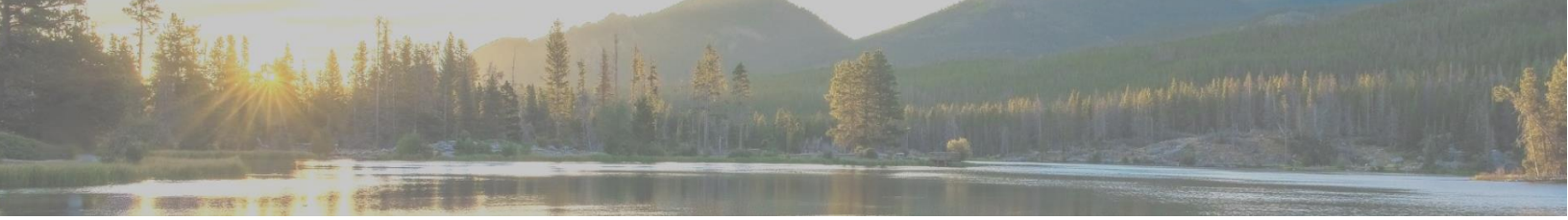
Invasive Species Council of BC

A Road Map for Invasive Species Research in BC

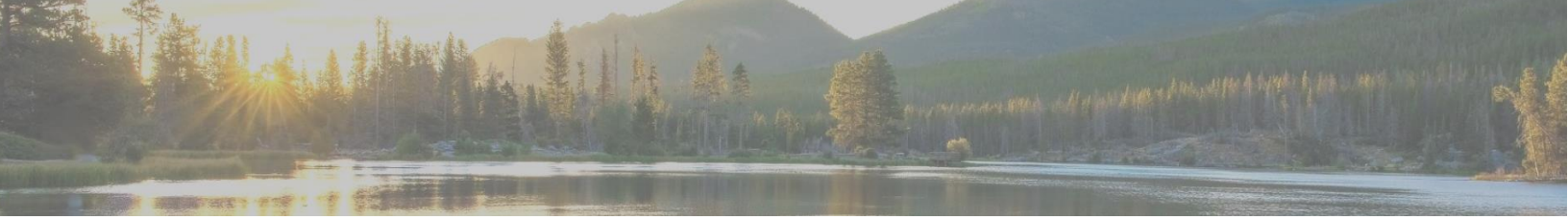
DECEMBER 2020

Healthy landscapes and communities free of invasive species



ACKNOWLEDGEMENTS

The Invasive Species Council of BC would like to acknowledge the input and expertise provided by researchers, managers and others in the development of the “Road Map for Invasive Species Research in BC”. In addition, the Invasive Species Council of BC wishes to acknowledge the financial support for the 2017 Research Conference and the 2020 Road Map update provided by the Province of British Columbia.



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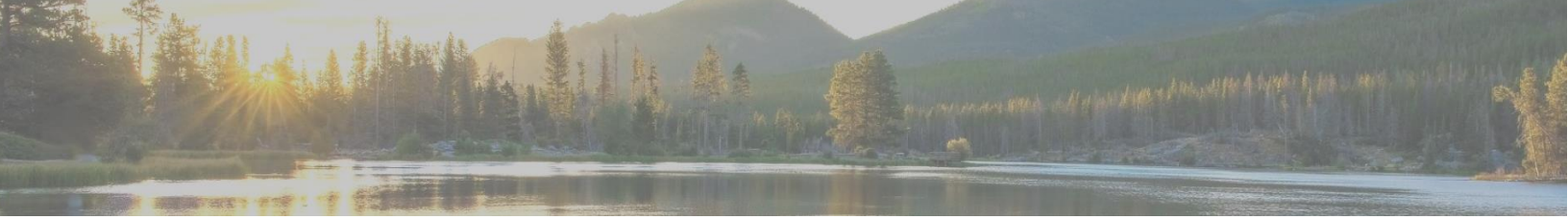


1. Executive Summary

The “Road Map for Invasive Species Research in BC” (the Road Map) is an evolving document facilitated by the Invasive Species Council of BC (ISCBC) with input from invasive species researchers, practitioners and others. The purpose of the Road Map is to share current knowledge and identify research needs with funders and other invasive species experts around the province.

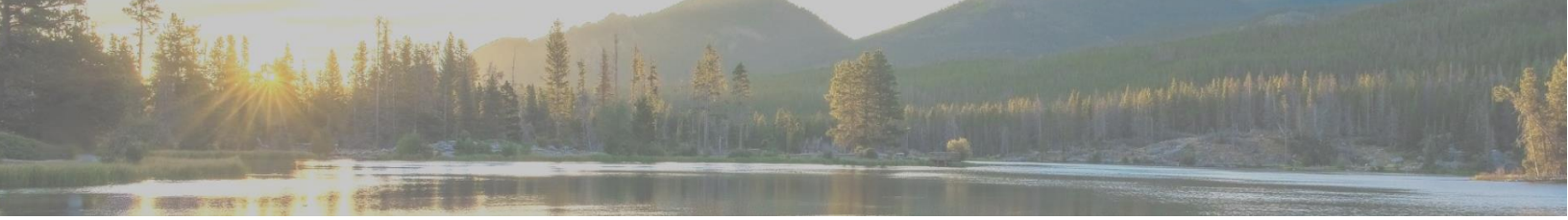
This 2020 Road Map was developed through a collaborative process that included input and consultation during: the 2008 Invasive Plant Research Conference, the 2011 Invasive Species Research Forum and the 2017 Invasive Species Research Priorities and Connections Workshop. Six research themes have been identified as key to determining future needs and priorities for invasive species research relevant to BC:

1. Management Tools
2. Best Management Practices
3. Ecological Restoration
4. Pathways of Invasion and Vectors of Spread
5. Biology and Ecology of Invasive Species
6. Social and Economic Impacts of Invasive Species

Within the Road Map, each research theme includes a brief introduction, an outline of identified key research priorities and indicators of success. The corresponding indicators of success for the identified research themes are:

1. New management methods for priority invasive species are developed and are widely accessible.
2. Best Management Practices for priority species and industries are available for all regions in BC.
3. An increased number of restoration projects across the province and sharing of strategies and successes.
4. Identification and subsequent reduction in number of new pathways of invasion and increased strategies to prevent invasive species spread.
5. Improved ability to predict and manage invasive species introduction and spread.
6. Accessibility of cost/benefit analyses of the social, cultural and economic impacts of invasive species in BC.

Following future Invasive Species Research Conferences, the Road Map will continue to be reviewed and updated based on input.



2. Background and Goal

2.1 BACKGROUND

In 2008, the Invasive Plant Council of BC (now Invasive Species Council of BC) hosted the international Invasive Plant Research in BC: Current Projects and Future Trends Research Conference in response to a call for improved collaboration, communication and the need for a collective vision for increased and coordinated research on invasive species in British Columbia. Collating input from researchers, practitioners and a Research and Development Committee, the 2009 "Road Map for Invasive Plant Research in BC" was developed to share current knowledge and identify research needs with funders and other invasive plant experts around the province.

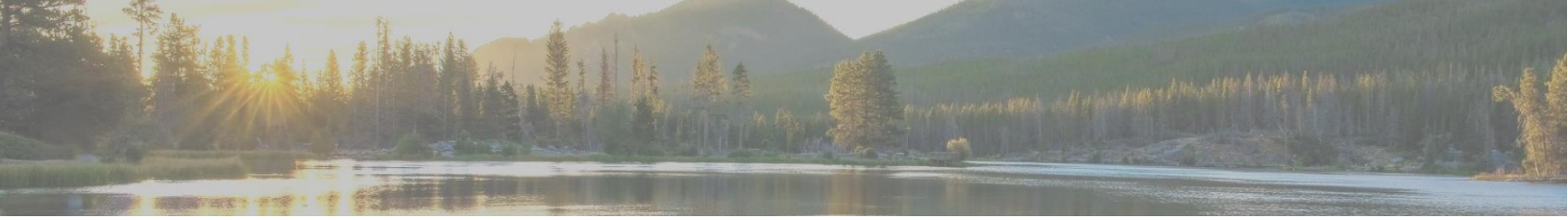
Based on an expanded mandate to include all invasive species, subsequent invasive species research conferences have followed approximately every three years to ensure continued dialogue and input into evolving invasive species research needs and collaboration. This 2020 Road Map was developed based on input and consultation with invasive species practitioners and researchers during the Invasive Species Research Priorities and Connections Workshop during the 2017 Invasive Species Research Conference, held on June 21, 2017 in Kamloops, BC and builds on work and input resulting from the 2008 and 2011 research conferences. This Road Map is inclusive of all taxa and includes six key research themes, key priorities for research, potential funding sources, and key indicators of success.

In 2018, with funding from the British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development, ISCBC and a Research Advisory Team addressed the need for knowledge transfer, collaboration and partnership by developing the user-friendly online *Invasive Species Research Hub*. Launched in 2019, the hub is a searchable database of invasive species experts and practitioners in BC and the Pacific Northwest (PNW) and is an online repository for applicable resources and research while providing a platform and communication tool to facilitate dialogue within the PNW's invasive species community.

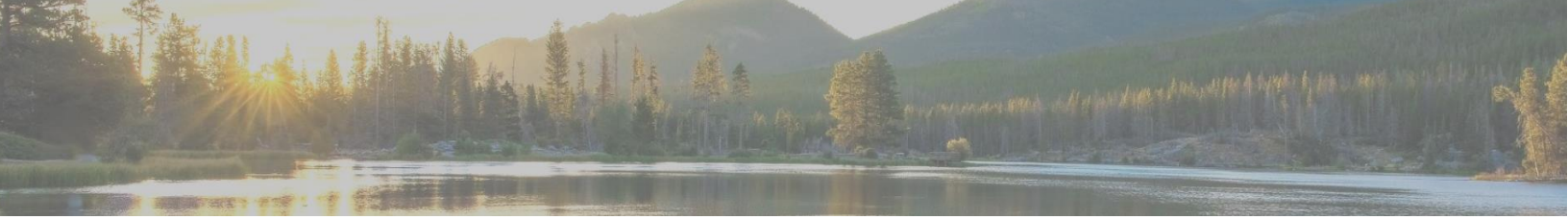
2.2 GOAL

The overall goal of the Road Map, invasive species research conferences and the Invasive Species Research Hub is to support researchers and practitioners to identify gaps in invasive species management and shared needs, and to foster collaboration to prevent and mitigate the negative environmental, economic, cultural and social impacts resulting from the introduction, establishment, and spread of invasive species. Within the Road Map itself, specific goals are identified:

- Identify and address current gaps in invasive species management in BC.



- Foster collaboration and communication for invasive species research across BC.
- Provide a list of research priorities determined by consensus and without bias of individual, agency or organizational mandates.
- Strengthen support for increased funding opportunities for research.



3. Research Themes and Priorities

The focus of invasive species research in BC will inevitably change over time as a result of new invasive species introductions, changing and evolving priorities for management, development of new methods and tools, and as a result of the changing climate. Future updates to the Road Map are expected to continue to reflect advances in invasive species management and associated research occurring across BC.

During the 2017 Invasive Species Research Priorities and Connections Workshop, participants identified thirty research topics relevant to invasive species management research in BC. These topics were then condensed into six key themes to provide a focus for research in BC over the following years. Themes identified in 2008 and 2011 were included. This section of the Road Map introduces the key research themes, associated research priorities by theme, and indicators of success. Appendix 1 includes a list of potential research topics by theme as collated from participants of the 2017 workshop and is not intended to be a comprehensive list.

The six key research themes identified are:

1. Management Tools
2. Best Management Practices
3. Ecological Restoration
4. Pathways of Invasion and Vectors of Spread
5. Biology and Ecology of Invasive Species
6. Social and Economic Impacts of Invasive Species

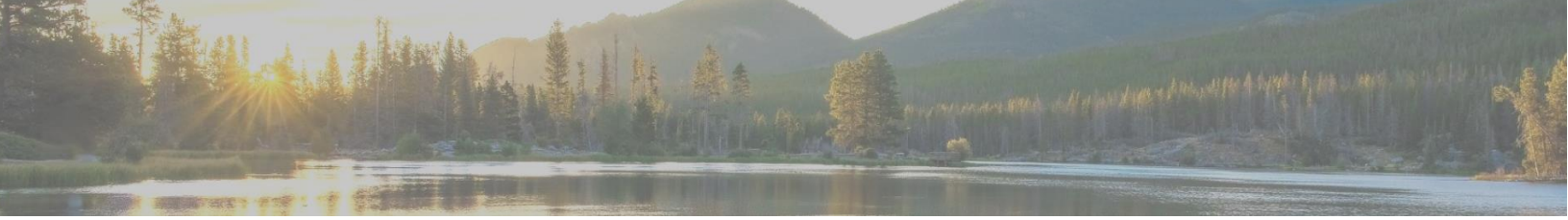
3.1 MANAGEMENT TOOLS

Research into developing new and existing monitoring, treatment and eradication tools and methods will enable researchers and invasive plant practitioners to develop more effective management strategies.

Having a range of available management options, whether mechanical, chemical or biological, can provide greater flexibility should there be constraints with respect to species sensitivities, non-target species, fiscal resources, human health or stakeholder mandates. Ensuring there is wide-spread sharing of novel tools and management options across stakeholders is key to the ongoing success of invasive species management in BC.

The key priorities for research into management tools are:

- Use of unmanned aerial vehicles for detection, mitigation, monitoring and treatment of invasive species.
- New treatment methodologies and products.
- Treatment tools for use in or near water bodies.



- Increased options for bio-control agents.

Indicator of Success #1: New management methods for priority invasive species are developed and are widely accessible.

3.2 BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) are guides developed for use by practitioners who have a role in invasive species management. BMPs provide a compendium of methods tested by researchers and operational experts and are those that are determined to be the most effective means of preventing or managing invasive species and their impacts.

A valuable BMP requires a breadth of information. Research is required to provide the fundamental biological and ecological data to make a reliable species identification and to recommend the most efficient treatment or eradication methods. As time and resources for invasive species management are most often finite, referring to an existing BMP is an efficient first step. It is important that the invasive species community in BC continues to collaborate and share advances to collectively improve the invasive species BMP library. In addition to research on invasive species, determining the effective ways to share and make efficient use of BMPs to achieve on-the-ground success is vital.

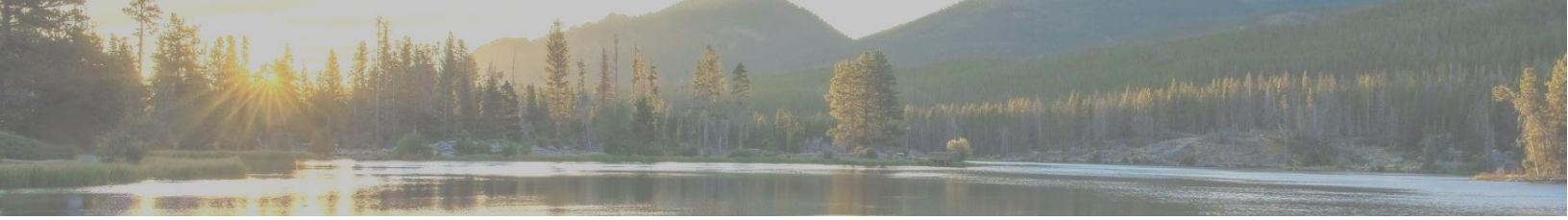
The key priorities for research into best management practices are:

- Development of provincial and regional BMPs on invasive species monitoring, disposal, prioritization, evaluation of treatment effectiveness, BMP design, identification and management strategies, and management of infested soil.
- Risk analysis of management strategies under varying conditions.
- Strategies to encourage use of BMPs by practitioners and managers.
- Strategies to foster volunteerism or stewardship in invasive management plans.

Indicator of Success #2: Best Management Practices for priority species and industries are available for all regions in BC.

3.3 ECOLOGICAL RESTORATION

Invasive species thrive in disturbed sites and are often the first to colonize. In addition to treatment and/or eradication, a holistic approach to managing invasive species should include ecological restoration. Research into what makes communities more resistant to invasion and ways to prevent reinvasion of restored habitats is a key component of invasive species management and prevention. Improved understanding of effective strategies to re-introduce native species to restored sites while managing for efficiency and cost-effectiveness is an important part of the process.



The key priorities for research into ecological restoration are:

- Social science research on effective recruitment of volunteers for restoration.
- Maintenance of restoration efforts in the long-term.
- Pre- and post-restoration inventory required for habitat affinities, including soil chemistry, post-treatment and monitoring.
- Best Management Practices after restoration or treatment.
- Seed bank establishment for native species or agronomics for invasive species prevention.

Indicator of Success #3: An increased number of restoration projects across the province and sharing of strategies and successes.

3.4 PATHWAYS OF INVASION AND VECTORS OF SPREAD

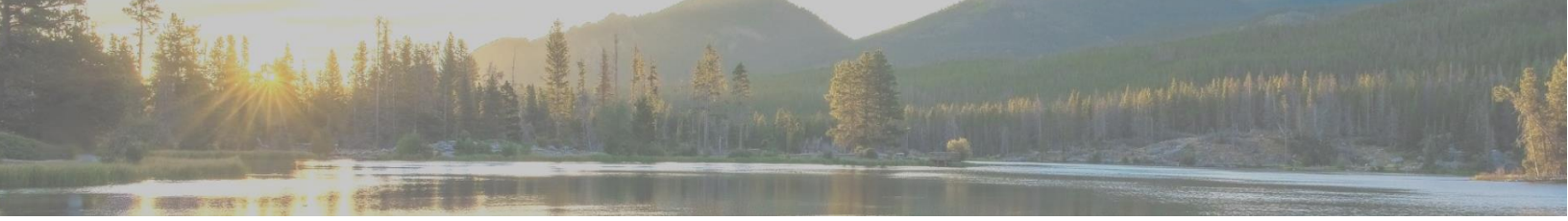
Pathways are the means and routes by which invasive species are introduced into new environments and can generally be classified as either *natural* or *man-made*. These pathways for entry are varied and can include natural means such as wind or currents or may be human-induced. Human induced pathways can include intentional or accidental introduction or importation via the pet and aquarium trade, horticulture trade, or industry operations including shipping and cargo. Vectors are the mechanisms that are responsible for the introduction and spread of invasive species in a certain area and include a wide variety of physical means or agents such as ballast water, horticulture, biological control and aquaculture.

Increased research on pathways is critical as it supports the prevention of new introductions and spread of existing ones, providing for a critical first line of defence in the management of invasive species. Through increased understanding of the risk level of the various pathways, surveillance and monitoring can be prioritized and adjusted accordingly and managers can strategically target education and outreach to specific audiences or stakeholders. This aspect of invasive species management is important in the prevention of invasive species and in minimizing impacts to BC's environment, economy and social well-being.

The key priorities for research into invasive species pathways of invasion and vectors of spread are:

- Identify and prioritize new and existing vectors and pathways.
- Develop risk assessments for prioritized pathways and vectors of spread.
- Identify target audiences and determine effective outreach and education.

Indicator of Success #4: Identification and subsequent reduction in number of new pathways of invasion and increased strategies to prevent invasive species spread.



3.5 BIOLOGY AND ECOLOGY OF INVASIVE SPECIES

To effectively and efficiently manage new invasive species introductions before they spread it is imperative that researchers understand the biological and ecological attributes prior to invasion. This enables rapid response by practitioners to identify and/or predict the new invaders, model their potential distribution, and establish effective management and monitoring strategies.

The key priorities for research into the biology and ecology of invasive species are:

- Distribution and movement of invasive species related to climate change and other influencing factors.
- Evolution and adaptation of invasive species.
- Short and long-term treatment efficacy.
- Modelling and predicting new and emerging pathways.
- Risk assessment for predicted and new invasive species.

Indicator of Success #5: Improved ability to predict and manage invasive species introduction and spread.

3.6 SOCIAL AND ECONOMIC IMPACTS

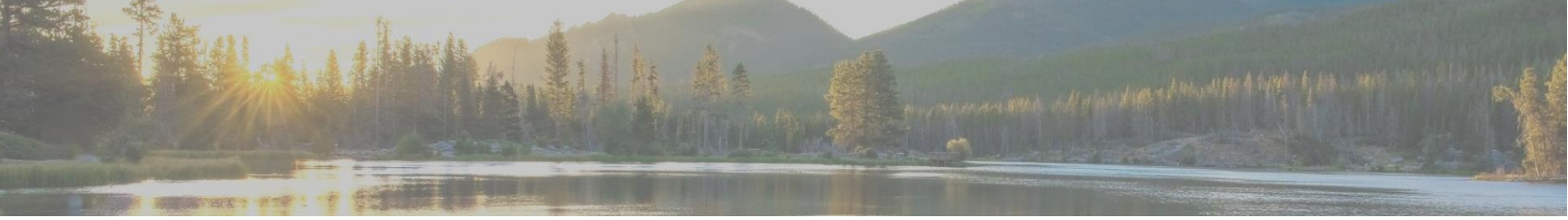
In addition to environmental impacts, invasive species can have detrimental consequences to BC's economy, people and communities. They can threaten ecosystems that represent a significant economic benefit to the province, can affect society by impacting a wide range of commodities and services, and can have direct impacts on human health.

Invasive species have well-known economic impacts on BC's industries including forestry, horticulture, agriculture, tourism, fisheries and aquaculture. Up-to-date research into understanding these impacts is important in garnering industry support and in facilitating research into improved management and treatment methods.

Research to identify social and economic impacts of invasive species must occur across wild and managed lands, as well as natural and human-modified ecosystems. Comparisons should be made between the costs of management (including prevention) versus the costs of inaction. As financial support is often crucial for the ability to manage an invasive species, it is important that the impacts are clearly communicated at all levels to support sound decision making. This includes higher level politicians, regulators and funders, as well as the those undertaking the field work.

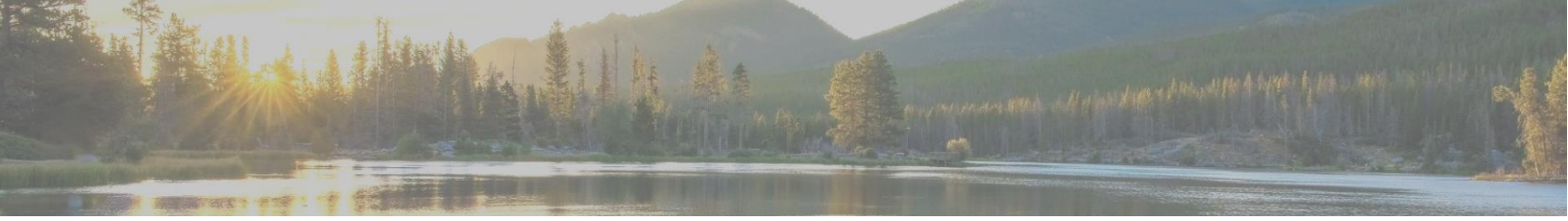
The key priorities for research into the social and economic impacts of invasive species are:

- The cost of not addressing invasive species.
- Fostering ownership and responsibility in stakeholders.
- Correlations between socio-economic and ecological impacts.



- Broad-based modelling to measure impacts.
- Analysis of potential positive values associated with invasive species.

Indicator of Success #6: Accessibility of cost/benefit analyses of the social, cultural and economic impacts of invasive species in BC.



4. Funding Sources

4.1 FUNDING NEEDS

Funding requirements and availability vary widely across regions, agencies and organizations. Based on input provided by research conference participants in 2009, it was identified that there is need for a centralized agency to allocate and distribute funds for research projects, or at minimum, a repository to coordinate and disseminate information regarding invasive species research-based funding sources or contract opportunities in British Columbia.

Longer-term funding for invasive species research and management is a collective goal as treatment to reach eradication and post-monitoring can be a lengthy process. Having stable and committed long-term funding for invasive species research would more likely produce applicable results.

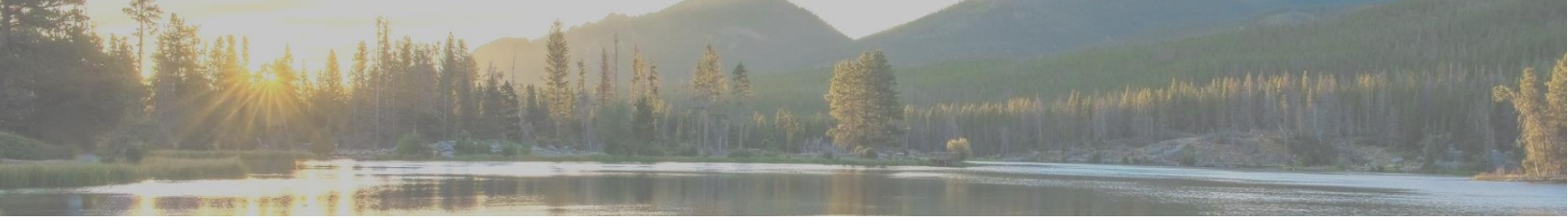
4.2 POTENTIAL SOURCES

Invasive species research in British Columbia is funded through a wide variety of sources. Funding sources are largely reliant on the research project topic. Many funders have strict criteria with respect to a given species or ecosystem type, however, if the value of the research results is clearly communicated in the proposal or application and shown to be beneficial, various organizations could be interested in supporting research. Governmental agency researchers use a combination of internal and external funding sources, while academic research by university faculty and students is primarily funded by the Natural Science and Engineering Research Council (NSERC) and supplemented by a variety of non-government organizations, such as Mitacs, Habitat Conservation Trust Foundation, The Nature Trust, Mountain Equipment Coop, Ducks Unlimited, natural history societies, environmental organizations, and other short-term government programs. Biological consulting firms compete for contracts funded by government and non-governmental agencies.

General funding sources include:

- Federal government
- Provincial government
- Municipal government
- Commodity groups and organizations
- Academia
- International agencies and organizations
- Companies and investors
- Non-Government Organizations
- Collaborative partners
- In-kind contributions
- Mechanisms
- Crowdsourcing

A detailed list of potential funding sources is provided in Appendix 2.



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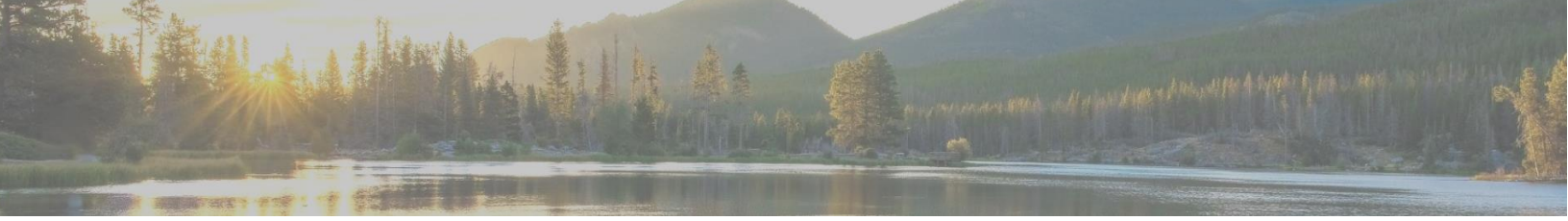


6. Appendices

6.1 APPENDIX 1: POTENTIAL RESEARCH PROJECTS

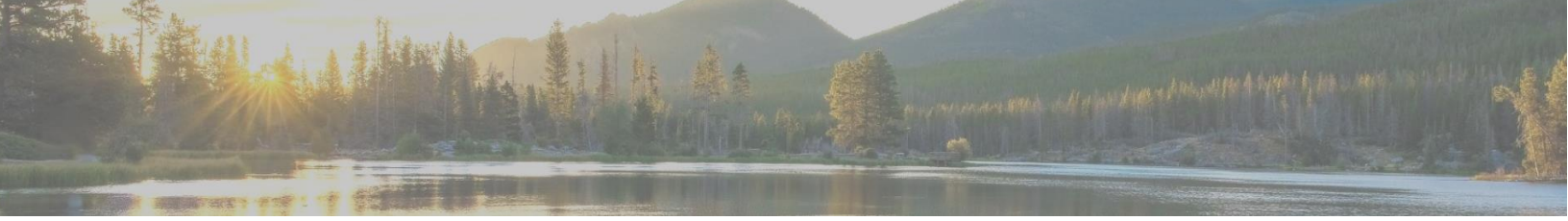
The following is a list of potential research projects, based on the identified research themes. Potential projects listed were provided by the 2017 Invasive Species Research Conference participants. The following is not a complete list, nor are they presented in order of priority.

6.1.1 Management Tools

- How to make people care and want to protect ecosystems (e.g. better ways to disseminate information)
- Develop tools for prioritizing control activities
- New biocontrol agents
- New attractants like sex pheromones and floral lures for trapping and surveillance
- Development of safer herbicides and types to use near waterways. More pesticide trials with priority invasive species
- Research into cultural control methods
- Can burning be effective as a tool for certain species
- How to implement more use of environmental DNA (eDNA)
- Determining the best timing of control activities for individual species based on biology and ecology
- How to develop a collaborative group management plan/system for a given invasive species
- Making the clear connection between invasive species and phytosecurity
- Creating dispersal models
- Using predictive species distribution modelling
- How to legislate the sale of invasive species to become illegal
- Impact of ranching practices on invasive species spread and ways to prevent spread
- Development of an invasive species ranking system based on severity and rate of spread
- Practical tools for specific user groups that are relevant and easily adapted with associated training

6.1.2 Best Management Practices (BMPs)

- Develop BMPs prioritized by region



- Develop BMPs for tree planters, wildfire fighters, agriculture, mining, ranching, seed and forage producers, vehicle decontamination, border services, movement of soil
- Include the timing of treatments in BMPs
- Practices for within the one-meter high water mark
- How to include volunteers
- BMPs for reporting to funders
- Adoption of BMPs from other regions of Canada or other countries

6.1.3 Ecological Restoration

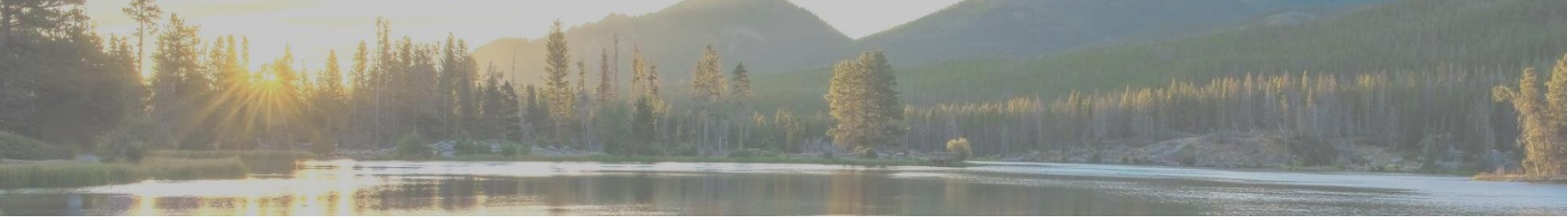
- Understanding the naturalization process
- Best practices for propagating native plants for restoration
- How to bridge the gap between the restoration and invasive species fields.
- How to choose the best native species based on the location.
- Techniques for both terrestrial and aquatic habitats
- How to incorporate volunteers in the restoration process
- Options for riparian areas
- Understanding ecosystem and soil health and ecosystem resilience.
- How can fertilization help in the restoration process
- Seed sourcing and competition
- How to determine priority areas

6.1.4 Pathways of Invasion and Vectors of Spread

- Better ways to enforce and gain compliance (E.g. at BC borders).
- How animals spread invasives
- Research into preventative measures
- How to increase support for increased inspection to prevent the movement of invasives
- Identifying new or unmanaged pathways
- Prioritization of critical pathways and vectors.
- Highlighting priority invasive species to watch for based on known pathways and vectors.

6.1.5 Biology and Ecology of Invasive Species

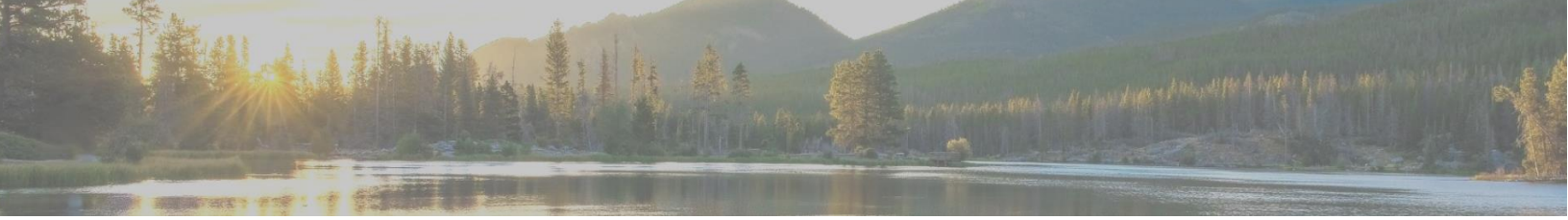
- Trait-based predictions of potential invasions or invasive species
- Impacts of climate change on invasive species
- Impact of invasive species on species at risk
- Study of physiological thresholds
- What types of soils do invasive species prefer



- Invasive species microbiomes

6.1.6 Social and Economic Impacts of Invasive Species

- Develop a risk and cost/benefit analysis system that can be applied to different invasive species.
- Costs to the economy from watershed and lake environment degradation due to invasive species.
- Economics of ecosystem disruption
- Improved ways of communicating social and economic impacts for greater public awareness
- Economic impacts of invasive mammals and pet trade
- Economic impacts of pet and aquarium invasive species,
- Economic impacts of invasive plants and insects on forest management



6.2 APPENDIX 2: POTENTIAL FUNDING SOURCES

The following is a list of potential funding sources as provided by participants of past research conferences. The following is not a complete list and nor are they presented in any order.

Federal Government

- Agriculture and Agri-Food Canada
- Canadian Forestry Service
- Environment and Climate Change Canada
- Parks Canada (under Natural Resources Canada)
- Fisheries and Oceans Canada
- Natural Sciences and Engineering Research Council (NSERC)
- Canada's Nature Fund

Provincial Government

- Inter-Ministry Invasive Species Working Group
- Ministry of Agriculture, Food and Fisheries
- Ministry of Tourism, Arts, Culture and Sport
- Ministry of Environment and Climate Change Strategy
- Ministry of Forests, Lands, Natural Resource Operations and Rural Development
- Ministry of Transportation and Infrastructure
- Ministry of Energy, Mines and Low Carbon Innovation
- Ministry of Advanced Education and Skills Training

Other Government

- Local/Municipal government
- First Nations
- Other provinces

Commodity Groups and Organizations

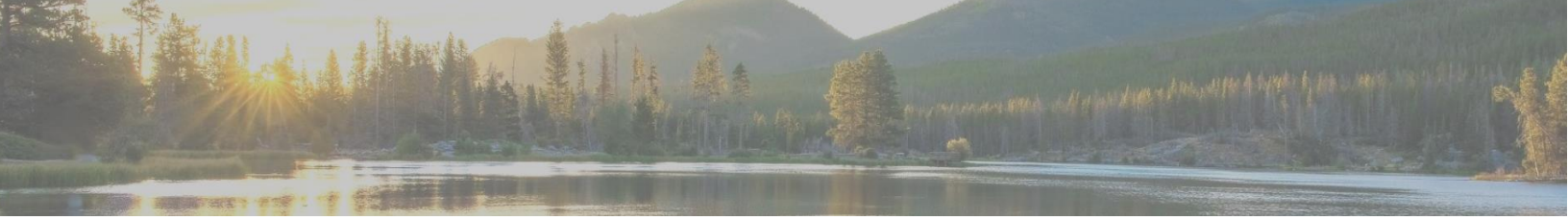
- Agriculture
- Forestry
- Horticulture
- Fisheries and Aquaculture

Academia

- Universities and Colleges
- United States Department of Agriculture Research Service
- US Forest Service
- Companies and Investors
- Biotech companies
- BC Transmission Corporation
- BC Hydro
- BC Venture Co.
- Forestry companies
- Oil and gas companies
- Railway companies
- Fishing Companies

Organizations

- Fraser Institute
- Pacific Carbon Trust
- Columbia Basin Trust
- Ducks Unlimited
- Pacific Streamkeepers Federation
- Non-profit organizations
- Environmental organizations



Collaborative Partners

- Cross-border groups (funds and in-kind services)
- Research community (conducting research)
- Private industry and corporations (funding)

In-Kind Contributions

- Consultants
- ISCBC and regional invasive species committees' collaborative partners
- Agencies and organizations providing staff contributions

Mechanisms

- Taxes
- User fees
- Tipping/dumping fees