Mount Revelstoke and Glacier National Parks Invasive Alien Plant Management Plan

December 2016

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Executive Summary

Invasive Alien Plants (IAP) have negative wide-reaching implications for native bio-diversity and ecosystem function. This Invasive Alien Plant Management Plan (IAPMP) addresses the prevention and control measures that will be utilized in Mount Revelstoke and Glacier National Parks to protect native bio-diversity and support healthy ecosystem functioning. All control efforts will be carried out applying integrated pest management principles to receive the maximum environmental benefit utilizing effective control measures with the minimum negative environmental impact. Adoption of this IAPMP will help guide the management of IAP in Mount Revelstoke and Glacier National Parks.

Acknowledgements

This document was produced and reviewed internally. It was also reviewed by Stuart M. Craig from SMC Consulting to ensure accuracy of technical details and consistency with regional practices. It has been produced with close reference and structure to the Invasive Plant Pest Management Plan for Provincial Crown Lands in the Southern Interior of British Columbia (2014).

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1.0 Introduction and Background

Invasive Alien Plants (IAP) are recognized as a serious threat to native ecological communities and bio-diversity. According to the International Union for the Conservation of Nature (IUCN), invasive species are the second most significant cause of global extinction following habitat loss (2011).

Invasive plants reduce biodiversity and compromise ecosystem function by out-competing native species, altering nutrient cycling, destabilizing soils and causing erosion, among other impacts (Pimentel et al. 2005, Zedler and Kercher 2004). Climate change may have synergistic effects on IAP, altering species distributions and local resilience to invasion (Zavalet and Royval 2002). Prevention and early action activities can prevent infestations before they become un-manageable in scope.

The Convention for Biological Diversity and associated Strategic Plan for Biodiversity 2011-2020, specifically address invasive species in Aichi Target 9; envisioning a world where: "*Invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment"* (UNEP 2011).

In Mount Revelstoke and Glacier national parks (MRGNP) IAP have been recognized as an important stressor to native biodiversity and have thus been chosen as a condition measure in the forest indicator of the Ecological Integrity Monitoring program (see Section 5.0). In Section 4.3 of the Mount Revelstoke and Glacier 2010 Park Management Plan, direction is given to "*Ensure MRGNP have the full complement of native species and communities that are characteristic of the Columbia Mountains Natural Region*" and "*Manage invasive non-native species and diseases likely to negatively affect native plant or fish populations*" (Section 4.3, Parks Canada 2010). The condition and trend of this measure is reported in the State of the Parks Report which helps direct management planning on a 10 year cycle with the next reporting period falling between 2017-2019.

1.1 Purpose and Objectives of IAPMP

The purpose of this Invasive Alien Plant Management Plan (IAPMP) is to prioritize, guide and coordinate invasive plant management in Mount Revelstoke and Glacier National Parks.

1.2 Geographic Area

The Plan applies to both Mount Revelstoke and Glacier National Parks.

1.3 Term of Plan

This plan will be reviewed every 5 years beginning with the Field Unit Superintendent (FUS) approval of this plan.

1.4 Project Component Schedule

Condition monitoring, management effectiveness monitoring, surveys and control work will occur on a rotating schedule as described in Appendix H.

2.0 Invasive Alien Plants

Invasive Alien Plants (IAP) are plants that are non-indigenous to the location in question and have the ability to outcompete native plants in their natural setting. While most alien species can be introduced to a new area with few consequences, a small proportion of these species will invade natural habitats and fundamentally alter species composition, native biodiversity and ecosystem function.

Many IAP share common traits including the ability to establish in a wide variety of conditions, prolific reproduction through seeds or other means, fast growth rates, ability to alter their environment to exclude other species, and lack of natural predators.

IAP alter ecosystem function and processes. They have the ability to change landscape level processes such as fire regimes, alter soil conditions and nutrient cycling, decrease water quality, alter riparian habitat and contribute to soil erosion (Zedler and Kercher 2004). In broader context, IAP can cause ecological damage, economic losses, threats to human health and social costs associated with loss of recreation opportunities.

Successful management of IAP involves prioritizing species, site and pathways of spread to most efficiently and effectively direct control and prevention efforts (McGeoch et al 2015).

2.1 Priority Alien Invasive Plant Species

Not all IAP species have comparable impacts on ecosystems. Some non-native plants have biological characteristics that significantly limit their ability to reproduce and spread in novel environments. Conversely, IAP with aggressive reproduction habits, high tolerance to a variety of environments and large dispersal distances have a greater ability to replace native vegetation or colonize disturbed areas. Given limited resources, it is imperative that MRG focus efforts on controlling and managing IAP species with the greatest risks and impacts.

For management purposes, IAP can be ranked according to the ecological damage they are likely to cause to an undisturbed environment, potential to spread, and current distribution within the Parks. In 2007, Michalsky produced a report ranking various IAP known to occur in the Mountain Parks. The ranking matrix took into account IAPs varying ability to invade, conservation implications and regional distribution (Michalsky 2007).

In 2015 MRG staff used Michalsky's Priority Ranking Matrix (2007) to update the priority species list based on current survey data (Tannas 2014), updated regional distribution (CSISS 2013) and updated provincial legislation (BC Weed Control Act). This resulted in IAP rankings of "High", "Moderate" and "Low" priority. A new category of "Very High" was developed for any IAP species designated as BC Provincial EDRR species that occur in the MRGNP.

RANKING	NUMBER OF SPECIES
Very High	2
High	16
Moderate	36
Low	49

Not all species present in the region or parks have a pre-developed ranking profile. These species were categorized according to the best knowledge of IAP ecological characteristics, partner rankings and regional distribution at the time and are denoted with an asterisk (*) in the species list (Appendix A). Ranking profiles for these species will be developed.

A MRGNP "Watchlist" for IAP not currently found within the parks was also developed based on species known to occur in the Columbia-Shuswap Regional District or Mountain Park Eco-zone (Appendix A). Provincial EDRR species and Watchlist species outlined in the CSISS 2013 Operational Plan were also incorporated if they were not known to occur in the parks.

Grasses (Family Poacea) were eliminated from the management list due to infeasibility of control and difficulty of detection and identification. Unlike the prairies, few habitats within MRGNP the park are invasible grasslands.

The priority species list should be reviewed annually and updated as further information about species local and regional abundance and impacts becomes known. A full list of Priority Plants in MRG can be found in Appendix A.

2.2 Sensitive Sites/ Ecological Management Zones

Just as IAP species have varying implications for native biodiversity, ecological sites have varying degrees of vulnerability to invasion. Certain sensitive habitats, if invaded, experience significant negative consequences for Ecological Integrity and ecosystem function. For example, wetlands overtaken by aggressive IAP are more prone to loss of biodiversity, altered nutrient cycling and increased productivity which can affect amphibians, invertebrates and fish (Zedler and Kercher 2004).

Other sites, such as roadsides, pull-outs and railways are most susceptible to novel invasions that could then spread to other, more sensitive areas in the parks. To prioritize management, efforts must be focused both on priority species, sensitive sites and areas at high risk for new invasions.

To facilitate strategic control efforts, MRGNP has been classified into three different Ecological Management Zones:

Zone 1: Integrated Control Zone (ICZ)

The ICZ consists of front-country areas such as transportations corridors (highways, railways, and access roads. etc), trailheads, picnic areas, pull-outs, and compounds within the parks. This zone is characterized by heavy human use and has the greatest probability of new introductions via the highest risk pathways of spread (see section 2.3). These corridors will be monitored for 'Watchlist Species' in close communication with neighbouring jurisdictions (Section 2.1, Appendix A). In this area, management efforts will focus on species in the 'Very high' and 'High' priority category and new introductions with low distribution across the landscape. The goal for this zone is Early Detection and Rapid Response of new IAP.

Zone 2: Enhanced Control Zone (ECZ)

The ECZ includes all backcountry areas, excluding the EPZ that are outside of the main transportation corridors. The goal for this zone is containment of IAP to keep 'Very High', 'High' and 'Moderate' priority species from spreading within the ECZ and into the EPZ; these priority species will be targeted for control on a site specific basis where they pose the greatest threat to the ecosystem.

Zone 3: Ecological Preservation Zone (EPZ)

The EPZ consists of three distinct habitats in MRGNP identified in Section 2.1 of the MRGNP Management Plan: wetlands, avalanche paths, subalpine wildflower meadows (Parks Canada 2010). These sites are likely to contain rare plants that are a priority for protection and IAP prevention. In addition to this criteria, all known occurrences of rare plants will be surrounded by a 25m buffer which will be defined as part of the EPZ. IAP introduction in these areas could greatly impact native bio-diversity and rare species. Where feasible, all IAP will be treated in these areas where they pose a threat to the ecosystems. The goal for this zone is to be free of IAP.

Ecological Zoning for IAP in MRGNP

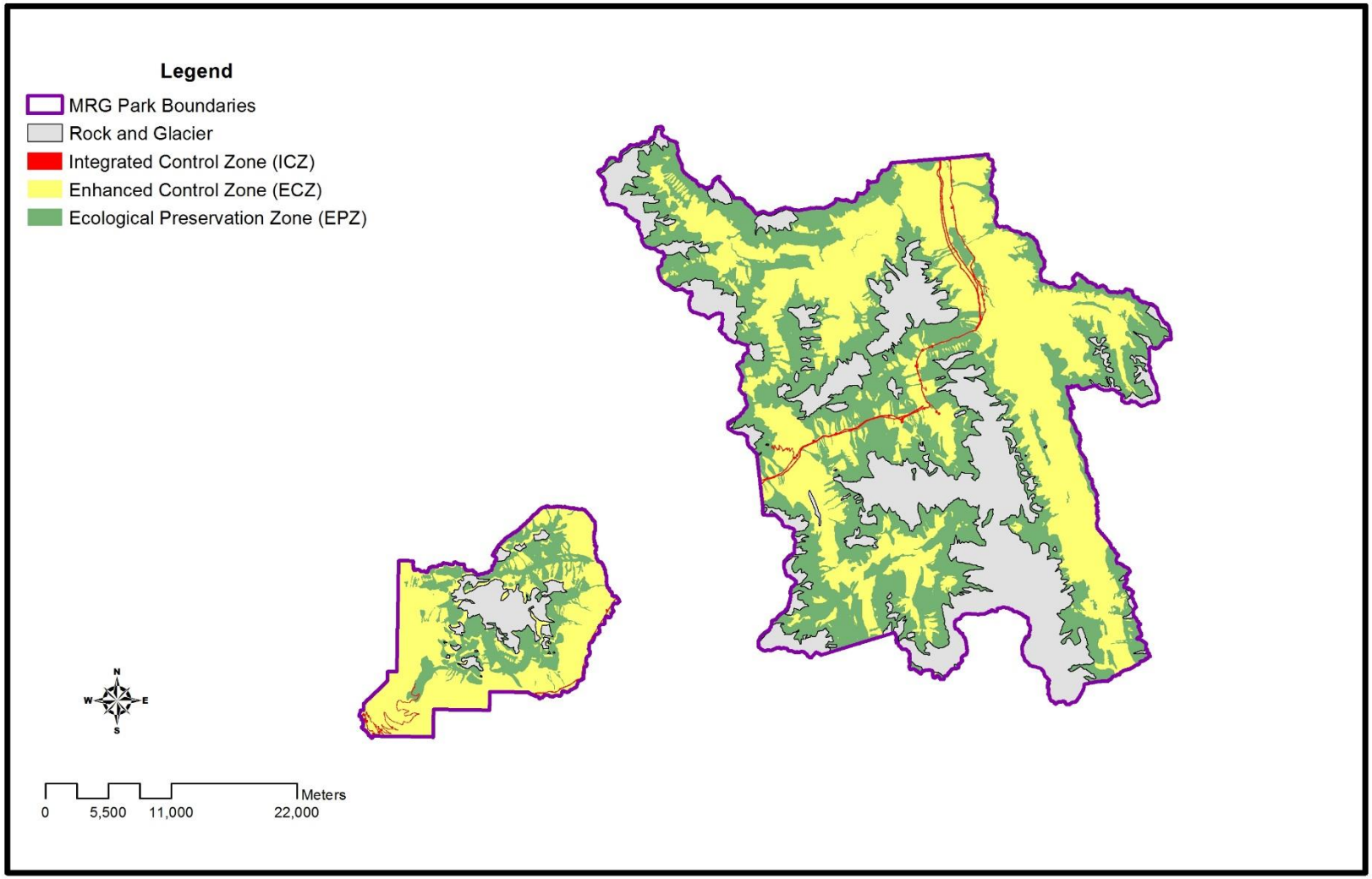

Figure 1: A detailed map identifying the three Ecological Protection Zones in the Parks as well as the non-vegetated alpine areas consisting of rock, ice and glaciers. A detailed guide to how these map layers were developed and defined can be found in Appendix B.

2.3 Priority Pathways and Mechanisms of Spread

Although IAP are often associated with human activity and disturbance, there are various vectors of spread of IAP (Table 1). Invasive Alien Plants can be intentionally introduced or unintentionally introduced through vegetative material and seeds. Transportation corridors and high use areas are major vectors of spread as people, animals, machines and equipment can inadvertently act as carriers. Contaminated materials such as soil, gravel and mulch can also contain seeds or vegetative material of IAP. Seed mixes can be contaminated with IAP if not properly certified and from a reputable source. Wind, waterways and wildlife can spread IAP beyond transportation corridors into sensitive ecological areas.

Table 1: Main Pathways of IAP Spread with Supporting Examples

Pathway	Examples	Detail	Mitigations
Contaminants	• Grass seed • Seedling plugs • Gravel/ fill	IAP seeds may be present in these and other materials.	Ensure seed certificates are checked, research source material and ensure it is certified weed free. Steam-treating of imported soils may also be an option at a small scale.
Human Transport and Disturbance	• Machinery and equipment • Recreation • Science and Restoration	IAP seeds may hitch-hike on machines and equipment, clothing and boots of both researchers and recreationists.	Clean all equipment and clothing between sites. Start work in pristine areas and work towards more heavily infested areas. Annually monitor and treat areas where highways ditching materials are disposed of.
Natural Transport	• Wind • Water • Vegetative growth • Wildlife	IAP species have different dispersal and reproduction strategies.	Prevent seed set (mowing, etc).
Release	• Ornamental planting • Illegal dumping	Some IAP arrive through intentional or unintentional means.	Consult Vegetation specialist before planting. Enforce penalties associated with illegal dumping.

Addressing these key pathways and implementing BMPs to reduce the likelihood of IAP introduction and spread will help prevent the establishment of IAP in MRGNP. Efforts will be made to establish and enforce mandatory equipment cleaning between sites, develop bio-security protocols for staff and

contractors managing for and surveying invasives, educate the public and park staff on best practices of invasive species prevention, and ensure no contaminated materials are used in the Parks.

Increased surveillance of transport corridors into Ecological Protection Zones may be prudent. This includes primary and secondary roads leading into sensitive areas as well as trails leading into the backcountry.

2.4 Reducing Disturbance as a Vector of IAP Spread

Projects resulting in site disturbance are often a vector of IAP spread. This vector can be managed through some of the appropriate practices and prevention techniques mentioned in section 2.3.

Each project that is proposed in MRGNP is reviewed to determine its compliance with Canadian Environmental Assessment Act (CEAA 2012) and all National Park regulations. The project is evaluated to determine whether the project components can be mitigated using Best Management Practices, or if the project requires a Basic Impact Assessment (BIA) or a Detailed Environmental Impact Assessment (DEIA) in order to assess potential adverse effects to natural and cultural resources.

The following table outlines the roles and responsibilities of MRG Staff and Project Proponents in regards to IAP prevention and monitoring. See also *Appendix F: Project Proponent Requirements for Reclamation and IAP Control*

Table 2: Roles and Responsibilities for MRG Staff and Project Proponents

Task	Responsibly party
• Ensure IAP mitigations are included in BMPs, BIAs and EIAs; • Work with Proponent to identify appropriate staging areas; • Approve seed mix and check Certificate of Seed analysis; • Review reclamation plans, and; • Review and approve any areas for dumping highways ditching material.	EIA Coordinator
• Ensure all equipment has been cleaned prior to arrival in park; • Conduct pre-treatment site inspections to note environmentally sensitive areas and treatment boundaries; • Conduct environmental and health and safety briefings for all contractors; • Monitor all herbicide application to ensure compliance with IAPMP, and; • Monitor re-seeding and re-vegetation	Environmental Surveillance Officer

PRIOR TO PROJECT WORKS • Evaluate the worksite for invasive plants before soil disturbance begins; • Prepare a reclamation plan prior to construction; • Conduct herbicide application and/or mechanical control of IAP prior to work start; • Ensure all equipment has been cleaned prior to arrival in park and between sites; • Minimize footprint of site disturbance, and; • Order MRG approved seed mix. **DURING PROJECT WORKS** • Salvage topsoil/ sod from site for reclamation purposes, and; • Control IAP during construction. **POST PROJECT WORKS** • Re-seed with native plant species at the earliest possible time; • Plant native shrub stakes where desirable; • Conduct early detection surveys of IAP post-disturbance; • Rapid control of IAP in the first three growing seasons post construction, and; • Monitor success of re-vegetation efforts.	Project Proponent in consultation with Vegetation Specialist Project Proponent in consultation with Vegetation Specialist

2.5 Justification for Active Management and Control

IAP are a "condition measure" under the Forest Indicator in Mount Revelstoke and Glacier National Parks Ecological Integrity Monitoring Program. IAP are therefore considered to have a direct effect on ecological integrity within the field unit and the IAPMP will focus on improving the condition of this measure. When IAP have the potential to replace native species, degrade habitat or alter ecosystem function active management is often less costly to the environment than inaction.

Interim thresholds describing 'good', 'fair' and 'poor' ecological condition have been described in the Invasive Alien Plant Condition Monitoring Protocol and stored on the Information Centre for Ecosystems (ICE) web platform. These thresholds will help inform the need for management action.

IAP elimination or control is not a goal justified in and of itself. Rather, it is within Parks Canada's core mandate to maintain ecological integrity, key ecological processes and native biodiversity. Protecting these values justifies the active management of IAP species.

3.0 Integrated Pest Management

Integrated Pest Management (IPM) is the practice of using all available information about a pest (biology, life cycle analysis, natural predators, etc) and potential control options to determine a suitably effective method to meet targets while minimizing environmental damage and harm. Parks Canada Management Directive 2.4.1 provides guidance on the application of IPM principals in National Parks that ensures that IAP are managed and controlled effectively with minimal harm to non-target species and the environment.

Key components of IPM are as follows:

1) Planning and managing landscapes to encourage pest prevention
2) Identifying the pest
3) Monitoring for new introduction and spread
4) Establishing management strategies, developing priorities, evaluating treatment options
5) Selecting effective treatment methods while minimizing negative effects
6) Evaluating treatment effectiveness and revising treatment strategy based on results

Parks Canada is committed to the utilization, practice and principals of IPM in evaluating its treatment options.

3.1 Prevention

Prevention is the most economical and successful technique when considering IAP. Mitigating vectors of spread as well as educating the public, contractors and employees about best practices associated with IAP prevention is the most cost effective method of managing IAP.

Some prevention measures implemented in the parks include:

- Utilizing certified native seed mixes and checking the Certificate of Seed analysis for any seed mix utilized by the parks
- Inspecting equipment for IAP seeds and contaminants prior to the start of project works
- Ensuring all soil, gravel and substrate entering the Park is sterilized and free of weeds
- Cleaning clothing and equipment when moving between IAP sites
- Re-vegetating disturbed areas with approved native species to prevent IAP colonization
- Minimizing disturbance and soil compaction in natural areas
- Planning work in least infested areas (higher elevation, etc) moving towards more heavily infested areas (lower elevations, etc).
- Avoiding staging equipment in infested areas and ensuring equipment storage areas are free of IAP
- Designating a pressure washing station for equipment between sites
- Addressing introduction of high risk species through pathways analysis
- Educating staff and the public about IAP and the desired behaviours such as Play, Clean, Go

3.2 Identification

Correct identification of the target IAP is essential. Once a species has been identified, research can be undertaken to learn about its life cycles, biology and when and how to best control it. In the absence of correct ID, management of the species will be unsuccessful, resulting in economic and environmental costs with no results.

Table 3: Web Sites for Identification of Noxious Weed and Invasive Plant Species

BC Ministry of Agriculture	"Field Guide to Noxious and Other Selected Weeds of BC"	http://www.agf.gov.bc.ca/cropprot/weedguid/weedguid.htm
Invasive Species Council of BC	Fact Sheets on Invasive Plants	www.bcinvasives.ca
WeedsBC	Weed Profiles	http://www.weedsbc.ca
E-flora	Weed Profiles	http://ibis.geog.ubc.ca/biodiversity/eflora/
Columbia Shuswap Invasive Species Society	Weed profiles	http://columbiashuswapinvasives.org/noxious-weed-list-for-the-columbia-shuswap/

In the event of uncertain IAP identification, or suspect EDRR occurrence, voucher specimens may be collected and sent to the Provincial Invasive Plant Specialist, Provincial EDRR Coordinator or the Royal Museum of BC for confirmation. The protocol for IAP specimen collection can be found in Appendix C.

3.3 Early Detection and Rapid Response

In the event that prevention is unsuccessful, Early Detection and Rapid Response (EDRR) is critical in controlling IAP before they become too widespread to be eradicated or maintained at a manageable level. Maintaining close communication with partners and utilizing the 'Watchlist' (Appendix A) in conjunction with on-the-ground monitoring of areas with a high risk of IAP introduction will facilitate early detection and enable rapid response. Detailed survey methods to support EDRR actions are outlined in Section 3.7.

3.4 Containment

When an IAP is established in a specific geographic area where eradication is not feasible, the goal is to contain the infestation to defined geographic boundaries and prevent it from spreading further. This can be achieved by preventing seed set and spread of vegetative materials of IAP as well as targeting any IAP individuals occurring outside of the defined containment areas for control.

3.5 Restoration

Disturbed areas are often the most susceptible to invasion by IAP. Even when ensuring clean equipment and materials, bare ground can be easily colonized by IAP. To prevent invasion or secondary invasion of a treated site, active site restoration is recommended depending on the site characteristics and restoration objectives. The Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas, published in 2008 by the Canadian Parks Council provides a reference for best practices in Restoration.

Properly restored sites will support a more resilient native plant population less susceptible to invasion. The Best Management Practices for MRGNP "Planting Criteria: Internal and External Expectations" for shrub, tree and grass re-vegetation should be adhered to when conducting any re-vegetation or restoration in MRGNP (Appendix D).

When understory vegetation is desirable on site (ie where site lines are not an issue and natural shrub growth would occur) native shrub stakes should be planted to encourage the formation of an understory canopy to shade out early IAP colonizers that are dependent on natural light. Shrub stakes should be cut in the early spring from nearby areas and not over harvested at any one site. Detailed methods for cutting shrub stakes for restoration purposes are covered in a report for a local Revelstoke restoration project (see Kellner 2015).

It is important that bare ground get seeded immediately following site disturbance using the appropriate MRG restoration and re-vegetation mix. For each order, parks staff should request a seed certificate for every species component in the mix and forward them along to the Fire and Vegetation specialist for review. This is important as each seed batch and order will vary. The certificates will be compared against the MRG species lists and Watchlist and if any species in the 'Moderate', 'High', 'Very High' or 'Watchlist' are recorded the seed mix will be rejected (Appendix A). The recommended approved seed mix for MRGNP can be found in Appendix D.

3.6 Surveys, Inventory and Data Management

Monitoring IAP for spread, new establishments and spatial extent is important in determining which tools of IPM to use to manage the species. In MRGNP detailed condition monitoring (see section 5.0) will occur on a 5 year basis (Parks Canada 2015). In addition to condition monitoring, a comprehensive survey of front-country roads and railways for management purposes will be completed on a 5 year rotating basis, off-set from the condition monitoring. The monitoring of roads and rails was most recently accomplished in 2014 by Tannas Conservation Services. To coincide with highway monitoring, Park staff will conduct detailed inventory of the trail networks and sensitive backcountry sites in MRGNP every 5 years to assess and pull IAP when found.

Detailed data will be stored in database for internal use and comparison. Information about priority invasive plants relevant to other land managers will be entered into the Invasive Alien Plant Program (IAPP) database managed by the Province of BC.

4.0 Invasive Plant Treatment Options

Yearly control operations will be guided by Operational Activity Plans updated annually and found here: Z:\ResCon-Revelstoke\Fire & Vegetation\Invasive plants\Integrated Pest Mgmt\Control\Planning

4.1 Mechanical Control

Mechanical control is any treatment of IAP by physical means. This can include mowing, mulching, covering, spot burning, hand pulling, digging, solarizing soil with plastic sheeting, steam weeding and weed whacking. For some IAP, mechanical control can be a good methods to limit seed set or even remove the plant entirely. Mechanical control can be highly specialized to avoid damage to non-target vegetation or can target a stretch of highway to prevent seed set by mowing.

Vegetation staff will work with the Highways Operations Unit (HOU) to coordinate a mowing schedule to target widely distributed IAPP prior to seed dispersal.

Table 4: Description of, Rationale, Benefits and Limitations of Manual and Mechanical Control Methods

Description and Rationale	Benefits and Limitations
Hand Cutting can be used in small areas along the ROW and access roads to ROWs and facilities. The most effective time for this method is generally in the late bud or early bloom stage, when the target invasive plant has used up most of the carbohydrate reserves in its roots.	The **advantages** of hand cutting is that it can sometimes be an effective approach to reducing small populations of invasive plant populations or reducing off site movement. Proper use will generally effectively eliminate the current year's seed production and significantly reduce the plant's root reserves that contribute to the next year's growth. The **limitations** of hand cutting are that it is not an effective control method where eradication of the target plants is the goal.
Hand Pulling is a viable control method only for certain established invasive plants that can be easily uprooted and where the roots can be fully removed. It is effective if the number of weeds to be pulled is small and the site is a manageable size. When hand pulling is used, the exposed soil should be immediately covered with gravel or re-seeded.	The **advantages** of hand pulling are that it is effective on tap-rooted invasive plants when the size of the infestation is small and the soils are amenable to hand pulling. It may be one of the only alternatives for invasive plants growing adjacent to bodies of water and other environmentally sensitive areas where herbicides cannot be used. It is sometimes an effective approach to reduce the numbers of invasive plants or reduce their movement off-site. It is rarely used when eradication of invasive plants is the goal, but can weaken the population and/or reduce their spread to new sites. The **limitations** of hand pulling are that it is labour intensive, and normally needs to be done for several years to eliminate invasive plants from a site, as there is usually a seed bank. It is not efficient for rhizomatous plants as it tends to break up the rhizomes and stimulates plant growth. On soils that are hard packed in dry conditions, it frequently results in the upper portion of the plant breaking off, leaving the crown intact and able to re-grow. Uprooting invasive plants can also cause soil disturbances along the body of water and lead to siltation. On steep slopes with fine textured soils, it can destabilize the slope, and it can provide an improved seed bed for invasive plant re-infestation in any soil or aspect.
Mowing is the cutting of invasive plants growing in the grassy areas within pipeline ROWs. Areas can be mowed using equipment such as commercial lawnmowers, garden tractors or industrial tractors.	The **advantages** of mowing include controlling invasive plants before they go to seed, thus reducing the seed source available for dispersal to other areas of low vegetation tolerance such as into facilities adjacent to the ROW. Mowing promotes aesthetics and is economical. The **limitations** of mowing are that it is not suitable in areas that are rocky, on slopes, or where low-growing compatible species predominate. Mowing could stimulate vegetative growth of some species, causing a matting effect. Mowing does not eradicate weed species and is a temporary solution. There are some safety issues due to flying debris. Mowing generally is very labour intensive, as it has to be done several times at each location during a growing season.
Steam weeding can be used to directly apply or spray super-heated water to kill IAP foliage and damage shallow root systems. It can also be used to sterilize soils and decrease the germination potential of a shallow IAP seed bed.	The **advantages** of steam weeding is that it can kill above-ground foliage and damage shallow root systems without the use of chemicals. This method can be used in sensitive areas where herbicide use is limited and can also be used to sterilize a shallow seed bank to prevent germination of IAP. The **limitations** (disadvantages) of steam weeding are that it will not eliminate deeply rooted IAP and may only produce short-term control. Additionally, access to certain sites may be limited as the MRG unit is truck-mounted and unavailable to access more remote sites.
Soil solarization can be used to increase soil temperatures and kill some IAP seeds and soil-born pests.	The **advantages** of soil solarization is that it can kill some annuals and shallow rooted plants in a shallow seed bank and prevent the germination of some IAP. The **limitations** (disadvantages) of soil solarization are that it will not eliminate deeply rooted IAP, perennials or deeply buried seeds.
Weed-Trimming at the ground surface can be used in areas such as along access roads to the ROW and to facilities, and at low priority sites to manage invasive plants.	The **advantages** of weed trimming are that it helps to remove seed heads when done early in the season, and is convenient and economical. The use of weed trimmers is generally more suitable than mowers for use in areas that are rocky, have stumps, on slopes, where invasive plant species predominate, or are not accessible to lawnmowers or tractors. The **limitations** (disadvantages) weed trimming are that it does not remove roots, and has only limited effectiveness on noxious weed and invasive plant species that reproduce from stem pieces. There are some safety risks due to flying debris.

4.2 Biological Control

Biological control is the use of a host-specific predator, insect, fungus or disease to attack or damage a target host. While bio-control agents rarely eliminate their host entirely the agents can be used when a plant has become so widely distributed across the landscape that eliminating it through chemical or mechanical means is unfeasible.

There are numerous insects approved as bio-control agents by the Province of BC for use on its lands (FLNRO 2015). Different modes of action of bio-agents include: Flower and seed feeders (reducing seed production up to 90%), gall producing insects, defoliators, sap suckers, stem miners, crown feeders, root feeders, parasites and pathogens (FLNRO 2015). The insects and pathogens are not meant to entirely eliminate their hosts but act as natural predators to bring them down to a manageable population at the landscape level.

There have been no bio-control releases in MRGNP, however the bio-agents released in the Province have likely made their way along the highway corridor. Given that bio-control from provincial lands may have already migrated into MRGNP, surveys of existing IAP for signs of bio-agent dispersal and effectiveness will provide initial insight into the efficacy and viability of utilizing bio-control agents in the Field Unit. This monitoring and documentation will help inform MRGNP's management options for various species of IAP. Detailed records of existing agents will act as a reference should bio-control be considered for use in MRGNP and help coordinate landscape level IAP management strategies with the Province of BC.

For a full list of all Bio-agents known to occur in BC, refer to the FLNRO Bio-control Agent on Invasive Plant Matrix website: https://www.for.gov.bc.ca/hra/plants/Agent-Plant_Matrix.htm. For identification in the field, the Guide to Biological Control of Weeds in BC is also a useful resource (Powel et al 1994).

Table 5: Description of, Rationale, Benefits and Limitations of Biological Control Methods

Description and Rationale	Benefits and Limitations
Bio-control is the use of host-specific predators, insects, fungi or disease to damage a target IAP and simulate natural controls of the host-plant in its natural environment. Bio-control is appropriate when IAP have reached a level of infestation where other treatments are not ecologically beneficial or economically feasible.	The **advantage** of utilizing bio-control agents is that, once established, little input beyond introduction and monitoring is required to maintain IAP control across a landscape level. The use of biological control has the potential to make widespread IAP less competitive due to natural predation. The **limitations** of bio-control are that it is not an effective method to eradicate or eliminate IAP populations and not all IAP species have specific bio-agents developed or established in BC. Additionally, not all biological control agents will persist and reproduce in certain environments and those that do may take more than 10 years to become well established.

4.3 Cultural Control

Cultural control practices involve preventative actions, active restoration and actions such as grazing, fertilization, and re-vegetation to make an environment unsuitable for the growth and/or propagation of IAP. One example of cultural control in MRGNP is the planting of native willow, cottonwood and alder stakes post-disturbance to create a canopy cover to shade out and prevent the establishment of invasives.

Table 6: Description of, Rationale, Benefits and Limitations of Cultural Control Methods

Description and Rationale	Benefits and Limitations
Active restoration/ Re-vegetation is the practice of seeding or planting site appropriate species to reduce the bare ground available for colonization by IAP and encourage healthy plant communities.	The **advantages** of restoration and re-vegetation include the prevention of IAP establishment, rehabilitation of the site to natural conditions and the lower relative cost of continued maintenance and control of IAP over the lifespan of the project. The **limitations** of restoration and re-vegetation are the initial input of staff time and resources to implement active-restoration and costs associated with monitoring the project.
Fertilization is the addition of nutrients to encourage plant growth and speed up the establishment of desirable plant species.	The **advantage** of fertilization includes the ability to rapidly re-colonize a site with an appropriate grass mix or native species. The **limitations** associated with fertilization are that it may alter the natural nutrient regime of certain areas and cannot be used where fertilizer runoff may enter streams, riparian areas or water bodies.
Best Management Practices are the principals that can be applied during special projects or day to day operations that prevent the establishment of IAP by reducing contamination and preventing the spread of seeds.	The **advantages** of implementing Best Management Practices include increased ability to prevent IAP establishment and spread, and clear expectations of the contractor and park staff when carrying out specific projects or day to day operations. The **limitations** of Best Management Practices include human error and the ability to monitor and enforce compliance with the stated BMPs.

4.4 Chemical Control

Some IAP (E.g., rhizomatous and creeping plants) do not respond readily to mechanical control or are too extensive to practically control by mechanical means. To effectively control or contain certain priority infestations, chemical control methods may be required. Herbicide use will be considered when all other treatment methods have been considered and deemed ineffective or impractical. See section 7.2 for more detailed information about herbicide selection and use.

Table 7: Description of, Rationale, Benefits and Limitations of Chemical Control Methods

Description and Rationale	Benefits and Limitations
Spot application of herbicide is the practice of selectively applying herbicide to priority IAP infestations to treat areas where no other control method is practical or effective.	The **advantages** of spot application of herbicide include effective control or eradication of priority IAP, little to no soil disturbance and lower treatment costs on a large scale compared to mechanical methods. The **limitations** of spot application of herbicide include avoidance of no-treatment and pesticide-free zones. Multiple applications may be required to deplete the IAP seed bank and site limitations may exist due to restrictions associated with sandy and gravel soils and moderate to steep slopes. Application windows are also affected by weather and growing conditions.

4.5 Treatment method selection

Treatment should be selected based on the most effective method with the minimal environmental damage. This can be determined by using information about the spatial extent, biology and phenology of the IAP as well as up to date information about the treatment effectiveness of a technique on the particular IAP in question. Site characteristics and associated restrictions will also need to be taken into account. All treatments must be made not with the goal of elimination of IAP in and of itself, but rather the preservation of native biodiversity and Ecological Integrity. Appropriate treatment will vary depending on site and species.

5.0 Condition Monitoring

IAP are a "condition measure" under the Forest Indicator in Mount Revelstoke and Glacier National Parks Ecological Integrity Monitoring Program. IAP have a direct effect on ecological integrity within the field unit and management efforts will focus on improving the condition of this measure.

The condition measure will take into account the percent cover of priority IAP in each Invasive Plant Management Zone. Within the condition monitoring protocol, interim thresholds are identified to determine whether the IAP condition of MRGNP is "good', 'fair' or 'poor' (Parks Canada 2015). The overall condition and trend of IAP in MRG will be assessed on a regular 5 year interval to help contribute to our understanding of the ecological integrity of forested ecosystems.

6.0 Management Effectiveness Monitoring

To assess the efficacy of treatments and whether or not management efforts are achieving their intended purpose, for each type of IAP treatment, a subset of the treated areas will be monitored for management effectiveness (MEM). A detailed protocol for MEM plots in MRG describes the methodology used to assess the plots over time (Parks Canada 2015).

6.1 Treatment monitoring

In addition to management effectiveness monitoring, a minimum of 10% of all areas treated for herbicide will be monitored according to the BC Invasive Alien Plant Program (IAPP) Reference Guide protocols (Range Branch 2010). An example of a treatment monitoring field datasheet with required IAPP inputs can be found in Appendix E. All treatment monitoring data will be uploaded to IAPP.

7.0 Operational Information

7.1 Qualifications and Responsibilities of Persons Applying Herbicides

Anyone applying herbicide in Mount Revelstoke and Glacier National Parks (hereafter referred to and the "Applicator") must possess a valid Pesticide Applicator's Licence recognized by BC. The Applicator will follow the safe work practices in compliance with Work Safe BC, Parks Canada and BC Pesticide Applicator License Practices and Policies. Furthermore the Applicator will:

- Coordinate with the Highways Operations Unit and Traffic Control as needed to ensure adequate safety coverage during all work periods adjacent to the TCH, and;
- Ensure safety practices are being followed for the specific herbicide being used.

Contractors will be required to maintain adequate WCB insurance and general liability coverage at their own expense.

7.2 Procedures for Safely Transporting Herbicides

The following describe the procedures for safely transporting herbicides to, from and within in MRGNP:

- Ensure that herbicides are carried in a compartment that is secured against spillage and unauthorized removal. The compartment shall be separate from food and drinking water, safety gear, spill containment equipment and people;
- Inspect all herbicide containers for defects prior to transporting. Keep herbicides in their original containers and with original labels. If original labels are not available, the herbicides shall be placed in appropriate containers that have the trade name, active ingredient concentration, and pesticide registration number affixed to the outside of the container;

- Ensure that the vehicle is equipped with a first aid kit, fire extinguisher, spill contingency plan and kit, and that the vehicle operator has been trained on how to handle spills;
- Ensure that all documents and placards are carried in, or placed on, transport vehicles if required under the *Transport of Dangerous Goods Act*, R.S.B.C 1996, c. 458; and,
- Read and understand the herbicide labels and the product Material Safety Data Sheet (MSDS) for all herbicides being transported.

7.3 Procedures for Safely Storing Herbicides

- Ensure that herbicides are stored in accordance with the IPMA, IPMR and the Workers' Compensation Board document *Standard Practices for Pesticide Applicators* (2009);
- Ensure herbicides are kept in their original containers and with original packaging. If original packaging not available, the herbicides shall be placed in appropriate containers that have the trade name, active ingredient concentration and herbicide registration number affixed to the outside of the container;
- Ensure that storage facilities are locked when left unattended, ventilated to the outside atmosphere, are entered only by persons authorized to do so, and that there is a placard affixed and maintained on the outside of each door leading into the storage area bearing, in block letters that are clearly visible, the words "WARNING – CHEMICAL STORAGE –AUTHORIZED PERSONS ONLY"; and,
- Keep storage facilities separate from work and living areas, and away from food, flammable materials, bodies of water and water sources.

7.4 Procedures for Safely Mixing, Loading and Applying Herbicides

- Ensure that all mixing, loading and application of herbicides is carried out by Certified Pesticide Applicators, and that all manufacturer's recommendations, as specified on the herbicide labels, are adhered to;
- Ensure that all mixing, loading and application of herbicides shall be undertaken in a safe manner. All mixing and loading shall be undertaken only in areas at least 15 meters from, and selected to prevent, any spilled herbicides from entering pesticide-free zones, no treatment zones, bodies of water, fish or wildlife habitat, water sources, or other environmentally sensitive areas;
- Ensure that containers used to mix, prepare or apply herbicides are not washed or submerged in any body of water;
- Ensure that eye wash station(s), protective clothing, safety spill kits, spill response plans, a copy of this integrated vegetation management plan, each herbicide product's MSDS, emergency telephone numbers and first aid supplies are present and available at or near the treatment site; and
- To follow all directions and restrictions on herbicide product labels, including adhering to the recommended re-entry times to treated areas unless personal protective equipment is worn.

7.5 Procedures for the Safe Disposal of Empty Herbicide Containers and Unused Herbicides

- Ensure that all herbicide waste is disposed of in a manner consistent with the requirements of the *Federal and Provincial* legislation, as appropriate;
- Ensure that empty herbicide containers are returned to the herbicide distributor as part of their recycling program; or triple rinsed or pressure rinsed, altered so that they cannot be reused, and disposed of in a permitted sanitary landfill or other approved disposal site; and

- Ensure that all leftover herbicide mix is stored for future use in a manner consistent with the requirements specified above.

7.6 Herbicide Selection and Use

The Applicator must follow all label recommendations of the specific herbicide in use. Only clean, triple rinsed, uncontaminated equipment must be used to store and distribute herbicide. When possible, selective herbicides with low residual and low toxicity to the environment and human health will be chosen. Application windows will be timed to be biologically appropriate based on herbicide mode action.

The following active ingredients[1] may be used alone or in combination under this IAPMP. All herbicides used must be registered for use in Canada under the Pest Management Regulatory Agency.

Aminopyralid	**Description**	Post-emergent synthetic enzyme that controls broadleaf weeds, invasive plants and woody plants. Functions by its systemic mode of action. Absorbed by both leaves and roots, and translocates throughout the plant.
	Residual	Yes; up to 3 years of residual control.
	Selectivity	Broadleaf specific; does not damage grasses.
	Site Restrictions	Avoid steep and moderate slopes, compacted soil or clay in areas adjacent to aquatic habitat. Also avoid areas with shallow water tables and/ or permeable (sandy) soils.
	Vegetation Restrictions	Avoid application within the drip line of desirable trees and shrubs.
	Examples of Trade Names	Milestone®

Clopyralid	**Description**	Selective, residual herbicide readily absorbed by foliage and roots and translocated upwards and downwards. Does not severely injure trees or shrubs when applied to target herbaceous species in close proximity.
	Residual	Yes; active for up to 2 years.
	Selectivity	Broadleaf specific; does not damage grasses.
	Site Restrictions	Inner banks or bottom of irrigation ditches, in areas where surface water runoff is possible.
	Vegetation Restrictions	Avoid direct application to foliage of desirable trees and shrubs.
	Examples of Trade Names	Lontrel 360®

Dicamba	**Description**	Used for the treatment of young, actively growing broadleaf weeds, brush species, and some species of invasive plants. Degrades rapidly in environment.
	Residual	No
	Selectivity	Broadleaf specific; does not damage grasses.
	Site Restrictions	Do not apply to areas where water is present. Avoid areas where downward movement in soil will result in transport to water or desirable vegetation.
	Vegetation Restrictions	Avoid application within the drip line of desirable trees and shrubs.
	Examples of Trade Names	Vanquish®

[1]These descriptions of active ingredients are meant to be summaries only; herbicide label directions are the ultimate authority on the properties, restrictions and residuals of the product. All label recommendations must be followed by law.

Glyphosate	**Description**	Non-residual herbicide that kills all vegetation on contact. Rendered inactive when it contacts soil. May be used within 1 meter of a high water mark if selectively applied for invasive plant control. Application near water is generally by wick or stem injection.
	Residual	No
	Selectivity	Non-selective
	Site Restrictions	Do not apply within 1 m of water.
	Vegetation Restrictions	Do not apply to desirable vegetation.
	Examples of Trade Names	Round-up®

Imazapyr	**Description**	Season-long control of most species of annual and perennial broadleaf plants, grassy weeds species, and some species of invasive plants. Readily absorbed through vegetation and roots and translocated throughout the plant. Prevents germination of seeds, readily absorbed through foliage and roots, and moves rapidly throughout the plant where it breaks down tissue. Treated plants stop growing soon after spray application.
	Residual	Yes; minimum 2 years.
	Selectivity	Non-selective
	Site Restrictions	Avoid areas where runoff could reach aquatic habitat.
	Vegetation Restrictions	Avoid application in areas twice the width of drip line of desirable vegetation
	Examples of Trade Names	Arsenal®

Triclopyr	**Description**	Controls many invasive broadleaf plants, and is very effective in controlling many new identified invasive shrubs and deciduous tree species. Accumulates in areas of active cell growth and interferes with normal plant growth processes. Absorbed by green bark, leaves, roots, and cut stem surfaces and moves throughout the plant. Toxic to fish. Easily degraded by soil microbes.
	Residual	Slightly; 1 season residual
	Selectivity	Broadleaf specific; does not damage grasses.
	Site Restrictions	Avoid steep and moderate slopes, compacted soil or clay in areas adjacent to aquatic habitat. Also avoid areas with shallow water tables and/ or permeable (sandy) soils.
	Vegetation Restrictions	Avoid application within twice the drip line of desirable trees and shrubs.
	Examples of Trade Names	Garlon® 4

Mecoprop-p	**Description**	Selective, non-residual, translocated herbicide that interferes with growth regulation in many noxious weed and invasive plant species. Most effective when the target plant is actively growing, and is more actively taken up by the foliage than the roots.
	Residual	Short residual
	Selectivity	Broadleaf specific; does not damage grasses.
	Site Restrictions	Avoid steep and moderate slopes, compacted soil or clay in areas adjacent to aquatic habitat. Also avoid areas with shallow water tables and/ or permeable (sandy) soils.
	Vegetation Restrictions	Avoid application within the drip line of desirable trees and shrubs.
	Examples of Trade Names	Mecoprop-p Herbicide

Metsulfuron methyl	**Description**	Non-selective, residual herbicide that is effective in the suppression and management of difficult to control invasive plants such as common tansy and Canada thistle. It works by causing rapid inhibition of plant cell division and growth.
	Residual	Yes; about 1.5 years
	Selectivity	Non-selective
	Site Restrictions	Avoid steep and moderate slopes, compacted soil or clay in areas adjacent to aquatic habitat. Also avoid areas with shallow water tables and/ or permeable (sandy) soils.
	Vegetation Restrictions	Avoid application in areas twice the width of drip line of desirable vegetation
	Examples of Trade Names	Escort®

Picloram	**Description**	Highly active, water soluble herbicide that can remain in the soil for several years and continue to control susceptible vegetation. Systemic herbicide for use on a wide variety of broadleaf invasive plants. Areas where soil may be moved or where there is a shallow aquifer or domestic water intake must be avoided.
	Residual	Yes; 3-7 years
	Selectivity	Broadleaf specific; does not damage grasses.
	Site Restrictions	Avoid steep and moderate slopes, compacted soil or clay in areas adjacent to aquatic habitat. Also avoid areas with shallow water tables and/ or permeable (sandy) soils. Moderately toxic to fish.
	Vegetation Restrictions	Avoid all non-target vegetation.
	Examples of Trade Names	Tordon 22K®

2,4 D Amine	**Description**	Selective, non-residual, translocated herbicide that interferes with growth regulation in many noxious weed and invasive plant species. Most effective when the target plant is actively growing, and is more actively taken up by the foliage than the roots.
	Residual	Slightly; up to 1 season residual
	Selectivity	Broadleaf specific; does not damage grasses.
	Site Restrictions	Avoid steep and moderate slopes, compacted soil or clay in areas adjacent to aquatic habitat. Also avoid areas with shallow water tables and/ or permeable (sandy) soils. Moderately toxic to fish.
	Vegetation Restrictions	Avoid application in areas twice the width of drip line of desirable vegetation
	Examples of Trade Names	2,4 D LV 600 Herbicide

Diflufenzopyr	**Description**	Improves the efficacy of certain auxin-like herbicides, such as dicamba, on many broadleaf weed species. Causes increased disruption of normal growth patterns at a plant's growing points in the roots and shoots. Persists in the soil, cannot be used near desirable trees or their root systems, and care must be taken to avoid areas where soil may be moved or where there is a shallow aquifer or domestic water intake, especially where there are permeable soils. It also may not be used in any residential areas. Currently in Canada, diflufenzopyr is only found in the herbicide products OVERDRIVE® and Distinct WDG®.
	Residual	Slightly; up to 1 season residual
	Selectivity	Broadleaf specific; does not damage grasses.
	Site Restrictions	Avoid steep and moderate slopes, compacted soil or clay in areas adjacent to aquatic habitat. Also avoid areas with shallow water tables and/ or permeable (sandy) soils. Moderately toxic to fish.
	Vegetation Restrictions	Avoid application in areas twice the width of drip line of desirable vegetation
	Examples of Trade Names	OVERDRIVE®, Distinct WDG®.

Surfactant or Adjuvants	**Description**	To allow easier mixing, increase adherence to plant surface or adjust droplet size, surfactants and adjuvants can added to the herbicide tank mixture. If required, surfactant/adjuvant products may be added to the herbicide active ingredients proposed for use under this IAPMP.

7.7 Use of Surfactants or Adjuvants

Adjuvants and surfactants are chemicals or agents that are sometimes added to herbicide spray mix to allow easier mixing, and to assist in the spreading of the herbicide spray mix and the wetting of, and adherence to, the surface of the plants being treated. This has been shown to decrease the possibility of drift (the movement of the applied material away from the intended target to adjacent areas by wind). Some adjuvants and surfactants are chemicals or agents that may also be used to adjust the pH of the herbicide spray mix. Spray mixes that are highly or mildly alkaline (i.e. pH greater than 7) have been shown to break down (degrade) or hydrolyze more rapidly, reducing the effectiveness of the

herbicide being applied. If required, surfactant/adjuvant products may be added to the herbicide active ingredients proposed for use under this IAPMP.

7.8 Maintenance and Calibration of Application Equipment

Contract Applicators will provide their own equipment and ensure that it is clean, triple rinsed, free of residue and safe for use. No aerial equipment will be used. Acceptable equipment application methods include application via backpack sprayers, hand held nozzles, vehicle mounted sprayers (boom or boom-less), wipe-on or wick applicators, stem injection equipment and/ or hand help squirt bottles. Where possible, spot applications will be used to avoid damage to non-target vegetation.

All herbicide application equipment used within the IAPMP area shall be safe, clean, in good repair, compatible and appropriate for the herbicide being used. As a minimum, all back sprayers and vehicle mounted sprayer shall be calibrated once per year prior to use, and at regular intervals throughout the season. Sprayers shall be re-calibrated when nozzle output begins to vary. The frequency of sprayer calibration shall be dictated by factors such as formulation of herbicides used. For example, abrasive formulations such as wettable powders normally result in greater nozzle wear and will require more frequent calibrations.

7.9 Pre-treatment Site Inspection

Parks Canada staff will conduct a pre-treatment site inspection to inspect for environmentally sensitive areas, delineate the treatment zone and determine what control methods are appropriate given the site conditions. This information will be conveyed to the Applicator during the contractor tailgate briefing.

7.10 Contractor Tailgate Briefing

All Contract Applicators will meet with Parks Canada staff prior to treatment application to review safety protocols, environmental regulations and get site specific information including environmentally sensitive areas and treatment area boundaries.

7.11 Posting of Treatment Notices

Prior to treatment, Applicators will post a sign at all public entrances to the site detailing the herbicide used, the active ingredient, the safe entry date and the date of treatment. These signs must be posted for a minimum of 14 days at which time Park Staff or the Applicator may retrieve and dispose of them.

8.0 Environmental Protection

As with any ecological intervention, beneficial environmental outcomes must exceed any negative treatment effects. Every effort must be taken to protect the natural environment and reduce negative effects associated with treatment or management action of any kind. In many cases, inaction will lead to worse environmental outcomes than active management. The following sections outline best management practices to minimize environmental impacts associated with herbicide use.

8.1 Definitions

The following definitions will be used to describe environmental protection areas and buffers.

Pesticide-free zone (PFZ) – an area of land that must not be treated with pesticides, and must be protected from pesticides moving into it. PFZs are measured by the horizontal distance from the high water mark. PFZs will be identified, marked/flagged prior to any herbicide application.
No-treatment zone (NTZ) – an area of land that must not be treated with pesticides. NTZs will be identified, marked/flagged prior to any herbicide application.
Body of water – any watercourse or body of water, such as a stream, river, wetland, or lake, but not including a human-made, self-contained body of water or structure of water.
Stream – a watercourse that contains water on a permanent or seasonal basis, is scoured by water, or contains observable deposits of mineral alluvium, and which has a continuous channel bed that is 100 m or more in length, or flows directly into a fish stream or a fish-bearing lake or wetland, or a licensed waterworks.
Wetland – a swamp, marsh, bog, or other similar area that supports natural aquatic and riparian vegetation, and which is distinct from adjacent upland areas.

8.2 Procedures for Weather Monitoring and Stop Treatment Conditions to Promote Environmental Safety

Measurements shall be made by the contractor to record weather conditions prior to, and periodically during, herbicide applications. Wind speed and direction, precipitation, temperature and sky conditions (clear, overcast, cloudy, partly cloudy), frost and dew conditions shall be recorded for all herbicide applications. Persons applying herbicides are responsible for checking each product label for guidelines for applying herbicides under various weather conditions.

Herbicide applications shall be stopped if:

- The maximum/minimum temperature stated on the herbicide label is exceeded; or
- The wind speed and/or direction cause the foliar or soil application of herbicide to drift
- and/or miss the target vegetation; or,
- Ground wind velocity is over 8 km/hour; or,
- It begins to rain steadily, increasing the chances of excessive runoff and leaching; or,
- There is ice or frost on the foliage.

8.3 Strategies to Protect Community Watersheds

For herbicide applications proposed to occur within 100 meters of the Connaught Creek watershed, the following strategies will be followed, where applicable:

- Herbicides shall not be stored within a community watershed for more than 24 hours prior to their use, and removed from the community watershed within 7 days of use, unless they are stored in a permanent structure;
- A 10 meter pesticide-free zone (PFZ) shall be maintained from the point of herbicide application and all bodies of water within the community watershed; Do not apply pesticides within 100 m upslope of a community water supply water intake; Do not apply pesticides within 25 m downslope of a community water supply water intake;
- All PFZs shall be measured and marked/flagged prior to herbicide use; and

- Herbicide use shall be discontinued if herbicide residues or herbicide breakdown products directly resulting from herbicide applications are detected at a community watershed water intake, and further use shall not be undertaken until the BC Ministry of Health has been satisfied that all required measures have been implemented to preserve water quality (if applicable).

8.4 Strategies to Protect Water bodies, Wetlands and Riparian and Aquatic Habitats

Many herbicides are toxic to aquatic organisms and can contaminate aquifers and groundwater if mis-applied. To protect these sensitive areas, refer to label recommendations. These guidelines align with those outlined in the Integrated Pest Management Regulations under the BC Integrated Pest Management Act.

- A 10m Pesticide Free Zone (PFZ) and associated buffer will be established around all fish and/or amphibian streams, lakes, wetlands and ephemeral wet areas. The only exception to the 10 m PFZ is when spot treating IAP using glyphosate. In this circumstance alone, the PFZ may be reduced to within 1 meter of the aquatic habitat. When there is any possibility of herbicide drift, No Treatment Zones (NTZ)'s will be designated as buffers in addition to PFZ to ensure no herbicide residue falls within the PFZ;
- Herbicide must be applied based on manufacturer and contract specifications to ensure that these materials do not enter streams or groundwater after application;
- Staging areas will be located a minimum of 30 m from watercourses (lakes, streams, wetlands and ephemeral bodies of water);
- In the event of precipitation during herbicide application, all activities must cease immediately, as there is an increased risk of chemical transport via surface runoff to watercourses;
- Herbicide must be applied according to temperature and wind specifications to avoid drift into non-target areas, and;
- Herbicide application will be avoided in areas of permeable (sandy or gravelly) soils and on steep and moderate slopes with clay or compact soil which are prone to surface runoff.

8.5 Avoiding Damage to Non-Target Vegetation

Native vegetation is crucial to ecological integrity. Protecting vegetation to maintain habitat functionality for wildlife is important when considering invasive plant control measures. Vegetation cover must be maintained where possible to reduce erosion potential and maintain ecosystem processes. To avoid damage to non-target shrubs and trees, herbicide application should be avoided within twice the width of the drip line of beneficial species unless otherwise stated on the label.

Specific vegetation to be avoided, where practical, when working outside of the TCH corridor:

- In any designated caribou habitat areas, false box (*Paxistima myrsinites*) will be avoided;
- *Vaccinium* spp. will be avoided.

The following shrubs will be avoided wherever practical:

- red elderberry (*Sambucus racemona)*,
- red raspberry (*Rubus ideaous*),
- thimbleberry (*Rubus parviflorus*),
- all current species (*Ribes* spp.),
- black twinberry (*Lonicera invulcrata*),
- high bush-cranberry (*Viburnum trilobum*),

- red-osier dogwood (*Cornus stolonifera)*

Moist areas shall also be avoided such as those containing skunk cabbage (*Symplocarpus foetidus)*, horsetail (*Equisetum* spp.), sedge (*Carex* spp.), lily (Liliaceae family), and cow parsnip (*Heracleum maximum*). These are preferred forage areas for grizzly bears and will be avoided.

8.6 Strategies to Protect Wildlife Habitat, Rare Plants and Species at Risk

Areas known or suspected to contain rare plants will be avoided when possible and assessed by park staff prior to initiation of treatment. If rare or endangered plants are encountered during the site surveys or treatments, treatment must cease and Resource Conservation must be notified.

Applicators are obligated to cease work and immediately contact Resource Conservation if caribou or bear(s) are observed in the work site. Applicators will report all wildlife sightings to Resource Conservation (ungulates, wolverines, amphibians, etc.) in a timely manner.

8.7 Spill Response Protocol

All Applicators must come adequately equipped to deal with a spill. The Applicator will report all spills (regardless of size) to Resource Conservation. If Resource Conservation is unavailable, the Applicator must report any spills directly to Jasper Dispatch (1-877-852-3100). The Applicator is responsible for all clean-up costs. All spills must be contained as soon as possible. Clean-up must be completed to the satisfaction of Parks Canada's Environmental Assessment Coordinator.

Each Applicator must come equipped with an adequate spill kit in each vehicle used to transport or apply herbicides containing, at minimum (as per Southern Interior PMP recommendation):

- emergency telephone numbers;
- agricultural white lime (25 kg);
- kitty litter (2-20 kg bags);
- large plastic garbage bags (4);
- shovels (2);
- 5 gallon bucket (with lid);
- pesticide neutralizing solution (1);
- an ABC type fire extinguisher;
- polyethylene or plastic tarp (3 x 3m minimum);
- dustpan and shop brush;
- flagging and rope;
- a herbicide first aid kit, and;
- personal protective clothing/equipment (rubber gloves, safety glasses, high visibility vest).

If a spill should occur the following protocols will be enacted:

1) Ensure personal safety and secure site.
2) Administer First Aid if necessary.
3) Suspend operations until incident is properly managed.
4) Contain spill if safe to do so (plug at source, build dam or ridge)
5) Report incident to Resource Conservation, or if unavailable report to Jasper Dispatch.
6) Cover spill with absorbent material
7) Collect all contaminated materials in clearly marked double bagged containers.
8) Dispose of properly at designated landfill

9) If more than 5 L or 5 kg of herbicide has spilled: notify Emergency Response Management BC (1-800-663-3456) as per Environmental Management Act.

9.0 Reporting

9.1 Herbicide Records

Applicators will retain herbicide application records as per law. Applicators will be required to provide adequate legal documentation of each treatment day and new location of all applications including:

- Name and licence number of applicator;
- Trade name of herbicide used and federal registration number;
- Date and time (start and end) of application;
- Method, rate and quantity of herbicide applied;
- Total area treated;
- IAP Species targeted;
- Hourly weather conditions (temperature, humidity, wind speed and direction) and;
- Any problems/ issues/ concerns associated with treatment (ie presence of rare or sensitive native species in the treatment area)

All chemical treatment information will be entered into the Invasive Alien Plant Program (IAPP) database annually.

9.2 Annual Activities and Treatment Report

Contract Applicators will submit an annual report by January 31st to the BC Ministry of Environment containing all required info as per the BC Integrated Pest Management Regulations defined under the Integrated Pest Management Act.

10.0 Coordination with Other Agencies and Stakeholders

IAP do not adhere to political boundaries and it is with this recognition that MRGNP will work closely in coordination with its partners to manage IAP on a landscape level. MRGNP will work in close collaboration with other Mountain Parks (Banff, Yoho, Kootenay, Waterton, Jasper) via semi-annual Fire and Vegetation Network meetings and maintain regular communication regarding program developments. Vegetation staff will also participate in National Invasive Species Working Group calls when appropriate.

In addition to working with federal partners, park staff will continue to work in close collaboration with regional partners such as the Province of BC, the Columbia Shuswap Invasive Species Society, Canadian Pacific Rail (CPR), Ministry of Transportation and Infrastructure (MOTI) and other relevant partners to coordinate treatment efforts and priorities. All Provincial Watchlist and EDRR species will be reported to the Provincial Invasive Plant Specialist (Appendix C). Where possible, relevant data from MRGNP will be entered into the Provincial IAPP database to facilitate regionally coordinated treatment.

11.0 Project Proponent Requirements for IAP Control

Pre-planning and proper reclamation is a preventative investment in long term health of disturbed sites. The project proponent will be obliged to abide by the requirements for pre-planning, best management practices and post-disturbance reclamation and IAP control described in Appendix F. The overall goal at any project-related disturbed site is the establishment of appropriate, self-sustaining native vegetation

cover which is stable, fully functional and compatible with surrounding vegetation. Generally 90% species appropriate native plant cover with no "Watchlist", "Very high' or 'High' priority IAP can be considered successful site reclamation.

12.0 Resources and Relevant Directives and Acts

The following Acts, Directives, BMPs and Guiding Principles are all relevant to the principals and application of the IPMP:

- Canada National Parks Act and its regulations. 2000. Amendments to 2007.
- Canadian Environmental Assessment Act. 2012.
- Parks Canada Agency Act. 1998. Amendments to 2015.
- Parks Canada Management Directive 2.4.1, Integrated Pest Management. 1998.
- Parks Canada Management Directive 2.4.2 on Impact Assessment. May 1998.
- Parks Canada Guiding principles and Operational Policies. 1994.
- Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas. 2008.
- BC Integrated Pest Management Act and IMP Regulations. Amendments to 2008.
- An Invasive Species Strategy for Canada. 2004.
- Pest Control Product Act and Regulations. 2002.
- BC Environmental Management Act. 2003. Spill Reporting Regulation. Item # 19
- Fisheries Act. 1985. Amendments to 2016.
- Parks Canada Directive on Impact Assessment. 2015.
- Best Management Practice 01.00. Vegetation Removal. MRGNP. 2015.
- Best Management Practice 06.00. Roadway, Highway, Parkway and Related Infrastructure. 2015.

12.0 References

International Union for Conservation of Nature (IUCN). 2011. Invasive Species. http://www.iucn.org/about/union/secretariat/offices/iucnmed/iucn_med_programme/species/invasive_species/ Accessed: November 24, 2015.

Kellner, M. 2015. Revelstoke Riparian Restoration Project W-F15-01. Kingbird Biological Consultants LTD.

McGeoch, M. A., Genovesi, P., Bellingham, P., Costello, M. J., McGrannachan, C. and Seppard, A. 2015. Prioritizing species, pathways, and sites to achieve conservation targets for biological invasion. Biological Invasions: 1-16

Michalsky, S. 2007. Invasive exotic plant assessment and ranking for the montane bioregion National Parks. Report for Parks Canada. pp.52.

Ministry of Forests, Lands and Natural Resource Operations (FLNRO). 2015. Biocontrol Agent on Invasive Plant Matrix. https://www.for.gov.bc.ca/hra/plants/Agent-Plant_Matrix.htm

Ministry of Forests, Lands and Natural Resource Operations (FLNRO). 2014. Invasive Plant Pest Management Plan for Provincial Crown Lands in the Southern Interior of British Columbia. https://www.for.gov.bc.ca/hra/Plants/publications/PMPs/FLNR_Southern_Interior_PMP_confirmed.pdf

Pimentel, D., Zuniga, R. and Morrison, D. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics: 52(3): 273-288.

Powell, G.W., Sturko, A., Wikeem, B.M. and Harris, P. 1994. Field Guide to the Biological Control of Weeds in British Columbia. Ministry of Forests. Province of BC.

Range Branch. 2010. Invasive Alien Plant Program Reference Guide: Part 1. Ministry of Forests, Lands and Natural Resource Operations: 51-52

Parks Canada. 2015. Invasive Alien Plant Condition Monitoring Protocol for MRGNP. Parks Canada Agency.

Parks Canada. 2015. MEM Field Protocol for Mount Revelstoke and Glacier National Parks. Parks Canada Agency.

Tannas, S. 2014. Invasive Plant Survey of Glacier and Mount Revelstoke National Parks. Tannas Conservation Services. Produced for Parks Canada Agency.

United Nations Environment Programme (UNEP). 2011. The strategic plan for biodiversity 2011-2020 and Aichi biodiversity targets. Nagoya, Japan. COP Convention on Biological Diversity 10th Meeting. *As found in McGeoch et al 2015.*

Walker, G. 2006. Unique Ecosystems in Mount Revelstoke and Glacier National Parks. Bio-region Program Development Meeting. Parks Canada Agency.

Zavaleta, E. S., and Royval, J. L. 2002. Climate Change and the Susceptibility of U.S. Ecosystems to Biological Invasions: Two Cases of Expected Range Expansion. *As found in*: Wildlife Responses to Climate Change: North American Case Studies. Schneider, S. and T. Root. 2002.

Parks Canada. 2010. Mount Revelstoke and Glacier National Parks of Canada, Roger Pass National Historic Site of Canada, Management Plan 2010.

Zedler, J. B. and Kercher, S. 2004. Causes and Consequences of Invasive Plants in Wetlands: Opportunities, Opportunists and Outcomes. Critical Reviews in Plant Sciences. 23 (5): 431-452.

Appendix A: Priority Invasive Alien Plan List

Categorization of IAP was performed using Michalsky's Priority Ranking Matrix (2007). Information inputs to the matrix (regional distribution, provincial ranking, etc) were updated in 2015 and are reflected in the rankings below. Not all species present in the region or park had a pre-developed ranking profile. These species were categorized according to the best knowledge of IAP ecological characteristics, partner rankings and regional distribution at the time and are denoted by an asterisk (*). Ranking profiles for these species will be developed.

Any IAP species designated as BC Provincial EDRR species that occur in the MRGNP, were automatically lumped into a "Very High" priority category regardless of ranking to reflect coordinated management with the Province.

Grasses (Family Poacea) were eliminated from the management list due to infeasibility of control and difficulty of detection and identification. Unlike the prairies, few habitats within MRGNP the park are invasible grasslands. A list of non-native grasses to the mountain park bio-region is listed in Appendix G.

The IAP "Watchlist" contains any IAP species known to occur in the Columbia-Shuswap Regional District or Montane Bio-region but NOT in MRGNP. EDRR species from the Province of BC and Watchlist species from the CSISS 2013 Operational Plan were also included on the list to enhance partner communication and EDRR response.

VERY HIGH PRIORITY		
Species Latin	**Common**	**Priority**
Hyoscyamus niger	Black henbane	Very high
Hieracium pilosella	Mouse-ear hawkweed	Very high

HIGH PRIORITY		
Species Latin	**Common**	**Priority**
Tanacetum vulgare	Common tansy	High
Lythrum salicaria	Purple loosestrife	High
Linaria dalmatica	Dalmation toadflax	High
Rubus discolor	Himalayan blackberry	High
Euphorbia esula	Leafy spurge	High
Cirsium palustre	Marsh plume thistle	High
Centaurea pratensis	Meadow knapweed	High
Hieracium aurantiacum	Orange hawkweed	High
Centaurea maculosa	Spotted knapweed	High
Hieracium piloselloides	Tall hawkweed	High
Hieracium flagellare	Whiplash hawkweed	High
Centaurea nigra	Black/Lesser knapweed	High
Vicia cracca var albida	Yellow tufted vetch	High
Hieracium maculatum	Mottled hawkweed	High
Juncus effusus	Common rush	High
Hieracium glomeratum	Yellow devil hawkweed	High

MODERATE PRIORITY		
Species Latin	**Common**	**Priority**
Vicia cracca	Tufted/ Purple vetch	Moderate
Carum carvi	Caraway	Moderate
Lathyrus sylvestris	Flat pea/ Narrow leaved peavine	Moderate
Sonchus oleraceus	Annual/ Common sowthistle	Moderate
Cirsium vulgare	Bull thistle	Moderate
Cirsium arvense	Canada thistle	Moderate
Arctium minus	Common/ Lesser burdock	Moderate
Campanula rapunculoides	Creeping bellflower	Moderate
Rumex crispus	Curled dock	Moderate
Centaurea diffusa	Diffuse knapweed	Moderate
Galeopsis tetrahit	Hemp nettle	Moderate
Cynoglossum officinale	Hound's-tongue	Moderate
Hieracium praealtum	King devil hawkweed	Moderate
Leucanthemum vulgare	Oxeye daisy	Moderate
Sonchus arvensis	Perennial/ Field sowthistle	Moderate
Digitalis purpurea	Purple foxglove	Moderate
Matricaria maritime (perforata)	Scentless chamomile	Moderate
Rumex acetosella	Sheep sorrel	Moderate
Caragana arborescens	Siberian peashrub	Moderate
Potentilla recta	Sulphur cinquefoil	Moderate
Ranunculus acris	Tall buttercup	Moderate
Melilotus alba	White sweetclover	Moderate
Hieracium caespitosum	Meadow hawkweed	Moderate
Melilotus officinalis	Yellow sweetclover	Moderate
Linaria vulgaris	Yellow toadflax	Moderate
Crepis tectorum	Annual/ Narrowleaf hawksbeard	Moderate
Hesperis matronalis	Dames rocket	Moderate
Erucastrum gallicum	Dog Mustard	Moderate
Asparagus officinalis	Garden asparagus	Moderate
Gnaphalium uliginosum	Marsh cudweed	Moderate
Hypochaeris radicata	Hairy cat's ear	Moderate
Lactuca serriola	Prickly lettuce	Moderate
Lappula squarrosa	European stickseed	Moderate
Silene pratensis	Evening campion	Moderate
Sonchus asper	Spiny sowthistle	Moderate
Artemisia absinthium	Wormwood	Moderate

LOW PRIORITY		
Species Latin	**Common**	**Priority**
Silene cucubalis	Bladder campion	Low
Brassica kaber	Wild mustard	Low
Cichorium intybus	Chicory	Low
Taraxicum officinale	Common dandelion	Low
Plantago major	Broad leaved plantain	Low
Vaccaria pyramidata	Cow-cockle	Low
Plantago lanceolata	Narrowleaf plantain	Low
Myosotis arvensis	Field forget-me-not	Low
Brassica campestris	Canola	Low
Tragopogon dubius	Yellow salsify	Low
Verbascum thapsus	Common mullein	Low
Trifolium aureum	Yellow clover	Low
Polygonum persicaria	Lady's thumb	Low
Chenopodium album	Lamb's quarters	Low
Dianthus deltoides	Maiden pink	Low
Maticaria matricarioides or discoidea	Pineapple weed	Low
Trifolium pratense	Red clover	Low
Spergularia rubra	Red sandspurry	Low
Capsella bursa-pastoris	Shepherd's purse	Low
Potentilla argentea	Silvery cinquefoil	Low
Hypericum perforatum	St. John's wort	Low
Thlaspi arvense	Field pennycress	Low
Trifolium repens	White clover	Low
Erysimum cheiranthoides	Wormseed mustard	Low
Medicago sativa	Alfalfa	Low
Trifolium hybridum	Alsike clover	Low
Neslia paniculata	Ball mustard	Low
Lotus corniculatus	Birds-foot trefoil	Low
Medicago lupulina	Black medic	Low
Astragalus cicer	Chick-pea milk-vetch	Low
Brassica napus	Winter Rape	Low
Mycelis muralis	Wall lettuce	Low
Rudbeckia hirta	Black-eyed Susan	Low
Anthyllis vulneraria	Common kidney vetch	Low
Silene csersei	Balkan catchfly	Low
Pisum sativum	Garden pea	Low*
Solidago canadensis	Canada goldenrod	Low*
Linum usitatissimum	Common flax	Low*
Potentilla norvegica	Rough cinquefoil	Low*
Prunella vulgaris	Self-heal	Low*
Rumex obtusifolius	Bitter dock	Low*
Lactuca canadensis	Canadian wild lettuce	Low*
Veronica officinalis	Common speedwell	Low*
Euphrasia canadensis or nemorosa	Common eyebright	Low*
Ranunculus repens	Creeping buttercup	Low*

Malus pumila	Cultivated/ Paradise apple	Low*
Iris sp.	Iris species	Low*
Lamium maculatum	Spotted dead-nettle	Low*
Clinopodium vulgare	Wild basil savory	Low*

WATCHLIST NOT FOUND IN MRGNP		
Abutilon theophrasti	Velvetleaf	Watchlist*
Aegilops cylindrica	Jointed Goatgrass	Watchlist
Alchemilla spp.	Lady's mantle	Watchlist
Alliaria petiolata	Garlic Mustard	Watchlist*
Anchusa officinalis	Common bugloss	Watchlist
Anthriscus caucalis	Bur Chervil	Watchlist
Arabis glabra	Tower Mustard	Watchlist
Arabis lyrata	Lyrate/Lyre-leaved rockcress	Watchlist
Berteroa incana	Hoary alyssum	Watchlist
Bromus japonicus	Japanese brome	Watchlist
Bromus tectorum	Downy brome	Watchlist
Butomus umbellatus	Flowering Rush	Watchlist*
Cardaria sp.	Hoary Cress	Watchlist
Carduus acanthoides	Plumeless thistle	Watchlist
Carduus nutans	Nodding thistle	Watchlist*
Cenchrus longispinus	Longspine sandbur	Watchlist*
Centaurea macrocephala	Bighead knapweed	Watchlist*
Centaurea solstitialis	Yellow Starthistle	Watchlist
Centaurea virgata ssp squarrosa	Squarrose knapweed	Watchlist*
Centurea scabiosa	Greater knapweed	Watchlist*
Cerastium vulgatum or fontanum	Mouse-ear/ Field Chickweed	Watchlist
Chelidonium majus	Greater celandine	Watchlist*
Chondrilla juncea	Rush skeletonweed	Watchlist
Clematis tangutica	Yellow clematis	Watchlist*
Convolvulus arvensis	Field bindweed	Watchlist
Conyza canadense	Canadian flea-bane; Canadian horseweed; Horseweed	Watchlist
Crupina vulgaris	Crupina	Watchlist
Cuscuta spp.	Dodder	Watchlist
Cyperus esculentus	Yellow Nutsedge	Watchlist
Cyperus rotundus	Purple Nutsedge	Watchlist
Cytisus scoparius	Scotch broom	Watchlist*
Datura stramonium	Jimsonweed	Watchlist*
Dianthus aremeria	Deptford pink	Watchlist
Dipsacus fullonum	Teasel	Watchlist*
Echium vulgare	Blueweed; Viper's bugloss	Watchlist
Elymus repens	Creeping wildrye; Quackgrass	Watchlist
Euphorbia cyparissias	Cypress spurge	Watchlist*
Fallopia sachalinensis	Giant Knotweed	Watchlist*
Fallopia x bohemica	Bohemian Knotweed	Watchlist*
Galium verum	Yellow bedstraw	Watchlist*
Geranium pratense	Meadow cranesbill	Watchlist

Glyceria maxima	Giant Mannagrass / Reed Sweetgrass	Watchlist
Gypsophila paniculata	Baby's Breath	Watchlist*
Heracleum mantegazzianum	Giant Hogweed	Watchlist*
Impatiens glandulifera	Policemen's helmet	Watchlist*
Iris pseudacorus	Yellow Flag Iris	Watchlist*
Isatis tinctoria	Dyer's Wood	Watchlist*
Knautia arvensis	Field scabious	Watchlist
Lepidium latifolium	Perrenial pepperweed	Watchlist*
Mirabilis nyctaginea	Wild Four 'O Clock	Watchlist*
Onopordum acanthium	Scotch thistle	Watchlist*
Oxycoccus macrocarpus	American cranberry	Watchlist
Petasites japonica var giganteus	Japanese butterbur	Watchlist*
Phragmites australis subsp. australis	Common Reed	Watchlist*
Polygonum cuspidatum	Japanese knotweed	Watchlist*
Polygonum polystachyum	Himilayan Knotweed	Watchlist*
Rhaponticum repens	Russian knapweed	Watchlist
Robinia pseudoacacia	Black locust	Watchlist*
Salsola kali	Russian thistle	Watchlist
Salvia nemorosa	Woodsage	Watchlist*
Senecio jacobaea	Tansy Ragwort	Watchlist*
Silene alba	Nightflowering Catchfly; Sticky cockle; Nightflowering silene	Watchlist
Silene latifolia	White cockle	Watchlist
Silybum marianum	Milk Thistle	Watchlist
Solanum dulcamara	Bittersweet Nightshade	Watchlist*
Solanum rostratum	Buffalo Bur	Watchlist*
Sonchus uliginosus	Smooth perennial sowthistle	Watchlist
Symphytum officionale	Common comfrey	Watchlist
Taraxacum laevigatum	Red-seeded/Rock dandelion	Watchlist
Tragopogon pratensis	Meadow goat's beard	Watchlist
Tribulus terrestris	Puncturevine	Watchlist*
Tussilago farfara	Coltsfoot	Watchlist*
Ulex europaeus	Gorse	Watchlist*
Ventenata dubia	North Africa Grass	Watchlist
Veronica serpyllifolia	Thyme-leaved speedwell	Watchlist
Zygophyllum fabago	Syrian bean caper	Watchlist*

Appendix B: Map Layer Definitions and Associated Meta-data

Data for the IAPMP Map came from the Ecological Land Classification (ELC), Vegetation Resource Inventory (VRI) and ACS Avalanche paths layer. The following sections detail what map components make up each Ecological Zone.

Integrated Control Zone

To define the ICZ, various buffers were created around linear features to capture their potential as vectors of IAP spread. High traffic vectors with large right-of-ways (TCH and rail lines) were buffered by 25 meters while smaller roads with smaller right-of-ways were buffered by 10 meters. Due to high human traffic (a potential vector for IAP spread) around front-country facilities, these were buffered by a 100 m radius.

- 25 M buffer around TCH
- 25 M buffer around CPR (aboveground)
- 10 M buffer all other roads (MIS, Fidelity, CPR Access, etc)
- 100 M buffer around Frontcountry Facilities

Ecological Protection Zone

The following ecological features were included in the EPZ as they were highlighted in the MRGNP 2010 Park Management Plan and generally contain unique vegetation communities:

Subalpine/ Alpine
ELC Subalpine[2]
VRI Alpine[3]

Avalanche paths
ACS Avalanche layer[4]
ELC Vegetation Associated with Avalanche Paths[5]
VRI Avalanche Modifying Process (Only MRNP)[6]

Wetlands
ELC Wetlands[7]
VRI Wetlands[8]

Rare Plants
25m buffer was included around all documented rare plant locations[9]

Enhanced Control Zone

The ECZ consists of anything not in the ICZ or EPZ.

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[2] ELC layer, heading: "GVEGETN" layer to get vegetation associations with subalpine habitat (H2, H16, H18, L5). Included all categories containing any these classification Note: Predominate veg types are listed first with subdominant types following
[3] VRI layer, heading: "BCLCS_LE_2", sites containing "A" for Alpine
[4] Avi_paths.kmz in Geomatics-> Layers -> Avalanche. Only roadsides, only GNP along TCH.
[5] ELC layer, heading: "GVEGETN" Associated with Avalanche Paths (AV4, AV5, AV6, S13, S15)
[6] VRI layer, heading "MODIFYING_" Avalanche Modifying Process (Only MRNP)
[7] ELC layer, heading: "GVEGETN" Associated with Wetlands (O23, H8 and S17)
[8] VRI layer, heading: "BCLCS_LE_2", sites containing "W" for Wetland
[9] Z:\ResCon-Revelstoke\Fire & Vegetation\Rare Plants and SAR\All rare vascular plants

Appendix C: Protocol for Specimen Collection and Identification

Key Contacts:

Catherine MacRae, P. Ag.
Invasive Plant Specialist
MFLNRO
1907 Ridgewood Road
Nelson, BC V1L 6K1
250 825-1159
Catherine.MacRae@gov.bc.ca

Dr. Ken Marr, Ph.D.
Curator of Botany
Royal Museum of BC
675 Belleville Street
Victoria BC V8W 9W2
Tel: 250-356-7226
KMARR@royalbcmuseum.bc.ca

If you are unable to identify a potentially invasive plant through regular means, contact Dr. Ken Marr and/ or Catherine MacRae with photos, location and description of unknown plant. If they are willing to assess the plant and request a sample follow the steps below:

HERBARIUM VOUCHER COLLECTION METHODS

Herbarium Methods provided by the Curator of Botany, Royal B.C. Museum.

1. Unless otherwise specified, collect underground parts, fruits and flowers. Press until dry.
2. Standard Plant Press: 46cm x 30cm (18”x12”); consists of corrugated cardboard sheets with wooden frames (or plywood) on each end; held together tightly with straps or rope.
3. Specimens are placed in newsprint and then pressed between corrugates. Place in warm place with air circulation. Change cardboard daily until dry (if no access to drier).
4. Standard Herbarium Mounting Paper: 41cm x 28cm (16”x11”). Specimens should be no larger than the dimensions of the paper.
5. Information to include on label:
    - Date
    - Collector(s) name and phone number
    - UTM coordinates
    - Location (eg. Vancouver Island; 17km SW of Nanaimo on east side of Hwy 1; north side of exit 5)
    - Habitat description (elevation, soil, aspect, other species, canopy cover, position on landscape, disturbance, density, distribution)
6. Put label information together with specimen(s) and mail in well-protected, cardboard-lined envelope (in original pressing paper is fine) to Dr. Ken Marr and Catherine MacRae.

IF SUSPECTED EDRR SPECIES

Send email to Ken Marr (Curator Botany, RBCM): KMARR@royalbcmuseum.bc.ca AND Becky Brown (Invasive Plant Specialist – Provincial EDRR Coordinator, FLNR): Becky.N.Brown@gov.bc.ca with the following information:

- Preliminary sample ID
- Indicate if species Prohibited weed and/or rapid verification required
- Indicate if sender wants to be notified of verification
- Date sample in the mail
- Indicate whether sample is to be gifted to museum or returned to sender

Appendix D: Planting Criteria for Re-vegetation in MRGNP

Mount Revelstoke & Glacier National Park
Planting Criteria – Internal and External Expectations
Adapted from Danielle Backman 2011

The following guidelines have been adapted from BC Ministry of Environment and Department of Fisheries and Oceans planting criteria, in conjunction with restoration expectations from Mt Revelstoke & Glacier (MRG) national parks. Restoration species should be appropriate for the environment where they are being planted to meet the local ecosystem requirements, i.e. replanting a riparian area with species that were present in the same locale prior to disturbance.

- All tree and shrub species should be native to the local area and where available, guaranteed nursery stock for successful transplanting.
- Purchased plant stock should be a minimum of 2 years old, and if transplanting an entire area, planted no greater than 2.0 meters apart for all stock.
- Salvage native plants wherever possible for replanting of the disturbed area, which can also be counted as replacement vegetation.
- For the replacement of individual trees, such as a danger or hazard tree, please refer to the British Columbia Provincial Tree Replacement Criteria. For individual shrub replacement, two shrubs should be replanted for each shrub removed; no replacement of shrubs for trees.
- Fruiting trees and shrubs should be planted where appropriate (avoid areas where human/wildlife conflict is likely) to promote re-colonization by seed and provide wildlife food sources.
- Stock should be planted in the fall (September to October) or spring (March to April) depending on local conditions.
- **To ensure success of the transplants, at least 90% should survive within the first year of planting.**
- Additional fertilizing, dedicated watering and/or replanting may be required to establish vigorous vegetative cover throughout the first year of growth.
- Coniferous trees should comprise not less than 10% or more than 25% of the tree stock planted.
- The botanical name should be used when ordering stock to ensure that the desired native species is being purchased. Each specimen should be tagged with the botanical name and the tag should be left attached after planting.
- Tree stock should be a minimum of 1.2 metres (4 feet) in height when purchased and planted 1.5 to 2 metres apart.
- A list of non-native grasses to the Montane Bio-region is available in Appendix G.

Approved and Recommended Seed Mix for MRG National Park:

Elymus trachycaulus / slender wheatgrass (25%)
Deschampsia caespitose / tufted hairgrass (15%)
Poa alpine / Alpine Bluegrass (13%)
Elymus glaucus / Blue Wild Rye (25%)
Festuca saximontana / Rocky Mountain fescue (22%)

Suggested Planting Layout
The planting layout will depend on what is required to re-establish or enhance existing vegetation, species selected, density of plants, mature plant heights and planting system: linear, random, grid, etc. Typical planting densities recommended are 1 plant per 1 meter^2. For site specific advice on plant selection and/or layout, please consult with a qualified professional or other knowledgeable source. Ensure that area is flagged off to ensure that new seedlings are not impacted by ground disturbance.

Seed Certificates
A seed certificate must be provided by the supplier when purchasing seed for use in the Park. This information should be provided to vegetation staff for approval prior to purchase. Information on how to check and approve seed certificates, as well as a list of current MRG seed suppliers can be found here: **Z:\ResCon-Revelstoke\Fire & Vegetation\Seed Mix- MRG Approved**

Ground Seeding
Growth of ground cover after seeding reduces surface erosion, enhances soil absorption and stability, as well as promotes establishment of newly planted trees and shrubs. For optimal germination, seeding should occur in the spring or fall. However, when used as an erosion control measure, seeding is suitable anytime within the growing season to protect disturbed soils.

Whether planting is scheduled immediately or not, seed should be placed on any disturbed soils that will lie dormant for a period of time. Laying mulch will further reduce erosion as well as enhance germination by protection of the seeds and retaining moisture. Additional information about site seeding and restoration, including seed and mulch application rates, can be found in Section 10 of the Roadway, Highway, Parkway and Related Infrastructure BMP.

Soil Amendments
Where soil quality in the targeted area is poor, soil amendments that are certified “weed-free should be utilized. Depending on soil properties, soil amendments can include, but are not limited to; topsoil, straw, gypsum, mulch or approved fertilizer or neutralizer. Top-soil should be sourced from a reputable source and the supplier’s contact information must be included in the final report/contract documents/memo to the park.

Structural Guidelines
Wherever a development site will result in land clearing activities, the opportunity exists to salvage and translocate structural materials (i.e. downed wood, stumps, mossy rocks, vascular plants, non-vascular plants) into the remaining environmentally sensitive areas. These key forest floor features provide a diversity of habitats for both invertebrates and vertebrate species. Consult with EIA Coordinator prior to moving or translocating materials to avoid transmission of forests pests and disease.

Appendix E: Invasive Alien Plant Treatment Monitoring Sheet

All IAPP data forms are available here: https://www.for.gov.bc.ca/hra/plants/IAPPforms.htm

Chemical & Mechanical Monitoring Record

Entered into IAPP (YYYY-MM-DD):	By:	Assigned Monitoring IDs recorded on this form: ☐

Inspection Record I

Inspection Date (YYYY-MM-DD): *	Site ID: *	Treatment ID: (ID of the treatment being monitored)	Monitoring ID: (Assigned at Data Entry)
Agency: *	Surveyor:		Monitoring Paper File ID:
Activity: * ☐ Chemical Mon. ☐ Mechanical Mon.	Compliance:		Efficacy Rating: (1-9)
Target Invasive Plant Species *	Comments:		

Inspection Record II

Inspection Date (YYYY-MM-DD): *	Site ID: *	Treatment ID: (ID of the treatment being monitored)	Monitoring ID: (Assigned at Data Entry)
Agency: *	Surveyor:		Monitoring Paper File ID:
Activity: * ☐ Chemical Mon. ☐ Mechanical Mon.	Compliance:		Efficacy Rating: (1-9)
Target Invasive Plant Species *	Comments:		

Inspection Record III

Inspection Date (YYYY-MM-DD): *	Site ID: *	Treatment ID: (ID of the treatment being monitored)	Monitoring ID: (Assigned at Data Entry)
Agency: *	Surveyor:		Monitoring Paper File ID:
Activity: * ☐ Chemical Mon. ☐ Mechanical Mon.	Compliance:		Efficacy Rating: (1-9)
Target Invasive Plant Species *	Comments:		

Inspection Record IV

Inspection Date (YYYY-MM-DD): *	Site ID: *	Treatment ID: (ID of the treatment being monitored)	Monitoring ID: (Assigned at Data Entry)
Agency: *	Surveyor:		Monitoring Paper File ID:
Activity: * ☐ Chemical Mon. ☐ Mechanical Mon.	Compliance:		Efficacy Rating: (1-9)
Target Invasive Plant Species *	Comments:		

* *indicates mandatory field*

Appendix F: Project Proponent Requirements for Reclamation and IAP Control

Project Proponent Requirements: Site Reclamation and Control of Invasive Alien Plants

Document shared with permission from BNP and tailored to MRGNP

Scope

This document applies to any project proposed within the Mount Revelstoke and Glacier National Park Boundaries that has a likelihood of disturbing soil and/ or creating a disturbed site.

Background

Proper reclamation is a preventative investment in long term health of disturbed sites. Pre-disturbance planning and timely post-disturbance reclamation can lead to the best outcomes.

Issues:

- Invasive Alien Plants (IAP) may be introduced through contaminated equipment.
- Loss of topsoil and lack of reintroduction of a growing medium for native plant species often leads to invasive alien plant colonization.
- Sites may be prone to erosion and slope stability post-disturbance prior to successful reclamation.

Obligations of Project Proponent

The project proponent will be obliged to abide by these requirements for pre-planning, best management practices and post-disturbance reclamation and invasive alien plant control.

1) Pre-planning:
   - Prepare a reclamation plan prior to construction;
   - Conduct a site inspection prior to developing site-specific reclamation recommendations;
   - Evaluate the worksite for invasive plants before soil disturbance begins,
   - Conduct herbicide application and/or mechanical control of IAP prior to work start,
   - Order sufficient quantities of MRG approved seed mix, and;
   - Prevent the introduction of IAP through thorough cleaning of equipment before it is delivered to the worksite.

2) Best Management Practices

   Prior to and during initiation of project works the following principals and general guidelines should be followed:

   - Minimize footprint of site disturbance;
   - Salvage topsoil/ sod from site for reclamation purposes;
   - Re-seed with MRG approved seed mix and native plant species at the earliest possible post-disturbance time;
   - If sod is not available, introduction of sterile organic soils may be required at sites with mineral soil to improve native seed germination capability and prevent habitat only suitable to invasive species;

- Where shrubs are desirable, native shrub stakes should be planted to reduce availability of disturbed ground for IAP colonization;
- Minimize new introduction of IAP through thorough cleaning of all equipment before moving equipment on and between sites (this includes equipment ranging from hand tools to large excavators);
- Early detection and rapid response to IAP in the first three growing seasons post construction to prevent the establishment of IAP seed bed;
- Large multi-year projects (ie highway construction) require IAP control during construction to prevent IAP seed bed establishment.

The following BMPs will apply to site reclamation in Mount Revelstoke and Glacier National Park:

- Best Management Practices for Tree Removal
- EA Guidelines for Trail Maintenance for MRG
- Best Practices for Parks Canada Trails
- MRG Planting Criteria (Appendix D)
- Roadway, Highway, Parkway and Related Infrastructure
- Best Management Practices for Vegetation Removal (MRG)

3) Post Disturbance Reclamation and Invasive Plant Control
Consistent with practices of Mountain National Parks, the Project Proponent will provide for the costs of monitoring seed germination, native plant establishment and remediation of invasive plants for 3 years following project initiation. Site reclamation, including seed germination and IAP control, will be part of the performance bond of the proponent of the project. Staff or subcontractors will be provided by the proponent to carry out these activities. The following details the yearly project requirements:

Years 1-3 Post-Disturbance Reclamation
Activities in Years 1-3 will include:

- Monitoring for grass seed germination and native plant establishment at site
- Monitoring for 'Watchlist', 'Very High', and 'High' IAP (Appendix A)
- Control of IAP through means described in this IAPMP
- Bagging and removing invasive plants that are at or post-flowering stage to prevent seed distribution and seed bed development.

Outcomes
The outcomes associated with following this protocol consist of the establishment of appropriate, self-sustaining native vegetation cover which is stable, fully functional and compatible with surrounding vegetation. Generally 90% species appropriate native plant cover with no "Watchlist", "Very high' or 'High' priority IAP can be considered successful site reclamation.

Appendix G: Non-native grasses to the Montane Park Bio-Region

These species were listed in Michalsky 2007 and appear on mountain park non-native plant lists with their corresponding priority ranking. Species listed in bold were specifically listed and ranked for MRGNP.

Non-native grasses to the Montane Park Bio-Region			
Common Name	Latin Name	Species Rank	MRGNP Rank
smooth brome	***Bromus inermis***	**Mod**	**Mod**
timothy	***Phleum pratense***	**Mod**	**Mod**
crested wheat grass	***Agropyron pectiniforme***	**Mod**	**Mod**
quack grass	***Agropyron repens***	**Mod**	**Low**
wild oat	***Avena fatua***	**Low**	**Low**
orchard grass	***Dactylis glomerata***	**Mod**	**Low**
red fescue	***Festuca rubra***	**Low**	**Mod**
perennial ryegrass	***Lolium perenne***	**Low**	**Low**
Kentucky bluegrass	***Poa pratensis***	**Low**	**Low**
green Foxtail	***Setaria viridis***	**Low**	**Mod**
colonial bentgrass	***Agrostis tenuis***	**Low**	**Low**
early hairgrass	***Aira praecox***	**Low**	**Low**
downy brome / cheatgrass	*Bromus tectorum*	High	N/A
sheep fescue	*Festuca ovina*	Mod	N/A
meadow fescue	*Festuca pratensis*	Mod	N/A
annual bluegrass	*Poa annua*	Mod	N/A
Canada bluegrass	*Poa compressa*	Mod	N/A
tall fescue	*Festuca arundinacea*	Mod	N/A
awnless or smooth brome	*Bromus inermis ssp. inermis*	Mod	N/A
Japanese chess	*Bromus japonicus*	Mod	N/A
Italian ryegrass	*Lolium multiflorum*	Mod	N/A
canary grass	*Phalaris canariensis*	Mod	N/A
Canada bluegrass	*Poa compressa*	Mod	N/A
crested wheatgrass	*Agropyron cristatum ssp. pectinatum*	Mod	N/A
Kentucky bluegrass	*Poa pratensis ssp. pratensis*	Mod	N/A
meadow brome	*Bromus commutatus*	Low	N/A
sainfoin	*Onobrychis viciifolia*	Low	N/A
soft chess	*Bromus mollis*	Low	N/A
rye-brome	*Bromus secalinus*	Low	N/A
barnyard-grass	*Echinochloa crus-galli*	Low	N/A
bulbous bluegrass	*Poa bulbosa*	Low	N/A

Appendix H: Project Component Schedule for Delivery of IAP Program

Component	Schedule	Resource	Funding	Comments
Management Effectiveness Monitoring	Yearly as Required	Resource Conservation Staff	A-Based Operations	Transect based, used to assess effectiveness of specific applied treatments
Environmental Assessment Mitigations	Yearly as Required	Resource Conservation Staff or Contract	Project Proponent	Site survey
Condition Monitoring	5 year Cycle/ Offset with Roadside Survey	Contract	Capital Projects	Random stratified transects, condition measure in forest indicator
Detailed Roadside Survey	5 year Cycle/ Offset With Condition Monitoring	Contract	Capital Projects	Assist with management decision making; Identify Watchlist Species
Detailed Trail Survey	5 year Cycle	Resource Conservation Staff	A-Based Operations	Assist with management decision making
Detailed Sensitive Site Survey	Yearly as Required	Resource Conservation Staff	A-Based Operations	Includes sites such as Meadows in the Sky trails and Beaver Fen
Planning and Active Management	Yearly as Required	Resource Conservation Staff or Contract	A-Based Operations/Capital Projects	Mowing/pulling/steaming/herbicide application