

No. 83 Fall 2019

Iris

The Alberta Native Plant Council Newsletter



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Cover photo: Marsha Hayward
Treed fen in autumn, northern Alberta.

City of Calgary's Bioengineering Demonstration and Education Project

Maggie Nelson, Public Program Coordinator, City of Calgary

The City of Calgary and Government of Alberta have partnered to create a project that demonstrates how bioengineering can be used to improve fish habitat and stabilize eroding river banks. The project is located on the bank of the Bow River between Pearce Estate Park and the Inglewood Bird Sanctuary. Our goal is to increase awareness and understanding of how soil bioengineering structures are built, what benefits they can bring to our watershed, and how they might be used to mitigate the impacts of future flood events.

Bioengineering is the science of using living plants and other natural

materials, like wood, to stabilize riverbanks and reduce erosion. Bioengineering techniques help to create fish and wildlife habitat, improve water quality and increase our resiliency to future flood and drought.

Bioengineering is not a new practice; however, the incorporation of bioengineering technology into stream bank erosion protection or flood mitigation works has been limited in Alberta, until recently, because of factors such as a lack of familiarity with techniques, concerns about long-term sustainability, cost, lack of available design and construction expertise, and a lack of opportunity.

City of Calgary



Bioengineering demo and education project along the Bow River in Calgary.

See **Bioengineering Demo Project**, page 8

Monitoring the Effectiveness of Long-Term Bioengineering Bank Restoration in the City of Calgary

Mike Gallant, MScE, P.Eng.

Water Resources Engineer, Kerr Wood Leidal Associates Ltd.

Healthy riparian areas provide many ecological, social and economic benefits, including water quality protection, resilience to floods and drought, biodiversity and recreational opportunities. In recognition of these benefits and the importance of healthy riparian areas, the City of Calgary (the City) developed a Riparian Strategy in 2013 and a Riparian Action Program (RAP) in 2016 to implement the strategy.

Monitoring over 80 riparian and bank restoration projects completed over the last decade and 30 projects planned for the next few years has been identified as a key action to meet the City's riparian restoration targets. The City initiated the Riparian Monitoring Program (RMP) in 2017 to support the goals and objectives of the RAP and retained a consultant team consisting of Kerr Wood Leidal Associates Ltd. (KWL) as prime consultant with partners Terra Erosion Control Ltd., Alberta Riparian Habitat Management Society (Cows and Fish), France's National Institute for Environmental Science and Research (Irstea), and Longview Ecological Ltd.

The RMP is a five-year program (2018-2022) with the goal of providing a better understanding of (1) long-term riparian health trends, and (2) the improvements in riparian health resulting from recent and ongoing riverbank bioengineering and riparian restoration projects in Calgary. Other key goals are to evaluate the effectiveness of riparian planting and bioengineering restoration techniques, and to provide recommendations on system improvement including design approaches and maintenance procedures.

The effectiveness monitoring component of the RMP consists of monitoring to assess post-construction project site conditions and to evaluate changes resulting from the implemented projects. The technical details of the RMP were developed in 2017-2018 and include field data forms, field data collection procedures, data analysis protocols, and reporting templates. Fifty-five bioengineering bank restoration sites were selected to be monitored at least once over the five-year RMP.

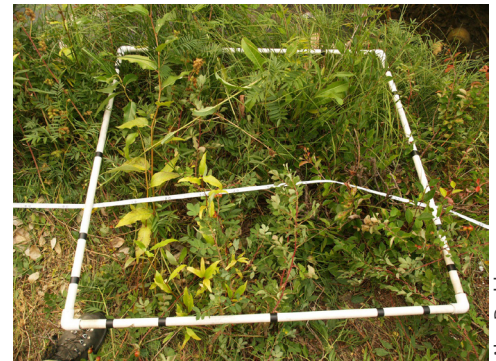
The annual data collection, analysis and reporting program began in the summer of 2018, where 19 bioengineering riverbank sites underwent detailed effectiveness monitoring. Statistical analysis from the 2018 data have led to the following advances in understanding of riverbank bioengineering project effectiveness:

- Placing soil amendment around live cuttings results in statistically longer average leader growth.
- Fencing around live cuttings appears to result in higher total live cutting survivorship.
- Reusing native topsoil may result in lower invasive species occurrence.
- Planting ends of live cuttings below the water table can lead to good survival despite harsh conditions.
- Rooted plants' survivorship was statistically higher than live cuttings.
- Following best practices for live cuttings harvest, storage, handling, installation, and maintenance leads to best project outcomes.
- Brush layers were used in the highest-ranking sites. However, other techniques such as live staking also resulted in successful sites.



RMP team discussing field protocols at a site on Nose Creek

Mike Gallant



Quadrat along a transect: components of the RMP vegetation assessment

Alan Dodd



RMP team discussing field protocols at a site on the Elbow River

Mike Gallant

Restoration Monitoring, from page 2

Several areas of improvement were also identified as listed below.

- Six failure sites¹ were identified with the main reasons for failure as follows:
 - herbivory by beavers (no fencing)
 - planting in anoxic soils
 - insufficient planting depth for live cuttings
 - construction inconsistent with design
 - inadequate or no maintenance
- Live cutting survivorship was low for most of the common species used in Calgary. Survival for live cuttings year 1 post-construction was measured to be 26% for balsam poplar (*Populus balsamifera*), 31% for hungry willow (*Salix famelica*), 62% for sandbar willow (*Salix interior*), and 53% for red osier dogwood (*Cornus stolonifera*). Survival for live cuttings year 3 post-construction was measured to be 0% for balsam poplar (*Populus balsamifera*), 44% for hungry willow (*Salix famelica*), 43% for sandbar willow (*Salix interior*), and 100% for red osier dogwood (*Cornus stolonifera*).
- Fourteen different invasive species were found with the most common being creeping (Canada) thistle (*Cirsium arvense*) found at 14 of 19 sites, smooth perennial sow thistle (*Sonchus arvensis* ssp. *uliginosus*) found at 13 of 19 sites, scentless chamomile (*Tripleurospermum inodorum*) found at 12 of 19 sites, and common toadflax (*Linaria vulgaris*) found at 10 of 19 sites.
- Construction timing outside of live cutting dormancy periods, particularly late summer construction, resulted in very low survival at some sites.

As part of the RMP protocols, ratings for design, implementation, maintenance, overall project success, and Bank and Riparian Quality Index (a new indicator developed specifically for the RMP) were assigned to each monitored site. On average, the bank effectiveness monitoring sites scored 60/100. The site with the highest score was Riverdale Phase 2 Downstream, with an overall rating of 92/100.

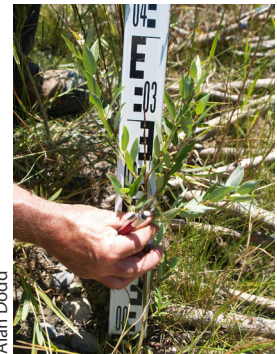
Based on the results and observations above, a series of recommendations were developed. Note that recommendations will be updated annually as more data is collected.

- Improve project documentation and record keeping and share it with the RMP team.
- Apply a soil amendment on live cuttings.
- Put fences around newly installed live cuttings and rooted stock until vegetation is established.
- Avoid planting in anoxic soils.
- Use the appropriate matting products and install according to best practices.
- Where appropriate, use potted plants instead of live cuttings.
- Install potted plants according to best practices.
- Install live cuttings according to best practices.
- Improve maintenance practices such as irrigation, controlling invasive weeds, repairing fencing, and replacing dead vegetation and reseeding poorly established areas.

The 2019 data collection for 21 riverbank bioengineering projects is complete, and results will be analyzed over the next few months. ♦



Alan Dodd

Tags placed on monitored vegetation

Alan Dodd

Measuring vegetation growth

Mike Gallant

Dead live cutting planted too shallow into anoxic soils

Mike Gallant

Successful establishment of live cuttings planted in April (right side of timber cribwall) and failure of live cuttings planted in August (left side of timber cribwall) ♦

¹ For the purposes of the RMP, riverbank bioengineering/riparian restoration failure sites are either due to structure failure or due to vegetation survival rates of less than 25%. Failure sites are removed from the program once reasons are documented and replaced with sites where vegetation data can be collected. The failure sites can be reintroduced into the program if they are repaired and are needed according to the sampling protocols to achieve statistically significant results.

The State of the Prairie

Prairie Conservation Forum, September 11, 2019

About the State of the Prairie PCF (Prairie Conservation Forum) Project: PCF 'State of the Prairie' Steering Committee

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This multi-stakeholder project was undertaken by the PCF and partners to determine the current extent of native prairie in the Grassland and Parkland Natural Regions at multiple scales and to quantify change in extent over time to inform decision-makers and programs. Data was analyzed for the time period of 1990–2010. Further analysis will take place between 2010 and 2020 when data becomes available.

Securing and sustaining the biological diversity of Alberta's native prairie and parkland ecosystems is the reason the PCF exists. The key word here is 'native'. While many species, including native species, can persist in human-modified landscapes, these are invariably simplified ecologies with a reduced suite of species, diminished ecosystem services performance and a greater prevalence of non-native and invasive species. So knowing how much of the Grassland and Parkland Natural Regions are still in native vegetation is of fundamental importance to the PCF.

Numerous provincial and federal vegetation inventories have been undertaken since the early 1990s when the first Native Prairie Reconnaissance Inventory was produced. In 2017, the



Marsha Hayward

PCF decided to look at all the various vegetation inventories, with their different dates and scales and kinds of information that have been captured, and summarize and integrate what is known to date in a State of the Prairie report. In addition to published inventories, the project also included an analysis of TimeScan remotely sensed statistical data provided for free from the German Aerospace Center and analyzed by Maaper Analytics. This data was developed by the German Aerospace Center and examines and calculates spectral indices from Landsat 5, 7 and 8 datasets for time series within a selected analysis period.

The project was overseen by a steering committee of representatives from the PCF Board of Directors with the serious work being undertaken by a technical team of volunteers, retired agency employees and geospatial teams in both Alberta Agriculture and Forestry, and Alberta Environment and Parks. The entire project was undertaken using in-kind support from the PCF membership and with funding from Alberta Agriculture and Forestry and PCF to complete the TimeScan analysis by Maaper Analytics.

Enormous contributions were made by all members of the technical team, but special recognition is due to Livio

Fent who oversaw both the work of the technical team and drafting of the technical report.

State of the Prairie Technical Report: a general overview

The *State of the Prairie Technical Report* is based on a comprehensive broad scale GIS analysis that focuses on two main questions: what is the current extent of native vegetation/features of the Grassland and Parkland Natural Regions, and what change has occurred from the earliest datasets (1990) to the latest (2016). Eleven datasets were used to determine extent, change, verification, and validation of the native vegetation/features results. The data are analyzed by a number of stratifications, at the very broad scale of natural regions (Grassland and Parkland), at the intermediate level of natural subregions (e.g., Mixedgrass), and at the ecodistrict level (e.g., Lethbridge Plain). The data are also analyzed by administrative areas (e.g., Lethbridge County) and by tenure (private vs. public). The analysis did not assess 'state' at the local levels (township, section, quarter section); as such, condition, fragmentation, invasive species and change at the local level are not evaluated in this report.

See **State of the Prairie**, page 5

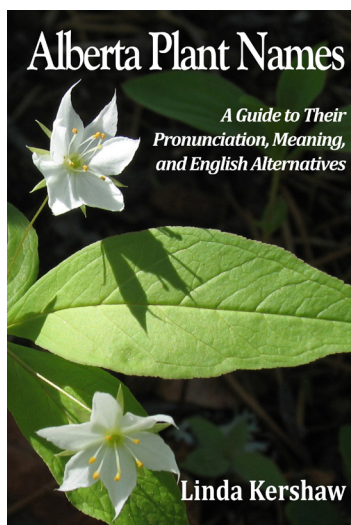
State of the Prairie, from page 4

Over the course of the analyses, three datasets stood out as being most apt to answer the two questions posed. For the Grassland Natural Region, this included the Grassland Vegetation Inventory (GVI) and the Agriculture and Agri-Food Canada Land Use (AAFCLU) datasets. For the Parkland Natural Region, only the AAFCLU data adequately represented the complete region. All these datasets were standardized to mimic the Native Prairie Vegetation Inventory's six classes (graminoid, shrub, trees, water, riparian, wetland). The GVI's compilation window spanned 10 years from 2006 to 2016 whereas the AAFCLU data was compiled for two separate years 1990 and 2010. These datasets provided the basis for assessing 'state' as of approximately 2010 and historical change back to 1990. It should be noted that the AAFCLU is scheduled to be compiled again for 2020 and that a 30-year change should be pursued at that time.

The key results from the analysis show that 'state of the prairie' in terms of the extent or amount of native vegetation/features remaining in the two natural regions is approximately 48% and 20% for the Grassland and Parkland, respectively. The amount of change occurring in the two natural regions between 1990 and 2010 is a decrease of approximately 2%. As the analysis focuses on increasingly smaller areas (subregions, ecodistricts, admin. areas, etc.), the magnitude and variability in the data increases. For example, the ecodistricts with the greatest amount of native cover are the Cypress Hills Slope (92%) and the Ribstone Plain (71%) in the Grassland and Parkland Natural Regions, respectively. The ecodistricts with the lowest amount of native cover are the Standard Plain (9%) and Olds Plain (7%) in the Grassland and Parkland Natural Regions, respectively. The greatest amount of change is seen in the Lethbridge Plain (-8%) and the Black Diamond Upland (-6%) for the Grassland and Parkland Natural Regions, respectively.

These types of analyses are at the core of the technical report and are presented for all the stratifications noted earlier (natural region, subregion, ecodistrict, admin. areas, and tenure), the reader is referred to the report for both the 'state' and 'change' values. Of note is the use of some of the statistical terminology in the report, data significance in particular. When the term 'insignificant' or 'not significant' is used, it is strictly with respect to the error and error analysis inherent in the data; it should not be confused with societal values regarding loss of native cover. For example, the loss of 2% of native cover in the Parkland may be statistically speaking 'not significant' based on the data error, but it will have a completely different meaning in a natural region that has only 20% native cover left. As the technical report notes, the PCF will follow up this purely technical analysis with the second phase of this project, which includes an occasional paper that would contextualize these findings in terms of impacts, condition, fragmentation, threat of loss, conservation, mitigation, and potential options and actions needed.

To view the full report, go to www.albertapcf.org/rsu_docs/state-of-the-prairietechnical-report_final-including-summary.pdf ♦



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Strengthening Invasive Plant Management in Alberta, Canada

Shauna-Lee Chai, PhD, P.Biol. & Diana Staley, MSc, InnoTech Alberta
March 29, 2018

Editor's note: The section "4.0 Economic Impacts of Japanese Knotweed in Alberta" has been removed from this reprint. To access the full report and references, go to abinvasives.ca/wp-content/uploads/2018/06/Chai_-etal_2018-Strengthening-Invasive-Plant-Management-in-Alberta.pdf on the Alberta Invasive Species Council website.

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 toward 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, on 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 white paper 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 and 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 toward 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 behaviour 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: third-party validation
3. Providing solutions: contributing to solutions for challenges (Van Der Hel and Biermann, 2017)

See *Invasive Plant Species*, page 7

Invasive Plant Species, from page 6

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:

- Scientists’ lack of interdisciplinarity or inability to connect science with the needs of society
- Poor scientific literacy or insufficient expertise on the part of managers and practitioners
- Lack of practitioner involvement in the planning of research
- Practitioners’ inability to access published scientific literature
- An academic system that does not incentivize scientists’ participation in policy or practice
- 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:

- Desktop studies that yield invasive species control options, risk assessments, economic analyses, distribution models and amalgamated data.
- 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”.)
- Climate change impacts on invasive species and their interactions with native ecosystems.
- Testing new control options for invasive species. (Some invasive species have few or no approved control options available to practitioners.)

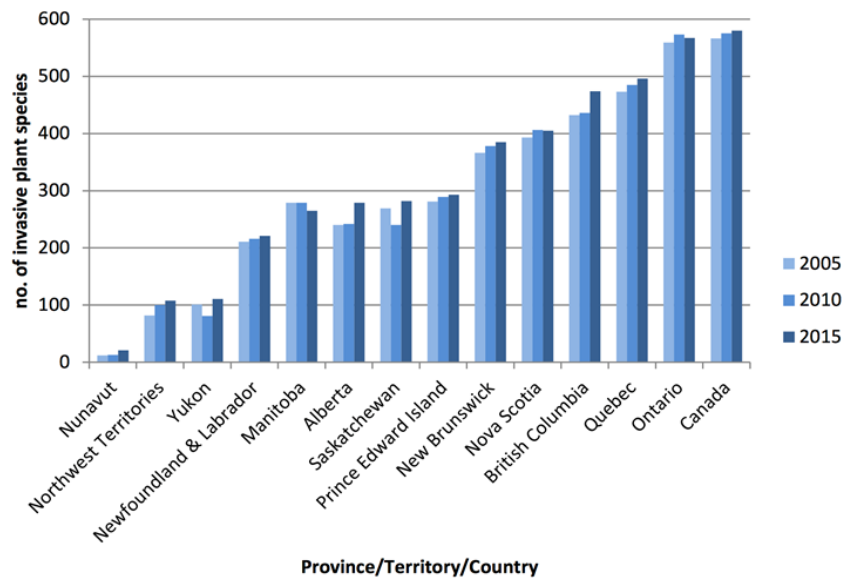


Figure 1. Number of invasive plant species across Canada

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 and 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 and Scientific Names of Weeds in Canada (CWS, 2014). Using this methodology, Canada has 580 invasive plant species in total. 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.

Bioengineering Demo Project, from page 1

The Bioengineering Demonstration and Education Project (BDEP) offers a unique opportunity to urban planners, environmental consultants and engineers to scientifically evaluate soil bioengineering techniques and their use in riparian restoration projects. In Alberta, many native plants such as several willow species can act as structural and mechanical elements to stabilize and naturally protect slopes. These plants can be easily obtained and propagated from cuttings or can be installed on site as live stake, plugs, shrubs or trees. Plant roots help to grab and hold soil, while the plant vegetation helps to slow the flow of water—a two-fold approach preventing further bank erosion.

The advantage to using bioengineering techniques is that they achieve a number of bank stabilization goals while also creating critical fish and wildlife habitat and improving water quality.

Bioengineering techniques can be used for the following:

- Slope stabilization
- Erosion control
- Shoreline protection
- Surface protection
- Control of runoff
- Re-establishment of fish and wildlife habitat

Once complete, the project will see the development of a forested corridor with native balsam poplar trees, willows and shrubs. An interpretive trail will act as a wildlife-friendly corridor designed to facilitate the movement of large and small mammals through the river corridor. The finalized design will provide citizens with areas to socialize and gather, enjoy scenic overlooks and relax by the Bow River. The area surrounding the BDEP site will be made a natural park, meaning it will be mainly composed of native animal and plant life.

Want to learn more about the project? Visit Calgary.ca/BDEP online or stop by the BDEP site and check it out for yourself! ♦

Invasive Plant Species, from page 7

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 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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Submission deadline for the next issue:
December 31, 2019

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