Strengthening Invasive Plant Management in Alberta

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SHAUNA-LEE CHAI AND DIANA STALEY

SUMMARY

Alberta has about one-half the total number of invasive plant species present in Canada (279/580 species). The economic cost to control just one new highly invasive plant species was calculated at CAD $100 million over 20 years (calculated for Japanese knotweed). With the risk of invasive species rising in the Northern Hemisphere, preventive strategies should be devised and effectively implemented, including an evidence-based approach to invasive plant management. This approach includes the use of risk assessments, economic analyses, species distribution models, field studies to quantify invasive species impacts and control efficacy in local ecosystems.

There is however currently a paucity of science and applied research in invasive plant programs in Alberta, and scientists and practitioners should begin to work together on areas of mutual interest. The result would likely be an increase in management effectiveness, and a stronger business case for both invasive plant management and science.

1.0 INTRODUCTION

With renewed momentum towards implementing the *Invasive Alien Species Strategy for Canada* (2004), a Federal-Provincial-Territorial Invasive Alien Species Task Force was struck by Ministers in 2015 to identify key actions to support continued progress on implementation of the Strategy. In support of this momentum at the national level, provinces such as Alberta, Ontario and British Columbia took steps to update their Invasive Species Frameworks, and formulate new strategies.

An *Invasive Species Framework Workshop* was held in Edmonton, Alberta from July 10-11, 2017. All invasive species programs supported by the Government of Alberta were reviewed with the objective of building a framework for a more effective invasive species program for Alberta. Invasive plant programs consisted of public awareness and education, weed identification, biocontrol releases, spraying, annual surveys, training of weed inspectors, and research on control methods.

From the workshop, it was evident that invasive plant management in Alberta could be strengthened by adopting a more evidence-based approach. This whitepaper will highlight the need for increased science and applied research to inform invasive plant programs in Alberta. The objectives are to describe the role of science and applied research in invasive plant programs, to provide information on the number of invasive plant species in Alberta, and to provide an economic cost evaluation for Japanese knotweed, a new invasive plant in Alberta.

2.0 THE ROLE OF SCIENCE AND APPLIED RESEARCH IN MANAGING INVASIVE PLANTS

Over the past few decades, invasive species management has been the subject of criticisms that deny the impacts invasive species can cause (e.g. Ricciardi & Ryan, 2017; MacLean's 2017). This denialism underscores the importance of science in invasive species management. Often however, invasive species program elements and budgets are diverted away from science towards public education and awareness that use generalizations in their messaging, without credence to scientific evidence of harm that can be caused by a species in a local context.

Public awareness and education campaigns often use language such as 'kills wetlands' or 'creates biological deserts' to effect behavior change in the public, which is in line with the precautionary principle often adopted in decision-making on environmental issues (CBD, 1992). The precautionary principle suggests that preventive action should be taken even in the face of uncertainty, and that lack of evidence should not delay decisions to safeguard a particular resource. The principle does however extend beyond this, with specific mention to the 'burden of proof' that should be provided by the proponents of an activity (CBD, 1992, Kriebel et al., 2001). In the case of public awareness campaigns, the proponents bear this burden of proof. Often however, resources dedicated to invasive species issues are limited, and do not allow for the simultaneous pursuit of scientific evidence to back public awareness campaigns or other management activities especially in a local context. For example, the National Invasive Alien Species Partnership Program, initiated to spur science and research to support the Invasive Alien Species Strategy for Canada lasted only five years (2005-2010).

2.1 Science in Governance and the "knowing-doing gap"

Science can be used to improve management or governance through:

1. Assessment: Integrating the best available knowledge, comprehensiveness, literature reviews
2. Independent advice: 3rd party validation
3. Providing solutions: Contributing to solutions for challenges

(Van Der Hel and Biermann, 2017)

There is however a disconnect between invasive species practitioners/managers and scientists, both in Canada and internationally (Matzek et al., 2014, Pullin and Knight 2005). The disconnect can be referred to as "the knowing-doing gap". The reasons for this "culture-clash" are summarized as follows:

1. Scientists' lack of interdisciplinarity or inability to connect science with the needs of society
2. Poor scientific literacy or insufficient expertise on the part of managers and practitioners
3. Lack of practitioner involvement in the planning of research
4. Practitioners' inability to access published scientific literature
5. An academic system that does not incentivize scientists' participation in policy or practice
6. Mismatches in scale, budget, or approach between scientific experiments and management activities

(Matzek et al., 2014)

2.2 Using science to inform invasive species programs in Alberta

At the interface of science and invasive species management in Alberta, the following focal areas emerge:

1. Desktop studies that yield invasive species control options, risk assessments, economic analyses, distribution models and amalgamated data
2. Field studies designed to elucidate invasive species impacts on local ecosystems. (Under the status quo, the same general statements and foreign studies are cited repeatedly, for example, “the species reduces biodiversity”, “displaces native species”, and “reduces forage”.)
3. Climate change impacts on invasive species and their interactions with native ecosystems.
4. Testing new control options for invasive species. (Some invasive species have few or no approved control options available to practitioners.)

If scientists and practitioners can work together on areas of mutual interest to pursue an evidence-based approach to invasive species management, the result would likely be an increase in invasive species management effectiveness, and a better business case for both invasive species management and science.

3.0 THE NUMBER OF INVASIVE PLANT SPECIES IN ALBERTA

Alberta, along with the other prairie provinces still have relatively low to medium numbers of invasive plant species compared with central Canada (279, 282 and 265 species in Alberta, Saskatchewan and Manitoba in 2015 respectively, compared with 567 and 496 species in Ontario and Quebec respectively; Figure 1). Invasive plant species numbers were calculated using the *Canada Wild Species Reports* (CESCC, 2016, 2011, 2006) to record non-native species presence by province, and then selecting invasive species (from the list of non-natives) using the USDA Composite List of Federal and State Noxious Weeds (USDA, 2017) combined with the Preferred Common & Scientific Names of Weeds in Canada (CWS, 2014). Using this methodology, Canada has 580 invasive plant species in total.

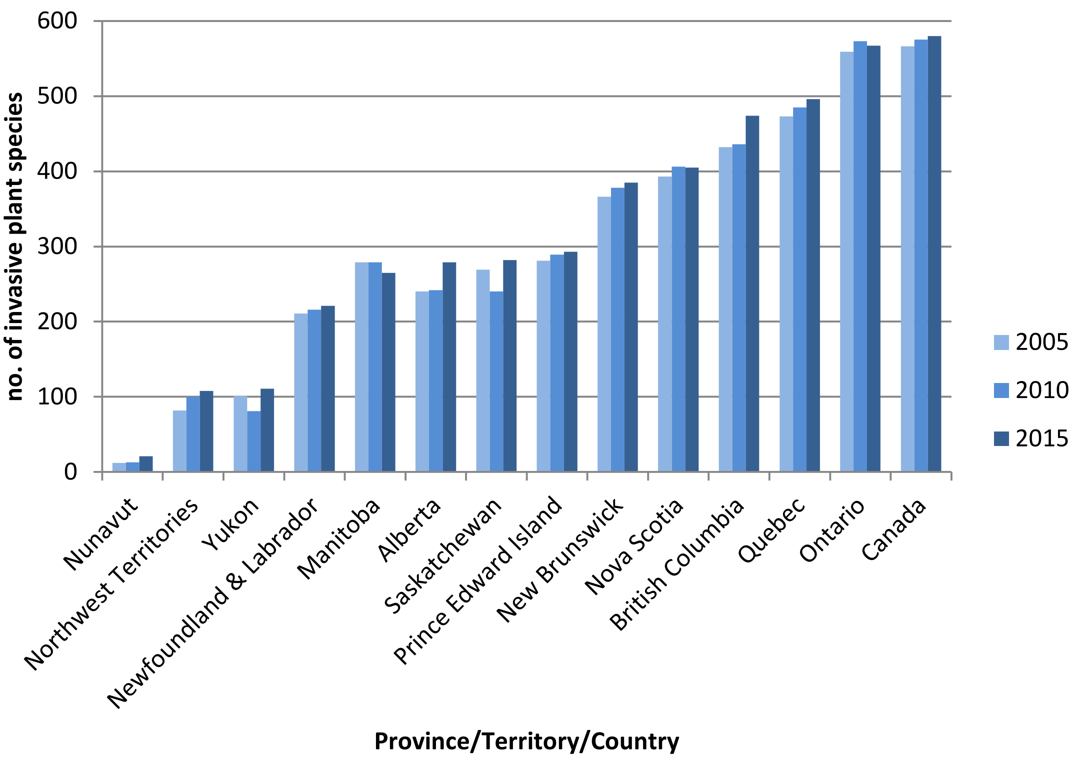

Figure 1. Number of invasive plant species across Canada. Figures were compiled using Wild Species Reports (CESCC, 2016, 2011, 2006) to confirm species presence and invasive plant lists from the USDA (USDA, 2017) and Canadian Weed Science Society (CWS, 2014) to confirm invasiveness. Note that temporal trends may be confounded by detection lags and species taxonomy.

Alberta is insulated from invasive plant species by virtue of its location, with the Rocky Mountains providing a physical barrier to dispersal of many species and the lag relative to Eastern Canada in European settlement (Langor et al., 2014). Alberta can expect most of its invasive plant species to arrive from Eastern Canada or to southern Alberta from the USA. For example, there are 317 invasive plant species currently present in Ontario that have not yet reached Alberta (using 2015 Wild species reports).

These include invasive species such as kudzu (*Pueraria montana*), Eurasian Water-milfoil (*Myriophyllum spicatum*) and dog strangling vine (*Cynanchum rossicum*). Thus, the optimal strategy for Alberta is preventing new species invasions (Kim et al., 2006). Alberta still remains in a good position to prevent new introductions if proactive strategies can be devised and effectively implemented. Fewer species usually means fewer control projects to be initiated and maintained.

4.0 ECONOMIC IMPACTS OF JAPANESE KNOTWEED IN ALBERTA

Japanese knotweed (*Fallopia japonica*; sensu lato) is a newly invasive plant species to Alberta. It has only been detected in approximately 9 municipalities (where it is uncommon). We used Japanese knotweed to quantify the economic impact that a single, new, highly invasive plant species can have on Alberta. Since Japanese knotweed is in a nascent stage of population growth, we illustrate the potential costs of the species, if it were to become more prevalent over a 20-year period where it is already present in the province (Leduc, Calgary, Grande Prairie, Sylvan Lake, Trochu, Crowsnest Pass, Cypress, Brazeau, Parkland; Alberta Weed Mapper) as well as where it may expand into new areas.

4.1 Methods

There are multiple methods and combinations of treatments for Japanese knotweed that can be factored into an economic analysis. We selected the treatment option that utilised the herbicide, glyphosate, as it has been deemed the primary and most effective treatment method for large-scale management of Japanese knotweed. Because we examine economic costs over a 20-year period, we assume that the species will not stay localized in small areas of the province, and therefore a method of application whereby herbicide can be sprayed onto a large area of the weed (broadcasting) at one time is used in the analysis.

A 20-year time period was chosen to assess economic impacts, as we assume that management options will remain relatively constant over that time period, and the timeframe can provide an assessment over the long-run.

The cost analysis is broken down by the economic impacts that affect municipalities versus private residences. Municipalities are generally responsible for public lands, which have unique risk factors and cost structures for managing Japanese knotweed. Our cost analysis provides an opportunity to show how different municipalities that already have Japanese knotweed could be affected by the growth of the species.

The analysis provides a range of results that are possible under different cost scenarios. In general, we focus on "worst-case" scenarios of managing Japanese knotweed to highlight the potential upper bounds of costs that could be expected if the species were to spread. The higher values are more likely to be representative of actual costs, which include both direct (e.g. herbicide cost) and indirect costs (e.g. invoicing, consultations, and permit processing). We did not include preventative measures, since those are considered the least-cost approach.

The approach to the economic analysis was to consider several different scenarios, which could provide a range of possible results. The multiple-scenario approach is valuable where there is significant uncertainty about the possible outcomes. In this case, there is uncertainty around how quickly the weed would spread, as well as the discount rates. We provide results for uncertainty in three different spread rates (slow, medium, fast), one treatment rate (50%), and four different discount rates (0%, 2%, 4%, 10%). Discount rates are used to determine how much a current dollar value is worth in the future. The combination of scenarios above produced 12 different possible results, using Monte Carlo simulations. Monte Carlo simulations are a computerized technique that allows a user to account for risk or uncertainty in decision-making. The Monte Carlo first requires a range of possible estimates to be inputted for each uncertain variable; the computer program then selects a random value from each specified range, and conducts a calculation based on the value selected; this process can be repeated hundreds or thousands of times. The results from the Monte Carlo simulations represent the probability or likelihood of a result and are a valuable tool that can be used in forecasting. In this study 1,000 simulations (or random draws from a specified range) were conducted for each of the spread rates and discount rates and then calculated using constant treatment and cost rates.

4.2 Results and Discussion

Annual spread rates of the species were determined through personal conversations with those working in the field in combination with desktop research. It was determined that if left unchecked, at a maximum, a Japanese Knotweed could grow up to approximately the length of an acre in a year; this was considered the maximum in the "fast" spread rate in the simulations with a range of 43 to 64 m; the "medium" spread rate was 22 m to 42 m (up to 2/3 ac); and the slow spread rate was .01 to 21 m (up to 1/3 ac; Table 1). These spread rates could occur in open areas where the plant is not necessarily restricted by barriers such as infrastructure or housing developments.

The annual treatments rates were held constant at 50% because in general it takes on average at least two years to eradicate a new infestation of the species. This means that over a two-year period, 50% of a population would be controlled in the first year and the remaining 50% would be controlled in the second year.

Discount rates are used in the model to capture the value of money over time. For example, a discount rate of 0% signifies that the value today is no different from the value in 20 years; however a discount rate of 10% signifies that the value today will be worth less in the future. Several factors can contribute to discounting, some examples include: inflation rates that could make today's dollar worth less in 20 years; or social/normative beliefs that inherently lead someone to discount the value of an unknown future cost (e.g. someone may not believe that the cost of controlling Japanese knotweed will cost as much as it does today because a new herbicide will be developed that will be more effective). In this study, we model four discount rates that show possible cost outcomes for each spread rate.

Table 1. Sensitivity Analysis of Costs to Manage Japanese Knotweed Over a 20-year Period

Max spread rate (m/year)	Treatment Rate (% of Japanese Knotweed treated)	Discount Rate (%)	Alberta	
			Mean ($)	S.D. ($)
21 (slow)	50%	0%	$ 54,949	$ 31,820
		2%	$ 43,081	$ 25,319
		4%	$ 36,995	$ 20,718
		10%	$ 22,748	$ 13,105
42 (medium)	50%	0%	$ 167,985	$ 31,260
		2%	$ 135,296	$ 26,420
		4%	$ 111,637	$ 21,860
		10%	$ 68,319	$ 13,215
64 (fast)	50%	0%	$ 277,779	$ 31,440
		2%	$ 225,255	$ 25,869
		4%	$ 186,737	$ 21,589
		10%	$ 114,614	$ 13,551

The lowest cost per plant (patch of 1 m^2) in 20 years is $22.7k with a slow spread rate, and the highest discount rate of 10%; the highest cost per plant in 20 years is $277.7k with a fast spread rate and a 0% discount rate (Table 1). The cost of managing Japanese Knotweed ranges widely, and depends on a combination of assumptions including the spread rate, treatment rate, and discount rate. Figure 2 shows what the costs could be if more than one plant/patch were found in a certain location or municipality. To simplify the combinations of costs, an average of the costs for all discount rates across each spread rate was taken to obtain one cost that could be used. Note that even with the slow spread rate, the difference between 1 plant and 5 plants increases substantially from nearly $40k to $197k. This signals the need for an aggressive treatment plan for controlling Japanese knotweed.

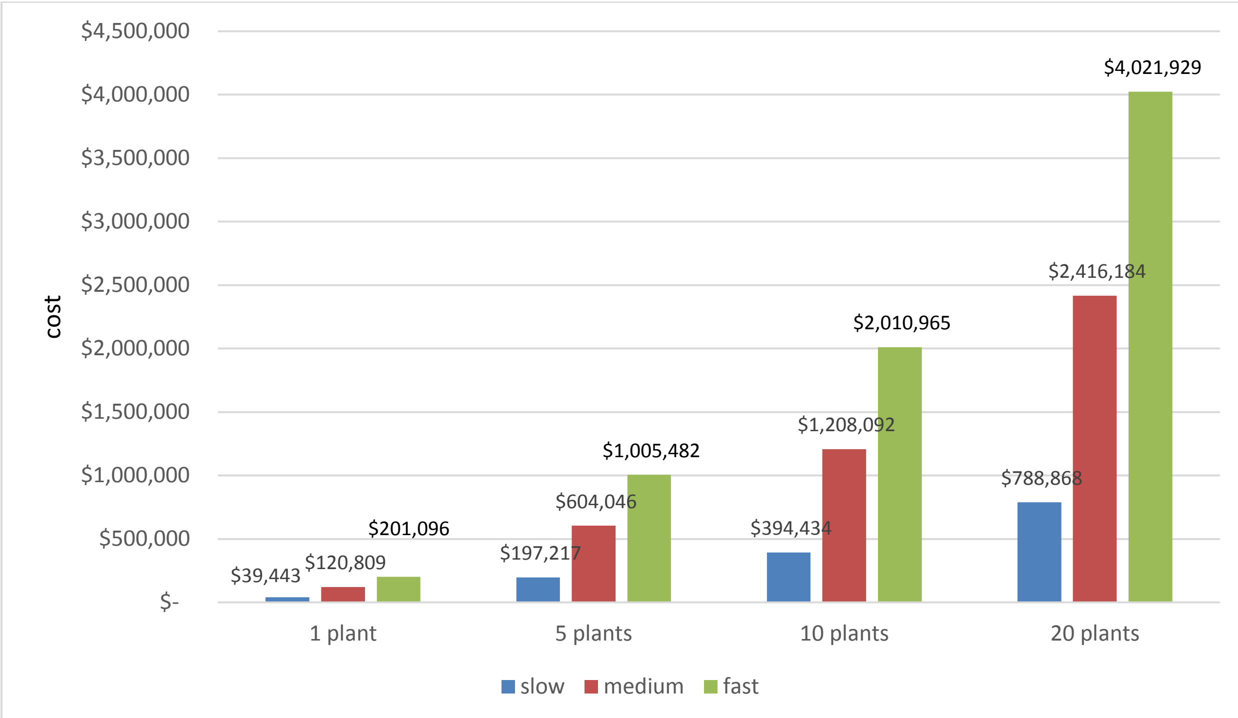

Figure 2. Average cost of Japanese knotweed management across all discount rates, by the number of plants

Finally, we estimated the total cost to manage Japanese knotweed on Municipal lands. The 9 currently invaded municipalities comprise about 3% of the province (Table 2), while the remaining municipalities comprise 97%, and could have 32 plants (97%/3%=32).

We estimated that the 9 sites or plants in currently invaded municipalities (in 2018) could grow to 180 sites or plants in 20 years (using a growth factor of x20 for current invasions), while the uninvaded municipalities (in 2018) could possess 320 plants in 20 years (using a growth factor of x10 for delayed invasions). This gives an estimate of 500 plants (320+180) in 20 years.

It was estimated that in 20 years if Japanese knotweed were to become prevalent, the total municipal cost would be approximately $100 million, or $5.02 million annually. This estimate is similar to estimates for the UK (Williams et. al., 2010). This cost includes direct costs related to the management of the Japanese knotweed, however, it does not include indirect costs. If indirect costs were included, such as labour to manage Japanese knotweed regulations or impacts on other industries, the total cost would increase significantly. Indirect costs are more difficult to measure and obtain, and as such are left out of this analysis.

Table 2. Total cost estimate to manage Japanese knotweed on Municipal lands over 20 years. Municipalities listed are those where Japanese knotweed has already been recorded.

Alberta total area (ha)	**66,118,500.0**	**100%**	**# of plants per area**	**Growth factor**	**# of plants in 2018**	**# of plants in 20 yrs.**
Leduc	4,307.8		9 plants (per 3% area)	x20	9	180 (9x20)
Calgary	84,800.0					
Grande Prairie	13,661.0					
Sylvan Lake	2,264.0					
Trochu	202.0					
Crowsnest Pass	38,039.0					
Cyress Co.	1,327,508.0					
Brazeau Co.	308,130.7					
Parkland Co.	242,595.0					
Sum of 9 municipalities (ha)	**2,021,507.5**	**3%**				
Rest of Alberta	**64,096,992.5**	**97%**	32 plants (per 97% area)	x10	0	320 (32x10)
					Total estimated # of plants in 20 years:	**500**

Sources for area (ha): http://www.municipalaffairs.alberta.ca/mc_municipal_profiles; http://www.nationsencyclopedia.com/canada/Alberta-to-Nova-Scotia/Alberta.html

CONCLUSION

Alberta's invasive plant species program could benefit from increased science and applied research. Specifically, applied research in areas of risk assessments, climate change, economic evaluations, impacts and control could provide the financial impetus for preventing further species invasions. With 279 invasive species already in the province, and 317 more not yet here (but in Ontario), any new arrival such as Japanese knotweed could cost the province 100 million dollars over the next 20 years.

A new fund should be established to spur science and applied research on invasive plant species in the province. Results from this applied research should be used as the basis for invasive plant management decisions in the province.

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