB) members as “the golf course.”

This area of TPIR, as well as others, is heavily impacted by an infestation of invasive, perennial sulphur cinquefoil (Juckers and Keefer, 2016). Sulphur cinquefoil prefers disturbed, open sites that have dry to moist conditions. It is commonly found in southern BC, frequently in waste places, roadsides, pastures and overgrazed grasslands in lowland to medium elevation zones (Klinkenberg, 2017). Sulphur cinquefoil is widespread throughout TPIR and thus targeted goat grazing offers a potential long-term and environmentally friendly alternative to herbicide application.

More commonly practiced in the United States (Banks, 2013), targeted goat grazing for control of invasive plants in Canada is not well documented. Within the East Kootenay, targeted goat grazing is a recent, novel approach. Application of targeted goat grazing on TPIR offers an opportunity to assess the effectiveness of using goats to manage invasive plants and provides organizations such as the East Kootenay Invasive Species Council, the Rocky Mountain Trench Natural Resources Society, and the Regional District of the East Kootenay, with information on the feasibility of using goats to address invasive plant infestations in the region.

Methods

Goat Herd Management

Rocky Ridge Vegetation Control, based out of Kamloops, BC, facilitated the targeted goat grazing. The company has a herd of approximately 300 goats which have been trained to target invasive plant species. The goats were managed by a combination of voice commands issued by the main herds person, Conrad Lindblom, riders on horseback, and herding by stock dogs. Additionally, they were protected from predators, and the onsite feral horse herd, by two large livestock guardian dogs.

During the night, and at midday, the goats were penned at camp in portable fence panels and were provided with water and salt (Figure 1). The young kids remained penned while the adult herd members grazed during the day.



Figure 1: Water being transported to camp, necessary every two to three days, for the animals (left). Goats penned with portable fence panels and horses tied to the horse trailer (right).

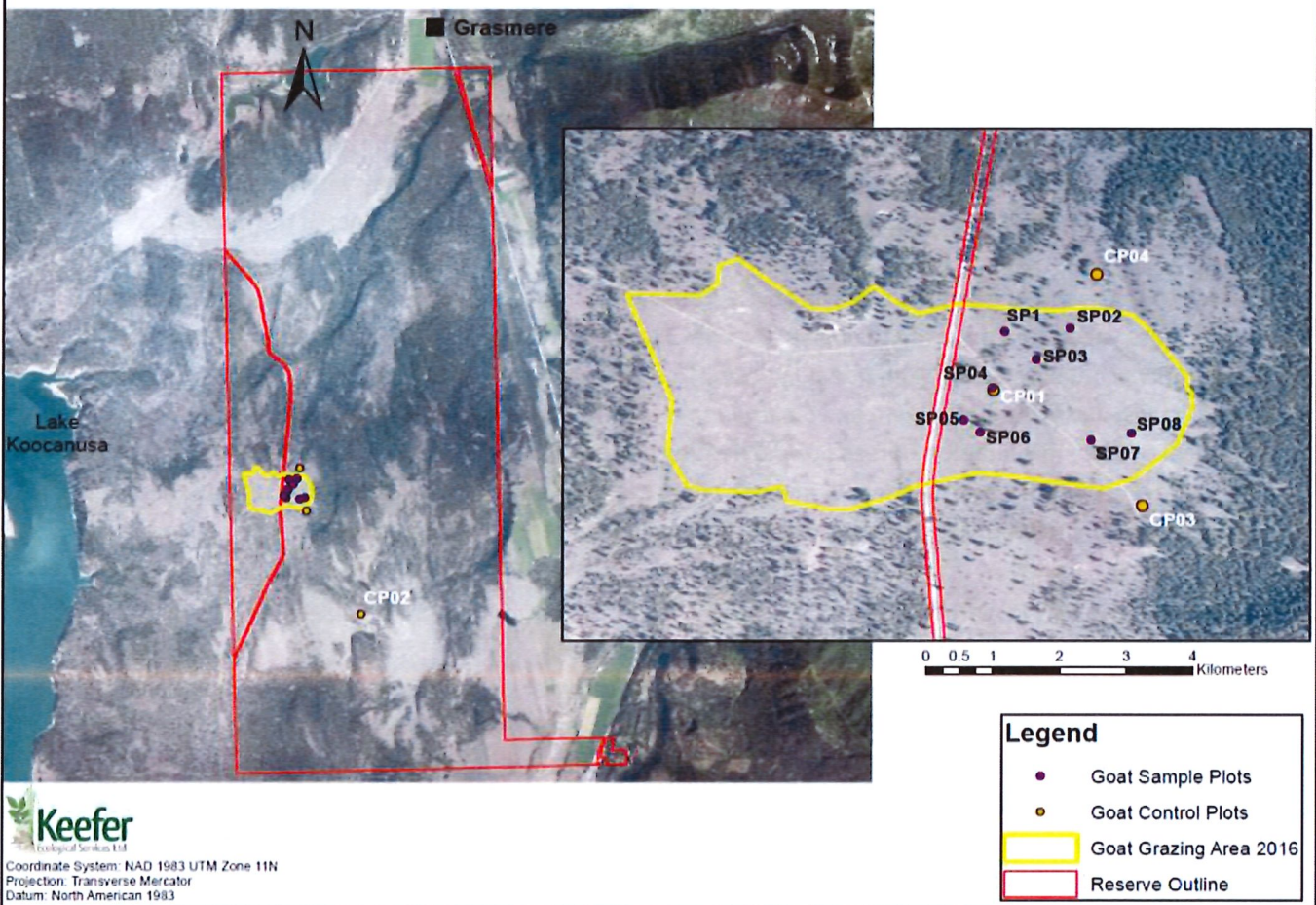
Always under the supervision of herdspersons and dogs, the goats grazed in the morning from about 9 am until noon, and would then be herded back to their pens at camp. Here they would ruminate (chew their cud), drink water and rest, until resuming grazing from about 2 pm until 6 pm in the evening.

To mitigate the risk of disease transfer from the domestic goats to big horn sheep (*Ovis canadensis*), the goats were vaccinated prior to arriving on site with Tasvax 8, which vaccinates the goats against *Clostridium chauvoei*, *Clostridium haemolyticum*, *Clostridium novyi*, Types B, C, and D *Clostridium perfringens*, *Clostridium septicum*, and *Clostridium tetani*. As well, as mentioned above, the goats were shepherded by individuals on horseback and herding dogs, which ensured the goats did not stray from the herd. Further, the goats were kept in a pen when they were not grazing, which was safeguarded by guardian dogs, preventing goats from escaping and wildlife interacting with the goats.

Vegetation Survey

A number of control (four) and sample (nine) plots were established at random locations within the 48 ha area before the goats had grazed those areas (see map). Each plot was marked with a permanent metal stake, driven into the ground, in the north east corner of the plot, with the exception of SP03, which was marked at the south west corner. Each plot was oriented north, from the relative position of the marker, using a compass bearing. Future studies would be able to locate these plots with a combination of the GPS coordinates (Table 1), visual inspection and possibly a metal detector if necessary. Control plots were not grazed, and could act as a baseline reference for long-term studies.

Sulphur Cinquefoil (*Potentilla recta*) Targetted Goat Grazing
Tobacco Plains Indian Band Reserve Area
Grasmere, British Columbia



Control plot CP01 had an enclosure erected to facilitate visual assessment of the effects of grazing around the plot. Sample plots were grazed after completion of both a plant species survey, and assessment of the size, phenology and coverage of sulphur cinquefoil plants. After grazing, the size, phenology and coverage of sulphur cinquefoil was reassessed. North facing photos were taken directly above, and horizontally from ground level, for all plots (Appendix A).

Table 1: UTM coordinates of the locations of the camp, control plots and sample plots within the 48 ha area that received eight days of targeted goat grazing treatment in July 2016.

Date	Landmark	Waypoint	Easting 11U	Northing 11U	Comments
7-Jul-16	Camp	CAMP	637368	5433578	-
8-Jul-16	Control Plot	CP01	637555	5433342	Enclosure built
9-Jul-16	Control Plot	CP02	638660	5431491	Area ungrazed by goats
13-Jul-16	Control Plot	CP03	637823	5433032	Area ungrazed by goats
13-Jul-16	Control Plot	CP04	637734	5433668	Area ungrazed by goats
7-Jul-16	Sample Plot	SP01	637571	5433505	marker at NE corner
7-Jul-16	Sample Plot	SP02	637689	5433518	marker at NE corner
7-Jul-16	Sample Plot	SP03	637630	5433429	marker at SW corner
8-Jul-16	Sample Plot	SP04	637553	5433351	marker at NE corner
8-Jul-16	Sample Plot	SP05	637503	5433261	marker at NE corner
8-Jul-16	Sample Plot	SP06	637533	5433261	marker at NE corner
8-Jul-16	Sample Plot	SP07	637735	5433211	marker at NE corner
8-Jul-16	Sample Plot	SP08	637808	5433231	Not marked, no post-treatment data
8-Jul-16	Sample Plot	SP09	637819	5433397	marker at NE corner
8-Jul-16	Sample Plot	SP10	637740	5433492	marker at NE corner

Plant Species Survey

In each of the control and sample plots, the plant species present within the 1m² quadrat were identified. Identification in the field was facilitated by the plant identification manual by Parish et al (1996), as well as photographing and collecting specimens for identification off-site when necessary.

Pre and Post Grazing Treatment Data on Sulphur Cinquefoil

Control and sample plot locations (Table 1) were chosen randomly in areas not yet grazed by the goats within the 48 ha grassland area. Data on the height of sulphur cinquefoil was conducted by documenting the number of plants that fell within the following height categories: >30 cm, 20-30 cm, 10-20 cm and <10 cm. Percent bare soil and percent cover by sulphur cinquefoil were also recorded. As well, the number of sulphur cinquefoil plants with seed heads (seed head #) and the number of clusters of those seed heads (seed cluster #) were recorded. Each of these measurements were collected before and after

grazing in the nine sample points, and only once in the control plots that were not grazed. The control plots are intended to help detect any long-term differences or changes between grazed and ungrazed areas, if targeted grazing of sulphur cinquefoil were to continue over multiple years on the same grassland.

Results

Goat Herd Management

Under the direction of the herders, the goats grazed the same location multiple times over the eight day trial. Goats were observed to target the sulphur cinquefoil, grazing the top of the plants first, and then grazing lower and lower with each successive pass. If the herd went off course, wandering into the trees for example, the herdsman, Conrad Lindblom, would get them back on track with a voice command such as "Come on guys, back to work!" The goats and stock dogs would respond immediately, resulting in the herd returning to the desired location on open grassland.

A small group of feral horses visited the area multiple times during the grazing trial. The herders on horseback and the livestock guardian dogs successfully maintained the feral horses at a safe, non-disruptive distance.

Plant Species Survey

Biological diversity is an indicator of the health of an ecosystem and invasive species are known to be one of the greatest threats to biodiversity. Generally, the higher the biological diversity, measured by a combination of the number of species in a given location and their relative abundance, the healthier the ecosystem. Before grazing, the number of plant species in each of the control and sample plots was recorded (Table 2). This information will serve as a baseline to know the species of plants that were present within the grassland site in 2016. As conditions improve or degrade over time, it would be expected that the number of plant species per 1m² quadrat would change resulting in a shift in the plant community. It is important to note that the types of plants found at these locations are expected to differ depending on time of the year, weather conditions of the year, and when surveys are conducted. A survey conducted in May would have different types of plants than this 2016 survey that was conducted in early July. Therefore, if using these data to compare to future years, it would be best to time future surveys for a similar date as past surveys and to also compare the seasonal weather conditions between years.

Table 2: Plant species identified within the 1m² quadrats at each of the four control plots (CP) and nine sample plots (SP) before targeted goat grazing, July 2016.

Plant species		Plot													
Common name	Scientific name	CP01	CP02	CP03	CP04	SP01	SP02	SP03	SP04	SP05	SP06	SP07	SP09	SP10	
Invasive Species															
sulphur cinquefoil	<i>Potentilla recta</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	
St. John's Wort	<i>Hypericum perforatum</i>		x							x					
cheatgrass	<i>Bromus tectorum</i>			x						x				x	
Grasses															
June grass	<i>Koeleria macrantha</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	
needle-and-thread	<i>Stipa comata</i>		x		x	x	x	x	x	x	x	x	x	x	
Canada bluegrass	<i>Poa compressa</i>		x	x			x	x	x	x	x	x	x	x	
Sandberg's bluegrass	<i>Poa sandbergii</i>	x			x				x	x	x	x	x		
Forbes															
brown-eyed susan	<i>Gaillardia aristata</i>	x				x			x				x		
golden aster	<i>Heterotheca villosa</i>					x		x		x					
yarrow	<i>Achillea millefolium</i>					x		x					x		
pussy toes	<i>Antennaria spp</i>	x	x			x	x	x							
bitter root	<i>Lewisia rediviva</i>	x				x			x						
desert parsley	<i>Lomatium macrocarpum</i>					x							x		
mariposa lily	<i>Calochortus macrocarpus</i>												x		
shaggy daisy	<i>Erigeron pumilus var. intermedius</i>						x	x					x		
goat's beard	<i>Tragopon dubius</i>							x							
wooly plantain	<i>Plantago patagonica</i>	x					x		x						
dandelion	<i>Taraxacum officinale</i>		x					x							
stiff phlox	<i>Phlox rigida</i>												x		
shooting star	<i>Dodecatheon pulchellum</i>												x		
graceful cinquefoil	<i>Potentilla gracilis</i>			x					x						
Plant species per plot		7	7	5	4	9	7	10	9	8	5	5	12	5	
Average species per plot		7.2													

Pre and Post Grazing Treatment Data on Sulphur Cinquefoil

The average height distribution of the sulphur cinquefoil observed in the nine 1m² sample plots decreased after the grazing treatment, excluding plants less than 10 cm in height, (Figure 2), illustrating a positive indication that the goats were impacting this plant.

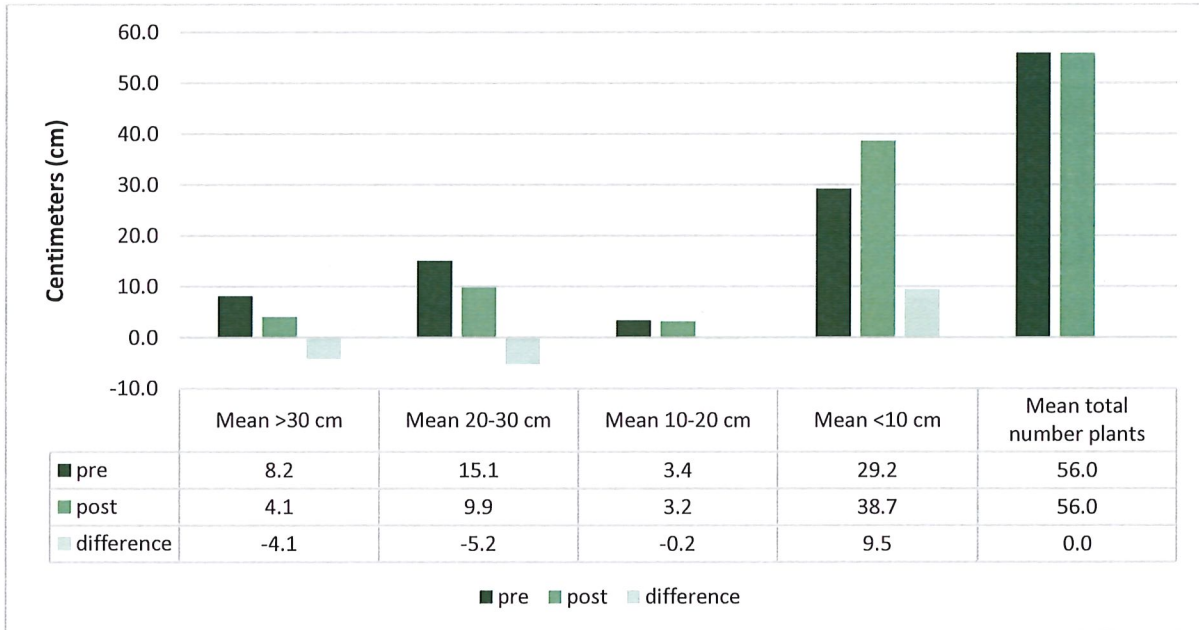


Figure 2: Mean height difference (cm) and distribution of sulphur cinquefoil pre- and post-targeted goat grazing from nine 1m² sample plots, July 2016.

There was no significant difference in the amount of bare soil pre- to post-grazing, which remained steady at 53% and 54% respectively. The number of sulphur cinquefoil plants with seed heads, the number of seed clusters, and the percent cover of this plant were all observed to decrease post-grazing compared to pre-grazing (Figure 3).

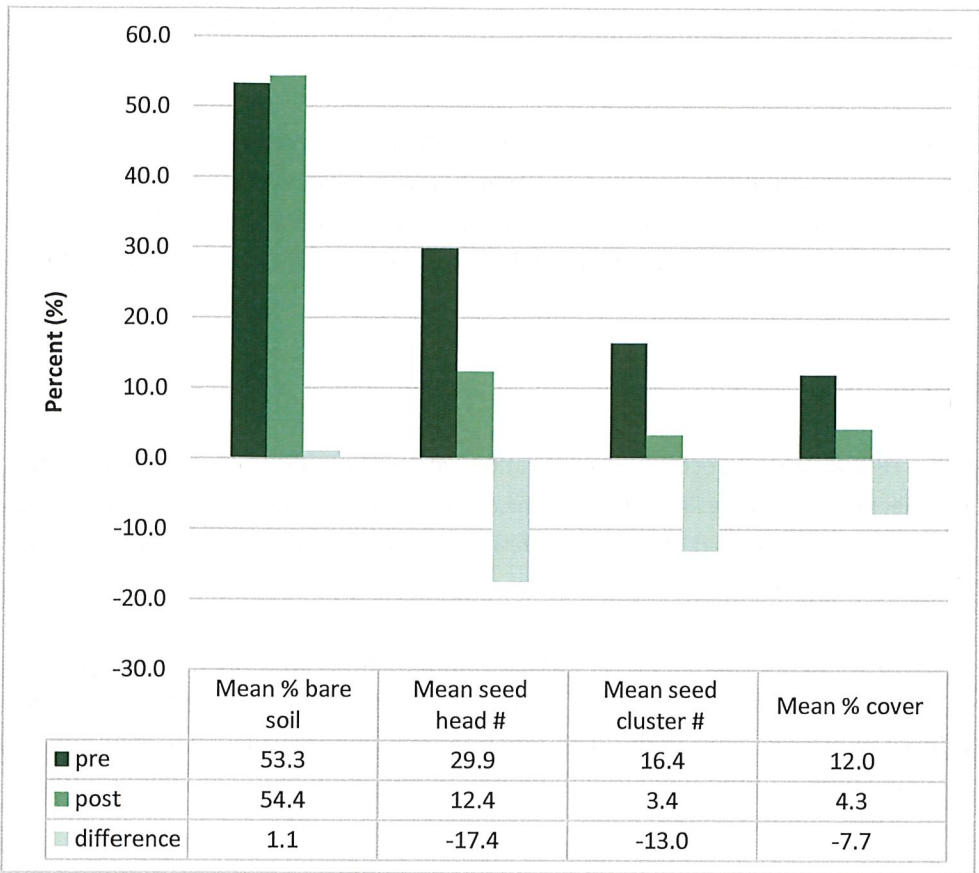


Figure 3: Mean % bare soil, number of sulphur cinquefoil with seed heads, seed cluster number, and % cover of sulphur cinquefoil pre- and post-targeted goat grazing from nine 1m² sample plots, July 2016.

Discussion

Targeted goat grazing has great potential to successfully reduce the density and impacts of many types of invasive plants in an environmentally beneficial manner if best management practices are applied when using this tool. The targeted plants should be grazed over multiple years to weaken them and give native vegetation a competitive advantage over the invasive species. Also, grazing should take place before the target species sets seed (Banks, 2013) in order to reduce the accumulation of seeds available to germinate in the future. The number of grazing days in 2016 was limited to eight, resulting in 48 ha grazed. To observe meaningful differences in prevalence of sulphur cinquefoil and other changes to the plant community composition, this work needs to be carried out over multiple, consecutive years and grazing must continue to occur prior to the seed set of sulphur cinquefoil.

The targeted grazing on TPIR took place just east of a fenceline, dividing TPIR from Provincial Crown Range, which is used primarily for cattle grazing. It was observed that the density of sulphur cinquefoil was noticeably greater on the TPIR side of the fence (east) than on the Crown Range side (west). This difference was observed up and down this fenceline for some distance. It would merit further discussion

with TPIR and surrounding land users to determine what differences in land management could be causing such a noticeable impact on the prevalence of sulphur cinquefoil.

Sulphur cinquefoil, among many other invasive plants, is known to thrive under conditions of overgrazing (Klinkenberg, 2017). The feral horse population which roamed TPIR was estimated at 110 head. This past winter, 90 horses were removed from the reserve (T. Phillips, pers.comm., March 27, 2017). The removal of the horses will aid in the recovery of the grasslands on TPIR in conjunction with targeted goat grazing efforts.

Community Engagement

Increasing capacity within TPIB to perform ecological restoration work is an explicit objective of the TPIR ecological restoration project in order to facilitate long-term commitment to restoring the grassland and open forest habitat. The use of targeted goat grazing for invasive plant management provides a training and potential business opportunity for TPIB.

During this grazing treatment, TPIB members were welcomed to both witness and participate in the project activities. Members of conservation organizations, including the East Kootenay Invasive Species Council as well as the Rocky Mountain Trench Natural Resource Society were also invited to view and learn about the project in the field.

References

- Banks, S. 2013. *A Well Designed Goat Grazing Plan Can Reduce Noxious Weeds*. Utah State University Cooperative Extension. Available at:
http://extension.usu.edu/files/publications/publication/AG_Weeds_2013-01pr.pdf
- Juckers, M. and M. Keefer. 2016. *Invasive Plant Management on Tobacco Plains Indian Reserve*. Keefer Ecological Services Ltd.: Cranbrook, BC.
- Klinkenberg, B. (Editor) 2017. *E-Flora BC: Electronic Atlas of the Plants of British Columbia* [eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. Available at: <http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Potentilla%20recta>
- Parish, R., Coupé, R., and Lloyd D. (Editors). 1996. *Plants of Southern Interior British Columbia and the Inland Northwest*. BC Ministry of Forests and Lone Pine Publishing.

