# An evaluation of invasive species including Scotch Broom (*Cytisus scoparius*) in the Trincomali Nature Sanctuary to form future management and monitoring strategies.

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## Executive Summary

The Trincomali Nature Sanctuary (TNS) is a plot of land on Galiano Island owned by the Islands Trust Conservancy and is presently managed by Habitat Acquisition Trust. The TNS is a very significant piece of land because it is made up of many important ecosystems including over 400 meters of intact coastal bluff, a rare and distinctive ecosystem. The bluffs at TNS provide critical habitat for several species at risk and are considered one of the largest nesting colonies of Double-crested and Pelagic Cormorants, both of which are provincially listed species. Due to previous logging and disturbance the TNS is infested with many invasive species. However, the southern half of the sanctuary is less degraded with cedar and older growth forest still intact, whereas the northern half of the sanctuary shows more signs of disturbance from recent logging. Since taking over management of the sanctuary HAT has conducted yearly invasive plant removals as well as conducted two native species plantings. This project focused on mapping out five invasive plants (Scotch Broom, Canada/Creeping Thistle, Cutleaf Evergreen Blackberry, Foxglove and Rose Campion) within the TNS and then conducting an invasive species pull.

Line transects were conducted in the TNS with a Garmin GPS, first in the northern half of the sanctuary during July and August as not to disturb the nesting avian species. Then, in October after the nesting season had ended the southern section of the sanctuary was surveyed. Photo-monitoring was done for each area marked on the GPS to assist in future monitoring by HAT. From that, an ArcGIS was created depicting the abundance, location and density of invasive species throughout the TNS. The northern section of the TNS had more locations with invasive species due to it being more recently logged and disturbed. An invasive species pull was conducted in October along the coastal bluffs. This area had the most extensive amount of Scotch Broom and was a priority area for removal due to its ecological significance.

Future monitoring and management should include yearly visits to the TNS where monitoring of species (through photo monitoring) and invasive species pulls are conducted. If funds are available more native species plantings should be conducted where large areas of invasive plants are removed to promote regrowth of native species. With Scotch Broom being the most prevalent invasive species in the sanctuary long-term monitoring and management should be conducted for at least the next twenty years as it’s seed bank can survive in the soil for around twenty years.

# Table of Contents

Acknowledgements……...1
Executive Summary……..2
Table of Contents……..3
1.0 Introduction……4
1.1. Site Description……4
1.2. History of the Trincomali Nature Sanctuary……4
1.3. Current Use……..5
1.4. The Coastal Bluff Ecosystem…….……....6
1.5. Species at Risk…….……7
1.6. Rationale……..7
2.0 Project Objectives……...7
3.0 Methods……...8
3.1. Line Transects……..9
3.2. Photo Monitoring……...10
3.3. Invasive Species Removal……..10
4.0 Results…….....12
4.1. Invasive Species Removal……..12
4.2. GIS Map……13
4.2.a. GIS Map Results……...13
5.0 Monitoring and Management……14
5.1. Priority Considerations……...14
5.2. Invasive Species Best Removal Practices……..15
5.2.a. Scotch Broom……15
5.2.b. Canada Thistle……...16
5.3.c. Rose Campion……...17
5.4.d. Foxglove……18
5.5.e. Cutleaf Evergreen Blackberry……...19
5.3. Long-term Monitoring and Management……...19
6.0 References……22
7.0 Appendices……....24

# 1.0 Introduction

## 1.1. Site Description

The Trincomali Nature Sanctuary (TNS) is located in the middle of Galiano Island on the south western coast of British Columbia (Figure 1). It is approximately twelve hectares in size and is made up of more than 400 meters of intact coastal bluff ecosystem, one of the rarest and most sensitive ecosystems in the region.

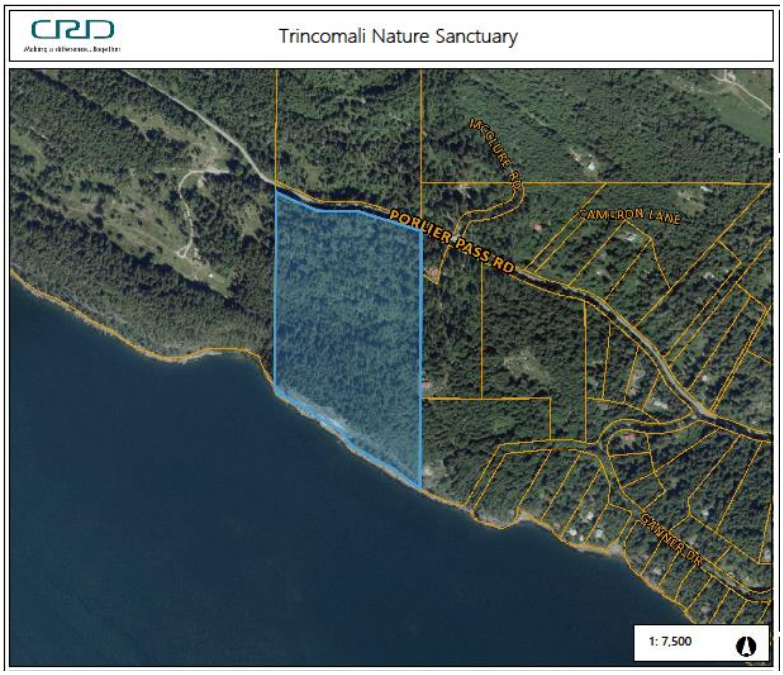


Figure 1. The Trincomali Nature Sanctuary on Galiano Island.

## 1.2. History of the Trincomali Nature Sanctuary

Before British Columbia was settled by Europeans, the TNS was likely used by the Aboriginal peoples, as many areas in this region were inhabited by the Lekwungen Nation. Later, long after Europeans settled in the area, a large plot about 150-200 meters in from Porlier Pass Road in the TNS was logged from 1994 to 2000 (this area is referred to as the "recently logged area" of the sanctuary). Currently, logging damage can still be seen in this part of the sanctuary (Habitat Acquisition Trust, Islands Trust Fund, & Searle & Associates, 2013).

The Islands Trust Conservancy (ITC) acquired the TNS in February of 2001 for the purpose of creating a nature sanctuary (Figure 1). When the land was acquired in 2001 a management plan and site inventory was conducted by Searle & Associates. From 2001 until 2009 the Wild Bird Trust was the management group for the TNS (Habitat Acquisition Trust et

al., 2013). Then, in 2009 the Habitat Acquisition Trust (HAT) signed a formal management agreement ensuring that long term management of the Sanctuary would continue and took over as the current management group. In 2013 the management plan and site inventory was updated by HAT. Since taking over management, HAT has been conducting extensive invasive species removals of Scotch Broom (*Cytisus scoparius*), English Holly (*Ilex aquifolium*), and Himalayan Blackberry (*Rubus armeniacus*) every year (Habitat Acquisition Trust et al., 2013). Additionally, HAT has implemented two plantings of native species (one in 2015 and one in 2017) in two of the largest areas to previously have broom (Figure 2).

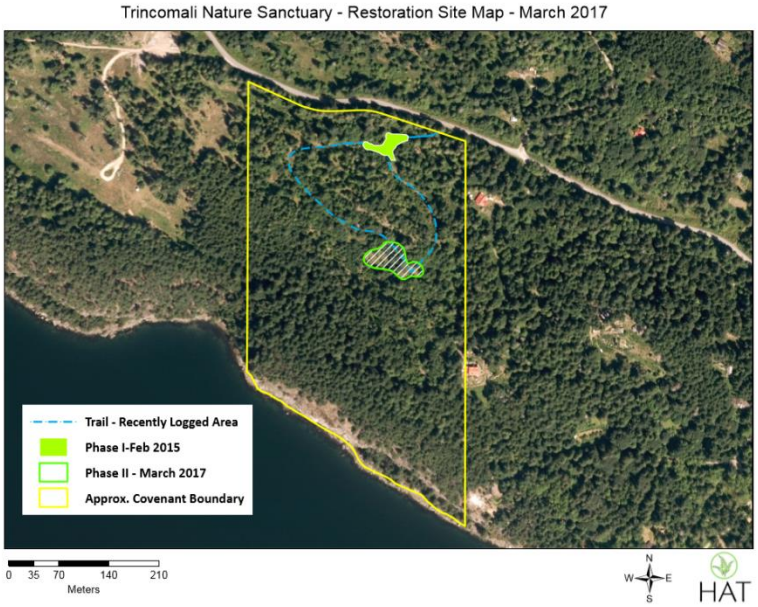


Figure 2. Two sites in the TNS that were replanted with native species after the invasive species were removed.

Fire also has a history within the TNS. Many tree scars can be found on the larger older trees within the sanctuary. In the winter of 2012, a controlled burn was conducted in the recently logged area of the TNS to dispose of a large accumulation of Scotch Broom that had been removed from the sanctuary during management that season (Habitat Acquisition Trust et al., 2013).

## 1.3. Current Use

Currently the site is rarely entered by the public. It is occasionally used by locals for hiking; however it is not heavily visited and likely sees less than twenty visitors per year (excluding HAT management) (Habitat Acquisition Trust et al., 2013). The lack of visitors to

the TNS helps preserve the ecosystem and prevent the disruption of the sensitive ecosystems the TNS encompasses.

## 1.4. The Coastal Bluff Ecosystem

Coastal bluff ecosystems are a rare distinctive ecosystem found within the TNS. They are made up of rocky shorelines, rocky islets and steep coastal cliffs (Habitat Acquisition Trust et al, 2013). Herbaceous species that reside in this ecosystem include: grasses, mosses, lichens and small shrubs (Ward et al., 1998). A distinct feature about this ecosystem is the presence of salt spray from the ocean. These ecosystems are quite rare and occupy less than 0.3% of east Vancouver Island and the Gulf Islands (Habitat Acquisition Trust et al, 2013). The coastal bluffs are such a rare and sensitive ecosystem due to their fragility, such as the lack of soil coverage these cliffs retain and how easily they can be disturbed (Ward et al., 1998). Additionally, these bluffs have a high level of biodiversity and contain specialized habitats only know to occur in these ecosystems (Ward et al., 1998). The coastal cliffs of these ecosystems are very valuable as they provide sheltered habitat for a variety of birds to nest and crevasses allow places for amphibians to hide/overwinter (Habitat Acquisition Trust et al., 2013).

The exposed cliff tops of the coastal bluffs are only covered by small grasses and shrubs which make them extremely susceptible to invasive species. The bluffs within the TNS are overrun with Scotch Broom, a shrub species that spreads rapidly and can have an extensive seed bank. Moreover, this species fast seedling growth rate and ability to reduce soil water availability make it a major threat to native species (Slesak et al., 2016). Scotch Broom also has nitrogen fixing nodes which allow the plant to enhance nitrogen levels in the soil which leads to decreases in plant species richness allowing for expansion of invasive species (Maron & Conners, 1996). The successful invasions of Scotch Broom into intact Garry Oak (*Quercus garryana*) ecosystems (such as the ecosystems on the coastal bluffs) make it a species of high concern with conservationists (Shaben & Myers, 2010).

Throughout the Gulf Islands habitat degradation and fragmentation has been accelerated by population and economic growth. This is why it is so important to prioritize protecting these sensitive ecosystems that are still intact as they encompass high levels of biological diversity (Habitat Acquisition Trust et al., 2013).

### 1.5. Species at Risk

The TNS has very specialized ecosystems that provide critical habitat for many species at risk. The coastal cliffs along the bluffs of the TNS provide nesting habitat to Double-crested Cormorants (*Phalacrocorax auritus*) which are a blue-listed species and Pelagic Cormorants (*Phalacrocorax pelagicus*) a yellow-listed species. It has been proposed by biologists that the TNS may be one of the most successful nesting colonies for these species in the Strait of Georgia (Trincomali Nature Sanctuary, 2018). Additionally, a pair Peregrine Falcons (*Falco peregrinus*), which are a red-listed species, nest near the coastal bluffs and the Ministry of Environment has been monitoring this pair of birds since 1980. The coastal bluffs and old growth Douglas-fir and Western redcedar forests provide critical habitat for this species.

Furthermore, the coastal bluffs along the TNS as well as along much of Galiano Island have been deemed potential suitable habitat for Sharp-tailed snakes (*Contia tenuis*) which are listed as a Federal and Provincial Endangered species.

### 1.5. Rationale

Since the management plan was last updated by the HAT in 2013, there has not been a full site inventory of invasive species in the TNS since then. This project focused on locating and mapping the remaining Scotch Broom in the area as well as Canada/Creeping Thistle (*Cirsium arvense*), Cutleaf Evergreen Blackberry (*Rubus laciniatus*), Foxglove (*Digitalis purpurea*) and Rose Campion (*Silene coronaria*). This will be done to create a GIS map showing the distribution of the invasive species to inform and assist the HAT in updating the current management strategy for the Sanctuary, designate priority areas for management and assist in restoration planning in the future. Overall, this work will help enhance the ecological integrity of the area and promote local species growth by determining priority areas for removal of the primary invasive species.

## 2.0 Project Objectives

The goal of this project is to determine the distribution of five selected invasive species: Scotch Broom, Canada/Creeping Thistle, Cutleaf Evergreen Blackberry, Foxglove and Rose Campion. Monitoring and management plans will also be determined from the ArcGIS Map

results showing the distribution of the selected invasive species. These goals will be accomplished though the following steps:

1. Identify the distribution of invasive species by running line transects through the TNS using a Garmin GPS to mark where all invasive species are located throughout the sanctuary.
2. Take photos at all sites invasive species are located for photo monitoring to aid in long term management.
3. Compile the data from the Garmin GPS of invasive species and create a GIS map showing the distribution of each invasive species throughout the Sanctuary
4. In partnership with HAT conduct an invasive species removal event with volunteers to help control the invasive species within the TNS.
5. Create a monitoring and management plan to support future ecological health of the TNS.

## 3.0 Methods

Before this project began permission was granted by HAT and the Island Land Trust to perform restoration as well as conduct vegetation surveys in the TNS. Due to the TNS being an important nesting area for avian species, especially along the coastal bluffs, data was only permitted to be collected in the northern section of the Sanctuary in July and August as to have a minimal effect on the nesting birds (Figure 3). Once avian nesting had ended data was collected in the southernmost portion of the sanctuary in October (Figure 4).


Figure 3. The Land Conservancy sign warning people to stay clear of important nesting areas in the TNS.

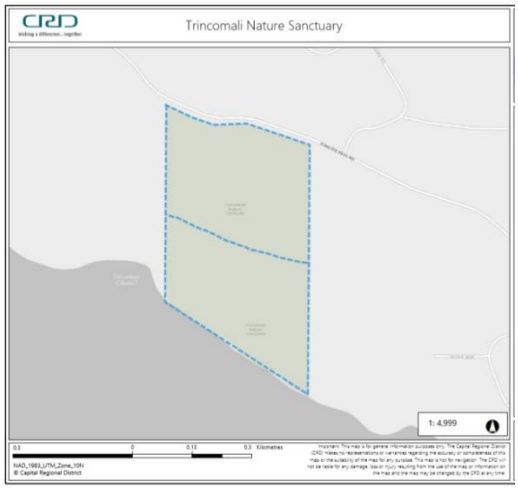


Figure 4. The TNS divided into two segments for data collection. The northernmost half of the TNS was surveyed in July and August and the southernmost half of the sanctuary was surveyed in October.

## 3.1 Line Transects

To begin, Google Earth Pro was used to map out the boundaries of the TNS using UTM coordinates. Then, start and end points for each transect were mapped out 15 meters apart on Google Earth Pro (running north to south) and the coordinates were entered into a Garmin GPS (Figure 5). The GPS along with a compass were then used throughout the TNS to walk along the line transects. While surveying each transect for invasive species, species were marked on the GPS anywhere within 7.5 meters of each side (east and west) of the transect. There were 14 transects surveyed in total (see Appendix 1 for transect data) and one transect (Transect 2) did not have any data points.


Figure 5. Line transects mapped out 15 meters apart on Google Earth Pro. Transect 14 is selected showing the start and end points.

## 3.2. Photo Monitoring

Photo monitoring took place between July and October of 2018. Photos were taken at all points where invasive species were located (Figure 6). A GPS waypoint was recorded with the photo number and the direction the photo was taken was documented. Photos were taken using a Panasonic point and shoot camera. Photo monitoring was done to provide a baseline for HAT in areas where they have not started removing invasive species yet. This will allow HAT to see what each site looked like in 2018 for future studies and management. See Appendix 1 for all photo monitoring data.

Figure 6. An example of the photo monitoring data from Transect 9. Photos are of data point F12 (See Appendix 1 for complete data information). Photo on the left was taken facing North and the photo on the left was taken facing South.

## 3.3. Invasive Species Removal

On October 20, 2018 volunteers along with myself and Wendy Tyrell of HAT conducted an invasive species removal at the TNS. The main species targeted for this event was Scotch Broom on the southernmost bluffs of the sanctuary (See Figure 7). Removal began on the southwestern side of the bluffs and the group worked their way east as the removal progressed.

Volunteers were directed through demonstration the best way to removal Scotch Broom by Wendy Tyrrell. For smaller plants this involved holding the plant close to the base while using your other hand to hold down the soil while pulling the plant out. For larger plants, plants were cut at the base or sawed under the soil as to sever the root ball. Both of these methods caused the least amount of disturbance to the landscape and avoided having loose soil which would lead to increased erosion on the bluffs. Volunteers were given gloves, clippers, shovels and saws to assist in removing the invasive species (Figure 8). Plants were then piled together

and thrown off the bluffs into the ocean as the terrain and remoteness of the location made taking the plants off site for disposal not possible.

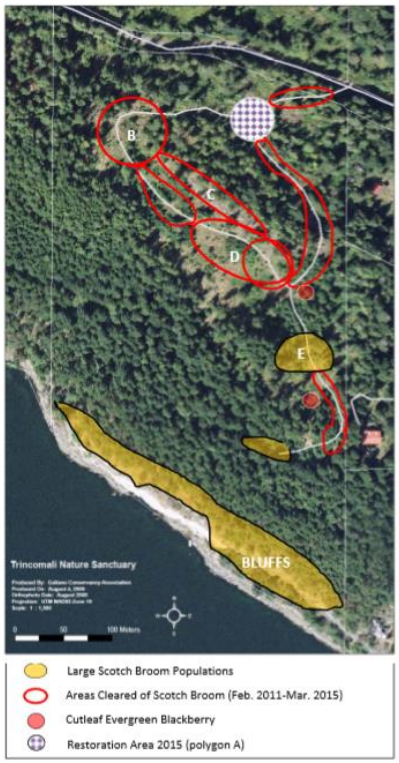


Figure 7. TNS map of where Scotch Broom was targeted for the invasive species pull on the southern bluffs.

Figure 8. Some of the tools used during the invasive species removal event.

# 4.0 Results

## 4.1. Invasive Species Removal

The Invasive species removal team was made up of eight people and the event ran from around 12pm – 4pm on October 20, 2018 (Figure 9). This resulted in the removal of almost all accessible Scotch Broom from the southern bluffs of the TNS. Due to limitations from the rough terrain we were unable to remove Scotch Broom from the step edges of bluffs due to safety hazards (Figure 10).

It is clear that long-term management will be necessary to control Scotch Broom in all areas of the TNS. Specifically to completely remove Scotch Broom from the bluffs it would require a team to rappel down the cliffs and remove it with the proper safety equipment which we did not have access to or the training for.

Figure 9. Volunteer group that conducted the invasive species pull on October 20th, 2018.

Figure 10. Scotch Broom growing on the step edges of the bluffs.

## 4.2. GIS Map

### 4.2.a. GIS Map Results

Figure 11 below shows all the invasive species mapped within the TNS during this project. The majority of species were located in the northernmost section of the sanctuary (Figure 4). This is likely due to logging and disturbance that occurred in the northern section of the TNS. The southernmost section of the TNS only had a few areas with invasive species throughout it and then a very large section of Scotch Broom right along the bluffs where the main extent of our volunteer restoration pull occurred. Individual points indicate that invasive species were within a 15 meter by 15 meter area and polygons indicate that the invasive species went beyond the 15 meter by 15 meter area. See tables in Appendix 1 for the quantity and density of species mapped in the TNS. Overall, as seen on the GIS map Scotch Broom was located in twelve locations, Canada Thistle in ten locations, Foxglove in eighteen locations, and Holly in one location; however the one Holly plant was removed during invasive species pull. Rose Campion and Cutleaf evergreen blackberry were not located within the TNS during this project. Due to the vast amount of Scotch Broom on the bluffs Scotch Broom was the most dominant invasive plants within the TNS.

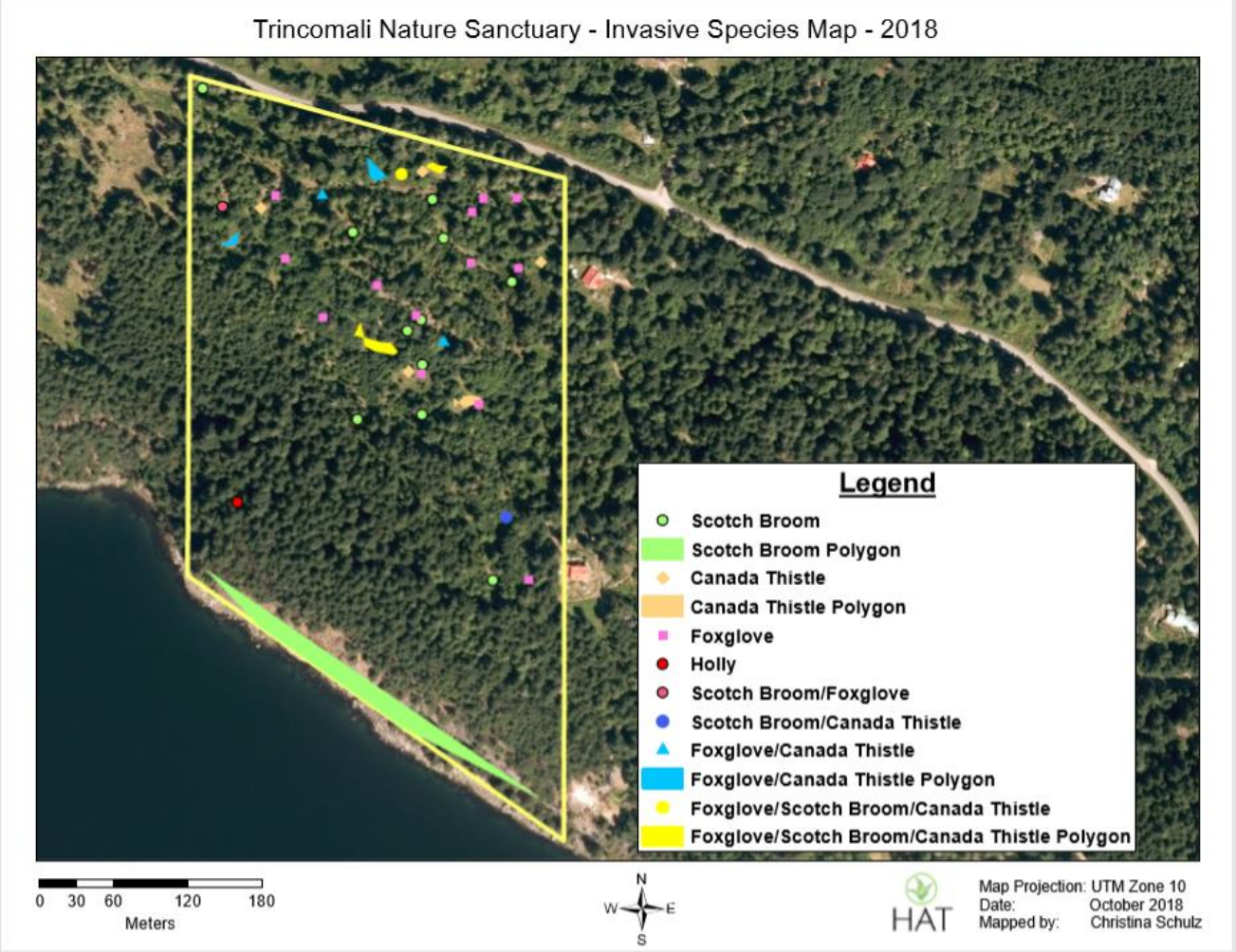


Figure 11. Map of Invasive Plants surveyed at Trincomali Nature Sanctuary.

# 5.0 Monitoring and Management

## 5.1. Priority Considerations

The Garry Oak Ecosystem Recovery Team (GOERT) recommends considering three major factors when creating a plan for removing invasive species from an area. Firstly, consider the density of the invasive species in the area that the removal is taking place. They advise that each invasive species is divided into three zones. Zone 1 is for isolated plants and lower density edges of species around larger and denser invasive species areas (GOERT, 2003). Zone 2 is for medium density invasive species areas and Zone 3 for high density areas(GOERT, 2003). They then recommend first containing the invasive species (to prevent further spread) and then working towards reducing its numbers (GOERT, 2003). Therefore, they recommend Zone 1

being the first priority and Zone 3 being the last as it will require the largest amount of time and resources. Secondly, prioritize areas within the zones that have the highest ecological value. These include areas where sensitive species are being threatened by the invasive species (GOERT, 2003). Lastly, take into account the accessibility of the landscape. Using these three factors will help prioritize the most important areas for efforts to be focused on for management within the TNS (GOERT, 2003).

Additionally, this project does not recommend herbicide use when looking at best removal strategies for the five invasive plants in the TNS as it is a protected land and herbicides are not used in these sensitive areas.

## 5.2. Invasive Species Best Removal Practices

### 5.2.a. Scotch Broom

Scotch Broom is a deciduous shrub that can grow up to three meters in height. Flush (seedlings) are green and spindly whereas older mature plants have more woody stems with green branches. These plants have yellow flowers and the seed pods are a black/purple colour (Figure 12). Scotch Broom is a prevalent invasive species in southwestern British Columbia and is extremely concentrated at the southern end of Vancouver Island. This species prefers open sites and disturbed areas and grows best in areas that have good draining and sandy soils.

Figure 12. Scotch Broom with seed pods.

Once Broom has established in an area it has been found to take around twenty years or longer to completely deplete the seed bank, making its management a large undertaking and

long-term project (GOERT, 2003). Scotch Broom management requires many repeated efforts because of regeneration of seeds already being in the soil, therefore it is recommended to first focus efforts on areas that can easily be accessed for repeated management (Garry Oak Ecosystem Recovery Team and Nature Conservancy Canada, 2002).

Many studies have been conducted on the best practices for removal of Scotch Broom. GOERT recommends removing species between November to January when there are no flowers or seeds present (GOERT, 2003). They recommend hand pulling small plants and using clippers for larger mature plants to avoid soil disturbance. Additionally, using a saw to damage the stems of any cut plants will hinder regrowth of the plant. Alexander & D'Antonio (2003) conducted a study in coastal California and found that the most effective way to remove Scotch Broom was repeated hand pulling or burning the area. Furthermore, studies have shown that the repeated hand pulling of Scotch Broom results in the greatest number of native species returning to the area after removal (Alexander & D'Antonio, 2003).

### 5.2.b. Canada Thistle

Canada thistle is a widespread invasive species throughout British Columbia. Canada thistle can be identified by its white to purple flower heads (about 1 cm in diameter) in clusters of 1-5. Plants range from 0.3-2 meters in height and leaves are long and narrow with spiny edges (Figure 13). This invasive species can have major effects on ecosystems due to its ability to spread rapidly and form dense patches which causes decreases in native species (Invasive Species Council of British Columbia, 2014).

Figure 13. Canada Thistle.

Management of Canada thistle can be difficult due to it creeping root system. This means that pulling or digging out plants does not effectively control this species. The most effective times of year to remove Canada thistle is in the spring. This is because in the spring when the plant is at bud to early bloom stage it has used much of its energy reserves in the root system and does not have as much energy left for regrowth (Scott, L. & Robbin, K., 1999). Mowing can be effective if done over several years to the point where the root system is depleted (Scott, L. & Robbin, K., 1999). Additionally if hand-pulling or hand-cutting is done multiple times throughout the season it can be effective at depleting the root system. However, this method is better used for areas with low density of this species as it is very time consuming (Jacobs, Sciegienka, & Menalled, 2006).

### 5.3.c. Rose Campion

Rose campion is an invasive species from Europe and Asia introduced as a garden cultivar with silvery grey stems and deep pink or white blossoms which can grow up to 2-3 feet tall (Figure 14). This species cannot survive harsh winters which make the temperate coast of BC an ideal place for this specie to grow.

Figure 14. Rose Campion flowering.

There are no known best practices for removing rose campion. Due to the knowledge that this species spreads through seed dispersion it is recommended that plants are pulled before they flower and that when pulling all or most of the roots are removed from the soil. Rose campion is

listed by the GOERT as a lower priority invasive species and does not require as intensive management as other species.

### 5.4.d. Foxglove

Foxglove is a toxic biennial plant that is fatal to animals who consume even small amounts (IPCW Plant Report, 2017). It survives best in disturbed habitats, colonizing disturbed soils and forming dense patches causing native vegetation to be displaced (IPCW Plant Report, 2017). It can only reproduce by seed and in areas with disturbed soils the seeds establish more readily (Figure 15).

Figure 15. Foxglove plants dying off with seed pods ready to be released.

Hand pulling stocks is one of the most effective controls however gloves must be worn as the leaves of this plant are poisonous (IPCW Plant Report, 2017). When the soils are moist in the spring the stalks and roots can easily be pulled from the ground. Pulled plants with flowers or seeds must be removed from the area as they will continue to mature and release seeds even after removal (IPCW Plant Report, 2017). Mowing and clipping are not very productive as these plants can bloom again in mid-late summer. Mowing can only be effective if the work is repeated several times throughout the season (IPCW Plant Report, 2017). Additionally, fire should not be used in management of Foxglove as the smoke from burning the leaves is toxic and can cause injury to workers (IPCW Plant Report, 2017).

### 5.5.e. Cutleaf/Evergreen Blackberry

Evergreen Blackberry, also referred to as Cutleaf Blackberry is a European species that was introduced for fruit production and has become a highly invasive species that is difficult to control (Figure 16). This species has an extremely deep root system which can make management a long process.

Figure 16. Cutleaf Evergreen Blackberry. Photo from https://www.nwcb.wa.gov/weeds/evergreen-blackberry

Hand pulling is an effective removal method for small infestations and is most effective between August and October. Workers need to make sure they are removing all roots from the soil as larger roots left in the soil can re-sprout. For larger patches, mowing several times per year over a number of years can be an effective method for killing this plant (Washington State, n.d.). Additionally, for larger patches mowing along with digging up the roots is much more effective than mowing on its own and has been shown to have greater success at controlling this species (Washington State, n.d.). However, in sensitive areas the use of shovels and digging up the soil should to be avoided if possible. The best practice is cutting plants back repeatedly over the seasons and working to reduce plant vitality.

## 5.3. Long-term Monitoring and Management

A long-term restoration plan for the TNS will be necessary due to the vast quantity of invasive species within the TNS and their seed banks that remain in the soil. Scotch Broom will be the species which will require the most management due to its vast presence and long lived seed bank which can at times take up to twenty years or more to deplete. Table 1 shows an overview of all five invasive species with management timelines as well as best tactics for removal of these species.

Table 1. Overview of monitoring and management plan for invasive species in the TNS.

| Invasive Species | Monitoring and Management Timeframe | Best Time of Year to Remove | Best Method for Removal |
|---|---|---|---|
| Scotch Broom | > 20 years | November - January | - Hand-pulling for smaller plants<br>- Clippers/Saws for larger plants |
| Canada Thistle | 5 – 10 years | Spring | - Mowing for high density areas<br>- Hand-pulling for low density areas |
| Foxglove | 5 – 10 years | Spring | - Hand-pulling |
| Rose Campion | < 5 years | Late Winter/Early Spring (Before plant flowers) | - Hand-pulling before plant begins flowering |
| Cutleaf Evergreen Blackberry | 5 years | August - October | - For small infestations hand-pulling<br>- For large infestations mowing along with digging up the roots |

Many studies have shown the positive impacts that removing Scotch Broom has on native vegetation. Shaben and Myers (2010) saw that the presence of Scotch Broom in their test sites depleted phosphorus levels in the soil overall leading to decreased native plant growth. Additionally, Scotch Broom enriches the nitrogen availability in the soil which is more favourable to non-native species and restricts the growth of native plants trying reestablish in the area (Haubensak & D'Antonio, 2006). This is why active management of the TNS is necessary to monitor and control new invasive species that may invade new sites where invasive species have been removed from.

Recommendations for long-term management include yearly visits to the TNS with volunteers during the late fall to early spring for invasive plant removal. This time of year is recommended as to not disturb the nesting avian species as well as it is the most desirable time to remove Scotch Broom (no flowering or seeds) which is the most widespread invasive species within the TNS as seen in Figure 11. Additionally, if funds are acquired additional native species plantings (such as the two previously done in 2015 and 2017) should be implemented to enhance the habitat where invasive species have been removed and to help promote native species growth. This will be especially important in the areas where large amounts of Scotch Broom are removed. This is important because without the replanting of native grass species or shrubs it is

likely that these sites will be invaded by other undesirable invasive species (Alexander & D'Antonio, 2003).

Management of the TNS will be an ongoing project due to the remote location and terrain in the area. As outlined by the GOERT (2003), primary restoration efforts should focus on removing invasive species from the bluffs (an area of high ecological significance) as well as outlying areas throughout the sanctuary as to control these species and prevent further spread. A problematic area in the TNS is the steep rocky bluffs along the coast which create a barrier for volunteers when conducting invasive species pulls. Complete eradication of all visible Scotch Broom has never been possible as the Scotch Broom grows on steep edges and sides of the cliffs. This allows the seed bank to continually grow and will mean yearly management of the TNS. If a grant was acquired, hiring professionals to rappel down the bluffs and remove some of the broom that is not accessible to the volunteers would be beneficial. This would need to be done carefully and in the late fall so nesting seabird habitat is not disturbed. If this became possible it would be a step towards getting more control over the Scotch Broom population at TNS. Disposal of invasive species should continue to be either burning biomass on site (with the supervision of the local volunteer fire department) or taking species off site to dispose of properly.

This projects invasive species pull focused on removal of the Scotch Broom near the southern coastal bluff ecosystem and due to time limitations it did not allow for work in other area of the TNS. Future management should focus on removal of invasive species located throughout the northern sections of the TNS (shown on Figure 10 of the GIS map). This will help control the spread of invasive species to other areas within the TNS and help enhance the ecological integrity of the sanctuary.

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## 7.0 Appendices

### Appendix 1. TNS Transect Data

Table 1. Transect 1 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Additional Notes |
|---|---|---|---|---|---|---|---|
| SB10 | Scotch Broom | 1 | In Seed | Healthy | 101-0864 | E | |
| CT02 | Canada Thistle | 2 | In Seed | Healthy | 101-0866 | S | Partially shaded area |
| F05 | Foxglove | 10 | In Seed | Dying | 101-0867 | W | |
| FCT03 | Foxglove | 15 | In Seed | Healthy | 101-0868 | SW | |
| | Canada Thistle | 50 | 50% in seed, 50% in bloom | Healthy | 101-0869 | NW | |
| F06 | Foxglove | 30 | In Seed | Dying | 101-0870 | E | |

Table 2. Transect 3 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Additional Notes |
|---|---|---|---|---|---|---|---|
| SBF01 | Scotch Broom | 10 | Flush | Healthy | 101-0934 | W | |
| | Foxglove | 5 | In Seed | Dying | 101-0935 | N | |

Table 3. Transect 4 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Additional Notes |
|---|---|---|---|---|---|---|---|
| F07 | Foxglove | 15 | In Seed | Dying | 101-0871 | E | |
| CT03 | Canada Thistle | 30 | 75% in seed, 25% in bloom | Dying | 101-0872 | E | |
| Poly 2 FCT | Canada Thistle | 20 | 67% in seed, 33% in bloom | Mostly Dying | 101-0873 | S | Photo Waypoint: Photo P2 FCT |
| | Foxglove | 15 | In Seed | Dying | 101-0874 | E | |
| Holly01 | Holly | 1 | Not in seed | Healthy | 101-0945 | NW | Plant is about 6.7 meters tall, removed during invasive species removal |

Table 4. Transect 5 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Additional Notes |
|---|---|---|---|---|---|---|---|
| FCT04 | Foxglove<br>Canada Thistle | 30<br>7 | In Seed<br>In Seed | Dying<br>Dying | 101-0875<br>101-0876 | E<br>W | |
| F08 | Foxglove | 1 | In Seed | Dying | 101-0877 | N | Shaded area lots of Stinging nettle |
| F09 | Foxglove | 13 | In Seed | Dying | 101-0878 | NE | Area partially shaded |

Table 5. Transect 6 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Additional Notes |
|---|---|---|---|---|---|---|---|
| SB11 | Scotch Broom | 15 | Not in Seed | All Healthy Except 1 | 101-0879<br>101-0881<br>101-0882 | E<br>W<br>N | Area mostly open about 15% tree cover. Lots of flush starting to grow<br>Mostly Flush, 3 Adults |

Table 6. Transect 7 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Additional Notes |
|---|---|---|---|---|---|---|---|
| Poly CT F | Canada Thistle<br>Foxglove | 40<br>12 | In Seed<br>In Seed | Healthy<br>Dying | 101-890<br>101-891 | E<br>S | |
| F10 | Foxglove | 2 | In Seed | Dying | 101-0893 | W | Small plants |
| Poly SB CT F | Scotch Broom<br>Canada Thistle<br>Foxglove | 45<br>20<br>10 | Not in seed or flowering<br>In Seed<br>In Seed | Healthy<br>Healthy<br>Half Dying | 101-0894<br>101-0895<br>101-0896<br>101-0897 | SE<br>E<br>N<br>S | Photo Waypoint: Photo 1 SB CT F Poly<br>Photo Waypoint: Photo 2 SB CT F Poly |

Table 6. Transect 8 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Additional Notes |
|---|---|---|---|---|---|---|---|
| SB12 | Scotch Broom | 5 | Not in seed or flowering | Healthy/Dying | 101-0898 | NW | 1 Healthy, others dying |
| CT04 | Canada Thistle | 30 | In seed with a few flowers | Healthy | 101-0899<br>101-0900 | N<br>W | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SB13 | Scotch Broom | 15 | Not in seed or flowering | Healthy | 101-0901<br>101-0902 | E<br>SE | 2 Larger, rest flush |
| F11 | Foxglove | 20 | In seed | Dying | 101-0903 | N | |
| SB14 | Scotch Broom | 40 | Flush | Healthy | 101-0904 | N | |
| CTSBF 01 | Canada Thistle<br>Scotch Broom<br>Foxglove | 15<br>10<br>4 | In Seed<br>Not in seed or flowering<br>In Seed | Healthy<br>Healthy<br>Dying | 101-0906<br>101-0908 | E<br>N | Near replanting cages |

Table 7. Transect 9 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Notes |
|---|---|---|---|---|---|---|---|
| CT05 | Canada Thistle | 3 | Not in seed or flowering | Healthy | 101-0909 | NE | |
| Poly F SB CT 01 | Foxglove<br>Scotch Broom<br>Canada Thistle | 25<br>10<br>5 | In seed<br>Not in seed or flowering<br>Not in seed or flowering | Dying<br>Healthy<br>Healthy | 101-0910<br>101-0911 | W<br>E | Photo Waypoint: Photo 1 F SB CT Poly<br>Photo Waypoint: Photo 1 F SB CT Poly |
| SB15 | Scotch Broom | 15 | Not in seed or flowering | Healthy | 101-0912<br>101-0913<br>101-0914<br>101-0915 | W<br>N<br>E<br>S | 1/2 Large plants 1/2 small |
| F12 | Foxglove | 15 | In seed | Dying | 101-0916<br>101-0917 | S<br>N | |
| SB16 | Scotch Broom | 15 | Flush | Healthy | 101-0918<br>101-0919 | E<br>S | |
| SB17 | Scotch Broom | 2 | Previously Cut Back | Healthy | 101-0920 | S | |

Table 8. Transect 10 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Notes |
|---|---|---|---|---|---|---|---|
| Poly CT 01 | Canada Thistle | 30 | In Seed | Healthy | 101-0921 | E | Photo Waypoint: Photo CT Poly |
| FCT05 | Foxglove<br>Canada Thistle | 4<br>1 | In Seed<br>In Seed | Dying<br>Healthy | 101-0922 | E | |
| SB18 | Scotch Broom | 1 | Not in seed or flowering | Healthy | 101-0923 | SW | In the middle of a patch of Oregon Grape |

Table 9. Transect 11 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Notes |
|---|---|---|---|---|---|---|---|
| F13 | Foxglove | 11 | In Seed | Dying | 101-0924 | E | |
| F14 | Foxglove | 12 | In Seed | Dying | 101-0927<br>101-0928 | W<br>N | Just outside of Poly CT 01 |

Table 10. Transect 12 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Notes |
|---|---|---|---|---|---|---|---|
| F15 | Foxglove | 1 | In seed | Healthy | 101-0927 | N | |
| F16 | Foxglove | 10 | In seed | Dying | 101-0928 | N | |

Table 11. Transect 13 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Notes |
|---|---|---|---|---|---|---|---|
| F17 | Foxglove | 2 | In seed | Dying | 101-0929 | W | |
| F18 | Foxglove | 15 | In seed | Dying | 101-0930<br>101-0931 | SW<br>NE | |
| SB19 | Scotch Broom | 1 | Not in seed or flowering | Healthy | 101-0932 | S | Looks previously cut |
| SBCT01 | Scotch Broom<br>Canada Thistle | 7<br>12 | Not in bloom | Healthy<br>Healthy | 101-0937<br>101- | W<br>N | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Not in bloom | | 0938 | | |
| SB20 | Scotch Broom | 25 | Few seeds | Healthy | 101-0940<br>101-0941<br>101-0942<br>101-0943 | W<br>N<br>E<br>S | |

Table 12. Transect 14 Data

| GPS ID | Species | Number of Plants | Stage | Health | Photo # | Direction Photo Taken | Notes |
|---|---|---|---|---|---|---|---|
| CT06 | Canada Thistle | 25 | In Seed | Healthy | 101-0933 | E | |
| F19 | Foxglove | 7 | Leaves no flowers | Healthy | 101-0946 | N | |