Climate change and the spread of *Reynoutria* spp.

along the Chilliwack River post 2021 flood

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Introduction

ORIGIN AND INVASIVENESS

- Knotweeds are some of the world's most invasive species as they outcompete native vegetation.[1]
- Japanese knotweed (*Reynoutria japonica*) and giant knotweed (*Reynoutria sachalinensis*) hybrid populations (*Reynoutria* x *bohemica*) produce viable seeds; however, in general knotweed (*Reynoutria* spp.) regenerates mostly from its rhizomes.
- Growth can occur from very small rhizome and stem fragments that include at least one node.[2] These fragments, as well as seeds, can spread through rivers due to their buoyant nature.[2]

Mechanisms of *Reynoutria* spp. that promote evolution:[3]

1. **POLYPLOIDY**
2. **HYBRIDIZATION**
3. **LOCAL ADAPTATION**
4. **CLONAL GROWTH**
5. **PHENOTYPIC PLASTICITY**
6. **EPIGENETICS**

Figure 1. Knotweed stands growing amongst wood debris in the river and beside it.

CHILLIWACK RIVER AND CLIMATE CHANGE

- The November 2021 Pacific Northwest floods prompted a state of emergency for British Columbia.[4]
- Slide damage, bridge collapses, floodwaters, and loss of life for people and animals were recorded.[5]
- The erosion of the riverbanks, a result of the floodwaters, led to a change in the course of the Chilliwack River by causing certain areas to collapse.
- Human-induced climate change is changing key aspects of the environment like rainfall, temperature, and the occurrence of extreme weather events; the probability of an atmospheric river to the scale of the 2021 event increased by more than 60% since the pre-industrial climate.[5]
- Invasive species tolerate a broader spectrum of environmental conditions than native species due to their high adaptability.[6]
- Climate change and invasive species interact and create problematic synergetic effects.[7]

ACKNOWLEDGEMENTS

We would like to thank Jaylene Braithwaite, Lauren Mckenna, Hannah Munnalall, and Alexis Graves for collecting field data; to Kathy Ma Green from FVISS for her guidance; to WSSA, NSERC, The Knotweed Lab, and TWU GENV and BIOL departments for their funding support; and to Sefa Tese and Joshua Demian for their design assistance.

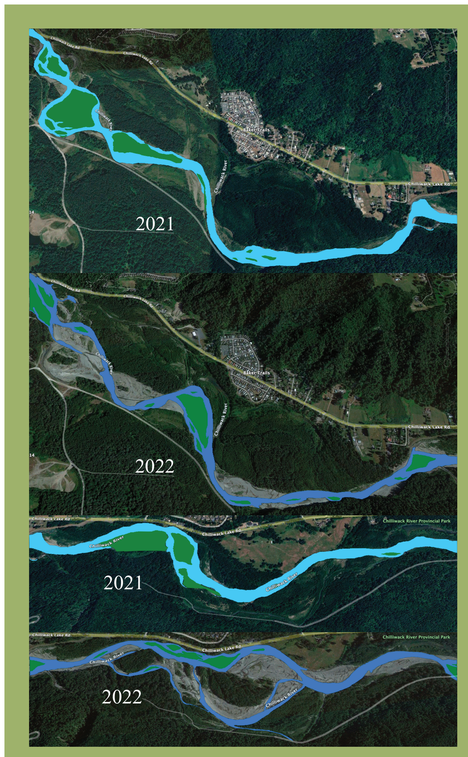

Figure 2. Observable Chilliwack River course changes post November 2021 flood.

- The flooding event changed the course of the river (Fig. 2).
- The neighbouring trees have been wiped out and carried to new locations along the river.
- Knotweed was frequently observed growing amongst wood debris (Fig. 1).

Results

1,690

knotweed patches were observed in 2022, compared to 341 knotweed patches in 2019 (Fig. 3).

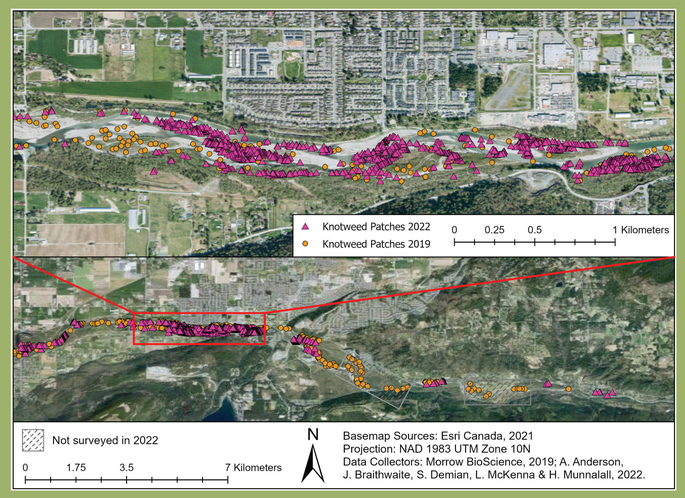

Figure 3. Map of knotweed patches from Chilliwack River surveyed in 2019 compared to 2022.

76%

of knotweed patches were under 100 cm in height in 2022. Stands/patches as short as 3 cm and as long as 780 cm were observed.

In areas surveyed in both 2022 and 2023:

- 55 patches in 2022 (**75% surviving in 2023**)
- 112 patches in 2023 (**63% new**; Fig. 5)

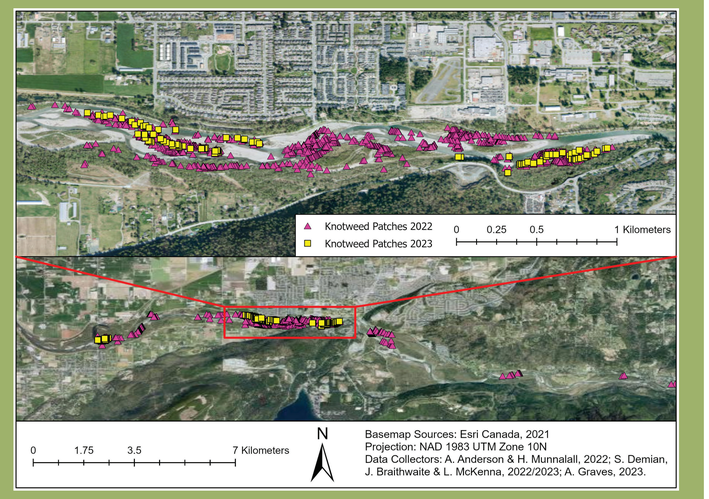

Figure 4. Locations of select knotweed patches at Chilliwack River surveyed in 2022 compared to 2023.

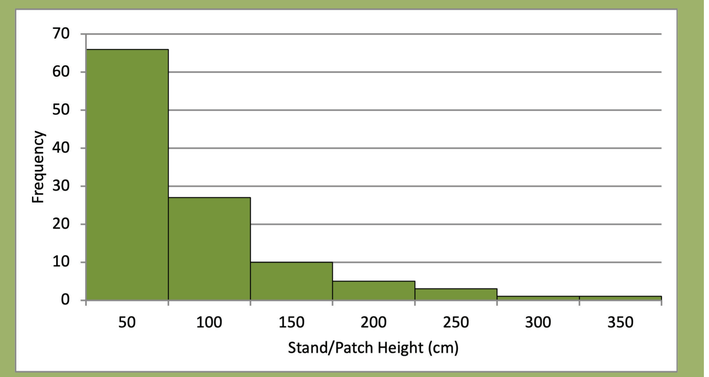

Figure 5. Histogram of the height distribution of knotweed stands and patches in 2023.

Methodology

FIELD SURVEYS

- Data points were collected from the Great Blue Heron Nature Reserve to Tamihi Creek Campground (British Columbia, Canada).
- Surveys were conducted on foot.
- Garmin GPS receivers, measuring tapes, and clinometers were utilized.

DATA COLLECTION

- Data from July/August 2022 and August 2023.
- Coordinates, height, length, width, presence of dead stems, isolated occurrence or in a patch, and stands per m^2.

ANALYSES

- ArcGIS Pro version 2.9 for comparison maps.
- Excel for size distribution histograms.
- Google Earth Pro to highlight the river course change.

- In 2023, the survey focused on the most densely concentrated knotweed patches.
- Only patches located along pedestrian routes on both islands and the main path were chosen for examination (Fig. 4).

Discussion

- Nearly a five-fold increase of knotweed was observed in 2022 compared to 2019.
- Knotweed patches were continuing to grow two summers after the flood in 2023.
- This updated survey of knotweed locations along Chilliwack River is beneficial for management and eradication purposes.
- Reducing the spread of knotweed is crucial for the survival of native plants within the ecosystem.[1] The increase in invasive species is majorly connected to a changing climate, as shown in Fig. 6.

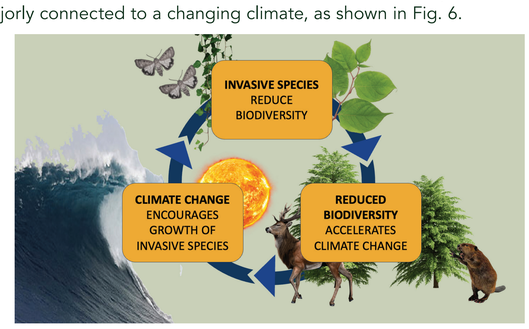

Figure 6. Visual representation of the relationship between climate change, invasive species, and biodiversity.

CLIMATE CHANGE SUPPORTS INVASIVE SPECIES

- Extreme weather events cause native species to lose their natural advantages.[8]
- Flooded rivers provide new pathways for invasive species to spread.
- Elevated atmospheric CO_2 levels can enhance CO_2 uptake by plants, influencing herbicide resistance.[13] Herbicides are often the most effective treatment for invasive plants.[13]

INVASIVE SPECIES REDUCE BIODIVERSITY

- Invasive species destroy habitats as they establish in new environments which lack their natural predators.[9]
- Invasive plant species spread aggressively, which for some invaders leads to the loss of native species from allelochemicals (stilbenes and catechins) and limited access to light.[1]

REDUCED BIODIVERSITY ACCELERATES CLIMATE CHANGE

- Atmospheric CO_2 levels increase from the decrease in carbon sinks (this contributes to the greenhouse effect).[10,11]
- Biodiversity loss disrupts pollination, and a decline in pollinators decreases ecosystem stability.[8,12]
- Biodiverse ecosystems provide natural buffers, mitigating the impact of extreme weather events.[11]

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