

Developing Priority Criteria for the Efficient Management of Scotch broom in the Mount Arrowsmith Biosphere Region

Prepared for: MABRRI & TRANSECTS' 2024 TILL

By: Team D-Pact | Diego Galdamez | Precious Samuel | Anna Gowera | Jon Chance | Thando May



June 21, 2024

Table of Contents

3	Abstract
4	Land Acknowledgment
4	General Acknowledgments
4	Positionality Statements
6	Research Focus & Background Information
7	Research Objectives
8	Sustainable Development Goals
9	Literature Review
9	Challenges Associated with Scotch Broom
11	Scotch broom Management
12	Research Methods Participant Recruitment
13	Data Collection
13	Data Analysis
13	Data Validation
13	Ethical Considerations
14	Proposed Priority Criteria Approaches
15	Scotch broom Priority Categories
20	Matrices for determining management priority
23	Action Plan
23	Discussion
26	Additional Recommendations
27	References

List of Tables and Figures

Tables

- 16 Table 1: Species Management Categories according to the SSISC
- 18 Table 2: Proposed Scotch broom Priority Categories
- 21 Table 3: Scotch broom Priority Rating Matrix
- 22 Table 4: Scotch broom Weighted Priority Rating Matrix
- 24 Table 5: Action Plan .

Figures

- 6 Figure 1: Scotch broom
- 12 Figure 2: Conceptual framework
- 15 Figure 3. Generalized Invasion Curve
- 19 Figure 4: Theoretical visualization of categorical priority sites overlaid on the MABR Interactive Map

Abstract

The management of Scotch broom (*Cytisus scoparius*) in the Mount Arrowsmith Biosphere Region (MABR) poses a significant management challenge. As an invasive species, Scotch broom has severely impacted local biodiversity, increased fire risks, poses health challenges, and imposed socio-economic burdens. Individual actors and organisations are presently involved in Scotch broom management efforts, with action implemented on different scales and stemming from different reasons. While this approach has realised some benefit, a comprehensive management plan with criteria for prioritising actions is currently lacking. The importance of setting priority criteria for management strategies for invasive species is highlighted by Odom *et al.*, (2005). A key reason for setting priority criteria is to help efficiently allocate resources available for Scotch broom management and foster consensus in its efforts.

This study aimed to define priority criteria to be used in developing a Scotch broom management plan within the Mount Arrowsmith Biosphere Region (MABR). The criteria were defined based on multiple factors deemed important for effective management, based on literature as well as themes emerging through interviews conducted. Importantly, there is emphasis on the involvement of Indigenous peoples in the Scotch broom management process, acknowledging traditional knowledge systems and indigenous peoples' deep connection to the land. By integrating multiple environmental, social and economic considerations, we sought to provide MABR with strategies for prioritizing Scotch broom control efforts.

Actions taken in this project included brainstorming, literature reviews, interviews, thematic analysis, and reflections. Given limited resources, we developed a spatially explicit decision-making method to identify effective management actions and minimize the likelihood of reinvasion. The priority criteria defined in this study as well as the action plans aim to optimize resource allocation for Scotch broom prevention and control efforts, contributing to the sustainability of the region.

In conclusion, this study offers a crucial element for developing a comprehensive management plan for Scotch broom in the MABR, by considering ecological, social, cultural, and economic dimensions to enhance sustainability and resilience in the region.

Land Acknowledgment

We acknowledge and thank the Qualicum, Snaw-naw-as, Snuneymuxw, K'ómoks, Tseshaht, Hupacasath, and Ditidaht First Nations, on whose traditional lands the Mount Arrowsmith Biosphere Region is situated within.

General Acknowledgements

We extend our sincere gratitude to the following for their indispensable contributions to this program:

- Our client: The MABRRI team, for hosting and providing us with this great opportunity.
- Heike Molitor and all the TILL mentors: For their unwavering support, guidance, and encouragement throughout the program.
- Community Members: For their warm welcome and support during our stay.
- Interviewees: For their time, insights, and willingness to share their experiences.

Your collective efforts have been significant in the success of this project.

Positionality Statements

Diego

I am a 27-year-old Salvadoran man. My mother tongue is Spanish. I have a background in Agribusiness, and now I am studying renewable energy projects from a quantitative economic perspective. I like to use a pragmatic approach question. I acknowledge the privilege that I have growing up in El Salvador, and the education I was fortunate enough to receive.

Precious

I am a Yoruba woman born and raised in Nigeria. My cultural heritage and upbringing significantly shape my worldview and approach to sustainability. My connection to the Yoruba culture, with its rich traditions and communal values, has exposed me to the importance of community in fostering sustainable practices. I hold a bachelor's degree in agriculture, specializing in Agronomy, and I am currently pursuing a master's degree in Regenerative Sustainability at the University of Saskatchewan. The intersection of my culture, education, and experiences informs my commitment to promoting sustainable practices that are inclusive, equitable, and effective in addressing both local and global environmental issues.

Anna

My name is Anna Gowera. I am a Shona woman from Zimbabwe, currently pursuing a PhD in Environmental Sciences at the University of the Witwatersrand in South Africa. My upbringing in Africa has instilled in me a respect for diverse worldviews, cultural practices, and knowledge systems. Having lived and worked in different countries and been exposed to the principles of ethnoecology and sustainable development, I recognize the importance of approaching transdisciplinary research with humility and a teachable spirit. As someone once said, "the more we know, the less we find we know."

While I acknowledge that my perspective may be shaped by my race, gender, and educational background, my commitment is to engage in genuine partnerships built on mutual respect, understanding, and a willingness to listen and learn from the communities I work with. I aim to put my best foot forward in contributing to solving real-world problems.

Chance

I am a non-binary US-American who has been living in Germany since 2019. I acknowledge the immense amount of privileges I have received for simply being born white and in the United States. I have long been inspired by and an advocate for nature and the environment. My interests in learning about social-ecological interactions has led me to study Biosphere Reserves Management MSc at Eberswalde University for Sustainable Development. As a 39-year old non-traditional student with a diverse employment past, I feel I bring interesting perspectives and skill sets to the world of conservation and sustainable development.

Thando

I identify as an indigenous South African woman. My academic background is in the biomedical sciences where I graduated with a bachelor's degree in biology, a Master of Science degree in pharmacology and am now in the final year of my PhD in anthropology. I am a trained, qualified and practising Indigenous Health Practitioner (THP) in South Africa with my specialization being in trauma management. I run my own health clinic in my community and am also serving as a community Elder and Indigenous Knowledge Systems (IKS) Educator.

Research Focus & Background Information

According to the UNESCO Biosphere Reserves Statutory Framework (2020), their aim to achieve three main functions: to protect biodiversity through conservation, support the transition to sustainable regional development, and to provide capacity to support research and education.

Complex socio-ecological issues, such as invasive and alien species, can pose serious threats to both the conservation and sustainable development functions. Broadly speaking, invasive species are known to out-compete native species, causing a series of ecological side effects throughout the web of life, while simultaneously affecting human well-being by posing risks to traditional-use of certain species or causing a decline in economic income by changing the species composition of an area. This is none more apparent than in the case with Scotch broom (*Cytisus scoparius*) within the Mount Arrowsmith Biosphere Region (MABR) on Vancouver Island, British Columbia, Canada.



During the first two weeks of the Transdisciplinary International Learning Lab (TILL) 2024, we learned how Scotch broom impacts local life: its interactions with other species, the risks it poses to human communities, as well as some of the drivers that enable the spread of the plant. The pervasiveness of Scotch broom in the MABR, as well as the lack of legal policies to support the control of Scotch broom, make it a significant challenge to manage as a biosphere region.

Figure 1: Scotch broom

Due to the limited available resources to manage Scotch broom, our research group recognizes the importance of a large landscape approach informed by a set of priority criteria. To support the development of a 10-year management plan, determining priority criteria would enable informed and concerted efforts within the decision-making processes of actionable management treatments.

There is already considerable effort by various shared responsibility holders working in and around the MABR, such as educational and awareness-raising by the Invasive Species Council British Columbia, (ISCBC), community volunteer cutting and removal events led by Broom Busters, and the eradication from Qualicum Beach city limits.

However, without well-defined priority criteria, and with limited resources to counteract its spread, Scotch broom may continue to spread and negatively impact the human and non-human communities of the MABR. Among those most at risk are the Indigenous First Nations

communities whose traditional plant medicines are quickly being replaced by the growing expanse of Scotch broom. The presence of Scotch broom also impacts negatively on indigenous peoples' social and cultural needs. Working together toward its effective management may be one pathway to upholding the commitments to Canada's Truth and Reconciliation process.

We therefore asked ourselves how to determine priority criteria for the effective management of Scotch broom? What would the process look like to minimize the wide array of threats and impacts to a diverse set of interests and communities? And who would be responsible for which parts of the process?

Research Objectives

The objective of this research was to establish priority criteria to be used in developing a Scotch broom management plan within the Mount Arrowsmith Biosphere Region (MABR). The necessity arose from recognizing that Scotch broom presents significant challenges across social (Broombusters Invasive Plant Society, n.d.; BC Invasives, 2019), environmental (Odom et al., 2003; Broombusters Invasive Plant Society, n.d.; Caldwell, 2006; BC Invasives, 2019), and economic dimensions (BC Invasives, 2019; Metro Vancouver and the Invasive Species Council of Metro Vancouver, 2021), yet there is currently no unified approach in the MABR for prioritizing its management. Various stakeholders and shared responsibility holders within the region are engaged to varying extents in Scotch broom management, each approaching the issue from different perspectives.

In line with the principles of sustainable development—people, planet, and profit—it is crucial for the priority criteria to consider these multiple factors, and any presenting sub-categories, simultaneously. While existing efforts are commendable, establishing priority criteria is crucial for optimizing resource allocation. The research ultimately aims to facilitate the development of a comprehensive Scotch broom management plan that can be universally applied within the MABR and potentially serve as a model beyond its borders.

Sustainable Development Goals

The United Nation's Sustainable Development Goals are a set of global objectives to accomplish so as to achieve a more equitable and prosperous world for everybody (United Nations, 2016). Throughout our research on the invasive species Scotch broom, we found some linkages that connect the SDGs (i.e. goals 9, 11, 15, and 17) and the control of invasive species:

Goal 11 – Sustainable Cities & Communities

- *Target 11.4*
Protect The World's Cultural and Natural Heritage: native species represent an important natural heritage for Vancouver Island, and Scotch broom is a threat to them.
- *Target 11.9*
Implement Policies for Inclusion, Resource Efficiency and Disaster Risk Reduction: Determining criteria for prioritizing Scotch broom management activities will lead to resource efficiency, facilitate inclusion of multiple actors and viewpoint, and reduce disaster risk posed by Scotch broom.

Goal 13 - Climate Action

- *Target 13.1*
Strengthen Resilience and Adaptive Capacity to Climate Related Disasters: Increase the adaptive capacity to climate-related hazards like invasive plants
- *Target 13.2*
Integrate Climate Change Measures into Policies and Planning: there should be national policies, and legislation to support the adaptive capacity to climate-related hazards like invasive plants

Goal 15 – Life on Land

- *Target 15.5*
Protect Biodiversity and Natural Habitats: we want to stop the loss of biodiversity caused by Scotch broom outcompeting native species.
- *Target 15.8*
Prevent Invasive Alien Species on Land and in Water Ecosystems: We want to reduce the impact of invasive alien species on native ecosystems.

Goal 17 - Partnership for the Goals

- *Target 17.H*
Encourage Effective Partnerships: promote effective local public and private partnerships, building on the experience of each other.

Literature Review

Challenges Associated with Scotch Broom

Scotch broom (*Cytisus scoparius*) significantly transforms ecosystems through several mechanisms. It increases both fire frequency and intensity, fixes nitrogen, and acidifies soils, leading to considerable ecological shifts (Bossard, 2015). This invasive species is known for forming dense stands, particularly in grasslands and lowland prairies (Zouhar, 2005). Scotch broom demonstrates a high establishment potential due to its prolific seed production, long-lasting seed bank, and multiple dispersal methods, including accidental human-mediated dispersal (Bossard, 2015; Zouhar, 2005). The environmental impacts of Scotch broom are extensive. It increases fire frequency, alters soil nutrient dynamics, and exhibits allelopathic properties that inhibit the growth of other plant species. Additionally, the dense stands it forms can significantly modify habitat structure, reduce species diversity, and pose threats to endangered plants and animals (Bossard, 2015; Grove et al., 2012; Zouhar, 2005).

Past research on the impacts of Scotch broom also revealed the findings detailed below:

Competitiveness & Displacement of Native Species

Scotch broom is highly competitive with native flora, forming dense thickets that prevent the growth of understorey species and displacing native plant species (Odom et al., 2003; Metro Vancouver and the Invasive Species Council of Metro Vancouver, 2021; BC Invasives, 2019; Broombusters Invasive Plant Society, n.d.).

Seed Production and Longevity

Each plant can produce up to 10,000 seeds per growing season, which can remain viable in the soil for up to 80 years, leading to long-lasting seed banks and rapid reinfestation (Odom et al., 2003; Metro Vancouver and the Invasive Species Council of Metro Vancouver, 2021).

Habitat Degradation and Obstruction

Scotch broom invades pastures, decreases productivity, blocks movement corridors, prevents access to watercourses, and restricts access to water sources, leading to habitat degradation. It can also impede the movement of large animals (Odom et al., 2003; Metro Vancouver and the Invasive Species Council of Metro Vancouver, 2021; BC Invasives, 2019).

Fire Hazard

The high oil content of Scotch broom makes it highly flammable, increasing the risk and intensity of wildfires (Metro Vancouver and the Invasive Species Council of Metro Vancouver, 2021; BC Invasives, 2019; Broombusters Invasive Plant Society, n.d.).

Soil Alteration

Scotch broom alters soil chemistry and nutrient availability by fixing nitrogen, releasing chemicals that impact soil mycorrhizae, and increasing soil organic matter content. This can hinder the growth of native plants and favor other invasive species (Caldwell, 2006; Broombusters Invasive Plant Society, n.d.).

Economic Impact

Managing Scotch broom requires significant resources, leading to substantial control costs. It invades rangeland, reduces forage plants for livestock, and competes with conifer seedlings, causing failures in plantations (BC Invasives, 2019; Metro Vancouver and the Invasive Species Council of Metro Vancouver, 2021).

Toxicity

The seeds and vegetative parts of Scotch broom are toxic to ungulates and humans and poses a risk to wildlife and livestock (Metro Vancouver and the Invasive Species Council of Metro Vancouver, 2021).

Persistence and Spread

Scotch broom is a prolific invader, spreading rapidly to various regions and forming dense monocultures that are difficult to eradicate due to its long-lived seeds and ability to regenerate quickly (Odom et al., 2003; Broombusters Invasive Plant Society, n.d.).

Control Challenges

Controlling Scotch broom is challenging due to its competitive nature, rapid regeneration from seeds, and limited effectiveness of control methods like herbicides and mechanical removal. Herbicidal control can be expensive and temporary, while mechanical control may lead to rapid regeneration (Odom et al., 2003).

Impact on Ecosystems

Scotch broom changes the structure and function of ecosystems, disrupting native plant communities and the wildlife that depend on them, including birds, insects, and mammals (Broombusters Invasive Plant Society, n.d.).

Human Health & Safety

The plant can obstruct visibility along roads and trails, and its toxicity can be harmful to humans and animals if ingested. Scotch broom also causes significant allergic reactions to some people (Broombusters Invasive Plant Society, n.d.).

Potential Impacts on Nutrient Cycling

Scotch broom alters microbial processes and nutrient cycles, particularly carbon, nitrogen, and phosphorus, potentially affecting ecosystem functioning and native plant communities (Caldwell, 2006).

Scotch Broom Management

The use of a bioeconomic model to address invasive species like Scotch broom and then incorporating priority criteria into decision-making processes, can highlight the repercussions that these plants can have on the environment and on the economy (Frid et al., 2012). By taking inventory of resources that are not normally considered in the conventional economic model, a more holistic approach emerges to conduct cost-benefits analysis of different management strategies. This can be very helpful for policymakers who might decide which management plan to use. Using the bioeconomic model, where biomass is converted into a product or energy, to conduct cost-benefit analyses can better allocate efforts and resources to more effectively combat Scotch broom in the MABR.

Setting a priority criteria is necessary for the management of Scotch broom in the MABR. This approach has been useful for allocating resources efficiently in the Australian national Park of Barrington Tops and for projecting future damages in Vancouver Island due to the utility corridors which serve as a main artery of spread on the island (Frid et al., 2012; Odom et al., 2005). Another important factor in effectively managing invasive species is to make sure that budget constraints are not an impediment to implementing the management plan and that future long-term funding can be secured to proceed with the control actions (Odom et al., 2003).

In a more practical sense, different grassroots organizations, the public in general and bigger organizations can follow reference Scotch broom management manuals that are specific to British Columbia and can help in raising awareness of the problem and how to combat the spread. (Metro Vancouver, 2021)

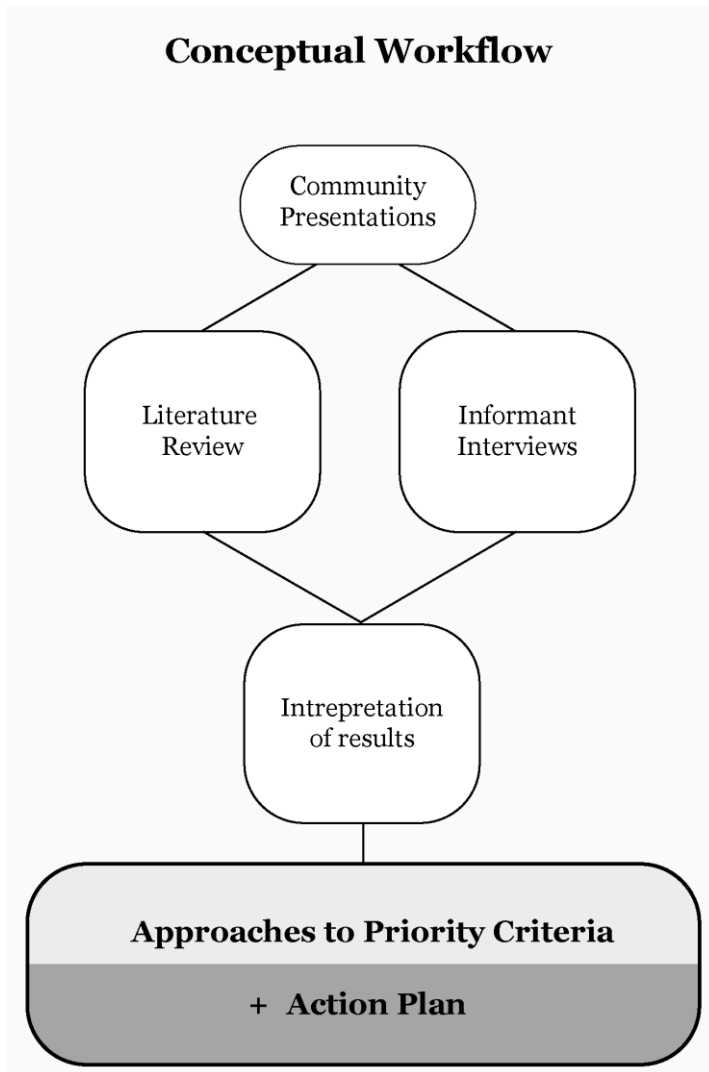


Figure 2: Conceptual workflow

Research Methods

Since the start of the Learning Lab, our understanding of invasive species in the MABR took form thanks to the presentations of shared responsibility holders and people involved in the biosphere region, which highlighted the challenges posed by Scotch broom. Literature review on this invasive plant species provided more insights on the challenges and perceived benefits that invasives pose to the environment. Additionally, the presentations, Scotch broom cutting exercises and literature review shed light on the need for prioritization criteria to inform a comprehensive Scotch broom management plan for the MABR. From there we decided to conduct key informant interviews to gain more insights into the problem. Finally, with our literature, and the interviews data, we proceeded to construct a priority criteria suggestion for the MABR.

Participant Recruitment

Key participants were recruited to participate in the study by using targeted purposeful sampling methods. Snowballing methods were utilized to recruit new participants. Key stakeholders identified included MABRI personnel, Indigenous Knowledge Holders and Community Elders as well as the Broom Busters organization and Mosaic Forestry Management personnel.

Data Collection

Data was collected utilizing semi-structured interviews and Anthropology of Extraordinary Experience (AEE). Interviews were conducted in English in person or virtually on Microsoft Teams. With permission, the interviews were recorded and transcribed into text. Data collected through AEE methodology was recorded on a research journal throughout the research process.

Data Analysis

A deductive open coding top-down approach was utilized to create codes and categories for thematic analysis. Codes were grouped together by similarity and topic into categories. Thematic analysis was utilized to find new emerging themes and sub-themes, which were subsequently categorized. The data was tabulated into a results table and analyzed for discussion using narrative analysis.

Data Validation

Triangulation was utilized to combine information emerging from various sources, such as interviews, AEE methods and literature searches. Reflexivity was utilized to validate data emerging from participant observations. This was done to account for bias as the researchers themselves come from various cultural and academic backgrounds that may present inherent biases in the data collection process. Peer debriefing was used prior to each interview and after data was collected to validate the findings and research processes used in data collection.

Ethical Considerations

Ethical clearance was granted by the University of Saskatchewan School of Environment and Sustainability. The ethical principle of Respect for Persons was adhered to by requesting informed consent from the participants prior to the data collection process. Respect for Autonomy was adhered to by allowing participants the right to withdraw from the study at any point during the research. The ethical principle of Justice was adhered to by prioritizing Indigenous Knowledge Systems (IKS) in the research process by including the perspectives and understandings of Indigenous Knowledge Holders, by respecting the validity of Indigenous methods, protocols and customs. Non-maleficence was adhered to by reducing the risk to participants throughout the study period. Interviews were primarily conducted in person, where

the researchers travelled to meet with participants, and in cases where the researchers were unable to travel to meet with participants, the interviews were conducted virtually via Teams. Beneficence is adhered to by sharing the study findings with the relevant stakeholders and partners.

Proposed Priority Criteria Approaches

Considering the literature on the management of invasive species in combination with the expressed interests and impacts reported by the interview community members, we provide three different approaches to define priority criteria for the effective management of Scotch broom. Each approach can be used in isolation or in combination with the others depending on the specific site being assessed.

The examples in each approach are only representative of our own limited research and should not be considered the final criteria for the 10-year management plan. As mentioned in the recommended Action Plan, more community input is required to collect all interests and specific priority criteria should ultimately be set by the community of shared responsibility holders. Ideally, to inform the approaches, a comprehensive monitoring inventory should be conducted to accurately map the current distribution of Scotch broom prior to prescribing management actions.

According to the Generalized Invasion Curve of invasive species (see figure 3), different management actions are recommended as the prevalence of a certain species increases. Once the species is abundant and eradication is no longer probable, the recommended action is to focus on asset-based protection. Using this as a starting point, assets, interests, risks, and threats posed by Scotch broom should be first understood in the local context.

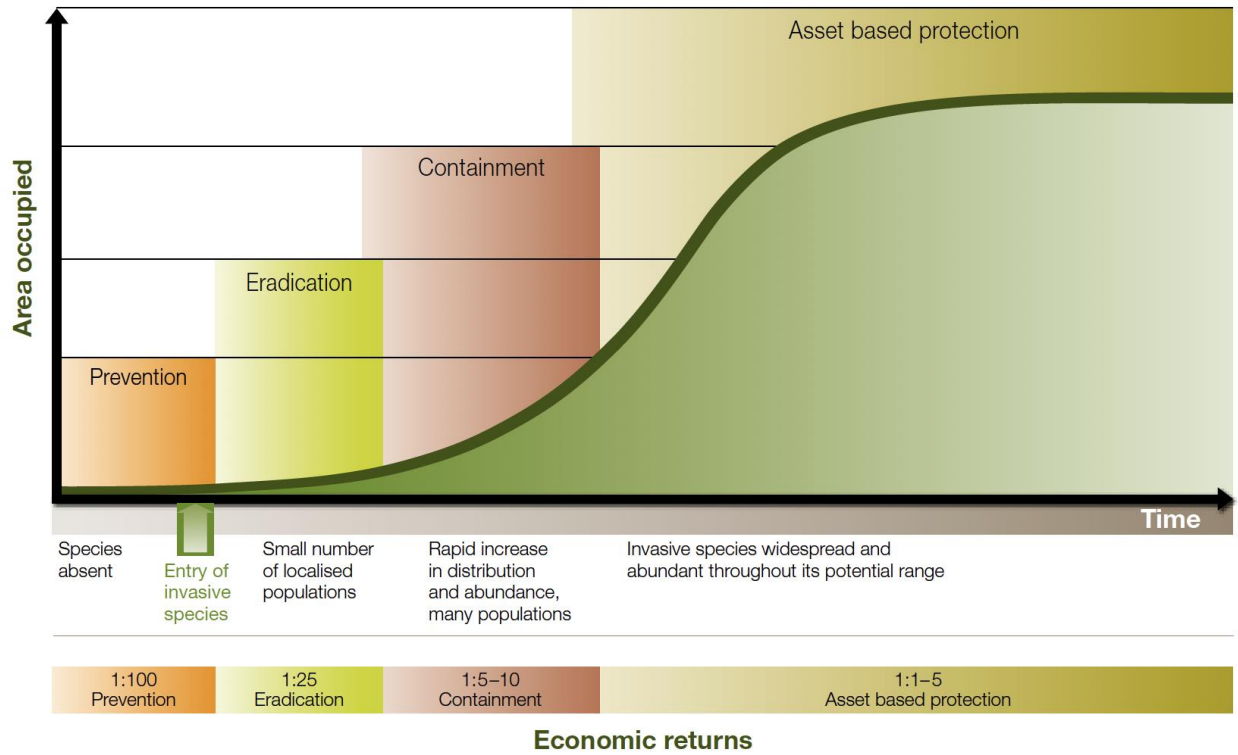


Figure 3. Generalized Invasion Curve (Source: Victorian Government, 2010)

Similarly, the priority criteria developed by and found on the Sea-to-Sky Invasive Species Council of British Columbia’s website sets a single priority level per species for their management areas. More specifically, for Scotch broom it has assigned it to category 3 based on its current distribution in the area, setting the recommended management treatment to ‘contain.’

Table 1: Species Management Categories according to the SSISC

Priority	Category	Definition	Management Approach
1	Prevention Watchlist	These species are not yet found in the region/ISMA, but found in neighbouring areas or are considered likely to arrive soon.	Alert or Watchlist species, focus on education & awareness with the goal of prevention. If prevention fails, and these species are detected in an ISMA where they were previously not known to occur, the goal is immediate eradication following the proposed new SSISC EDRR protocol.
2	Eradicate	These species exist in the region/ISMA, but with very limited distribution. Eradication is feasible.	Eradication is the goal. These species are the highest priority for planned control programs.
3	Contain	These species are abundant in certain portions of the ISMA/region, but have not yet infested all potential habitats.	Management efforts are delineated by containment lines which may be based on geographic (i.e. a specific region) or jurisdictional (e.g. private gardens only) boundaries. Some of these species have biocontrol agents available which may be useful within the containment line. Containment to currently infested areas is the management objective.
4	Strategic Control	These are widespread species that are beyond landscape-level control and/or have relatively low impact.	The goal of management efforts for these species is to protect site-specific values or assets. Land managers may choose to treat these species at sites they deem valuable to protect (e.g. wildlife habitat, corridors of spread, agricultural land etc.) based on specific land management objectives. Some of these species have biological control agents available.
5	No Action	These are widespread species, where site-scale control is ineffective or futile; and/or these species have relatively low impact. Lost causes.	Not included in control programs. Education only (e.g. do not plant in gardens).
6	Insufficient Information	There is insufficient information for these species on their distribution, impacts, potential for spread and/or feasibility of control. Not enough information to assign a management category.	Carry out inventory if required, monitor known locations, and/or access more information from other regions.

Scotch Broom Priority Categories

Using these two approaches as inspiration and other literature on invasive species management (Dana et. al, 2019; Diaz, 2021; Finley et al., 2023), Approach 1(*see Table 2*) assigns a priority category of an area based on the current distribution of Scotch broom in the MABR and the types of interests, impacts, and threats posed in that given area as indicated in our interviews.

Having determined the management priority levels of each area to be managed, a map would ideally be created, providing a visual representation of required management strategies and urgency. This is illustrated in Figure 4.

Table 2: Approach 1 - Proposed Scotch Broom Priority Categories

Priority	Identified Areas of Concern	Supporting Evidence	Recommened Management Action
1	Areas without Scotchbroom	Holding action; Easier and cheaper to prevent than to manage	Prevention
2	Areas with life-threatening fire risks; Indigenous-use lands; Least impacted/few plants/small patches; High-value ecosystems (Gary oak, sensitive Habitats for species of concern, etc); Streams & rivers	to provide safe escape routes for individuals & communities considering climate change & the increased risk of wildfire; to support reconciliation and partnerships with indigenous peoples and support ecocultural restoration; to reduce/prevent future maintainence; to protect biodiversity and ecosystem services; to prevent spread through watersheds	Erradicate
3	Areas with activites that promote spread (development, clear cuts, etc)	Any activity that disturbs soils and promotes spread should have reliable measures to place to prevent spread	Contain
4	Areas that provide benefits(soil erosion prevention)	Discreation is needed for sites with acknowledged benefits that are not in conflict with priority sites 1-3	Strategic Control
5	Well-established patches in dangerous terrain	Avoid areas that pose high risk to personal safety and/or needs specail equipment to remove	No Action
6	Areas that have not yet been monitored	Identified sites with gaps in knowledge throughout monitoring cycle	Insufficient Information

Note: Additional modifications could be used to include setting additional priority within each category, for example, including categories 1a, 1b 1c, etc.

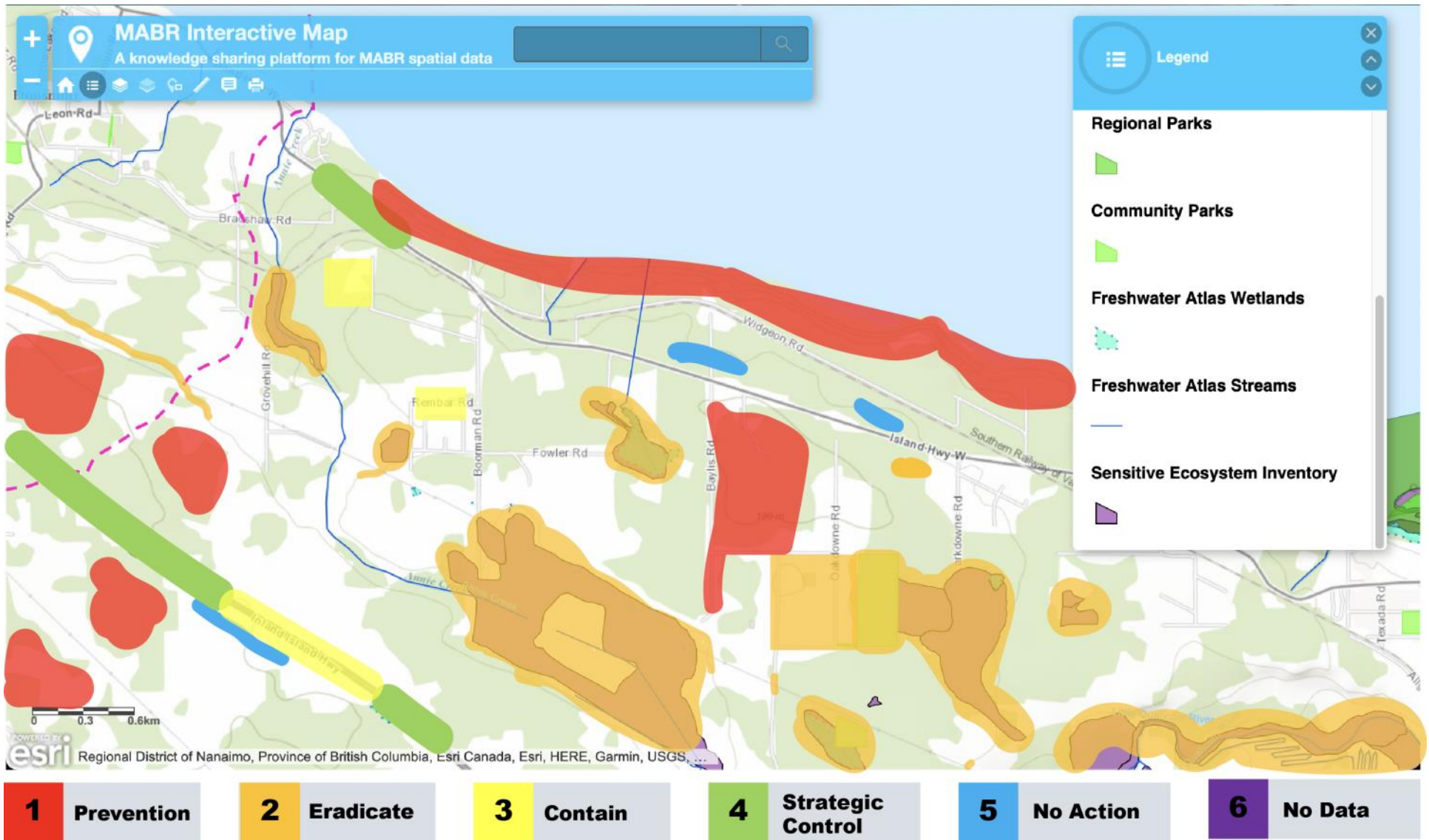


Figure 4: Theoretical visualization of categorical priority sites overlaid on the MABR Interactive Map

Matrices for Determining Management Priority Levels

Matrices can help determine the priority status of different areas within the MABR by simultaneously considering various factors relevant to each location. Two examples of such matrices are given in tables 3 and 4. The tables were designed using important themes as emerged in the research and inspired by traditional risk rating matrices.

Approach 2: Scotch broom Priority Rating Matrix

This matrix facilitates management priority assignment based on specific predetermined attributes and factors of the areas under consideration. Locations identified as 'high priority' across multiple factors will receive high priority status for management and resource allocation.

Table 3: *Scotch broom management priority rating matrix example*

Factor	High Priority	Medium Priority	Low Priority
Ecosystem Impact	<ul style="list-style-type: none"> • Sensitive/rare ecosystems • High value ecosystems • High biodiversity areas • Riparian / wetlands 	<ul style="list-style-type: none"> • Moderately disturbed areas • Moderate biodiversity 	<ul style="list-style-type: none"> • Highly disturbed areas • Low biodiversity
Biodiversity Impact	<ul style="list-style-type: none"> • Presence of rare/endangered species • High native species richness 	<ul style="list-style-type: none"> • Moderate native species richness • Dominated by invasive species 	<ul style="list-style-type: none"> • Low native species richness
Societal Impact	<ul style="list-style-type: none"> • High public use areas (parks, trails, etc) • Fire hazard zones • Residential areas 	<ul style="list-style-type: none"> • Moderate public use areas • Industrial/commercial areas 	<ul style="list-style-type: none"> • Remote areas
Cultural Considerations	<ul style="list-style-type: none"> • Sites with cultural/historical significance • Traditional gathering areas • High value areas for indigenous communities 	<ul style="list-style-type: none"> • Moderate cultural value 	<ul style="list-style-type: none"> • No known cultural value
Legislation	<ul style="list-style-type: none"> • Areas regulated by laws/policies • Protected areas 	<ul style="list-style-type: none"> • Areas with some regulations 	<ul style="list-style-type: none"> • Unregulated areas
Infestation Size	<ul style="list-style-type: none"> • Large, dense infestations 	<ul style="list-style-type: none"> • Moderate infestations 	<ul style="list-style-type: none"> • Small, scattered infestations
Accessibility	<ul style="list-style-type: none"> • Easily 	<ul style="list-style-type: none"> • Moderately accessibility 	<ul style="list-style-type: none"> • Remote, difficult access...
Potential for Spread	<ul style="list-style-type: none"> • Pathways for rapid spread • Vectors present (animals, water, vehicles) 	<ul style="list-style-type: none"> • Moderate spread potential 	<ul style="list-style-type: none"> • Low spread potential • Isolated sites

Note: Consider multiple factors together: Look at the combination of priority ratings across multiple factors. Sites that have high priority ratings for several factors should be prioritized for management over sites with fewer high priority factors.

Approach 3: Scotch broom Weighted Priority Rating Matrix

This table presents an alternative method for determining priority in location management through mathematical computations. Each factor considered is assigned a weighting reflecting its perceived importance, totaling 1 (or 100%). Factors are also rated on a scale from 1 to 5, indicating their relative importance (1 being least significant, 5 being critical). The weighted score is then calculated by multiplying each factor's weighting by its assigned rating. These weighted scores determine the management priority level for each location.

Table 4: *Scotch broom Weighted Priority Rating Matrix*

Criteria	Weight	Rating (1-5)	Weighted Score	Control Strategies
Ecosystem Impact	0.2			Mechanical removal, chemical control, prescribed burning
Biodiversity Impact	0.2			Revegetation, biological control
Social Impact	0.15			Community involvement, awareness campaigns
Cultural Considerations	0.1			Consultation with cultural groups
Legislative Requirements	0.1			Compliance with legal requirements, advocacy for stronger laws
Economic Impact	0.1			Cost-benefit analysis, securing funding
Feasibility of Management	0.1			Resource allocation, partnerships
Urgency of Action	0.05			Rapid response teams, monitoring and surveillance
Total	1.0			

Action Plan

The research efforts culminated into an action plan (Table 5), with actions proposed for implementation by various shared responsibility holders in the MABR. The Action plan has two main objectives and multiple actions beneath each objective. The goal of the action plan is to aid in the comprehensive and effective management of Scotch broom in the MABR.

Special Notes for Action Plan:

- *1.2 Secure, pool, and reallocate resources to appropriate shared responsibility holders*

Efficient coordinated action will require a sharing of resources including funding. Some resources may be already be readily available (such as certain equipment) and would only require a signed agreement to share with additional shared responsibility holders.

- *1.3 Facilitate co-production workshops for more community input to identify priority sites*

Participatory-influence mapping is one possible pathway that would allow for a great collaborative approach within the integrated communities

- *1.6 Train & engage shared-responsibility holders to utilize a collaborative mapping database*

For example; the BC Invasive Alien Plant Program (<https://maps.gov.bc.ca/ess/hm/iapp/>) or similar platform

- *1.7 Complete monitoring inventory of all Scotch broom within the MABR*

By using a variety of methods such as Field surveys, remote sensing GIS, and citizen science projects

Discussion

The success of any priority criteria, and the approach(es) used, is highly dependent upon the proceeding and subsequent steps within the overall Scotch broom management plan. In order to engage all shared responsibility holders in the subsequent Action Plan, a collaborative co-creative approach should guide the process of identifying priority criteria and the appropriate management action (Cockburn, 2022).

Action Plan

Table 5: Action Plan

Action	Responsible	Timeline	Priority	Cost	Notes	Status
Objective #1: Develop Long-term Scotch Broom Collaborative Management Plan for the MABR						
1.1 Add Scotch Broom to Noxious Weeds Act	<ul style="list-style-type: none"> UBCM 	Short		Low		
1.2 Secure, pool, and reallocate resources to appropriate shared responsibility holders	<ul style="list-style-type: none"> MABR Roundtable 	Long		High	Including funding	
1.3 Facilitate co-production workshops for more community input to identify priority sites	<ul style="list-style-type: none"> MABRRI ISCBC 	Short-Medium		Medium	Participatory-influence mapping	
1.4 Choose appropriate priority criteria approach(es)	<ul style="list-style-type: none"> MABR Roundtable 	Short		Low		
1.5 Design scotch broom inventory and monitoring protocol	<ul style="list-style-type: none"> ISCBC MABRRI 	Short		Low/Medium		
1.6 Train & engage shared-responsibility holders to utilize a collaborative mapping database	<ul style="list-style-type: none"> MABR ISCBC SSISC 	Medium		Medium/High	BC Invasive Alien Plant Program or another platform	
1.7 Complete monitoring inventory of all Scotch broom within the MABR	<ul style="list-style-type: none"> MABRRI Mosaic Broom Busters 	Medium		Medium	Field surveys, remote sensing GIS	
1.8 Develop action-oriented research project with shared-responsibility holders to begin facilitating active management	<ul style="list-style-type: none"> Broom Busters Mosaic Ministry of Transportation 	Medium		Low		
1.9 Prioritize Scotch Broom management in fire-risk areas	<ul style="list-style-type: none"> BC Wildfire BC Hydro 	Medium		Medium		
1.10 Monitor, review, and adapt management of treated areas	<ul style="list-style-type: none"> MABR MABRRI 	Medium-Long		Medium/High		

Table 5: Action Plan Continued

Action	Responsible	Timeline	Priority	Cost	Notes	Status
Objective #2: Continue supporting reconciliation efforts with Qualicum, Snuneymuxw, Snaw'naw'as, K'ómoks, Tseshaht, Hupačasath, and Ditidaht communities						
<i>2.1 Continue supporting reconciliation efforts with Qualicum, Snuneymuxw, Snaw'naw'as, K'ómoks, Tseshaht, Hupačasath, and Ditidaht communities</i>	<ul style="list-style-type: none"> All 	Ongoing				
<i>2.2 Continue to foster and nurture the close relationships established with Indigenous Elders, Indigenous Knowledge Holders and Cultural Leaders</i>	<ul style="list-style-type: none"> All 	Ongoing				
<i>2.3 Continue with the ground up approach of mutual co-operation and knowledge exchange with a focus on including indigenous methodologies in the process</i>	<ul style="list-style-type: none"> All 	Ongoing				

Additional Recommendations

1. MABRRI has established relationships with Indigenous knowledge holders, elders and community members. These relationships have taken a significant amount of time to establish as they require trust. We recommend that MABRRI continues to foster such relationships and to continue to respect the First Nations that are within the MABR.
2. The resultant management plan should consider alternative uses for the Scotch broom biomass after clearing has taken place. A recurrent theme found in the research was the need to provide an incentive for active participation in Scotch broom management, and offering actors associated tangible benefits. An example of an alternative use would be the institution of a Biomass-to-energy or a Biomass-to-biofuel project.
3. There is need for research on possible uses and/or benefits of Scotch broom. This would better inform the management steps and actions required.
4. It may be profitable to invest in more wide-spread education and awareness of Scotch broom in the MABR, to garner more public support and participation in the plant's management activities.

References

- BC Invasives (2019). Scotch broom (*Cytisus scoparius*). [online] Available at: https://bcinvasives.ca/documents/Scotch-Broom_Factsheet_10_04_2019.pdf [Accessed 10 June 2024].
- Broombusters Invasive Plant Society, n.d. About Broom. [online] Available at: <https://www.broombusters.org/about-broom/> [Accessed 10 June 2024].
- Caldwell, B.A. (2006). Effects of invasive Scotch broom on soil properties in a Pacific coastal prairie soil. *Applied Soil Ecology*, 32(1), pp. 149-152.
- Central Vancouver Island Multicultural Society (no date) CVIMS - Central Vancouver Island Multicultural Society. Available at: <https://www.cvims.org/> (Accessed: 20 May 2024).
- Cockburn, J. (2022) 'Knowledge integration in transdisciplinary sustainability science: Tools from applied critical realism', *Sustainable Development*, 30(2), pp. 358–374. Available at: <https://doi.org/10.1002/sd.2279>.
- Frid, L., Knowler, D., Myers, J. H., Scott, L., & Murray, C. (2012). A multi-scale framework for evaluating the benefits and costs of alternative management strategies against invasive plants. *Journal of Environmental Planning and Management*, 56(3), 412–434. <https://doi.org/10.1080/09640568.2012.684458>.
- Grove, S., K. A. Hausenbak, and I. M. Parker. 2012. Direct and indirect effects of allelopathy in the soil legacy of an exotic plant invasion. *Plant Ecology* 213:18691882.
- Hess, M.C.M., Mesléard, F. and Buisson, E. (2019) 'Priority effects: Emerging principles for invasive plant species management', *Ecological Engineering*, 127, pp. 48–57. Available at: <https://doi.org/10.1016/j.ecoleng.2018.11.011>.
- McGeoch, M.A., (2016) 'Prioritizing species, pathways, and sites to achieve conservation targets for biological invasion', *Biological Invasions*, 18(2), pp. 299–314. Available at: <https://doi.org/10.1007/s10530-015-1013-1>.
- Metro Vancouver and the Invasive Species Council of Metro Vancouver (2021). Best Management Practices for Scotch broom in the Metro Vancouver Region. Invasive Species Council of British Columbia.

Metro Vancouver. 2021. *Cytisus scoparius* Best Management Practices For. [online] Available at: <https://metrovancover.org/services/regional-planning/Documents/scotch-broom-best-management-practices.pdf> [Accessed 20 June 2024].

Odom, D.I.S., Cacho, O., Sinden, J.A., Griffith, G.R. (2003). Policies for the management of weeds in natural ecosystems: the case of Scotch broom (*Cytisus scoparius*, L.) in an Australian national park. *Ecological Economics*, 44, 119-135.

Odom, D., Sinden, J.A., Cacho, O., Griffith, G.R. Economic issues in the management of plants invading natural environments: Scotch broom in Barrington Tops National Park. *Biol Invasions* 7, 445–457 (2005). <https://doi.org/10.1007/s10530-004-4295-2>.

‘Priority Species – SSISC’ (2024). Available at: <https://ssisc.ca/priority-species> (Accessed: 13 June 2024).

Tye, A. (ed.) (2018) *Guidelines for invasive species planning and management on islands*. 1st edn. IUCN, International Union for Conservation of Nature. Available at: <https://doi.org/10.2305/IUCN.CH.2018.15.en>.

Victorian Government (2010) *Invasive Plants and Animals Policy Framework*, DPI Victoria, Melbourne.

United Nations. (2016). *THE 17 GOALS | Sustainable Development*. <https://sdgs.un.org/goals>.

Zouhar, Kris. 2005. *Cytisus scoparius*, *C. striatus*. In: *Fire Effects Information System*, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. [Online] <http://www.fs.fed.us/database/feis/>.