Microsite Habitat Characteristics of *Reynoutria spp.* in the Chilliwack River

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Introduction

Knotweed:

Invasive species pose a significant threat to global biodiversity by outcompeting native species[4]. Knotweed, specifically *Reynoutria japonica* (Japanese Knotweed) and *Reynoutria* × *bohemica* (Bohemian Knotweed), has invaded British Columbia through anthropogenic means and is negatively altering the environment. Knotweed is economically concerning due to its ability to grow through buildings, concrete, and damage infrastructure[1]. Ecologically, not only does it decrease native biodiversity it also increases stream bank erosion[2].

Knotweed regenerates vegetatively through rhizomes and can utilise flooding events for long distance dispersal[2]. Waterways, roadways and railways are major vectors of knotweed distribution[2].

Knotweed has successfully invaded the Chilliwack River in the region of Chilliwack, BC . Fieldwork in the summer of 2022 has shown its exponential increase throughout the river system post-flood events (**Figure 1**).

Figure 1: Knotweed measurement and mapping along the Chilliwack River.

Microsite Characteristics:

Studying knotweed invaded and un-invaded site characteristics along the Chilliwack River (**Figure 2**) could provide insight regarding the knotweed habitat preference in comparison to site availability. Research to date provides preliminary insights into knotweed niches and alterations.

- Soil characteristics:
  - Decreases soil pH.[3,5]
  - Alters nutrient cycling of Nitrogen and Phosphorus.[3,4]
- Habitat characteristics:
  - Prefers open areas of increased disturbance.[6]
    - Increased slopes.
    - Low biodiversity.
  - Reduce biodiversity of plants.
    - Grow monocultures.[6]
  - Reduce arthropod abundance and diversity.[7]

Differentiation between knotweed habitat alterations and preferred site characteristics can help manage invasions by allowing one to predict susceptible sites beforehand. Therefore, the main objectives of this study are:

1. To document the knotweed habitat along the Chilliwack River.
2. To determine the preferred site characteristics of knotweed.
3. To integrate recorded site alterations by mature knotweed.

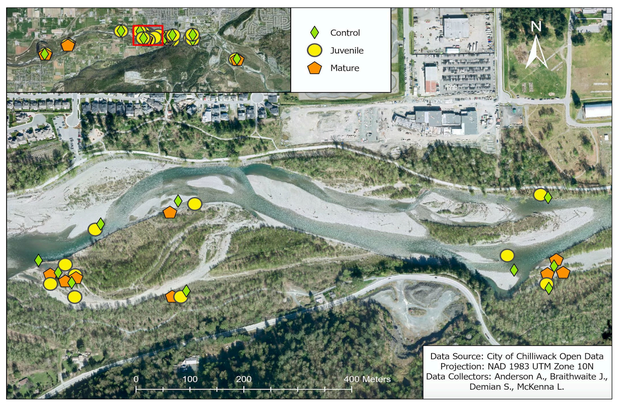

Figure 2: Locations of randomly selected knotweed stands and control sites along the Chilliwack River, BC.

Methodology

- Timeline: June-August 2023.
- Location: Along the Chilliwack River between the Great Blue Heron Nature Reserve and Keith Wilson Bridge.
- Data collection:
  - Randomly selected sites based on 2022 survey (**Figure 2**).
  - Control sites compared to mature and juvenile knotweed stands.
    - 2x2m control sites were selected adjacent to knotweed sites, greater than 2m away.
    - Knotweed stands with 1-5 shoots and a height <50cm were considered juvenile (**Figure 3**).
    - Knotweed stands with 10+ shoots and a height >200 cm were considered mature (**Figure 3**).

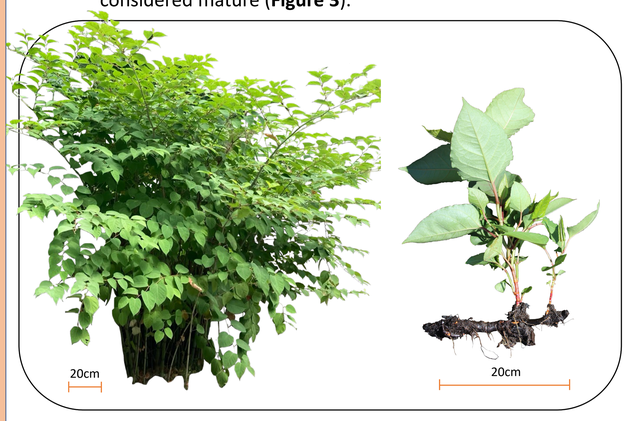

Figure 3: Mature stand (left) and juvenile stand with rhizome (right).

Microsite Characteristics:

- Soil pH
  - Measured using Kelway Tester Model HB-2 soil pH meter.
- Soil type
  - Soil type (i.e sandy, sandy loam, clay) was recorded according to texture.
- Bank slope
  - Recorded using a Suunto clinometer.
- Soil nutrients
  - Three soil samples from each site type (mature, juvenile, control) were sent to Element soil testing facility for chemical analysis.
- Surrounding plant and arthropod diversity.
  - The Shannon Diversity Index calculation was used to determine plant and arthropod diversities.
  - $H = -\sum_{i=1}^{S} p_i \, lnp_i$
  - Arthropods were collected using pitfall traps set for 5 days.
    - Specimens then filtered through 2mm mesh and counted under dissecting microscope.
- Channel morphology
  - Riverbank features were recorded at each site.
  - Categories included: islet, island, straight, cut bank or point bar.

Statistical Analyses:

- T-tests used to compare the between control/juvenile against mature sites
  - To determine the effects of knotweed on its environment.
- T-tests used to compare between mature/juvenile against control sites.
  - To examine whether knotweed is seeking preferential locations.
- ANOVA of plant diversity index among the three site types.
- Pearson's Chi-squared tests used for soil type and river morphology comparisons among the site types.

Results

Figure 4: Plant percentage composition between sites.

- No significant differences were found in invasive and native plant species composition among the three site types (**Figure 4**).
- The differences in Shannon diversity index were not found to be significant based on an ANOVA with an F-statistic of 0.52 and p-value of 0.59 (**Figure 5**).

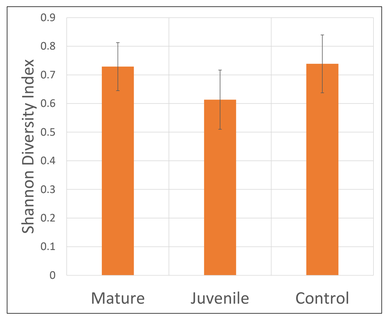

Figure 5: Plant diversity index scores between sites.

- Comparing between mature/juvenile against control sites did not result in any statistically significant findings for slope nor pH (**Table 1**).
- There was a significant difference in pH when comparing mature/juvenile against control sites (**Table 1**).
- No significant results were found among sites when analyzing river morphology nor soil type (**Table 2**)

Table 1: t-test results for pH and slope comparing between sites.

Variable	Mean		P-value
	Mature (N=15)	Juvenile with Control (N=28)	
Slope	11.0 +/- 2.2	8.2 +/- 2.1	0.40
pH	6.65 +/- 0.06	6.54 +/- 0.08	0.46
	Mature with Juvenile (N= 27)	Control (N= 15)	
Slope	10.8 +/- 2.0	6.9 +/- 2.5	0.24
pH	6.54 +/- 0.06	6.75 +/- 0.06	0.04*

Table 2: Chi-squared results comparing soil type and channel morphology between sites.

Comparison	Chi-Squared Value	P-value
Soil type	12.17	0.14
Channel morphology	1.1	0.98

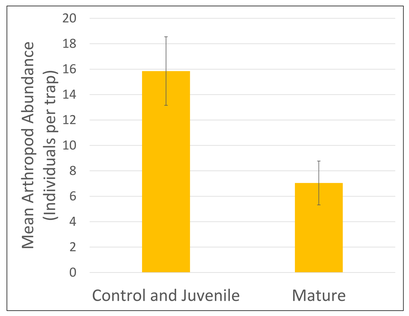

Figure 6: Arthropod abundance comparison. N=42 for control/juvenile, N=21 for mature sites.

- A statistically significant difference in arthropod abundance was found between control/juvenile against mature sites (**Figure 6**).
  - T-statistic of 2.2
  - p-value of 0.03
- No significant differences were found between control sites compared to juvenile/mature sites.

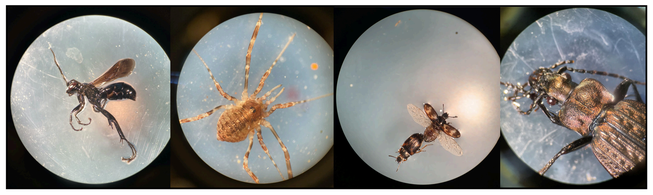

Figure 7: Example arthropods collected in pit traps during field surveys. From left to right: *Sphex* sp., *Phalangium* sp., *Phaleromela variegate*, *Carabas granulatus.*

- No significant differences in arthropod species diversity were found between sites.
  - A total of 762 arthropods were collected 21 locations (7 per stand type) over three collection periods.
- Advanced soils analysis completed by Element showed concentrations of four soil chemicals all within the deficient and marginal ranges (**Figure 8**).
- T-tests showed that the only statistically significant difference was found in the phosphorus concentrations comparing mature stands vs juvenile stands and control sites (**Table 3**).

Table 3: T-test results comparing soil chemical concentrations between mature, juvenile and control sites.

Variable	Mean (ppm)		P-value
	Mature (N=3)	Juvenile & Control (N=6)	
Nitrate	1.9	2.1	0.47
Phosphorus	5.6	7.3	0.02*
Potassium	32.6	41.3	0.12
Sulphate	2.3	6.0	0.25

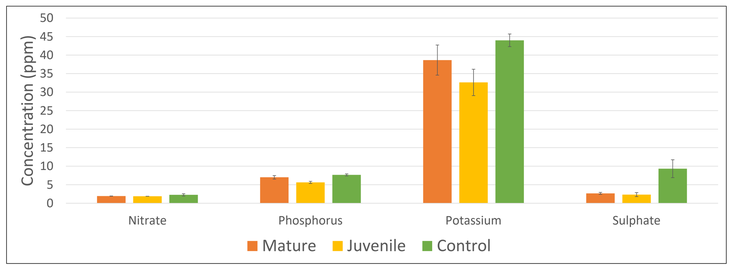

Figure 8: Mean soil chemical concentrations for mature (N=3), juvenile (N=3) and control (N=3) sites.

Discussion

In a riparian habitat, knotweed does not appear to have major preferential selection but does have habitat transformation ability.

- Knotweed preference:
  - No preference for:
    - Soil nutrients, bank slope, plant diversity, channel morphology or soil type.
  - Possible preference for:
    - Soils with a lower pH.
      - Mature and juvenile knotweed sites had more acidic soil than the control.
      - Suggesting that knotweed does not alter the soil pH but rather better regenerates in a lower pH.
- Knotweed habitat alterations
  - Decreased soil phosphorous concentrations.
    - Mature knotweed soil exhibited less total phosphorous suggesting an alteration of the soil by the plant itself.
    - It is important to further test this preliminary result on a larger scale and consider how this might impact an environment with increased native flora.
  - Knotweed did not decrease plant species diversity to a noticeable degree.
    - The Chilliwack River is dominated by invasive species and has relatively low diversity levels.
    - This likely accounts for the lack of observable alteration of plant diversity by mature knotweed stands.
  - Arthropod abundance was significantly lower surrounding mature knotweed stands; however, diversity was not affected.
    - Mature stands may act as a potential deterrent for arthropods.
    - Further analysis focusing on species identification could provide insights into potential species-specific effects.

Implications of this research:

- Knotweed was found to have no significant microsite preference, indicating its ability to grow in a variety of conditions—including those with poor soil quality.
- Further demonstration that knotweed reduces habitat quality by reducing nutrient levels.

Therefore, it is critical that knotweed invasions via flooding are quickly controlled to prevent the species from overtaking currently unaffected waterways and damaging additional environments.

Acknowledgements

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