Understory Biodiversity Plantings within Canopy Gaps in the King Creek Watershed of Haida Gwaii

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Abstract

This project involved understory plantings at five sites in canopy gaps created in a riparian spacing prescription in the upper Yakoun watershed of Haida Gwaii. Five species were selected as high potential for understory restoration (Highbush cranberry (*Viburnum edule),* Western yew (*Taxus brevifolia),* Pacific crabapple (*Malus fusca),* Devil's club (*Oplopanax horridus),* Stink currant (*Ribes bracteosum)* based on three criteria (Haida cultural value, ability to reach free growing height (>1.5m), and berries used and dispersed by wildlife). If these species can become successfully established they may contribute to landscape level diversity through seed dispersal processes. A monitoring program was designed to measure the success of the understory plantings and to develop an understanding of natural revegetation of the shrub layer in canopy gaps. Canopy openness was measured with smartphone spherical photography at the centre of each gap to track changes in light availability in the gaps through time. This project aims to explore the opportunity created by canopy gaps to mitigate adverse impacts of introduced Sitka black tailed deer (*Odocoileus hemionus sitkensis)* on understory richness, by expanding existing silviculture methods to include important understory species.

Introduction

Haida Gwaii is an offshore temperate rainforest archipelago and the home of the Haida people. The remote location of the islands has resulted in many unique or endemic plant and animal populations. The main threats to these populations are loss of habitat through logging and a myriad of introduced species with heavy browsing habits, primarily Sitka black tailed deer, Roosevelt Elk (*Cervus canadensis roosevelti)*, and beaver (*Castor canadensis)*. Introduced browsing mammals have in many locations decimated the shrub layer (Martin and Daufresne 1999, Martin et al. 2010), with a heavy impact on culturally significant species (Stockton 2004) (Pojar 2008). The combination of logging and browsing have effectively removed many sensitive shrub species from the ecosystem. The presence of deer in particular has been directly linked to loss of mid and understory species, and a lack of songbird abundance and diversity, as many songbirds require shrub species for habitat and foraging (Allombert et al 2010). Sooty grouse (*Dendragapus obscurus*) populations are low in areas with high deer browsing, negatively affecting the endangered Northern Goshawks (*Accipiter gentilis)*, which feed on grouse (Doyle 2006).

Taan Forest Products is a Haida owned logging company which is Forest Stewardship Council certified and works to achieve a high standard of sustainability for the Haida Nation. For the past several years Taan has been working on a silviculture based riparian restoration program in the Yakoun and Mamin watersheds, involving the reduction of stems per hectare and increasing structural complexity, with the goal of improving habitat for salmon (*Oncorhynchus spp.)*, northern goshawk (*Accipiter gentilis)*, saw whet owl (*Aegolius acadicus brooksi)*, marbled murrelet (*Brachyramphus marmoratus*), black bear (*Ursus americanus)*, and other species. Taan's prescription for restoring old growth attributes in King Creek has resulted in a large increase in canopy gaps in the riparian forest.

Canopy gaps are an important characteristic of coastal old growth forests, as these forests are shaped by extreme wind events and large windthrown trees as the primary disturbance event. In the ecologically similar Clayoquot Sound old growth,, roughly 56% of the forest area was influenced by either canopy gaps or extended canopy gaps (Lertzman et al 1996). Canopy gaps are defined as vertical openings within the canopy through which light reaches the forest floor, and extended gaps are spatially larger, defined by the stems of the trees bordering the gap (Lertzman et al 1996). All but the most shade tolerant vegetation species depend on canopy gaps to become established. After a time the canopy closes in with conifers, light dependant species die back, and shade tolerant species continue to grow more slowly.

Berry production is positively associated with increased light availability in small scale disturbed areas (Dawe et al. 2017),(Turner 2021). Canopy gaps create an important niche for understory berry plants, which are important food sources for wildlife. As canopy gaps are created in Taan's silvicultural restoration project, there is an opportunity to increase plant diversity, enhance wildlife forage and habitat, and learn more about the important role that canopy gaps play in forest succession. Long term monitoring will show how long it takes for a canopy to close in with conifers, and how understory communities respond to light availability. This is important to determine if shrub planting can meet management goals in that timeframe.

A number of plants have been identified by the Haida Nation as Haida Traditional Forest Features (HTFFs) because of their cultural significance and are afforded some level of protection under the Haida Gwaii Land Use Objectives Order (2014). Most of these plant populations nonetheless have low abundance due to browsing pressure. These populations have not been enhanced by cultivation in recent times. HTFF plant species are known to have been culturally important to the Haida Nation, and to have once existed in greater numbers (Turner 2021). Nine out of 15 HTFFs are shrub layer plants which also provide wildlife value, so they are useful species for increasing ecological function and understory richness and structure. Cultural importance ascribed to species is often related to their

ecological function (Christancho and Vining 2004) and ecological restoration should acknowledge the interrelation between cultural diversity and ecological diversity (Cuerrier et al 2015).
In areas without excessive deer browsing, stand reduction prescriptions have resulted in an increase in understory species richness (Newton et al. 1996),(Bailey et al. 1998). However on Haida Gwaii it is likely that only common species such as salal (*Gaultheria shallon)* and red huckleberry (*Vaccinium parvifolium)* will increase, and deer browsing will keep growth to a minimum. A ten-year study of deer exclosures on Haida Gwaii observed that while understory abundance increased dramatically in exclosures, species richness was not significantly affected, and culturally important plants were absent from nearly all exclosures (Mackenzie 2009). This suggests that seed dispersal processes have been disrupted, possibly because culturally important plants are so rare on the landscape. This project looks to achieve two goals:

Goals and Objectives

Goal #1: Restore seed dispersal processes by establishing and protecting hotspots of diverse and high value understory berry producing shrubs.

> **Objective:** Develop a successful silvicultural methodology for planting high value understory species for unique conditions on Haida Gwaii.
>
> **Objective:** Increase understory diversity by establishing 60 individuals of 5 underrepresented shrub species in 6 different canopy gaps in King Creek.

Goal #2: Design and implement monitoring in the canopy gap sites.

> **Objective:** Collect baseline vegetation data.
>
> **Objective:** Collect baseline canopy openness data in six canopy gaps.
>
> **Objective:** Develop a plan for ongoing monitoring of the six sites.

Biodiversity Enhancement (Goal #1)
The project aims to use canopy gaps created by existing thinning prescriptions to enhance understory habitat by planting locally rare shrub species suited to the site series and protecting them from deer browse. The results would demonstrate feasibility for shrub plantings in gaps, a technique which could have implications for wildlife management (eg. sooty grouse, songbirds) and culturally significant plant management.

Post-Work Monitoring (Goal #2)
Site description data collected in gaps will help improve our knowledge of canopy gaps, and how certain characteristics (species composition, light availability, wildlife presence) change through time following anthropogenic disturbance. Canopy openness and shrub cover by species will be important measures for understanding how canopy gaps develop following disturbance. Monitoring will also be

important to evaluate success of understory planting methods. It is expected that deer will suppress the growth of unprotected shrub species, and that within 10-15 years canopy closure will restrict understory growth, with management implications. If understory plantings can use this window to become established, they may be able to grow above deer browse and contribute to seed dispersal processes.

Study Area

The study area is located within the riparian area of the King watershed of Graham Island (Figure 1). King creek flows east out of the San Cristobal range of Graham Island, into the Yakoun river, which flows north into Masset Inlet. Riparian forests are typically highly productive and rich in species diversity (Van Pelt et al 2006),(Smith 2005). The unique microclimates and structural attributes in riparian forests make them vulnerable to logging (Brosofske et al. 1997). Historic logging in the project area has resulted in even aged over dense stands of western hemlock (*Tsuga heterophylla)* and Sitka spruce (*Picea sitchensis)*. Streams are lacking large woody debris and bank stabilizing large trees. Within even aged stands, a lack of canopy complexity negatively impacts the threatened endemic goshawk and marbled murrelet, as they require an open and structurally diverse canopy to travel (both) and forage (goshawk) within the forest (Doyle 2006),(Ralph 1995).
Because of deer overbrowsing on Graham Island, many understory species are largely absent from both the landscape and the scientific literature. Understory communities are poorly detailed in the CWH BEC site series descriptions, because from the time of the earliest scientific studies these plant communities had already been severely impacted. Only the earliest timber cruising reports from the islands make note of the "luxuriant growth" of the understory (Gregg 1923). This project focuses on canopy gaps as sites for understory restoration.
Six canopy gap sites were selected in the King Creek riparian area for understory planting and vegetation monitoring (Figure 2). The sites are at an elevation of approximately 70m, and fall within TFL 60. These sites are within an area that was part of a riparian thinning prescription which took place in 2021, aiming for a variable density from 650-750 stems per hectare. The prescription resulted in a number of canopy gaps which are believed to be useful for the purpose of establishing a diverse understory. The sites were selected because of their position in a riparian buffer zone, adjacent to a forest reserve zone, and in proximity to several known HTFF locations, which demonstrated the viability of the habitat for these species. The sites are reasonably accessible from QC56, a deactivated logging road.

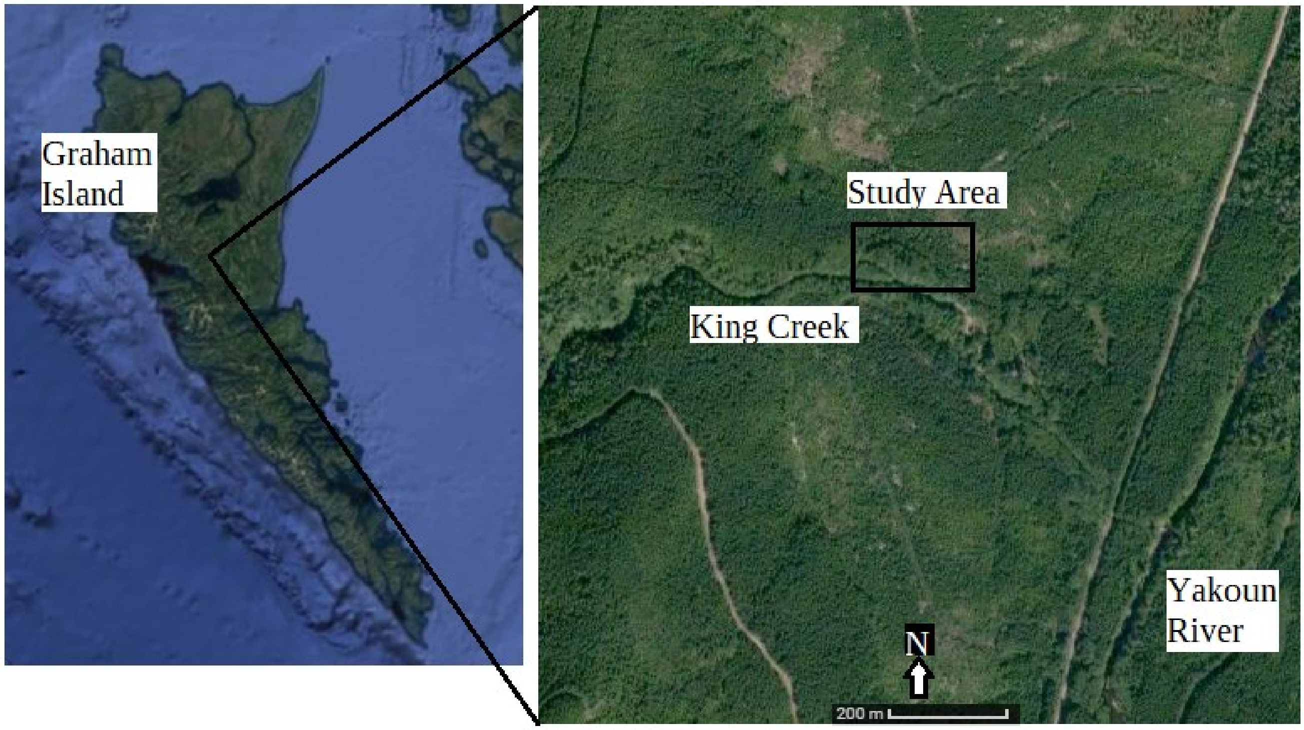

Figure 1: King Creek Study Area

Methods

Species Selection Criteria

Five understory species were selected for the project, based on three criteria:

1. **Haida cultural value:** Haida Traditional Forest Features were identified in the Haida Gwaii Land Use Objectives Order as either Class 1 or Class 2 depending on their importance and/or rarity. All plants used in this project are Class 1 or Class 2 HTFFs. Plants of Haida Gwaii (Turner 2004) was also a valuable resource in learning about the cultural significance of some of these plants.

2. **Ability to grow above deer browse height (>1.5m):** All the species used in this project have the ability to grow to at least 2m, which is important for the long term sustainability of the plants and their seed dispersing processes.

3. **Berries used and dispersed by wildlife:** Berries will have direct and indirect effects on species of concern such as Sooty grouse, black bear, and northern goshawk. Herbivory on berries will result in seed dispersal processes that may increase landscape level vegetation diversity.

Five species were selected using these criteria: Highbush cranberry (*Viburnum edule),* Western yew (*Taxus brevifolia),* Pacific crabapple (*Malus fusca),* Devil's club (*Oplopanax horridus),* and Stink currant (*Ribes bracteosum).* More information on the characteristics of these plants is available in Appendix 1.

Pre Work HTFF Observations

Several of the species selected for planting have been mapped by Taan Forest near the King Creek study area in adjacent old growth forest (*Ribes bracteosum*, *Opplopanax horridus,* and *Taxus brevifolia).* *Malus fusca* was also found in the watershed during initial site visit. *Ribes bracteosum* and

Opplopanax horridus were found growing high on cliff faces above the creek, and *Taxus brevifolia* was also growing on steep slopes in the canyon. It was my intention to dig soil pits near these species occurrences to gather data on their site preferences, but the conditions made it impossible. *Malus fusca* was found growing in an edaphic gap where poor drainage and standing water are preventing larger trees from establishing. These few occurrences in such marginal habitats emphasize the need for restoration, and also demonstrate that these species are suited to the climatic and terrain conditions found in the fluvial benches of King Creek.

Site Layout

Sites were measured and laid out with the two longest perpendicular axes within the projected canopy gap. Gap size can be estimated from these two axes using the formula for an ellipse (3.14xLxW/4), where L= longest axis, and W= longest perpendicular axis (Runkle 1992). The L and W axis were also used as vegetation transect lines, and bearings for photo point monitoring from plot centre. Only the projected canopy gap was mapped, but planting included microsites within the extended canopy gap.

Figure 2: Six Canopy Gap Sites. Pink and black line shows 2021 thinning prescription boundary. Red line shows stream channel.

Site assessment

Study Area Assessment

The study area falls within the Coastal Western Hemlock Wet Hypermaritime subzone, in the Submontane variant of the Biogeoclimatic Ecosystem Classification (BEC) system. The study area includes mid and upper floodplain site series, as well as zonal forest at the upper edge of the slope (Figure 3). The study area has a southern aspect and an elevation of approximately 70m. Sitka spruce dominates the canopy, and large remnant spruce stumps indicate this was the pre-disturbance overstory. Soils are fluvial, including gravel and silt in benches, with some coarse fragments in upper slope, and Mor humus forms in the uppermost zonal site where conifers are dominant. Lower sites have mixed conifer and deciduous canopies, red alder indicating wet soils. Soils are especially rich on fluvial benches, with spruce much larger than the zonal forest above. The shrub layer is nearly absent, and the herb layer is dominated by Oregon beaked moss (*Kindbergia oregana)*, step moss (*Hylocomium splendens)*, and lanky moss (*Rhytidiadelphus loreus)*.

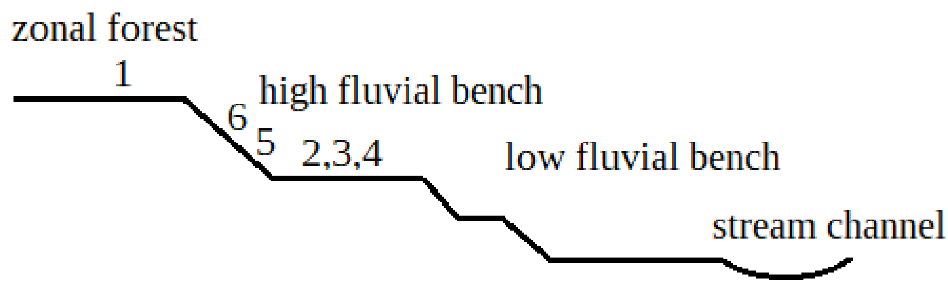

Figure 3: Profile view of study area. Numbers indicate canopy gap planting sites

Shrub layer sampling

Shrub layer cover was sampled so that future monitoring can show how the understory regenerates naturally on these sites. The L and W transects were used to sample shrub layer vegetation using the line intercept method. All shrub species and trees <4m were recorded when their projected cover crossed the transect line. This was done at the same time the site layout was being done, and the tape was left on the ground so the observer could walk along and measure shrub occurrences.

Canopy measurements

Canopy gap measurements were taken at each site so that future monitoring can show precisely how light availability changes in these sites through time as the canopy develops**.** The canopy cover at each site was measured using hemispherical smartphone photography and Gap Light Analyzer(GLA) software (Frazer 1999). 360 degree panorama photos were taken at plot centre of each site using the Google Streetview app (Figure 4). Care was taken to keep the camera in the same position, and some of the photos were retaken until an accurately stitched panorama was created. Hemispherical images (Figure 5) were extracted from spherical panoramas using a command line on the Image Magick program (Arietta 2022). Hemispherical photos were binarized on the Gap Light Analyzer program using default parameters (Figure 6). The GLA offers the option of site specific weather, radiation, and cloudiness inputs, but default parameters were used to facilitate reproducibility of the measurements. The Gap Light Analyzer program was used to calculate the canopy openness of each site using pixel counts. A detailed set of instructions for this methodology can be found in the *Forestry* article by Andis Arietta in the References section (2022).

Figure 4: Spherical Panorama captured by smartphone using Google Streetview app

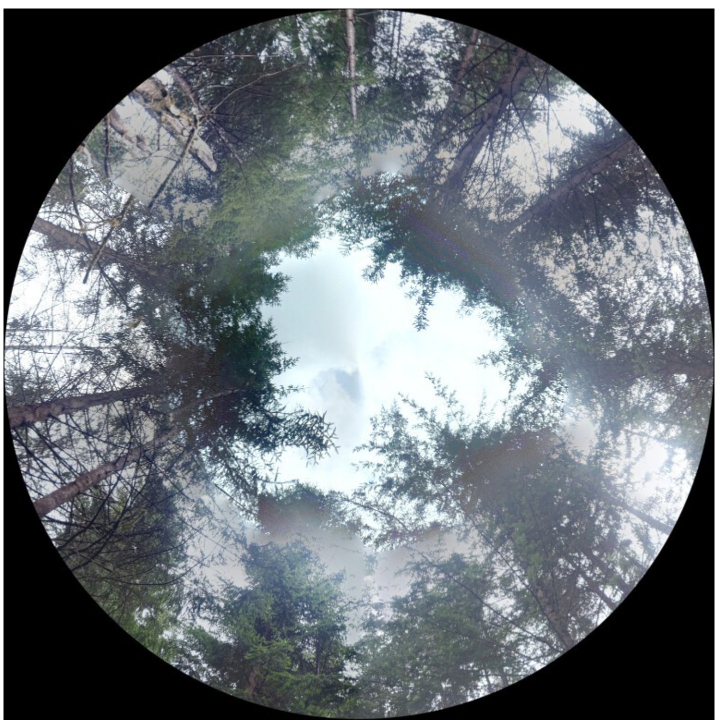

Figure 5: Hemispherical photo extracted using Image Magick program

Figure 6: Binarized Image created with Gap Light Analyzer program

Planting methods

Nursery stock was sourced in 1 gallon pots and transported to the site (Figure 7). While more cumbersome than the plugs used commonly in silviculture, the added size was considered to be beneficial in giving the plants a head start. Microsites were selected within the sites which offered rich soil or abundant moisture. Moss and duff were screefed with cork boots to clear a growing site approximately 30x30cm. A fir stake was pounded in and secured to a steel welded wire enclosure to protect the shrub from deer browse (Figure 8). The browse protectors were of 25cm diameter, 5' in height, and cut from a 100' roll on site. Care was taken to avoid air gaps and position the root crown of the plants level with the soil height. Planting took place in the spring rains of May to encourage successful establishment.

Figure 7: Author with planting bags

Figure 8: Western yew with browse protector

Results and Interpretation

Site #	1	2	3	4	5	6	Mean	sx
Gap Size (m^2)	40.29	59.22	42.96	197.11	61.3	36.46	72.89	61.71
Canopy Openness %	29.45	33.18	25.8	44.79	42.76	29.91	34.32	7.72
Shrub cover (%)	7	10.4	0	0	26.5	0	7.31	10.38

Table 1: Table 1: Data collected for Gap Size, Canopy Openness, and Shrub Cover

Understory Cover

The shrub cover in the six sites was low, and entirely absent from half the sites (Table 1). Mean shrub cover was 7.31%. The absence of the shrub layer on Haida Gwaii has been well documented (Martin and Daufresne 1999, Martin et al. 2010). Shrub cover on the west coast of Vancouver Island was observed to be correlated with stand age, as canopy gaps create light conditions favorable for understory growth (Gerzon et al. 2011). The same study found an average shrub layer cover percentage of more than 80% in old growth stands.

Understory Composition

Shrub layer species richness was low within all six canopy gap sites. Only four taxa were observed, both during line intercept surveys and site observations (Figure 9). Shrubs were defined as any vegetation with understory life history or conifers in the shrub layer (<4m). Understory composition was dominated by conifers (86.7%). This is consistent with the vegetation tables for site series 112 (Banner et al. 2014), which only list *Vaccinium spp.* (>70% constancy) and rarely *Rubus spectabilis* (25-50% constancy) in the shrub category, as well as *Tsuga heterophylla* and *Picea sitchensis* in the Regen category. Shrubs were mostly located on the ground, although some were growing on logs. A particularly large *Vaccinium* was observed growing on a stump just outside Site 2. Line intercept data can be found in Appendix 3.

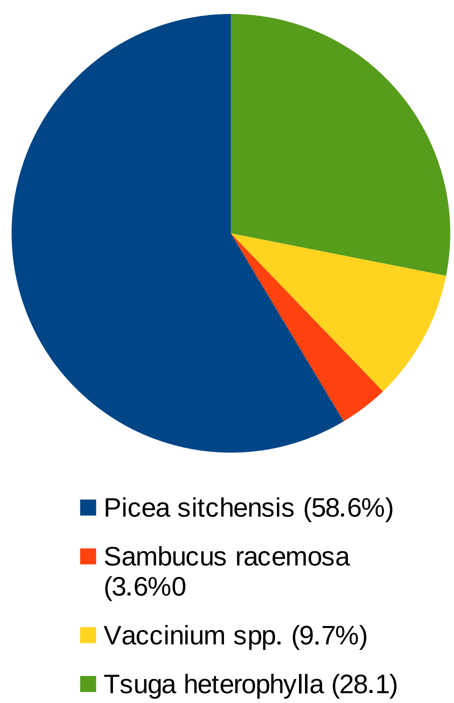

Figure 9: Understory species composition in canopy gap sites. Data was sampled using line intercept transects

Gap Characteristics

Gaps ranged in size from 36.46 m^2 to 197.11 m^2, with a mean area of 72.89 m^2 and a standard deviation of 61.71 m^2. Gaps were all created by hand felling of Red alder (*Alnus rubra).*

Canopy openness ranged from 25.8% to 44.79%, with a mean openness of 34.32% and a standard deviation of 7.72%. Although the sample size is too small to be statistically significant, these results appear to reflect the positive correlation between gap size and canopy openness which other researchers have observed (Van der Meer and Bongers 1996). Gap size should not be understood as static or steadily decreasing with age or "closing in". In this ecosystem, wind is the primary disturbance event, and will often continue to modify and expand gaps for several years after they are created. Canopy gaps created on Lyell Island were modified by natural wind events for several years, increasing variation in light levels closer to old growth light variation levels (Collings 2008).

Understory Planting Results

A total of 60 shrub individuals were planted in six canopy gaps in the upper fluvial benches of the King Creek. The soil appeared to be rich and it is expected that most of the plants will do well. The positions of all planted shrubs were mapped in a diagram of each site, and each was flagged with an identifying code. Each plant was measured (height and width), and its condition was noted. Height was defined as the highest branch or fork in main stem. 50 plants were considered healthy, 9 were considered fair, 1 was considered poor. Plants not considered healthy were mostly on account of foliar damage or wilting from transportation stress.

Monitoring

Monitoring will increase our knowledge of the needs of understory species and the feasibility of enhancing their populations in canopy gaps. Monitoring will also contribute to our understanding of how anthropogenically created canopy caps develop over time.

Planted Shrub monitoring

The next visit to the site will occur at the end of the growing season of 2022 to assess survival and growth rates of planted shrubs. Height and width will be measured again, and condition will also be noted. This is also the time to maintain browse protectors if needed. It is not expected that any planted shrubs will have reproductive structures in 2022, but these structures should be noted and their quantities estimated if present in subsequent growing seasons. If there are significant differences in growth rates from site to site then growth rate may be tested for correlation with gap size, canopy openness, or other site conditions. Later stage monitoring should also make observations of any wildlife feeding at the sites.

Shrub layer natural regeneration

The line intercept shrub layer sampling is repeatable and should be sampled every two years to better understand natural regeneration of understory in canopy gaps. A total of 24 photo points were also recorded, 4 from each plot centre along each transect bearing. These will show broad scale changes to the conditions of each site, including vegetation regeneration.

Canopy openness monitoring

Canopy openness can be measured in subsequent years using the methodology described above. It should occur at the same time of year to minimize differences in leaf development.

Discussion and Recommendations

Canopy Gap Light Characteristics

Six canopy gaps were surveyed for light availability, shrub cover, and shrub composition. Hand felling of Red Alder in riparian areas results in canopy gaps of various sizes, which can be efficiently measured with smartphone spherical panorama photography. This technique may provide accurate measurements of canopy closure over time, if photos are taken at the same time of year from the same location and the same methodology is followed. Canopy closure information could be important for managers to plan additional thinning treatments, or to design future understory planting prescriptions that take advantage of light availability following disturbance. Canopy gap creation projects have been undertaken on Haida Gwaii before in 2010, but an opportunity for understanding long term effects was lost because of lack of monitoring (Collings 2012). If canopy gaps in King Creek can be effectively and efficiently monitored in the long term through spherical panorama photography from permanent sample plots, there is an opportunity to better understand the complex gap phase dynamics in these forests, and their effects on undergrowth.

Canopy Gap Understory Characteristics

The understory is either sparse and homogenous or entirely lacking from newly created canopy gaps in the study area. The browsing effects of introduced Sitka black-tailed deer on Haida Gwaii are well documented, but more information is needed to understand the relationship between canopy disturbance and understory development in the presence of high browsing pressure. Higher understory cover is associated with old growth forests in similar ecosystems, so as riparian thinning prescriptions restore old growth stand structure it is expected there will be an increase in shrub cover. However, understory composition in the study area was dominated by conifer regen (86.7%), and only two shrub species were observed, one of which only had one occurrence. Ongoing monitoring is recommended to better understand if the increased light availability created by thinning prescriptions can have a positive outcome on natural regeneration and species diversity in the understory.

Opportunities for Understory Management

The planting methods used for this project were dissimilar from standard silvicultural practices in several ways. The plants were of a larger size than most nursery stock used in forestry operations (1 gallon pots vs. plugs). Many of them were grown on island with local seed or cuttings. The browse protectors used were of welded wire construction for increased longevity, and a wider diameter for lateral plant growth. If understory prescriptions were scaled up it is possible that traditional plastic browse protectors could be used, which also can provide benefits of a warm microclimate. However lateral growth, fruiting structures, and pollinator access could be restricted in traditional browse protectors, which are important for seed dispersal processes.

Some of the techniques that were used are more common in gardens or orchards than silvicultural operations. Indeed, forest gardens have been cultivated on the northwest coast for millennia by Indigenous peoples, with resulting ecosystems that are more diverse and abundant than adjacent areas (Armstrong et al 2021). It may be that within the heavily depleted understory of Haida Gwaii's forests is an opportunity to work more closely with the management of edible and medicinal shrub species to increase accessibility of these plants for the Haida people. Especially in riparian corridors which are protected from timber harvesting operations, there is potential for canopy gaps and understory populations to be managed together for long term social and environmental benefits.

Deer free islands in the archipelago can provide reference ecosystems for coastal areas, but mid elevation sites lack pre browsing references. Rather than accept the current state of the understory as a baseline, there is an opportunity for land managers to explore restoration potential of culturally and ecologically important understory species. Through careful monitoring, this project may begin to provide a baseline of information for understory management on Haida Gwaii. While projects of this scale will not transform the overbrowsed understory into their former condition, they may offer valuable genetic repositories for the future and opportunities for education, engagement, and inspiration.

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Appendix 1: Selected Species Profiles

Highbush Cranberry (*Viburnum edule)*
Skidegate Haida: **hlaayaa hlk̲'a'ii**
Masset Haida: **hlaayaa hlk̲'a.aay**


Figure 10: Highbush Cranberry Photo: Delena Rose 2011

A shrub species that grows in moist forests, forest edges, and streambanks, Highbush Cranberry has opposite leaves and smooth reddish grey bark. It spreads by seed and rhizomatously, grows to a height of 3.5m and produces clusters of 2-5 red berry-like drupes at approximately 5 years of age. Berries remain on the limbs into winter and provide food for overwintering birds (Bails 2016). Songbirds and grouse feed on the berries and disperse the seeds (Vierrick and Little 1972).
This shrub "used to be more common in Haida Gwaii, and the berries were eaten in large quantities" (Turner 2021). The berries were highly prized, and are the food most frequently mentioned in Haida stories (Swanton 1905b, 1908b).

Western yew (*Taxus brevifolia)*
Skidegate Haida: **hlG̲iid**
Masset Haida: **hlG̲íid**

Figure 11: Taxus brevifolia Photo: CJ Earle


Evergreen shrub to small tree (2-15m). Papery reddish bark on trunk that is often fluted, twisted or gnarled. Bright red seed cups appear like huckleberries, but the seeds are poisonous to humans. The fruit cups are eaten by many species of songbirds including the Townsend's solitaire, varied thrush, and hermit thrush (Johnson and Simon 1987). Seeds are commonly dispersed by birds (McCune and Allen 1985). Western yew is a slow growing understory tree in moist mature forests. Yew trees responf favorably to canopy gaps created by falling debris, which promotes layering of the stems when the tree is struck (McCune 1983). The reddish tight grained wood is elastic, durable, and rot resistant, making it valuable for a number of woodworked items including bows, handles, wedges, halibut hooks and spoons. "Berries" were consumed by the Massett people, and the bark was used medicinally (Turner 2021).

Pacific crabapple (*Malus fusca)*
Skidegate Haida: **k'anhl'l**
Masset Haida: **k'ayanhla**

Shrub or small tree (2-12m). Bark is rough and fissured, armed with sharp thorns. Toothed and lobed leaves are green in spring, turning orange in fall. White flowers and orange-red apples with a tart flavor, becoming sweeter after frost. Crabapple lives in a variety of habitats including moist woods, swamps, creeks, beaches, and estuaries, and are generally shade intolerant, thriving on edges and disturbance sites. Formerly an important food for the Haida, the fruit were boiled and placed in cedar boxes covered in water for storage. The hard wood was also used for various handles and digging sticks (Turner 2021).

Figure 12: Pacific Crabapple Photo: Native Plants PNW

Figure 13: Devil's Club Photo: Pfly

Devil's club (*Oplopanax horridus)*
Skidegate Haida: **ts'iihlinjaaw**
Masset Haida: **ts'iihlanjaaw**

A sprawling shrub (1-3m), thick stems are armed with large irritating spines. Large green leaves are lobed and spiny on underside. The stems have an agreeable and medicinal odor. White flower clusters, and bright red berries. Found growing in moist woods, especially seepage sites and streams. It is shade tolerant and associated with mature forests and riparian areas. Devil's club growing near streams provide shade for salmonid eggs and fry. The abundant clusters of berries are favored by bears (DeMeo 1989). A medicinal and spiritual plant for the Haida, Devil's club is used for skin and hair medicine, and also protection from evil and illness (Turner 2021). Early timber cruising reports from Haida Gwaii in the 1920s and 30s mention the luxuriant stands of devil's club found at that time (Gregg 1923)(Hopkinson 1931).


Figure 14: Stink Currant   Photo: Walter Siegmund

Stink currant (*Ribes bracteosum)*
Skidegate Haida: **GalGun xil**
Masset Haida: **Gal.un hlk'a.aay**

An erect deciduous shrub growing to 3m, with a skunky smell and large green lobed leaves. Long clusters of white flowers, blue-grey edible berries with a whitish bloom. Stink currants grow in moist woods, streambanks, and thickets at low to subalpine elevations. The berries are an important food source for songbirds and bears and germination improves after passge through the digestive system (Traviset and Willson 1997). The berries were traditionally eaten by the Haida, and are still eaten today. The shrub is also used medicinally (Turner 2021).

Appendix 2: Shrub Plantings Measurement Data

Table 2: Shrub plantings measurements and obeservations of condition. Height is measured from base to highest branching point, width is maximum spread of foliage.

Site #	Plant label	Plant height (inches)	Plant Width (inches)	Condition (healthy, fair, or Poor)	Comment
1	HC1	8	5	H	
	PC1	17	7	H	
	DC1	21	11	F	Wilted leaves
	SC1	10	5	F	Minimal foliage
	WY1	6	6.5	H	
	DC2	28	6	F	Leaves wilted
	PC2	20	8	H	
	SC2	6	7	H	
	WY	9	6	H	
	HC	6	13	H	Minimal foliage
2	WY1	5	7	H	
	PC1	20	14	H	
	WY2	4	8	H	
	DC1	18	5	H	Missing leaves
	SC1	8	4.5	F	Leaf damage
	HC1	9	9	H	
	DC2	30	9	F	wilted
	HC2	8	10	H	
	SC2	7	6	H	
	PC2	21	4	H	
3	DC1	33	7	F	Foliar damage
	SC1	8	6	H	
	HC1	8	13	H	
	PC1	22	7	H	
	PC2	19	4	H	
	WY1	5	7	H	
	HC2	11	8	H	
	DC2	25	8	F	Foliar damage
	WY2	8	5	H	
	SC2	10	6	H	
4	PC1	13	5	H	
	WY1	5	10	H	
	WY2	3	6	H	
	HC1	7	8	H	
	WY3	3	5	H	
	HC2	10	6	H	
	PC2	19	5	H	
	SC1	4	3	H	
	SC2	8	9	H	
	DC1	23	7	H	
5	HC1	6	7	H	
	SC1	12	5	H	

WY1	3	6	H	
SC2	5	4	H	
DC1	23	1	L	No foliage
PC1	26	10	H	
HC2	5	5	F	Minimal foliage
PC2	17	9	H	
DC2	29	6	F	wilted
WY2	5	8	H	
DC1	25	2	H	
HC1	8	7	H	
WY1	4	5	H	
PC1	23	6	H	
PC2	15	4	H	
WY2	6	6	H	
PC3	34	3	H	
SC1	9	4	H	
HC2	4	5	H	
SC2	9	9	H	

Appendix 3: Line Intercept Data

Site #	Line length(m)	Bearing	*Vaccinium spp.*	*Tsuga heterophylla*	*Sambucus racemosa*	*Picea sitchensis*	Total Shrub Cover (%)
1	4.5	330°					7.2
	3.1	240°					
	2.8	60°	.8m	.25			
	4.2	150°					
2	6.3	360°			.3		10.2
	5.8	90°				1.5	
	2.9	180°					
	2.7	270°	.01				
3	3.4	360°					0
	2	90°					
	3.8	180°					
	5.6	270°					
4	13.5	200°					0
	3.2	290°					
	7.6	20°					
	8.7	110°					
5	9.2	40°		2.1		4.4	33.5
	3.2	130°					
	4.5	220°					
	2.5	310°					
6	6.4	300°					0
	3.5	30°					
	2.2	120°					
	1.9	210°					