

**Weeding Through the Options:
Policy Alternatives to Address Invasive Plants on
In-SHUCK-ch Territory**

by

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B.Sc. (GRS), University of British Columbia, 2008

Research Project Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Public Policy

in the

School of Public Policy

Faculty of Arts and Social Sciences

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SIMON FRASER UNIVERSITY

Spring 2013

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Abstract

Invasive plants invade ecosystems and displace native plants, significantly threatening the environment. In-SHUCK-ch First Nation has an interest in protecting the ecological integrity of the traditional lands and resources that are fundamental to its culture. This study examines strategic options and best practices for First Nations to address invasive plant management in their jurisdiction. Methodology includes a survey of In-SHUCK-ch membership, and interviews with experts, representatives from provincial and regional jurisdictions, and First Nations' staff. Findings indicate a range of best practices including conducting inventories, establishing priorities based on impact and ability to control, and prevention and control strategies. Four policy approaches are evaluated based on criteria of effectiveness, budget, administrative capacity, and community acceptability. This study recommends that in the short-term In-SHUCK-ch Nation implement an education program to increase members' awareness and incorporate preventative best practices into the Nation's own operations. In the long-term it recommends that In-SHUCK-ch. conduct an invasive plant inventory to determine a treatment plan for existing infestations.

Keywords: First Nations; Invasive Plants; Invasive Plant Management; Invasive Plant Policy; Best Practices; First Nations Resource Management

*For the present and future generations of
In-SHUCK-ch people.*

Acknowledgements

First and foremost I would like to thank the members and leaders of In-SHUCK-ch Nation for welcoming me to their territory and giving their support to my work. Special thanks to David Skerik and Josh Alexander for recommending a topic for my research and facilitating introductions with In-SHUCK-ch staff and leaders.

Kukwstemckacw

(Thank you)

I would also like to acknowledge the generous spirit of the all those who participated in my research. Their insights and knowledge are much appreciated. I am sincerely humbled by all of the First Nations represented in this report that agreed to share their experience in the hope that they may assist other First Nations in protecting the integrity of the lands and resources against invasive plants.

I extend my appreciation to Doug McArthur for his guidance and encouragement throughout the research and writing process. I would also like to thank my other teachers throughout the program, whose instruction fostered valuable skills that I applied throughout my research and will take with me in my career.

Finally, my deepest gratitude is to my family, friends and mentors for their continued wisdom and constant inspiration.

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List of Acronyms

Term	Definition
AANDC	Aboriginal Affairs and Northern Development Canada
BCR	Band Council Resolution
CIPC	Coastal Invasive Plant Committee
FLNRO	Ministry of Forests, Lands and Natural Resource Operations
FRPA	Forest and Range Practices Act
FVIPC	Fraser Valley Invasive Plant Council
FVRD	Fraser Valley Regional District
IAPP	Invasive Alien Plant Program
IMISWG	Inter-Ministry Invasive Species Working Group
IPCBC	Invasive Plant Council of British Columbia
IUCN	International Union for Conservation of Nature
LNIB	Lower Nicola Indian Band
LRISS	Lillooet Region Invasive Species Society
MOE	Ministry of Environment
NWIPC	Northwest Invasive Plant Council
SFU	Simon Fraser University
SLRD	Squamish-Lillooet Regional District
SSISC	Sea to Sky Invasive Species Council
WLIB	Williams Lake Indian Band

Executive Summary

Invasive plants are species that are not indigenous to a particular ecosystem, but once introduced are quickly established and become wide spread, dominating their new habitat. As a result invasive species can cause significant harms to the environment and the cultures and economies that rely on functioning ecosystems.

In-SHUCK-ch First Nation has a growing concern about the threat of invasive plants spreading across its communities and throughout its traditional territory. . Even though there is relatively less development in the territory than in more urban centres, the increase in activity in the territory has created land disturbances, which increase the risk of introduction and spread of invasive plants. As invasive plants establish and spread they impede the cultural practices and traditions associated with the native, culturally significant plants that they displace. This is an especially relevant concern to First Nations who rely on native plants in their territories for food, medicines, and ceremonial purposes.

Though the full scope of the invasive plant infestation in In-SHUCK-ch's territory is not certain, application of the precautionary principle prescribes getting ahead of the problem before it grows into an unmanageable scale. The adverse environmental and cultural impacts of invasive plants, both real and potential, represent a policy problem for In-SHUCK-ch's government. This study examines this problem and identifies policy alternatives for In-SHUCK-ch to consider.

The “Aboriginal Community Toolkit for Invasive Plant Management” (the Toolkit), published by the IPCBC in 2011, sets out a step-by-step framework for First Nations to develop their own plan for invasive plant management. The seven steps of the toolkit are:

1. Identify the management area;
2. Conduct an inventory to determine the species and locations of infestations;
3. Establish measurable management goals and objectives;
4. Set priorities;
5. Select appropriate management strategies including prevention and manual, chemical or biological control techniques;

6. Combine this information into a work plan; and
7. Carry out ongoing monitoring to keep track of progress

The academic literature is consistent with the toolkit's framework. In terms of setting achievable objectives, the predominant view is that total eradication of plant species is very difficult and often not possible. Therefore, alternative goals and targets are needed, such as reducing the density of an invasive plant over an area, slowing the rate of spread, or containing the infestation within a defined zone. Due to limited resources and funding, invasive species management generally focuses on a select subset of infested areas or species. The literature recommends establishing priorities based on risk, which is a function of the severity of impact that the species can cause, and the distribution of the plant and likelihood of being able to control it.

Prevention is accepted as the most effective strategy to manage invasive plants in the long-term. For those invasive plants that have already established themselves control strategies are needed to eradicate or, more realistically, diminish the infestation. Various manual, chemical or biological methods can be used. These methods vary in their effectiveness "depending on the weed species, distribution and density of invasive plant populations and the environmental conditions under which invasive plants grow" (Forest Practices Board, 2006, p. 30). The relative costs of control techniques factor into the choice of method as well.

I applied a mixed methods approach to my research, which combined a survey of In-SHUCK-ch members and qualitative interviews with invasive plant experts, representatives of regional weed committees, and other First Nations.

In-SHUCK-ch members have a low level of awareness of invasive plants in the territory as only 25% of survey respondents indicated they had noticed invasive plants. Although this may, in part, be attributed to potential low levels of infestations, there is an opportunity to increase members' awareness.

Several other First Nations in BC have become increasingly aware of the threat that invasive plants pose on their lands and resources. A few First Nations have undergone a process to develop a strategic plan to address invasive plants. Others have jumped right into taking management action. They have conducted invasive plant

inventories on their reserve lands and hired and trained members to carry out treatment of priority infestations. Many First Nations are averse to broad cast spray of herbicides, as they are concerned about the impact to near-by berries and other traditional plants, as well as wildlife. Some First Nations have chosen to prohibit the use of herbicides both on reserve and in their territory, or at least minimize their use to those situations where alternative methods have proven ineffective.

In addition to conducting their own treatment programs, First Nations described ensuring that they bring up invasive plants in response to project referrals from proponents planning operations in their territory, as well as mandating that lease-holders on reserve remove invasive plants on their property. Several First Nations have incorporated education of members and staff in their invasive plant management approach as well. Commonly First Nations partner with the regional weed committee in their territory to access needed resources and expertise, and avoid duplication of efforts. For some First Nations invasive plant management on reserve have led to additional business opportunities for their treatment crews off-reserve. First Nations have experienced several challenges and limitations during implementation such as access to funding and capacity.

Invasive plant specialists as well as representatives from regional weed committees reiterated that prevention is the best management strategy. Interview participants recommended that In-SHUCK-ch conduct an inventory of their settlement lands before deciding a course of treatment. Participants suggested two approaches to prioritizing species and/or locations for treatment. The first is to prioritize treatment of those invasive species that cause the most severe impact and are most feasible to control. The alternative is to prioritize based on maximizing protection of sensitive resources and locations. This entails treating all invasive species within the proximity of important native plant areas.

Based on an analysis of my research findings I developed four policy alternatives that In-SHUCK-ch can enact either now on reserve lands or after treaty across the entire treaty settlement lands. The alternatives are:

1. Administer an education program for members;

2. Incorporate best preventative practices into In-SHUCK-ch's own governance, administration and operations;
3. Implement a general treatment program in which treatment is prioritized based on severity of impact and feasibility of control; or
4. Implement a culturally-prioritized treatment program in which treatment is focused on establishing invasive free zones around sensitive locations.

The policy options are evaluated against five criteria: Effectiveness, Cost, Capacity Requirements, Community Acceptability and Spillover Effects. The effectiveness criterion is broken down into three components based on how well the policy option achieves the objectives of awareness, prevention and control. The criteria illuminate the trade-offs that In-SHUCK-ch faces when selecting one policy approach over another. The results of the analysis favour an education program firstly, followed by incorporating best preventative practices into In-SHUCK-ch governance and operations. These options scored highly because they are more effective in achieving awareness and prevention of invasive plants than the other two options and are significantly less costly. ,

I recommend that In-SHUCK-ch implement these two options in tandem. An education program alone will likely influence members to push for more direct prevention and control of invasive plants in order to reduce the threat of invasive plants on resources of cultural value. At the same time, incorporating prevention measures into the way In-SHUCK-ch conducts its business will involve education aspects since In-SHUCK-ch consults the community on major rule changes and projects in the territory.

Furthermore, I recommend that In-SHUCK-ch develop a partnership with one or both of the regional invasive plant committees that intersect with In-SHUCK-ch's jurisdiction. . By partnering with one of these organizations, In-SHUCK-ch can gain access to their educational materials and networks of experts and professionals who can offer advice. In addition, if In-SHUCK-ch has a representative on the board of one of these organizations it will be able to assert its interests in invasive plant policy to other jurisdictions in its traditional territory.

Over the medium and long term I recommend that In-SHUCK-ch conduct an inventory of their settlement lands. This information will allow In-SHUCK-ch to determine if a treatment program is necessary, and which treatment approach is most appropriate

to their goals to protect their valuable cultural and ecosystem resources against the growing threat of invasive plants.

1. When a Weed Isn't Just a Weed – The Growing Problem of Invasive Plants

Noxious weeds, alien species, exotic flora, non-native biota... these are all commonly used terms to describe a growing problem: Invasive plants. Invasive plants are species that are not indigenous to a particular ecosystem, but once introduced are quickly established and become wide spread, dominating their new habitat and harming ecosystems, economies, cultures and human health (Forest Practices Board, 2006; Pfeiffer & Voeks, 2008).

Invasive plants are introduced to new areas by a variety of vectors. The most direct way is through intentional introduction, such as the sale or trade of non-native species (Canada, 2004). They can also be introduced unintentionally, such as when they “hitch-hike” on other trade goods (Canada, 2004). Invasive plants can spread by wind, water, animals, and humans (Forest Practices Board, 2006). Boats and vehicles can transport invasive plants by carrying them into new areas on their hull or tires, respectively (Forest Practices Board, 2006). “Seeds and propagules¹ can be distributed on trucks and all-terrain vehicles. This can especially become a problem as formerly pristine areas become open for resource extraction” (Canada, 2004, p.15).

In-SHUCK-ch Interim Government (In-SHUCK-ch), which represents Skatin and Samahquam First Nations at the Treaty table, has identified a growing concern about the threat of invasive plants spreading across its communities and throughout its traditional territory. In-SHUCK-ch’s traditional territory is called the *tmicw*, which means “the land and the people as one” in the *Ucwalicwts* language. In-SHUCK-ch has inhabited the *tmicw* since time immemorial. The In-SHUCK-ch people have a long-standing relationship with the land and its resources, hunting, fishing, and gathering plants for

¹ A propagule refers to a vegetative portion of a plant, such as a bud or another offshoot, that when detached from the plant can grow into a new individual. Many plant species rely on propagules for reproduction (propagule, n.d.)

food and medicines for generations. Over time In-SHUCK-ch members have observed changes to the land base, including the encroachment of invasive plants. David Skerik, policy analyst for In-SHUCK-ch explained:

“There is a very long tradition of collecting things from the forests so somewhere along the line people started to notice change. People go where they are used to collecting and it has changed. Part of that might have to do with global warming but part of that has to do with access roads. So people are noticing changes and it has come back to us that there is invasive species and what do we do about it?”

The threat of invasive plants has not been a hot-button issue among In-SHUCK-ch members and leadership. It has come up once in a while, both directly and, more commonly, indirectly, during various meetings with community members or proponents doing business in the territory. In-SHUCK-ch’s vegetation management contract with BC Hydro to clear invasive plants along power lines and transmission corridors in the territory, has increased In-SHUCK-ch’s awareness of the presence of invasive plants and the impacts they cause.

The harms that invasive species can cause are numerous. Scientists are only beginning to fully understand the impacts caused by invasive plants, and they “may be much greater than we currently realize” (Boersma, Reichard & Van Buren, 2006, p.xv).

Invasive species have a range of adverse impacts on the environment, some potentially disastrous (Pfeiffer & Voeks, 2008). In British Columbia and around the world invasive species have been recognized as one of the largest threats to biodiversity (Forest Practices Board, 2006; Forest Practices Board, 2010). The World Conservation Union ranked invasive species second only to habitat loss on their list of most significant threats to biodiversity. Invasive plants, by virtue of their definition, out-compete the native plants in their new home. The displacement of native flora, including rare and endangered species, results in significant homogenization of the world’s species (Boersma et al., 2006). The resilience and rapid population growth of invasive plants often impedes the restoration of native plants in areas disturbed by development. By displacing native plants, invasive plants also reduce the forage available to native wildlife species, which further threatens biodiversity of an ecosystem.

Invasive plants cause further ecological harm by altering the structure of the ecosystems they invade. For example, invasive plants can alter sedimentation, cause erosion, change soil chemistry and decomposition rates, modify hydrology, and alter the nutrients available (Canada, 2004). These changes interfere with critical ecosystem processes (Canada, 2004).

Impacts of climate change are expected to exacerbate the ecological effects of invasive plants. Hellmann, Byers, Bierwagen and Dukes (2008) have identified several possible consequences of climate change for invasive species. For instance, climate change could enhance the probability of plant propagules from surviving transport, thereby increasing their success of reaching the new site. Climate change may alter the climatic or other biological constraints that currently prevent an introduced species from becoming invasive. These changes may also reduce the competitive resistance of native plants, allowing invasive plants to increase their rate of growth and spread. Changes in temperature, soil moisture content, and wild-fire frequency will alter the constraints on invasive plants, potentially expanding the range over which invasive species can spread (Hellman et al., 2008). The effectiveness of various control methods for invasive species may also decrease due to climate change impacts (Hellman et al., 2008). By further enhancing conditions that are favourable for invasive plants and thereby increasing their numbers, climate change could, in turn, increase the subsequent ecological impact. These impacts will be further exacerbated if climate change reduces the availability of those vital ecosystem components that plants compete for, such as water (Hellman et al., 2008).

Humans are dependent on many essential non-market ecosystem goods and services for our survival and livelihoods (Boersma et al., 2006). These include clean water to drink, habitat for animals that we rely on, pollination of our agricultural crops and timber for our homes. These services are not free to us, and are dependent on healthy, balanced ecosystems. Therefore, the cumulative environmental effects of invasive plants cause significant economic, health and cultural effects for us as well.

Many economic sectors are dependent on natural native resources and sustainably functioning ecosystems. "Biological invasions are a significant economic issue, causing enormous losses in agricultural, conservation, fisheries, forestry,

transportation and tourism sectors worldwide” (Pfeiffer & Voeks, 2008, p.181). In the USA, for instance, economic losses from invasive plants have “reach[ed] billions of dollars, with conservative estimates of \$137 billion/year” (Boersma et al., 2006, p. xix).

For British Columbia, most economic analyses of invasive plant impacts have been done for the agricultural industry. “Estimates for agricultural losses from invasive plants on crop and rangelands in BC may exceed \$50 million annually, not factoring in the costs of weed control” (Forest Practices Board, 2006, p.9). In addition to lost productivity, economic costs include the rising costs of trying to contain spreading invasive plants (IPCBC, 2004). Invasive plants have also caused economic losses for the forestry sector, since they can reduce timber yield, inhibit conifer regeneration, and increase risk of forest fires (Lower Nicola Indian Band Natural Resources Department (LNIBNRD), 2007; IPCBC, 2011). For First Nation communities, whose economic development opportunities are limited and are often dependent on the resources of their land base, the potential economic impact of invasive plants can be severe.

The cultural impacts of invasive plants are largely under-recognized and unexamined. As invasive plants establish and spread they impede the cultural practices and traditions associated with the native, culturally significant plants that they displace. This is an especially relevant concern to First Nations who rely on native plants in their territories for food, medicines, and ceremonial purposes. Any alteration of the land and resources potentially threatens the cultural fibre of an indigenous culture, since traditional knowledge, stories, and art forms are connected to the land. By causing changes to habitats, invasive plants can physically alter the nature of sacred or otherwise culturally significant sites on the land. This may impede the ability of members from accessing sacred places, or affect the cultural meaning or stories tied to those locations. Invasive plants may also create physical barriers, such as thorns or thickets, to access traditional plants. These impacts exacerbate the existing challenges First Nations face in maintaining their traditions, practices and way of life (Pfeiffer & Voeks, 2008).

Some physical characteristics of invasive plants can also cause health and safety concerns. For example, some plants cause burns, some have sharp spines, and others are toxic (IPCBC, 2004). Invasive plants can also increase fire hazards as they can be a

source of fuel, and some can break through cement, undermining structural integrity of infrastructure (LNIBNRD, 2007).

In-SHUCK-ch has not yet noticed the impacts of invasive plants on such a dramatic scale. However, the potential for invasive plants to alter their territory and impact their economic development opportunities represents a serious threat. In recent years the provincial and federal governments have begun to recognize and acknowledge First Nations' concerns regarding invasive plants. The Invasive Plant Strategy for BC states:

“First Nations are very concerned about the effects of invasive plants on their sustenance activities within their traditional territories, including hunting, fishing, and the gathering of food and medicinal plants. First Nations are also involved in ranching, farming and eco-tourism, businesses that are vulnerable to the socio-economic and environmental impacts of invasive plants. As well, the threat by invasive species to the health and availability of native plants and their associated spiritual values could inflict serious impacts on aboriginal peoples.” (IPCBC, 2004, p.12)

The provincial government, in concert with various regional and local invasive plant councils or committees, is responsible for managing invasive plants on Crown land. However, land belonging to First Nations, including reserves and treaty settlement lands, remains under a significant jurisdictional gap (IPCBC, 2004). The federal government has jurisdiction over lands reserved for Indians. Through the *Indian Act* band councils are empowered to make by-laws related to noxious weeds, and the protection of fish and wildlife” (Canada, 2004, p.31). First Nations with modern treaties have jurisdiction over treaty settlement lands.

In-SHUCK-ch Nation is currently in the final stages of the BC treaty process and anticipates a ratified agreement within the next few years, after which the Nation will have management authority over its treaty settlement lands. In-SHUCK-ch is preparing for Treaty through the development of policy plans and frameworks, which will be the foundation for any legislation that In-SHUCK-ch passes once the treaty comes into effect. In the meantime, In-SHUCK-ch also provides policy support to Skatin and Shamaquam band councils with respect to governance of reserve lands.

This study examines the following policy problem: **The spread of invasive plants are threatening valuable ecosystems and resources on In-SHUCK-ch's lands.** This study identifies policy alternatives for In-SHUCK-ch to take with respect to the threat of invasive species, and makes a recommendation as to which alternative is most appropriate for In-SHUCK-ch.

2. Digging Deeper – The Threat of Invasive Plants in the *Timcw*

2.1. Where is the *Timcw*?

In-SHUCK-ch's traditional territory, the *timcw*, is situated in the Lower Lillooet River and Harrison Lake region of south-western BC, shown in Figure 1. Its northern boundary is half way up Lillooet Lake, on the eastern side of Garibaldi Park. The territory stretches south to Long Island in Harrison Lake, and also encompasses the land around the upper portions of the Stave and Pitt River watersheds (In-SHUCK-ch, 2011). The territory covers 476,943 hectares of land and water, most of which is land (473,058 hectares), over half of which is provincial Crown land. Only 1% of the territory is Indian Reserve land. The *timcw* straddles two regional districts: The Squamish- Lillooet Regional District (SLRD) and the Fraser Valley Regional District (FVRD). In-SHUCK-ch's reserve communities are all located within the FVRD, though most of the services that members access are supplied by the SLRD (In-SHUCK-ch, 2011).

Skatin and Samahquam combined currently have 15 small reserves (four of which are inhabited by communities), roughly totalling 853 hectares (D. Skerik, personal Communication, March 15, 2013).

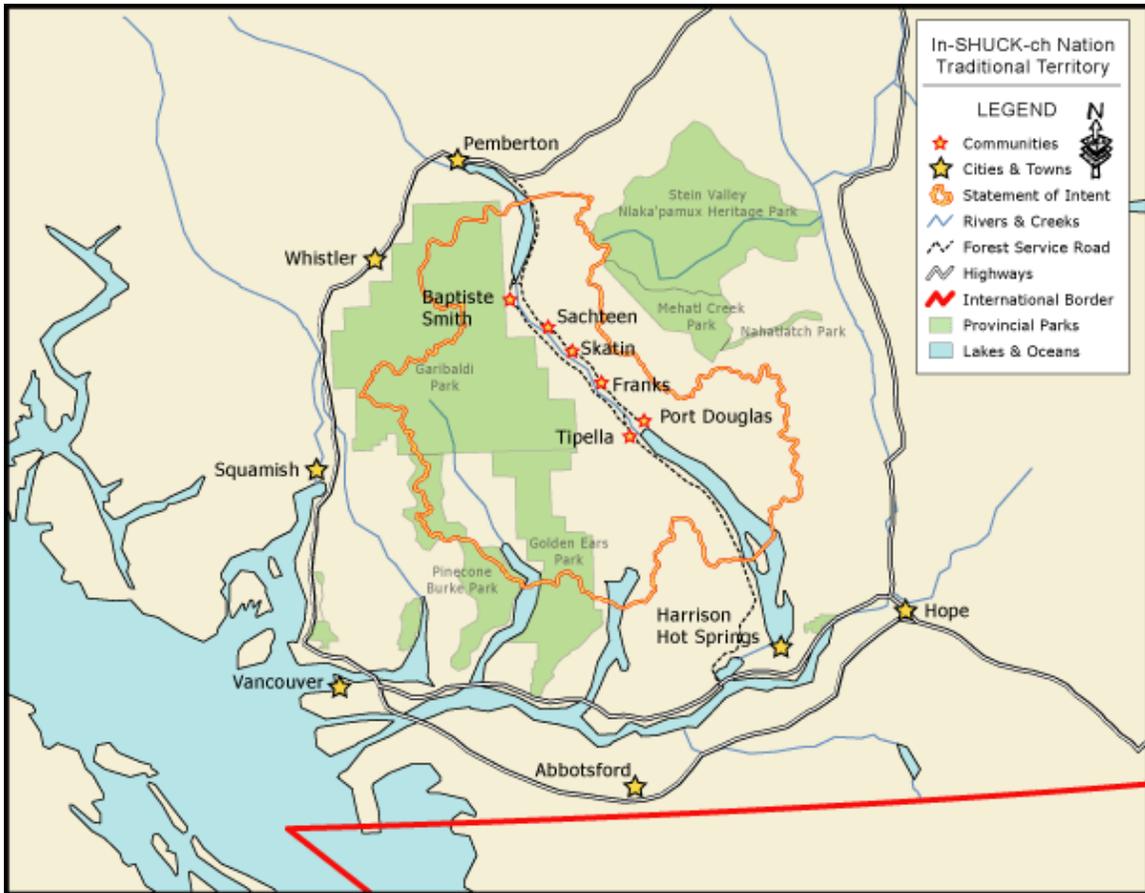


Figure 1: Map of In-SHUCK-ch Nation traditional territory

(from www.In-SHUCK-ch.com)²

2.2. The *Tmicw*'s Susceptibility to Invasive Plants

The level of land disturbance is the primary factor affecting the susceptibility of an area to invasion (Forest Practices Board, 2006). When the native plant community has been disturbed, it is easier for an invasive plant to take over the area (IPCBC, 2007).

Factors such as wildfires, timber harvesting, and other land development and recreational activities cause forest ecosystems in BC to be increasingly vulnerable to

² This map includes Xa'xla First Nation, which is culturally part of In-SHUCK-ch but no longer part of the In-SHUCK-ch interim government or treaty negotiations.

invasive plants (Forest Practices Board, 2010). This is important given that the main development activity in the territory is logging. In-SHUCK-ch itself has a forest tenure in the territory, which it logs through a partnership with another company. BC Timber Sales also operates in the area. Forest activity brings invasive plants into the territory, while the logging industry itself is at the same time vulnerable to the impacts of invasive plants.

Many First Nations reserves, including In-SHUCK-ch's, are paved with gravel, which is often infested with invasive plants. The distribution of infested gravel to new areas, through construction or maintenance of logging roads for example, causes rapid spread (IPCBC, 2011).

Other forms of development in the territory are constrained by infrastructure limitations. There may be some run-of-the-river projects in the territory in the future, and BC Hydro transmission lines have created open corridors throughout the territory. The hot springs in the territory attract some tourism traffic into the area, and some people ride recreation all-terrain vehicles throughout the territory as well. Even though there is relatively less development in the territory than in more urban centres, the activities in the territory do create land disturbances, which put the *tmicw* at risk for increasing introduction and spread of invasive plants.

2.3. Invasive Plants Identified in the *Tmicw*

In-SHUCK-ch has not done a survey of any of their reserves to determine the scope of invasive plants in their communities. However, invasive plants are known to be present in the *tmicw*. IAPP showed that there are a total of fifteen invasive plant species, found in 182 sites in the area³ surrounding the reserves, primarily along the logging roads. Each site varies in size. When a site is entered in the database, an estimate of the area (in hectares) of the plant's distribution at that site is also entered. The 182 invasive plant sightings covered a combined estimated area of 11.63 hectares. The

³ Data taken from IAPP database (http://webmaps.gov.bc.ca/imf5/imf.jsp?site=mofr_iapp). Only plant sites within the following mapsheets were considered: 092J028, 092J018, 092J008, 092J038, 092G089, 092G080, 092G079

fifteen species and the corresponding number of sites and total estimated area of distribution are described in Table 1⁴.

Table 1: Invasive plant species in IAPP near In-SHUCK-ch's reserves

Species Common Name	Number of sites entered in IAPP	Sum of estimated area per site (hectares)
Bull thistle	46	1.5146
St. Johns wort	36	5.7311
Canada thistle	22	0.2276
Burdock species	22	1.7210
Oxeye daisy	21	2.2677
Common tansy	14	0.0850
Spotted knapweed	6	0.0161
Sulphur cinquefoil	3	0.0390
Mullein	3	0.0101
Diffuse knapweed	3	0.0042
Scotch broom	2	0.0020
Orange hawkweed	1	0.0010
Western goat's-beard	1	0.0040
Spotted hawkweed	1	0.0010
Sowthistle species	1	0.0020
15 species	182 sites	11.6264 (units)

The top five most prevalent of these species, whether determined by number of recorded sites or by size of total estimated area, are: Bull thistle, St. John's wort, Canada thistle, Burdock species, and Oxeye daisy.

⁴ The IAPP database only includes the first date that an invasive plant site was observed and entered into the database. If an individual plant or infestation is observed in the same location in subsequent years, it is not entered into the database. If a previously infested site is eradicated and no invasive species are further observed at that location, the site is not removed from the database either. Therefore, it is not clear from the database whether the observations in Table 1 accurately describe the current landscape near In-SHUCK-ch communities.

Local weed committees for the area have identified many invasive plants of concern, which are confirmed to be present in the region at varying densities. The Fraser Valley Invasive Plant Council's (FVIPC) website lists forty invasive plant species present in their region: over twenty-seven invasive plants that are widespread throughout their jurisdiction; another six species that have established infestations in portions of the region; and five more that are known to occur at least in limited populations (FVIPC, n.d.). Similarly, the Sea to Sky Invasive Species Council (SSISC) lists a total of 52 species confirmed present within their region of jurisdiction: at least eight species are present in the region in limited distribution; another eight species of concern are found in some areas, and twenty-six species are widespread across their whole jurisdiction (SSISC, 2010). There are 12 species with similar distributions across the two jurisdictions, and 24 species that are found in both regions but at different densities or scale of distribution. Additionally there are species unique to each invasive plant council's list, indicating they are present in one region but have not yet established populations in the other. A full list of the species is provided in Appendix A.

A few of the species identified by SSISC and FVIPC, including Japanese knotweed and Purple Loosestrife, are listed on the World Conservation Union's list of the world's 100 worst invasive species (Canada, 2004). In addition, some of the species on FVIPC and SSISC's lists appear in Boersma et al.'s (2006) book on invasive species in the Pacific Northwest. Boersma et al. only included species that were ranked as highly invasive and having a concerning level of impact on the Pacific Northwest bioregion⁵. Boersma et al.'s ranking score is included in Appendix A for applicable species.

2.4. The Precautionary Principle

There is always some uncertainty of the true scope of an invasive plant species in a particular ecosystem or geographic region. This is due to several interacting factors,

⁵ The authors distributed their initial list of all known non-native species to scientists and government agencies for review. After narrowing the list based on expert input, the authors evaluated the list to determine which species were invasive to the Pacific Northwest ecosystems, using criteria developed by the Nature Conservancy and the California Invasive Plant Council.

including a lack of data and coordinated inventory, measurement errors, and variability in rates of spread of different species, or of the same species in different conditions (Eiswerth & van Kooten, 2002). Measurement inconsistencies are a challenge, since descriptive terms for categorizing the scale or density of an infestation are generally imprecise. “For example, one scientist may categorize a particular weed infestation as “minimal,” while another classifies the same state as “highly” infested.” (Eiswerth & van Kooten, 2002, p.1317). However, scientists argue for use of the precautionary principle when it comes to the uncertain risk of invasive plants. Rather than waiting for non-native plant invasion to reach severe levels, the precautionary principle prescribes preventing the problem altogether or, barring that, getting ahead of the problem while it still remains at a manageable level (Finoff et al., 2007).

2.5. Current Management of Invasive Plants

2.5.1. *In-SHUCK-ch*

In-SHUCK-ch does not have any existing policies or by-laws regarding invasive plants, nor does it operate any form of control programs on reserves. In-SHUCK-ch has a stewardship field crew, which has a vegetation management contract with BC Hydro that involves removal of invasive plants along transmission corridors. Other than this, In-SHUCK-ch has not had any involvement in invasive plant management on reserve or within the *tmicw*. This project is the first effort to address the issues.

2.5.2. *Federal*

The federal government has the power to make regulations, establish objectives, and develop codes or guidelines for the protection of reserve lands through the *Canadian Environmental Protection Act* (In-SHUCK-ch, 2011). The *Indian Act* permits First Nations to make by-laws with respect to noxious weeds and the protection of ecosystems and wildlife (Canada, 2004).

2.5.3. Provincial & Regional

BC’s current institutional regime for invasive plant management is made complex by overlapping jurisdictions and a range of legislations and policies. There are several ministries whose responsibilities relate, in some way, to the management of invasive plants. These include the Ministries of Agriculture, Environment, Transportation, and Lands, Forests and Natural Resource Operations (FLNRO). These ministries work together on invasive species issues through the Inter-Ministry Invasive Species Working Group (IMISWG), formed in 2004.

There is a gamut of provincial legislation that applies to the management of invasive plants in BC. The three most significant acts are the *Weed Control Act*, the *Forest and Range Practices Act*, and the *Integrated Pest Management Act*, described in Table 2.

Table 2: Key Provincial legislation pertaining to invasive plants

Act	General Description
<i>Weed Control Act</i>	<ul style="list-style-type: none"> • Applies to all provincial Crown land • Identifies 49 “noxious weeds” (plant species of concern)
<i>Forest and Range Practices Act</i>	<ul style="list-style-type: none"> • Requires any company carrying out a forest or range practice to plan and implement measures to prevent the introduction and spread of invasive plant species from their activities. • Identifies 42 species of concern
<i>Integrated Pest Management Act</i>	<ul style="list-style-type: none"> • Requires an approved pest management plan to authorize the use of herbicides to treat any area of Crown land that exceeds 50 hectares (Forest Practices Board, 2006).

None of these three acts apply on Indian reserve lands (Canada, 2004).

Invasive Species Council of BC

The Invasive Plant Council of BC (IPCBC) is made up of over 1000 individual members and 300 organization members, representing different ministries, stakeholders and interest groups including public and private interests (Forest Practices Board, 2010). In 2004 the Invasive Plant Council developed its Invasive Plant Strategy for BC (Forest Practices Board, 2006). The Strategy has 94 signatories, most of which have a direct role to play in controlling invasive plants. The focus of the strategy is on early detection

of new invasive species, before they establish themselves in the area, and rapid response procedures to prevent their spread (Forest Practices Board, 2006). The strategy identifies ten significant challenges for effective management in the province. One of these challenges is how to increase invasive plant management on federal lands, particularly First Nation reserves (IPCBC, 2004). The strategy also aims to encourage cooperation by First Nations with neighbouring governments and the IPCBC (IPCBC, 2004).

Regional Governments and Weed Committees

The role of local governments in invasive plant management varies across municipalities and regional districts. Some local governments operate their own invasive plant management and/or education programs, or participate in regional invasive plant committees. There are over twelve regional invasive plant committees in BC (sometimes also called invasive species councils, weed committees, or some other variation), covering most of the area of the province (Forest Practices Board, 2010).

Representatives on the committees include various government agencies, utility companies, livestock associations, forest companies, conservation groups, local governments and other interest groups. Weed Committees set their own agendas for their respective local geographic area, identifying sites of high priority requiring treatment. Weed Committees themselves do not have legal authority to conduct control programs on Crown land, but are sometimes contracted by regional districts, local governments or private companies to develop plans, conduct inventories of invasive plants in the area, and even administer treatments on the land. Additionally, Weed Committees also conduct public awareness campaigns and some offer education and training programs to promote prevention and effective control measures (Forest Practices Board, 2006).

The two invasive plant committees whose jurisdictions overlap with the tmcw are the Sea to Sky Invasive Species Council (SSISC) and the Fraser Valley Invasive Plant Council (FVIPC).

3. Literature Review

Although the federal and provincial invasive plant strategies recognize the role of First Nations in invasive plant management, the academic literature regarding First Nations' activity in this regard is sparse.

A search of the grey literature found “the Aboriginal Community Toolkit for Invasive Plant Management” (the Toolkit), published by the IPCBC in 2011. The Williams Lake Indian Band, with input from IPCBC’s Aboriginal Working Group Sub-Committee wrote the Toolkit to guide Aboriginal communities in developing invasive plant management strategies of their own.

3.1. The Aboriginal Community Toolkit – A Seven Step Invasive Plant Policy Framework

The Toolkit sets out a step-by-step framework for First Nations to develop their own Invasive Plant Management Plans. The first and second steps are to identify and map the management area, and conduct an inventory of invasive plants within the management area. The Toolkit recommends looking at existing maps of the area, done by other jurisdictions, as a starting point.

The third step is to establish management goals and objectives that are specific and measurable. The fourth step is to set priorities, based on the aggressiveness of the species, as well as the location of the species. The Toolkit provides limited information how First Nations should set such objectives and priorities. A review of available information in the literature pertaining to objectives and priorities is provided in Section 3.2.

After determining priorities, the fifth step is to select appropriate management strategies. The Toolkit supports an integrated approach of preventative strategies,

combined with various manual controls, cultural methods, as well as the use of herbicides. Further detail of these strategies is described in Section 3.3

The sixth step is to combine all of the above information into a work plan. The seventh and final step is to develop a complimentary monitoring plan and program to evaluate the effectiveness of the management plan.

3.2. Setting Objectives and Establishing Priorities

3.2.1. Objectives

“Sustainable invasive species management is not defined by achieving a specific outcome, but by meeting desired objectives throughout the management process” (Larson et al., 2011, p.17). Setting unfeasible goals can result in loss of community and social support, as well as financial support for an invasive plant management program. Therefore, it is important to set feasible, but meaningful benchmarks for success (Larson et al., 2011). “If progress can be demonstrated and publicized at reasonable intervals, stakeholders will be more inclined to continue their support” (Larson et al., 2011, p. 18).

There are some circumstances in which complete eradication is attainable. It can be feasible to eradicate small infestations that have only recently established themselves (Rejmanek, 2000). However, in general, total eradication of plant species is very difficult and often not possible (Simberloff, 2003; Larson et al., 2011). Therefore, alternative goals and targets are needed. These targets could include reducing the density of an invasive plant over an area (Myers et al., 2000), or slowing the rate of spread and reducing the impacts of invasive plants (Hatcher & Melander, 2003). Another option is to establish barrier zones, with the goal of containing invasive plants within that zone, prohibiting them from spreading beyond the perimeter (Myers et al., 2000). If this is successful, in subsequent years the target could be to incrementally push back the barrier zone so as to decrease the size of the infested zone over time (Reichard, 2007).

3.2.2. *Priorities*

Due to limited resources and funding, invasive species management generally focuses on a select subset of infested areas or species (Januchowski-Hartley, Visconti & Pressey, 2011). This means that some areas may be left untreated, or that some invasive species will have to be tolerated as a permanent part of the ecosystem (Larson et al., 2011). Decision makers must decide which areas or species to prioritize over others. The literature discusses a range of criteria used to determine priorities, including:

- Physiological characteristics of the plant such as rate of spread;
- The nature and severity of the species' impact on culture, human health and safety, the environment, and the economy. A plant such as Hogweed, which burns people's skin, may be prioritized over other, less harmful plants, for example;
- The locations of invasive species and their proximity to sensitive areas such as people's residences, vital infrastructure, or riparian zones;
- The feasibility of control and the likelihood of reinvasion after treatment;
- The availability of effective control methods and the frequency at which they must be applied;
- The availability of funding; and
- The level of community support (Januchowski-Hartley et al., 2011; Larson et al., 2011).

Prioritization methods can range from best guesses to more explicit methods such as using a scoring approach based on these different criteria (Januchowski-Hartley et al., 2011; Rejmanek, 2000), or conducting a risk assessment (Luken & Thieret, 1997).

Risk assessment for invasive plants is an early stage of application (Kapler et al., 2012; Powell, 2004). Several risk-assessment models exist for non-native plants, though common models focus on exposure and effects analysis:

- **Exposure Analysis:** Involves evaluating the likelihood that an invasive species will be introduced to and invade a particular ecosystem, habitat or jurisdiction (Kapler et al., 2012; Powell, 2004).
- **Effects Analysis:** Involves assessing the probability and severity of the ecological and environmental impacts of the invasion in the region of concern (Powell, 2004).

The final risk measure is a combination of the exposure and effect scores. Variations on this model consider the risk of the plant's impact against the probability of control. Though not perfectly accurate, the probability of control is often presumed to be the inverse of the size of the plant's distribution: the more widespread a plant is, the more difficult it is to control (Luken & Thieret, 1997).

Scientists have been critical of the simplistic methods that policy makers have used to assess risk of invasive plants, but they also acknowledge the difficulties of finding an improved approach (Miller et al., 2010). Risk assessment models are constrained by the availability of information and expertise (Kapler et al., 2012). There is also significant uncertainty in predicting the nature of impacts of invasive plants and disagreement about their magnitude (Miller et al., 2010). Risk assessment can be a costly and time-consuming exercise (Andersen, Adams, Hope & Powell, 2004). Therefore First Nations and other jurisdictions should be practical when using risk assessment to establish invasive plant management priorities, and recognize these limitations (Powell, 2004).

3.3. Strategies for Managing Invasive Plants

The Toolkit identifies several strategies available to First Nations to manage and control invasive plants. These strategies can be grouped into two categories:

- **Prevention:** Includes such strategies as education, minimizing soil disturbance, and early detection.
- **Control:** Includes manual, chemical and biological techniques.

Some aspects of these strategies described in the literature are discussed in the following subsections.

3.3.1. Prevention

The literature is consistent in reporting that prevention is the most effective strategy for the control of invasive plants (Mehta, Haight, Homans, Polasky & Venette, 2007). There is “growing acceptance that the most efficient way to manage invasions is

to prevent the establishment of new species and new populations of species already present” (Reichard, 2007, p.6).

Prevention entails assessing the risks of invasion, and then managing those risks to reduce the probability that an invasive species will enter into the territory, or, if already established, reducing the likelihood of spread (Kapler et al., 2012).

One way to manage the risk of invasion is by influencing human behaviour. Therefore, education and awareness is mentioned throughout the literature as a strategy to effect changes in behaviour that will facilitate prevention (Reichard, 2007). However, some recent research questions the effectiveness of education in actually bringing about the desired change in behaviour. Kubeck found that there has been “very little previous research on the human dimensions of invasive species and the attitudes, norms and control beliefs that influence behaviours that impact the spread of invasive species” (2008, p.5). In her 2008 thesis Kubeck explores the barriers that prevent groups of recreationalists, such as gardeners, hunters, fishers and boaters from changing their behaviours to help prevent the spread of invasive species in Oregon, USA. She examined attitudes, social norms and behavioral control beliefs held by these stakeholders and found six barriers to changing behaviours, including an attitude that the fight against invasive species is a losing battle, and that personal efforts seem futile if institutions do not prioritize preventative action.

Kubeck suggests that in order for education campaigns to be effective in getting individuals to carry out preventative behaviours, corresponding institutional and regulatory support is needed. This could include infrastructure support such as boat or vehicle washing stations, or incentive programs to enable and motivate individuals to take preventative action.

In addition to education, another component of prevention is early detection. This involves monitoring the territory to find species that have already entered the territory and are just beginning to establish themselves (Mehta et al., 2007). “By increasing resources to detect invasive species, managers may increase their chances of finding a species at a smaller population level, lessening the extent of damages and making

subsequent control potentially less expensive and more effective” (Mehta et al., 2007, p. 237).

There is a trade-off between allocating resources to prevention and detection versus subsequent control efforts. Generally it is agreed that resources spent on prevention create cost-savings in the long-term. However, rather than focusing exclusively on prevention, Mehta et al. suggest that optimal invasive species policy should involve a combination of prevention/early detection and control (2007).

3.3.2. Control Methods

There are a variety of methods to control invasive plant infestations, which vary in effectiveness “depending on the weed species, distribution and density of invasive plant populations and the environmental conditions under which invasive plants grow” (Forest Practices Board, 2006, p. 30). Therefore, no single treatment option is likely to work for every species.

- **Manual:** Involves physically damaging invasive plants to remove or reduce the infestation. Examples include hand pulling, hoeing, cutting, mowing; mulching, grazing, and prescribed burning (Tu, Herd & Randall, 2001; Forest Practices Board, 2006). Manual techniques are slow and resource-intensive, which makes them costly for larger areas. Typically, treatments must be repeated several times to prevent invasive plants from re-establishing (Tu et al., 2001). Manual control is a good option for sensitive habitats, or where herbicide or biological controls are not feasible or appropriate (Forest Practices Board, 2006)
- **Chemical:** Involves the application of herbicide, by various techniques including spray over a wide area, localized spot treatments, or injection directly into the stem of the plant (Tu et al., 2001). They need to be applied at the proper time and rate to be effective, but offer more immediate and certain results than manual controls (Forest Practices Board, 2006). There are several concerns regarding the impact of herbicides on soil and water quality, as well as non-target species and human health, which limit their use. Herbicides should only be used when the threat of potential spread of invasive plants outweighs these risks (Tu et al., 2001).
- **Biological:** Involves the use of biological organisms, such as insects or pathogens, which attack or interfere with the physiology or reproductive system of the invasive species. Typically, biological agents are used to reduce the invasive species’ population to ecologically or economically acceptable levels. Biological control is generally viewed as environmentally-friendly,

though there is a probability that the biological agent can become invasive themselves (Tu et al., 2001).

Most of these control methods are not mutually exclusive and land managers can choose more than one technique from the set of options, applying them in various orders depending on the characteristic of the site, the plant, and the infestation level (Eiswerth & van Kooten, 2002). The selection will depend on policy objectives and targets, resource and cost considerations, as well as cultural and social acceptability factors.

3.3.2.1. *Relative Costs of Control Methods*

Larson et al. note that for management of invasive species to be sustainable, it is “important to consider efficiency when selecting management practices. Research and adaptive management are necessary to ensure that selected management practices are as cost-effective as possible, and to account for inherent risk and incomplete information” (2011, p. 17). When considering funding for invasive plant management, follow-up treatment and long-term maintenance should be considered. Without follow-up, it may not be worth it to spend the money on short-term measures, because subsequent reinvasion can seemingly waste the investment (Larson et al., 2011).

The Forest Practices Board provides a comparison of approximate costs of the three types of control methods (2006). The Lower Nicola Indian Band also provides relative cost estimates of these control methods in their “Invasive Plant Management Plan” (LNIBNRD, 2007). These estimates are shown in Table 3. While the estimates vary- particularly those for biological control - it is clear that manual techniques are more expensive than chemical methods. Prevention is believed to be the most cost effective strategy. “In the USA it was estimated that every dollar spent in early control and prevention returned, on average, \$17 in prevented expenditure” (Caplat & Coutts, 2011, p. 879).

Table 3: Estimated costs of control methods

Control technique	Approximate cost (Forest Practices Board, 2006)	Approximate cost (LNIBNRD, 2007)
Mechanical	332 \$USD/ acre	700 \$CDN/ day (hand pulling)
		250 \$CDN/ km (mowing)
Chemical: ground applied	95 – 135 \$USD/ acre	275 \$CDN/ km (spot applied)
Biological control	40 – 50 \$USD/ acre	800 \$CDN/ day

The costs of not managing invasive species are significant, though the literature did not provide a consistent estimate. The literature indicates that the cost of non-action includes cumulative ecological damage, loss of function, loss of species and natural heritage, as well costs to the economy. The non-market costs are commonly undervalued in traditional cost-benefit analysis. If appropriately valued, these costs make “giving up” an unpalatable option (Larson et al., 2011).

4. Methodology

I applied a mixed methods approach to my research, which combined qualitative interviews and a survey of In-SHUCK-ch members. A systematic comparison of suspected invasive plant species for the region informed a high-level risk assessment of invasive plants in In-SHUCK-ch's territory.

4.1. Survey of In-SHUCK-ch Members

The first method was a survey of In-SHUCK-ch members. age 19 and older, at a series of five regional community gatherings held at locations in the Lower Mainland, the Fraser Valley, and two of In-SHUCK-ch's reserve communities. These gatherings were scheduled and coordinated by In-SHUCK-ch for their own community engagement purposes, and my survey was added to their existing agenda. To encourage participation I held a draw for a fifty-dollar gift certificate to a grocery chain at each gathering. Although I had aimed to get 75 responses, I received 62 completed surveys. 60 responses were valid, and two were disregarded since the participants had not properly indicated that they were from either Skatin or Samaquam First Nation.

The survey instrument is provided in Appendix B. The survey was designed with the purpose of ascertaining In-SHUCK-ch members' observations and knowledge in regards to invasive plants in their territory.

The survey also included a hypothetical scenario asking participants to indicate how much of In-SHUCK-ch's budget they would be willing to allocate toward invasive plant treatment and prevention. However, due to limitations in knowledge and information available at the time the survey was created the usefulness of this question is restricted. A discussion of the responses to this question is included in Appendix F, but these findings are not included in my analysis, other than to say that most participants were willing to allocate some of In-SHUCK-ch's budget to the problem.

I conducted a descriptive statistical analysis of the data, using the Statistical Package for the Social Sciences (SPSS).

4.1.1. Limitations

A major limitation of the survey was the number of participants who completed surveys. Skatin and Shamahquam First Nations have approximately 586 adult members over the age of eighteen. Since the survey received only 60 valid responses, this amounts to a response rate of only 10% (David Skerik, personal Communication, March 15, 2013). This limits the representativeness of the survey responses. Furthermore, though there were 60 responses, participants did not answer all the questions. This indicates that questions may have been confusing or unclear to participants. The small sample size also limited the ability to find the statistical significance of trends in the data and potential correlations between variables.

Furthermore, the survey is limited in that it relies entirely on words, and does not provide any examples of the species that it asks about. Members may not know the common English names of plants but may have been better able to identify plants, and with greater certainty, if photographs had been provided.

4.2. Semi- Structured Interviews

I conducted semi-structured interviews with several participant groups: In-SHUCK-ch Nation staff; experts such as biologists and environmental consultants; other jurisdictions including the provincial government, regional invasive plant councils or committees, as well as other First Nations in BC who are involved in developing invasive plant management policies. Participants were identified through personal contacts, government and regional committee websites and subsequent introductions to additional potential participants. I also attended a two-day invasive species forum hosted by the IPCBC where I networked with experts and representatives in the field. Participants are listed in Table 4.

Table 4: List of interview participants

Participant Name	Position	Organization
Anonymous	Invasive Plant Specialist	FLNRO, Invasive Plant Program
Dave Ralph	Director, Invasive Plant Specialist	
Caroline Astley	Wildlife and Vegetation Specialist	Hemmera
David Carson	Owner	Land Forest People Consulting Ltd.
Dave Caswell	Traditional Land Use Coordinator	Lower Nicola Indian Band
Ernie Sellentin	Project Coordinator	CIPC
	Owner	Sellentin's Habitat Restoration & Invasive Species Consulting Ltd
Guy Fried	Planning Forester	BC Timber Sales
	Board Member	FVIPC
Katherine Wolfenden	Environmental Monitoring Technician	Fort Nelson First Nation, Lands Department
Kristina Swerhun	Executive Director	SSISC
Merci Hillis	First Nations and Programs Coordinator	NWIPC
Odin Scholz	Coordinator	LRISS
Randall Lewis	Environmental Coordinator	Squamish First Nation
Willie Sellars	Counsellor and Special Projects Coordinator	Williams Lake Indian Band
Micheal George	Cultural Advisor	Tseil-Waututh Nation, Treaty, Lands, and Resources Department
Bridget Doyle	Environmental Stewardship Coordinator	
Erin Hanson	Referrals Analyst	
Sarah Breaks	GIS Analyst	
Alan Gabriel	CEO	In-SHUCK-ch
David Skerik	Policy Analyst	
Josh Alexander	Director of Operations	
Shawn Gabriel	Community Relations Officer	
Stephen Jimmie	Economic Development Officer	
Maureen McBride	Economic Development Assistant	

Interviews were approximately one hour and conducted in-person or over the telephone, at the participants' convenience. Both telephone and in-person interviews are synchronous in time, which allow the interviewer and the participant to react to what one another says. It also helps the interviewer to pick up on social cues such as intonation to interpret the responses. Conducting some interviews by phone allowed me to have greater geographical access to participants throughout the province (Opdenakker, 2006). I chose a semi-structured format because it allows for free-flowing conversation that encourages the participant to elaborate on their knowledge and expertise. Semi-structured interviews maintain focus, while also allowing divergence so that the participant can bring up issues or ideas not anticipated by the interviewer in advance. Based on the objectives for each participant group, I developed interview schedules to guide the conversation. The objectives were as follows:

- **In-SHUCK-ch Staff:** The objective of these interviews was to learn about In-SHUCK-ch territory, better understand the impact of invasive species on their community, the capacity of the Nation, and any considerations that should inform analysis of alternatives.
- **Experts:** The goal of these interviews was to learn more about the characteristics of the invasive plants threatening In-SHUCK-ch lands, as well their recommendations for policy options and best practices to prevent, contain or eradicate the spread of invasive species.
- **Other Jurisdictions:** From these interviews I hoped to learn what policies these jurisdictions had developed, as well as significant challenges and lessons learned.

Interviews were transcribed and reviewed by those participants who requested to do so. I then analyzed the transcripts for common themes or messages. Information about what different First Nations are doing was compiled into separate narratives for each First Nation.

4.2.1. Limitations

In person interviews require a lot of concentration about what questions to ask next at the same time as listening to the response given, since there is no time delay between the question and answer. For those interviews conducted over the phone, it is more difficult to create interview ambiance and build rapport since the interviewer cannot

control the room or space, nor read the facial cues of the participant (Opdenakker, 2006).

Though I interviewed participants from several regional invasive plant committees, the existing provincial framework and strategy underlies the actions and decisions of each of these committees. Therefore the range of approaches described in these interviews is limited.

Finally, I did not interview any First Nations from other provinces because none were identified as taking action in the invasive plant field. I also chose not to examine how other countries approached invasive plant management, because the authority and resources at the nation-state level are not comparable to the jurisdiction, and capacity of a First Nation.

5. In-SHUCK-ch's Awareness and Concern about Invasive Plants

Interviews with In-SHUCK-ch staff indicated that they were not certain as to the membership's awareness of invasive plants and the impacts they can have. Several responses to the open-ended general comment section of the survey indicated a general awareness that invasive plants were establishing in the territory. As one participant wrote: "[I] just know they are not supposed to be there, don't remember them as child."

5.1. Have In-SHUCK-ch Members Noticed Invasive Plants?

Out of sixty responses, fifteen (25%) participants had indicated they had noticed invasive plants in the territory themselves. Over half (57%) of the participants said they had never noticed invasive plants. Assuming that there are in fact invasive plants in In-SHUCK-ch territory, this result indicates that a large portion of members are not able to differentiate a plant as invasive. It is possible that they may not be observant of plants in general, invasive or otherwise.

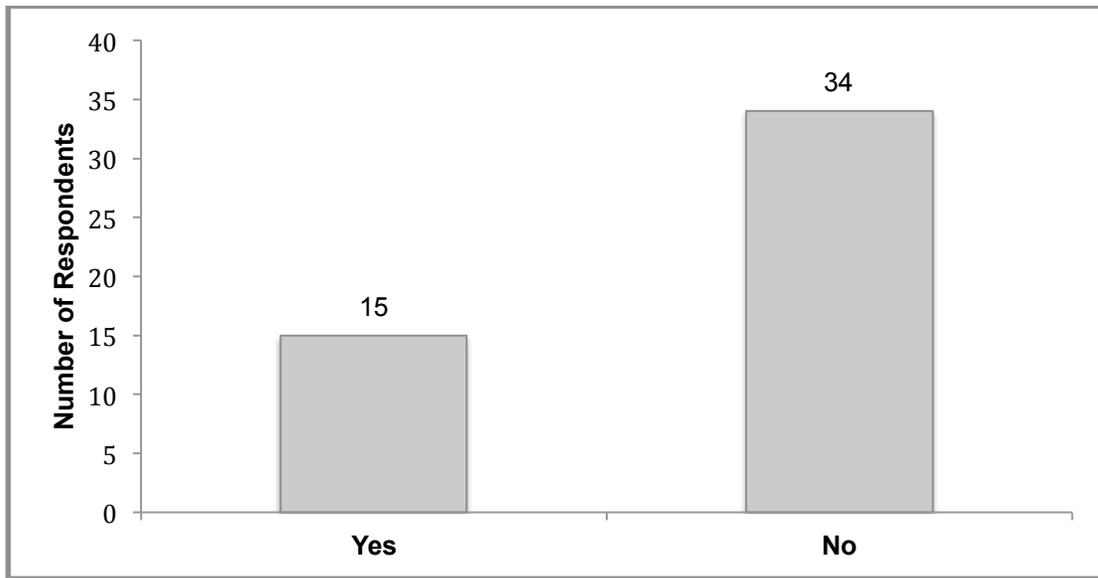


Figure 2: Distribution of In-SHUCK-ch survey responses to whether the participant has noticed invasive plants

The demographic breakdown of respondents that did notice invasive plants is shown in Appendix D and the demographics of those that did not notice invasive plants are found in Appendix E.

Table 5: Frequency comparisons of whether In-SHUCK-ch members harvest traditional plants and have noticed invasive plants

		Harvest Traditional Plants?		Total
		Yes	No	
Noticed Invasive Plants?	Yes	10	5	15
	No	8	18	26
Total		18	23	41

Table 5 shows a comparison of the frequencies of respondents who noticed invasive plants and harvest traditional plants. Of the fifteen respondents who have noticed invasive plants, two-thirds (66%) also actively harvest traditional plants in the territory. Conversely, of the eighteen respondents who indicated they did harvest traditional plants, over half (56%) noticed invasive plants. This suggests that there may be a correlation between participation in traditional plant harvest and the observation of invasive plants.

5.2. Which Species?

The survey asked those that had responded yes to having seen invasive species to identify which species they had seen. The survey provided a list of potential invasive plant species, asking participants to indicate whether they had observed each species. The list was created based on a cursory overview of invasive species observed in the Fraser Valley and Squamish-Lillooet Regional Districts. The list also included an option for other species not listed, and asked people to indicate the name of the species if they could. Other species identified in response to this question included “Algae”, “Fireweed”, “Dandelion”, “Millweed”, and “Japanese Huckleberry”. Only responses from participants who had indicated they had noticed invasive plants in the territory were considered.

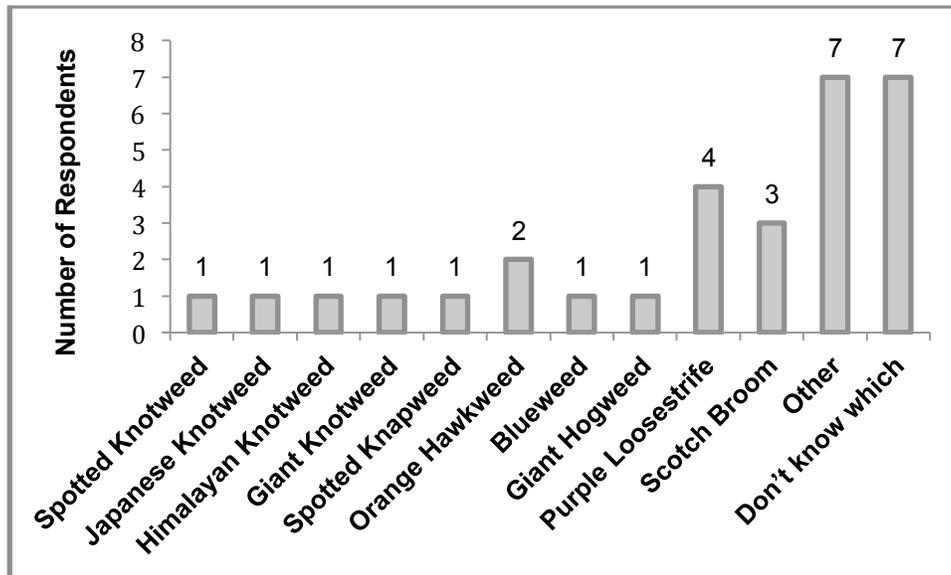


Figure 3: Distribution of In-SHUCK-CH survey responses to which invasive plant species participants have observed

Interviews with In-SHUCK-ch staff did not reveal any additional invasive species of concern.

5.3. Locations of Infestations

Those that had answered yes to noticing invasive plants were asked to identify the types of locations where they had noticed the plants. Results are indicated in Figure 4. The most commonly indicated location was along rivers and creeks, followed by roads and transmission lines. “Other” locations described included those adjacent to communities; logged out areas, burn sites, and swimming areas such as lakes and rivers.

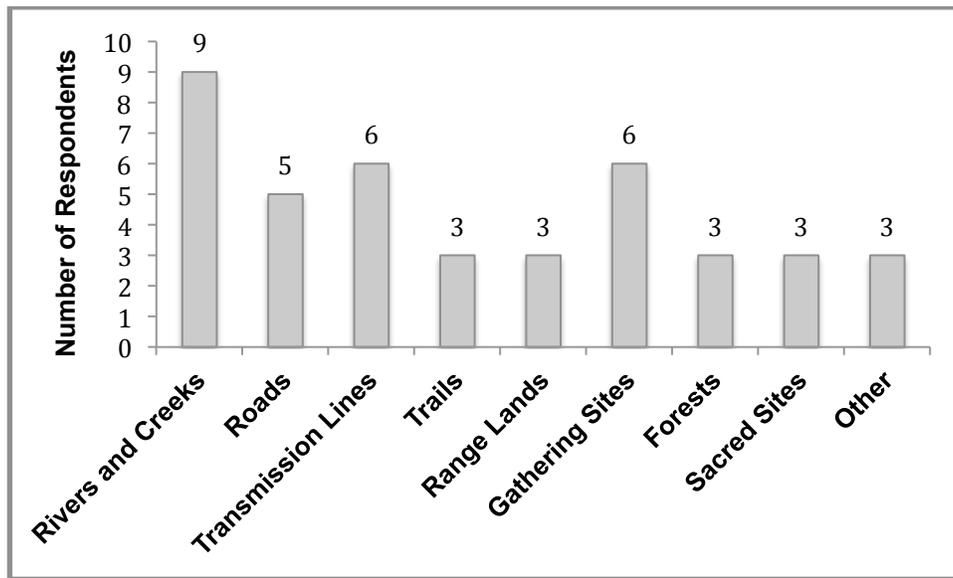


Figure 4: Distribution of In-SHUCK-ch survey responses to locations where invasive plants have been observed

A couple participants were more specific with regard to locations in the open-ended comment section at the end of the survey. One participant expressed concern about an invasive plant observed spreading in the lake. Another participant wrote: “our graveyards are invaded by other plants as are our land we have cleared. Yearly graveyards are visited and we notice other types of plants growing.” This comment shows a general understanding that invasive plants grow in cleared or disturbed areas. Several other comments also indicated an awareness of the vectors of plant invasion. One participant wrote: “primarily the invasion is with coniferous and deciduous [sic] type unmanaged overgrowth. More so the coniferous. It appears that this is the result of

clearing and logging where reforestation has not been done“, while another instructed: “look after the sides of the roads as the plants come in by vehicle tires.”

5.4. Time Spent Removing Invasive Plants

Among the participants, nine members answered that they had spent time removing invasive plants. Seven of these nine participants also indicated having taken part in harvesting traditional plants. However, over half (65%) of the participants that harvest traditional plants have not spent any time removing invasive plants. These results are shown in Table 6.

Table 6: Frequency comparisons of whether In-SHUCK-ch members harvest traditional plants and have spent time removing invasive plants

		Harvest Traditional Plants?		Total
		Yes	No	
Spent Time Removing Invasive Plants?	Yes	7	2	9
	No	13	27	40
Total		20	29	49

The time (days) that these nine respondents spent removing invasive plants in the last year is shown in Table 6.

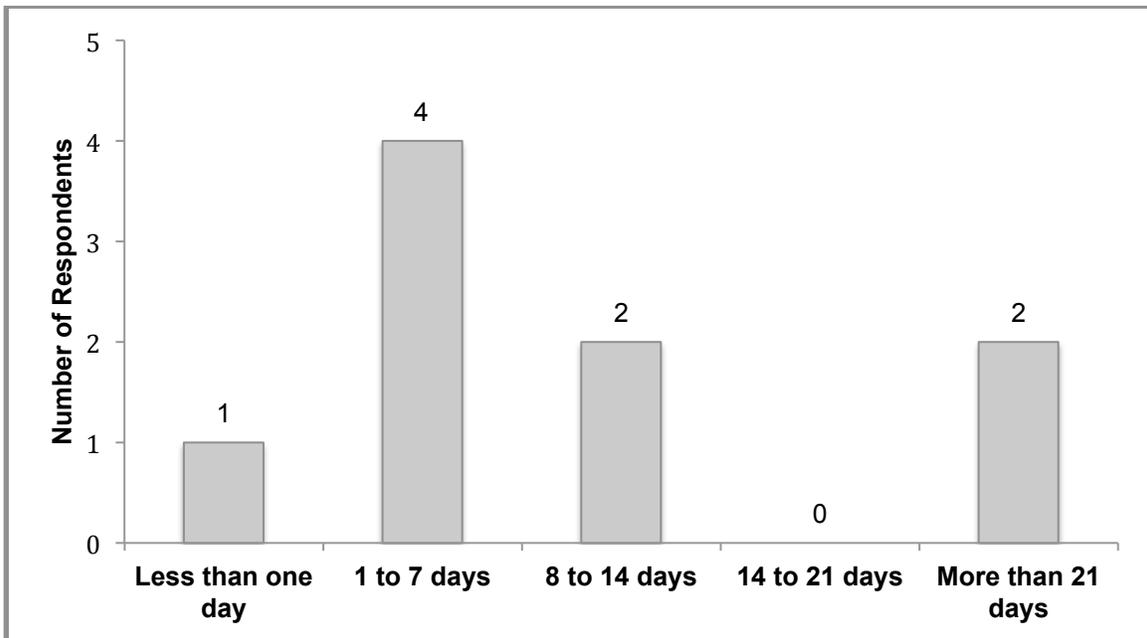


Figure 5: Distribution of In-SHUCK-ch survey responses to amount of time spent removing invasive plants within the last year

(Four additional respondents, who had indicated they did not spend any time removing invasive plants, responded to the question of how much time within the last year had been dedicated to removal activities. Two indicated they spent less than one day, which is consistent with their prior response; whereas two indicated they had spent 1 to 7 days removing invasive plants. This suggests that they may not have understood one or both of these questions.)

Only two participants indicated that they had been compensated for removal activities. One of these respondents indicated they were employed in the field of government administration, while the other was not employed in the wage economy.

6. What Are Other First Nations Doing?

As in In-SHUCK-ch's case invasive plants have come up as a concern for other First Nations in BC. Tsleil-Waututh First Nation, for example, had noticed non-native plants on their reserves and territory for some time, but did not always know them to be invasive. A presentation to staff by the Invasive Plant Council of Metro Vancouver brought a greater recognition of the impacts that invasive species can cause.

Interviews with representatives from several First Nations revealed that once First Nations are aware of the problems invasive plants can cause, they are motivated by a sense of stewardship to protect the ecosystems and resources of their traditional lands, which are vital to their culture. Members of Fort Nelson First Nation, for example, became aware of the impact invasive plants can have when Common Tansy began to over-grow the community's strawberry patches.

R. Lewis of Squamish First Nation explained that Squamish elders were concerned that important medicinal plants were not growing back, and their habitat had been alienated by invasive plants such as Scotch Broom, Hawkweed and Giant Hogweed species. Blackberry has also caused problems for Squamish Nation. "Blackberry bushes are growing at riverside and stream systems where they weren't before and First Nations who want to access traditional fishing grounds can't because there are these tall big blackberry bushes all over the place." The access barriers caused by blackberry bushes also affect traditional ceremonies and spiritual practices. R. Lewis asserted that "not only our Squamish Reserve Lands but the whole watersheds are being alienated by invasive species plants." Squamish also faced an issue of people dumping unwanted (and non-native) plants on reserve lands.

Some First Nations are also motivated to manage invasive plants in order to protect economic opportunities. The Williams Lake Indian Band (WLIB) for example, owns and operates a golf course, which they must maintain and protect against invasive plants.

6.1. Develop a Strategy

A few First Nations have undergone a process to develop a strategic plan to address invasive plants. In 2010 WLIB, for example, developed a management strategy that identifies “four priority invasive plant species and targeted areas to manage” (IPCBC, 2011, p. 1).

Similarly, Lower Nicola Indian Band (LNIB) has also developed an Invasive Plant Management Strategy. D. Caswell, along with another member of LNIB staff, conducted an invasive plant inventory of reserve lands. Through the inventory and engagement with the local weed committee LNIB had information to develop a list of priority species and a strategy for treatment that was consistent with community values. D. Caswell used a risk matrix to inform the priorities and decision-making regarding treatment. Community engagement was a significant part of developing the strategy, and involved informing members about the different treatment methods and where and why they would be deployed.

6.2. Put Management to Action

Other First Nations did not develop a formal strategic invasive plant management plan, but have begun to take action by conducting inventory and carrying out treatment of invasive plants on reserve:

- **Fort Nelson First Nation:** Fort Nelson First Nation runs its own monitoring and treatment program with funding from the Fort Nelson Invasive Plant Management Steering Committee (FNIPMSC). Fort Nelson First Nations’ program involves inventorying, monitoring, education and treatment. There are only three invasive plant species that have shown up on reserve lands so far. Preventing new species from appearing is the First Nation’s top priority, as well as containing or eradicating those already established. The First Nation hires and trains its own members to carry out on-reserve treatment.
- **Gitksaan First Nations:** Several First Nations on the Northwest Coast, including the five Gitksaan communities have also begun to treat invasive plants on their reserves. Firstly, they conducted an inventory on reserve and input the data in the IAPP database. Following the inventory, the First Nations hired some of its own members to carry out treatment. M. Hillis of the NWIPC explained that the treatment crews treat what and wherever they can. They prioritize sites by starting with the small ones.

- **Tsleil-Waututh Nation:** Since learning more about invasive plants through co-management of Say Nuth Khaw Yum (Indian Arm Provincial Park) in their territory, Tsleil-Waututh has begun assessing the scope of the problem on reserve. Tsleil-Waututh conducted an inventory of its reserve lands, focused on locating five species: Giant Hogweed and Knotweed, Scotch Broom, Holly, Ivy. These five were recommended by IPCBC and Tsleil-Waututh's staff foresters based on several factors such as presence in the region, health and safety impacts, and feasibility of control. Blackberry was not included in the inventory because it is so widespread, and therefore unrealistic to control.
- **Squamish Nation:** According to R. Lewis, Squamish has not completed a full inventory of invasive plants, but is in the process of inventorying so-called hot spots. "We have the Squamish Nation maintenance crew ... and Christine [from SSISC] has done some training with our maintenance personnel and crew in identifying the species and once they are identified they would be mapped and then we look at prioritizing removal of them." Areas of priority for Squamish Nation are places where elders and children frequent, as well as salmon areas and areas where invasive plants impact wildlife corridors. Priority is also based on impact. R. Lewis noted that the goal for Hogweed, which is very harmful to human health, is total removal; but not all invasive plants have such a harmful effect.

6.3. Select Control Methods

As described in the Aboriginal toolkit, First Nations must decide which methods they will use to treat invasive plants on reserve. Many First Nation community members are averse to broad cast spray of herbicides, as they are concerned about the impact to near-by berries and other traditional plants, as well as wildlife. Other more selective herbicide application methods, such as stem injection or wiping target species, are generally more accepted by members. Some First Nations have chosen to prohibit the use of herbicides both on reserve and in their territory, or at least minimize their use to those situations where alternative methods have proven ineffective:

- **St'at'imc Nations:** According to O. Shulz of the LRISC, "the St'at'imc Chiefs Council has a moratorium on herbicides in the territory." He maintains that the LRISS respects and adheres to that moratorium, but is also working with the St'at'imc and their wildlife/resource department to raise awareness and develop a pest management plan in which herbicides are an option of last resort, appropriate for certain situations.
- **Tsleil-Waututh Nation:** Tsleil-Waututh's policy is to avoid the use of herbicides or pesticides anywhere within their territory. This position has been incorporated into the protected areas plan for Say Nuth Khaw Yum, and is incorporated into all referral letters with proponents who are consulting with

the First Nation. However, Tsleil-Waututh has had to re-examine this position for certain species such as Knotweed, due to its rate of spread and resilience against manual methods.

- **Squamish Nation:** Squamish Nation members were very averse to herbicide use. In the past the Ministry of Forests as well as railway companies had applied herbicides via aerial and broad spraying methods, which caused concern over impacts to children, medicinal plants, fish and wildlife. Through its partnership with SSISC Squamish Nation has done some more research into herbicides and adjusted their position. R. Lewis explained: “we grind our teeth and agree ‘ok you can use this stuff now’ as we understand it is the only herbicide that will have any effect on these plants. But it will be applied on the specific plant and its root area only.” However, if it is a residential area or there is any risk to health and safety, they will remove the plants manually and replace the soil. Typically, for plants on reserve, they will stick to non-herbicide means.

6.4. Mandate Proponents to Take Action

The Aboriginal toolkit proposes creating by-laws requiring certificate of possession, traditional land owners, and lease-holders to remove invasive plants on their property. My interviews did not identify any First Nations in BC who have implemented a by-law that placed obligations on their individual members. Some First Nations, such as Squamish, explained that the band may remove invasive plants off individual lots, but does not require the individual home-owner to do so. First Nations were more favourable towards establishing requirements for non-member lease-holders to remove invasive plants on their leased property. Furthermore, several First Nations described ensuring that they bring up invasive plants in response to project referrals from proponents planning operations in their territory. During negotiations with the proponent, the First Nation requests that the proponent takes measures to prevent introducing and spreading invasive plants as a result of the project activity. For example, LNIB brings up invasive plants in technical responses to the larger referrals. LNIB’s referral coordinator, D. Caswell pointed out that LNIB can hand its strategy to proponents operating in their territory and say “here is the strategy - you need to maintain this policy.”

6.5. Incorporate Best Practices in Nations' Own Activities

While several First Nations spoke of requiring proponents to implement best practices to prevent and mitigate invasive plant impacts, Tsleil-Waututh Nation also spoke of incorporating some best practices into its own operations. For example, contractors hired to do work on reserve are encouraged not to spread the topsoil removed from a site over new areas. This is to prevent the spread of invasive plants that may be present in the soil. Tsleil-Waututh has plans to incorporate these kinds of best practices into its environmental management plan for reserve, but has not yet done so.

6.6. Educate Members and Staff

In addition to treating existing infestations and establishing requirements for proponents, several First Nations have incorporated education of members and staff in their invasive plant management approach:

- **Tsleil-Waututh Nation:** Tsleil-Waututh has used educational materials such as posters provided to them by Metro Vancouver Invasive Plant Council, as well as information in their community newsletter to increase members' awareness of the impacts that invasive plants can cause.
- **Fort Nelson First Nation:** K. Wolfenden described the First Nation's plans to conduct more invasive plant education with the larger community through a community meeting/information session, as well as incorporating it in the lessons taught at the school. She hopes that educating members will encourage them to take ownership of invasive plants in their own yards. She has also set up some trial plots to test different treatment methods (general herbicide application, stem-injection and mechanical cutting with a weed-whacker) in order to inform and engage the community in selecting the most effective method.
- **Squamish Nation:** Through their partnership with the SSISC, Squamish Nation has done some awareness sessions with Chief and Council, as well as the Nation's maintenance crew. Squamish Nation does not have a budget to do additional education across staff. As a result, invasive plants are still not on the radar of all the departments in the Squamish Nation. R. Lewis described trying to make sure to bring up the issue of invasive plants whenever working collaboratively with other departments. This is in order to make sure invasive plant issues are appropriately addressed during all business dealings, whether it be the Nation's own operation or that of proponents.

Treatment operations themselves can also serve as an opportunity to generate awareness about invasive plants and their impacts. The Gitksaan crews, for instance, knock community members' doors when they are out conducting treatment, explaining what they are doing and trying to get the community more involved. K. Wolfenden of Fort Nelson First Nation echoed this sentiment:

“In the first couple of years of the program it was all band members working for us and they would go home and talk to their families and point out the plants and I would get phone calls ‘Oh, I have this, can you come and look at this plant’. So it was a real eye opener for community members and it is good for me to have as many eyes on the ground as possible.”

6.7. Form Partnerships

A common theme among First Nations is partnership with regional invasive plant committees. The NWIPC, for instance, has had ongoing partnerships with eight First Nations, and recently started partnership agreements with another four. Squamish Nation realized they could not manage the issue on their own and hence partnered with SSISC. As R. Lewis explained, “they have already done the important homework”. By engaging with the regional organization, Squamish can make sure everyone is on the same page, and can communicate its position for the territory beyond their reserve.

Like R. Lewis who is a representative on the SSISC Board, some other First Nations, such as Fort Nelson First Nation and St’at’imc Nations also have representation on the Board of Directors of their respective regional invasive plant committee.

Partnering with regional weed committees gives First Nations access to knowledge and expertise to aid them in developing their own strategies. Through partnerships, First Nations also have access to educational materials. For example, the NWIPC provides a booth and educational pamphlets and materials for their First Nations partners to use at community events to educate members about invasive plants. Regional committees have also trained their First Nations partners in plant identification and removal methods.

Since they operate as non-profit organizations, some regional invasive plant committees require First Nations to contribute financially to the partnership. The regional committees aid First Nation to form relationships with other partners, such as municipalities or proponents, to fund the operation further.

Tsleil-Waututh Nation has developed a relationship with the IPCBC and the Invasive Plant Council of Metro Vancouver through co-management of Say Nuth Khaw Yum Park. The relationship has brought several opportunities for collaboration on invasive plants. Members of Tsleil-Waututh's field crew have participated in some of the regional invasive plant council's monitoring and inventorying activities in the park, while also alerting the council to infestations at sites not previously known to them. However, Tsleil-Waututh has not signed a formal partnership agreement with the regional invasive plant council because it wants to first determine its own objectives and policies, including their position on the use of chemical control methods.

6.8. Business Opportunities

Getting involved in invasive plant management has led to some business and employment opportunities for several First Nations and their members. Firstly, First Nations hire their own members to form a treatment crew for on-reserve treatments. Sometimes these crews are hired by proponents to help them carry out their own pest management plans. For example, the oil and gas companies in Northeastern BC often pay the Fort Nelson First Nation's crew to hand-pick the infested sites in the project area. Fort Nelson First Nation's crew has also been employed by the contractor who works for the regional weed committee to treat invasive plants off-reserve. The contractor hired Fort Nelson First Nation's crew to help her carry out her contract to treat roadsides. Similarly, Tsleil-Waututh Nation also owns a natural resource consulting company, which has vegetation management contracts throughout the lower mainland. Some of their work has involved invasive species management.

6.9. Challenges & Limitations

First Nations have experienced several challenges and limitations in their efforts to implement their invasive plant management strategies. The most consistently described limitation is funding. For example, after developing their strategy, LNIB had difficulty accessing funding for treatment and implementing the strategy. D. Caswell explained that LNIB “basically [has] a static strategy that has had little implementation.” Tsleil-waututh Nation’s participation in invasive species inventory and management has also been limited by funding availability.

Capacity and expertise is another challenge for First Nations. When responding to referrals, for example, it is necessary to have qualified people who can evaluate how a project might impact the land in terms of promoting or enabling invasive species invasion. Even if a First Nation has some staff with these qualifications, staff turnover is common in First Nations’ administrations.

M. Hill noted that crew turnover is a big challenge for First Nations’ treatment programs. Weed contracts only offer short-term seasonal employment, and it can be challenging physical labour. NWIPC hopes to assist First Nations’ to take control of their own programs and become more independent, but it is challenging for communities to find an individual to take over coordinating and running the program.

Some First Nations, such as Tsleil-Waututh, have also experienced some resistance from community members when removing invasive plants on reserve, particularly in individuals’ yards. This is in large part due to a lack of understanding and recognition of certain familiar plants as invasive or harmful. Tsleil-Waututh staff member M. George expressed that lack of community awareness is a significant barrier but can be easily overcome by education.

7. What Do the Experts Recommend?

Several participants noted that invasive plant management, both the science and policy, is in its infancy. C. Astley, a vegetation ecologist for Hemmera, stated “first of all, there is not a whole lot of science behind it, it is spotty, we have ongoing research, we have forums and conferences yearly that keep bringing more and more information, there are more and more invasive species becoming known every year.” G. Fried, a registered professional forester at BC Timber Sales and board member of the Fraser Valley Invasive Plant Council (FVIPC) was also of the opinion that policy in this field is still very much in the early stages of development.

Nevertheless, the interview participants did not hesitate to express their thoughts on the best methods and strategies to deal with invasive plants, and what In-SHUCK-ch should do.

7.1. Prevention is Best

Experts interviewed were of the opinion that In-SHUCK-ch’s territory does suffer from invasive plant infestation, but the number of species and the degree of infestation is likely less than more urban and developed areas. However, participants stressed that the proximity of the *tmicw* and the expectation of increased traffic through the region puts In-SHUCK-ch at increasing risk of invasive plant spread and proliferation.

G. Fried expressed the view that In-SHUCK-ch is in a unique position to enact effective prevention. He and other participants recommended that the principles of “early detection and rapid response” should be the basis of any invasive plant policy framework.

Participants spoke of several strategies and best practices to prevent introduction of new species into the territory. One example is targeting the pathways by which

invasive plants enter the area. The most obvious prevention target is intentional introductions from landscaping and gardening, and the businesses that sell invasive plants. Prevention should also be targeted at unintentional introductions. Suggested tools include foot wiping stations at the bottom of hiking trails and vehicle washing stations for off-road recreational vehicles. E. Sellentin explained that gravel and gravel storage pits are where a lot of Scotch Broom comes from. He suggested that requiring the gravel to be cleaned and treated before being used in the territory is one prevention effort that could prove effective.

Some participants also spoke of techniques to prevent the spread of existing invasive plants across wider ranges of the territory. K. Wolfenden, co-chair of the Fort Nelson Invasive Plant Management Steering Committee, talked about the use of containment lines, which were discussed in the literature.

“So down south closer to Prince George and Fort St. John there is wild Caraway and stuff like that so we have drawn a containment line about 100 km out of Fort Nelson so that is where we don’t want to see that wild Caraway spilling over. Like a big polygon, you keep all your plants in here and the years go on if you treat around outside hopefully you can shrink that infestation to become smaller and smaller.”

One of the most common prevention methods discussed by participants was increasing awareness. Regional weed committees spend a significant portion of their budgets on education campaigns designed to generate public awareness of invasive plants. While participants agreed that awareness is important, some participants questioned how effectively education campaigns actually increase awareness. One participant expressed that education at a general level, in schools or addressing the general public, is not likely to be effective, but that education targeted towards business operators could be. This participant also suspected that the reason First Nations have not been more active or vocal against invasive plants, despite the significant threat posed to their cultural resources, is a lack of knowledge or awareness. The participant agreed that targeted education among First Nations members, particularly resource users, might make an impact.

A. Gabriel states that the most effective way to educate In-SHUCK-ch’s community is through school children. “If you educate them young enough they start

watching for that stuff. And then school kids just naturally bring information home to their parents.” He also identified workshops as a vehicle for educating members. S. Gabriel agreed that information sessions tend to be effective, and added that the newsletter, In-SHUCK-ch website, and social media are the most effective way to reach the membership. He stated that community members would be open to representatives from outside groups, such as local weed committees, coming to community sessions and giving presentations. He was also open to putting together a presentation himself, so long as he was provided with accurate materials and the necessary information. He stressed that it is important to provide a lot of visuals for people. “I am a visual person and don’t know [the name of] this plant but when I see a picture of it I can say I have seen this plant.”

Although prevention was stressed as the most effective strategy against invasive plants, participants also spoke of the benefits of managing existing infestations in In-SHUCK-ch’s territory. Invasive plant specialists and regional weed committees recommended inventory as the first step to formulating a control strategy. Participants recommended that, based on the inventory, In-SHUCK-ch establish priorities and then carry out a treatment plan using appropriate control methods. These recommendations are discussed in the subsequent sections.

7.2. Inventory is the First Step

In-SHUCK-ch CEO A. Gabriel explained that “right now there is no real knowledge of what kind of invasive species are really in the territory so there is no point of coming up with any policy until we actually understand that there is something there that we have to have concern over.” Interview participants agreed that an invasive plant inventory is the first step for effective management. The sentiment that “you have to know what you are dealing with before you can make a plan”, was echoed throughout the interviews.

Inventory of an entire region is generally not feasible. E. Sellentin recommends targeting areas of ecological or cultural significance, high traffic corridors, and areas of economic productivity. The LRISS has begun their first phase of inventory, which will

target main arteries throughout their region. They plan to do a second, more detailed phase of inventory in future years that will target a greater range of locations. Participants recommend repeating inventories every five years.

Inventories are often contracted out. C. Astley explained that conducting inventories is not super skill intensive, but requires an attention to detail, and ability to identify and differentiate plant species. O. Shulz said that some basic GPS skills and data entry skills are also useful. E. Sellentin recommends hiring at least one professional who can then work with a crew from the community to conduct the inventory. C. Astley said “I think most people can do it given a little bit of training at the front end and having someone overseeing that has the plant ID skills. If there is one that is questionable you can take a picture and bring it back and you can always have an ID later on.”

The cost of conducting an inventory is dependent on the experience or qualifications of the surveyor(s), the size of the area covered, and the density and variety of invasive species within the region. A more formal methodology involving setting up transects is more time consuming and thus more costly than an informal road-side survey approach. This latter approach is more common. E. Sellentin estimated that a 770 acre park took him and a colleague two full days to conduct the inventory, and another full day to summarize all the findings.

Inventory is the first step before priorities can be determined and control techniques are selected. The Lillooet Region Invasive Species Society, which has only been in operation for a year and a half, is a primary example. Their first year in existence has been focused on conducting on the ground inventory. O. Shulz, from LRISS, explained “[we are] trying to build up our database for what species are here, and based on that figuring out a strategy on how to move forward and prioritize on where we have to focus our efforts and what are the major concerns.”

7.3. You Can’t Fight Them All

Participants generally agreed with the literature that due to limited funding it is important to identify priorities. LRISS is in the beginning stages of its operation and O. Shulz provided some insight into how LRISS have identified priority species based on

their cursory inventory. Invasive plants that are in limited distribution have been ranked as high priority. O. Shulz explained: “Orange Hawkweed is another [priority], and again because it is in limited distribution and we feel we could really get on top of it and hopefully eradicate it as opposed to something like Knapweed or Toadflax which you can only control as there is so much of it here.” For more prevalent species, the LRISS’s goal is preventing further introduction and spread. They have accepted that “in some of the big pockets in the major centres there is not much we will be able to do.”

Most participants spoke of establishing priorities from the perspective of minimizing the probability and impact of invasion. The diversity of impacts is an important factor to consider in establishing priorities. Participants asserted that the greater the range of impacts (from human health, to infrastructure, to economies, to ecosystems) the greater priority it should be given. In addition, the severity or magnitude of the impact is also important.

One participant offered an alternative approach. Rather than prioritizing invasive plants based on impact, one could establish priorities from the perspective of maximizing the protection of native species, and sensitive ecosystems. This approach would focus on managing all invasive species within the proximity of important native plant areas.

7.4. Costs of Control Will Influence Priorities

An invasive plant specialist for FLNRO explained that the selection of the control method should really be based on the science of the particular plant species; for some plants manual control is effective, while for others herbicides are necessary. Several participants spoke to the benefits of an integrated approach using a combination of methods for maximum effect.

Experts acknowledged that public concern for herbicides exists. However, most interview participants emphasized that this could be overcome with adequate education. None of the experts were opposed to using herbicides if used appropriately (in accordance with regulations which restrict use in riparian areas). A. Gabriel of In-SHUCK-ch agreed that educating members about the tradeoffs of using herbicides or

allowing invasive plants to proliferate is likely to be successful in overcoming community members' opposition.

As discussed in the literature, participants reiterated that the cost of control methods vary by amount of effort and time involved, as well as the cost of inputs. G. Fried emphasized that control is very expensive, requiring multiple years of treatment and monitoring. Participants identified some of the elements that affect the cost of control, including the technique itself (hand pulling, mowing, spray application of herbicide, stem injection etc), as well as the equipment needed, the size of the area, and the frequency of application. One invasive plant specialist interviewed submitted that in the short-term, herbicide treatment is the most cost effective. Mechanical or manual control is very expensive, but is better than nothing in areas declared pesticide-free. In the specialists' opinion bio-control is, in the long-term, the most cost effective. Other experts interviewed did not all have the same view of bio-control. E. Sellentin explained that bio-control is a way of slowing down the spread of invasive plants, but does not actually reduce the population size to levels below that which can sustain the bio-control agent.

Although there are best practices to prevent the introduction of invasive plants, once an invasive plant has established itself it will continue to spread. Whether the goal is to contain the infestation to a particular area and prevent its spread, or to reduce the size and density of the infestation, some application of control methods is needed. The relative cost and effectiveness of each control method against the species of interest will influence how treatment priorities are established.

7.5. Regular Monitoring Allows Re-Evaluation of Goals and Priorities

Most participants brought up the importance of monitoring as a way to measure progress towards targets or benchmarks. Monitoring is important to determine whether control techniques have been effective and to continuously inform strategy. Participants who spoke of benchmarking said that it was important to set specific benchmarks for each species. For some species with a less severe impact, the benchmark may just be

to contain the population at its current size, whereas for very harmful species such as Giant Hogweed, the goal may be to come as close to total eradication as possible.

7.6. There is No Need to Re-Invent the Wheel

Finally, several participants spoke of the benefits of partnerships and collaboration across agencies and jurisdictional lines. C. Astley referred to efficiencies that partnerships can create to reduce duplication of efforts. In her words “working together with weed committees is really key to stop spending money needlessly, and re-inventing the wheel.” Partnerships between regional weed committees and First Nations were consistently recommended because partnerships can make resources go further. Participants spoke of the benefits of accessing the tools, templates and strategies already developed by other organizations, and adapting it to fit their needs. If a First Nation chooses to partner with a weed committee, it should assign a representative from the First Nations’ forestry/lands/resources department who is empowered to represent the community and is committed to attending committee meetings regularly.

8. Discussion of Findings

Entries in the IAPP database, combined with results of the survey, confirm that invasive plants are present in the *tmicw*. The full scope of the problem is not certain, though it is suspected to be less significant than that of more urban areas. Nevertheless In-SHUCK-ch has a mandate to protect its lands and resources, as outlined in its Environmental Management Plan. However, In-SHUCK-ch has yet to develop its own policy approach to invasive species management on its reserves and territory. The literature and interviews suggest that employing the precautionary principle is advisable, given that the invasive plant problem is expected to grow with increased traffic and development in the territory, combined with the impacts of climate change. Enacting preventative measures will, in the long-term, be In-SHUCK-ch's most effective strategy against invasive plants.

The results of the survey indicate that members are aware that the plants in their territory are changing, though they have limited knowledge and understanding about the impacts of invasive plants. Comments from participants indicating a concern and interest in the issue suggest an opportunity to raise awareness about impacts and prevention, while increasing support for an invasive plant management program.

The data from interviews with experts was consistent with the literature. The participants did not identify any mutually exclusive policy alternatives, but rather a suite of strategies and corresponding best practices to achieve the best results. All participants spoke in some way to the idea that no organization or government will be able to implement every strategy and best practice, and therefore must prioritize among them, usually by choosing those that are most cost-effective. According to the survey and interviews with staff invasive plants are most prevalent along riparian areas, roads and transmission lines crossing the territory. This is consistent with the literature about invasion vectors. One option for In-SHUCK-ch could be to prioritize these high traffic areas throughout the territory for treatment. Alternatively, as one participant pointed out,

In-SHUCK-ch could establish treatment priorities based on the protection of key cultural resources.

Like In-SHUCK-ch other BC First Nations have also recognized the need to begin addressing invasive plants in their territory. Several First Nations have implemented some of these best practices, sometimes in an ad-hoc manner, sometimes as part of a strategic approach. All First Nations identified through my research have been guided in some way by partnerships with a regional district or regional weed committee. For some this has just involved educational presentations to leadership or members, while other First Nations have formed formal partnership agreements. First Nations have largely dealt with invasive plants in a reactive manner by forming treatment crews to control or contain existing infestations. However, as First Nations have become more aware of the real destructive impact that invasive plants can have on culturally vital plants and ecosystems, they have been compelled to take more proactive and strategic action. Unfortunately, for those who have developed formal management plans to deal with invasive plants, implementation has been severely limited by capacity restrictions.

In-SHUCK-ch faces similar capacity restrictions, which limits the options that are feasible for them. The next section describes four approaches that In-SHUCK-ch could take to address invasive plants in the *tmicw*.

9. Policy Options

In-SHUCK-ch's primary objective with respect to invasive plants is to protect traditional plants and animals, as well as culturally significant sites and ecosystems from the threat of invasive plant infestation. Interviews with In-SHUCK-ch staff revealed three goals for an effective invasive plant management policy:

- **Inform:** Spread awareness about invasive plants among members.
- **Prevent:** Ensure the prevention of new invasive plant species from entering the territory, as well as preventing existing species from establishing in new un-infested areas of the territory.
- **Control:** Eradicate or reduce the distribution and density of existing invasive plant populations and mitigate the impacts from established infestations.

Prior to Treaty In-SHUCK-ch can implement programs on reserve in accordance with the parameters established by the Indian Act. In-SHUCK-ch can also strongly suggest action to proponents operating in the territory and other levels of government managing the region. After Treaty In-SHUCK-ch will have legal authority to use its governance powers to set policy, pass and enforce laws and regulations and implement their own programs with respect to treaty settlement lands.

Based on the objectives expressed by In-SHUCK-ch, I developed four policy alternatives that In-SHUCK-ch can enact either now on reserve lands, or after treaty across the entire treaty settlement lands. The alternatives are:

1. Administer an education program for members;
2. Incorporate best preventative practices into In-SHUCK-ch governance, administration and operations;
3. Implement a general treatment program; or
4. Implement a culturally-prioritized treatment program

Each of the four options directly achieves at least one of the identified objectives, and is consistent with recommendations of interview participants. The status quo, which

currently involves deferring action to other jurisdictions, was not selected as an alternative for consideration because it does not achieve any of the objectives. Prohibitive regulation banning the sale of invasive plant species was not considered since it is not relevant within In-SHUCK-ch's jurisdiction (there are no plant nurseries on reserve, nor any identified within the proposed treaty settlement lands).

The following sections describe the proposed policy options in more detail.

9.1. Administer an Education Program for Members

An information and education program is a more passive approach that is primarily focused on addressing the awareness objective. An education program would teach members about the problems invasive plants can cause, how they are spread, and which plants to watch out for. Targeted education will provide them with the knowledge to change their behaviours in ways that mitigate the introduction and spread of invasive plants into the territory and onto the reserve. Education can take the form of social media alerts and updates, articles in the monthly community newsletters, or interactive workshops. Workshops could be made available to all members, or targeted at members who actively travel and gather resources in the territory.

9.2. Incorporate Best Prevention Practices into In-SHUCK-ch Governance, Administration and Operations

Another approach to prevention involves implementing various best practices that avert the introduction and spread of invasive plants into new areas. In-SHUCK-ch could incorporate this portfolio of best preventative practices into all aspects of its governance and operating standards, from land-use planning, to economic development, to public works, to housing. For example, any vehicles used for projects in the territory, be it an infrastructure construction project or waste management, must not park in an infested area, and must be washed and cleaned to prevent transport of seeds or propagules. Another example is ensuring that invasive species are not permitted within any community composting facilities. Additionally, In-SHUCK-ch can incorporate supply chain standards into construction projects, such as sourcing clean gravel from non-

infested gravel sites. In-SHUCK-ch can incorporate these standards into agreements with any contractors working in the territory and into the operating practices of all In-SHUCK-ch departments.

9.3. Implement a General Treatment Program

This option involves In-SHUCK-ch designing and implementing its own mitigation and control program for its reserves and the territory. A general control program involves applying several of the best practices identified in the literature and interviews, with the goal of reducing the degree of infestation and mitigating the spread of established invasive species populations into new areas. It involves conducting an inventory of the territory and identifying appropriate control strategies for the various populations. Inventory is carried out for the whole territory, with a focus on disturbed and high-traffic areas such as roads, transmission lines and other disturbance corridors. Priority is given to species which cause the greatest impact, and have the highest probability of control. Small, low density infestations are considered most feasible to eradicate, or at least reduce. (See Appendix A for an assessment if the risk of those invasive plants suspected in In-SHUCK-ch territory). Larger, denser populations, which likely cannot be significantly reduced, would be treated along a containment perimeter to mitigate the growth and spread of the population.

This approach involves monitoring to observe whether treatment is reducing population or density of infestations, and whether new populations have established. Follow-up treatments will likely be necessary.

9.4. Implement a Culturally-Prioritized Treatment Program

One interview participant mentioned an alternative way to prioritize treatment of invasive plants: focusing on maximizing protection of native species, and sensitive ecosystems, rather than minimizing the invasive species. This option stems from this idea and would also involve In-SHUCK-ch designing and implementing a control program. However, priority for treatment is assigned to those invasive species in

proximity to sensitive locations and/or resources such as high-production berry patches, riparian zones, and significant cultural sites. First, an inventory of existing invasive plant populations is conducted at these cultural priority locations. Secondly, this approach also involves defining containment perimeters, but rather than applying them around an established invasive plant population, the perimeter is defined around the priority protected area. Any infestations along the perimeter are treated to prevent infestations from spreading into the protected zone. Any infestations inside the perimeter are treated with the goal of complete eradication.

This approach involves monitoring at the prioritized sites to ensure the area inside the perimeter remains invasive species free. Follow-up treatments will likely be necessary.

10. Criteria and Measures: The Framework for Weeding through the Options

The policy options in the previous section will be evaluated against five criteria: Effectiveness, Cost, Capacity Requirements, Community Acceptability and Spillover Effects. Effectiveness is broken down into three sub-criteria. The criteria illuminate the trade-offs that In-SHUCK-ch faces when selecting one policy approach over another. By measuring each of the proposed alternatives against the criteria, these trade-offs can be examined and the alternatives can be ranked to reveal the most appropriate policy option for In-SHUCK-ch.

Each criterion, except spillover, is measured on a three-point scale. The highest score, three, is assigned to policy options which perform strongly; whereas the lowest score, one, is assigned if a policy option performs poorly against the criterion. Because the effectiveness criterion is divided into three components it is weighted more heavily than the other criteria. Criteria scores are summed to give each policy option a total score out of 18. Spillovers, explained in more detail below, are simply identified qualitatively, and are not assigned a score. They are used to inform decisions between close-scoring options. A summary of the criteria and measures is provided in Table 7 at the end of this section, following the description of each criterion.

10.1. Effectiveness

Effectiveness measures whether the policy option meets the overall objective of protecting the *tmciv* from the growing threat of invasive plants, and how well it does so. Effectiveness can be further defined as a measure of how successfully the proposed alternative achieves the three outcome goals: inform, prevent, and control.

10.1.1. Awareness

According to the literature, “many environmental managers cite a lack of public awareness and support as one of the major obstacles to successful [invasive species] management” (Sharp, Larson & Green, 2011, p. 2098). Policies that generate a high degree of awareness among staff and members are assigned a high score, while low scores are attributed to policies that provide fewer opportunities to raise members’ awareness, or the opportunities are less direct.

10.1.2. Prevention

Interview participants consistently cited prevention as the most effective arsenal against invasive plants. Prevention includes thwarting new species from entering the area and hindering existing invasive species from spreading and establishing new populations. Though awareness facilitates prevention, the prevention-effectiveness criterion refers to how well the policy encourages direct preventative actions. Policies that directly prevent invasive plant introduction and spread are assigned a high score, and those that do not incorporate any direct preventative actions receive low scores.

10.1.3. Mitigation and Control

Removing or reducing the threat of invasive plants to In-SHUCK-ch also requires controlling existing infestations that impact, or have the potential to impact, In-SHUCK-ch’s lands and culturally or economically important resources. This component of effectiveness criterion refers to how well the policy option mitigates the impacts from invasive plants and controls established infestations. Policies that involve direct control of established invasive species and mitigate the impact of these species are assigned a high score, whereas low scores are allocated to policy options that do not incorporate any control measures.

10.2. Cost

In interviews with In-SHUCK-ch staff, funding was identified most consistently as their biggest limitation in terms of creating regulations and operating programs. Competing policy priorities limit the funding available to spend addressing invasive plants. Therefore, policy options that cost more in terms of time, number of resources, and financial expenditure are viewed as less favourable. An inverse scale is used to measure alternatives against the cost criteria: the more costly the policy the lower the score.

10.3. Capacity Requirements

In-SHUCK-ch also has limited internal capacity, which must be considered when evaluating policy alternatives. These capacity limitations significantly restrict In-SHUCK-ch's ability to administer and enforce its own policies. However, In-SHUCK-ch staff, as well as D. Carson, acknowledged that many members have a good knowledge about medicinal and cultural plants, and expanding that knowledge to protection from invasive plants would not be too difficult, though it would require some extra training. The capacity criterion is measured on an inverse scale, where low capacity requirements receive a high score, and high capacity requirements receive a low score. Consideration is given to the amount of qualifications, training and expertise needed to implement a policy alternative.

10.4. Community Acceptability

“If public land managers do not include public input and account for public attitudes in the planning process, they run the risk of losing support for invasive species control” (41, p. 2098). Therefore, an important criterion is the acceptability of the policy option to In-SHUCK-ch members. Interviews with In-SHUCK-ch staff indicated that cultural and traditional use considerations must factor into all policy development in order to ensure community support. Impacts to other community priorities, in terms of reduced focus, funds, or time, will also affect the level of community acceptability. A high

score is allotted to options that are likely to be widely accepted by members, while a low score is given to options that are likely to receive a high degree of resistance from the community.

10.5. Positive or Negative Spillover Effects

Lastly, any positive or negative spillover effects as a result of the policy option do not receive a score, but are identified and noted so that they can be considered when evaluating the options. For example, interviews with In-SHUCK-ch staff revealed that if a policy generates potential employment opportunities for members it will be looked at more favourably by the In-SHUCK-ch government. In-SHUCK-ch staff expressed hope that there may be some further employment opportunities for the Stewardship Crew to build on their existing skills and extend their work season. D. Skerik explained: “for this office [job creation] is everything. We strongly believe in this office until people gain employment that they are happy and proud of we will not solve the underlying issues like housing, health and others.”

Potential negative spillover effects, such as burdens placed on In-SHUCK-ch businesses like its forestry operation, must also be considered. A. Gabriel stated: “I know that it’s just something that has to be done but we cannot do it to the point where it is going to hamper on business too. So [we] have to make sure that it is done so business can still be done. We are mindful that we have those policies in place and follow them with our own companies too.”

10.6. Summary of Criteria and Measures

Table 7: Criteria and measures for the assessment of policy options

Criteria	3	2	1	
Effectiveness	Awareness	Policy promotes a high degree of awareness among both staff and members	Policy promotes some level of awareness in staff or members	Policy does not promote awareness among either staff or members
	Prevention	Policy implements several direct prevention measures	Policy implements a few direct prevention measures	Policy implements no direct prevention measures
	Control	Policy likely to eradicate or reduce many existing infestations and mitigate impacts	Policy likely to reduce some existing infestations	Policy not likely to reduce any existing infestations
Cost	< \$50,000 Policy can be implemented with minimal staff time and additional expenditures	\$50,000-\$100,000 Policy requires some additional staff time and small expenditures	> \$100,000 Policy requires a large amount of staff time, resources, as well as significant expenditure on materials and equipment	
Administrative Capacity	Policy does not require hiring of experts or training of staff	Policy requires some staff training	Policy requires hiring expert	
Community Acceptability	Level of community support is high	Level of community support is medium	Level of community support is low and there may even be high resistance	
Spillover Effects	Any positive and/or negative spillovers are identified and described (no score is given)			

11. Analysis of Policy Options

This section describes how each policy option was evaluated and measured against the criteria defined in the previous section. A summary of the scores for each policy option are shown in Table 8 at the end of this section.

11.1. Administer Education Program for Members

11.1.1. *Effectiveness*

An education program is intrinsically intended to generate awareness. An education program that is specifically designed for In-SHUCK-ch members will be more effective at generating understanding of the issues and impacts that invasive plants can cause, why members should be concerned, and how they can take action through their own behaviour. There are limitations to how effective education campaigns are in fostering long-lasting awareness of invasive plants. For example, there are issues of attendance at community workshops and attracting people to information sessions when it is an issue they do not know much about in the first place. The community newsletter, combined with regular social media updates, will help to attract interest, and maintain consistent ongoing messaging about the issue. **Overall (and in relation to the other four alternatives) an education program is highly effective in fostering awareness and is assigned a score of three.**

An education program can also encourage people to alter their behaviours to help prevent the introduction of invasive plants. If individuals can recognize invasive plant species when they are walking through the territory they can make sure not to walk directly through infestations. Individuals can also clean their vehicles (including any recreational vehicles) to prevent the transfer of seeds into new areas. If the education program specifically informs individuals of such actions and sufficiently motivates people it may, indirectly, facilitate prevention. However, the literature indicates that the ability for

education to motivate a significant behaviour change is limited (Kubeck, 2008). Kubeck identified that a lack of institutional action or support can be a significant barrier to individual behavioural change (2008). Without any institutional or infrastructure changes, such as car washing stations at entry roads into the territory, expectations of individual preventative behaviours is unrealistic. Furthermore, education about the prevalence and problems of invasive plants may discourage individuals to act, because they may feel that invasive plants are a losing battle and their individual efforts would be futile. **Therefore, an education program is given a medium score of two in effectiveness of prevention.**

Finally with respect to control effectiveness, an education program has the potential to indirectly influence individuals to treat infestations through manual pulling. However, the likelihood of this is low, and the impact of small-scale treatment action is very limited in actually controlling established infestations. **Therefore this policy is assigned a score of one in control effectiveness.**

11.1.2. Cost

An education program requires a few weeks of a staff person's time to develop. There are many resources and information available publicly through provincial and regional invasive plant committee websites. Designing a workshop for In-SHUCK-ch would involve pulling relevant information together and tailoring it to the audience in a format that is accessible and understandable. Ongoing education through the monthly newsletter and through social media will require a few hours a month of one staff member's time. Based on assumptions identified in Appendix G, the cost of designing and delivering a workshop, producing educational materials, and sending out newsletter and social media updates is an estimated \$20,000. **Overall an education program will not require a large expenditure above and beyond the status quo. Therefore, this option is assigned a score of three.**

11.1.3. Capacity Requirements

To pull together the information to be included in an education program the staff person will need an understanding of workshop and training design and how to formulate

materials to be accessible to members. Additionally, the individual designing and implementing the training workshop will need a basic understanding of the impacts that invasive species can have on In-SHUCK-ch lands, resources and culture, as well as the invasive species in and around the territory. The knowledge of current staff members at In-SHUCK-ch will be sufficient to design and administer workshops and newsletter stories about invasive plants, though In-SHUCK-ch may elect to hire an invasive plant expert to facilitate the workshop and answer members' specific questions. **The capacity requirements of this policy option is low, and is therefore assigned a high score of three.**

11.1.4. Community Acceptability

Comments in the survey responses indicated that several members were interested in learning more about invasive plants, particularly before making any decisions regarding allocations of budget towards treatment measures. Interviews with In-SHUCK-ch staff revealed that they anticipated the community would support educational workshops on the topic. However, there is a possibility that in administering an education program highlighting the presence of invasive plants and the potential impacts to culturally important resources, the community would expect In-SHUCK-ch to take more directive action in addressing the problem. An education program on its own may achieve some community opposition. **Therefore this policy option receives a middle score of two for the community acceptability criterion.**

11.1.5. Potential Spillovers

More awareness and understanding about the problems that invasive plants can cause may prompt members to demand more direct action from In-SHUCK-ch above and beyond an education program.

11.2. Incorporate Best Prevention Practices into In-SHUCK-ch Governance, Administration and Operations

11.2.1. Effectiveness

This approach offers opportunities to generate awareness among members about invasive species, though less directly than an education program. By incorporating preventative practices into all aspects of its governance and operations, invasive plants issues will be discussed during regular community consultation and information sessions about In-SHUCK-ch business. For example, when discussing a decision to authorize a proponent to work in the territory, or partner with In-SHUCK-ch, invasive plant prevention will come up as part of the considerations. Yet, since this information will be ancillary to many other aspects of the discussion, the opportunity to share information about the nature of invasive plants is somewhat limited. **Consequently, this option only receives a medium score of two for its effectiveness in achieving In-SHUCK-ch's awareness goals.**

This policy option is directly targeted at achieving the prevention objective. By incorporating best practices into its own policies and operations, In-SHUCK-ch can implement some preventative measures that reduce the possibility of introducing new invasive plants into the territory, and distributing existing invasive plants across a further range throughout the *tmicw*. Both In-SHUCK-ch's own activities and those of proponents authorized to work in the territory will be carried out in ways that incorporate preventative practices. At the same time, this option does not legislate or encourage individual behaviours of members or visitors to the territory. Nevertheless, the scale of land disturbance from government and developers' activities is much more significant than from individual people. Therefore, this policy option is still likely to be effective in reducing the introduction of new species into the territory and into disturbed land sites in particular. **It obtains a high prevention effectiveness score of three.**

Finally, in terms of effectiveness in achieving the goal of control, this option does not directly reduce the presence of any existing infestations or mitigate the impacts from established invasive plants. There may be some indirect control outcomes as a result of incorporating prevention into operating standards. For example, if In-SHUCK-ch was to

carry out an infrastructure project such as a new building, the construction site preparation may require removing all existing infestation on the lot to prevent construction trucks from spreading invasive plants. However, the probability of direct control outcomes as a result of incorporating prevention practices into operations is low. **As a result, this option is assigned a low control effectiveness score of one.**

11.2.2. Cost

Incorporating best practices into all aspects of governance and operations will present In-SHUCK-ch with some cost, particularly with respect to time. For example, ensuring all trucks are regularly washed before moving to a new site will slow down operations. Another example is the time it may take to research clean sources of gravel for construction projects. There may also be some financial costs added to operations such as the increased cost of certified-native seed mixes for planting at project sites. The added governance cost of this option is estimated at approximately \$30,000. Added operations costs would mostly be transferred to proponents; however there may be some additional operation costs to In-SHUCK-ch's own operations such as public works. These costs are estimated to be \$40,000. The combined total cost for this option, based on assumptions identified in Appendix X, is \$70,000. **Inclusively, this approach receives a medium cost score of two.**

11.2.3. Capacity Requirements

This option will involve some training of staff to understand how best practices work to prevent invasive plant spread, and how they can be incorporated into the everyday business of In-SHUCK-ch governance and operations. However, once initially interpreted and written into operation standards, no additional skills and capacity are specifically needed. To negotiate the inclusion of best prevention practices into partnerships with other companies may require a somewhat greater degree of knowledge of invasive plants and the best practices. However, much of this knowledge can come from in-house research and In-SHUCK-ch will not likely need to consult an invasive plant expert. **Thus, this option obtains a medium score of two for the capacity criterion.**

11.2.4. Community Acceptability

In light of the fact that the survey indicated members are willing to accept some allocation of funds towards invasive plant management, but not an expenditure amount that jeopardizes other priorities, the cost attributed to this option is likely acceptable to the community. This approach is also consistent with In-SHUCK-ch's principles of incorporating land and resource stewardship into the way it conducts business and development. **Overall, a high level of community support is anticipated for this option. The policy scores a three for the acceptability criterion.**

11.2.5. Potential Spillovers

Incorporating best practices into all aspects of governance and operations, including economic development activities could place time or financial burdens on businesses, either Nation-owned or external companies operating within In-SHUCK-ch's jurisdiction). This may affect the profitability of In-SHUCK-ch's own businesses, or deter companies from conducting business and investing in the territory. However, the probability that these added costs will affect the overall success of business is low, since these costs would be considered in project approvals and project design.

11.3. Implement a General Treatment Program

11.3.1. Effectiveness

This policy option has some potential to generate awareness about invasive plants if members are involved in conducting the treatments. However, the information learned through the treatment program will likely not be in-depth, and will not be accessible to all members. **Therefore, this policy option only receives an awareness score of one.**

By controlling small infestations a general treatment approach is effective in preventing the spread of existing populations into new un-invaded areas of the territory. At the same time, it does not take any direct action to prevent the initial introduction of invasive species into the territory, nor does it act to alter individuals' behaviour in such a

way as to prevent infestations. **Consequently, this approach receives a medium prevention effectiveness score of two.**

A general treatment program uses integrated control methods (a combination of manual and chemical control) and targets infestations based on a risk assessment of feasibility of control and severity of impact. Small low-density populations, which are more feasible to eradicate, are primary treatment candidates. Large, widespread and dense populations are treated along the perimeter to mitigate further growth and spread of the population. Additionally, high-impact species are prioritized over lower-impact species. Interview participants and the literature consistently recommended this approach as the most effective to control established infestations. **Therefore, this policy option is assigned a high control effectiveness score of three.**

11.3.2. Cost

A general treatment program will require hiring (and potentially training) a treatment crew as well as purchasing chemicals and tools to treat invasive plants. To effectively eradicate small populations as well as contain larger populations a significant expenditure is required to carry out the initial treatment as well as to pay for ongoing monitoring and follow-up treatments. The cost of treatment depends on the types of species, the types of control method needed, and the total size of the treatment area. Assuming a per hectare treatment cost of \$ 80 it would cost \$200,000 to treat an area 25% of the total treaty settlement lands. Adding in management/administration costs as well as inventory, the total cost without monitoring or follow up is estimated at \$210,000. **Since cost is measured on an inverse scale, this high-cost approach is assigned a score of one.**

11.3.3. Capacity Requirements

Implementing a treatment program involves several stages, each of which require particular skill sets. The first stage is conducting an inventory. This requires plant identification and geo-information system (GIS) mapping skills as well as someone who can manage the process and make informed decisions about where and when to inventory. After an inventory some level of risk assessment is necessary to decide how

to prioritize the treatment based on feasibility of control and severity of impact. Approaches to risk assessment can vary in the level of detail and quantification of risk, but even a basic risk assessment requires some understanding of invasive plants. Finally, carrying out the treatment itself requires a skilled and trained crew. If chemical control methods are used for any treatment the crew will need someone certified in pesticide application; however, staff interviews confirmed that at least one member of staff has this qualification already. Overall, implementing a treatment program will require some training and may require hiring an expert to consult with In-SHUCK-ch on the development and management of a treatment program. **For this reason this option receives a score of one.**

11.3.4. Community Acceptability

The results of the willingness to accept survey indicate that the community members are likely to oppose a significant allocation of the budget away from other priorities. The high cost of a general treatment program may generate some community opposition to this approach, particularly given the community's current limited knowledge and recognition of the impact of invasive plants to their territory and traditional resources. If In-SHUCK-ch hires and trains community members, either the existing stewardship crew or additional individuals, the community will be more likely to approve this approach. **Given these trade-offs this policy option is assigned a medium score of two for the community acceptability criterion.**

11.3.5. Potential Spillovers

Carrying out a treatment program requires hiring a treatment crew. This creates potential employment for In-SHUCK-ch members, most likely providing an extended work season for the existing stewardship crew.

11.4. Implement a Culturally-Prioritized Treatment Program

11.4.1. *Effectiveness*

A culturally-prioritized treatment program is more likely to increase In-SHUCK-ch's members' awareness about invasive plants than the general treatment option since treatment at culturally important (and therefore frequented) sites will be more visible to members. So long as members see treatment being conducted, and have the opportunity to ask questions, this approach will facilitate members becoming directly informed about potential impacts of invasive plants on their culture and resources, and how these impacts can be mitigated. **This policy option is assigned a medium score of two for effectiveness in achieving awareness goals.**

Since this treatment program does not specifically target new, recently established populations, this approach is likely less effective in achieving prevention outcomes. Furthermore, it does not take any direct action to prevent the introduction of new species into the territory, or influence individuals' behaviour in such a way as to directly prevent infestations. **Consequently, this approach receives a low prevention effectiveness score of one.**

This approach targets infestations on the basis of impact and proximity to culturally significant locations deemed vulnerable to invasion and disturbance from invasive plants. This approach is effective at mitigating the impact of invasive plants on traditional plants, sacred sites, and riparian areas. However, it may not be as effective as the general treatment program in reducing the full scope of invasive plant populations throughout the territory. By leaving invasive species to grow un-treated in any non-prioritized area, the species can continue to proliferate and spread throughout the territory. The un-treated presence of invasive species in other areas of the territory remains a potential reproductive source, which could allow the species to proliferate and re-invade the sensitive locations. **Consequently, this policy option is assigned a medium control effectiveness score of two.**

11.4.2. Cost

Like the general treatment program, a prioritized treatment program will require significant expenditure on conducting an inventory, hiring and training a treatment crew, purchasing equipment and tools to implement treatment, and conduct ongoing monitoring and follow-up treatments. The total treatment size will likely be less, since it will be limited to priority areas only. Monitoring will also be less costly as for the general treatment program, but follow-up treatments may be more frequent since treatment approached in this way is likely to be less effective. Assuming a per hectare treatment cost of \$80, it would cost \$80,000 to treat an area 10% of the total treaty settlement lands. Adding in management/administration costs as well as inventory, the total cost excluding monitoring or follow up is estimated to be \$87,000. **Given that this is over \$100,000 less than the general treatment program this option was assigned a cost criterion score of two, indicating a medium cost.** However, it should be noted that the total treatment area may greater than 10% of the settlement lands, which would increase the cost.

11.4.3. Capacity Requirements

In-SHUCK-ch has already completed a traditional use study and therefore will not likely have to complete any additional studies to identify important gathering and harvest sites and spiritually significant locations. In-SHUCK-ch may need to consult an expert to identify which ecological areas, such as riparian habitats, are particularly vulnerable to invasive plants and should be prioritized for protection. In-SHUCK-ch will need to hire an expert to manage the inventory process at the identified sites. Further, while this approach does not require a risk assessment in the same vein as the general treatment program, expert knowledge on effective treatment methods for the invasive plants in proximity to the identified protected locations will be beneficial. A trained treatment crew will also be necessary. **This option has high capacity requirements and is assigned a low score of one with respect to this criterion.**

11.4.4. Community Acceptability

The high cost of this option and the allocation of In-SHUCK-ch's budget away from other fundamental community priorities will not be highly accepted by In-SHUCK-ch members. However, given that the survey denoted a high importance of traditional plants to members' well being, a treatment program focused on protecting traditional resource sites from invasion by non-native species will likely be more favourable to the community. If treatment of these sites can be conducted in combination with harvesting activities it will likely garner more support, since it encourages traditional practices. **Consequently, this policy option obtains a high community acceptability score of three.**

11.4.5. Potential Spillovers

As with the general treatment program, this option also creates increased employment for In-SHUCK-ch's stewardship crew. In addition, since treatment is focused on harvesting and spiritual locations, this policy approach may have the positive added effect of increasing the frequency with which members engage in traditional practices at these sites.

11.5. Summary Matrix

Policy Option		1: Education	2: Internalize Best Practices	3: General Treatment	4: Prioritized Treatment
Criteria					
Effectiveness	Awareness	High (3)	Medium (2)	Low (1)	Medium (2)
	Prevention	Medium (2)	High (3)	Medium (2)	Low (1)
	Control	Low (1)	Low (1)	High (3)	Medium (2)
	Sub-Total	6	6	6	5
Cost	Low (3)	Medium (2)	High (1)	Medium (2)	
Administrative Capacity	Low (3)	Medium (2)	High (1)	High (1)	
Community Acceptability	Medium (2)	High (3)	Medium (2)	High (3)	
TOTAL	14	13	10	11	
Spillover Effects	May prompt members to demand more direct action against invasive plants	May burden businesses	May generate jobs	May generate jobs; and may encourage more traditional use	

Table 8: Comparison of criteria scores for policy options

12. Recommendations

The results of the analysis favour an education program firstly, followed by incorporating best preventative practices into In-SHUCK-ch governance and operations. However the difference in scores between these options is minor. A sensitivity analysis (Appendix H) shows that even when different weights are given to the various effectiveness criteria, these two options continually score higher than the two treatment options, and are always close. These two options complement each other in that one is more effective in generating awareness, while the other is more effective in prevention. Consequently, I recommend that In-SHUCK-ch implement these two options in tandem. An education program alone will likely influence members to push for more direct prevention and control of invasive plants in order to reduce the threat of invasive plants on resources of cultural value. At the same time, incorporating prevention measures into the way In-SHUCK-ch conducts its business will involve education aspects since In-SHUCK-ch consults the community on major rule changes and projects in the territory. Since these two policy options are complementary, cost-efficiencies can be found by implementing both in tandem. As the literature and several interview participants emphasized, prevention is the most powerful tool against the threat of invasive species; more effective than control in the long-run. After these plants establish themselves it is much harder to stay ahead of their growth and get rid of them completely. The current record in IAPP of In-SHUCK-ch's territory shows that the density and distributive range of invasive plants is lower in respect to other areas of the province. This is due to the limited disturbance and development in the region. As development in the *tmicw* increases, there will be more opportunities for invasive plants to enter, establish and proliferate. If In-SHUCK-ch can establish a governance and business culture that acknowledges and considers the impact of invasive plants at the planning phase, In-SHUCK-ch will be in a unique position to actually deter the threat.

By educating members about the strain that invasive plants can have on the ability of the land and resources to sustain In-SHUCK-ch's unique culture, In-SHUCK-ch

may be able to incite members to participate in volunteer-efforts such as weed pulls, or to potentially garner support for expenditure on treatment programs. If such support is achieved, In-SHUCK-ch can then implement one of the treatment programs proposed, or some combination of the two approaches.

12.1. Implementation

Interview participants frequently tout the benefits of partnerships to increase capacity, share resources, and create cost efficiencies. Therefore it is recommended that In-SHUCK-ch foster collaborative relationships with either the SSISC or FVIPC (or both) to implement its chosen policy direction. It is in the interest of each of these regional invasive plant committees to partner with First Nations to close the jurisdictional gap that currently occurs in invasive plant management. By partnering with one of these organizations, In-SHUCK-ch can gain access to their educational materials and networks of experts and professionals who can offer advice. In addition, if In-SHUCK-ch has a representative on the board of one of these organizations it will be able to assert its interests in invasive plant policy to other jurisdictions in its traditional territory.

12.1.1. Short Term

In the short-term In-SHUCK-ch should focus on implementing the recommended policy option: designing and administering an invasive plant education program to all members. While workshops should be made open to all members, particular attention should be made to promoting the workshops to members who reside within the *tmicw* and actively harvest traditional resources. This sub-set of members is most likely to pass-by and/or interact with invasive plants. Ensuring that this group of individuals is knowledgeable in identifying invasive species and understands how to alter their own behaviour on the land to prevent spreading invasive plants increases In-SHUCK-ch's capacity to effectively prevent occurrence of and control invasive plants. Taking into account the barriers to behaviour change regarding invasive plants (Kubeck, 2008), an education workshop should cover the following topics and design features:

- What makes a plant invasive;
- How invasive plants can impact In-SHUCK-ch's traditional plants and resources, the land and ecosystems of the *tmicw*, and future economic opportunities;
- Examples of invasive plants known or suspected in the *tmicw*, including photographs and tips for members to identify them at different stages of the plant life-cycle;
- How invasive plants spread, and how human activity contributes to the spread;
- The positive and negative aspects of different types of control methods, emphasizing that not all plants can be effectively treated the same way. The workshop should allow discussion of the trade-offs between using chemicals versus allowing invasive plants to go untreated; and
- Simple preventative measures that individual members can take to avoid introducing and spreading invasive plants in the territory, explained in a clear, easy-to-understand way.

Regular newsletter and social media updates, with information such as how to identify specific invasive plant species, where to report invasive plant sightings, and prevention tips will help to continue invasive plant messaging and retain it in the collective conscience of In-SHUCK-ch members.

At the same time, In-SHUCK-ch should begin identifying where it can incorporate best preventative practices into its governance and operations. Firstly, In-SHUCK-ch should identify upcoming projects where elements of these best practices can be incorporated at the planning stage. Such projects would include new housing or building developments, road upgrades, and other infrastructure construction projects. In-SHUCK-ch should incorporate best prevention practices into the planning of their own projects, as well as during consultation with proponents. Best practices include washing vehicles to prevent transfer of plant reproductive material, and sourcing gravel from non-infested sites.

In-SHUCK-ch should identify all areas of policy development coming up on its agenda that could incorporate principles of invasive species prevention. This includes any policies related to economic development approval processes, as well as land and resource planning. After looking ahead, In-SHUCK-ch should then look back at already written policies, plans and operation processes, and identify how they could be modified

or updated to include best preventative practices. For example, In-SHUCK-ch has recently developed an Integrated Hazardous and Solid Waste Management Plan (part of a larger Environmental Management Plan), which identifies targets for composting and green waste diversion. Invasive plant best practices dictate that invasive plants should not be composted with other green waste, since seeds can remain in the soil. In-SHUCK-ch should update this plan to include this best practice.

12.1.2. *Medium to Long Term*

In the medium term In-SHUCK-ch should seek to conduct an inventory of invasive plants to better understand the scale of the problem, and where invasive plants are most prevalent in the territory. Inventory should be targeted at both high-traffic and high disturbance sites, as well as sensitive and culturally significant areas that should be protected. By conducting such an inventory In-SHUCK-ch can update the risk assessment with more reliable information. Having a more precise knowledge of which species are present and their level of distribution will give In-SHUCK-ch a better indication of the feasibility of controlling established populations. Further, by assessing the proximity to culturally significant and sensitive areas, In-SHUCK-ch will have a more dependent gauge of the potential impacts the existing species can cause.

This information will allow In-SHUCK-ch to determine if a treatment program is necessary, which approach is most appropriate for its goals, and the level of risk. In the medium term, In-SHUCK-ch can seek funding for treatment programs, by leveraging partnerships with regional invasive plant councils, and negotiating with other levels of government and proponents in the area. In the long-term, In-SHUCK-ch can implement a treatment program tailored to its needs.

Whichever treatment approach In-SHUCK-ch chooses - whether it be based on feasibility of control or protection of key cultural resources - it should establish measurable targets to assess the effectiveness and progress of the treatment plan. “Managers should communicate measurable progress to the community to maintain interest, demonstrate accountability and maintain trust” (Larson et al., 2011, p. 16).

Management of invasive plants is not a one-time activity. It will require ongoing commitment and dedication of resources to stay on top of these rapidly spreading species. By incorporating best preventative practices at all stages, from policy planning to operations, and in all departments, from natural resources to housing and public works, In-SHUCK-ch can situate itself ahead of these species, before they become an unmanageable problem.

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Appendices