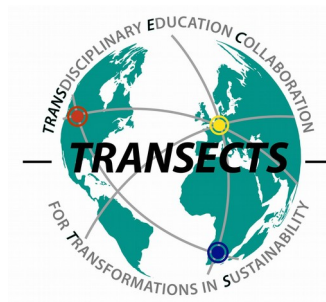


Eliciting Action and Awareness in Youth of the Mount Arrowsmith Biosphere Region, for managing invasive species.

Group: Duck Pond

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The Duck Pond group

Abstract

Invasive species pose a significant threat to the indigenous flora and fauna within the Mount Arrowsmith Biosphere Region (MABR) as well as local communities by disrupting the balance of its diverse ecosystems and increasing the region's vulnerability to climate change threats. Initial conversations with the MABR community highlighted a concern about the lack of youth involvement in invasive species management, with efforts largely driven by an older population. Youth education and involvement in addressing the issue of invasive species is crucial because young people are the future stewards of our environment. The aim of this research is to find out how the Biosphere Region can raise awareness and elicit action within youth and to propose actions that can be taken in order to overcome this gap in youth involvement. Seventeen shared responsibility holders from various sectors were interviewed to identify existing youth engagement programs, as well as the gaps, barriers, and factors for success. Based on these interviews and a literature review on youth engagement tools, we propose a set of actions to achieve four primary goals for the shared responsibility holders of the MABR: improving outreach to youth, incorporating invasive species topics into educational curricula and programs of non-governmental organizations (NGOs), engaging youth as co-creators to foster responsibility, and strengthening collaborations with schools, stewardship groups, and the Mount Arrowsmith Biosphere Region Research Institute (MABRRI).

Table of contents

Land Acknowledgement.....	2
Acknowledgements.....	2
Abstract.....	3
Table of contents.....	4
List of abbreviations.....	5
List of tables and figures.....	5
Positionalities.....	6
Research focus and background.....	7
Methods.....	9
Results.....	10
Shared responsibility holder map.....	10
Gaps.....	11
Barriers.....	12
Factors for Success.....	13
Literature Review: Successful Tools & Case Studies.....	15
Discussion.....	17
Action plan.....	20
Reference List.....	23

List of abbreviations

BC	British Columbia
CCS	community and citizen science
ESA	environmental science agency
IAS	Invasive Alien Species
MABR	Mount Arrowsmith Biosphere Region
MABRRI	Mount Arrowsmith Biosphere Region Research Institute
NGO	non-governmental organization
SDGs	Sustainable Development Goals
UNESCO	United Nations Educational, Scientific and Cultural Organisation

List of tables and figures

Figure 1: Shared Responsibility Holder Map

Figure 2: Barriers and challenges in youth involvement

Figure 3: Factors for Successful Youth Programs

Table 1: Interviewees per sector

Table 2: Action Plan

Positionalities

Anas Ansari: I am a South Asian man from Kerala, India, raised in a forest-fringe village in the southern part of the Western Ghats, a global biodiversity hotspot. Growing up in this unique environment, I frequently witnessed human-wildlife conflicts, which deeply influenced my perspective on ecological and social issues. These early experiences inspired me to pursue a Bachelor's degree in Forestry, providing me with a solid foundation in ecological principles and conservation strategies. Now, as a Master's student in Regenerative Sustainability at the University of Saskatchewan, I am committed to developing sustainable, inclusive, and culturally sensitive solutions to complex socio-ecological problems through my research aspirations.

Frederike Helmke: As a white German woman in my mid-twenties I have experienced many privileges within the western culture. As the second child of three from a middle-class family, I have been fortunate to access quality education and diverse opportunities. I have received a bachelor of science in the field of human biology and a second degree in ecology and environmental planning. I am currently enrolled in the masters program in global change management, an international and interdisciplinary study program. My studies have allowed me various experiences living abroad in countries like the USA, South Africa and Canada. This enabled my curiosity of learning about new cultures and traveling to new places. Additionally, having grown up playing field hockey, I bring in strong teamwork skills and a collaborative mindset to our transdisciplinary project.

Laila Heising: I was born as a white woman into a German family with a long history in academia. Growing up I had easy access to resources, amenities as well as to education. My environmentally conscious parents nurtured the inherent connection to my natural environment and introduced me to the political debate around nature conservation and climate change. I took up undergraduate studies in environmental sciences and am now studying the Master program Global Change Management. I also concluded a training program for wilderness education that was rooted in indigenous knowledge and wisdom passed on through many indigenous as well as non-indigenous hands. There I was offered a glimpse into this way of viewing and connecting to the world that resonated strongly with my own understandings and feelings and strengthened the pledge I had taken to dedicate my work to the reconciliation of humans with nature.

Shannon Rutherford: As a white South African woman and first-generation university (Rhodes University) student from a working-class background, my academic journey has profoundly shaped my perspective on our transdisciplinary project. With an undergraduate degree in botany and microbiology and a current master's in biotechnology focusing on cancer diagnostics, I bring a unique blend of scientific knowledge to our initiative. My personal and academic experiences guide my approach to ensuring our educational initiatives are scientifically accurate and accessible. I am committed to continuous self-reflection, embracing diverse perspectives from our international team and surrounding community to make our efforts inclusive and effective.

Research focus and background

The Mount Arrowsmith Biosphere Region, a designated UNESCO Biosphere Reserve, is situated on the east coast of Vancouver Island in British Columbia (BC), Canada. This region boasts a diverse array of ecosystems, including ancient temperate rainforests, alpine meadows, and pristine lakes. Its extraordinary biodiversity supports numerous rare and endemic plant and animal species. Additionally, the area's rich cultural heritage, highlighted by a long history of Indigenous stewardship and exploration, enhances its unique significance (Canadian Biosphere Reserves Association, 2024).

Invasive alien species (IAS) pose a significant threat to the Mount Arrowsmith Biosphere Region (MABR) by disrupting the delicate balance of its diverse ecosystems (Clermont, 2006). These species, whether plant, animal, or microorganism, can have a variety of negative impacts on native species, ecosystems, and social systems. They can cause biodiversity loss (prey on or outcompeting native species for resources such as food, light, and habitat), ecosystem disruption (alteration of the structure and function of ecosystems), economic impact (affecting agriculture, forestry, fisheries, and tourism, leading to costly management and mitigation efforts) and cultural impact (impacting the cultural practices and heritage of Indigenous communities that rely on specific native species for traditional practices, food, medicine, and spiritual purposes) (C. Rankin & Assoc., et. al., 2004). It is to be noted, that these effects are not a result simply of the nature of these species but are caused by the displacement - mostly through human activities - from their original ecosystems, in which they would have been part of a balanced network of inter-species interactions. Stressing this cause-effect relation is important in assigning responsibility on the side of human activity which not only contributes to the displacement of species but also to a disruption of ecosystems, making them more vulnerable to the spread of non-native species.

Current invasive species, identified by the Invasive Species Council of British Columbia, include terrestrial invasive species (Japanese knotweed, Emerald ash borer, the European rabbit, Scotch broom, Spongy moth, Feral pig, etc.), and aquatic invasive species (European green crab, Goldfish, Eurasian watermilfoil, Yellow floating heart, Yellow perch, Yellow flag iris, etc.) (Bosch, 2024). Current management programs include monitoring, removal (mechanical, chemical, and bio control), and education (awareness and prevention) (Bosch, 2024).

Education is a vital component in addressing the issue of invasive species. Through comprehensive educational initiatives, a broad and diverse audience can be reached, informing them about the risks and impacts of invasive species on local ecosystems. By raising awareness, individuals and communities are empowered to take proactive steps in preventing the introduction and spread of these harmful species. Educational programs can: (1) raise awareness by informing the public about the characteristics of invasive species, their effects on native biodiversity, and the ecological, economic, and cultural consequences of their spread; (2) promote prevention by educating people on best practices for preventing the introduction and spread of invasive species; (3) encourage participation by inspiring community involvement in invasive species management; (4) foster stewardship by cultivating a sense of environmental responsibility; and (5) build partnerships by strengthening collaborations between educational

institutions, governmental agencies, non-profit organizations, Indigenous communities, and other shared responsibility holders. Overall, education serves as a powerful tool in the fight against invasive species. By informing and engaging the public, a well-informed community can be created that is equipped to take action, support conservation efforts, and contribute to the preservation of the Mount Arrowsmith Biosphere Region's unique and valuable ecosystems (Nova, et. al., 2017).

Youth engagement encompasses a variety of activities that promote civic participation and social responsibility (Lerner et al., 2005). The United Nations Educational, Scientific and Cultural Organisation (UNESCO) defines it as the active, empowered, and meaningful involvement of young people in decision-making processes, particularly in areas affecting their lives and communities (UNESCO, Youth 1970). According to UNESCO, 70% of young people feel they lack sufficient opportunities to participate in public debates and express their concerns and ideas, highlighting a significant gap in their inclusion in societal discourse. UNESCO emphasizes that addressing this gap is essential for protecting young people's rights and upholding fundamental principles of inclusion and engagement (UNESCO, n.d.). It is important to engage youth as “young people in all countries are both a major human resource for development and key agents for social change, economic development and technological innovation” (UN, 1995).

Youth education and involvement in addressing the issue of invasive species is crucial because young people are the future stewards of our environment. Engaging youth in this cause fosters a lifelong commitment to environmental conservation and equips them with the knowledge and skills needed to tackle ecological challenges. In a Youth Engagement Toolkit, the Government of BC lists the following reasons for why focusing on youth education and involvement is essential: (1) Building Awareness from an Early Age: by starting education at a young age, a generation that is informed and proactive about environmental issues is cultivated; (2) Fostering Engagement and Participation: involving young people in hands-on activities makes the learning process engaging and practical, reinforcing their understanding but also empowers them to make a direct impact on their local environment; (3) Developing Future Leaders: by involving youth in environmental conservation efforts, these young individuals can become influential voices within their communities, promoting sustainable practices and advocating for policies that protect native ecosystems; (4) Promoting Intergenerational Learning: youth education can also facilitate intergenerational learning and cooperation. When young people are knowledgeable about invasive species, they can share this information with their families, friends, and broader communities. This exchange of knowledge can lead to greater community-wide awareness and collective action against invasive species; (5) Innovative Problem-Solving: young minds often bring fresh perspectives and innovative solutions to complex problems; and (6) Strengthening Community Ties: youth involvement in environmental projects can strengthen community ties and foster a sense of shared responsibility (Government of BC, 2016).

Research has shown that youth education and engagement yield personal, institutional, and community benefits. On a personal level, outdoor education equips students with practical knowledge and planning skills (Checkoway & Cahill, 1981). It helps youth realize their value and rights, understand their role in improving systems, and recognize that their opinions matter. Engagement also encourages them to contribute to their community, develop resilience, pride, accountability, self-esteem, leadership, and problem-solving skills, and connect with their peers and community. It also bridges generational gaps, fostering a sense of belonging and easing

their transition to adulthood and independence (Government of BC, 2016). Extracurricular activities significantly enhance academic achievement and strengthen social connections among students, parents, and schools, positively impacting overall achievement (Broh, 2002). Institutions and organizations benefit from the additional knowledge, skills, and creativity that youth bring to planning and decision-making, leading to more effective policies, programs, services, and greater transparency and accountability (Government of BC, 2016). Adults gain from a balance between positive youth interactions and crisis management, skill development, career growth, and enhanced job satisfaction. They benefit from more accurate service assessments and better relationships with youth (Government of BC, 2016). Communities benefit from having knowledgeable, active citizens who collaborate to address issues and challenges. Youth and adults working together foster greater generational understanding, empathy, and the ability to challenge stereotypes. This engagement promotes democracy, social responsibility, and increases social capital (Government of BC, 2016).

Initial conversations with the MABR community highlighted a concern about the lack of youth involvement in invasive species management, with efforts largely driven by an older population. This demographic imbalance raises sustainability concerns and misses the opportunity to harness the energy, ideas, and potential of younger generations.

As a result this research focuses on how the MABR can raise awareness and elicit action in youth for the management of invasive species. This will be done by identifying gaps and potential, and proposing actions to raise awareness, bring different perspectives together, build capacity and agency and strengthen participation.

This research supports the achievement of several of the United Nations Sustainable Development Goals (SDGs). Firstly, it addresses SDG 2 "Zero Hunger" by combating invasive species that outcompete native flora and fauna that serve as food sources, especially for Indigenous peoples, thus helping secure these vital resources. It aligns with SDG 4 "Quality Education" by focussing on educating youth and those involved in youth education within the MABR about invasive species and their impacts. For SDG 11 "Sustainable Cities and Communities," the research is crucial for preserving the natural heritage of the region. By involving youth, the project contributes to sustainable ecosystem management, enhancing community resilience and sustainability. It also relates to SDG 13 "Climate Action," since invasive species can exacerbate climate change impacts on ecosystems; hence, educating youth on this issue and involving them in mitigation efforts builds capacity for climate action and adaptation strategies. Furthermore, the project addresses SDG 14 "Life Below Water" by managing invasive species that threaten aquatic life, and SDG 15 "Life on Land" by introducing measures to prevent and reduce the impact of invasive alien species on terrestrial ecosystems. Lastly, it aligns with SDG 17 "Partnerships for the Goals" by encouraging and promoting effective public, public-private, and civil society partnerships. Collaborating with schools, community organizations, and other shared responsibility holders to involve youth in managing invasive species fosters the partnerships essential for achieving sustainable development (United Nations, 2024).

Methods

In order to determine how the Mount Arrowsmith Biosphere Region can raise awareness and elicit action in youth for the management of invasive species, a series of semi structured interviews were conducted with various shared responsibility holders within the MABR. These interviews were aimed at identifying the existing programs for youth engagements as well as gaps, barriers, potential factors and ideas for success for further action, and what current collaborations exist between actors and what collaborations could be developed. In order to identify relevant actors, a preliminary stakeholder analysis was conducted using an internet search with a snowballing approach. These stakeholders were mapped according to their sectors (Figure 1). Throughout the interviews, that map was developed further. Interview candidates were chosen to represent a broad variety of sectors in an attempt to get a broad view over the current situation and a multitude of different perspectives on potential solutions. In total, 17 people were interviewed. There was an imbalance in the number of interviewees resulting from varying numbers of active actors, power distribution in that sector, as well as availability of actors within the time frame of the research process. In addition to the formal interviews, however, insights gained from informal conversations in the course of the project were also used to inform and enrich the outcomes.

The interviews were conducted in a semi-structured form with the help of an interview guide that differed slightly between practitioners and educational institutions. The interviews were audio recorded, transcribed and analysed through thematic analysis with a qualitative data analysis tool (MaxQDA). Categories for analysis were defined using a mixed-methods approach, with main categories being derived from the research objective and interview guide (deductive) and subcategories being defined in the process of analysis (inductive).

Literature was also reviewed using a berry-picking method to identify factors for the success of youth engagement and good practice examples implemented elsewhere.

Using information gathered from the interviews and literature a number of recommendations in the form of an action plan were put together on how best to elicit awareness and action in youth for the management of invasive species.

Results

Shared responsibility holder map

The shared responsibility holders identified in the MABR as well as those involved in this research are outlined below, in the shared responsibility holder map (Figure 1). This map represents our best understanding of the relevant shared responsibility holders without any claim to completeness. It can be used to identify possible partners for collaborations - in general as well as with the focus on managing invasive species. Such collaborations can help to make use of synergies, pool resources and create interventions with a broader and stronger impact.



Figure 1. MABR shared responsibility holder map.

Gaps

Despite an abundance of existing initiatives and programs, the conversations with shared responsibility holders in the MABR have shown a number of gaps when it comes to effectively engaging youth in the management of invasive species. Defining those gaps was a crucial step in identifying potential for improved action.

Most of the actors observed a general lack of awareness around the existence, the impact, possible introduction pathways and management options of invasive species. While some acknowledge a missing focus on these issues in their own programs, many bemoan the lack of representation of the topic in school curricula, media and public spaces and express a desire for more outreach to the general public and youth in particular. With many programs aimed at the general public there is also some undeveloped potential to strengthen the focus on youth engagement. In order to engage youth, generating a general awareness about the problem that

non-native species pose is an essential first step. Explaining the impacts on native habitats and species helps to foster a sense of responsibility and understanding for the necessity of management. Here the awareness about impacts on the livelihoods of Indigenous peoples and the colonialist implications of the introduction of non-native species plays an important role as well. A First Nation representative shared strong feelings of anger and explained: “I go on my trail that I’ve always walked on and all of a sudden there’s all these tansy plants and I feel like it’s just another pressure, like just one more layer of colonizing [...] So I think that my biggest concern is losing our important indigenous plants.” Knowledge about harmful practices such as using invasive plant species in gardens, releasing pets into the wild or transporting outdoor sports equipment between infested and pristine areas without cleaning is necessary for the prevention of further spread in which youth can play a role through changing their own behavior as well as by educating their families and peers.

A stronger representation of the issue of invasive species in school and university curricula can be instrumental in raising that awareness, however actors also stress the importance of media channels, especially social media in reaching out to and activating youth. One interviewee mentioned a successful content creator on Instagram who is “fully focused on invasive species removal, management prevention, communication. So his content is quite funny [and] I’ll see, like my student friends like these videos. So it’s kind of attracting people through humor.” In general, it was observed that the topic is not being sufficiently discussed publicly by political leaders, educators and media and therefore has little focus in the minds of the general public.

Increased collaborations between holders and transmitters of knowledge has been identified as a possible strategy to help bridge that gap. First Nations, environmental stewardship groups and academics hold the information, skills and values needed for a holistic management of the issue. While also providing education and engagement opportunities of their own, further collaborations with schools, teachers, museums and journalists would be desired for their potential to widen the reach, especially for a younger target group. Actors also stress the importance of action from local and provincial governments to support the management and outreach on the issue of invasive species by providing legislative and financial support and putting the topic on the political agenda to strengthen its presence in public discourse. One interviewee summarised this by stating: “Our politicians and our leaders have to make it an important issue and right now our local government are more worried on healthcare and schools and things and that’s great, that’s true, but you know, climate change, invasive plants, all these things are tied together. If our environment is not healthy, we are in trouble and it’s all connected.”

Barriers

Following the identification of gaps, shared responsibility holders were also asked about barriers standing in the way of filling those gaps and increasing outreach to youth. Figure 2 shows the barriers that were mentioned.

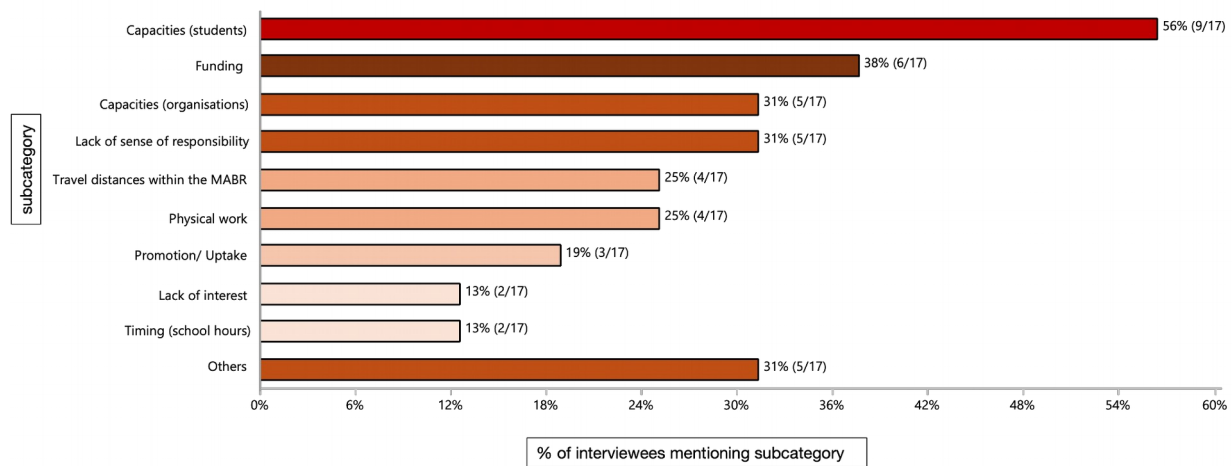


Figure 2. Barriers and challenges in youth involvement. Showing the % of interviewees mentioning themes of subcategories that represent a barrier or challenge to involve youth within their program.

As the biggest barrier to youth involvement, actors mentioned a lack of capacities in the students they were trying to reach. With full curricula and potential work obligations leaving very limited room for additional engagement and an abundance of offers and activities competing for attention, only a few find their way to programs targeted at invasive species management. The distances within the MABR add to this, making it difficult for students to take part in activities outside their immediate vicinity. The timing of activities during school hours will exclude any youth bound to these. In terms of attention, many actors mentioned a lack of awareness of existing programs, struggling to find effective forms of promotion to reach young people “tied up in their own lives”. The limitation of capacities also applies to the organisations that could provide these programs – such as schools or environmental stewardship groups. Few have capacities left to spare for the implementation of additional programs or the building of collaborative relationships with other organisations, with insufficient funding further limiting available resources. A low sense of responsibility for the issue of invasive species as well as a general lack of interest, possibly resulting from a lack of awareness about the topic, were also named as a cause for limited engagement. For the involvement of young children, the physical aspect of active management work emerged as a limiting factor, though some actors had implemented alternative forms of education not involving physical work. Other challenges mentioned include legal requirements for youth education, differences in work focus and culture between organisations and lack of technical capabilities for social media outreach.

Factors for Success

To understand the factors for a successful youth program, interviewees were asked several questions, which gave them the opportunity to elaborate on the topic of youth engagement. Interviewees were asked about existing programs, how youth has been involved in them and what has been working well so far. The recorded responses are based on the interviewees experiences and opinions. Figure 3 shows the six most frequently mentioned factors in percent of interviewees mentioning the respective subcategories.

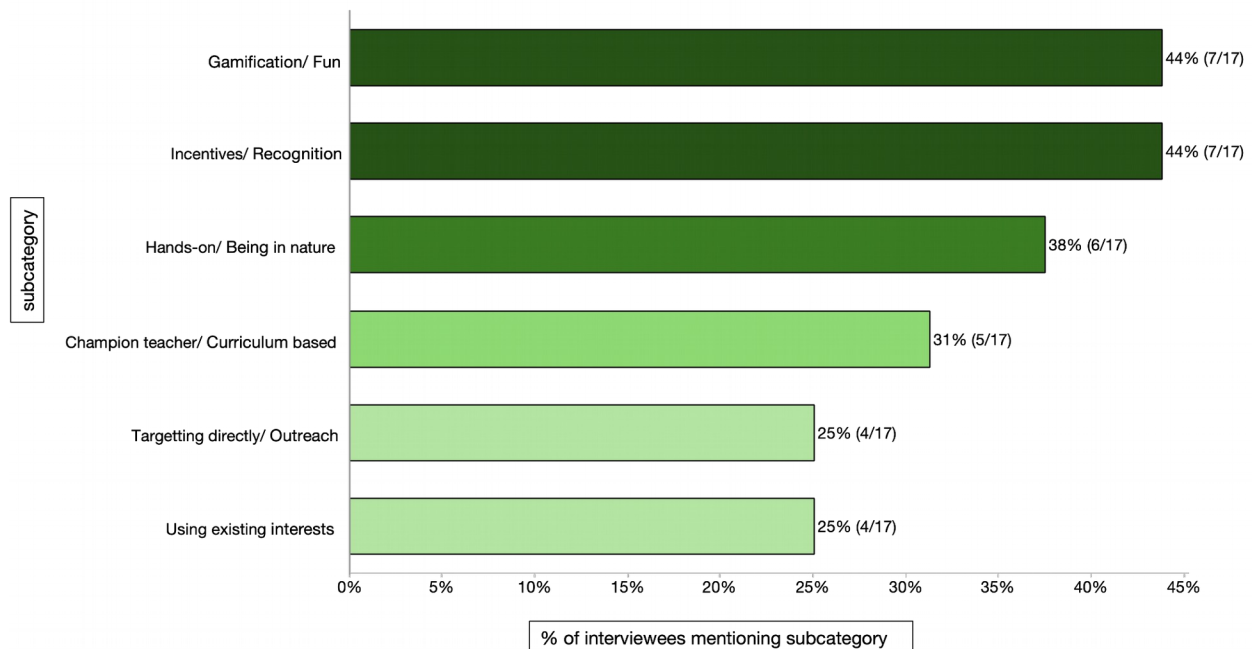


Figure 3. Factors for successful youth programs. Showing the % of interviewees mentioning themes of subcategory that contribute to successful youth programs, based on their experiences and opinions.

The factor of gamification/fun has been one of the most frequent categories mentioned by shared responsibility holders. Gamification and fun involves transforming work tasks into enjoyable and engaging activities that are both entertaining and educational. Gamification incorporates various playful methods, such as drawing, games and contests. The aim is to create an environment where peers come together to participate in activities that feel more like games than work, fostering collaboration and a sense of community. Through these interactive and enjoyable experiences, youth can learn and achieve goals in a way that feels natural and fun.

The category of incentives/recognition is also seen as a very important factor for success. Incentives and recognition focus on creating a give-and-take relationship that motivates participation by offering rewards. This approach ensures that participants gain value, whether it enhances their resume, provides a unique hands-on experience, or offers other forms of appreciation. Examples of incentives include paying a small amount to participants, offering treats like pizza and ice cream, featuring participants in a newspaper article, granting volunteer hours, and allowing youth to take over certain responsibilities to give them recognition. These strategies aim to motivate and acknowledge contributions, making participation more appealing and rewarding.

Interviewees have seen a great value in having hands-on activities and being in nature with students. It engages students by making learning tangible and exciting. Students learn through active participation, which solidifies concepts and fosters a deeper understanding. Outdoor activities can break the monotony of the classroom, introduce diverse educators, and create a dynamic learning environment. They not only educate but also connect students to nature,

enhancing their appreciation and well-being. Exploring nature up close, provides learning opportunities that a normal classroom setting cannot offer.

Champion teachers and curriculum-based initiatives focus on integrating environmental projects into school curricula. These programs engage students by taking them out of the classroom to connect with natural environments, like watersheds, where they can learn hands-on in nature. These projects are embedded into the school schedule. Embedding projects within the curriculum ensures continuity and knowledge transfer to successive student generations. The success of these initiatives relies heavily on champion teachers who are passionate about environmental education and willing to collaborate. These teachers can help integrate projects into the classroom, making those part of a regular routine. Effective programs also benefit from school liaisons who understand the administrative and logistical aspects of schools, ensuring smooth implementation and compliance with school policies. This approach can maximize reach and impact, embedding environmental awareness and action into student education.

Targeting schools and students directly through outreach involves structured, consistent engagement across multiple institutions. Outreach programs can be designed to enhance direct student involvement ensuring continuous and effective programming. Outreach extends beyond the classroom to include student-led groups like high school eco clubs. These clubs empower students to lead environmental initiatives, fostering leadership and ownership. Targeting students directly also involves supporting students to direct their own projects. This approach not only engages students but also empowers and motivates them to take initiative and see the impact of their efforts, fostering a sense of agency and accomplishment.

Using existing interests involves leveraging activities and themes that already captivate students' interest to foster engagement and learning. For example, representing environmental topics at non-environmental events, like Family Day or local fairs, helps reach broader audiences who might not attend dedicated environmental events. Connecting environmental issues to topics of personal interest, such as biodiversity loss and its impact on beloved animal species, can also engage youth effectively. It raises awareness about the broader environmental issues which can act as an opening portal to the issue of invasive species. This strategy of tapping into pre-existing interests can make environmental education more relatable and impactful.

These findings do not represent empirical data but rather insights into interviewees' experiences and perceptions. However, they indicate the significance of including these aspects when designing successful youth programs.

Literature Review: Successful Tools & Case Studies

Various innovative tools and strategies have been employed world wide for engaging youth in understanding and addressing the challenges posed by invasive alien species, these include field trips and outdoor and indoor education programs, which are effective in raising awareness about biodiversity issues (Rijal et al., 2018). Integrating problem-based courses into the curriculum that link to multiple disciplines, such as economy, business, social, and ecological studies, is another successful approach (Kricsfalusy et al., 2016). Citizen science projects can

significantly influence participants' attitudes, behaviors, and scientific understanding (Feder et al., 2009), and involving students in platforms like iNaturalist and EDDMapS further supports this engagement (Adriaens et al., 2015).

It has been shown that young individuals are driven to act due to their growing anxiety about climate change and the perceived absence of leadership from older generations. This heightened sense of urgency propels youth and initiatives focused on climate justice and sustainability (Partridge, 2008). Additionally, young people have been shown to frequently reject the hierarchical structure of organizations, highlighting the need for their representation in management and decision-making roles, and are mostly utilising online tools and networks to get involved in a political and social context (MacKinnon et al., 2007).

Two youth-focused community and citizen science (CCS) programs—one coastal and one focused on water quality monitoring—were studied in various settings across the San Francisco Bay Area. The study assessed the impact of youth participation on conservation efforts, particularly in site and species management. Findings revealed that youth involvement significantly informed regional resource management and improved local habitats. Additionally, the research explored the environmental science agency (ESA) of youth participants, including their understanding of environmental science, inquiry skills, and belief in their ability to influence ecosystems. The study identified three central CCS processes through which youth developed ESA: rigorous data collection, sharing scientific findings with real-world audiences, and exploring complex social-ecological systems. These processes enhanced youth engagement in current conservation efforts and prepared them for future conservation actions (Ballard et al., 2017).

In Belgium, the AlterIAS program utilizes tangible plant specimens and identification keys to immerse students in hands-on learning experiences, enhancing their comprehension of invasive plants beyond traditional visual aids. This approach is complemented by a communication campaign targeting horticultural schools and the provision of toolkits for educators. The Netherlands' ECOSIM project enhances understanding of aquatic invasive species through an advanced 3D simulation game, while the LINVEXO initiative provides e-learning modules covering various species' introduction, impacts, and management techniques (Verbrugge et al., 2021).

In Germany, the KORINA project adopts a multifaceted approach, incorporating indoor and outdoor instructional techniques, a card game, an exhibition, identification materials, and an e-learning resource to combat invasive alien plants comprehensively. In Portugal, the Forest Invaders program employs interactive methodologies, including presentations and practical exercises, to raise awareness among secondary school students about invasive species' impact on forest ecosystems (Verbrugge et al., 2021).

Similarly, the Alien Species Exhibition in Finland toured the country, educating the public about invasive species' detrimental effects, while the Florida Education Initiative & Curriculum equips educators in the USA with comprehensive resources and workshops to educate students about invasive alien plants (Verbrugge et al., 2021).

Lastly, in New Zealand, the Winning the War against Weeds initiative engages students in interactive learning experiences to reconnect them with the natural environment and raise awareness about weed-related challenges and invasive species identification. These initiatives collectively highlight the importance of innovative approaches in educating youth about invasive alien species and fostering their engagement in conservation efforts (Verbrugge et al., 2021).

Discussion

The Mount Arrowsmith Biosphere Region faces significant threats from invasive species, impacting its ecosystems and the cultural practices of its Indigenous communities (Clermont, 2006). Enhancing youth engagement in invasive species management is crucial for the future and long-term solution (Nova, et. al., 2017). This research focused on how the MABR could raise awareness and encourage action among youth, addressing current gaps and barriers, and proposing effective strategies. Engaging youth is essential for fostering lifelong conservation commitments, equipping them with necessary practical skills, and leveraging their innovative potential (Government of BC, 2016).

There is a common understanding among the shared responsibility holders about the importance of raising awareness and engaging youth within the MABR. Throughout the interviews, actors mentioned seeing youth as the caretakers of the planet in the future and stressed the importance of youth involvement to sustain stewardship groups with an aging membership base. Therefore, empowering youth by recognizing their potential through outdoor activities, enabling them to take on leadership roles and participate in invasive species removal efforts is instrumental to sustainable management of the issue of invasive species. Engaging youth at a young age can help raise early awareness and also promote intergenerational learning.

Through conversations with shared responsibility holders in the MABR as well as a literature review, key gaps and barriers and solutions to engaging youth in the management of invasive species were identified. Using successful case studies within and outside the MABR as inspiration, barriers can be strategically addressed in order to fill those gaps.

The major barrier identified by the shared responsibility holders was the limited capacity of students. This could be overcome by involving the topic of invasive species in their curriculum as suggested by the shared responsibility holders and by literature (Verbrugge et al., 2021). Achieving this potentially requires changes in educational legislation, engaging with school boards, and finding champion teachers to implement the topic attractively, either as part of the curriculum or for academic credits.

Funding is the second major challenge in engaging youth in the management of invasive species within the MABR. Many shared responsibility holders continue to struggle with securing sufficient funds. While there is no definitive solution at present, it is recommended that actors persist in applying for grants and conducting fundraising efforts. Funding organisations are encouraged to support interventions for the management of this central issue. In addition to limitations in terms of funding, organisations are also faced with a lack of general capacities.

This can be addressed by fostering synergies through increased collaborations and by directly or indirectly boosting youth volunteering within these organizations.

The lack of sense of responsibility has been identified as a major challenge for the management and education about invasive species. This can be linked to a general lack of awareness about the topic. Creating collaborations with the MABR, stewardship groups and schools can help schools and NGOs to take up that issue and include invasive species in the education curriculum & NGO programs. This includes having champion teachers that include the topic into their curricula and that provide field trips and outdoor hands-on learning experiences together with the stewardship groups. These activities help students connect to their local environment and understand the importance of managing invasive species. Direct outreach and giving youth the opportunity to take over roles of responsibilities, such as representing a youth voice at the MABR roundtable, would give them recognition and a sense of agency (Ballard et al., 2017). Additionally, several stakeholders noted that the distances between locations within the biosphere region further hinder youth engagement. This problem could be overcome by implementing virtual engagement strategies, organizing regional hubs, and providing transportation support to bridge the gap between locations within the biosphere region

Physical work was also raised as a barrier when involving children, especially during removal activities and hands-on training. More targeted, group-specific programs can address this barrier, such as using more physically demanding activities to target college or high school students while involving elementary school students in activities such as native plant seed bomb-making and raising native plants in their home gardens with their parents.

Responsibility holders have noticed a lack of promotion and uptake of information about existing initiatives and programs to attract young people towards invasive species. MacKinnon et al., (2007) suggest that youth are mostly utilising online tools and networks to get involved in a political and social context. Hence an online campaign program with a mascot specifically for invasive species could be a potential initiative for more effective promotion.

Lack of interest was identified as a challenge. Most interviewees suggested that incorporating gamification and fun activities could attract more young people. Literature suggests that youth should be treated as co-creators and partners and given equal significance as adults to maintain their trust and make a sense of responsibility (Riemer et al., 2014; MacKinnon et al., 2007). It encourages them to contribute to their community, develop resilience, pride, accountability, self-esteem, leadership, and problem-solving skills, and connect with their peers and community. It also helps bridge generational gaps, fostering a sense of belonging and easing their transition to adulthood and independence (Government of BC, 2016).

Timing of organizational activities was also identified as a barrier in engaging youth as most of them take place during weekdays when students are in school. This can be overcome by scheduling organizational activities during weekends or school holidays when youth are more likely to be available. Additionally, coordinating with schools to integrate these activities into the school day as part of the curriculum or extracurricular programs could also help mitigate this barrier.

An action plan for engaging youth in invasive species management within the Mount Arrowsmith Biosphere Region (MABR) was created to address the critical challenges identified through the research and stakeholder consultations.

Action plan

Table 2: Action Plan to Elicit Action and Awareness in youth of the MABR

Action	Responsible	Timeline	Priority	Status	Cost	Notes
Goal #1: Improved outreach to youth						
Improved social media presence	NGOs	Ongoing			low	Contact influencers, promote fun activities, interactive campaigns, and latch on to events (IAS awareness week, earth day), to engage better with youth, and families.
Social media training for NGOs	MABRRI	Short-term recurring			low	How to work different platforms, what to focus on posting (info about invasives, alternative native options, events, how to remove etc.) - fosters agency. Use topics of interest (landscaping, gardening, community fairs). Engage the tourism sector.
Campaigns	NGOs, MABRRI	Short-term			High	Campaigns which attract youth such as Woodsy Owl and Smokey the Bear.
Volunteer program platform	MABR	Short-term			low	All the volunteer opportunities available in the MABR are in one platform for youth to easily find.
Goal #2: Including invasive species in education curriculum & NGO programs						
Legally incorporating it in the curriculum	Provincial government	Long-term			High	Changing the provincial curriculum, making it mandatory to teach about IAS and include field trips
Incorporating a section on invasive species into current	Education department,	Ongoing			Low	Introducing it in different subjects (e.g. business- the cost effects of invasives, biology - their effect on

Action	Responsible	Timeline	Priority	Status	Cost	Notes
curriculum	champion teachers, school boards					the environment, anthropology - their effect on indigenous lives etc.). Equip educators with comprehensive resources. Gamification to keep them interested: scavenger hunt, crossword puzzles, card/board games, collaborate with Play Clean Go for materials.
Incorporating IAS in current outreach programs	NGOs, MABRRI	Ongoing			Medium	Assist school boards and develop materials on IAS. Targeting schools and students directly through outreach involves structured, consistent engagement across multiple institutions. Programs can run in two batches—fall and spring—spanning several months with activities occurring multiple days a week
Goal #3: Youth as co-creators - eliciting responsibility						
Youth representative on roundtable	MABR roundtable	Short-term			Low	Put out a call, with proper advertising (potentially through lecturers) to students/ youth.
Mentorship programs	NGOs	Short-term			Low	Engage youth in the organisation. Train youth to be capable of taking on responsibility within organisations, to ensure continuation of activities in the future.
Peer-mentoring/ambassador program	VIU, high school	Medium			Low	VIU students giving talks at high schools on invasive species - role models.
Goal #4 Strengthening collaborations						
Collaboration with RDN on	RDN &	Ongoing			Low	The regional district of Nanaimo (RDN) has a youth

Action	Responsible	Timeline	Priority	Status	Cost	Notes
youth ambassador outreach program	MABRRI					ambassador outreach program intended for the critical age of high school students. This is an excellent opportunity for MABRRI to partner with RDN to go into schools and connect with teachers, students and school eco clubs.
Collaborating with schools	MABRRI	Ongoing			Low	Finding those champion teachers that open the opportunity for curriculum based outdoor activities Adding a member of the school board to the roundtable representing secondary educational institutions
Connect stewardship groups with schools	MABRRI & NGOs & Schools	Ongoing			Low	Find school liaisons and champion teachers in order to facilitate field trips in cooperation with stewardship groups
Co-developing invasive species materials and programs for students of different ages	Educators and knowledge holders, MABRRI	Short-term / Ongoing			Low - medium	Having audience specific material MABRRI has structures in place but not specifically for invasive species.

Reference List

1. Adriaens, T., Sutton-Croft M., Owen K., Brosens D., van Valkenburg J., Kilbey D., Groom Q., Ehmgig C., Thürkow F., van Hende P., Schneider K. (2015). Trying to engage the crowd in recording invasive alien species in Europe: experiences from two smartphone applications in northwest Europe. *Management of Biological Invasions* 6: 215–225, <https://doi.org/10.3391/mbi.2015.6.2.12>
2. Ballard, H.L., Dixon, C.G.H., Harris, E.M. (2017). Youth-focused citizen science: Examining the role of environmental science learning and agency for conservation. *Biological Conservation*. Vol 208. 65-75.
3. Bosch, L. (2024). *Invasive Species Management*, s.l. Invasive Species Council of BC.
4. Canadian Biosphere Reserves Association. (2024). Mount Arrowsmith. [Online] Available at: <https://biospherecanada.ca/biosphere/mount-arrowsmith/#:~:text=Dominated%20by%20the%20towering%20peaks,alpine%20meadows%20and%20pristine%20lakes.> [Accessed 04 06 2024].
5. Clermont, H. (2006). *Financing conservation management in parks and conservation areas: A case study of Mount Arrowsmith Biosphere Reserve* (Doctoral dissertation, Master's thesis). Retrieved from <http://www.biosphereresearch.ca/Files/Research%20papers/Clermont%202006.pdf>).
6. Feder, M. A., Shouse, A. W., Lewenstein, B., & Bell, P. (2009). *Learning science in informal environments: People, places, and pursuits*. National Academies Press.
7. Government of BC. (2016). *Youth Engagement Toolkit*. [Online] Available at: <https://www2.gov.bc.ca/gov/content/family-social-supports/data-monitoring-quality-assurance/information-for-service-providers/youth-engagement-toolkit> [Accessed 10 06 2024].
8. Kricsfalusy, V., George, C., & Reed, M. G. (2016). Integrating problem- and project-based learning opportunities: Assessing outcomes of a field course in environment and Sustainability. *Environmental Education Research*, 24(4), 593–610. <https://doi.org/10.1080/13504622.2016.1269874>

9. Lerner, R. M., Almerigi, J. B., Theokas, C., & Lerner, J. V. (2005). Positive youth development a view of the issues. *The Journal of Early Adolescence*, 25(1), 10–16. <https://doi.org/10.1177/0272431604273211>
10. MacKinnon, M. P., Pitre, S., & Watling, J. (2007). *Charting the Course for Youth Civic and Political Participation*.
11. Novoa, A., Dehnen-Schmutz, K., Fried, J. et al. (2017) Does public awareness increase support for invasive species management? Promising evidence across taxa and landscape types. *Biol Invasions* 19, 3691–3705. <https://doi.org/10.1007/s10530-017-1592-0>
12. Patridge, E. (2008). *From ambivalence to activism: Young people's environmental views and actions*. 27, 18–25
13. Rankin, C. & Assoc, Madrone Environmental Services Ltd, The Nature Conservancy of Canada, Booth, J. & Assoc, Cannings, S., Osiris Wildlife Consulting, (2004). *Invasive Alien Species Framework for BC Identifying and Addressing Threats to Biodiversity*. [Online] Available at: https://shuswapwatershed.ca/teacherguide/D-Reports/alien_species_framework_BC_0205.pdf [Accessed 04 06 2024].
14. Rijal, M., Saefudin, & Amprasto. (2018). Field trip method as an effort to reveal student environmental literacy on biodiversity issues and context. *Journal of Physics: Conference Series*, 1013(1), 012020. <https://doi.org/10.1088/1742-6596/1013/1/012020>
15. United Nations. (1995). *World Programme of Action For Youth to the year 2000 and beyond*. United Nations. <https://digitallibrary.un.org/record/202231>
16. United Nations. (2024). THE 17 GOALS. [Online] Available at: <https://sdgs.un.org/goals> [Accessed 10 06 2024].
17. UNESCO. (n.d.). *Meaningful youth engagement*. <https://www.unesco.org/en/youth/engagement>
18. Verbrugge, L.N., Dawson, M., Gettys, L.A., Leuven, R.S., Marchante, H., Marchante, E., Schneider, K. and Vanderhoeven, S. (2021). Novel tools and best practices for education about invasive alien species. *Management of Biological Invasions*, 12(1), 8-24.

19. UNESCO. (1970). *Youth*. <https://www.unesco.org/en/youth>