Nimpkish River
Knotweed Eradication Project
Summary Report (2018 to 2021)

Pesticide Use Permit No. 738-0027-18/21 (Aug. 20, 2018 to Aug. 19, 2021)

Prepared by the B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Invasive Plant Program

January 2022

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1.0 BACKGROUND

The rugged and remote Nimpkish River is the heart of 'Namgis First Nation's ('Namgis) traditional territory, located at the north end of Vancouver Island. It is the longest river on the Island (more than 100 km long), flowing northwest into Nimpkish Lake and then north into the Broughton Strait, 8 km east of Port McNeill. The 'Namgis have used this area for at least a thousand years, and it is rich with cultural and natural values, including productive salmon populations. The only major settlement in the valley is the logging town of Woss, with a year-round population of 200.

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) North Island District staff reported invasive knotweed presence on the Nimpkish River to the FLNRORD Invasive Plant Program in early 2016. That summer, the Invasive Plant Program staff and North Island District staff completed invasive knotweed aerial and ground surveys to determine knotweed extent; a workshop with staff from the District Office, 'Namgis river crew and fisheries staff, and Western Forest Products (WFP) staff; and assessed management options with the 'Namgis Natural Resource Department. Regular communications with the 'Namgis resulted in a June 2017 vote by the 'Namgis Council to support herbicide treatments on knotweed in and around the Nimpkish River, with the goal of minimizing the risks and impacts of knotweed and eventually eliminating it from the river system.

In 2017, most knotweed sites downstream of Vernon Camp were relatively small (one to two square metres) but frequent, presenting high risk of further clone expansion and spread downstream. Since introduction, the knotweed has been travelling downstream at a rate of approximately 17 kilometres per year. Knotweed continues to occupy a small fraction of its potential habitat on the Nimpkish River, presenting land occupiers with a significant opportunity to eliminate knotweed from the Nimpkish watershed. The FLNRORD Invasive Plant Program developed the Nimpkish River Invasive Knotweed Action Plan in response to the need to control knotweed and a request from the 'Namgis to develop and implement a knotweed control project on Nimpkish River.

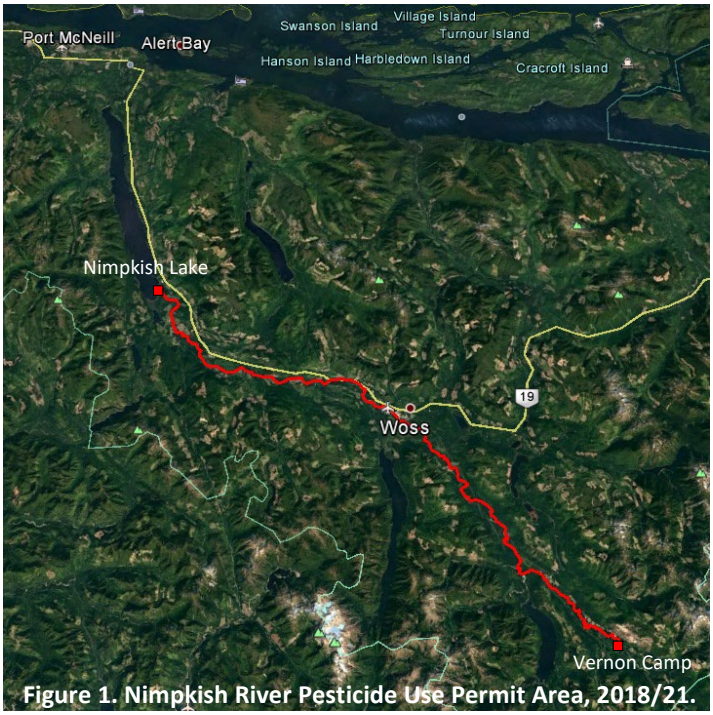


Figure 1. Nimpkish River Pesticide Use Permit Area, 2018/21.

In 2017, the FLNORD Invasive Plant Program established a three-year Pesticide Use Permit (PUP) No. 738-0027-18/21 with the B.C. Ministry of Environment; permitting backpack foliar, stem injection and wipe-on applications of Roundup WeatherMAX (a.i. glyphosate) to treat invasive knotweed to the water's edge on the Nimpkish River from Vernon Camp (the confirmed source population of knotweed) to the head of Nimpkish Lake (approx. 8 km downstream of the most downstream known knotweed site)(See Figure 1. Pesticide Use Permit Area 2018/21). The permit was effective August 20, 2018 to August 19, 2021. Ground surveys and treatments started on the Nimpkish River at Vernon Camp working downstream in August 2018. Since that time, knotweed surveys and treatments have occurred on

the river between July 1 to September 15 annually.

In addition to the ‘Namgis First Nation, impacted land managers include FLNRORD, Western Forest Products (WFP), BC Parks, and BC Hydro. The primary knotweed populations in the Nimpkish watershed are Bohemian knotweed, with a secondary land-based population of Himalayan knotweed. Both populations appear to originate at a reclaimed logging camp (Vernon Camp) on WFP land, where they occur in the greatest area, density and distribution found in the watershed. Surveys also identified Vernon Camp as the most upstream source.

2.0 PURPOSE & STRATEGY

The purpose of the Nimpkish Knotweed Eradication Project is to eliminate invasive knotweed species from the river system, including side channels and adjacent wetlands and estuaries. The strategy to achieving successful control and eradication of knotweed is to first remove the source population upstream, then remove the colonies moving downstream; consistently survey, treat, and monitor all knotweed sites on an ongoing annual basis until all reproductive plant parts are completely removed from the water system; and limit the disturbance caused by these activities. Failure to achieve these points will increase, rather than decrease the population.

3.0 OVERVIEW

The Nimpkish River Knotweed Eradication Project is the first watershed-scale knotweed eradication project to occur in B.C. Occurring in the heart of the traditional territory of the ‘Namgis First Nation who have occupied the Nimpkish River and surrounding area for more than a thousand years, the interest and support of the ‘Namgis Council and community has been central to the success of this project since the beginning. The ‘Namgis Natural Resource Department and FLNRORD Invasive Plant Program and North Island District staff worked closely together for more than a year prior to presenting the proposed project to a gathering of the ‘Namgis Council. During this time, FLNRORD provided technical information, including management options which were reviewed, discussed and the preferred option developed into a project proposal. The ‘Namgis Natural Resource Department provided historical background about culturally significant areas and natural resource sector relationships in the region, an explanation of how the current ‘Namgis Administration operates, periodic updates to Council and advised FLNRORD about the most appropriate time and way to engage with the ‘Namgis community and present technical information to Council for decision.

In May 2017, FLNRORD staff made a presentation to the ‘Namgis Council, including elected and hereditary chiefs, providing a summary of the knotweed situation and risks on the Nimpkish River, recommendations, and request for Council to consider supporting herbicide treatments to eradicate knotweed from the Nimpkish River. In June 2017, the ‘Namgis Council voted to support herbicide treatments on knotweed in and around the Nimpkish River, with the goal of minimizing the risks and impacts of knotweed to eventually eliminate it from the river system. Project support was provided with the request that FLNRORD create opportunities for members of the ‘Namgis community to be actively involved in the project.

4.0 RESULTS

4.1 Participating Organizations & Contributions

Knotweed ground surveys and treatments started on the Nimpkish River at Vernon Camp working downstream in August 2018. Since that time, knotweed surveys and treatments have occurred on the river between July 1st to September 15th annually. Project funding, planning, permitting, and fieldwork is coordinated by the FLNRORD Invasive Plant Program annually. Fieldwork is completed by multiple crews funded by FLNRORD, and occasionally other impacted land managers (e.g. BC Hydro, Western Forest Products)(See Table 1. Survey & Treatment Crew Composition). Data management and reporting is completed by the FLNRORD Invasive Plant Program annually. The FLNRORD Invasive Plant Program invites ‘Namgis project involvement on an annual and ongoing basis in the form of participating in annual planning sessions, survey and treatment crews (treatment applicators must hold a valid Pesticide Applicator Certificate) and other project related meetings and activities. In 2018 and 2019, FLNRORD provided two 3-day Pesticide Applicator Training opportunities to interested members of the ‘Namgis First Nation and employees with Western Forest Products and the FLNRORD North Island Natural Resource District (FLNRORD District).

Table 1. Survey & Treatment Crew Composition for the Nimpkish River Knotweed Project, 2018 to 2021.

	2018	2019 1st Pass	2019 2nd Pass	2020 1st Pass	2020 2nd Pass	2021 1st Pass	2021 2nd Pass
FLNRORD Invasive Plant Program	5	2	1	5[4]	4	4[5]	6[5]
FLNRORD North Island District	2	5	4	4	6	4	6
‘Namgis First Nation	1	-	-	-	-	-	-
Western Forest Products	5[1]	-	6[3]	2	-	-	4[6]
BC Hydro	-	2[2]	-	-	-	-	-

[1] WFP contracted a 4-person crew from Joe Dowe Enterprises Ltd.

[2] BC Hydro contracted a 2-person crew from the Coastal Invasive Species Committee.

[3] WFP contracted a 4-person crew from Joe Dowe Enterprises Ltd.

[4] FLNRORD Invasive Plant Program contracted 4-person crew from Joe Dowe Enterprises Ltd.

[5] FLNRORD Invasive Plant Program contracted 4-person crew from Joe Dowe Enterprises Ltd.

[6] WFP contracted a 4-person crew from Joe Dowe Enterprises Ltd. For a single pass.

4.2 Operational Delivery & Outcomes

2018 and 2019

An aerial survey by helicopter of the Nimpkish River was repeated in 2018 and 2019 by FLNRORD staff and the 'Namgis First Nation. The aerial surveys updated the status of sites identified in the original 2016 aerial surveys, documented new sites, and supported on-ground planning and coordination. The 2019 aerial survey also gave an indication of 2018 treatment efficacy as most of the treatments occurred on large clones in 2018 and damage was visible from the air. Aerial survey for knotweed can be useful on a watershed scale, as it allows coverage of the entire length of the river in a relatively short period of time, identifies the most upstream source population, allows access to sites that are impassable by water or ground, and gives a baseline from which more detailed ground surveys can be planned. Aerial surveys are limited in that it is difficult to detect small or immature clones, especially those occurring in log jams or other debris, and not possible to detect knotweed occurring under canopy cover (e.g. forest edge). Aerial surveys were not conducted after 2019 due to the limitations of this method in detecting increasingly small and obscured clones.

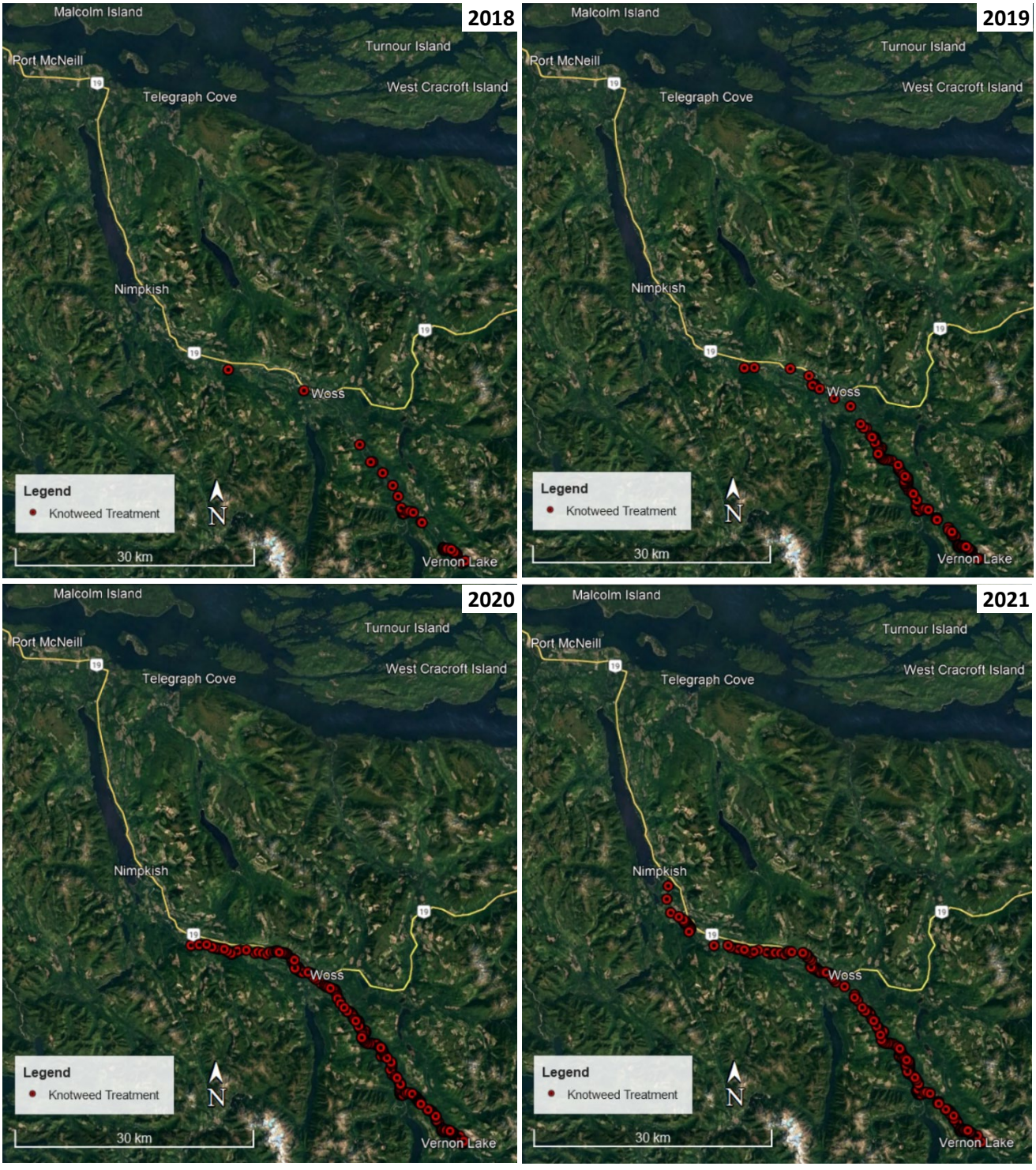
In 2018 and 2019, ground surveys were completed following the aerial surveys to determine knotweed site details, such as area, density, distribution, and site accesses via road. Sites were grouped into 13 distinct polygons based on access, proximity to each other, number of sites, or a combination of these factors using the best available information. Polygons were used to reference large treatment units and to divide the work between the crews to ensure full coverage of the project area and no overlap. Site surveys also occurred concurrently with treatment activities.

The PUP was granted August 20, 2018, providing a short treatment window of only six days at the end of August. Treatments were also limited by precipitation, which resulted in the majority of treatments being stem injection and focus on the most upstream and downstream knotweed occurrences, and the largest clones. Treatments occurred from Vernon Camp to approx. 18 km upstream of Nimpkish Lake (See Figure 2. Knotweed Treatments 2018). Wipe-on application was tested on the first day of treatments but was deemed inefficient and the decision was made not to use this application method moving forward.

The 2018 ground survey and single treatment pass totaled 48 person days worked (8-hrs per day). 38 sites were identified for a total site area of 28.94 ha (See Table 2. Operational Statistics). All 38 sites were treated for a total treatment area of 0.06 ha; with 0.04 ha (62% total treatment area) of foliar applications, 0.02 ha (38% total treatment area) stem injection, and 0.0001 ha (<1% total treatment area) of wick applications. Total herbicide product used was 42.35 L; with 0.05 L (<1% total concentrated product used) applied by foliar application, 42.31 L (>99% total concentrated product used) applied by stem injection, and 0.0022 L by wick application (See Table 3. Treatment Method & Herbicide Statistics).

In 2019, two treatment passes occurred with two crews working simultaneously, each composed of four to six people. The first pass occurred from July 22 to 29 and the second pass from August 26 to 30. Treatments focused on all detectable knotweed clones of all sizes on the main channel from the most upstream to the most downstream occurrences, and detectable knotweed clones of all sizes on side channels as time permitted. Treatments occurred from Vernon Camp to approx. 18 km upstream of Nimpkish Lake (See Figure 2. Knotweed Treatments 2019). Favourable weather allowed crews to use both stem injection and foliar application methods.

Figure 2. Nimpkish River Knotweed Chemical Treatments, 2018 to 2021.



The 2019 ground survey and two treatment passes totaled 95 person days worked (8-hrs per day). 106 sites were surveyed, including 68 new sites detected, for a total site area of 49.11 ha (See Table 2. Operational Statistics). All 106 sites were treated for a total treatment area of 1.65 ha; with 1.62 ha (98% total treatment area) of foliar applications, 0.03 ha (2% total treatment area) of stem injections and 0 ha of wick applications. Five of the sites were treated twice (See Table 3. Treatment Method &

Herbicide Statistics). Total herbicide product used was 65.54 L; with 9.7 L (15% total concentrated product used) applied by foliar application, 55.85 L (85% total concentrated product used) applied by stem injection, and no treatments using the wick application method (See Table 3. Treatment Method & Herbicide Statistics).

Treatment monitoring was performed by FLNRORD Invasive Plant Program staff August 12, 2019 and September 18, 2019. Monitoring confirmed treatment method efficacy and those sites requiring a second treatment pass due to newly emergent clones or missed stems. No sites required re-treatment in 2019 following the second treatment pass.

2020

In 2020, two crews worked simultaneously to complete two survey and treatment passes on the largest contiguous stretch of the river to date. Crews consisted of four to six people. The first and second passes were completed periodically during the dates of July 20 to September 15, 2020. Treatments focused on all detectable knotweed clones of all sizes on the main channel from the most upstream to the most downstream occurrences, and all detectable knotweed clones of all sizes on side channels as time permitted. Treatments occurred from Vernon Camp to approx. 13 km upstream of Nimpkish River)(See Figure 2. Knotweed Treatments 2020). Many additional side channels were surveyed in 2020; however, full surveillance of floodplains was not completed due to large areas, dense vegetation and debris, and difficult terrain (e.g., huge old growth logs to navigate around). Treatment methods consisted of foliar applications only, to reduce the overall volume of herbicide used.

The 2020 ground survey and two treatment passes totaled 105 person days worked (8-hrs per day). 205 sites were surveyed, including 87 new sites detected, for a total site area of 46.77 ha (See Table 2. Operational Statistics). 172 of the sites were treated for a total treatment area of 0.54 ha; with 0.54 ha (100% total treatment area) of foliar applications and no treatments using the stem injection or wick application methods. Total herbicide product used was 3.22 L applied using foliar application methods only. This is a significant reduction in herbicide use compared to 55.85 L in 2019 and 42.31 L in 2018.

2021

Surveys and treatments were performed simultaneously by two crews over two passes. The first pass of surveys and treatments occurred during the period of July 12 to August 4. The second pass of surveys and treatments occurred during the period of August 9 to 18. Treatments occurred on knotweed clones of all sizes for the entire length of the main channel and side channels from Vernon Camp to 2 km upstream of Nimpkish Lake (See Figure 2. Knotweed Treatments 2021). 2021 is the first year that the entire permit area received ground survey and treatments, including all side channels.

The 2021 ground survey and two treatment passes totaled 147 person days worked (8-hrs per day). 249 sites were surveyed, including 44 new sites detected, for a total site area of 40.37 ha (See Table 2. Operational Statistics). 169 of the sites were treated for a total treatment area of 0.48 ha; with 0.48 ha (>99% total treatment area) of foliar applications, 0.0001 ha (<1% total

treatment area) of stem injection, and no wick applications. Total herbicide product used was 2.96 L; with 2.90 L (98% total concentrated product used) applied by foliar application and 0.06 L (2% total concentrated product used) applied by stem injection.

Table 2. Operational Statistics for the Nimpkish River Knotweed Project, 2018 to 2021.

Description		2018	2019	2020	2021
# Person Days Worked	Total Person Days Worked (based on 8-hour days)[1]	48	95	105	147
	Person days from contractor crew – Round 1	-	-	35	56
	Person days from contractor crew – Round 2	-	-	26	28
	Person days from FLNRO crew – Round 1	-	-	30	35
	Person days from FLNRO crew – Round 2	-	-	14.5	28
Surveys	Total number of sites surveyed	38	106	205	249
	Total area surveyed (ha)[2]	28.94	49.11	46.77	40.37
	Number of No Weed Found sites	n/a	0	26	74
	Number of new sites found	n/a	68	87	44
	Number of sites on side-channels	-	-	17	22
	Number of sites on floodplains	-	-	5	6
Treatments	Total number of sites treated	38	106	172	169
	Number of sites treated twice	0	5	25	34
	Total area treated (ha)	0.06	1.65	0.54	0.48
Herbicide	Total Product Used (L)	42.35	65.54	3.22	2.96

[1] Total Person Days Worked (based on 8-hour days) includes tailgate meetings and calibration, travel to sites, treatment of sites, and cleanup.

[2] Survey area totals capture first pass areas for each year only.

Table 3. Treatment Method & Herbicide Statistics for the Nimpkish River Knotweed Project, 2018 to 2021.

Area Surveyed Subtotal (ha)	**2018**	**2019**	**2020**	**2021**
Total Area Surveyed (ha)	**28.94**	**49.11**	**46.77**	**40.37**
Area Treated Subtotal (ha)				
Backpack Foliar Area	0.04	1.62	0.54	0.48
Stem injection Area	0.02	0.03	0.00	0.00
Wick-On Application Area	0.00	0.00	0.00	0.00
Total Area Treated (ha)	**0.06**	**1.65**	**0.54**	**0.48**
Concentrated Herbicide Product Subtotal (L)				
Foliar Product Concentrate	0.05	9.70	3.22	2.90
Stem Injection Product Concentrate	42.31	55.85	0.00	0.06
Wick-On Product Concentrate	0.00	0.00	0.00	0.00
Concentrated Herbicide Product TOTAL (L)	**42.35**	**65.54**	**3.22**	**2.96**

Figure 3. Bohemian Knotweed Total Area (ha) Treated Annually, Nimpkish River 2018-2021.

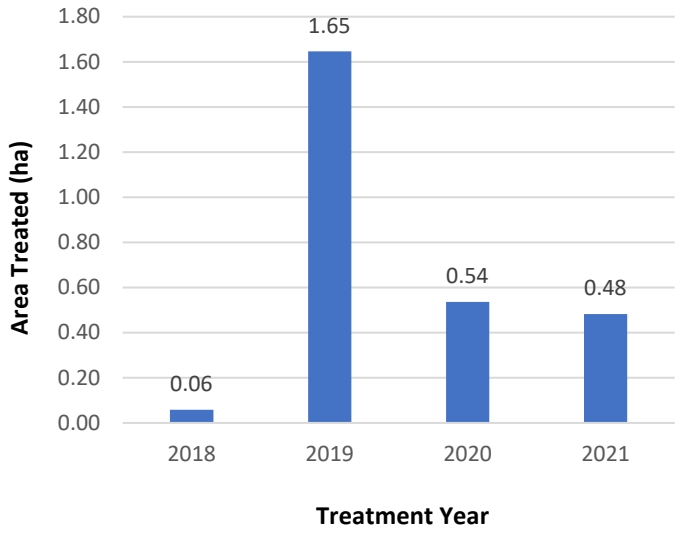
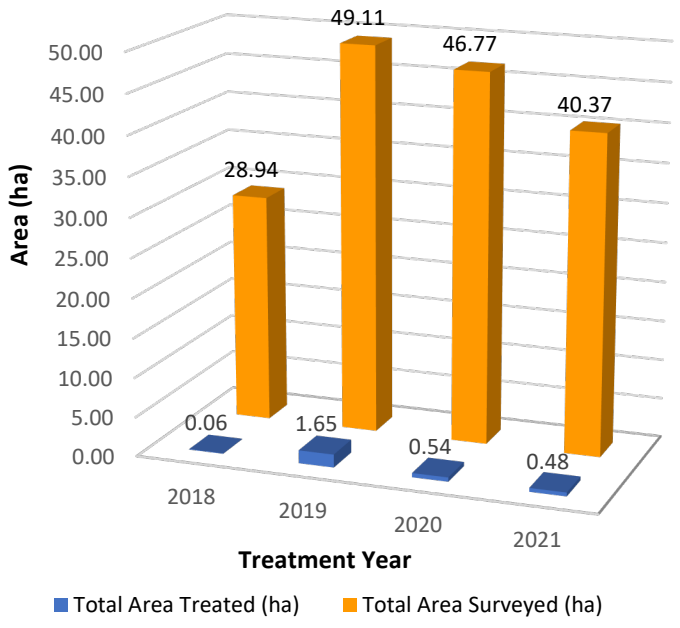


Figure 4. Bohemian Knotweed Total Area (ha) Treated Relative to Total Area (ha) Surveyed Annually, Nimpkish River 2018-2021.



The total area treated annually was greatest in 2019 at 1.65 ha, the first year of two treatment passes. Two treatment passes also occurred in 2020 and 2021, however the 2020 total treatment area declined considerably to 0.54 ha and this decline continues in 2021 for a total treatment area of 0.48 ha (See figure 3. Knotweed Total Area Treated Annually). Figure 4 demonstrates that the annual total survey area declines from 2019 to 2021, however, at a more gradual rate than the total treatment area (Figure 4. Total Area Treated Relative to Total Area Surveyed).

2019 indicated the highest concentrated herbicide use of the project over four years at 65.54 L, this was the first year of two treatment passes where the stem injection method was still widely used on large clones. Herbicide use underwent a significant reduction in 2020 to 3.22 L, a decline of 95% compared to 2019. Herbicide use continued to decline in 2021 to 2.96 L, a decline of 8% from 2020 (Figure 5. Concentrated Roundup Total Annual Use). All 2020 treatments and most 2021 treatments used only the foliar application method. Figure 6 indicates the volume of concentrated herbicide used with foliar application versus stem injection from 2018 to 2021. The years where stem injection was the primary treatment method, 2018 and 2019, resulted in significantly higher herbicide use (Figure 6. Concentrated Roundup Annual Use by Application Method). The higher herbicide use reflects both the treatment method (Figures 5 and 6) and the quantity of knotweed requiring treatment (Figure 3).

Figure 5. Concentrated Roundup WeatherMAX (a.i. glyphosate)(L) total annual use for the treatment of Bohemian Knotweed, Nimpkish River 2018-2021.

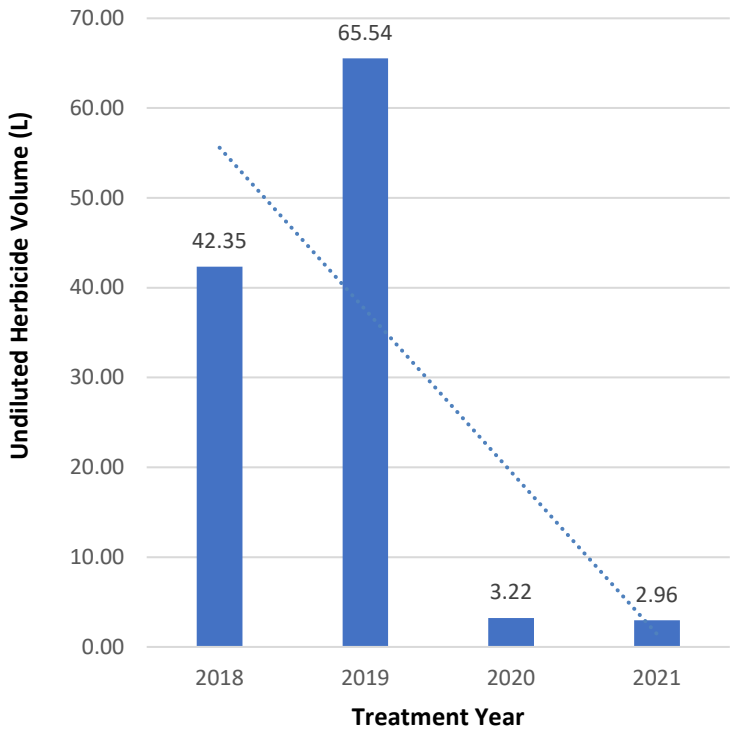
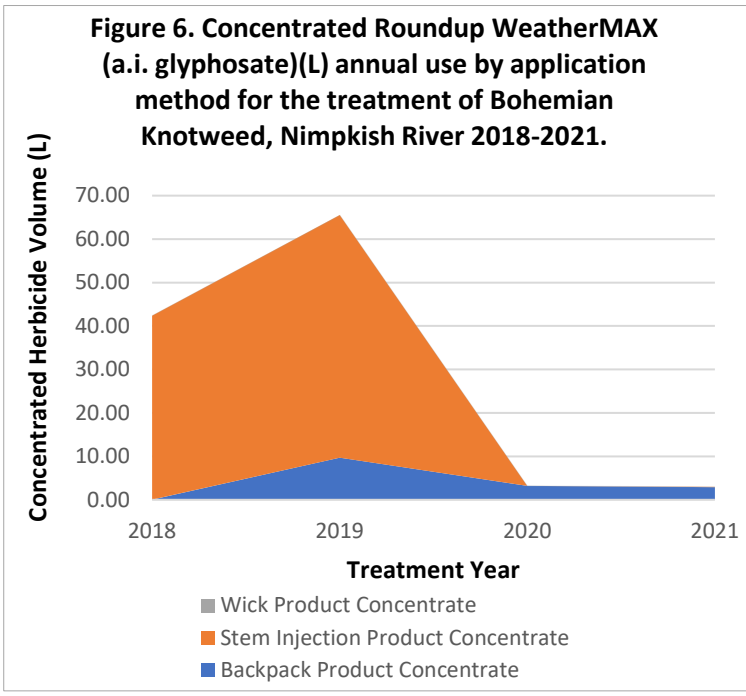


Figure 6. Concentrated Roundup WeatherMAX (a.i. glyphosate)(L) annual use by application method for the treatment of Bohemian Knotweed, Nimpkish River 2018-2021.



5.0 DISCUSSION

5.1 Outcomes

In 2018, there was only a single treatment pass and due to the large clones and poor weather, stem injection was the primary treatment method. The clones were easy to detect and treatments were highly effective in reducing the size and stature of the knotweed clones. It is important to note that as the annual survey area increased (Figure 4), so did the number of No Weed Found sites (Table 2). From 2020 onward, considerably more sites were detected annually but sites were significantly smaller in stature and area (majority <3m^2) and more scattered, requiring more time to detect and access. This trend is typical on multi-year projects using effective treatment methods and consistent survey methods from year to year.

2021 marked the first year that the entire length of the Nimpkish River from Vernon Camp to where it enters Nimpkish Lake was surveyed and treated. Prior to 2021, some sections were not accessible due to water levels, debris or limited crew time

Knotweed is moving progressively closer to Nimpkish Lake with 2021 surveys indicating that the most downstream occurrence is only 2.2 km upstream of the lake. Ongoing efforts similar to 2021, which achieved survey and treatment of the entire project area, are essential to prevent further movement downstream and knotweed establishment in Nimpkish Lake.

Despite a greater area of the Nimpkish River and increasing number of knotweed sites being surveyed and treated each year, the overall quantity of herbicide used and area treated continues to decrease. The decreased total treatment area is due to the majority of clones becoming smaller from year to year. The decreased herbicide volume is due to the increased use of foliar applications instead of stem injection, which uses significantly less herbicide concentrate, smaller clones requiring less product and fewer sites overall. Stem injection requires that 5 mL of concentrated herbicide be injected into each knotweed stem. Stem injection uses significantly more herbicide volume than backpack foliar applications, which are typically applied at a rate of 6L of concentrated herbicide per hectare, or less than 0.6 mL per stem. Limiting treatment methods to foliar applications in 2020, significantly reduced the total volume of herbicide used. This transition in 2020 coincided with a significant decline in the size of knotweed clones (majority <3m^2), which again required less herbicide to effectively treat. Foliar applications remained the primary herbicide treatment method in 2021 and knotweed clones remained small and were less frequent, resulting in a further decline in herbicide use. It is expected that this trend will continue until the main project focus will become survey and detection with only occasional treatments required. The highest risk to the Nimpkish River is undetected knotweed clones that will continue to spread and establish downstream if not managed. The newly emerged, small clones are difficult to detect and require a shift in resourcing with greater focus given to surveying opposed to treatments over time

The decline in treatment area and herbicide volume, paired with the increasing amount of No Weed Found sites (NWF – sites where knotweed was previously treated and is no longer detectable), suggests that treatments are effectively reducing the knotweed population on the river and associated impacts. Continued efforts are required to ensure further success in reducing knotweed on the Nimpkish River with the goal of eradication, and a new PUP is required to ensure treatments continue into 2022.

5.2 Opportunities, Challenges & Recommendations

Planning & Coordination

1. Knotweed is now only 2.2 km upstream of Nimpkish Lake and will be more difficult to detect and manage if it reaches the lake.
   Recommendation: Conduct shoreline survey of the entire Nimpkish Lake by boat in 2022 to confirm the most downstream occurrence of knotweed.

2. Site access is remote and rugged, and it took a couple years to determine the closest road access points and foot access to the river. River sites are commonly accessed by bush-whacking one to two kilometres from the closest road. Knotweed site access also commonly includes wetted channel crossings and traversing around sections of the river that are unnavigable. Fortunately, these inaccessible areas are often unsuitable for knotweed establishment.
   The Nimpkish River is a dynamic system with gravel bars and shoreline inundated with high water flows during the rainy season, causing knotweed sites to shift and move from year to year. Thorough surveying of floodplains is challenging for treatment crews. Many of the floodplains are large in area, difficult to traverse, and densely vegetated, making knotweed detection difficult. Floodplains can also be difficult to recognize on the ground, resulting in knotweed sites sometimes being detected by chance when accessing or departing the river. As knotweed area and distribution declines, detecting small new clones will be increasingly challenging and time consuming.
   Recommendation: It is important to continue using the knowledgeable and experienced Nimpkish crews and allocating sufficient time and resourcing for thorough surveys on the entire length of the Nimpkish River on foot from Vernon Camp to the head of Nimpkish Lake, including all side channels and active flood plains. It is also important that annual efforts include two treatment passes of each knotweed site to ensure treatment of late emerging clones or missed foliage. This work is most easily coordinated by segmenting the river into the following treatment areas and using three crews simultaneously to ensure full coverage of floodplains and a full second pass over the entire project area:
   - Vernon Camp to Maquilla Reload (Vernon polygon-polygon 4 – assigned to FLNRO crew)
   - Maquilla Reload to Woss (polygons 5-11)
   - Woss to Nimpkish Lake (polygons 12-13)

   Recommendation: Flood plain mapping could further aid crews in locating those areas requiring greater survey attention.

3. Support from non-government industry stakeholders in the form of funding and on-the-ground workers has contributed to project progress on the Nimpkish River to date. However, the contributions have been inconsistent and unpredictable each year.
   Recommendation: Request that industry partners commit to annual crew contributions for the duration of the next PUP (2022 to 2024) to ensure sufficient crews to achieve annual management goals.

4. The project is coordinated by FLNRORD staff outside of the North Island district. The benefit is that those coordinating the project are closely engaged with knotweed and other invasive plant projects happening elsewhere in the province and best practices. The drawback is reduced flexibility to support crews in the field due to changes in weather and build local partnerships.
   Recommendation: FLNRORD create a technical invasive plant position based in the North Island district to better support the field operations of this and other North Island invasive plant projects.

5. The Nimpkish Knotweed Project is a technical project requiring current knowledge and understanding about pesticides, knotweed and other invasive plant best management practices province-wide, and basic river hydrology. The project requires coordination with multiple provincial departments, First Nations, forest industry, BC Hydro and treatment contractors.
   Recommendation: It is important that the field operations continue to be coordinated by a single project field coordinator directed by the FLNRORD Invasive Plant Program, regardless of location, to ensure that the appropriate survey and treatment methods are being used, crews are adequately trained to perform technical activities and deliver work safely, the PUP is being followed, data is recorded accurately and entered into the provincial invasive plant database, and annual reporting occurs.
6. This project generates a large amount of survey and treatment data annually. Annual herbicide use reporting is a PUP requirement and annual project reporting is important to ensure that project goals are being met, practices are adapted to address technical challenges (e.g. epinastic growth preventing effective treatment), and project partners remain current in order to lend there ongoing support.
   Recommendation: For consistency and accuracy, field data should continue to be recorded by a single person from each crew and compiled and entered into the provincial database by the project field coordinator. Annual PUP reporting and overall project reporting should continue to be completed by the project field coordinator.

Pesticide Use Permit (PUP)

7. Ongoing annual management is required to continue reducing the knotweed population in the Nimpkish River, with the goal of eradication.
   Recommendation: FLNRORD Invasive Plant Program to establish a second three-year PUP for the period of July 1, 2022 to June 31, 2025. Proposed PUP changes include: 1) Include Roundup WeatherMAX and Habitat Aqua herbicide products, the addition of aquatic herbicide Habitat Aqua will diversify the chemistry used for controlling knotweed and will present lower environmental risk for treatments in and adjacent to water, 2) Ability to treat knotweed in or adjacent to water's edge, 3) Ability to select the most effective treatment method on a site-by-site basis, regardless of stem size, with preference given to foliar applications that will minimize the amount of herbicide used, 4) Remove wick application method as it was determined to be inefficient early in the 2018-21 PUP and not used, 5) increase the overall PUP treatment area to include Vernon Camp

downstream to the mouth of the Nimpkish River, this will accommodate shifts in the location of the knotweed population over time.

8. The 2018-21 PUP requires that all knotweed stems larger than 1.27 cm (0.5 inches) in diameter between the 2nd and 3rd internode use stem injection herbicide application. This results in significantly higher volumes of herbicide being used than if foliar applications were the preferred method. The efficacy and risk of herbicide drift of foliar applications compared to stem injection are negligible when appropriate treatment conditions and the option of shrouding are applied.
   Recommendation: Remove the requirement to stem inject herbicide in all knotweed stems larger than 1.27 cm (0.5 inches) in diameter between the 2nd and 3rd internode, and use backpack foliar application method as the preferred treatment method wherever possible. Maintain the use of stem injection as a treatment option for large, mature clones with leaf canopy that can not be reached by foliar applications.

9. Some clones have been observed growing in the wetted channel. The provisions of PUP 2018-21 allowed treatments to water's edge but in the water. Manual removal of these clones is not recommended due to the high risk of fragmentation downstream and the need to transport the removed plant material for suitable disposal.
   Recommendation: Add the option of treating emergent knotweed clones occurring in the wetted channel using foliar application of the aquatic herbicide Habitat Aqua (active ingredient imazapyr). This herbicide product is designed for use in and adjacent to water and does not present risk of harm or damage to aquatic life or water quality when used as directed by the label.

Treatment Efficacy

10. Knotweed clones previously treated using stem injection are in some cases displaying atypical growth forms and reduced herbicide uptake over time. The atypical growth rarely has sufficient leaf surface to allow for follow up foliar application. It is speculated that repeated exposure to high concentrations of glyphosate is causing a stress response in the knotweed that is limiting further herbicide uptake and reducing treatment efficacy.
    Recommendation: While stem injection is sometimes the most appropriate treatment method, it should be used sparingly, and foliar applications should be applied as a preference on all Nimpkish River sites. Starting in 2022, all sites should be treated using foliar applications of Habitat Aqua wherever possible. This change of application method and herbicide will target the knotweed in a different way and will likely result in higher treatment efficacy.

Training & Safety

11. Maintaining experienced and well-trained crews that can successfully detect and treat all sizes of knotweed clones in a variety of site types. Pesticide Applicator certification is required of all crew members conducting herbicide treatments. Members of the 'Namgis First Nation have a long history of living and working in and adjacent to the Nimpkish River, 'Namgis involvement and knowledge is an asset to the knotweed fieldwork.

Recommendation: Continue providing periodic Pesticide Applicator training to members of the 'Namgis First Nation, FLNRORD and industry staff to create more opportunities for project involvement.

12. The Nimpkish River is remote and rugged terrain presenting workplace risks in and around swift water, wildlife, steep or unstable terrain, danger trees, wildfire, heat exhaustion, etc.
    Recommendation: Ensure crew members work in pairs at all times to minimize risk. At least one person per pair should always carry a radio, bear spray and a knife. If an individual plans to be isolated isolated from their crew, the individual should carry the above-mentioned safety items to remain in regular contact with the crew.

13. At times, crews had difficulty maintaining regular contact with other crews using handheld radios or contacting the Fire Centre for safety check-ins using truck or handheld radios.
    Recommendation: Each crew should have at least one Spot or In-Reach device. Each crew should be responsible for their own safety check-ins in case contact with the other crews is not possible.

Equipment

14. Stem injector needles come in short or long form, each are appropriate for a different life stage of the plant. Sometimes stem injector needles bend or break.
    Recommendation: When stem injection applications are expected, each crew should carry spare short and long needles for stem injectors, in order for the treatments to continue as planned regardless of equipment malfunction.

15. Herbicide mix over time can form hard deposits in hoses and valves, causing blockages and impacting sprayer function.
    Recommendation: Backpack and stem injector units should be serviced and tested prior to and following each treatment pass, and thoroughly flushed with water following each treatment day, to ensure that they remain reliable and in good functioning condition. Repair parts and tools should be brought into the field during treatments and applicators should be trained in how to service units prior to treatments commencing.

16. River water is used to refill the backpacks when making the herbicide mix, however naturally occurring sediment and debris in the water can impact sprayer function by obstructing the flow in the hoses and valves.
    Recommendation: When drawing water from the river to refill backpacks for treatment, the person making the collection should stand downstream of the collection site and the opening of the collection jug should face downstream to avoid sediment and debris.

6.0 CONCLUSION & NEXT STEPS

Overall, the survey and treatment results are consistent with expectations. The treatment methods are effectively reducing the knotweed population in the Nimpkish River. However, achieving the goal of eradication will be dependent on consistent, ongoing investment of sufficient resources to detect and eliminate all knotweed clones, which means that the entire area impacted by knotweed must be surveyed and all knotweed clones treated annually.

The ‘Namgis will be invited on an annual and ongoing basis to be involved in the project in the form of supporting project design, participating in annual planning sessions, survey and treatment crews (treatment applicators must hold a valid Pesticide Applicator Certificate) and other project related meetings and activities as interest dictates.

The FLNRORD Invasive Plant Program will be working with the ‘Namgis and North Island District to establish a new three-year PUP to take effect July 2022. All impacted land managers will be requested to provide annual project support in the form of survey and treatment crews. The FLNRORD Invasive Plant Program will continue to coordinate the Knotweed Eradication Project with significant support from the North Island District, as funding and staff resources permit.