ECONOMICS, PEOPLE AND URBAN GREEN SPACE

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Introduction:

Privacy, quiet, clean air and water are scarce goods. Far scarcer now than 20 years ago, and sure to be still scarcer in the future. Highly valued by millions of urban residents, anxious to find a quiet place to live or to enjoy recreation, be it home or work, these resources cannot be considered free goods, as if so abundant that a little more or less made no difference to the quality of our lives. As crucial amenities, they need careful husbandry for use by current and future populations. The realization has come slowly. Planners now promote urban and regional plans for creating better human living conditions and improved environmental quality; goals that can be realized in both city and regional contexts, providing opportunities for solitude, public open space, and the aesthetic pleasures of a natural, or at least semi-rural landscape (3).

During the current decade, both private and public concern has been expressed over the disappearance of "open space". Open space is not clearly defined, and few totally agree about the definition. To some, open space means free space around urban areas; parks, golf courses, wild life sanctuaries. To others it means open land, not yet developed, but capable of development. Still others may consider reservoirs, lakes, rivers, parkways, and anything not covered by concrete, steel, or asphalt, as open space. The term has an unfortunate negative connotation. Open space seems to mean the absence of something - an area not serving residential, industrial or urban land uses (6). The aim of many open space programs has been to keep development off the landscape , to hold an area open, to prevent the intrusion or roads, buildings, and parking lots. (19). The terms "open land", "greenbelt land", "park land", "green space" and "recreation areas" overcome the negative term open space and the positive terms are, perhaps, more useful. A sound general definition of open space in the urban community is still illusive (3).

The definition of open space is changing from a strict geographical concept to a functional definition of the public goods and services provided by natural areas and worthy of maintenance by public policy and planning. Certainly, when regions are considered as a whole, some parts should unquestionably left as natural areas or open space. However, as a forester, I am reticent to use only the term open space. Rarely is vacant land bereft of vegetation. In fact vegetation is an integral part of open space and I have therefore preferred the term urban green space for the title of this paper.

Urban green space performs several valuable functions; including biological productivity, allowing aquifer recharge, reducing urban run-off, preventing erosion, and possibly providing horticultural opportunities. Urban green space is also needed for recreation (as used here, the term has the meaning of that adopted by Clawson (6) as any activity, or activities, including inactivity if freely chosen, engaged in during leisure time.) at a variety of scales and for a variety of age groups, to assure freedom from natural hazards as in flood planes and areas susceptible to erosion and to provide visual relief; a respite from hard surfaces, regular forms, parking lots, and wall to wall houses. In considering urban green space then, the key point is the function of the land.

Generally, there are three kinds of urban green space: reserved land, semi-reserved land and non-reserved land (17). Reserved lands for specific purposes include: parks, nature centres, wild life refuges and sanctuaries, arboretums, and natural areas. Parklands are the most common reserved land, often varying in size from the recent concept of urban vest-pocket parks to sizeable tracts encompassing thousands of acres. Semi-reserved land includes airports, golf courses, water sheds, foreshore land and similar areas. These are often important sources of present and future space . Unreserved lands are normally privately owned, capable of sale and susceptable to development; city and suburban lots, privately owned estates, and investment properties would all fall in this category. Perhaps, in inventorying our urban green space, there should be a clearly recognizable fourth category which would involve areas of critical environmental concern. This would include coastal and inland wet-lands, beaches and dunes, re-charge areas for aquifers,

urban rivers, streams or lakes, areas susceptible to erosion, and rare, valuable or highly productive ecosystems. Too little is known of these resources, yet without an adequate inventory we cannot determine the areas of strategic importance in controlling the patterns of future land development, an essential prerequisite to a well-planned greenspace program for our enjoyment and health.

It has been observed that the vitality and health of a people depend, in large part, on the quality and quantity of significant, meaningful recreation opportunities during the leisure and uncommitted time of the citizens (2). The truth of this becomes abundantly clear as technological advances make more and more of this leisure and uncommitted time available in our society. There are subtle changes of attitude in society which, perhaps, give us cause for optimism. The old philosophy of "broaden the tax base" with communities expanding for so-called economic reasons has now been recognized as a manifest delusion. At least it appears that new strategies are being developed to guide and control growth in an attempt to prohibit urban sprawl. No longer are municipal governments so keen to subsidize the land and encourage the real estate developers with free servicing. The general public has become more acutely aware of the social, mental, psychological, cultural and physical values derived from urban green spaces. However no change comes without growing pains. Advocates for more open space programs have consistently called for public expenditures to purchase or control large areas. The financial stress, in most local governments, argues heavily against massive expenditures for land acquisition and management. To date, open space acquisition and protection has been largely ad hoc, local and disorganized (3). Future green space acquisition will have to recognize and accommodate, on the one hand our changing public attitudes and, on the other, the finite boundaries of our economic, natural resource, and organizational capabilities.

The purpose of this paper is to briefly examine the history of urban green space, the needs, benefits and costs that society has or must recognize, some of the conflicts which have arisen, some methods of financing green space, examine some of the encouraging signs for the future and to provide, by way of conclusion, a short look at two studies which have examined the viability of retaining urban green space.

History of Urban Green Space:

The "positive" terms used here to describe open space are, of course, of recent origin. In the past, organized open space has been synonimous with the park. It seems that the origin of the park can be traced back to the vineyards and fish-ponds of the Sumerian kings of 2340 B.C. (7). The hanging gardens of Babylonia were constructed about the 9th or 10th century B.C. Certainly public open spaces played a very important part in the life of Classical Greece where groves were dedicated to gods and temples often had a garden attached. (19). During the time of the Roman Empire, most of the larger Roman villas had substantial gardens or a hunting park attached. It is during the Roman era that we have the first record of a public bequest when Julius Caesar gave his own gardens in Rome to the general public as an endowment. From the time of the fall of the Roman Empire the idea of parks was barely kept alive - largely in the monastries which frequently were the former villas of the nobility, which had been turned over to or had become possessions of the Church. Gradually some of the barons, and of course the Crown began to acquire sizeable estates, including not only hunting preserves but gardens for interest, medicinal purposes and beauty. Be the time the 13th and 14th centuries came about, there were a number of important gardens in Europe and in Italy, particularly in Florence, public grounds were established for the leisure of people (7). From the period 1500 to the latter part of the 18th century, all over Europe, England, the Scandinavian countries and, to some extent, Russia, private parks became most elaborate developments. By the latter part of the 18th century, some of the great Royal parks were being opened to the general public, especially in the United Kingdom. Moreover, most of the Mediaeval towns had obtained a strong agricultural bias, mindful of sieges, many of them contained fields, orchards and gardens within their walls. This was municipal land, yet encroachment became a pressing problem. The spread of buildings in the suburbs throughout the 19th and 20th centuries, which restricted the access of town dwellers to the country side, increased the demand for official action to protect the commons.

The first parliamentary act in Britain, 1843, created a park near the Mersey River at Birkenhead, financed from the betterment of the houses which were developed on

the surrounding land. More was now known about the working man. Victorian society of wealth and power began to recognize the economic and social benefits to the health of working men and parks began to be built at public expense to help alleviate the effects of the Industrial Revolution. The idea rapidly spread abroad. Huge parks appeared in cities all over Europe. For example, in 1850, Paris had only one acre of open space for every 5,000 head of population, but by 1870 there was an acre for every 390 inhabitants (19).

In the middle of the 19th Century, North America still lacked a proper park in any of its cities. It was not until 1858, when L. . Olmstead started work on Central Park in New York that the idea had free expression on this continent. Central Park was an immediate success, both economically - it more than quadrupled the value of the property in its vicinity - and socially; it was visited by 4 million people in 1863 and by 11 million eight years later before it was officially opened in 1876. (19). The interest was infectious, Olmstead went on to design nearly 50 further parks in the United States. It is sad to observe that up until fairly recently we have not kept pace with those early days and, in fact, erosion of park land has been a serious problem until very recently. Latest trends have seen the introduction of miniature vest-pocket parks, organized children's adventure playgrounds, and the increasingly successful pars cours physical education tracks. Diversity and availability would seem to the the key words for the future to meet the great upsurge in population and affluence in money, leisure time, and mobility, particularly with the increased partitioning of society into a huge segment of the population below 30 years old and an ever-increasing life span in old age.

The Need for Urban Green Space:

Three centuries of settlement and population expansion have appreciably changed the North American landscape. Cities and roads have been built and expanded at the expense of forest and agricultural land. Shomon (17) suggests that about two and one-half percent of our land area represents cities, roads and airports below the 53rd Parallel. Parks and similar regulated open spaces represent about

three and one-half percent. Crops cover almost 20%. The problem is our open land is being used up alarmingly fast. As cities become crowded, there is a spill-out of people to new urbanized areas, creating new towns and subdivisions and engulfing existing towns and villages. It is calculated (Citizens' Committee for the Outdoor Recreation Resources Review Commission, 1963) that each year a million acres of land is developed in one way or another.

For those who value open areas for aesthetic or ecological reasons, these developed lands are lost. A loss which has been hard-felt but poorly accommodated in our economic analysis of resources in the past. In following this theme, Krutilla (11) attempts to value the amenity resources of natural environments. It is observed that these are gifts of nature, not produceable by man. Increases in the demand for services of natural environments cannot be met by increases in the supply. The total stock of such environments cannot be increased and the previous reduction of the stock in the past is virtually irreversible. Under conditions of uncertainty regarding future circumstances, it is, of course, very difficult to make decisions that may result in significantly adverse and irreversible consequences. An attempt is made to asses resource valuation in a dynamic model that reflects the growth in demand and the appreciating nature of the value of the service flow from green space resources. The relative merit of short term and long run analysis is discussed and it is concluded that although individual actions, in the short term, may be of no great moment, there are however long run effects of individual actions, that may be anything but trivial for society as a whole.

The collected impact of individual actions has had a staggering impact on our ecologically important resources. By 1970, it had been suggested that our population had become 70% urban in North America, with 97% of Canadian and the United States growth occurring in urban areas. The attrition of North America's landscape, due to urbanization, is amply illustrated in its effect on the wetlands and parks. Of the original 127 million acres of wetlands in the United States, the Soil Conservation Service estimates that 45 million acres have been destroyed by individual projects of drainage, filling, levees and dredging. In New Jersey, for example, nearly 5% of all wetlands were destoryed in just five years - 1954-1959,

primarily through filling for residential or industrial purposes (Open Space for Urban America, 1965).

A spiraling human population is presumably the basic cause of the disappearance urban land. Before the end of this century, the forecast is that not only the population of the world is likely to double to 7 thousand million, and double again to 14 thousand million by the year A.D. 2046, but longevity and automation will mean that people in industrial countries will have twice the amount of time for leisure than they have today (19).

The whole character of society has changed in the last few decades. It used to be that the working man had low pay, long working hours and little leisure time. The work week has dropped from 60 hours in 1925, to 40 by 1953, to a little over 30 now, and a projected drop to 25 by the year 2000. Moreover, the increasing affluence has cut the number of poor by half. In the decade 1956 to 1966, those categorized as poor in North America have dropped from more than 8 million to less than 5 million. (18). The prospect then is 4-day weeks, 4 to 6 week vacations, and yet more spendable income. The Urban Land Institute (18) a devleoper-oriented organization, concludes that greater mobility, 50% of the population in an age class under 20, and greater longevity (a 33% increase in the retired population in a decade) (19), leads them to conclude that there will be an increasing requirement for land to be developed for resorts, hotels, second homes, ski lodges, beach cabins, mountain retreats, golf, yacht harbours, shopping malls and organized camp grounds. This is not a mentality which forbodes well for the future if it becomes uppermost. Developers are, however, not the only culprits. In urban areas, highway engineers appear positively attracted to park land and if there is any detailing to be done it seems to be toward open green space, not away. The attractions are compelling: open space, not built up, requires far less demolition or relocation; there are no home owners in the park to form protest associations and put pressure on the politicians. Best of all, the land is "cheap". If it is public land, often nothing is paid for, and where restoration is done, it is usually scant recompense for the loss of the irreplaceable. There has been little redress (20); the highway departments, electrical utilities and animals of like ilk, have demand, procedure and precedent on their side. Opportunity cost and externalities are furthest from their minds. Environmental impact statements

have brought some small measures of change but to date public outcry has been the only successful instrument.

A decent urban life demands that the extra people that we have now, and will continue to have for some time, despite efforts of population control, must be accommodated without continuing the blight of urban sprawl. The inevitable increased housing densities, our extended life span, continuing increases in the population as a whole, no foreseeable change in the structure and scale of the urban community, increasing affluence, mobility and leisure time, all would seem to point toward a need to protect, improve and enlarge our open green space needs.

Urban Green Space Needs in the Lower Mainland of British Columbia:

In a compendium of five reports on Recreational Policies for British Columbia, (9), I can find nothing in their three hundred or so recommendations, which demonstrates any organized cohesive approach to examining urban green space as a resource. The report prepared for SPEC (5) makes more interesting and relevant reading, and is comprehensive in discussing finance, time horizons, health benefits, public awareness, attitudes and abilities, location, management, regulation of tourism and ownership, along with inventory requirements, carrying capacity, zoning, education, and the need for adequate communications networks. It sadly concludes with broad sweeping recommendations, prominant amongst which is the formation of another quasi-government department. The report does, however, address one problem really touched on in several of the references read; that of access to urban green space for the less fortunate. It notes that since funding from all levels of government is derived from each and every citizen, the question of access to leisure resources is crucial. Some interesting propositions, including a guaranteed income, welfare tickets, a provincial voucher scheme and an argument for and against the proposition of free access, provides some interesting options to the problem of including the alienated in the use of urban green space.

By far the most comprehensive appraisal of lower mainland green space needs is contained in the report, A Regional Parks Plan for the Lower Mainland (16).

Despite the fact that this report is now over ten years old, it contains a ready appraisal of park land needs. Appendix I, An Outline of a Complete Parks System, is fairly comprehensive and with the exception of the recent advent in vest-pocket parks, mini-parks and pars cours circuits, it is just as useful a document now as it was in 1966. Appendix II of this report is taken from Table 2 - Responsibiliy - Recreational Activities and Facilities, which is a useful outline of the levels of responsibility and types of activity suggested for all but passive urban and semi-urban green space.

Expanding park needs are discussed in the context of increasing leisure time (suggesting a 53 hour leisure segment for the average worker by 1981 , an increase of 9.3% between 1966 and 1981, and suggests a further 9.4% increase between 1981 and the year 2001, by which time the average worker would have almost 60 hours of leisure a week, very comparable to the figure of 3000 leisure hours a year suggested by Artz) (2). In addition to increased leisure time, there is a discussion of our material improvements in social and economic resources, indicating a theoretical limit of participation in recreational activity increasing 22.7% from the level in 1966 to 1981, and increasing a further 17.4% from 1981 to the year 2001. It is noted that the lower mainland population of about 1 million in 1966 will have increased to 1-1/2 million by 1981. Using some per capita standards, it is ascertained that between the period 1966 and 1981, there is a need for 86,600 acres of park land: 1, 300 acres in neighborhood and community parks, 2,600 acres in town parks and open space, 21,600 acres in regional parks and greenbelt, and 61,100 acres in provincial parks. It is further suggested that by the year 2001 there will be a need for a further 86,000 acres. These needs are summarized in Appendix III of this paper.

The per capita standards that are used to derive park land needs per thousand of population, are shown to be, for all types of open space, 65 acres per 1000 in 1966, 80 acres per 1000 in 1981, and 94 acres per thousand in the year 2001. A loose correlation is suggested between our increasing leisure time and the per capita requirements for open space. However, this theme is not developed. Not only is it difficult to interpret these figures for open space standards, but it is near impossible to reconcile these figures with those of other authors. Whitaker (19) for example, notes that in 1943, the County of London Plan proposed a figure of 7 acres per 1000 people, which was modified to allow three of these acres to be later planted in the Greater London Greenbelt. The inner city figure has now decreased to 2-1/2 acres per 1000 people, while a number of the London suburbs are down below 1.7 acres, while cities like

Manchester and Glasgow are up to about 4 acres per 1000 head of population Incidently, it is noted that if that same 4 acre figures is applied, London's open space deficiency at present amounts to almost 6000 acres. Rather than a decrease, some European cities have attempted an active program of increasing their open green space. In Holland, for example, figures of 2.2 sq. meters in 1930 were increased to 10 square meters in 1945, 17 in 1965 and 28 in 1975. In trying to compare different densities from different jurisdictions, not only is there the difficulty of metrification, somewhere I have a ready reckoning table, but there is also the difficulty of separating local green space standards from suggested regional requirements. Further, it is also difficult to determine what is and is not included. What might be categorized as semi-reserved in some standards, appears to be reserved or even unreserved land in others. The Baltimore local that is non-regional green space standard of 17 acres per 1000 persons is a composite of 3 acres per 1000 persons in Baltimore City, plus 25 acres per 1000 persons in the surrounding five county area. Green space is defined as land that is "open" in character and used at relatively low intensity. Such use is generally considered institutional, but also includes non-recreationally used reservoirs, etc. There is obviously a need for clear, socially, environmentally and economically sound standards, if one is going to use this as a basis to determine green space requirements. Without a sound benchmark from which to compare actual and proposed green space needs, it becomes most difficult to justify the passive defence of existing green space or the active strategy of purchasing and landbanking.

A strategy to "protect and develop regional open space" is suggested in the Livable Region Report for Greater Vancouver, with the noble justification to "keep this a Livable Region and retain unobstructed views of the mountains and sea, protect our wilderness areas and provide future residents with access to recreation", but it would be infinitely better to advocate these ideals on the basis of sound reasoning. This is not to discount the benefits of urban green space but rather to strengthen the argument and endorse the "open space conservancy" embraced in the realistic plan for the Lower Mainland.

Benefits Accruing from Urban Green Space:

Benefits accruing from Urban Green Space have been touched upon already. However, in order to assist in establishing a clearer corner stone of utility, it is worth looking at these benefits in greater depth.

One might open by suggesting that there is a broad philosophical public good derived from urban green space. In the preamble to the Constitution of the United States, there is an expressed desire to "promote the general welfare". The U.S. Supreme Court, in a landmark case, concerning redevelopment and provision of open space, the justices unanimously agreed "that the concept of public welfare is broad and inclusive. The value it represents is spiritual as well as physical, aesthetic as well as monetary. It is within the power of the legislature to determine that the community shall be beautiful as well as healthy, spacious as well as carefully patrolled".

Mohrle (15), in discussing the needs for recreation in Switzerland, discusses psychological benefits. It is implied that the individual satisfaction and pride associated with trades of the past has been lost to production techniques, where product completion and hence sense of achievement have been all but withdrawn from the eye of the individual worker. Moreover the self-regulation of the working rate by man, in accordance with his individual readiness to perform, has been partly or entirely lost. Man - the Machine, or Man - The Machine Watcher. In addition, employment has undergone drastic changes inasmuch as mobility has been increased for both the employer and the employee. For the employer, this means that entrepreneur decisions become of greater consequence and involve greater risks owing to the increased financial investments connected with technical advance. A single wrong decision may jeopardize the existence of a venture. From the point of the average worker, the greater risk is reflected by the disappearance of conventional occupations and the advent of new ones. It is quite possible that a worker or employee may, in the future, have to learn and carry on three or four trades in succession in the course of his life. These subtle changes in society, troubled with technological complexity, have led to lesser physical exertion, yet placed much greater stress and demand on our

psychological stability. Open green space and active recreations areas have become one of society's most important rejuvenating forces, providing a level of physical and mental health to counteract social and occupational stress.

It is suggested (15) that if things were allowed their way, unimpeded, our descendents would live within an endless sea of buildings in which only schools and cemetaries could incorporate scant greenery. Green areas, really designed for recreation, would not exist in the vicinity for the majority of the urban population. With the disorderly growth of towns, the way to major green areas would become further and further removed from the city proper, divorcing the poor, the young, the aged and the infirm from participating in a public good to which they were entitled.

It is important to recognize that one person's use of urban green space may not necessarily be another's. Glass (as reported in 19) has attempted to link user group, age and types of use. A typical survey form used to determine green space activities and needs, along with a more comprehensive breakdown of active and passive recreation, is contained in Appendix IV.

Social and therapeutic values apart, a number of other quantifiable benefits obtain from urban green space. The least easy to quantify perhaps, certainly one of the least recognized benefits, are those derived from the ecological values of urban green space. In a holistic sense, there are the carbon and hydrological cycles, the nitrogen cycle, there are physical values associated with climate modification, dust reduction, watershed control and soil conservation and sometimes noise and air pollution abatement.

In an economic framework, there are values associated with enhancement of nearby real estate (5 years after New York's Central Park was acquired, it was found that it was desirable to enlarge the park by the addition of 65 acres to the north. The appraised value of this addition at the time of the original park acquisition was $180,000 but in 1859, the commission had to pay the then appraised value of almost $1,200,000, a more than six-fold increase in less than 5 years), economic values generated by use, both directly from concessions and indirectly in social values (ingeniously calculated by Clawson (6), using the willingness to pay technique), and finally of course the income derived in the adjacent area to

urban green space, from those who travel to the area and purchase services while there.

The Costs of Urban Green Space:

Kavanagh (12), in discussing both benefits and costs for urban recreation decisions, provides perhaps the best simple outline of costs associated with urban green space. Naturally the most obvious cost incurred is that associated with the opportunity costs of the land alienated for urban green space. In the context of publicly owned green space, it might be argued that the loss of rental stream or income on capital occurs with the allocation of urban green space, since this may not be the highest and best use. In addition, since most public property is not on the tax rolls, there is a loss of implied tax stream. Direct benefits might accrue to the community from alternate use but are, of course, negated when an area is allocated for urban green space.

Direct program costs for capital expenditures, maintenance and depreciation, may be seen as a burden on the community, particularly by those unable to enjoy the specific benefits of individual areas. Private costs too, must also be recognized. These include the purchase of equipment to participate in specific recreational or sport programs, travel costs, and any costs to society which occur from loss of production either on the small scale from extended coffee breaks to whole open "sick days" used for recreational activities.

Inevitably some social costs occur in association with urban green space. The cynical might suggest that unnecessary increases in the population may be one consequence; however I have more in mind : problems of congestion, vandalism, noise and the problems associated with administration, servicing and policing.

Some Conflicts:

> "When urban design is dominated by the profit motive, some very sterile and monotonous urban patterns are likely to result. The common agglomeration of box-like houses, one after another, row upon row, acre upon acre, sub-division upon sub-division,

> is pathetic, depressing and disheartening. If our future envirnonment is to improve, rather than to continue to deteriorate, aesthetics must plan a more important role in urban and suburban planning than it has in the recent past (18, at Page 7.)

The most blatant of conflicts must surely be that between the open space advocate and the developer. The developer acts as an entrepreneur in the business of producing saleable combinations of house and lot, by applying land, capital, labour and luck. The selection of a site for the production of residential packages is often made by attempting to estimate the effect of site characteristics upon profit - the fewer the constraints , hopefully the greater the profit. The developer is primarily interested in raw land costs, his production and servicing costs, social class structure in the area in question, and critically the sales price and sales volume that can be obtained for a unit area. The greater the costs, the more the developer seeks to concentrate people and activities for maximum profit. Most open green space, therefore, is residual. It's what is left after economic competitors have made their claims. It might be suggested that perhaps the best defensive strategy for the green space advocate is to try to anticipate development pressure, acquiring desirable open space in the path of development before land owners realize the potential value of their property. A more offensive strategy, perhaps, would be to buy desirable open land in the path of development and to buy additional land around it for future development. There will be a general rise in land values, and from the additional value created by the undeveloped open space, servicing and subdivision costs can be obtained from sale of the lands to be developed. Unfortunately, public land banking has not enjoyed great success. Often suitable land should have been acquired long before potential land values reached their present levels. There are no fail-safe techniques. Perhaps participatory development and subdivision, coupled with forceful zoning, is the only answer. This is not to negate the long-range planning, purchase and allocation of green space at the regional and local level, but is to suggest that the innovative municipality, with well-qualified staff, may assist the developer in maximizing his return for any specific site, including an adequate benefit cost analysis with and without the provision of urban green space.

The importance and value of urban green space, must be more fully recognized by

all who are in a position to affect environmental change. There is a danger that unless this recognition comes soon, before the end of this century, tomorrow will be too late. The professions often do themselves and those whom they serve, a disservice. There is often a dichotomy between the so-called open "recreation" people and the open "park" people. Often, the "recreation" people are open space developers, working as an antagonist to those concerned with conservation and broader environmental values. There is a danger that the administrative mind will overrun. Too often open green space is treated as an entity rather than a resource, an entity rather than a unity.

When any decision is made on the use of a community's land, whether for commercial, private or public use - the future community is being shaped for a long time, and so recreation planning or any planning for that matter, is most crucial. If these decisions are disparate, arbitrary and not integrated, the chances for a community to reflect some foresight and creativity in its development are slim (4).

Methods of Financing Urban Green Space:

Much has been written on where the money should come from to provide urban green space. Opinions differ. A range of options is considerable, and it is doubtful that any one particular facet is appropriate. Most frequently, General Revenues has been the principal source of at least capital funds. However, with spiraling inflation, labour demands, a plethora of public priorities, there must be a concerted effort to not only ear-mark public funds, but also cast about for innovative alternatives. Even back in 1956, Meyer (13) was struggling with the preparation of guidelines to determine appropriate allocation criteria and alternatives. His 8-point suggestions were as follows:

i) financial condition of the community
ii) legal tax limits
iii) efficiency of municipal financial administration
iv) actual community needs and resources
v) capacity and generosity of voluntary contributions
vi) physical plant available
vii) time and staff experience
viii) accessibility of resources other than community-supplied.

Many of the authors consulted, Meyer included, have also wrestled with some technique for determining a per capita spending level for open space. Figures seem to range from $6.00 to a high of $22.00. It does not seem like a very fruitful enterprize and ignores the important questions of opportunity and merit. All too often, annual budgets are prepared on rule of thumb figures.

In the private sector, some innovative approaches have been developed for financing recreational open space. In particular, Real Estate Investment Funds created by an alteration in the United States tax legislation in 1961, have allowed two types of support. The equity type allows for the provision of actual buildings (as would be the case, for example, with the building of a roller rink), and those which are basically mortgage trusts, which allow for land acquisition development and construction (18).

Shomon (17) examines four mechanisms:

i) Charitable tax deductions
ii) Reserved life estates
iii) Gifts to the community
iv) Scenic and conservation easement agreements

Flexibility and community support are discussed and it is concluded that these are essential, particularly where urban green space is acquired by local initiative.

Artz (2), in a comprehensive text in 1970, entitled Guide to New Approaches to Financing Parks and Recreation, examines grants and loans, the legal capacity of the land through Eminent Domain zoning and condemnation, bond issues, citizen iniative and gifts to the community. Also addressed are the possibilities of tax incentives, small and large scale concessions of urban green space, along with the concept of pay-as-you-go fees. It is concluded that competition for both tax dollars and contribution dollars is so intense that park and recreation agencies must develop more effective finance programs and requirements attuned to the total community needs.

It is surprising that of the references consulted, none seriously tackles financing derivatives from multiple land use. All those associated with manipulating

housing density, allow for provision of urban green space. This would seem like a fruitful area for further work.

Future Prospects:

Despite a suggested deficit in urban green space in many communities (5) (9) (11) (19), public awareness and public pressure provide sufficient emphasis to enable at least a green space network of some scale and capacity in most locations. The advent of regional and long-term planning, strategic land analysis, environmental impact statements, more flexible property and zoning laws (3), and the advent of elective citizen action (see Teska B1970 Barrington's Land-Bank Corporation. Landscape Architecture Year Book 1970) - all auger well for the future.

Public, professional and political awareness of the ecological contributions from urban green space has been growing steadily. Short run economics, ineptitude, complaisancy, and administrative expediency are now challenged and derided. This is as it should be.

It is better to end on a note of optimism.

The Changing Face of the Real World:

The findings of two major studies (Economic Impact of a Regional Open Space Program for the San Francisco Bay Area, Harmon, R.J., et al, 1970, and Foothills Environment Design Study - Open Space vs Development. Livingston, L. 1971) are interesting in the context of confirmation for some of the thoughts presented in this paper. The first story begins in the late 1950's when the City of Palo Alto decided to annex about 7500 acres connected with the rest of the City by a highland ridge. Of the 7,500 acres, 1,400 were purchased by the City for a foothills park. Shortly after annexation, utilities were extended into the lower foothills and later, in response to petition of the owners, to upper foothills properties . A private golf club was built in the early 1960's and about 50 acres along the easterly boundary were subdivided into acre lots and developed with expensive homes.

In the mid-60's a development company purchased 530 acres of Crown land in

the lower foothills and submitted to the City a series of development proposals. Because these plans called for residential density exceeding one unit per acre they did not win approval. The City was unable to decide whether acre-minimum lot development or cluster development at a higher density was more suitable for the lands adjacent to the park. Largely in response to the urging of conversation-minded citizen groups, lands in the City, around the park, became the subject of an intensive study. It is this study that is outlined in the Livingston report.

The original focus of the study was not on development vs open space, but rather on what kind of development was most suitable in the foothills. Some hoped that the area would prove to be a likely location for low-moderate housing, to help relieve the Palo Alto area's critical shortage. Others hoped that open space preservation would be the principal result of the study. These were almost certainly minority views at the outset.

The entire study area was divided into 20 acre squares and each was rated as to its suitability - or vulnerability - for development on the basis of planning and market factors. A move in the City Council for a moratorium on all foothills development until completion of the survey failed, but the developer did not win approval of its plan.

Of the total of 22 different development patterns studied, none yielded a positive net cash flow to the City. The cost of municipal facilities and services generally exceeded revenues from property tax, sales tax, utility sales, and other sources. Not surprisingly, cash flow to the school district was consistently negative. Having determined that foothills development costs would outweigh taxes and other revenues, the consultants decided to find out how the cost of purchasing all the land to keep it in open space, would compare with the cost of development to the taxpayer. A detailed social, environmental and economic analysis was undertaken.

Development of the foothills was an issue of City-wide interest, not only because of the community's investment in the rural foothills park, but also because the ridge above the park formed a scenic backdrop for Palo Alto and neighbouring

communities. In 1970, after protracted public hearings, the consultants recommendations, on the lands both above and below the existing park, was for the City to retain them as open green space. On February 22nd, 1971, the City Council adopted a policy that the lands around the park were to remain in open space for park addition and land-bank purposes. The City staff was directed to pursue all means available to accomplish this objective.

In the second of these studies, on the economic impact of a major regional open space program in the San Francisco Bay area, the consultants were pleased to report that the benefits of the regional open space system were dramatic and wide-spread - to a considerably greater degree than they had anticipated when starting the study. After careful analysis, it was determined that the regional open space program would not impose a major financial burden on the Bay Area residents. Even the most costly technique, complete purchase of all proposed permanent open space lands - would cost no more than $10.00 per person per year, and the net costs would approximate only $3.00 per person per year after deducting the qualifiable benefits of such a program. It was dramatically shown that the projected difference between the cost for serving the growth patterns that would take place without an open space program, and the more compact patterns with open space, were approximately $300,000,000 for municipal services and over $800,000,000 for utilities.

In addition, the consultants suggested that one of the Bay Area's principal economic resources was its superior environmental quality. If that was lost, its competitive position for desirable new development would be greatly weakened, thus preservation of the environment, through a major open space program, was shown to be good business. It was demonstrated that a common and widespread fear that open space programs would result in a net loss of assessed values, should be discounted. Removing a large amount of land from the supply available, could quickly increase the values of all otherbuilt-up and raw land, thus quickly restoring any temporary reductions in the tax base caused by use restrictions or public ownership . It was suggested that there would be a re-dispersal of values within the overall region. Finally, in order to tackle the administrative complexities and reflect the benefits which had accrued to regional management, it was suggested that a Regional Green Space Administration should be created.

What then can we conclude from these two instances and the general thrust of this paper? On balance, it would appear that the scales indicate, on the basis of quantifiable benefits alone, that the benefits are about equal to or even well above, costs. Next the valuable asset of permanent public open space is added - land which is fully owned by the public in perpetuity. If all of the non-quantifiable benefits are added, and the total benefit-cost relationship clearly shown, it would seem that the scales tilt heavily in favour of open space.

The question is often raised : "Can we afford to keep our open space?"
When all of the economic impacts of open space are taken into consideration, perhaps the real question is: "Can we afford not to preserve open green space?"

1. Appleton, I (Edit) 1974. Leisure Research and Policy

Scottish Academic Press.

The book, a selection of papers, attempts to present a broad picture across the spectrum of research and policy in the field of leisure and indicates the present state of the art. The book covers a range of indoor and outdoor situations and is in five parts, examining aspects of historic economic and social contact of leisure, research methods in urban and rural situations to determine demand, policies of various public agencies, and managerial methods. A paper by Wright, W.D. is entitled "Some aspects of the economics of leisure" and examines the extent to which leisure decisions can be fitted into economic theory.

2. Artz, R.M. 1970 Guide to New Approaches to Financing Parks and Recreation. The National Recreation and Park Association.

The book deals with land acquisition, grants, taxes, revenue sharing, fees and foundations. The chapters attempt to outline inovative approaches to providing adequate financing for improved and expanded recreation and park services.

3. Bradley, M.D. 1975. Future opportunities for open space in Landscape Planning 2 (1975) 13-22.

This paper examines changes in the traditional methods of acquisition, environmental protection and financing of open space at the urban and regional level.

4. Bannon, J.J. 1976. Leisure Resources, Its Comprehensive Planning Prentice Hall.

A comprehensive, well organized, planning approach to leisure time and resources leading from a conceptual over-view through a graphic planning process, surveys and site analyses to management and evaluation of leisure systems. A section on "Population and Implications for Planning" reviews the socio-economic implication of growth and environmental quality.

5. Campbell, C et al 1973. Toward a policy for Future Leisure Management in British Columbia. Canadian Scientific Pollution and Environmental Control Society.

A detailed discussion paper presented to the Man and Resources Conference in 1973 outling specific recommendations on (1) Access (11) Creation and Maintenance of Quality Leisure Environments and (111) the Need for Management Diversity. The section of Access deals specifically with problems of financing and economic equality for all citizens.

6. Clawson, M. and Knetsch, J.L. 1966. Economics of Outdoor Recreation. Resources for the Future.

An attempt by economists to write a text suitable for the non-economist addressing the present situation demands for outdoor recreation, actual resources and their use or protection, the economics of land and water resources for recreation and an examination of future concerns in research and public policy.

7. Doell, C.E. and Twardzik, L.F. 1973. Elements of Park and Recreation Administration. Burgess Publishing Company.

An outline of the nature of recreation, the history of parks, the physical resources for recreation in the U.S. in the cities, counties, state and federal level, the compilation of a park plan, staff organization, budgets, detailed sections on policies and a review of law enforcement in parks. Seven appendixes are included as topic papers by different authors including one on elements of park value.

8. Harman, R.J. and McElyea, R.J. 1967. Economic Impact of a Regional Open Space Program for the San Francisco Bay Area. Development Research Associates.

An overview of a specific region in report form which examines the open space plans around San Francisco, methods of preserving and acquiring regional open space, and uses cost-benefits methods to examine alternative Organizational and Financial consideration at the State level are examined.

9. Joyce, E. 1975. Recreational Policies for B. C. - A summary of Recommendations from recent conferences and reports.

Planning Rpt. #33 Research Section Planning Division Parks Branch. B.C. Dept. of Recreation and Conservation.

A compilation of recommendations from five conferences; one in 1973, three in 1974, and one in 1975, concerning leisure, recreation and parks in B.C. Sections include encouraging public awareness of outdoor recreation, development of research and planning programs, education and training administration (including funding), trails and wilderness.

10. Krutilla, J.V. (edit) 1972. Natural Environments. Studies in Theorctical and Applied Analysis. Resources for the Future.

Nine papers examine various facets of natural environment economics including; alternative uses of Natural Environments, the effects of technological change on different uses of environmental resources, management of wilderness quality, estimating wilderness demand, the problems of migratory wildfowl, classifying aquatic environments and classifying landscape aesthetics.

11. Krutitta, J.V. and Fisher, A.C. The Economics of Natural Environments. John S. Hopkins, University Press

This text examines the valuation, allocation and management of both public and commercial resources in the natural environment. Specific care studies are examined in detail including Hells Canyon, White Cloud Peaks, Mineral King Valley, Prairie Wetlands, and the Trans-Alaska Pipeline.

12. Kavanagh, J.M. et al 1973. Program Budgeting for Urban Recreation - Current Status and Prospects in Los Angeles. Praegar Publishers.

The book reviews the nature and scope of urban recreation, details the budget process, examines cost-benefit analysis for urban recreation, decision making, and discusses roof-top park sites .

13. Meyer, H.D. and Brightbill, C.K. 1956. Recreation Administration - a guide to its practices. Prentice-Hall.

This book gives an insight into early approaches to recreation needs, planning, staffing, facilities, services and financing a community recreation

14. Livingston, L and Blayney, J.A. 1971 . Foothills Environment Design Study. Open Space vs. Development. Livingstone and Blayney Planning Association.

A report on the Preservation of Open Space around Palo Alto, Calif.

15. Mohrle, R. 1971. A Popular Initiative for an Act for the Creation of Recreation Areas in the Canton of Zurich 10(2).

A paper which outlines the specific case of initiative from the public sector to central government for the expansion of park resources.

16. Pearson, W. 1966. A Regional Parks Plan for the Lower Mainland Region. Lower Mainland Regional Planning Board.

A complete summary of the projected park system needs for the lower mainland of B.C. with detailed suggestions for implementation. A historical forerunner to the present Regional District.

17. Shomon, J.S. 1971. Open Land for Urban America - acquistion, safekeeping and use. National Audubon Society.

An attempt to illuminate methods for preservation and enhancement of the urban environment with emphasis at three levels, city, suburbs, and regional with supporting case studies. Appendixes provide some legal instruments for management of open space.

18. Urban Land Institute. 1970. Land: Recreation and Leisure Abstract from First Hand. U.S.C. Symposium. Urban Land Institute. The Developer Mentality.

19. Whitaker, B. and Browne, K. 1971. Parks for People, Winchester Press.

A largely British prospective on park planning and administration including detailed accounts of park costs for municipalities.

20. Whyte W. H. 1968. The Last Landscape. Doubleday and Company.

A book about metropolitan areas and open space. Chapter on the devices for obtaining and maintaining open space and on green space now to the year 2000 flow from an in depth account of the politics of open space.

APPENDIX I

TABLE I THE COMPLETE PARK SYSTEM[1]

PARK TYPE AND RESPONSIBILITY	PARK FUNCTION[2]	PARK FEATURES
PLAY LOTS (municipal, private, or joint responsibility[3])	• to provide pre-school children in a garden apartment, housing project, or other higher density residential area with a substitute for the "backyard"; day use.	• location: at the focus of a "block" or housing development assuring access without street crossings. • size: one or two lots, as needed. • development: simple, safe apparatus at child's scale to instill sense of self-discovery; paved areas for wheeled toys.
NEIGHBOURHOOD PARKS (municipal responsibility[3])	• mainly to provide activity areas for pre-school and elementary school children in the residential "neighbourhood" (3,000-6,000 people) served by an elementary school; day use. • may include play lot.	• location: at the centre of a "neighbourhood", preferably next to the elementary school grounds, facilitating access on foot avoiding major street crossings. • service radius: 1/4 to 1/2 mile, depending upon density. • current standard: 1.25 acres per 1,000 population excluding school grounds, 2.5 acres per 1,000 including school grounds. • size: 4 acre minimum. • development: apparatus and fields for play and active games; may have some seasonal supervision.
COMMUNITY PARKS (municipal responsibility[3])	• mainly to provide activity areas for high school students and young adults in the "community" (15,000-40,000 people) served by a high school; day use. • may include neighbourhood park.	• location: at the centre of a "community", preferably next to the high school grounds, facilitating access on foot and by bicycle. • service radius: 1/2 to 1 1/2 miles, depending upon density. • current standard: 1.25 acres per 1,000 population excluding school grounds; 2.5 acres per 1,000 including school grounds. • size: 20 acre minimum. • development: heavier apparatus; fields for team sports; specialized facilities for tennis, lacrosse, or swimming; indoor facilities; seasonal or year-round supervision for all age groups.
URBAN PARKS (municipal responsibility[3])	• to provide areas of special treatment or landscaping as a contrast to assure variety in a highly urbanized area such as a city or town centre, shopping area, office area, or industrial area; for working or shopping adults; day use.	• location: at the heart of a commercial core, an area of heavy pedestrian traffic, a parkway or boulevard, a localized focus in an industrial area. • size: small enough to fit into the urban texture; numerous enough to fulfil the function. • development: a shopping mall with benches and landscaping, a city square, a small landscaped node at a key intersection, a special vantage point, a busy passageway for pedestrians between buildings to interconnect key areas.
TOWN PARKS (municipal level of responsibility[3,4])	• to provide central natural areas and activity areas for residents in a "regional town" (over 50,000 people); for both active and casual use, also providing a focus for major civic facilities and civic pride; day use on an incidental stop or special trip basis. • may include community park.	• location: one or more within each "regional town", permitting access by transit and car. • service radius: 3 to 5 miles. • current standard: 4.5 acres per 1,000 population. • size: 40 acre minimum. • development: natural areas and activity areas, as a single function or in combination; natural areas consisting of natural or developed open lawns, wooded areas, water areas, and vantage points, activity areas consisting of a unique sports area, fairgrounds, or building complex.
REGIONAL PARKS (regional level of responsibility[3,5])	• to provide residents of a natural region with major natural areas and activity areas within a convenient distance for day use on a special trip or incidental stop basis. • may include a town park, but only when located within or beside a regional town.	• location: primarily to serve regional town population concentrations, with unique natural features as a secondary consideration; access by car or special trip transit. • service radius: up to 1 hour driving time. • current standard: 13.0 acres per 1,000 population. • size: 150 acre minimum; smaller for a unique feature. • development: in natural areas, a minimum of development to augment natural topographic features; in activity areas, such development as is necessary to realize the recreational potential.
PROVINCIAL PARKS (provincial responsibility)	• to provide residents and tourists with wilderness areas of province-wide significance for weekend use and extended stay use, natural areas of province-wide and regional significance for day use, overnight use, and limited extended stay use, and activity areas of province-wide and regional significance for day use and limited overnight use. • may include a regional park when located within or near region.	• location: dependent upon location of outstanding natural features, but must be related to major population concentrations in the province and to major transportation linkages. • service radius: indefinite for wilderness areas, 3 hours for natural areas, 2 hours for activity areas. • current standard: 30 acres per 1,000 population for wilderness areas and natural areas, 15 acres per 1,000 for activity areas. • development: in wilderness areas, trail access only; in natural areas, trails and related facilities, with incidental recreational development where not in conflict with casual atmosphere; in activity areas, careful intensive or extensive development with provisions for off-season or incidental casual use.
NATIONAL PARKS (national responsibility)	• to provide people in a visitor or tourist role with wilderness areas for extended stay use, and natural areas of national significance for day use and extended stay use; emphasis on extensive natural areas with incidental recreational features.	• location: totally dependent upon location of outstanding localized scenery, unique scenic, geographic, or geological features of national interest, outstanding examples of flora and fauna of national interest, features providing outstanding opportunity for non-urban outdoor recreation amid superb surroundings. • development: in wilderness areas, trail access, and in natural areas, trails and related facilities; careful development to assure preservation of geographic, biological, and geological features of national significance for the benefit, education, and enjoyment of present and future residents and visitors, avoiding impairment by private exploitation, over-use, or improper use.

[1] Based on an assessment of material in Park and Recreation Administration by C. E. Doell, Recreation Areas by G. E. Butler, Parks for America by the U. S. Department of the Interior, and Project Open Space reports of the Puget Sound Intergovernmental Conference, and discussions with municipal, provincial, and federal parks officials.

[2] In describing park function: wilderness areas mean large tracts of undeveloped land providing people the opportunity to expand their knowledge and experience of the outdoors in its natural wild state, divorced from civilization; natural areas mean native or developed areas of special scenic quality, of historic or other special interest, or of cultural significance preserved for casual viewing or experiencing, which may include incidental recreational activities such as hiking, camping, picnicking, and swimming, if they do not conflict with the casual qualities of an area; activity areas mean areas with natural features suited to one or several active outdoor sports activities on an intensive or extensive basis, which may include incidental or off-season casual activity.

[3] Responsibility in Unorganized Areas lies with the Provincial Government.

[4] Responsibility lies with the two or three affected municipalities jointly where an individual municipality is too small to provide such a park on its own, or where a distinct social unit overlaps municipal boundaries.

[5] Responsibility falls to the affected municipalities jointly, to the province, to the municipalities and the province jointly, or to a regional governmental body.

TABLE 2 RESPONSIBILITY FOR RECREATIONAL ACTIVITIES AND FACILITIES[1]

ACTIVITY OR FACILITY[2]	LEVEL OF RESPONSIBILITY					NOTES
	MUNICIPAL	REGIONAL	PROVINCIAL	NATIONAL	"PRIVATE"[3]	
Sports and Games						
• children's play areas	yes	incidental				It is most difficult to develop a major park of wide appeal without including some incidental facilities of this type.
• athletic fields	yes	incidental				
• golf courses	yes	yes			yes	Provision of golf courses is split between municipal, regional, and "private" responsibility. They should only be considered as a regional facility where they can be combined with other regional park activities.
• recreation and cultural centre	yes				yes	
• commercial sports events	yes				yes	
Observation						
• nature study	some	yes	yes	yes		Driving for pleasure is not confined to parks, but applies to any street of scenic value. Attention should be given by each government level responsible for roads to assure their beautification. Since at present there is no regional agency with responsibility for roads, Regional Park agency responsibility would be confined to the beautification of roads within Regional Parks.
• sightseeing	yes	yes	yes	yes		
• pleasure driving	yes	incidental	yes	yes		
Picnicking and Camping						
• picnicking	yes	yes	some		some	Overnight camping for the general public is not considered a regional parks activity, but group camping for charitable groups, etc. could be included on a limited regional basis.
• group camping		some	yes		some	
• overnight camping			yes	yes	yes	
Beach Use						
• swimming and beach activity	some	yes	yes			Municipal role limited to facilities of localized use or limited size.
Water Sport						
• boating, canoeing, sailing	some	yes	yes		yes	Areas for boating are a federal and provincial responsibility, while launching and mooring facilities have been largely private, with some municipal facilities. Major mooring facilities might well fall to regional administration with private operation. Care must be taken to avoid conflicts between boating, swimming, and fishing.
• water sport (other than boating)		yes	yes		incidental	
Winter Sport						
• skiing		little	yes	yes	yes	Because of the scale of operation and facilities required, skiing should remain a provincial and national responsibility, with private responsibility limited to management. Other winter sports, which may include "beginner" skiing, might be accommodated in some regional parks.
• winter sport (other than advanced skiing)	some	yes	yes	incidental	incidental	
Trail Use						
• strolling	yes	yes	incidental	incidental		Public responsibility should centre around trail provision while facilities such as hostels, stables, or bike rentals should be a "private" responsibility.
• hiking		yes	yes	yes	some	
• mountaineering			yes	yes	some	
• trail riding		yes	yes	yes	yes	
Fishing and Hunting						
• sports fishing		yes	yes	yes	yes	Controlled hunting in regional parks strictly limited to special areas, if any, that would not be in conflict with general recreational use.
• hunting		in special areas only	yes	yes	yes	

[1] Refer also to the statements about Provincial Parks and National Parks, Appendix A and B.

[2] Activities are not independent, as one activity may also be incidental to another. For example, sightseeing would be incidental to walking for pleasure.

[3] "Private" includes commercial operations and concessions, private clubs, and charitable organizations and institutions providing recreation for specific groups.

TABLE 4 EXISTING PARK ACREAGES AND PROJECTED PARK LAND NEEDS[1]

MUNICIPALITY OR AREA	POPULATION ESTIMATES[2] 1966	1981	2001	NEIGHBOURHOOD & COMMUNITY PARKS EXISTING ACRES(1965)	BY 1966 STANDARDS	BY 1981 STANDARDS	BY 2001 STANDARDS	TOWN PARKS[3] EXISTING ACRES(1965)	BY 1966 STANDARDS	BY 1981 STANDARDS	BY 2001 STANDARDS	REGIONAL PARKS[3] EXISTING ACRES(1965)	BY 1966 STANDARDS	BY 1981 STANDARDS	BY 2001 STANDARDS	PROVINCIAL PARKS[3] EXISTING ACRES(1965)	BY 1966 STANDARDS	BY 1981 STANDARDS	BY 2001 STANDARDS
BURRARD PEN.																			
Burnaby	115,700	162,000	217,000	284	289	421	596	627	521	794	1,139	40	1,504	2,673	4,340	0	5,206	9,080	14,322
Coquitlam	39,300	63,000	120,000	108	98	164	330	642	177	309	630	0	511	1,039	2,400	0	1,769	3,560	7,920
Fraser Mills	150	150	150	4	0	0	0	0	1	1	1	0	2	2	3	0	7	8	10
New Westminster	39,900	43,000	45,000	61	100	112	124	99	180	211	236	0	519	709	900	0	1,795	2,410	2,970
Port Coquitlam	10,700	21,000	38,000	45	27	55	104	0	48	103	200	0	139	347	760	0	481	1,176	2,508
Port Moody	6,300	10,000	18,000	18	16	26	49	0	28	49	95	0	82	165	360	0	284	560	1,188
Vancouver	429,700	464,000	494,000	735	1,075	1,210	1,358	1,259	1,934	2,273	2,593	1,095	5,586	7,656	9,880	0	19,337	26,000	32,604
U. E. L.	3,350	25,200	28,000	0	8	66	77	0	15	123	147	555	44	416	560	0	151	1,411	1,848
C. P. A. 13	650	800	1,000	0	2	2	3	0	3	4	5	188	8	13	20	0	29	45	66
TOTAL:	645,750	789,150	961,150	1,255	1,615	2,056	2,641	2,627	2,906	3,867	5,046	1,878	8,395	13,020	19,223	0	29,059	44,250	63,436
NORTH SHORE																			
North Van.City	27,300	35,000	42,000	71	68	91	116	69	123	172	220	0	355	578	840	0	1,229	1,960	2,772
North Van.Dist.	47,700	78,000	83,000	252	119	203	228	352	215	382	436	615	620	1,287	1,660	5,840	2,147	4,365	5,478
West Vancouver	34,100	40,000	45,000	113	85	104	124	345	153	196	236	218	443	660	900	0	1,534	2,240	2,970
TOTAL	109,100	153,000	170,000	436	272	398	468	766	491	750	892	833	1,418	2,525	3,400	5,840	4,910	8,565	11,220
RICHMOND-S.SHORE																			
Delta	19,700	55,000	115,000	60	49	143	316	15	89	270	604	0	256	907	2,300	0	886	3,080	7,590
Richmond	51,500	109,000	164,000	103	129	283	451	103	232	534	861	0	670	1,799	3,280	0	2,318	6,105	10,824
Surrey	79,100	168,000	263,000	377	198	437	723	604	356	823	1,381	263	1,028	2,772	5,260	16	3,559	9,420	17,358
White Rock	7,800	10,000	12,000	2	19	26	33	32	35	49	63	0	101	165	240	0	351	560	792
TOTAL	158,100	342,000	554,000	542	395	889	1,523	754	712	1,676	2,909	263	2,055	5,643	11,080	16	7,114	19,165	36,564
METRO TOTAL	912,950	1,284,150	1,685,150	2,233	2,282	3,343	4,632	4,147	4,109	6,293	8,847	2,974	11,868	21,188	33,703	5,856	41,083	71,980	111,220
NORTH BANK																			
Harrison H. S.	500	600	700	0	1	2	2	0	2	3	3	0	7	10	14	0	23	34	46
Kent	2,400	3,500	4,700	19	6	9	13	0	11	17	25	0	31	58	94	49	108	196	310
Maple Ridge	19,600	48,000	123,000	98	49	125	338	156	88	235	646	0	255	792	2,460	15,500	882	2,690	8,118
Mission City	3,500	4,800	7,000	25	9	13	19	24	16	23	37	0	46	79	140	0	157	269	462
Mission Dist.	5,900	12,000	28,000	76	15	31	77	84	27	59	147	285	77	198	560	0	265	672	1,848
Pitt Meadows	2,700	4,000	6,000	11	7	10	17	60	12	20	32	0	35	66	120	0	122	224	396
Unorganized	2,500	3,300	5,000	0	6	9	14	0	11	16	26	0	33	54	100	809	112	185	330
TOTAL	37,100	76,200	174,400	229	93	199	480	324	167	373	916	285	482	1,257	3,488	16,358	1,669	4,270	11,510
SOUTH BANK																			
Abbotsford	900	1,000	1,000	4	2	3	3	0	4	5	5	0	12	17	20	0	41	56	66
Chilliwack City	9,100	11,400	14,000	15	23	30	39	28	41	56	73	0	118	188	280	0	410	639	924
Chilliwhack D.	20,500	32,600	51,000	36	51	85	140	95	92	160	268	0	267	538	1,020	0	922	1,825	3,366
Hope	3,100	5,400	7,000	9	8	14	19	45	14	26	37	0	40	89	140	0	139	302	462
Langley City	2,900	7,200	15,000	7	7	19	41	26	13	35	79	0	38	119	300	0	131	403	990
Langley Dist.	16,100	49,000	152,000	85	40	127	418	67	72	240	798	0	209	809	3,040	0	724	2,742	10,032
Matsqui	16,900	36,000	80,000	42	42	94	220	32	76	176	420	54	220	594	1,600	0	761	2,018	5,280
Sumas	6,000	8,500	17,000	17	15	22	47	46	27	42	89	0	78	140	340	0	270	476	1,122
Unorganized	2,800	4,200	7,000	0	7	11	19	0	13	21	37	522	36	69	140	1,620	126	235	462
TOTAL	78,300	155,300	344,000	215	195	405	946	339	352	761	1,806	576	1,018	2,563	6,880	1,620	3,524	8,696	22,704
VALLEY TOTAL	115,400	231,500	518,400	444	288	604	1,426	663	519	1,134	2,722	861	1,500	3,820	10,368	17,978	5,193	12,966	34,214
REGIONAL TOTAL	1,028,350	1,515,650	2,203,550	2,677	2,570	3,947	6,058	4,810	4,628	7,427	11,569	3,835	13,368	25,008	44,071	23,834[4]	46,276	84,946	145,434

[1] Existing acreage figures include both developed and undeveloped park areas.

[2] Population estimates for 1966 based on building permit trends since 1961; for 1981 based on Population Trends 1921-1981 modified by changes in the 1966 estimates; and for 2001 based on unpublished Board data.

[3] Detailed figures are given for each municipality only to demonstrate the needs generated by each, and not to suggest that these needs are to be satisfied in total within the boundaries of the same municipality.

[4] To this can be added 24,200 acres of Provincial Parkland that are outside the Region but accessible within three hours driving from the regional population centre. A further 24,000 acres could be given access to bring them within this range.

Section 5 **Parks and open spaces**

Information sheet Landscape 11

Parks and open spaces: General

Many existing parks and sports centres are under-used at present, and represent poor value for money on highly priced urban land. In this sheet GERRY PERRIN *and* TIMOTHY COCHRANE *briefly sketch the historical background to Britain's urban parks and then go on to examine new planning trends and new methods of increasing the attraction of parks and open spaces. They analyse three examples of urban open spaces to illustrate the principles involved, and conclude with a list of key points for future design*

1 Historical background

1.01 Except in new towns, Britain's parks and open spaces are largely the legacy of urban evolution in the late nineteenth and early twentieth centuries. Central area parks in particular owe much to Victorian and Edwardian leisure patterns, tending to be places for Sunday afternoon perambulation, picnics, and boating, where people could observe nature (often their only chance to do so) and other people.

1.02 Between the two world wars suburban growth mushroomed, leaving pre-1914 parks to ossify, and creating a need for subsidiary parks, amenity spaces and—for the first time—organised play space.

1.03 Play space areas have for almost 40 years been based on an empirical standard of 2·43 hectares of play space per 1000 population, including 0·20 hectares for children's playgrounds. Such standards have been partly responsible for the loose-knit structure of the first eight new towns built around London after the second world war.

1.04 Recently, however, the increasing use of hard surfaces and floodlighting for outdoor sports areas and the increasing use of indoor recreation facilities, all of which tend to lead to more intensive use of space, have caused the appropriateness of these figures to be questioned. Some authorities have even advocated the abandonment of such standards altogether, believing that provision should be related to individual circumstances instead.
Studies[3] indicating (*a*) frequency and patterns of use in urban parks, (*b*) time and money spent, and (*c*) catchment areas, are likely to become increasingly important as a basis for future provision, in place of the old empirical standards.

Future trends

1.05 With the value of land at a premium, attention needs now to be directed towards improved usage of open space; increasingly parks, play spaces, amenity space, and school grounds will be regarded as part of an integrated pattern of provision.

1.06 Co-ordination of management bodies and rationalisation

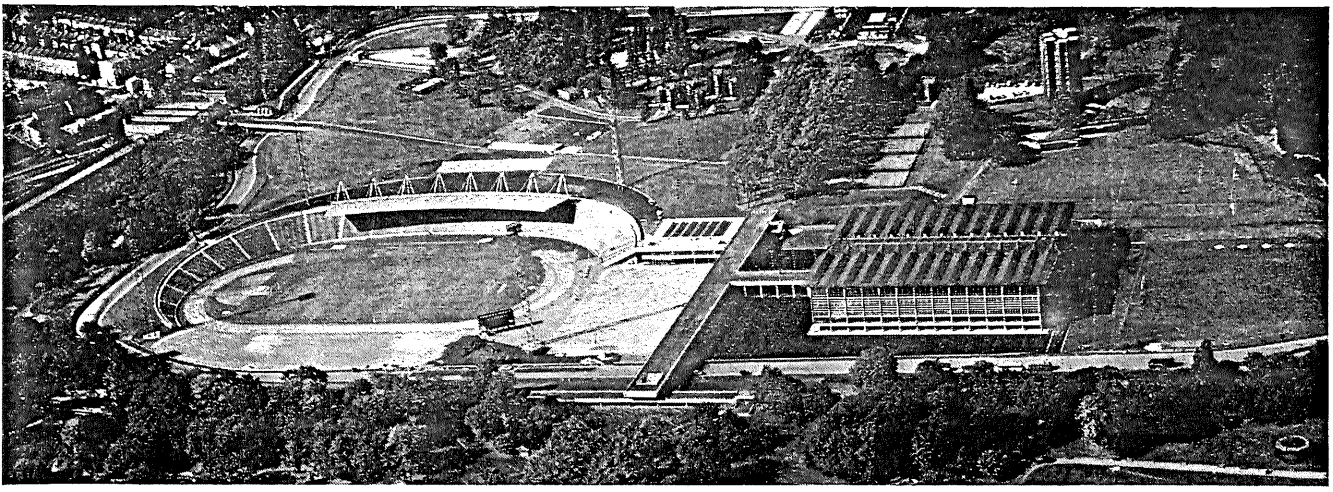
permit, leisure parks will be combined with intensive recreation areas (indoor and outdoor) providing maximum choice of activity—recreational, cultural, entertainment, social.
Such facilities will require spaces suitable for a large number of activities and, even more important, spaces within which new activities and impromptu happenings can be generated when the demand arises. In town centres, land values may often preclude large areas of open space, and indoor leisure centres in the town centre could be complemented by outdoor facilities in outer areas.

1.07 Industrial concerns are also beginning to combine with local authorities to provide facilities for the whole community whereas before they provided, on their own, facilities for their own employees. Surveys show that people apparently prefer to spend their leisure time at places which are open to all.
Similarly, universities are beginning to encourage sports associations to make use of their sports centres. Community schools are under-used assets with great scope for accommodating a wide range of leisure pursuits, but their management and organisation are not geared to developing their full potential as evening and weekend leisure centres.
However, there are some examples of this idea working, especially in Scotland; in such cases the schoolchildren have access to better standards of provision than they could normally expect.

2 Leisure in towns

2.01 The main types of open space in and around towns are the following*:

2.02 *Linear recreation spaces* Parks must be accessible from and linked to the rest of the urban area. The old concept of parks with finite boundaries is being replaced by that of a series of linear parks, for both active and passive recreation, linking all outdoor and indoor recreation facilities together like beads on a chain—shops, social facilities, recreation centres, and peripheral open spaces. Old railway lines, rivers, streams and canals offer natural routes for linear ways. Water has strong visual attraction, and can be used for boating and fishing, while disused railway lines can be used for footpaths, cycle tracks and



2 *Crystal Palace sports centre, example of subregional centre which attracts large numbers of users because it offers varied facilities and activities*

team recreations (eg football, cycling and cricket) is fairly static. The BTA note in their predictions for the future that golf and sailing have the greatest unsatisfied demand, while swimming, riding and fishing also have great growth potential[2, 3].

1.06 The increasing popularity of active forms of recreation, requiring a lot of room, is exerting great pressure on regional and rural recreation spaces. This pressure can to some extent be lessened by the use of artificial recreation aids such as climbing walls, golf driving ranges and practice machines, rowing and canoe tanks, artificial ski slopes and so on, which enable recreational activities not previously associated with the urban scene to become part of it (see para 4).

1.07 Many of those preferring more passive kinds of recreation, such as driving out into the country, would also be happy to keep near the town if there were attractive places to go to. These need not necessarily be spectacular—as demonstrated by the depressingly ordinary places where the motorised hordes choose to picnic.

2 Financing and organisation of leisure

Commercial leisure facilities

2.01 These have to include revenue-earning activities such as gambling, eating, drinking and dancing, to balance losses made by other facilities such as swimming pools, which help to attract people to the centre as a whole but lose money ('loss leaders'). Private developers may be eligible for grants from the Exchequer, under the Countryside Act, for the development of country parks or picnic sites.

Publicly financed leisure facilities

2.02 These could learn valuable lessons from commercially financed facilities on how to pay their way, or at any rate defray costs. Savings can result if sports and cultural facilities can be combined, and joint planning by local and education authorities can help maximise the use of facilities*. Also several local authorities may join together to finance a project for the use of their communities, particularly where a development in a rural area is intended primarily for use of the adjoining urban area. Local authorities in rural areas are comparatively poor and can hardly be expected to pay for the recreation of their urban neighbours.

* See MHLG circulars 31/66 and 42/55.

3 Supply of leisure facilities

3.01 Leisure facilities can be grouped broadly into a hierarchy of four categories, as shown in table 1. These categories overlap, and clear definitions or classifications are not possible except theoretically. This does not matter as long as a hierarchy of recreation areas of varying intensities of use is established.

Local spaces

3.02 The main types of local open spaces for leisure and recreation are the following. They are described in more detail in information sheet LANDSCAPE 11.

1 *Linear recreation networks:* parks, recreation centres, social centres, peripheral open spaces and so on linked together in a continuous, easily accessible chain of varied facilities **3, 4, 9.**

2 *Central open spaces:* parks, shopping malls, squares etc.

3 *Recreation-orientated housing developments:* a rapidly growing trend.

4 *Playgrounds and playing fields:* See information sheets LANDSCAPE 12 to 17.

Subregional spaces

3.03 Subregional open spaces include the following types:

5 *Sports centres:* Complexes containing several indoor and outdoor games facilities grouped together **2.** See information sheets 11 to 17.

6 *Rest and leisure parks:* Combined sports, arts and social centres catering for interests of wide variety of users. Gruga park in Essen is a good example; the idea has not yet been fully put into practice in this country. See information sheet LANDSCAPE 11.

Regional spaces

3.04 Regional leisure facilities include open spaces such as country parks and picnic sites, regional parks, and weekend and annual holiday areas, situated on or near the urban periphery. For example:

7 *Country parks and picnic sites*
Detailed criteria are outlined in the Countryside Commission's booklet[14] setting out policy on park and picnic sites. Country parks are loosely defined as sites over 10 hectares; picnic sites are under 10 hectares. The purpose of *country parks* is to draw off recreation seekers who might otherwise

THE URBAN FOREST

Managing Part of the Landscape Around Us

Prepared for Chad Day

MRM 601

Submitted by:

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ABSTRACT

A brief review is made of the needs to manage urban forest land. While no description of the term urban forestry is given, specific examples of lands that form part of the urban forest are noted. Four examples, parkland with a closed canopy of trees and open parkland, derelict or undeveloped land, ravines, and boulevard tree plantings are examined in the context of specific management techniques. In order to provide an overall framework for the management suggestions for each area and the concept of a simple Municipal Treescape Master Plan is developed. An outline is given of each of the components that might form part of such a master plan.

THE URBAN FOREST-MANAGING PART OF THE LANDSCAPE AROUND US

1/ M. R. Gardner

INTRODUCTION

Urban forest is a term seen with increasing frequency to describe a portion of our North American landscape. At face value it appears to be a useful and descriptive term, yet it has stirred some controversy and remains without unanimous meaning. It is a term that embodies a number of concepts that heretofore have remained unfocused since man began to establish permanent dwellings in a planned fashion in the wooded lands of the continent.

A transition in values has occurred since the early days when the tree resource was seen only to be exploited. Today, encroachment into existing woodland is coupled with outspoken public demands for preservation of forest character and with new residential areas yielding greater returns to the developer if tree retention on public or private land has been pre-planned and accomplished successfully. Often this is not the case and the unsuspecting home buyer or understaffed and underbudgeted municipal park department inherits a costly, dangerous incubus. Many professionals who, at first thought, should be able to provide either informed assistance once the problem is recognized, on a holistic management approach during the early planning process, are ill prepared both by formal education or by experience for the complex problems that characterize the interface between wooded lands and urban development.

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Land that has been set aside through the early forsight of urban planners or through the dectates of certain greenspace guidelines per unit of population have often faired somewhat better than treed lands subject to very recent disturbance for residential or commercial development. Nature has great capacity to heal the scars of man's past intrusions. Yet these areas too, are not without increasing need for careful planning and expert care. While, on the one hand mature trees suffer from severe environmental stress in newly developed areas, on the other hand, the quiescent atmosphere of established park lnd belies the dynamic nature of the forest as it evolves from seedling through maturity to death and decay. How we manage the treed element of our urban communities will perhaps reflect our broader resolve to provide stewardship for our global environment. If we are successful then there is hope that we will not irrevocably spoil our limited world.

We can already articulate much of the pure science involved in understanding biological resources. What we have yet to accomplish is a systematic approach integrating our scientific understanding with the administrative necessities of complex society. To produce commonly accepted management strategies that adequately reflect human values, that respond to the limitations imposed by biological principles and that will accommodate the restraints inherent in the bureaucracy of formality and fairness, will take sometime yet. It will not

come to pass, however, if we fail to try and understand the processes involved or if we do not advocate change when change is needed.

Rather than attempt to provide any specific definition of urban forestry it is perhaps more useful to actually describe the management of some specific types of area that might form part of the overall treescape within or surrounding a community. Some basic ideas are also presented in the following section on how the management of individual parts may be woven into an overall framework. No one profession can claim to have the expertise necessary to prepare the working documents or information implicit in such a framework. Moreover, a considerable amount of synthesis is required to integrate administrative and "political" requirements with biophysical data. This writer feels strongly that it is only in a team setting that this is possible. It is here that the landscape architect can contribute his or her talents to the developmnt of an overall treescape plan for a community. It is also here that the landscape architect can provide the advocacy so necessary to catalize the thoughtful planning of this element of our urban environment.

GENERAL MANAGEMENT OF THE URBAN FOREST

Before dealing explicitly with the specific recommendations for tree management, in typical municipal locations it is worthwhile to stress some general principles that should underlie any approach to trees in urban areas.

The first, and obvious point, is that "trees" cannot be divorced from the "land" on which they grow. This is often lost sight of when proposals for management are made. Moreover, in any municipality the overall character of the city as a result of impressions created by "vegetation", rests not only in the resource base created by the municipality on public land, but also in the retention, planting and maintenance of trees and other landscaping on private land. As the bulk of such areas are around private homes, some concern should be centered on residential land. Since such land is "private" and we have a long tradition in Canada of recognizing the individual freedoms that accompany land ownership, the emphasis in the context of tree management on such land must be on public education that encourages citizens to maintain their trees as a vital contribution to the overall treescape of each community.

The first segment of perception is derived from the residents of a community and is reflected in their choice of elected officials. Such officials bring with them to their respective official duties certain attitudes which, in a democratic society, are assumed to be congruent with the will of majority. These attitudes in turn effect how municipal trees are managed in two ways. Appointed staff of the municipality will take their lead from the attitudes adopted by their elected officials and the tree programs instituted will be a direct result of the priorities set by political direction (policies) and by fiscal limitations.

The second segment of "approach" is that of strategies and style. If, it is deemed that the treescape of the city <u>is</u> important to the quality of life in a municipality and that certain tree management policies should be followed, then there are many ways of carrying out both the broad intent of such policies and the specific tasks that flow from them. Four components embody the important pre-requisites that will ensure the appropriate atmosphere for orderly implimentation of an urban forestry program:

(i) elected officials must have attitudes that support a healthy, expanding, vibrant community treescape and thus a willingness to support specific tree oriented programs at budget time,

(ii) there must be clear, explicit policies that provide appointed officials with the mandate to carry out such programs,

(iii) programs must be set in a cohesive management framework that amalgamates, co-ordinates and integrates conflicting needs and differing responsibilities toward an overall goal of a desirable community treescape, and

(iv) a municipality must have clear standards and methods, adequately supervised, in order to carry out the individual jobs that comprise the projects embodied in its urban forest program.

The second general point concerns the approach taken to the general appearance of any municipality by those responsible for public lands. "Approach" might be suggested as the sum of two separate areas of human perception and is critical and fundamental to the final results that will be achieved in making a town a desirable place to live. If any one of the components discussed here are not the case, then the municipality cannot hope to have a viable urban forest resource that engenders civic pride and sets an example for private, commercial and industrial development. This point also deals with how we all think about trees. In this case, it is possible to apply a simple test: <u>are trees in the community to be considered an asset or a liability</u>? <u>If the answer is an asset, then the community can readily justify</u>:

(a) some investment in the resource, and;
(b) comprehensive management of the resource.

This section now outlines a suggested overall management format in which an urban forest program could be prepared for any municipality. The format has four basic parts:

(i) an inventory
(ii) a statement of objectives
(iii) a plan and;
(iv) a timetable

(i) Inventory

In order to manage any resource adequately, it is essential to have an accurate picture of the tree resource by location, description and condition. Since trees and land go together as an integral unit, it is necessary to also identify and provide a legal description of the land resource associated with each component of the tree resource. For example; park boundaries provide a specific identifiable location commonly understood by all municipal managers.

(ii) Statement of Objectives

The Statement of Objectives should probably have two tiers. The first should be a broad statement of expectations and intent prepared and endorsed by those responsible for a municipal urban forest area. An example would be:

"The Council of this City recognizes the substantial contribution that trees make to the landscape of the municipality. Council wishes to ensure that the treescape of the City is properly managed and maintained. Be it, therefore, resolved that City Council endorses a City Tree (or urban forest) Program and that this program has the goal of providing, in perpetuity, appropriate, healthy, safe and beautiful trees throughout the City, in order to create and maintain an attractive central business district, peaceful residential streets, improved commercial or industrial landscape, safe, pleasing parks as well as production and useful treed ponds."

This simple statement of a goal and objectives would then provide the essential underpinning for an Urban Forest Program and the appropriate mandate to appointed officials for the development of more detailed objectives and implementation of individual projects.

(iii) Plan

In order to carry out the overall program, it is envisaged that an organized Plan would be the most effective management tool. A MUNICIPAL TREESCAPE MASTER PLAN would draw together each aspect of the tree resources of the City and unite these under one simple cohesive framework. The extent of detail contained in the Plan would depend on the priorities placed by Council in its Statement of Objectives. In general, however, the Plan might contain:

Part I

(a) An Introduction. This would contain a discussion of the use and benefits of trees in the City, an outline of the purpose of the Treescape Master Plan, a discussion of the Plan in relationship to other planning processes in the City, and a discussion of the Plan in relation to the broader objectives of all greenspace management in the Municipality.

(b) A description of the Municipality. This would examine location, climate, original natural vegetation and history of preservation or removal, topography as well as layout of the city, and location of special areas of historic, geographic, natural or cultural interest. This section would also document briefly the physical makeup of the City in the context of existing land use and zoning.

(c) A description of the Municipal Tree Resources. This section would combine the information gathered from existing sources, the tree and land inventory of public lands, and any important sectors of private lands, with those areas of open space that had potential for supporting trees. Also included would be those lands where trees were an important adjunct to an existing land use such as watersheds or those areas of dereliction that might be developed to incude existing trees. Wherever appropriate this description should address the complete forest eco-system including soils, drainage, all vegetation and forest stand dynamics.

(d) A description of Program Management. This section would examine and describe the Tree Program in the context of administrative policies, procedures, practices and responsibilities. Also described here would be any subordinate plans that were developed for specific

units of the urban treescape. An example would be brief Park Management Plans. (These are described in greater detail under management of specific areas)

Part II

(a) A discussion of the Tree Resource. This section would review the history of the municipal treescape to date and appraise its present condition, age, composition and suitability at particular locations. In addition, this section would identify trees or areas of trees for preservation and areas needing improvement or renewal of the resource. Since part of the forest resource will include areas of a complete eco-system, appropriate management of these areas would also be discussed.

(b) A discussion section on Program Opportunities. This section would review and discuss those constraints and opportunities that restricted or governed the program. Included here would be an analysis of the areas that could be planted, or thinned, for example those areas that should receive some type of silvicultural treatment and those areas or locations that should not. These areas would also have to be split into two categories; those under direct control of the municipality where criteria that would govern the decisions associated with silvicultural or arboricultural treatment would be

established, and those areas in private ownership where incentives might be instituted or examples encouraged through assistance from City staff or other appropriate government departments.

In the case of land under municipal control, specific projects would be developed in this section and their relative merits reviewed. In the case of private lands, opportunities for public education, public participation or recreation and possible joint projects with other jurisdictions would be outlined. This section would also contain an outline of the specific standards and regulations that might govern trees in the public domain and the recommendations for guidance to citizens and business in managing private areas.

MANAGEMENT OF SPECIFIC AREAS

The headings here are not given in any order of priority since each general area is unique in its contribution to the City treescape and all are important. Only four examples are given here since this brief paper is not intended as an exhaustive compilation of management requirements for every component of the urban forest. The following sections do, however, provide an indication of format that might apply in approaching the management of other areas. These areas might include foreshore lands, riverbanks, buffer strips,

greenbelt, and watershed lands with tree cover, institutional lands, various types of right-of-way corridors and, of course, actual forest land on the periphery of urban communities that has been designated for multiple use.

Designated parklands provide the municipality with an ideal opportunity to maintain the treescape character of the municipality since it has full control of these areas. Such parkland can be broken into two categories for the purpose of urban forest management; those areas with complete tree cover over much of the area and those high-use parks, or portions of parks which are largely grass interspersed with small clumps of trees or single trees.

1. Parkland with closed canopy. Areas of contiguous tree cover provide two types of impression, the distant view and the immediate, which are crucial in providing a basic impression of the natural qualities of the municipality and its desirability as a place to live. Trees are, however, a dynamic resource - they evolve from young seedlings, through mature tree, to death and eventual decay. Although this takes time, certain species of tree, particularly pioneer hardwood may do this in fifty years. Since most of the treed land in many municipalities has experienced substantial disturbance in the past and, perhaps with the exception of some few

conifers and very old hardwoods, has only grown trees from that particular time, the tree resource will largely be of one age class. This means trees can be expected to all become decadent and die within a fairly short span of time. Although this may not occur for some years, in order to ensure a continued, successive growth and replacement of the tree resource, the first concern is that of ensuring uneven ages within the tree stands of each park. This will ensure that, as trees become overmature and die or are removed, new younger, vigorous trees will take their place without there being a period between youth and maturity when there are almost no trees in some particular areas. The key, obviously, is selective thinning, removal and selective replacement on a continuous basis.

In order to ensure orderly, sound, manipulation of the tree resource and to impliment desired silvicultural objectives, it is necessary to develop a detailed inventory of the trees in each park. This inventory should identify species diversity and composition, ages, condition, location, size and numbers. From this information it is possible to identify life expectancy, desirability and opportunities for the resource. From this information, in turn, it is possible to predict needs for repair, removal or replacement. It is then possible to plan actual field practice, and to identify staff, financial and plant material resource needs over time. Important too are the public/political information

processes that will be required to explain the reasoning, standards of work and anticipated results that provide can public support for such a program.

The objectives of management in each part should be summarized in a brief Park Management Plan. Included in this plan should be a section devoted to the park resources stating the general goal or goals for tree management in all community parks and supported by specific objectives applicable to each specific location. For example, a simple goal would be to:

> Maintain in perpetuity appropriate healthy, safe, attractive trees in park woodlands for the enjoyment of all citizens of the municipality.

At first appearance this appears a fairly simple goal. However, to develop a plan, work methods, timetable and staff able to accomplish this, and a tree resource in each park that reflects the full silvicultural implications, takes a determined effort even for large communities with relatively few parks.

Possible management objectives might include, but by no means be limited to:

(i) ensure there is sufficient age class diversity amongst the tree resource in each park so there is no overall attrition from the resource, with immature additions at lease equalling overmature tree and thinning removals.

(ii) ensure that the character or design of each park, as influenced by the existing tree resource, is not changed by manipulation of the tree canopy, by pressure of usage effecting the health of trees, by new tree establishment or by any unnecessary tree removals. The exception will be when explicit intent to alter the park is contained in the Park Plan and approved by Council.

(iii) ensure that mature trees predominate in the tree cover of each park and that there is an ecologically appropriate balance of species, tree numbers and conifer to deciduous ratios.

In parkland with only individual trees scattered throughout the area. Open grown trees are, in general, subjected to considerably greater stress than would be the case in a closed canopy situation where the first layer protects the trees from ground compaction and surrounding trees protect individuals from other environmental stress. Single parkland trees must often face stress from root damage caused by constant human or equipment traffic, from watertable fluctuations, from vandelism, from unintentional damage such as mower wounding and from exposure.

Again, it is recommended that a Park Plan containing tree management goals and objectives should be prepared for these types of park. In addition, specific standards for:

(i) acceptable minimum tree condition for retention in parks,
(ii) acceptable tree surgery, repair and maintenance,
(iii) acceptable minimum tree size (height and caliper e.g. 7 meters & 9 centimeters)
(iv) acceptable tree species (not too great an emphasis on exotics) and;
(v) acceptable tree establishment methods (e.g. tree space planting, fertilizing, guying and watering).

In order to provide a framework for the Park Management Plans suggested here, a Park Master Plan can be prepared and adopted which integrates the individual Park Plans and amplifies the recommendations concerning parks made in any Treescape Master Plan or in a Community Plan if one has been developed.

In addition, a Park By-law with specific provision for controlling or prohibiting activities which damage or destroy park trees can be introduced and adopted.

2. Derelict or "Undeveloped" Lands form an important component of a municipal urban forest resource and can often be unknowingly at risk. This is occasioned by two factors. The first concerns the number of mature trees that may contribute substantial benefits to the community but are on older tracts of privately owned land, for example old estate lands. These lands are often broken up for new housing and the tree resource removed.

The second factor relates to holding potential development land for investment but allowing a tree "resource", even though it is only alder, to grow and produce a "woodland" or scrub appearance. In addition, existing large trees often give the impression of a park area. It is not until a development permit application or the start of actual construction that local residents become aware of the potential loss of amenity and any attempt at preservation appears. This is usually too late to effect any major change or regulation of a developer's intentions. These areas can make a major contribution to the appearance of the community but there is no guarantee they will be retained unless specific action is taken long before major development plans are prepared.

Areas of this type should be identified and an organized inventory detailing:

(i) Legal Description
(ii) Ownership
(iii) Area, general location, access, zoning and intended use, value and importance to the community
(iv) Opportunities and costs

developed in order to establish priorities for possible preservation action. Such action might take the form of an offer to purchase, zoning limitations, negotiations for restricted covenant, education and tax or other incentives for owners to retain the urban forest character of particular areas.

There are often small areas of publically owned "derelict" lands that have not been managed in any intensive manner. The appropriate City Department should maintain an inventory of these areas. It should not be construed that intensive management means negating the natural appearance and condition of an area. Rather, it means that these locations are properly identified and are managed so they do not detract from the overall community. Restoration, clean up, noxious weed control, arboricultural safety, tree planting or removal, control of encroachment and prevention of dumping should all be concerns that are adequately dealt with in the management process.

3. Ravine areas are often of unique natural landscape character but rarely reach their full potential. This can be ascribed to the fact they are "left over" land and fall somewhere on the scale between parkland and derelict land. Ravine land is often vulnerable to encroachment, tree removal, windblow, eroion and fire risk. Unauthorized dumping, water pollution, noxious weed growth and rampant brush growth are also common.

As with parkland, a detailed inventory of large and small ravine land should be conducted and the tree resource assessed. Plans should be made for immediate and future management. Ravine land should be specifically mentioned in any Park By-law and specific provisions included to control dumping.

Potential for recreational useage such as interpretative walks should be explored since ravines offer natural features and plant diversity often unique to an area, particularly when the surrounding land is built-up. Objectives of management should support and exploit the natural characteristics of each valley and water body.

Management of ravine land must, in addition to the normal requirements for tree management discussed for parkland, include an explicit component for priority inspection and regulation. Although a major natural asset to a community, public perception of such areas is often of a natural refuse disposal and firewood supply point. Such activities must be controlled and an aggressive program of public education developed to ensure this component of the urban forest is protected from the ravages of urban man.

4. Boulevard Tree Planting. This type of planting can be one of the most important components of the municipal contribution to the treescape of a community. This type of planting may be broken down by street type and by planting location. Street types are often designated as arterial roads, feeder roads and residential streets. Street tree planting areas include centre boulevards, street triangles, tree lawns, sidewalk cut outs and large container planting. Substantial street tree planting has not been undertaken in many cities despite strong recommendations supporting this activity. This

is unfortunate, particularly in central business districts where tree planting can substantially improve the attractiveness of many commercial areas. Where provision has been made on residential streets for a tree lawn or planting strip, it is vital that tree choice fit the constraints of street clearance, height and width limitations, spacing and distance from street lights, signs and furniture, in order to minimize future maintenance.

Engineering limitations and design criteria should be established as written guidelines for tree planting. Whenever possible, adequate space to ensure a tree growth should be incorporated to overcome the problem of narrow tree planting and landscape islands which are too small for all but the most limited of small tree species.

As with parkland, a Boulevard Tree Master Plan should be prepared. This plan should identify a goal for this component of the communities' treescape program and set clear objectives, for example:

1. The City Boulevard Tree Program should enhance the central business district, residential and public areas of the City to a standard that will ensure that the municipality is an attractive place to live, work or visit.

2. The Boulevard Tree Program should ensure that suitable tree species are chosen for use on appropriate city streets and maintained to a standard that encourages business and private tree planting.

3. The Boulevard Tree Program should be comprehensive, technically competent and fiscally sound.

A simple Boulevard Tree Master Plan might contain:

(i) A brief introduction containing a discussion of the use and benefits of trees in the streetscape and the purpose of the Master Plan.

(ii) A description of the City climatically, graphically and topographically.

(iii) A description of the existing street tree resource.

(iv) A description of the present street tree management responsibilities, goals, objectives, policies, funding and legislation (if any).

(v) A discussion section outlining a brief history of the area and its natural tree cover, a history of the present tree resource and an appraisal of the condition, age and suitability of existing street trees.

(vi) A discussion section examining the constraints that limit tree planting in various parts of the city, such as road improvement, development plans or view restriction. This section of the Master Plan would also discuss public participation and general funding of the Program.

(vii) A discussion and design section would examine the design opportunities for individual locations and streets; outline possible design objectives and develop actual design plans for priority locations.

(viii) The actual implementation timetable for individual projects within the overall program would be given for each year of the program for a first five year segment.

(ix) Plans for a second five year segment would complete the Master Plan which should thereafter be prepared and adopted for a ten year period. Further planning would then be incorporated in a new Street Tree Master Plan at the end of the first ten year program.

(x) Included in the Master Plan should be provision for updating specific plans as a result of changing conditions in the city or experience of tree management success or difficulty. In this regard, specific projects should be monitored for unanticipated problems and findings fedback into the design process.

A number of optional practices should be adopted to ensure that the Boulevard Tree Program is efficient and fiscally sound. These include:

(i) A Street Tree By-law.
(ii) Appointment of a City Arborist or Foreman specifically responsible for all aspects of trees on Municipal property.
(iii) A properly trained crew with appropriate tools, equipment and knowledge for tree establishment, tree care or tree removal and replacement.
(iv) A tree inventory of those trees under city management giving location, species and condition in turn, this should be translated into a simple workload analysis that relates work requirements to staff availability.
(v) A record system that tracks unit costs and tree needs.
(vi) A community relations program that informs citizens about the program, city policy toward trees, the location of aid and upcoming projects.
(vii) An information program for developers that outlines tree protection measures, responsibilities and procedures for sidewalk crossings, encroachments, etc.
(viii) Detailed procedures and practices for tree planting, care and replacement, including specifications, approved methods and equipment, supervision, safety and tree choice.
(ix) A budget system that is equally keyed to the implimentation and maintenance segments of the Stree Tree Master Plan.

CONCLUSION

It is possible, with some forethought, to develop a simple framework in which to organize and plan the management of treescape information. Each component of the urban forest can be individually identified and a mini-plan developed to meet specific needs. In turn, these plans can be amalgamated into an overall Master Plan that will provide a community with a detailed document on its urban forest resources. The landscape architect has the skills and opportunity to participate as a resource manager. It remains for him or her to seek out those communities who are keen to retain or enhance their natural forest heritage.

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THE URBAN FOREST

Managing Part of the Landscape Around Us

Prepared for Dr. J. Neill

Pl. Sc. 530

Submitted by:

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95-41389776

ABSTRACT

A brief review is made of the needs to manage urban forest land. A description of the term urban forestry is given, and specific examples of lands that form part of the urban forest are noted. Four examples, parkland with a closed canopy of trees and open parkland, derelict or undeveloped land, ravines, and boulevard tree plantings are examined in the context of specific management techniques. In order to provide an overall framework for the management suggestions for each area and the concept of a simple Municipal Treescape Master Plan is developed. An outline is given of each of the components that might form part of such a master plan.

LIGHT RAPID TRANSIT -

A PLACE FOR THE LANDSCAPE ARCHITECT ?

SUMMARY OF SEMINAR MARCH 1978

Robin Gardner
Plant Science 516
Professor: Dr. John Neill

INTRODUCTION

In the decade 1950 - 1960 the total population of the largest urban areas in North America increased by nearly 25 percent; yet the population of the central cities in these areas increased less than 2 percent (Scheffer, 1964).

The total number of persons entering the central business district of our large metropolitan areas has remained more or less constant over the past 20 years, but the percentage of trips made by automobile has increased substantially in almost every case. Those trips which have remained on the public transit systems have been confined increasingly to the rush hours alone. Although the total number of trips throughout each urban area has increased as population increased, automobiles have absorbed the entire growth and more. (Witness the Liveable Region Plan of the G.V.R.D. predicting an increase in the number of people on the Lower Mainland by 25 percent from 1.2 million in 1978 to over 1.5 million by 1986, yet an actual decline in Hydro Bus Service with a concomitant increase in the operating deficit. In addition there is a recent history of removal and abandonment of light rapid transit facilities as with for example the service to Richmond.)

As the pattern of urban decentralization has spread travellers have not illogically shown a growing preference for the comfort, convenience, freedom from schedules, flexibility of movement and in some cases, the lower short run cost of the private automobile.

The general attitude toward transit has also affected its use. As the automobile has acquired increasing importance both from the standpoint of flexibility and social status, the social acceptance of transit has declined. As peak-hour transit travel has become more crowded, it has perhaps seemed more demeaning to a population able to afford the luxuries of one, possibly two automobiles. Moreover people are willing to accept the congestion and the lost time in order to retain their privilege of personal travel.

The result is that many transit systems appear caught in a spiral of

declining patronage and revenue, causing financial inability to take the necessary steps to stem the decline without gigantic public subsidy. (A proposed two hundred million for the Vancouver Rapid Transit System alone).

The very growth of the urban sprawl which has been the undoing of at least the older transit systems has now in most cities also brought the road system to the brink of supersaturation with even the smallest incident at rush hour snarling traffic for miles. The simple solutions proposed (for the construction of urban freeways) seems to succeed in making the city even more uninhabitable with demands on urban land, noise, pollution, and social disruption of local communities. The conflicts have reached a pitch where the urban planner, the architect, the engineer and the politician have started to cast around for alternatives - and inevitably, the quiet, clean, energy efficient, and economic land use (rail transit may carry as many as 40,000 passenger trips per hour compared with 3,000 for a similar width single line highway) have prompted a re-examination of the place of L.R.T. in the transportation needs of the city.

Those hopeful to boost the fortunes of Light Rapid Transit are faced with two (at least) grave problems; how to finance the capital cost of such expensive public works, and how to attract the commuter from the most common mode of city transport, the personal automobile. A small facet perhaps, of this latter dilemma finds a place for the landscape architect to contribute his skills. How best can the facilities so necessary for rapid transit fit the purpose and the place in the city landscape by providing an esthetic appeal to the user?

DEFINITIONS

Rapid Transit: a system of inter-urban passenger transportation employing single or multiple unit electric trains supported on two rail track and utilizing separate rights of way free of interference with other modes of transportation. Also referred to as rail rapid transit.

Light Rapid Transit: form of inter-urban passenger transportation employing single or multiple unit electric cars supported on two rail track in a centre reservation, a side reservation, pedestrian malls or short lengths of subway.

While these definitions exclude those forms of technology which are loosely subsumed under the heading of "Monorails", there are many strong similarities between rail transit and certain types of monorail proposals.

STATUS AND GROWTH OF RAPID TRANSIT SYSTEMS AROUND THE WORLD

There are seventeen countries in Europe, eight cities in Soviet Russia, eight cities in the United States, Mexico City, the Argentine, three cities in Japan and one city in Australia already operating rapid transit systems of one type or another. In addition of course there are two well known systems already operating in Canada, those in Montreal and Toronto. In order to put in perspective the potential for the landscape architect it is perhaps worth examining in greater detail proposed or planned rapid transit systems for the 1970s throughout the world.

Canada (i) Calgary - the city has been recommended, as a result of a two year study to develop a twenty mile railway system.

(ii) Edmonton - the city council has authorized an initial construction programme for the Commonwealth Games using rubber tire German made transit cars largely in a subway system.

USA (i) Atlanta - in metropolitan Atlanta the Rapid Transit Authority has plans for a forty mile system but a proposal to finance construction failed when submitted to the electorat.

(ii) St. Louis - the U.S. Department of Transportation has provided funds for a study.

(iii) Baltimore - a master plan costing 1.5 million dollars has resulted in a proposal for a 1.7 billion dollar rapid transit system of 71 miles.

(iv) Los Angeles - plans have been prepared for an 89 mile route costing 2.5 billion dollars.

South America (i) Sao Paulo, Brazil - have contracted for a system costing 38 million dollars.

(ii) Santiago, Chile - twelve kilometers are in operation of a proposed 57 kilometer route, mostly underground, no costs available.

Asia (i) Yokohama, Japan - 46 mile route costing 180 million dollars proposed for completion by 1985.

(ii) Hong Kong - work has started on a proposed 40 mile route costing some $3,404 million.

Australasia - New Zealand, Auckland and Wellington and Australia, Melbourne are all studying the possibility of rapid transit systems.

Europe (i) Cologne, Germany - new 7.5 kilometer network of tram tunnels is being constructed, no cost available.

(ii) Stuttgart, Germany - 17 kilometers of tram tunnel in construction phase, no costs available.

(iii) Gothenburg, Sweden - 44 miles of rapid transit rail system in final proposal stage.

(iv) Helsinki, Finland - construction started in 1970 on a total route of 75 kilometers, no costs available.

(v) Manchester, United Kingdom - work has started on an 11 mile rapid transit system at a cost of some 100 million dollars.

Plans also exist for new systems in the Soviet Union, Italy, Israel and possibly Mainland China. These systems described are of course mainly heavy rail systems rather than light rapid transit although in some cases it would appear that the two technologies are intermingled.

POTENTIAL BENEFITS OF L. R. T.

Quantifiable

Persons benefits accruing to	Type of benefit
Existing user of public transit	Time saving
Motorist diverted to L.R.T.	Time saving and reduced vehicle operating cost
Motorist not using transit	Less congestion
The transit system	Restrained growth of competing systems
Property owners	Enhanced value and access
The business community	Reduced private parking, time savings and trucking savings
Central government	Reduced highway expansion

Non-quantifiable Benefits

Persons benefits accruing to	Type of benefit
Present community resources	Strengthening of existing communities
New community resources	Support for orderly land development
Social benefits	Greater mobility
Urban quality	Less pollution and noise, etc.
Safety	Fewer accidents, reduced social costs
Municipal services	Reduced enforcement and maintenance

POLICY AND ITS INFLUENCE ON URBAN TRANSIT

A. The United States Experience

Public awareness on mass transit in the U.S. has increased sua stantially as a result of Federal funding since 1961. In addition environmental concerns and the realization that there cannot be a continuation of the strong and singular emphasis on the sutomobile for urban transportation has led urban planners to look for viable alternatives.

Further the 1972/1973 energy crisis and government realization that mass transit represented a possible means of conserving scarce energy resources expanded the interest and has resulted in considerable increases in publication.

See Smerk, George M., 1973 Urban Mass Transportation - a dozen years of Federal policy. Indiana University Press.

This textbook examines transit in the context of surface street cars, buses, trolley buses, and rapid rail transit on exclusive rights of way, elevated or underground. There is an in depth study of urbanization in the United States and some of the urban transportation problems are examined. The book outlines the Federal role in policy making through seven statutes. The pros and cons for mass transit are described and a detailed account of the successes and failures in the American approach is outlined for the transportation planner. The book concludes with an analysis of the problems and possible solutions including Federal Demonstration Programmes.

A further detailed discussion on the correlation between growth of urban communities and transportation can be found in the following publication.

United States Department of Transport, 1974, Suburbanization and its Implications for Urban Transportation Systems. Superintendent of Documents.

This report examines the trends of population growth, the research and development needs and transportation, urban demographic transportation trends and the currently viable system options. In addition the report examines in considerable depth the possible growth of Personal Rapid Transit, primarily in the context of personal cars on an integrated rail system.

B. The Canadian Experience

A major urban transportation investment in Canada has been planned around freeways. Forthe periods from 1970 there is expected to be more than a doubling of freeway mileage from 440 miles to about 990 miles in a 12 year period. The capital cost of these plans are expected to be 3,900 million, of which about 330 million will be in highways and 600 million for various types of transit improvement. Although Montreal and Toronto have and are expanding their existing mass transit systems, Edmonton appears to be the only other major Canadian city willing to take the plunge from transit to mass transit with a rail based system.

Although the Federal government has verbally endorsed the concept of urban mass transit, two outstanding problems appear presently unresolved. The first is the obvious and continuing conflict of constitutional responsibility. Until that conflict is resolved it would appear that there will be no unifying coordinated effort. In addition the continuing trend of diminished Federal funding coupled with a continuing escalation of inflation, would appear to leave unresolved the problem of financial burden on local communities.

However the Federal government has stated its interest and involvement in rail transit of all types. Energy conservation, problems of congestion and inefficiency, land use and other urban service costs and the saturation capacity of other transportation modes are put forward as substantive reasons for Federal government participation in urban rail transit planning.

D.J. Reynolds, 1971, Urban Canada Problems and Prospects - The Urban Transit Problem, a research monograph no. 3, Central Mortgage and Housing Corporation. This research document is divided into 6 parts, examining the future demand for urban, inter-city and rural transportation up to the year 2,000, the supply of transportation facilities, the plans of major Canadian cities, the pricing of urban transportation systems, the impact of urban transportation on the environment and a section of conclusions which caution against simple solutions, the problems of emphasis or de-emphasis or major highways, the lack of general urban transportation research in Canada, and a more thorough appraisal of viable technology.

C. The Vancouver Situation

Vancouver is greatly constrained by its geographical location and by sea, river and high ground. Consequently it can expand easily only to the south-east and its central business district is considerably cut off on the peninsula. In general it is a low density city with an overall density of about 6,000 people per square mile, excluding the west end. Car ownership is well above the national and major city average and transit use of the B.C. Hydro Bus System has stabilized at about 70 rides per capita per annum. The Burrard Inlet and the Fraser River are major obstacles to transportation development. Plans presently exist for an increase of some 24 miles of freeways around the city centre and 38 miles of arterial roads to be added to the present system at a total cost of about $200 million.

Continuing lack of leadership from either the province or the G.V.R.D. has frustrated efforts to provide a coordinated approach to mass transit in the lower mainland. Mayor Volrich has recently attempted to rekindle an interest in the problem but without outside financial support is unlikely to make other than political mileage.

A number of important references should be mentioned in the context of rapid transit in the Vancouver and Greater Vancouver area.

B.C. Research, 1962 Rapid Transit for Metropolitan Vancouver, prepared for the Department of Highways in the Province of British Columbia.

This report suggests that rapid rail systems are unlikely to be justified in Vancouver before 1980 and that since an east west freeway may well be constructed by that time, the cheapest solution would then be to operate express buses on the freeway. It was then envisaged that there would be a switch to rail once freeway capacity was reached. The problems of insufficient density in Vancouver, even by 1980 were recognized as a possible impediment in rapid rail for the lower mainland. The experience in other cities, namely Toronto, Cleveland, Shaker Heights, close to Cleveland, Chicago, San Francisco and the proposals for Los Angeles, Washington, D.C., St. Louis and Atlanta are described. Possible alignments for Vancouver are discussed and it is concluded that a line from Vancouver east to Boundary Road is

the only route on which passenger volumes could be justified in the ensuing twenty year period. Alignments on Arbutus and for the First Narrows crossing are quickly discounted.

De Leuw Cather & Company, 1970, report on the Greater Vancouver Area Rapid Transit Study, G.V.R.D. and B.C. Hydro and Power Authority. This report prepared by the foremost rapid transit consulting firm in North America is confined to the main topics of rapid transit, concludes that in the period from 1970 to 2000 the amount of travel in the region will more than double. The studies showed that rapid transit should be an essential part of an integrated and balanced transportation system for the area, playing a vital role in supporting other forms of transportation and land use development policies in the region. Four alignments; Arbutus to Richmond, a distance of eight miles, Kingsway to Willingdon, a distance of seven miles, Hastings to Willingdon, a distance of five miles and the north shore to the Upper Levels Highway, a distance of four miles, giving a total of twenty-four miles with twenty-three stations and a capital cost of $269,000,000 are adopted by the report. Portions of this report seem to form the basis of the latest proposals referred to earlier. Of additional interest are the following reports.

Burnaby Planning Department, 1974, Burnaby Transportation Study to 1985. Although essentially concerned with private cars and bus transit, the use of rapid transit is reviewed both historically and functionally.

Parkinson, T.E., 1972, A Preliminary Study of Light Rapid Transit in Vancouver, British Columbia, G.V.R.D.

Thompson, G., 1975, Light Rapid Transit, Description and Definition, G.V.R.D., a small hard-cover publication describing and illustrating various alternatives of L.R.T. particularly centre reservation, side reservation, pedestrian mall and short subway types. Pictures of recent examples, mainly from Europe and including station designs and rolling stock provide useful pictorial comparisons. The historical development from the 1890s of the old streetcar system to the gradual decline during the 1950s of the lower mainland Rapid Transit System is described. The preference

of transit designers for light rapid transit cars over buses and their ability to go underground, travel more rapidly and be linked together is discussed in brief terms. It is noted that LRT has an initial capital cost of around 1.7 million dollars per mile compared with heavy rail costs of around 10.9 million dollars per mile.

BACKGROUND TO RAPID TRANSIT

A

1. Criteria

A number of basic necessities are apparently required to justify the use and investment in rapid transit.

i To be economical there must be 10,000 people per square mile or above.

ii The population must exceed 2 million.

For example New York has a population of 24,000 per square mile, Boston a population of 14,000 per square mile and Philadelphia, 15,000 per square mile. The Toronto system which is presently 21 miles long and the Montreal system which is 16 miles long also operate in areas of similar population density.

2. The physical shape of the city may benefit or restrict the use of rapid transit.

3. Typography and natural obstacles may either severely limit or escalate the cost of rapid transit to a prohobitive level.

B. The Economics of Rapid Transit lend serious question to their viability. With tunnels costing upwards of $100 million per mile, relatively small systems become extremely expensive. The Mass Transportation Assistance Act, 1974 in the United States provided eight billion dollars for rapid transit. However serious questions about the use of that money over the

short term is illustrated by the comparison that a rail system at the end of ten years using that money could carry one million passengers a day whereas it is estimated that buses bought for the same capital cost could move sixty-four million passengers a day. It is concluded that three factors must justify the use of rapid transit:

(i) The financial capacity of the community.

(ii) The type of transportation that city residents prefer or can be educated to prefer.

(iii) That there is adequate city growth and that provision of a rapid transit system will not encourage decay of the central city.

C. Benefits and disbenefits of rapid transit can be summarized briefly:

Advantages	Disadvantages
Speed	Capital Cost
Comfort	Operating Deficits
Safety	Inflexibility
Space Savings of Urban Land	Technological Change, making some systems obsolete
Provides a Physical Framework for land development	Does not normally reach the group who already lack cars
Can assist in making cities more compact	
Can provide high density housing around stations	
Can reduce pollution and noise	
May be used as a focus to improve esthetic landscape	

In Berkeley and San Francisco for example the station areas and subway construction routes have provided an opportunity for substantial remodelling of the streets. There have also been successful efforts to introduce

landscaping along B.A.R.T. elevated structures.

See also Owen, W., 1976, Transportation for Cities, the role of Federal Policy. The Brookings Institution.

This publication examines in greater detail the dependence on the automobile and public transportation as an alternative, American aid to communities and key policy issues, compares the large investment option of rapid transit with the low cost option of improving existing systems, develops some concepts of integrated transportation and examines the economics of transit alternatives.

ASSESSING THE NEED FOR RAPID TRANSIT

A. With increasing numbers in urban areas and increasing salaries people expect improved public services. Studies must aim at enlarging on the background of underlying forces which shape urban development. In recent year many metro areas have transportation studies coupled with land use programmes where the studies alone have been in the millions of dollars. Mistakes are particularly high for eventual systems may cost in the billions of dollars.

B. There have been three principal types of study in the past.

(i) What type and scale of public investment should be made in rapid transit.

(ii) What measures can be taken to improve present resources.

(iii) How will transportation facilities affect spatial distribution of activities in the urban area.

C. General techniques have included:

(i) Estimating trouble patterns in relation to land use in a base year.

(ii) Predict land use development.

(iii) Forecast travel patterns for target years.

(iv) Prepare a plan.

The principal inputs have been:

(i) A census of the population, employment, land use, and existing transportation for each sub-area of the study of the area.

(ii) Sampling trip generation and origin destination patterns at a three to ten percent level.

D. A number of shortcomings can be seen in this type of analysis.

(i) High cost.

(ii) It is normally conducted in a vacuum of the knowledge on structure of the decision making processes in a community.

(iii) There is a paradox of historical review of how transportation has influenced land use patterns while then proceeding with a study of land use to predict travel.

(iv) Planning has often shown a paucity of analysis in comparing alternative modes, has often contained little more than repetitive engineering with poor engineering vs. cost analysis. In addition planning studies normally provide little comparison of mix, for example rail vs. other mass transit vs. private transportation. A prime example is highways being analysed in isolation from other transportation modes.

(v) Financial analysis has put great emphasis on investment decisions and "new systems", but few studies look at allocating existing resources more efficiently.

E. There would seem to be a number of important needs in assessing the potentials of rapid transit in a community.

(i) Integrated studies of the forces shaping the city.

(ii) More complete user evaluation of existing transportation resources.

(iii) A study on the financing of improved existing facilities.

(iv) Development of community-based rather than private choice models.

(v) A much better assessment of the role of government in local land use policy and level of involvement in the transportation field.

For more information on this topic see The Rand Corporation 1961. Transportation for Future Urban Communities, a Study Prospectus.

THE REAL WORLD

A study conducted on the Park and Ride Rail Service in New Brunswick, New Jersey had the following findings:

I. After 18 months, the study was terminated but there was still slow growth of passengers to the system.

II. The area had a 30% population increase and most of the new travellers using the system were new residents.

III. The bulk of the passengers moved in a narrow time band at peak hours.

IV. 90% of the travelling passengers actually drove to the station with one or two people in the car. 60% parked, while only 19% were dropped off.

V. Train frequency was important in the useage pattern.

VI. Most important in attracting patrons was the free, convenient, well laid out parking lot.

For more information, see Tri State Transportation Commission, 1973, Park and Ride Rail Service, New Brunswick, New Jersey.

RAPID TRANSIT DESIGN

A. Guidelines and Principles for Design of Rapid Transit Facilities:

General:

Patron circulation and exits

Security

Fire Protection

Lighting

Subway Ventilation

Acoustics

Graphics

Public Telephones and communications

Concessions

Sanitary facilities

Facilities for the handicapped

Station finish

Waterproofing.

For more information, see Institute for Rapid Transit, 1973, Guidelines and Principles for Design of Rapid Transit Facilities. This design manual, by the Institute for Rapid Transit, unfortunately makes no mention whatsoever of landscape design.

B. It is suggested that there is a need for tools that the architect can utilize in the design of Transit Stations. A report from the University of California at Los Angeles, suggests that :

1. Boundary Definition:

(i) that the route is fixed

(ii) that the choice of vehicle mode has been made

(iii) that overlaying existing systems, with adequate interchange between systems, has been determined.

1. (iv) the design has been specifically determined.
   (v) public participation has been undertaken.
   (vi) all the decision-makers and planners have been properly involved.
   (vii) the elements of goals, objectives and performance criteria have been determined. It is suggested that these must be discreet, must be at the same level of generality, and unambiguous.

   Specific detail is given concerning stations occupying a special position within the fabric of streets and buildings.

   For more information, see Anon, 1975, Prototype Transit Station Design, School of Architecture and Urban Planning, University of California at Los Angeles.

2. Specific design criteria was set for BART in San Francisco.
   (i) utilization of open space under and around structures for park and recreation areas, plus meandering paths and bicycle paths.
   (ii) creation of openness in structures so that design characteristics were not bulky, space consuming or light absorbing.
   (iii) local design and landscaping gave diversity to each station.
   (iv) control of scale, location and freedom from advertising.
   (v) specific emphasis went to landscaping, parking lots, fair collection facilities and stations.

PLANT MATERIAL FOR TRANSIT FACILITIES

The function or use of plant material should be borne in mind under four headings:

1. Architecture

   Privacy

   Accentuation of architectural elements

   Space articulation

   Progressive realization

2. Engineering

Erosion control

Acoustic modification

Atmospheric purification

Traffic control

Glare and reflection

3. Climatic Modification

Solar

Wind

Precipitation

Temperature

4. Aesthics

Visual dimension

Texture

Nature appearance

Colour

Unifiers

Attracters

Emphasizers

Diverters

Decorators

Indicators

Modulators

Softeners

For more information, see Robinette G.O., 1972, Plants, People and Environmental Quality, American Society of Landscape Architects Foundation.

2. The importance of site analysis should be stressed and examined in the context of maintenace, in particular:
   (i) serviceability
   (ii) durability
   (iii) practicality
   should characterize vegetation used in rapid transit facilities.

   For more information, see Anon, 1964, Transit Planting, A Manual, American Horticultural Society.

PLACE OF THE LANDSCAPE ARCHITECT IN TRANSIT DESIGN

1. The individual landscape architect or perhaps more importantly the professional societies should consider preparation and publication of guidelines for design of transit facilities. In addition, it would seem important that resource material on experiences or specific design either successful or unsuccessful, should be available to planners, engineers, architects, and the landscape architecutral profession.

2. The landscape architect should broaden his interest and participation in public projects. In particular, involvement in competitions, judging local design panels, and formulation of component terms of reference should be seen as a professional responsibility.

3. Since public projects are now often the subject of a public hearing process, the landscape architect is in a unique position to direct, influence, synthesize, and advise on or in the public hearing process.

4. As the landscape architect becomes more involved in macro-scale urban development and land use studies, and environmental impact statements, his expertise becomes particularly important in the design of linear land uses,

such as those associated with transit location and design.

5. The competent landscape architect should be an integral part of the design team for rights of way and station design, including parking lot design and traffic flow studies. His training and site analysis and circulation should lend considerable weight to arguments for ecologically and aesthetically sensitive design.

6. The landscape architect's abilities in design of exterior and interior transition space, signage and pedestrian control, safety and securety considerations, screening and the functional use of plant material from the previous section should allow him a unique and important role in rapid transit design.

7. Finally, the landscape architect's ability to predict maintenance requirements and suggest shedules, practices and procedures, should provide operating personnel with the maintenance knowledge to protect the original design characteristics.

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People movers: easing traffic congestion

The congestion of downtown areas and the growing needs for a quiet, clean, efficient way of transporting people, has made an old idea emerge as "an idea whose time has come." It's known as people movers or horizontal elevators.

The cars are computer-controlled and quietly propelled by electric motors. They contain their own right of way, and are spaced so that one car can follow another by just a few seconds, or "trains of cars" can be timed as necessary. They operate like elevators, only horizontally; doors open and close exactly like elevators.

John C. Marous of Westinghouse views his company's answer to the car-congestion of a downtown area, as a way to ease traffic pile-up, conserve energy, curb urban decay, and stop car-made air pollution. These horizontal elevators from Westinghouse would augment mass transit, not compete with it.

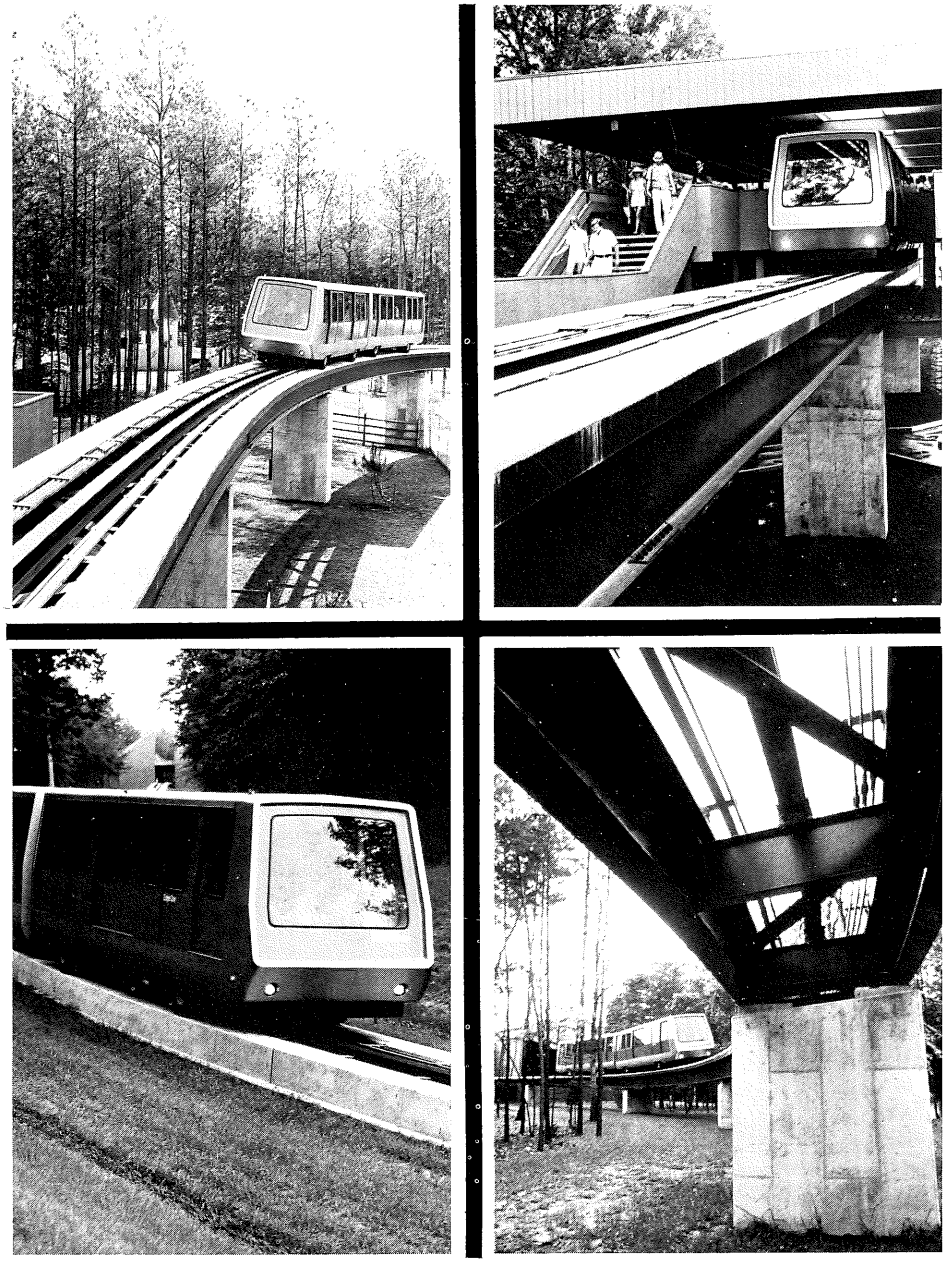
Marous, who is executive vice president in charge of construction, explained how the horizontal elevator works:

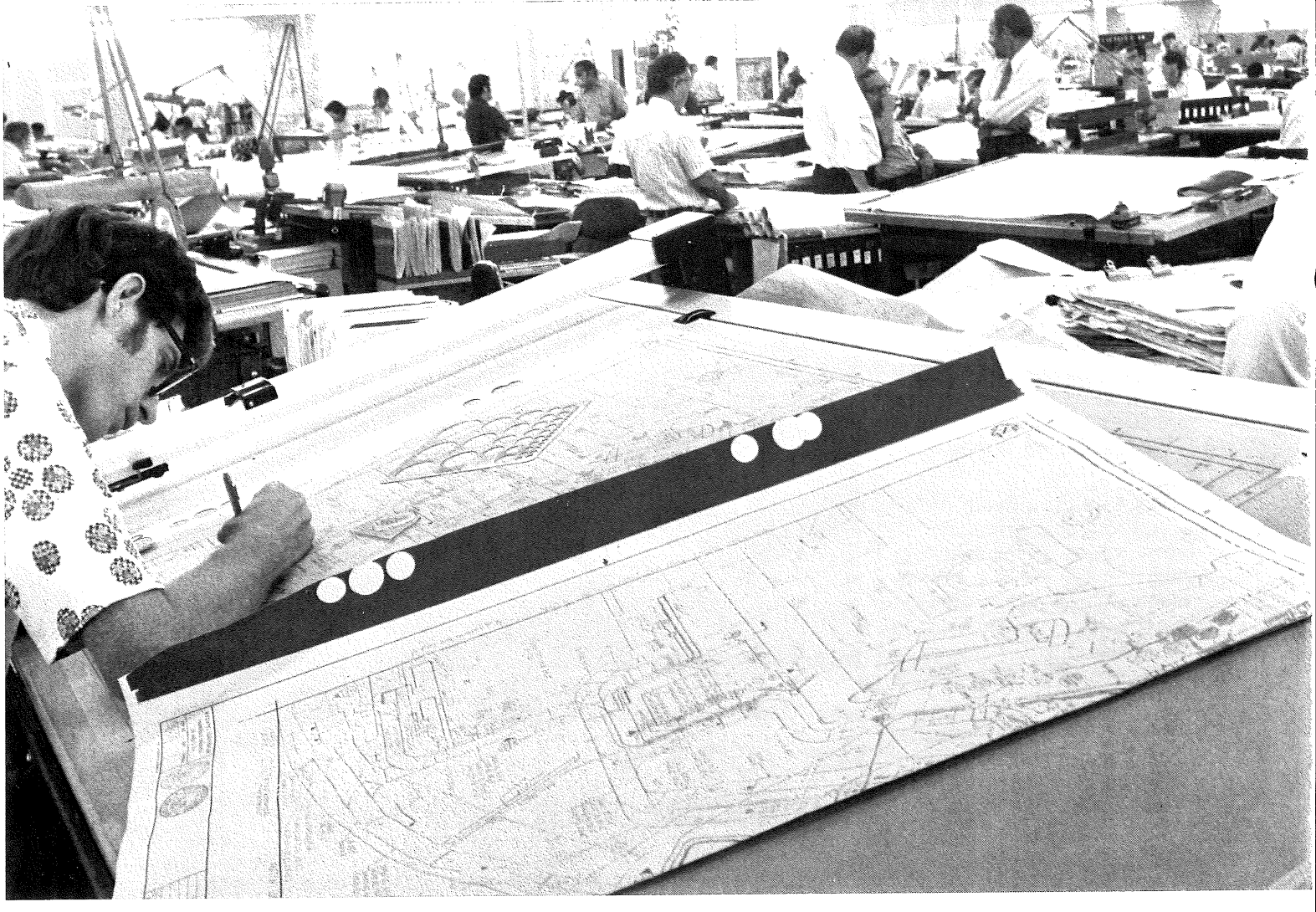
"You would take a car, bus or train to convenient parking and intercept points, just outside the center city. Then you would transfer to a horizontal elevator that comes by every two minutes or so, or is 'on-call' like a vertical elevator."

The rubber-tired cars — either singly or in trains — would roll along elevated guideways of a mile or two or less with stops in and around shops, offices, apartments or entertainment centers downtown. The door would open automatically and passengers then would transfer to elevators, escalators or electric walks. Usually, there would not be an operator aboard.

Westinghouse officials point out the horizontal elevator is not new technology — it just hasn't been tested yet in an urban environment. For several years they have operated at speeds of up to 30 m.p.h. at the Tampa and Seattle-Tacoma airports, at the Busch Gardens theme park in Williamsburg, VA, and a dozen or so other locations.

Preliminary studies of the applications of people movers to downtown areas have begun in Cleveland, Houston, Los Angeles and St. Paul, funded as part of a $220 million matching grant announced by the Department of Transportation in





Bechtel draftsmen use plastic pencils on Mylar to produce drawings which must meet the strictest standards for microfilm legibility.

Aerial view of San Onofre Nuclear Generating Station Unit 2 and 3, scheduled for completion in 1982.

Reprodrafting for a nuclear power plant

by George A. Magnan

If there is any technological field existing today which poses a critical challenge to the state-of-the-art of engineering documentation, it is the design and construction of nuclear power plants. According to Don Thorpe, Bechtel Power Corporation Senior Project Administrator responsible for all engineering documentation on the San Onofre Nuclear Generating Station Units 2 and 3, nuclear power plants are a "whole new ball of wax."

To a much greater extent than ever before, the industry has to prove and justify the safety and validity of its engineering design at every step. This means clear documentation records of every phase dating back to day 1, Thorpe asserts.

In 1968 there were about 12 Nuclear Regulatory Guides governing the design and construction of a nuclear power plant; by 1976 there were 212. Since then, about a hundred have been added. ERDA and the Federal Nuclear Regulatory Commission plus several state agencies also have generated their own regulations and specifications which must be strictly adhered to. This has led to a significant increase in the complexity of system design for the plant, which has generated a tremendous increase in documentation. Because of the need for constant legibility, both during design and construction and of course for the life of the plant, Bechtel has developed a program for achieving an overall quality and thoroughness in documentation that Thorpe considers unprecedented in the industry.

Pioneer in nuclear plants

Bechtel's Los Angeles Power Division, located in Norwalk, California, is the Engineer/Constructor for SONGS 2 & 3 owned by the Southern California Edison Company and

M A R I N E D R I V E N O R T H

A Brief Visual Analysis and Report
on the
Property
Lying to the North of Marine Drive
on the Campus of the
University of British Columbia

B. J. Elliott
M. R. Gardner
J. Peepre

INTRODUCTION

In 1973 it was agreed between the Vancouver Board of Parks and Public Recreation, the Board of Governors and the Administration of the University of British Columbia that: "The area surrounding the Museum of Anthropology and the Anthropology and Sociology complexes will be developed with a view to maximizing the public use of these outdoor areas in as natural a setting as possible."

In July of 1974 the areas were assigned to the Botanical Garden who were at that time charged by the Board of Governors with future management and development of the site. Budget constraints have limited the available resources for extensive examination and development of the site by the Garden staff. However, recent concerns regarding the general appearance of the site appear to have renewed interest in a comprehensive plan for the site as a whole.

As one part of such a review and plan, a brief and limited inventory and analysis has been made of the present visual integrity, circulation, safety, and condition of the site. This analysis has been followed by the development of possible restorative measures and some proposed implementation mechanisms. The study scope was limited at the onset, in the initial terms of reference, by excluding the Graham House School of Social Work and Cecil Green Park properties as well as the shoreline and cliff areas from the study area. In addition, it has not been possible in the time allotted to prepare a proposed budget for expenditure which would be incurred if the suggestions made here are implemented.

The following points are presented in short form in the interest of brevity and clarity.

The Study Area

All of the property between the blacktop of Marine Drive and the cliff top to the northwest and bounded on the easterly edge by Cecil Green Park Road and to the west by the old Marine Drive road. Situated on the study area are

(i) Mary Bollert Hall Building
(ii) The Anthropology and Sociology Complex
(iii) The Museum of Anthropology
(iv) The Totem Park Building
(v) The House Management Building
(vi) The Botanical Garden Office

The Process

The area was studied using three general topics for inventory and analysis. These general topics were:

(i) Visual character
(ii) Circulation
(iii) Function

The inventory endeavoured to determine specific problem areas and assign them to one of the general topics which the analysis endeavoured to provide specific remedies. However, from this presentation of the process it should not be infered that the writers were not constantly aware of the necessity to establish the unity of the site as a single entity and to provide a uniform character in keeping with the original objectives outlined in the attached Appendix A. At the same time there was a conscious effort to ease the long term maintenance expenditures in order to make the suggestions practical and to limit the capital expenditure to those seen as essential for serious improvement of the site.

Before detailing the specific problem areas it is worth noting that the study team drew some initial impressions of the site which tended to be reinforced as the study progressed. The general impressions might be stated thus.

(i) The site lacks clear definition of sequence and space
(ii) The site lacks identity as a whole and sense of space within specific location
(iii) Initial impression of the site from the highway is dominated by car parking on the site
(iv) There is no clearly defined hierarchy for circulation
(v) The density, variety and placement of signage on the site provokes a cluttered effect.
(vi) The original design of the site makes subsequent maintenance extremely time consuming

Visual Character

Identified problem area	Suggested remedy
Car parking in Student Lot E is discordant, disorganized and unsafe.	Screen widen and resurface Cecil Green Road Car Park.
Car parking for Bollert Hall etc. is open and provides a discordant visual impression of the museum site.	Extend the screening from Cecil Green Park Road to the existing entry way of the car park in the same density as the continuing strip.
Buses park for long periods in front of the Museum.	A revised parking area or procedure should be considered.
Bareness of the Anthropology complex from the rear.	Foundation planting.
Institutional character of Anthropology complex from the rear.	Removal of the tall fence.
Poor visual impact of the cliff top fence.	Sandblasting, spraying with dark paint and over planting with native rose species.
Cluttered effect of signage.	A full examination of need, style and density.

Visual Character (cont.)

Identified problem area	Suggested remedy
Inappropriate and unnatural appearance of wooden garbage cans.	Repainting with "soft" finish.
The staff parking to the east of the Museum is visible from the interior.	Re-surfacing, widening and screening.
The views to the Sea and the North Shore are curtailed by the cliff top vegetation.	Limited removal or clipping of vegetation should be considered.
The view to the North Shore from the Museum is interupted by the original berm design for the pond.	The berm should be lowered and contoured to a more natural form.
The large screening berm for the Museum complex are ragged and difficult to maintain. They are ecologically unstable.	Low growing shrubs native to the indoor environment should be established to retard tree succession.

Circulation

Identified problem area	Suggested remedy
Safety for pedestrian crossing of Marine Drive and entry to the site must be improved.	Clear pedestrian entry ways into the site, not utilizing the parking entries and exits should be established opposite each main Campus footpath A full width herbed sidewalk should be constructed on the north side of Marine Drive from West Mall to Cecil Green Road.
The entryway to the Museum appears unkept and allows passage accross the ferns and plantings.	Revision of berm step interface and pedestrian control on the west side of the entryway, possible seating provision.
No simple access to Nitobe Garden from the site.	Establishment of a path, exiting on Marine Drive opposite Nitobe Garden.
Present paths to the rear of the Museum are undefined.	Bark mulch and possibly salal edging for a full circulation pattern as shown on the plan.

Function

Identified problem area	Suggested remedy
The utilization of exterior space is limited and not meeting the original management objective for public utilization.	Four thematic plantings emphasizing the Indian culture and utilizing of plants should be established on the circulation system.
The "roof top" gardens are not suitable for maintenance.	Establishment of salal or other suitable ground cover as mass plantings.
The Museum parking has a poor pedestrian vehicle interface.	Provision of pedestrian walkway at the rear of each parking buffer.
The Museum parking is evident from the main road, especially in fall and winter.	Strengthen the present tree screen with conifer and evergreen shrub planting.
The present cliff top is accessible from the site.	The safety fence should be rewired and extended to meet the Botanical Garden property beside the existing tennis court.
The maple tree on the berm to the rear of the Museum is in poor health.	The tree wall should be re-constructed and the tree given root feeding.
The present path for emergency and maintenance use are poorly designed allowing gravel to migrate into grass areas. The odd square shaped edges cause wheel rutting.	Re-alignment and edging of the road.
No adequate definition exists at the Cecil Green Park exit, the staff entrance for the Museum and the end of the Student Parking Lot.	A simple roundabout, turnaround should be considered.
There is no direct entrance to the museum for invalid persons.	Review of the problem.

Implimentation

Responsibilities: The Botanical Garden as lead agency. As such will designate and co-ordinate all responsibilities for site (does not include Buildings) development, improvement and repair.

The Botanical Garden will be responsible for organizing, calling and chairing a new Marine Drive North Co-ordinating Committee.

The Botanical Garden will be responsible for developing a long term management plan for the site including the School of Social Work and Cecil Green Park properties and the cliff and shoreline areas.

The Botanical Garden must solicit imput for such a plan and consider membership on the co-ordinating committee from

(i) Museum staff
(ii) Physical Plant
(iii) Department of Highways
(iv) Vancouver Parks
(v) President's Office
(vi) Federal/Provincial Governments if required
(vii) Campus Landscape Committee (no dual membership to be allowed)
(viii) Anthropology and Sociology Administration
(ix) Mary Bollert Hall Administration
(x) Any other identifiable interest group.

*The Botanical Garden would use the Management Plan mechanism to assign agreed upon, ongoing responsibilities to other parties involved in the area management.

*The Botanical Garden would be responsible for preparation of the final Management Plan and Approval of this plan by simple majority of the co-ordinating committee would constitute full approval of the plan with the single exception of vito power by the President's Office. Appeal by any party would also be made to the President's Office.

*(Note: these suggestions are made in isolation from a full knowledge of the Administrative pressures and precedents already existing, they are, however, presented to indicate that some formulae would be required.)

The Botanical Garden would be responsible for preparation of working drawings, supervision and inspection of the final plan. Where possible construction work should be tendered.

Budget: the budget for both capital and maintenance expenditures should be prepared by the Botanical Garden as a distinct entity from other budget requirements.

The Botanical Garden should resolve the question of 1978 funding by a special warrant request if necessary.

Staging: A proposed program should be available for presentation to a first meeting of the suggested Co-ordinating Committee by the end of April 1978.

As quickly as possible, priorities for implementation should be established as appropriate by Committee Members.

The Management Plan for the area should be developed during 1978 and be in a position for final approval before the end of the current fiscal year.

APPENDIX A

DEC 1973

FOR IMMEDIATE RELEASE

The following statement was issued today (Thursday, Dec. 6) after a meeting between representatives of the Vancouver Board of Parks and Public Recreation and the Board of Governors and administration of the University of British Columbia:

"1. Construction of the University's Museum of Anthropology and the Anthropology and Sociology Complex will proceed as planned. However, the area surrounding the Museum and the Anthropology and Sociology Complex will be developed in consultation with the Vancouver Board of Parks and Public Recreation with a view to maximizing the public use of these outdoor areas in as natural a setting as possible."

(The $4-million Museum of Anthropology, designed by internationally renowned Vancouver architect Arthur Erickson, is now being built on the site of the former Fort Camp student residence on the northwestern fringe of the UBC campus. The Anthropology and Sociology Complex is adjacent to and east of the Museum site. It consists of three former women's residences, which will be renovated and linked together by a new structure.)

"2. In the part of the University campus between the present Marine Drive and the foreshore, southwest of the Museum of Anthropology, the University, in consultation with the Vancouver Board of Parks and Public Recreation will strive for the utmost public use consistent with a 'wilderness' condition as part of a shoreline natural preserve.

"3. The Vancouver Board of Parks and Public Recreation will award the contract to control cliff erosion at the base of the cliff as soon as possible."

(A sum of $350,000 has been provided by the provincial government as a one-time investment in a project to control sea erosion at the base of the Point Grey cliffs overlooking Tower Beach. The Parks Board Monday deferred making a decision to award the contract for the project until it had discussed the matter with UBC.)

"4. The University and the Vancouver Board of Parks and Public Recreation will share the ongoing costs of maintenance of erosion control measures at the base of the cliff, including public access to the beach areas. In this connection a joint committee has been struck to discuss these costs and proposed sharing arrangements for consideration by the two principals. This committee will also concern itself with the ongoing planning of the area seaward of Marine Drive."

For further information:

Contact T.A. Myers,
UBC Information Services,
228-2108

Areas assigned to Bot Garden by Board of Governors on July 3, 1974.

AN OUTLINE OF TWO CANADIAN VERTEBRATE PESTS IN THE FOREST SYSTEM

North American Porcupine
Erethizon dorsatum

and

Red Squirrel
Tamiasciurus hudsonicus

ABSTRACT

A profile is given of two ubiquitous vertebrate forest pests in Canada; The North American Porcupine, Erethizon dorsatum and the Red Squirrel Tamiasciurus hudsonicus. These two pests with cosmopolitan distribution were chosen from the group of fourteen major vertebrate forest pests in order to briefly assess their importance in the Canadian Forest system, to illustrate the magnitude of their impact, and to review the biology of the two animals. The changing pattern of forestry in Canada is discussed in the context of the overall importance of forestry to the Canadian economy. The types of damage inflicted on the various developing stages of the forest resource by all vertebrate pests is reviewed and the injuries caused by Red Squirrel and Porcupine noted in greater detail with appropriate references. A complete profile of each animal is presented after an outline developed by Sadleir (38) and including a review of the rational for classifying each animal as a pest, the specific nature of the damage, the biology of the pest and the response alternatives reported to negate or contain the impact of injury.

INTRODUCTION

The forests of Canada cover nearly half the country's total area. About one half of this forest land contains merchantable timber - 8% of the worlds total timber resource (59). Potential forest land is calculated as 805 million acres (61) of which approximately one million square miles are presently carrying productive forest. Stanton in a recent publication on Canadian Forestry (45) notes that the present annual demand for timber is 4.5 billion cubic feet which will rise by the year 2000 to 7.6 billion cubic feet. Present demand represents 2.25 million acres harvested annually. Since the mid 1950's active programmes have been pursued to replant cut-over areas; four million acres have now been artifically restocked and it is expected that this will rise to ten million acres in 1985 (59). It is estimated that 290,000 acres are planted annually with a further 60,000 acres directly seeded from collected seed. Greater emphasis is being placed on the genetic improvement of growing stock and much of the seed collected is from superior seed sources. In addition some 30,000 acres of forest plantation are being fertilized annually. In addition to the direct income from forestry and the employment which it provides, 250,000 people in B. C. alone (64) some 5.3 million dollars worth of christmas trees and some 13 million dollars of maple syrup products are produced annually (45).

In recent years recreational use of the forest has grown enormously as the mainly urban dweller seeks peace and pleasure in the countryside. There are now 28 national parks, one park reserve and 1,800 provincial parks across Canada, encompassing some 85 million acres of forest land utilized by some 42 million visitors in 1972 (62). Howard (24) however has noted that many urban citizens need a more enlightened outlook on man's relationship with wildlife and that an effort should be made to obtain a more objective treatment and training about wildlife and resource management in public education and school programmes, giving adequate attention to wildlife damage problems as well as

stressing the asthetic and beneficial values. Just as important it would seem is the need to stress the economic impact of vertebrate pests to the forest profession in Canada. Three indicators point to this conclusion; virtually all of the literature over the past 15 to 20 years concerning vertebrate pests in North American Forests is the work of researchers in the United States. In the last major Canadian survey (63) only 50% of the respondent regions mention vertebrate pests and the Canadian forest service unlike other countries (57) (65) has apparently no publications dealing specifically with vertebrate pest management. Perhaps one of the reasons for this, has been the difficulty in providing reliable data on economic losses caused by vertebrates, (24) although for one forest company in the American Pacific Northwest it has been estimated to exceed one million dollars annually (22). Certainly recognition of the problem has been more formal with the formation of a Forest Wildlife Problems Committee under the aegis of the Northwest Forest Pest Action Council. This group has been responsible for a handbook used extensively in this review (31). In addition in the early 1960's the American Wildlife Society formed a Committee on Economic Losses caused by vertebrates which was, along with other goals, charged with developing a standardized technique for measuring losses and values and for reporting such data (24).

Since the depression years of the 1930's, Canadian Forestry moved into a second phase - the cutting of second growth timber since most of the economic virgin timber had been completely depleted. The high cutting rates mentioned earlier in this paper indicate that a third major phase will be entered by the late 1980's; that of intensive forest systems. This will be the only way that Canadian Forestry, particularly in the west, can continue to be competative on world markets. As labour and processing costs rise there will be an increasing trend toward mechanization. In turn this will require the more specialized intensive land use associated with plantation forestry. Here the degree of vertebrate pest damage, perhaps tolerable in the open forest system, is unacceptable. Further the Red Squirrel and Porcupine are both vertebrates capable of inhabiting the climax forest thus perpretrating their damage through all phases of growth of the forest plantation from initial seeding to harvest of the mature timber. A more specific outline of the stages in plantation development is given in table II, but is briefly: cone and seed losses, seedling and sapling injuries and mature tree injuries. A complete review of the damage caused by all types of forest vertebrate pests is given in table III, while a definition of the types of damage, for example barking, clipping etc., is given in table I.

In summary then, the trend towards increased cutting of forest resources continues unabaited. Ontario for example has recently introduced a policy which will allow for 911 million cubic feet of timber to be cut by the year 2020. The challenge for forest regeneration is formidable. In addition to the 2.25 million acres of forest land harvested annually there is almost as much again lost to fire and there is an estimated backlog of 42 million acres inadequately regenerated in the Canadian forest system (45). In 1962 D. H. Janzen then Director, Bureau of Sport Fisheries and Wildlife U.S. Department of the Interior, noted that some of the most difficult damage problems in the forest system from the point of view of control are those related to the smaller mammals (27). It was noted however that it was with great difficulty that the

wildlife biologist came to any firm assertion as to the acceptable population levels for any animal. Research, was nevertheless being undertaken in three concurrent directions: effects of timber management practices on wildlife populations was being examined; methods of preventing wildlife populations from reaching pest proportions in the forest were being developed and a major programme was devoted to testing potential repellents in order to lessen vertebrate pest injury in high value stands without radically altering population balance. Sadly it appears that Canada is unwilling to embrace a similar coordinated management approach to what must be an existing and potential problem of considerable dimension.

The following is a synoptic report of Porcupine and Red Squirrel as important forest pests.

American Porcupine, Erthizon dorsatum

The American porcupine is considered one of the most important mammalian forest pests since it attacks both trees less than six inches in diameter at B.H. and merchantable timber (3). Complete girdling may result in the death of the tree, but even spot damage may seriously effect growth and timber value (18). Banfield (3) indicates that Ponderosa and Lodgepole Pine, Eastern White and Red Spruce are of prime importance while Eastern and Western Hemlock, Balsam Fir, Tamarack, Sugar Maple, American Beach and Baswood are all severely damaged. In addition Caras (8) adds to this list Cottonwood, Willow, Aspen, Jack Pine, Elm, orchard trees and their fruit. Peterson adds : White Birch as an important food source. Indirect damage includes the eating of wooden tool handles left in the wood because of salt attraction, the gnawing on buildings, picnic tables and latrines for the same reason. The chewing of rubber tires and also in forest recreation areas-the danger of pets being attacked and requiring veterinary attention for quills in the mouth (4) (8) (23) (36). Wood lot areas near agriculture can allow for porcupine harbourage and damage to corn, alphalfa and clover (18) and in recreational areas the pungant and annoying odor of urin (31) and the animals perchant for eating forest signs (60) further defines their pest status. Fletch writing on the infectious diseases of wild mammals in (10) indicates that porcupine may be a vector of foot and mouth disease.

While economic thresholds are poorly defined, some studies have attempted to quantify actual losses due to porcupines. Banfield, quoting a study from 1940 indicates 11.5 to 36¢ per animal per year damage in Maine, 45¢ to $1.10 in Colorado and a $1.66 in Montana. If we allow for a 480% inflation rate since 1940 (66) this provides a range of economic impact of $1.72 to $7.96 with a mean of $5.00. Banfield also notes studies indicating 6 to 8 animals per square mile in New Brunswick, up to 20 to 28 animals per square mile in Maine. If we take a mean of ten animals per square mile on one million square miles of forest in Canada, we have an indicated figure of some 10 million animals. This figure of ten million animals on 650 million acres corresponds well with the known animal habitat requirement of approximately 6.5 acres. This would indicate that porcupines may be responsible for up to 50 million dollars worth of damage in the Canadian forest system per year. In another study (30) in the Great Lakes region it was found that porcupine damage accounted for 20.8¢ per acre per year or 5.2% of the board feet growth and 8.3% of stumpage values. There is little doubt that damage can be severe (15 (63)

More specifically, direct damage includes barking injury to seedlings and saplings with broad prominent inciser marks in exposed sapwood and feeding on older trees which appears to be confined to the unplated bark of the upper bole where top girdling produces characteristic bushy crowns. There is also feeding on young full size trees, in particular Douglas Fir and, at denning time, branch cutting to feed young (31). Clipping of leaders, multi-leaders and stag heading along with bleeding of resin from wounds is also recorded (4). Exposure to disease and insects especially cankers and borers would seem likely. Costs are associated not only with loss of increment and top growth, but with reduced yields per acre and in younger stands labour and tree costs for replacement, and future management problems resulting from uneven stocking.

Specific damage thresholds are not readily calculated. In particular there seems to be some difficulty in obtaining exact figures on investment in plantations. Even ignoring the fixed costs associated with tasks outlined in Table II, and using only costs for seedlings and transportation (9), planting, and supervision (28)-there is approximately $75 invested in every site re-planted with 400 2 + 1 seedlings. The net disconcounted revenue on forest investments is relatively low ranging only from 1 to 3% (28). On a $75.00 investment 1% at 10 years equals $83.00 at 2% $91.00 and at 3% $101.00. The gain therefore at even the best rate of investment, is only $26.00. A damage rate of 10% in conifer plantations appears quite common (13) (30) but may rise as high as 90% (63). For such a small return on investment, it would appear that little damage at this level can be tolerated. However there is an obvious need for more detailed studies under Canadian conditions and on a wider scope before reliable figures can be developed.

The porcupine is the only member of a typically South American group of rodent that crossed the Isthmus of Panama during the Pleistocene era and invaded North America of its own accord (4). The Old World porcupine Hystrix belongs to another family, though illustrates convergent evolution.

Distribution in North America is from Northern Mexico to Alaska and from the Atlantic to the Pacific and in Canada all of continental Canada north to the tree line and in Northern Quebec, Labrador, Northwest Territories and the Yukon. The porcupine is not found in Newfoundland and Anticosti, Prince Edward Island, Cape Breton, Grant Manon or Campobello Island in the East or on Vancouver Island or Queen Charlotte Islands in the west (36) (4) (33) (8).

Porcupine belongs to the Order Rodentia and suborder Caviomorpha. It is in the family Erethizontidae and is of the species Erethizon dorsatum. There are four sub species whose name and distribution is given in Figure I. Common names include porcupine, porky, quill pig, and in French, Pore-épic.

Subspecies dorsatum is the typical form in Eastern Canada and is found also in the Prairies east of the McKenzie River and in the Northwest Territories. Epixanthum is found in the short grass areas of Alberta and Saskatchewan and has paler greenish yellow tip guard hairs than the cream tips found in dorsatum. Myops is brownish colour with long rusty yellow tipped guard hairs and is found in the Yukon, west of the McKenzie River, northeast B. C. and northwest Alberta. Nigrescens is blackish hair with rusty yellow tips and is found in B. C. and the Rocky Mountains (4) (34). Comments on habitat appear to differ,

Banfield notes that the animal is found in both deciduous and coniferous forested areas. In summer it may be found far from trees in Eastern farm land. Mc T. Cowan and Lawrence note that it is rarely found in the Coastal Douglas Fir forest. It is however abundant where there is broken rock and cliffs which occur with Pine forest. Caras also add Poplar woodland to common porcupine habitat.

Caras in describing the porcupine, gives it as a flat footed, deliberate, robust, short legged, clumsy rodent. It has a small head, short ears and beady eyes, its muzzle is blunt and his tail short and muscular. The animal is reported to have good hearing and smell but poor eyesight. His fur is long, soft and wooly, he walks with a shuffle leaving pigeoned toed tracks. Banfield notes that his Pelage is composed of sensory hairs with a dense wooly brown undercoat, long cream tufted guard hairs and stiff quills. The hairs are arranged in transverse rows, the quill rows are separated from the rows of coat hairs. Quills are located on head, neck, rump and tail, the longest is about 60 millimetres, the shortest 30 millimetres. The quills are easily pulled out and may grow one half a millimetre per day and may be replaced in ten days to four months. The tip has a backward projecting scale preventing withdrawal and may cause the tip to work inwards in flesh. There are about 30,000 quills per animal. Ventral surfaces and legs are coated with hair, the underbelly with soft down. Coat hairs are moulted annually between Spring and late Summer from nose to tail. Broken quills can be shed. The short strong legs are equipped with long curved black claws, four toes on the forefeet and five on the hind. Soles of the feet are flesh
Albino porcupines occur fairly often.

The porcupine is Canada's second largest rodent after the beaver. Its weight is given by Banfield as 11.2 kilograms and a length of 91 centimeters as against 18 kilograms and 101 centimeters by Caras and 10 kilograms and 78 centimeters by Mc T. Cowan. These differences may accounted for in the different sub-species. Hind foot is noted by the the latter author as 9.8 centimeters.

The behaviourof porcupines appears relatively well documented. It is noted as a solitary and cantankerous animal which pairs only for mating, it has dens or ground shelters particularly in winter. Rocky tallus slopes, quarries, caves and rocky road fill appear suitable denning sites as do road culverts, hollow logs, brush piles and wind blown trees. One author (34) notes that the base of trees with branches to the ground are often used. Snow tunnels appear common in the winter (4). Porcupines can climb extremely well (20) and will swim without effort (4). They are primarily nocturnal and spend much of the daylight hours resting in loafing trees, normally a bushy confier (31). They are active throughout the winter (4) (8) (23) (31) (36). The front teeth keep growing and actively need to be worn down (8). The porcupine is an easy animal to approach. When threatened it puts its unguarded snout between its forelegs often near a log or rock, lowers its body, arches its back and spines, and moves around to keep its rump towards an enemy. It can lash its tail leaving quills in the attacker (4) (8) (36).

Home range appears to be from five to six acres although some animals may wander considerably further, 30 acres in a 30 day tag study being recorded (4). It is common for porcupine to have regular paths to and from feeding areas (8).

Most authors note that there are marked seasonal changes in the feeding patterns of porcupine. In summer Banfield notes that leaves of the yellow Pond Belly, Aspen, White Birsh, various shrubs and forbes are consumed. In winter the cambium of all species and new twigs and buds are eaten while in the spring unfolding Poplar and Baswood leaves and branches are consumed. Caras specifically notes the Cottonwood twigs as winter food. Lawrence notes that in spring and summer suculent herbaceous vegetation is consumed and porcupines are attracted to moist meadows and stream banks. In Fall and Winter the bark and foliage of conifers preferably Ponderosa and Lodgepole Pine but White Fir, Sugar Pine and Juniper are also eaten. Taylor (48) indicates that Douglas Fir and Spruce may be injured while this author and Horn (26) note that dwarf Mistletoe is sometimes eaten.

Eadie in a comprehensive study of the porcupine in 1954 notes that the animal has a large daily food requirement approaching 10% of its body weight (13) which equates to 2.7 to 3 pounds (.3 to 1.3 kg.) per day. If the same rough figure of 10 million animals in the Canadian forest system is used this is equivalent to 5,000 tons of green matter a day using a median one pound consumption rate per animal. Even assuming that most summer feeding is not on woody plants this is still a considerable impact on forest productivity. Banfield also notes that there is a high demand for salt, already mentioned under damage and bones and antlers found on the ground are consumed for mineral content.

Mating occurs in November and December according to Banfield and September to December according to Lawrence. Patterson favours November and December but notes that mating may take place in January or April. Mc. T. Cowan records November as the principal month in British Columbia. There is a highly developed mating ritual and females may mate with a number of males, however it appears that males require prolonged association with the female before mating and are normally restricted to one female per season (4). Gestation data is quite varied, Mc T. Cowan indicating 112 days while Paterson, Caras and Banfield give figures of 209 to 217 days. The weight at birth according to Banfield is .53 grams while Patterson extends this up to 1.5 kilograms. Length is on average 22 to 28 centimetres. Birthdate is mainly mid May to the end of July or in later conceived young October. There is normally one and rarely two offspring.

Young porcupines are unique among Canadian rodents, born at an advanced stage of development and are precocious. Eyes are open and they can walk within an hour of birth. The young are covered with long black hairs and 10 to 25 millimetre quills which although soft at birth harden within an hour. They are playful but exhibit defense turning very quickly. Banfield indicates that weaning takes place after two weeks however Peterson indicates nursing may continue up to four months and Caras up to five months. Sexual maturing for both males and females appears to occur between two and two and one half years old.(4) (34)

Population studies by Spencer (67) indicate that porcupine populations have fluctuated in past centuries in the Central United States. There were population explosions well documented by Dendrochronology in 1845, 1885, 1905 and 1935. Earlier population increases are indicated for 1716, 1746, 1785 and 1815.

The population density of porcupines have been reviewed by a number of authors (4) (8) (18) (23) (30). On average there appears to be something in the order of ten animals per square mile each with a home range of five to six acres. Diurnal movement is about 80 metres and nocturnal movement up to 130 metres.

Mortality is not great. Porcupines exhibit a high ratio between conception and Embryonic survival indicating few complications occur during pregnacy. This is coupled with a high post natal survival rate and precocious young contribute to the high biological potential for porcupines dispite their low birth rate (18). Banfield gives a life span of eight to ten years and Caras five to six years. Natural predation includes the large carnivors Wolvarine, Fisher, and Bobcat all of which may search for winter denning places and have developed the skill to turn porcupines over to avoid the quills. Caras notes that when other food is unavailable wolves, coyote and foxes may also attack porcupine.

Control programs in Canada are poorly recorded and as is often the case those programs noted (4) (18) have concentrated on chemical elimination of the problem. Biological control is not recorded by any authors but perhaps could be investigated with the use of palatetable herbaccous or woody plants interplanted in single species conifer plantations. Physical control seems to have included clubbing; shooting-where it is suggested that after sunset; along forest roads is the most successful denning and electrical fences (4) (8) (18). Denning would appear to be a fairly successful method as the winter dens are readily identifiable (19). The electric fences are suggested only for the potection of agricultural problems (8). Two chemical control methods are recorded (4) (18) and appear to have been relatively successful. One has involved using strychnine in a salt bait and the other sodium arsenite in apple baits. No integrated management methods are reported in the literature and cost effectiveness of any method is poorly reported. A report from Oregon (56) indicates that poison baiting of porcupines has not been particularly successful since the animal prefered to chew the plywood structure used to protect the bait rather than eat the bait itself.

The benefits from porcupine appear to include the use of quills for decorative work their providing food for desireable carnivors; some thining of weed trees; such as Balsam and Poplar.

There are, as is so often the case, no cost/benefit analysis covering the impact of this animal on the productive forest system.

Red Squirrel, Tmiasciurus hudsonicus

The damage caused by red squirrels may be seen in two catagories: that of cone and twig cutting, and girdling or barking injury to the upper bole of mature trees. Lawrence (31) notes that conifer seed is the principal food of red squirrel especially during winter months. Heavy cone cutting in late summer in order to store cone crop may result in as high as 85% of the current cone crop being removed and 9% of all developing cones being taken before they have the opportunity to mature Squillau (47). Lawrence notes that there are considerably more twigs cut and eaten, while Lutz (33) records cutting of branches on Black Spruce. Adams (2) reports bark and branch tips cut from Ponderosa Pine which also destroys developing cones. Schmidt (39) records red squirrel as taking 66% of mature cones in the Ponderosa Pine forest, while Smith in a quite detailed study (43) indicates that a single squirrel may cut between 12 and 16,000 cones in a normal heavy crop year. Brink (7) indicates 144 cones being cut per squirrel per day from Picea glauca in Alaska. Zaitsev (54) in a study on a European squirrel species notes an 80% destruction of Larch cones.

In the second class of damage; that to mature trees, Viidik (53) noted decapitation of the leader and branches of the first Whorl or in some cases removal of lateral buds. Lawrence noting that much of this damage occurs in the 20 to 60 year age class, states that considerable damage can be sustained by Douglas Fir and Ponderosa Pine, that small strips of bark may be removed in order to lick the sapwood or completed girdling may take place. This later damage can be confused with that of porcupine.

In addition to direct damage to the forest resource a number of indirect problems or potential problems occur. As far back as the mid 1800's squirrels extracted a considerable toll on nursery stock especially Spruce (17). In hardwood or mixed forest there is the problem of disease introduction after winter or spring feeding especially in Maple where virulent canker may later result (41) and in Oak where a wilt fungus may be transmitted by the animal (16) An important side effect of feeding preference in red squirrel on fertilized plantations is discussed by Asher (1) which could have significant impact on forest management practice in the plantation forests (see also Straton) (45). In recreational forest areas squirrel can cause damage to camping food, clothing and bedding (4) but more importantly may be the vectors for western and eastern equine encephalitis (10) and in the Sierra Nevadas at least, as a carrier Bubonic plague. For example a park directive dated August 1976 lists five precautions of which the first suggests to avoid all contact with squirrels, including not feeding the rodents, and the fifth "should one become ill within one week of visiting a park, a physician should be immediately contacted." It is thought that such advise can only but depress park attendance. Finally red squirrels exert some preda ion pressure on smaller forest wildlife and in particular gamebird eggs and broods may be effected.

The red squirrel belongs to the order Rodentia and the family Sciuridae which includes five species of chipmunk, one woodchuck, three marmots, five ground squirrels, one black tailed prairie dog, three regular squirrels and two flying squirrels. The red squirrel however belongs to a separate genus than other squirrels and has two closely related species-the red squirrel Tamiasciurus hudsonicus and the douglas squirrel T. douglasii. The North American red

squirrel should not be confused with the European red squirrel Sciurus vulgaris leucourus. North American red squirrel is a highly plastic species which has been divided into 15 geographic sub-species across its Canadian range as outlined in Table II.

The habitat of the red squirrel indicates that it is more versatile than the grey. Boreal coniferous forest is its principal habitats and it is one of the few mammals to inhabit climax conifer forest. Preference appears to be for mixed forest with White Pine and Hemlocks on cooler north facing slopes (4) However it is found in the Eastern hardwood deciduous forest (36) and in immature hardwood forest (32). On the westcoast it is common throughout the Ponderosa Pine and Douglas Fir cover types (31) (35) (68).

Distribution in North America includes the broad forested belt from Atlantic to Pacific, south in the Rocky Mountain region almost to the Mexico border It does not occur in the south of Manitoba or the southeast of Alberta nor in the central plains or deep south of the United States (4). As noted before it has 15 Canadian sub-species which differ in size, length of tail and colour.

Peterson provides general descriptions as follows: a rusty olive tail with bright yellowish, orange rusty or deep red tips of long tail hair which is white to pale orange. In winter there is a reddish band on the back and tail. Also in winter the black line on the side separating the upper and lower body colours is lost. Feet are bright reddish in summer with thin hair turning heavy grey in winter. Mc T. Cowan indicates that upper parts are grey to olive brown with a reddish wash heaviest along the mid line. Under parts are white to greyish white. Tail is as long as the body, flatish but bushy. The tail upper colour is the same as the body while the lower side is lighter, tips of hairs in the tail are black sometimes the tail tip is black. There is again a black line bright in summer which separates body colour. Ears in the winter have pencils of hair from the tips. Banfield in a more detailed description opens with a notation that there are black vibrinae prominant on the side of the nose, eyebrows and cheeks that are also tactile hairs on the forearms and abdomen. The main coat is glossy olive brown flecked with white with the back of the ears cinnamon, white eye rings and black flank strip separating the body colours. The tail is rufous red with black subterminal black border and tips and grizzled grey. Ear tuffs identify sub-species and may be red or black. The normal palage in winter produces longer more silken fur with a thick leaden grey to buff tipped undercoat. Albinos, part albinos and melanisic types are recorded.

There are two annual moults from March to July starting at the nose and feet working towards the rump; in most individuals this moult will take two months either April, May or May, June however pregnant females will not moult until late Autumn. The second moult occurs in August to December lasting only one month starting at the tail, which only moults once per year, moving from the rump to head and lastly to the feet (4).

Description of size and weight though differing among the sub-species is reported by most authors to be in the range of 350 to 400 millimetres for length (4) (8) (31) although Mc T. Cowan notes the British Columbia sub-species columbiensis - to be somewhat smaller in the range of 300 to 320 millimetres with a tail length of 125 millimetres Hind foot is recorded as being 50

millimeters in diameter. Banfield notes a similar length for tails and 25 millimeters for ears though this varies depending again on sub-species. Weight of a full grown adult which does not appear to differ between males and females ranges between 140 and 250 grams. The head is short and broad, there is a thick glandular area around the anus where two orifices can discharge a musky fluid used for marking (4).

Movement of the animal is, surprisingly, rather poorly documented by Caras indicated that the animal will normally be found within 200 yards of a single nest tree and over a season may range over an area of some five square miles. Other authors (55) (32) indicate the home range to vary from 2.73 to 6.03 acres. Density is reported to be from 0.28 to 1.85 per acre depending largely on food availibility (4) . Various authors indicate that the squirrel normally dens alone except in extremely cold weather, it is normally a solitary animal intolerant of strange individuals of its own or other species. It exhibits fierce territoriality at feeding station and dens however, it may form a (loose attachement) during the mating season.

Inhabit

The red squirrel is recorded as being a bold inquisitive animal, an extremely agile climber able to travel up to 15 miles an hour both up and down the trunk of trees. Further, it both hops and walks on the ground and can leap some five feet if startled. It is quite at home in the trees where it is judged to be the most arboreal of the squirrels being able to jump up to 15 feet and drop from heights of 30 feet without injury. (34) (8) (4) (36) The red squirrel is generally durinal but may be out in moonlight nights in summer and autumn. During the day it may sleep or sun itself in high branches though seek shade during high sun. It dislikes, cold, rain, snow and high wind (8). The tail is extremely sensitive to wind currents and is used for balance, for shade or for heat in cold weather (8). It has an extremely keen sense of smell, sight, hearing and can swim strongly (4). Activity peaks occur two hours after sunrise and just before sunset with the balance of the day being spent sleeping or basking in the sun. Winter activity is restricted to only the warmest part of the day (8) and the animal does not hibernate (31) (8) (4).

Nests, probably called drays, are constructed both for living and reproduction. Finely shredded plant material is used to line burrows, cavities in trees or on sheltered basil branches within six to eight feet of the trunk (34). Caras notes that hollow trees are often used while Peterson suggests that nesting in trees is more common only in the south of the red squirrels range. Banfield indicates the use of tree cavities, woodpecker holes, birds nests, rock piles, fallen trees and from five to sixty feet above the ground in living trees. The dray is normally up to one foot in diameter with a five inch cavity in the inside. It may only be used in the summer in northern parts of the squirrel's range in Canada. In this situation long winter tunnels may be constructed at ground level.

Feeding of the red squirrel is most varied. Lawrence includes fungi, berries, buds and bark of conifers, branch tips, ripening pollen buds and of course conifer seed. Peterson includes cones, nuts, buds, flowers, fruits, mushrooms, sap, other herbaceous plants, insects, small birds and eggs and small mammals. Mc T. Cowan also specifies leaf buds of Poplar and Birch and dead flesh while Caras suggests corn and commercial berry fruits. Banfield concurs with these authors and notes that the poisonous Sly amanita mushroom may be eaten with immunity and that mice, voles and young cottontails may be predated. Of the conifers White and Red Spruce, Balsam Fir, Douglas Fir, Hemlock, Larch and Cedar are included in the conifers and in the hardwood forest nuts, catkins, and slashing of bark especially on Sugar Maple is reported. Other authors (3) (7) (35) (39) (43) (46) (54) (68) list a variety of different conifers severly attacked. A most interesting indication came from the review of feeding literature, in that five authors (1) (14) (45) (53) indicates that there is very distinct preference exhibited in squirrel feeding. Edlin for example indicates that the squirrel is able to judge when seeds are ripe and that unripe or infertile cones are not attacked. Smith and Viidik indicate that specific trees are more susceptible to attack. It would seem that the squirrel has the ability to maximize its energy budget. In mid summer cone collection starts with climbing to the crown and cutting of terminal twigs that have green cones. These cutting sautes will last up to two hours and from ten to 100 cones will be allowed to fall to the forest floor. These are then cached in piles from one to many bushels, up to four yards in diameter and a yard in height. These middens are normally in a damp place so that cones do not open and disperse the seed before the squirrel can eat it. Food consumption is given by Caras as 100 pounds of food a year which is approximately four and one half ounces per day. Repeated attempts have been made to obtain figures on the value of forest seed but without success in time for this paper (25). It is known however, that Hemlock produces 0.61 kilograms of seed per bushel, Douglas Fir 0.52 , Lodgepole Pine 0.18 and Spruce 0.45. By knowing the number of bushels cut by and individual squirrel and population density it would be possible to calculate an approximate loss per acre figure, however, in terms of total consumption if it is assumed that there is only one squirrel per ten acres on the 650 million acres of the forest land some three and one quarter million tons of food per year would be consumed.

In the southern part of its range the red squirrel is polyoestrous with oestrus occuring in February, March and again June or July in northern Canada, however, only one litter is born per year. In the male the testes develop in February and then the animal is in breeding condition until August. The testes are withdrawn from September to mid January. Mc T. Cowan indicates that April is a common mating month. There are mating chases as with other squirrels (8) (4) (31). Births seem to predominate in the months of April, May and August, September, jestation is 40 days and litter size from one to eight. The newborn are altricial, virtually hairless, toothless, and with the eyes closed for the first month. The first hair appears at seven days and well defined by ten days. The external meatus of the ear develops in 18 days and by 38 days the young can play together. They are weaned at seven to eight weeks and appear outside the den by ten weeks old at which time they are about one third grown. The young squirrels will train with the mother for up to 18 weeks and then disperse (4) (49). The young have a soft rufous coat which they moult at the age of 11 months. They are sexually mature as yearlings.

The newborn are 65 to 75 millimetres in length and five to eight grams in weight (4). Young born in spring may spend the summer with the mother or in the case of fall born young have a complete winter (8).

Predation plays the most important role in the control of squirrel numbers as conversely the squirrels do in the population of predators. As one of the most abundant herbibores the squirrel is preyed on by Redtailed, Red Shouldered, Broadwing and Cooper's hawks. In addition the Goshawk, Sparrow, and Marsh Hawks may also take small squirrels. The Barred and Great Horned owls may prey on squirrels especially at dusk. The marten, fisher, bobcat and linx are predators of the squirrel in trees while weasel, coyote and wolf will attack the animal on the ground. In many areas vehicles take a heavy toll on squirrel populations. Man is also a direct predator mainly for the fur bearing industry. The squirrel has developed extremely good eyesight and the defense reaction of freezing on a tree so that its movement does not draw attention. Its life span is given variously from eight to ten years however Caras indicates that 50% of all young squirrels do not reach their first birthday.

Not withstanding the considerable toll in the forest crops the squirrel does have some important benefits; it is credited with consuming many forest insects and by providing some reforestation by leaving seeds in the ground in caches which are not eaten. It provides an important buffer prey species, removing predator pressures from other more desireable species. It has provided food and "sport" in the field of recreation and is used fairly extensively for lining and edgings of winter clothing especially in the north. In 1971-72 390,884 pelts were sold at an average value of 54¢ which equals $217,971 (4).

Responses in Canada to squirrel population are not well documented in the literature. Certainly modification of habitat does not seem a likely or profitable persuit since the animal is extremely adaptable. It may be that control measures are only warranted in high value crops; some plantations, seed orchards, and Plus Tree seed collection sites. Specimen trees may warrent some protection. The types of control include the encouragement of habitat for predators and perhaps research into natural disease mechanisims which control red squirrel populations. Coccidiousis is certainly reported to have controlled squirrel populations in Europe (52). Physical controls include live baited traps (57) the Imbra trap (42), the common Havahart trap and tree bans which expand with the tree and when attached to the trunk preclude climbing (29) (70). The common practice in Europe has been drey-poking (42) however this may not be particularly successful in Canada where ground burrows form a significant proportion of the nesting sites. Chemosterilants are not mentioned in the literature and surprisingly only one repellant (58) is reported. The most common method of reducing squirrel populations has been shooting the animal, often supported by bounties (37) (42) (50) (51). In the past very substantial numbers have been taken by this process. For example in the period 1903 to 1933 in Scotland the Hyland Squirrel Club shot some 82,000 European Red Squirrels (45). In the United States where squirrel hunting has been popular, records indicate that over 2 million squirrels were killed in one season in North Carolina on an area less than 52,000 square miles while in West Virginia the numbers killed range from 750,000 to 1,500.000 (51). These later programs were however directed to the grey squirrel.

In Canada where there is history of extensive squirrel shooting it could be expected that such policies would be publically unpalletable. In fact their usefullness is probably suspect. Without better definied economic criteria it is not possible to form any reasonable conclusions. It can however be said that squirrel do present a potential problem in high valued crops and that this potential will increase with the continuing trend toward intensive forest systems.

AN OUTLINE OF TWO CANADIAN VERTEBRATE PESTS IN THE FOREST SYSTEM

North American Porcupine
Erethizon dorsatum

and

Red Squirrel
Tamiasciurus hudsonicus

ABSTRACT

A profile is given of two ubiquitous vertebrate forest pests in Canada; The North American Porcupine, Erethizon dorsatum and the Red Squirrel Tamiasciurus hudsonicus. These two pests with cosmopolitan distribution were chosen from the group of fourteen major vertebrate forest pests in order to briefly assess their importance in the Canadian Forest system, to illustrate the magnitude of their impact, and to review the biology of the two animals. The changing pattern of forestry in Canada is discussed in the context of the overall importance of forestry to the Canadian economy. The types of damage inflicted on the various developing stages of the forest resource by all vertebrate pests is reviewed and the injuries caused by Red Squirrel and Porcupine noted in greater detail with appropriate references. A complete profile of each animal is presented after an outline developed by Sadleir (38) and including a review of the rational for classifying each animal as a pest, the specific nature of the damage, the biology of the pest and the response alternatives reported to negate or contain the impact of injury.

INTRODUCTION

The forests of Canada cover nearly half the country's total area. About one half of this forest land contains merchantable timber - 8% of the worlds total timber resource (59). Potential forest land is calculated as 805 million acres (61) of which approximately one million square miles are presently carrying productive forest. Stanton in a recent publication on Canadian Forestry (45) notes that the present annual demand for timber is 4.5 billion cubic feet which will rise by the year 2000 to 7.6 billion cubic feet. Present demand represents 2.25 million acres harvested annually. Since the mid 1950's active programmes have been pursued to replant cut-over areas; four million acres have now been artifically restocked and it is expected that this will rise to ten million acres in 1985 (59). It is estimated that 290,000 acres are planted annually with a further 60,000 acres directly seeded from collected seed. Greater emphasis is being placed on the genetic improvement of growing stock and much of the seed collected is from superior seed sources. In addition some 30,000 acres of forest plantation are being fertilized annually. In addition to the direct income from forestry and the employment which it provides, 250,000 people in B. C. alone (64) some 5.3 million dollars worth of christmas trees and some 13 million dollars of maple syrup products are produced annually (45).

In recent years recreational use of the forest has grown enormously as the mainly urban dweller seeks peace and pleasure in the countryside. There are now 28 national parks, one park reserve and 1,800 provincial parks across Canada, encompassing some 85 million acres of forest land utilized by some 42 million visitors in 1972 (62). Howard (24) however has noted that many urban citizens need a more enlightened outlook on man's relationship with wildlife and that an effort should be made to obtain a more objective treatment and training about wildlife and resource management in public education and school programmes, giving adequate attention to wildlife damage problems as well as

stressing the asthetic and beneficial values. Just as important it would seem is the need to stress the economic impact of vertebrate pests to the forest profession in Canada. Three indicators point to this conclusion; virtually all of the literature over the past 15 to 20 years concerning vertebrate pests in North American Forests is the work of researchers in the United States. In the last major Canadian survey (63) only 50% of the respondent regions mention vertebrate pests and the Canadian forest service unlike other countries (57) (65) has apparently no publications dealing specifically with vertebrate pest management. Perhaps one of the reasons for this, has been the difficulty in providing reliable data on economic losses caused by vertebrates, (24) although for one forest company in the American Pacific Northwest it has been estimated to exceed one million dollars annually (22). Certainly recognition of the problem has been more formal with the formation of a Forest Wildlife Problems Committee under the aegis of the Northwest Forest Pest Action Council. This group has been responsible for a handbook used extensively in this review (31). In addition in the early 1960's the American Wildlife Society formed a Committee on Economic Losses caused by vertebrates which was, along with other goals, charged with developing a standardized technique for measuring losses and values and for reporting such data (24).

Since the depression years of the 1930's, Canadian Forestry moved into a second phase - the cutting of second growth timber since most of the economic virgin timber had been completely depleted. The high cutting rates mentioned earlier in this paper indicate that a third major phase will be entered by the late 1980's; that of intensive forest systems. This will be the only way that Canadian Forestry, particularly in the west, can continue to be competative on world markets. As labour and processing costs rise there will be an increasing trend toward mechanization. In turn this will require the more specialized intensive land use associated with plantation forestry. Here the degree of vertebrate pest damage, perhaps tolerable in the open forest system, is unacceptable. Further the Red Squirrel and Porcupine are both vertebrates capable of inhabiting the climax forest thus perpretrating their damage through all phases of growth of the forest plantation from initial seeding to harvest of the mature timber. A more specific outline of the stages in plantation development is given in table II, but is briefly: cone and seed losses, seedling and sapling injuries and mature tree injuries. A complete review of the damage caused by all types of forest vertebrate pests is given in table III, while a definition of the types of damage, for example barking, clipping etc., is given in table I.

In summary then, the trend towards increased cutting of forest resources continues unabaited. Ontario for example has recently introduced a policy which will allow for 911 million cubic feet of timber to be cut by the year 2020. The challenge for forest regeneration is formidable. In addition to the 2.25 million acres of forest land harvested annually there is almost as much again lost to fire and there is an estimated backlog of 42 million acres inadequately regenerated in the Canadian forest system (45). In 1962 D. H. Janzen then Director, Bureau of Sport Fisheries and Wildlife U.S. Department of the Interior, noted that some of the most difficult damage problems in the forest system from the point of view of control are those related to the smaller mammals (27). It was noted however that it was with great difficulty that the

wildlife biologist came to any firm assertion as to the acceptable population levels for any animal. Research, was nevertheless being undertaken in three concurrent directions; effects of timber management practices on wildlife populations was being examined; methods of preventing wildlife populations from reaching pest proportions in the forest were being developed and a major programme was devoted to testing potential repellents in order to lessen vertebrate pest injury in high value stands without radically altering population balance. Sadly it appears that Canada is unwilling to embrace a similar coordinated management approach to what must be an existing and potential problem of considerable dimension.

The following is a synoptic report of Porcupine and Red Squirrel as important forest pests.

American Porcupine, Erthizon dorsatum

The American porcupine is considered one of the most important mammalian forest pests since it attacks both trees less than six inches in diameter at B.H. and merchantable timber (3). Complete girdling may result in the death of the tree, but even spot damage may seriously effect growth and timber value (18). Banfield (3) indicates that Ponderosa and Lodgepole Pine, Eastern White and Red Spruce are of prime importance while Eastern and Western Hemlock, Balsam Fir, Tamarack, Sugar Maple, American Beach and Baswood are all severely damaged. In addition Caras (8) adds to this list Cottonwood, Willow, Aspen, Jack Pine, Elm, orchard trees and their fruit. Peterson adds White Birch as an important food source. Indirect damage includes the eating of wooden tool handles left in the wood because of salt attraction, the gnawing on buildings, picnic tables and latrines for the same reason. The chewing of rubber tires and also in forest recreation areas-the danger of pets being attacked and requiring veterinary attention for quills in the mouth. (4) (8) (23) (36). Wood lot areas near agriculture can allow for porcupine harbourage and damage to corn, alphalfa and clover (18) and in recreational areas the pungant and annoying odor of urin (31) and the animals penchant for eating forest signs (60) further defines their pest status. Fletch writing on the infectious diseases of wild mammals in (10) indicates that porcupine may be a vector of foot and mouth disease.

While economic thresholds are poorly defined, some studies have attempted to quantify actual losses due to porcupines. Banfield, quoting a study from 1940 indicates 11.5 to 36¢ per animal per year damage in Maine, 45¢ to $1.10 in Colorado and a $1.66 in Montana. If we allow for a 480% inflation rate since 1940 (66) this provides a range of economic impact of $1.72 to $7.96 with a mean of $5.00. Banfield also notes studies indicating 6 to 8 animals per square mile in New Brunswick, up to 20 to 28 animals per square mile in Maine. If we take a mean of ten animals per square mile on one million square miles of forest in Canada, we have an indicated figure of some 10 million animals. This figure of ten million animals on 650 million acres corresponds well with the known animal habitat requirement of approximately 6.5 acres. This would indicate that porcupines may be responsible for up to 50 million dollars worth of damage in the Canadian forest system per year. In another study (30) in the Great Lakes region it was found that porcupine damage accounted for 20.8¢ per acre per year or 5.2% of the board feet growth and 8.3% of stumpage values. There is little doubt that damage can be severe (15 (63)

More specifically, direct damage includes barking injury to seedlings and saplings with broad prominent inciser marks in exposed sapwood and feeding on older trees which appears to be confined to the unplated bark of the upper bole where top girdling produces characteristic bushy crowns. There is also feeding on young full size trees, in particular Douglas Fir and, at denning time, branch cutting to feed young (31). Clipping of leaders, multi-leaders and stag heading along with bleeding of resin from wounds is also recorded (4). Exposure to disease and insects especially cankers and borers would seem likely. Costs are associated not only with loss of increment and top growth, but with reduced yields per acre and in younger stands labour and tree costs for replacement, and future management problems resulting from uneven stocking.

Specific damage thresholds are not readily calculated. In particular there seems to be some difficulty in obtaining exact figures on investment in plantations. Even ignoring the fixed costs associated with tasks outlined in Table II, and using only costs for seedlings and transportation (9), planting, and supervision (28)-there is approximately $75 invested in every site re-planted with 400 2 + 1 seedlings. The net disconcounted revenue on forest investments is relatively low ranging only from 1 to 3% (28). On a $75.00 investment 1% at 10 years equals $83.00 at 2% $91.00 and at 3% $101.00. The gain therefore at even the best rate of investment, is only $26.00. A damage rate of 10% in conifer plantations appears quite common (13) (30) but may rise as high as 90% (63). For such a small return on investment, it would appear that little damage at this level can be tolerated. However there is an obvious need for more detailed studies under Canadian conditions and on a wider scope before reliable figures can be developed.

The porcupine is the only member of a typically South American group of rodent that crossed the Isthmus of Panama during the Pleistocene era and invaded North America of its own accord (4). The Old World porcupine Hystrix belongs to another family, though illustrates convergent evolution.

Distribution in North America is from Northern Mexico to Alaska and from the Atlantic to the Pacific and in Canada all of continental Canada north to the tree line and in Northern Quebec, Labrador, Northwest Territories and the Yukon. The porcupine is not found in Newfoundland and Anticosti, Prince Edward Island, Cape Breton, Grant Manon or Campobello Island in the East or on Vancouver Island or Queen Charlotte Islands in the west (36) (4) (33) (8).

Porcupine belongs to the Order Rodentia and suborder Caviomorpha. It is in the family Erethizontidae and is of the species Erethizon dorsatum. There are four sub species whose name and distribution is given in Figure I. Common names include porcupine, porky, quill pig, and in French, Pore-épic.

Subspecies dorsatum is the typical form in Eastern Canada and is found also in the Prairies east of the McKenzie River and in the Northwest Territories. Epixanthum is found in the short grass areas of Alberta and Saskatchewan and has paler greenish yellow tip guard hairs than the cream tips found in dorsatum. Myops is brownish colour with long rusty yellow tipped guard hairs and is found in the Yukon, west of the McKenzie River, northeast B. C. and northwest Alberta. Nigrescens is blackish hair with rusty yellow tips and is found in B. C. and the Rocky Mountains (4) (34). Comments on habitat appear to differ,

Banfield notes that the animal is found in both deciduous and coniferous forested areas. In summer it may be found far from trees in Eastern farm land. Mc T. Cowan and Lawrence note that it is rarely found in the Coastal Douglas Fir forest. It is however abundant where there is broken rock and cliffs which occur with Pine forest. Caras also add Poplar woodland to common porcupine habitat.

Caras in describing the porcupine, gives it as a flat footed, deliberate, robust, short legged, clumsy rodent. It has a small head, short ears and beady eyes, its muzzle is blunt and his tail short and muscular. The animal is reported to have good hearing and smell but poor eyesight. His fur is long, soft and wooly, he walks with a shuffle leaving pigeoned toed tracks. Banfield notes that his Pelage is composed of sensory hairs with a dense wooly brown undercoat, long cream tufted guard hairs and stiff quills. The hairs are arranged in transverse rows, the quill rows are separated from the rows of coat hairs. Quills are located on head, neck, rump and tail, the longest is about 60 millimetres, the shortest 30 millimetres. The quills are easily pulled out and may grow one half a millimetre per day and may be replaced in ten days to four months. The tip has a backward projecting scale preventing withdrawal and may cause the tip to work inwards in flesh. There are about 30,000 quills per animal. Ventral surfaces and legs are coated with hair, the underbelly with soft down. Coat hairs are moulted annually between Spring and late Summer from nose to tail. Broken quills can be shed. The short strong legs are equipped with long curved black claws, four toes on the forefeet and five on the hind. Soles of the feet are flesh
Albino porcupines occur fairly often.

The porcupine is Canada's second largest rodent after the beaver. Its weight is given by Banfield as 11.2 kilograms and a length of 91 centimeters as against 18 kilograms and 101 centimeters by Caras and 10 kilograms and 78 centimeters by Mc T. Cowan. These differences may accounted for in the different sub-species. Hind foot is noted by the the latter author as 9.8 centimeters.

The behaviourof porcupines appears relatively well documented. It is noted as a solitary and cantankerous animal which pairs only for mating, it has dens or ground shelters particularly in winter. Rocky tallus slopes, quarries, caves and rocky road fill appear suitable denning sites as do road culverts, hollow logs, brush piles and wind blown trees. One author (34) notes that the base of trees with branches to the ground are often used. Snow tunnels appear common in the winter (4). Porcupines can climb extremely well (20) and will swim without effort (4). They are primarily nocturnal and spend much of the daylight hours resting in loafing trees, normally a bushy confier (31). They are active throughout the winter (4) (8) (23) (31) (36). The front teeth keep growing and actively need to be worn down (8). The porcupine is an easy animal to approach. When threatened it puts its unguarded snout between its forelegs often near a log or rock, lowers its body, arches its back and spines, and moves around to keep its rump towards an enemy. It can lash its tail leaving quills in the attacker (4) (8) (36).

Home range appears to be from five to six acres although some animals may wander considerably further, 30 acres in a 30 day tag study being recorded (4). It is common for porcupine to have regular paths to and from feeding areas (8).

Most authors note that there are marked seasonal changes in the feeding patterns of porcupine. In summer Banfield notes that leaves of the yellow Pond Belly, Aspen, White Birsh, various shrubs and forbes are consumed. In winter the cambium of all species and new twigs and buds are eaten while in the spring unfolding Poplar and Baswood leaves and branches are consumed. Caras specifically notes the Cottonwood twigs as winter food. Lawrence notes that in spring and summer suculent herbaceous vegetation is consumed and porcupines are attracted to moist meadows and stream banks. In Fall and Winter the bark and foliage of conifers preferably Ponderosa and Lodgepole Pine but White Fir, Sugar Pine and Juniper are also eaten. Taylor (48) indicates that Douglas Fir and Spruce may be injured while this author and Horn (26) note that dwarf Mistletoe is sometimes eaten.

Eadie in a comprehensive study of the porcupine in 1954 notes that the animal has a large daily food requirement approaching 10% of its body weight (13) which equates to 2.7 to 3 pounds (.3 to 1.3 kg.) per day. If the same rough figure of 10 million animals in the Canadian forest system is used this is equivalent to 5,000 tons of green matter a day using a median one pound consumption rate per animal. Even assuming that most summer feeding is not on woody plants this is still a considerable impact on forest productivity. Banfield also notes that there is a high demand for salt, already mentioned under damage and bones and antlers found on the ground are consumed for mineral content.

Mating occurs in November and December according to Banfield and September to December according to Lawrence. Patterson favours November and December but notes that mating may take place in January or April. Mc. T. Cowan records November as the principal month in British Columbia. There is a highly developed mating ritual and females may mate with a number of males, however it appears that males require prolonged association with the female before mating and are normally restricted to one female per season (4). Gestation data is quite varied, Mc T. Cowan indicating 112 days while Paterson, Caras and Banfield give figures of 209 to 217 days. The weight at birth according to Banfield is .53 grams while Patterson extends this up to 1.5 kilograms. Length is on average 22 to 28 centimetres. Birthdate is mainly mid May to the end of July or in later conceived young October. There is normally one and rarely two offspring.

Young porcupines are unique among Canadian rodents, born at an advanced stage of development and are precocious. Eyes are open and they can walk within an hour of birth. The young are covered with long black hairs and 10 to 25 millimetre quills which although soft at birth harden within an hour. They are playful but exhibit defense turning very quickly. Banfield indicates that weaning takes place after two weeks however Peterson indicates nursing may continue up to four months and Caras up to five months. Sexual maturing for both males and females appears to occur between two and two and one half years old.(4) (34)

Population studies by Spencer (67) indicate that porcupine populations have fluctuated in past centuries in the Central United States. There were population explosions well documented by Dendrochronology in 1845, 1885, 1905 and 1935. Earlier population increases are indicated for 1716, 1746, 1785 and 1815.

The population density of porcupines have been reviewed by a number of authors (4) (8) (18) (23) (30). On average there appears to be something in the order of ten animals per square mile each with a home range of five to six acres. Diurnal movement is about 80 metres and nocturnal movement up to 130 metres.

Mortality is not great. Porcupines exhibit a high ratio between conception and Embryonic survival indicating few complications occur during pregnacy. This is coupled with a high post natal survival rate and precocious young contribute to the high biological potential for porcupines dispite their low birth rate (18). Banfield gives a life span of eight to ten years and Caras five to six years. Natural predation includes the large carnivors Wolvarine, Fisher, and Bobcat all of which may search for winter denning places and have developed the skill to turn porcupines over to avoid the quills. Caras notes that when other food is unavailable wolves, coyote and foxes may also attack porcupine.

Control programs in Canada are poorly recorded and as is often the case those programs noted (4) (18) have concentrated on chemical elimination of the problem. Biological control is not recorded by any authors but perhaps could be investigated with the use of palatetable herbaccous or woody plants interplanted in single species conifer plantations. Physical control seems to have included clubbing; shooting-where it is suggested that after sunset; along forest roads is the most successful denning and electrical fences (4) (8) (18). Denning would appear to be a fairly successful method as the winter dens are readily identifiable (19). The electric fences are suggested only for the potection of agricultural problems (8). Two chemical control methods are recorded (4) (18) and appear to have been relatively successful. One has involved using strychnine in a salt bait and the other sodium arsenite in apple baits. No integrated management methods are reported in the literature and cost effectiveness of any method is poorly reported. A report from Oregon (56) indicates that poison baiting of porcupines has not been particularly successful since the animal prefered to chew the plywood structure used to protect the bait rather than eat the bait itself.

The benefits from porcupine appear to include the use of quills for decorative work their providing food for desireable carnivors; some thining of weed trees; such as Balsam and Poplar.

There are, as is so often the case, no cost/benefit analysis covering the impact of this animal on the productive forest system.

Red Squirrel, Tmiasciurus hudsonicus

The damage caused by red squirrels may be seen in two catagories: that of cone and twig cutting, and girdling or barking injury to the upper bole of mature trees. Lawrence (31) notes that conifer seed is the principal food of red squirrel especially during winter months. Heavy cone cutting in late summer in order to store cone crop may result in as high as 85% of the current cone crop being removed and 9% of all developing cones being taken before they have the opportunity to mature Squillau (47). Lawrence notes that there are considerably more twigs cut and eaten, while Lutz (33) records cutting of branches on Black Spruce. Adams (2) reports bark and branch tips cut from Ponderosa Pine which also destroys developing cones. Schmidt (39) records red squirrel as taking 66% of mature cones in the Ponderosa Pine forest, while Smith in a quite detailed study (43) indicates that a single squirrel may cut between 12 and 16,000 cones in a normal heavy crop year. Brink (7) indicates 144 cones being cut per squirrel per day from Picea glauca in Alaska. Zaitsev (54) in a study on a European squirrel species notes an 80% destruction of Larch cones.

In the second class of damage; that to mature trees, Viidik (53) noted decapitation of the leader and branches of the first Whorl or in some cases removal of lateral buds. Lawrence noting that much of this damage occurs in the 20 to 60 year age class, states that considerable damage can be sustained by Douglas Fir and Ponderosa Pine, that small strips of bark may be removed in order to lick the sapwood or completed girdling may take place. This later damage can be confused with that of porcupine.

In addition to direct damage to the forest resource a number of indirect problems or potential problems occur. As far back as the mid 1800's squirrels extracted a considerable toll on nursery stock especially Spruce (17). In hardwood or mixed forest there is the problem of disease introduction after winter or spring feeding especially in Maple where virulent canker may later result (41) and in Oak where a wilt fungus may be transmitted by the animal (16) An important side effect of feeding preference in red squirrel on fertilized plantations is discussed by Asher (1) which could have significant impact on forest management practice in the plantation forests (see also Straton) (45). In recreational forest areas squirrel can cause damage to camping food, clothing and bedding (4) but more importantly may be the vectors for western and eastern equine encephalitis (10) and in the Sierra Nevadas at least, as a carrier Bubonic plague. For example a park directive dated August 1976 lists five precautions of which the first suggests to avoid all contact with squirrels, including not feeding the rodents, and the fifth "should one become ill within one week of visiting a park, a physician should be immediately contacted." It is thought that such advise can only but depress park attendance. Finally red squirrels exert some preda ion pressure on smaller forest wildlife and in particular gamebird eggs and broods may be effected.

The red squirrel belongs to the order Rodentia and the family Sciuridae which includes five species of chipmunk, one woodchuck, three marmots, five ground squirrels, one black tailed prairie dog, three regular squirrels and two flying squirrels. The red squirrel however belongs to a separate genus than other squirrels and has two closely related species-the red squirrel Tamiasciurus hudsonicus and the douglas squirrel T. douglasii. The North American red

squirrel should not be confused with the European red squirrel Sciurus vulgaris leucourus. North American red squirrel is a highly plastic species which has been divided into 15 geographic sub-species across its Canadian range as outlined in Table II.

The habitat of the red squirrel indicates that it is more versatile than the grey. Boreal coniferous forest is its principal habitats and it is one of the few mammals to inhabit climax conifer forest. Preference appears to be for mixed forest with White Pine and Hemlocks on cooler north facing slopes (4) However it is found in the Eastern hardwood deciduous forest (36) and in immature hardwood forest (32). On the westcoast it is common throughout the Ponderosa Pine and Douglas Fir cover types (31) (35) (68).

Distribution in North America includes the broad forested belt from Atlantic to Pacific, south in the Rocky Mountain region almost to the Mexico border It does not occur in the south of Manitoba or the southeast of Alberta nor in the central plains or deep south of the United States (4). As noted before it has 15 Canadian sub-species which differ in size, length of tail and colour.

Peterson provides general descriptions as follows: a rusty olive tail with bright yellowish, orange rusty or deep red tips of long tail hair which is white to pale orange. In winter there is a reddish band on the back and tail. Also in winter the black line on the side separating the upper and lower body colours is lost. Feet are bright reddish in summer with thin hair turning heavy grey in winter. Mc T. Cowan indicates that upper parts are grey to olive brown with a reddish wash heaviest along the mid line. Under parts are white to greyish white. Tail is as long as the body, flatish but bushy. The tail upper colour is the same as the body while the lower side is lighter, tips of hairs in the tail are black sometimes the tail tip is black. There is again a black line bright in summer which separates body colour. Ears in the winter have pencils of hair from the tips. Banfield in a more detailed description opens with a notation that there are black vibrinae prominant on the side of the nose, eyebrows and cheeks that are also tactile hairs on the forearms and abdomen. The main coat is glossy olive brown flecked with white with the back of the ears cinnamon, white eye rings and black flank strip separating the body colours. The tail is rufous red with black subterminal black border and tips and grizzled grey. Ear tuffs identify sub-species and may be red or black. The normal palage in winter produces longer more silken fur with a thick leaden grey to buff tipped undercoat. Albinos, part albinos and melanisic types are recorded.

There are two annual moults from March to July starting at the nose and feet working towards the rump; in most individuals this moult will take two months either April, May or May, June however pregnant females will not moult until late Autumn. The second moult occurs in August to December lasting only one month starting at the tail, which only moults once per year, moving from the rump to head and lastly to the feet (4).

Description of size and weight though differing among the sub-species is reported by most authors to be in the range of 350 to 400 millimetres for length (4) (8) (31) although Mc T. Cowan notes the British Columbia sub-species columbiensis - to be somewhat smaller in the range of 300 to 320 millimetres with a tail length of 125 millimetres Hind foot is recorded as being 50

millimeters in diameter. Banfield notes a similar length for tails and 25 millimeters for ears though this varies depending again on sub-species. Weight of a full grown adult which does not appear to differ between males and females ranges between 140 and 250 grams. The head is short and broad, there is a thick glandular area around the anus where two orifices can discharge a musky fluid used for marking (4).

Movement of the animal is, surprisingly, rather poorly documented by Caras indicated that the animal will normally be found within 200 yards of a single nest tree and over a season may range over an area of some five square miles. Other authors (55) (32) indicate the home range to vary from 2.73 to 6.03 acres. Density is reported to be from 0.28 to 1.85 per acre depending largely on food availibility (4) . Various authors indicate that the squirrel normally dens alone except in extremely cold weather, it is normally a solitary animal intolerant of strange individuals of its own or other species. It exhibits fierce territoriality at feeding station and dens however, it may form a (loose attachement) during the mating season.

Inhabit

The red squirrel is recorded as being a bold inquisitive animal, an extremely agile climber able to travel up to 15 miles an hour both up and down the trunk of trees. Further, it both hops and walks on the ground and can leap some five feet if startled. It is quite at home in the trees where it is judged to be the most arboreal of the squirrels being able to jump up to 15 feet and drop from heights of 30 feet without injury. (34) (8) (4) (36) The red squirrel is generally durinal but may be out in moonlight nights in summer and autumn. During the day it may sleep or sun itself in high branches though seek shade during high sun. It dislikes, cold, rain, snow and high wind (8). The tail is extremely sensitive to wind currents and is used for balance, for shade or for heat in cold weather (8). It has an extremely keen sense of smell, sight, hearing and can swim strongly (4). Activity peaks occur two hours after sunrise and just before sunset with the balance of the day being spent sleeping or basking in the sun. Winter activity is restricted to only the warmest part of the day (8) and the animal does not hibernate (31) (8) (4).

Nests, probably called drays, are constructed both for living and reproduction. Finely shredded plant material is used to line burrows, cavities in trees or on sheltered basil branches within six to eight feet of the trunk (34). Caras notes that hollow trees are often used while Peterson suggests that nesting in trees is more common only in the south of the red squirrels range. Banfield indicates the use of tree cavities, woodpecker holes, birds nests, rock piles, fallen trees and from five to sixty feet above the ground in living trees. The dray is normally up to one foot in diameter with a five inch cavity in the inside. It may only be used in the summer in northern parts of the squirrel's range in Canada. In this situation long winter tunnels may be constructed at ground level.

Feeding of the red squirrel is most varied. Lawrence includes fungi, berries, buds and bark of conifers, branch tips, ripening pollen buds and of course conifer seed. Peterson includes cones, nuts, buds, flowers, fruits, mushrooms, sap, other herbaceous plants, insects, small birds and eggs and small mammals. Mc T. Cowan also specifies leaf buds of Poplar and Birch and dead flesh while Caras suggests corn and commercial berry fruits. Banfield concurs with these authors and notes that the poisonous Sly amanita mushroom may be eaten with immunity and that mice, voles and young cottontails may be predated. Of the conifers White and Red Spruce, Balsam Fir, Douglas Fir, Hemlock, Larch and Cedar are included in the conifers and in the hardwood forest nuts, catkins, and slashing of bark especially on Sugar Maple is reported. Other authors (3) (7) (35) (39) (43) (46) (54) (68) list a variety of different conifers severly attacked. A most interesting indication came from the review of feeding literature, in that five authors (1) (14) (45) (53) indicates that there is very distinct preference exhibited in squirrel feeding. Edlin for example indicates that the squirrel is able to judge when seeds are ripe and that unripe or infertile cones are not attacked. Smith and Viidik indicate that specific trees are more susceptible to attack. It would seem that the squirrel has the ability to maximize its energy budget. In mid summer cone collection starts with climbing to the crown and cutting of terminal twigs that have green cones. These cutting sautes will last up to two hours and from ten to 100 cones will be allowed to fall to the forest floor. These are then cached in piles from one to many bushels, up to four yards in diameter and a yard in height. These middens are normally in a damp place so that cones do not open and disperse the seed before the squirrel can eat it. Food consumption is given by Caras as 100 pounds of food a year which is approximately four and one half ounces per day. Repeated attempts have been made to obtain figures on the value of forest seed but without success in time for this paper (25). It is known however, that Hemlock produces 0.61 kilograms of seed per bushel, Douglas Fir 0.52 , Lodgepole Pine 0.18 and Spruce 0.45. By knowing the number of bushels cut by and individual squirrel and population density it would be possible to calculate an approximate loss per acre figure, however, in terms of total consumption if it is assumed that there is only one squirrel per ten acres on the 650 million acres of the forest land some three and one quarter million tons of food per year would be consumed.

In the southern part of its range the red squirrel is polyoestrous with oestrus occuring in February, March and again June or July in northern Canada, however, only one litter is born per year. In the male the testes develop in February and then the animal is in breeding condition until August. The testes are withdrawn from September to mid January. Mc T. Cowan indicates that April is a common mating month. There are mating chases as with other squirrels (8) (4) (31). Births seem to predominate in the months of April, May and August, September, jestation is 40 days and litter size from one to eight. The newborn are altricial, virtually hairless, toothless, and with the eyes closed for the first month. The first hair appears at seven days and well defined by ten days. The external meatus of the ear develops in 18 days and by 38 days the young can play together. They are weaned at seven to eight weeks and appear outside the den by ten weeks old at which time they are about one third grown. The young squirrels will train with the mother for up to 18 weeks and then disperse (4) (49). The young have a soft rufous coat which they moult at the age of 11 months. They are sexually mature as yearlings.

The newborn are 65 to 75 millimetres in length and five to eight grams in weight (4). Young born in spring may spend the summer with the mother or in the case of fall born young have a complete winter (8).

Predation plays the most important role in the control of squirrel numbers as conversely the squirrels do in the population of predators. As one of the most abundant herbibores the squirrel is preyed on by Redtailed,Red Shouldered, Broadwing and Cooper's hawks. In addition the Goshawk, Sparrow, and Marsh Hawks may also take small squirrels. The Barred and Great Horned owls may prey on squirrels especially at dusk. The marten, fisher, bobcat and linx are predators of the squirrel in trees while weasel,coyote and wolf will attack the animal on the ground. In many areas vehicles take a heavy toll on squirrel populations. Man is also a direct predator mainly for the fur bearing industry. The squirrel has developed extremely good eyesight and the defense reaction of freezing on a tree so that its movement does not draw attention. Its life span is given variously from eight to ten years however Caras indicates that 50% of all young squirrels do not reach their first birthday.

Not withstanding the considerable toll in the forest crops the squirrel does have some important benefits; it is credited with consuming many forest insects and by providing some reforestation by leaving seeds in the ground in caches which are not eaten. It provides an important buffer prey species, removing predator pressures from other more desireable species. It has provided food and "sport" in the field of recreation and is used fairly extensively for lining and edgings of winter clothing especially in the north. In 1971-72 390,884 pelts were sold at an average value of 54¢ which equals $217,971 (4).

Responses in Canada to squirrel population are not well documented in the literature. Certainly modification of habitat does not seem a likely or profitable persuit since the animal is extremely adaptable. It may be that control measures are only warranted in high value crops; some plantations, seed orchards, and Plus Tree seed collection sites. Specimen trees may warrent some protection. The types of control include the encouragement of habitat for predators and perhaps research into natural disease mechanisims which control red squirrel populations. Coccidiousis is certainly reported to have controlled squirrel populations in Europe (52). Physical controls include live baited traps (57) the Imbra trap (42), the common Havahart trap and tree bans which expand with the tree and when attached to the trunk preclude climbing (29) (70). The common practice in Europe has been drey-poking (42) however this may not be particularly successful in Canada where ground burrows form a significant proportion of the nesting sites. Chemosterilants are not mentioned in the literature and surprisingly only one repellant (58) is reported. The most common method of reducing squirrel populations has been shooting the animal, often supported by bounties (37) (42) (50) (51). In the past very substantial numbers have been taken by this process. For example in the period 1903 to 1933 in Scotland the Hyland Squirrel Club shot some 82,000 European Red Squirrels (45). In the United States where squirrel hunting has been popular, records indicate that over 2 million squirrels were killed in one season in North Carolina on an area less than 52,000 square miles while in West Virginia the numbers killed range from 750,000 to 1,500.000 (51). These later programs were however directed to the grey squirrel.

In Canada where there is no history of extensive squirrel shooting it could be expected that such policies would be publically unpalletable. In fact their usefullness is probably suspect. Without better definied economic criteria it is not possible to form any reasonable conclusions. It can however be said that squirrel do present a potential problem in high valued crops and that this potential will increase with the continuing trend toward intensive forest systems.

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CONTROL AS AN ELEMENT IN MANAGING THE LANDSCAPE

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CONTROL AS AN ELEMENT IN MANAGING THE LANDSCAPE

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Abstract

A landscape control model based around the prompting questions of Who? What? When? Where? Why? How? is developed to provide an insight into the mechanisms of control that can be exerted on landscape projects. The model is used as a basis from which to describe six major areas where control options exist. These are suggested as education, professional practice, management, institutionalized constraints, control of the added bio-physical environment, and manipulation of design components and variables. It is concluded that a wide variety of control options for manipulating the landscape are available to the landscape manager or landscape architect but the complexity, inter-relationship and extent of these controls is rarely understood. It is suggested that the landscape architect with a broad knowledge of these control options is in a position to take full responsibility, at a level equal to any other discipline, in administering development projects in our highly technical and ever expanding society.

INTRODUCTION

The Oxford dictionary notes that the verb "control" has a number of meanings dating from its English usage (controul) after literal translation from the French (controle) in 1475. These meanings have evolved to include "check or verify", "to reprehend", "to overpower" and, of specific interest in the context of landscape, "to exercise restraint or direction upon the free action of", while the root noun has come to include the means of restraint. The purpose of this paper is to examine some of the specific mechanisms that embody the elements of restraint in managing the landscape and to examine their utilization for that purpose. An important starting place in this examination is to clearly identify the general areas in which control can be exerted in order to provide the preparatory framework for a later discussion of each component.

In general, it may be said that control is exerted in a number of broad areas. These areas may be summarized as:

1. Decisions by people.
2. Fiscal limitations on money and thence indirectly on time.
3. Manipulation of sources, quality and quantity of information.
4. Manipulation of resources in the existing or planned physical environment.
5. Supervision of people.
6. Regulation of ideas.
7. Specificity of methods.

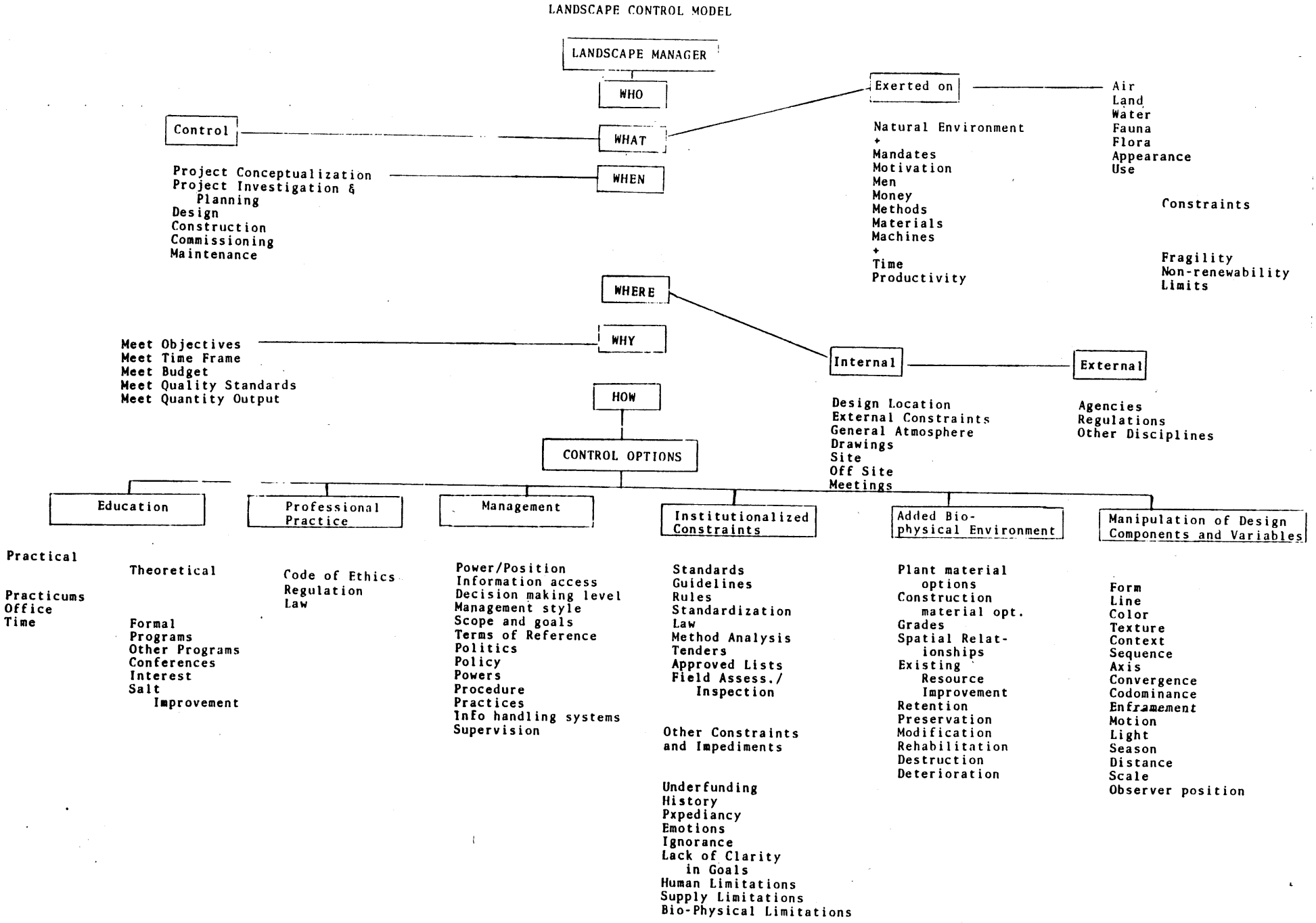
An expansion of these areas and their relationship to each other has been constructed as a simple model using as its core the prompting questions, who, what, when, where, why and how? The model combines implicit and explict controls, identifies their internal or external nature, links them to a related element - constraints, aggregates like types and illustrates time horizons wherein controls may be exercised. An intrinsic conclusion from the model is clearly that information begets power and power underscores control. Thus information, in the continuum of data-information-knowledge, yields a symbiotic relationship with control.

DISCUSSION

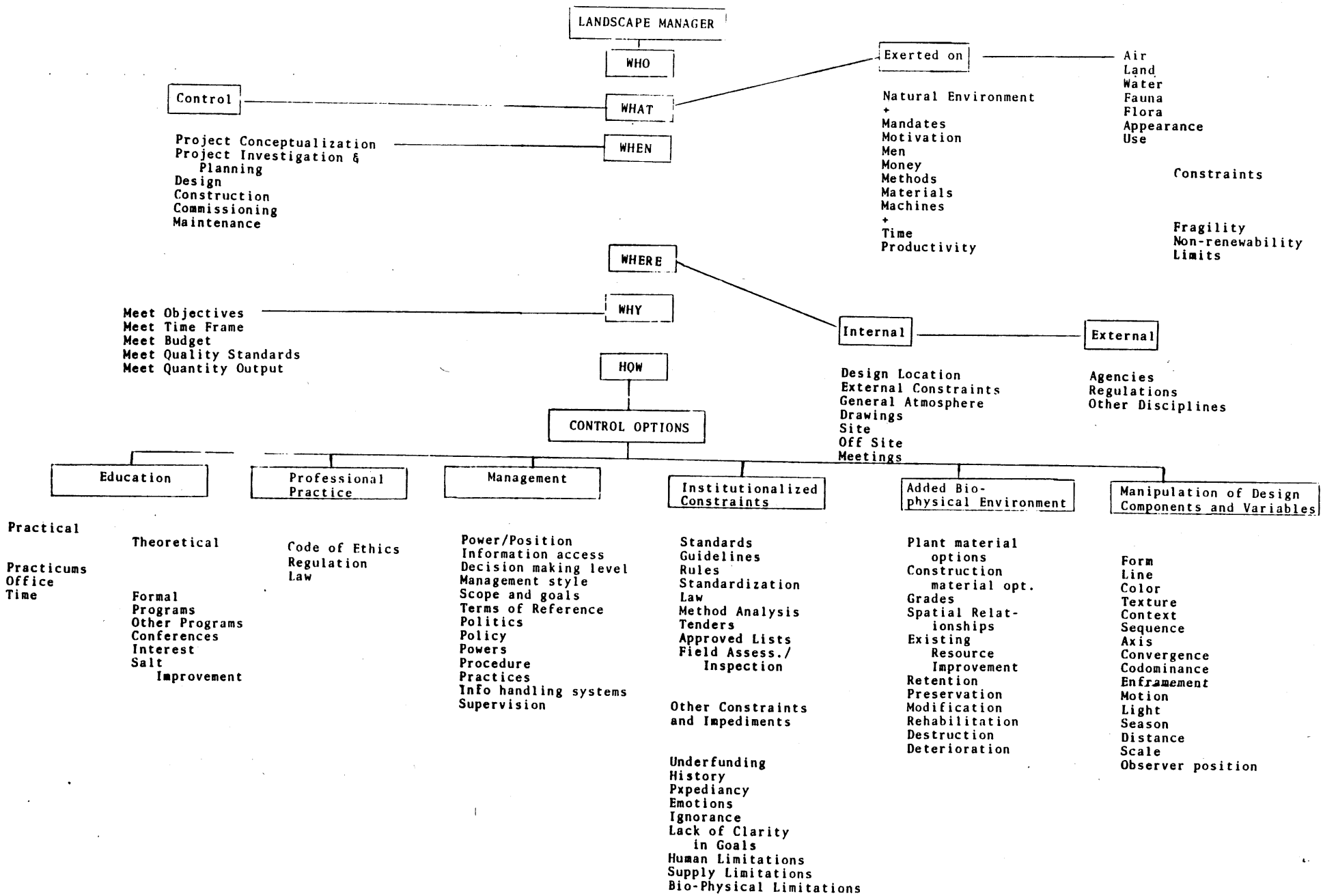
Since control can be exerted in such a broad range of areas and used in both constructive and negative ways, it is important to examine the underlying reasons for exerting control both over the physical environment and over the social/psychological sub-entity which predecates all landscape activities. The latter must recognize and reflect the expectations of three classes of people influenced by elements of control and, of course, by the interactions and synergies that derive from the inherent or forced social bond. There are the proponents of the scheme, economic, professional, political and local; there are those for whom the scheme is derived; active, passive or unknowing; and there are those charged with implementation of a project, constrained by the exigencies of time and money. In a more general sense, it can be said that control is exerted to meet, probably in order of priority, (i) the set or modified objectives for the project, (ii) budget limitations including escalation for inflation, (iii) a given timeframe related to project completion, (iv) quantity output in terms of productivity from design stage through to implementation and finally (v) in projects of high profile, above average or advanced quality standards.

Elements of control, though they may be altered in scope and direct applicability, operate in defined segments of a time horizon. This time horizon is initiated at the rising of project conceptualization, carries through the midway point of construction and sets in the afterglow of subsequent maintenance. The time spectrum is segmented only in format but not in substance. The portions intermesh, often causing confusion as extension and iteration of information reclassifies or redefines conclusions. Control becomes more difficult as greater emphasis is placed on disaggregation of the organizational and physical parts of a project with a concomitant loss in holistic comprehension.

Throughout the time/space interface there is the contradiction of stages and interim multiple objectives predicating a unified and integrated finale. Control elements must concentrate and co-ordinate the multiplicity of events through the time spectrum from project conception through project feasibility investigations, planning, site investigation, design, approval, and construction to acceptance, commissioning and eventual maintenance. The complexity of this task has given rise to the various systems of critical path analysis and P.E.R.T. (program evaluation and review technique) which are now widely used for


LANDSCAPE CONTROL MODEL
LANDSCAPE MANAGER
WHO
Control
WHAT
Exerted on
Air
Land
Water
Fauna
Flora
Appearance
Use
Natural Environment
+
Mandates
Motivation
Men
Money
Methods
Materials
Machines
+
Time
Productivity
Constraints
Fragility
Non-renewability
Limits
Project Conceptualization
Project Investigation & Planning
Design
Construction
Commissioning
Maintenance
WHEN
WHERE
WHY
Meet Objectives
Meet Time Frame
Meet Budget
Meet Quality Standards
Meet Quantity Output
Internal
External
Design Location
External Constraints
General Atmosphere
Drawings
Site
Off Site
Meetings
Agencies
Regulations
Other Disciplines
HOW
CONTROL OPTIONS
Education
Professional Practice
Management
Institutionalized Constraints
Added Bio-physical Environment
Manipulation of Design Components and Variables
Practical
Practicums
Office
Time
Theoretical
Formal
Programs
Other Programs
Conferences
Interest
Salt
Improvement
Code of Ethics
Regulation
Law
Power/Position
Information access
Decision making level
Management style
Scope and goals
Terms of Reference
Politics
Policy
Powers
Procedure
Practices
Info handling systems
Supervision
Standards
Guidelines
Rules
Standardization
Law
Method Analysis
Tenders
Approved Lists
Field Assess./ Inspection
Other Constraints and Impediments
Underfunding
History
Pxpediancy
Emotions
Ignorance
Lack of Clarity in Goals
Human Limitations
Supply Limitations
Bio-Physical Limitations
Plant material options
Construction material opt.
Grades
Spatial Relat-ionships
Existing Resource Improvement
Retention
Preservation
Modification
Rehabilitation
Destruction
Deterioration
Form
Line
Color
Texture
Context
Sequence
Axis
Convergence
Codominance
Enframement
Motion
Light
Season
Distance
Scale
Observer position

LANDSCAPE CONTROL MODEL



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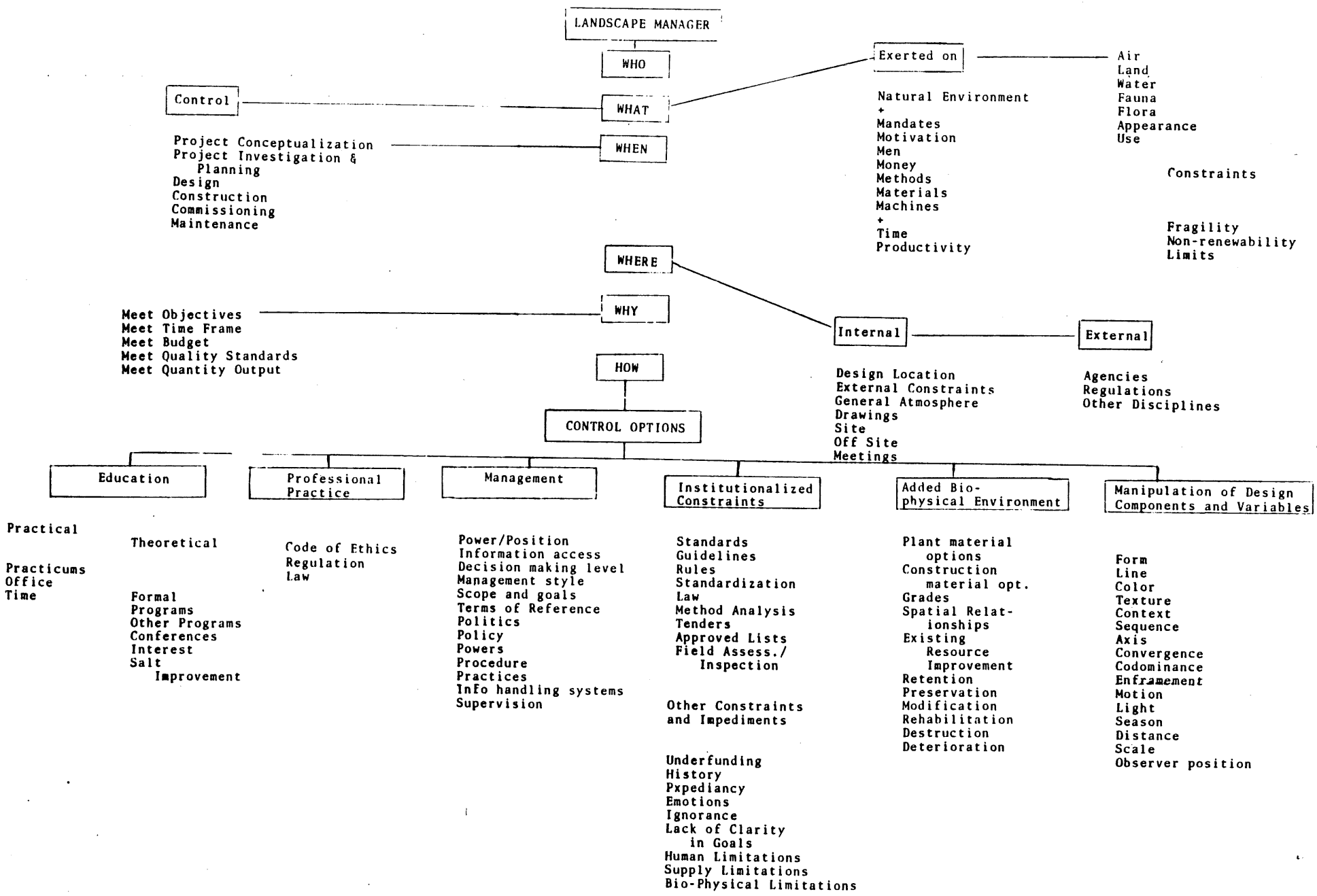

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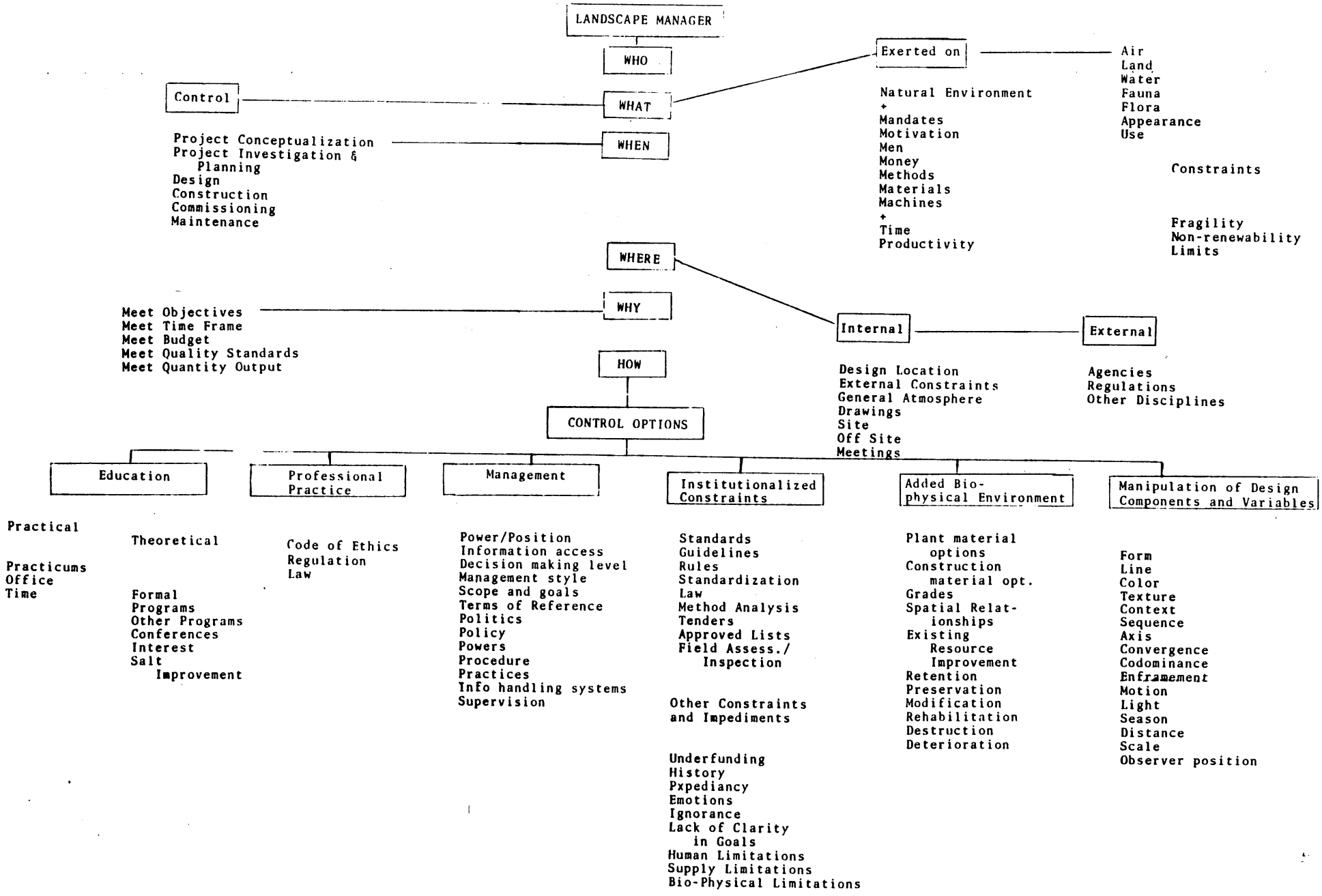

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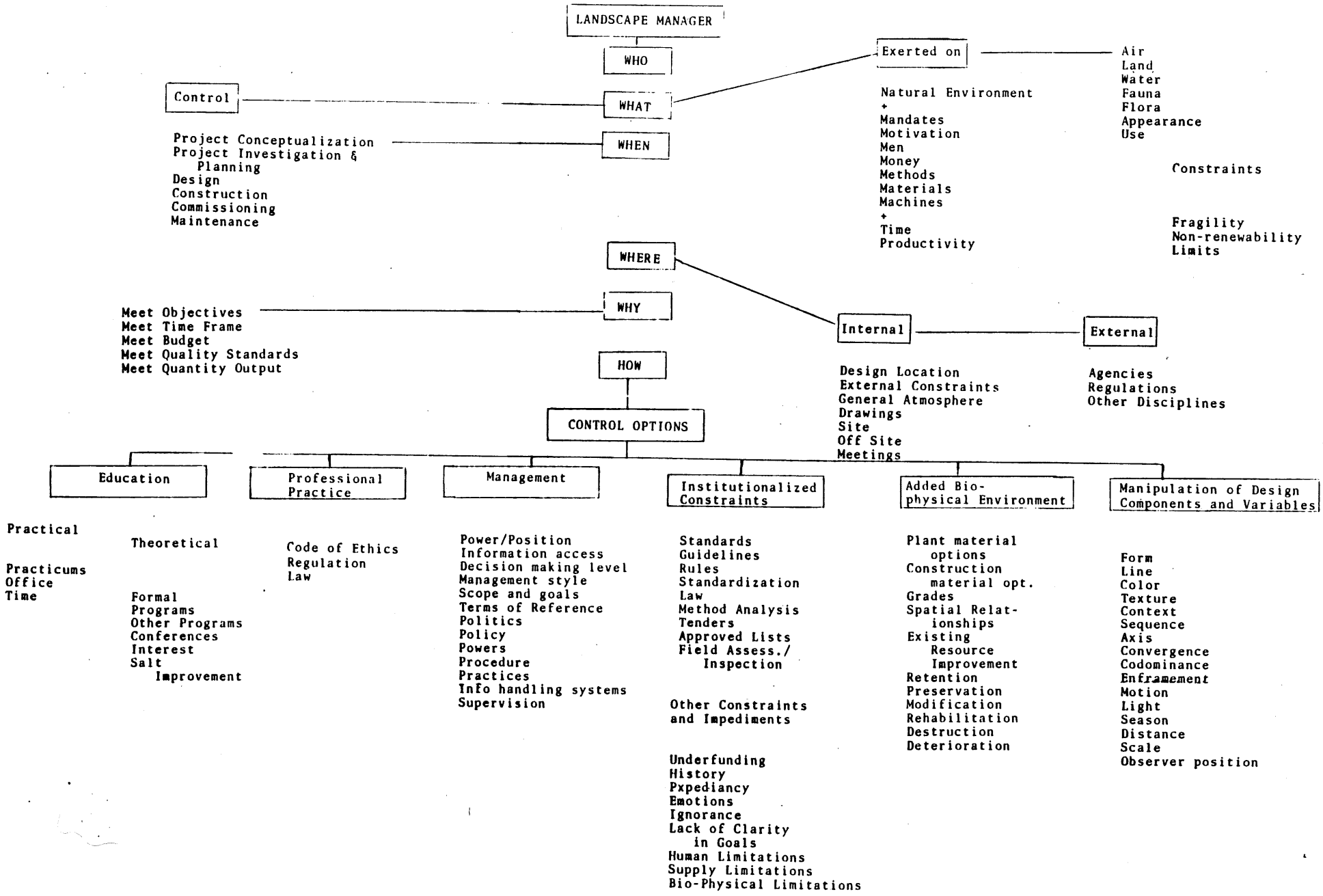

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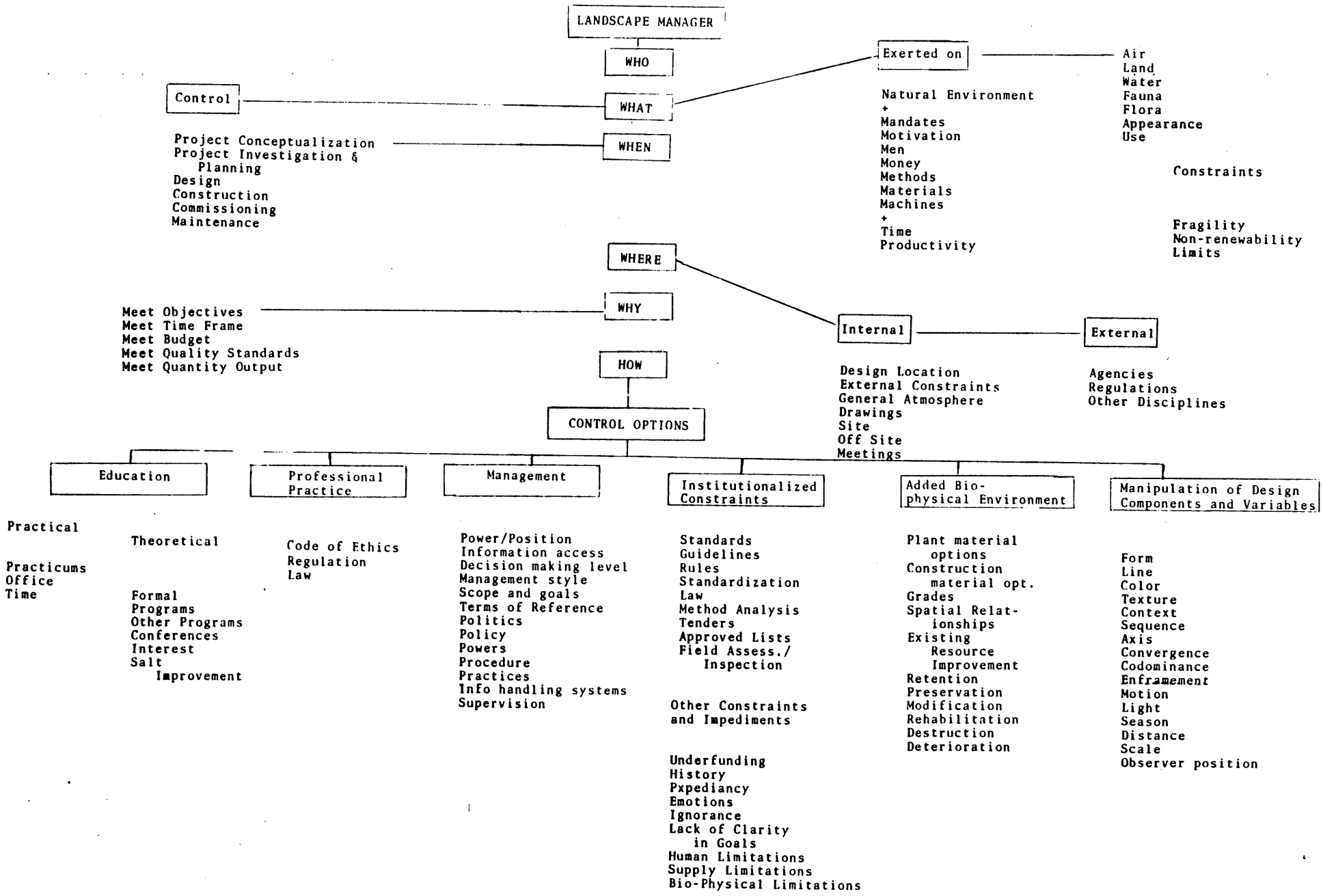

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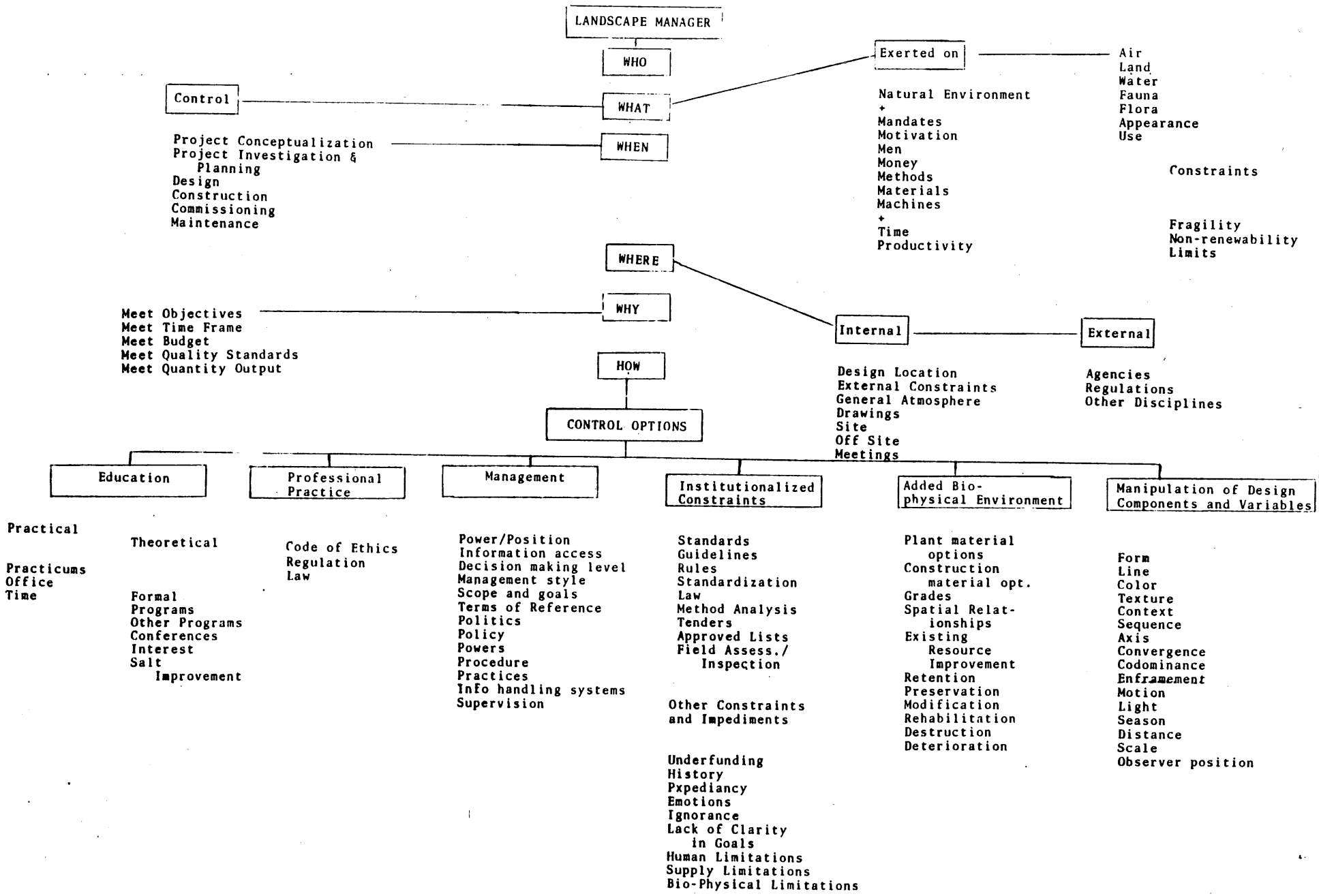

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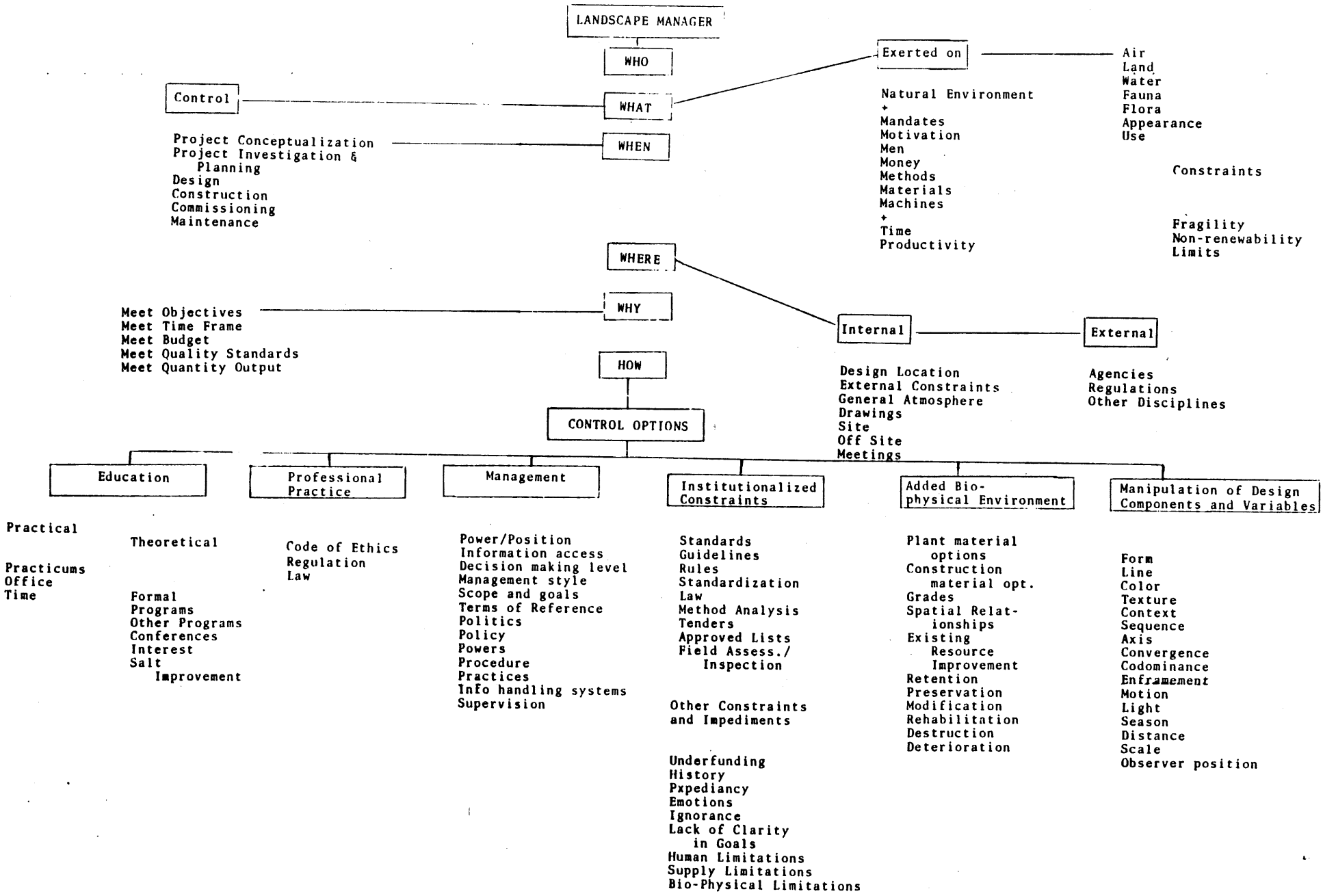

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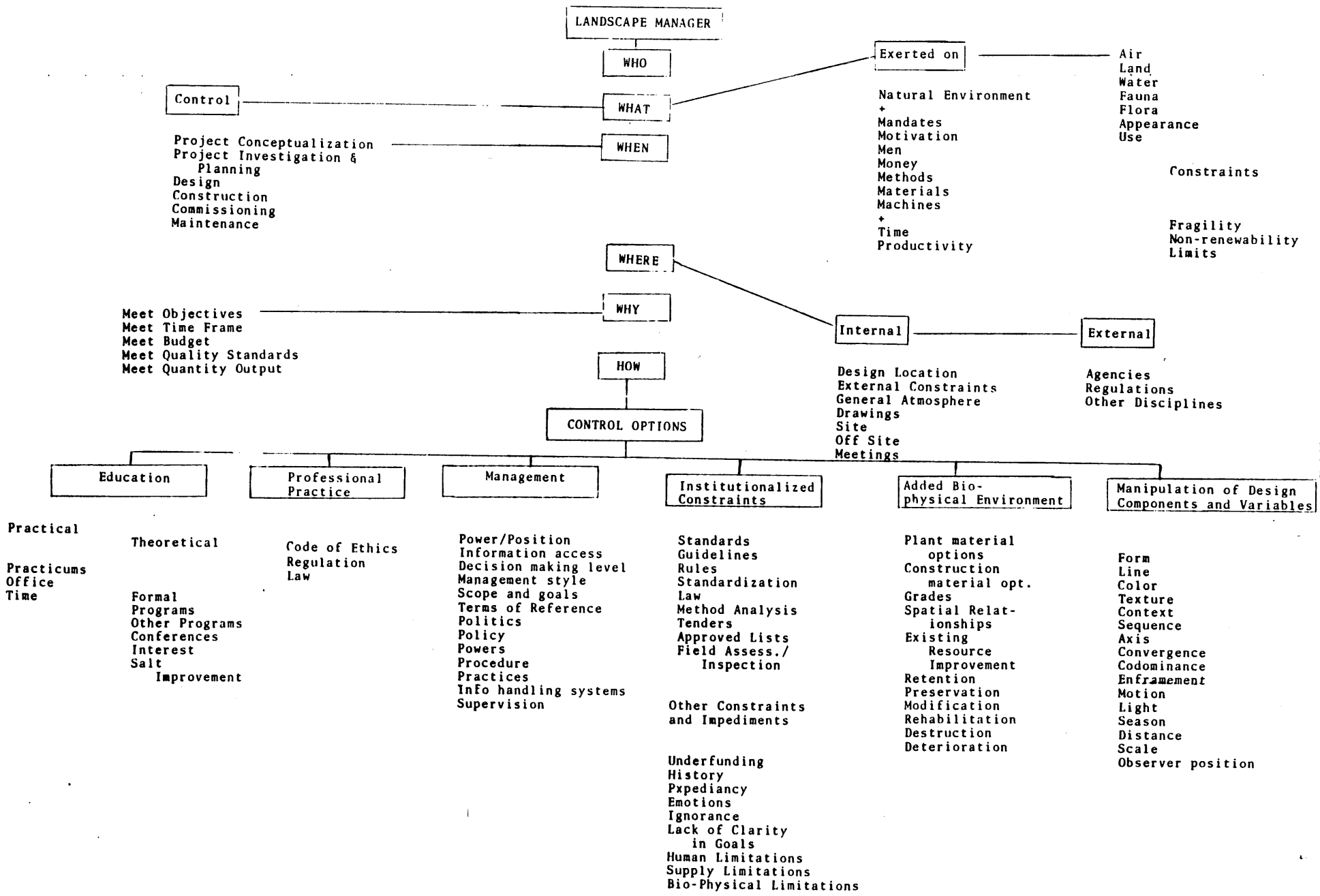

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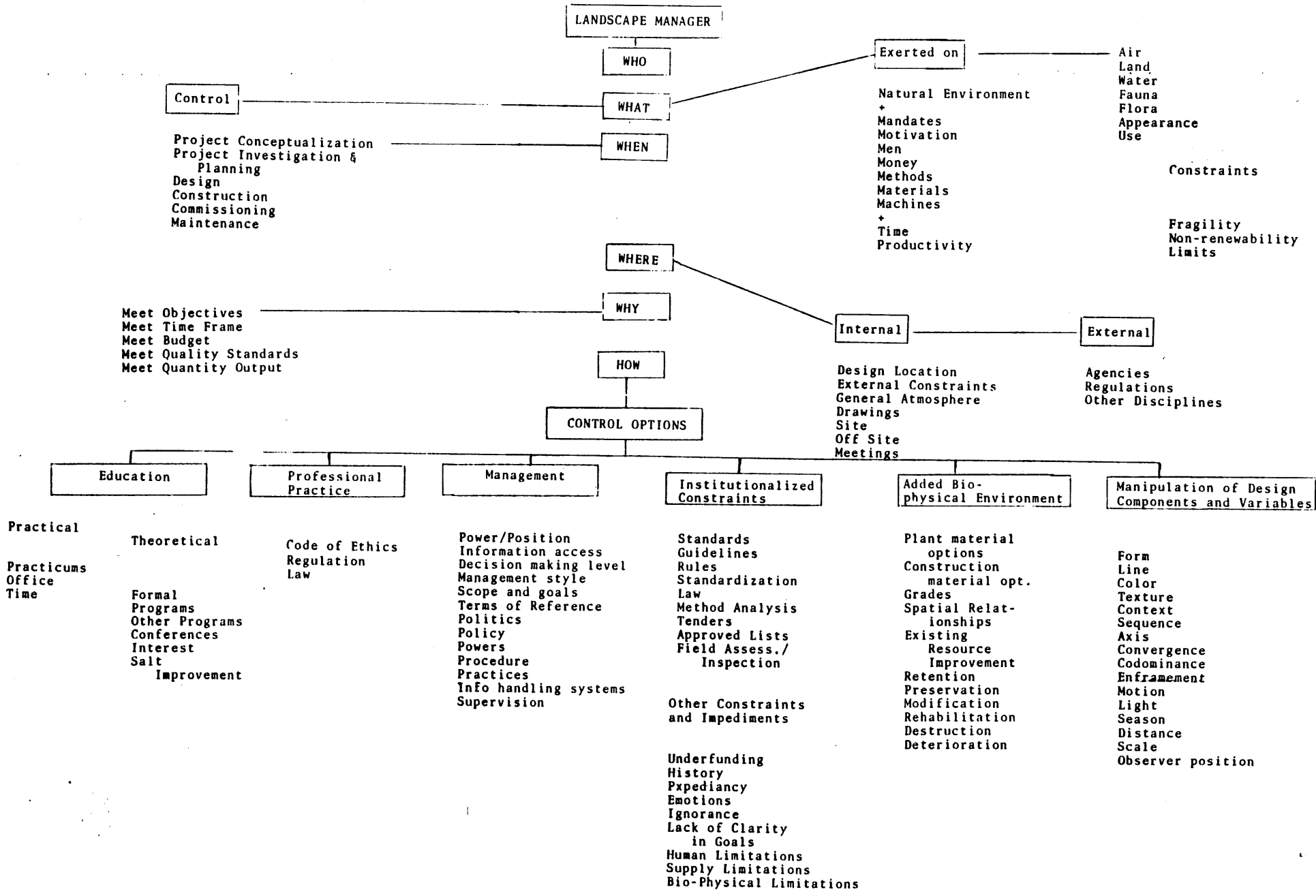

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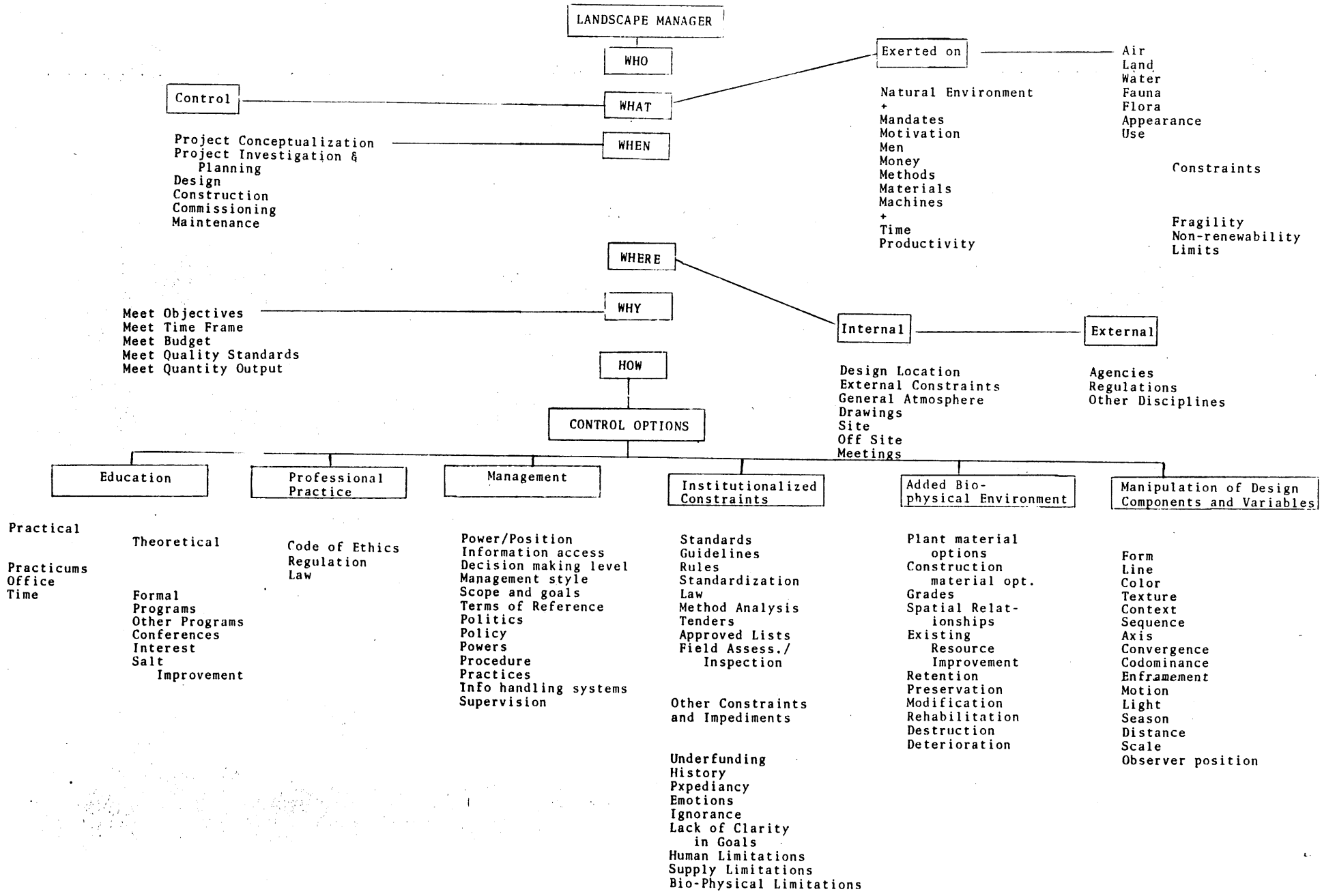

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REPORTS

STRATEGY

STATUS

SYSTEM

SCHEDULING

SCOPIC

SCHEMATICS

LOGISTICS

WHAT

WHERE

WHEN

WHO

WHY

PROBLEM SYMPTOMS

SIGN

SOURCE

SIZE

STAGE

SEVERITY

SIGNIFICANCE

SOLUTION

SOLUTION

MEN

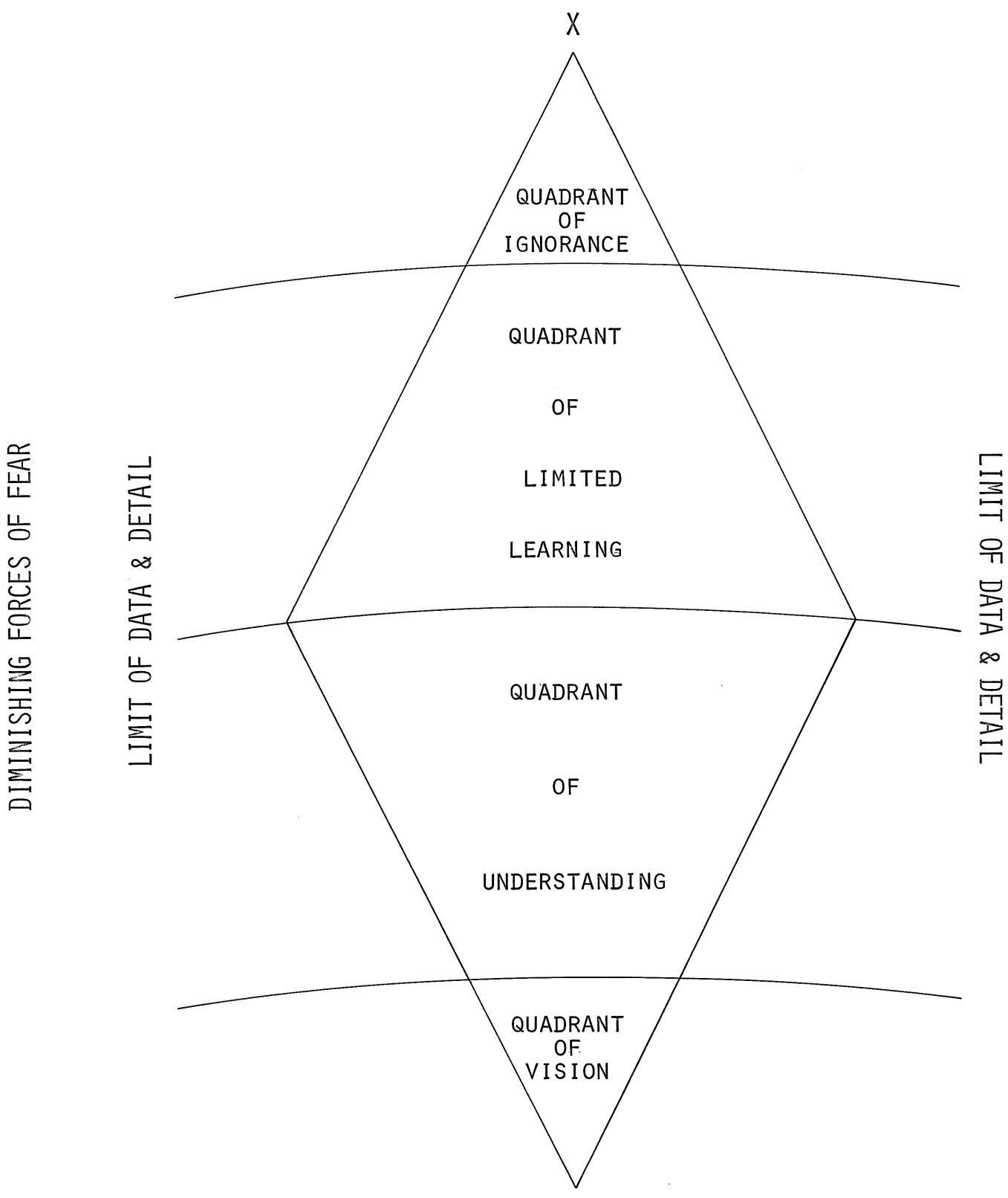
METHODS

MACHINERY

MATERIALS

MONEY

FOCUS OF PROBLEM PERCEPTION



DIAMOND OF INDIVIDUAL INSIGHT

SEVERITY


M A C R O
MAXIMUM
MAJOR
MODERATE
MINOR
MINUTE
MINUSCULE
MINIMUM
M I C R O

FACTORS OF GROWTH

SPECIES

SOIL

SUSTINANCE

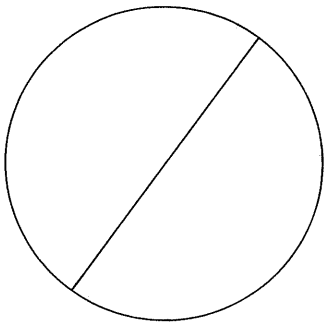
SITE

SLOPE

SEASON

SUN

VEGETATION



ENDANGER

OR

ENHANCE

CONTROL

CUT

CHEMICAL

CULTIVATE

COMBUST

COARETATE

COMBINATIONS

DISPOSAL

CHIP

COLLOCATE