RESOURCE MANAGEMENT PLAN

CENTRAL PARK

BURNABY, B.C.

LETTER OF TRANSMITTAL

Dear Mr. Spelay:

We are most pleased to enclose our report on the management of vegetation resources in Central Park. We have endeavored to provide both an intensive analysis of these resources in the context of their location and present condition, and a comprehensive review of how they may best be managed to ensure that they continue to contribute as major components of the park character. In so doing, we trust that we have provided a format that could apply, with some modification to reflect use patterns, size and type of vegetation resource, to any of the parks in Burnaby.

We have found that the major tree canopy in Central Park, particularly in open areas, is suffering from both intensive public use and intensive maintenance of the grassed areas. In order to remedy this situation we have provided specific recommendations for management of these locations. In addition, we have examined the landscaped and more heavily wooded areas and have given some suggestions for future maintenance. Few, if any, of the recommendations require major alterations to present activities and should, therefore, require only modest budget changes to ensure implementation.

M.R. Gardner

per Juri Peepre

1982

ACKNOWLEDGEMENTS

The authors wish to thank a number of staff at the municipality for their assistance and time spent outlining constraints that have affected park development. In addition, a number of part-time staff assisted the principal writers and we wish to recognize their contribution.

Mr. Barry Elliot was instrumental in providing the work outline for the study and prior to his departure to enter private practice provided logistical assistance in the initial stages of the study.

Mr. Walter Spelay in the Burnaby Parks and Recreation Department provided the liaison necessary to complete the report while staff in the planning, legal, and computer mapping groups provided support assistance.

Ms. Jill Singleton was responsible for analysis of the understory in the park and provided some sections of the written report. Ms. Carolyn Girard and Ms. Lea Price assisted in the graphics and photography respectively while Mr. Peter Wharton undertook the field work and analysis of the transects for the wooded areas. Mrs. Terry Salway and Ms. Susan Munro typed and edited the drafts and final copy of this report.

To all we extend our thanks for their participation, cooperation and assistance.

TABLE OF CONTENTS

LIST OF PLATES

18. Severe turf dieback emphasizes the bareness of path and water edge treatments.

19. Opportunities to view birdlife and small forest mammals will be enhanced by development of the water and forest edges.

20. Spot thinning of the shrub understory is required for underplanting of this single-age stand.

21. Park character is diminished by the open parking areas. These may benefit from some screening with appropriate shrub species.

22. Turf condition, inappropriate formality of shrub plantings, poor trail definition and the need for more intensive maintenance of newly planted trees is evident here.

23. The small crowns and fairly narrow stems are a reflection of original spacing. Initial crown dieback due to compaction is evident on the tree in the centre.

24. Severe crown dieback is prevalent in many high-use areas as a result of soil conditions, poor drainage and compaction by foot traffic and mowing equipment.

25. Various stages of crown dieback are evident from each of the trees on the edge of this open area.

26. The drawn-up nature of some trees and the extremely small crown to height ratio is already evident in this location.

27. As dieback has become evident with unthrifty crowns, removal of lower dead branches has been an ongoing maintenance task.

28. This cross section of a Douglas-fir in the area with severe dieback shows the original fairly rapid growth which has diminished in the last eight or so years as compaction has increased.

LIST OF MAPS

(a) Enclosed in body of report

1. SITE LOCATION MAP

(b) Enclosed in envelope at back of report

2. SITE MAP

3. LANDSCAPE MANAGEMENT PLAN

4. WOODLAND MANAGEMENT PLAN

LIST OF TABLES

LIST OF APPENDICES

1.0 REPORT INTRODUCTION

The Park Management Plan was commissioned by the Burnaby Parks and Recreation Department as part of a program to preserve and enhance the existing condition of Central Park. A further intention has been to provide a suitable format for management of other similar park facilities in the municipality.

1.1 Scope of Study

The study set out to inventory the tree resource; to develop a management plan upon which operations and budgets can be based and to summarize sound woodland management practices that apply to the various wooded or landscaped areas within the park.

1.2 Approaches

This report addresses two aspects of Central Park. These are those areas that are primarily supporting trees as overstory, trees as understory and shrubs, referred to in this report as "woodland", and those areas that have been developed, planted or have intensive use facilities, which are referred to as "landscape".

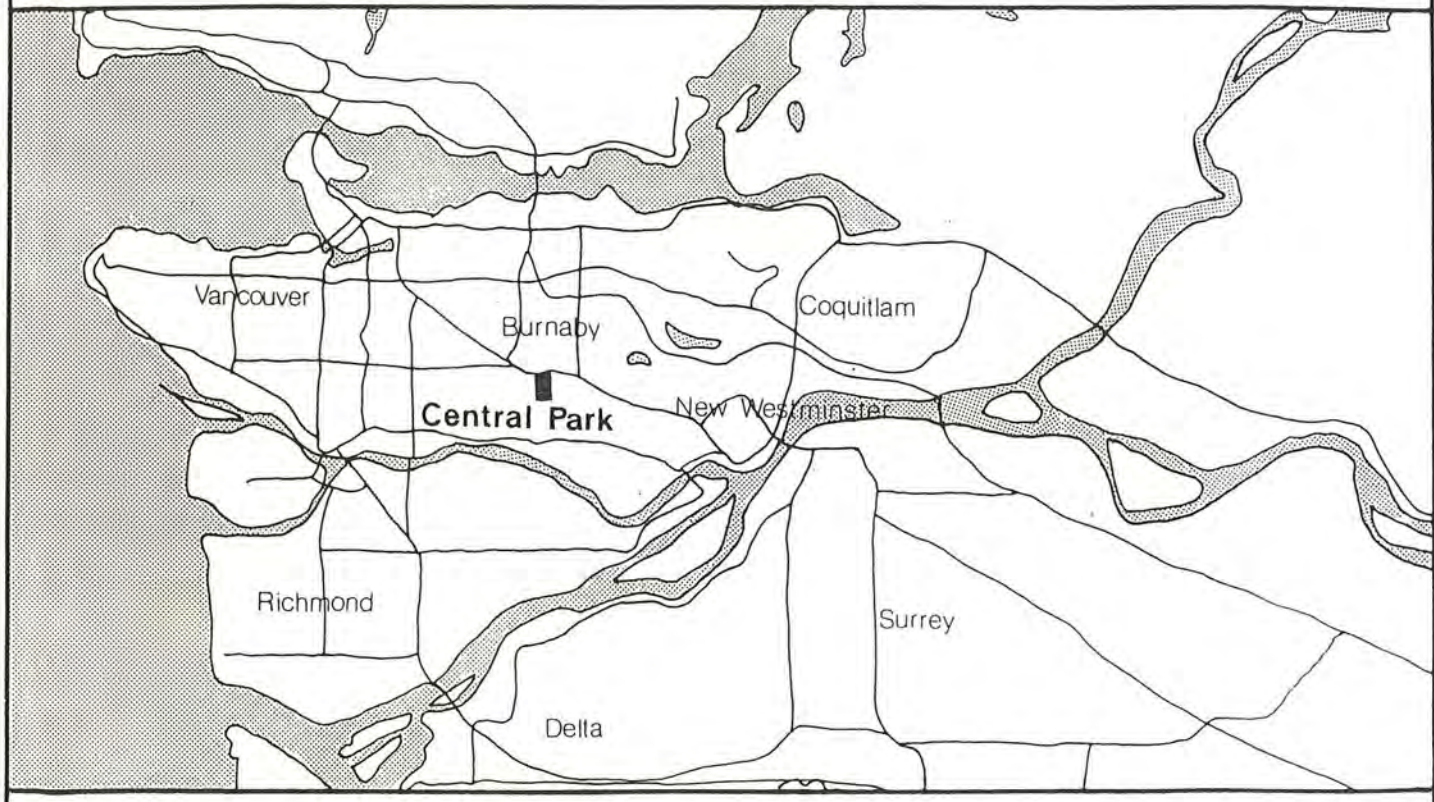
The report is divided into two analytical approaches, resource analysis areas and future management units. These are based on evaluation of aerial photographs and the site inventories conducted earlier in the year. The inclusion of Landscape Management Areas in the report is intended to illustrate that an integrated approach to the entire park resource will benefit and reinforce efforts to protect individual tree cover. Landscape Management is therefore inseparable from Woodland Management, and the approach to the study reflects this dual strategy.

1.3 Concerns and Problems Addressed

Preservation of the treed character of the park was addressed from both the aesthetic and ecological point of view. Controlling the pedestrian pressures on the site, maintaining tree health and an ecological balance as well as reinforcement of woodland character throughout Central Park were seen as priorities.

CENTRAL PARK RESOURCE MANAGEMENT PLAN

BURNABY, B.C.



SITE LOCATION

SCALE:
1:125,000

GARDNER, PEEPRE & ASSOC. LTD.

1.4 Summary of Report Recommendations

Implementation of recommendations in this report requires the preparation of a Landscape Management Plan that should be carried out in conjunction with a Woodland Management Plan as contained in this report. [Concepts are elaborated in the detailed Landscape Management Plan contained in the section under Landscape Management Units or in the Woodland Management Plan contained in that Section].

1. A major proportion of the park should continue to reflect natural coastal forest conditions, with relatively large contiguous treed areas left undeveloped, but carefully managed, in perpetuity to ensure this objective.

2. A simple Park Management Plan should be developed, generally following the format suggested in this report and encompassing a woodland management component, with the objective of ensuring the continued diversity and health of the natural plant community, and a landscape management element, with the objective of managing unnatural, planted and developed areas within the park environment.

3. The park periphery should be maintained for access, parking and active uses, and the park core retained as the primary resource buffered with effective woodland transition areas.

4. Intensive turf management, including coring, topdressing and fertilization, or in some locations drainage, topsoil and turf replacement, will help to alleviate the detrimental effects of sustained foot traffic. In other intensive use areas, turf replacement with compacted pathways, natural flagstones or boardwalks and the use of plantings to direct through specific locations will be desirable.

5. New plantings in key areas of open turf should define circulation, delineate open spaces and act as an improved visual screen from activities outside the park.

6. The transition zones from existing forest understory edge into open turf zones should be reinforced with natural shrub plantings, while intensive maintenance in these areas should be reduced to encourage longer grass, forbs and wildflowers. In this way, compaction effects on edge trees will be reduced and the present abrupt visual change will be softened.

7. Very poorly drained open turf areas that preclude public use and that suffer continuing compaction

from repeated mowing should either be examined for drain installation and improvement or allowed to develop to natural successional areas without grass cutting.

8. A planting plan emphasizing native species of trees and shrubs should be developed to improve the screening of the B. C. Rail right-of-way.

9. Specimen trees reflecting the natural appearance of the conifer overstory and adjacent woodland should be established in the pitch and putt area to supplement and eventually replace the remaining Douglas-fir. Small treed islands should be developed as much as possible and basal removal of shrubs diminished around existing trees. The screening of the pitch and putt area along the east and south should be reinforced to provide improved protection from the distraction of moving traffic.

10. Individual trees in the pitch and putt area should be inspected for stability, stem soundness, crown dieback and unsafe branches. Potential windblow trees and other unsafe trees should be removed and replaced with native-appearing conifer standards.

11. Pond and streambank areas subject to very heavy pedestrian traffic should hve surfaced paths, raised walkways, stone or slate stepping stones, decks, plantings or replacement of turf as appropriate to improve the appearance of these areas and to permanently reduce ongoing maintenance.

12. The pond-stream-pond area should be considered for a more natural interpretive function, with greater emphasis on the water/land transition zone, increased natural plantings at the water's edge in some instances, replacement of purely ornamental species, and flat rock access to shallower water areas, coupled with a more diverse marsh edge to encourage wildfowl.

13. To the west of Swangard Stadium, the question of widening Boundary Road requires resolution. This can be accomplished with little material effect on the park if coupled with substantial reinforcement of the existing Douglas-fir buffer with natural plantings of specimen size and 1.5 meter fir and cedar, along with shrubs such as Salal and some ferns and groundcovers.

14. To the north and northwest of Swangard Stadium, there is a significant need to improve this major focal introduction to the park from both Boundary southbound and from Kingsway. In particular, mixed conifer planting with native

deciduous trees and appropriate shrubs and groundcovers is recommended on the turf terrace below the Stadium fence. This native tree planting might be reinforced with a substantial foreground of large rhododendrons. It is also suggested that the major tree planting might give way to a more open glade effect and sweep eastward to join the existing conifers bordering Kingsway. In addition, there is a need to enhance the southerly end of the pedestrian overpass and provide a less alien transition to the park.

15. The low fenced areas near the swimming pool and horseshoe pitch are not in keeping with the woodland character of the park and would benefit from foundation plantings at the fences with Oregon Grape, Salal and ferns. In areas where volunteer paths or observation locations have developed, these should be either formalized, and incorporated into the overall development as secondary trails, or precluded with intensive plantings.

16. Horticultural displays throughout the park should be appropriate in species, colour, texture and height relative to the native forest.

17. Stronger definition of the trails that make up the park experience should be implemented through a three-tiered trail hierarachy system, improved signage, and use of vegetation buffers. Trail widths and surface treatments should be carefully planned.

18. Habitat reserve areas should be defined as a refuge for small wildlife and to maintain the woodland resource as whole units. Trail access should be limited.

19. Woodland and 'marsh edge' habitats should be developed to encourage a variety of interesting birds and small mammals. Opportunities exist for a wet meadow by directing excess surface drainage.

20. Where trails are envisaged within the wetter forested areas, the use of boardwalks or simply bark mulch paths is strongly recommended to reduce the compaction impact on adjacent trees and to improve the walking or jogging experience.

21. In managing the major wooded areas, it is strongly recommended that there be no significant reduction in the areas presently designated as "treed". Moreover, it is recommended that there be a move to reinforce the natural transition zones from open space to overstory with increased shrub and groundcover plantings.

22. In open glade areas with overstory in good conditon, it is recommended that there be some replenishment planting with Douglas-fir standards and that vigilance be continued for signs of crown stress. Mowing in these areas should be limited to drier months and restricted when ground conditions are soft.

23. In open glades where the overstory is in poor condition and shows severe crown dieback, dangerous trees will require either topping or removal. A topping program over the next three seasons will allow an orderly removal of hazardous crowns or branches but will have to be followed later with whole tree removal. In specific locations tree removal now will be preferable, followed by replacement plantings in the centre and shrubs on the periphery. These islands should allow at least 10 meters from mowing area to mature tree roots.

24. In the larger treed block, selective thinning of stressed trees, windblow or larger deciduous growth should be coupled with suppression of undergrowth and planting with mixed conifers ranging from standards to seedlings in the resulting openings in the canopy. Douglas-fir should predominate in ratio on the drier sites, with cedar dominating on the wetter sites. In areas where natural regeneration is developing successfully, selective encouragement by thinning and weeding will be required.

25. Specific recommendations applicable to the eight woodland management units are provided in the body of the report and are accompanied by mapping detail for each unit. It is anticipated that the program encompassing these recommendations can be instituted in the spring of 1982 with little change in existing operations. Implementation will, however, require some field review of the consultant's investigations, identification of site specific locations within the units discussed in the report and, of course, procurement of appropriate planting stock.

26. A program of more intensive maintenance is required to ensure replacement of dead or dying plants in display areas, appropriate care for trees planted in open areas and subject to damage from the general public, as well as for weeding, fertilizing, watering and replacement in the tree islands and shelterwood clearings.

2.0 SITE RESOURCES

2.1 Introduction

A brief overview of soil, topography, climate, history and viewshed characteristics is presented as they relate to the woodland resource.

2.2 Soil and Topography

Central Park is located on a gently sloping vantage point of a major glacial ridge. The extremely compact basal till is overlain by variable depths of fine textured material, with soil development generally averaging under one metre in depth.

Good soils but varying depth and varying drainage. Some tendency to windblow when roots cannot penetrate compacted till.

The resulting variations in drainage lead to Central Park being a mosaic of wet and dry spots. Areas most severely windblown by hurricane Frieda in 1962 are the shallower soils and less well drained areas. Swangard Stadium has a history of drainage problems due to poor water permeability of glacial till near the surface.

2.3 Climate

Climate conditions at Central Park can be described as wet subzone, Coastal Western Hemlock Zone (Appendix 1) with an average annual precipitation exceeding 1800 mm, peaking in December. The predominantly easterly winds (E and ESE 33% of the year) vary up to 85 km/h in gusts and emphasize the effect of the Central Park forest resource as a shelter belt.

2.4 History

Central Park was originally a Military Reserve for the defence of New Westminster. In 1891, the land was established as a public park in the B. C. Gazette. From 1910 to 1922 the park was under the control of a Central Park Provincial Park Board. In 1922, the Corporation of the District of Burnaby was granted a ninety-nine year lease of the land for the purposes of a public park and pleasure ground.

In 1933, the Central Park Act was amended adding an additional parcel of land. Up to this time, the park had been left in a natural state without the addition of formal facilities, and apparently received only casual use from citizens. Over the next several years, the pressures of urban development and population made it necessary that more formal use be made of the extensive land holdings. This meant the assignment of development and maintenance funds which Burnaby was unable to provide alone. Arrangements were made for the burden to be shared between the Municipalities of Burnaby and Vancouver.

In 1959, this lease was surrendered, a new lease was signed jointly by the City of Vancouver and the District of Burnaby to run for the unexpired portion of the original lease, and Vancouver and Burnaby entered into an agreement to maintain and develop Central Park with the costs to be shared equally.

In 1960, the management of the 225 acres (91 ha) of the park was placed under the control of a Central Park Committee comprised of Burnaby and Vancouver representatives. This Committee served the citizens of both municipalities for the next 17 years, and during this period many of the Central Park facilities were constructed. Also during this period, Burnaby reached a stage where it was able to assume the development and management of the park alone. The Vancouver Parks Board wished to concentrate its park development in the newly created Champlain Heights area, and the operating agreement was cancelled at the end of 1977.

In 1978, a new Burnaby/Vancouver Park Liaison Committee was set up to cover all mutual park interests for the full length of the Burnaby/Vancouver border.

Functional responsibility for the management and maintenance of the park now rests with the Parks and Recreation Department of the Corporation of the District of Burnaby.

Boundaries of the park, its major trail system, parking areas and present buildings or sites of activity are shown on Map 2.

2.5 Viewshed

Central Park is a prominent focal point, being seen as a crest of tall trees from points such as Queen Elizabeth Park and the slopes of North Vancouver. The trees form the major close-up view from the B. C. Telephone Building and other highrises adjacent to Central Park.

The most prominent view from Central Park is towards the North Shore from the knoll in the main open glade, and it is particularly favourable for summer sunsets (see Plate 2).

3.0 EXISTING RESOURCE USE AREAS

3.1 Introduction

At present, Central Park in Burnaby represents one of the largest developed municipal parks in the Lower Mainland, with over 200 acres of partially treed land and a wide variety of recreational facilities serving the urban population. As a woodland environment reflecting natural coastal forest conditions, Central Park is unique within Burnaby in that relatively large contiguous land areas have been left undeveloped.

The purpose of this study was to identify the composition and condition of the existing natural resource and to evolve a plan for management in perpetuity. Increasing user pressures on the natural environment, and the apparent decline of the woodland resource have crystalized the need for careful assessment of land use patterns as they may influence the integrity of the tree resource.

Hence, the study identifies two necessary components of an effective management plan: the urban forestry element, with the objective of ensuring the continued diversity and health of a naturalized plant community, and the landscape development aspect, which identifies and solves problems relating to the management of people within the park environment. The strategy for preserving the unique quality of Central Park must, therefore, be holistic in that the full range of park resources are integrated into the management plan, and perpetual to ensure that the resource is continually monitored and refurbished during the life-span of the woodland.

3.2 Existing Resource and Land Use Areas

Although plans for park utilization have been formulated and partially implemented, it is evident that no definitive master plan or strategy has evolved. Adoption of such a strategy would facilitate improved woodland management, as the various land use areas may be identified, evaluated, and incorporated into the program. A brief review of existing activity areas will illustrate the types of pressures extended by users on trees and the forest environment, as well as denoting the different remedial landscape practices required.

Recommendations for modification or improvement of certain activity zones will often have a direct beneficial effect on the protection of the tree resource as a whole, as well as improving the aesthetic quality of the park.

A general delineation of park use areas indicates that the primary woodland resource lies within the core area roughly surrounded by a

transition zone characterized by mixed uses and vegetative cover. The periphery of the park is utilized most intensively for vehicular access, parking, and active recreation, with a predominantly ornamental landscape treatment in many developed areas. A more detailed description of general activity and landscape areas follows.

3.3 Specific Areas

.1 Open Turf Areas

- informal play and games
- picnicking

The existing open turf lands are subjected to heavy pedestrian traffic, with significant dieback and soil compaction evident in localized areas. Normal turf maintenance practices, including coring, topdressing, or fertilization, will help to alleviate the detrimental effects of foot traffic, although in specific locations additional planting would be desirable. Clumps of vegetation in key areas would define circulation, delineate open spaces, and act as a visual screen, while extending the existing forest understory edge into turf zones would offset soil compaction around peripheral trees. On the edge of open glades, for example, the Salal and other groundcovers growing under the drip-line of trees help to protect the root zone from soil compaction, and prevent damage to the trunk area.

.2 Open Glades

- walking, jogging
- informal play and games
- picnicking

The open glade zones of the Park are characterized by stands of Douglas-fir and a turf groundcover. The vigour of these trees is clearly in decline, and recommended treatments are outlined in Section 5.10. However, from a landscape planning and development perspective the management of these areas must address allowable uses, pedestrian circulation, visual effect, drainage, and turf species as each factor may have an influence on tree health.

Current usage includes picnicking, informal play, games, and walking or jogging. Formal circulation routes are typically minimal, with evidence of localized turf wear and soil compaction.

Surfaced paths in critical areas may help to reduce pressure on root zones by controlling pedestrian movements, while additional planting around the base of the clumps will extend the buffer around tree trunks and drip-lines, thereby further improving soil aeration. Additional Douglas-fir should also be planted to ensure the long term maintenance of the glade effect, and particular attention should be paid to screening the B. C. Rail right-of-way.

A contributing factor to the decline of some of the Douglas-fir may be the inadequate surface drainage present in many of the glade areas. The Douglas-fir roots may be subjected to extended periods of standing water, and the resulting loss of aeration will lead to physiological stress and possible eventual mortality.

.3 Pitch and Putt Golf Course

- golfing

The pitch and putt golf course is also an open glade zone of the park, although the use is specific and sustained. Extensive tree dieback and poorly developed crowns are evident throughout the area, although not all trees appear to be affected. The removal of virtually all shrub and groundcover vegetation from the vicinity of individual tree clumps obviously benefits the current golf activity, yet this practice may also contribute to root stress.

The aesthetic appeal of the golf course may be attributed to its natural surroundings, and the addition of plant material to replace the aging Douglas-fir should reflect this quality. As an extension of the woodland area, the golf course glade has the potential to reflect the character of Central Park, yet offer a recreational activity area. However, in order to realize this potential, plant material must be carefully selected to blend in with the native tree cover.

.4 Intensive Use Areas/Feature Areas

(i) Pond and Stream Environs

The pond and stream environment, although artificially created, contributes positively to the woodland experience. However, the intensive use of these areas has resulted in considerable wear on turf as well as informal footpath development, particularly around the water features. The associated soil compaction and damage to existing plants reduces the aesthetic appeal of the environs, as well as requiring an ongoing maintenance program.

Surfaced paths sited to reflect existing major pedestrian routes would help to alleviate the problem by defining circulation patterns. Selection of appropriate durable plant material would further benefit the pond and stream area by resisting foot traffic.

From an aesthetic or thematic perspective, the pond-stream-pond sequence does not appear to be congruous either as a defined use area, or with the surrounding woodland

environment. The design objective of the ponds and water courses should be evaluated to determine an appropriate planting concept. For example, should an interpretive function be desired, a naturalistic planting scheme utilizing native material would be required; whereas if simple visual harmony with the woodland is considered an objective then a wider range of natural appearing ornamental plants would be acceptable.

Regardless of the theme, the visual strength of the ponds and streams could be improved considerably if a plan is implemented. As older material dies, replacement plants would begin to reflect the design concept.

(ii) Stadium

Swangard Stadium represents one of the primary focal points in Central Park, yet the overall landscape treatment is visually one of the weakest. As Central Park is approached from the major arterials a stronger design statement reflecting the woodland character would be desirable. Hence, reinforcement of the Douglas-fir border along Boundary Road, enhancement of the pedestrian overpass entrance and the careful use of coniferous species on the turf terraces below the stadium would be positive contributions to improving the visual quality of this important focal point.

(iii) Swimming Pool and Horseshoe Pitch

Landscape treatment in this area has been minimal. The space is presently defined by metal link fencing and does not blend well with the woodland character of Central Park. Plantings of Oregon Grape or Salal near the fences would be appropriate. Surfacing of secondary trails and their incorporation into a landscape development plan is required.

(iv) Tennis Courts and Maintenance Shed

The landscape development around the tennis courts is relatively recent, and the mature appearance is not yet evident. However, the existing maintenance building is not adequately screened from the pedestrian paths. Landscape treatment around the building should strive to reflect the woodland environment as this would draw attention away from the presence of the maintenance function. Colourful ornamental planting in this case attracts attention, and reduces the effectiveness of a vegetative screen.

(v) Scrub Lands

The scrub lands bordering the parking lot along Boundary Road are characterized by mixed deciduous

species which lose their visual screening capability during the winter months.

As natural regeneration of coniferous trees would be slow, considerable thinning and underplanting will be required, as outlined in Section 5.10.

(vi) Trail Hierarchy

The woodland environment of Central Park is subject to increasing pedestrian pressures that is best handled by a defined hierarchy of trails.

A three-level system of trails should be defined on the basis of trail surfaces, width, appropriate signage and vegetation density. Opportunities for new volunteer trails and vandalism should be discouraged. Wildlife habitat should retain its integrity with an active policy of no new incursions into the forest parcels that remain in Central Park.

A landscape development plan is essential for minimizing pedestrian pressures on the forest resource at Central Park.

Trail definition would be enhanced by:

1) Signage
2) Plantings, clumps
3) Surfaces
4) Widths
5) Linearity

3.4 Summary of Landscape Management Unit Recommendations

The various landscape units in the peripheral areas of the park have been numbered, as indicated in Table 1, in order to facilitate reference. Although the boundaries of the proposed management units are approximate, the area within each unit represents an identifiable landscape zone with specific recommendations for improvements, modifications, or management practices. (See Map 3).

As part of a transition zone around the naturalized woodland area, the appropriate treatment of these lands may help to enhance the "urban forest" appearance of the park, as well as improve the health and vigour of existing vegetation.

3.5 Landscape Management Plan

A landscape development plan or landscape management plan should incorporate the park facilities, park users, and woodland resource into a strategy for optimum protection of existing conditions and should identify needs and methods for park improvement.

A Landscape Management Plan should address:

1. Functional considerations.

   - Vehicular access, parking and control.

   - Trail surfaces, trail hierarchy, linkage connections.

   - Appropriate separation and buffering of activity zones.

   - Workable signage plan.

   - Relationship of facilities to circulation patterns.

2. Aesthetic considerations.

   - A harmonious balance and unity of park facilities and areas.

   - Optimum visual relationship with the rest of the community; the identification of the park as a unique area with a distinct image.

   - Plantings appropriate for a woodland character.

   - Plantings with suitable colour, texture and form to reflect woodland species.

   - Use of appropriate materials for all park construction, including site furniture, paving and other facilities.

PLATE 1

Open turf areas at Central Park with soil compaction and dieback clearly evident.

TABLE 1

LANDSCAPE MANAGEMENT UNITS

NO.	TYPE	RECOMMENDATIONS	AREA
1	Open turf & pond	- turf maintenance required - reinforce park edges with appropriate plantings - define pond edges - path development required - integrate and unify signage - partially screen parking area from pond area	4.0 ha
2	Open turf	- turf maintenance required - improve field drainage - reinforce park edges - improve playing field safety	2.1 ha
3	Open glade	- tree "island" planting - Douglas-fir underplanting - screen B. C. Rail R.O.W. - investigate drainage amendments - path surfacing required - integrate and unify signage - arboricultural inspections	4.7 ha
4	Open glade	- tree "island" planting - develop pedestrian routes - drainage amendments - open glade clump planting in wet areas - arboricultural treatments for tree safety and inspection	3.5 ha

TABLE 1 CONTINUED

LANDSCAPE MANAGEMENT UNITS

NO.	TYPE	RECOMMENDATIONS	AREA
5	Pitch & putt	- landscape planting plan required - maintain size and plants in present "tree islands" - arboricultural inspections	10.0 ha
6	Stream environs	- landscape plan required - path development required - drainage amendments required	1.8 ha
7	Upstream pond	- landscape plan required - develop pond edge treatment	1.0 ha
8	Swimming pool	- develop woodland character in plantings - incorporate into landscape development plan	3.0 ha
9	Stadium slope	- woodland character should be reflected in feature plantings - reinforce Boundary Road with plantings to west and north of stadium	2.0 ha
10	Tennis court	- screen maintenance buildings with appropriate species	2.3 ha
11	Deciduous treebelt	- thinning and underplanting required - maintain visual screening	1.7 ha

PLATE 2

The main open glade opposite the B. C. Telephone Building typifies the park's woodland character.

PLATE 3

Conifers in the pitch and putt area may be subject to tree dieback, more windblow, and sparse crowns.

PLATE 4

Horticultural displays should respond to the park's woodland character with harmonious plant species, colours, forms and textures. The standard of maintenance in shrub beds requires some improvement.

PLATE 5

Wide, hard surfaced trails for major circulation loops and in areas of intensive use are typical of heavy-use trails in a planned hierarchial system.

PLATE 6

Moderate use trails require loose surfacing and appropriate signage. Confusion over direction and poorly maintained trails encourage the development of many volunteer trails and subsequent detrimental impacts.

PLATE 7

While definition of some minor trails is appropriate in a hierarchy of trails, excessive volunteer trail development leads to irreversible changing of the forest resource character. Dense plantings, improved directional signage and nature interpretation points could be used to reduce the problem.

PLATE 8

Raised boardwalk trails are required in the wettest part of the main forest. (Woodland Management Unit B)

PLATE 9

Confusing trail junctions and signage are negative aspects of the woodland walk experience. Disorientation of users leads to development of volunteer trails. Clarity of trail systems and signage should be an integral part of a landscape development plan.

PLATE 10

The major aesthetic appeal of Central Park as a jogging fitness route can be attributed to the cool green of the tree canopy. This fitness station lacks an element of privacy and partial enclosure that would encourage more popular use.

PLATE 11

Improved trail and water edge treatment is required to reduce the effects of pedestrian traffic. Concentrating park use in high-intensity areas of the park reduces pressure on the forest resource. Development of circular, trail loops and definition of all park entrances distributes pedestrian pressures more efficiently.

PLATE 12

Buffer tree plantings around this turf area will enhance the park's forest character from the road and make this a safer place for sports. Drainage could be amended in field centre.

PLATE 13

Tree and shrub "islands" in open glade areas can protect root zones from mower and soil compaction damage and are also visually pleasing. Turf adjacent to these is popular for activities such as resting and picnicking.

PLATE 14

This open-glade area is sensitive to blowdown and requires underplanting to function as an effective longterm shelterbelt.

PLATE 15

Plant material should be carefully selected to blend in with form and colour of native tree species.

PLATE 16

Circulation problems and root zone stress can be alleviated by location of hard surfaced paths that define pedestrian routes and avoid root zones.

PLATE 17

Trail systems can be more clearly defined by filling out vegetation clumps. Formation of tree/shrub islands will also protect the root zone of these developing trees.

PLATE 18

Severe turf dieback emphasizes the bareness of path and water edge treatments.

PLATE 19

Opportunities to view birdlife and small forest mammals will be enhanced by improving water and forest edge habitats. Protecting the forest resource at Central Park means maintaining the ecological balance between adjacent habitats.

PLATE 20

Spot thinning of the Salmonberry (Rubus spectabilis) understory is required for underplanting of this single-age Douglas-fir stand.

4.0 WILDLIFE HABITAT

4.1 Introduction

Wildlife habitat depends on both territory space and available niches. Central Park is effectively larger than its 225 acres (91 ha) for migratory and free-ranging species who use other treed sites in the Burnaby area, but effectively smaller for species requiring habitat diversity not well supplied there. The wildlife species list used here is based on the Burnaby Lake Park Report.

A balance of available niches leads to a balance of species. The best example of this is control of mouse populations by provision of suitable habitats such as nesting snags, forest edges, and marshed edges for predator species. The Douglas mouse has been documented as the major problem in reforestation of seeded clearcuts in B. C., due to rapid expansion of mouse populations feeding on the Douglas-fir seed.

4.2 Habitat Size

Known minimum bird habitats for species using the park vary from 0.5 acres (0.2 ha) per mallard pair to a 30 acre (12 ha) range for hawks. The woodpeckers will utilize a 300 acre (120 ha) area and require at least 12 nest snags per 100 acres (40 ha).

Habitats of small mammals vary from 5 acres (2 ha) for a shrew population to 160 acres (65 ha) for a hare population. The Douglas squirrel requires a 100 acre (40 ha) range per individual. There is insufficient stream length in the park to sustain a regular muskrat or raccoon population.

4.3 Habitat Diversity

.1 Wet Habitat

This is composed of moist meadows, creeks, ponds, marshes and adjacent cottonwoods stands. It is used by waterfowl, bald eagles, ospreys and owls. In Central Park, this habitat is only partially available.

.2 Woodland Edges

This shelter habitat is important to some marsh birds, most of the forest birds, grouse, hawks, owls and small mammals. This habitat requires substantial reinforcement throughout the park, along with development of the "forest islands" in the open glade areas.

.3 Snags

Snags are essential for nesting and feeding for woodpeckers, flickers, goshawks, bald eagles, ospreys, kestrels and great horned owls.

4.4 Recommendations

.1 Habitat Integrity

Habitat integrity should be maintained by conforming to a trail hierarchy in the park; setting aside five 30 acre (12 ha) undisturbed areas to remain untouched with minimal access.

.2 Marsh Edges

Develop marsh edges, especially in the vicinity of moist meadows such as west of each of the lakes adding some cottonwood clumps.

.3 Woodland Edges

Develop woodland edges as an 'ecotone', using native species of varying heights. Salal, Salmonberry and Flowering Dogwood are suggested.

.4 Snag Removal

Minimize snag removal and top only where needed for safety. These snags are important to the full life cycle of birds and small mammals common to Central Park.

PLATE 21

Park character is diminshed by the open parking areas. These may benefit from some screening with appropriate shrub species.

PLATE 22

Turf condition, inappropriate formality of shrub plantings, poor trail definition and the need for more intensive maintenance of newly planted trees is evident here. Single deciduous tree plantings are not suited to the park character.

PLATE 23

The small crowns and fairly narrow stems are a reflection of original spacing. Initial crown dieback due to compaction is evident on the tree in the centre.

PLATE 24

Severe crown dieback is prevalent in many high-use areas as a result of soil conditions, poor drainage and compaction by foot traffic and mowing equipment.

PLATE 25

Various stages of crown dieback are evident from each of the trees on the edge of this open area. Shrub islands must be larger to protect tree root zones.

PLATE 26

The drawn-up nature of some trees and the extremely small crown-to-height ratio is already evident in this location.

PLATE 27

As dieback has become evident with unthrifty crowns, removal of lower dead branches has been an ongoing maintenance task.

PLATE 28

This cross section of a typical Douglas-fir in the areas with severe top dieback shows the original fairly rapid growth which has diminished in the last eight or so years as compaction has increased.

5.0 VEGETATION RESOURCE

5.1 Introduction and Methodology Used for Assessment

The City of Burnaby is in the wet subzone of the Coastal Western Hemlock Zone. It is characterized by an average annual precipitation of 1800 mm and dense, vigorous growth of forest tree and shrub species as described below. Central Park is a good example of the mature Douglas-fir stands that once covered the Lower Mainland.

The Central Park woodland was divided into inventory "Areas" on the basis of differences in tree canopy and the ease of later definition as management units.

The heavily forested areas were surveyed in a manner consistent with the objectives of this study. This was undertaken to obtain a realistic assessment of the vegetation variations within the areas marked on Map 2. A regular sampling method was applied to obtain valid data, especially where there were irregular age-class distribution variations.

Transects were laid out after initial field investigation. Location and direction of the transects is also shown on Map 2.

The first transect was started at a known fixed point on the edge of each area. In area A a compass bearing of 330° N was chosen to start a pattern of equidistant bearings with parallel transects 300' (90 m) apart with plots at 300' (90 m) intervals. Intervals were measured with tape and back bearings were used to check the accuracy of each transect bearing. After completing the first transect a distance of 300' (90 m) was measured at right angles (i.e. east or west depending on the area) to the next transect. In areas other than A and B compass bearings were chosen for more representative sampling.

The distance between plots and transects was also based on initial field observations. The average density of understory vegetation during the winter allowed reasonable visibility to a distance of 300' (90 m) from plot to plot and between transects. Data was collected during November, 1980.

5.2 Review of Management Principles

Following from a recommended policy of managing that part of the park which will remain treed in perpetuity, there are some underlying principles which should be observed.

The tree resource is a dynamic, changing entity. The main variable factors in this context are species, age, size and stocking. Since it

would appear appropriate to maintain the existing native composition and refrain from introducing tree species not presently, or formally, associated with the park in its natural state, the number of species will be limited to those typical of the West Coast in the Western Hemlock biogeoclimatic zone and listed with detailed outlines in Appendix 2.

The first key factor that must be addressed, then, is the question of acceptable species diversity to reflect the species associated with the zone.

The next factor of importance is that of tree ages. If, for example, the predominent age of all major overstory trees is within a very narrow range, it can be anticipated that those trees will be lost to the resource stock at approximately the same time. Should there be little second story tree cover to replace the mature component of the woodland area then there would be a significant change in the woodland character of the park. Such is the case in areas where the mature trees are affected by compaction and are now being topped. With no young trees to replace declining single stems these areas will soon be devoid of tree cover unless some replacement planting is undertaken.

Thus it is essential, if areas are to be managed for tree cover in perpetuity, that these areas be afforded a management strategy that maximizes age class diversity. Coupled with species diversity, this means that the full range of species must be present in each area in whatever proportions are thought to be suitable or desirable, all the way from young seedlings through intermediate stages to major understory and, for the climax species, through to semi-mature and mature stages.

Since losses from the resource base will occur at each stage of growth from seedling stage to overmaturity, then there must be constant replenishment of the resource stock. Losses will occur from ecological, environmental, biological, and human pressures, competition, losses attributable to weather or poor soil conditions, insects and disease as well as trampling, compaction or vandalism. All will contribute to incremental losses. Added to this will be accidental or deliberate losses. Here fire and actual thinning to remove undesirable, hazardous, or overmature trees will possibly be the most important factors.

While natural regeneration will accommodate replenishment of a proportion of the loss level, the intensive use patterns in much of the park preclude complete reliance on this approach. Consequently, some planting of seedlings at 2+0 stage through larger nursery stock and even some specimens will be called for in some situations.

Tree size at any given age is a function of genetic constraints embodied in each species, site conditions, degree of competition and environmental or biological pressures such as climatic cycles or pest problems. A very obvious factor is that the close spacing of some trees has drawn them up, resulting in narrow stem diameters disproportionate to height, and very small crowns disproportionate to total tree size. This is particularly evident in edge conditions, in clumps of Douglas-fir and in some areas where trees have been lost due to extreme weather conditions in the past or to soil compaction. The very tall, rather thin trunks with small crowns on top can be seen in many locations throughout the peripheral areas of the park, as shown in plates 23 through 26.

5.3 Stipulations Under the Central Park Lease

The most recent lease for Central Park was signed on the 4th day of September 1959. It was executed pursuant to the Short Form of Lease Act and was between "Her Majesty the Queen in the Right of British Columbia and jointly the City of Vancouver and the Corporation of the District of Burnaby". The first lease was apparently signed in 1921 with revisions or changes in the enabling authority made in 1933 and 1957. The most recent change of circumstance is that the City of Vancouver is no longer a party to the lease. The lease is authorized in an original Central Park Act assented to 3rd December 1921.

The legal description indicates that the area leased to the Corporation is 219 acres (89 ha), sightly less than the figure currently used by the municipality. The lease also stipulates that it is for a term of 61 years 332 days commencing 22nd of July 1959 and that an annual rental of $1.00 applies, to be paid on the 19th of June each year. As can be calculated, the lease expires between the 30th of April and the 1st of May in the year 2021.

A number of the specific provisions of the lease are of special interest in the context of this report. Section 4 (j) of the lease for example notes "that the demised premises shall be used as public park and pleasure ground for the recreation and enjoyment of the public, and for no other purpose...".

Subsection (k) notes that the Lessees covenant with the Lessor "not to do or permit anything to be done in or upon the demised premises or any part thereof, which may be or become a nuisance or annoyance...".

Subsection (m) requires the Lessee to close the demised premises once in each and every year for one day, against the use thereof by the public.

In Section 5 provision is made for re-entry by the Lessor on non-payment of rent, or non-performance of the covenants.

In Section 6 the Lessor covenants with the Lessees for quiet enjoyment.

Section 7 (d) clearly stipulates that "the Lessees hath not removed any tree or trees from the demised premises, except on the approval of the District Forester, Vancouver, B. C. being first had and obtained. Provided, however, that the proceeds of the sale of any timber so removed shall be applied to the maintenance and development of the demised premises.".

Two apparent requirements, then, that apply to the tree resource, are for the Corporation staff to involve the Forest Service in tree removal presumably for whatever purpose except in emergency conditions, and for there to be a trust account established for any monies derived from sale or conversion of any of the large timber removed and for the monies in that fund to be used expressly for the upkeep and improvement of the park.

Despite a number of the other provisions, being those that could be anticipated in a short form lease executed for property of this nature, Burnaby is still obligated to observe a number of specific management provisions. Non-compliance could be sufficient cause to cancel the existing lease should the Provincial Government find it politically expedient or appropriate to renegotiate the terms before the year 2021 or should it become necessary to use part of the park for another purpose.

5.4 Woodland Management Guidelines

This study required the formulation of detailed silvicultural prescriptions for each of the eight management units indicated on Map 4. Areas A and B contain the relatively undisturbed high forest core of Central Park, (40% of the park area). The southwest/northeast pedestrian access route separates areas A and B. A policy of selective felling and underplanting is required to correct the age-class distribution and will require some urban forestry expertise and financial commitment by the municipality in future. Although an immediate decision to initiate a modified form of shelterwood system is not required, a long term commitment to this end should be considered. Extensive windblow, which often creates sizable clearings, may present the future woodland managers with the opportunity to promote this kind of silvicultural management system.

In urban areas such as parks with extensive tracts of natural or semi-natural woodland, it is desirable to manage this resource on a long term basis. It is vital in these relatively small urban forests to maintain a healthy age-class distribution. The urban shelterwood system proposed is not designed to produce commercial timber, but to favour healthy standing trees.

To initiate this silvicultural system, man-made or natural clearings must be located and their sizes ascertained. The clearings should then be planted with suitable tree species to adequately stock the area. The opening of the canopy is likely to encourage rampant weed growth and, therefore, larger nursery stock and some tree standards should be used to minimize establishment costs and ensure successful stocking.

It is conceivable that at a later date further windblow will occur on the periphery of these initial clearings. These blowdown areas will serve as a nucleus for future clearings and expansion of the replacement areas.

5.5 Trees as Overstory

The following is a brief species review of the overstory trees found in Central Park.

.1 Species - General

(i) Coniferous

Douglas-fir (*Pseudotsuga menziesii*)
Western Hemlock (*Tsuga heterophylla*)
Western Red Cedar (*Thuja plicata*)

(ii) Deciduous

Western Paper Birch (*Betula papyrifera*)
Black Cottonwood (*Populus trichocarpa*)
Willows (*Salix* spp.)

.2 Conifers

Douglas-fir is the dominant coniferous overstory tree at Central Park. It is intimately associated with Western Hemlock, and occasionally with Western Red Cedar at wetter sites.

.3 Deciduous Species

Western Paper Birch is the overstory species characterizing very wet sites in the dense forest canopy. Black Cottonwood and Willow are replacing Douglas-fir in poorly drained sites with open canopy.

5.6 Trees as Understory

The following is a brief species review of the understory trees found in Central Park.

.1 Species - General

(i) Coniferous

Western Red Cedar (*Thuja plicata*)
Western Hemlock (*Tsuga heterophylla*)

(ii) Deciduous

Vine Maple (*Acer circinatum*)
Western Paper Birch (*Betula papyrifera*)
Western Flowering Dogwood (*Cornus nuttallii*)
Cascara (*Rhamnus purshiana*)
Red Alder (*Alnus rubra*)
Bitter Cherry (*Prunus emarginata*)

.2 Conifers

The shade tolerance of Western Hemlock allows it to regenerate under Douglas-fir and with time it gradually assumes dominance.

Western Red Cedar is usually prevalent on sites well supplied with soil moisture, such as sites of restricted groundwater flows over impermeable glacial tills at Central Park.

.3 Deciduous Species

Vine Maple is the most common understory shrubby species found on areas of impeded drainage.

Western Flowering Dogwood occurs on moist loamy, well-drained soils where the canopy is relatively open.

A detailed review of the major tree species is given in Appendix 2.

5.7 Shrubs

The following is brief species review of the shrubs found in Central Park.

.1 Species - General

Salmonberry (*Rubus spectabilis*)
Huckleberry (*Vaccinium parvifolium*)
Vine Maple (*Acer circinatum*)
Hazel (*Corylus cornuta* var. *californica*)
Hardhack (*Spiraea douglasii*)
Cascara (*Rhamnus purshiana*)
Western Flowering Dogwood (*Cornus nuttallii*)
Elderberry (*Sambucus racemosa* var. *arborescens*)

5.8 Groundcovers

The following is a brief species review of the groundcovers found in Central Park.

.1 Species - General

Salal (*Gaultheria shallon*)
Sword Fern (*Polystichum munitum*)
Deer Fern (*Blechnum spicant*)
Lady Fern (*Athyrium filix-femina*)
Bracken Fern (*Pteridium aquilinum*)
Oregon Grape (*Mahonia nervosa*)
Moss (Musci)

Note: Features of Special Interest

Climax rain forest with insignificant undergrowth due to dense shading of canopy; swamp trails.

Old logging stumps suitable for public interpretation; nurse logs correlate with post-logging regeneration.

Typhoon Frieda windblow sites suitable for public interpretation.

Douglas-fir exposed to compaction and showing crown dieback as physiological strees suitable for public interpretation; correlates with soil types.

5.9 Woodland Resource Inventory

Data obtained in the field was recorded on a Site Information Sheet. These sheets were then collated to form the basis of the following resource inventory.

.1 AREA A

(i) Tree Species Present in Overstory

This block, outlined on Map 1, is characterized by coastal coniferous high forest. Douglas-fir (Pseudotsuga menziesii) is the dominant species, and Western Hemlock (Tsuga heterophylla) and Western Red Cedar (Thuja plicata) are co-dominant species.

Natural forest succession has progressed to the stage where the more shade tolerant Western Hemlock and Western Red Cedar are beginning to dominate the forest understory.

Over the greater part of this forested area the overstory was in excellent health, with crowns actively expanding and moderate height growth occurring in favoured localities.

Sparse crown growth is only encountered where the soil and/or ground cover were damaged during the clearing and development stage of the park. These disturbed areas were observed close to the main access routes around this area and particularly on the southern perimeter.

A marked imbalance in the age-class distribution exists in nearly all treed areas within Central Park.

(ii) Tree Species Present in Understory

In this area, the understory is dominated by both coniferous and deciduous species, including Western Red Cedar, Western Hemlock, Vine Maple (Acer circinatum), Western Paper Birch (Betula papyrifera), Bitter Cherry (Prunus emarginata) and Western Flowering Dogwood (Cornus nuttallii). Individual tree species are very variable in the understory. Clumps of Vine Maple, Western Hemlock, Bitter

Cherry, Western Red Cedar and Red Alder (Alnus rubra) are locally dominant. Western Hemlock, Western Red Cedar and Vine Maple are consistently dominant. Vine Maple is prevalent throughout the area, indicating sites with moist soil conditions throughout the year. Several clearings at poorly drained sites where a hard indurated glacial till is present near the soil surface. Western Paper Birch was often associated with Western Red Cedar and Cascara (Rhamnus purshiana) at these sites.

Some overgrown stands of Red Alder are present, located in areas of past disturbance. These areas should be cleared and planted with appropriate species, depending on the moisture status at the site.

(iii) Shrubs Present

The density of the shrub layer was directly related to both light intensities and ground moisture conditions. The following shrubs were noted: Hazel (Corylus cornuta var. californica) and Salmonberry (Rubus spectabilis) were found on moist open sites, and Elderberry (Sambucus racemosa var. arborescens) and Vine Maple dominated on moist rich sites. Huckleberry (Vaccinium parvifolium) was plentiful on old logs or stumps. Cascara was a locally common species on moist well-lit sites.

Salmonberry is the dominant shrub; forming dense thickets that present an access problem if underplanting is considered. Vine Maple is dominant at a few sites.

European Holly (Ilex aquifolium), European Mountain Ash (Sorbus aucuparia) and Cherry Laurel (Prunus laurocerasus) have been introduced to the park by birds from neighbouring areas. These shrubs will become quite dominant locally in the years to come.

(iv) Groundcovers Present

Groundcovers characterize site moisture conditions. Listed in increasing order of moisture requirements the following species were observed: Salal (Gaultheria shallon), Bracken Fern (Pteridium aquilinum var. pubescens), Lady Fern (Athyrium filix-femina), Deer Fern (Blechnum spicant) and Sword Fern (Polystichum munitum).

(v) D.B.H. Measurements of Dominants

Within each plot the d.b.h. (diameter measured at breast height) of all the dominant trees were measured. Douglas-fir and Western Hemlock measurements range from 47" (119 cm) d.b.h. to 24" (61 cm) d.b.h. and 32" (81 cm) d.b.h. to 18" (46 cm) d.b.h. respectively.

(vi) Age-Class Diversity

Three major age classes were identified in the forest: 60-80+ years, 24-40 years and 15-20+ years though these groupings are less distinct in some areas.

(vii) State of the Overstory Canopy

The overstory canopy throughout this area is in generally good condition with active leader growth recorded in several plots. Some of the older Douglas-firs close to areas with a history of soil and vegetational disturbance, displayed rather sparse crown foliage.

Damage to the understory was directly related to offpath pedestrian traffic. This damage included crushed groundcovers, broken branches, inscriptions cut into tree bark by vandals and the dumping of garbage into the bush.

(viii) Incidence of Windblow and Hazardous Trees

The occurrence of windblow and hazardous trees was generally low. The chief problems are suppressed or dying Douglas-fir and a number of snags of Douglas-fir and Western Hemlock. Along major pedestrian routes there is a need for further high pruning of Douglas-fir to reduce the danger of dead branches falling onto pedestrians, particularly during winter windstorms. A stand of decadent Red Alder need felling and replanting with Western Red Cedar.

(ix) Incidence of Disease

Red Alder was observed to have been attacked by alder sawfly (Hemichroa crocea). The trees appear to have been preconditioned by severe late summer drought two years ago. A few individuals of Western Flowering Dogwood were infected by collar rot (Phytophthora cactorum).

(x) Soil Type and Moisture Status

A varied range of soils have developed on a glacial till of variable thickness, overlying a hard indurated boulder clay. These soils ranged from sandy tills with generally low to moderate moisture content to moist muck soils with standing water during the winter months. On badly drained sites the hard indurated boulder clay was found to be near the soil surface. These poorly drained areas are prone to windthrow.

(xi) Quantity of Regeneration

Regeneration is sporadic, with Western Hemlock being the most numerous species, and Western Red Cedar present on moist sites. In quantity Douglas-fir regeneration was extremely limited. The only location identified with moderate regeneration was in an area of sparse Douglas-fir overstory

adjacent to the horseshoe pitch. The quantity of deciduous tree regeneration was restricted to clearings where Paper Birch, Cascara, Red Alder and Black Cottonwood (Populus trichocarpa) were actively colonizing.

(xii) Need of Thinning/Clearing

Where underplanting is undertaken, semiclearing of the understory and shrub layer will have to be done. Large areas dominated by Salmonberry may have to be controlled with an appropriate herbicide to facilitate underplanting. Thinning will be required in several decadent Red Alder stands to allow underplanting with Western Red Cedar.

(xiii) Suitability for Underplanting

Underplanting will help fulfill the goal of rectifying the irregular age-class distribution of the forest at Central Park. Underplanting should be undertaken in several locations, including decadent Red Alder stands, where the overstory and understory are sparse and allow sufficient light to penetrate the forest floor. Even where the canopy is closed, Western Hemlock can be used if the stocking is not too dense. Western Hemlock and Western Red Cedar will be the chief species used throughout this area.

(xiv) General Comments

There is a great need for definition of individual pathways throughout this wooded area.

.2 AREA B

(i) Tree Species Present in the Overstory

This thickly forested area is continuous to Area A and is again dominated by a coniferous overstory dominated by Douglas-fir, with Western Hemlock and Western Red Cedar being subsidiary species. Paper Birch was present on very wet sites. The overstory was generally in good condition. Douglas-fir crowns were sparse only near areas of standing water.

(ii) Shrubs Present

The shrubs present include Salmonberry, Vine Maple, Western Flowering Dogwood, Huckleberry, European Holly, Elderberry, Hazel and Hardhack (Spiraea douglasii). The density of shrub growth was directly related to light intensity and the dominant tree overstory. The shrub layer was suppressed, particularly under Western Red Cedar. Where light intensity was greatest, Vine Maple and Salmonberry dominated the understory.

(iii) Groundcovers Present

Groundcovers were the result of moist conditions. Salal, Sword Fern, Oregon Grape (Mahonia nervosa) and Deer Fern were present.

(iv) D.B.H. Measurements of Dominants

The d.b.h. of dominant species at plot sites were measured. Douglas-fir ranged from 46" (117 cm) to 17" (43 cm) while Western Hemlock ranged from 30" (76 cm) d.b.h. to 10" (25 cm) d.b.h.

(v) Age-Class Diversity

Three major classes were identified, 60-80 years, 30-40 years and 15-20 years.

(vi) State of the Overstory Canopy

The overstory conditions were similar to Area A.

(vii) Incidence of Windblow and Hazardous Trees

Windthrow was identified on a few sites where a hardpan layer was present near the surface with subsequent poor drainage. In a few localities dead Douglas-fir snags and several groups of dead and dying Red Alder will require removal to facilitate replanting.

(viii) Incidence of Disease

The root and butt rotting fungi Polyporus schweinitzii was found on the root systems of two old Douglas-fir, indicating that some of the older trees could be in a weakened condition and liable to windthrow.

(ix) Soil Type and Moisture Status

Soils range from moist muck soils to stony sandy tills. On a few sites the ground is hummocky with Douglas-fir predominating on the drier hummocks and surrounded by moist ground.

(x) Quantity of Regeneration

Regeneration of Western Hemlock ranged from poor to prolific and was sometimes accompanied by Western Red Cedar. Paper Birch regeneration was confined to open sites with muck soils.

(xi) Need of Thinning/Clearing

Thinning of Vine Maple and Salmonberry will be required if underplanting is contemplated and to encourage natural regeneration of the dominant tree species.

(xii) Suitability for Underplanting

On moderately moist semi-shaded sites Western Red Cedar should be planted, while on moist sunny sites Paper Birch would be the appropriate species. On

drier sites in deep shade Western Hemlock should be used, especially under mature Douglas-fir.

(xiii) Special Conditions

The area is covered with an abundance of fallen logs, many dating back to when the area was logged.

(xiv) General Comments

The area is characterized by rough hummock ground.

.3 AREA C

(i) Tree Species Present in Overstory

The area is dominated by Douglas-fir and Black Cottonwood on the dry and moist sites respectively.

The watertable in the northwest section of this area was disturbed when Swangard Stadium was constructed, and this has resulted in previously dry ground dominated by Douglas-fir becoming waterlogged. The Douglas-fir have gradually died out and are being replaced by Black Cottonwood and willows (Salix spp.).

The southeast section of the area is dominated by the original mature stands of Douglas-fir.

(ii) Tree Species Present in Understory

The following understory tree species were present: Paper Birch, Red Alder, Cottonwood, Cascara and Western Red Cedar. The understory in the drier, heavily forested section of this area is not well developed.

Red Alder and Paper Birch were the most prevalent understory species in the moist areas, with Western Red Cedar occurring in the deeply shaded areas.

(iii) Shrubs Present

The following shrubs were recorded: Vine Maple, Huckleberry, Salmonberry, Western Flowering Dogwood and Hardhack. The shrub layer is well developed throughout the area.

In the wetter areas Hardhack and Salmonberry predominate the shrub layer, while Salmonberry, Vine Maple and Western Flowering Dogwood are present on the drier sites.

(iv) Groundcovers Present

The badly drained northwest section of this area has a groundcover dominated by moss and Salal, especially on logs. Salal dominates the dry, heavily forested southeast section.

(v) D.B.H. Measurements of Dominants

Douglas-fir ranges from 34" (86 cm) d.b.h. to 18" (46 cm) d.b.h.

(vi) Age-Class Diversity

Two age classes are present: 80+ years and 15-20 years.

(vii) State of the Overstory Canopy

The crowns are generally rather sparse and little height growth was observed.

(viii) Damage to Understory and Groundcover

Pedestrian damage to the understory was slight, although groundcovers beside pathways were in poor condition.

(ix) Incidence of Windblow and Hazardous Trees

In the waterlogged northwest corner of this area there is a constant danger of windblow due to waterlogged conditions around the trees' main support roots. Root systems will often die due to the poorly aerated conditions.

(x) Soil Type and Moisture Status

In the badly drained northwest section of the area muck soils predominate, with open pools in many areas. The southeast section is overlain with a sandy stony till, where well drained sandy soils have developed.

(xi) Quantity of Regeneration

Very sparse regeneration of Western Hemlock was observed.

(xii) Suitability for Underplanting

In the moist areas Western Red Cedar would be an appropriate species while Western Hemlock would be successful beneath mature Douglas-fir.

.4 AREA D

(i) Tree Species Present in Overstory

This linear treed area contains the largest Douglas-firs in the whole of Central Park. The following tree species were recorded: Douglas-fir, Western Hemlock and Western Red Cedar. The health of these trees was exceptional and every effort should be made to preserve this stand. Douglas-fir is dominant with Western Hemlock. Douglas-fir ranged from 44" (112 cm) d.b.h. to 14" (36 cm) d.b.h. while Western Hemlock measured from 35" (89 cm) d.b.h. to 24" (61 cm) d.b.h.

(ii) Tree Species Present in Understory

The understory was dominated by Western Hemlock, Western Red Cedar, Paper Birch, Western Flowering Dogwood and Vine Maple. Many of these species have had to struggle for light and have been drawn-up as canopy closure is almost complete.

(iii) Shrubs Present

The shrubs present included Salmonberry, Huckleberry, Vine Maple, Cascara and Hazel in order of decreasing dominance.

(iv) Groundcovers Present

The groundcover was dominated by Sword Fern and Salal.

(v) State of the Overstory Canopy

In generally good health with active leader growth.

(vi) Damage to Understory and Groundcover

Some pedestrian damage to the understory was noticed.

(vii) Soil Type and Moisture Status

The soil developed on this stony, sandy till has a moderate moisture status.

(viii) Quantity of Regeneration

Sparse regeneration of Western Red Cedar and Western Hemlock has occurred.

.5 AREA E

This area has an overstory of Douglas-fir with a varied understory including Western Red Cedar, Paper Birch, Vine Maple and Western Flowering Dogwood. Vine Maple and Salmonberry are the main shrubs present, while the groundcover is dominated by Sword Fern and Salal.

D.B.H. measurements of the Douglas-fir range from 25" (63 cm) to 26" (66 cm). The general state of the canopy is good. General soil conditions are moist and silty, resulting in a dense understory of Vine Maple. If underplanting is contemplated, Western Red Cedar should be used after some thinning of the Vine Maple.

5.10 Summary of Woodland Management Unit Recommendations

.1 Unit A

(i) Introduction

This area (indicated on Map 4) is characterized by a low stocking of healthy, mature Douglas-fir (Pseudotsuga menziesii), with a high proportion of stressed, sparse crowned

individuals. It requires an immediate program of underplanting and selective felling.

The high public visibility of this area will necessitate a very high level of professional expertise in felling, underplanting and landscaping. It is important to minimize damage to the understory during felling and to create a westerly peripheral planting zone adjacent to the grassed area that is effective in screening the public both visually and physically from the environmentally sensitive areas to the east, where the main underplanting program will take place. The larger, sparsely crowned Douglas-fir should be felled in conjunction with the moribund Douglas-fir and Western Hemlock (Tsuga heterophylla). Careful selection and evaluation of individuals is a necessity. Felling should be done over a three year period to reduce the impact of disturbance. The high public visibility of this activity will require public awareness and input into the operation. A public meeting to explain the objectives of these activities could enhance public acceptance of these recommendations.

(ii) Tree Underplanting

This open area located on the western side of Area A (shown on Map 2), bounded by a dry ridge running northwest by southeast, requires an immediate underplanting program. Planting activities should be concentrated in this area for the next two years. A temporary waterline should be installed in the area before planting begins, but after any felling has been completed.

(iii) Planting

Actual plant spacing should be determined by the quantities of existing natural generation. Only where natural generation is inadequate should any planting take place. Douglas-fir should be the principal species used, with Western Hemlock a subsidiary component in localized shady areas.

(iv) Type of Planting Stock and Staking

Any planting that occurs within 3 m from the open grass should be 1.5 m standards, tied with plastic ties to 2.5 m high, 5 cm x 5 cm wooden stakes. Areas away from the peripheral zone can be planted with 0.5 to 1 m trees.

(v) Aftercare, Maintenance and Weeding

Great attention should be paid to maintaining strong, young, developing trees. Fertilizing should take place, over the next two years, in early June, with a balanced slow release fertilizer such as Osmocote. Weeding

will be required throughout the growing season. After one year, any losses should be replaced with vigorous new stock.

(vi) Peripheral Buffer Planting

Dense peripheral planting on the western edge of Area A should be undertaken to discourage human disturbance to the underplanted areas in the rear. The following tree and shrub species should be considered for this area: Ocean Spray (Holodiscus discolor), Cascara (Rhamnus purshiana), Bitter Cherry (Prunus emarginata), Vine Maple (Acer circinatum), and Western Flowering Dogwood (Cornus nuttallii).

.2 UNIT B

This area of poor drainage is dominated by a distinct plant community with Western Paper Birch (Betula papyrifera), Cascara, Vine Maple and lesser quantities of Western Red Cedar (Thuja plicata). This moist area is very susceptible to damage and we recommend the construction of sturdy wooden walkways to minimize pedestrian damage to the fragile muck soil. The generally low deciduous vegetation provides for greater plant diversity in an otherwise conifer-dominated habitat. The natural vegetational succession to a forest dominated by Western Red Cedar should be allowed to progress.

An area north of the horseshoe pitch lacks a definite understory and, in some areas, a shrub layer. In future years underplanting with Western Hemlock, Vine Maple, Elderberry (Sambucus racemosa), and Hazel (Corylus cornuta var. californica) should be considered. In a few of the larger open areas Douglas-fir would be the appropriate species.

In all remaining areas underplanting with Western Hemlock should be used in the larger forest openings where regeneration is inadequate.

.3 UNIT C

This forested area is broken up with intervening grassed turf areas. These treed islands should be expanded using Western Hemlock and shrubs including Elderberry, Hazel, Western Flowering Dogwood and Vine Maple. Peripheral to these forest islands, and adjacent to the grass, further planting of ground covers including Salal (Gaultheria shallon) and Sword Fern (Polystichum munitum) should be undertaken to maintain the health of the trees growing in these areas.

.4 UNIT D

This contains the finest Douglas-fir and Western Hemlock stands in Central Park. The groundcover of Sword Fern and Salal should be carefully protected from pedestrian damage as the healthy vegetation covers the root zone of the Douglas-fir.

.5 UNIT E

This area should be left in its existing state.

.6 UNIT F

This is an area of poorly drained land dominated by Red Alder (*Alnus rubra*), Western Paper Birch, willows (*Salix* sp.) and Black Cottonwood. A few mature Douglas-fir are found on this area of periphery. As a first priority, drainage must be improved to eliminate standing water. Underplanting should be considered using Western Red Cedar to diversify the generally deciduous forest.

.7 UNIT G

This unit between Area D and Boundary Road (see Map 4), which is now dominated by Vine Maple, Black Cottonwood, Western Paper Birch, Cascara and Bitter Cherry, should be underplanted with Western Hemlock and Western Red Cedar. They will eventually form a predominantly coniferous forest that will modify the severe edge of the now mature Douglas-fir stand (Area D - Map 2). This abrupt, unexposed edge is a potential site for windblow. It may be desirable to release some of the underplanted conifers at a later stage by thinning the vigorous deciduous overstory which could shade and stunt young developing coniferous trees.

.8 UNIT H

This unit contains numerous "forested islands" in a matrix of generally poorly drained grassed areas. Many of the major canopy dominant trees in these "forest islands" are showing advanced signs of stress due to a combination of soil compaction and/or poor drainage in the root zone. Removal of dead and senescent Douglas-fir and Western Hemlock should be a priority undertaken in the manner described in section 5.4.

All felling should be completed before a comprehensive drainage scheme is considered for this area. Many of the stress symptoms, including sparse foliage, fungal attack and lack of leader growth, are attributable to poor drainage and/or soil compaction. The latter probably results from public use and repeated passage of mowing equipment, which should be curtailed.

The understory vegetation, including groundcover, should be reinforced with Western Flowering Dogwood, Western Hazel, Cascara, Ocean Spray, Vine Maple, Salal and Sword Fern. Some "forest islands" could be expanded or combined together to form more stable vegetative groups. Large 1.5 m Douglas-fir transplants should be used to replace all felled trees. A post-planting watering program should be implemented for dry periods.

5.11 Park Management Plan

It is now fairly commonplace for Provincial and State Park authorities to prepare an overall Park Management Plan to provide the managerial framework for administrating and guiding the development of park areas. While the technique is not yet well-used at the municipal level, the process has much merit in providing a review and documentation of future park activities for all types of municipal park.

The park plans proposed here are structured around seven topic headings.

1. Introduction

This section would examine the general setting of each park, the place of the park in a regional and local perspective, the park facilities as they exist at the time of the plan preparation and an evaluation of the projected demand for use of the park.

2. Statement of Purpose

This section would state the designated role(s) of each park and the objectives of management for the designated uses.

3. Park Resource Statement

This section would normally place each park in the appropriate biogeoclimatic zone and review the soil types involved in supporting any vegetation resource. It would also examine the condition of that resource as well as any other resources of note, such as facilities, water, wildlife or special scenic attributes.

4. Zoning

This section would be used to geographically designate those areas to be developed, those areas to be left in a largely natural state, and those areas to be enhanced or restored.

5. General Management Statements

This section would be used to indicate the type of management strategy that would be used for the future, consistent with the role and objectives for the park. This section would also be used to indicate the specific chain of responsibilities that would apply to the management of the park.

6. Specific Management Statements

This part would be the main thrust of specific management policies and be reflected in three phases. The first section would discuss the management of the natural resources of each park. The second section would discuss management of park use, and the third part, specific improvements envisaged in facilities, vegetation resources, landscape, circulation, etc. This section could encapsulate

actual management plans and activities in much the same form as this report does for landscape and woodland management.

7. Implementation of the Plan

This section would discuss the priorities for immediate, early and later implementation of specific components or needs identified in previous sections of the Plan document, most notably in those parts dealing with management of the park. It would also specify who was actually responsible for each stage of implementation.

This brief review gives an indication of the type of plan that could be prepared for all Burnaby parks. The extent and breadth of detail in each plan is, of course, coupled to the size, importance and intensity of use experienced in each park area. However, the basic format and concept would be applied to each as the need arose.

TABLE 2

WOODLAND MANAGEMENT UNITS

NO.	TYPE	RECOMMENDATIONS	AREA
A	Main forest	- selective felling of stressed trees over a 3 year period - underplanting with Douglas-fir, Western Hemlock in very shady non-felled areas - public information program - edge/buffer planting	35.6 ha
B	Wet forest	- wooden walkways - define trail hierarchy - use mainly Western Red Cedar	1.2 ha
C	Open glade	- expand native shrub islands at base of trees to protect root zones from mower compaction - Start Douglas-fir standards - define trail hierarchy	5.2 ha
D	Shelterbelt	- underplant the deciduous, western side of this zone with Western Hemlock and Western Red Cedar	4.7 ha
E	"Stressed crowns"	- retain as existing trees with topping; replace as in Unit H	1.3 ha

TABLE 2 CONTINUED

WOODLAND MANAGEMENT UNITS

NO.	TYPE	RECOMMENDATIONS	AREA
F	"Stadium drainage"	- amend drainage system from stadium - underplant with Western Red Cedar, Douglas-fir and shrubs	0.5 ha
G	Deciduous treebelt	- create small clearing in existing deciduous stand - underplant with Western Hemlock and Western Red Cedar - thin deciduous overstory as conifers develop - reduce proportion of Black Cottonwood, Paper Birch and Red Alder - introduce native Dogwood	1.2 ha
H	"Stressed open glade"	- reduce mowing - increase size of treed islands - remove dead and dying tall conifers and top those showing crown dieback - in new larger islands, establish understory of large and intermediate replacement Douglas-fir with small proportion of Western Red Cedar	1.7 ha

REFERENCES

Burnaby Planning Department. 1975. A Development Programme for Burnaby Lake Regional Park. The Corporation of the District of Burnaby.

Burnaby Planning Department. 1977. Burnaby Metrotown. A Development Plan. Report submitted to the Corporation of the District of Burnaby.

Burnaby Planning Department. 1977. Burnaby Park Study. The Corporation of the District of Burnaby.

Burnaby Planning Department. 1980. A Development Plan for Metrotown Area 11. The Corporation of the District of Burnaby.

Burnaby Planning Department. 1980. Burnaby Trail Study. The Corporation of the District of Burnaby.

Deer Lake Park Design Team. 1977. Deer Lake Park. A Plan for Development. Prepared for the Corporation of the District of Burnaby.

Rhone & Iredale, Architects and Planners. 1978. Burnaby Lake Sports Centre. A Plan for Development. Final Summary Report, submitted to the Corporation of the District of Burnaby.

Ripley, Klohn & Leonoff International Ltd. 1973. Swangard Stadium Subsurface Drainage Study. Report submitted to the Corporation of the District of Burnaby.

Sullivan, T. P. 1979. Repopulation of Clearcut Habitat and Conifer Seed Predation by Deer Mice. J. Wildlife Management 43(4).

U.S.D.A. Forest Service. 1979. Wildlife Habitats in Managed Forests. The Blue Mountains of Oregon and Washington. Agricultural Handbook No. 553.

APPENDIX 1

BIOGEOCLIMATIC SUMMARY

COASTAL WESTERN HEMLOCK ZONE

1. Climate (after Koppen):Cfb (and the mildest Dfb)
2. Regimen: equable (marine) mesothermal (or the mildest microthermal) humid to rainy.
3. Accumulated day degrees over 6° C: 1500-2500 (-3000)
4. Number of frost free days: 120-250 (-275)
5. Mean annual temperature: 5-9° C
6. January mean monthly: -4 to 5° C
7. July mean monthly: 13-18° C
8. Number of months above 10° C: 4 - 6
9. Number of months below 0° C: 0-3 (-4)
10. Annual range of temperature (mean monthly): 9-21° C
11. Absolute maximum: 26 to 40° C
12. Absolute minimum: -30 to -7° C
13. Annual total precipitation: 165-665 cm
14. Annual snowfall: 12.7-750 cm
15. Snowfall in % of annual total precipitation: 0.9-38%
16. Driest month precipitation: 3-16.5 cm
17. Wettest month precipitation: (15-) 28-117 cm
18. Seasonal occurrence in % of total precipitation:

    South: wet-winter (30-45%)
    dry-summer (7-15%)

    North: wet-winter (30-40%)
    dry-summer (10-15%)

19. Clouds - very common
20. Elevation:

    South: windward side: 0-900 m
    leeward side: 450-1050m

    North: 0-300 m

21. Latitude: 48-60°N (along the coast of B.C.)
22. Mesic (zonal) soils: Orthic Ortstein or Humo-ferric or Ferro-humic podzols (in the drier subzone)
23. Prevailing pedogenic processes:

    (a) moorformation
    (b) podzolization
    (c) gleization
    (d) kaolinization
    (e) high moorformation
    (f) solodization
    (g) very weak laterization

APPENDIX 2

Douglas-fir (*Pseudotsuga menziesii*)

Geographical Range and Climatic Requirements:

Douglas-fir is one of the major timber tree species in coastal southwest British Columbia and excels in this region's humid to super-humid climate. It occurs throughout the Rockies to the Pacific from central B. C. to central California and Mexico.

Soils, Topography, Moisture, Nutrient Requirements:

Douglas-fir does not thrive on poorly drained soils or soils with an impervious layer near the surface. It attains its most luxuriant growth on deep, moist, well-drained sandy loams.

Associated Trees and Shrubs:

Characteristic associates include Red Alder (*Alnus rubra*), Grand Fir (*Abies grandis*), Western Hemlock (*Tsuga heterophylla*), Western Red Cedar (*Thuja plicata*) and Big-leaf Maple (*Acer macrophyllum*).

Major understory species include Salal (*Gaultheria shallon*), Oregon Grape (*Mahonia nervosa*), Huckleberry (*Vaccinium parvifolium*), Salmonberry (*Rubus spectabilis*) and Western Thimbleberry (*Rubus parviflorus*). Vine Maple (*Acer circinatum*) occurs as a small tree in moister sites throughout the area.

Reproduction and Growth:

Seed is produced in appreciable amounts between the 20th and 30th years, with maximum seed production occurring at 200 and 300 years of age. On average, heavy seed crops occur at 5 to 7 year intervals.

Douglas-fir will germinate on almost any seedbed that provides adequate moisture and proper temperature. Moisture requirements are high but the soil must be well-drained.

Douglas-fir regeneration is most successful on shaded northerly aspects. New seedlings need light shade, but once established they grow best in full sunlight.

Douglas-fir is able to maintain a fairly rapid rate of height growth over a very long period of time. On an average site, annual growth is more than 2' at age 20, 0.5' at age 100 and 0.3' at age 120.

Douglas-fir is very long-lived; ages in excess of 500 to 1000 plus are known.

Douglas-fir has a strong, widespreading, lateral root system in deep loamy soils.

Reaction to Competition

For satisfactory establishment and development, Douglas-fir requires more light than Western Hemlock, Western Red Cedar and Grand Fir. It is recognized as a subclimax species and rarely maintains a climax position. Its widespread occurrence in extensive even-aged stands is caused by fires, clear-cutting and insect attack.

Young seedlings and saplings of Douglas-fir respond to release from competing brush or overstory trees. Trees at pole and small saw timber size respond well to conservative thinning. Douglas-fir that have developed in closed stands are poorly adapted to radical release.

When exposed, the long slender boles with short crowns are highly susceptible to damage from sunscald, snowbreak and windfall.

Principal Enemies:

High winds following heavy rainfall may cause widespread windthrow.

Crown fires are destructive to all ages. The thick bark of older Douglas-fir makes them fairly resistant to ground fires.

Douglas-fir beetle (Dendroctonus pseudotsugae) attacks trees from the large pole stage to maturity. Western spruce budworm (Choristoneura occidentalis) is a potentially serious pest of Douglas-fir but at present it is absent from the Lower Mainland.

The most serious heartwood decays in young growth Douglas-fir are caused by Fomes pini. Polyporus schweinitzii causes another common heart rot in young growth Douglas-fir. Fomes subroseus heart rot enters via broken tops.

The killing root disease Poria weirii is the most serious fungal enemy of Douglas-fir and is of concern in British Columbia since it can cause widespread windthrow in infected stands.

Western Red Cedar (Thuja plicata)

Geographical Range and Climatic Requirements:

Western Red Cedar is confined almost entirely to regions having abundant precipitation and atmospheric humidity. This species grows from coastal southern Alaska to northwestern California. Inland, it grows eastwards to the western slopes of the Continental Divide and thence south to the Salmon River Mountains of Idaho.

Soils, Topography, Moisture and Nutrient Requirements:

Western Red Cedar is generally found along stream bottoms, moist flats, terraces, and gentle slopes and in moist gulches and ravines. Northern aspects are optimal for growth. The fertile, occasionally flooded soils of the Pseudotsuga-Thuja-Adiantum association is near optimum for cedar growth in the Douglas-fir region.

Associated Trees and Shrubs:

Western Red Cedar seldom occurs in pure stands, and then only over small areas. In Oregon, western Washington and British Columbia, Western Hemlock (Tsuga heterophylla), Sitka Spruce (Picea sitchensis), Grand Fir (Abies grandis), Douglas-fir (Pseudotsuga menziesii) and Pacific Silver Fir (Abies amabilis) are common coniferous associates. Big-leaf Maple (Acer macrophyllum), Red Alder (Alnus rubra) and Black Cottonwood (Populus trichocarpa) are frequent deciduous associates at low elevations or near water.

Dense stands of Western Red Cedar and its associates exclude nearly all subordinate vegetation. The following species are plentiful in coastal forests: Vine Maple (Acer circinatum), Oregon Grape (Mahonia nervosa), Western Dogwood (Cornus nuttallii), Hazelnut (Corylus cornuta), Salal (Gaultheria shallon), Ocean Spray (Holodiscus discolor), Indian Plum (Oemleria cerasiformis) and Elderberry (Sambucus racemosa).

Reproduction and Growth:

Western Red Cedar is a prodigious seed producer. Good crops are produced every 2 to 3 years.

Germination is better on burned and unburned mineral surfaces than on duff. Seedlings survive best under partial shade.

Compared to most of its associates, Western Red Cedar is a slow growing species. Height growth is most rapid before the 30th year and is steadily sustained for 200 years.

The root system is shallow and widespreading, but strong. On wet

soils, cedar is very susceptible to windthrow. On drier soils it is fairly windfirm.

Reaction to Competition:

Western Red Cedar is rated as a very tolerant tree. It is common for it to reach maturity in the shade. Its growth is retarded in proportion to the density of the shade. Cedar responds well to release.

Principal Enemies:

Western Red Cedar has few important enemies other than fire, which destroys its fibrous bark and shallow root system. It can suffer from magnesium and calcium deficiency.

The amethyst cedar borer (Samanotus amethystinus) occasionally kills healthy trees, but usually limits its attacks to injured, stressed or dying trees. Its range is limited to coastal cedar forests. The western cedar bark beetle (Phloeosinus punctatus) is a widespread species and attacks trunks and larger limbs, particularly those of stressed trees.

In B. C., wood decay in trees between 50 and 450 years old does not exceed growth increment, but decay in younger stands is more important. The following species of fungi are important in this respect: Poria asiatica, P. albipellucida and Fomes pini.

Western Hemlock (*Tsuga heterophylla*)

Geographical Range and Climatic Requirements:

Western Hemlock thrives in the super-humid and mild climate along the Pacific slope of North America from Prince William Sound in Alaska south to northern California.

Soils, Topography, Moisture and Nutrient Requirements:

Western Hemlock thrives best under high rainfall conditions on deep, internally well-drained soils with abundant organic matter.

Associated Trees and Shrubs:

Western Hemlock is usually subordinate in association with Western Red Cedar (*Thuja plicata*), Grand Fir (*Abies grandis*), Douglas-fir (*Pseudotsuga menziesii*), Black Cottonwood (*Populus trichocarpa*) and Red Alder (*Alnus rubra*).

Major understory species include Salmonberry (*Rubus spectabilis*), Huckleberry (*Vaccinium parvifolium*), Salal (*Gaultheria shallon*) and Vine Maple (*Acer circinatum*).

Reproduction and Growth:

Western Hemlock is a very prolific seeder. Heavy seed crops occur every 3 to 4 years. Seedbearing begins between 25 and 30 years.

If moisture is adequate, germination under forest conditions is excellent. Germination on old stumps and trunks is often prolific.

Under optimum conditions, trees grow to 0.9 to 1.3 metres in diameter and 53 to 70 meters high.

The root system is fibrous and shallow, but widespreading.

Reaction to Competition:

Western Hemlock is rated as very tolerant, more so than Douglas-fir or Pacific Silver Fir. Western Hemlock responds well to release after long periods of suppression. When Western Hemlock develops in a dense, even-aged stand, natural pruning takes place early. Western Hemlock is a true climax type.

Principal Enemies:

Chief causes of mortality in young growth Western Hemlock are wind and/or snow causing damage to the crown, with resulting sites for pathogens to enter. Hemlock looper (*Lambdina fiscell areia*) and hemlock sawfly (*Neodiprion tsugae*) are two defoliating pests of the species.

A number of trunk, butt and root rots, including *Fomes annosus*, *F. pini* and *Poria weirii* are important. These decays are more destructive in old growth than in young growth stands.

Dwarf mistletoe (Arceuthobium campylopodum) increases mortality, especially of mature trees, and reduces growth in trees of all sizes. It is not known to occur on the site.

Fire and wind cause considerable losses in old growth stands. Thin bark and the occurrence of exposed roots are reasons for a high rate of susceptibility to fire damage. the shallow rooting characteristics of this species result in windthrow being a major destructive element.

Red Alder (*Alnus rubra*)

Geographical Range and Climatic Requirements:

This is the major pioneer tree species in the Coastal Douglas-fir and Western Hemlock zones of southwest British Columbia. It excels in this region's mild, super-humid climate and occurs from northern B. C. along the coast to northwest California.

Soils, Topography, Moisture and Nutrient Requirements:

Alder tends to be more prevalent on soils with restricted internal drainage, but is excluded from bottlomlands subject to periodic flooding. Red Alder is common on most alluvial soils and extends up the lower slopes until accelerated drainage limits tree development. Best growth occurs on deep well-drained loams or loamy sands of alluvial origin.

Red Alder will grow on poor soils and it contributes to the physical and chemical improvement of soils. The development of a rich mull humus layer improves soil structure and liberates plant nutrients. Soil fertility is further improved through symbiotic fixation of nitrogen by microorganisms contained in root nodules. Dense stands may fix nitrogen at rates of 320 kg/ha/yr on nitrogen deficient soils.

Associated Trees and Shrubs:

Characteristic associates include Black Cottonwood (*Populus trichocarpa*), Grand Fir (*Abies grandis*), Douglas-fir (*Pseudotsuga menziesii*), Western Red Cedar (*Thuja plicata*), Western Hemlock (*Tsuga heterophylla*), Big-leaf Maple (*Acer macrophyllum*) and Vine Maple (*Acer circinatum*).

Major understory species include Salmonberry (*Rubus spectabilis*), Elderberry (*Sambucus racemosa*), Western Thimbleberry (*Rubus parviflorus*), Indian Plum (*Oemleria cerasiformis*) and Sword Fern (*Polystichum munitum*).

Reproduction and Growth:

Seed production is prolific, with good crops every fourth year. Seeds are dispersed through fall and winter and carried great distances by wind.

Germination and growth are rapid, particularly on scarified mineral soils.

Red Alder regeneration is favoured by either clear-cutting or large group cutting. Any method of providing full overhead light and exposure of mineral soil will ensure good regeneration if moisture is available.

Red Alder is known as a pioneer species because of its rapid initial growth, which allows it to become established before its conifer associates. Average 5 year old seedlings on good sites can reach 5 m, while 10 year old trees may be 10 m to 12 m high. At about 25 years old, Douglas-fir, its chief competitor, usually overtakes it in height.

It is a short-lived tree, seldom surviving more than 60 years.

Reaction to Competition:

Alder is generally considered an intolerant tree. It is less tolerant than Western Hemlock, Western Red Cedar and Grand Fir.

Principal Enemies:

Red Alder is virtually free from disease for about the first 40 years.

White heart rot (Fomes igniarius) is the most destructive disease of the living tree.

Considerable amounts of foliage are periodically consumed by tent caterpillars (Malacosoma pluviale and M. disstria). Outbreaks usually last for only one year and practically all trees recover.

Damage by fire is unusual because of the lower amount of litter accumulation below this species, and resistance of the bark to light surface fires.

The root system is shallow and widespreading, but Red Alder is seldom windthrown because in mixed stands it has the protection of conifer associates, and in pure stands density is high and individual trees protect each other. Trees exposed as a result of logging or thinning are susceptible to windthrow and windbreak.

Big-leaf Maple (*Acer macrophyllum*)

Geographical Range and Climatic Requirements:

Big-leaf Maple ranges from the mountains of southern California north to B. C. It is best developed on alluvial soils where it occasionally forms pure, dense stands.

Optimum growing conditions occur in the humid and super-humid climates of western Oregon.

Soils, Topography, Moisture and Nutrient Requirements:

Big-leaf Maple is found on a variety of soils from deep loams to thin rocky slopes. Deep alluvial soils near streams are optimal for the species.

In B. C., Big-leaf Maple occurs as a pioneer on hillsides laid bare by slides or fire. In B. C., it rarely occurs at elevations above 305 m.

Associated Trees and Shrubs:

Occasional pure stands are found near streams, but this species normally associates with Red Alder (*Alnus rubra*), Douglas-fir (*Pseudotsuga menziesii*), Western Red Cedar (*Thuja plicata*), Grand Fir (*Abies grandis*), Western Hemlock (*Tsuga heterophylla*), Black Cottonwood (*Populus trichocarpa*) and Vine Maple (*Acer circinatum*).

Reproduction and Growth:

Big-leaf Maple often bears enormous seed crops. Natural regeneration is usually adequate. In the early part of its life it will outgrow Douglas-fir and can survive beneath Douglas-fir until the canopy closes.

Growth rate is rapid for the first 40 to 60 years. Mature trees average about 15 m in height and 0.5 m in diameter.

In almost all habitats, Big-leaf Maple develops a shallow, widespreading root system.

Maturity is reached in 150 to 300 years.

Reaction to Competition:

Big-leaf Maple is less tolerant than most of its associates, including Vine Maple, Western Hemlock, Western Red Cedar and Pacific Yew. Tolerance decreases with age. During early life, Big-leaf Maple can endure considerable shade. Even though this tree makes rapid early growth, it is often overtopped by competing conifers.

Principal Enemies:

Big-leaf Maple is subject to a wilt disease (*Verticillium* sp.). Summer leaf dieback is also common. It is also subject to heart rot in old age, usually caused by *Fomes* sp. and *Polyporus* sp.

Vine Maple (*Acer circinatum*)

Geographical Range and Climatic Requirements:

Ranging from coastal B. C. to northern California, Vine Maple requires a humid to super-humid climate to occur widely away from stream banks. Its altitudinal range is below 1,200 m in coastal B. C.

Soils, Topography, Moisture and Nutrient Requirements:

In B. C., it attains its largest size on rich alluvial bottomlands, often forming impenetrable thickets of contorted and interlaced trunks that can be many acres in extent. It has a common habit of layering itself from bowed branches that touch the earth.

Associated Trees and Shrubs:

It occurs with Western Hemlock (*Tsuga heterophylla*), Western Red Cedar (*Thuja plicata*), Red Alder (*Alnus rubra*), Douglas-fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), Black Cottonwood (*Populus trichocarpa*) and Paper Birch (*Betula papyrifera*).

Common understory associates include Salmonberry (*Rubus spectabilis*), Salal (*Gaultheria shallon*), Elderberry (*Sambucus racemosa*) and Sword Fern (*Polystichum munitum*). [Vine Maple is an edaphic climax shrub in both the coastal Western Hemlock and coastal Douglas-fir forest types].

Reproduction and Growth:

Vine Maple is often a coarse shrub, but under good conditions it will grow into a tree, sometimes attaining heights of 10 m and diameters of 15 cm. Growth is generally quite rapid.

Reaction to Competition:

Vine Maple is extremely tolerant of dense shade and often forms a constituent of the coastal forest understory, particularly in areas recently logged over.

Principal Enemies:

Coral spot (*Nectria* spp.), a common maple disease, can spread from dead wood to live where a tree is prestressed by drought or sudden exposure.

Western Flowering Dogwood (*Cornus nuttallii*)

Geographical Range and Climatic Requirements:

Natural distribution is from southwest B. C. to California and to the western slopes of the Cascade Mountains. In B. C., the Western Flowering Dogwood is found on the Lower Mainland portion of the province and the southern portion of Vancouver Island.

Soils, Topography, Moisture and Nutrient Requirements:

Western Flowering Dogwood is found in the coastal Douglas-fir and dry coastal Western Hemlock zones. It is often found along streams in the southern portion of its range, and often in open to partially open dense forest below 1,800 m in the northern part of the range. It is well adapted to moist loam soils with adequate humus and fairly low pH (5.5 to 6.0).

If found in dense forest, it usually possesses a long tapering trunk that supports a thin narrow crown. Trees assume a bushy habit with several leaders in open situations.

Associated Trees and Shrubs:

Western Flowering Dogwood occurs with a number of western coastal tree and shrub species. Douglas-fir (*Pseudotsuga menziesii*), Grand Fir (*Abies grandis*), Western Red Cedar (*Thuja plicata*), Western Hemlock (*Tsuga heterophylla*), Red Alder (*Alnus rubra*) and Big-leaf Maple (*Acer macrophyllum*) are common tree associates, while Salmonberry (*Rubus spectabilis*), Vine Maple (*Acer circinatum*), Elderberry (*Sambucus racemosa*) and Sword Fern (*Polystichum munitum*) are common understory species.

Reproduction and Growth:

This species is relatively slow growing, becoming 15 to 30 cm in diameter and 10 m tall in 50 to 100 years. Large trees are 125 to 150 years old. Under good growing conditions, trees can exceed 20 m in height.

Western Flowering Dogwood has a spreading, shallow root system.

Reaction to Competition:

This species normally prefers full or partial shade, requiring protection from full sun.

Principal Enemies:

Western Flowering Dogwood is very susceptible to sun damage in winter months. The result of such damage is a checking of the bark and cold damage to the growing tissues.

Botryotinia fuckeliana causes bark canker and *Phytophthora cactorum* causes crown rot and trunk canker. The latter fungus enters via injured tissue.

Black Cottonwood (*Populus trichocarpa*)

Geographical Range and Climatic Requirements:

The range of this species extends from southeast Alaska to mountains in southern California. It develops best in the humid climate of the Pacific Northwest.

Soils, Topography, Moisture and Nutrient Requirements:

Black Cottonwood grows in soils ranging from moist gravels and sand to rich humus soils and, occasionally, clays. The largest trees grow at low elevations on deep alluvial soils. The species requires abundant moisture, nutrients and oxygen in combination with a high pH for optimum growth.

Associated Trees and Shrubs:

Black Cottonwood occurs with Douglas-fir (*Pseudotsuga menziesii*), Western Red Cedar (*Thuja plicata*), Western Hemlock (*Tsuga heterophylla*), Red Alder (*Alnus rubra*), Vine Maple (*Acer circinatum*), Big-leaf Maple (*Acer macrophyllum*) and willows (*Salix* spp.).

On good sites, Salmonberry (*Rubus spectabilis*), Stinging Nettle (*Urtica* spp.), Sword Fern (*Polystichum munitum*), Hazel (*Corylus cornuta*) and Elderberry (*Sambucus racemosa*) occur as understory species.

Reproduction and Growth:

Black Cottonwood is generally a prolific annual seed producer. The seed is light and buoyant and can be transported long distances by wind.

Black Cottonwood makes very rapid juvenile growth on good moist sites. It is capable of reaching 15 m in 10 years. In B. C., the species reaches maturity at 200 years.

Reaction to Competition:

Black Cottonwood is the most shade intolerant of its associates. Rapid juvenile growth, which exceeds that of most of its associates, helps it to keep its favourable position in stands.

Principal Enemies:

Late frosts frequently kill or injure Black Cottonwood. Frost cracking provides entrance for decay fungi. After reaching 24 m or more, wind damage becomes a factor in determining eventual height.

Black Cottonwood is very susceptible to fire damage. Wood decay fungi include *Polyporus delectans* and *Pholiota destruens*.

Paper Birch (*Betula papyrifera*)

Geographical Range and Climatic Requirements:

Paper Birch, with its varieties, has a transcontinental range. In western North America, it extends from Alaska southwards to Washington and Oregon. Paper Birch is a cold climate species. It seldom occurs when average July temperatures exceed 21°C.

Soils, Topography, Moisture and Nutrient Requirements:

Paper Birch usually grows on podzols derived from glacial tills and is best developed on fresh, well-drained sandy loams. It is cosmopolitan in the more favourable northern parts of its range. In its southern range it is restricted to the cooler sites of higher elevations and steep north- and east-facing slopes.

Associated Trees and Shrubs:

In B. C., this species can grow in pure stands or in association with Western Red Cedar (*Thuja plicata*), Western Hemlock (*Tsuga heterophylla*), Red Alder (*Alnus rubra*), Black Cottonwood (*Populus trichocarpa*) and Big-leaf Maple (*Acer macrophyllum*).

It is often associated with such understory species as Salmonberry (*Rubus spectabilis*), Thimbleberry (*Rubus parviflorus*) and Sword Fern (*Polystichum munitum*).

Reproduction and Growth:

Optimum seed-bearing age is between 40 and 70 years. Seeds are light and may be carried a considerable distance by wind.

Mineral soil and rotten logs are best for germination and initial establishment. Even under favourable conditions, seedlings that survive are only 5 to 10 cm height after the first season. Compared to other *Betula* species, Paper Birch has a long period of height growth.

Individual trees often have a diameter of 20 cm after 30 years. Trees in mature stands average about 25 cm in diameter and 20 m in height. Trees mature in about 60 to 75 years. Paper Birch is considered a short-lived species.

Reaction to Competition:

Paper Birch is an intolerant species. In the natural succession, Paper Birch usually lasts only one generation.

Paper Birch requires overhead light from the seedling stage to maturity. Unless suppressed trees are released early, they soon die.

Principal Enemies:

A condition known as post-logging decadence often develops where Paper

Birch have been exposed by opening of stands. The symptoms include lowered vigour, reduced growth and substantial dieback.

The most important rot-causing fungi attacking the species are *Fomes igniarius* and *Poria obliqua*.