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MEMORANDUM

TO: **Nechako Water Engagement Initiative Technical Working Group**
FROM: **Nicole Wright, Ph.D., PWS, P.Geo., Ecofish Research Ltd.**
DATE: **December 7, 2022**
FILE: **1316-09**

RE: **Review of Flow Effects on Nechako River Reed Canarygrass**

1. INTRODUCTION

During Main Table and Technical Working Group (TWG) meetings of the Nechako Water Engagement Initiative (WEI), concerns were raised about potential effects of reed grass on fish and wildlife habitat and whether there is a linkage between Rio Tinto (Alcan) operations and the growth and distribution of reed grass. Anecdotal field observations report the presence of abundant tall grasses growing along channel margins and side channels. Its rapid and dense growth, particularly reed canarygrass (*Phalaris arundinacea*), is a growing cause of concern to the health and functioning of riparian and wetland habitats. This issue can affect fish and wildlife using side channel, riparian, and wetland habitats where reed canarygrass can become the dominant species. The TWG asked Ecofish Research Ltd. (Ecofish) to review literature and summarize the status of current knowledge of reed grass.

This memo provides an overview of reed canarygrass, including its potential effects on fish, wildlife, riparian, and wetland habitats. It also examines flow related effects to the growth and distribution of reed canarygrass and offers practicable recommendations or next steps to inform water management decisions and minimize any negative effects of operational flows on reed canarygrass growth in the Nechako River.

2. BACKGROUND

The grasses of concern observed along channel margins and side channels of the Nechako River have been commonly referred to as "reed canarygrass". Until recently, these grasses have not been identified to species, although as part of this assessment the species reed canarygrass (*Phalaris arundinacea*) has been confirmed along the river (see results). Nonetheless, this issue could apply to one or more species of grass, some of which may be native (e.g., native common reed, *Phragmites australis spp. americanus*) and some invasive (e.g., European common reed, *Phragmites australis spp. australis*).

Reed canarygrass has not been studied in the Nechako River. General information about this species in BC is available, including information about managing the distribution and abundance, and this geographically-broad information has been relied upon for this memo.

2.1. Geographic Scope

This issue concerns the impacts of reed canarygrass growth in the margins and riparian areas of the mainstem and side channels of the Nechako River, from the Skins Lake Spillway downstream, with particular interest between Cheslatta falls and Vanderhoof. The issue also concerns any adjacent wetlands hydrologically connected to the Nechako River.

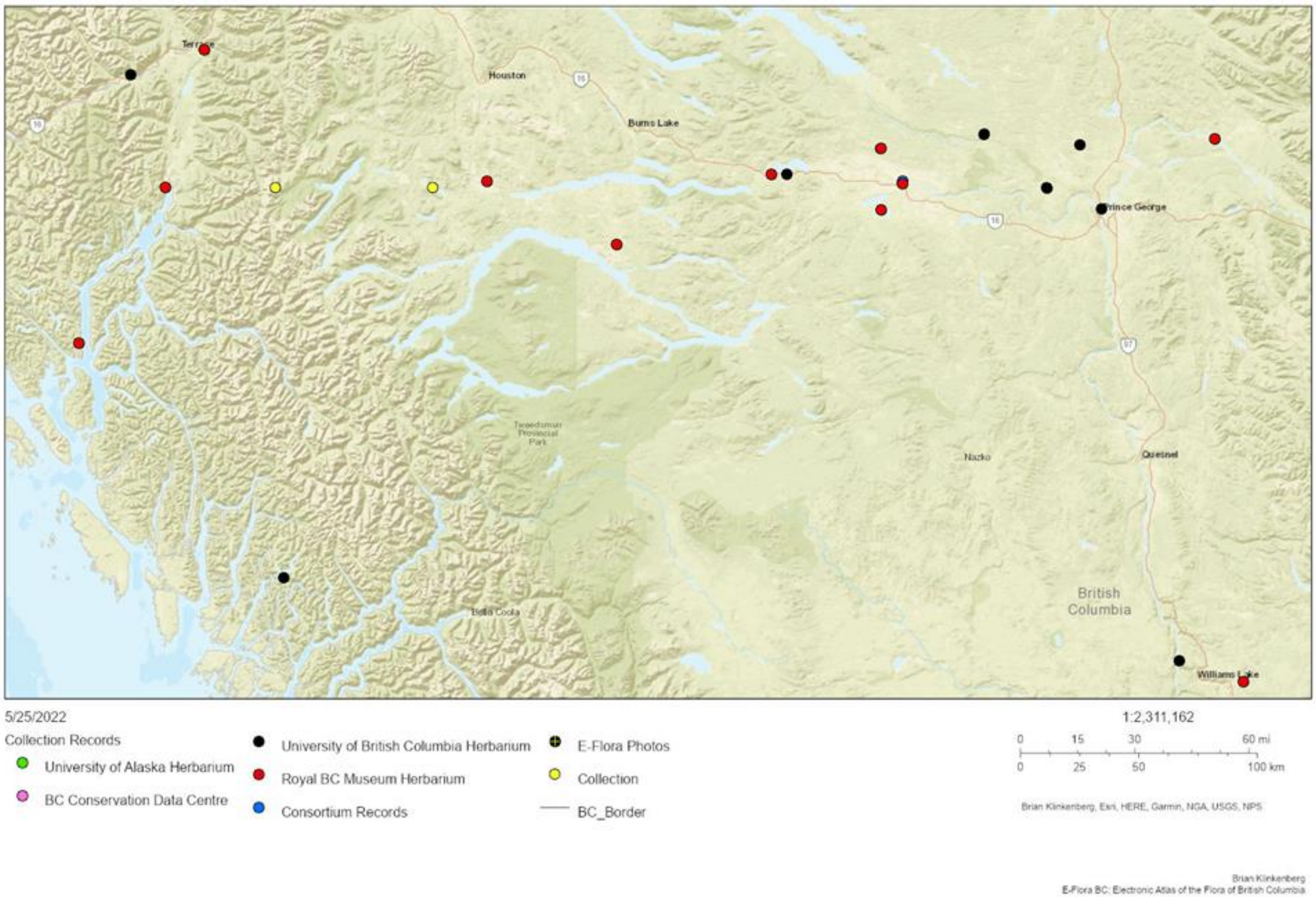
2.1. Reed Canarygrass Status and Distribution

Reed canarygrass is a circumboreal species (Larson 1993). In North America, reed canarygrass is common throughout most of Alaska and Canada as well as all but the south-east part of the USA. It is listed as native in North America by the United States Department of Agriculture (USDA 2010) but is considered an exotic species in British Columbia (CDC 2022). Cultivated varieties were brought in from Europe for ornamental use, erosion control, and as pasture grasses in the central and western regions of the continent (Inasive.org 2009). This mixture of native and introduced types has resulted in debate about the origins of the species and invasiveness in some regions (Merigliano and Lesica 1998), especially where it appears to be undergoing a large expansion in range and density (Maurer and Zelder 2002).

Reed canarygrass occurs across the province, and more commonly in the southern regions from Vancouver Island to the Okanagan (Pojar and MacKinnon 1994). It is known to occur near Vanderhoof but may be present elsewhere along the Nechako River and its tributaries. The distribution of reed canarygrass near the Nechako River documented by E-Flora BC is shown in Figure 1.

Reed canarygrass inhabits a wide range of elevations and sites. It generally prefers low elevation, wet and poorly drained sites and may be found in river channel margins, ditches, along edges of ponds and lakes, and in marshlands, wet meadows, and riparian areas (Weinmann *et al.* 1984). It can also be found in waste places, perennial crops, and in some upland sites (e.g., in Washington State; Harrison *et al.* 1996).

Figure 1. Documented occurrences of reed canarygrass near the Nechako watershed (Klinkenberg 2022).



2.2. Reed Canarygrass Biology and Habitat Requirements

Reed canarygrass is a cool season perennial grass species with long, noticeable creeping rhizomes and hollow stems. It has wide and flattened leaves, slightly hairy in appearance, and three flowered spikelets. The species is illustrated in Figure 2 and pictured in Figure 3. There are two subtaxa present in BC: *Phalaris arundinacea var. arundinacea* and *Phalaris arundinacea var. picta*. It can be confused with bluejoint reedgrass (*Calamagrostis canadensis*), a native species, which is also widespread in BC and found in similar habitats as reed canarygrass. Bluejoint reedgrass has blueish-green coloured leaves with hairs (Klinkenberg 2022), and stems have distinct dark purple joints (Anderson 2012).

Figure 2. Illustration of reed canarygrass (Douglas *et al.* 1999).

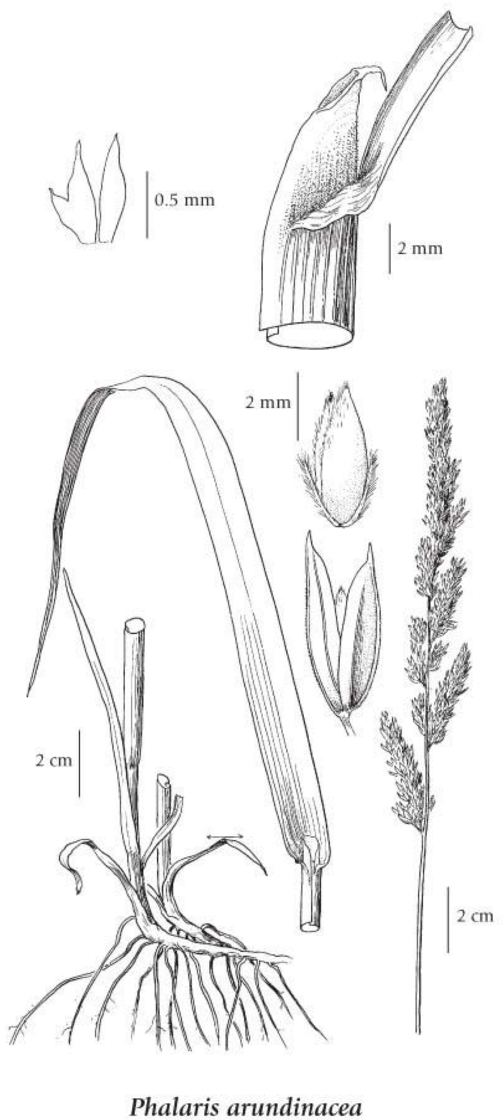


Figure 3. Reed canarygrass in a marsh.

2.2.1. Reproductive Biology

Reed canarygrass is tolerant of freezing and emerges in May, June and July in the Pacific Northwest (Weinmann *et al.* 1984). Growth and productivity peak twice during the growing season, first in late spring and again in late summer. Leaf and flower growth dominate in the spring and stem and rhizome growth dominate during the late summer peak.

Reed canary reproduces sexually by seed production or vegetatively by means of dense rhizome (underground horizontal stems) and shoot (or tiller) growth (White *et al.* 1993; Gifford *et al.* 2002). The seeds can germinate immediately upon maturation or they can germinate after one year of dormancy (Apfelbaum and Sams 1987). It spreads by creating new plants from existing plants by running roots across or under the ground (stolons or rhizomes, respectively), creating a dense turf, and will produce roots and shoots from the nodes of freshly cut, well-jointed above ground stems

(Harrison *et al.* 1996). Large quantities of highly mobile seed are produced in the first year of life, and a soil seed bank and permanent rhizome bed quickly build up.

2.2.2. Environmental Requirements

Reed canarygrass generally favours moist to saturated soils for most of the growing season. It can survive in anaerobic (oxygen-free) conditions and is resistant to flooding (for up to two months during the growing season; McKenzie 1951), and to regular flooding cycles (Rice and Pinkerton 1993). Reed canarygrass is also drought tolerant (WRCGMWG 2019), though it does not typically survive in dry uplands.

The species has poor tolerance of high salinity (CABI 2020), though it can survive well in brackish waters. There is evidence to suggest that nutrient enrichment by nitrogen from agricultural runoff improves habitat suitability for reed canarygrass and is contributing to increasing colonization and dominance of this species in wetlands (Green and Galatowitsch 2002).

Reed canarygrass is only moderately tolerant of shade; it prefers full sun. In the Pacific Northwest, it is shaded out by willow (*Salix sp.*), red-osier dogwood (*Cornus stolonifera*), choke cherry (*Prunus virginiana*), sedges (*Carex sp.*), and rushes (*Juncus sp.*) (Harrison *et al.* 1996).

2.2.3. Abundance

Reed canarygrass has been used as a forage source for livestock, fuel, and environmental plantings to treat wastewater and control erosion. These anthropogenic uses have led to the spread of reed canarygrass across landscapes (Galatowitsch *et al.* 1999; Kercher and Zedler 2004; Kidd and Yeakley 2015). After establishing aboveground biomass, reed canarygrass quickly spreads through its belowground root system (Adams and Galatowitsch 2005). It can be found from coastal estuaries to high mountain meadows throughout BC, and is largely associated with rivers, lakes, and wetlands (Klinkenberg 2022).

Reed canarygrass is known to occur in the Nechako River watershed (see Section 2.1, Figure 1). It has been anecdotally reported in abundance along the Nechako River, from Cheslatta Falls to Vanderhoof and beyond along channel margins, islands, and side channels of the Nechako River (Kurtz, pers. comm. 2022; 2022 Figure 4).

Figure 4. Reed canarygrass along the shoreline of the Nechako River at Vanderhoof.

2.2.4. Contributing Factors

Much of the land surrounding the Nechako River is farmed for crops and cattle. Reed canarygrass can exist and thrive in a variety of growing conditions that may result from these land practices, such as increased nitrate (N) in the soil and heavy soil disturbance (Green and Galatowitsch 2002, Kercher and Zedler 2004); it also drought tolerant and can survive in fluctuating water tables (Galatowitsch *et al.* 1999).

Studies on the effects of cattle grazing on the growth and spread of reed canarygrass have mixed results, with some studies showing a reduction in abundance (Kidd and Yeakley 2015) and others little to no change (Paine and Ribic 2002; Hillhouse *et al.* 2010; James *et al.* 2017; Guretzky *et al.* 2018). While the Nature Conservancy found that grazing has little to no impact on reed canarygrass growth and survival, they note that seeds could be spread by adhering to the animals (Invasive.Org 2009).

Several studies have noted positive effects of grazing on slowing the spread of reed canarygrass; though it should be noted that reed canarygrass is not the preferred feed for cattle. A study in northwest Minnesota found that grazing cattle reduced the cover of reed canarygrass in two restored wetland sites, while maintaining or increasing native plant species richness (Cleys 2019). In this study, grazing was found effective at reducing reed canarygrass canopy cover because cattle defoliated the plant, suppressing flower development and reducing or eliminating seed production and spread. Other studies have shown that when reed canarygrass is grazed the plant does not create monoculture stands

(Kidd and Yeakley 2015; James *et al.* 2017). However, the effects of cattle grazing on river banks may be more detrimental to riparian habitat than the reed canarygrass growth (as observed in Kamloops, BC; Van Woudenberg 2000). Another consideration is that other exotic species can increase in abundance when reed canarygrass is removed (James *et al.* 2017).

2.3. Socio-economic and Cultural Context

Culturally, reed canarygrass was used for imbrication (decorative overlap) of coiled cedar-root basketry by some of the Interior Salish people (the Stl'atl'imx or Lillooet and the Nlaka'pamux or Thompson) and the coastal Halkomelem people (Turner 1998). The Okanagan people wove mates and hats from reed canarygrass, as well as bound fish weirs with it (Turner 1998).

Reed canarygrass has been cultivated for hay and planted for livestock forage (Klinkenberg 2022). It has been shown to be effective at erosion control and dune stabilization (CABI 2020). Reed canarygrass is used for water purification in reed bed systems that treat grey water or sewage effluent from municipal and industrial sources. It also has ornamental value as a landscaping plant and for dried flowers, though its planting is not recommended (e.g., Anderson 2012).

3. METHODS

A review of readily available literature, including those of primary (third-party reviewed journal articles), secondary (books), and tertiary (best practice handbooks) sources, was conducted to describe known effects of reed canarygrass on fish and wildlife habitat, particularly riparian and wetland areas, and how changes to water levels and flow influence reed canarygrass growth. The objective of the literature review was to evaluate whether operations can be modified to reduce the growth and spread of reed canarygrass to reduce the impacts to native flora and fauna. In addition to the literature review, local knowledge from TWG members or others has been incorporated. Gaps in knowledge and the limitations of the studies reviewed have been noted.

Secondarily, a sample of grass specimen was collected by Ecofish biologists during other WEI field work from the banks of the Nechako River near Vanderhoof, a location commonly described as being abundant with "reed canarygrass". The sample was identified to species using standard identification keys (Hitchcock and Cronquist 2018).

4. RESULTS

4.1. Species Identification

The sample specimen collected from the banks of the Nechako River appeared representative of the broader grass community and was positively identified as reed canarygrass (*Phalaris arundinacea*) or a hybrid thereof.

4.2. Current Level of Knowledge

4.2.1. Effects of Reed Canarygrass on Habitats

Reed canarygrass has negative impacts on habitats, wetland and riparian plant species and plant communities, biodiversity, and wildlife (Apfelbaum and Sams 1987). The dense stands and rhizomes of reed canarygrass collect sediment which causes siltation along stream banks, in ditches and wetlands, impeding water flow and preventing scouring needed to maintain fish and waterfowl habitat (Coops and Van der Velde 1995; Antieau 2000; Heutte *et al.* 2003; Gebauer 2013). Dense stands of reed canarygrass in wetlands can result in a reduction in open water areas and may increase the risk of flooding by changing the hydrology and soil infiltration capacity of wetlands and affecting the ability of the wetland to hold water during heavy rains (Anderson 2012).

Reed canarygrass grows so vigorously that it quickly out-competes other plant species for space and nutrients (Apfelbaum and Sams 1987; Maurer and Zelder 2002). It can outcompete plants growing less than 1 m above the maximum water level (Barnes 1999) but has also been shown to outcompete and overshadow taller wetland and riparian plant species such as Tussock sedge (*Carex stricta*) and Cattail (*Typha latifolia*) (Wetzel and van der Valk 1998; McCain and Christy 2005). Other plants have a difficult time establishing in locations where reed canarygrass dominates.

Reed canarygrass reduces native plant biodiversity in undisturbed as well as disturbed wetland habitats (reviewed in Waggy 2010). It can replace native vegetation with monospecific stands (Lindig-Cisneros and Zelder 2002), and in some locations has become the dominant species in a short period (within 5-6 months; Anderson 2012). Areas that have existed as monocultures of this species for extended periods may have seedbanks that are devoid of native plant species (Apfelbaum and Sams 1987).

Dense stands of reed canarygrass have lower wildlife value than native vegetation: few species can feed on this plant, and the stems grow too densely to provide suitable cover for mammals and waterfowl (Maia 1994; KCNWCP 2015). Invasive reed canarygrass can have a negative impact on some species which are already considered threatened or at-risk in Ontario and Canada. Reed canarygrass has been found to lower Hemipteran (true bugs) abundance and diversity, reduce small mammal populations, and lower floristic quality (Spyreas *et al.* 2010). Some species of birds, such as swamp sparrows (*Melospiza georgiana*), avoid areas of high reed canarygrass cover (Kirsch *et al.* 2007).

The invasive, dense mats of reed canarygrass can impact the hydrology of waterways and prevent channel evolution in response to flows, this is especially detrimental in the lower portions of waterways where streams tend to lose gradient and become slower (Diefenderfer *et al.* 2016). It has been suggested that reed canarygrass impacts hydraulic characteristics of surface waters and fish habitat by:

- Clogging ditches and streams with thick mats (Antieau 2000);

- Collecting silt in roots and rhizomes that rapidly form berms at the water's edge; these silt deposits and the emergent stems and leaves of reed canarygrass reduce the volume of water that a channel can carry and thus impede water flow (Coops and Van der Velde 1995; Gebauer 2013); and

- Slowing streamflow and eliminating the scouring action needed to maintain salmon habitat (Heutte *et al.* 2003).

There is little data on fish stranding associated with reed canarygrass other than anecdotal observations of obstruction and stranding risk to salmon migration paths. One notable exception was in western Washington, where 158 Coho salmon (*Oncorhynchus kisutch*) migrating upstream during a high flood event became stranded and died in a field of reed canarygrass and pale-yellow iris (*Iris pseudacorus*) when flood waters receded quickly (Carrasco 2000). The author suggested that dense stands of reed canarygrass and pale-yellow iris made escape from the field more difficult for the coho salmon, especially where the canal was ill-defined. Other studies (e.g., Hawes and Drieschner 2014) noted fish passage concerns, but the concern for fish stranding and desiccation was linked to the decline in water levels and not to the fish occupying wet areas amongst reed canarygrass.

In addition to effects on flow, the monoculture does not provide a diversity of habitats for salmon or their prey, and the production and quality of microdetritus that is available when salmon are present decreases with increasing percent cover of reed canarygrass (Borde *et al.* 2016). Reed canarygrass displaces woody vegetation which has been found to reduce the number of arthropods foraging in riparian areas, which may in turn deprive juvenile salmon of an important food source (review by Miller *et al.* 2008). Nevertheless, studies have noted that reed canarygrass can offer protection for fish and amphibians (e.g., Gilbert *et al.* 1994; Holzer and Lawler 2015), and provide food, cover and nesting habitat for some birds, ungulates, and small mammals (e.g., Kirsch *et al.* 2007; Suring and Vohs 1979; Takos 1947); but many of these observations are anecdotal and empirical evidence is lacking.

4.2.2. Flow Effects on the Growth and Distribution of Reed Canarygrass

Reed canarygrass is not easy to control once it is established. Since all plant parts of reed canarygrass float on water and aquatic corridors can facilitate dispersal, reed canarygrass can spread rapidly along ditch systems and land adjacent to watercourses (Apfelbaum and Sams 1987). Seeds are viable for up to four years (KCNWCP 2015) and may remain viable after periods of 50 days to three years of inundation (review by Waggy 2010). In addition, reed canarygrass regenerates and re-colonizes riparian habitats quickly after disturbance (CABI 2020).

While the species is flood tolerant (WRCGMWG 2019), altering the hydrology of the site to lengthen the time an area spends totally submerged may be a viable control strategy for sites with high density growth of reed canarygrass (Tu 2004). Flooding or altering site hydrology can be an effective control if the adjusted water depth is greater than 30 cm and this level can be maintained for more than a year

(WRCGMWG 2019). Flooding may be most effective at controlling reed canarygrass when timed to coincide with maximum rhizome growth and tillering (Klimesova 1994). Submerged reed canarygrass rhizomes will eventually die and reed canarygrass growth has been found to be adversely impacted by extended periods of flooding (minimum of 7 weeks over the growing season will prevent new growth; Coops and Van der Velde 1995). However, established populations can survive over one year of flooding, especially where not all parts of the plant are submerged (Tu 2004).

Flooding can also prevent seed germination (WRCGMWG 2019) and may promote the growth of some native plants such as cattail (*Typha latifolia*). However, flooding may not be suitable for sites with desirable vegetation that cannot withstand flooding and care must be taken to evaluate whether flooding could result in negative effects on the native flora and fauna.

Several studies have evaluated flooding as potential control measure in wetlands. In Oregon, within one year of restoring historical spring and summer flooding regimes to a slough, reed canarygrass cover was reduced by 6.1% where inundation was >0.85 m deep and 10.7% where inundation coincided with regenerating willow forest (Jenkins *et al.* 2008). A Wisconsin marsh had been dominated by reed canarygrass, but it was drastically reduced following the first year of flooding and a subsequent drawdown; though seeds remained viable through three years of flooding, after this time, cattails had re-emerged as the dominant species and reed canarygrass did not re-establish (Beule 1979).

Reed canarygrass expansion in stream channels may also be controlled by plant submergence. Elliot *et al.* (2018) conducted a set of mobile-bed (flume) experiments in a physical model to examine the if colonization of reed canary grass, via the expansion of an individual emergent patch located mid-channel, may be driven by differences in flow depths. Their results showed that as submergence depth increased, longitudinal expansion of the patch decreased. They conclude that managers concerned with reed canary grass expansion in rivers where depth will not increase over the height of the plants should expect patch expansion. Removal of these reed canarygrass stands may prevent further spread downstream within the channel. Results also suggest that patch expansion is less likely in medium (75%) submergence conditions than in shallower (31%) submergence. Therefore, managers may see less of an aggressive invasion if water levels are at medium submergence. However, the authors did not study the time the patch needed to be submerged for effective control of expansion or the effects of varied flow velocities (flow velocity was kept constant).

While flooding can be an effective control measure, reed canarygrass can also respond favorably to flooding. Floods of increasing intensity and duration have been found to increase the biomass and frequency of reed canarygrass (Kercher *et al.* 2007; Kercher and Zedler 2004; Miller and Zedler 2003). For example, reed canarygrass established in wetlands that were reflooded following a five-year-drawdown in northwestern Minnesota (Harris and Marshall 1963).

Other treatments (see Section 4.3) may be necessary along the edges of the flooded area, and replanting or reseeding native species is essential if a seed bank is eliminated after treatment to prevent the establishment of other invasive or exotic species (Tu 2004). For example, tilling (described in Section 4.3) followed by flooding can successfully eliminate reed canarygrass (Tu 2004). To use this technique, first the sod layer of the reed canarygrass should be tilled through as soon as possible (when site conditions are dry enough for the heavy equipment). This may take a few passes during the growing season in order to dry out and break up the roots, with the final result being broken clumps of soil and no viable plant material. Next, if water levels can be managed, the entire area should be inundated at least 50 centimetres until late May/June the following year (Tu 2004).

4.3. Other Measures to Manage Reed Canarygrass

Despite decades of study, there is currently no comprehensive strategy for the effective management of reed canarygrass (Seebacher 2008), which is a difficult species to manage and requires an integrated management approach using multiple treatment methods (KCNWCP 2015).

Some experts recommend first focusing efforts on depleting the seed bank prior to replanting the area (KCNWCP 2015). Seeds are viable for up to 4 years (KCNWCP 2015) although most germinate within two years (Anderson 2012). It is unrealistic to expect control on large reed canarygrass infestations within one year, but it may be possible within 3-5 years (WRCGMWG 2019). Allowing the seeds to grow and then managing the plants multiple times over several seasons may improve efficacy of many of the methods for controlling reed canarygrass outlined below, which were sourced from several best management practice reports authored in Canada and the United States (Anderson 2012; Invasive.org 2009; Tu 2004).

- Shading/planting - establishing a diversity of native grasses, sedges, rushes, shrubs, or trees. Reed canary grass is intolerant of year-round shade; forming a shade canopy will discourage reed canary grass growth and seed germination. Trampling or stomping reed canarygrass prior and during establishment of shrubs and trees can support these plantings to outcompete reed canarygrass (CMN 2019).
- Covering/mulching – using mulch, cardboard, coarse bark chips and wood fibre, geotextile, black plastic, and/or other material to supress growth. This method is not suitable for areas where reed canarygrass is mixed with desirable plant species.
- Digging – remove the entire root mass (including rhizome fragments that can resprout), preferably in wet conditions, by shovel. May not be practical for larger areas or at sites with a denser sod layer.
- Excavation – remove entire root mass of reed canarygrass by machinery; suitable for large sites dominated by reed canarygrass. Method will require implementation of several different control methods under a long-term adaptive management plan since many challenges should be expected (MV 2021).

- Seed head clipping by hand – a containment measure to prevent the release of seeds, but it is not an effective measure on its own.
- Mowing and cutting - using a mower, brush cutter, weed eater, or a hand tool such as clippers or machete can be used to remove reed canarygrass biomass and to stress and reduce its spread (mowing prior to flowering can eliminate the seed bank for the current year), but it will not kill plants or eradicate infestations. Multiple passes are required per year (up to 5) for several years in a row to eliminate the seed bank (Anderson 2012); if mowing occurs only 1-2 times per year, it may stimulate additional stem production (Tu 2004). Mowing should be followed up with another treatment method (e.g., shading/planting, tilling or herbicide application).
- Tilling - the use of machinery to turn over and break up soil (also called disking), which breaks up reed canarygrass breaks up and exposes the rhizomes. Tilling is most effective when combined with another control method such as covering or flooding (Tu 2004). Seebacher (2008) recommends tilling and then covering the infestation with a thick, dense cover and leaving it undisturbed for at least one year. This method is not suitable for areas where reed canarygrass is mixed with desirable plant species.
- Burning – can be used to reduce reed canarygrass in late spring if the fire burns through the plants and entire sod layer down to the soil (Tu 2004), but should be done before native grasses break dormancy, and only if there are native fire-adapted species present in the seed bank which will be encouraged by fire (CMN 2019) or there is a native planting program in place. Prescribed spot burning has been found effective at killing seedling or young reed canarygrass (Tu 2004).
- Grazing – see Section 2.2.4. Grazing alone cannot be used as a control measure for reed canarygrass, but can be used prior to other methods, such as tilling, covering, or herbicide, to reduce biomass and height (Tu 2004; Guretzky *et al.* 2018).
- Application of herbicides – chemical application may be used to control large reed canarygrass infestations that are not feasible to control manually/mechanically. This method should be used with caution for the following reasons (Crosby 2018 in MV 2001):
    - Weather conditions greatly influence treatment efficacy;
    - Reed canarygrass often grows in riparian areas where pesticide use is restricted; and
    - Native vegetation is often integrated with reed canarygrass infestations and mortality of non-target plants or native species is possible.

  Thus, site characteristics must be considered with the herbicide prescribed, based on site goals and objectives and in accordance with legal requirements (BC's *Integrated Pest Management Act*).

Foliar application for reed canarygrass is typically by backpack, hand sprayer, or wicking tool. Herbicide should be applied during the growing season at mid-summer or late in the fall for maximum translocation of the herbicide into the roots (Tu 2004). Large infestations will require multiple treatments over several years (Tu 2004).

Mowing or cutting can be used prior to herbicide treatment; if using this method, allow the reed canarygrass to re-grow back to boot height and then apply the herbicide; Tu 2004). Herbicide can also be used prior to covering methods to increase efficacy (KCNWCP 2015).

Reed canarygrass often grows in large contiguous patches right up to the edge of water courses. The impact of control techniques and the resulting bare soil on the adjacent aquatic environment needs to be considered and scheduled removal works during a period of least risk to fish species.

For all applicable methods, care must be taken to clean all equipment after use and to bag and dispose of all plant material for removal and disposal (Anderson 2012). Do not compost; all plant materials should be placed in black plastic bags. Bags should be sealed tightly and left in direct sunlight for about a week to allow stems and rhizomes/roots to dry out thoroughly before disposing of them. The best disposal methods of the dried plant material are to burn them or send them to the landfill.

5. DISCUSSION

5.1. Managing Reed Canarygrass

Reed canary grass is generally flood tolerant, often taking > 1 year of continuous and total submergence to kill off rhizomes and prevent seed germination. Greenhouse and mesocosm studies have demonstrated that reed canarygrass establishment and spreading is favoured under cyclic or short-term flooding. Aquatic corridors can facilitate dispersal of reed canary grass since all plant parts float. In rivers, reed canary grass thrives along streambanks and can spread into the wetted channel. However, little research has been conducted on reed canarygrass along riverbanks, so the mechanism by which reed canarygrass so rapidly colonizes rivers is not well understood.

While studies thus far have provided some insight on how to control reed canarygrass, there is conflicting evidence of whether flow, alone or with other mechanisms, can control reed canarygrass. In summary, there is not enough information available to accurately predict the outcome of controlling flows and water levels in the Nechako River and Nechako Reservoir to reduce the expansion of reed canarygrass.

Digging out stands of reed canary grass that are not moderately or fully submerged in the river at low flows, outside of the fish window, and controlling reed canarygrass along the banks of the river may be an alternative or combined method (with flooding) to help control reed canarygrass in the Nechako River.

5.2. Structured Decision Making and Performance Measures Operational Considerations

Based on our general understanding of reed canarygrass, there is not likely a strong relationship (or any relationship) to its establishment, abundance and distribution that could be feasibly managed by changing flow (water level or velocity). Therefore, we do not recommend including this issue in structured decision making, cannot recommend a PM, and know of no practical operational considerations to help manage reed canarygrass. Non-operational controls are recommended for the control of reed canarygrass.

5.3. Other Management Options

There are multiple control measures that can be implemented to manage reed canary grass growth and spread (described in Section 4.3). The methods chosen will depend on site-specific conditions, the scale of the invasion, and the management objectives. Effective control of the species will likely require multiple methods employed over several years (at minimum), with results monitored and adaptive management measures in place to increase success.

Regardless of which treatment options are used, the potential for post-treatment reinvasion by reed canarygrass or other invasive species should be considered, and ongoing maintenance to control sprouting and seedling establishment may be necessary to maintain long-term reed canarygrass control.

6. CONCLUSION/CLOSURE

"Reed canarygrass" is anecdotally reported in abundance along the Nechako River, and we have confirmed that this species (*Phalaris arundinacea*) is indeed present. Reed canarygrass has not been studied in the Nechako watershed, but general scientific knowledge overwhelmingly concludes that this prolific species spready rapidly and overtakes native riparian vegetation, decreasing habitat availability and suitability for a variety of fish and wildlife species. Reed canarygrass is hardy; it survives both drought and flood conditions, and is unlikely to be controlled by Rio Tinto operations/Nechako flows. Field studies specifically evaluating the distribution and effects of reed canarygrass in the Nechako watershed, and trial studies on physical (e.g., tillering) and flow control (e.g., flooding) measures would help better understand and manage this invasive species.

Yours truly,

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Personal Communications

Kurtz, J. 2022. Fisheries Biologist. Teams meeting with Nicole Wright, August 2022.