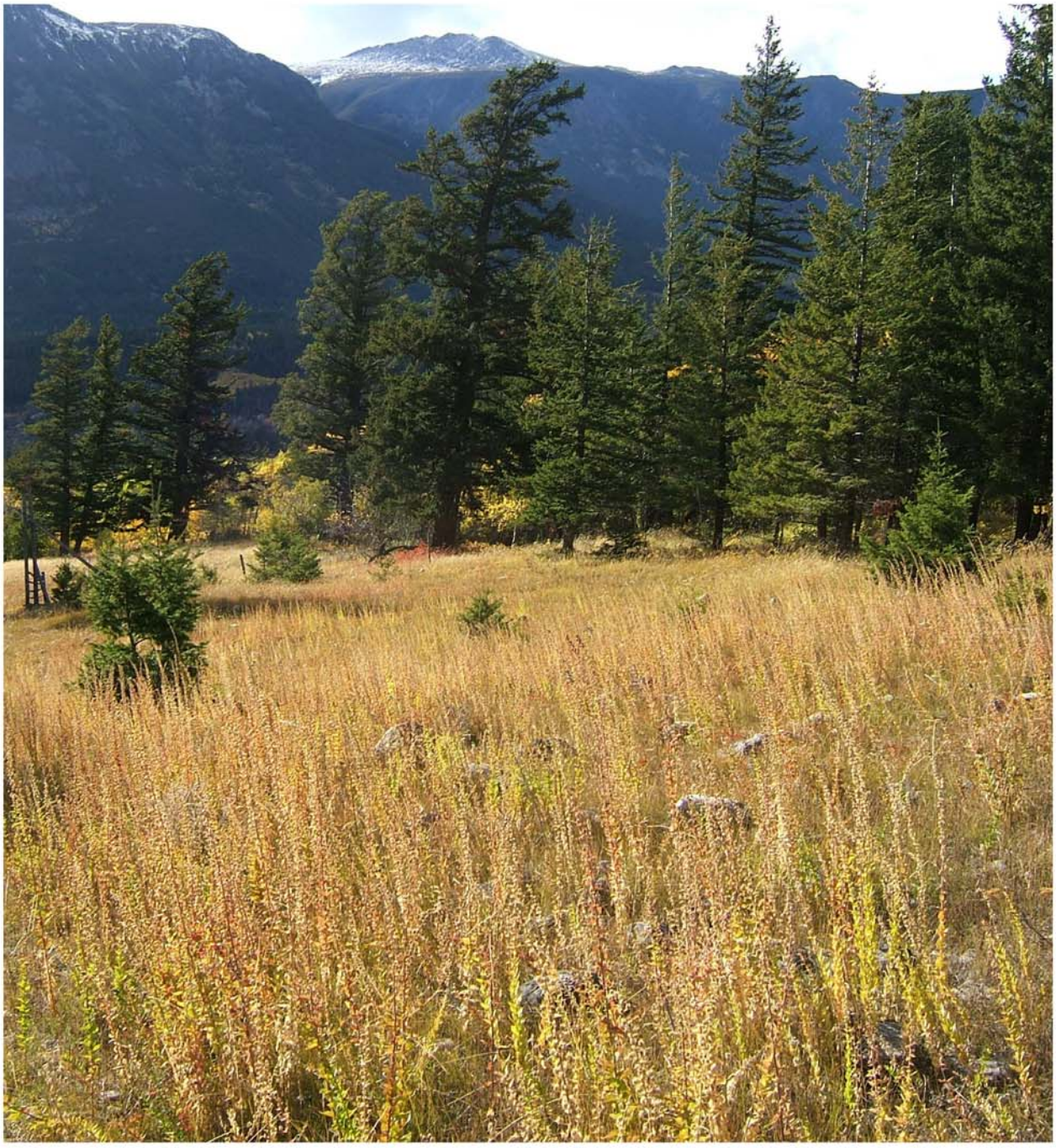
INVENTORY AND CONTROL OF INVASIVE PLANTS IN TATLAYOKO VALLEY

PREPARED FOR THE NATURE CONSERVANCY OF CANADA
BY SANDY HART, KEN MACKENZIE AND BOB SAGAR
FEBRUARY 2008



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February 2008

ACKNOWLEDGEMENTS

We would like to acknowledge the helpful discussions and contributions to field investigations and biocontrol measures provided by Percy Folkard, Ministry of Forests and Range Invasive Plant Agrologist and by Allison McDonald, (former) Cariboo Regional District Invasive Plant Specialist. We're also grateful to Peter Shaughnessy, Nature Conservancy of Canada Project Manager in Tatlayoko Valley for his collaboration and field support of this project. Finally, this project could not have been carried out without the willing participation of valley residents – we thank them for their cooperation and for their commitment to tackling invasive plant problems in the valley.

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1.0 INTRODUCTION

The Nature Conservancy of Canada (NCC) initiated this project both to devise a strategy for invasive plant management on their Tatlayoko Valley properties and to contribute to management of this threat throughout the valley. The spread of invasive alien plants can have a wide range of negative economic and environmental impacts. These introduced species can out-compete both native plants and tame forage species, resulting in significant losses to rangeland, pasture, and hayfield, and, in severe cases, with attendant reduction of property values. Consequences for wildlife and aquatic species can also be substantial, due to reduction of natural habitat diversity and productivity. For NCC, as an owner of lands managed both for biodiversity and agricultural values, control of invasive plants in Tatlayoko Valley is of critical importance.

The project was comprised of three main components: an inventory of invasive plants; development of an invasive plant control strategy; and design and implementation of a program for monitoring invasive plant control measures. This report presents the results of the 2007 inventory and sets out a control strategy. A companion report by Mellott (2007) outlines the design and first-year results of the monitoring program.

The inventory component focused on private land, encompassing properties along the northeastern side of Tatlayoko Lake and within the Homathko River basin upstream of the lake (Figure 1). The significant invasive plant threats in the valley are described and the range of control practices is discussed. Specific control measures are recommended for invasive plants found on NCC properties and broad recommendations are provided for management of this threat throughout the valley.

2.0 METHODS

The initial stage of the invasive plant inventory in the study area involved an overview survey of invasive plants and other noxious weeds present in the valley, based on discussions with landowners and brief field inspections.[1] Ministry of Forests and Range and Cariboo Regional District invasive plant staff were also consulted in order to identify plants in the region which pose a threat of establishment in the valley. This presence-absence survey information was provided to the inventory team to guide their fieldwork.

The detailed invasive plant inventory was conducted during July 16-27, 2007.[2] The survey included all Nature Conservancy lands and the larger private and leased land holdings of residents who elected to participate in the inventory (Figure 1). Invasive alien plants observed incidentally on Crown land were also recorded.

Invasive plant information was collected according to the standards of the BC Ministry of Forest and Range Invasive Alien Plant Program (IAPP)[3]. The location of each site where invasive alien plants were found was determined using hand-held GPS units and recorded along with the elevation, slope, aspect, infestation area, distribution characteristics, plant density, and treatments. The biogeoclimatic system variant was added based on available mapping. In several cases, where infestations were extensive, polygons rather than sites were mapped.

The data for each invasive plant site were entered directly into the IAPP on-line application using NCC's access authorization for this project. Polygon data were prepared as shape files and submitted to the Ministry of Forests and Range IAPP GIS Technician for processing as IAPP records. IAPP data collected during the inventory as well as all preceding data collected by other agencies are available for public viewing at the Forest Practices Branch, Invasive Alien Plants website (http://www.for.gov.bc.ca/hfp/invasive/IAP_01.htm).

For resource users having access to the data entry module, numerous data extracts can be performed including records of treatments, monitoring, and invasive plant site characteristics. For reference when using the IAPP public map display, Appendix 1 lists the infestation area, plant density, and plant distribution for each site entered in the application.

Invasive plants entered in the IAPP application included all legally-designated species present in the study area plus a selection of the less abundant, non-designated species (see Section 3). Appendix 1 lists the infested area, plant distribution, and density for the sites entered in the on-line application. The polygon data are described in Section 3.1, but were not available on-line at the time of writing.

The description of invasive plants and the discussion of control measures are based on review of the literature and consultation with government personnel and researchers engaged in invasive plant management.[1]

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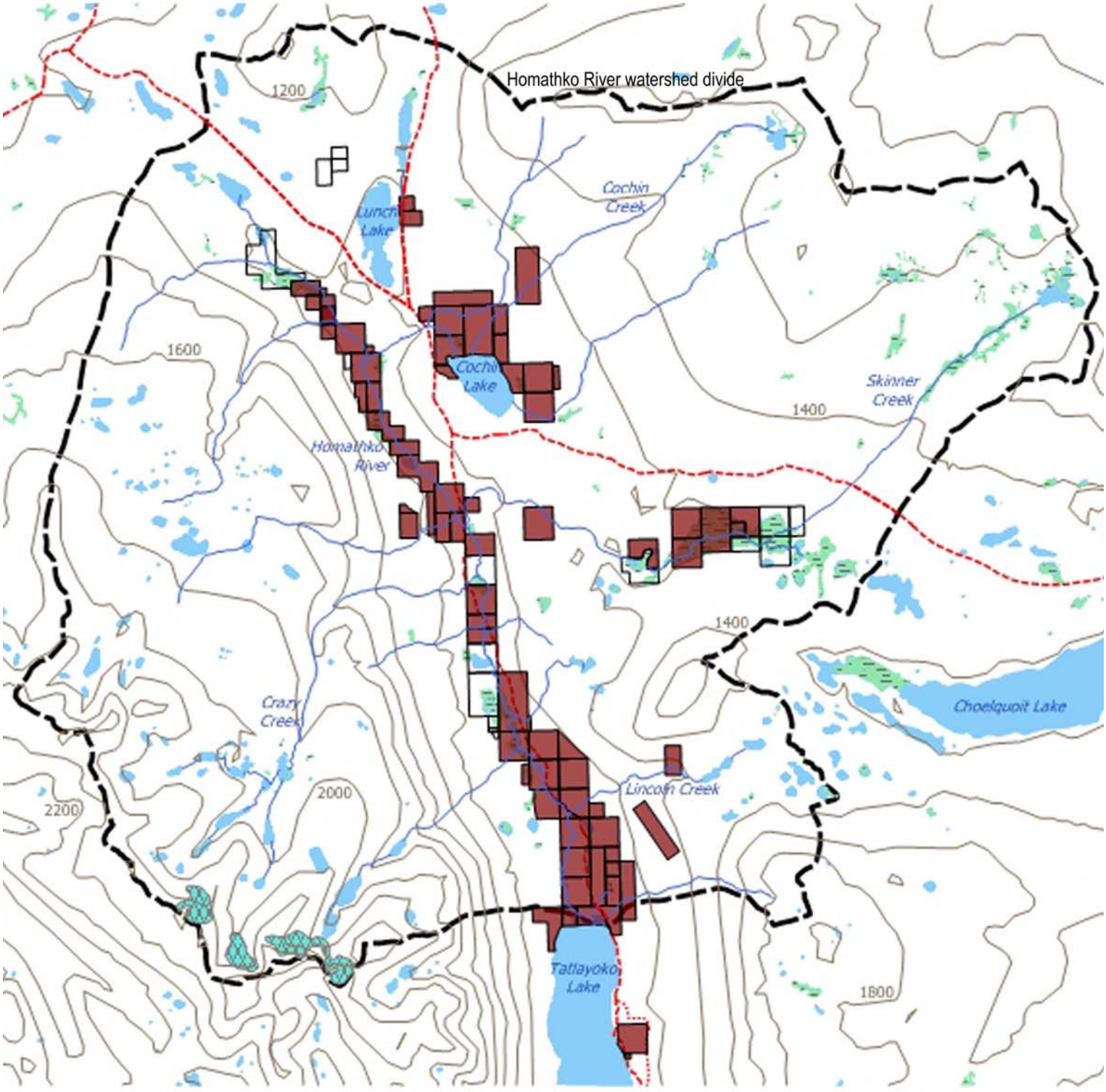
[1] Carried out by Bob Sagar, Tatlayoko Lake.
[2] Carried out by Ken MacKenzie, Lac la Hache and Leet Mueller (technician), Tatlayoko Lake.
[3] Ministry of Forests and Range. 2006. IAP Reference Guide.
(http://www.for.gov.bc.ca/hfp/invasive/documents/ReferenceGuide)

On August 30, 2007 a public information meeting was held at Lincoln Creek Ranch to present the preliminary inventory observations, to discuss the invasive plant control measures being considered for NCC properties, and to solicit input from residents concerning invasive plant management strategies for the valley.

Figure 1. Private and lease lots included in invasive plant inventory, 2007.



Red-coloured lots were included in the inventory.

Scale: 1: 150 000

3.0 INVASIVE PLANT INVENTORY

Surveys were conducted in both the dry warm Interior Douglas fir (IDFdw) and the Chilcotin variant dry, cool Interior Douglas fir (IDFdk4) biogeoclimatic units. The majority of IAP sites (76%) were found in the IDFdw unit which extends southward along the valley from the base of Park's Hill, despite approximately equal areas surveyed in each unit. IAP sites were found from 830 m elevation on the shores of Tatlayoko Lake to 1200 m, with almost 80% of detections below 950 m.

Ten of the legally designated invasive plants in the Cariboo Regional District have been identified in Tatlayoko Valley. All of these plant species have the potential to spread, displace native species, and decrease crop and habitat quality; however, five species are of critical concern.

3.1 CRITICAL INVASIVE ALIEN PLANTS

Among the five IAP species of critical concern in Tatlayoko Valley, four are found only in a few locations and aggressive action now may prevent establishment of a large, chronic infestation. The fifth critical species, Dalmatian toadflax, is already well established; therefore, and control actions should concentrate on reducing the current density of plants and preventing spread of the infestation.

Dalmatian toadflax (*Linaria dalmatica)* is the most widespread of the invasive plants in Tatlayoko Valley. Residents report that it was introduced to the southern part of the valley sometime in the period 1935-1950. During the mid to late 1990's it spread extensively on Lincoln Creek Ranch, especially in the cultivated field to the north of the ranch buildings, onto adjacent open hillsides, and in the weather station vicinity. In these areas, three polygons totaling 39.7 ha of near continuous, high-density toadflax distribution have been mapped (Figure 2). A fourth polygon on Lincoln Creek Ranch, encompassing 'Harry's Field', is 2.6 ha in area and has a low toadflax density.

The area of highest toadflax density in the valley extends southward from the north boundary of SW¼ of L 364 (approximately at Kerr's driveway) to the north end of Tatlayoko Lake. In this core area, the main infestation is east of Tatlayoko Road; however, smaller infestations are also present on private properties on the west side of the road. Toadflax is common along the roadside as far south as the airstrip area on the Tatlayoko Lake Ranch and its most southerly occurrence is at DL 1075 on the east side of Tatlayoko Lake, 3 km south of the north end of the lake. Northward from Lincoln Creek Ranch isolated occurrences are present along Tatlayoko Rd. and on nearby private land as far north as the Lunch Lake vicinity. Plants have also been found along the access to the Skinner Mountain mine and near the mine site itself.

A single yellow toadflax (*Linaria vulgaris*) site was identified within a grazing lease held by NCC (Figure 2). The patch is fairly small, only a few dozen stems and, being removed from public access, it was likely spread by livestock. All of the stems were pulled at the time of inventory.

A diffuse and spotted knapweed infestation on an NCC grazing lease has been established at least since 1994 and appears to be increasing in size (Figure 3). Chemical treatment has been applied periodically since 1994 and annual hand-pulling has taken place in recent years. In 2007, to provide detailed inventory information and to control the infestation, all 1375 plants in the 0.13 ha grazing lease polygon were counted and hand-pulled by NCC contractors.

An additional spotted knapweed infestation on private land site was identified during the 2007 inventory. The landowner was informed of the infestation and the need to control it. No follow-up visits were carried out.

A knapweed site has also been identified by valley residents at an inactive mining exploration site on Crown land on Skinner Mtn. In summer 2007 the writers hand-pulled all 260 plants within the 28 m^2 infestation area.

Sulfur cinquefoil (*Potentila recta*) was found for the first time in the Tatlayoko Valley in 2007 at two widely separated sites, one on Crown land along the main Tatlayoko Lake Road, and the other on NCC property (DL 222, Figure 3). The Crown land site, situated near the Tatlayoko Community Grounds, was identified by the Ministry of Forests and Range in July 2007 and was chemically treated by a Cariboo Regional District invasive plant control crew. The DL 222 infestation has not yet been treated.

3.2 LESS AGGRESSIVE INVASIVE ALIEN PLANTS

The following five, legally designated invasive plants were identified during the inventory, but they are considered to be lesser threats since they do not spread as rapidly. They are nevertheless persistent noxious weeds and their control is recommended in all cases except sowthistle.

Canada thistle (*Cirsium arvesis*) was found in a number of cultivated fields and pastures in the Tatlayoko Valley (Figure 4), including four dense infestations totaling 1.2 ha in area in NCC's Tatlayoko Lake Ranch pastures. Relative to elsewhere in the region, Canada thistle occurs sparsely in the valley. Awareness of this species by residents was found to be good.

Bull thistle (*Cirsium arvense*) was found at only two locations in the valley (Figure 4) and, in both cases, the residents are aware of the necessity for its control.

Oxeye daisy (*Chrysanthemum* leucanthemum) is found throughout the valley, primarily along roadsides, but also in a number of pastures (Figure 5). The largest infestation is along Tatlayoko Rd. near Cochin Lake. This species is persistent and can impact forage production. Perception of oxeye daisy was different than that of most other invasive alien plants; a number of landowners viewed it as a desirable wildflower. Increased education about the impacts of this species is recommended.

Scentless chamomile (*Matricaria maritima*) was found at several sites in the valley (Figure 5). Most of the sites were small, but one infestation on private land occupied almost one hectare and encompassed many thousands of plants. The perception of this species was similar to that of oxeye daisy, and a number of people considered it desirable.

Sowthistle (*Sonchus* spp) occurs in a number of locations (Figure 6), particularly in cultivated fields (including Tatlayoko Lake Ranch fields). This species is the least invasive of the designated IAPs and requires highly disturbed soil to become established. No actions are required to deal with this species, as it is unlikely to spread beyond cultivated fields.

TABLE 1. LEGALLY DESIGNATED INVASIVE ALIEN PLANTS IN THE CARIBOO REGIONAL DISTRICT.

Species	Scientific Name	Status
Anchusa	Anchusa officinalis	FRPA
Annual sowthistle	Sonchus oleraceus	WCA
Baby's breath	Gypsophila paniculata	FRPA
Black knapweed	Centaurea nigra	FRPA
Blueweed	Echium vulgare	WCA/FRPA
Brown knapweed	Centaurea jacea	FRPA
Bull thistle	Cirsium vulgare	FRPA
Burdock	Arctium spp	WCA/FRPA
Canada thistle	Cirsium arvense	WCA/FRPA
Common tansy	Tanacetum vulgare	FRPA
Crupina	Crupina vulgaris	WCA
Dalmatian toadflax	Linaria dalmatica	WCA/FRPA
Diffuse knapweed	Centaurea diffusa	WCA/FRPA
Dodder	Cuscuta spp	WCA
Field scabious	Knautia arvensis	FRPA
Hoary alyssum	Berteroa incana	FRPA
Hoary Cress	Cardaria draba	FRPA
Hound's-tongue	Cynoglossum officinale	WCA/FRPA
Japanese knotweed	Polygonum cuspidatum	FRPA
Jointed goatgrass	Aegilops cylindrica	WCA
Leafy spurge	Euphorbia esula	WCA/FRPA
Marsh thistle	Cirsium palustre	FRPA
Meadow hawkweed	Hieracium pilosella	FRPA
Meadow knapweed	Centaurea pratensis	FRPA
Nodding thistle	Carduus nutans	FRPA
Orange hawkweed	Hieracium aurantiacum	WCA/FRPA
Oxeye daisy	Chrysanthemum leucanthemum	WCA/FRPA
Perennial pepperweed	Lepidium latifolium	FRPA
Perennial sowthistle	Sonchus arvensis	WCA
Plumeless thistle	Carduus acanthoides	FRPA
Puncture vine	Tribulus terrestris	FRPA
Purple loosestrife	Lythrum salicaria	FRPA
Rush skeletonweed	Chondrilla juncea	WCA/FRPA
Russian knapweed	Acroptilon repens	FRPA
Scentless chamomile	Matricaria maritima	WCA/FRPA
Scotch thistle	Onopordum acanthium	FRPA
Spotted knapweed	Centaurea maculosa	WCA/FRPA
St. John's-wort	Hypericum perforatum	FRPA
Sulphur cinquefoil	Potentilla recta	FRPA
Tansy ragwort	Senecio jacobaea	WCA/FRPA
Teasel	Dipsacus fullonum	FRPA
Velvetleaf	Abutilon theophrasti	WCA
Yellow toadflax	Linaria vulgaris	WCA/FRPA

Notes:
Highlighted species are present in Tatlayoko Valley.
FRPA – Invasive plants specified in British Columbia Forest and Range Protection Act, Invasive Plants Regulation.
WCA – Noxious weeds designated in British Columbia Weed Control Act, Weed Control Regulation.

3.3 NON-DESIGNATED ALIEN AND NOXIOUS WEEDS

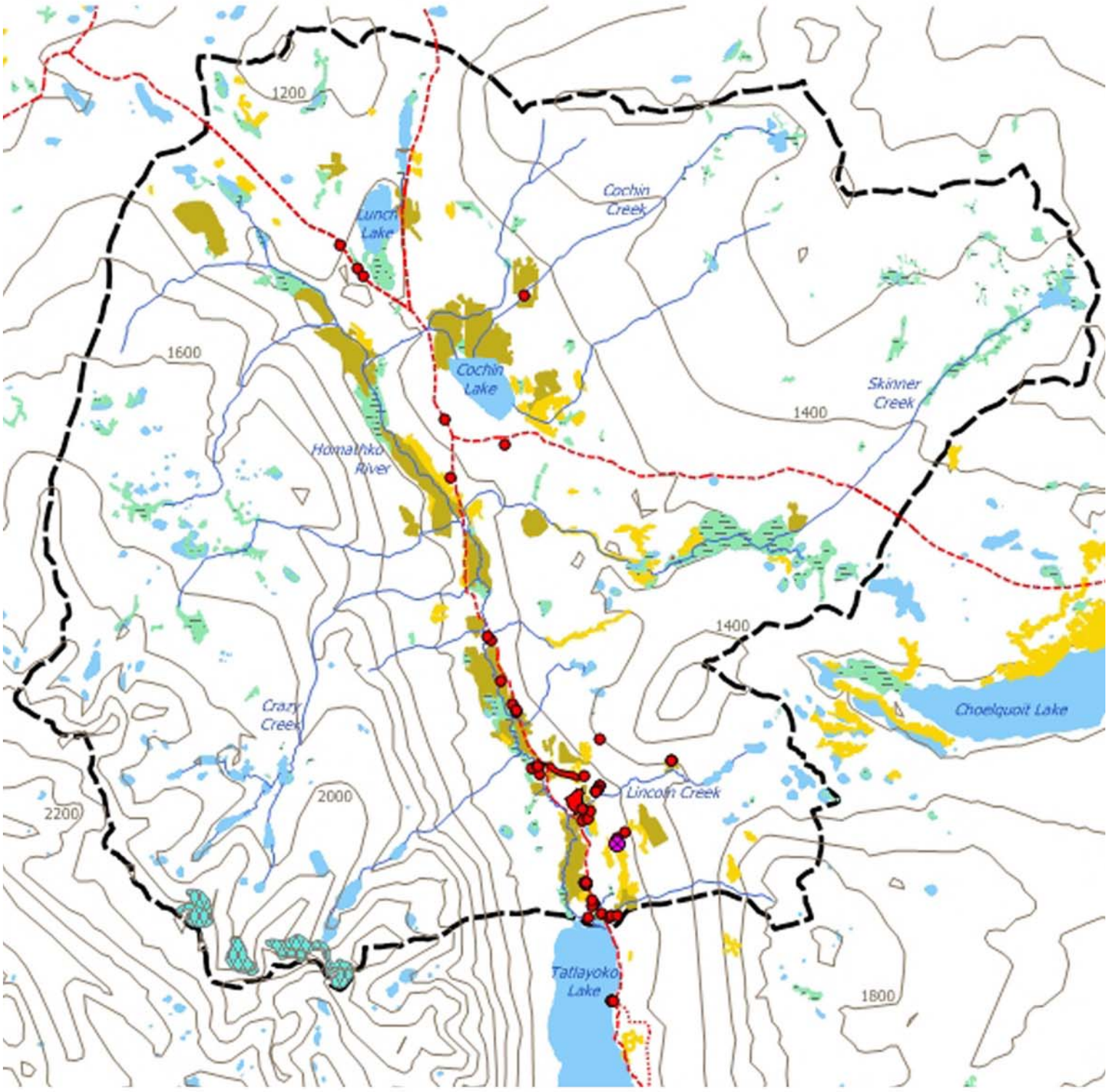
A number of other alien and noxious species were found throughout the valley. These species include stickseed (*Lappula* sp.), stinkweed (*Thlapsi arvense*), shepherd's purse (*Capsella bursa-pastoris*), sorrel (*Rumex* spp), pineappleweed (*Matricaria matricarioides*), meadow buttercup (*Ranunculus acris*), mullein (*Verbascum thapsus*), lamb's quarters (*Chenopodium album*), bladder campion (*Silene cucubalus*), night-flowering catchfly (*Silene noctiflora*), cress (*Cardaria* spp), flixweed (*Descurainia sophia*), tumble mustard (*Sisymbrium* spp.). Of these species, only bladder campion and curled dock (*Rumex crispus*) were submitted to the MoFR Invasive Alien Plant Program application.

These species are generally only found in disturbed or over-grazed areas, and usually will disappear after longer-lived vegetation becomes well established. Many of them are seed-banking and will quickly become established following ground disturbance. No actions are recommended for their control.

3.4 REGIONAL THREATS

On the list of legally-designated invasive alien plants in the region there are three species which have been identified as particular threats in the Chilcotin (McDonald, 2007) - orange hawkweed, yellow hawkweed, and leafy spurge. These species are regarded as high priorities for immediate treatment and eradication if found in Tatlayoko Valley. A fourth species, field scabious (*Knautia arvense*), is an invasive species present in the Central Chilcotin which is expected to be added to the list of high priority threats in the area.

Figure 2. Toadflax distribution in Tatlayoko Valley, 2007.



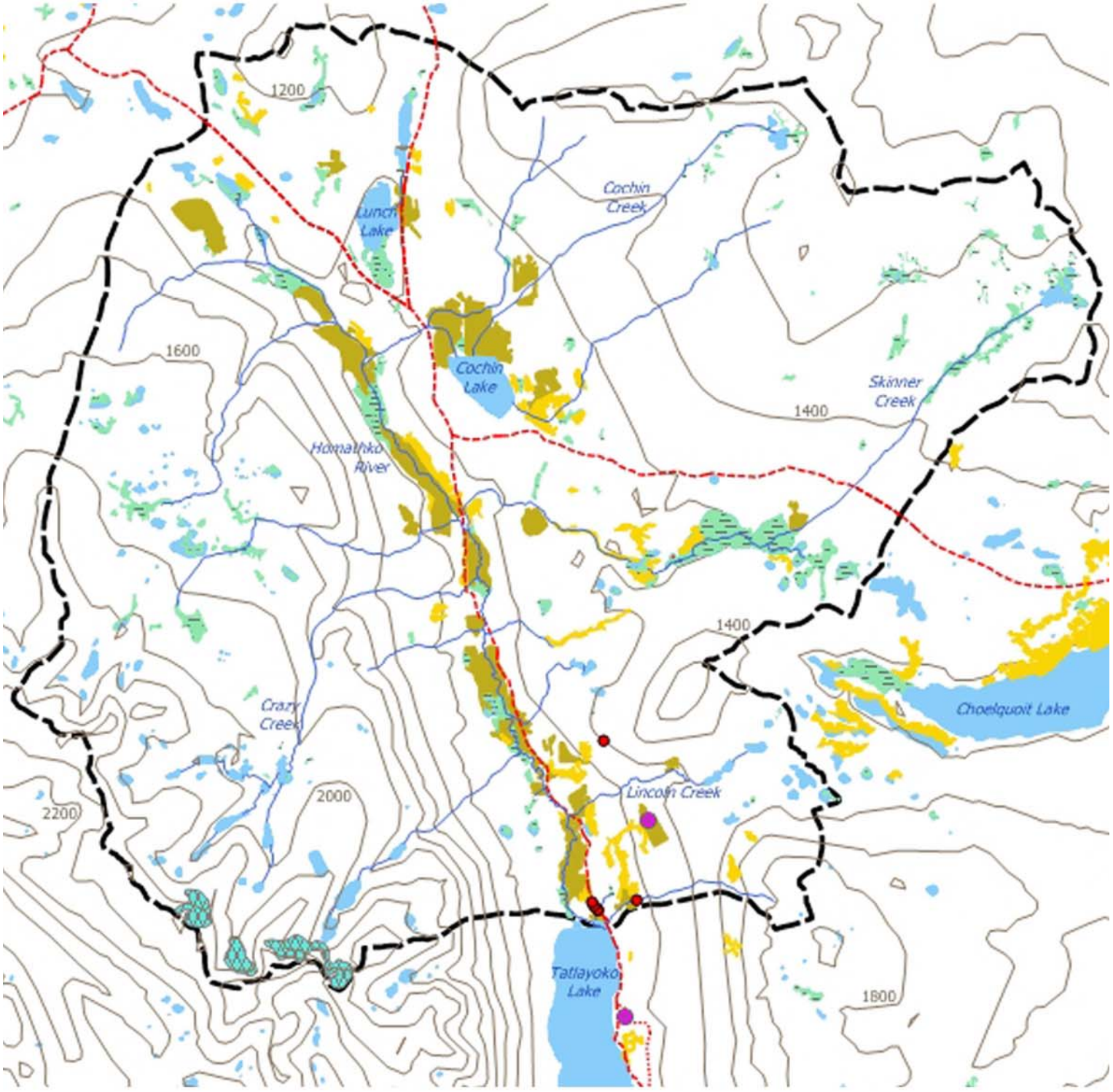
Legend:

- Dalmatian toadflax
- Yellow toadflax
- Wetland
- Grassland
- Cleared land

Scale: 1: 150 000
(1 cm = 1.5 km)

N

Figure 3. Knapweed and sulphur cinquefoil distribution in Tatlayoko Valley, 2007.



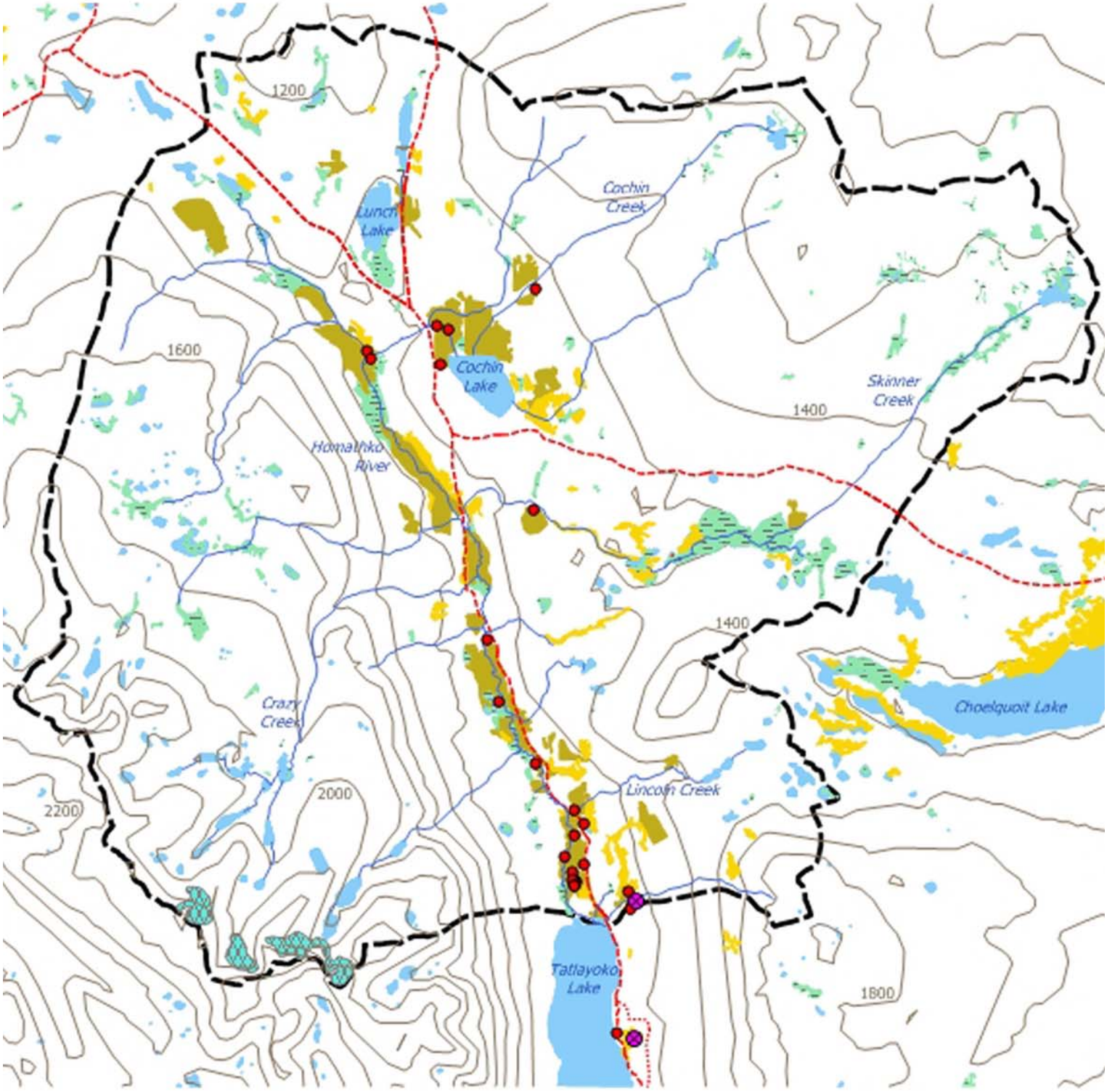
Legend:

- Knapweed (diffuse and spotted)
- Sulphur cinquefoil
- Wetland
- Grassland
- Cleared land

Scale: 1: 150 000
(1 cm = 1.5 km)

N

Figure 4. Canada thistle and bull thistle distribution in Tatlayoko Valley, 2007.



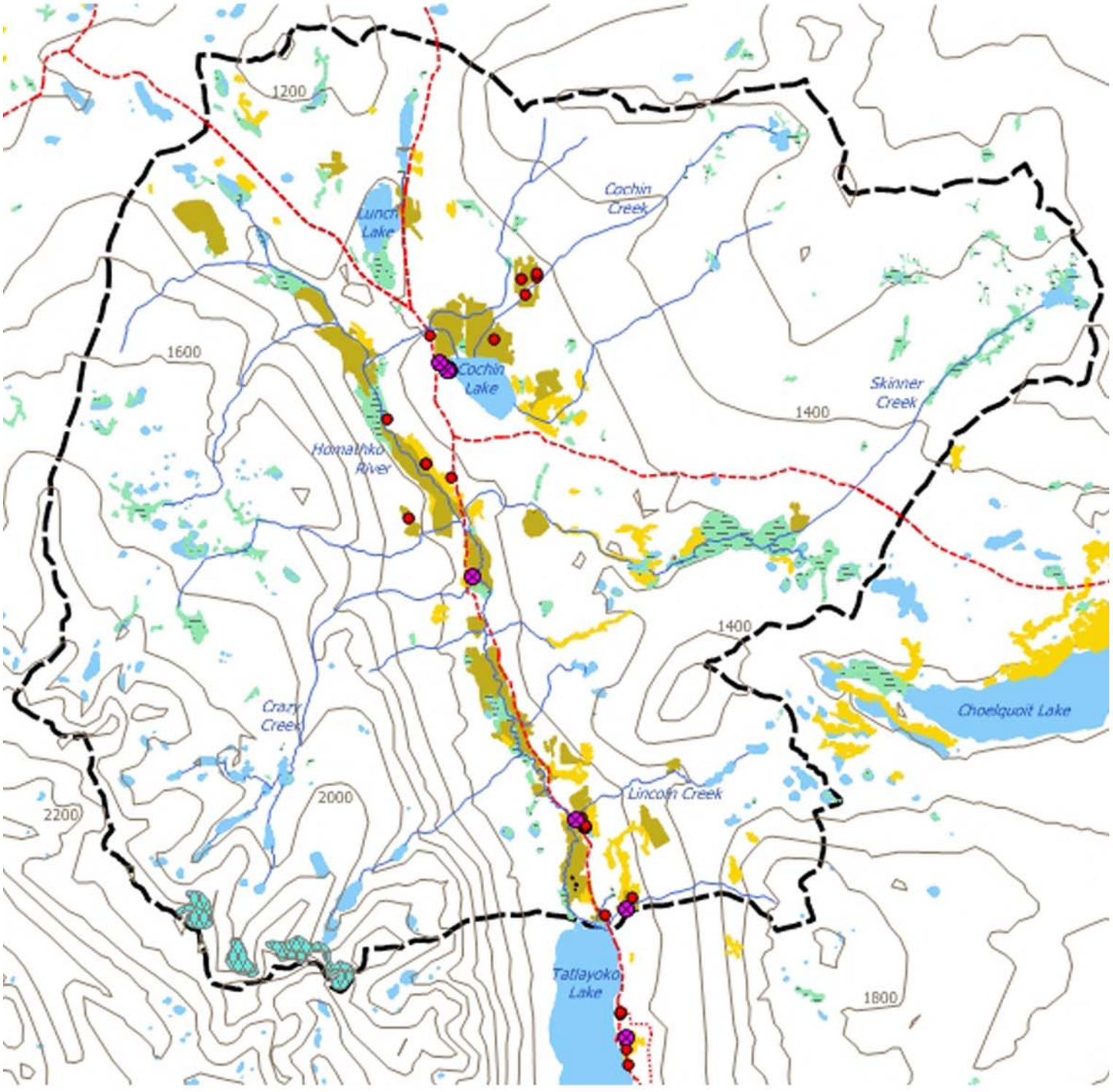
Legend:

- Canada thistle
- Bull thistle
- Wetland
- Grassland
- Cleared land

Scale: 1: 150 000
(1 cm = 1.5 km)

N

Figure 5. Oxeye daisy and scentless chamomile distribution in Tatlayoko Valley, 2007.



Legend:

- Oxeye daisy
- Scentless chamomile
- Wetland
- Grassland
- Cleared land

Scale: 1: 150 000
(1 cm = 1.5 km)

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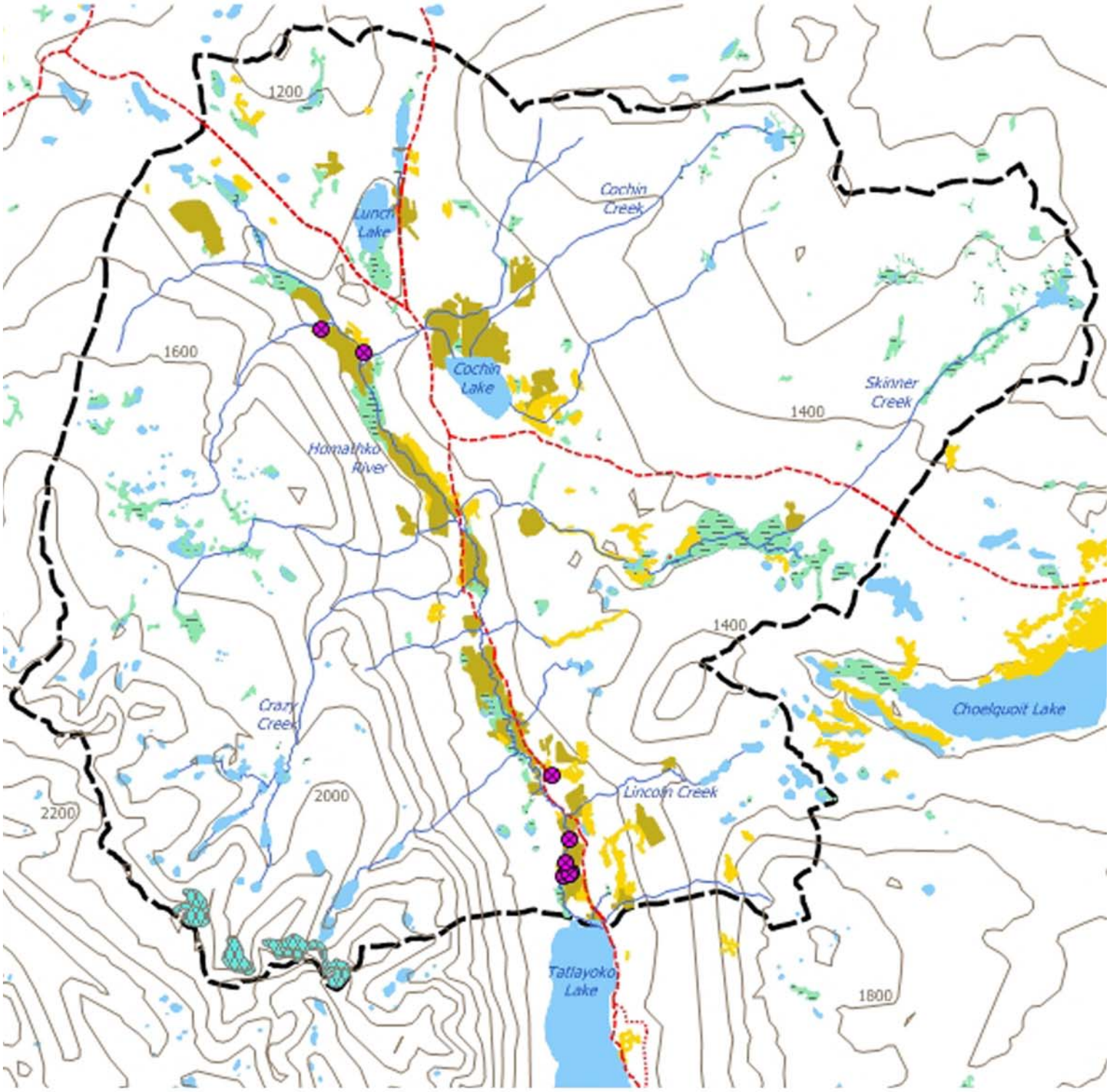
Figure 6. Sowthistle species distribution in Tatlayoko Valley, 2007.



Legend:

- Sowthistle species
- Wetland
- Grassland
- Cleared land

Scale: 1: 150 000
(1 cm = 1.5 km)

N

4.0 INVASIVE PLANT DESCRIPTION AND CONTROL

4.1 DALMATIAN AND YELLOW TOADFLAX

Dalmatian toadflax (*Linaria dalmatica*) and yellow toadflax (*Linaria vulgaris*) are perennial noxious weeds of the figwort family, introduced to North America from Eurasia. Toadflax grows in open to partially-shaded areas, but not under dense forest canopy. It is an aggressive invader along roadsides and other areas of disturbed ground, including overgrazed rangeland. Toadflax spreads by seed - producing up to 500,000 seeds per plant for Dalmatian toadflax - and vegetatively, by shoots from extensive root systems which can be over 3 m long (Carpenter and Murray 1998; Beck 2001). Both Dalmatian and yellow toadflax are cold-hardy and tend to prefer coarse-textured soils. In western Canada, Dalmatian toadflax has been found as far north as the Peace River region, while yellow toadflax has been recorded in Dawson Creek, Yukon (Vujnovic and Wein 1996; Saner et al. 1995).

There are a number of options for controlling toadflax, including hand-pulling, mowing, cultivation, biocontrol, and chemical methods. Cutting and mowing of toadflax can be used to prevent seed production and weaken the plants; however, hand-pulling, which removes a portion of the root mass, is considered more effective. Manual and mechanical methods must be carried out consistently for a period of at least 10 years. On a 28-acre property in Washington state hand-pulling was found to be effective in eliminating most toadflax within a 10 year period (Carpenter and Murray 1998). Intense cultivation for two years (8-10 times in year one and 4-5 times in year two) has also proven effective (Morshita 1991).

It has been reported in the literature that grazing by livestock is not an effective control for toadflax, due to the plant being unpalatable and because livestock disturbance of the ground can favour toadflax over grasses; however, anecdotal observations of cattle grazing of toadflax in a pasture at Lincoln Creek Ranch during the 2006 and 2007 summers suggest declining toadflax density. NCC has initiated a program to monitor the effects of cattle grazing (amongst other control measures) on the toadflax infestation at Lincoln Creek Ranch (see Mellott, 2007).

A number of herbicides including picloram (Tordon©), dicamba and glycophosphate have been shown to be effective in controlling toadflax (Carpenter and Murray 1998). Paterson (pers. comm.) of the Regional District of East Kootenay has obtained good toadflax control by boom spraying with Tordon on infestations of up to 2 hectares. He recommends spring spraying (when plants are young and actively growing) with a combination of Tordon and 2/4-D along with a surfactant (Silgard 309).

Biocontrol agents being used in British Columbia include *Brachypterolus pulicarius* (shoot- and flower-feeding beetle), *Calophsia lunula* (defoliating moth), *Etoibalea intermediella* (root-boring moth) , *Gymnaetron antirrhini* (seed-eating weevil), *Rhinusa antirrhini* (seed-eating weevil), and *Mecinus janthinus* (stem-boring weevil) (Wikeem and Wikeem 2002). In most cases, these agents are still being tested with varying levels of success being reported.
In the southern interior of British Columbia *Mecinus janthinus* has reached high population levels and proven effective at controlling toadflax populations (Folkard, pers. comm.). In early summer 2005 an estimated 250 surviving *Mecinus janthinus*[4] were released at three sites on Lincoln Creek Ranch and 50 were released close to Tatlayoko Lake at the south boundary of an NCC grazing lease (W ½ of E ½ of L.

[4] A total of 600 weevils had been provided by the Ministry of Forests and Range, Kamloops; however, approximately half died in transit (Mueller, pers. comm.).

366). In May 2007, three thousand *M. janthinus* were released in two locations at Lincoln Creek Ranch (Figure 7).[5]

Rhinusa antirrhini has also proven to be an effective toadflax control in the Southern Interior when used in conjunction with *M. janthinus* (Folkard, pers. comm.). In September 2007, two hundred *R. antirrhini*[6] were released at Lincoln Creek Ranch (Figure 7). NCC has established a program to monitor the effectiveness of these biocontrol agents at Lincoln Creek Ranch (Mellott, 2007).

There is some question whether the climate of Tatlayoko Valley will be suitable for the survival and flourishing of *M. janthinus*. McClay and Hughes (2007) formulated a simple model which can be used to predict the amount of time it takes *M. janthinus* to reach adulthood from the time of oviposition, based on hourly air temperatures. It is crucial that the weevil reaches the adult stage before overwintering in toadflax stems. The model calculates a *cumulative development index* in which a value of 1.0 corresponds to 50% of the eggs laid at the beginning of the season reaching adulthood. McClay and Hughes compared two sites where *M. janthinus* had been released and monitored for at least 10 years. One of the sites was near Grand Forks, British Columbia, where the cumulative development index averaged 1.75 and the other was near Camrose, Alberta, where cumulative development index averaged 1.17. The populations of *M. janthinus* at the Grand Forks site reached outbreak levels, causing heavy damage to toadflax, while those in Camrose did not reach damaging levels.

Climate data for the past five years at the automated weather station located on the Lincoln Creek Ranch were used to calculate cumulative development indices. The totals ranged from 0.84 to 1.09 with the average being 0.99. These numbers suggest that *M. janthinus* populations may have difficulty reaching high levels in Tatlayoko Lake due to lack of summer heat. Another potential problem is that winter mortality of *M. janthinus* is very high when air temperatures drop to –28 ° C or lower (De Clerck-Floate and Miller 2002). It was found that the insulating effect of snowcover allowed *M. janthinus* to survive air temperatures of –40 ° C in Alberta. In Tatlayoko Lake, extreme winter temperatures are often below –30 ° C and snowcover is frequently low, especially in the southern part of the valley near Tatlayoko Lake.

4.2 SPOTTED AND DIFFUSE KNAPWEED

Spotted (*Centaurea maculosa*) and diffuse knapweed (*Centaurea diffusa*) are noxious weeds introduced to North America from Europe about 100 years ago (Watson and Renney 1974). They are found in grassland, disturbed sites such as roadsides, and open forests, but not under dense forest canopy. Knapweed has become a serious invader on rangeland in the semi-arid areas of western North America, including the southern interior of British Columbia. Both species aggressively suppress native grasses by releasing allelopathic compounds (Fletcher and Renney 1963) into the soil and by forming dense stands. They act either as annuals, biennials, or short-lived perennials which reproduce primarily by seed (with up to 140,000 seeds per square metre in the case of spotted knapweed). They tend to invade disturbed land such as overgrazed rangeland, but can spread into healthy rangeland when they reach high populations. Methods of seed dispersal include livestock, vehicles and, in the case of diffuse knapweed, by wind moving the plant tops in a tumbleweed-like fashion.

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[5] These weevils were collected by Ministry of Forests and Range (Percy Folkard and staff) near Kamloops and released by the Cariboo Regional District (Allison MacDonald and staff).

[6] Provided by the Ministry of Forests and Range, Kamloops.

A number of herbicides, including picloram, dicamba, 2,4-D, clopryalid and glycophosphate have proven effective in controlling knapweed. Picloram is the most effective herbicide but it can linger in the soil and cause damage to other plants (Watson and Renney 1974; Beck 2003).

Hand-pulling can eradicate small infestations if carried out repeatedly and thoroughly. One issue with hand-pulling is that it can cause too much soil disturbance, which can actually favour knapweed. Cutting or mowing the plants avoids this soil disturbance, but cut plants can survive to bolt again and produce seed.

A myriad of biocontrol insects are being tried on diffuse and spotted knapweed with none able to control infestations by themselves. Some researchers have suggested that a combination of different biocontrol insects may be most effective (Beck 2003). In any case, the Tatlayoko Valley infestations remain too small for establishment of biocontrol agents.

Grazing by cattle or sheep (especially sheep) has been shown to have some efficacy for controlling spotted knapweed, while diffuse knapweed is more spiny and unpalatable to livestock.

In some cases fire has shown promise for knapweed control (Zimmerman 1997). With the right conditions and timing fire may kill knapweed and stimulate growth of grasses which out-compete the surviving knapweed.

4.3 SULPHUR CINQUEFOIL

Sulphur cinquefoil, *Potentilla recta*, is a perennial noxious weed introduced into North America from Eurasia. It occupies a wide variety of habitats, ranging from dry to moist, including roadsides, disturbed land, and overgrazed pastures (Douglas et al. 1999). It has also been reported to displace natural vegetation in undisturbed grassland and dry forest habitats (Endress and Parks 2004). Sulphur cinquefoil can spread both vegetatively (sprouting from roots) and by seeds.

Sulphur cinquefoil is present throughout most of the United States and southern Canada, including southern British Columbia. It is commonly found in sites also containing diffuse knapweed (Powell 1996).

Some forms of chemical control have been found effective against sulphur cinquefoil including Picloram, clopyralid, and 2,4-D (Wikeem and Wikeem 2002). Small infestations can be effectively controlled by hand digging, as long as care is taken to remove as many root fragments as possible. Tilling and reseeding with grass can provide effective control on agricultural land. No effective biocontrols have been found to date, but testing of several candidates is proceeding.

4.4 CANADA THISTLE

Canada thistle, *Cirsium arvense*, is a noxious weed introduced to North America from the Mediterranean region of southern Europe. It prefers finer-textured soils and moderate annual precipitation of 450-900 cm (Wikeem and Wikeem 2002). Canada thistle infests both crop and pasture lands. It also can be a problem in wetland and riparian areas. Newly cultivated fields are especially susceptible to infestation if thistle seedlings can get established before they are outcompeted by the planted crop. Canada thistle reproduces both by seeds and vegetatively through shoots from its extensive root system. Taproots can extend as much as 6.75 m into the soil in order to reach the water table, while horizontal root growth can be up to 6 m per year (Rogers 1928).

Canada thistle is widespread throughout all parts of British Columbia. Scattered small patches of Canada thistle have been found throughout the Tatlayoko Valley. It is unlikely to be a problem on the drier side slopes of the valley and is mainly a threat to agricultural and riparian areas in the valley bottom.

A number of mechanical control methods can be effective against Canada thistle. Mowing or hand-cutting can cause the plant to expend its extensive root food reserves over several growing seasons while also preventing seed production (Nuzzo 1998). Monthly cutting has been found to be critical to its success; mowing only during haying can actually stimulate the plant (Beck 2003). Similarly, intensive cultivation can also be effective but must be carried out frequently for numerous years to avoid re-establishment from root fragments.

Cultural practices such as fertilization to encourage growth of competing crops can be effective because Canada thistle is shade intolerant. The kind and amount of fertilizer is important, as too much nitrogen may favour the thistle (Beck 2003).

A number of herbicides including picloram, clopyralid plus 2,4-D, clopyralid alone, dicamba, 2,4-D alone, and chlorsulfuron have been found effective in controlling Canada thistle, especially when combined with mechanical and cultural control methods (Nuzzo 1998).

Biocontrol agents released on Canada thistle in British Columbia have not had much success. A seed weevil, *Larinus planus*, and a stem gall fly, *Urophora carduii*, are being tested (Wikeem and Wikeem 2002). Use of *Larinus planus* at Tatlayoko Lake Ranch has been considered; however, the weevils are collected in the Okanagan and first indications are that the timing of thistle flowering in the Cariboo and Chilcotin would not be suitable (Folkard, pers. comm.).

4.5 Bull thistle

Bull thistle is a coarse, spiny, unpalatable weed which can spread aggressively in open areas such as roadsides, fields, and other areas of disturbed soils. It is common throughout the province and region, but it was mapped at only two locations in Tatlayoko Valley during the inventory, and reported at one additional location during the initial presence-absence survey. Isolated occurrences of bull thistle can be controlled by repeated cutting or mowing. Chemical treatments with picloram, dicamba, glyphosate, or 2,4-D are also effective (Wikeem and Wikeem 2002).

4.6 Oxeye daisy

Oxeye Daisy, *Leucanthemum vulgare*, is a short-lived perennial noxious weed introduced from Eurasia. In British Columbia it is common south of latitude 56° N. Oxeye daisy is often found along roadsides and disturbed forestry sites such as landings and skid trails (Wikeem and Wikeem 2002) and can become a major problem in pasture and cropland. Oxeye daisy reproduces vegetatively and from roots. It is unpalatable to cattle but favoured by sheep and goats.

Hand-pulling or digging of plants for small infestations before seed production can be effective for oxeye daisy control. Sheep and goats can provide control by selectively grazing oxeye daisy. Maintenance of healthy plant communities by nitrogen fertilization combined with herbicide applications has also been

found to be effective (Wikeem and Wikeem 2002). The herbicide Milestone© (aminopyralid) is used by the Ministry of Forests and Range for oxeye daisy control (Folkard, pers. comm.).

4.7 SCENTLESS CHAMOMILE

Scentless chamomile, *Matricaria perforata*, is a noxious weed with an annual, biennial or short-lived perennial growth habit. It is widely distributed across North America and in British Columbia it occurs in all agricultural regions (Wikeem and Wikeem 2002). It prefers fine-textured soils in areas along water with periodic flooding (Alberta Government 2001). It can be a problem in hayfields, pastures and cultivated crops. It reproduces via copious seed production of up to one million seeds per plant which can be effectively dispersed by wind and water.

Hand-pulling of young plants before they go to seed is a good way to prevent establishment of scentless chamomile. Frequent shallow tilling will provide good control on agricultural land (Government of Alberta 2001). Mowing will limit seed production; however, new flowers will form beneath the cut line. Burning of seed heads destroys seeds and helps prevent spread. A seed-head weevil (*Omphalapoin hookeri*) and a stem-boring weevil (*Microplontus endentulus*) are being tested as biocontrol agents in British Columbia (Wikeem and Wikeem 2002). Maintaining competition by encouragement of desirable plant communities is important for controlling and preventing scentless chamomile infestations. Picloram, dicamba, and MCPP are effective for control in uncropped areas.

5.0 CONTROL MEASURES FOR NATURE CONSERVANCY LANDS

In general, an *integrated pest management* approach should be adopted (Ministry of Forests and Range 2007); that is, control should include a combination of biological, mechanical and chemical means together with measures to restore areas of degraded land. Without restoration of degraded areas, reinvasion by noxious weeds is very likely. It is recommended that the use of herbicides be minimized wherever possible; however, for small patches of aggressive noxious weeds, a risk management approach should be used, in which the risks of a one-time use of herbicide on a small area of land are weighed against the risk of the noxious weed spreading and degrading large areas of natural habitat. The noxious weeds on NCC lands for which specific control measures are required are Dalmatian and yellow toadflax, spotted and diffuse knapweed, Canada thistle, sulphur cinquefoil, and oxeye daisy.

5.1 DALMATIAN TOADFLAX

Dalmatian toadflax has reached outbreak proportions on Lincoln Creek Ranch and adjoining properties. According to staff of the Cariboo Regional District and the Ministry of Forests and Range, this is the largest infestation in the Cariboo-Chilcotin and may be the largest contiguous tract of infested land in the province.

The size of this infestation makes eradication unlikely and the use of herbicides for control of the infestation impractical and undesirable. Spraying such a large area with picloram would be costly and risk contamination of groundwater and surface runoff. Picloram will also damage or kill other broadleaf plants including trees, and possibly have a residual effect for several years. Furthermore, large-scale herbicide use within the valley is not considered acceptable by many residents.

In the core infestation area the focus should be on reducing the plant density and on controlling the spread of toadflax to uninfested areas. Particular effort should be made to remove toadflax along routes travelled by vehicles within and between NCC properties. Toadflax currently extends 500 m east of Lincoln Creek Ranch along the road to the Lincoln Pass property and, since it is established on the road itself, it can readily be transported upslope. A single toadflax plant found (and hand-pulled) at Lincoln Pass during the 2007 inventory was likely established by this means. Similarly, the back road to Skinner Meadows should be monitored for toadflax; an isolated patch was found and hand-pulled on a branch of this road, close to the Skinner Mine site. If hand-pulling is not feasible due to plant abundance, then weed-whacking or mowing should be carried out.

The roadsides adjoining the airstrip area of the Tatlayoko Lake Ranch should be another focus area for toadflax control efforts. Where competing vegetation is well established, toadflax should be hand-pulled, weed-whacked, or mowed. In areas of exposed soil such as the airstrip, grass should be re-established in order to control toadflax and other invasive species, currently including knapweed and mullein.

Despite the apparent climatic constraints, continued use of *M. janthinus* as a biocontrol agent is advised, given that the control options for the core infestation of toadflax are limited. Additional releases of *M. janthinus* over the next three years are recommended together with monitoring of release sites for evidence of overwinter survival. It is hoped that at least a small population can be established, and that the weather will allow for an outbreak at some point. It would also be desirable to release additional biocontrol agents, in an effort to find some that are adapted to the Tatlayoko Valley climate. NCC's monitoring program will examine the efficacy of the biocontrol releases.

Another control strategy being tried at the present is grazing by cattle in the large field north of the Lincoln Creek Ranch yard. It appears that the cattle have been eating toadflax flowers, thus limiting seed production and possibly reducing the toadflax populations in the grazed area. These observations will be tested through the monitoring of toadflax population transects which were established during the summer of 2007 (see Mellott, 2007). Continuation of the mid and late summer grazing is recommended in order to control toadflax seed production in this field.

If NCC chooses to discontinue grazing of the Lincoln Creek Ranch field, an additional toadflax control strategy would be to re-establish the area as pine and mixed forest. Toadflax, which occupies open land and transitional woodland-grassland sites (Powell et al. 1994; Carpenter and Murray 1998), would not thrive under a pine forest canopy. Forest re-establishment would be a long-term approach, and one which would only be justified by other land management purposes (to be set out in NCC's agricultural and management plans in preparation).

5.2 YELLOW TOADFLAX

The inventory identified a small, isolated yellow toadflax patch within an NCC grazing lease (SE¼ of L. 365). Close monitoring and control by hand-pulling are recommended.

5.3 SPOTTED AND DIFFUSE KNAPWEED

The small area of (mainly) spotted knapweed and diffuse knapweed, on the grazing lease adjacent to the south end of the airstrip (W ½ of E ½ of L. 366), should be given a high priority for control and eradication. There is potential for knapweed to spread widely within Tatlayoko Valley, as much suitable habitat is available.

A combined program of grazing management, hand digging, and herbicide applications is recommended. If possible, livestock should be excluded from the area of knapweed infestation. This will prevent soil disturbance, encourage growth of native grasses and prevent the spread of knapweed seeds. A thorough hand-pulling of bolting rosettes should take place just prior to flowering and a further pulling should follow within about four weeks to remove any bolting knapweed that was missed. An early September application of picloram on rosettes should then be carried out, with a final inspection in October to remove any dried seed heads. Hand-pulling and spot applications of herbicide will need to continue for an extended period of time - up to 10 years - to exhaust the soil seed bank.

Monitoring should consist of annual mapping of the infested area boundary, together with a count of the number of hand-pulled plants.

5.4 SULPHUR CINQUEFOIL

Since this noxious weed is confined to a small patch on DL 222 there is a good opportunity for its eradication. Control of this plant is a high priority because it is an aggressive invader which could find much suitable habitat in Tatlayoko Valley. It's recommended that, as soon as the patch is in flower, it should be removed by hand digging. Alternatively, the plants could be treated with picloram (Tordon). Any subsequent germinants should be hand dug. The site and surrounding area will need to be monitored for a number of years with any new growth being manually removed or treated with spot applications of picloram.

5.5 CANADA THISTLE

Four polygons of Canada thistle totaling 1.2 ha in area have been mapped in Tatlayoko Lake Ranch pastures and hayfields on both sides of the Homathko River riparian zone. If thistle becomes established in the Homathko River riparian zone or in the wetland area north of the lake, it has the potential to dominate these areas causing degradation of important wildlife habitat. The existing infestations on the ranch should be given a high priority for control and eradication.

The use of repeated mowing is recommended to prevent any seed production and, more importantly, to deplete root energy reserves of Canada thistle. Depending on the distribution of thistle within the hayfield, mowing could be carried out either with a hand-held brush saw (with a flail attachment) or with a tractor and mower. The mowing should take place 3 or 4 times per year and may need to be continued for up to 4 years. Nuzzo (1998) suggests that cutting should be at a height which retains at least 9 leaves or about 20 cm of bare stem, because mature leaves inhibit the development of shoots from root buds.

The first step in this process will be to map precisely the Canada thistle patches within the fields and near the metal barn. Patches should be staked to aid the cutting process. It will be important to cut a large enough area to include all shoots. After the Canada thistle has been controlled the treated areas may need to be reseeded and possibly fertilized. Establishment of a good stand of alfalfa and grasses should prevent reinfestation. Monitoring of treatment effectiveness should consist of annual mapping of patch size and density.

Hay harvested in fields containing Canada thistle should not be transported off Tatlayoko Lake Ranch, unless the NCC Project Manager is confident that the plants had not set seed at the time of harvest.

5.6 OXEYE DAISY

The minor oxeye daisy infestation on Lincoln Creek Ranch should be hand-pulled as soon as flowers emerge, followed by monitoring for regrowth and additional infestations.

5.7 ANNUAL INVENTORIES

It is recommended that NCC conduct annual inventories to monitor existing invasive plant infestations on their properties and to identify any new threats. This inventory information should be provided as a layer on their GIS maps and, if feasible, be entered into the Invasive Alien Plant Program (IAPP) database. If resources are available, further inventory work in Tatlayoko Valley would also be valuable, in order to identify any new threats (particularly in areas not yet surveyed) and to monitor the changing distribution of existing invasive plants.

6.0 MANAGEMENT STRATEGIES FOR TATLAYOKO VALLEY

The inventory of invasive plants in Tatlayoko valley has revealed that, with the exception of toadflax, invasive plant populations are still at a level at which they can be effectively controlled. The infestations of yellow toadflax, sulphur cinquefoil, and spotted and diffuse knapweed, pose critical threats, but are established in only a few sites and could be eradicated with effective treatment. Several less aggressive species identified - in particular Canada thistle, bull thistle, oxeye daisy, and scentless chamomile - are more widespread but could be controlled with careful management practices.

6.1 TOADFLAX CONTAINMENT

The 2007 inventory identified an area of denser toadflax infestation extending southward from the north boundary of SW¼ of L 364 (approximately at Kerr's driveway) to Tatlayoko Lake. Both northward and southward of this zone toadflax occurs at widely scattered sites with less dense infestation. Toadflax removal at these sparser sites is vital to the control of further, widespread dispersal of the plant within the valley and elsewhere [7].

Much of the core infestation area is within NCC properties where a comprehensive control strategy is being implemented to contain and reduce the infestation (see Section 5.1). For the dispersed occurrences (as for other noxious weeds), community action (Section 6.2) and involvement of regional agencies (Section 6.3) are recommended.

6.2 EDUCATION AND COMMUNITY INVOLVEMENT

Active involvement of landowners and tenure holders is essential for controlling noxious weeds and preventing additional infestations. Tatlayoko residents are aware of the prevalent noxious weeds such as Dalmatian toadflax, knapweed, Canada thistle, and bull thistle; however, the threats posed by other invasive species, such as sulphur cinquefoil, scentless chamomile, and oxeye daisy are less well known. Residents should also become familiar with four additional species present elsewhere in the region which should be treated immediately if discovered in the valley: orange hawkweed, yellow hawkweed, leafy spurge, and field scabious.

An ongoing program of noxious weed education would be beneficial. This program would inform residents about noxious weeds known to be present in the community and about weeds in the Cariboo-Chilcotin which are potential invaders. One possibility would be to form a local weed committee to coordinate community education and control initiatives. Representation by the Tatla Lake Livestock Association, Nature Conservancy of Canada, the Tatla Resource Association, the Eniyud Community Forest (currently under application), the Tatla Lake and Tatlayoko Lake Community Associations, as well as interested community residents would be beneficial.

A local weed committee could organize an annual summer field day to identify and hand-pull or weed-whack toadflax outside the core infestation area as well as any other invasive plant species within the valley. A record of weed location, density, extent, and treatment (especially during the field day) could be

[7] Outside the study area a significant patch of toadflax was found and hand-pulled on Hwy 20, 1.5 km west of Tatla Lake; this occurrence suggests seed transfer by vehicle from a Tatlayoko Valley source, and underscores the need for aggressive control measures.

maintained by the weed committee (and possibly submitted to the IAPP database). Such active involvement of valley residents will be essential to control of noxious weeds.

It is recommended that NCC prepare an information pamphlet for general distribution in the Tatlayoko/Tatla Lake community, describing existing invasive plants, regional threats, and control and prevention strategies. The pamphlet could be mailed individually to Tatlayoko residents who participated in the 2007 inventory with inclusion of details of the noxious weeds identified on their properties. In the same mailing an offer could be made to provide any additional information regarding NCC's invasive plant inventory, control measures, and monitoring programs.

Establishment of signage in the valley to inform residents and visitors of the invasive plant threat would also be beneficial. Some signs could identify the invasive plants present in the valley as well as the regional threats and could outline prevention and control measures. Signs could also identify specific infestations and treatments, such as the knapweed site on NCC's grazing lease. Identification of a core toadflax area would be very helpful, together with a request for public assistance in toadflax removal from outlying areas.

6.3 COMMUNICATIONS WITH REGIONAL AGENCIES

A crucial aspect of noxious weed prevention and management efforts is communication amongst stakeholders - such as NCC, local residents, and Crown tenure holders - and the various government agencies responsible for land management. Government agencies can keep local interests apprised of noxious weed threats in the region and provide assistance with control measures; and local landowners can provide valuable information to government agencies regarding the location and extent of noxious weed infestations.

The regional umbrella organization for noxious weed management is the Cariboo Chilcotin Coast Invasive Plant Committee (CCCIPC) based in Williams Lake[8]. This organization was formed in 2006 to provide a forum for cooperation amongst the various government agencies and other stakeholders. Tatlayoko Valley participation in the activities of this organization would support the community's invasive plant control efforts and would provide the committee with information relating to West Chilcotin conditions.

The Ministry of Forests and Range, Southern Interior Forest Region (SIFR) is responsible for invasive plant management on Crown land. The Ministry actively treats rangeland in Tatlayoko Valley, with a particular focus on knapweed, and including a 2007 identification and treatment of a sulphur cinquefoil patch near Tatlayoko Lake. The SIFR has been supporting toadflax biocontrol efforts in the valley by provision of biocontrol agents and providing advice regarding control practices.

The Cariboo Regional District (CRD) has regulatory responsibility for noxious weed management on private land. The CRD conducts education initiatives to inform the public about noxious weed issues; assists property owners with identification and control of noxious weeds; operates a spray program on road rights-of-way and on private properties infested with knapweed; contributes to maintenance of the Invasive Alien Plant Program database; and participates in the CCCIPC.

[8] Cariboo Chilcotin Coast Invasive Plant Committee, Mike Simpson, Coordinator; c/o Fraser Basin Council, Williams Lake

6.4 Livestock management

Livestock should be fed hay produced on the ranch or from sources known to be free of noxious weeds. Winter feeding areas should be closely monitored for invasive plants during the growing season. Supplemental feeding should be discontinued several days before livestock are turned out on rangeland.

Pastures and rangeland should be managed to ensure that overgrazing does not occur. Good practices include not grazing below minimum stubble heights; not turning out livestock prior to initial spring growth; and discontinuing fall grazing early enough to allow regrowth to replenish grass energy reserves. Grazing wet pastures should be avoided to minimize soil exposure and compaction by livestock. Where possible, ranchers should avoid grazing of weed-infested areas on Crown range.

Livestock which are brought in from other areas should be kept in a confined area for several days to allow any digested weed seeds to be eliminated and any weed seeds on coats or hooves to drop off.

6.5 Crop management

Hayfields should be managed to maintain dense forage crop cover in order to inhibit invasive plant establishment. Only certified weed-free seed should be use when reseeding hayfields and pastures. The presence of noxious weeds which can be spread by root fragments, such as Canada thistle, should be evaluated prior to cultivation operations. It may be necessary to postpone cultivation until weeds are eliminated. Measures should also be taken to ensure good germination and establishment of the forage crop, for example, by irrigation and maintenance of adequate fertility. Where irrigation is not possible, fields should be seeded in late fall to allow for spring germination.

6.6 Soil disturbance

Soil disturbance caused by activities such as fencing, building construction, or excavation should be reseeded promptly with certified seed and monitored closely for noxious weeds. Fill sources, such as sand and gravel pits, should be inspected for noxious weeds before using the fill. Existing areas of soil disturbance or degraded pasture should be revegetated. The airstrip area at Tatlayoko Lake Ranch, which is host to several invasive plant species is an example.

6.7 Equipment Use

All equipment entering private land, especially from outside the valley, should be cleaned before commencing operations. Equipment operators should avoid areas of noxious weed infestation.

6.8 Visitors

Noxious weed education and awareness should extend to nonresidents entering the community. . Visitors should be encouraged to ensure that their vehicles, ATVs, boats, and other equipment are clean before entering the valley. A sign at the Hwy. 20-Tatlayoko Rd. intersection could inform visitors of noxious weed threats and precautionary practices.

6.9 WEED DISPOSAL

Ideally, weeds are cut or pulled before they flower, or at least soon after flowering and well before seeds are set. They can then simply be left on the ground. If seeds have started to form they can still mature and become viable after being removed from the soil. For Tatlayoko Valley, Folkard (pers. comm.) suggests that residents place weeds with seeds in heavy-duty or double plastic bags and to dispose of them at the landfill site. This method is not without risk of seed release; however, efforts to dispose of weeds by burning in barrels or brush piles often fail to destroy seeds and can result in plant re-establishment.

7.0 CONCLUSION

This report presents the results of an invasive plant inventory conducted during summer 2007 in Tatlayoko Valley. Five invasive plant species have been identified which pose a critical threat to the established vegetation ecosystems in the valley: Dalmatian and yellow toadflax, spotted and diffuse knapweed, and sulphur cinquefoil. Dalmatian toadflax is already widespread and its control will be a long-term process. The other four species are present at only a few locations and are high priorities for early, aggressive control measures to prevent their spread.

An additional five species are described as somewhat lesser threats since they do not spread as rapidly – Canada thistle, bull thistle, oxeye daisy, scentless chamomile, and sowthistle species. These plants, nevertheless, pose significant, long-term threats to existing vegetation and (with the exception of sowthistle) on-going control measures are advised. Canada thistle, which is not yet widely established, could be particularly damaging if it spreads to wetlands and riparian zones.

All ten of the foregoing species appear on the Cariboo Regional District's list of legally designated alien plants. Also on this list are three species which are not yet present in Tatlayoko Valley – leafy spurge, orange hawkweed, and yellow hawkweed. These three species, plus field scabious which occurs in the central Chilcotin, are high priorities for eradication should they appear.

Summarized below are the specific measures recommended for removal of invasive plants in the valley: In most cases repeated treatments and close monitoring will be required.

Dalmatian toadflax – biocontrol for long-term control; hand-pulling or cutting in high traffic areas within core infestation area; hand-pulling of all plants outside core area.
Yellow toadflax – hand-pulling.
Spotted and diffuse knapweed – herbicide application; hand-pulling; livestock exclusion.
Sulphur cinquefoil – hand-pulling or digging.
Canada thistle – mowing or hand-cutting.
Bull thistle – hand-cutting.
Oxeye daisy – hand-pulling or digging of small infestations; herbicide applications for large infestations.
Scentless chamomile - hand-pulling or digging of small infestations; frequent tillage for agriculture soils; herbicide applications for other large infestations.

A range of strategies are suggested for management of invasive plants throughout the valley. Of foremost importance is the active participation of valley residents in invasive plant identification, control, and prevention. A concerted, on-going community effort is required to stop the advance of toadflax up the valley; and other invasive plant threats require prompt treatment while they can still be readily controlled.

Further weed infestation can be curtailed by attention to appropriate land and livestock management practices. Exposed soils, cultivated areas, heavily grazed areas, and open grasslands are at particular risk of infestation by invasive plants. Throughout the valley, careful use of vehicles and equipment by residents and visitors is important to minimize their spread. Close communication with regulatory agencies is advised in order to implement a comprehensive and coordinated strategy for invasive plant management.

PERSONAL COMMUNICATIONS

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Appendix 1. Invasive plant site records, Tatlayoko Valley inventory, 2007. (extracted from Ministry of Forests and Range Invasive Alien Plant Program on-line application)

Jurisdiction	Site ID	Invasive Plant	Est. area (ha)	Distribution	Density
	243167	Annual sow thistle	0.0500	5 | a few patches or clumps of a species	1 | <= 1plant/m2 (Low)
Private Land	243168	Annual sow thistle	0.0020	5 | a few patches or clumps of a species	1 | <= 1plant/m2 (Low)
Private Land	243184	Annual sow thistle	0.0001	4 | several sporadically occurring individuals	1 | <= 1plant/m2 (Low)
	243192	Annual sow thistle	0.0020	4 | several sporadically occurring individuals	1 | <= 1plant/m2 (Low)
Private Land	243276	Annual sow thistle	0.0002	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243287	Annual sow thistle	0.0001	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
Private Land	243302	Annual sow thistle	0.0025	3 | single patch or clump of a species	3 | 6-10 plants/m2 (High)
Private Land	243303	Bladder campion	0.0004	5 | a few patches or clumps of a species	1 | <= 1plant/m2 (Low)
Private Land	243309	Bladder campion	0.0003	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243295	Bull thistle	0.0001	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
	243167	Canada thistle	0.0500	7 | continuous uniform occurrence, well-spaced	2 | 2-5 plants/m2 (Med)
Private Land	243186	Canada thistle	0.0300	5 | a few patches or clumps of a species	1 | <= 1plant/m2 (Low)
	243187	Canada thistle	0.0200	4 | several sporadically occurring individuals	1 | <= 1plant/m2 (Low)
Private Land	243188	Canada thistle	0.2500	5 | a few patches or clumps of a species	1 | <= 1plant/m2 (Low)
Private Land	243189	Canada thistle	0.3000	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
Private Land	243190	Canada thistle	0.0160	7 | continuous uniform occurrence, well-spaced	3 | 6-10 plants/m2 (High)
Private Land	243191	Canada thistle	0.0100	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243207	Canada thistle	0.0100	3 | single patch or clump of a species	3 | 6-10 plants/m2 (High)
Private Land	243208	Canada thistle	0.0010	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243209	Canada thistle	0.0002	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243212	Canada thistle	0.0600	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
Private Land	243218	Canada thistle	0.0130	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
Private Land	243277	Canada thistle	0.0400	3 | single patch or clump of a species	3 | 6-10 plants/m2 (High)
Private Land	243286	Canada thistle	0.0500	3 | single patch or clump of a species	3 | 6-10 plants/m2 (High)
	243288	Canada thistle	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
MoT	243292	Canada thistle	0.0001	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
	243293	Canada thistle	0.0030	3 | single patch or clump of a species	3 | 6-10 plants/m2 (High)
Private Land	243295	Canada thistle	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243296	Canada thistle	0.0002	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243306	Canada thistle	0.0100	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
	243310	Canada thistle	0.1600	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243311	Canada thistle	0.0150	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243312	Canada thistle	0.0100	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243314	Canada thistle	0.0030	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243317	Canada thistle	0.0005	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)

Appendix 1, continued.

Jurisdiction	Site ID	Invasive Plant	Est. area (ha)	Distribution	Density
	243280	Curled dock	0.0001	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
	243283	Curled dock	0.0001	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
Private Land	243300	Curled dock	0.0250	6 | several well-spaced patches or clumps	2 | 2-5 plants/m2 (Med)
Private Land	243323	Curled dock	0.0001	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
Private Land	243324	Curled dock	0.0001	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
MoFR	128302	Dalmatian toadflax	1.2000	6 | several well-spaced patches or clumps	2 | 2-5 plants/m2 (Med)
	243142	Dalmatian toadflax	0.0300	4 | several sporadically occurring individuals	1 | <= 1plant/m2 (Low)
	243166	Dalmatian toadflax	0.0500	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
Private Land	243195	Dalmatian toadflax	0.2000	8 |continuous occurrence with a few gaps	2 | 2-5 plants/m2 (Med)
Private Land	243197	Dalmatian toadflax	0.0010	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243199	Dalmatian toadflax	1.1000	8 |continuous occurrence with a few gaps	2 | 2-5 plants/m2 (Med)
Private Land	243200	Dalmatian toadflax	0.0200	6 | several well-spaced patches or clumps	1 | <= 1plant/m2 (Low)
	243202	Dalmatian toadflax	0.0010	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
	243203	Dalmatian toadflax	0.0080	7 | continuous uniform occurrence, well-spaced	2 | 2-5 plants/m2 (Med)
	243205	Dalmatian toadflax	0.1500	5 | a few patches or clumps of a species	1 | <= 1plant/m2 (Low)
Private Land	243206	Dalmatian toadflax	0.1500	6 | several well-spaced patches or clumps	2 | 2-5 plants/m2 (Med)
	243210	Dalmatian toadflax	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243211	Dalmatian toadflax	0.0005	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
Private Land	243213	Dalmatian toadflax	0.0005	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243214	Dalmatian toadflax	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243215	Dalmatian toadflax	0.0004	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
	243216	Dalmatian toadflax	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243219	Dalmatian toadflax	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243220	Dalmatian toadflax	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243221	Dalmatian toadflax	0.0001	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
Private Land	243222	Dalmatian toadflax	0.0600	6 | several well-spaced patches or clumps	1 | <= 1plant/m2 (Low)
Private Land	243275	Dalmatian toadflax	0.2500	8 |continuous occurrence with a few gaps	2 | 2-5 plants/m2 (Med)
Private Land	243291	Dalmatian toadflax	0.0001	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
Private Land	243298	Dalmatian toadflax	0.0009	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243301	Dalmatian toadflax	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243304	Dalmatian toadflax	0.0100	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
Private Land	243305	Dalmatian toadflax	0.0001	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243307	Dalmatian toadflax	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243308	Dalmatian toadflax	0.0001	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243318	Dalmatian toadflax	0.0004	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243298	Yellow toadflax	0.0005	3 | single patch or clump of a species	3 | 6-10 plants/m2 (High)

Appendix 1, continued.

Jurisdiction	Site ID	Invasive Plant	Est. area (ha)	Distribution	Density
	229950	Diffuse knapweed	0.1300	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
Private Land	243196	Diffuse knapweed	0.0010	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243198	Diffuse knapweed	0.0010	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
MoT	243139	Oxeye daisy	0.0100	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
MoT	243141	Oxeye daisy	0.0010	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243194	Oxeye daisy	0.0010	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243201	Oxeye daisy	0.0010	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243209	Oxeye daisy	0.0003	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
Private Land	243223	Oxeye daisy	0.0001	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243224	Oxeye daisy	0.0001	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243225	Oxeye daisy	0.0002	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243281	Oxeye daisy	0.0900	5 | a few patches or clumps of a species	1 | <= 1plant/m2 (Low)
Private Land	243285	Oxeye daisy	0.0001	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
	243289	Oxeye daisy	0.0001	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
MoT	243290	Oxeye daisy	0.0001	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243299	Oxeye daisy	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243316	Oxeye daisy	0.2000	8 |continuous occurrence with a few gaps	2 | 2-5 plants/m2 (Med)
Private Land	243318	Oxeye daisy	0.0004	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243319	Oxeye daisy	0.0002	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243320	Oxeye daisy	0.2500	8 |continuous occurrence with a few gaps	2 | 2-5 plants/m2 (Med)
Private Land	243321	Oxeye daisy	0.1500	6 | several well-spaced patches or clumps	2 | 2-5 plants/m2 (Med)
MoT	243322	Oxeye daisy	0.1500	8 |continuous occurrence with a few gaps	2 | 2-5 plants/m2 (Med)
MoT	243325	Oxeye daisy	0.0080	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
Private Land	243282	Scentless chamomile	0.0001	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
Private Land	243284	Scentless chamomile	0.0001	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243291	Scentless chamomile	0.0001	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243313	Scentless chamomile	0.2000	8 |continuous occurrence with a few gaps	3 | 6-10 plants/m2 (High)
Private Land	243314	Scentless chamomile	0.0001	3 | single patch or clump of a species	1 | <= 1plant/m2 (Low)
Private Land	243315	Scentless chamomile	0.0001	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
MoFR	243744	Spotted knapweed	0.0028		3 | 6-10 plants/m2 (High)
Private Land	243294	Spotted knapweed	0.0080	3 | single patch or clump of a species	2 | 2-5 plants/m2 (Med)
Private Land	243204	Sulphur cinquefoil	0.0001	5 | a few patches or clumps of a species	1 | <= 1plant/m2 (Low)