



## **Kootenay Riparian Invasive Plant Control (COL-F23-W-3694)**

Prepared for: Fish and Wildlife Compensation Program

Prepared by: Khaylish Fraser, Aquatics Program Coordinator, CKISS

Erin Bates, Executive Director, CKISS

Kalenna Olynyk, Field Program Manager, CKISS

Prepared with financial support of the Fish and Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of B.C., Fisheries and Oceans Canada, First Nations and Public Stakeholders

31-Mar-2023



# Executive Summary

---

Numerous infestations of the invasive riparian plants yellow flag iris (*Iris pseudacorus*) and purple loosestrife (*Lythrum salicaria*) are threatening the riparian ecosystem along the shoreline of Kootenay Lake's West Arm and down Kootenay River to Brilliant Dam. The Central Kootenay Invasive Species Society, with the support of several agencies, organizations, and First Nations has implemented an invasive riparian plant control project in this area in order to improve riparian ecosystem function and protect high value conservation areas. This project is in alignment with the habitat-based action of preventing and controlling invasive species, under the *Columbia Region: Rivers & Riparian Areas Action Plan*, action COLRRA.ECO.HB.10.01 Prevention and control of invasive species-P1, and the *Columbia Region: Reservoirs & Large Lakes Action Plan*, action COLRLL.ECO.HB.13.01 Prevention & control of invasive species in Kootenay, Arrow, Pend d'Oreille, Koocanusa-P1.

Plant surveys in 2023 found no new infested sites. Surveys at known sites found *L. salicaria* and *I. pseudacorus* to be present over an estimated 18.8 ha and 14.6 ha, respectively. Biological control agent surveys found adult agents, black-margined loosestrife beetle (*Galerucella californiensis*) at one site. Physical control measures were used to remove 0.6565 ha of *I. pseudacorus* and 0.7997 ha of *L. salicaria*. Where biocontrol agents were present, plants were intentionally left untreated to encourage continued establishment of the agent's population to contribute to ongoing control efforts. An ecological restoration consultant was employed to assess treated sites and provide recommendations. One site was determined to be appropriate for restoration with the most appropriate restoration technique determined to be replacement planting with native plants. To increase awareness of the negative impacts of invasive riparian plants and long term stewardship among local residents, education and outreach at various public and targeted events and through traditional and social media platforms reached an estimated 285,000 people.

Surveys should continue in future project years to detect new incursions and fill any remaining inventory gaps within the project area. Mechanical treatment should continue as needed and where feasible. Treated sites should be monitored for several years following initial plant removal with follow-up removal as required. Once the Provincial biocontrol collection and dispersal policy is finalized, collection and release of agents should commence as soon as possible on applicable sites. Restoration should commence as recommended: immediate planting after *L. salicaria* removal on a trial basis, while overall, replacement planting after all individuals have been removed and the seedbank has been addressed. Human activities are the primary vector for invasive species introduction and spread so education to increase public awareness and change the behaviours that are responsible for spreading invasive species should continue.

# Table of Contents

---

1. Introduction .....	5
2. Goals and Objectives .....	5
3. Study Area .....	6
4. Methodology .....	7
4.1 Instream Works and Archaeological Permitting.....	7
4.2 Invasive Riparian Plant and Biological Control Agent Surveys .....	8
4.3 Invasive Riparian Plant and Biocontrol Agent Data .....	8
4.4 Invasive Riparian Plant Control .....	9
4.5 Treated Sites Restoration Review .....	9
4.6 Education and Outreach .....	9
5. Results and Outcomes .....	10
5.1 Instream Works and Archaeological Permitting.....	10
5.2 Invasive Riparian Plant and Biocontrol Data and Surveys .....	10
5.3 Invasive Riparian Plant Control .....	11
5.4 Treated Sites Restoration Review .....	12
5.5 Education and Outreach .....	13
6. Discussion .....	15
7. Recommendations.....	16
8. Acknowledgements .....	18
9. Literature Cited .....	19
10. Appendix A: Kootenay Riparian Invasive Plant Removal Site Restoration Recommendations Year 2 .....	20

## LIST OF TABLES

Table 1. Riparian invasive plant treatment site recommended for restoration, Kootenay Lake, B.C.....	12
Table 2. Site factors used to determine successful restoration of sites where riparian invasive plants were removed, Kootenay Lake and River, B.C. ....	13
Table 3. Aquatic invasive species focused education and outreach activities conducted by the Central Kootenay Invasive Species Society, 2022.....	14
Table 4. Aquatic invasive species focused traditional and social media delivered by the Central Kootenay Invasive Species Society, 2022. ....	14

## LIST OF FIGURES

Figure 1. Map of Central Kootenay Invasive Species Society's Operation Area. ....	6
Figure 2. Kootenay Lake and River survey and treatment area, 2022.....	7
Figure 3. Sites where purple loosestrife or yellow flag iris are present in Kootenay Lake and River, Central Kootenay region, B.C., 2022. ....	11

This page has intentionally been left blank

# 1. Introduction

---

The Central Kootenay Invasive Species Society (CKISS) was established in 2005 as a non-profit with the mission to protect ecosystems and communities by preventing and reducing the harmful impacts of invasive species. In order to fulfill its mission, CKISS educates, works with, and calls to action area residents, visitors, and a diverse range of communities and organizations.

Invasive species cause major losses in biodiversity and ecosystem function globally (Green & Grosholz, 2021). Invasive species are non-native plants and animals that become well established because natural predators or controls are absent in the areas into which they are introduced (Central Kootenay Invasive Species Society, n.d.). These introduced, non-native species spread quickly and have the ability to out compete native plant and animal species, impacting fragile ecosystems, species at risk, and water quality (Environment Canada, 2004). Invasive plants can impart costly ecological, social, and economic impacts on local and global scales (Lockwood, Hoopes, & Marchetti, 2013; Ricciardi, Hoopes, Marchetti, & Lockwood, 2013).

Numerous infestations of yellow flag iris (*Iris pseudacorus*) and purple loosestrife (*Lythrum salicaria*) are threatening the riparian ecosystem along the shoreline of the West Arm of Kootenay Lake and down the Kootenay River to Brilliant Dam. *I. pseudacorus* is known to change the hydrology, ecosystem complexity and function of an area, reducing habitat suitability for native plant and animal species (Pathikonda, Ackleh, Hasenstein, & Mopper, 2009). Similarly, *L. salicaria* has been shown to alter the structure, function, and productivity of wetland habitats where it has negative impacts on waterfowl and fish populations (Thompson, Stuckey, & Thompson, 1987).

## 2. Goals and Objectives

---

The goal of this project is to improve riparian ecosystem function in the Kootenay Lake and River system, protect high value conservation areas, and increase awareness and long term stewardship among local residents.

The objectives of this project are as follows:

- Inventory of upstream target plant seed source areas;
- Removal of target riparian plants;
- Dispersal of biological control agents;
- Assessment, restoration, and monitoring of treated sites; and,
- Landowner and public outreach

This project is in alignment with the habitat-based action of preventing and controlling invasive species, under the *Columbia Region: Rivers & Riparian Areas Action Plan*, action COLRRA.ECO.HB.10.01 Prevention and control of invasive species-P1, and the *Columbia Region: Reservoirs & Large Lakes Action Plan*, action COLRLL.ECO.HB.13.01 Prevention & control of invasive species in Kootenay, Arrow, Pend d'Oreille, Kooconusa-P1.

### 3. Study Area

The study area for this project was within the CKISS’ operational area (Figure 1). During year two of this multi-year project, activities focused on the West Arm of Kootenay Lake and the Kootenay River to the Upper Bonnington Dam, where possible (Figure 2).

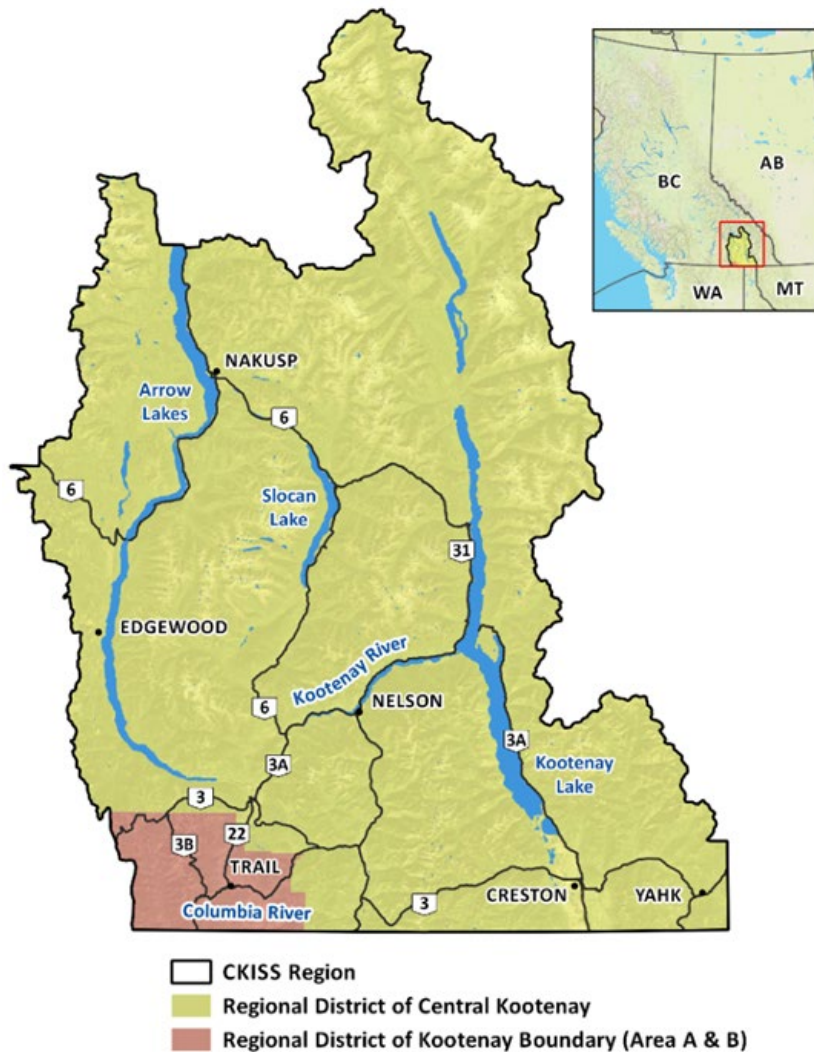


Figure 1. Map of Central Kootenay Invasive Species Society's Operation Area.

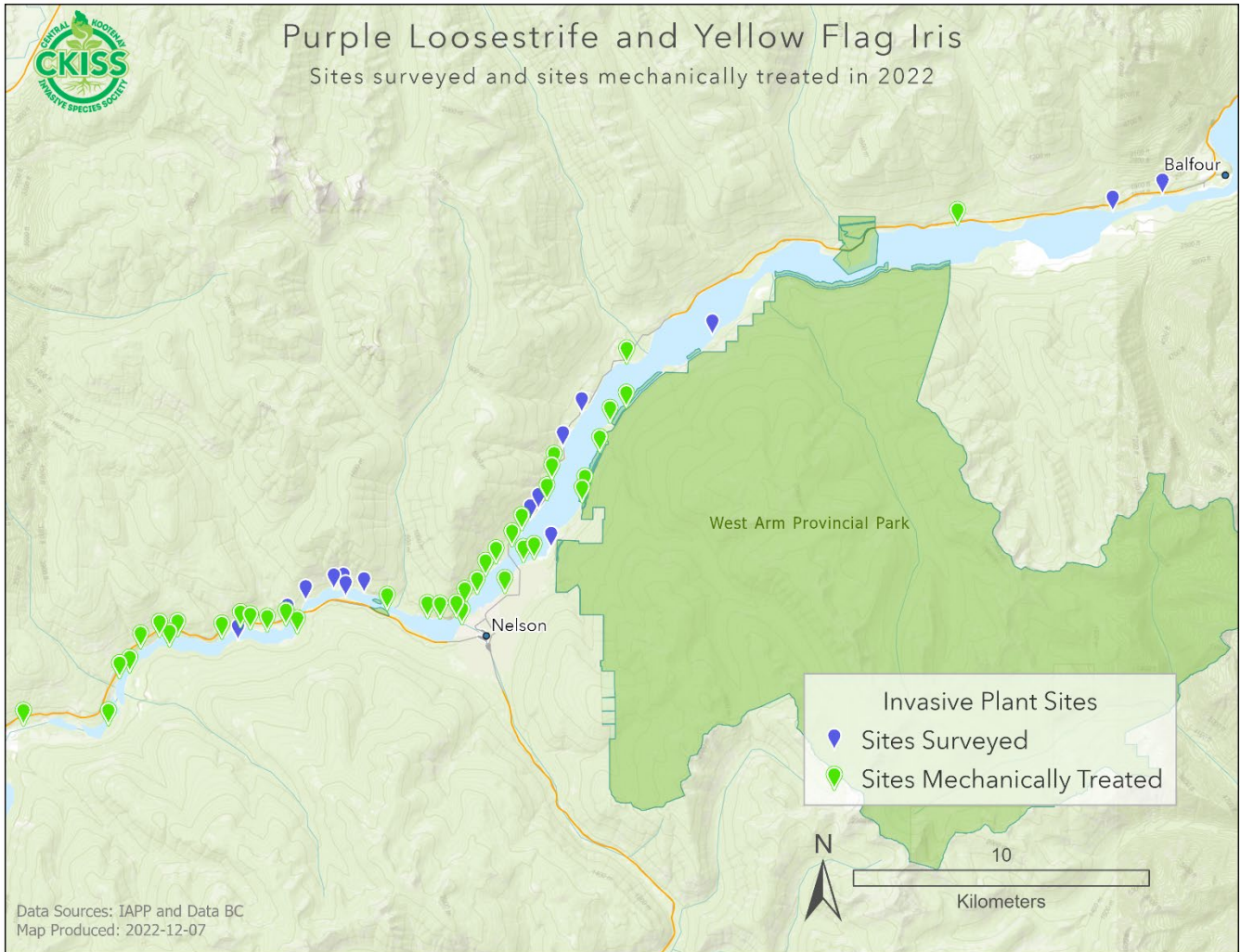


Figure 2. Kootenay Lake and River survey and treatment area, 2022.

## 4. Methodology

### 4.1 INSTREAM WORKS AND ARCHAEOLOGICAL PERMITTING

Three notices of instream work for invasive species removal were completed and submitted to FrontCounter BC on May 18, June 1, and June 2, 2022, and approved on June 21, 2022. Multiple notices were submitted as there is a limit of 20 work sites per application, and proposed start dates varied between work sites (notices need to be submitted 45 days prior to start date). The Ministry of Forests Regional Habitat Officer who approves permitting reviewed the possible work sites to identify any overlap with fish redds.

A BC archaeological information request form was submitted to, and approved by, the Ministry of Forests Archaeology Branch on April 14, 2022. Archaeological and heritage site data within 100 metres of the existing shoreline of the Kootenay River upstream of the Brilliant Dam and Generating Station up to and including the West Arm of Kootenay Lake was requested.

## 4.2 INVASIVE RIPARIAN PLANT AND BIOLOGICAL CONTROL AGENT SURVEYS

Invasive plant and biological control (biocontrol) agent surveys were conducted in accordance with the B.C. Government Invasive Alien Plant Program Reference Guide<sup>1</sup>. For the priority invasive riparian plant species *I. pseudacorus* and *L. salicaria*, sites that were scheduled to receive treatment were resurveyed prior to treatment commencing: when a site that was treated in a previous year was also treated in a subsequent year, the width and length of the area infested with plants, as well as the plants density and distribution were monitored prior to treatment commencing. Crews opportunistically inventoried new sites while traveling throughout the project area to access treatment sites. Biocontrol agent surveys for the black-margined loosestrife beetle (*Galerucella calmariensis*) and the golden loosestrife beetle (*G. pusilla*) were conducted on the plant species *L. salicaria*, when accessible.

## 4.3 INVASIVE RIPARIAN PLANT AND BIOCONTROL AGENT DATA

Invasive plant survey and treatment data and biocontrol agent data were collected in a digital format using mobile devices and spatial data collection software. All survey data was uploaded to the B.C. Government Invasive Alien Plant Program (IAPP) database. In addition to standardized data collection, site information relating to access, safety, and appropriate control methods (e.g. hand pulling, digging, benthic barriers, etc.) was identified during surveys to assist with current and future management plans. Additionally, site level data was collected using points, lines, and polygons in a digital spatial data collection software. Data was collected in this manner to increase usability of the data for the new and redesigned provincial spatial invasive species database planned for release in the near future. Data was streamlined to increase ease of collection, management, and monitoring.

---

<sup>1</sup> <https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/invasive-species/iapp>

## 4.4 INVASIVE RIPARIAN PLANT CONTROL

Manual control measures (e.g. digging, hand pulling) were used to remove *I. pseudacorus* and *L. salicaria* between August 10 and September 29, 2022. Control methods followed current Best Management Practices<sup>2,3</sup> for removal, disposal, and prevention of spread. All treatment also was conducted in accordance with stipulations identified in the approved stream work application authorization letters provided by the Regional Habitat Officer. The rhizomes of *I. pseudacorus* and roots of *L. salicaria* were dug up, wherever feasible, to reduce regrowth of the plants. When digging was not possible due to site characteristics (e.g. rocky areas), *L. salicaria* was hand pulled or cut as low as possible and *I. pseudacorus* seed heads were removed. All cut or dug plant material was bagged, removed from site and disposed of in a landfill. Special care was taken to minimize soil disturbance, root fragmentation, erosion, and accidental seed spread. All treatment data was uploaded to the provincial IAPP database.

## 4.5 TREATED SITES RESTORATION REVIEW

Following site disturbance from invasive plant removal and in line with Best Management Practices, sites were assessed to determine if restoration of the treated sites was warranted and feasible and would be beneficial for the ecosystem. An ecological restoration consultant was employed to assess treated sites and provide recommendations for restoration. Assessment of treated sites occurred on October 27, November 3 and 21, 2022.

## 4.6 EDUCATION AND OUTREACH

A variety of educational outreach events were provided to target audiences and the general public to increase awareness of invasive riparian plants and the threats they pose to native biodiversity and species at risk. Species-specific information was disseminated in combination with PlantWise messaging, an international program that uses community-based social marketing to influence human behaviour. CKISS also maintained an active online presence, using our website, Facebook, Instagram, and e-newsletters to engage with members of the public.

---

<sup>2</sup> <http://www.metrovancouver.org/services/regional-planning/PlanningPublications/YellowFlagIrisBMP.pdf>

<sup>3</sup> <http://www.metrovancouver.org/services/regional-planning/PlanningPublications/PurpleLoosestrifeBMP.pdf>

## 5. Results and Outcomes

---

### 5.1 INSTREAM WORKS AND ARCHAEOLOGICAL PERMITTING

Approved works were restricted to sites identified on the notice applications and approved physical treatment methods were pulling, digging, and barriers. All invasive plant material removed during treatments was required to be removed from site and transported to an appropriate disposal facility. The Ministry of Forests Regional Habitat Officer identified overlap between possible treatment sites and fish redds at seven sites; works were approved at these locations but with a delayed start date. All works were subject to stipulations identified in the stream work application authorization letters, and this and all other documents pertinent to the works were kept at each work site (e.g. application, Kootenay-Boundary Water Sustainability Regulation Notification Terms and Conditions).

A shapefile set identifying 183 archaeology/heritage sites within the area of interest was received from the B.C. Archaeology Branch and then overlaid on the proposed project area map using ArcGIS to identify any overlap between archaeological or heritage sites and possible treatment sites. Seven sites known to have one or both of the target species present were found to overlap fully with known archaeological sites; these sites were not proposed for treatment on the notice applications. Ten sites had a partial overlap with known archaeological sites; therefore, only the portions of these sites that did not overlap received treatment. Further, all field staff were familiarized with, and kept present on site, the *Chance Find Procedures for Archaeological Material* document provided by the Ministry of Forests. This document provided information on how to manage for potential archaeological material discoveries while undertaking construction and/or maintenance activities, and assisted field crews in the identification of archaeological remains and the procedures to follow if a discovery was made. During the course of the treatment efforts, no archaeological material discoveries were made.

Seventeen possible treatment sites overlapped with known heritage sites, for all of which the City of Nelson is the governing body. Following communication with the appropriate City of Nelson department (Development Services), approval was given to proceed with manual removal of target plants as the community heritage register does not add any extra protection to plant species.

### 5.2 INVASIVE RIPARIAN PLANT AND BIOCONTROL DATA AND SURVEYS

Invasive riparian plant surveys in year two of this multi-year project resulted in the detection of no new infested sites. Plant surveys were conducted prior to treatment at known sites. Six sites treated in year one were resurveyed in year two. *L. salicaria* and *I. pseudacorus* were present over an estimated

18.7952 ha and 14.603 ha, respectively. By comparison, in 2022, *L. salicaria* and *I. pseudacorus* were present over an estimated 18.0863 ha and 0.7231 ha, respectively. Sites where *I. pseudacorus* and *L. salicaria* were present in 2022 in the project area are mapped in Figure 3. Biocontrol agent surveys were conducted at 36 sites and adult biocontrol agents, *G. californiensis*, were found at one site. No *G. pusilla* at any life stage were detected during surveys. By comparison, in 2022, 24 sites were surveyed for biocontrol and evidence of agents was detected at nine sites.

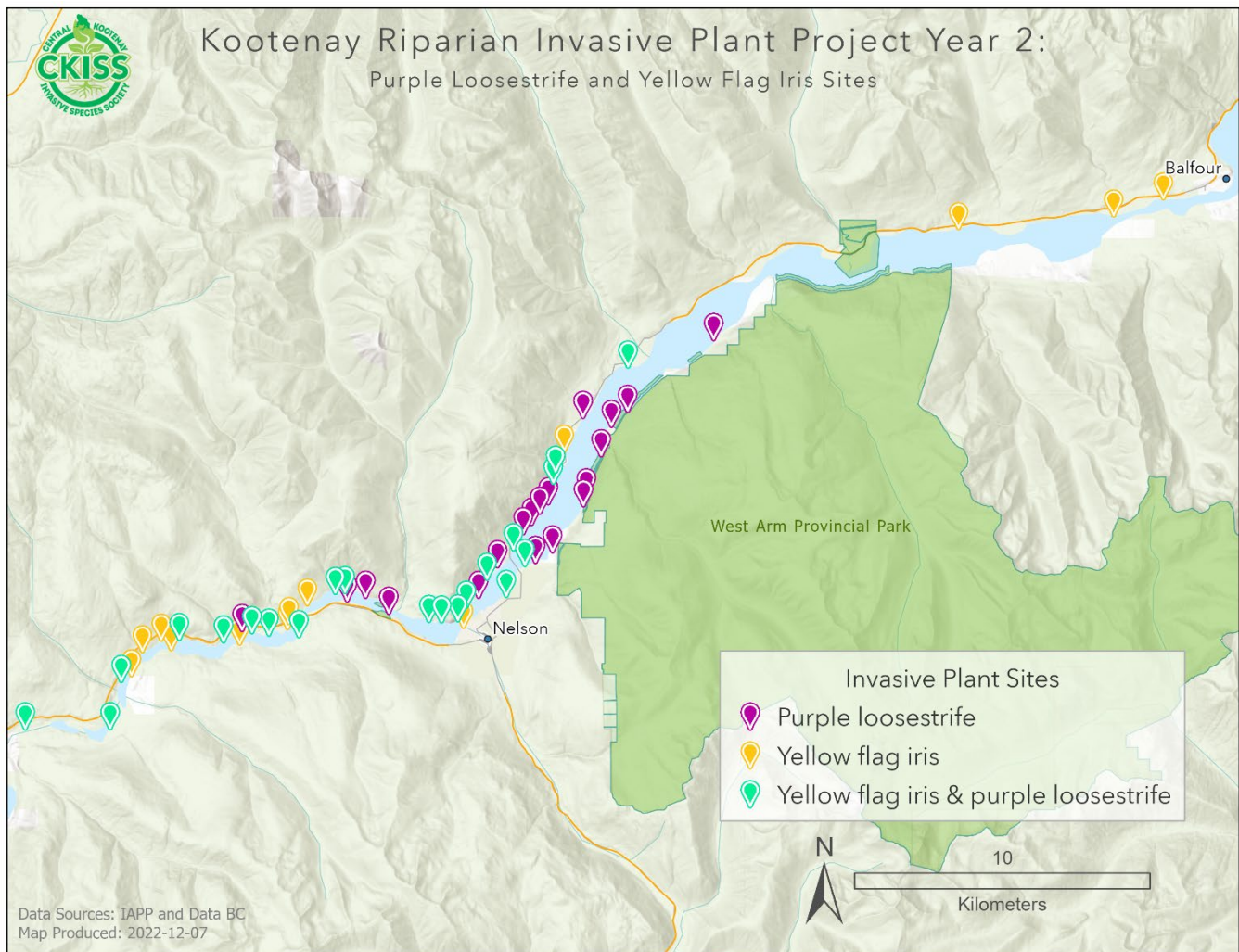


Figure 3. Sites where purple loosestrife or yellow flag iris are present in Kootenay Lake and River, Central Kootenay region, B.C., 2022.

### 5.3 INVASIVE RIPARIAN PLANT CONTROL

Physical control measures were used to remove 0.6565 ha of *I. pseudacorus* at 22 sites and 0.7997 ha of *L. salicaria* at 20 sites. A total of 3900 kg of invasive plant material was removed. Forty-eight person days were spent of control efforts. Sites where full treatment was not completed was due to the high

number of plants and/or difficulty of removal in certain environments; staff resources were not sufficient to remove all plants. Where biocontrol agents were present, plants were intentionally left untreated to encourage continued establishment of the agent’s population to contribute to ongoing control efforts.

## 5.4 TREATED SITES RESTORATION REVIEW

An ecological restoration consultant was employed to assess treated sites and provide recommendations. The detailed assessment is provided in a separate report titled *Kootenay Riparian Invasive Plant Removal Site Restoration Recommendations Year 2* (Appendix A<sup>4</sup>). In summary, thirty treated sites were assessed for restoration potential, and one site was determined to be appropriate for restoration (Table 1).

Table 1. Riparian invasive plant treatment site recommended for restoration, Kootenay Lake, B.C.

Species on Site	Habitat Type	Dominant Species	Plant #	Plant Size	Comment
PL/YFI	Foreshore Riparian	Sedges, loosestrife, cottonwood, alder, red osier dogwood, willow	1	2 or 5 gallon	PL present along foreshore in cobble/boulder substrate but not treated. Single YFI clump remains in riparian. When removed this clump should be replaced with 2-5 gallon potted stock to prevent PL from colonizing disturbed area. Move cobble/boulder to ensure all plant parts including the entire root system are removed before planting.  <b>This site is also a good candidate for restoration trial – replacement planting with sedge plugs (<i>Carex aquatilis</i>) during PL removal, to determine if it helps prevent reestablishment.</b>

Suitable restoration site(s) are those that have the highest potential for successful establishment of planted vegetation over the long term. The following site factors were assessed to determine if restoration was warranted and feasible: disturbance, existing vegetation, re-invasion risk, maintenance, elevation, substrate, and browse. These factors are described in Table 2.

<sup>4</sup> Original PDF document provided by consultant has been converted to JPEG to preserve formatting and inserted into this MS Word document.

Table 2. Site factors used to determine successful restoration of sites where riparian invasive plants were removed, Kootenay Lake and River, B.C.

Site Factors	Restoration Candidate	Not Suitable for Restoration
<b>Level of disturbance</b>	exposed soil areas caused by control activities; minimal anthropogenic disturbance	no disturbance observed from control activities; ongoing anthropogenic disturbance present
<b>Existing native vegetation</b>	native vegetation either young or not well developed and needs help to regenerate	native vegetation well developed and will regenerate naturally
<b>Re-invasion risk</b>	root systems fully removed, planting would help prevent reinvasion from seedbank, invasive species present nearby that could reinvade site	root systems not fully removed during control; seed bank would counteract restoration efforts
<b>Maintenance</b>	high potential for success with no maintenance (shady slope aspect, cover from existing vegetation to retain moisture); no irrigation, browse protection required	Low potential for success with no maintenance (hot, dry, exposed sites); requires irrigation and/or browse protection
<b>Elevation</b>	appropriate to accommodate growth (along or above normal HWM for shrub/tree species, higher portion of littoral zone for sedges/rushes)	not appropriate to accommodate growth (site inundated too many months per season)
<b>Substrate</b>	appropriate to accommodate growth (consists of soil/silt/mixed sand)	not appropriate to accommodate growth (pure sand, cobble, boulder, bedrock)
<b>Browse</b>	minimal browse present	high levels of browse present

The most appropriate restoration technique was determined to be replacement planting with native plants. Similar to the recommendation provided in year one of this project, revegetation is known to be effective when it is implemented after treatment is complete (all individuals have been removed and the seedbank has been addressed). However, as noted in Table 1, a trial was suggested in which native plants would immediately replace *L. salicaria* in the same spot from which it was removed in an effort to prevent future disturbance of the seedbank.

## 5.5 EDUCATION AND OUTREACH

Awareness of invasive riparian plants and the ecological threats they pose was raised through the delivery of the PlantWise campaign messaging at various public and targeted events (Table 3), as well as through traditional and social media platforms (Table 4). Through these efforts, up to 7,534 people

received information through in-person/interactive events, and an estimated 278,000+ through media activities. The local community also was engaged through CKISS' citizen science projects on iNaturalist to help track invasive species in the region. iNaturalist is a crowdsourced citizen science platform where people can record and share their observations of living things, and this has been useful as an education and early detection tool. FWCP's contribution was recognized at all relevant events and media opportunities.

Table 3. Aquatic invasive species focused education and outreach activities conducted by the Central Kootenay Invasive Species Society, 2022.

Activity Type	Activity Number	No. ppl. reached directly	No. ppl. reached indirectly
Community Weed Pull	3	34	25
Educational Outreach Booth	9	946	6080
Presentation	5	91	32
Restoration Event	3	135	-
Webinar	3	56	60
Workshop	5	35	2
Youth Field Trip	2	38	-
PlantWise and species specific resources distributed = 530			

Table 4. Aquatic invasive species focused traditional and social media delivered by the Central Kootenay Invasive Species Society, 2022.

Media Platform	Number of Posts/Spots	Like/Views/Hits/Followers
Facebook	4	739 people like CKISS page; post reach 926
Instagram	4	437 followers; post reach 329
Website Blog	2	25,872 visits to the CKISS website
CKISS n'Tell E-newsletter	2	890 subscribers
Radio Interview	3	Estimated reach 50,000+

Media Platform	Number of Posts/Spots	Like/Views/Hits/Followers
Online or Print Article	3	Estimated reach 200,000+
iNaturalist public reports	8	6 YFI; 2 PL

## 6. Discussion

---

Seventeen possible treatment sites were found to partially or fully overlap with known archaeological sites according to the data provided by the B.C. Archaeology Branch. Treatment in the overlapping areas may be considered in future project years if funds are available to enlist the services of an Eligible Consulting Archaeologist to determine the steps in managing impacts to the archaeological site.

As was the case in year one of this project, plant survey results showed *L. salicaria* to be more abundant than *I. pseudacorus*, as such, biological control agents may be the best option to address this species long-term. However, biocontrol agent surveys were conducted at 36 sites and agents were found at only one site. Further, of the two species of agents known to be released in the area in the past, only one species was found. *Galerucella californiensis* and *G. pusilla* are reported to be mobile and disperse in search of new plant sites and second generation beetles are reported to be more prone to dispersal than those that overwinter and emerge in spring (first generation) (Ministry of Forests, Lands, Natural Resource Operations and Rural Development, n.d.). However, this may not be the case locally given the low number of agents detected. Following review of air temperature data in 2021, it is possible that regional temperatures in the project area may not be adequate to facilitate maximum reproduction for the biocontrol agents that are released in this part of the province, which may be a primary reason for low population densities.

The release of more agents, and their use as a primary control method on suitable *L. salicaria* sites was to be incorporated into this project in 2022. In October 2021, the Province's Biocontrol Specialist announced that biocontrol agents would be available for collection and dispersal by non-government agencies on *L. salicaria* sites starting in 2022. This control method was previously restricted to requests submitted to the Ministry of Forests each year and resourcing shortages meant that it was effectively unavailable for most sites. Unfortunately, this method of control has not yet been incorporated into the project because the Province has yet to finalize the biocontrol collection and dispersal policy and the timeline for this is unknown.

One of the treated sites was determined to be appropriate for restoration efforts with the most appropriate restoration technique being replacement planting with native plants. Site(s) were deemed to be suitable candidates for restoration when treatment disturbance was evident; anthropogenic disturbance was minimal; native vegetation needed help to regenerate; root systems and seedbanks were fully removed; no irrigation nor browse protection would be required; elevation and substrate were appropriate to accommodate growth; and evidence of browse activity was minimal.

## 7. Recommendations

---

It is recommended that alternate treatment methods for *L. salicaria* be explored in addition to physical control methods such as digging or hand pulling, or in place of, where terrain or site size prevents effective digging/pulling. The primary alternate treatment recommendation is to source and distribute substantial quantities of both biological control agents used in this area that are known to attack *L. salicaria*. If less than ideal air temperatures could be a limiting factor on reproduction, population density should be monitored annually, at minimum, as adult life expectancy is approximately eight – ten weeks, and new agents released as needed. When treatments are made with small numbers of beetles released, small populations will usually continue, therefore large releases perform best, and thus are recommended. By combining the two *Galerucella* species, benefits are gained: *G. californiensis* feeds on early plant growth, causing the plants to send out new shoots that then coincide with *G. pusilla* feeding requirements. Additionally, the two species prefer different densities of plants, and therefore, should feed on a wider range of plants in an infestation. For these reasons, it is recommended that both *Galerucella* species be sourced and released. Once the Provincial biocontrol collection and dispersal policy is finalized, collection and release of agents should commence as soon as possible on applicable sites and continue into future project years as needed, as determined by follow-up monitoring.

Mechanical treatment should continue to be conducted annually as needed (e.g. new sites, follow-up control of previously treated sites), where feasible, on both *L. salicaria* and *I. pseudacorus*. For *I. pseudacorus* sites where neither benthic barrier nor digging methods may be suitable, removal of seed heads should be conducted. Treated sites should be monitored for several years following initial plant removal with follow-up removal as required as there will be ongoing germination and re-establishment from the seedbank as well as from root or rhizome fragments.

Functional eradication is a management technique focused on suppressing invader populations below levels that cause unacceptable ecological effects within high-priority locations when eradication of an invasive species is unfeasible. For both of the target plant species in this project it is recommended that

this management technique be given consideration as it may assist in identifying management targets or criteria to evaluate what level of control is sufficient to mitigate ecological impacts of *L. salicaria* and *I. pseudacorus* in high-priority management areas.

For site(s) that are considered to be appropriate for restoration, it is recommended that larger potted stock native plants be used to infill the area(s) where *I. pseudacorus* is removed, while smaller plants such as plugs are more suitable for infilling where *L. salicaria* is removed. Planting native plugs immediately after removal of *L. salicaria* is recommended on a trial basis, while overall, replacement planting is recommended after treatment is complete (all individuals have been removed and the seedbank has been addressed).

Some infested sites exist on private property and given that human activities are the primary vector for invasive species introduction and spread, an important component to the success of this project would be to continue providing education to increase public awareness and change the behaviours that are responsible for spreading invasive species. A variety of outreach activities and media directed at specific target audiences and the general public should continue so as to raise awareness about invasive species and promote the PlantWise program.

## 8. Acknowledgements

---

CKISS acknowledges that we are privileged to live and work in the unceded territories of the Ktunaxa, Syilx, Secwépemc, and Sinixt First Nations.

The CKISS would like to gratefully acknowledge the following organizations and representatives for lending their assistance, expertise, cash or in-kind support to the success of this project:

- Okanagan Nation Alliance
- Ktunaxa Nation Council
- Nature Trust of B.C.
- FortisBC
- Ministry of Forests
- Columbia Basin Trust
- Teck Metals Ltd.
- Fish and Wildlife Compensation Program
- BC Parks
- City of Nelson
- BC Hydro
- Columbia Power

Title page photo credit: CKISS.

## 9. Literature Cited

---

- Central Kootenay Invasive Species Society. (n.d.). What are invasive species? Retrieved from Central Kootenay Invasive Species Society: <https://ckiss.ca/species/what-are-invasive-species/>
- Environment Canada. (2004, September). Government of Canada Publications. Retrieved 2022, from Government of Canada: <https://publications.gc.ca/site/eng/home.html>
- Green, S. J., & Grosholz, E. D. (2021). *Functional eradication as a framework for invasive species control*. *Frontiers in Ecology and the Environment*, 19(2), 98–107.
- Lockwood, J. L., Hoopes, M. F., & Marchetti, M. P. (2013). *Invasion Ecology*. Chichester, England: Wiley-Blackwell. Retrieved 2022, from [https://www.esf.edu/efb/parry/502-18lecture\\_summaries/Lockwood\\_etal\\_pp1-30.pdf](https://www.esf.edu/efb/parry/502-18lecture_summaries/Lockwood_etal_pp1-30.pdf)
- Ministry of Forests, Lands, Natural Resource Operations and Rural Development. (n.d.). Agents & Plants. Retrieved 2022, from Government of B.C.: <https://testwww.for.gov.bc.ca/hra/Plants/plants/purple-loosestrife.htm>
- Pathikonda, S., Ackleh, A. S., Hasenstein, K. H., & Mopper, S. (2009). *Invasion, Disturbance, and Competition: Modeling the Fate of Coastal Plant Populations*. *Conservation Biology*, 23(1), 164-173. doi: <https://doi.org/10.1111/j.1523-1739.2008.01073.x>
- Ricciardi, A., Hoopes, M. F., Marchetti, M. P., & Lockwood, J. L. (2013). *Progress toward understanding the ecological impacts of nonnative species*. *Ecological Monographs*, 83(3), 263-282. doi: <https://doi.org/10.1890/13-0183.1>
- Thompson, D. Q., Stuckey, R. L., & Thompson, E. B. (1987). *Spread, Impact, and Control of Purple Loosestrife (Lythrum salicaria) in North American Wetlands*. Jamestown, U.S.A.: U.S. Fish and Wildlife Service. Retrieved 2022, from <http://stoppinginvasives.com/dotAsset/670d2f92-cd0c-41ab-9955-7204f1a9a192.pdf>

## 10. Appendix A: Kootenay Riparian Invasive Plant Removal Site Restoration Recommendations Year 2

---



Central Kootenay Invasive Species Society  
Suite 19 - 622 Front St  
Nelson, B.C., V1L - 4B7

January 30, 2023

Attn: Khaylish Fraser

**Re: Kootenay Riparian Invasive Plant Removal Site Restoration Recommendations Year 2**

Masse Environmental was retained by CKISS to identify sites that require restoration following removal of yellow flag iris (*Iris pseudacorus*; YFI) and purple loosestrife (*Lythrum salicaria*, PL) in year 2 of the Riparian Restoration project. The goal of the project is to improve riparian ecosystem function, protect high-value conservation areas, and increase awareness and long-term stewardship among local residents. The project is being conducted with funding and contributions from FWCP and other supporting partners.

The scope of work was to assess treatment sites along the Kootenay River and West Arm of Kootenay Lake where yellow flag iris and purple loosestrife were mechanically removed by digging and hand pulling and determine if they require restoration based on the level of disturbance caused by the treatment. For sites that were determined to require restoration, recommendations are provided. This letter provides the results of the assessment and associated recommendations for restoration.

**Methods**

Field surveys were conducted on October 27, November 3 and 21, by Lisa Pavelich P.Ag. and Khaylish Fraser at 30 treatment sites where yellow flag iris and purple loosestrife were removed by CKISS crews during the 2022 field season. Sites were accessed by boat or traversed on foot to assess site conditions and identify the need for restoration post treatment. Multiple factors were considered to determine if restoration is warranted and feasible (Table 1).

Table 1. Site factors for successful restoration.

<b>Site Factors</b>	<b>Restoration Candidate</b>	<b>Not Suitable for Restoration</b>
<b>Level of disturbance</b>	exposed soil areas caused by control activities; minimal anthropogenic disturbance	no disturbance observed from control activities; ongoing anthropogenic disturbance present
<b>Existing native vegetation</b>	native vegetation either young or not well developed and needs help to regenerate	native vegetation well developed and will regenerate naturally
<b>Re-invasion risk</b>	root systems fully removed, planting would help prevent reinvasion from seedbank, invasive species present nearby that could reinvade site	root systems not fully removed during control; seed bank would counteract restoration efforts
<b>Maintenance</b>	high potential for success with no maintenance (shady slope aspect, cover from existing vegetation to retain moisture); no irrigation, browse protection required	Low potential for success with no maintenance (hot, dry, exposed sites); requires irrigation and/or browse protection
<b>Elevation</b>	appropriate to accommodate growth (along or above normal HWM for shrub/tree species, higher portion of littoral zone for sedges/rushes)	not appropriate to accommodate growth (site inundated too many months per season)
<b>Substrate</b>	appropriate to accommodate growth (consists of soil/silt/mixed sand)	not appropriate to accommodate growth (pure sand, cobble, boulder, bedrock)
<b>Browse</b>	minimal browse present	high levels of browse present

**Results**

Of the 30 sites assessed one was determined to require restoration (Attachment 1). No other treatment sites met the factors for successful restoration; however many purple loosestrife treatment sites were identified that would benefit from continued mechanical treatment and potentially the introduction of biocontrol. The individual site and associated recommendations are summarized in Table 2 and specific restoration techniques are described for each target species below.

Table 2. Treatment sites recommended for restoration.

Site ID	Treated Species	Habitat Type	Dominant Species	Plant #	Plant Size	Comment
206926	PL/YFI	Foreshore Riparian	Sedges, loosestrife, cottonwood, alder, red osier dogwood, willow	1	2 or 5 gallon	PL present along foreshore in cobble/boulder substrate but not treated. Single YFI clump remains in riparian. When removed this clump should be replaced with 2-5 gallon potted stock to prevent PL from colonizing disturbed area. Move cobble/boulder to ensure all plant parts including the entire root system are removed before planting.  <b>This site is also a good candidate for restoration trial – replacement planting with sedge plugs (<i>Carex aquatilis</i>) during purple loosestrife removal, to determine if it helps prevent reestablishment.</b>

*Yellow flag iris*

The most effective restoration technique for yellow flag iris treatment sites, where appropriate, was determined to be replacement planting with native plants. The removal of invasive plants such as yellow flag iris sometimes creates large, disturbed areas (up to 1m<sup>2</sup>) from excavation of the root system. Native plants can be planted in the depression where the invasive plant was removed to revegetate the area, prevent other invasive species from colonizing and improve the habitat along the shoreline. In this case, larger potted stock native plants are best suited to infill the area and compete with surrounding vegetation. Appropriate replacement species should align with the habitat and dominant species present on site, however a full list of species is provided in Table 3.

## CKISS – Riparian Invasives Restoration

### *Purple loosestrife*

The most effective restoration technique for purple loosestrife control sites was determined to be continued mechanical treatment combined with the introduction of biocontrol. This is because on many occasions loosestrife was found to be growing within both foreshore and riparian habitats where well-established native vegetation occurs preventing the need for replacement planting where suitable vegetation already exists. Biocontrol may provide a more effective method for long term control in this circumstance and reduce the need for repeated mechanical treatments.

In some situations, replacement planting may also be appropriate to help jump start natural succession following treatment. Replacement planting creates direct competition with purple loosestrife ingrowth and makes the site more resistant to future invasions (Warne 2016<sup>1</sup>). It is known to be effective when revegetation is implemented after treatment is complete however it would be worthwhile exploring if it would also be effective when implemented during treatment to prevent repeated site visits and disturbance of the seedbank. Any soil disturbance by pulling or digging can bring thousands of seeds to the surface (Warne 2016<sup>1</sup>). Since purple loosestrife has a smaller root system than yellow flag iris and leaves largely undetectable disturbance following removal, it might be effective to install smaller plants such as plugs in the same hole the weed is being removed from. A trial could be conducted at Site 206926 as suggested in Table 2 to determine the effectiveness of this technique in helping to prevent reinvasion. If successful it would provide a cost-effective control option, specifically in the foreshore environment when replaced with sedges and rushes where appropriate substrate exists. The site would need to be monitored to document the effectiveness of the trial and some maintenance should be expected to conduct spot treatments for additional mechanical removal.

A list of native species appropriate for replacement planting along Kootenay Lake and the Kootenay River is provided in Table 3.

Another restoration technique that could be used following purple loosestrife treatment is seeding. Seeding with an annual cover crop or native plant mix over the disturbed area, immediately following treatment, may help prevent the establishment of undesirable vegetation or new invasive species (Warne 2016<sup>1</sup>). This technique may be particularly useful on sites with coarse (cobble/boulder) substrate, where roots were difficult to remove, in tandem with biocontrol. Further background review is required to fully explore the viability of this option given the seasonal inundation of these sites, identify appropriate species, and source certified weed free seeds.

---

<sup>1</sup> Warne, A. 2016. [Purple Loosestrife \(\*Lythrum salicaria\*\) Best Management Practices in Ontario](#). Ontario Invasive Plant Council, Peterborough ON.

CKISS – Riparian Invasives Restoration

Table 3. Plant species suitable for restoration along the shoreline of Kootenay Lake and Kootenay River.

Common Name	Latin name
<b>Tall Shrubs</b>	
Sitka willow	<i>Salix sitchensis</i>
Bebbs willow	<i>Salix bebbiana</i>
Narrow leaf willow	<i>Salix exigua</i>
Red osier dogwood	<i>Cornus sericea</i>
Mountain alder	<i>Alnus incana</i>
Nootka rose	<i>Rosa nutkana</i>
Woods rose	<i>Rosa woodsii</i>
Black hawthorn	<i>Crataegus douglasii</i>
<b>Low shrubs</b>	
Common snowberry	<i>Symphoricarpos albus</i>
Pink spirea	<i>Spirea douglasii</i>
<b>Grasses</b>	
Bluejoint reedgrass	<i>Calamagrostis canadensis</i>
Tufted hairgrass	<i>Deschampsia cespitosa</i>
<b>Sedges</b>	
Slender-beaked sedge	<i>Carex athrostachya</i>
Columbia sedge	<i>Carex aperta</i>
Water sedge	<i>Carex aquatilis</i>
Inflated sedge	<i>Carex exsiccata</i>
Beaked sedge	<i>Carex utriculata</i>
Sitka sedge	<i>Carex sitchensis</i>
Kellogg's sedge	<i>Carex lenticularis</i>

**Closure**








I trust the information contained herein meets your current requirements. If you have any questions or comments, please contact the undersigned.




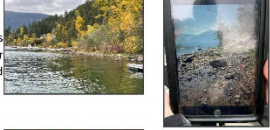


Sincerely,

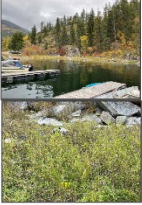














Lisa Pavelich, PAg  
 Masse Environmental Consultants  
 E: [lisa@masse-env.com](mailto:lisa@masse-env.com)



**Attachment 1**  
Results of Field Assessment

Site ID	Treated Species	Habitat Type	Dominant Species	Substrate	Restoration Candidate	# Plants	Plant Size	Comment	Photo
206930	PL, YFI	Riparian	narrowleaf willow, red osier dogwood, black cottonwood, horsetail, rushes	sand	N			No disturbance from control present. PL growing within well established riparian vegetation. <b>Continue mechanical treatment to reduce seedbank and consider biocontrol.</b>	
360016	PL	Riparian	willow, red-osier dogwood	boulder, cobble, sand	N			Planted willows along shoreline of John's walk in front private properties. Extensive anthropogenic disturbance. No disturbance from control observed. <b>Continue mechanical treatment to reduce seedbank and consider biocontrol.</b>	
359974	PL	Riparian	mature black cottonwood, alder, red-osier dogwood	mixed sand	N			Small site upstream of Bealby Point. PL growing within well established riparian vegetation. No disturbance from control observed. <b>Continue mechanical treatment to reduce seedbank and consider biocontrol.</b>	
359973	PL	Riparian	red-osier dogwood, willow, alder, black cottonwood	cobble, boulder	N			Small site with established riparian and few plants within boulder substrate. No plantable substrate. No disturbance from control observed. <b>Continue mechanical treatment to reduce seedbank and consider biocontrol.</b>	
359972	PL	Riparian	willow, mature black cottonwood	sand, cobble, boulder	N			Upstream of Troup beach PL interspersed in man made rock groyne difficult to remove. <b>Continue mechanical treatment to reduce seedbank and consider biocontrol.</b>	
359971	PL	Foreshore	red-osier dogwood, willow, alder, black cottonwood	boulder, bedrock	N			Between train tracks and lake, well established riparian vegetation, however PL pulled from foreshore zone in coarse boulder substrate and high likelihood of remaining root fragments. No plantable substrate. <b>Continue mechanical treatment to reduce seedbank and consider biocontrol.</b>	
359953	YFI	Foreshore	willow, grasses, forbes	sand	N			Single clump YFI removed from sand where dock meets shore. Low potential for restoration success due to sandy substrate and frequent anthropogenic disturbance.	

Site ID	Treated Species	Habitat Type	Dominant Species	Substrate	Restoration Candidate	# Plants	Plant Size	Comment	Photo
359978	YFI	Foreshore	red-osier dogwood, alder, rose, sedges, rushes	sand, boulder	N			Downstream of Nasookin small YFI site no obvious sign of disturbance from removal.	
359979	YFI	Foreshore	red-osier dogwood, alder	sand	N			Downstream of Nasookin small removal site underwater, therefore site has low potential for restoration success.	
359957	PL	Foreshore	grasses, forbes	sand	N			Large site downstream orange bridge between two docks, many PL still remain on private property, treatment sites underwater. <b>Consider biocontrol.</b>	
206929	PL	Foreshore	black cottonwood, red-osier dogwood, alder	mixed sand, boulder	N			Upstream James Johnstone Park, treatment sites underwater, therefore site has low potential for restoration success based on inundation period and substrate.	
359980	PL	Foreshore	willow, alder, Douglas maple, red-osier dogwood	boulder, bedrock	N			Site underwater at time of survey, therefore site has low potential for restoration success based on inundation period and substrate.	
206926	YFI	Foreshore/Riparian	sedges, loosestrife, black cottonwood, alder, red-osier dogwood, willow	boulder, cobble, fines	Y	1	2-5 gallon	PL present along foreshore in cobble/boulder substrate but not treated. Single YFI clump is present in riparian. When removed this clump should be replaced with 2-5 gallon potted stock to prevent PL from colonizing disturbed area. Move cobble/boulder to ensure all plant parts including the entire root system are removed before planting. <b>This site is also a candidate for restoration trial - replacement planting with sedge plugs (<i>Carex aquatilis</i>) during purple loosestrife removal, to determine if it helps prevent reestablishment.</b>	

Site ID	Treated Species	Habitat Type	Dominant Species	Substrate	Restoration Candidate	# Plants	Plant Size	Comment	Photo
359982	PL	Foreshore	willow, alder, grasses, forbs	boulder, bedrock	N			Site underwater at time of survey, therefore site has low potential for restoration success based on inundation period and substrate.	no photo available
359983	YFI	Foreshore	willow, alder, grasses, forbs	boulder, bedrock	N			YFI removed from within bedrock. No restoration due to coarse substrate.	no photo available
206925	YFI	Riparian	reed canarygrass, black cottonwood, willow, red-osier dogwood	sand, boulder, soil	N			Small bay next to Grohman Docks. Heavy anthropogenic use of area by residents and dogs. Four clumps of yellow flag iris are still present. <b>Continue mechanical treatment to reduce seedbank.</b> Although some disturbance from treatment activities observed, site not suitable for restoration due to presence of reed canarygrass, anthropogenic disturbance and natural cottonwood regeneration occurring. Maintenance such as irrigation and browse protection would be required if planted.	 
359994	YFI	Riparian	hybrid white spruce, Douglas-fir, alder, black hawthorn, beaked hazelnut	silt, sand, soil	N			Across from Sproule Ck on island. Treatment sites underwater. Signs of beaver activity. Not suitable for restoration.	
359992	PL	Riparian	alder, beaked hazelnut, willow, black hawthorn, ponderosa pine, Douglas-fir	cobble, Soil	N			Downstream Taghum below Wapple Rd. Wildlife trails and browse present. Not a candidate for restoration: S. facing aspect, rocky substrate, abundant browse, no signs disturbance from treatment.	
115447	PL	Foreshore	black hawthorn, rose, red-osier dogwood, grasses, sedges, forbes	mixed sand, soil	N			Island on Teck property downstream Taghum Hall. No restoration recommended due to seasonal inundation, abundant wildlife browse, native species present, no disturbance from treatment observed. <b>Continue mechanical treatment to reduce seedbank and consider biocontrol.</b>	
360014	PL	Riparian	red-osier dogwood, thimbleberry, black cottonwood, reed canary grass, horsetail, sedge	boulder, cobble	N			Downstream City of Nelson wastewater treatment plant. Narrow strip riparian between CPR and lake. No restoration recommended due to rocky substrate, poor growing conditions, no disturbance from treatment observed.	

Site ID	Treated Species	Habitat Type	Dominant Species	Substrate	Restoration Candidate	# Plants	Plant Size	Comment	Photo
360015	PL, YFI	Foreshore	grasses, forbes, sedges, rushes, weeds, rose, red-osier dogwood	boulder, bedrock, soil	N			Blewett Rd. bridge over Kootenay River. Small bay surrounded by bedrock. PL individuals remain. No disturbance from control observed. <b>Continue mechanical treatment to reduce seedbank and consider biocontrol.</b>	
301535	YFI	Riparian	alder, red-osier dogwood, rose, willow, grasses	riprap bank, soil	N			Cottonwood Ck Mouth ~50m US bridge, single clump removed, no disturbance from treatment observed. Native species present.	
360001	YFI	Wetland	red-osier dogwood, willow, snowberry, rose, reed canary grass	silt, sand, soil	N			Duck Bay wetland, no disturbance from treatment observed. Single clump YFI remains. Continue mechanical treatment, no restoration is necessary as other native species are present.	
359997	PL	Foreshore/ Riparian	reed canary grass, red-osier dogwood, black hawthorn, rose, snowberry	mix cobble, sand, silt	N			Treatment sites along foreshore and riparian in dense reed canarygrass. No disturbance from treatment observed. No restoration recommended due to competition from reed canarygrass.	
359987	YFI	Riparian	alder, grasses, sedges, forbs	cobble, boulder, soil	N			Beaver activity present. Treatment site underwater. No restoration required.	
360011	YFI	Foreshore	grasses, forbs, rose, himalayan blackberry	silt, sand, soil	N			NW bank upstream Corra Linn between CPR and river, abundant elk sign (scat, browse). No disturbance from treatment observed. No restoration recommended due to exposed hot site, heavy browse present.	
359988	YFI	Riparian	alder, rose, red-osier dogwood, grasses, forbs,	soil, cobble, boulder	N			Small bay, private property, anthropogenic disturbance due to use of area by property owner. Disturbance from treatment minimal and will be colonized by native species.	

Site ID	Treated Species	Habitat Type	Dominant Species	Substrate	Restoration Candidate	# Plants	Plant Size	Comment	Photo
359989	YFI	Riparian	alder, black hawthorn, rose	cobble, boulder	N			Bank of CPR tracks. No disturbance from control observed, no restoration required.	
359990	PL	Riparian	willow, alder, grasses, forbs	boulder, soil	N			Bank of CPR tracks bottom of Curtis Rd. No disturbance from control observed, site may be underwater, no restoration required.	
359991	PL,YFI	Foreshore	willow, alder, rose, red-osier dogwood, snowberry, grasses, forbs	cobble, soil	N			Peninsula with tall shrubs, grasses, forbes, browse present throughout. No restoration recommended due to browse pressure and existing native vegetation that will colonize site.	