Draft - Stanley Park Forest Management Plan

"Stanley Park's forest be a resilient coastal forest with a diversity of native tree and other species and habitats, that allows park visitors to experience nature in the city."

– Forest Vision Statement, Stanley Park Restoration Plan

February 19, 2009

Executive Summary

The Stanley Park Management Plan is intended to provide an overview of the types of management activities that are required to realize the vision statement first published in the Stanley Park Restoration Plan (Vancouver Park Board, April 2007). This statement seeks to attain a balance between the safe enjoyment of the park and the continued functioning of the urban forest. Ecosystems function in complex ways at the best of times, but within the context of an urban park and shifting climatic norms the job of understanding their current and future condition becomes a difficult scientific challenge. Additionally, the interaction with park visitors and workers adds several more layers of complexity. It was therefore necessary to break down the management activities into modules which represent different disciplines of knowledge. In this preliminary document, each module has stated goals and objectives, and a brief sketch of their relevance to the achievement of the vision statement.

These modules pertain to three somewhat separate functional categories: forest maintenance, forest protection, and forest improvement. Forest maintenance modules speak of day to day activities not much different from what has been done for the past twenty years. They include the tree hazard management program, and wood debris dispensation. Forest protection work modules, whose need was clearly demonstrated by recent storm events, outline essential objectives that seek to reduce the likelihood of large scale forest changes which would compromise the forests value to Stanley Park for many years. Rapid changes should also be guarded against because of significant costs association with their correction. The windthrow, fire, forest health, and invasive plant modules fit into this category. Finally, there are opportunities to enhance the forest by undertaking work which is beneficial to wildlife or forest development, as achieved through the practice of silviculture. A list of activities is generated from the combination of all nine modules, which are summarized in Appendix 2.

Appendices are intended to provide operational level guidelines and instructions so that field work can be conducted to current standards; be they of the forestry or ecological professions. Adaptive management must be used to ensure that changing conditions and our increased understanding will allow for the modification and improvement of park management practices. Therefore, the appendix section is intended to be an actively changing resource as the professional knowledge base continues to develop.

As part of their consultative agreement, the University of British Columbia has conducted extensive forest survey and mapping work which is in an advanced stage of development. The maps will be a key component to the translation of ground data to field decisions and longer term planning and costing. The Park Board, and its consultants during the restoration work, have added to the library of maps; providing the necessary baseline work to manage future park forest operations work through a geographic information system (GIS).

Although the storms of 2006 / 07 were devastating, the extensive media coverage and subsequent community discussion forums generated a great deal of interest in the forest. The community now better understands the complexity of issues set before park managers, and their input should continue to be actively engaged. The Stanley Park Ecology Society has continued with its public education role, and become more participatory with its involvement in stewardship. The University of British Columbia, Faculty of Forestry, is a research and education body of international repute. Significant insights into the changing forest, and the impacts of forest management, can be gained through the continuance of this new relationship. The forest management plan will contain guidelines on how forest managers can structure future interactions with the public, park partners, and the academic community; in order to make the most of these available contributory resources.

Introduction

Stanley Park is Vancouver's oldest and largest park. The forest is a central feature within it. Close to 300 hectares of coastal temperate rainforest provides a place for Vancouverites and visitors to explore an impressive patch of nature within walking distance of the downtown core of the city. One can stroll down corridors of Douglas-fir trees fifteen stories tall, gaze at centuries old tree trunks larger than in any other municipal park in Canada, or witness eagles raising their young in the treetops. It is a place for learning, recreation, healthy exercise and mental relaxation. It is a remnant island of one of the largest and most ecologically productive forests on the planet.

While natural processes still sustain their vibrancy, urban encroachment has irrecoverably changed the complex pathways of ecological function. Keystone species such as elk and bear have long been extirpated from the park. Nobody knows for certain how many smaller creatures of importance have disappeared. Early logging removed many of the healthiest cedar spruce and fir, leaving behind conditions rife for an overabundance of hemlock, a much shorter-lived tree. Early park managers sometimes took very controlling measures in an attempt to enhance aesthetics and other anthropocentric values. Trails, roads, a provincial highway, and the city itself have fragmented ecosystems which have reliance upon connectivity. New species of animals, plants and fungi have become naturalized here, generally at the expense of those already present. Added to these stresses are air pollution, climate change, and ever increasing human activity penetrating the most remote corners of the forest. Incremental degradation from a combination of all these factors has occurred and will remain a threat to the parks ecosystems. Medium scale disturbances caused by wind storms or forest fires can threaten not only ecosystems, but park visitors and structures. Climate change and extreme air pollution, along with their accompanying biological shifts have the potential to cause the most harm.

Over seven million visitors come to the park each year – many more if you count people traveling through the park on Highway 99. Most come close to, or enter into the forest. It is the Park Board's duty of care to take reasonable measures to safeguard these people. The windstorms of 2006 – 07 were a clear reminder of the potential dangers posed by the forest. The subsequent threats of fire, insect damage, and invasive plants forced the Park Board to expend considerable time and money to rectify the damage. A forest fire, or another windstorm, could cause similar damage and risk to human life and property. There are several potential insect or disease outbreaks which, if reaching infestation proportions, could cause widespread setback of the forest canopy. Larger cleanup resources would have to be portioned if the park were to remain safe for visitors. More worrisome still is the considerable possibility that a highly invasive insect which is under federal quarantine protection might establish itself in the forest. International shipping is active all around the park. The mandated actions of the Canadian Food and Inspection Agency have resulted in several preemptive forest clearing operations in major centers such as Toronto and Halifax. The hardship and loss of park beauty would be devastating for a long time.

This management plan tried to 'walk the line' between maintaining a long term functioning ecosystem, and a park environment that is both safe and enjoyable. It contains recommendations for the both the protection and enhancement of the surviving natural processes. It also recommends the continuation and extension of forest management activities that help to guard against the dangerous and catastrophic changes to the forest, particularly its largest elements – the trees.

There will be times when the value of natural function and park management are consistent with one another, at other times they may be more or less contradictory. For this reason, the forest has been divided into 'management emphasis area's (MEA's). They are termed; Safety emphasis MEA's, Regeneration MEA's, Wildlife MEA's, and Resilience MEA's. Within each zone; the value of forest safety, forest resilience, and biodiversity are given different priorities according to the usage of the area. As a basic example; snags may be left for cavity nesting birds in the area adjacent to Beaver Lake, but not if adjacent to the causeway. These values determine the goals and objectives for each area, which flow through to activities and even the timing of activities. They are not mutually exclusive, there will be activities appropriate for all emphasis zones; but the prioritizing of activities will be assisted by this categorization. All activities relate back to the fulfillment of the park forest Vision Statement:

"That Stanley Park's forest be a resilient coastal forest with a diversity of native tree and other species and habitats, that allows park visitors to experience nature in the city".

Forest Management Plan Rationale

The Vancouver Park Board has the duty to care for this resource in such a way that risks to people and property are reasonably managed. Also, there are certain events that occur naturally, such as forest fire or major blowdown, that would have an unacceptable catastrophic impact on the park. Intervention becomes prudent should the risk of these types of events become unreasonably high.

The forest, while historically affected and manipulated by humans, remains a vibrant coastal rainforest of significant beauty with important ecological properties. A balance between human safety and the natural processes that bring people to the forest must be maintained.

Stanley Park's forest has changed considerably since European settlers arrived. At that time, the forest had roughly equal quantities of Cedar, Douglas fir, and Hemlock; as well as greater proportions of Spruce, True fir, and Pine. Due to logging activity and other influences, many parts of the forest are dominated by Hemlock, a tree which is shorter lived, and less resilient to storms and diseases than the other species.

Humans continue to impact the forest. A network of roads and trails cause fragmentation, and alter water flows. Invasive exotic plants, diseases, and animals may be accidentally introduced at any time. The monitoring of these known threats can inform proactive management strategies.

There is an increased global understanding of the importance of all organisms and processes within a forest, not only its trees. The Stanley Park Ecology Society has been leading monitoring programs that continue to yield informative local results. This new information can be brought to bear on forest management decision activities in order to offer improved protection and enhancement strategies for all of the forest flora and fauna.

Module 1 - Tree Inspection and Safety Management

Goals

To reduce the risk of personal injury or property damage caused by failing trees or tree parts to a reasonable level, while sustaining a healthy forest ecosystem. Focus is to be on observable defects in trees.

Objectives

To visually inspect all high usage areas at least once per year.

To remain vigilant to new tree hazards as they may occur throughout the season.

To efficiently correct known hazards on a priority basis.

Policy

The Park Board tree inspection policy (June 7, 1993) was approved by the Park Board in June 1993. It in part reads:

> 'Park trees in high usage areas (e.g. facilities, trails and roads) are inspected annually for signs of defects which could result in their failure. Trees that are evaluated as hazardous are prioritized and scheduled for corrective action.' (V.P.B. 'Tree Inspection Policy,)

Inspection, record keeping, and mitigation

In order to prioritize tree hazard mitigation work, a hazard rating system is used that combines the assessed likelihood of tree or branch failure, with that of the likelihood of causing injury or damage should failure occur. Trained arborists walk the park and inspect every tree with the potential to fall into an area used by people. They look for defects which could indicate imminent tree or branch failure. Those trees with a high combined hazard and target rating are tagged and mapped.

Information pertinent to the tree condition, as well as the recommended corrective action, is recorded and stored. Work sheets can be produced from these records. Photography or other forms of historic record keeping tools are used where appropriate.

Imminent hazards that come to the attention of arborists whether within or outside of the inspection program are attended to as soon as available resources allow.

Hazard abatement generally consists of designated crews which address listed trees by the order of their rating, attending to those in the highest hazard rating category first. Types of abatement activities consist of, but are not limited to; dead/ broken branch removal, crown weight reduction pruning, the attachment of metal reinforcements, or whole tree removal. Historically, a couple of dozen large trees are removed per year, and several hundred are pruned or dead-wooded.

Module 2 - Log and Debris Dispersal

Goals

Provide timely cleanup of debris on a balanced priority of need basis.
Balance efficiency with environmental, aesthetic, and community needs.

Objectives

After future storm events …

Quickly restore access throughout park on a prioritized basis.

In larger blowdowns, first assess the amount of course woody debris (> 12 cm diameter) resulting from both pre and post blowdown conditions.

Retain between 80 and 120 tonnes / ha of course woody debris for reason of ecological integrity (Blackwell & Assoc.) Retain biomass on site when current levels are below high range of target.

During routine work …

Maintain a level of cleanliness appropriate to the park locale.

Discussion

The responsive actions to be taken to the cleanup of fallen or felled trees, or tree parts, vary on a situational basis. Factors affecting these action types are: urgency of cleanup, location of debris, size and type of debris, amount of material, and community demand for specialized community uses.

The order of operations after a major storm event should be prioritized on the basis of the following hierarchy:

Storm cleanup order of operations

Priority	Activity	Area type
I	Emergency / rescue access	- Personal first aid and rescue situations.
2	Park and through park access	- Causeway - Service yard, Major park access roads and driveways, electrical and communication conductors - Seawall - minor roads and driveways
3	Park functionality	- Sports facilities, gardens, major trails - Parking spaces
4	Fire risk	- Areas of high ignition probability during fire season
5	Aesthetic	- Passive use areas, beaches - forest trailsides, watercourses

Tree parts can have environmental, monetary or social value. Other parts are a disposal liability. Where they exist along this scale is individually specific, so decisions on their dispersal should be situational and versatile.

The default value is environmental. Plant parts that are retained or returned to the forest are valuable for nutrient recycling, understory development, and habitat reasons. This action is appropriate wherever the benefit exceeds the damage, and safety allows, logs of merchantable quality included. Factors limiting the retention or return of material are fire risk, safety, equipment availability, and other situational circumstances. Small blowdowns in wildlife emphasis areas generally should be left as is. Those in others management areas may be left as is, or may be bucked to ground level and replanted, depending on the surrounding fire fuel type and other management objectives. Smaller material is run through a chipper and blown into the forest wherever appropriate, but chip deposition depth should be limited to about 10 cm to allow the survival of current understory plants.

From time to time, unusual pieces of wood are brought down. They might be of rare size, shape, or species. Where they do not constitute significant environmental value, consideration can be given to making it available to local first nations or wood craftsmen, or artists. Priority can be given to those projects which represent the greatest amount of public good, as judged by a management authority.

In 2007, a store of unique or individually valuable pieces of wood was created. Its presence was advertised to the public at large and to community wood working 'not for profit' societies, and a giveaway date was set. Much of this wood found its way into willing hands.

After larger storm events, there may come about a third circumstance where significant quantities of merchantable wood either falls from the forest, or must be removed for forest resilience reasons. This occurred in 2006/07, but it has also occurred on several other occasions. Extremely large storm events, which are hopefully very rare, may require dedicated restoration plans; but more regular storm events could be managed within Park Board operations. There are direct costs associated with this cleanup (overtime, crane lift trucks etc) and subsequent forest recovery work, costs for which can be offset by sales of merchantable logs.

Material removed from site that is of non merchantable quality, but is nonetheless suitable for firewood, is currently trucked to a depot at Spanish Banks. The public is allowed to cut and remove the wood on a first come – first serve basis. Some material satisfies none of the above criteria and is therefore sent to a landfill site.

Recommendation

That wood debris and logs continue to be dispersed by a variety of situational dependent methods, as suggested in the flow chart of appendix x

Merchantable timber should be sold through an intermediary, within the statutes of the *BC Forestry Act.* Merchantable logs that are being sold should be cut to a length that maximizes its value, their butts marked with the Park Board timber sales stamp. Any profit from its sale should be placed in a fund that is directed toward established 'Stanley Park Forest Management' fund.

That a fair means of dispersal be devised that maximizes the benefit to the community of occasional pieces of wood of exceptional value, that are of low or negative environmental or monetary value. appendix x provides a suggested hierarchy of needs structure and guidelines for fair dispersal.

Module 3 - Windthrow Management

Windthrow management

Goals

To reduce the potential for wind storms to impact park visitors or staff, or cause damage to park infrastructure or the forest at large, while maintaining natural forest functioning

Objectives

Assess the vulnerability of different parts of the forest to wind damage from routinely recurring wind storms.

Identify the areas within the park where impacts of windthrow are most significant.

Develop and implement zone and stand specific strategies that are expected to reduce the likelihood of personal injury, property damage, or substantial area of tree loss.

Discussion

Wind damage includes major branch loss, stem breakage, or uprooting. Windthrow occurs when storm winds penetrate a forest to an extent rarely experienced, and exerts forces that cause healthy trees to topple. It often begins where there are pre-existing tree defects such as root rot or stem decay, or severely restricting rooting habit. As trees fall and the canopy opens, more wind is allowed into the sensitive interior causing a progression of tree failures. Falling trees impact other trees causing them to break or fall in a sort of 'domino effect'. Windthrow stops when the spreading damage either encounters a wind resistant stand of trees, or the storm winds ebb.

Stanley Park is in a relatively wind exposed location. Historically, damaging winds have come from the southeast (Hurricane Frieda) and the west (December 2006). High winter winds are typically associated with the passage of Pacific low pressure systems and associated fronts. Stanley Park is also exposed to easterly winter outflow winds, to summertime on-shore winds, and to thunderstorm activity. Researchers at the University of British Columbia have made significant advances on the subject of identifying the factors of windthrow risk. The understanding of these factors and their relative weighting is increasing and is being modeled to improve our ability to predict the probability of future events (Landquaye-Opoku and Mitchell 2005, Scott and Mitchell 2005). These factors relate to individual tree, stand level, soil, and topographic characteristics. Many studies have also evaluated the effectiveness of mitigating treatments.

Future storms may come from different directions which could cause a different pattern of canopy opening. Edge boundaries from previous disturbances may be breached and cause further damage. Predictive modeling, when enhanced with field assessments and an understanding of historical patterns, can provide important guidance as to stand vulnerability throughout the park. Current techniques in windthrow modeling enhanced by field assessments and an understanding of historical patterns will provide important guidance to stand vulnerability near newly created edges. While catastrophic windthrow

cannot be prevented without proactively cutting down all tall trees, the frequency and extent of damage can be diminished by conducting a set of preventative actions. It can also be diminished by remaining cognizant of wind damage factors while performing such regular operations as hazard tree management, planting, and trail maintenance. These preventative actions should occur primarily within the safety, regeneration, and forest development zones, though may be shared purpose within *wildlife emphasis zones.* The safety priority zones should take first priority.

As an unmanaged stand of trees in the coastal forest grows following a disturbance, there is much competition between individuals. In a continuing process, the number of large trees over a given area decreases. Those which can best attain sunlight and nutrients thrive; while those that are less fortunate gradually get suppressed by their neighbours. These suppressed trees might die and then fall, or they might have enough resources become very tall, slender, and top heavy but remain alive somehow. They become increasingly unstable until they predictably break or uproot. While this process may be desirable from a wildlife habitat point of view, it is not suitable in the *safety emphasis zones*. A measure of this weakness is the height to stem diameter ratio. While many factors combine to determine what the limit of this ratio is, it should be considered a factor within the hazard tree management program.

The likelihood of windthrow is heightened for several years after a major event. Surviving trees are subject to wind forces to which they are unaccustomed. Some will have had their roots damaged and will therefore be susceptible to pathogens. The newly created forest edge should be treated to prevent a spread of the damage in subsequent storms. The best suited technique of wind firming these newly created edges involves the pruning of remaining branches in a spiral pattern, especially near the top portion of the crown. This reduces the wind forces acting on the crown. Properly pruned trees will regrow the lost foliage, but also have the time for their stems and root systems to adapt and acclimatize to greater wind forces. The amount of branches removed depended upon the species of tree, its position within the newly created edge, and the amount of branch loss during the storm. A sample windfirming prescription is contained in appendix 1. Variations of windfirming techniques have been shown to reduce new edge failure rates by 40 % (Rowan C, 2003).

The windfirming tree work that was conducted as part of the 2007 park restoration followed a prescription drawn from field inspections, but was augmented by the results of computer modeled assessments of vulnerability. Only one of the newly created edges was breached by subsequent storms. It was a small area that was shown by the model to be vulnerable, but had not yet been attended to because there was little risk to the public at that location. All edges have since been treated.

A surprising amount of wind resilience can be designed into a forest at its early stages. Care should be taken to avoid a forest structure where trees are crowded, racing against each other for a bigger share of the sky. A planting strategy where trees are placed in small clusters, with open spaces between clusters, has been shown to develop trees which retain their lower branches. This makes the stems stronger, and brings about a more favourable weight distribution. Using different species within each cluster will result in tree group that have different sway properties in the wind, which helps to dampen motion during high winds.

There are existing stands of trees which have been planted so densely that there they are becoming susceptible to wind storms. Their long term viability can be enhanced through the application of a judicious thinning program, as described in Appendix 2. Wind resilience, a more vibrant understory, and a faster track to reach stand objectives are the advantages, but care should be taken not to increase fire , insect or disease risk .

Recommendations - general

Continue the Hazard Tree Management Program

Investigate the usefulness of software tools that inform decision making (e.g. WindCalc)

Recommendations – safety emphasis zones

a While performing hazard tree assessment work, consider the height to stem diameter of suppressed trees. Remove trees with such tall and slender dimensions that they are likely to be unsustainable, or those that will soon to grow into that range.

b Where light conditions are adequate for the recruitment of canopy trees, plant Douglas fir, red cedar or bigleaf maple in secure mineral soil. Brush around replacement trees only long enough to ensure their health.

c Consider ditching, draining, or culvert expansion as a means for improving soil conditions in places where impaired drainage restricts roots.

h & i See below. Use most conservative thinning regimes when working in safety emphasis zones.

Recommendations for regeneration emphasis zones (new forest openings)

d Windfirm canopy trees adjacent to new openings by spiral pruning. Appendix 1 contains sample prescription.

e Plant trees in clusters of three to five. Gaps between clusters, and between stand edge and clusters, should be within a range of eight to ten metres. Resulting density will be 300 – 500 seedlings per hectare.

f Use at least two species per cluster, in order to increase future wind dampening effect.

g Reduce densities of natural hemlock regeneration where it competes with other species, to achieve stand target objectives.

Recommendations for forest development zones

h Tree stands planted between 1988 and 1998 should be considered for thinning, dependent on their current conditions. Appendix 2a contains recommended prescription.

i Tree stands planted in the post Hurricane Frieda era of the 1960's should be considered for thinning, dependent on their current conditions. Appendix 2b contains recommended prescription. Cost benefit analysis suggests that the priority of this work is secondary to that of those planted after 1988.

Module 4 - Fire Management

Goals

To reduce the likelihood of uncontrolled fires burning the forest, and to minimize the extent of damage and risk to park visitors caused by escaped fires.

Objectives

To continue to strengthen and implement the existing Stanley park fire management plan.

Implement an ecologically sensitive fuel reduction program that is responsive to changes.

Discussion

While wildfire is an integral and necessary part of the functioning of many British Columbian ecosytems; it is less critical to the Stanley Park forest. Throughout the ecological history of the coastal temperate rainforest, fire has been relatively rare. Fire in the urban forest interface is a threat to persons, property, and the aesthetics of the forest. Smouldering ground fires will emit high levels of carbon monoxide, as well as potentially dangerous levels of airborne particulate matter. Depending on wind direction, smoke from a Stanley park fire will disrupt air and vehicular traffic. Higher intensity fires can spread very quickly and spark new fires ahead of its front, and in buildings. Even if persons and property are protected, a wildfire could cause widespread devastation to the forest that would be an eyesore for many years.

It is for these reasons that fire in Stanley Park should be prevented and suppressed.

Fire Management Plan

The Park Board currently has a Fire Management Plan, albeit that it is distributed over several documents. Updating and repackaging the document is recommended. As a municipal park on federal land, the provincial Wildfire Act (SBC2004) and the Wildfire Regulation (BC Reg. 38/2005) do not legally apply to Stanley Park. Nonetheless, much of their accumulated knowledge and recommended procedures are directly applicable and should continue to act as a guide. After the disastrous Kelowna forest fire in 2003, the provincial government commissioned a review of the events with the aim of preventing recurrences of that severity (Filmon, 2004). The lessons and recommendations from that inquiry have been also taken into consideration.

The three elements of the fire management plan are: preparedeness, prevention/detection, and suppression. A considerable amount of work on each of these elements has already been done over the last twenty years, and is here summarized.

Preparedness	Prevention / detection	Suppression
- Interagency collaboration - Communications and media plan - Infrastructure - Pre-fire season preparation - Fuel and fire risk mapping - Fire hazard abatement - Staff training - Fire fighting equipment upgrades	-Fire watch patrols -Bylaws, Prohibition schedules -Fire weather monitoring -Public awareness protocols -Communication with local air services - enforce camping prohibitions	- Park evacuation procedures - In event of fire - Staff level hand tools for extinguishing controlled fires -Vancouver Fire & Rescue Services wildlands equipment -Metro Vancouver Rapid Attack Team -MoFR water bombers

Strategies

Procedural

That the fire preparedeness plan be reviewed annually.

Maintain a contact list of people that could potentially be involved in the execution of the fire management procedures. Review it for correctness before each fire season.

Continue meeting with the Vancouver Fire and Rescue Services; and the South Coast Interface Committee on a regular basis to maintain and improve interagency cooperation.

That the Stanley Park Fire Preparedeness - Media Communications and Media Plan be maintained in a ready state, and followed should events require.

Replace missing trail markers at intersections to assist Fire Department crews with way finding.

Erect a system of gates and barricades to prevent unauthorized vehicular access to the trail system.

Maintain a database of fire start locations to assist in fire prevention efforts.

Fuel reduction

Chip or remove trailside and park edge pockets or piles of brush

Reduce, disperse, or lower to ground level excessive slash in areas with fuel types S-2 (see Fire preparedeness IV).

Remove deadfall, wood piles, and shrubs of flammable species from within 10 metres of flammable structures (FireSmart BC, 2005).

In areas where ignition probability and potential consequences are high, consider the trailside removal of low branches that form a fuel ladder effect within areas of fuel types of c2, c3, and c4.

Module 5 - Invasive Plant Management in Forested Ecosystems of Stanley Park

Goal:

To promote resilient and diverse forest ecosystems in Stanley Park by managing and controlling alien invasive plant species in a timely, environmentally sensitive and effective manner.

Objectives:

1) To regularly monitor forested areas and surroundings to ensure emergent invasive plant infestations are recognized before they have a significant impact on ecosystems.
2) To prioritize management efforts to focus on invasive species according to their potential and realized threats to forest ecosystems.
3) To apply best management practices for invasive plants while taking into account legal requirements, impacts on Park ecosystems, as well as the safety of Park staff, volunteers and visitors.

Issues

Invasive plants are non-native species that pose undesired or negative impacts on native biota and ecosystems, managed landscapes and/or human health. These species are able to spread quickly, grow rapidly, and thrive in their new environments, resulting in impacts to environmental, economic and social systems. (Examples include English Ivy, Japanese Knotweed and Himalayan Blackberry)

Invasive species contribute to habitat loss. They are able to shade-out, smother and displace native plants that provide valuable habitat in our ecosystems. Some of these plants also produce toxic substances that inhibit the growth of native species. Others can alter water flow, cause erosion, or increase fire hazard. Invasive plants causing each of these issues can be found in Stanley Park's forest today.

Management Strategies for Invasive Plants in Stanley Park

Management of invasive plants should take a multi-pronged approach that recognizes the immediacy and extent of the threat. Some newly introduced plants should be eradicated quickly, while established plants should be contained.

Monitoring

Stanley Park's ecosystems should be regularly monitored for changes in vegetation through on-going sample plots and mapping

Targeting and Prioritizing Species for Removals

Prioritizing actions to deal with potential or realized infestations is imperative to ensure timely and effective measures to manage invasive plants. The following table exhibits key traits to consider when developing these plans.

Factors	Lower priority	→	Highest priority
Size of area infested	Large	Medium	Small
Density in invaded areas	> 40% coverage	10-40% coverage	<10% coverage
Degree of establishment	Well-established	Somewhat established	New introduction/ just getting established
Potential negative impact to Park ecosystems or public safety	Low	Medium	High

Implementing Best Management Practices (BMPs)

By implementing BMPs in the management, control and removal of invasive plant species in Stanley Park, the Vancouver Park Board and its partners will be poised to successfully manage invasive species in a way that takes into consideration legal requirements (such as the breeding bird season as legislated in the Wildlife Act), and promote practices that minimize impacts to Stanley Park's ecosystems and recreational values. This may include mulching and replanting after an invasive plant pulling exercise.

Long-term Monitoring, Maintenance and Re-evaluation of Management Practices

Following treatment, it is important to monitor sites over the long-term. The successful removal of invasive plants from an area often requires multiple maintenance treatments. Depending on the success of treatments, different management techniques may need to be applied.

The Role of Collaboration, Information Sharing and Knowledge

Throughout the management process, it is important to maintain strong ties with partners, researchers, regional groups and other agencies involved in invasive plant management to remain up-to-date on invasive plant concerns, share best management practices, and to contribute to initiatives at a regional level. In 1998, the Vancouver Park Board adopted a Volunteer Policy that describes the relationship between volunteer work and union work. Invasive plant pulling in the park has been conducted within that policy since that time.

SPES are also members and active participants within the VPB Park Partners Program. Stanley Park Ecology Society staff and volunteers have worked alongside parks staff, providing background and physical assistance for invasive species control. The cooperative relationship between Park Board and SPES will help to ensure that the strategies are applied effectively in Stanley Park.

Module 6 - Forest Health Factors

Goals

To manage the health of the forest such that severe insect or disease infestations, or abiotic disorders, do not cause tree losses constituting catastrophic changes to the ecology of the forest

Objectives

To identify and understand which forest health factors represent significant threats to Stanley Park, and to remain current as environmental conditions change;

To develop and implement monitoring protocols for threatening insects and diseases;

To implement biorational control strategies when population levels reach the point where damaging infestation is imminent.

Discussion

An unhealthy forest is one that is going through rapid change from its current condition to that of another which is less diverse, and less robust in its production of biomass and creatures. If the management plan is to improve resilience and diversity, it must be able to guard against agents of insects and diseases which bring about such rapid change. They may be in the form of invasive pests, which almost always reduce forest health, or they may be in the form of indigenous pests which are opportunistic to some new environmental stress. Forest managers must be aware of the difference between insects and fungi which are merely speeding up the cycling process, killing a weak tree here and there, and those which can cause long term reduction in forest health.

The University of British Columbia has been conducting intensive studies within the park as part of the restoration work and consultative agreement. Insect trapping work by Dr John McLean has provided us with the good news that there have been no captures of the most serious quarantined pest insects. And what is further good news, there has not been a rapid increase in numbers of indigenous insects that can also pose a threat. Forest technicians found many of the well known pathogens that attack Hemlock or Cedar, but found no indications of Douglas fir root rot. Nevertheless, vigilance is required. The plethora of stumps in the park can be a source of energy for insects and diseases which may later move to healthy trees. Climate change and an aging tree population are preconditions for damaging infestations, both are factors at work in Stanley Park forest. Monitoring is essential if there is to be hope of warding off a major problem before it exceeds our ability to control it. Species specific monitoring protocols for all expected problems in our forest have already been developed, but require customization.

Control strategies would need to be consistent with the biodiversity and habitat protection goals within the vision statement, and the City of Vancouver Pesticide bylaw.

Expected threats

Insects	Diseases
Douglas fir bark beetle	Mistletoe – hartigii stem rot
Hemlock looper	Butt rots (various)
Invasive insects (long horned beetle, gypsy moth)	Laminated , Shoestring root rot

Dwarf mistletoe (*Arceuthobium tsugense*) / *Phellinus hartigii*:
Very common in the park, primarily on Hemlock trees. Causes 'witches broom' disfigurements on branches and vectors a serious heart rotting fungus called *Phellinus hartigii*. This heart rot is responsible for many tree failures.

Butt rot (*Heterobasidion annosum*):
A root rotting fungus that attacks all conifers, primarily Hemlock. It is common throughout the park, and causes whole tree failure. It is difficult but possible to detect.

Laminated root rot (*Phellinus weirii*):
A root rotting fungus that attacks entire stands of Douglas fir, spreading from tree to tree. Preemptive tree removal is considered necessary to cease its spread. It has not been confirmed in the park, but the windthrow damaged forest is at higher risk.

Shoestring rot (*Armillarea* species):
Occasional in the park, on either hardwood or softwood trees. Causes mortality. There is likely to be a heightened risk since the blowdown.

Douglas fir bark beetle (*Dendroctonus pseudotsugae*):
Pheromone traps confirm its presence at sub-infestation levels. It has the ability to breed in large numbers when there is a source of Douglas fir logs, but most of these were removed during restoration work, to the prescription of Blackwell & Associates. A infestation has the potential to cause mortality under high population pressure. See http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/beetle/betletoc.htm for more information.

Western hemlock looper (*Lambdina fiscellaria*):
There have been periodic outbreaks of this foliage feeding caterpillar, with numbers building up over several years prior to widespread mortality. The last infestation was in1959, but the insect is present in the park and remains a potential threat. See http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/defoliat/chap4c.htm for more information.

Exotic insects

The Canadian Food Inspection Agency (CFIA) monitors for threatening invasive insects. None have been found in Stanley Park since the 1992 Asian Gypsy Moth discovery, but an eradication program would be mandated should certain insects or diseases be found. Significant threats include, but are not limited to:

Gypsy moth	(*Lymantria dispar*)
Asian Long horned beetles	(*Anoplophora glabripennis)*
Sudden Oak Death	*(Phytopthora ramorum)*

For more information see http://www.for.gov.bc.ca/hfp/gypsymoth/history.htm, http://www.inspection.gc.ca/english/plaveg/pestrava/anogla/asialonge.shtml and http://www.inspection.gc.ca/english/plaveg/pestrava/phyram/sodmsce.shtml

Module 7 - Managing for Wildlife and Habitat in Forested Ecosystems of Stanley Park

Goal

To manage for the stewardship and enhancement of wildlife species and their habitats within Stanley Park forested areas.

Objectives

Establish Wildlife Management Emphasis Areas within the park.

Ensure that the Forest Management Plan conforms with all applicable federal and provincial legislation related to wildlife and fisheries habitat.

Protect those species with special status (such as 'Species at Risk') and their habitat.

Facilitate projects that protect or enhance wildlife and their habitat.

Discussion

Wildlife Management Emphasis Areas represent those areas of the forest that are of high importance to the ecological integrity of the Park. They may be areas of productive wildlife habitat or areas of unique or rare habitat. They may provide essential corridors for wildlife movement or be important habitat for Species at Risk. They may also be places of disappearing biodiversity, requiring protection. Maps are used to indicate designated areas.

Wildlife Management Emphasis Areas

1. Wetlands, Watercourses and Riparian Areas.
These are essential habitat for many species of wildlife including waterbirds, migratory songbirds, small mammals, amphibians, fish and aquatic invertebrates. Riparian Zones are areas of mostly deciduous vegetation directly adjacent to watercourses. They are areas where several habitats can be found in close proximity and are important corridors for wildlife movement.

2. Bird Colonies and Raptor Nests and Veteran trees
Stanley Park has important habitat features favoured by colonial nesting birds and birds of prey. Rocky cliffs, large stands of mature trees and veteran trees in close proximity to the seashore provide valuable breeding habitat for cliff nesting species such as pelagic cormorants, colonies of great blue herons, bald eagles, and other birds of prey.

3. Rare Forest Habitats

(i) Remnant old growth forest features in the Park are found adjacent to Tunnel trail and Pipeline road. The veteran trees that have persisted in the Park since before logging provide essential habitat to many species including bald eagles, owls, bats, and flying squirrels.

(ii) Skunk cabbage Woodland Site Associations have very wet and nutrient rich soils which are particularly sensitive to compaction. They are also important habitat for many rainforest species including amphibians, shrews, and insects.

4. Rocky Outcrops - Surficial Geology
These areas of the Park are found primarily along the steep slopes near Prospect Point and Siwash Rock. They provide protection to wildlife from predators and while many species, such as peregrine falcons may use these locations for only brief periods, others like cormorants, guillemots and gulls use them extensively.

5. Ecotones
These are edge habitats which provide special refuge, breeding and feeding opportunities for wildlife. Shrub-forest edges are the most productive for wildlife in Stanley Park but all edges are used preferentially by certain species of breeding birds, aerial predators, grazers and small mammals.

Monitoring Wildlife Activity
Long-term management will require that wildlife and habitats are inventoried, mapped, and monitored. During the restoration process inventories were completed in blowdown areas by professional biologists for Species at Risk. The Stanley Park Ecology Society has been adding to this baseline information and continues to work on several wildlife inventory projects independently, and in collaboration with academic institutions and professionals in the field. Long-term wildlife monitoring projects in the Park are undertaken by the Stanley Park Ecology Society in cooperation with the Park Board.

Operations in Wildlife Areas
The Forest Management Plan must balance the needs of wildlife with other issues of the urban forest such as public safety or fire risk. For Wildlife MEA's, wildlife and habitat guidelines and practices will be given high consideration during regular park maintenance activities. Where Management Areas overlap, each area's recommendations will be considered and decisions will be prioritized. For example, if a safety MEA and wildlife MEA overlap, the priority may be determined to go to safety operations (such as hazard tree removal) but due to the sensitive nature of the habitat, special attention will be paid to the methodology and timing of these activities.

The Forest Management Plan appendix will describe a list of recommended activities and work precautions that will help to protect and enhance wildlife and their habitat.

Module 8 – Establishing New Stands

Goals

After a disturbance, establish a diversity of new trees which will be resilient against further disturbances, while protecting ecological values. Survival and growth rate should be enhanced by using a variety of tools and methods.

Establish new forest stands in small parcels of current forest edge that currently serve no recreational, aesthetic, or operational purpose.

Objectives

Plant trees that will start the area on a path toward achieving the stand objectives; which are determined by the site growing conditions, and other specialized objectives.

Control the competing vegetation that would kill or slow the growth of planted trees.

After the trees are large and healthy enough to no longer require the brushing of competing vegetation, selectively thin their numbers to desired stocking levels and special arrangements. Transplanting to other locations may be considered.

Discussion

There are three basic categories of areas that will require stand establishment treatment; small stands established between 2002 and 2006, blowdown areas from the 2006 / 07 storms, and future stands that are yet to be planted.

All tree planting since the 2006 storms have been done according to prescriptions based upon the nutrient and moisture regimes, exposure, and light availability. These prescriptions had the following elements:

- native species mixtures suited to the site series and local conditions;
- suitable seed source, genetically adapted to current and future conditions;
- 615 container nursery stock, or 1 gallon containers;
- cluster planting using irregular clumpy or scattered spatial distribution;
- wide spacing between clusters to allow shrub and understory development;
- carefully selected sites for each tree;
- plans to brush (weed) and thin over crowded clusters as they grow.

Module 9 – Established plantation treatments

Goals

Increase future wind resilience of established plantations by thinning the stand density to a level where trees can retain their side branches and develop strong stems.

Enhance wildlife habitat by opening the forest floor within plantations to more sunlight.

Hasten the development of plantations toward their stand objectives by increasing tree growth and species diversity.

Objectives

Determine which plantations would benefit significantly by the application of thinning treatment, and the most effective order in which to address them.

Bring stand density in these plantations down to a level that will achieve the stated goals.

Discussion

Two goals of the Forest Management Plan are the enhancement of wildlife habitat, and the reduction of the potential for wind storms to cause damage to the forest. A low impact way to positively direct the development of human originated plantations is to reduce the density of trees. Until 2007, plantation work involved the planting of trees at a very close spacing, with the expectation that they would be thinned manually at a later date. This work has occurred, and should continue to occur on a programmed basis if those stands are to achieve the vision of this plan. Failure to do so would result in plantations full of poorly structured trees of tall and slender stems, top heavy with a tuft of branches located only near the tips. Additionally, insufficient light will permeate their canopy to nurture the shrub, herb, and moss layers beneath.

Thinning should be conducted after the trees are tall enough to compete with the resultant regrowth of shrubs; which is, depending upon the site richness, between four and six metres in height (eight to fifteen years of age). It should be done before the trees reach a size such that the trees become too technically difficult to cut down. After they reach the height of about ten to twelve metres (about thirty years), falling results in dangerous hang ups. The remaining trees can then become vulnerable to wind damage themselves. Many of the plantations are stocked with Douglas fir, whose stems at that age are too large to run through the portable chip grinder. Removal from the stand is costly and risks damaging retained trees, yet leaving stem logs over 30 cm in diameter provides breeding material for bark beetles (see appendix X). Work should therefore be conducted during the juvenile stage, according to stand specific prescriptions. There are approximately ten hectares of plantations within this workable maturity range that are eligible for thinning treatment.

Recommendations

Perform cost benefit analysis on a plantation by plantation basis in order to determine the need, and priority for treatment.

Thin eligible conifer stands according to stand specific prescriptions (see appendix X)

Survey and collect tree and understory data prior to, and subsequent to thinning treatments.

Survey and collect wildlife data prior to, and subsequent to thinning treatments.

Assess impacts of thinning treatment and make necessary adaptations to thinning regimes.

Management Emphasis Areas

In a large space such as Stanley Park, there is a considerable gradation of public usage patterns and expectations. Some areas are visited frequently while others are so remote that it is very rare for anybody to pass by. On a different level, the natural makeup of the forest varies substantially as well: ranging from cliff bluffs to ravines, and from homogenous stands of planted trees to multi aged mixed species stands. Management practices should reflect this varied pattern of park use while respecting the range of ecosystems within the forest.

'Management Emphasis Areas' are where park usage patterns, distinctive work requirements, or ecological preconditions suggest a similar emphasis placement upon management objectives. They are not exclusionary to each other, but can act as a guide to decision making. They may utilize unique sets of work practices or restrictions, or be used to set activity priorities.

> **Safety emphasis area**: Near enough to well used portions of the park for tree failures to cause damage or injury. The correction of danger trees, and the fostering of resiliency are on a higher priority level than other portions of the forest.
>
> **Regeneration emphasis area:** Blowdown patches from the 2006/07 storms, or smaller openings created by other recent storms, where the primary emphasis is to ensure the successful colonization of a well adapted community of trees and understory. Other values such as wildlife habitat and resiliency are intended to benefit from the proper management of this establishment period.
>
> **Wildlife emphasis area**: Riparian areas and wetlands, bogs, forest edges, deciduous stands, bluffs, veteran trees, and ephemeral raptor nesting trees have been identified as having a particularly high value to wildlife. Protection and enhancement activities are given a higher level of consideration than in other areas of the forest. Sub-area specific strategies are detailed in table xxx.
>
> **Forest Resilience area:** Areas where subtle interventions that improve forest resiliency are employed where most necessary, but the allowance of natural processes is generally favored. It's area is defaulted to the remainder of the forest. Priority activities are to favor resiliency; by undertaking practices that reduce threats of major disturbances (wind, fire, pest outbreak), as suggested by forest conditions.
>
> **Views and other special areas:** Three areas near Prospect Point (see map xxx) contain attractive water and mountain views that were opened up by 2006 storm. Maintenance of these corridors would be an asset to the park visitor's experience.

Map xxx is a depiction of suggested boundaries of management emphasis areas. The map is a visual guide only, more detailed ground level assessment is advisable. Safety emphasis areas are determined in the field and are dependent upon tree height and other tree hazard related factors. The Regeneration Emphasis area boundaries may shift when more storm openings occur, and as the 2007 planted trees become established. Some of the Wildlife Emphasis area boundaries are related to unchanging features such as riparian

and wetland areas or bluffs, but included within them are more ephemeral protection areas around raptor nests or bird colonies. Future parks managers will make judgement on the continuance of view corridors.

When boundaries overlap, which they often will, then a more complex decision making process must be employed. The emphasized values of all overlapping areas must be considered on a situational basis. Where a Safety Emphasis area is involved, the well being of the public and workers must be held as the highest priority.

Climate change

Goal:

To maximize the forest's contribution to reduction of atmospheric greenhouse gases by managing it for maximum productive health

Objectives:

Preparing for expected changes in weather patterns by implementing management practices that reduce the likelihood of catastrophic fire, insect/disease outbreak, or windthrow

Adapting tree planting and silvicultural practices, including invasive plant control, such that they are effective under today's climatic conditions, and also under those projected for the future

Setting up 20 permanent sample plots within the forest to monitor ecological change over time, and thereby informing further adjustments to the management plan

Discussion:

The Intergovernmental Panel on Climate Change (IPCC) reports that "a global assessment of data since 1970 has shown it is likely that anthropogenic warming has had discernible influence on many physical and biological systems Major changes in ecosystem structure and function, species 'ecological interactions', and species' geographical ranges, with predominantly negative consequences for biodiversity and ecosystem goods and services" can be expected. It is therefore important that the Park Board work toward global sustainability by protecting the forest for its contributions to the global atmosphere. At the same time, it must guard against the negative effects that are likely to result.

The Stanley Park forest has a landscape level role in the sequestration and storage of green house gases. The coastal temperate forest has some of the highest carbon stores in Canada, averaging 311 tonnes / hectare (David Suzuki webpage). Estimates of 600 tonnes / hectare of carbon from some parts of Stanley Park have been made (Blackwell). Fast growing stands of trees, notably the post hurricane Frieda Douglas fir stands, are growing very rapidly and are helping to remove greenhouse gases from the atmosphere. Other areas are likely to be giving off more greenhouse gas than they are absorbing, but they nonetheless continue to store carbon in the form of slow-to-rot cedar logs. An occurrence of forest fire, disease outbreak, or a large scale windthrow event will cause a surge of carbon release. Therefore, the maintenance of a healthy forest in Stanley Park is the best way to maximize its net greenhouse gas benefit.

Vancouver's mean annual temperature is expected to rise between 1.5 and 3 degrees Celsius over this century. The summers are expected to be hotter and drier than in the recent historical past (Dr. S. Aitken). Those species which are adapted to that condition do well, but those requiring damper summers will weaken and decrease in population. A study of pristine west coast

temperate forests, released in 2009, found that the rate of tree mortality has been doubling every seventeen years. Climate models by Hamann and Wang (2006) predict that the coastal forest ecosystem in which Stanley Park now resides will shift northward and to higher elevations. Based upon that prediction, our Western Red Cedar is expected to struggle on the drier sites that it is now capable of occupying, and perhaps to decrease significantly in number, but it would probably be tolerant to the change on wetter sites. Hemlock could face a similar shift. Douglas fir is adapted to more interior forests that are hotter and drier now than Stanley Park will be at the end of the century, so it is capable of expanding its coverage. The shrub and herbaceous layers are expected to experience similar upheavals. The wet nature of large parts of the park gives hope that few species of plants and animals will disappear completely, but that is a speculative statement.

Assuming climatic projections are correct, the frequency of catastrophic forest fire is likely to increase. Whether insect and disease outbreaks will increase in frequency and intensity is open to conjecture, but it is well established that stressed plants are more vulnerable. Invasive plants that are accustomed to growing in open, sun-exposed environs may have a stronger competitive advantage over indigenous plants.

There is much speculation that warming ocean temperatures will increase the severity of storms by adding more kinetic energy to the atmospheric/hydrospheric system. Research on tropical hurricanes in the southern US revealed that the 'increase in the most severe storms – category 4 and 5 hurricanes, which have doubled since 1990 – was directly linked to the rising temperatures of tropical oceans, which warmed globally by 1 degree F during the same period. Warm water vapor rising from the sea helps energize massive storms' (Curry J. Science 2005, 309 1844-1846). Hurricane Frieda, which caused widespread damage throughout the lower mainland in 1962, generated in tropical waters.

The extent of climate change and its effects on the forest are not completely understood. Adaptive management techniques that are both proactive and appropriately responsive should be employed.

Target Stand Conditions

Current forest stands in Stanley Park have been heavily influenced by a long history of both natural and anthropogenic disturbances. Coupled with underlying variation in soil and terrain conditions, the result is a varying patchwork of tree species composition, age classes, spatial pattern and horizontal structure. Taken in its entirety, this variation contributes greatly to the biological diversity of the park and the corresponding opportunities for human enjoyment.

The tremendous variation that exists within stands cannot be captured completely in a set of stand management objectives. Instead, a set of archetypical descriptions has been developed that encompass the most common patterns of stand structure and development within the park. These descriptions cover a wide range of developmental stages, starting with the period immediately after a major disturbance. While relatively ephemeral and hopefully small in extent at most time periods in the future, very young stands are important to recognize as it is this stage in development where managers have the greatest opportunities to shape long term outcomes.

The philosophy behind these stand management objectives is the development of a diverse and resilient forest condition, with plant communities ideally suited to the underlying environmental conditions. The described targets emphasize a forest structure with a moderately open canopy, both to promote wind firmness of individual trees and to enhance opportunities for regenerating trees and a range of understorey plant species such as vine maple, salmonberry, sitka mountain ash and sword fern. It is expected that a rich diversity in floral composition will also lead to increased niche opportunities for faunal species.

In order to facilitate development of an appropriate range of stand diversity, the archetypal descriptions below are intentionally flexible. It is intended that stands as recognized by lines on a map will also contain considerable internal variability, and no one position within a stand will or should perfectly conform to the written descriptions. It is also important to recognize that stand boundaries are often indistinct, and become more so as stands age. The spatial gradation from one stand type to another is often a desirable feature that should be embraced through appropriate application of the stand management objectives.