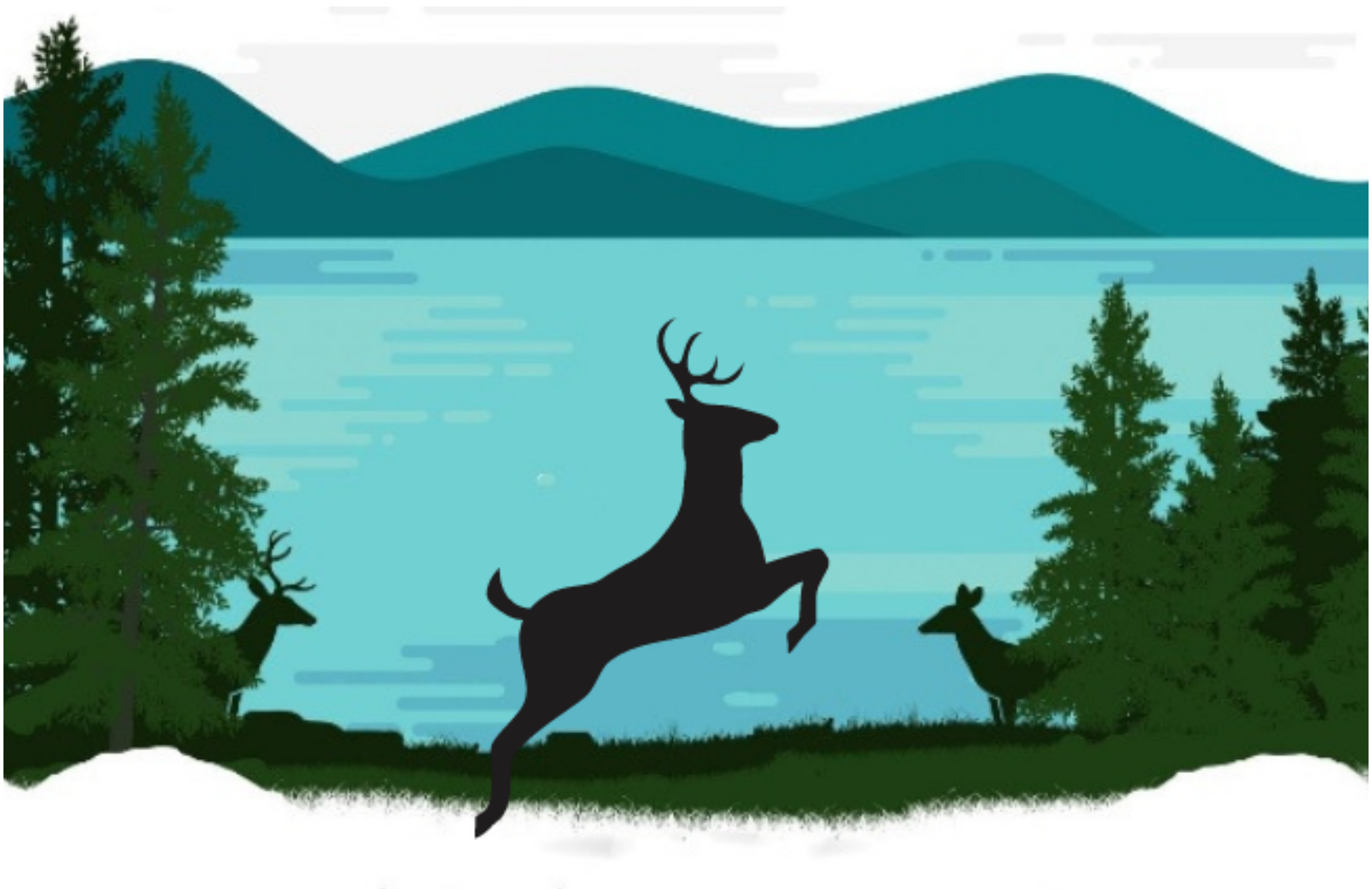
Hyperabundant Deer:

Making a Case for Monitoring and Management



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Abstract

Overbrowsing by hyperabundant ungulate populations influence the density and abundance of palatable flora and serve as a driver of local biodiversity decline. The population of native black-tailed deer (*Odocoileus hemionus*) to Galiano Island have been driven to hyperabundance as a result of the lack of a predator species in the community, as well as movement away from hunting deer as a food source. At this high density, black-tailed deer are capable of shaping the vegetation structure of forest ecosystems and initiating trophic cascades, impacting species interactions throughout the ecosystem. One of the current challenges to the Galiano Conservancy Association (GCA) and the success of restoration projects on the Millard Learning Centre property is the browsing pressure introduced by the high density of deer, yet deer population management remains a contentious issue within the Galiano community. Some experimental measures are in place, such as deer exclosure plots, which have had observational success but have not been evaluated using the collected data. Our project reviews and redefines the research focus and methodologies involved with the impacts of hyperabundant deer in order to support a clear future direction for the GCA. To accomplish this, we have completed three main goals: 1. Conducted a review of past research and monitoring for both black-tailed deer population management and the impacts of overbrowsing on the property; 2. Defined a research question and methodology for future use by the GCA; 3. Developed resources that can be used by the GCA to educate visitors and the community on the challenges associated with hyperabundant ungulate populations. Our review points to promising work in expanding the use of current methods, as well as recommends alternative methods used in the literature.

1.0 Introduction and Context

1.1 Geographical Location

Galiano Island, located within the Southern Gulf Islands is a long, narrow island, and the driest in the Gulf Island chain. The climate of Galiano Island is classified as warm-summer Mediterranean climate (Csb) under the Köppen climate classification system, characterized by cool, wet winters and warm, dry summers. Similar to the other Gulf Islands, the rain shadow effect of the Olympic and Vancouver Island mountains, and the moderating effects of the ocean, are the dominant influences on the regional climate (IslandsTrust, 2013). Galiano Island lies in the heart of the Salish Sea and the Coastal Douglas-fir zone. This island is distinctive due to its natural ocean upwelling with protection from severe storms, and its comparatively dry climate in the midst of temperate rainforest. (GCA, N.D).

1.2 The Galiano Conservancy Association

The Galiano Conservancy Association (GCA) is located on the traditional territories of the Penelakut First Nation and Hul'qumi'num speaking peoples. Formed in 1989 as an instrument for community-based acquisition, management and conservation of land and habitat, the GCA is a community based non-profit society and registered charity dedicated to "To preserve, protect and enhance the quality of the human and natural environment" on Galiano Island. (Figure 1; GCA, N.D.).

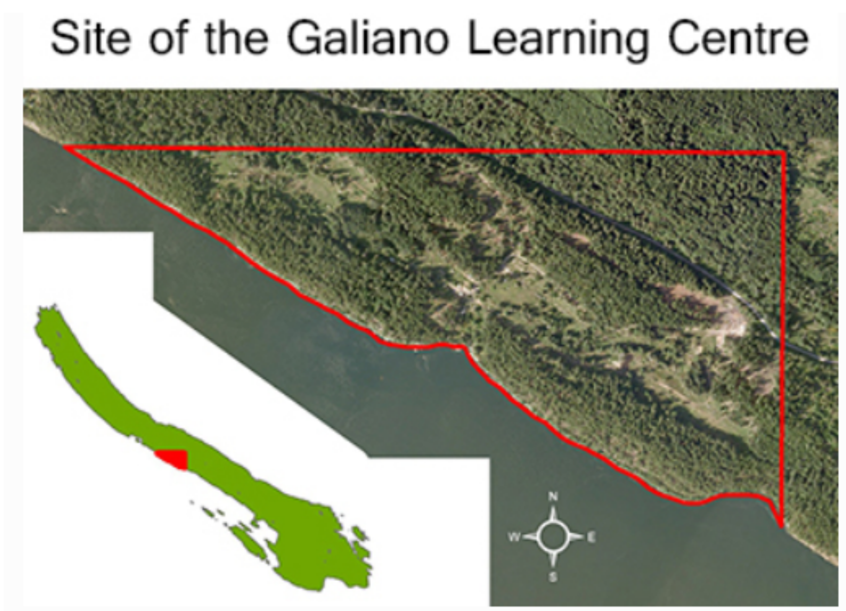

Figure 1: Site of Millard (formerly Galiano) Learning Center. Part of the protected Mid-Galiano Conservation Network (GCA, N.D.).

When colonists and settlers came to Galiano Island they brought with them an intensive approach to land use that resulted in diminishment of ecological integrity and displacement of Indigenous cultural practices. Agriculture, logging, mining, fishing and urbanization continue to transform the South Coast of British Columbia, which is now one of the most densely populated regions in Canada (GCA, N.D).

The GCA is developing and applying restoration methods to conserve biodiversity and preserve ecological integrity on some of Galiano Island's protected lands. The GCA, the Nature Conservancy of Canada and the Islands Trust Fund has jointly protected roughly 4000 square meters of forestland throughout the Island. This property has become part of a continuous protected area known as the Mid-Galiano Conservation Network (IslandTrust, 2013). The Millard Learning Centre property represents 0.76 square kilometers and features over two kilometers of waterfront, two seasonal streams, a working food forest farm, wetlands, and over 0.3 square kilometers of mature forest.

1.3 The Ecology of Black-tailed Deer

Black-tailed deer (*Odocoileus hemionus*; Figure 2) are a native herbivore species to the Southern Gulf Islands of British Columbia (Martin et al., 2011). Despite being characterized as a prey species to other large mammals, black-tailed deer inhabiting this region have become hyperabundant, meaning that human-induced impacts have allowed a species to increase to unnaturally high population levels (Keenleyside et al., 2012). Several factors driven by settler activity have contributed to the rapid growth of deer populations in this area. With the removal of large-bodied predators dating as early as the late 1800's, hunting of deer has been required to maintain historically low densities (Martin et al., 2011). Reductions in hunting through regulation and sentiment changes, the loss of predation by wolves (*Canis lupus*) and cougars (*Felis concolor*), and fluctuations in land use leading to more early seral stage vegetation that provides a food source for deer (Wingard et al., 2019) has led to a hyperabundant deer population with limited opportunities for population control. As a result, increased deer activity in this area threatens to perpetuate the ongoing biodiversity crisis.

Figure 2: Black-Tailed Deer native to British Columbia

Browsing pressure can drastically impact ecosystem structure and vegetation communities when herbivore populations become hyperabundant as a result of direct and indirect anthropogenic activity (Arcese et al., 2014). Observed increases in black-tailed deer amongst the Southern Gulf Islands of British Columbia has led to an impact in the diversity and abundance of palatable understory flora, with a notable impact to restoration activities led by the GCA (Underhill, 2013). Some monitoring and data collection have occurred and is ongoing at the Millard Learning Center property, with a goal to prevent the trophic cascade that is often a consequence of increased browsing pressure (Arcese et al., 2014). As overbrowsing can disrupt species interactions in an ecosystem, cascading effects are seen at all levels and most notably for songbird habitat with changes in forest structure, which has been well studied in the literature (Martin et al., 2011). Though overbrowsing most directly impacts palatable vegetation density and abundance, the indirect impacts of an increasingly high deer density causes major concern for island biodiversity in general.

1.4 Penelakut First Nation Hunting and Land Use

The Penelakut Tribe is a Hul'qumi'num speaking community that is separated into four reserve locations: Tsussie, Northern Tip of Galiano, Tent Island, and Penelakut Island. Together they have a total of 1,001 registered Penelakut Community Members. The Penelakut people plan and care for their land based on the Penelakut Indigenous laws. (Penelakut, 2020).

The Penelakut First Nation have traditionally hunted deer on Galiano and other Gulf Islands for thousands of years, and deer remains an important cultural and ceremonial food (Penelakut, 2020). Venison represents a unique local source of high-quality protein for island communities. By ethically and humanely hunting, respect for the animals is integral in this process and the intention is to use every part of the hunted animal. Hunting may provide an opportunity to reduce some of the native impacts of hyperabundance while also strengthening the conservation values of protected areas and feeding people with traditional food sources (Penelakut, 2020).

1.5 The Current Challenge

1.5.1 The Challenge of Deer Hyperabundance

Hyperabundant ungulate populations have been observed throughout many forest ecosystems globally as the impact of humans is reflected in changing cultural values, land use preferences, and resource extraction (Bransfield, 2015). Degradation of ecosystems caused by overbrowsing, such as with moose (*Alces alces*) in Gros Morne National Park (Rae et al., 2014) and the Sitka black-tailed deer (*Odocoileus hemionus* sitchensis) on Haida Gwaii (Stroh et al., 2008), demonstrate the threats hyperabundant ungulates pose to biodiversity and some food resources.

Figure 3: Browsed mock-orange after the removal of caging at the Millard Learning Centre former Millsite restoration project.

Anecdotal observations and pilot student projects strongly suggest palatable understory flora targeted by deer herbivory has been reduced in density and abundance throughout the Millard Learning Centre property (Figure 3). Browsing effects from the hyperabundant deer population are most noticeable in exclosure areas, both previous and ongoing, in which deer have been fenced out of specific areas, typically coinciding with other restoration projects carried out by the GCA. The success of vegetation communities within the exclosures are far greater when compared against adjacent control sites, speaking to the intensity of browsing pressure on the property. Threats to biodiversity caused by overbrowsing are inconsistent with the GCA's vision and goals for stewardship of this area, indicating that some intervention or population management may be required. Though some past monitoring and project development has responded to some of these pressures, impacts of browsing to vegetation density and abundance is an ongoing issue for the GCA and with subsequent trophic cascades, will continue to threaten biodiversity if left uncontrolled. The current challenge is the lack of a clear research direction to further efforts of deterring overbrowsing. Initiatives to uncover deer population information, impacts of herbivory, and potential methods to deter adverse impacts are pertinent and facilitated by this project.

1.5.2 Causes of Deer Hyperabundance

The initial causes of black-tailed deer hyperabundance on Galiano Island stem from the lack of a predator to regulate the population density and the movement away from hunting as a means for food resources and other products, both of which are related to the impacts of settlers to this area in the late 1800's (Arcese and Martin, 2020). In combination with these factors, the subsequent changes in land use to incorporate gardens, settlements, and road verges have created more habitat for deer. Currently, the interactions hyperabundant deer have with their environment are creating the potential for ecologically novel vegetation structure on the Millard Learning Centre property (Heger et al., 2019). This is caused by increased browsing with more deer occupying the site and may impede restoration efforts in the logged areas of the property where palatable early seral stage vegetation is exposed. Overbrowsing may exacerbate other drivers of biodiversity loss affecting the property, such as invasive species presence that are not palatable to black-tailed deer and climate change.

The lack of a current strategy for population management reflects the contentious nature of this topic. Antipathy towards lethal control methods by the community is rooted in the absence of regionally specific scientific understanding of the impacts of these deer to vegetation structure and biodiversity (Arcese et al., 2014), as well as personal connections to resident deer and moral beliefs. Though some data have been collected related to population density and exclosure use, as detailed above, a clear direction forward has yet to be established and recommendations toward these objectives are detailed in the findings of this report.

1.5.3 Current State of Deer Management and Impact

Currently, high deer density on Galiano Island is a major driver in biodiversity decline on the Millard Learning Centre property, and represents a significant barrier to restoration success. In Arcese et al. (2014), Galiano Island ranked mid-range in faecal standing crop (a measure of pellets in a plot), as well as species cover, richness, and diversity; estimates for nearby Mayne Island were ranked similar, but both islands faecal standing crop counts were comparatively low compared to Sidney Island which is known for extremely high deer densities (Arcese et al., 2018). Faecal standing crop values were calibrated using the ocean spray ratio on Pier's Island, BC from Martin et al., and used to determine deer density, In this analysis, island size and deer density were unrelated yet increasing deer density, even at low levels, was a negative predictor of species richness for native and culturally significant vegetation. A UVic student project at the

Millard Learning Centre in 2015 collected data using the ocean spray method adopted from Martin et al. 2015, but no estimation was given for population density. To our knowledge, there is not a more recent estimate available.

1.5.4 Ethics and Management

Population management can be a contentious topic, which suggests public engagement is important. Public engagement is always important in restoration, and especially so when there is an ethically charged or socially contentious challenge (Keenleyside et al. 2012). Deer have become part of our everyday landscape in southern Vancouver Island and the Gulf Islands, and therefore many people cohabiting these ecosystems have developed an emotional connection to the species. Our report is anchored by a compassion for deer, and also the recognition they are one species among many. Our suggestions and discussion are focused around biodiversity conservation and restoration and following a whole-systems approach. On balance, we recommend some intervention in the Millard Learning Centre ecosystems are necessary in order to reach stated goals of conserving and restoring biodiversity.

2.0 Goals and Objectives

The GCA has committed to “maintain and restore the integrity of terrestrial, freshwater and marine ecosystems” as well as “provide opportunities for research and innovation on effective methods in ecological restoration, conservation biology and sustainable living as well as the relationship between human well-being and time spent in nature.” The current challenges to ecological integrity caused by overbrowsing, as well as the need for the assessment and development of a clear research direction, provide the basis for this project.

Based on these goals set by the GCA, we developed project specific goals and objectives that are in alignment with the values of the GCA. The goals are presented (numbered) in combination with the corresponding objectives (lettered) and are as follows:

1. Conduct a review of past research and monitoring for both black-tailed deer population management and the impacts of overbrowsing on the property.

    a. Perform a literature review of the past reports, protocols, and articles written on this subject.

b. Evaluate and critically assess the methods and findings of past work in order to provide a direction for future research.

2. Define a research question and methodology for future use by the GCA

a. Utilize information from the literature review to guide the research process.
b. Perform any available analyses on existing data collected by the GCA.
c. Define a research framework for the GCA to investigate.

3. Develop resources that can be used by the GCA to educate visitors and the community on the challenges associated with hyperabundant ungulate populations.

a. Present the findings of our work to the community.
b. Provide a report to the GCA that can be displayed as a resource on the website.

3.0 Methods

3.1 Review of Past and Current Monitoring Programs

To better evaluate past and current monitoring methods employed by the GCA, research groups, and student projects, we compiled all existing literature, reports, and protocols as part of a literature review.

This involved sourcing literature on monitoring initiatives related to:

a. Fencing of restoration sites to exclude deer and allow for plant regeneration.
b. Experimental exclosure plots.
c. Coordination with local researchers and managers to take advantage of the best available science.
d. Public education to increase community investment and involvement in stewarding local ecosystems and deer populations.
e. Opening the Millard Learning Centre to coordinate indigenous hunting during the fall and winter months.
f. Research projects conducted by students at the University of Victoria.
g. Public documents from the CRD and IslandsTrust.

These documents were then compiled in a table and separated into the main components: Title, Authors, Year of Publication, Type of Publication, Objective, and Findings, to create a useful resource for the GCA and future research groups investigating this topic in the future.

3.2 Data Analysis of Exclosure Data

We used data recorded from open and exclosure plots at four locations in 2019 and five locations in 2020 as per the Deer Monitoring Protocol (n.d). Using these data, we evaluated species composition, percent cover, and browsing at three of these sites using Excel. Data was provided by Adam Huggins, the Restoration Coordinator at the GCA and was collected by GCA staff over two years.

3.3 Literature Review for Future Directions

Expanding on our literature review of past and current methods, we conducted a literature review of other available methods related to deer management and impacts. This information from the literature was divided into four topics: camera trap data and population density estimates, aversion, immunocontraception, and novel disease, with the intention of creating awareness for expanding or complimenting current initiatives used by the GCA.

4.0 Results

4.1 Table of Past and Current Monitoring

We have created a table of all the current and past monitoring strategies in order to create accessibility of past research objectives and their findings (Table 1, see Appendix A). We also included previous students' projects in our research list, as these projects have been a significant contribution to the resources available on this topic and are also generally available through the GCA website. Government documents provided a broader scale argument for deer population active management, as did journal articles from notable researchers in the area, whereas student projects focused in on GCA specific goals and research. Potentially a gap in the literature is work focused on Galiano Island as a whole, similar to the work by the Mayne Island Conservancy in Underhill (2013). Most documents focused on managing the impacts of deer herbivory on vegetation, but few focused on managing the population itself. Most of these documents were published between 2005 and 2015, and an interesting comparison would be to evaluate the goals and objectives in these earlier documents against current data to see if any of these objectives have been met or if challenges have increased through time.

4.2 Data Analysis of Exclosure Data

For 2019 and 2020, data was collected from various exclosure plots around the property on species composition, percent cover, and browsing. In 2019, data was collected at the Fuelwood Forest, the Trimcomalli Bluffs, the Forage Forest, and the Millsite. In 2020, data was collected from these sites with the addition of a site at Mt. Sutil. Our brief analysis focuses on the Trimcomalli Bluffs, the Forage Forest, and the Millsite due to lack of complete data in some locations.

Species composition (Figure 4 and 5) was highest in the exclosure plot at the Mill Site, which may be a reflection of the length of time the exclosure has been in place as fencing has been present here since the 2014 restoration project. For the sites, species composition was relatively similar between open and exclosure plots for both years, which may point to some interesting research in the future about biodiversity. Between years, there were generally less recorded species in 2019, potentially indicating some observation biases.

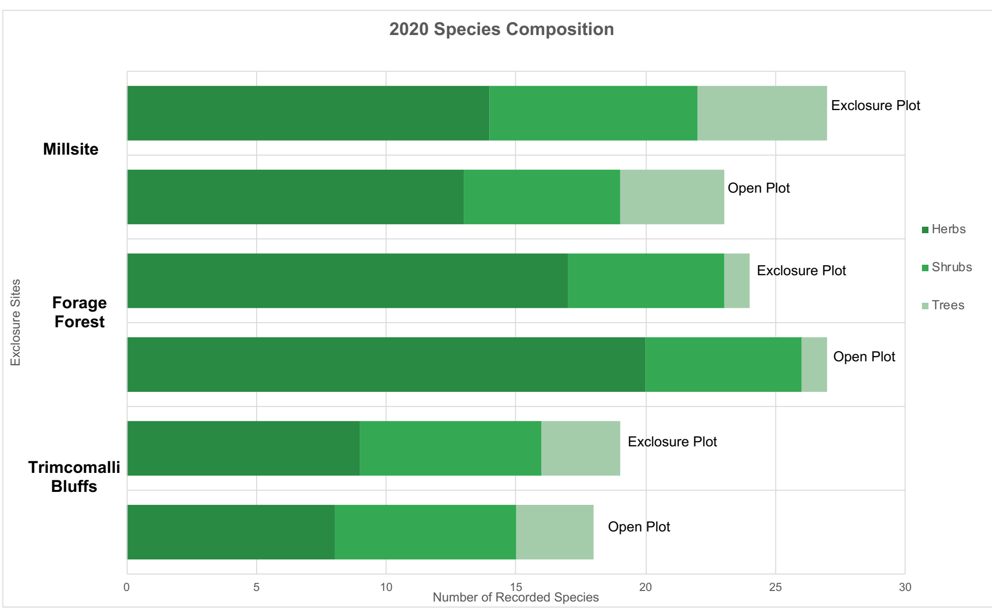

Figure 4: Graphed exclosure plot species composition for 2020 data.

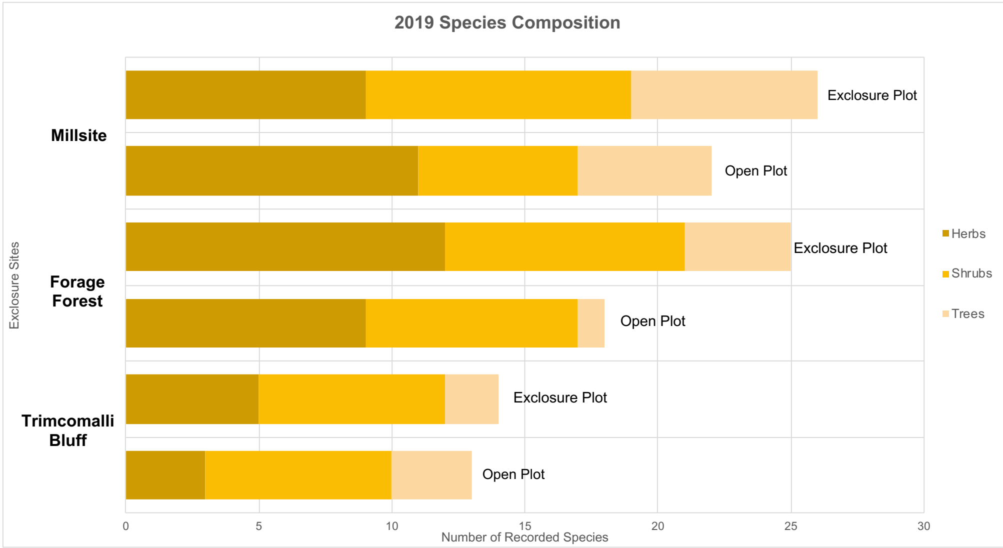

Figure 5: Graphed exclosure plot species composition for 2019 data.

For percent cover (Table 2, 3, and 4, see Appendix A), there was significant variance amongst the sites. Of note is that total percent cover was generally greater in the exclosure plots compared to open plots, which speaks to the density of vegetation present when browsing is deterred, however, this was not always observed. This relationship was less well observed at the Trimcomalli Bluffs (Table 2), potentially indicating that this area is more difficult for deer to access or perhaps the vegetation is less preferentially selected for browse. A challenge with using these data is that often the species present in one year would be absent or very different in the next year. This may be the result of some ecological processes, but it may also be caused by observational biases as the data was likely recorded by different observers between years.

The browsing assessments had incomplete data inhibiting cross-site comparison, but there were some trends in selected browsed vegetation. In 2019, *Rubus spectabilis*, *Alnus rubra*, and *Salix spp*. were favored by deer, all being observed as heavily browsed (over ⅔ browsed) as per the monitoring protocol. In 2020, browsing data was not always recorded but results were similar with the addition of *Cytisus scoparius* as moderately browsed (½ to ⅔ browsed). It is of note that known preferred browse will likely be absent from these data as browsing impacts are so strong that the species is absent from the site completely. This is likely the case for *Holodiscus discolor*, as it was present in some exclosure plots but never observed in open plots.

4.3 Evaluation of Current Methods

4.3.1 Exclosure Plots

Exclosures present an opportunity to collect qualitative evidence and observational studies can have immense value, especially from an educational standpoint. The challenge currently is in using the available quantitative data, as well as shaping monitoring protocols around a central focus. Exclosures require significant upkeep and do not occur naturally in the environment, as well as create an expense for the GCA. Observational science is subject to biases and assumptions, and the quality of the recorded data differs from year to year. As many exclosures are already in place they present opportunities for long term monitoring within the landscape, but it may be difficult for the GCA to support each new restoration initiative with a new exclosure. Using exclosure monitoring to measure the impact of deer herbivory on vegetation in combination with another method that manages the population may yield more effective results, rather than just deterring browsing in small areas.

4.3.2 Ocean Spray Transects

The ocean spray method is useful in monitoring deer density, differentiating it from the exclosure plots. It is easier to derive quantitative data with the ocean spray method by adopting the analysis from Martin et al. (2011). Martin *et al*. suggests that the ratio of foliar width at 2:1 meter's above ground on ocean spray shrubs can provide an index of browsing impacts because the species becomes umbrella-shaped when browsed. To validate the ocean spray ratio as a regional indicator of deer density and impact, it's been predicted that native shrub species richness, diversity and cover all decline as ocean spray ratio and pellet density increased. This relationship between deer density and shrub species cover, richness and diversity can all be displayed using general linear mixed models. The value presented by this technique is in the relative ease of conducting these transect surveys, making the data viable for collection each year by the GCA or by volunteers A challenge with this method is the relative time of conducting mass transects throughout the property, and the requirement of working in teams of at least three for effective field work. A student group in 2015 collected data using this technique (see Appendix B) that is available for analysis and may create opportunity for a comparison with more recent data should this method be continued.

5.0 Future Directions

5.1 Current Methods

5.1.1 Exclosure Plots

Vegetation monitoring via exclosure plots presents several opportunities to answer questions about the impacts of herbivory. Visually, the exclosure plots provide qualitative evidence for the impacts deer are presently having on early successional ecosystems around the property; , this also positions exclosure plots to be educational tools. However, some challenges arise when using this approach quantitatively. Data recorded from the exclosures are subject to variability among observer teams in terms of quantifying percent cover and impacts of browsing. Analysis is made difficult by the marked differences between the recorded years (2019 and 2020).

Several examples in the literature promote exclosures as a potential vegetation monitoring method (Pendergast et al., 2016; Wright et al., 2012; Bennett et al., 2008). Future research using exclosures at the Millard Learning Centre may be better directed by focusing on a specific research question. An example could be:

How much biomass is being removed from control plots when comparing species abundance and composition with the exclosure plot?
Do the data from browsing assessments confirm species palatability assessments in Arcese et al. (2014)?
Do exclosed plots contain increased species diversity compared to adjacent open plots? Does this diversity decrease over time through successional pathways?

There is variation in the literature regarding size of plots, number of plots, and duration of observation with little information on chosen methods. For continuing with this monitoring, it is recommended to standardize plot size (if additional plots are added) and continue data collection under clear and detailed protocol and training. Specific data collection may be amended if one of the suggested research questions was focused on, and it would be useful to have several years of data in the analysis to incorporate successional trajectories of larger species.

5.1.2 Ocean Spray Transects

The ocean spray monitoring method is presently the best available way for the GCA to derive information on deer density without employing new techniques. For this reason, ocean spray monitoring is valuable in addition to ongoing monitoring, as population density estimates will be essential if any actual management is to be done. The data collected from ocean spray monitoring may be better conformed by a camera trap program in the future to assess the effectiveness of this method. If the GCA was interested in population density estimation, it is recommended that ocean spray transects be routinely monitored on an annual basis to develop a coarse estimate that can be integrated into future research. Data from a student group collected in 2015 (see Appendix B) is available, and to our knowledge no statistical analysis has been run for this dataset. An interesting comparison would be to repeat the 2015 transects in the upcoming field season to generate population density estimates for both years, and evaluate how density has changed or been maintained on the property in accordance to land use change.

Following work in Martin et al. (2011) and more current work completed in student projects, future guiding research questions might be:

Which areas of the Millard Learning Centre have the highest densities of deer? Does this correlate with natural exclosures (such as cliff edges) or increased densities of palatable vegetation?
Can we confirm the effectiveness of ocean spray monitoring using outside methods?

A similar study and review as conducted by Underill (2013) for the Mayne Island Conservancy may be of significant use to the GCA in combination with future objectives for the Penelakut hunting program. The major finding in this report supports that pellet count and ocean spray browsing occurred at higher amounts and intensities in non-hunted areas of the island, and it may be of interest to the GCA to compare data from transects on the property to other public areas on Galiano Island.

5.1.3 Localized Hunting by the Penelakut First Nation

It is difficult to predict if localized hunting efforts will cause an aversion to the Millard Learning Centre property for deer, and more monitoring, such as radio-collared marked individuals and a camera trap array to capture activity, would likely need to be in place to test this hypothesis. To date, 15 individuals have been removed from the population through the Indigenous hunting program. Little is known about this particular black-tailed deer populations home range; it is difficult to predict if sustained hunting efforts would serve as a significant method of population control, or if the property would serve more as sink habitat but deer numbers would be supported by increasing populations elsewhere.

Some research has investigated the behavioral impacts of discrete hunting events on deer. Sullivan et al. (2018) found that white-tailed deer (*Odocoileus virginianus*) found that deer registered an increased risk during a hunting season, and increasingly shifted temporal activity to nocturnal or crepuscular periods but did not change activity spatially. In the context of the Millard Learning Centre property, changes to the period of activity of deer would likely not have major impacts on current overbrowsing challenges, and predator-prey interactions would not be influenced by discrete hunting events as there is currently no apex predator to suppress deer activity.

5.2 Other Methods for Consideration

5.2.1 Camera Trap Arrays and Population Density Estimation

To better understand deer activity both spatially and temporally, establishing a camera trap array both on the property, as well as Galiano Island as a whole, may assist in answering necessary ecological questions prior to discussions of population management or methods to deter herbivory. Camera traps are an emerging approach in wildlife monitoring, which presents opportunities for non-invasive observation over a 24-hour period (Burton et al., 2015). The addition of camera trap data to current monitoring methods such as exclosure plots and ocean spray monitoring may help to confirm or inform assumptions of deer density, activity, and land use.

The GCA has already adopted camera trap data as part of their rockfish (*Sebastes*) monitoring program (GCA, n.d.). Perhaps there is potential to expand the camera trap work to an “Ungulate Monitoring Program” where cameras are placed in key locations as a preliminary assessment for deer spatiotemporal activity. If the GCA were to expand a potential program to obtain more statistically relevant information on deer movement and demographics, they would have to make several decisions about the type of research questions to be answered as detailed in Sollmann (2018). The GCA would likely use a capture-recapture model with marked individuals in order to answer questions pertaining to density but could rely on non-marked individuals for data on activity and occupancy.

5.2.2 Aversion

The tactic of aversion is often exercised for wildlife that become habituated to urban centers but could also be applied in this context. Kloppers et al. (2005) used aversion techniques to deter radio-collared moderately habituated elk in Banff National Park using conditioning treatments to simulate predation. The treatments were variably successful, with both aversive conditioning to dogs and human activity. It seems unlikely that aversion would work on the hyperabundant deer on Galiano Island, or more specifically the Millard Learning Centre Property, as predation has been absent for a significant period of time, altering deer behavioral responses. Creating a sampling design to test aversion techniques could lead to an interesting ungulate research project in the future.

5.2.3 Immunocontraception

Immunocontraception (IC) is currently being adopted as part of a population management pilot program for black-tailed deer located in Oak Bay, BC (UWSS, 2019). Based on a preliminary report from 20 collared female deer, or does, who received the IC treatment, the program appeared to be successful as a form of contraception and has been expanded to encompass more of the population. As part of this work, camera trap data of marked individuals also provided population density estimates. Results of this round of IC treatment will provide further insight for a similar IC project in Esquimalt, BC.

IC treatments of various deer species have been commonly studied in the literature, especially in the context of urban and suburban management (Curtis, 2020; Evans et al., 2016; Rutberg et al., 2008). Traditionally offered as an alternative to failed culling programs, IC treatments have also been controversial due to high costs and the experimental nature of such programs (Curtis, 2020). As with all forms of population management, public consultation and engagement would likely be a keystone piece of this method if it were to be integrated into any of the Gulf Islands populations.

5.2.4 Novel Disease

Adenovirus Hemorrhagic Disease (AHD) has been identified in coastal black-tailed deer populations in 2020 and is at present responsible for the mortality of deer on Galiano, Mayne, Salt Spring, and Pender Island, as well as Southern Vancouver Island (Schwantje, 2020). AHD has a range of hosts not limited to deer, and mortality rates are higher in fawns than adult deer. AHD is transmitted through direct contact of fluid between deer, and no treatment or vaccine exists currently. AHD may lead to reductions in localized populations of deer, but there is still much to understand about the impacts and mortality rates of this virus. Data from outbreaks in Oregon and California, USA should be monitored to infer the potential repercussions of this novel disease.

6.0 Our Recommendations

Camera trap array. The clearest path forward begins with answering basic questions on the hyperabundant deer population: where are they active, how far do they travel, and at what present densities? Establishing a camera trap array is the most effective and accurate method for this type of monitoring (Burton et al., 2015), and will be important in informing future management for all available options the GCA decides to pursue. Establishing an array as an island-wide initiative presents as the optimal scale for answering these questions. There are several benefits of using camera data, such as low-maintenance long term monitoring, 24-hour observation periods, and the ability to derive quantitative data (Burton et al., 2015). Pursuing this route creates the opportunity for community engagement, more informed discussion, and further partnerships with research groups at the University of Victoria, such as the Applied Conservation Macro Ecology Lab (ACME LAB, n.d), who have expertise in this field (Fisher et al., 2020; Fisher et al., 2016)

Ocean spray monitoring technique and other options. As establishing a camera trap array is a substantial investment in equipment, partnerships, and staff/volunteer time. A more immediate action would be to repeat the 2015 ocean spray transects (see Appendix B) and create a comparison analysis for deer density across the property. Having an estimate for the population is a priority, as this knowledge will facilitate future work. These data could later be validated by a camera trap program. We also recommend the exclosure plot monitoring continue with designated plots, and that the effectiveness of this method be re-evaluated after several years of data can be incorporated into analysis. We believe there are some interesting opportunities here but the current data is limited in consistency and observational bias. We do not recommend extending monitoring to all current plots, and future plots. In addition, we advocate for the preservation of the Penelakut Hunting Program as long as this relationship continues to serve Penelakut First Nation community members. Though discrete, localized hunting may not prove to be effective for population control, returning sustainable harvest to the landscape and using this program as a tool for promoting education and relationship building is significant.

An integrated approach. Regrettably, there is no simple, easy, and low-cost solution for managing this hyperabundant population of deer to achieve system-wide benefits. The suggested management options in this report serve more as a means than an end. These methods will likely yield the best results for achieving the overall goal of protecting biodiversity is as an ensemble rather than in isolation.

7.0 Conclusion

Hyperabundant black-tailed deer continue to present a significant concern for native vegetation density and abundance and biodiversity in general in the form of a trophic cascade (Martin et al., 2011). As current deer populations exceed historical levels, deer impact the composition and structure of forests in unprecedented ways by preferentially feeding on select plant species. Based on overbrowsing as a driver of biodiversity loss at the Millard Learning Centre and on Galiano Island, we believe it is important to revisit research and monitoring for both black-tailed deer population management and the impacts of increased herbivory on the property. We hope that our review and recommendations provide a resource for the GCA and future research projects investigating deer hyperabundance.

8.0 Acknowledgements

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Appendix A

Table 1. Compiled documents from our literature review on past and current monitoring and research pertaining to hyperabundant deer (see Section 4.1).

TITLE	AUTHORS	YEAR OF PUBLICATION	TYPE OF PUBLICATION	OBJECTIVE	FINDINGS
DEER MANAGMENT REPORT	Bransfield, J.	2015	Report	The report reviews options for managing the speculated, hyperabundant deer population at the LC property and makes recommendations as to which management practices are most appropriate for the restoration goals recommended by the author.	The preliminary results from the qualitative data suggests that there is medium to high intensity browsing on site. Reviewed the potential management strategies that could aid in reducing browsing intensity in forest ecosystems on site.
DEER TRANSECT PROJECT REPORT	Lipp, D., Faeth, M., and Braun, J.	2015	Report	Ocean spray monitoring is about getting an idea of how dense the deer population at the Learning Center property.	The highest browsing of ocean spray can be found on the ecological community of Mature Forest – Zonal and on the lowest in the Old-Growth-Talus. The highest average can be found on Shrub Dominated-Zonal areas.
ASSESSING THE EFFECTS OF DEER BROWSE ON MAYNE ISLAND'S ECOSYSTEMS	Underhill, R.	2013	Report	In order to quantify the effects of deer browse we compared vegetation characteristics between three deer management conditions: fenced from deer, areas that have been hunted in recent years, and areas away from recent hunting.	They indicated that the combined browsing of deer populations on Mayne Island is resulting in a lack of recruitment of some palatable woody plant species, and a reduction in palatable woody species diversity and percent cover.
FACILITATING TRADITIONAL FOOD HARVESTING	GCA	2020	Briefing	They have adopted a policy to permit traditional deer harvesting by Indigenous hunters in hopes of correcting the current overabundance of	Hunting activities at the MLC is assumed to have a negligible effect on the Galiano deer population at a whole, it also is their goal to achieve a better ecological

				native Columbian black--tailed deer.	balance for the deer population and ecosystems by simulating natural predation through hunting. This is ongoing till 2022.
DEER MONITORING METHODS	GCA	N.D	Protocol	Species were recorded inside exclosure and open plots. All species were recorded regardless of abundance.	Plant species composition shows the extent of browsing impacts on a site. Preferred species like red-osier dogwood, bitter cherry, ocean spray, Douglas fir, Garry oak, red alder, and arbutus may be consistently browsed to the point they are entirely absent from sites.
DEER DENSITY AND PLANT PALATABILITY PREDICT SHRUB COVER, RICHNESS, DIVERSITY AND ABORIGINAL FOOD VALUE IN A NORTH AMERICAN ARCHIPELAGO	Arcese, P. et al.	2014	Journal Article	They compared plant communities at 66 island and mainland sites to test the hypothesis that deer determine species cover, richness and diversity and that palatable species become rare at high deer density.	The impacts to native and culturally significant shrub cover, richness and diversity were 52–85% lower at sites with abundant deer (0.9–2.8 ha^{-1}) versus no deer. Shrub architecture provided an easily applied index of native and culturally significant plant cover and deer density.
REGIONAL DEER MANAGEMENT STRATEGY	Capital Regional District	2012	Report	They wanted to address the economic loss in agricultural areas by reducing the deer population to acceptable levels. As well as maintain the population at that level by improving programs and tools for farmers to minimize crop losses.	The main ways to address deer population would be: Mitigation, Population Reduction, Fertility Control. As well as short vs long term solutions.
REGIONAL CONSERVATION PLAN	Islands Trust Fund	2018	Report	They identified, investigated and communicated the importance of natural areas to generate action on conservation priorities.	The Trust Fund Board elected to create a ten-year Regional Conservation Plan.

BROWSING DOWN OUR NATURAL HERITAGE: DEER IMPACTS ON VEGETATION STRUCTURE AND SONGBIRD POPULATIONS ACROSS AN OCEAN ARCHIPELAGO	Martin, T., et al.	2011	Journal Article	How do deer influence vegetation structure and bird assemblages in a large island archipelago in western North America using surveys of 18 islands?	They recommend adaptive management be used to test the validity of the threshold, and that without active management of deer abundance, local extinctions of native flora and fauna appear likely to accelerate.
PRIOR INFORMATION REDUCES UNCERTAINTY ABOUT THE CONSEQUENCES OF DEER OVERABUNDANCE ON FOREST BIRDS	Martin, T., et al.	2013	Journal Article	They used prior information in a Bayesian model to inform about the consequences of overabundance.	Deer browsing in these island archipelagos must be managed if the risk of local extinctions among native flora and fauna is to be avoided.
IMPACTS OF BROWSING ON KEY WILDLIFE SHRUBS IN BRITISH COLUMBIA AND RECOMMENDATIONS FOR THEIR USE	Wikeem, B. and Wikeem S.	2005	Report	They reviewed the literature on browsing for the important shrubs in B.C. to assist in developing browse-use guidelines.	They developed 8 recommendations for providing and establishing a shrub-use guidelines in B.C.

Table 2. Percent cover data from the Trimcomalli Bluffs exclosure site, comparing data from 2019/2020 open and exclosure plots.

Trimcomalli Bluffs		**2020 % Cover**		**2019 % Cover**	
		Open	**Exclosure**	**Open**	**Exclosure**
Herbs	*Plantanthera transversa*	1%	0%	0%	0%
	Anisocarpus madioides	0%	3%	0%	0%
	Lysimachia latifolia	0%	15%	0%	0%
	Polystichum munitum	0%	17%	0%	0%
	unk. carrot spp.	0%	0%	1%	1%
	unk. aster spp.	0%	0%	1%	1%
	Trientalis borealis	0%	0%	0%	10%
Shrubs	*Lonicera hispidula*	5%	8%	10%	10%
	Berberis nervosa	10%	15%	12%	15%
	Rosa gymnocarpa	10%	9%	10%	8%
	Gaultheria shallon	20%	10%	15%	6%
	Symphoricarpos albus	0%	2%	0%	1%
	Rubus ursinus	0%	1%	0%	1%
	Berberis aquifolium	0%	0%	0%	1%
Trees	*Arbutus menziesii*	17%	15%	5%	5%
	Pseudotsuga menziesii	25%	20%	50%	43%
	Prunus emarginata	7%	0%	0%	0%
	Thuja plicata	0%	1%	0%	0%
	Salix spp.	0%	0%	6%	0%

Table 3. Percent cover data from the Millsite exclosure site, comparing data from 2019/2020 open and exclosure plots.

Millsite		**2020 % Cover**		**2019 % Cover**	
		Open	**Exclosure**	**Open**	**Exclosure**
Herbs	*Hypochaeris radicata*	5%	5%	0%	0%
	Leucanthemum vulgare	15%	15%	5%	0%
	Lapsana communis	3%	10%	0%	0%
	Cirsium arvense	7%	40%	15%	12%
	Cirsium vulgare	3%	0%	0%	1%
	Ranunculus repens	2%	3%	0%	0%
	Digitalis purpurea/Digitalis spp.	7%	5%	6%	4%
	Vicia sativa	0%	5%	0%	0%
	Nemophila parviflora	0%	3%	0%	0%
	Galium aparine	0%	4%	0%	0%
	Polystichum munitum	0%	0%	0%	4%
	Juncus effusus	0%	0%	15%	12%
	Unk. aster spp.	0%	0%	0%	10%
	Urtica diotica	0%	0%	0%	4%
	Cats tongue	0%	0%	10%	0%
	Trifolium repens	0%	0%	2%	0%
Shrubs	*Rubus spectabilis*	0%	4%	3%	8%
	Symphoricarpos albus	0%	1%	0%	5%
	Polystichum munitum	0%	1%	0%	0%
	Rubus laciniatus	2%	5%	3%	2%
	Rubus vestitus	0%	3%	0%	0%
	Rubus ursinus	1%	8%	2%	8%
	Gaultheria shallon	1%	8%	1%	10%
	Rosa gymnocarpa	1%	0%	0%	0%
	Cystisus scoparius	3%	0%	0%	0%
	Rubus armenicus	0%	0%	0%	1%
	Berberis nervosa	0%	0%	0%	1%
	Cornus stolinifera	0%	0%	0%	3%
Trees	*Abies grandis*	1%	1%	0%	0%
	Alnus rubra	10%	40%	4%	45%
	Thuja plicata	1%	0%	1%	1%
	Acer macrophyllum	0%	5%	0%	3%
	Pseudotsuga menziesii	0%	3%	1%	5%
	Abies amabalis	0%	0%	1%	4%
	Poplus trichocarpa	0%	0%	0%	1%

Table 4. Percent cover data from the Forage Forest exclosure site, comparing data from 2019/2020 open and exclosure plots.

Forage Forest		**2020 % Cover**		**2019 % Cover**	
		Open	**Exclosure**	**Open**	**Exclosure**
Herbs	*Polystichum munitum*	35%	35%	30%	60%
	Pteridium aquilinum	15%	8%	15%	12%
	Anaphalis margaritacea	1%	2%	0%	0%
	DIgitalis purpurea	2%	1%	0%	0%
	Lonicera hispidula	7%	15%	0%	0%
	Cirsium vulgare	4%	1%	7%	3%
	Achlys triphylla	5%	0%	0%	0%
	Torilis arvensis	1%	0%	0%	0%
	Cirsium arvense	4%	0%	0%	0%
	Hypochaeris radicata	1%	0%	0%	0%
	Trifolium repens	1%	0%	0%	0%
	Mycelis muralis	2%	0%	0%	0%
	Lysimachia latifolia	0%	3%	0%	0%
	Galium aparine	0%	1%	0%	0%
	Clematis ligusticifolia	0%	1%	0%	0%
Shrubs	*Gaultheria shallon*	40%	30%	65%	40%
	Berberis nervosa	20%	0%	3%	0%
	Rubus occidentalis	4%	3%	0%	0%
	Rubus ursinus	0%	20%	20%	35%
	Rubus spectabilis	0%	5%	0%	0%
	Holodiscus discolor	0%	12%	0%	15%
	Prunus emarginata	0%	1%	0%	0%
	Lonicera hispidula	0%	0%	0%	20%
	Rubus leucodermis	0%	0%	0%	5%
Trees	*Thuja plicata*	1%	9%	0%	3%

Appendix B

Transect #	Waypoint	Northing	Easting	1m diameter (m)	2m diameter (m)	Ratio	Canopy (open, partial, full)	Slope	Aspect	Notes
0	D1	5419686	465898	0.8	2.5	0	partial	35	NNE	
0	D1	5419659	465886	0.1	1.8	0.0556	partial	50	ENE	
0	D1	5419523	465893	0.05	0.8	0	full	50	SSW	
0	D4	5419461	465874	2.55	3.6	0.708	full	25	S	
0	D3	5419459	465861	0.7	1.2	0.583	full	10	S	
0	D4	5419462	465859	1	4.2	0.238	full	10	SSE	
0	D4	5419461	465853	1	3.1	0.32	partial	5	S	
0	D4	5419459	465851	1.7	2.6	0.654	partial	30	SSE	
0	D5	5419456	465878	0.05	1.1	0.0455	partial	36	SSW	
0	D5	5419447	465878	1.2	2.7	0.444	partial	60	SSW	
0	D5	5419467	465877	2	3	0.667	partial	15	SSW	
0	D1	5419438	465868	1.3	2.1	0.619	partial	10	SSW	
0	D1	5419435	465874	1.1	3.1	0.355	partial	44	SSW	
0a	D4	5419581	465822	0.55	1.5	0.367	full	60	SW	young plant - on game trail
0a	D2	5419578	465836	0.3	2.7	0.111	full	40	SSW	4/6 completely browsed
0a	D2	5419563	465838	0.48	1.7	0.282	partial	52	WSW	deer pellets underneath
0a	D1	5419560	465832	1.8	1.1	1.64	partial	38	WSW	
0a	D1	5419428	465833	0.75	3.75	0	partial	44	SSW	
0a	D2	5419441	465849	0.05	1.5	0.0333	partial	42	SSW	
1	D2	5419773	465805	0.3	0.75	0	open	20	NNE	In a heavy salal bush 1 sapling within
1				0.75	0.3	3	open	20	NNE	
1	D1	5419619	465793	0.3	0.75	0	full	35	SSW	No folliage under 2 meters, 1 saplin within each individual/lots of starters. I dead ocean spray plant
1	D2	5419618	465789	0.3	1.22	0.246	full	35	SSW	
1				0.43	1.05	0.41	full	35	SSW	
1a	D1	5419468	465736	0.65	1.72	0.378	partial	30	N	
	D3	5419612	465774	4.16	1.75	2.38	open	20	SSE	
	D4	5419617	465761	2.65	1.78	1.49	full	40	SE	
	D4	5419620	465766	0.25	2.1	0.119	open	30	SSE	
	D4	5419612	465756	0.25	0.6	0.417	full	30	SSE	
	D4	5419611	465755	0.4	1.9	0.211	open	30	SSE	
	D1	5419628	465747	2	3.05	0.656	partial	50	SSE	
	D1	5419634	465756	0.55	2.88	0.191	partial	0	SSE	
	D8	5419663	465749	1.8	2	1	full	30	SSE	
	D8	5419661	465748	1.5	2	1	partial	20	SSE	
1a	D8	5419669	465748	1.5	0.2	8	partial	50	SSE	
	D3	5419675	465744	1.3	0.5	3	full	40	SSE	
	D2	5419773	465737	1	2.2	0.455	open	30	SSW	
2	D1	5419862	465699	0.6	1.9	0.316	Partial	25	SSW	
2	D2	5419783	465698	2.2	2.2	1	Partial	35	SSE	
2	D2	5719782	465702	0.4	1.2	0.333	Partial	30	S	
2	D2	5419773	465739	0.3	1.2	0	open	15	SSW	

2	D2	5419775	465724	4.8	2.75	1.75	Partial	40	SSW	On a flat section surrounded by slope
2	D2	5419779	465717	2.2	4.5	0.489	Partial	25	S	
2	D4	5419739	465685	2.85	3.5	0.814	open	30	WSW	
2	D3	5419741	465693	1	1.5	0.667	Partial	15	SW	
2	D3	5419729	465695	0.3	0.4	1	Partial	40	WSW	
2	D2	5419717	465707	1.3	2.45	0.531	Partial	20	SSW	
2	D3	5419684	465689	1.3	3.5	0.371	Partial	50	SSW	
2	D1	5419642	465706	4	3	1.33	Open	5	WSW	
2a	D2	5419873	465674	0.9	3.05	0.295	partial	30	ssw	
2a	D2	5419870	465679	1.2	2.5	0	partial	30	ssw	
2a	d2	5419873	465680	1	2.9	0.345	full	10	ssw	
2a	d1	5419777	465673	1.9	0.5	4	open	45	s	
2a	d5	5419748	465674	3	4.87	0.616	open	25	sw	
2a	d5	5419742	465674	2.8	3.6	0.778	open	15	wsw	
2a	d5	5419732	465680	0.1	1	0	open	10	sw	
2a	d1	5419543	465657	2	3.05	0.656	pARTIAL	10	n	
2a	d1	541557	465644	0.34	1.4	0.243	partial	15	n	
2a	d4	5419515	465640	2.6	4	1	partial	10	nne	
2a	d4	5419513	465651	0.05	0.1	1	partial	10	nne	
2a	d4	5419514	465646	2.6	2.2	1.18	partial	10	nne	
2a	d4	5419516	465650	2.5	2.2	1.14	partial	10	nne	
2a	d4	5419518	465653	4.12	4	1	partial	10	nne	
2a	d4	5419518	465645	3.3	2.5	1	partial	10	nne	
3	D1	5419891	465587	2.5	1.6	2	open	20	S	
3	D3	5419748	465611	1.5	1.73	0.867	partial	35	SSW	clumped with small cedar
3	D1	5419564	465613	0.4	2.7	0.148	full	30	NNE	
3	D1	5419540	465599	0.4	1.9	0.211	full	30	N	
3	D1	5419553	465588	0.4	1.9	0.211	full	20	E	
3	D2	5419551	465583	0.3	4.8	0	full	20	N	
4	D3	5419995	465483	0.05	2	0	full	30	NNE	
4	D1	5419988	465504	0.3	1.6	0	full	50	NNE	
4	D5	5419948	465492	1.15	1.85	0.622	partial	90	SSW	
4	D5	5419942	465499	1.5	1.3	1.15	PARTIAL	20	SSE	
4	D5	5419939	465499	1.25	2.9	0.431	PARTIAL	60	SSE	
4	D1	5419808	465497	1.3	3	0.433	full	90	SSW	
4	D1	5419781	465544	1.6	3.9	0.41	open	70	S	
4	D2	5419774	465507	0.05	1.2	0.0417	open	30	WSW	
4	D2	5419775	465504	0.6	4	0	PARTIAL	50	WSW	
4	D2	5419770	465511	2	1.5	1.33	open	70	WSW	
4	D2	5419765	465504	1	4	0	PARTIAL	40	SSW	
4	D2	5419778	465490	3.5	1.7	2.06	PARTIAL	50	WSW	
4	D2	5419779	465482	1.1	2.5	0	open	70	WSW	completed up to pathway towards cove (just past thistles)
4a	D1	5419856	465429	0.85	2	0	partial	48	SSW	
4a	D3	5419848	465436	3.1	5	1	partial	45	SSW	
4a	D2	5419846	465443	0.5	4.5	0.111	partial	20	SSW	
4a	D1	5419594	465436	0.03	0.9	0.0333	partial	18	S	
5	D3	5420080	465397	3.1	4.8	0.646	partial	40	NNE	very large height exceeds to telephone line 6-7m

										approx. Healthy trees and bushy
5	D3	5419885	465389	0.9	2.3	0.391	full	50	SW	other individuals around are quite small
5	D3	5419881	465406	1.25	1	1	full	45	SW	
5	D1	5419867	465396	0.9	2.4	0	partial	40	SW	dead foliage low down. New growth seen
5	D1	5419857	465394	0.8	2	0	open	20	SSW	
5	D1	5419605	465400	3.8	6	0.633	partial	40	SSW	
6	D8	5420128	465314	3	6	1	Open	55	NNE	
6	D1	5420043	465308	4.5	2.3	1.96	Partial	25	W	
6	D2	5420036	465294	2	4	1	Partial	30	WSW	
6	D2	5420035	465297	6.7	5.2	1.29	Partial	40	SSW	
6	D2	5420032	465291	2.6	2.4	1.08	Parrtial	20	S	
6	D6	5420010	465306	1.8	2	1	Partial	35	WSW	Small flat portion of a 35 degree slope
6	D6	5420024	465325	1.8	4.5	0	Partial	15	WNW	
6	D5	5419970	465293	3	4	1	Partial	30	WSW	A few clumps surrounding the cable house
6	D5	5419964	465289	2.3	3.7	0.622	Partial	10	W	
6a	d2	5420087	465258	0.5	1.65	0.303	partial	30	ssw	
	d2	5420090	465260	1.3	1.6	1	partial	30	ssw	
	d2	5420083	465262	2.6	3	0.867	partial	30	ssw	
	d1	5420055	465264	1.7	0.9	1.89	partial	5	wsw	
	d1	5420053	465286	1.6	2.7	0.593	partial	65	s	
	d2	5419935	465231	3.4	3.75	0.907	full	25	ese	
	d2	5419818	465237	0.25	1.5	0.167	open	0		
	d2	5419813	465232	0.6	1	1	open	2	n	
	d4	5419803	465226	0.15	1	0	partial	40	wsw	
	d4	5419802	465222	2.25	2.8	0.804	partial	45	wsw	
	d4	5419802	465219	1.2	2.4	1	partial	45	wsw	
	d4	5419801	465220	0.9	3.5	0.257	partial	45	wsw	
	d4	5419806	465214	3.15	3.5	1	partial	20	wsw	
	d4	5419809	465214	0.04	2.3	0.0174	partial	20	wsw	
	d4	5419786	465231	1	1.6	1	full	15	wsw	
	d4	5419783	465224	2.25	2	1	full	90	wsw	
	d4	5419778	465231	2.3	3.1	0.742	partial	90	wsw	
7	D2	5420119	465214	1.8	1	2	partial	0	SW	on cliff edge
7	D2	5420078	465185	0.6	3.5	0.171	full	20	SSW	
7	D3	5420074	465190	1.5	0.2	8	full	0	NNE	
7	D2	5420056	465191	0.1	1.5	0.0667	full	35	SSW	
7	D2	5420050	465218	2.6	2	1	partial	25	SSW	
7	D1	5419993	465187	0.8	4.75	0.168	partial	10	SSW	under fir
7	D1	5419932	465200	0.4	1.6	0	full	10	SSW	
7	D2	5419892	465211	0.2	0.4	1	partial	20	SSW	
7a	D1	5420136	465152	1	4.5	0.222		O		
7a	2	5420099	465159	0.7	2.2	0.318		P		
7a	2	5420110	465156	0.9	3	0		P		
7a	2	5420085	465145	0.8	2.9	0.276				
7a	3	5420032	465106	1.5	3.1	0.484				
7a	2	5420030	465088	1.8	4.6	0.391		P		
7a	4	5419988	465096	1.4	4.2	0.333		F		

7a	6	5419991	465110	0.05	2.4	0.0208		P		
7a	6	5419989	465106	2.5	2	1		F		
7a	2	5419901	465066	1.7	3.2	1		F		
7a	2	5419899	465063	0.5	2.9	0.172		F		
7a	3	5419898	465051	2.2	4.3	0.512		F		
7a	3	5419893	465059	0.95	2.3	0.41		F		
7a	2	5419837	465044	2.5	2	1		F		