THE DEVELOPMENT OF AN OPEN SPACE SYSTEM FOR THE QUEENSBURGH MUNICIPAL AREA.

BY

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SUBMITTED IN FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE M.Sc
IN THE FACULTY OF SCIENCE
BIOLOGY DEPARTMENT
UNIVERSITY OF NATAL

DECEMBER 1994

PREFACE

The work described in this thesis was carried out in the Department of Biology, University of Natal (Durban) from January 1993 to December 1994, under the supervision of Professor J. Cooke.

This study represents original work by the author unless specifically stated to the contrary in the text, and has not been submitted in any form to another university.

Kerry Ann Seppings
December 1994

ACKNOWLEDGEMENTS

I would like to extend my sincere gratitude to the following people for their assistance with this study:

The Council and staff of Queensburgh Municipality, especially Councillor Gloria Rolando and the Engineers Department, for their support, both financial and otherwise and their assistance in the field.

Dr R. Westfall for his time and computer expertise and the use of his computer program package.

My mom and dad for their financial and moral support throughout this project and for their assistance with the many public events hosted to promote the Queensburgh Open Space System.

My sister for all the proof reading and colouring in of maps.

Oliver for all his help in the field (despite the many confrontations with extensive stands of *Chromolaena* and *Lantana*) and the many, many hours spent promoting environmental awareness and helping with the public events.

Prof. Cooke for his advice and guidance in the compilation of this thesis.

As always - Dr Debra Roberts for initially supervising this project and continued advice and encouragement.

To the people of Queensburgh (especially the children) - your renewed interest in nature and support of my project has made all the long hours worth while.......

ABSTRACT

This project was conducted with the view of extending the Durban Municipal Open Space System into surrounding municipalities. It was aimed at adopting a holistic approach to nature conservation by providing for the needs of the current human population whilst ensuring the long term survival of representative natural biota of the area.

A preliminary study was conducted to: provide a basis for a more detailed vegetation survey; to assess the current public open space areas and to determine the land use history of the area. The vegetation was categorised into 14 community types and mapped to provide the basis for more detailed sampling. A survey of public open spaces revealed that most of the public parks were not providing for the needs of the local residents and that nature reserves and sports fields were more popular than conventional public parks. The land use history study revealed that the study area has been utilised for: cultivation; grazing; market gardening and more recently residential and industrial development purposes.

A vegetation survey using phytosociological methods revealed that the vegetation in Queensburgh was dominated by alien invasive plant species although pockets of indigenous vegetation did occur. Drawing from the principles of reticular biogeography an open space system was designed using the information gained from the vegetation survey and preliminary study. The design included: 4 core areas where conservation was a priority; 3 corridors linking the core areas and a number of buffer areas. A general management plan was subsequently developed for the system. Management suggestions were concerned with: ecological; economical and sociological aspects.

The open space system offers Queensburgh the opportunity to contribute to the national reconstruction and development program (RDP) by upgrading the current standard of living of the local residents without compromising the natural resources available to future generations.

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CHAPTER ONE

INTRODUCTION

1.1 Urbanisation

Most of the current urban environmental problems are a result of two factors:

1) The increasing rates of urbanisation;

2) The attitudes to and perceptions of nature by urban dwellers (Kearney 1994).

Population growth is the most important factor effecting the rate of urbanisation (Lowe 1991). It is expected that, at the present rate of growth, by the year 2050, 10 billion people will inhabit the earth. As much as 97% of this growth will occur in developing countries (Wynberg 1992), where people will be living in cities comparable to the megacities of today (Lowe 1991).

Africa has the highest population growth rate and the highest rate of urbanisation in the world (Huntley, Sigfried & Sunter 1989). In South Africa, more than 40% of the population of 42 million live in the 4 largest metropolitan areas and the urban population is expected to reach 35.7 million by the year 2000. By which time 79% of the population will be urbanised (Huntley *et al.* 1989; Yeld 1993). Poor planning in the past has resulted in a shortfall of housing units in South Africa and an estimated 198 000 houses must be built per year for the next decade to clear the housing backlog (Yeld 1993). Associated with such large scale development are the provision of sufficient land and services which will ultimately place huge demands and stresses on the natural environment .

Durban is the epitome of a South African city. It is the fastest growing urban area in the country and second fastest growing city in the world (Bothma 1988). This is largely because of widespread migration from the rural areas and other towns of the province (Coovadia, Dominik, Walton & Wulfsohn 1993). Durban's population has more than tripled since 1973, and its population is expected to double by the end of the century (Huntley *et al.* 1989). It is realistic to assume that most of the increased population will be black Africans (Davies 1986), as most of he other race groups are already urbanised. Approximately half of Durban's population are currently housed in large unplanned settlements. These settlements have resulted in various types of environmental damage including impaired water quality, soil erosion and flooding of precariously sited shacks (Coovadia *et al.* 1993).

Much attention has therefore been focused on the need to provide levels of housing and infrastructure compatible with the requirements of a growing population. The implications that this rapid growth and development may have for urban conservation and the protection of natural areas within the city are considerable and will require an extreme effort to be made to integrate the processes of urban development and conservation.

1.2 Nature and city life

1.2.1 Introduction

Cities generate and accommodate wealth and they are the main centres for education, job opportunities, health care and cultural options (Yeld 1993). They are also massive consumers of resources and require large quantities of land, water, food, energy and raw materials (Wynberg 1992). In these areas: population, industry and energy are centralised; synthetic structures exist in ever increasing size and number, decreasing the area of natural soil surface and the amount of natural vegetation, causing rain water to more rapidly run off; air and water pollution increase and the isolation of humans from all other biota is promoted (Numata 1975).

Although cities have been in existence for between 6000 and 8000 years (Mumford 1961) and large industrialised urban areas for 200 years (Sjoberg 1965) only in the last three decades has there been a growing awareness of the need to consider ecological processes in urban design and management (Hough 1984). This can be attributed to the alienation of urban society from environmental values and cultural connections with the land (Hough 1984). What follows is an attempt to explain this alienation by reviewing the trends and values in urban landscape design that have shaped the physical landscape of todays cities.

For the purpose of this thesis urban open space will refer to all vegetated areas within the city and include private or public gardens, parks and other recreational grounds, institution grounds, cultivated, derelict and undeveloped land, and even roadside and railway verges within the city (Poynton & Roberts 1985).

Five major phases can be identified in urban open space design:

1) The exclusion of nature from urban areas;

2) The incorporation of controlled nature into urban design;

3) The incorporation of amenity and recreation orientated open space into urban design;

4) A combination of controlled nature and amenity and recreation orientated open space;

5) The recognition of ecological process in urban design.

1.2.2 The exclusion of nature from urban areas

The physical exclusion of nature from the city first appeared in the ancient Greek and Roman cities where extensive walls surrounded the city. Hence the city provided a place of security where the forces of nature could be curtailed if not escaped (Mumford 1961; Sjoberg 1965). People tended to have an innate fear of nature which originated when people experienced floods and droughts and other ecological disasters and associated these dangers with nature. The open space that was included in these cities functioned to serve the community in various ways, but did not incorporate nature into the urban environment. Open spaces were normally built areas encompassing little, if any greenery (Bacon 1974). Although these ancient cities had clearly defined limits (Morris 1979), the town and country were in close knit and city life was always conscious of its natural background (Gallion & Eisner 1983).

1.2.3 Controlled nature and city design

The incorporation of controlled nature into city design was first evident in the Rennaissance and Baroque cities when public gardens with manicured lawns and formalised plantings were introduced (Gilbert 1989). This trend persisted in the designs of the Picturesque and Gardenesque periods, the utopian city designs of the 19th century and more recently in some 20th century urban designs. It is an important trend as it is still evident in many cities (Roberts 1990). These designs were aimed at greening the city through the construction of parks, gardens, green belts and leafy suburbs and were meant to provide a sense of scale and aesthetic pleasure to the people who lived in the cities. They were not aimed at conserving nature and the open space areas contained mostly exotic plant species (Mumford 1961).

1.2.4 Amenity and recreation orientated open space

Amenity and recreation orientated open space areas were introduced in the medieval period in the form of large back yards. This was a result of the wars raging in the surrounding countryside which restricted many of the activities of the people to the confines of the city (Gallion & Eisner 1983). During the Industrial Revolution open spaces were included in urban design as a direct revolt against the "ugliness" of these cities and culminated in the creation of extensive urban parks (Abrams 1965; Crouch 1981; Jackson 1981). Although these parks may have been aesthetically pleasing they had low ecological value.

1.2.5 A combinaton of controlled nature and amenity and recreation orientated open space

The city design proposed by Ebenezer Howard is characterised by an attempt to combine controlled nature and amenity and recreation orientated open space (Mumford 1961). He contributed a new pattern for city development that would use modern facilities to break down the widening gap between the countryside and the city. He proposed to do this by decentralising city functions and reintroducing into city planning the Greek concept of a natural limit to city growth in terms of limited areas and numbers. To achieve and express this reunion of city and country Howard surrounded the new city with an agricultural green belt. The function of the green belt was to give back to the city fresh air, sunlight and beauty. However, Howard failed to realise the lure of the metropolis (Mumford 1961). Many people regard Howard's approach to the life and growth of cities doomed to failure by the very nature of the expanding technological economy. However, people living in these New Towns are today living in far superior physical and ecological conditions to those endured by the majority of city dwellers. The quality of nature in Howard's city was questionable. It is apparent that although Howard recognised the need for green areas in the city he did not aim at incorporating nature into city design. These green areas consisted of agricultural zones and the sole reason for Howard's design was to improve the city by creating a more appealing environment. The conservation of natural resources was never an objective. Besides their recreational and supposed aesthetic value they had no functional ecological purpose, and rather than depict the "natural" surroundings of the city, were either synthetic substitutes or contained ecologically unsuitable exotic species. A lack of affiliation between the city and countryside existed and a disregard for the natural resources that permitted the development of cities was evident.

1.2.6 Ecologically orientated open space

Fredrick Law Olmsted and Calvin Vaux introduced ecologically orientated open space planning in the late 19th century (Roberts 1990). Their design for Central Park, New York maintained half the park site in its natural condition. Olmsted also regarded the creation of isolated parks as inappropriate and stressed the need to integrate all of the open space within the city. This functioned to create a larger, more effective area where the conservation of wildlife would be viable. He also suggested possible solutions that ecological processes could have for the problems faced by the city. Olmsted went on to realise the need for a scientific data base from which planning decisions could develop in addition to the need to balance human requirements with those of nature. These progressions in the perception and planning of nature were revolutionary and are evident in many successful open space plans today (Roberts 1990).

1.2.7 Conclusion

Throughout history, little attention has been paid to the understanding of natural processes that contributed to the physical form of the city and which have been altered by it. The aesthetic values and formal doctrines from which parks and open spaces have evolved have little connection with the dynamics of natural processes and have led to the establishment of misleading priorities. Recreation and amenity are seen as the exclusive functions of city parks. Horticultural science rather than ecology, determine their development and maintenance. Although the world is becoming aware of global environmental crises not enough attention is being paid to conservation in the city (Hough 1984).

1.3 Why conserve nature in the city?

1.3.1 Introduction

Aldo Leopold (1933) introduced the concept of "conservation" as a movement to prevent the deterioration of the environment by properly managing all natural resources. Many and varied definitions of conservation have ensued (Soulé & Wilcox 1980; Soulé 1985; Briffett 1991; Holmberg, Bass & Timberlake 1991) that seem to converge on two points (Aplet, Laven & Fiedler 1991): that the diversity of organisms is good and that humans should act to protect this diversity. What follows is an attempt to verify this statement in the urban context by expanding on the significance of conserving nature in the city.

1.3.2 Economics

It is often assumed that economics must go against the grain of environmentalism and will thwart environmental goals (Shaw 1991). However, the economy and the environment are inextricably linked. A sound economy can not be based on a damaged environment and natural resource base (Yeld 1993). Benefits to the society from protected areas are often underestimated because financial returns are economically inadequate, and the costs of protection appear large in comparison (Dixon & Sherman 1991).

Economic benefits of urban vegetation have been quantified for some direct and indirect benefits (Rolston III 1981; Smardon 1988). Appraises and property owners pay more for properties with trees and which are adjacent to urban parks and open space areas. Studies have shown that the presence of trees on developed residential lots contributed up to 12%, and on undeveloped land up to 27%, of the estimated market values (Kitchen & Hendon 1967; Payne 1973; Smardon 1988). It is also significant that the costs of establishing and maintaining natural areas are substantially lower than those incurred for conventional parks and gardens. Increased plant and animal diversity can therefore be attained at less cost in terms of both money and energy. Provided that the areas are managed well another source of income could be sustained by the harvesting of certain plants (Dazhong, Yingxin, Xunhua & Yungzen 1992). Timber could be collected from the clearance of undesirable tree species whilst other plant species could be sustainably harvested and sold as "muthi" plants.

1.3.3 Aesthetics

Although people's perception of what is beautiful may vary, most people find "green" areas in cities aesthetically pleasing (Tivy & O'Hare 1982). These areas render the city a pleasant place in which to live as well as a sought-after destination for tourists (Director of Parks, Beaches and Recreation 1989; Ehrlich & Ehrlich 1992).

1.3.4 Recreation

Recreation is important for relaxation, sport and other social functions such as building morale (Rolston III 1981; Hough 1984). Recreation in the city can be active or passive. Active forms of recreation include activities comparable with running, playing football or hiking whilst passive activities include bird watching, picnicking or sitting in a park. Public open space areas are also a means of perpetuating, in sport form, the more virile and primitive skills in pioneering travel and experience. They can provide a series of sanctuaries of primitive arts of travel, for example back packing (Leopold 1949). Income gained from the hiring of facilities can then be redistributed according to the needs of the community.

1.3.5 Environmental quality

In recent years there has been much concern about environmental deterioration (Bilsborrow & Okoth-Ohendo 1992). Pollution control is crucial to the maintenance of environmental quality. Natural areas in cities can help reduce the amount of air, water and noise pollution (Givoni 1991; Ellis, Shutes, Revitt & Zhang 1994):

1) Plants can enhance the deposition of dust and they also remove sulphur dioxide and heavy metals from the atmosphere via dry deposition and contribute oxygen (Hough 1984; Ehrlich & Ehrlich 1992);

2) Water pollution is reduced by natural water courses, particularly those with water plants, which are self cleansing as a result of aerobic decomposition of organic pollutants (Givoni 1991);

3) Vegetation absorbs noise from industrial areas and highways.

Natural areas also reduce the occurence of urban heat islands. Plants increase transpiration and do not reflect as much heat as the building materials used in urban areas. In addition they use up energy that would otherwise be converted to heat energy, further contributing to the heat island (Hough 1984).

1.3.6 Stormwater management

Run-off after heavy rains and floods can cause excessive damage to city areas including: the destruction of houses and infrastructure; increased rates of soil erosion and sedimentation and the loss of plant and animal life and habitats. Open space areas have the potential to reduce the occurence of these disasters by promoting the infiltration of water into the soil (Dixon & Sherman 1991; Givoni 1992).

1.3.7 Biodiversity

The maintenance of biodiversity is a popular argument used to promote the protection of natural areas in cities (Dixon & Sherman 1991). Although much effort is presently devoted to conserving biodiversity very few people are actually fully aware of the arguments supporting this action. Biodiversity is a term that describes the degree of variation in the biota of a particular area (Linder 1994). This variation may be taxonomic, phylogenetic or functional (Linder 1994).

Fundamentally biodiversity is important because of the interdependence of nature. If each species is part of an ecosystem, the loss of one part may lead to instability of the whole (Chaplin III, Schulze & Mooney 1992). In addition, the more species in a community often the greater its resilience to perturbation so that conserving species will maintain the ecosystems continued existence (Walker 1992). Species are also valuable genetic resources (Schnoor 1993). Potential uses include the selecting of natural biological control chemicals to control pests. The scientific and cultural value of diversity must not be overlooked since, among other things, this allows for the application of the comparative method to understand evolution and adaptation, and also provides the inspiration and raw materials for making art, music and literature. Finally, the aesthetic or collector's urge to preserve all rarities which has incredible public appeal and can be used in fund raising campaigns (Bond 1989; Burton, Balisky, Coward, Cumming & Kneeshaw 1992).

1.3.8 Education

The educational value of natural areas is undisputed (Hough 1984, Roberts 1990). It creates an awareness among inhabitants of the natural processes operating in the urban environment and emphasises the fact that an acceptable quality of life is dependent on the way the environment is treated. Formal education includes activities that are related to national and institutional curricula. Natural areas can facillitate the learning of all aspects of environmenal science and in many curricula such study will seek to teach fundamental skills such as mathematics and communication (Castri, Baker & Hadly 1984; Dixon & Sherman 1991). Environmental studies in the United Kingdom National Curriculum is a cross-curricula activity and, by law, lower schools must have access to open space (Cooke pers. comm. 1994). Informal education incorporates any learning experience outside of these boundaries.

In South Africa the education system has largely ignored environmental principles resulting in a society that has become accustomed to living with little regard for the natural environment and understanding the links between survival of humanity and conservation of the natural world. Environmental education therefore needs to be centered on the understanding of environmental issues on local, national and global scales. It should also enable all citizens to acquire the neccessary understanding of ecological processes enabling them to make informed choices and decisions about the use of the environment (Yeld 1993).

1.3.9 Community involvement

For any conservation project to be successful it must involve local communities at all levels of decision making from planning to implementation (Yeld 1993). Natural areas have the potential to encourage community involvement. People in a community, working together to maintain a mutually beneficial area of land, will develop a range of social and communication skills and it has been demonstrated that maintenance of communal grounds can enhance community values of the improved physical surroundings of low-income areas which has resulted in a reduction in vandalism (Hough 1984; Hough 1991). In South Africa, community work groups have been involved in various conservation projects including the Durban Metropolitan Open Space System and Johannesburg's Co-ordinating Committee for Community Open Space (van der Merwe 1986).

1.3.10 Philosophy

Another approach to resource conservation is that which breaks away from our anthropocentric traditions and argues for the moral considerability of the non-human world (Fox 1990). The basis of this philosophy is that no living organism should be exploited as it is morally unacceptable (Fox 1990). The people supporting this philosophy have been termed the intrinsic value theorists (Evernden 1984; Norton & Roper Lindsay 1992).

Leopold (1949) explains the conservation system in terms of an ethical sequence. He suggests that ethics, since it provides limitation on the freedom of action in the struggle for existence, is possibly a kind of community instinct in the making. The "land ethic" enlarges the boundary of the human community to include soils, waters, plants and animals or collectively the land. The land ethic therefore affirms the right of resources to continued existence in a natural state and changes the role of *Homo sapiens* from conqueror of the land community to a member of it.

There is, however, another approach in which the conception of "self" is much broader (Evernden 1984; Naess 1989; Fox 1990). This approach differs from the former in that there is no moral obligation to conserve nature. It is based on the philosophy that all living things are interdependent and therefore to ensure self survival all else must be preserved. Naess (1989) distinguishes between shallow and deep ecology in his discussion of the Ecosophy concept. He believes that environmental problems can only be solved by people who will be required to make value judgements in conflicts that go beyond the narrowly conceived human concerns. He sees humanity as being inseparable from nature, thus anything we do to "harm" nature actually damages ourselves. If we are to exist fully we cannot destroy nature. His philosophy considers the abandoning of the concept of what nature can do for humans. He is not as much interested in ethics and morals rather in how we experience the world (Naess 1989). A more emotional stance, on basically the same concept was taken by Macy (1990). She believes that all life on our planet is interconnected. In order to "green" oneself the conventional concept of self needs to be replaced by wider constructs of identity and self interest. Instead of seeing oneself as a person trying to save a rainforest we should believe that we are part of that forest and we should suffer the pain as if we ourselves were being destroyed.

1.3.11 Conclusion

It is evident that there is a considerable need to conserve nature in the cities. Although most city dwellers are aware of diminishing natural resources it is their isolation from fundamental environmental processes in their immediate vicinity that alienates them from these problems. Reducing the pressures on our vanishing resources will require commitment from people from all walks of life. Nature in the city is the only way that these people can reinforce their bonds with nature and truly understand the environmental problems that face the world today (Roberts 1990). The significance of the philosophical environmental conservation concepts should not be underestimated and it is likely that conservation strategies in the future will seriously consider the concept of humanity and nature being intricately connected. It is, however, suggested that in a developing country like South Africa, the more practical "selling points" promoting urban nature will have to be employed. This will necessitate the promotion of economically-viable conservation strategies as well as those which deliver short term results with obvious benefits to the local human community.

1.4 City Open Space Systems - an ecologically-orientated design option

According to Cole (1983), the three main objectives of urban nature conservation can be defined as follows:

1) To conserve and press for the appropriate management of urban sites of intrinsic natural history value;

2) To increase the habitat diversity of formalised areas of public open space;

3) To create new wildlife habitats on downgraded and derelict sites within the inner city.

These objectives can only be achieved if ecological processes form the basis for the design of natural areas (Hough 1984; Gilbert 1989; Jiang, Huang & Lin 1992). Incorporating ecological processes into design can also make natural areas economically feasible which is a highly regarded attribute in the economically-centred society that urban areas have become. Furthermore, if ecological processes are considered in design, human development could have a positive impact on the environment by creating more diverse habitats, energy flows and nutrient pathways (Hough 1984).

Current designs for urban open space areas are tending towards ecological and conservation-based networks. This transition in design has occurred because urban areas are expanding and the exclusion of conservation practices from these environments may result in species extinction (Gilbert 1989). Many plant and animal species are now endemic to urban areas and open space planning must provide for the habitat requirements of these species (Roberts 1990). Furthermore, linkages between open spaces increase the effective conservation area by providing dispersal corridors for plants and animals especially if habitat connections are maintained with the surrounding natural areas.

The long term success of projects aimed at nature conservation in urban environments necessitates the design of open space systems whose goals seek the maximum sustainable number of species by conserving areas of both unique and diverse systems of indigenous fauna and flora (Poynton & Roberts 1985; Roberts 1990). It would be optimal to conduct comprehensive ecological studies as a basis for the design of such systems, however, time constraints usually prevent this process. The design of open space systems is therefore usually based on a vegetational surveys. Vegetation is often the most recognised component of an ecosystem and may provide a yardstick by which the rest of the ecosystem components can be measured (Mucina 1990). In the urban context plants are also effective indicators of the environmental conditions. Disturbance, induced by both natural and human factors can be recognised by changes in the plant community (Gregson, Clifton & Roberts 1994). Usually open spaces within cities are highly fragmented. The metaphor commonly used to visualise this scenario is that of natural "islands" in a "sea" of urban development. MacArthur and Wilson's (1963) Equilibrium Theory of Island Biogeography has thus been used by various workers to design urban nature reserves.

The theory attempted to explain what the authors considered the three basic characteristics of insular biogeography: species number increases with increasing island size; the number of species decreases with increasing distance to the nearest source; and a continual turnover of species occurs but the number of species remain the same. MacArthur and Wilson's (1963) also proposed that the number of species inhabiting an island represents an equilibrium between opposing rates of colonisation or extinction.

Although the theory was widely accepted considerable doubt surrounds the biological basis of the species-area relationship notwithstanding its doubtful conservation implications. In light of these criticisms its widespread application to the problems of biogeography and conservation would be inappropriate (Gilbert 1980).

The theory did, however, contribute to Reticular Biogeography as it formed the basis for the development of Diamond's geometric design principles for nature reserves (Diamond 1975). Reticular biogeography is the term used exclusively to refer to the study and design of viable conservation networks within fragmented landscapes (Roberts 1990).

Diamond's geometric design principles (Figure 1.1) can be reduced to three basic concerns:

1) The benefits of increased size of reserves;

2) The best spatial arrangement of a system of reserves and;

3) The optimal shape of reserves.

Diamond's principles have been widely used in the design of reserves and even though criticisms of the principles do exist no workable alternatives have been suggested by the critics (Hobbs 1992; Villa, Rossi & Sartore 1992; De Santo & Smith 1993).

Design A (Figure 1.1) indicates that a large reserve is more beneficial than a small reserve. This has never been disputed. However, in the urban context where financial resources are limited there may be cost benefits in not conserving as large an area as possible. Design B (Figure 1.1) suggests that one large reserve will conserve more species than a group of smaller reserves of the same total area. There has been much supporting evidence for this design rule (Gilbert 1980; Shaffer 1981;

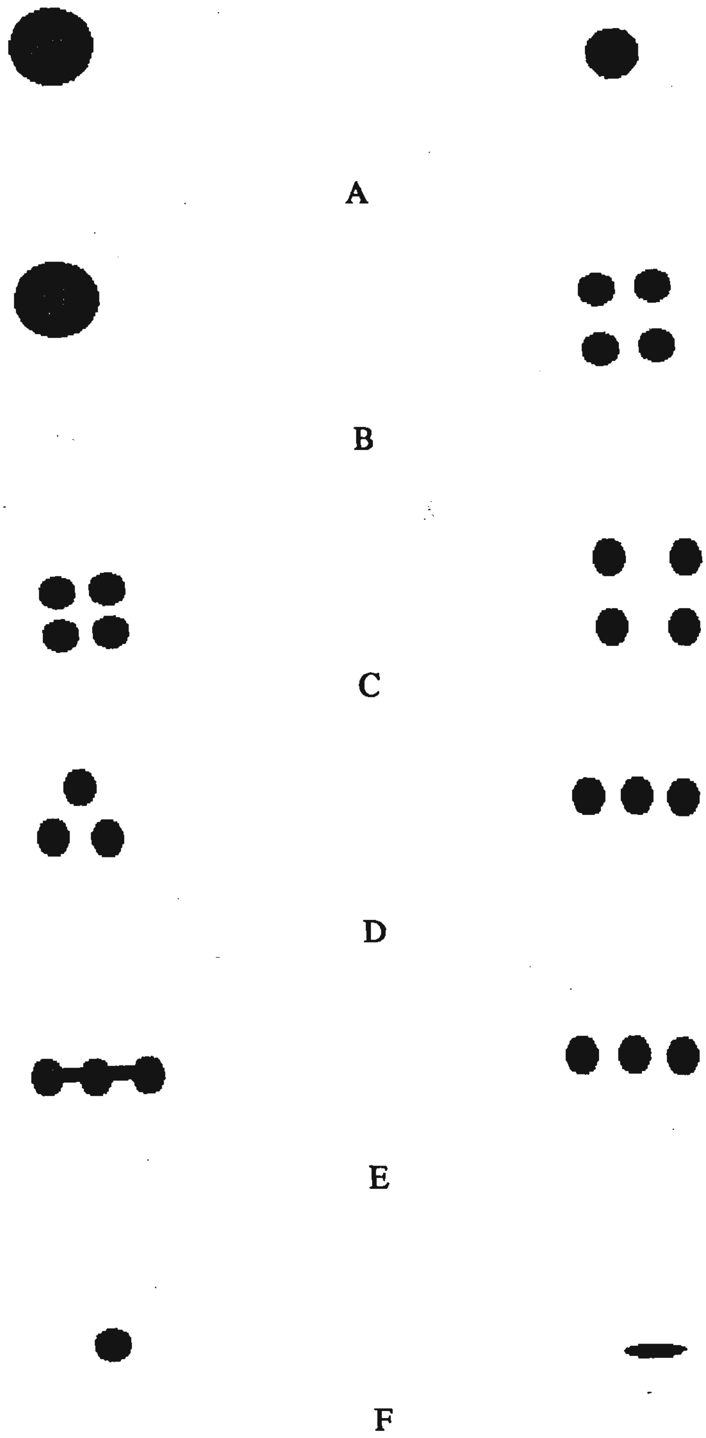

Figure 1.1: Diamond's Geometric Design Principles.

Simberloff 1982; Simberloff & Abele 1987; Soulé & Simberloff 1986). If extinction rate is area dependent (Diamond 1975) then part of the justification for this design rule is that one large area will result in fewer extinctions than several smaller areas. Furthermore there exists a critical population size for every species below which extinction is very rapid and one would expect that smaller islands have higher extinction rates irrespective of habitat diversity simply because more of their species will have population sizes below this critical size (Roberts 1990).

Designs C and D (Figure 1.1) assume that local immigration between reserves is important in maintaining species richness, and that local immigration between areas of homogenous habitat will be increased by closer proximity of the sites. This will help overcome the effect of localised extinctions. There is, however, little evidence on the effect of immigration and isolation in maintaining species numbers in reserves.

Design E (Figure 1.1) is aimed at showing the advantage of corridors or links between reserves. They are meant to function as routes for local dispersion. Continuity between reserves can therefore be seen as a way in which to increase the effective area of a reserve system. In doing so ecological diversity and stability are promoted (Diamond 1975; Wilson & Willis 1975; Simberloff & Cox 1987; Harrison 1992; Simberloff, Farr, Cox & Mehlman 1992).

Design F (Figure 1.1) suggests that if a reserve is too elongated or has peninsulas, dispersal rates to outlying parts of the reserve from more central parts may be sufficiently low to perpetuate local extinctions. It has been argued by Game (1980), however, that non-circular reserves may have both higher immigration rates and extinction rates, and that the optimal shape will depend on a balance between these two factors. Long perimeters decrease the effective area of central habitat and reserves with long edges may have proportionally fewer species characteristic as the central area. Thus edge species will benefit from reserves with high perimeter to area ratios. Cognisance should be given to the fact that many edge species fare well in non reserve habitats and it is the edge-intolerant species which are the most dependent on reserves for survival (Yahner 1988). Empirical evidence for the effect of reserve shape on local extinctions within reserves or on the rates of immigration and extinction between reserves is lacking (Higgs 1981).

1.5 General background to the development of an open space system for Queensburgh

1.5.1 Introducation

One of the major problems with ecological studies in the past is that the problems in cities, factories, farms and forests etc., have been largely ignored by ecologists who endeavour to comprehend natural and unspoiled ecosystems (Bradley & Lewis 1992). As a result, ecology has contributed to a widespread but false impression that it is the more remote areas that most require protection. This factor has helped to obscure the obvious: that people are increasingly recognised as the dominant force in most ecosystems, and various socioeconomic processes are ecologically relevant. An integration of sociological aspects into ecological studies is therefore necessary.

The loss of biodiversity in the urban and periurban areas of developing countries throughout the world has, however, recently generated much concern. These countries are characterised by high population growth rates resulting in rapid urbanisation, housing problems and ultimately decreasing amounts of land being available for conservation (Bilsborrow & Okoth-Ogendo 1992).

1.5.2 Environmental protection in South Africa

In South Africa current government policies are centered on an increase in the standard of living for the majority of the population (Roberts 1994 pers. comm.). Sustainable development of the country's natural resources is being promoted. Sustainable development means development that meets the needs of the present population without compromising the ability of future generations to meet their needs (Yeld 1993). For conservation projects to be implemented they must therefore provide suggestions for improving the present quality of life of the local population as well as protecing natural resources for future generations.

1.5.3 Durban and the development of D'MOSS

Durban is the fastest growing city in South Africa and houses almost half its population in squatter developments on the urban periphery (see section 1.1). These problems are exacerbated by the fact that the Durban Functional Region (DFR) is positioned in an extremely well developed and diverse biogeographical transition zone between tropical and temperate faunas and floras (Roberts 1993).

The expansion of the city is threatening the survival of the biological diversity of the DFR for future generations of urban dwellers. A growing awareness of this crisis prompted the development of the Durban Municipal Open Space System (D'MOSS) programme. D'MOSS is a holistic approach to planning whereby natural vegetation forms an integral part of the urban landscape and has made Durban a world leader in urban conservation. D'MOSS is an open space system that has been designed for the Durban Municipal area. It is aimed primarily at the preservation of indigenous plant and animal communities but also considers the social, recreational, educational and economic requirements of the local human population.

In urban environments, areas of natural vegetation are generally fragmented by building developments. The design of the D'MOSS system was therefore aimed at maintaining links between remnant patches of original vegetation and towards restoring open areas which have been disturbed, to their previous natural state (Director of Parks, Beaches and Recreation 1989).

A thorough investigation of the vegetation in the open space areas preceded the use of biogeographic principles as a basis for the design of the system. Biogeographically, Durban is situated in a transition zone between the tropical subtraction zone extending south from Mozambique and the afro-temperate subtraction zone extending north from its core in the Cape (Roberts 1990). Many of the local plant and animal species are nevertheless endemic and habitat destruction in the Greater Durban Area will result in the extinction of these species.

Diamond's Geometric Reserve Design Principles (Figure 1.1) were used as a basis for the design. Three categories of open space are included in the D'MOSS structure plan: cores, corridors; and buffers (Roberts 1993). Core areas are dominated by indigenous communities or show significant signs of active regeneration. Dispersal corridors function as habitat links between core areas. Buffer areas have the potential to be natural habitat islands if they are used effectively to favour species composition and diversity through programmes of naturalisation and natural habitat reclamation.

1.5.4 Towards a regional open space system

A recent study (Roberts *et al.* in prep.) highlighted the present shortfalls in the planning of urban open space systems. The need for a regional planning initiative, the development of centralised data banks and detailed environmental surveys of the remaining open spaces as a prerequisite to the appropriate holistic planning of this resource base, was underscored.

Bearing these considerations in mind the long term ecological survival of an open space network like D'MOSS necessitates its application on a regional rather than municipal scale (Roberts pers comm.). There is a need to consider the continuity of the landscape. Nature is not restricted to municipal borders, and any effort to conserve natural areas should therefore be primarily concerned with the conservation of the landscape as a whole. The unique biogeographical position of the greater Durban area (see section 1.5.3) also requires the operation of the system on regional scale.

Queensburgh Municipality borders Durban and would therefore provide a logical option for an extension of the open space system. Queensburgh also contains many extensive natural areas in the valleys of the Umbilo and Umhlatazana rivers which are currently being threatened by proposed industrial and residential developments.

1.6 Study area

1.6.1 Introduction

Queensburgh is situated in the centre of the Durban Metropolitan Area. It is an 18km^2 borough located approximately 15km from the centre of Durban between 29 51' 05" and 29 54'35" south and 30 51'45" and 30 56'15" east (Figure 1.2). Queensburgh is divided into four suburbs: Malvern, Escombe, Northdene and Mosely which are bisected by the M7 freeway and the railway line (Figure 1.3). Other

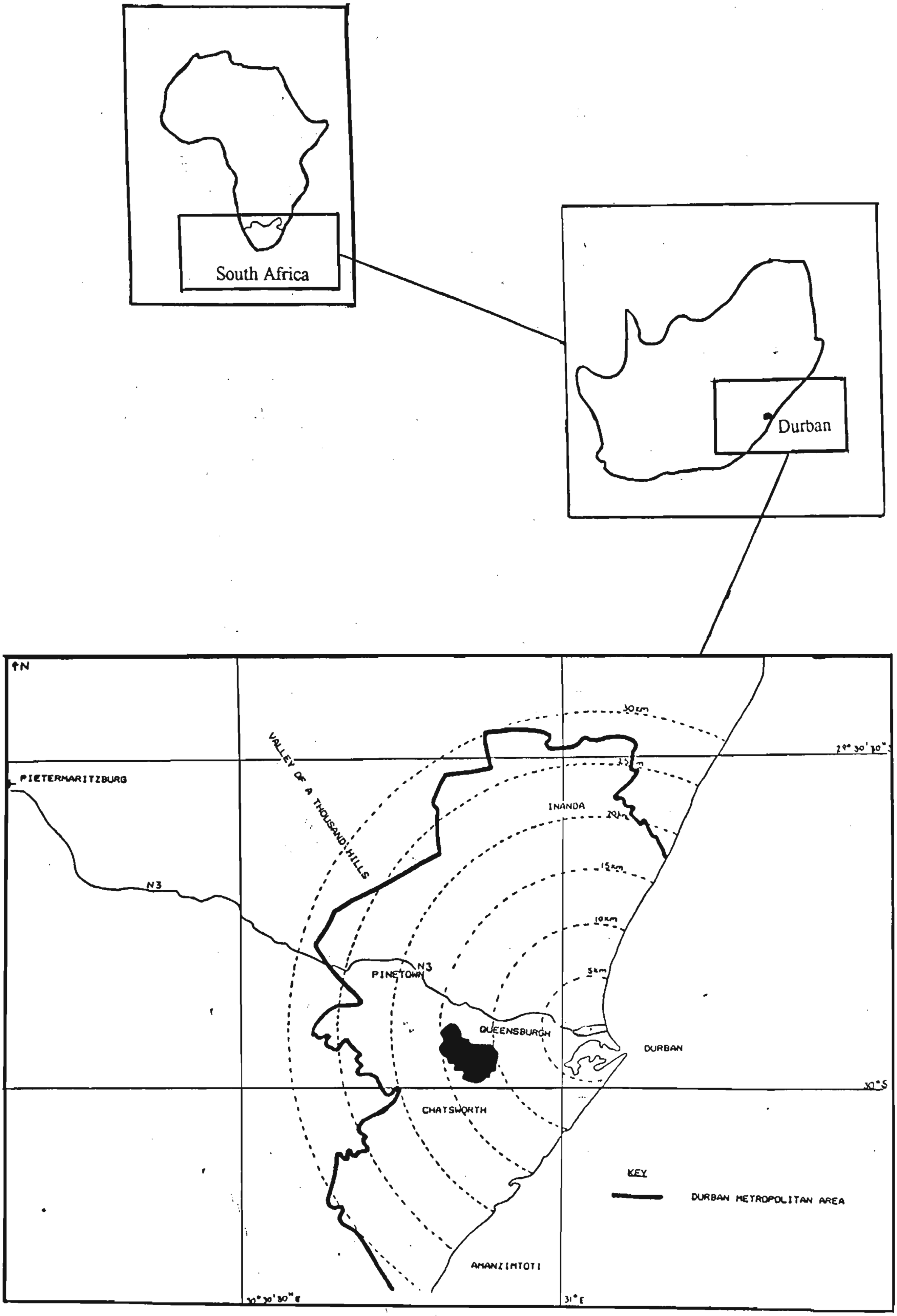

Figure 1.2: Location of Queensburgh.

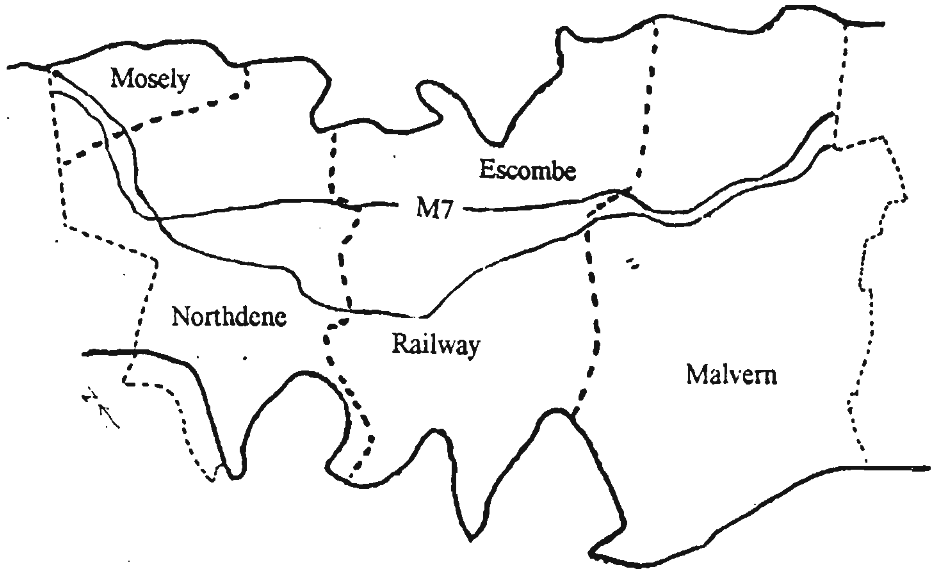

Figure 1.3: Queensburgh consists of 4 suburbs and the most noticeable features of the area are: the Umbilo and Umhlatazana rivers; the M7 freeway and the railway line.

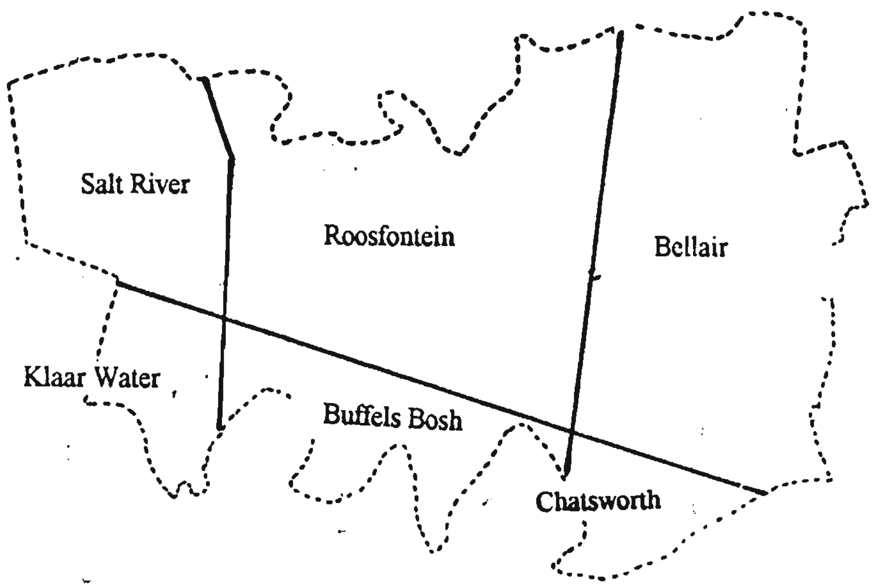

Figure 1.4: Queensburgh was situated on 6 farms: Salt River; Roosfontein; Bellair; Klaarwater; Buffels Bosh and Chatsworth.

prominent features are the Umbilo and Umhlatazana rivers which demarcate the northern and southern borders of the borough respectively .

1.6.2. Historical Outline

Queensburgh was siuated on 6 large farms during the middle of the nineteenth century (Figure 1.4). The land was gradually subdivided and sold. The first houses, in what was then known as Upper Malvern, were built by retired British Army Officers. The high lying areas between the two rivers were preferred for development. Natal Railways extended a line through the area in 1878. Malvern Station was established which led to the first commercial developments, a store and a hotel. (English 1950; Kloppenborg 1994 pers. comm.)

In the early days the railway line and Main Road served to link Queensburgh to Durban, Pinetown and Pietermaritzburg. When the N3 through Westville was built, Queenburgh lost the development advantages that accompany a location on a main communication axis (DeLeuw Cather 1992). Queensburgh has, however, grown substantially in the last 50 years as a residential town with a small light industry sector, and now has a population of approximately 25 000.

1.6.3 Climate

Situated 213 metres above sea level, Queensburgh lies above the humidity belt of the Natal coast. The average temperature is 23^{0} C during the summer months and 16.4^{0}

C during winter. Although the majority of the rain falls during summer, averaging 104 millimeters/month, winter months are not without rainfall, averaging 36 millimetres (South African Weather Bureau 1994).

1.6.4 Topography, geology and soils

The topography of Queensburgh is characterised by the deeply incised steep sided river valleys of the Umbilo and Umhlatazana rivers. The outward tilting of the coastal margin in Quaternary times and the geology of the region have led to the formation of the valleys. The plateau between the valleys is undulating and the topography rugged (DeLeuw Cather 1992). The topography has resulted in significant areas being steeper than 1:3 and not suitable for development. Approximately one third of the 333ha of vacant land is in this category (Figure 1.5).

Table Mountain Sandstones are the dominant underlying rocks although some Dwyka Tillite occurs in the extreme north-east of the borough. Sandy soils predominate with some clay occurring as the result of weathering of the dolerite and other basic rock intrusions (King & Maud 1964).

1.6.5 Natural Landscape

The natural environment is dominated by the steep river valleys of the two major rivers and their tributaries. Although no previous vegetation studies have been conducted in the area it is immediately apparent that Queensburgh is a well "treed" urban area with the vacant land being dominated by secondary vegetation. There are, however, pockets of visibly undisturbed indigenous forest vegetation on the steeper slopes. Detailed descriptions and discussions of the natural vegetation have been reserved for subsequent chapters.

1.7 This research project

This thesis describes the process research conducted in developing an open space system for Queensburgh. It has been structured in the order of the fundamental stages in the overall procedure. This has necessarily compartmentalised the research into sections whereas in practice the research is an integrated process and continual feedback is important and occurs at various points.

The aims of the project were:

1) To design an open space system for Queensburgh that will primarily secure the conservation of specific biotic communities that are representative of the natural status of the area; and

2) To adopt a holistic and long term approach to conservation by ensuring that the secondary functions of the system include: economic viability; provision of an educational and recreational facility for the local community; prevention of further deterioration of the existing landscape; improvement of already degraded areas;

increasing the public awareness of the need for conservation and the promotion of the use of open space.

Four basic stages have been recognised to achieve these aims (Figure 1.6).

Appropriate data which would form the basis for subsequent research were collected. The objectives of this process were to supply preparatory information required for a subsequent vegetation survey and to contribute the supplementary information necessary to: prioritise areas to be conserved; develop general management strategies; and ultimately design an open space system which can be modified as additional or updated information becomes available. This forms the preliminary study.

A vegetation survey was conducted in the second phase of the project. This research was aimed at describing and mapping the vegetation communities of the study area. This information could then be used as a basis for the design of the open space system.

Basic biogeographic design principles were employed to design the open space system. The design was based on the results of the vegetation survey although relevant data from the preliminary study were also considered.

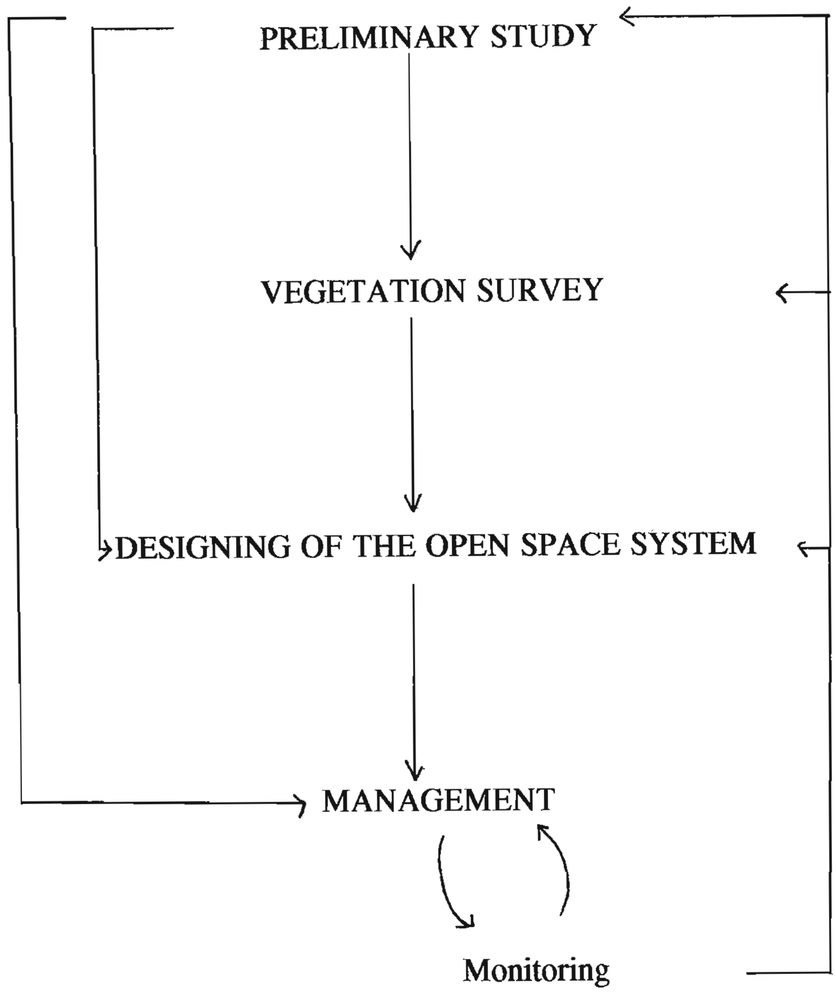

Figure 1.6: A diagrammatic representation of the processes involved in the development of an open space system for Queensburgh.

A management strategy aimed at ensuring the long term ecological, social, economic, educational and recreational functioning of the open space system was compiled. A monitoring system has been included to make provisions for inevitable design changes and to facilitate decision making by management.

The thesis structure was determined by the procedure outlined above. Chapters 2,3,4 and 5 detail the preliminary study, vegetation survey, design of the open space system and management strategy respectively. A final chapter (Chapter 6) containing a general discussion has been included.

CHAPTER TWO

PRELIMINARY STUDY

2.1 Introduction

The availability of information pertaining to the system being planned determines the level of primary data collection required. Similarly, not all the information available will be relevant. An effort was therefore made to obtain appropriate data which was detailed, accurate and comprehensible enough to form a reliable basis for the planning and management of a multi-purpose open space system. This approach is inductive as it is an attempt to develop knowledge, generate hypotheses or derive general statements from specific data (Roberts 1990).

The preliminary study consisted of the following:

1) Reconnaissance of the study area;

2) Research of past land uses and human influences;

3) Evaluation of present ownership and management;

4) Assessment of currently zoned public open spaces.

2.2 Reconnaissance

2.2.1 Introduction

The preliminary inspection of the study area, or reconnaissance, prior to sampling can have various objectives:

1) To familiarise the researcher with the floristic and environmental components of the study area (Werger 1974);

2) To permit mapping of tentative vegetation communities prior to sampling (Mueller-Dombois & Ellenberg 1974);

3) To establish access points and obtain permission from land owners.

The stratification process (preliminary vegetation mapping prior to vegetation sampling and classification) which concludes reconnaissance, is based on the perception of overall character and pattern in vegetation and is therefore highly subjective. It requires the balancing of relative similarities and dissimilarities, and apparent correlations with factors that seem important to the observer (O'Callaghan 1989). The stratification process is critical because the sampling intensity of the plant communities, using the Braun-Blanquet approach, is far too low for the community borders to be defined by the sampling units, without some form of stratification (Westfall 1992). Furthermore it ensures that each vegetation unit is represented in, and allotted specific portions of, the total sample (Freund & Williams 1958). Once the stratification of the vegetation is complete the different plant communities are essentially defined, therefore, the importance of a thorough reconnaissance and familiarisation before sampling is considerable (Roberts 1990).

2.2.2 Materials and methods

Maps were used extensively in this study and it was therefore important to establish an appropriate scale at which to work. Scale determines the maximum detail that can be obtained with a particular study and is dependent on the aims of the study (Westfall 1992). Kuchler (1967) said it was impossible to determine categorically which scale is best but it should be around the same scale as the final map. Since the Queensburgh Municipality uses a 1:5000 cadastral series this scale was considered optimal. This scale should also provide sufficient ecological data to permit comprehensive open space planning.

All open spaces including zoned public open spaces, vacant land, large road and railway verges and undeveloped land were located using base maps, aerial photographs and orthophotos. Field work confirmed the locality and boundaries of all sites.

Aerial photographs are an essential feature of vegetation mapping (Colwell 1964). The advantages of using them include reliability, favourable vantage point, minuteness of detail and completeness of coverage, ease of interpretation, opportunity to extend the limited grounds of observation, ease of measurement and location of source of error, suitability for comparative studies and making discrete appraisals. They are also economical and facilitate the tracing of vegetation boundaries of individual vegetation units therefore save time (money) and increase the accuracy of mapping (hence value). The scale of the aerial photographs (dated 1981) used for this study was 1:1750 (4 times enlargement of 1:11 000 contact prints) which made them almost compatible with the 1:2000 orthophotos (dated 1974 and 1976) onto which the results of the preliminary study were mapped.

Orthophotos were also used because of the distortion of aerial photographs due to tilt and relief displacement. "Orthophotos are produced from perspective photographs (usually aerial photographs) through a process called differential rectification, which eliminates image displacements due to photographic tilt and relief"(Wolf 1974). An orthophoto is basically an aerial photograph showing images of objects in their true orthographic positions. By removing relief displacements from any photograph, scale variations are also removed and scale becomes constant throughout the photograph. They are planometrically correct and can therefore be used as maps for making direct measurements of distances, angles, positions and areas without making corrections for image displacements which cannot be done with perspective photographs (Wolf 1974; Roberts 1990).

Prior to stratification an estimate was made of the number of structural/floristic vegetation communities that existed in the study area. Although floristic sampling of vegetation can be concerned with the frequency or relative distribution of species it was decided to investigate the distribution of vegetation communities as this knowledge is essential for management purposes and would therefore yield appropriate information on which to base a management program for the open space system (O'Callaghan 1989).

This estimate was generated from information collected during field excursions and careful reviewing of available literature and maps. This process is required for stratification and need not be precise but an overestimate of communities is better than an underestimate (Westfall 1992).

Fourteen plant communities based on the species composition, vegetation height and habitat of the stand were defined (Table 2.1). A vegetation stand being "a concrete aggregation of plants of more or less similar uniformity in physiognomy, species composition, spatial arrangement and condition to distinguish it from adjacent communities" (Gabriel & Talbot 1984 cited in Westfall 1992). The classification of the communities was determined by the author although some communities resemble those described by Moll (1976), Cawood (1980), Acocks (1988) and Roberts (1990). This is, however, of secondary importance since these preliminary classifications are always open to question, no matter how carefully devised, how clearly designed, or how well proved (Kuchler 1967).

Data sheets (Figure 2.1) were completed at each vegetation stand. By systematically recording observations the scientific value of reconnaissance was increased (Westfall 1992). Much effort was placed on species identification as familiarity with common

Table 2.1: Preliminary plant community Classification Table (* alien plant species).

Name	Average Height (m)	Habitat	Indicator species * alien
Riverine	variable	bordering natural water courses	*Bridelia micrantha,Ficus natalensis,Syzygium cordatum*
Exotic valley veld	1-2	Umhlatazana river valleys	**Mangifera indica, *Eucalyptus grandis, *Melia azedarach*
Market gardening	3-7	variable	**Mangifera indica,*Litchi chinensis,*Carica papaya*
Grassland	0.5-1.5	dry slopes of valleys	*Aristida junciformis, Digiteria eriantha*
Valley bushveld	2-3	Umbilo river valleys	*Albizia adianthifolia, Erythrina lysistemon, Acacia spp.*
Bushveld	2	generally slope <1:3	**Lantana camara, *Chromolaena odorata*
Verge	1-2	road and railway verges	**Eucalyptus grandis, *Melia azedarach, grass spp.*
Parks	variable	variable, manicured	*Albizia adianthifolia, Mowed grass, Trichelia dregeana*
Coastal forest	3-5	valleys, slope >1:3	*Strelitzia nicolai, Protorhus longifolia*
Thornveld	1-2	dry slopes of valleys	*Acacia spp. Aristida junciformis*
Swamp	2-3	wetland	*Typha latifolia*
Cliff	variable	slope >1:10	*Aloe arborescens, Euphrobia spp.*
Physically disturbed	variable	variable	alien species
Eucalyptus plantation	>6	top of valleys	**Eucalyptus grandis*

A	Queensburgh Open Space System	

Kerry Seppings
445087/8163192

PRELIMINARY STUDY

Date:..

Area:..

Comments:..

....

....

Orthophoto no.:..

Comm. Type	Dom. Spp. (no.)	Disturbance

Figure 2.1: Data sheet used in preliminary study.

species would facilitate the vegetation sampling process. Any factors (biotic and abiotic) that may have influenced the vegetation were noted on the data sheet.

Each vegetation stand was then categorised into one the 14 predetermined categories and mapped onto the orthophotos. The most recent orthophotos of the borough of Queensburgh date back to 1976 for some areas and 1974 for others and the vegetation cover has changed substantially since then. The dissimilarity between the prevailing vegetation and the vegetation depicted on the orthophotos complicated the mapping process. Video recordings were made of the vegetation to aid confirmation of current vegetation.

A video camera was used to scan large areas of land especially on the steep river valleys. The video footage was subsequently viewed at slow speed to improve the accuracy of the mapping. Video recordings of the vegetation also permitted repeated viewing and therefore facilitated a more intensive study of each area.

The recordings were also used to identify trees that were inaccessible as the zoom feature on the video camera permitted relatively accurate long range tree identification. Although satellite imagery has been used for this purpose and found to be very useful it was not practical for this study (Matson & Ustin 1991; Roughgarden, Running & Matson 1991).

2.2.3 Results and discussion

The orthophotos containing the stratified vegetation stands are part of the results, however, it is not practical to present all 23 orthophotos. This information was therefore transferred onto a A4 map (Figure 2.2). A total of 60 preliminary data sheets were also completed and a summary of these results is presented below.

Riverine (Wetland/s - Roberts 1990)

Riverine vegetation was primarily located along the Umbilo and Umhlatazana rivers. Fragments of this vegetation were also found near small streams at River Plate Road, Leeway Road and Jesslyn Avenue. Most of the vegetation appeared to be secondary in nature and was dominated by alien species (Table 2.2). The vegetation was thicker and contained more indigenous tree species along the Umbilo river. This can be attributed to the limited access to these areas and the absence of recent disturbance. The riverine vegetation along the Umhlatazana river was sparse and dominated by alien species. Alien plant species introduced by the Indian market gardeners were prevalent in the riverine vegetation. Although market gardening is no longer practised in Queensburgh it was once a thriving industry occupying most of the vacant land in the area (see section 2.3).

The indigenous riverine vegetation was best represented in the North Park and Roosfontein Nature Reserves and in areas where steep topography has minimised human influence. The dominant indigenous species were *Bridelia micrantha, Ficus natalensis* and *Syzygium cordatum* and the dominant alien species are *Chromolaena odorata, Eucalyptus grandis, Lantana camara, Mangifera indica, Melia azedarach* and *Solanum mauritianum*.

Exotic valley veld (Disturbed - Cawood 1980; Roberts 1990)

Exotic valley veld was found on the valleys of the Umhlatazana river. It consisted primarily of grasses with alien tree species dispersed at various intervals and densities (Table 2.2). Species diversity was low and tree species were limited to: *Eucalyptus grandis, Jacaranda mimosifolia, Mangifera indica, Melia azedarach* and *Pinus spp*. Dense stands of *Chromolaena odorata* and *Lantana camara* were also found.

The height of the grasses was approximately one metre and the trees were seldom shorter than two and half metres. Grasses dominated the steep valley slopes and trees dominated the vegetation at the base of the slopes. The dominance of fruit tree species and other species favoured by the market gardeners suggests that these valleys were farmed earlier this century.

Market gardening (Market gardening - Roberts 1990)

This vegetation consisted of a dense fruit tree canopy with very little undergrowth. *Mangifera indica and Litchi chinensis* dominated the vegetation, although *Acacia mearnsii, Carica papaya, Chromolaena odorata, Jacaranda mimosifolia, Lantana*

Table 2.2: Species recorded during preliminary vegetation study. (1-Riverine, 2-Exotic Valley Veld, 3- Market Gardening, 4-Grassland, 5-Valley Bushveld, 6-Bushveld, 7-Verge, 8-Parks, 9-Coastal Forest, 10-Thornveld, 11-Swamp, 12-Cliff Community, 13-Physically Disturbed, 14-*Eucalyptus* Plantation)

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Acacia dealbata												•		
Acacia karoo	•				•					•				
*Acacia mearnsii	•		•		•					•			•	
Acacia robusta	•				•	•				•				
Acacia spp.				•								•	•	
Acacia xanthophloea	•			•	•								•	
Ageratine aderaphora														
Albizia adianthifolia	•				•	•		•				•	•	
Aloe arborescens								•				•		
Alloteropsis semialata				•						•				
Antidesma venosum	•				•									
Aristida junciformis							•			•				
*Artocarpus heterophyllus	•													
Baphia racemosa	•										•			
*Boganvilla								•						
Bridelia micrantha	•										•			
*Canna								•						
*Carica papaya	•		•											
*Cassia didymobotrya	•													
Celtis africana				•					•					
Cenchrus ciliaris													•	
Chloris gayana				•										
Chloris virgata														
*Chromolaena odorata	•	•	•		•	•	•	•	•	•	•	•	•	
*Cordylie terminalis	-							•						
Combretum kraussii	•								•					
Croton sylvaticus	•							•			•			
Cussonia sphaerocephala									•					
Dalbergia obovata				•	•				•					
Dichrostachys cinerea	•			•	•	•				•				
Digiteria eriantha							•			•				
Digitaria spp.														
Diheteropogon amplectens														
*Dracena draco								•						
Drypetes natalensis				•										
*Eichhornia crassipes	•			•							•			
Eragrostis capensis													•	
Eragrostis racemosa										•				
Eragrostis spp.							•							
Erythrina lysistemon					•			•						
*Eucalyptus grandis	•	•				•	•	•	•		•	•	•	•
Euphorbia spp.						•			•	•	•	•		
Euphorbia triangularis	•										•	•		
Ficus natalensis	•				•	•			•		•	•		
Ficus sur	•							•			•			
Ficus trichopoda	•			•	•				•		•			
*Hedychium gardenerianum	•										•			
Heteropogon contortus													•	
*Hibiscus spp.								•						
Hyparrhenia dregeana					•									
Ipomea spp.				•	•									
*Jacaranda mimosifolia		•	•				•	•						
*Lantana camara	•	•	•		•	•	•	•		•	•	•		
*Litchi chinensis	•		•									•		
*Litsea glutinosa	•		•								•	•		

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14
**Mangifera indica*	*	*	*		*	*	*	*					*	
Macaranga capensis	*				*		*	*	*		*	*		
**Melia azedarach*	*	*		*	*	*	*	*		*	*	*	*	
Mimusops caffra	*										*			
**Morus alba*	*													
**Morus nigra*	*													
**Myriophyllum aquaticum*	*										*		*	
Panicum spp.				*									*	
Phoenix reclinata	*							*			*	*		
**Pinus spp.*	*	*			*	*					*			
Podocarpus latifolius	*										*			
Protorhus longifolia									*				*	
**Psidium guajava*	*												*	
Psychotria capensis												*		
**Quercus spp.*								*						
Raphia australis	*													
Rhus chirindensis									*			*		
**Riccinus communis*	*										*			
**Rubus cunefolius*	*										*		*	
Salix subserrata	*										*			
**Schinus terebinthefolius*					*	*								
Sclerocarya caffra	*													
**Sesbania punicea*	*										*			
Setaria megphylla														
**Solanum mauritianum*	*				*									
Strelitzia nicolai	*								*			*		
Syzygium cordatum	*				*	*					*			
Syzygium cumini					*			*					*	
**Tithonia diversifolia*	*				*			*			*		*	
Trema orientalis					*	*			*			*		
Tricalysia lanceolata													*	
Trichelia dregeana								*						
Trimeria grandifolia														
Tristachya leucothrix				*						*				
Typha latifolia														
Vepris undulata					*				*		*			

camara and *Litsea glutinosa* were also recorded (Table 2.2). With the exception of a few grass species no indigenous vegetation was observed in this area.

Grassland (Bushclump and grassland mosaic - Moll 1976; Cawood 1980; Acocks 1988; Roberts 1990)

Most of the grassland areas in Queensburgh have been developed. The remaining stands were small and appeared to be facing similar threats. The most substantial area of grassland in Queensburgh bordered the Umhlatazana river, near the Queensmead industrial area. Much of this grassland has recently been acquired by the municipality and has been zoned public open space. The major threat to the survival of this grassland is the expanding squatter development on the Chatsworth side of the Umhlatazana river. The dominant grass species were *Arisitida junciformis* and *Digitaria eriantha* (Table 2.2). The presence of indigenous and alien woody species in the grassland suggest that woody encroachment is occurring.

Valley bushveld (Dry valley scrub and bushland mosaic - Moll 1976; Cawood 1980; Acocks 1988; Roberts 1990)

Stands of valley bushveld were found on the steep valley slopes of the Umbilo river. The average height of the vegetation was about 2 metres and few trees exceed 2.5 metres. Trees and shrubs were dominant although grasses also occurred (Table 2.2). Although *Chromolaena odorata* and *Lantana camara* were often found in this vegetation community they did not form extensive dense stands. The dominant indigenous species in this vegetation were *Albizia adianthifolia* and *Antidesma venosum* and the dominant alien species was *Melia azedarach*.

Bushveld (Disturbed - Cawood 1980; Roberts 1990)

Bushveld differed from valley bushveld in that it was more dense, occurred mainly on flat land and was dominated by *Chromolaena odorata* and *Lantana camara*. It was also of lower average height than the valley bushveld and comprised more shrubs and grasses than trees (Table 2.2). Bushveld often appeared in areas that have been physically disturbed.

Verge (Disturbed - Cawood 1980; Roberts 1990)

The vegetation located on road and railway verges consists primarily of alien woody species and indigenous grass species (Table 2.2). These areas are often used as out door churches by the local black people. These activities are having detrimental effects on the vegetation. The grasses are the most severely effected as they are down trodden and removed in seating areas. The trees are also stripped for firewood and for medicinal purposes.

Parks (Parklands, sportfields, reservoirs, cemeteries and mown areas - Roberts 1990)

All conventional public parks, sportsfields, school grounds, cemeteries and plant nurseries were included in this category. These areas were dominated by manicured indigenous and exotic vegetation (Table 2.2). Plants have been chosen for their aesthetic appearance rather than their conservation potential. *Albizia adianthifolia, Strelitzia nicolai* and *Trichelila dreageana* were the most dominant tree species recorded in the parks.

Coastal forest (Coastal forest - Moll 1976; Cawood 1980; Acocks 1988; Roberts 1990)

Pockets of coastal forest were found in the river valleys. The stand of coastal forest least invaded with alien plant species was located in North Park Nature Reserve. Most stands were difficult to access because of the slope of the valleys on which they were located. Trees of this vegetation type were seldom shorter than 3 metres and usually higher than 5 metres. Dominant species are *Macaranga capensis, Protorhus longifolia, Strelitzia nicolai* (Table 2.2).

Thornveld (Bushclump and grassland mosaic Moll 1976; Cawood 1980; Acocks 1988; Roberts 1990)

Stands of thornveld consisted of grass and tree species and were scrubby areas with few bush clumps. The increased abundance of trees differentiates the thornveld from the grassland areas. In some areas the grasses are relatively high (greater than 1 metre) whilst in others they are less than 0.5 metres. Soils in these areas appear to be shallow and well drained. Species composition (Table 2.2) and height of the trees was variable. *Acacia* species, *Albizia adianthifolia* and *Aristida junciformis* are the dominant species in this vegetation.

Swamp (Wetland/s - Roberts 1990)

These were natural areas, not associated with the Umbilo or Umhlatazana rivers, where water saturated soil conditions are persistent. This was the rarest vegetation in Queensburgh. The Municipality had recently secured two plots of land in the Chrisway Road swamp area. Vegetation found in these areas was similar to the riverine vegetation (Table 2.2). The dominant species was *Typha latifolia*.

Cliff community (Mesic and zeric cliff communities - Moll 1976; Roberts 1990)

This community is dominated by indigenous vegetation (Table 2.2). It is generally well established and contains both canopy and understorey plants. Alien species tend to be limited to peripheral areas were residential development has occurred.

Physically disturbed (Disturbed - Cawood 1980; Roberts 1990)

This community was totally dominated by alien plant species (Table 2.2). Most sites had recently been exposed to a major physical disturbance eg. bulldozing.

Eucalyptus plantation (Plantation - Cawood 1980; Roberts 1990)

This community was dominated by *Eucalyptus grandis* (Table 2.2.) and stands can be found throughout the study area. In many cases the stands of *Eucalyptus* appeared to be separating developed and undeveloped areas. The understorey of this community was variable depending on the density of the *Eucalyptus grandis* tree species.

General

The preliminary vegetation study revealed that much of the character of the remaining natural vegetation in Queensburgh can be attributed to topography. The only areas where substantial areas of open space still remain are along the deeply incised river valleys. Furthermore, the rivers and their associated vegetation have the potential to form ecologically viable conservation links between Queensburgh and surrounding municipalities.

Diverse and representative indigenous communities were found in some areas although alien plant species dominate the vegetation. Alien plant species were less dominant in areas that are physically inaccessible to humans or in areas where they are eradicated and controlled. Various disturbances including residential development, industry, dumping, major roads and railways and sewage works have influenced the vegetation. There was also evidence of market gardening, cultivation and grazing.

2.3 Past land-use and human influences

2.3.1 Introduction

It is well documented that natural and human disturbances play a major role in influencing plant community structure and landscape change in many ecosystems (Hobbs & Huenneke 1992; Ramey-Gassert & Runkle 1992). A knowledge of landscape change is also important for the planning and management of urban landscapes (Friedman & Zube 1992).

The present survey produced a static view of the plant communities within the Queensburgh municipal area. In time repeated sampling will facilitate the construction of a more dynamic model of community process. In an attempt to overcome this lack of temporal dimension it was decided to map the past vegetation of Queensburgh based on available information.

2.3.2 Materials and Methods

The easiest and perhaps most efficient method of mapping past vegetation would be to use early aerial photographs (Roberts 1990, Friedman & Zube 1992, Numata 1992). The lack of suitably dated material, however, necessitated a more time consuming approach.

The works of various ecologists and historians who have studied the vegetation of Natal and Southern Africa were studied in an attempt to establish the probable pristine vegetation conditions of the area (Adamson 1938; English 1950; Acocks 1988; van Oudtshoorn 1992; Pooley 1993). Pristine being the historical natural vegetation, indicating the local natural vegetation distribution independent of actual land use and existing vegetation associations. Topographical maps were used as a guideline in the mapping process. Town Planning records were used to compile the other maps and subsequent information regarding past land-use and human influences in the area. Inaccuracies in the stratification of past vegetation communities will have occurred as a result of an inadequate data base. The information obtained from this research is, however, useful in determining past land-uses and human influences on vegetation.

All relevant broad existing land uses were mapped in each of the major periods of land use change in the history of Queensburgh. Percentage cover of each land use was calculated using a 5x5mm grid overlay on analogous scale maps of each period. The total number of grids covering the entire study area were counted. The percentage coverage for each land use was subsequently calculated by counting the number of grids overlaying the specific land use and expressing this as a percentage of the total number of grids for the study area.

2.3.3 Results and discussion

Pristine

Although there is no direct historical evidence to go on Acocks (1988) has, using indirect methods of: vague descriptions from early travellers; previous naming of various areas (eg. the east coast was known as the Land of the Fire) and statements made by early farmers, been able to compile maps of probable veld types as far back as 1400. This indirect evidence gives valuable clues and starting points of study. More direct evidence of formerly existing vegetation types can however be obtained by studying relic patches of vegetation found in spots suitable for their preservation (Acocks 1988). An example of relic vegetation can be found on many of the steep cliffs in Queensburgh.

It is likely that Queensburgh was mostly forest (38%) (riverine 20%, cliff 5% and coastal 13%) and bushveld (35%) (Table 2.3, Figure 2.3). The bushveld establishing on the drier and less steep areas with forest dominating the steep, south facing valleys, cliff and riverine areas. It is probable that the upper parts of the north facing sides of valleys and the central region of the study area were open areas dominated by grassy thornveld (25%). Small pockets of wetland vegetation (2%) are likely to have occurred in low lying areas where water was retained for most of the year. Although remnants of the forest vegetation can still be seen on the cliffs and on certain steep sided river valleys there is very little evidence of the original bushveld and the grassy thornveld has all but totally been destroyed because of the suitability of the high lying flat areas for development.

Farming

In the late eighteen hundreds when the governor of Natal divided the land which surrounded the development associated with the (Durban) harbour into large farms (English 1950), Queensburgh was divided into six farms (Figure 2.4) (Town Planning Records). Mainly wheat and maize were grown and the farming took place mostly on the high lying flat areas although cattle were taken into the steeper valleys

Table 2.3: Percentage cover of existing land uses during the: pristine vegetation; farming; market gardening and present periods.

Land Use	Pristine	Farming	Market Gardening	Present
Grassland	25	0	0	5
Bushveld	35	4	0	16
Riverine	20	10	8	16
Cliff	5	5	5	5
Wetland	2	2	2	2
Coastal Forest	13	8	4	4
Cultivation	0	40	3	0
Grazing	0	26	4	0
Market Gardening	0	0	48	0
Residential	0	5	26	40
Undeveloped	100	29	19	29
Commercial	0	0	0	2
Industrial	0	0	0	10
Public/Private Open Space	0	0	0	19

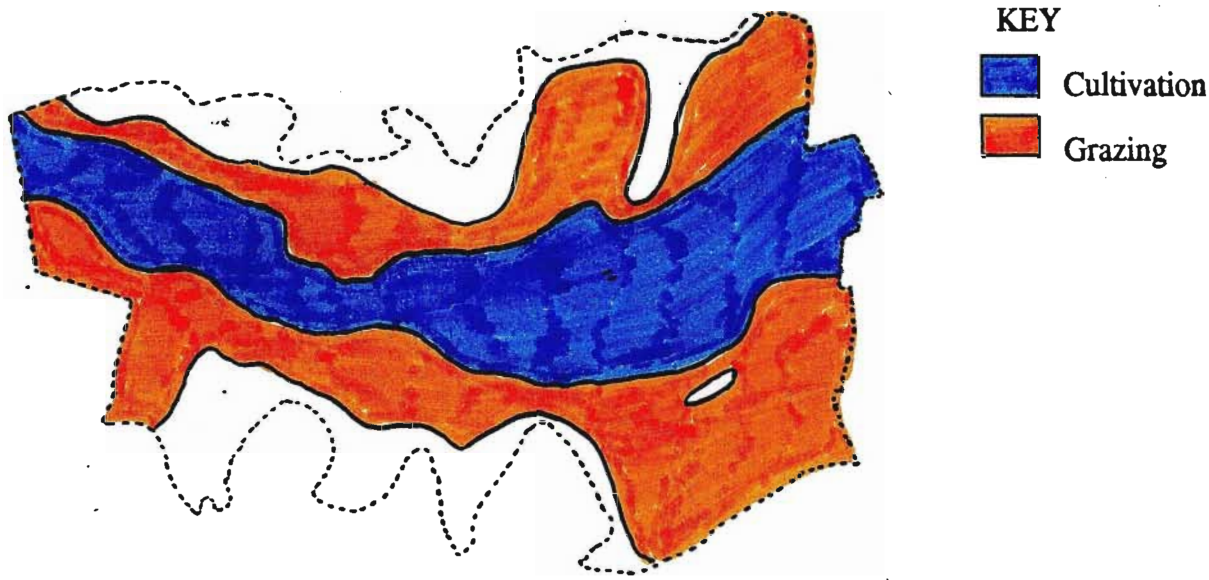

Figure 2.4: Areas used for cultivation and grazing.

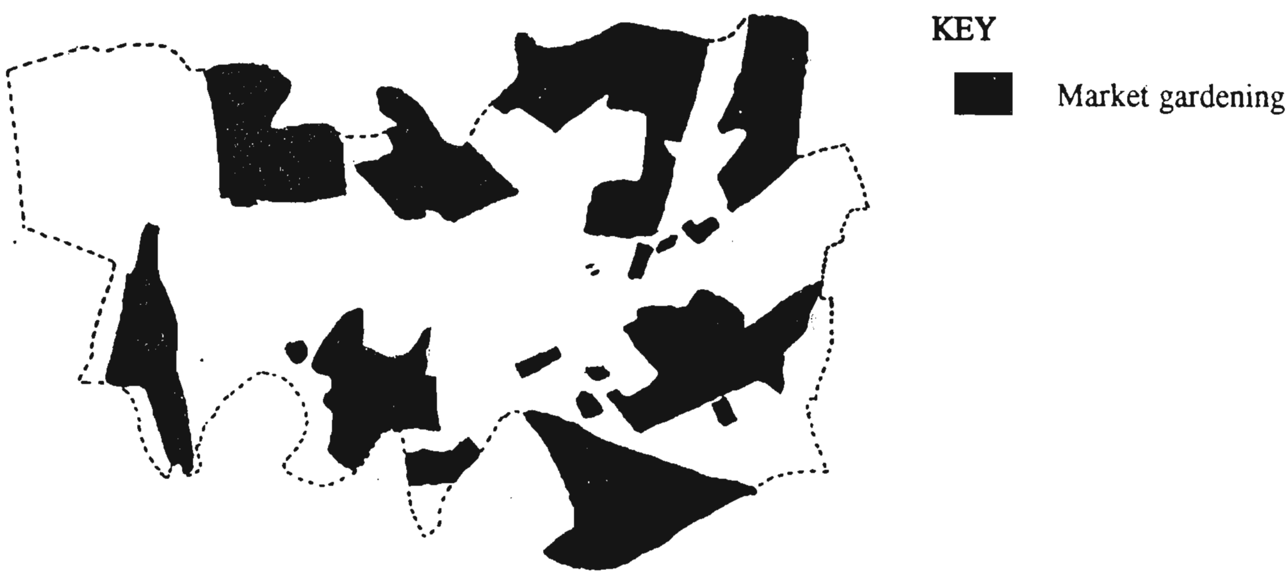

Figure 2.5: Land occupied by market gardeners in 1950.

to feed and down to the rivers to drink. The farmers also planted many of the Eucalyptus trees which can still be seen scattered throughout Queensburgh. During this period most if not all of the pristine grasslands and bushveld were probably destroyed. The riverine vegetation was probably impacted on and destroyed in certain areas and trees from the coastal forests were felled for fuel (Table 2.3). The high lying flat areas were preferred for the little development that did occur (Table 2.3). As more people settled in Queensburgh with the construction of the railway station the centralised high lying residential areas expanded.

Market Gardening

People from India who were originally shipped to Natal to work on the sugar cane fields of the Natal North Coast, began to appropriate property for market gardening in the early nineteen hundreds (Town Planning Records). By 1950 the six original farms had been subdivided and sold. The market gardeners owned 48% of the land (Figure 2.5). The popularity of the area for market gardening was probably due to the close proximity of almost all farms to a reliable source of water. Easy access to the railway line further encouraged farming in the area. Mango, litchi, jackfruit and vegetable farming were introduced in this period. Many of these species like the mango have now become naturalised.

During this period: the residential sector of Queensburgh increased; what remained of the pristine bushveld was probably destroyed (Table 2.3); the area occupied by large scale cultivation and grazing declined drastically and the pristine riverine and coastal forest vegetation were also probably reduced (Table 2.3).

Present

The group areas act of 1951 forced the Indians to sell back their farms to the municipality who have subsequently subdivided the plots and zoned them according to prevailing town planning schemes. It is evident that most of the land in Queensburgh has been developed for residential purposes (40%) (Table 2.3, Figure 2.6) which is suitable for a suburban town of this size (De Leuw Cather 1992). Although there is still a fair amount of undeveloped land (29%) in Queensburgh it is extremely threatened open space since much of it has been zoned for residential development. The undeveloped land consists of secondary or tertiary grassland, bushveld and riverine vegetation (Table 2.3) and pockets of probably pristine cliff, coastal forest and wetland vegetation. The industrial sector (10%) is well defined and expansion has been limited by the absence of further industrial zoning in the borough. Land occupied by the commercial sector (2%), although increasing, is insignificant by comparison to other broad existing land uses.

Public and private open space areas (19%) are for the most part limited to sports fields, schools and conventional public parks with very little land been specifically zoned for conservation. Riverine and coastal forest vegetation is, however, included in some of the areas zoned as public open space.

Figure 2.6: Present land use practices in Queensburgh.