ER 390 Selected Restoration Project

Invasive Species Restoration Project and Management Recommendations

Munson Pond, Kelowna, Central Okanagan, BC

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Executive Summary

Munson Pond is a park located centrally in Kelowna near the junction of KLO and Benvoulin Roads. This report summarizes an invasive plant treatment study that occurred at the park from November 2019 to September 2021. Over that time period, multiple site visits were completed to document the natural character of the site (plant species and ecosystems) and develop an overall treatment plan. The project included three treatment types (mow, mow/spray and hand pull) and three restoration types (none, grass seed and native plant retention) combined in six plots.

Results were inconclusive across treatment types with respect to the percent cover of target (desirable) and non-target species. For the mow and spray treatment, the percent cover of non-target species initially decreased for some sub-plots in 2020 but by 2021 the results contradicted themselves between plots with contrasting decreases and increases in non-target species. Results for the mow/spray treatment were inconclusive but a decrease in non-targeted species were dominated by plots with grasses. For the hand pull treatment in one plot non-target species percent cover increased or stayed the same for all restoration types; in the second plot, no non-target species returned. The plot with no non-target re-establishment was dominated by grasses. For the mow sites, there was a contrast between plots but in general a decrease in non-target species was associated with a high percent cover of grasses and the presence of only a single invasive species (thistle).

With respect to restoration types the results were variable as well. No restoration type and grass seed were associated with a decrease in non-target species 50% of the time. For the native subplots, non-target species percent cover stayed the same or decreased 83% of the time.

Given the aggressiveness and prevalence of invasives at the site and the fact that the site is surrounded by an urban environment, several wider scale intervention techniques are proposed moving forward. In forested areas or where invasives are not prevalent, selective hand pulling of or weed whacking of non-target species combined with selective herbicide use on emergent non-target species in the spring is recommended. In other areas, mowing and increasing the variability of the soil substrate by creating "rough and loose" conditions as described in reference materials (Polster, date unknown) along with live staking or native planting of early successional species is recommended. Grass seeding may be acceptable but only if plantings are taller and intervention is used to prevent grass from choking out any shrubs that are planted. Both live stakes and transplanting trees is recommended to improve the source of target plant species at the site and hopefully transplant some of the beneficial mycorrhizae that are found in natural forested environments. This approach is preferred over sourcing nursery stock.

The report included recommendations to protect the character of the park, limit the spread of invasive species, encourage the expansion of natural areas and improve or create habitat features at the site. Finally, an adaptive management program is recommended to monitor ongoing success of interventions and plan and adapt accordingly.

The author would like to thank the Central Okanagan Land Trust for their involvement, interest and support of the project.

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1.0 Introduction

The purpose of this invasive species restoration project (trial), in partnership with the Central Okanagan Land Trust (COLT), is to develop invasive plant management strategies and a management plan for the terrestrial area surrounding Munson Pond in Kelowna, BC. Munson Pond is an urban park and one of several sites that falls under COLT stewardship.

Munson Pond is a green space located centrally in Kelowna that is preserved under COLT direction in partnership with the City of Kelowna (CoK). It contributes to local habitat and green space within the community. The pond was historically a combination of abandoned farm land and a gravel pit used to source material for the old Okanagan Lake bridge crossing (Michaels 2018).

2.0 Background Information

2.1 Site Location and Context

The site is located in the traditional territory of the Okanagan Nation in an urban/semi-agricultural area north of K.L.O. Road and West of Benvoulin Road (Figure 1). The total area of the park is 9.8 ha with the pond representing 3.8 ha. The civic address of the park is 2855 Burtch Rd, Kelowna, BC.

Figure 1 - Munson Pond Study Area Shown in Green Outline (Source: City of Kelowna Map Viewer)

The study area is bound by farmland on all sides and includes a housing development to the west and commercial office space and a school to the east. UTM coordinates for a central point on the site are (UTM Zone 11 NAD 83): Northing: 5526342, Easting: 323078.

The site is currently zoned as A1 agriculture and is designated as a park on the CoK website (City of Kelowna, 2020a, City of Kelowna 2020b). According to the City of Kelowna's website, the pond is named for the Munson family who were pioneer farmers in the area from the early 1890s. There is an irrigation ditch along the southern end of the pond that feeds the pond and reflects historical agricultural use in the area (City of Kelowna 2020b).

2.2 Ecosystems

Historical ecosystem mapping is available for the Munson Pond area and provides information for the years 1800, 1938 and 2005 (Lea, date unknown). The ecosystems likely to be present during each of these years are included in the following table:

Table 2: Historical Ecosystem Mapping Information for the Munson Pond Area (Lea 2005)	
Year	**Representative Ecosystem**
1800	Open water and western birch – red-osier dogwood surrounding the pond
1938	Open water and western birch-red-osier dogwood; the western birch – red-osier dogwood type is restricted in range to the southern portion of the pond
2005	Similar to the ecosystems identified in 1938 but the open water areas are also restricted to the southern half of the pond

The site is located within the Ponderosa Pine biogeoclimatic zone and Okanagan Very Hot Dry Ponderosa Pine variant. These ecosystems are characterized by open stands of ponderosa pine (*Pinus ponderosa*) and grass species. Forests are dominated by open stands of "parklike" ponderosa pine and understory dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*) (Meidinger and Pojar 1991). Dry sites lack a well developed shrub layer and have an open herb layer dominated by grass along with exposed soil. Wetter sites contain young climax stands of interior Douglas fir with lesser amounts of ponderosa pine and trembling aspen (Ministry of Forests 1990).

2.3 Sensitive Ecosystem Inventory and Species at Risk

In 2008 CoK retained a consultant to conduct a sensitive ecosystem inventory (SEI) for the city (Iverson 2008). The study resulted in mapping of two polygons on the Munson Pond property coinciding with the area that is currently forested and the open water area. The open water area is classified as a shallow open water wetland. The forested site series was classified as Ponderosa pine/Black cottonwood – Snowberry Riparian with a young forest structural stage. This site series is typically found on lower slopes and active floodplains. The SEI goes on to further classify this polygon as a fringe riparian ecosystem typically associated with shorelines, including sites with seepage that are sensitive to soil and hydrology changes.

A list of species at risk with the potential to be found in the study area based on a set of search criteria specific to the ecology present at the site is included in Appendix A.

2.4 Surficial Geology and Soils

Surficial deposits historically mapped in the study area included alluvial fans, deltas and associated gullies and stream channels (Nasmith 1962). Predominant soil types mapped in this area included two gleysolic soils, the Guisachan and Tanaka soil types (Wittneben 1968). These poorly drained soils contain gravel and sand with minor amounts of silt and rarely clay. Natural vegetation in uncleared areas in both of the soil types includes willow (*Salix* spp.), black cottonwood, cattail (*Typha latifolia*), water birch (*Betula occidentalis*), some grasses, sedges and reeds (Wittneben 1968).

Guisachan soils typically occur on upper parts of gentle undulations in nearly level to gently sloping landscapes, while the Tanaka soils tend to occupy depressions. Guisachan soils are found in medium to moderately coarse-textured stone free veneer, between 30 and 100 cm thick overlying gravelly, coarse-textured fluvial fan and delta deposits (Wittneben 1968). Surface soil textures include loam, silt loam

or sandy loam while subsoil textures are very gravelly sand or loamy sand. These soils are constrained for urban use by high water tables (Wittneben 1968).

Tanaka soils tend to be medium to moderately coarse textured fluvial fan deposits. Soil textures range from sandy loam to silt loam and occasionally silty clay loam; subsoil textures are sandy loam or gravelly sandy loam. These soils are poorly drained and the water table fluctuate between the surface and 1.5 m.

3.0 Project Rationale

The idea for an invasive plant study at Munson Pond came from COLT. The presence of non-native and in some cases invasive species at the site has been a concern of COLT for some time and there have been several field efforts by volunteers to try and remove some of the invasive species that are present. The site contains native, non-native, invasive and noxious species. In general the goal is to promote the presence of native species (and in some limited cases non-native/non-invasive species) while reducing the prevalence of invasive species. Those species that are native and acceptable will be referred to as target species (TS) in the report and those invasive species or other non-native species that are undesirable will be referred to as non-target species (NTS). In order to support the distinction between what plants are desirable and which are not, the study is relying on definitions obtained and paraphrased below from the Invasive Species Council of BC web page (www.bcinvasives.ca):

- **Native plants** reached their location without assistance from people.
- **Invasive species** are not native to BC whose introduction and spread threatens and harms native species, economy and human health. Without predators, they move aggressively into an area and monopolize resources to the detriment of other species.
- **Exotic plants** are non-native species that are introduced but do not have negative impacts.
- A **weed** is an unwanted plant in a given area, such as a lawn.
- **"Noxious weed" (BC Weed Control Act)**
    - *…non-native plants that have been introduced to BC without …predators and plant pathogens ... For this reason and because of their aggressive growth, these plants can be highly destructive, competitive and difficult to control.*

4.0 Methods

The overall goal of the project is to reduce invasive species and promote native species at Munson Pond. In other words invasive species are those that are undesirable or non-target species (NTS) and native species are desirable or target species (TS). In some cases exotic plants that are not invasive may be tolerated as well. The objectives are to use non-herbicide treatments (mechanical and chemical) to attempt to reduce the presence of NTS which are not desirable and promote largely native TS which are. All invasives are considered NTS in this report and the terms NTS and invasives will be used interchangeably. This concept of invasive of non-native species being undesirable is consistent with direction received from COLT.

Target species = native species and in some limited cases non-native non invasive species = DESIRABLE
Non-target species = most non-native species including all invasive species = UNDESIRABLE

The methodology used to prepare this invasive species restoration trial and management plan included the following:

Five field visits were carried out in fall, spring and early summer to collect information on species, map terrestrial ecosystems and characterize soils information. The site visits were planned for various times when native and invasive species might be flowering.

The methodology used for the terrestrial ecosystem system mapping exercise included a modified version of standard terrestrial ecosystem mapping methods (BC Ministry of Environment, Lands and Parks 1998).

Six locations were selected as treatment plots. Locations were not selected randomly but were specifically targeted to capture as many different NTS and ecosystems as possible. Treatment plots were omitted from the forested area along the southern lobe of Munson Pond as this area had the highest percentage of native forest cover.

Three treatments were chosen to determine qualitatively the effectiveness of the treatment between plots. Since there were six plots in total each treatment was applied to two plots:

- Treatment 1 - Use of an eco-friendly plant deterrent. This approach was discussed with the CoK. The product selected was concentrated vinegar.
- Treatment 2 - Hand pulling.
- Treatment 3 - Mowing (with a hedge trimmer).

Table 1: Treatments and Restoration Techniques Applied to Each Plot

Plot #	UTM Coord. (Zone 11U)	Treatment	Restoration Technique (from North to South or East to West)		
1	323491 5526329	Mow/ spray (vinegar)	native - north	grass seed	none - south
2	323491 556328	Hand pull	none - north	grass seed	native - south
3	322889 5526227	Hand pull	native - east	none	grass seed - west
4	322888 5526206	Mow	none - east	native	grass seed - west
5	322897 5526220	Mow	grass seed - north	None	native - south
6	322900 5526233	Mow/ spray (vinegar)	grass seed - north	None	native - south

For each treatment plot, the area was divided into thirds to apply a restoration technique. The three restoration techniques were no treatment, grass seeding and native species.

Attempts were made to salvage native plant material and propagate rooted cuttings of snowberry for fill planting in the "native" subplot. The rooted cuttings did not survive; as a result, treatment plots were selectively placed such that the "native" sub-plot had some well established TS cover.

Any treatment technique in any subplot (hand pulling, mowing or spraying vinegar) avoided native species in an effort to promote their growth and spread. This approach reflects the fact that there is a lot of native vegetation present in amongst the NTS and attempting to protect this native material source is likely to be more successful than fill planting.

Each of the 6 treatment plots measured 3 m by 1 m. Plots were marked in the field using nails and flagging tape as well as a spray paint dot in each corner. A small sign was placed at each plot indicating this work was part of a restoration project. These materials were removed at the end of the project.

The site was revisited several weeks after treatment to assess changes in the plant species and again in the fall (2020) and summer (2021). The same square used to lay out the plots was repositioned and percent cover of the different plant species was noted in keeping with terrestrial ecosystem mapping methodology.

****Note:** The word trial is used to describe the effort given that the treatment areas were relatively small and were aimed at proofing the techniques used.

Following completion of the field trials, this report was prepared outlining the methods were most effective at treating various types of NTS. Feedback was solicited from members of the COLT board for preparation of the final report.

5.0 Results

5.1 Site Conditions

Field reviews to collect information on plant species and ecosystems were completed on November 18 and 24, 2019 and May 18, 2021. The treatment was first implemented on August 5, 2020, and evaluated on October 18, 2020. Final assessment and evaluation of treatments was completed on July 4, 2021.Site photos taken during the field visit are included in Appendix B. Field cards have been included in Appendix C.

5.1.1 Terrestrial Ecosystem Units

Four site types were mapped within the study area (Figure 2). A legend is provided below in Table 4.

Figure 2 - Site Series Polygon Mapping and Treatment Locations for the Restoration Study

Table 3 –Site Series Mapped in the Munson Pond Park Study Area

Polygon	***Site Series***	***Site Modifiers***	***Structural Stage***	***Stand Modifier***
1	Cultivated field			
2	80% Ponderosa pine – Black cottonwood – Snowberry riparian 20% Cultivated field	j, f	2b	
3	90% Douglas-fir – Water birch – Douglas maple 10% Cultivated field	j	2b, 3a	
4	80% Ponderosa pine – Black cottonwood – Snowberry riparian 20% Cultivated field	J	2b, 3a	
5	50% Douglas-fir – Water birch – Douglas maple 30% Ponderosa pine – Black cottonwood – Snowberry riparian 20% Shallow open water	j	5s	B
6	Shallow open water			

5.1.1.1 Site Series Codes and Legend

The following section provides a legend detailing the ecosystem units, site modifiers and forest composition / structure types mapped in the field.

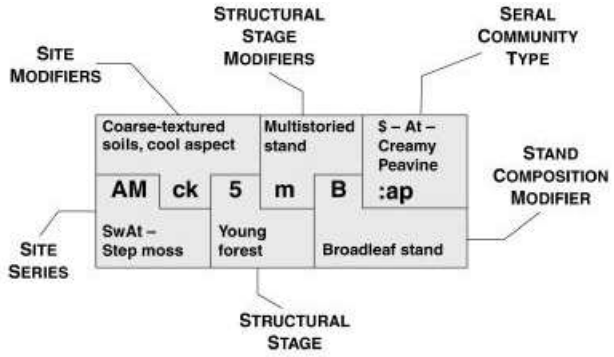

Table 4: Okanagan Very Dry Hot Ponderosa Pine Variant (PPxh1) Mapping Codes Legend	
SITE SERIES / ECOSYSTEM UNITS	
Symbol	**Description**
CD	00 - Ponderosa pine – Black cottonwood – Snowberry riparian
CF	Cultivated Field
DM	08 – Douglas-fir – Water birch – Douglas maple
OW	Shallow Open Water
SITE MODIFIERS	
Symbol	**Description**
f	Fine textured soils
j	Gentle slope
STRUCTURAL STAGE and STRUCTURAL STAGE MODIFIERS	
Symbol	**Description**
2b	Herb – Graminoid dominated
3a	Shrub/Herb – Low shrub
5s	Young Forest – Single storied
STAND COMPOSITION MODIFIERS	
B	Broadleaf

5.1.1.2 Site Series Descriptions within the Study Area

The CD (pine cottonwood) site appeared to be rich and slightly wetter than the surrounding soils on site and local topography suggests that the larger landscape area generally drains west towards Okanagan Lake. One of the plots for this site type was close to the edge of Munson Pond and is likely influenced by the water table here. The site contained poorly drained soils and seepage and was characterized by humic gleysols with a predominantly clay loam texture.

The DM (fir birch) site type was associated with the remainder of the site, predominantly wetter areas surrounding the southern half of the pond. Both the forested and non forested areas were classified as the fir birch ecosystems, but at different stages of development. Wetter parts of the fir birch site type (mid bench flood ecosystems) contained skunk cabbage and other water tolerant species. A higher percentage of NTS was noted in the CD areas over the DM leading sites. The forested DM ecosystem unit had the lowest percentage of NTS. In the area north of Munson Pond several non native species were noted such as Norway maple (*Acer platanoides)* and European white birch (*Betula pendula*). Soils were characterized as brunisols or gleysols and soil texture ranged from sandy clay loam to silt loam.

The CF sites series was an anthropogenic unit used to describe the "field areas" that are typically mowed or have been mowed previously.

The OW unit represents the shallow open water (Munson Pond) and also describes a small open wetland in the forested area to the south.

Table 5: Common Vegetation Mapped within the Study Area

Common Name	Scientific Name
alfalfa	Medicago sativa
American vetch	Vicia americana
baltic rush	Juncus balticus
Bebb's willow	*Salix bebbiana*
black cottonwood	Populus balsamifera ssp. Trichocarpa
black hawthorn	*Crataegus douglasii*
blue wildrye	Elymus glaucus
bluebunch wheatgrass	*Pseudoroegneria spicata*
bull thistle	Cirsium vulgare
creeping buttercup	*Ranunculus repens*
Canada goldenrod	*Solidago lepida*
Canada thistle	*Cirsium arvense*
catnip	*Nepeta cataria*
cattail	Typha latifolia
cheatgrass	*Bromus tectorum*
chicory	*Cichorium intybus*
choke cherry	*Prunus virginiana*
cleavers	*Galium aparine*
common bugloss	*Anchusa officinalis*
common burdock	*Arctium minus*
common dandelion	*Taraxacum officinale*
common groundsel	*Senecio vulgaris*
common lilac	*Syringa vulgaris*
common snowberry	*Symphoricarpos albus*
curled dock	*Rumex crispus*
dalmation toadflax	*Linaria genistifolia*
diffuse knapweed	*Centaurea diffusa*
dwarf mallow	*Malva neglecta*
european white birch	*Betula pendula*
field bindweed	*Convolvulus arvensis*
field pennycress	*Thlaspi arvense*
fireweed	Epilobium angustifolium
small flowered forget me not	*Myosostis laxa*
german madwort	*Asperugo procumbens*
giant horsetail	*Equisetum telmateia*
goatsbeard	*Aruncus dioicus*
graceful cinquefoil	*Potentilla gracilis*
hedge mustard	Sisymbrium officianale
knapweed	*Centaurea spp.*
lamb's quarters	*Chenopodium album*
Loesel's tumble mustard	*Sisymbrium loeselii*
lombardy poplar	*Populus nigra*
marsh yellow cress	*Rorippa palustris*
mock orange	*Philadelphus lewisii*
narrow-leaved water-plantain	*Alisma gramineum*
Nootka rose	*Rosa nutkana*
Norway maple	*Acer platanoides*
orchard grass	*Dactylis glomerata*
oregano	*Origanum vulgare*
Russian olive	*Elaeagnus angustifolia*
Saskatoon	*Amelanchier alnifolia*
scarlet firethorn	*Pyracantha coccinea*
scouring rush	*Equisetum hyemale*
sedges	*Carex spp.*
sheep sorrel	*Rumex acetosella*
showy milkweed	*Asclepias speciosa*
Siberian elm	*Ulmus pumila*
stork's bill	*Erodium cicutarium*
sulphur cinquefoil	*Potentilla recta*
trembling aspen	*Populus tremuloides*
tumbleweed	*Amaranthus albus*
virginia creeper	*Parthenocissus quinquefolia*
water birch	Betula occidentalis
water purslane	*Ludwigia palustris*
white sweet clover	*Melilotus albus*
willow spp.	*Salix spp.*
woolly sedge	*Carex pellita*
wormwood	Artemesia absinthium
yarrow	*Achillea borealis*
yellow flag iris	*Iris pseudacorus*
yellow salsify	Tragopogon dubius

5.1.1.3 Wetland Site Associations

The site series described above can be grouped into two wetland site associations (Mackenzie and Moran 2004): the Fl07 – lower flood bench *Betula occidentalis – Rosa* site association and the Fm01 – middle flood bench *Populus balsamifera – Symphoricarpus albus – Rosa* site association.

The low flood bench site association resembles the wetter site types found in polygon 5. These ecosystems occur as a narrow band where flooding is minimal but the watertable remains within the rooting zone for much of the year (Mackenzie and Moran 2004). The mid flood bench site resembles drier parts of polygon 5 that tend to be less inundated and are dominated by black cottonwood.

5.1.2 Ecosystem Condition

As indicated above the highest percent cover of NTS appear to be on the north and east sides of the site. There are several trees species that appear to have been planted as they are not known to be NTS but also not native to BC (i.e. Norway maple, firethorn (*Pyracantha*), lilac (*Syringa* spp.) and European white birch).

The condition of these most heavily infested areas is poor and without intervention these sites are unlikely to develop into later successional communities/ forested areas. These areas are heavily infested with NTS and percentage and diversity of NTS is noteworthy.

Aside from the areas to the north and east, the forested area and the grassy areas to the west have a low percentage of NTS cover. The forested areas have a thick shrub layer which likely helps to deter the establishment of NTS. Despite the fact that this is a popular urban park, there was little garbage found on site and for the most part it appears that park users stick to established paths. Erosion doesn't appear to be a concern here since the site is flat.

5.1.3 Watercourses

The Okanagan Habitat atlas data suggests that the nearest watercourses are irrigation channels to the north and south of the site; this likely reflects previous and ongoing agricultural use of these areas. No well defined watercourses were noted during the field review (i.e. lack of a well defined channel with evidence of scour and deposition). There do appear to be two drainage channels entering the pond on the north side and one existing on the south side but neither of these features appeared to meet the criteria for classification as a watercourse (i.e. scour, deposition, well defined banks).

5.1.4 Wildlife Use

Although the focus of this project was on identification and treatment of NTS, a range of wildlife presence and activity was noted during the field visit, including bird sightings, beaver sign, animal browse and scat. The author helped to free a western painted turtle found caught on a neighbouring commercial property and believes the turtle is a resident in either Munson Pond or one of the surrounding open water sites.

5.2 Treatment Results

5.2.1 Plot Conditions and Response to Treatments

The survey and treatment results are summarized below.

Table 6: Percent Cover of NTS Over Time by Treatment and Restoration Technique							
Plot	**Representative Species and Percent Cover Pre Treatment (* NTS)**	**Treatment**	**Restoration Technique**	Percent Cover NTS			
				Pre Treatment	Post Treatment	October 18, 2020	August 2021
1	*Canada thistle 40 *perennial sow thistle 25 *catnip 20 *purple loosestrife 5 goldenrod 5 red osier dogwood 10 →native sub plot had 35% red osier dogwood and 10% goldenrod cover Percent cover native species: 10	mow / spray	none	70	0	60	80
		mow / spray	grass seed	70	0	70	80
		mow / spray	native	70	0	40	20
2	grass 70 *catnip 5 *field pennycress 5 →native sub plot had 80% red osier dogwood and 30% grass Percent cover native species: 30	hand pull	none	25	0	25	40
		hand pull	grass seed	25	0	20	50
		hand pull	native	25	0	5	5
3	Grass 80 Black cottonwood 20 *White sweet clover 40 goldenrod 20 showy milkweed 15 scouring rush 1 Percent cover native species: 80	hand pull	none	40	0	0	0
		hand pull	grass seed	40	0	0	0
		hand pull	native	40	0	0	0
4	Grasses 50 goldenrod 15 *prickly lettuce 10 American vetch 10 pulse milk vetch 10 *bull thistle 5 *common mullein 2 *hoary alyssum 2 *catnip 2 Percent cover native species: 50	mow	none	10	0	0	20
		mow	grass seed	10	0	0	25
		mow	native	10	0	0	30
5	Grass 60 *Canada thistle 55 Percent cover native species: 50	mow	none	55	0	30	15
		mow	grass seed	55	0	35	5
		mow	native	55	0	10	15
6	grass 30 reed canarygrass 25 *Canada thistle 20 *prickly lettuce 15 *catnip 5 Percent cover native species: 30	mow / spray	none	30	0	25	15
		mow / spray	grass seed	30	0	30	10
		mow / spray	native	30	0	10	15

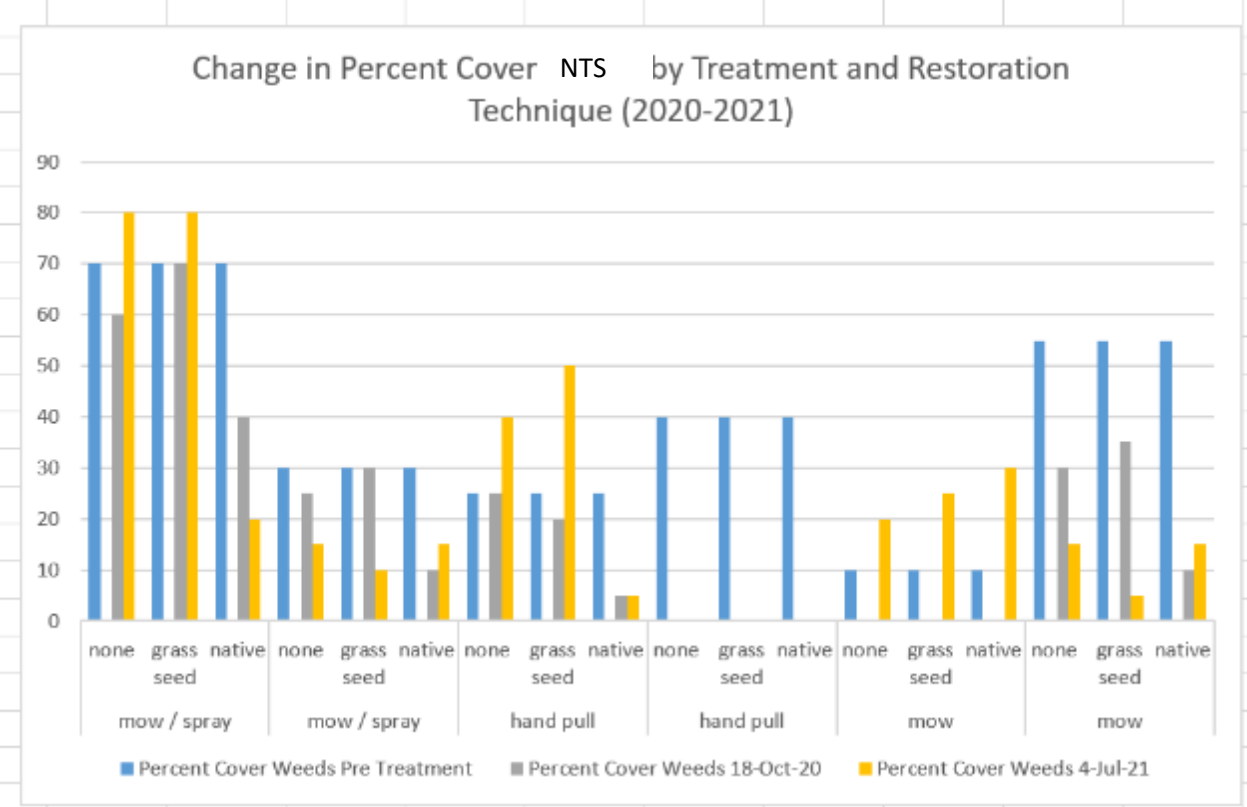

Figure 3: Results of Field Treatments (**Areas with no bars are "0" percent cover)

The results were inconclusive in determining what treatment type (mowing/spraying, hand pulling or mowing) and restoration type (none, grass seed or native) was the most effective in reducing NTS.

Results were inconclusive across treatment types. For the mow and spray treatment, the percent cover of NTS decreased or stayed the same in 2020 for all restoration subplots but by 2021 the results contradicted themselves between plots with contrasting decreases and increases in NTS. Results for the mow/spray treatment are inconclusive but plots that showed a decrease in NTS in general were dominated by grasses. For the hand pull treatment in one plot NTS percent cover increased or stayed the same for all restoration types; in the second plot, no NTS returned. The plot with no NTS re-establishment was dominated by grasses. For the mow sites, there was a contrast between plots but in general a decrease in NTS cover was associated with a high percent cover of grasses and the presence of only a single NTS (thistle).

With respect to restoration types the results were variable as well. No restoration type and grass seed were associated with a decrease in NTS 50% of the time. For the native subplots, NTS percent cover stayed the same or decreased 67% of the time.

For plot number 2 the author incorrectly assumed that Canada goldenrod is a native species. Based on discussions with other COLT members (Laura Hooker and Wayne Wilson, personal communication) and a review of E-flora, the sub species of Canada goldenrod growing at Munson Pond is likely not native. Eflora lists three species of plants that are referred to by the common name Canada Goldenrod: *Solidago altissima, Solidago Canadensis* and *Solidago lepida.* Of these three species only *Solidago lepida* is considered to be native. According to e-flora "In 2010, this species was reassessed in the province by

the BC Conservation Data Centre, and most BC specimens were annotated to other species. Only a handful of specimens were determined to be *Solidago canadensis*" (Klinkenberg 2020). Based on this information it is likely the "native" subplot in plot 2 is actually invasive Canada goldenrod. The goldenrod at site was extensive and tended to outcompete other species suggesting it may be classed as invasive or a NTS. Because the plots were laid out under the assumption that this species was native it was not possible to go back and re-evaluate the percent cover.

6.0 Discussion and Recommendations

Despite the fact that the results were inconclusive, the author made some general observations with respect to the prevalence of invasive species. In areas with a high percentage cover of shrubs like one it was very difficult for NTS to become established. Grass seed did not become well established in any of the areas treated which may be attributed to the fact that the grass seed was spread in areas without any scarification or "raking in" of the seed and without the addition of top soil. The spray treatment (vinegar) did not seem to be effective in treating NTS, particularly in areas with multiple species and aggressive NTS like thistle. Unfortunately without repeat treatments of vinegar on cut stems this treatment is not likely to be effective long term. Hand pulling was effective in areas that were dominated by grasses. Finally, the treatment was carried out in August after many of the species had produced seeds. Treating individual plants would likely be more effective in spring when the new plants first emerge. Hand pulling the NTS without digging up their root system also likely decreased the efficacy of the treatment.

6.1 Mitigation Recommendations and Re-establishment of Native Vegetation

Given the scale of the NTS problem at Munson Pond, NTS treatments that are more extensive and aggressive are recommended. The NTS problem at Munson Pond is extensive and challenging. As a result of this more aggressive treatments like the use of approved herbicides (with appropriate setbacks for watercourses and important natural features) might be considered. In other areas, wide scale mowing and scarification with site specific native grass seed mixes might be beneficial. A grass seed that contains species that establish early and die off making way for more well-established longer growing grasses in the mix may be effective in out competing certain NTS. The grass seed used in this trial was a combination of early establishing and slower growing species but the fact that it was spread in August with no scarification provided little chance for the grasses to establish. The history of the site as a former gravel pit suggests soil compaction could be a concern along with the lack of available local seed source.

While the forested areas to the southeast contain mature native trees species, the remainder of the site is highly degraded and contains a mix of native and non native trees, shrubs and forbs. If the goal is to establish riparian forest cover surrounding the pond it may be beneficial to transplant early seral species like alder or cottonwood from forested areas. By transplanting the trees from native areas with some of the root ball and soils intact, it may help to introduce beneficial fungal mycorrhizae into heavily disturbed parts of the site. Studies have shown the importance of fungal mycorrhizae in re-establishing forests (Simard 2009). The author also attended field classes at the University of Victoria where the instructor demonstrated failure rates of trees planted from local nurseries that were attributed to a lack of fungal associations for natural forested areas. A combination of grass seeding and tree planting or grass seeding and live staking may help to re-establish forest cover in these areas. Combining this prescription with early spring application of selective herbicides may help to increase the percent cover

of native species at the site long term. David Polster, a restoration ecologist in BC recommends the use of natural restoration techniques over grass seeding to re-establish heavily degraded sites long term (see: https://cascadiaprairieoak.org/wp-content/uploads/2015/12/Polster_Physical-and-mechanical-actions-to-restore-soil-structure_CPOP2015Conf.pdf). Dr. Polster has used techniques such as live staking and creating a "rough and loose" substrate to promote the establishment of native species over time (Polster 2016, Polster Date Unknown A, Polster Date Unknown B). This treatment might be ideal for the riparian fringe present at Muson Pond. Live stakes or transplants of early successional species like willow, red-osier dogwood and cottonwood may help to improve soil conditions at the site and promote the conversion from an urban vegetated area to a more natural site type. Grass seed, if recruited successfully, could be beneficial in deterring the establishment of NTS. Provided the trees are taller than the grass seed, the trees should be able to outcompete the grasses. In keeping with the "rough and loose" technique described by Polster, planting trees in depressions may promote better survival of the plantings in the absence of irrigation. It is possible to transplant shrub species from native forests as well but based on the author's experience with reforestation and restoration sites for previous projects, the plantings would need irrigation (could be implemented by hand watering from Munson Pond) and would need regular mowing around the perimeter of the planting to ensure the plantings are not outcompeted by grasses.

The following are recommendations for NTS treatment in the park. These treatments could be implemented in small "test areas" with approval from the CoK to determine efficacy. The use of material sourced from crown land and volunteer labour (if available) would meant the project would not require too much financial input. Potential costs could include the cost of grass seed, mowing required to clear the sites and potential herbicide application costs. These larger and more intrusive techniques are considered necessary to compete with the aggressive NTS on site. In addition to the recommendations provided here, recommended species specific treatment options for the different invasive species found on site are included in Appendix D. **Note: ANY treatment that is proposed should aim to protect and avoid damaging native species whenever possible. Existing established native plants, trees and grasses already functioning to "keep out" or deter the establishment of invasive species.**

Figure 4 – Suggested Treatment Areas for the Sites Surrounding Munson Pond

Table 7: Recommendations for Future Possible Treatment Initiatives by Location	
Location	**Potential Treatment**
1	This area is predominantly forested. Recommended treatments include selective hand pulling of NTS by volunteers. Both yellow flag iris and purple loosestrife are challenging NTS in these locations, efforts to hand dig root system would be beneficial.
2	This area has some trees and some native species. NTS include white sweet clover, chickory, curled dock, prickly lettuce, bladder campion, bugloss and knapweed. White sweet clover is prevalent. Cut Siberian elm and treat the stumps. Brush or selectively weed whack white sweet clover (rather than mowing) and hand pull other NTS. Selectively treat emergent NTS in spring with herbicide.
3	This area is similar to location 2 but there is no elm present. Plant riparian trees and shrubs (or stakes of willow, red osier dogwood or cottonwood) in low lying microsites. May need to use a small excavator to create microsites.
4-5	Either hand pull NTS or leave the site as is. Weed whack along the trail.
6	These areas are already mowed and will likely continue to be mowed by the City.
7	Similar to sites 4 and 5. Either hand pull NTS or leave the site as is. Weed whack along the trail.
8	These areas are already mowed and will likely continue to be mowed by the City.
9	Hand pull or weed whack thistle and spot treat regrowth with herbicide.
10	Extensive NTS in this area; some representative species include triangle orache, thistle, white sweet clover, catnip, hoary alyssum, burdock, catnip and Virginia creeper. This

	site would likely benefit from mounding or creating "rough and loose" conditions described in the Polster references. Consider planting trees or live stakes. Light grass seeding and follow up herbicide application to treat emergent NTS in spring over multiple seasons would likely be beneficial.
11	Mow or weed whack invasives in this area including thistle, bindweed, prickly lettuce, catnip and burdock. Canada goldenrod is also prevalent. May benefit from stakes or tree plantings and selective treatment of emergent vegetation.
12	These areas are already mowed and will likely continue to be mowed by the City. Consider pocket planting of native trees and shrubs.

For the work recommended above planting and grass seeding are likely to be most successful if carried out in fall or spring. Live stakes should be installed in spring to allow time for the stakes to flush and become established. Herbicide treatments should occur in spring when the NTS are young and just becoming established. **Any herbicide applications should be carried out by an approved herbicide applicator and will likely need to be applied under an approved pest management licence or under a City of Kelowna or Regional District of Central Okanagan approved Pest Management Plan**. Below are general guidelines with respect to setbacks for herbicide application:

Table: 8 Suggested No Treatment and Pesticide Free Zones	
Buffer (m)	Description
100 m No Treatment Zone	**Upslope from licensed water intakes in a community watershed**
30 m No Treatment Zone	**Potable domestic and agricultural wells and water intakes. Downstream from licensed water intakes in a community watershed.**
10 m Pesticide Free Zone	**Any waterbody or stream***

*Varies based on herbicide
No Treatment Zones are areas that must NOT be treated with pesticide. Pesticide Free Zones are areas that must NOT be treated with pesticide AND must NOT have pesticide move or drift into them.

It would be highly beneficial to consult a local invasive species expert or weed committee for more site specific recommendations on treatments and appropriate herbicide application methods and products.

6.2 Park Management and Access Recommendations

In other situations a management plan for a park like Munson Pond would be extensive and might incorporate a range of values and associated objectives. For example, a park management plan could include recreational, historical, cultural, natural environment and economic aspects. Since this restoration project focussed specifically on the natural environment and impacts associated with invasive species at the site, the management plan included here will be limited to natural environment and invasive species aspects of the site. Consultation was not carried out in developing these recommendations; however that would be an important component to consider when developing a more extensive plan for the park.

According to the City of Kelowna Official Community Plan (OCP), the core direction relating to environmental protection includes:

- **Protect natural areas** including wetlands, riparian areas and forested slopes from the impacts of a growing city
- **Encourage Sustainable site and community development**
- **Protect Species Biodiversity,** both species and the ecosystems they live in

Each of these directives can be broken down further into specific goals and objectives for the site upon which to build a management plan. The author has taken some liberties in developing the following list of goals and objectives to align the management plan recommendations with the OCP vision.

Table 9: Restoration and Management Objectives for Munson Pond

Goal	Objectives (Opportunities)
Protect the existing character of the park	• Avoid formal development in the park like buildings and other amenities. Limit site improvements to pathways and facilities that support safe recreational use of the site without impacting natural values • Maintain existing drainage patterns and/or restore historic drainage patterns • Planting and protection of species should be focussed on native species only • Continue to limit dog use in the park or adopt on leash only or dog friendly specific areas • Carry out annual inventories of wildlife and terrestrial and aquatic ecosystems and monitor changes to these inventoried items over time • Continue to fund maintenance of the park (i.e. maintenance of site amenities, garbage cleanup, treating invasives, mowing certain areas, etc.).
Limit the spread of invasive species	• Develop invasive plant mitigation strategies • Reach out to invasive species groups and the Ministry of Environment to seek ways to manage aquatic invasive species present in the pond • Consider fencing all areas beyond the walking path
Encourage the expansion of natural areas	• Look for opportunities to expand the park onto adjacent sites • Develop a plan to "re-naturalize" the west side of the park from a mowed field to a more natural green space (i.e. consider creating more wetland area or attempting to repopulate the area through natural succession with trees and shrubs) • Look for connectivity options between the park and other nearby green spaces in Kelowna. Even semi green spaces, like Michaelbrook Golf Course, might be beneficial
Improve or create habitat features at the site	• Consider installing wildlife features like nest boxes, basking logs and specific habitats for locally present species at risk (i.e. consider developing a nesting site on the perimeter of the park for painted turtle) • Top hazard trees to retain these features as possible wildlife trees for primary and secondary cavity nesters • Consider installing wildlife "corridor features" to assist known wildlife movement between green spaces locally

7.0 Long Term Monitoring and Adaptive Management

If recommendations or restoration efforts are implemented in the Munson Pond park, a continuous monitoring program should be implemented to monitor and evaluate success and drive future changes to the work. The conversion of portions of the site to more natural forested riparian habitats will take many years and it is not uncommon to have restoration projects monitored for 5 to 10 years or more. Ongoing long term interventions to deal with NTS infill and re-establishment will likely be required. Below is an example of an adaptive management strategy that could be used for Munson Pond (ESSA 2021).

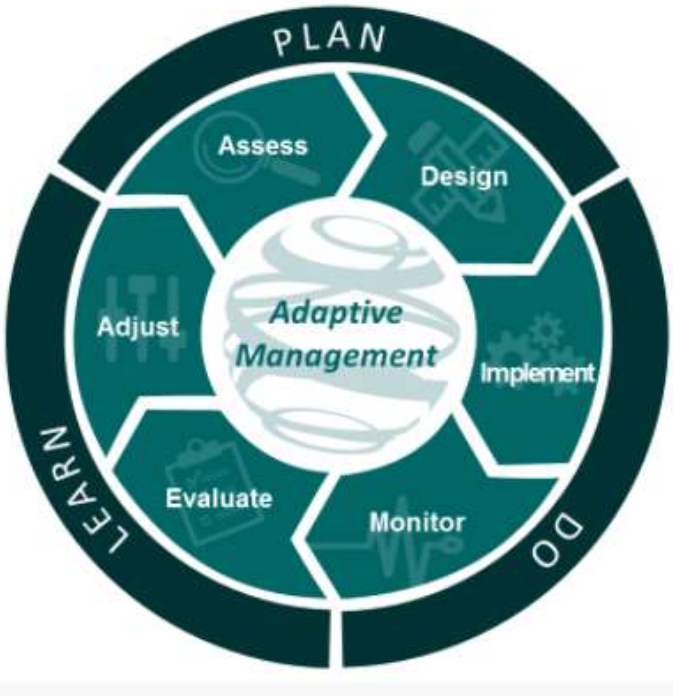

Figure 5 – Example of an Adaptive Management Strategy that Might be Used at Munson Pond

8.0 Conclusion

This reports summarizes NTS treatments and restoration trials completed at Munson Park. In general areas with well established cover were most effective at deterring the establishment and return of NTS. A combination of fill planting, manual and mechanical removal of NTS and selective herbicide application is recommended to reduce the presence of NTS. An adaptive management plan could help to evaluate and direct treatments moving forward.

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Appendix A

List of Species at Risk with the Potential to be Found in the Study Area

Scientific Name	English Name	Provincial	BC List	COSEWIC	SARA
Accipiter gentilis atricapillus	Northern Goshawk, *atricapillus* subspecies	S3S4 (2017)	Blue	NAR	
Aechmophorus clarkii	Clark's Grebe	S1B (2015)	Red		
Aechmophorus occidentalis	Western Grebe	S1B,S2N (2015)	Red	SC	1-SC (2017)
Aeronautes saxatalis	White-throated Swift	S3S4B (2015)	Blue		
Aeshna constricta	Lance-tipped Darner	S2S3 (2015)	Blue		
Ambystoma mavortium	Western Tiger Salamander	S2 (2016)	Red	E	1-E (2018)
Ammodramus savannarum	Grasshopper Sparrow	S1B (2018)	Red		
Anaxyrus boreas	Western Toad	S4 (2016)	Yellow	SC	1-SC (2018)
Antrozous pallidus	Pallid Bat	S2 (2015)	Red	T	1-T (2003)
Aplodontia rufa	Mountain Beaver	S4 (2015)	Yellow	SC	1-SC (2003)
Apodemia mormo	Mormon Metalmark	S1S2 (2020)	Red	E	1-E (2005)
Arctoparmelia subcentrifuga	abrading ring	S3 (2019)	Blue		
Ardea herodias herodias	Great Blue Heron, *herodias* subspecies	S3? (2017)	Blue		
Argia emma	Emma's Dancer	S3S4 (2015)	Blue		
Argia vivida	Vivid Dancer	S2S3 (2015)	Blue	SC	1-SC (2019)
Asio flammeus	Short-eared Owl	S3B,S2N (2015)	Blue	T	1-SC (2012)
Astragalus sclerocarpus	The Dalles milk-vetch	S2 (2019)	Red		
Athene cunicularia	Burrowing Owl	S1B (2020)	Red	E	1-E (2003)
Azolla mexicana	Mexican mosquito fern	S3 (2019)	Blue	T	1-T (2003)
Bartramia longicauda	Upland Sandpiper	S2B (2015)	Red		
Berula incisa	cut-leaved water-parsnip	S3? (2019)	Blue		
Botaurus lentiginosus	American Bittern	S3B, SNRN (2015)	Blue		
Branta bernicla	Brant	S3M (2015)	Blue		
Bryoerythrophyllum columbianum	Columbian carpet moss	S2S3 (2015)	Blue	SC	1-SC (2005)
Buteo lagopus	Rough-legged Hawk	S3N (2015)	Blue	NAR	
Buteo platypterus	Broad-winged Hawk	S3?B (2015)	Blue		
Buteo swainsoni	Swainson's Hawk	S2B (2015)	Red		
Butorides virescens	Green Heron	S3S4B (2015)	Blue		
Calcarius pictus	Smith's Longspur	S3S5B (2015)	Blue		
Callophrys affinis	Immaculate Green Hairstreak	S2S3 (2020)	Blue		
Catherpes mexicanus	Canyon Wren	S3? (2015)	Blue	NAR	
Centrocercus urophasianus	Greater Sage-Grouse	SX (2015)	Red	XT	1-XT (2003)
Charina bottae	Northern Rubber Boa	S4 (2018)	Yellow	SC	1-SC (2005)
Chlosyne hoffmanni	Hoffman's Checkerspot	S2 (2020)	Red		
Chondestes grammacus	Lark Sparrow	S3S4B (2015)	Blue		
Chordeiles minor	Common Nighthawk	S4B (2015)	Yellow	SC	1-T (2010)
Chrysemys picta	Painted Turtle	S3 (2018)	No Status	E/SC	1-E/SC (2007)
Chrysemys picta pop. 2	Painted Turtle - Intermountain - Rocky Mountain Population	S3? (2018)	Blue	SC	1-SC (2007)
Cicindela decemnotata	Badlands Tiger Beetle	S1S3 (2017)	Red		
Cicindela hirticollis	Hairy-necked Tiger Beetle	S2S4 (2017)	Blue		
Cicindela parowana	Dark Saltflat Tiger Beetle	S1 (2015)	Red	E	1-E (2012)

Scientific Name	English Name	Provincial	BC List	COSEWIC	SARA
Cicindela pugetana	Sagebrush Tiger Beetle	S3S4 (2017)	Blue		
Claytonia cordifolia	heart-leaved springbeauty	S2S3 (2019)	Blue		
Coccothraustes vespertinus	Evening Grosbeak	S5 (2015)	Yellow	SC	1-SC (2019)
Coccyzus americanus	Yellow-billed Cuckoo	SXB (2015)	Red		
Coluber constrictor	North American Racer	S2S3 (2018)	Blue	T	1-SC (2006)
Contopus cooperi	Olive-sided Flycatcher	S3S4B (2015)	Blue	SC	1-T (2010)
Copablepharon absidum	Columbia Dune Moth	SH (2009)	Red	DD	
Corynorhinus townsendii	Townsend's Big-eared Bat	S3S4 (2015)	Blue		
Cottus hubbsi	Columbia Sculpin	S3 (2019)	Blue	SC	1-SC (2003)
Crataegus atrovirens	dark-green hawthorn	S3 (2019)	Blue		
Crataegus okanaganensis var. *okanaganensis*	Okanagan hawthorn	S3?	Blue		
Crepis atribarba ssp. *atribarba*	slender hawksbeard	S3 (2019)	Blue		
Crossidium seriatum	tiny tassel	S3 (2015)	Blue	SC	1-SC (2019)
Crotalus oreganus	Western Rattlesnake	S2S3 (2018)	Blue	T	1-T (2005)
Cygnus columbianus	Tundra Swan	S3N (2015)	Blue		
Cypseloides niger	Black Swift	S3S4B (2021)	Blue	E	1-E (2019)
Danaus plexippus	Monarch	S1?B (2020)	Red	E	1-SC (2003)
Dermatocarpon intestiniforme	quilted stippleback	S2S3 (2019)	Blue		
Dolichonyx oryzivorus	Bobolink	S3B (2015)	Blue	T	1-T (2017)
Dryobates albolarvatus	White-headed Woodpecker	S1 (2015)	Red	E	1-E (2003)
Efferia okanagana	Okanagan Hammertail	S1S2 (2019)	Red	E	1-E (2017)
Eleocharis engelmannii	Englemann's spike-rush	S3 (2019)	Blue		
Empidonax wrightii	Gray Flycatcher	S3B (2015)	Blue	NAR	
Enallagma clausum	Alkali Bluet	S3 (2015)	Blue		
Entosthodon rubiginosus	rusty cord-moss	S2S3 (2015)	Blue	E	1-E (2006)
Epargyreus clarus	Silver-spotted Skipper	S3 (2020)	Blue		
Eremobates scaber		S2? (2016)	Red		
Eremobates sp. 1		S1? (2016)	Red		
Eremobates sp. 2		S1? (2016)	Red		
Eremophila alpestris merrilli	Horned Lark, *merrilli* subspecies	S3? (2017)	Blue		
Erythemis collocata	Western Pondhawk	S3S4 (2015)	Blue		
Euderma maculatum	Spotted Bat	S3S4 (2015)	Blue	SC	1-SC (2005)
Euphagus carolinus	Rusty Blackbird	S3S4B (2015)	Blue	SC	1-SC (2009)
Falco mexicanus	Prairie Falcon	S1 (2018)	Red	NAR	
Falco peregrinus	Peregrine Falcon	S3 (2015)	No Status	SC	1-SC
Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	S2? (2011)	Red	NAR	1-SC (2012)
Falco rusticolus	Gyrfalcon	S3S4B, SNRN (2015)	Blue	NAR	
Fulgensia desertorum	desert sulphur	S2S3 (2019)	Blue		
Galba dalli	Dusky Fossaria	S3S4 (2015)	Blue		
Galba obrussa	Golden Fossaria	S2S3 (2015)	Blue		
Galba truncatula	Attenuate Fossaria	S3S5 (2015)	Blue		
Gayophytum ramosissimum	hairstem groundsmoke	S3? (2019)	Blue		
Gonidea angulata	Rocky Mountain Ridged Mussel	S2 (2014)	Red	E	1-SC (2005)

Scientific Name	English Name	Provincial	BC List	COSEWIC	SARA
Gulo gulo	Wolverine	S3 (2015)	No Status	SC	1-SC (2018)
Gulo gulo luscus	Wolverine, *luscus* subspecies	S3 (2010)	Blue	SC	1-SC (2018)
Hemerotrecha sp. 1		S1? (2016)	Red		
Hemileuca nuttalli	Nuttall's Sheepmoth	S1 (2018)	Red	E	
Hemphillia camelus	Pale Jumping-slug	S3 (2015)	Blue		
Hesperia nevada	Nevada Skipper	S3S4 (2020)	Blue		
Hirundo rustica	Barn Swallow	S3S4B (2015)	Blue	SC	1-T (2017)
Hydroprogne caspia	Caspian Tern	S3B (2015)	Blue	NAR	
Hypsiglena chlorophaea	Desert Nightsnake	S2 (2018)	Red	E	1-E (2003)
Icteria virens	Yellow-breasted Chat	S2B (2018)	Red	E	1-E (2003)
Larus californicus	California Gull	S2S3B (2015)	Blue		
Leptosiphon harknessii	Harkness' linanthus	S1S2 (2019)	Red		
Lepus townsendii	White-tailed Jackrabbit	SX (2015)	Red		
Libellula pulchella	Twelve-spotted Skimmer	S3 (2015)	Blue		
Limenitis archippus	Viceroy	SX (2020)	Red		
Limnodromus griseus	Short-billed Dowitcher	S2S3B (2015)	Blue		
Limosa haemastica	Hudsonian Godwit	S1B (2020)	Red	T	
Lindernia dubia var. *dubia*	yellowseed false pimpernel	S3? (2018)	Blue		
Lipocarpha micrantha	small-flowered lipocarpha	S1 (2019)	Red	E	1-E (2005)
Lithobates pipiens	Northern Leopard Frog	S1 (2016)	Red	E	1-E (2003)
Lupinus sulphureus	sulphur lupine	S3 (2019)	Blue		
Lycaena nivalis	Lilac-bordered Copper	S3 (2020)	Blue		
Macromia magnifica	Western River Cruiser	S3 (2015)	Blue		
Magnipelta mycophaga	Magnum Mantleslug	S2S3 (2015)	Blue	SC	1-SC
Marsilea vestita	hairy water-clover	S3 (2019)	Blue		
Massalongia microphylliza	chopped liver	S2S3 (2019)	Blue		
Megascops kennicottii	Western Screech-Owl	S4 (2015)	No Status	T	1-T
Megascops kennicottii macfarlanei	Western Screech-Owl, *macfarlanei* subspecies	S3 (2017)	Blue	T	1-T (2005)
Melanerpes lewis	Lewis's Woodpecker	S2S3B (2015)	Blue	T	1-T (2012)
Melanitta perspicillata	Surf Scoter	S3B,S4N (2015)	Blue		
Microbryum vlassovii	nugget moss	S2 (2015)	Red	E	1-E (2009)
Myotis ciliolabrum	Western Small-footed Myotis	S2S3 (2015)	Blue		
Myotis lucifugus	Little Brown Myotis	S4 (2015)	Yellow	E	1-E (2014)
Myotis thysanodes	Fringed Myotis	S3 (2015)	Blue	DD	3 (2005)
Navarretia propinqua	near navarretia	S2S3 (2019)	Blue		
Neofuscelia loxodes	blistered toad	S3 (2019)	Blue		
Neofuscelia subhosseana	erupting toad	S2S3 (2010)	Blue		
Numenius americanus	Long-billed Curlew	S3B (2018)	Blue	SC	1-SC (2005)
Nycticorax nycticorax	Black-crowned Night-heron	S1 (2015)	Red		
Oenothera pallida ssp. *pallida*	pale evening-primrose	S2 (2019)	Red		
Oncorhynchus clarkii clarkii	Cutthroat Trout, *clarkii* subspecies	S3S4 (2004)	Blue		
Ophiogomphus occidentis	Sinuous Snaketail	S3 (2015)	Blue		
Oreamnos americanus	Mountain Goat	S3 (2015)	Blue		
Oreoscoptes montanus	Sage Thrasher	S1B (2015)	Red	E	1-E (2003)

Scientific Name	English Name	Provincial	BC List	COSEWIC	SARA
Ovis canadensis	Bighorn Sheep	S3? (2015)	Blue		
Patagioenas fasciata	Band-tailed Pigeon	S3S4 (2015)	Blue	SC	1-SC (2011)
Pelecanus erythrorhynchos	American White Pelican	S1B (2015)	Red	NAR	
Peltula euploca	powder-lined rock-olive	S1S3 (2019)	Red		
Perognathus parvus	Columbia Plateau Pocket Mouse	S3 (2015)	Blue		
Phalacrocorax auritus	Double-crested Cormorant	S3S4 (2015)	Blue	NAR	
Phalaropus lobatus	Red-necked Phalarope	S3S4B (2015)	Blue	SC	1-SC (2019)
Phanogomphus graslinellus	Pronghorn Clubtail	S2S3 (2015)	Blue		
Phlox speciosa ssp. *occidentalis*	showy phlox	S2 (2019)	Red	T	1-T (2006)
Pholisora catullus	Common Sootywing	S3 (2020)	Blue		
Phrynosoma douglasii	Pygmy Short-horned Lizard	SX (2018)	Red	XT	1-XX (2003)
Physcia dimidiata	exuberant rosette	S3 (2019)	Blue		
Pinus albicaulis	whitebark pine	S2S3 (2019)	Blue	E	1-E (2012)
Pituophis catenifer	Gophersnake	S3 (2018)	No Status		1-XX/T (2005)
Pituophis catenifer deserticola	Gopher Snake, *deserticola* subspecies	S3 (2018)	Blue	T	1-T (2005)
Plestiodon skiltonianus	Western Skink	S3S4 (2018)	Blue	SC	1-SC (2005)
Pluvialis dominica	American Golden-Plover	S3S4B (2015)	Blue		
Podiceps nigricollis	Eared Grebe	S3B (2015)	Blue		
Polites sabuleti	Sandhill Skipper	S2 (2020)	Red		
Polites sonora	Sonora Skipper	S3 (2020)	Blue	NAR	1-SC (2007)
Polygonum polygaloides ssp. *confertiflorum*	close-flowered knotweed	S3 (2021)	Blue		
Pristiloma arcticum	Northern Tightcoil	S3S4 (2015)	Blue		
Promenetus umbilicatellus	Umbilicate Sprite	S2S3 (2015)	Blue		
Psiloscops flammeolus	Flammulated Owl	S3B (2015)	Blue	SC	1-SC (2003)
Pterygoneurum kozlovii	alkaline wing-nerved moss	S3 (2015)	Blue	T	1-T (2006)
Pyrgus communis	Checkered Skipper	S3 (2020)	Blue		
Rangifer tarandus pop. 1	Caribou (Southern Mountain Population)	S1 (2017)	Red	E	1-T (2003)
Recurvirostra americana	American Avocet	S2S3B (2015)	Blue		
Reithrodontomys megalotis	Western Harvest Mouse	S3 (2015)	Blue	E	1-SC (2009)
Rhinichthys umatilla	Umatilla Dace	S2 (2019)	Red	T	3 (2005)
Rotala ramosior	toothcup	S1 (2019)	Red	E	1-E (2003)
Salix amygdaloides	peach-leaf willow	S3 (2019)	Blue		
Salvelinus confluentus	Bull Trout	S3S4 (2018)	Blue	SC	
Satyrium behrii	Behr's Hairstreak	S1 (2020)	Red	E	1-E (2003)
Satyrium californica	California Hairstreak	S3 (2020)	Blue		
Satyrium semiluna	Half-moon Hairstreak	S1 (2020)	Red	E	1-E (2007)
Scytinium schraderi	collapsing vinyl	S2? (2019)	Red		
Sisyrinchium idahoense var. *occidentale*	Idaho blue-eyed grass	S1S3 (2015)	Red		
Sorex merriami	Merriam's Shrew	S1 (2015)	Red		
Sorex preblei	Preble's Shrew	S1S2 (2015)	Red		
Spea intermontana	Great Basin Spadefoot	S3 (2018)	Blue	T	1-T (2003)

Scientific Name	English Name	Provincial	BC List	COSEWIC	SARA
Speyeria mormonia erinna	Mormon Fritillary, *erinna* subspecies	S2 (2021)	Red		
Sphaerium occidentale	Herrington Fingernailclam	S2S3 (2015)	Blue		
Sphaerium striatinum	Striated Fingernailclam	S3S4 (2015)	Blue		
Sphyrapicus thyroideus	Williamson's Sapsucker	S3B (2020)	Blue	E	1-E (2006)
Sphyrapicus thyroideus thyroideus	Williamson's Sapsucker, *thyroideus* subspecies	SNRB (2012)	No Status	E	1-E (2006)
Spizella breweri breweri	Brewer's Sparrow, *breweri* subspecies	S2S3B (2018)	Blue		
Stagnicola apicina	Abbreviate Pondsnail	S2S3 (2015)	Blue		
Stagnicola traski	Widelip Pondsnail	S3S4 (2015)	Blue		
Sterna forsteri	Forster's Tern	S1B (2015)	Red	DD	
Stylurus olivaceus	Olive Clubtail	S2 (2015)	Red	E	1-E (2017)
Sylvilagus nuttallii	Nuttall's Cottontail	S3 (2015)	Blue	SC	1-SC (2007)
Symphyotrichum frondosum	short-rayed aster	S2 (2019)	Red	E	1-E (2007)
Synaptomys borealis artemisiae	Northern Bog Lemming, *artemisiae* subspecies	S2S3 (2006)	Blue		
Taraxia breviflora	short-flowered evening-primrose	S1 (2019)	Red		
Taxidea taxus	American Badger	S2 (2015)	Red	E	1-E (2018)
Triglochin concinna var. *debilis*	slender arrow-grass	S2S3 (2015)	Blue		
Tympanuchus phasianellus columbianus	Sharp-tailed Grouse, *columbianus* subspecies	S2S3 (2005)	Blue		
Tyto alba	Barn Owl	S2? (2015)	Red	T	1-T (2018)
Ursus arctos	Grizzly Bear	S3? (2015)	Blue	SC	1-SC (2018)
Viola sororia	woolly blue violet	S3 (2019)	Blue		

Appendix B

Site Photographs

Photo 1: View of soil profile in survey point 1 (May 2020)

Photo 2: View of survey point 1 looking north (May 2020)

Appendix

Photo 3: Area recently hydro seeded on the north side of Munson Pond (May 2020)

Photo 4: Lilac shrub growing on site, one of many landscape varieties found in this area (May 2020)

Photo 5: View of soil profile at survey point 2 (May 2020)

Photo 6: View looking west of site at survey point 2 (May 2020)

Appendix

Photo 7: View of a mowed section near the fence line on the north side of the pond (May 2020)

Photo 8: Soil profile at survey point 3 (May 2020)

Appendix

Photo 9: View of vegetation at survey point 3 (May 2020)

Photo 10: View of the dominant cottonwood overstory in the riparian forest on the south end of the pond (May 2020)

Appendix

Photo 11: Treatment plot 1 – before treatment (August 2020)

Photo 12: Treatment plot 1 – after treatment (August 2020)

Appendix

Photo 13: View of sign identifying treatment plot (August 2021)

Photo 14: Treatment plot 1 regrowth in year 1 (October 2020)

Photo 15: Treatment plot 1 regrowth in year 2 (July 2021)

Photo 16: View of NTS present in the general area of treatment plot 1 (July 2021)

Photo 17: Treatment plot 2 – before treatment (August 2020)

Photo 18: Treatment Plot 2 – after treatment (August 2020)

Photo 19: Treatment Plot 2 – regrowth in year 1 (October 2020)

Photo 20: Treatment plot 2 – regrowth in year 2 (July 2021)

Appendix

Photo 21: Treatment plot 3 – before treatment (August 2020)

Photo 22: Treatment plot 3 - after treatment (August 2020)

Photo 23: Regrowth treatment plot 3 – Year 2 (July 2021)

Photo 24: Plot 4 – before treatment (August 2020)

Photo 25: Plot 4 – after treatment (August 2020)

Photo 26: Treatment Plot 4 – regrowth year 2 (July 2021)

Photo 27: Plot 5 – before treatment (August 2020)

Photo 28: Plot 5 – after treatment (August 2020)

Photo 29: Plot 5 regrowth after treatment (October 2021)

Photo 30: Treatment plot 5 – regrowth in Year 2 (July 2021)

Photo 31: Plot 6 before treatment (August 2020)

Photo 32: Plot 6 – after treatment (August 2020).

Photo 33: Regrowth plot 6 (October 2020)

Photo 34: Treatment plot 6 – regrowth after Year 2 (July 2021)

Photo 35: Siberian elm growing in the southwest corner of the site (October 2020)

Photo 36: Open water present in the south half of the site near survey point 5 (October 2020)

Photo 37: Wetted channel in the south half of the site (October 2020)

Photo 38: Riparian forest along the south end of the site (October 2020)

Photo 39: Possible treatment area #2 (July 2021)

Photo 40: Possible treatment area 3 (July 2021)

Photo 41: Possible treatment area 5 (July 2021)

Photo 42: Possible treatment area 7 (July 2021)

Photo 43: Possible treatment area 10 (July 2021)

Photo 44: Possible treatment area 11 (July 2021)

Photo 45: Possible treatment area 12 (July 2021)

Appendix C

Field Data

West

BRITISH COLUMBIA — GROUND INSPECTION FORM

G ☑ vs V ☐	PHOTO	X:	Y:	DATE 2020May 18
PROJECT ID. UVIC 390 Munson		SURV. AC/MM		
MAP SHEET 82E.083		PLOT # 001		POLY. #
UTM ZONE 11U WGS84	LAT. / NORTH 5526342		LONG. / EAST 323078	
ASPECT Flat °		ELEVATION 336 m		
SLOPE 1 %	SMR 6 (66)		SNR D	

MESO SLOPE POSTION
☐ Crest ☐ Upper slope ☐ Mid slope ☐ Lower slope ☐ Toe ☐ Depression ☑ Level

DRAINAGE - MINERAL SOILS
☐ Very rapidly ☐ Rapidly ☐ Well ☐ Mod. well ☐ Imperfectly ☑ Poorly ☐ Very poorly

MOISTURE SUBCLASSES - ORGANIC SOILS N/A
☐ Aqueous ☐ Peraquic ☐ Aquic ☐ Subaquic ☐ Perhumid ☐ Humid

MINERAL SOIL TEXTURE
☐ Sandy (LS,S) ☐ Loamy (SL,L,SCL,FSL) ☐ Silty (SiL,Si) ☑ Clayey (SiCL,CL,SC,SiC,C)

ORGANIC SOIL TEXTURE N/A
☐ Fibric ☐ Mesic ☐ Humic

SURF. ORGANIC HORIZON THICKNESS
☑ 0–40 cm ☐ > 40 cm

HUMUS FORM
☐ Mor ☐ Moder ☑ Mull

ROOT RESTRICTING LAYER N/A
Depth _____ cm Type _____

COARSE FRAGMENT CONTENT
☑ < 20% ☐ 20–35% ☐ 35–70% ☐ > 70%

TERRAIN

COMPONENT: TC1 ☑ TC2 ☐ TC3 ☐

TERRAIN TEXTURE	SURFICIAL MATERIAL	SURFACE EXPRESSION	GEOMORPH PROCESS
1 Z	1 A	1 P	1 U
2 C	2 FG	2 V	2

ECOSYSTEM

COMPONENT: EC1 ☐ EC2 ☐ EC3 ☐

BGC UNIT PPxh1	ECOSECTION Northern Okanagan Basin (NOB)
SITE SERIES 08 - DM	SITE MODIFIERS jf
STRUCTURAL STAGE 2b Graminoid dominated herb	CROWN CLOSURE Ø %

ECOSYSTEM POLYGON SUMMARY

	%	SS	SM	ST
EC1				
EC2				
EC3				

TERRAIN POLYGON SUMMARY

	%	Classification
TC1		
TC2		
TC3		

DOMINANT / INDICATOR PLANT SPECIES

TOTAL %	A: ∅ one snag	B:	C:	D:

L.	SPECIES	%	L.	SPECIES	%	L.	SPECIES	%
B2	Bebb's willow	1						
	Red o.	3						
	Prairie Rose	3						
C	Hemp dogbane	5						
	showy milkweed	10						
	woolly sedge	15						
	baltic rush	20						
	quackgrass	40						
	sheep sorrel	1						
	unknown spp. seedbox?	3						

A1 - vets
A2 - main
A3 - sub (i.e < 20)
B1 2-10
B2 < 2 - ons
C herb
D - moss lichen
E - epiphyte (growing on others)

COMPLETE ☐ PARTIAL ☐

Tree Mensuration

Spp.	DBH	Ht. Calculation to DBH						Ht. to DBH	Total HT	BH Age	Path Y/N
		Top	Bot	SD	SL	HD	HT				
N/A											

NOTES (site diagram, exposure, gleying, etc.)

Close to open water
Nearby plot - dead willow, rose and red o.

LFH 3-0
Ah 0-11 10YR2/2 CL
Bfg 11-22 10YR 2/1 CL
Bg 22+ 10YR 4/1 CL
Fera Humic Gleysol

Photos
Pit 106
N 107
S 108
E 109
W 110

NORTH

BRITISH COLUMBIA — GROUND INSPECTION FORM

G ☐ vs V ☐	PHOTO	X:	Y:	DATE 2020Nov18
PROJECT ID. UVic 390 Munson Pond		SURV. AC/MM		
MAP SHEET 82E.083		PLOT # 002		POLY. #
UTM ZONE 11	LAT. / NORTH 5526171		LONG. / EAST 323134	
ASPECT level °		ELEVATION 332 m		
SLOPE 3 %	SMR 5-6		SNR C	

MESO SLOPE POSTION
☐ Crest ☐ Upper slope ☐ Mid slope ☐ Lower slope ☐ Toe ☐ Depression ☑ Level

DRAINAGE - MINERAL SOILS
☐ Very rapidly ☐ Rapidly ☐ Well ☐ Mod. well ☑ Imperfectly ☐ Poorly ☐ Very poorly

MOISTURE SUBCLASSES ORGANIC SOILS N/A
☐ Aqueous ☐ Peraquic ☐ Aquic ☐ Subaquic ☐ Perhumid ☐ Humid

MINERAL SOIL TEXTURE
☐ Sandy (LS,S) ☑ Loamy (SL,L,SCL,FSL) ☐ Silty (SiL,Si) ☐ Clayey (SiCL,CL,SC,SiC,C)

ORGANIC SOIL TEXTURE N/A
☐ Fibric ☐ Mesic ☐ Humic

SURF. ORGANIC HORIZON THICKNESS
☑ 0–40 cm ☐ > 40 cm

HUMUS FORM
☐ Mor ☑ Moder ☐ Mull

ROOT RESTRICTING LAYER N/A
Depth _____ cm Type _____

COARSE FRAGMENT CONTENT
☐ < 20% ☐ 20–35% ☑ 35–70% ☐ > 70%

TERRAIN

COMPONENT: TC1 ☑ TC2 ☐ TC3 ☐

TERRAIN TEXTURE	SURFICIAL MATERIAL	SURFACE EXPRESSION	GEOMORPH PROCESS
1 Z	1 A	1 P	1 U
2 C	2 FG	2 √	2

ECOSYSTEM

COMPONENT: EC1 ☐ EC2 ☐ EC3 ☐

BGC UNIT PPxh1	ECOSECTION Northern Okanagan Basin
SITE SERIES CO-CD	SITE MODIFIERS j
STRUCTURAL STAGE 3a. (low shrub)	CROWN CLOSURE Ø %

ECOSYSTEM POLYGON SUMMARY

	%	SS	SM	ST
EC1				
EC2				
EC3				

TERRAIN POLYGON SUMMARY

	%	Classification
TC1		
TC2		
TC3		

DOMINANT / INDICATOR PLANT SPECIES

TOTAL %	A:	B: 15	C: 85	D: Ø

L.	SPECIES	%	L.	SPECIES	%	L.	SPECIES	%
B1	Ac	15		quackgrass ?	65			
B2	Ac	10		mullein	1			
	Lilac	2		yellow flag iris	1			
	Snowberry	5		dandelion	+			
	prickly rose	1		rough fescue	2			
	rootka rose	2		cheatgrass	1			
	willow spp	+						
C	toadflax	5						
	bull thistle	2						
	Canada thistle	10						
	lamb's quarters	7						
	catnip	4						

COMPLETE ☐ PARTIAL ☐

Tree Mensuration

Spp.	DBH	Ht. Calculation to DBH						Ht. to DBH	Total HT	BH Age	Path Y/N
		Top	Bot	SD	SL	HD	HT				
NIA											

NOTES (site diagram, exposure, gleying, etc.)

LFH 5-0

Ach 0-13 SCL 10YR 2/2

B_{fg} 13 - LS 10YR 4/1

B_2^{fg} 41 + S 10YR 4/2 sand lens?

Photo

151 - pit
152 N
153 S
154 E
155 W

SOUTH

BRITISH COLUMBIA — GROUND INSPECTION FORM

G ☐ vs V ☐	PHOTO	X:	Y:	DATE 2020 May 18
PROJECT ID. UVIC 390 Munsan Pond		SURV. AC / MM		
MAP SHEET 82E.083		PLOT # 003		POLY. #
UTM ZONE 11	LAT. / NORTH 5526281		LONG. / EAST 323440	
ASPECT level °		ELEVATION 336 m		
SLOPE %	SMR 4-5		SNR C	

MESO SLOPE POSTION: ☐ Crest ☐ Upper slope ☐ Mid slope ☐ Lower slope ☐ Toe ☐ Depression ☑ Level

DRAINAGE - MINERAL SOILS: ☐ Very rapidly ☐ Rapidly ☑ Well ☑ Mod. well ☐ Imperfectly ☐ Poorly ☐ Very poorly

MOISTURE SUBCLASSES - ORGANIC SOILS N/A: ☐ Aqueous ☐ Peraquic ☐ Aquic ☐ Subaquic ☐ Perhumid ☐ Humid

MINERAL SOIL TEXTURE: ☐ Sandy (LS,S) ☐ Loamy (SL,L,SCL,FSL) ☑ Silty (SiL,Si) ☐ Clayey (SiCL,CL,SC,SiC,C)

ORGANIC SOIL TEXTURE: ☐ Fibric ☐ Mesic ☐ Humic

SURF. ORGANIC HORIZON THICKNESS: ☑ 0–40 cm ☐ > 40 cm

HUMUS FORM: ☐ Mor ☑ Moder ☐ Mull

ROOT RESTRICTING LAYER: Depth _____ cm Type _____

COARSE FRAGMENT CONTENT: ☐ < 20% ☑ 20–35% ☐ 35–70% ☐ > 70%

TERRAIN

COMPONENT: TC1 ☑ TC2 ☐ TC3 ☐

TERRAIN TEXTURE	SURFICIAL MATERIAL	SURFACE EXPRESSION	GEOMORPH PROCESS
1 Z	1 A	1 P	1 U
2 S	2 FG	2 ✓	2

ECOSYSTEM

COMPONENT: EC1 ☐ EC2 ☐ EC3 ☐

BGC UNIT PPxh1	ECOSECTION Northern Okanagan Basin
SITE SERIES 07/00 - CD	SITE MODIFIERS j
STRUCTURAL STAGE 5 (Young forest)	CROWN CLOSURE 10 %

ECOSYSTEM POLYGON SUMMARY

	%	SS	SM	ST
EC1				
EC2				
EC3				

TERRAIN POLYGON SUMMARY

	%	Classification
TC1		
TC2		
TC3		

no gw

VM - groundwater W · 0-30

F103 6 7 fm o1 02

DOMINANT / INDICATOR PLANT SPECIES

TOTAL %	A: 10	B: 15	C: 85	D: 2

L.	SPECIES	%	L.	SPECIES	%	L.	SPECIES	%
A3	Ac	10						
B1	Ac	15						
	Siberian elm	5						
B2	Ac	3						
	red osier dogwood	6						
	mock orange	2						
	Snowberry	85						
	Nootka rose	1						
C	Burdock	2						
	mullein	+						
	Canada thistle	+						

COMPLETE ☐ PARTIAL ☐

Tree Mensuration

Spp.	DBH	Ht. Calculation to DBH						Ht. to DBH	Total HT	BH Age	Path Y/N
		Top	Bot	SD	SL	HD	HT				
Ac	35							1.3	30		N

NOTES (site diagram, exposure, gleying, etc.)

LFH 2-0
Ah 0-11 SiL 10YR 2/2.
Bm 11+ SiL 2.5Y 4/2
→ 31-36 sand lens
C 36

Pit 176
N 177
S 178
E 179
W 180

light wind
Wx: Sun +10

Munson's Pond – Spp. List

2019 Nov 24

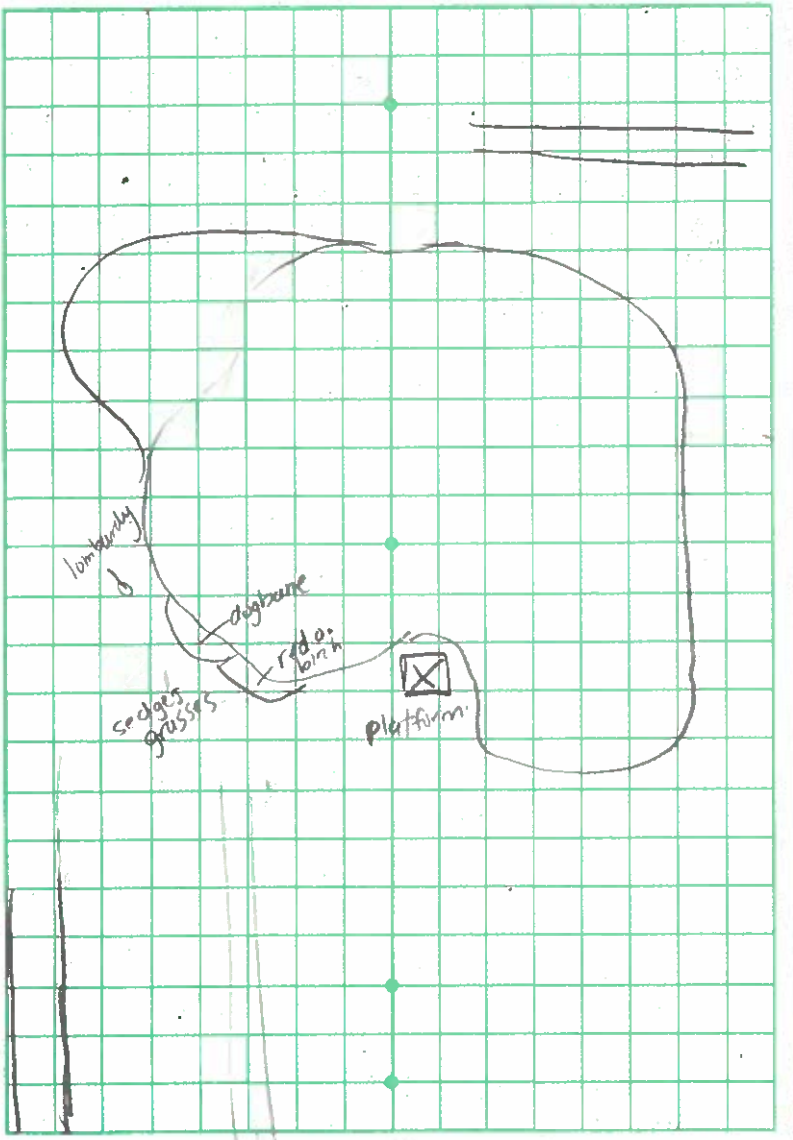
Crew: AC

hemp dogbane
water birch
red o.
fireweed
rushes
sedges
blue wildrye
reed canarygrass
thistle - Canada bull
curled dock
Nootka rose
chickory
bugloss
saskatoon
cottonwood
yarrow
white sweet clover
Salix spp
knapweed
Siberian elm
crab apple ?
russian olive

beaver activity
inlet stream
mullein
low + Canada Geese
salsify
hawkweed
burdock
echinacea ?
prairie pepper grass
showy milkweed ?
goatsbeard
Rorippa sp ? (marsh yellow cress)
tumble mustard spp.
cinquefoil
diffuse knapweed
common groundsel
Aster, spp.
Cattail
Loesel's tumble mustard

SURVEY OF: Munson Pond PAGE 2 of 2

DATE 2019 Nov 24 JOB NO. ER390



SURVEY CREW Munson Pond
AC

Munson Pond Survey

May 16, 2020

Crew: AC

* need to go later in season to confirm some spp

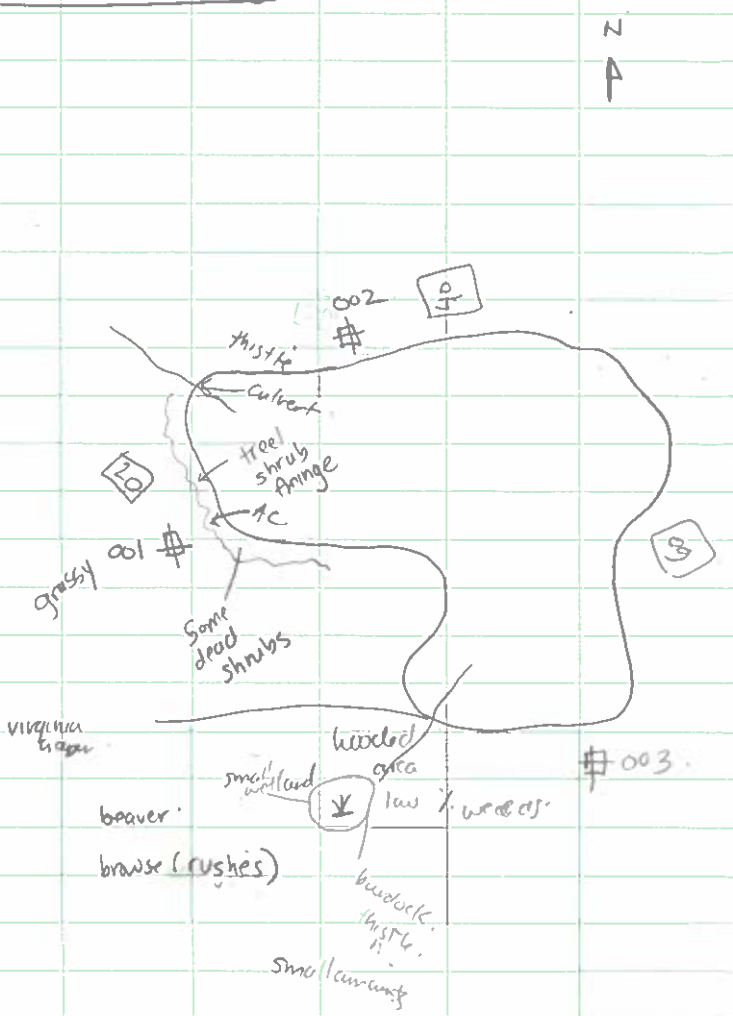
willow
x curled dock
* yellow flag iris
lombardy pop. (dead)
willow (dead)
x thistle spp.
rough fescue
x bull thistle
canada thistle
Ac
prickly rose
snowberry
Nepeta cadenca
trembling aspen. At
goldenrod
Siberian elm
elm spp?
nootka rose
cattails
alfalfa
cheatgrass
henbit
forget me nots
cleavers

giant horsetail
dandelion
mullein
cheatgrass
german madwort
lamb's quarters
Artemesia absinthium (wormwood)
Sisymbrium officinale (hedge mustard)
bugloss
fireweed
fire-thorn
oregano
european white birch (planted)
norway maple (planted)
virginia creeper
mock orange
mustard spp.
yellow salsify
tush spp.
pigweed?
lilac
yarrow
oregon grape
Cross tumble mustard

narrow leaved plantain spp
goats beard
mullein
American vetch.
scouring rush.
Idaho fescue
Stark's bl
elderberry
saskatoon.
morning glory
bluebunch wheatgrass
prickly lettuce
black hawthorn
orchard grass
choke cherry
graceful cinquefoil
buttercup

Munson Pond Survey

May 18, 2020



2 of 2

2020 Aug 5 Munson Pond Restoration Plots Crew: AS/MM

#1 323491 / 5526335 W 70 / N 10

perennial sow-thistle 25

purple loosestrife 5 grass 20

goldenrod 5

red o. dogwood 10

Canada thistle 40

catnip 20

Treatment - mow / spray

#2 32349I 5526328 W 25 N 30

Canada thistle 25

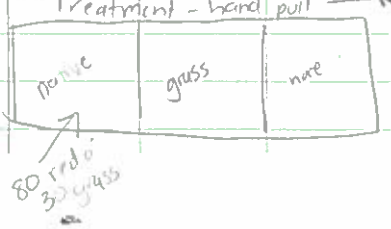
catnip 5

field pennycress 5

treatments spread weed seeds

grass 70

Treatment - hand pull



1 of 3

2020 Aug 5

W55 N 4

#5 322 897 5526220

Grass 60 (fescue ? 20)

Canada thistle · 55

south ↑ treatment : mow

#6 322908 5526233

reed canarygrass 25 grass 30 (55 total)

prickly lettuce 15

catnip 5

Canada thistle 20% treatment mow/spray

2020 Aug 5

W N
40 80

#3 322889 5526227

Goldenrod 20

Showy milkweed 15 (buds)

white sweet clover 40

cottonwood 20

grass 80

scouring rush 1

treatment hand pull

tansy 10

East

#4 322888 5526206

Bull thistle 5

American vetch 10

pulse milk vetch 10

mullein 2

goldenrod 15

catnip 2

prickly lettuce 10

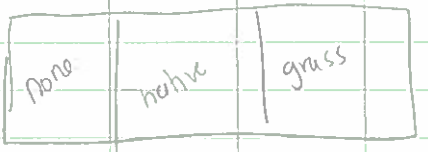
hoary alysum 2

Showy milkweed 15

Grasses 50 (blue bunch)

treatment: mow

East



#6 Weeds
(1) grass - 30% - thistle (Canada)
(2) nonc - 25 "
(3) native spp - 10 "
Some grasses regen

△4 - area South of trail
- open area high % grasses, weeds
Nootka rose, strawberry, goldenrod
Siberian elm protected by beaver net
exposed soil, mounded
wooded fringe @ S end = aspen
CFC - 30%
worm 3-4 mm v. slightly sticky, soapy, gritty
SNR C-R SMR 5-6

△5 wetland - dead paper birch, Ac, cattail
wetland - creek running through
perimeter here is cottonwood
Knights hade infestation
perimeter rose, dogwood, birch, Cattail
highbush cranberry ~~Quercus~~, skunk cabbage, mountain sweet

SURVEY CREW A. Cormano Cruly
M. March.

△5 cont'd.

heavily infested knapweed

2 kinds birch

			weeds	
#1	1 -	none	60	thistle.
	2 -	grass	70	catnip, thistle, sow thistle
	3 -	native.	40	" "

			weeds	
#2	1 -	none.	25	thistle.
	2 -	grass	20	"
	3 -	native	5	thistle

blue elderberry

			weeds	
#3	1 -	native	- ∅	→ native (grasses, goldenrod) cottonwood
	2 -	none	- ∅	
	3 -	grass	- ∅	

- grasses choke out weeds
- beyond trail Ac fringe

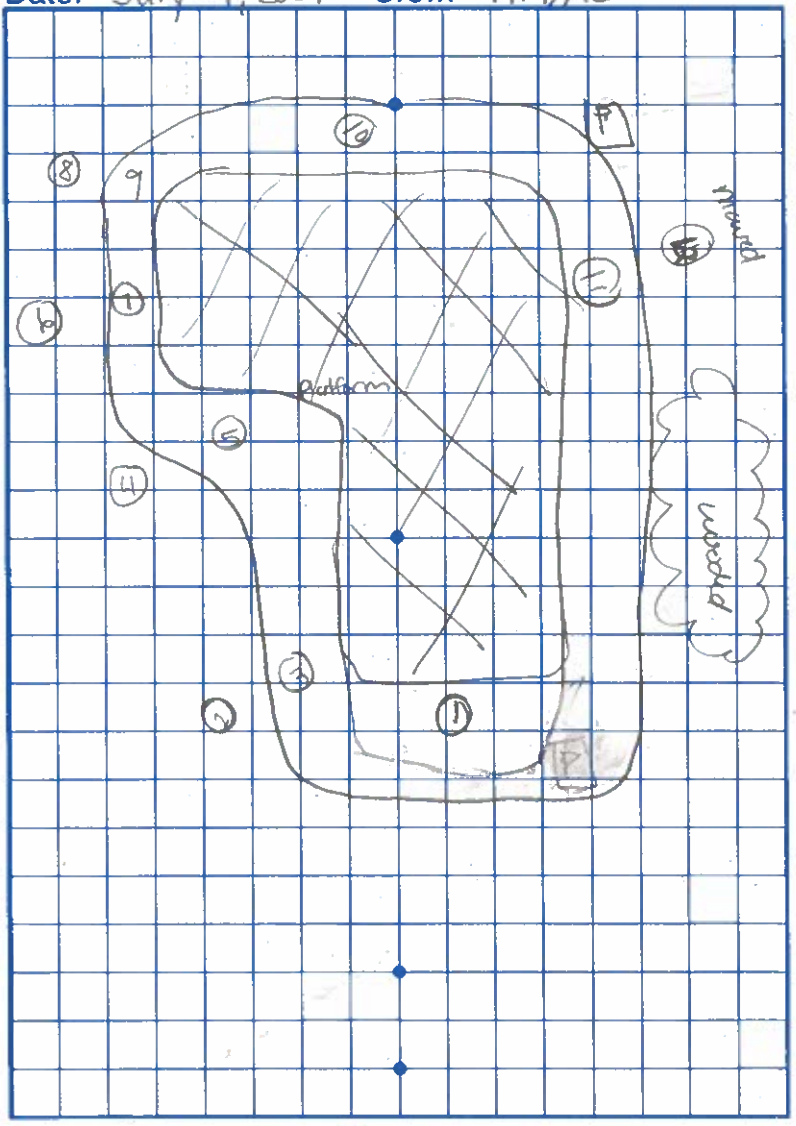
			weeds	
#4	1 -	none	∅	
	2 -	native	∅	grasses
	3 -	grass	∅	

#5	1 -	grass	35	thistle
	2 -	none	30	
	3 -	native.	10	

Job No: UVIC ER390 Page: 1 of 2

Survey of: Munson Pond

Date: July 4, 2021 Crew: MM/AC



1	Wooded area – hand pull selective		928
2	cut siberian elm.	rep spp - salsify	929/30
	AC stakes	white sweet clover	
	ww clover	Chicory	curled dock
	hand pull other	prickly lettuce	
		bladder campion	
		bugloss	Knapweed
3 –	similar to 2 but no elm		931/932
	plant riparian trees/shrubs		
4–5	hand pull / leave		(4)/(5) 933/934
	weed whack along trail		
6/8	– already mowed		935
7	see treatment 4/5 hand pull		936
In general	weed whack - spot treat regrow herb / fall plant stakes / gross seed		
9 –	hand pull / ww thistle spot treat regrowth		937–939
10	– selectively mow / ww spot treat grass s. stakes		
	triangle rake thistle. clover.	hoary alyssum burdock thistle.	
	catnip	virginia creeper	940–944
(11)	mow weed whack	tumble weed / mustard	
	thistle, bindweed, prickly lettuce, burdock.		
	burdock.	catnip	945
(12)	mowed 945		

2021 July 4 — Munson Pond — Recce — Crew: AC

NE — SW

△1 — native grass — none — p 901-904

% weeds — 20 — 80 — 80

- bull thistle
- bladder campion
- red o.
- Canada thistle
- goldenrod
- catnip
- grasses
- nearby purple loosestrife

△2 — none — grass — native

40 — 50 — 5 - if goldenrod is >10

Canada thistle — black medick — 95

Nootka rose — triangle arche — musk mallow

goldenrod — lanceleaf tickseed

bindweed — grasses — p 908-911

prickly lettuce

△3 — none — native grass

Ø — Ø — Ø — unless goldenrod is weed

milkweed

AC — screaming rush

goldenrod — goldenrod — 912-915

grasses

△4 — none — native — grass seed — 916-919

26 — 30 — 25

milk thistle — heavy dyssome

goldenrod — sow thistle

yellow salsify — cornucopia vetch

catnip — knapweed

NE | SW

△5 grass 5 | none 15 | native 15

920–923

Canada thistle
Brome

△6 grass 10 | none 15 | native 15

brome
Canada thistle
prickly lettuce

bull thistle
catnip

924–927

Appendix D

Invasive Species Treatment Options

Red = provincially noxious, Blue = regionally noxious

Common Name	Scientific Name	Ecology/Habitat	Flowering Period / Life History	Treatment Options	References
alfalfa	Medicago sativa	Mesic to dry cultivated fields, roadsides and ditches (ssp. sativa), and roadsides and dry slopes	flowers from March to October, propagation by seed	~Tillage (usually requires multiple passes) ~Herbicides	1, 2,4
bull thistle	Cirsium vulgare	Mesic to dry roadsides, fields, pastures and disturbed areas in the lowland, steppe and montane zone. prefers sunny, open areas and can tolerate a wide range of conditions, from moist to dry soils, and is typically found in disturbed areas such as roadsides, trails, logged areas, vacant land, pastures and cultivated land. Overgrazed pastures are susceptible to bull thistle encroachment, and it can sometimes form dense stands that reduce productivity and stocking levels. Bull thistle may also dominate forest clear cuts and reduce growth of tree seedlings	Two year life cycle with flowering and setting seed in year 2. Seeds are short lived on soil surface but can persist if buried. Germination occurs in fall and spring. Basal rosettes form and continue to grow until winter.	~Prevent seeds from spreading/ do not leave cut stems on ground. ~Do not spread hay that is likely to be contaminated with seeds. ~Dig up with shovel, removing top couple of inches usually sufficient to kill plant. ~Collect and destroy stems to prevent them from flowering and producing seed. ~Cut stems twice per year; cut them when they are in bud if you can only cut them once. ~Several herbicides are effective. For grassy areas use a selective broadleaf to retain the grass. ~*Biological control includes head gall fly* (*Urophora stylata).* This will not eradicate the thistle but will reduce its impact. ~Grazing with goats, sheep and horses can help reduce number of flowers. ***** Suggestion for Munson Pond: Have volunteers, cut and collect stems or flowering heads of individual plants once or twice per year especially when they are in bud.***	1, 3
Canada thistle	*Cirsium arvense*	commonly found on roadsides, cultivated fields, pastures, logged forests, riverbanks, and other disturbed areas	Canada thistle spreads rapidly through horizontal roots that give rise to large infestation patches nearby and out-competing native plants. Seed is also dispersed by wind.	~Promote healthy grasslands that can outcompete the thistle ~Avoid excessive livestock grazing ~Clean machinery and equipment ~immediately revegetate disturbed areas ~aggressive mowing for several years will deplete root reserves ~Because this plant is spread via rhizomes, digging up the roots is not effective ~Cultivation to a depth of 1 cm in spring followed by regular cultivation every 21 days is an effective control (to reduce root reserves) ~planting a competitive species that can shade thistle seedlings can be effective ~biological controls include the seed weevil *Larinus planus* and the stem gall fly *Urophora carduii.* The weevil consumes the flowers while the fly burrows into the stem.	6,7
catnip	*Nepeta cataria*	mesic to dry waste places in lowland and steppe zones	Perennial, reproducingby seed and by very short underground rhizomes	~Often intentionally planted for cats ~Remove the flowers before they go to seed ~cut back	1
cheatgrass	*Bromus tectorum*	invades grasslands and dry forests, forms dense stands on disturbed sites and is common in recently burned rangeland, winter crops, disturbed areas, abandonded fields and heavily grazed rangelands.	Reproduces by seeds which mature in mid to late June.	~prevent establishment by promoting a healthy natural plant community ~hand pull small infestations ~no biological control agents approved in Canada ~repeated mowing every 3 weeks in spring and summer will manage seed production ~controlled grazing but not overgrazing can help control populations	9
chicory	*Cichorium intybus*	Chicory, like most invasives, prefers roadsides, fields and disturbed areas. It is often found along highway right-of ways. It can grow on many different soil types but is found on soils with high lime.	Reproduces by seed	Mechanical treatment can be effective because it reproduces only by seed. Hand-pulling, digging and mowing is best for small infestations and must be completed before seed sets.	10
common bugloss	*Anchusa officinalis*	Common bugloss invades disturbed areas where competing vegetation is sparce, pastures and hay lands — reducing yield and carrying capacity. It grows in sandy, gravelly areas such as disturbed areas, roadsides, fields and pastures	Reproduces by seed	Control includes cutting or mowing before plants flower to prevent seed production. Common bugloss also has a deep taproot to remove to prevent re-establishment, and plants and all plant parts should be bagged, removed from the site, and burned. Monitor disturbed sites, especially on sandy or gravelly areas, for new outbreaks. Please take care to clean equipment, vehicles, and footwear before leaving an infested area.	11, 12
common burdock	*Arctium minus*	Dry roadsides, disturbed areas and pastures in the lowland, steppe and montane zones	Pink to purple flowers form clusters along the stems and bloom between July and October. Burrs are transported by various means including animals. Large leaves shade young plants.	~Plants live up to four years producing 6,000 - 16,000 seeds per plant ~Mowing or cutting is best done before flowering to eliminate seed production. ~ to remove the plant fully, the large taproot system that grows deep underground must be tilled ~Re-seed bare soil where possible, and encourage desirable, competing vegetation ~Most broadleaf herbicides are also useful for control.	1,13
common dandelion	*Taraxacum officinale*	disturbed sites including lawns, roadsides, and pastures	Reproduce from seed. In the spring, bright yellow flowers are present, flowers appear year-round and have mutiple petals and flowers. Plants have thick, long taproots.	~dandelion has a thick, deep, central taproot and is difficult to control by cutting or hand pulling, as it can be difficult to make sure the entire root has been removed ~Is persistent even in health lawns because of its deep taproot ~chemical treatments are effective	1,14
common groundsel	*Senecio vulgaris*	Mesic to dry roadsides, disturbed areas and gardens; common in WC and SW BC, rare elsewhere in S BC; introduced from Europe.	early spring / seeds usually dispersed by wind	~eliminate plant before it flowers through cutting or tilling, biological control less effective ~seedlings cannot push through a 3 inch deep layer or mulch ~glyphosate is effective	1, 15
common lilac	*Syringa vulgaris*	Hardy shrub that reproduces by seed. Grows on dry, rocky (often limestone) slopes in colder climates. Often planted in agricultural areas and is a good indicator of growing conditions (weather)	lower mid-May through June on the previous year's growth. Can live for 50 years. Seeds disperse	~Cut the shrub at ground level and apply herbicide (glyphosate) ~Pull the plant completely out of the ground removing the root system entirely ~This is a well known agricultural shrub and may want to be left in place, reportedly installing roots barriers helps to prevent the plant from spreading through the root system	16, 17
creeping buttercup	*Ranunculus repens*	Moist to wet lawns, clearings, fields, roadsides and ditches. Found in rural and urban areas such as farmlands, natural wetlands, city gardens, and lawns	blooms mid spring, creeping buttercup spreads by seed and by long branching stolons that root at the nodes, forming new plants. In more established woodland and grassland communities, this plant increases mostly through stolons unless the soil is disturbed. Stolons grow from the leaf axils in spring and summer and growth peaks in late summer	~Promote healthy grass that competes with buttercup by over seeding ~Dig out plants removing roots, digging more effective in fall through spring when roots less likely to break ~soil disturbance can increase germination, seeds stay viable for 20 years ~mowing unlikely to affect low growing plants, cultivation can bury viable plants that have the potential to grow back ~glyphosate can be applied on actively growing plants before they seed, using a broadleaf herbicide won't kill grass, chemical treatments likely require two or three applications	5
curled dock	*Rumex crispus*	oist to mesic roadsides, ditches and disturbed sites	This is a perennial weed, reproducing primarily by seeds, but also by taproot fragments. Curled dock is a prolific seed producer.	The most successful methods of controlling curly dock are mowing it down regularly, where applicable, and the regular use of herbicides. Herbicides should be applied at least twice a year, in spring and fall.	1,18
dalmation toadflax	*Linaria genistifolia*	open, low-elevation, coniferous forests and adjacent shrub-steppe habitat. It is most commonly found on sandy or gravely soil on roadsides, railroads, pastures, cultivated fields, rangelands and clear cuts. While toadflax can rapidly colonize disturbed or cultivated ground, plants can also invade healthy native plant communities.	plants begin emerging in the early spring, with flowering occurring from May-August	~Several biological control agents available ~Hand pulling is most successful where soils are sandy and/or moist, remove as much of root as possible ~Hand-cutting to ground level in spring or early summer can eliminate seed production ~Mowing is less effective because it leaves several cm of stem above the soil surface that may allow plants to re-sprout more rapidly. ~Physical removal must be repeated annually for at least ten years to completely deplete the seed bank. ~Herbicide may also be used	19
diffuse knapweed	*Centaurea diffusa*	commonly found on roadsides, fields and disturbed areas. Both species are well adapted to well-drained, light to coarse textured soils but are not tolerant of dense shade	Flower buds are formed in early June and flowering occurs from July to October.	~elminate new seed production, hand pull small infestations when soils are moist to remove the entire taproot ~Mowing or cutting may be used but should be done in the early flower stage ~Plants that have gone to seed should be bagged ~chemical control is an option	20
dwarf mallow	*Malva neglecta*	found in cool and damp areas such as marshes and bogs. However, it has adapted to a variety of soil types. It also invades disturbed areas such as cultivated lands, gardens, turf, roadsides and drainage ditches.	reproduces primarily by seed. Seeds are borne in smooth, round flattened, button-like fruits, which break into single-seeded segments at maturity. Flowers bloom from June to September.	~young plants can be pulled or dug up but this can be difficult given the large tap root ~Cultivation can be used to control young plants, mowing is not viable ~mulching may prevent regrowth and herbicdes are an option	20
european white birch	*Betula pendula*	favours sunny conditions, disturbed and nutrient poor soils	reproduces via seed, was not prevalent at the Munson Pond site, may not need to be treated	Treatment options include girdling the tree and treating with application of herbicides. Herbicides can be applied to foliage, cut sotems or as a basal spray. Tree is susceptible to bron birch borer	21

Common Name	Scientific Name	Ecology/Habitat	Flowering Period / Life History	Treatment Options	References
field bindweed	*Convolvulus arvensis*	highly adaptive plant and can be found in a range of soil conditions, from moist to dry. Field bindweed invades fields, turf and farmland, as well as residential settings such as flower gardens, rockeries and ornamental borders.	Seeds germinate throughout the growing season, but peak germination usually occurs mid-spring through early summer. Seeds can remain viable in the soil for up to 30 years. Field bindweed can also reproduce vegetatively from roots, rhizomes and stem fragments.	~hand pull seedings before they become well established ~avoid digging the soil around roots as this will fragment them and further disperse the plant ~mowing is not recommended ~covering plants with mulch or tarps can suprress growth ~chemical control and bio control agents are effective	20
field pennycress	*Thlaspi arvense*	occur in disturbed nonagricultural areas and agricultural lands (pastures and croplands) over a wide range of soil types and environmental conditions	seedlings can emerge in late February and adult plants start blooming by middle March, depending on the accumulated temperatures towards the end of winter	Field pennycress can be easily controlled mechanically with tillage or with herbicides. Herbicide treatments will provide best control when plants are in the early stages of development, preferably in the rosette stage when growth is active and before plants start shedding seed.	22
german madwort	*Asperugo procumbens*	Dry to moist disturbed areas and waste places	**no information found	**no information found	--
great mullein	*Verbascum thapsus*	found along roadsides, rights-of-way and waste areas. Common mullein also grows in meadows, pastures and forestry cut blocks. It is one of the first species to appear on recently burned sites. Mullein prefers, but is not limited to, dry sandy soils	Flowers from June to August and can continue to flower into October	~can be hand pulled, if it has gone to seeds stalk must be cut and bagged ~tillage provides good control of rosettes, mowing is less effective ~chemical control is an option ~biological control less effective	20
hedge mustard	Sisymbrium officianale	common in waste places, gardens and edges of fields and only occasionally appearing as a weed in grainfields	flowers from June to August	~Pull out the young shoots or mow them ~Herbicide is effective	23,24
hoary alyssum	*Berteroa incana*	dry sandy or gravely soils and establishes well in dry, disturbed habitat such as pastures, hayfields, roadsides, rangelands and embankments.	plant emerges as a rosette in early spring and then bolts and grows a cluster of white flowers. From late spring flowers and seeds continue to be produced until the first frost. When acting as a perennial, it over-winters as a rosette and emerges again in the spring	~small populations can be controlled annually by hand pulling during spring ~mowing is not effective ~no biological controls ~chemical controls can be effective ~revegetation of areas with competing desireable species can prevent establishment	20
knapweed	*Centaurea spp.*	Flower buds are formed in early June and flowering occurs from July to October.	commonly found on roadsides, fields and disturbed areas; well adapted to well-drained, light to coarse textured soils but not shade tolerant	~cutting or mowing early in the growing season can be effective, to be repeated annually ~pull when plants are young and soils moist ~chemical and biological controls can be used	20
lamb's quarters	*Chenopodium album*	grows well in disturbed sites, particularly in cultivated land. Lamb's Quarters can be found in gardens, croplands, old fields, weedy meadows, roadsides, and railways.	majority of seeds germinate at the beginning of the growing season, though some will also germinate later in the summer. Seeds can remain dormant in the soil for 20 years or more.	~can be easily hand pulled, should be pulled before plant goes to seed ~can be controlled using a pre-emergent herbicide but is resistant to some chemicals ~is edible and can be harvested for food	25
lombardy poplar	*Populus nigra*	well drained soils	roots can spread and can sucker when cut	~generally planted as a hedge row, can be removed by girdling (to create wildlife trees) or simpy letting the tree die over time. Susceptible to insects and disease and typically not long lived	1
Norway maple	*Acer platanoides*	Mesic forest openings in the lowland or montane zones	blooms in early spring	~control by cutting it down and treating stump with chemical	1
orchard grass	*Dactylis glomerata*	Dry meadows, pastures, roadsides, drought and shade tolerant	perennial bunchgrass spreads by seed	Flaming with a roof torch, or cutting below the plant crown can be used on isolated plants or small patches. Mowing can be used on larger areas after the wild flowers have bloomed but repeated mowing is required annually and over several years. Ploughing or the use of barriers such as landscape fabric is recommended in areas with no native species. All treatment methods to be followed with immediate seeding or planting of native species and sites require monitoring afterwards. Biocontrol agents are not available.	26
perennial sow thistle	*Sonchus arvensis*	wide range of conditions including saline soils, does best on moist fertile soil with full sunlight	Seeds can germinate in spring or fall – fall seedlings overwinter as rosettes. Seed produc tion is highly variable and seeds are relatively short-lived	~annual mowing or pulling of plants by hand can be effective ~intense cultivation over long periods can compete with these plants ~resistant to some herbicides but herbicides can be effective ~seed head feeder and gall former are biological controls	27
prickly lettuce	*Lactuca serriola*	dry roadsides, thicket clearings, agricultural areas, abandoned fields and other disturbed areas. It is also commonly found at waste disposal sites.	propagated by seed, and is predominantly self-pollinated. Its seeds germinate with the onset of winter rains.	~mowing is not effective ~easily pulled by hand ~pesticides are only effective if applied early	25
purple loosestrife	*Lythrum salicaria*	can tolerat a wide range of growing conditions; found near wetlands, lake and river shores, ditchbanks, marshlands, freshwater tidal flats, and riparian meadows.	late July to September	~revegetate disturbed soils with native plants ~pull small infestations by hand and attempt to pull the entire root system ~mechanical control has been unsuccessful ~chemical controls typically not feasible because of the aquatic habitats it grows in ~plant propogates through fragmentation so be sure to remove all plant parts ~As a biocontrol option, the root boring beetle (Hylobius transversovittatus) and two species of leaf eating beetles (Galerucella calmariensis and Galerucaella pusilla) have proven effective against purple loosestrife in B.C.	1, 20, 25
quackgrass	*Elymus repens*	esic to dry roadsides, fields, gardens and disturbed sites	mid spring, spreads readily by the roots	~digging out as much of the roots system as possible and covering the area with a tarp or a combination of cardboard and wood chips ~herbicides are effective	1, 28
reed canarygrass	Carex spp.	Wet meadows, ditches and lakeshores	late spring, reproduces by seeds and rhizomes	Combining herbicide treatment with a manual control can also be effective. Remove the above-ground dead material by mowing or burning and then allow the plants to regrow to about 15 cm in height before applying the herbicide. This will result in better herbicide coverage and reduce total herbicide use. Treatment may be necessary for several years to ensure complete control. Smaller populations can be controlled by digging them up trying carefully to remove all of the roots. Chemical treatment should occur in summer to early fall.	1, 29
Russian olive	*Elaeagnus angustifolia*	will grow in a variety of soil and moisture conditions. It can tolerate extreme temperatures and low humidity and drought. Russian olive generally prefers sandy floodplains and is often associated with open, moist riparian habitats	blooms in June to July, seed dispersal facilitated by birds that eat berries produced in August to October	~seedlings can be hand pulled or dug up when the soil is moist ~once seedlings are well established remove roots with an excavator in winter, all resprouts must be continually cut and removed throughout the growing season, this is more effective when followed with chemical control ~a mite has been identified as a biological control	20
scarlet firethorn	*Pyracantha coccinea*	Mesic to moist waste places, fields and forest edges in the lowland zone	late spring	~not readily identified as an invasive species although not native to BC, recommend cutting it down and monitoring regrowth	1

Common Name	Scientific Name	Ecology/Habitat	Flowering Period / Life History	Treatment Options	References
sheep sorrel	*Rumex acetosella*	Mesic to dry gardens, fields, roadsides and waste places	flowers from May to September, reproduces by seeds and rhizomes	~Smaller infestations can be controlled by hand being careful to dig up the root system ~herbicide treatment can be effective if applied to young plants	1, 30
Siberian elm	*Ulmus pumila*	tolerate a wide range of conditions including long periods of drought, cold winters, poor soil conditions, high winds and low moisture. However, Siberian elm prefers sunny, open areas. It commonly grows on disturbed roads, moist streambanks, in pastures and rangelands, along roads and railroad rights-of-way. It will not tolerate flooding and does not often invade mature forests because of its high requirement for sunlight.	spread by seed but can reproduce from roots when plant is damaged; seeds produced in early spring and spread by wind	~Seedlings can be hand-pulled or dug out when the soil is moist. ~for established plants the most effective control method is the cut-stump herbicide treatment during late spring. ~Bulldozing, mowing, and brush-cutting can also be effective, but only if all re-sprouts are continually cut and removed which will likely take many consecutive years of treatment. ~Girdling may also be an inexpensive and useful technique for control, which involves manually cutting away bark and cambial tissues around the trunks of trees. This control method should be undertaken using an ordinary axe in the spring when the trees are actively growing.	20
stork's bill	*Erodium cicutarium*	Mesic to dry fields, woodlands and waste places		~manual removal before fruit develops ~no biocontrol options are available ~herbicides can be effective	1, 31
sulphur cinquefoil	*Potentilla recta*	growing from valley bottom grasslands to mid-elevation forests. This long-lived perennial infests disturbed areas, meadows, pastures and rangelands and can dominate a site within two to three years of first appearance.	blooms in mid June and produces plants throughout the summer	~small infestations can be hand pulled but this is effective only when upper root system is removed ~not controlled by mowing and no current biocontrols ~can be controlled by herbicide	20
tumbleweed	*Amaranthus albus*	roadsides, railroad tracks, pastures, fields, disturbed rangeland and other disturbed habitats. It grows on well-drained, uncompacted soil with a sunny exposure. It cannot tolerate saturated soil for extended periods	flowers July through October	Small infestations can be hand pulled, mowed or hoed out. Russian thistle can only be managed by eliminating seed production and be depleting the soil seed bank. Cull, pull, or treat plants with herbicide before seed set.	20
virginia creeper	*Parthenocissus quinquefolia*	variety of conditions		~can be controlled by hand pulling small infestations, larger infrestations are best controlled with herbicides	32
white sweet clover	*Melilotus albus*	prefers to grow in calcium-rich (calcareous) loamy soil, but it can also grow in a variety of soil conditions. It can grow in full-sun or partial-shade, but is shade-intolerant. Due to its nitrogen-fixing capabilities, it is also able to grow in nutrient poor soil	flowers from June to October	~control small infestations by hand pulling and larger infestations by mowing or cutting to reduce seed dispersal ~chemical control should only be used on large infestations, it is not necessary for smaller infestations	33
wormwood	Artemesia absinthium	will survive in both dry and moist soils, but it thrives in poor, dry soils with full sun. It is generally found on dry, open waste areas or overgrazed rangelands, but also along roads and fencerows as well as in pastures.	prolific seed producer, and seeds can remain viable in the soil for 3 – 4 years. Seedlings can emerge at any point from late spring to early fall. It can also reproduce vegetatively, by cuttings.	~hand-pull or dig up small patches; make sure all the roots have been removed. ~mowing may prevent seed production, as long as it is done prior to seed set and repeated ~chemical treatments may be used. ~biological controls are not available	25
yellow flag iris	*Iris pseudacorus*	Moist ditches, sloughs, marshy meadows and streambanks	flowering occurs in May and June, extensive spread through thick rhizomes that can remain viable after drying out for several months	~small infestations can be controlled by digging up all of the roots, larger infestations can be dug up using small equipment but this can be damgaing to the ecosystem ~cutting seed heads may help ~covering dug up areas with black tarp, pond liner or heavy PVC matting can work but needs to remain in place for 4 to 12 months ~herbicide cannot be used in aquatic areas where these plants are found ~replanting areas with aquatic species like cattail may prevent spread	1, 20, 25
yellow salsify	Tragopogon dubius	prefers full sun, mesic to dry conditions, and poor soil, like sand, clay or gravel. However, it will also grow in fertile loam, where it will become taller. Yellow Salsify can be found in relatively dry, open areas.	reproduces by seed. It can either be pollinated by insects or self-pollinate	~no biological control is available ~pull young rosettes ~plants will grow back if the plant is broken off before the top 10 cm of the root can be removed ~spring tillage can eliminate plants ~chemical treatment is an option	25

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