A Monitoring Baseline for a Forest Restoration Project on Galiano Island.

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Abstract

The Galiano Conservancy Association is in its third year restoring a 25-year-old Douglas-fir plantation on a152-acre parcel of forested land owned by our organization. We are developing and applying innovative restoration techniques on this land to foster the diversification of the forest's genetic, species and structural composition with the intention of improving the overall forest function and ecological integrity. Our restoration efforts include ecology driven thinning treatments, distributing coarse woody debris, planting native species and controlling exotic species. One ongoing challenge is to implement efficient and achievable monitoring strategies that inform future restoration management and measure restoration treatment success. We have devised strategies that monitor our treatment area, designated control areas and neighboring mature forest reference ecosystems. We are employing a range of monitoring techniques that vary in sampling intensity and frequency. Methods include repeat photography, permanent plots, stand composition mapping and anecdotal observations. This paper presents a synthesis of our monitoring strategies and early examples of the effects our efforts are having on the stand.

Introduction

Extensive stands of old growth forests are known to be structurally and functionally complex (Franklin et al, 2000). Managing tree plantations for quick rotation (50-100 years) wood production severely limits the structural and biological diversity potential in a forest stand. It has been recognized that monoculture Douglas-fir plantations take a long time before supporting species diversity (Chan et al, 1999). Our restoration work begins with a monoculture Douglas-fir plantation whose management objectives have been shifted from commercial forest wood production to that of conserving and enhancing ecological values. To physically alter the plantation's trajectory away from homogeneity, we are making a well planned restoration treatment entry to encourage earlier recruitment of species diversity and mature forest characteristics.

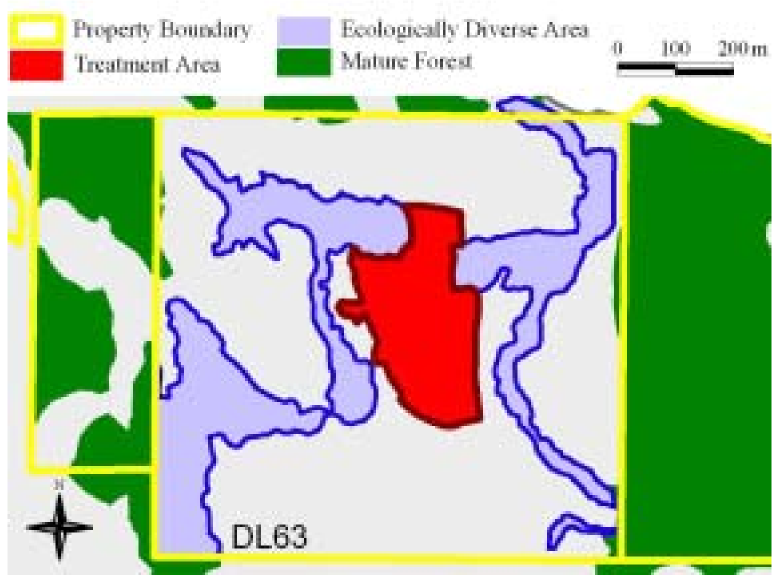
Our efforts are innovative and labour intensive and, as with most restoration projects, we want to be able to say with confidence that our efforts have been effective. Devising a long term monitoring strategy that tells us where we have been successful and when further treatments are required is crucial to our projects success. Monitoring restoration efforts can easily foray into the realm of arduous scientific research exploring the myriad aspects of ecology and succession while sucking up valuable resources. Observing the effects of restoration efforts can also be very intuitive and subjective. Settling on a balanced strategy where useful information can be obtained with moderate effort and reasonable resource demands is the current challenge of our restoration team. As a community based non profit organization our long term monitoring options are also influenced by the tenuous nature of our project funding.

Twenty-five years post clearcutting, windrowing, tree planting and brushing has District lot 63 on the verge of becoming a dark monoculture stand of genetically selected Coastal Douglas-fir trees with species and spatial diversity at a premium. Our restoration initiatives introduce a premeditated disturbance into the stand intended to alter its successional trajectory by immediately changing stand structural complexity and relative species composition. The nature of our disturbance lies in strategically rearranging existing structural components, namely coarse woody debris (cwd) and in creating openings in the forest canopy. Creating gaps by reducing the density of planted trees allows for simultaneous selection and promotion of diversity in tree species, tree phenotypic expressions, vegetative composition, vegetative layering and gap distribution. By altering present plantation tree densities we hope to shift the successional trajectory of the stand away from imminent canopy closure and resulting stem exclusion, which in this stand will mean the loss of much of the naturally occurring trees and shrubs which currently lift the stands species diversity. Ascertaining the effectiveness of this initial treatment through time and eliciting when subsequent treatment entries are warranted are the principle goals of the monitoring component of our project.

Brief Project History

In 2002 we conducted a thorough mapping, inventory, examination and categorization of the ecological variability within DL63. We then ranked mapped polygons according to weighted structural and compositional attributes in order to assess for and prioritize restoration treatment (See Erickson et al, 2002). Attributes considered included seedling occurrence, understory vegetation cover, large tree occurrence, cwd volumes, tree species diversity and snag occurrence. Looking at the quantitative data for polygons and considering spatial distribution pointed to the selection of a five hectare patch of the 26-year-old plantation as a logical site to begin our restoration treatments. This site was located based on a perceived opportunity to restore connectivity between patches of forest attributed with relatively high degrees of ecological integrity (Fig. 1). Connecting areas with relatively higher levels of structural or species diversity, became a central principle in our restoration work applied at the micro site and landscape levels (See Scholz et al, 2004).

Figure1. Restoration and Connectivity on the regional scale.



Prior to the application of restoration treatments, a comprehensive data set was amassed for the initial five hectare treatment area helping to establish a clear ‘before’ picture of the site. Our baseline data included mapping stand composition and vegetative cover of the five hectare area, establishing five 400m² permanent biodiversity monitoring plots, and establishing repeat photo monitoring points. This comprehensive baseline information will provide a solid foundation for future comparative, and reference monitoring.

Key to the success of this intensive, multi-generational restoration project undertaken by the Galiano Conservancy Association is ensuring that the monitoring program persists. Equiping the project for future challenges required the monitoring strategy to be broadly rooted, giving it the freedom to grow and sway in the winds of resource availability.

Developing a Monitoring Strategy

Setting Out Goals

Given the nature of our organization as a non-profit, community based, funding dependant organization, and given the fathomless complexity of ecological systems, we needed a clear idea of what our monitoring goals are. So what do we want in our monitoring strategy?

1. To be able to show clearly and credibly that the restoration treatments were effective.
2. To indicate what and when adaptive response and subsequent restoration treatment entries are required.
3. To be effective and achievable over the long term within a range of potential economic constraints.

To best achieve these monitoring goals our strategy incorporates a variety of monitoring techniques that ride a sliding scale spanning the rigorous scientific to anecdotal observation. To meet our monitoring needs we have devised four main techniques to gather data; detailed stand mapping, 20X20m permanent biodiversity monitoring plots, permanent repeat photography points and an anecdotal observation trail. The data from these techniques rely on comparative analysis of before and after treatment conditions, of contemporary comparisons between the treatment area and untreated control area, and of relative comparisons between the treatment area and reference ecosystem mature forest stands.

Our restoration addresses the overarching principle of pursuing the diversification of forest ecosystem structure, composition and function. What then do or can we monitor? When? How often? In order to assess the effectiveness of our restoration treatments we divided the forest ecosystem into seven components: soil development, coarse woody debris (cwd) , understory vegetation, exotic species, snags, tree and canopy development, and wildlife.

<u>Soil Development</u>

During logging and subsequent site preparation the soils of DL 63 were heavily disturbed by machinery. In many instances stumps, soil, logs and other woody debris were ploughed into windrows reducing much of the forest floor to bare often compacted mineral soil. The current organic layer on the forest floor which averages <7cm in depth, represents the past 25 years of accumulated biomass. We anticipate our restoration efforts redistributing cwd across the plantation floor and diversifying the forest spatial and species composition will effect short and long term soil development. To monitor soil health we are sampling the organic (LFH) and A horizons in treatment areas before and after restoration. Spies and Franklin (1991) determine combined F and H litter layers as a distinguishing characteristic between old growth, mature and young Douglas-fir forests in Oregon and Washington. Reflecting on their results we hope to see variation in F and H layer development in the restoration site relative to the control area and mature forest samples.

<u>CWD Ecology</u>

Large wood provides a unique substrate and habitat for fungal, faunal and vegetative colonization. Perry, (1994) acknowledges decaying wood as playing a keystone role in forest ecosystems storing water and providing habitat for a myriad of species. Dispersing cwd from windrows as well as adding material via pulling and topping trees added immediate complexity and structure to the forest floor (Fig. 2). Girdled and topped trees will contribute additional material to the forest floor staggered over the next 5-20 years.

We hypothesize that cwd distributed across the forest floor has greater ecological value to the forest soil, floor, vegetation and fungal and faunal communities than it would lying in linear windrow piles. Further, the distribution of wood across the forest floor will enhance the rate of species diversification throughout the

Figure 2 Intial stages of restoration site is pruned and cwd moved in from nearby windrow.

BEFORE

AFTER

forest stand. We will be assessing cwd to monitor decay rates, vegetative colonization and wildlife use. Additional questions for our monitoring include when does cwd become incorporated into the forest floor? Does the wood effect soil development? Does the placed cwd influence ecological function and biodiversity? These questions may be answered with sampling comparisons made relative to control areas and pre treatment site conditions.

Snag ecology

The considerable importance of snags to the ecology of many wildlife species in forest ecosystems is well documented (Thomas etal.,1979). Larger snags provide potential cavity nesting sites for a greater number of species therefore providing more enduring wildlife values than smaller diameter trees. As the average diameter at breast height (dbh) of plantation trees is <30cm we are creating high densities of smaller diameter snags. To partially fill the gap on larger diameter trees we are standing logs (> 30 cm dbh) salvaged from windrows to immediately restore a keystone structural element to the plantation forest. Girdled and topped trees add smaller diameter snags to the stand while diversifying horizontal space and redistributing forest biomass. By managing for large diameter trees in our current thinning entry we are recruiting large diameter snags that will be created in future entries. Part of the adaptive management trigger mechanism will be determining how long created snags stand thus signalling when to cull more trees and provide additional large diameter snag structure. Snags are being monitored for decay, colonization and wildlife use indicating ecological function and a successful restoration effort.

Understory vegetation patterns

Understory herbs, shrubs and seedling communities are a reflection of a diverse forest canopy and contribute to biodiversity and forest function. We hypothesize that the cover and species diversity of the understory will remain static or decline barring restoration treatment. Restoratively thinning the stand to increase light penetration will promote the retention, recruitment and growth of understory vegetation. By creating conditions which promote a prolonged presence of seral stage species we counter the artificially homogenous stem exclusion phase initiated by intensive site preparation efforts and subsequent establishment of a uniform plantation. We will monitor the understory for changes in the distributions of herbs, graminoids, and deciduous shrubs, as well as the densities of shade tolerant saplings and sub-canopy tree saplings. These attributes have been identified as significant indicators of forest structural stage by Spies and Franklin(1991).

Exotic Species

A number of invasive exotic species are known to occur within the forest stand on DL63 and throughout the island at large. Observing the presence of exotics in the restoration area is a constant task for all restoration workers and monitors in the stand. Scotch broom (*Cytisus scoparius*), Butterfly bush (*Buddleja davidii*) Himalayan blackberry (*Rubus discolor*) Evergreen blackberry (*Rubus laciniatus*), English holly (*Ilex aquifolium*) and recently Tansy ragwort (*Tanacetum vulgare*) all have a presence on DL63. Although not yet observed in DL63, English ivy (*Hedra helix*) and Daphne (Daphne laureola) are some of the more common invaders on the island that also top the not wanted list. Monitoring for the presence of invasive exotic species will be a part of vegetation monitoring but also a constant vigilance on the part of workers and volunteers.

Tree growth and canopy development

Our restorative thinning of the plantation simultaneously complexes stand structure and shifts species composition. One key criterion observed when laying out treatment areas for culls and keepers is to focus on releasing deciduous and other trees present by natural design. We expect canopy layering and average tree dbh to be more varied within the treatment area than in the control. Thinning is also expected to increase growth rates of individually targeted trees leading to larger diameters sooner than in the control. Monitoring individual tree dbh's, heights, crown depths and widths, along with stand densities, gap distribution and gap size will capture changes in tree growth and canopy development. Comparative analysis between control and treatment plots through time will allow us to test our hypothesis that barring treatment, over the next 5-10 years much of the vegetative and spatial diversity within the stand will decline, leaving an oppressive even aged monoculture of Douglas-fir.

Wildlife

"Planting does produce a better tree farm, but as far as diversity for wildlife, it's zero…Once into a closed canopy conifer succession, the food plants are crowded out" (Robbins, 1991). Based on observations such as these we hypothesize that stem exclusion will reduce faunal diversity. Thinning to promote heterogeneity within a stand has proved effective in increasing wildlife species diversity (Hagar et al, 1996; Hayes et al 1997; Carey and Wilson, 2001). By increasing structural, spatial and vegetative species diversity through thinning we hope to simultaneously maintain or indeed, heighten faunal species diversity. Monitoring the presence of wildlife (actual or sign) is a constant component of every trip into the stand. We are building a journal log of wildlife observations with the hope that patterns may be evident through time. We are also encouraging specialists to study faunal species presence and distribution within the stand whenever possible. Population trends among species of birds, amphibians and small mammals may offer insight into whether restoration treatments have been successful in providing connectivity accross the landscape. This will require monitoring wildlife in surrounding mature forest patches as well as within our restoration and control areas.

Defining the Monitoring Matrix

Photo Monitoring

Repeat photo monitoring can be one of the most vivid methods of recording change in an ecosystem. With photo monitoring you are limited to the lens picture frame but the effect of having the exact frame reproduced through time simulates time travel, dramatically conveying ecosystem change. Photo points were placed throughout the stand to store a visual record of the change initiated by the restoration treatments. Stakes were driven to permanently mark photo points. These points were selected in a fairly subjective manner to insure most of the images would, at least initially, have a clear frame 10 meters distant to a meter board. From each photo point images were captured to each of the four Cardinal directions with a meter board placed at a 10m distance from the photo point marker. At least two photo points per treated hectare were installed. Conspicuous reference features such as large boulders and stumps were identified and photographed to aid in the relocation of the actual photo pins. Photo pins and reference objects were referenced by GPS to aid future relocation. Photos were taken and the lens height recorded, ideally around 1.5 m with the top of the metre board centered in the frame.

Photos were employed to gather a fairly broad picture of canopy changes. In place of a fish-eye lens, a sequence of five photos of the canopy were taken beginning at the center pin and moving the tri pod to each of the points where the meter board previously referenced each cardinal direction,. For each canopy photo the camera lens height was set at breast height 1.3m with the base of the camera always pointing north. The camera lens was levelled and picture taken. The canopy images will record initial forest cover and subsequent gap creation as trees in the frames are topped or pulled (Fig. 3). Future photos will capture the slow light infiltration as girdled trees die back, and conversely, the gradual expansion of remaining tree canopies into gaps. Photography should be carried out in the spring-summer months to maximize the capture of vegetation and deciduous canopy trees.

Photo point monitoring has many values not the least is the minimal amount of expertise and moderate equipment required to repeat the surveys. The key to the success of photo monitoring lies in accurately recording each step in the process and recreating the identical set up in the future. Permanent pins are necessary as stated by Hall (2001) single pins followed by re-measuring seemed to open to human error. Permanent markers also make it easier for one person to repeat the photography procedure with accuracy. For now centre pins are metal spikes and the cardinal directions are marked with wooden stakes to minimize our footprint. Copies of original photos are carried into the field to aid in the accurate set up of the photo retakes.

Figure 3. Canopy shots at Treatment area 1, conifer in lower center of left hand frame was pulled.

The oft used adage 'a picture is worth a thousand words" is the strength of this purely visual monitoring tool. The visual nature endows it with universal appeal. Before and after images provide an immediate sense of change (Fig. 4). The treatment area 01 (TR01) sequence provides an example of photos taken prior to treatment, immediately after treatment and one year later. We see canopy layering beginning with epicormic branching on Red Alder trees to the left side of the frame, as well as understrory vegetation diversification with the influx of understory herb species, mosses and Stinging Nettle. The associated walk through the photopoint site while taking the pictures allows for further general observation of the area. In this case the photographer was able to note exotic thistle and the naturalized Cardimine oligosperma spreading throughout the area, along with noting bract fungi forming on pulled trees (Fig. 5) and insect bore holes in topped trees (Fig. 6). These anecdotal observations broaden the data pool contributing to the story of stands succession.

Figure 4. Permanent Photopoint North TR01. Note: Canopy shots shown in Figure 3 were taken from the meter board seen in these frames.

Figure 5. Fungi growing on pulled tree in TR01 one year after treatment.

Figure 6. Frazz from insect bore holes on one year old topped tree in TR01.

It is hoped that by photographing comparable sites in our control area we will have a visual record showing the successional divergence between treated areas and untreated areas. Canopy photos will aid in assessing canopy response and gap dynamics which will in turn inform managment decisions around the timing and intensity of future restoration treatments. Photo points established in the mature forest reference ecosystem will help to assess whether our restoration site is moving towards a healthy mature or old growth forest condition.

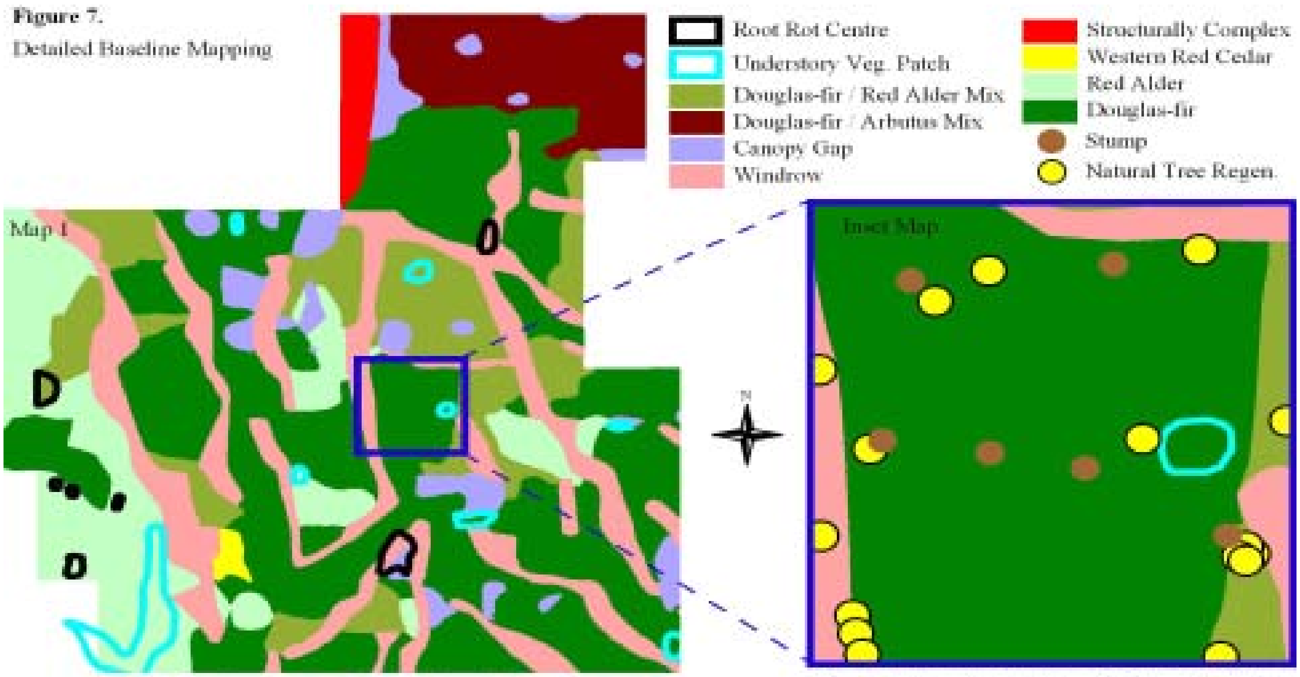
Detailed Stand Mapping

After the initial assessment of Dl63 and the decision on where to begin our restoration work was made we embarked upon a more intensive mapping of the selected area. This process aided in familiarizing ourselves with some to the nuances of the site that were not detected in the intial survey. We flagged a 20x20 meter grid througout our 5ha area providing a dependable ground-based reference for mapping. This enabled us to map, at a very detailed scale, attributes and patterns within the canopy and on the forest floor that were indiscernible from air photos. The mapping provided a comprehensive baseline picture of the initial resoration area.

A single anchor point for the grid was permanently marked with an iron pin and accurately surveyed with a global positioning system. This allowed for the grid to be re-created within a GIS mapping program. The grid was laid out by two surveyors with chain and compass. The mapping was best carried out by three people, one drawing the map and the other two providing reference locations for all significant features within each of the 20x20 meter quadrats. Features were mapped one quadrat at a time onto laminated sheets with permanent marker. Mapped features included:

- A stratification by dominant canopy composition, 5 categories were determined (Plantation Douglas-fir, Douglas-fir/Red Alder, Douglas-fir/Arbutus, Red Alder and Western Red Cedar)
- Canopy gaps
- The location of native trees critical for maintaining or enhancing the stands species diversity such as Red Cedar, Western Hemlock, Broadleaf Maple, Grand fir, Bitter Cherry, Pacific Yew, Western Flowering Dogwood, Scoulers willow and Cascara
- The perimeter of laminated root rot (Phellinus wierii) pockets evident through die back and dead trees
- Old stumps larger than 30 cm in diameter
- The perimeter of windrows
- Significant patches of understory vegetation mainly Salal, Oregon grape and Sword fern
- Deer trails and old skidder roads

Figure 7.
Detailed Baseline Mapping



Map 1 is displayed at a 1 : 2,000 scale and shows general stand composition along with patches of vegetation and areas affected by root disease.

The inset map, displayed at a 1 : 500 scale shows the distribution of individual naturally regenerated trees and large diameter stumps.

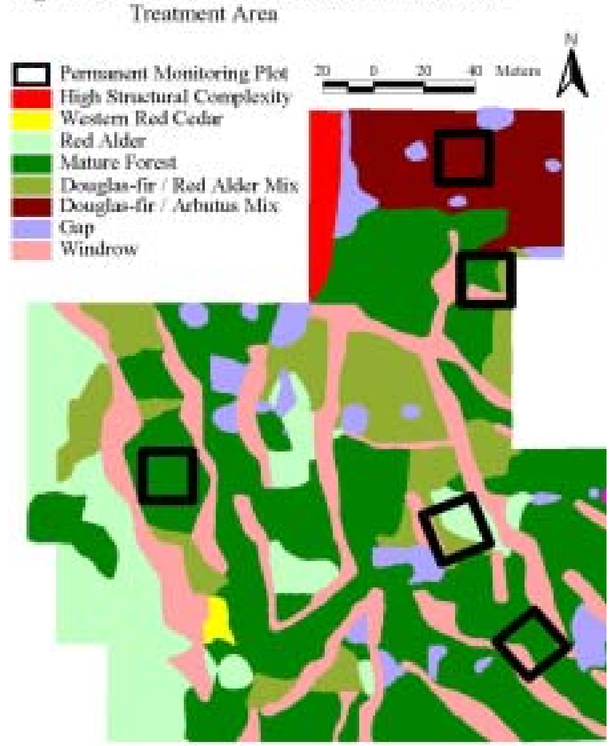
Gathered data was entered into Arc view GIS software to create a fine scale, layered baseline map of the area (Fig. 7). The software allows for linking detailed information to mapped features. Permanent photo points and plots were added later as layers to the digital map. Mapping in this way will allow us to monitor stand compostion, gap and patch dynamics as well as the elimination of windrows as a visible feature in the stand. The restoration site was also divided into a number of treatment areas roughly corresponding to stand composition polygons. Details of treatments (eg. number of girdled, pulled and topped trees) were recorded for each area providing a simple account of our progress as well as potentially helping to explain any variations of ecological response encountered through future monitoring of the site. Due to the extensive labour and time requirement associated with this monitoring strategy it has been recommended to be repeated on a 10 year cycle. We are also completing the detailed mapping protocol for a 1 hectare section of our control area. This will aid our comparative analysis between treated and untreated areas.

Permanent Plots

Five 20m x 20m permanent plots were established within the 5 hectare treatment area prior to the commencement of restoration work. Plots were subjectively located to pick up key treated stand types, two were put in plantation Douglas-fir polygons, two in Douglas-fir/Red alder, and one in Douglas-fir/ Arbutus (Fig.8). All plots incorporated portions of windrows. Plots were not placed in the Red alder and Western Red Cedar polygons as these areas were not treated but rather left as areas with greater ecological integrity, less influenced by the plantation. By establishing permanent plots before our treatments we captured stand characteristics that will serve as a baseline for comparisons with subsequent data collection repeated on a 5 year cycle.

Plot corners were marked by permanent metal pins. Individual trees were mapped and sampled according to the Ecological Monitoring and Assessment Network's (EMAN) Terrestrial Vegetation Biodiversity Monitoring Protocols (Roberts-Prichette and Gillespie,1999). Data regarding site, soils and vegetation were recorded based on the Describing Terrestrial Ecosystems guidebook. Each piece of cwd within the plot was measured for volume, species type, decay class and % vegetative cover. Thus far, 2 permanent plots were placed in the control areas and the same data gathered within these sites. We are exploring the need to establish more plots in the control area. Two, one hectare sized plots were established, using the EMAN protocols, within neighbouring reference mature forest sites.

Figure 8. Permanent Plot Locations in Restoration Treatment Area



<u>Tree mensuration</u>

A detailed site map is produced for each plot from the EMAN software (BIOMON) which depicts trees spatially and by relative dbh. Using the mapped trees as references we added other significant features to the maps such as large stumps, gaps and patches of understory vegetation. These maps will prove excellent reference tools when layered under future maps from resurveys. They will provide a vivid pictorial story of post restoration succession.

Individual tree characteristics were recorded, including species, diameter, status alive or dead, and general comments including whether or not they have been identified for removal. Approximately 10 sampled leave trees were selected to measure heights, crown widths and depths. The entire plot was then given a percent live crown estimate. In addition, we measured canopy gap sizes and annual leader and branch growthIn addition, we measured canopy gap sizes and annual leader and branch growth.

Drawing on the work of Spies and Franklin (1991), data will be used to monitor key indicators of forest structure as the stand moves along its successional path towards a mature forest (Table 2).

Table 2. Proven indicators differentiating Young, mature and Old-growth 'natural' Douglas-fir forests. (Spies and Franklin, 1991)

Overstory structure	Tree density Mean dbh Total basal area Broadleaf basal area Shade tolerant species basal area Standard deviation of dbh
Understory Structure	Herb cover Graminoid cover Deciduous shrub cover Density of shade tolerant saplings Sub-canopy tree sapling density
Forest floor and Woody debris	Combined depth F and H litter layers Snag volume Decay class 2 log volume

<u>Soils</u>

A soil sampling methodology is being applied within the permanent plots. Initially a grid was set up within each plot with 6 sampling points. Two rows were established at 5 and 15 m along lower slope line of a plot, pit sites were placed at 5, 10 and 15 meters along each. At each point along the grid soil data was collected within a 25x25cm square and data was recorded describing the LFH (humus) and (A) horizons. Anecdotal observations were made of soil sample micro-site including type of litter and surrounding vegetation. Further information was recoded from a shallow excavation through the LF and H layers as included in "Describing Terrestrial Ecosystems in the Field". The intention is to monitor biomass accumulation and soil development over time, including general observations of soil macro fauna and observable mycorrhizal fungi.

<u>Vegetation</u>

Vegetation diversity data was collected and categorized by layer and percent cover in plots. We assessed species occurrence by frequency and density, as well as the vertical arrangement of the plant communities.

Special note was taken of pit and mound complexes that were formed when trees were pulled over. These are prime microsites for species recruitment. As mentioned, exotic species occurrence will always be noted and appropriate steps for removal will be taken.

Snags

Many of the trees measured in pre-treatment data were marked for culling. Of the cull trees over 88% were turned into snags by either topping or girdling. Permanent plot surveys will allow us to follow closely the wildlife use and gradual decay of these culled trees, culminating with their inevitable fall. We will also keep track of snag recruitment to monitor natural additions of snag structure over time, this will be particularly relevant in the control area plots where we expect many broadleaf snags to occur due to canopy closure.

Gaps

Gaps that occur in the permanent plots from topped and pulled trees will be immediately apparent. These gaps will be measured for size by approximating them as ellipsoidal shapes as in Runkle (1992). Remeasuring gaps and observing closure dynamics, ie. from the ground up or the canopy in, may help guide future thinning entries including created gap sizes. The permanent plots will allow us to observe more gradual gap creation from girdled tree dieback. We anticipate that girdled trees may fall sooner than topped trees.

Wildlife

Any sign of wildlife presence in and around the plots is noted including direct observation, signs of snag use, carcasses, scats, prints, feathers, pluck sites and vegetation browse.

Upon completion of the treatments a second survey of the permanent plots is scheduled to record immediate treatment effects - mainly changes in canopy cover and understory vegetation. An optimum time frame of 5 years for repeat surveying has been adopted in harmony with EMAN protocols. If necessary, maintaining flexibility with this scheduling will allow the future collection of data to occur during times of optimum resource availability. A key consideration should be collecting all data from each treatment, control and mature forest plots at the same time over a period of a month or two. As with photo-monitoring, it is preferred that data be collected during spring and summer months to maximize capture of understory vegetation.

Anecdotal Information

Much time is spent in the treatment area, due to the relatively slow rate in which our treatments are applied. This allows us to make observations about our surroundings while we are there. We are making an effort to record any wildlife sightings or interactions that we observe in a daily journal, maintained at our forest base camp. We hope to gather some data about wildlife use within the restoration site and see changes seasonally and through time. This is by no means a scientific inquiry, however it directs some energy towards an important indicator of ecological function.

We have built a restoration trail that passes through an area where we have applied the full range of our treatments. We are asking for the public to record any observations made while walking the trail and submit them to be included in an anecdotal journal record. We are also developing a monitoring route that keen volunteers, preferably with some naturalist experience or interest, could walk seasonally making simple observations and taking pictures of features such as snags, cwd, understory vegetation, planted seedlings etc. This anecdotal information would be sorted and stored in a database.

Working within Constraints

We are proposing a 20 year monitoring timeframe with repeat monitoring intervals for each strategy indicated in Table 1. During this time period reassessments can be made refining monitoring techniques and repetition times. The monitoring approaches vary in a number of ways including cost, rigour, expertise, time commitment and effectiveness. However, each technique has merit and can be matched to available funds and resources to insure that some form of monitoring be implemented on a regular basis. And when funds are available the most comprehensive methods are employed. Ideally as our project continues to develop, our monitoring scope could be enhanced through partnerships with local and regional interest groups and specialists ie. the Galiano Naturalists, birders, mycologists, botanists and biologists as well as students graduate and otherwise. To date we have attracted 3 interns and 1 masters student to our restoration project and the work of each will fill out our monitoring database and broaden the scope of our project.

Table 1. Monitoring Techniques relative to attributes and ecosystem components.

Ecosystem Components, attributes / Monitoring technique	**Scale**	**Soil Develop ment**	**Coarse Woody Debris Ecology**	**Snag Ecology**	**Understory Vegetation Development**	**Canopy development**	**Wildlife presence**	**Optimum Time Frame**	**Time Commitment**
Detailed Stand Mapping	Broad				Medium	High	Medium	10 years	80 person/days
20 x 20 Permanent Quadrats	Fine	High	High	High	High	High	Medium	5 years	14 person/days
Permanent Photo Points	Fine		Low	High	High	Medium	Low	2 years	4 person/days
Naturalist Observation Trail	Broad		Low	High	Low	Low	Medium	Seasonal – 4 times / year	2 person/days per year

High – Monitoring strategy is very effective in measuring component
Medium - Monitoring strategy is effective in measuring part of the component
Low – Monitoring strategy partially addresses the component

Conclusion

Monitoring is an integral part of ecological restoration. Long term monitoring programs need to show restoration success and detail when and what future treatments may be required. Monitoring a restoration site can be both intuitive and scientific. Through repeat photography, permanent plots, detailed stand mapping and anecdotal observations we hope to capture the qualitative and quantitative effects of our restoration treatments. The Galiano forest restoration project has established a range of baseline data to support a long term monitoring program. The data is affixed to a variety of techniques that vary in their resource- labour, knowledge, tools and time- requisites. By providing a broad range of monitoring tools we, as a non- profit organization functioning on tenuous long term funding, have made it easier to ensure that some monitoring is carried on in perpetuity.

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Acknowledgements

We acknowledge the Penelekut First Nations upon whose ancestral lands we carry out our restoration work. We thank Ken Millard, and the rest of the Galiano Conservancy Association staff, board of directors, volunteers and members for their continued support of our efforts. We also thank Herb Hammond for his mentorship and guidance with this project.