AN ASSESSMENT OF SURVEYING, MAPPING AND CARTOGRAPHIC PROCEDURES IN THE PRESENTATION OF FEATURES IN TWO UNMAPPED AREAS: ÖLÜ DENIZ AND KIDIRAK NATIONAL PARKS, S.W. TURKEY

Graeme F. Sandeman

A Thesis Submitted for the Degree of MPhil
at the
University of St Andrews

1997

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by

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Declaration

I, Graeme Sandeman, hereby certify that this thesis has been composed by myself, that it is a record of my own work, and that it has not been accepted in partial or complete fulfilment of any other degree of professional qualification.

Signed .... Date 5th February 1997

I was admitted to the Faculty of Science of the University of St Andrews as a candidate for the degree of M.Phil. in April 1993.

Signed .... Date 5th February 1997

I hereby certify that Graeme Sandeman has fulfilled the conditions of the Regulations appropriate to the Degree of M.Phil.

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Abstract

This thesis examines the problems encountered in the survey, mapping and cartographic reproduction of features in two unmapped National Parks (Ölü Deniz and Kidirak) in S.W. Turkey. The role of satellite imagery in modern map production is examined in this context, in both map construction and in combining imagery with field maps produced of the study areas.

The methodologies involved in the creation of both field maps and the final cartographic products are discussed. These include the problems of survey without the benefits of modern, bulky survey instruments, and the measures taken to ensure maximum accuracy in both linear and areal dimensions given the inherent problems of the Compass-Traverse technique used.

Cartographic procedures and the design problems involved in the transfer of field data to produce a finished full colour map are explained. New technological developments in computer aided cartography are used to produce maps of the parks in both colour and monochrome, at a variety of scales. Limitations of methodology, including legend construction, are discussed and the adjustments required to produce an acceptable end product are explained.

Successive editions of the maps were used by a group of Honours Geography students in which biogeographical details and land resource assessments were noted and, where necessary, useful suggestions have been incorporated into the final edition.

The possibility of producing a photo-image map using Landsat TM imagery is explored, together with examining the problems of using a Global Positioning System (GPS) to produce a more accurate map. It is concluded that neither offer significant advantages over the methods used in this particular study.

Finally the use of these maps as a tool to monitor environmental change and differentiation in the two parks is discussed and the cartographic depiction of change over the 3 year period of survey is demonstrated.

Acknowledgements

I am indebted to my supervisor Dr. J.A. Soulsby (University of St Andrews) for his encouragement, advice, guidance and correction throughout the writing of this thesis. My thanks also to Dr. J. Jarvis (University of St Andrews) for transferring satellite imagery into the R-Chips image processing system and to Dr. Twahiri Saidi for his assistance in the operation of the R-Chips system and generating suitable images for export to the Apple Macintosh platform. I am also grateful to Andrew Collins (University College Dublin) for demonstrating the manipulation of satellite images on an Apple Macintosh platform at the Forest Institute of Remote Sensing Technology at UCD.

I also extend my appreciation to Dr. A.F. Sandeman (University of St Andrews) for her invaluable assistance in surveying two national parks over a two year period and to Dr. J.A. Soulsby who also assisted in the survey and identified flora within quadrat surveys. Thanks also to Dr. Peter Cundill (University of St Andrews) for his guidance in identifying the flora discussed in Chapter 6.

My thanks also go to Dr. R. Duck (University of Dundee) and Professor J. McManus (University of St Andrews) for their encouragement and support in undertaking this project and to the School of Geography & Geology at the University of St Andrews for allowing me the use of School facilities to construct the maps and images within.

Finally many thanks to my wife Alison who supported me as a field assistant and has continually encouraged me in the development and completion of this project.

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Chapter 1

Introduction & Aims of the Study

Cartographers have at their disposal today a wide range of source materials from which a map can be designed and developed. These range from traditional sources such as national topographic maps, plans and aerial photographs to the new medium of satellite imagery. The cartographer can create a graphic image of an area from the sources available. However, it is the construction and design of a map without sources and the discussion of problems found and solved that will be the prime aim of this thesis.

Generally a cartographer can create a map without ever having explored a particular landscape and is in effect detached from that reality. Indeed Brannon (1991) goes as far as to suggest that designing a map has much in common with illusion, with the cartographer creating the illusion of terrestrial reality.

The aims of this thesis cover several disparate areas within the methodologies involved in the creation and construction of a map. In this study, two maps will be constructed and designed from the terrestrial reality of two National Parks in S.W. Turkey known as Ölü Deniz and Kidirak. These parks are used as a location for a Geography Honours field class and as a result detailed maps were required. As Watts (1992) discovered, none existed locally and owing to the absence of aerial photographs and the prohibitive expense of SPOT satellite imagery it was deemed necessary to construct these maps from first principles, i.e. survey and plot the parks on site.

This thesis will examine the methodologies employed in the construction of these maps. These include, the initial survey, cartographic principles involved in changing the survey data into recognisable map form, and the integration of the map with Landsat TM satellite imagery. The examination of these methodologies, in particular cartography and satellite imagery will show a working procedure within the School of Geography & Geology combining various computer hardware platforms and associated software to create final products of maps and derived map & satellite images.

Each methodology will be examined in turn to explain the reasons why a particular route has been pursued, and to examine the problems that arise and apply potential solutions.

Although not part of the methodological nature of this thesis, the study will also explore the characteristics of the area under investigation and explain the background as to why such a locale was chosen and its importance as a defined National Park. The areas under investigation (in particular Ölü Deniz) are environmentally fragile, yet play a major role in the booming Turkish tourist industry. This conflict of fragile environment and tourist attraction will be examined looking at past development and existing pressures within Ölü Deniz National Park and speculation about its future prospects will be attempted. The nature of the National Park will be explored and this in turn will explain the reasons for selecting criteria in the classification of subject matter which appears on the maps.

The thesis is therefore an empirical study focusing on several key areas with particular regard to observations and experiments within the methodologies employed in the creation and construction of a map. It is hoped that these methodologies and their successful application will show that it is possible to survey an area using basic surveying techniques and construct and design a map that will reflect the detail of the survey and the environment of each National Park. The thesis will also investigate whether it is feasible to extract sufficient data from satellite imagery to produce a map at the scale of the study site. In addition, the analysis will examine the benefits of combining satellite imagery with ground survey data in terms of improving overall map accuracy and legibility.

1.1. Introduction to the Study Area of Ölü Deniz & Kidirak

The study areas of Ölü Deniz and Kidirak National Parks are located on the south-western coast of Turkey where the Aegean meets the Mediterranean Sea. Both parks are situated on a small coastal plain approximately 15 km. south of the main population centre of Fethiye *(Figure 1).*

Asiatic Turkey is characterised by highland and mountains belonging to the uplands of Western Asia which cover over 80% of the land mass. A limited amount of land may be described as gently sloping or flat and refers in part to the narrow coastal plains along the Aegean and Mediterranean coasts. The Aegean coast extends from the shore to the hill ranges that make up the barrier to Western Anatolia forming the watershed between the interior uplands and the coast. The land of the Aegean coast is broken by a series of depressions running west to east between which mountain ranges rise to around 2000 metres.

The Mediterranean coast where Ölü Deniz is situated forms part of the large coastal plain of Antalya where the limestone mountain range of Western Taurus rises steeply from the sea to altitudes of over 2000 metres. The highest mountain within the vicinity of the study area is Baba Dag (1969 metres) while the surrounding land is covered with valleys and plateaux. In this particular area, the narrow coastal plain of Ölü Deniz *(Figure 2)* is a rarity as the mountain ranges usually end abruptly at the sea.

The climate of the study area is typically Mediterranean with dry, very hot summers and mild rainy winters. Indeed the area is noted for the warmest winters in Turkey with a mean temperature between 9° & 10°C in January, and average summer temperatures in July of over 28°C. This attracts a large tourist population from the industrialised countries of Western Europe.

Figure 1

Figure 1 (above) shows the general location of the Study Area containing Ölü Deniz and Kidirak National Parks within the context of Turkey and its neighbouring states.

Figure 2

Figure 2 (left) shows the Study Area of Ölü Deniz and Kidirak National Parks. This map was derived from a false colour Landsat MSS satellite image and clearly shows the coastal plain of Ölü Deniz and the beach at Kidirak.

1.2. Ölü Deniz National Park

The National Park of Ölü Deniz is situated at the north end of Belçegiz Bay, in the province of Mugla and is an excellent example of a coastal spit measuring approximately 850 metres in length and 100 metres wide at the tip and enclosing a lagoon on the landward side. Ölü Deniz literally means Dead Sea referring to the sheltered lagoon and is regarded as the finest beach area in Turkey. This reputation, enhanced by its continual use in publicity photographs for tourist brochures and books, has led to a tourist boom and rapid development of this area *(Plate 1)*.

Plate 1: The Ölü Deniz National Park viewed looking east, showing the distal end of the spit with the channel in the foreground joining the lagoonal side left of the spit to the coast on the right.

Although part of a much larger expanse of beach, the National Park area is confined to the area of the spit and lagoon covering 16.5 hectares. The area was defined as a National Park in 1980 as part of conservation measures designed to maintain the spit and lagoon area. Along the beach on the seaward side there is evidence of concrete blocks (now broken and partially buried) as former protection methods to prevent damage from wave and wind action. Since the introduction of National Park status there are ongoing programmes to ensure the stability of the spit by the formation of a series of planned man-made enclosures stocked with a variety of plant species in an attempt to recolonise areas which were being rapidly eroded.

1.3. Spit and lagoon

The spit has formed where the shoreline undergoes a sharp change of direction and distinct breaks of slope have formed where wave action is removing sand and shingle. Towards the distal end of the spit such erosional breaks of slope are no longer present. The presence of extensive planted vegetation enclosures created by the National Park authorities along almost two-thirds of the spit also points to significant erosion on the landward section of the spit. Vegetation is often used to prevent further reworking of the spit by trapping wind blown sediments. As previously noted, a former method of conservation to slow down erosion at the proximal end of the spit was the placement of concrete blocks on the foreshore. However the protection offered by such structures is very temporary (*Plate 2*), as most of the blocks have now broken up or are completely buried.

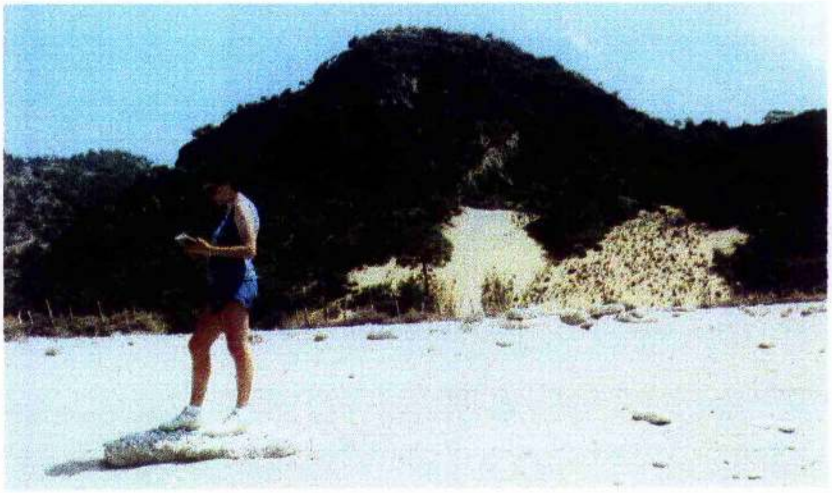


Plate 2:
Foreground shows concrete block remnants with the recently vegetated enclosures at the top of the beach. The background shows wind-blown sand on rock outcrops outwith the park to the north.

The lagoonal area shoreward of the landform at Ölü Deniz is typical of many spits. As spits grow, these lagoonal areas may gradually change into tidal marshes or swamps as the embayments fill in with fluvially derived sediments. Clear evidence of this can be found at Ölü Deniz with extensive development of marshes and associated vegetation regimes.

Little is known about recent sea level changes along this area of the Turkish coast. However, as the whole region is still tectonically active it is likely that sea levels have undergone change much more recently than 3000 years. It is quite possible that the spit at Ölü Deniz has formed within the past two to three hundred years. There is evidence of former habitation on the spit in the remains of a ruined Greek Church and also submerged in the lagoon are remains of a former settlement and field system boundaries.

1.4. Future development of landform at Ölü Deniz

The future development of the spit and lagoon area is of crucial importance to the tourist economy of Ölü Deniz. If the spit continues to grow, it could join with the headland to the west and cutoff the lagoonal area to the north. Consequently, marsh areas could develop over the entire bay resulting in hotel and tourist activities and facilities around the lagoon being lost. Alternatively, if spit extension is halted and erosional processes become dominant the feature could diminish in both size and importance and an important beach area would be lost.

Spit extension is usually halted by one of three factors:

1) diminution in supply of shingle

2) presence of a deep water channel

3) presence of strong river and tidal currents.

First, there is no evidence that the supply of sand and shingle will decrease from along the coast. Littoral drift from the south still appears to contribute quantities of sediment to the spit. The vegetation enclosures may however prevent reworking of some existing material. Second, the channel between the tip of the spit and headland to the west is only 80 metres wide and sediment build-up around the spit has produced a gently sloping shore under the first 25 metres of the channel. And third, as there are no strong river or tidal currents to keep the channel open, it is quite likely that spit growth could continue and in time cut-off the lagoon. Therefore, if the feature was left to develop naturally, there seems little doubt that the landform would continue to grow. Indeed Ritchie (1993) argues that nature should be allowed to take its course unless there is justification for a stabilisation programme such as a flood barrier or if there is a threat to communications, and that dune erosion, retreat and instability should be regarded as a natural and normal evolution of a coastline.

1.5. National Park status

As a National Park, Ölü Deniz with an area of 16.5 ha. is quite small and perhaps should be compared to a British country park or Site of Special Scientific Interest (SSSI). The reasons for ascribing National Park status to this area are vague. However as it has been a National Park since 1980, it is fair to assume that the reasons for designation were for preservation of a natural environment rather than the financial gain from tourism, as the tourist boom did not occur until the mid to late 1980's.

The preservation measures adopted by the National Park authorities, in particular the planting of vegetation enclosures, have been undertaken in order to maintain the equilibrium of the spit. The effectiveness of the vegetation enclosures is difficult to assess over a short time scale, however they do serve the purpose of acting not only as wind breaks but as protection for a variety of species planted within them in an effort to regenerate vegetation and stabilise sand movement on the spit. The existence of these enclosures indicates a desire by the authorities to conserve the National Park and it is assumed that their progress will be monitored and other measures adopted if required. An example of sand movement from the spit lies outwith the park directly to the north *(Plate 2)* where wind-blown sand has formed to a height of over 30 metres on a rock outcrop overlooking the spit and lagoon.

Although the National Park was probably established with the principal reason being preservation of a natural environment, it may not be the sole reason today. The influx of tourists into this fragile environment, attracted by the beauty of the beach and lagoon, has seen a change in perception from a National Park protecting an environment to that of a large play area for tourists. A small fee is required for access to the park, a fee most tourists pay for access to its beach and lagoon and not to experience and enjoy the natural environment. As with any beach development a number of facilities designed to cater for tourists have been created; roads, car parks, toilets and cafes have been built, and a plethora of small traders and water sports facilities exist. The outsider's perception remains that the park today is a financial venture primarily designed to extract money from tourists, with environmental considerations a secondary issue. Unlike conserved features in Britain and the U.S.A., there is no attempt to highlight the value of the park or explain the natural phenomena of the spit and lagoon and the variety of conservation methods adopted to stabilise the area, nor is there any information regarding the former habitation of the area.

1.6. Kidirak National Park

In contrast to the National Park at Ölü Deniz, a few kilometres south lies the relatively untouched National Park at Kidirak. This too is a fee paying protected area in a marine location with a secluded beach which includes part of the base of an alluvial fan that has been terraced and is covered in pine trees *(Plate 3)*. A vegetation succession exists from the top of the dune ridge to the main road bounding the park. The vegetation on the margins of this succession have been disturbed or destroyed by road construction.

Plate 3: Kidirak National Park viewed looking south, bounded by a road to the north and east. The southerly extent of the beach includes the base of an alluvial fan that has been terraced and covered with pine trees.

Kidirak is smaller than Ölü Deniz and is relatively unspoiled with little development of tourist facilities. There is a single road, a small informal area for parking, a toilet block and some changing areas and shelters. It does however cater for campers and is used primarily by Turkish families during national festive holidays. Adjoining the National Park is an official camp site and a residential village or town called 'Robinson Lycia Village' designed to cater solely for German tourists. This settlement, built at the bottom of a valley on an alluvial fan, caters for up to 5000 visitors and includes 1100 apartments. It may be that the reason Kidirak has been designated as a National Park is to prevent further development of the area by the 'Robinson' complex and to avoid the beach being annexed as part of this private complex. Considering the tourist population adjoining the park at Kidirak it is surprising that visitor pressure is so low and as a result, unlike Ölü Deniz, it would appear that there is less trampling and damage to vegetation. This lack of interest may be because the 'Robinson' complex caters satisfactorily for the needs of its customers and that the park at Ölü Deniz has more to offer the local or seasonal visitor in terms of facilities and attractions such as a variety of water sports. Another reason may be that Kidirak is relatively isolated requiring either public transport by 'dolmus' or taxi or a walk of a few kilometres from Ölü Deniz to get there.

1.7. The effects of tourism

The explosion of tourism in Turkey has seen tourist numbers rise from less than one million in the early 1980's to around four million today (Cole & Cole, 1993). The area of Ölü Deniz began to be developed as a tourist area with the attraction of a superb stretch of beach and the beauty of the spit and lagoon area. The area has attained national recognition and the spit and lagoon now provide what is widely viewed as the "finest beach area in Turkey". Today the National Park is heavily used both by tourists from Western Europe and the Turkish people themselves, in particular during national religious festivals or holidays, similar to traditional Bank Holidays in Britain.

The influx of tourists into this area, in particular the effect human interference has on this natural environment, cannot be overstated. Several thousand visitors visit the park daily in high season. This is borne out by the available number of car park spaces (220) and a coach park within the park itself which are invariably full and augmented by overspill areas outside the park. On peak national holidays, cars are parked negligently all over the spit causing further damage. Apart from the enclosure wind breaks at the top of the dune ridge between road and beach, the problem of trampling the vegetation cover is now apparent as people do not restrict themselves to the various metalled paths and roads throughout the park, in the process damaging some vegetation. Lloyd (1970) showed that in Lincolnshire, vegetated fixed dunes suffered damage as a result of 3500-4000 visitors per year. It would appear that it may become a more acute problem in Ölü Deniz as reeds, rushes and dune grasses surrounding the lagoon have been broken down by people pushing through to the waters edge and pedestrian pressures at Ölü Deniz far exceed that of the Lincolnshire study. There is also an increasing litter problem, to the extent that part of the ruined Greek church within the spit complex has been used as a rubbish dump. At the northerly boundary of the park behind a toilet block near the entrance remains the detritus of some of the building works that have been carried out to cater for the tourist.

Like other coastal resorts in S.W. Turkey, Ölü Deniz has developed recently and grown rapidly as interest has been stimulated by the promotion of the area by holiday companies. Whether this area can sustain continual growth remains to be seen. The settlement of Ölü Deniz which has grown alongside the National Park would appear to exist solely for tourists as it contains a number of hotels, pensions and camp-sites together with a myriad collection of bars, cafes, restaurants and shops in a shanty town style set up along a newly constructed promenade. Without planning or development control this expansion may lead to over development as the existing conditions have already despoiled an area of great natural beauty. As the economy of the area is highly dependant on tourism, it would be ironic if the natural resource of the spit and lagoon which attracted tourists to the area may well hasten its own destruction through the vast numbers using (and abusing) the National Park.

Chapter 2

Background to the Survey methodology

The coastal area of South West Turkey has in recent years provided the venue for a 3rd Year Honours Undergraduate geography class studying Biogeography, Rural Geography and Growing Awareness of Landscape in the field. The Ölü Deniz National Park was selected as being an area which offered considerable opportunities for field study in all the sub-disciplines noted above. One major problem encountered in the initial evaluation of the area was the absence of a suitable map or plan of the Park. This project therefore arose out of the need to provide a suitable map showing the extent, layout and features present within the park for future field parties.

Normally this would not present a problem as the local equivalent of an Ordnance Survey map could be purchased, however, these maps are not available in Turkey for a variety of political and security reasons. Similarly there is an absence of available aerial photographs at any scale thus ruling out the possibility of producing a map photogrammetrically. The only products available are small-scale maps such as the 1:435,000 of S.W. Turkey by Bartholemew and various maps at scales of 1:3,000,000. The Bartholemew map is a useful general guide but can be of no consequence for this particular study area at this particular scale. The only map available at a reasonable scale was a sketch map produced by a British botanist of the local area (Turland, 1990). This map did serve a useful purpose in allowing the environs of the area to be put in a broad local context. It was used as a base map by the initial field party. It still did not show the Ölü Deniz National Park in any detail, simply the location.

As the resources to compile information were not available the problem of producing a field map without source material led to the decision to use other means to provide such a map. There were three options:

a. Produce a map from satellite imagery

b. Conduct a land survey and produce a map in-house

c. Combine satellite imagery with surveyed map

The preferred option was to use land survey techniques in the field to enable the production of a map in-house and investigate whether suitable satellite imagery could be combined with an original map. The use of satellite imagery would also allow Land Classes to be identified and a comparison made with the accuracy of the surveyed field map.

The problems of using these production methods were quickly identified. An accurate survey of the National Park could only be done using a plane table level and theodolite or by using an Electronic Distance Measurement system (EDM). However such methodology is not without its own difficulties, relating back to Turkish security problems as all research in Turkey must be approved by the Turkish Government. In addition to a three month delay, it was deemed unlikely that the Turkish authorities would grant permission.

The Turkish border areas are both sensitive and unstable, especially so on the Aegean and Mediterranean Coasts owing to the close proximity of Greece. Relations with Greece are traditionally extremely poor and even more so following the Cyprus dispute in the late 1970's when war between the two nations was narrowly avoided. There is therefore a great deal of distrust between the two nations compounded by perceived Greek militarization of some islands off the Turkish coast e.g. January 1996. It is perhaps understandable that large-scale maps of this area are not available and why the authorities would not be in favour of having a beach area mapped, particularly so as the Greek island of Rhodes is situated less than 70 km from the study area of Ölü Deniz National Park. Also there is ongoing instability in relations with Turkey's Middle East neighbours, in particular since the Gulf War of 1991, and the Kurd problem along the eastern boundary with Iraq. This continuing hostility with nearby Greece and potential conflict with Arab neighbours in the east undoubtedly explains the lack of availability of suitable large-scale maps in Turkey .

Because of the above problems it was decided that detailed measurement of the park by EDM was therefore not applicable and that a simpler methodology would be used. The methodology selected was that of a compass traverse using bearings and tape measurement. Permission would then be sought to survey the park at local level. This most basic method of surveying involves a minimum of equipment and personnel and would hopefully be agreeable to the park authorities. It also meant that the use of satellite imagery would be an important factor in assessing the accuracy of the completed field map which would encompass and require a vast amount of detail to be noted.

The production of a suitable map base from the surveys carried out in 1993 and 1994 would therefore be an extremely valuable aide in assessing the effects, if any, of increasing tourist pressures on the fragile ecosystem of Ölü Deniz National Park and it would allow subsequent field classes to monitor rates of change and factors of instability.

Chapter 3

Survey Methodology

The problems of surveying in a foreign country are usually surmountable if the country is sympathetic to the needs of the field workers, and if equipment such as Electronic Distance Measurement (EDM) systems, theodolite and level can be imported. Problems arise when a field map is required of a particular area in a country where the Government is less sympathetic and importing surveying equipment is problematic both logistically and politically. In March 1993 an application was made to the Turkish Embassy in London to acquire permission to enter Turkey in May of that year with a range of surveying equipment. Permission was denied pending a three month delay to consider the request. However as the field investigation could not be delayed, a decision was made to proceed with the field work using a different survey methodology. Instead of using sophisticated surveying equipment, the field map would be produced, if possible, using a compass traverse with a 30 metre tape. The method employed would require only two people in the field and a minimum of equipment, namely compass, clinometer, 30 metre tape, protractor, rulers and notebooks.

Although the methodology had changed, the principal reasons behind surveying the National Park had not. The aim was to construct a detailed field map showing vegetation classes within the boundaries of the park, identify the extent of vegetation types and classes then construct a map and combine and compare it with Landsat TM Imagery using existing computing hardware and software applications available within the School of Geography & Geology. The map would also be used as a base outline for future Biogeography field classes to the area. The prime reason for surveying this particular area was that there were no suitable sources such as large scale maps or aerial photographs from which a map could be compiled.

The aim of employing this particular method of survey was to show that it was possible to produce a detailed map in the time available from a simple compass traverse, that it would be reasonably accurate and show that such a surveying project was viable when considering the methodology used.

Permission was sought and gained at local level from the Ölü Deniz National Park wardens to carry out a survey of the vegetation classes present in the park. Thus the Ölü Deniz National Park could be surveyed with a minimum of personnel and equipment and with little or no intrusion to other park users.

3.1. Field Methodology-Compass Traverse

A compass traverse is used to determine the length and direction of a series of connected straight lines on the earth's surface (Raisz, 1962).

The decision to employ compass and tape as a field method was primarily a response to not being able to use sophisticated surveying equipment and a desire to see if such a method would work within certain tolerances of accuracy over a relatively large area of approximately 16.5 hectares. Before beginning the survey, a visit to the Ölü Deniz National Park was deemed necessary to establish its layout and prepare a sketch plan of the area. This sketch plan *(Figure 3)* was important as it allowed the construction of a work schedule dividing the park into 3 main sectors.

1. From the entrance to the 'spit head'; including roads, shingle beach and man-made conservation enclosures *(3 days)*.

2. From the 'spit head' back to the main entrance; including extent of vegetation classes, paths, buildings, roads and car-parks *(3 days)*.

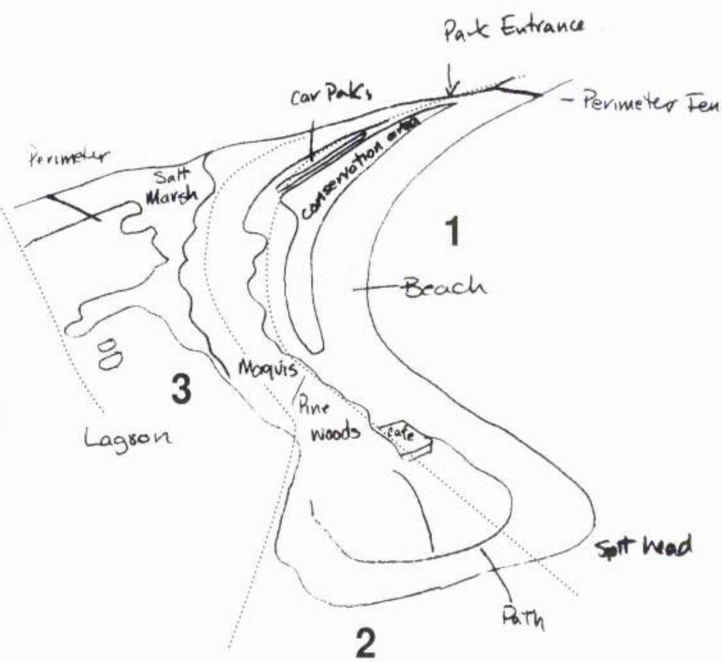


Figure 3: Sketch plan of Ölü Deniz National Park
(derived from a postcard view)

3. From 'spit head' to the boundary of the park around the lagoon edge; including islands, sand beaches, vegetation classes, salt marsh and from the park entrance following the perimeter fence to the boundary on the lagoon *(2 days)*.

The surveying procedure was further refined, when it became apparent that measurement of distance using tapes was neither practical because of the size of the park nor was it considered desirable by the park authorities. Therefore distances would be measured in steps. To use this as a unit of measurement it is necessary to establish an average step length for each surveyor. This was achieved by measuring out a distance of 30 metres which both surveyors walked at a normal stride counting the number of steps. This was repeated a number of times until an average stride value was obtained.

Surveyor '1'	37 steps =	30 metres
	1 step =	0.81 metres
Surveyor '2'	42 steps =	30 metres
	1 step =	0.71 metres

Measurements were therefore in steps with distances over 50 metres being stepped out twice by either surveyor and an average figure noted. The survey detail would later be plotted in steps onto metric graph paper at a scale of 1 step = 1 millimetre as this would be quicker than converting steps to metric values using the calculated ratios.

The next procedure to be established was that of compass sightings and readings. Bearings would be noted from a fixed station point and measured clockwise from North (otherwise known as azimuths). For consistency Surveyor '2' would take compass bearings on Surveyor '1' who would be stationed at particular points. Surveyor '1' stepped out and noted (a) the distance (steps) to these points and (b) the bearings on these points given by '2'.

The problem of recording the data and retaining a visual record was overcome by marking a central point on a page and schematically annotating lines radiating from that point to ground features. The central point was regarded as a survey station. Each station and readings from it were noted on a single page including a bearing and distance to the next station. Page 1 therefore consisted of readings taken from survey station 'A' and measurements to station 'B'. The annotations to points on lines gave distance in steps and an azimuth bearing from North, i.e. 30, 90° (30 steps from station 'A' on a bearing of 90°).

The next sheet, page 2 consisted of measurements of various ground features from station 'B' including a backsight measurement to station 'A'. This was repeated until the entire park had been covered. An example of one such page (sheet 20) is shown below in Figure 4.

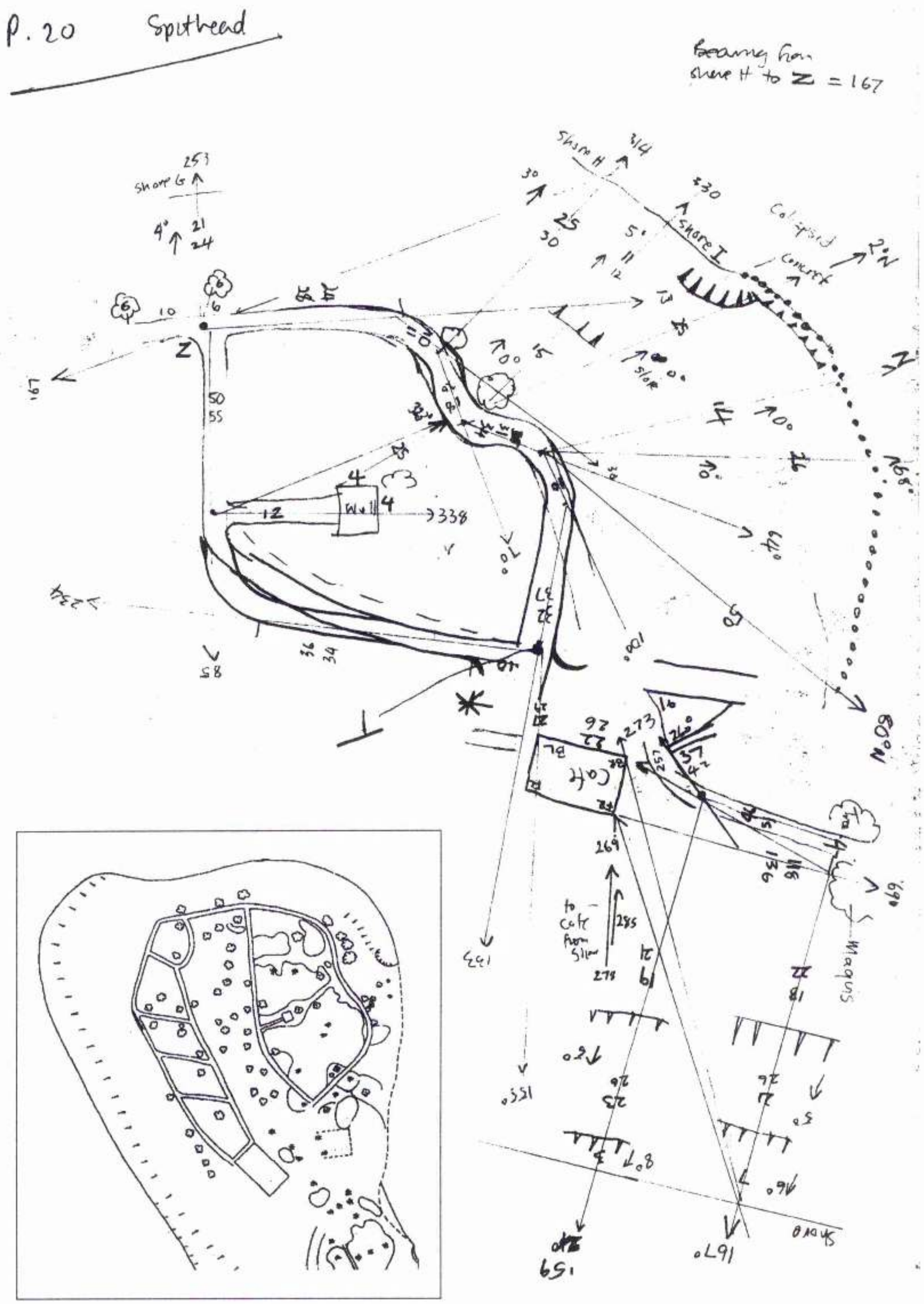


Figure 4: Example of field survey notes (sheet 20) together with fair drawing (inset) of area from data

As the survey progressed bearings and distance measurements were taken to the same ground features. This intersection of points allowed a double check on previous measurements and also helped average out any obvious errors in reading off compass measurements or errors in the recording of figures.

Each sheet also contained additional notes on what had been surveyed; naming vegetation types, noting particular features within the conservation enclosures, measurements relating to road and path widths, number of car park bays etc.. Symbols were used to depict different tree species such as deciduous and coniferous. This was done to enable identification of stations at a later date and to list comprehensively every ground feature possible within the time-scale of the survey. All these features would add to the amount of detail which could be included on a map and would aid the production of the final map by the inclusion of a wealth of reference points.

Other features noted on the survey sheets were breaks of slope using a clinometer. As noted earlier, logistical and political problems prevented the import of dedicated surveying equipment such as theodolites or levels. This meant that although it was possible to make a basic compass traverse of the National Park, it was not possible to 'level' and thus contour it. However on inspection in the field it was found that there was only a few metres difference in height levels and therefore by using a clinometer, significant breaks of slope were noted together with distance and bearing from a particular station.

3.2. Survey compilation

The compilation of the survey detail was plotted by protractor and scale ruler directly from the field notebook, onto metric graph paper at a scale of *1 step = 1 millimetre* and orientated to Magnetic North (True North was unknown at this stage).

Beginning with station 'A', the bearings and distances were plotted for all features noted. Symbols were used to denote particular features such as man-made conservation enclosures and tree types. Average positions were taken of any point intersections which failed to coincide as it was accepted that there would be errors in the survey owing to incorrect reading and recording of data and the vagaries of compass mapping over long distances. The plotting of the survey data is essentially a compromise between ensuring that every point is mapped to its correct position according to field notes and, perhaps more importantly, that a particular feature be in its correct spatial location in relation to other ground features plotted.

Where conflict or doubt arose over the location of particular phenomena, photographic evidence was used to clarify the situation. This was in the form of photographs taken in the field area and from a variety of postcards, many showing the park from an oblique aerial angle and from differing orientations. They provided a visual reference in that they showed clearly the relationships between the ground features surveyed - in particular man-made conservation areas. This greatly assisted the construction of the first draft map *(Figure 5)* as it not only helped resolve problems but also supported the relative spatial accuracy of many ground features located during the course of the fieldwork.

8 days fieldwork.

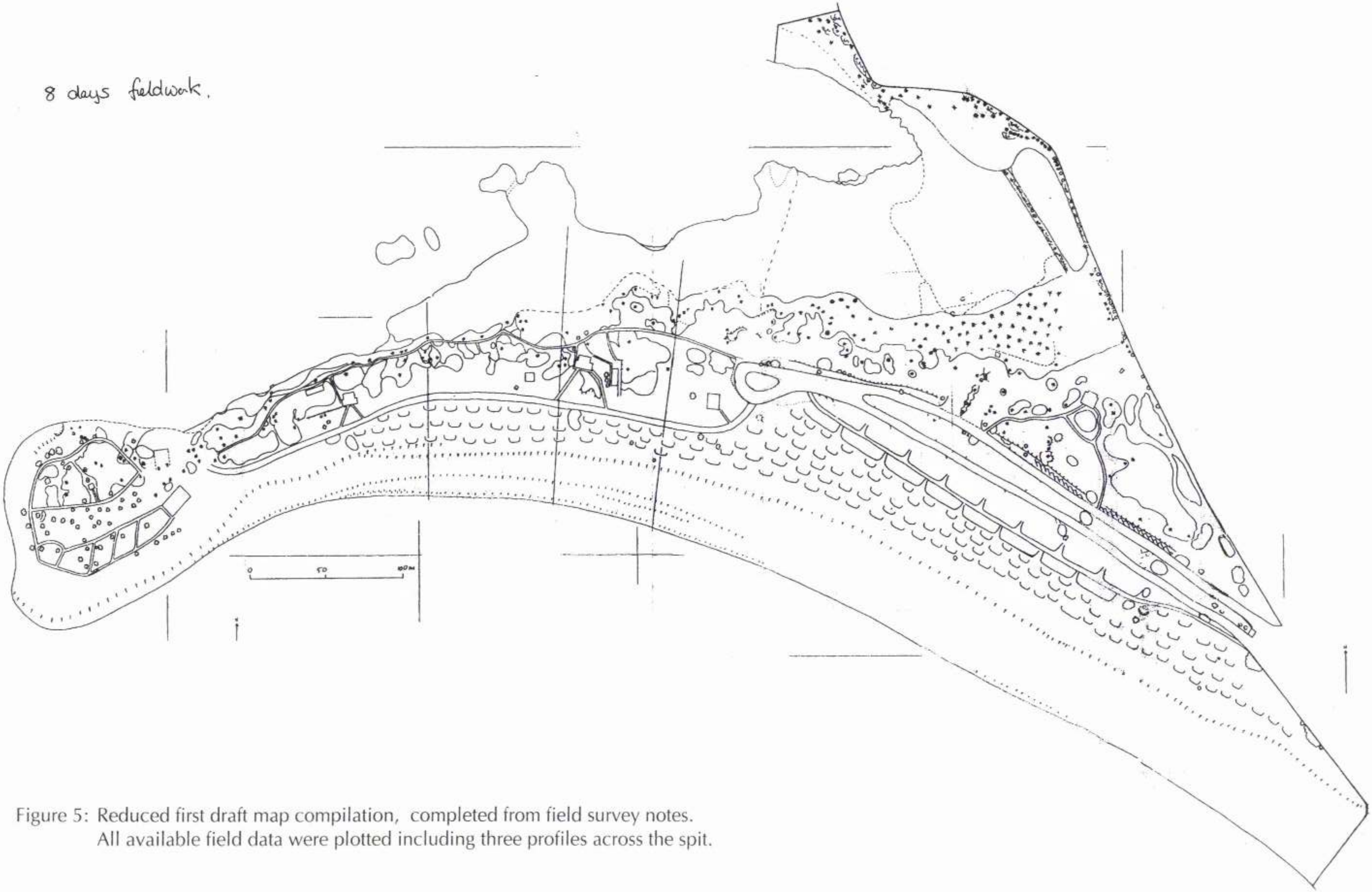


Figure 5: Reduced first draft map compilation, completed from field survey notes.
All available field data were plotted including three profiles across the spit.

3.3. Compass Traversing - some critical considerations

The success of employing a compass traverse as a field survey methodology is open to question especially regarding the degree of accuracy that can be achieved. That it is not as accurate as using Electronic Distance Measurement (EDM) systems, theodolites and levels is beyond question. Nevertheless as a method which can be employed in the field with a minimum of personnel and equipment it can prove worthwhile, given certain obvious limitations. The limitations are essentially that the map contains some inaccuracies in terms of correct bearings, distances and height levels, as errors will undoubtedly have become incorporated in the survey. For example, using steps as a measurement device is time saving but also error inducing as distances cannot be as precise when compared with tape or chain measurements. Over long distances cumulative error is introduced, although having two surveyors step out the same distance can help overcome this by averaging the measurement. Error is also introduced if the terrain is uneven as the true horizontal measurement is unknown, although this may be overcome over short distances by using a tape measure or chain.

The use of a compass can also lead to error being introduced as it is not as precise a method of reading bearings to a particular feature when compared with readings obtained using a Theodolite or an EDM. The compass used for the survey was broken down into 360 single divisions of degree, whilst a theodolite will measure single degrees, minutes and seconds using a Vernier scale or a reading will be produced electronically and stored using an EDM. The compass is hand held allowing movement to occur, producing perhaps a variation of one or two degrees as opposed to the accuracy achieved from the stationary position of a theodolite when sighting to a surveying staff, or, to a reflector in the case of an EDM. Error is inevitable using compass traverse as a field survey method, but the realisation that error will be introduced is an important factor in ensuring that there is an emphasis in the field to record as much detail as possible as accurately as possible within the given time constraints. Relative spatial relationships of features are maintained through the booking method which ensures that features are plotted schematically in the field and annotated for further reference.

However by accepting the limitations of compass traversing it did allow an area of some 16.5 hectares to be surveyed in eight days, forming the basis for a map for future use in the field. The amount of detail that may be noted and plotted in this time-scale is substantial as compared with a sketch map of the Ölü Deniz National Park carried out over a single day by two Geography third year students in May 1993 *(Figure 6)*.

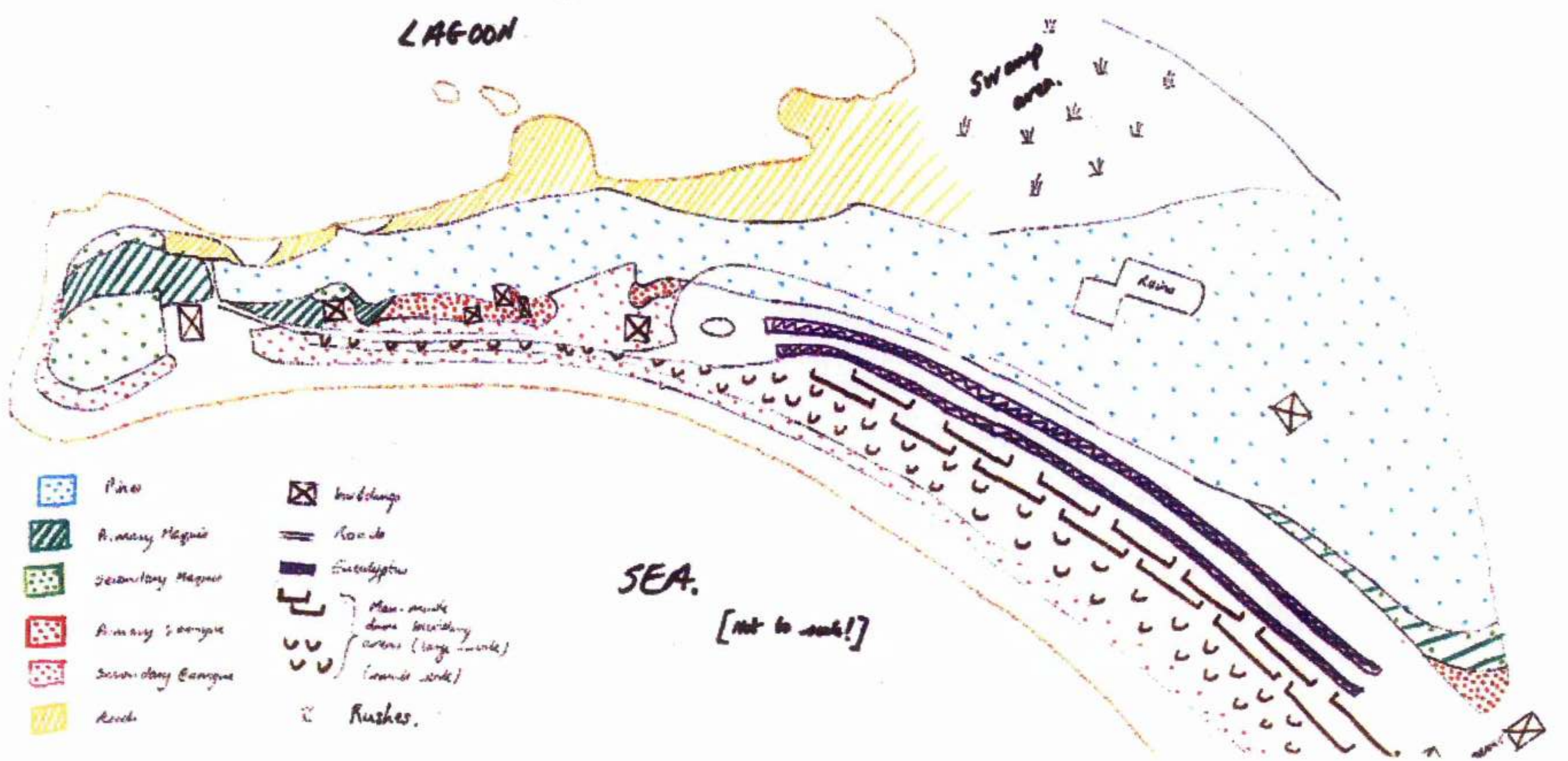


Figure 6: Generalised sketch map of the National Park from a days field work by two Geography third year students; Lee Hamilton & Lindsay Stother, May 1993

To conclude, therefore, compass traversing is a successful way to record a vast amount of data using a minimum of personnel and equipment. It is best carried out on relatively flat terrain to minimise step errors and, if possible, bearings should be taken from fixed positions such as a fence post or stake to avoid movement of body or hands whilst sighting. If time allows, as much information as possible should be recorded to enable a variety of stations to be checked and cross checked from different bearings. It is a method that can be easily adopted, if (as in this case) the use of more sophisticated equipment is prohibited.

It must be restated that when employing compass traverse methodology what is being surveyed cannot be plotted with the precision that a detailed plan demands and therefore cannot be confidently described as such. However, recognising and accepting the lack of precision allows the creation of an accurate field sketch which can justifiably be called a map if the spatial relationships between phenomena are preserved.

The purpose of the map must also be borne in mind. In this case, it is designed to depict an area not mapped previously which shows the variety and extent of vegetation classes within the National Park. The map will also depict the relationships of phenomena within the confines of the Park and allows a framework to be constructed showing prominent features for students to use in the field. For this latter purpose the map will eventually be produced at a size to fit onto an A4 page rendering many inaccuracies irrelevant owing to the influence of cartographic structures such as generalisation, simplification and symbolisation.

The methodology therefore served its purpose. According to Debenham (1948), it is a suitable field technique given the particular circumstances of the field site in an undeveloped country. It supports the idea that using a compass and tape in the field is an acceptable practical method for surveying without accurate sophisticated instruments, and that it lends itself to mapping the peculiarities of this particular site such as the conservation areas, sand dunes, trees and other vegetation of the Ölü Deniz National Park.

Chapter 4

Cartographic Methodology

The cartographic production of a first draft from the original survey map was produced as a base for a variety of maps which differ in both size and detail. The reduced scale of the original survey map was 1:2500 allowing it to fit onto an A3 page (420 x 297 mm). This was deemed an appropriate size for the first computerised draft *(Figure 7)* allowing all ground features where possible to be included as individual point symbols depicting spatial relationships on the ground.

The overall design of the map was not a consideration at this stage as the compiled classified map was being used as a document to aid the production of later, finalised versions. The only consideration at this stage was to have as much ground information plotted and classified as possible so that the first draft map would contain all relevant information and include all vegetation classes. This first draft was later used as a field document to assess accuracy and to consider alterations to vegetation classification where there was conflict. The map was, at this stage, a working document.

Following the production of the original survey map, the 1:2500 version was then used to produce a classified map describing all of the ground features recorded during the field survey. This entailed the production of a legend to denote all natural and man-made phenomena such as vegetation types and buildings.

The production of the classified map was entirely computer based using an Apple Macintosh platform and the graphic arts application, Adobe Illustrator. This methodology, as Woods (1993) rightly commented, allows small cartographic units to embrace new technological developments and encourage improvements in map design. Given that cartographic output in the University of St Andrews had been computer based since 1987, this therefore was an appropriate medium to use in the design and construction of the maps of both National Parks.

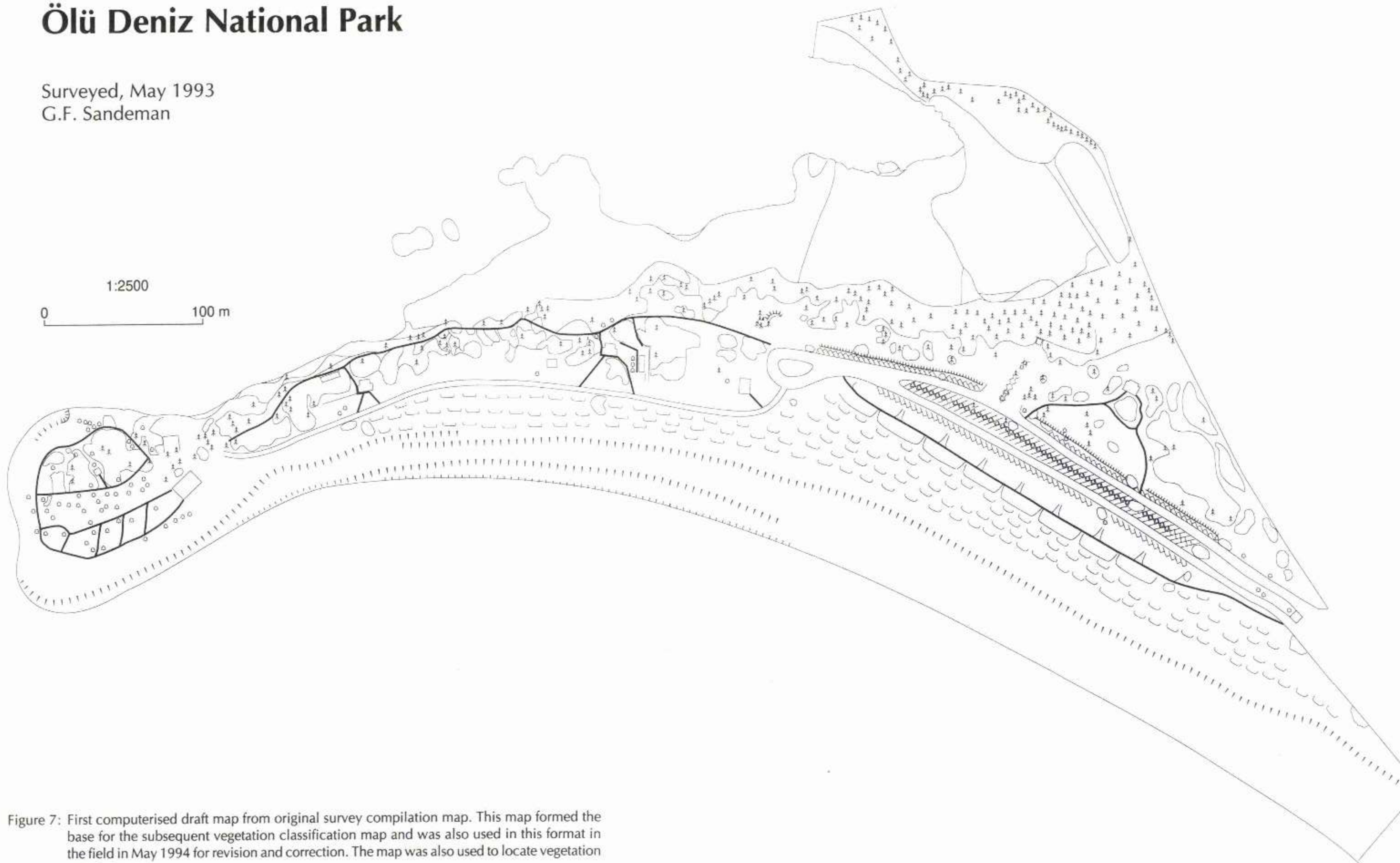


Figure 7: First computerised draft map from original survey compilation map. This map formed the base for the subsequent vegetation classification map and was also used in this format in the field in May 1994 for revision and correction. The map was also used to locate vegetation quadrat surveys.

4.1. Legend

The legend on any map is extremely important in that it is essential to explain clearly to the user what phenomena are being depicted on the map. Maps in general are composed of symbols in both graphic and text format, arranged and organised on a flat surface and representing phenomena at particular scales. The most basic requirement for any map (and indeed any legend) is that it be a clear, unambiguous form of visual communication. The map and legend should have a clarity and legibility in all components or elements of the map which include clearly defined graphic symbols be they area, point, line or name and must exclude all possibilities for ambiguity. Depending on the nature of the map, the legend can be used to reinforce a particular point of view as it can be used both objectively and subjectively depending on the author's needs.

The requirements of this particular map were to enable the plotting of the extent of various vegetation types and as many other features as possible on the ground given both time and survey methodology constraints. Thus the map could be used subjectively by selecting particular features on the ground or objectively by including every feature plotted. As the original survey included as much detail as was possible, given the various constraints already noted, it could be argued that the original survey map was therefore an objective result of what was recorded. This is true in terms of the mapping but the survey must be viewed as being subjective as it was not possible to record every feature.

As the compilation survey map *(Figure 7)* includes all recorded information, the problem arises as how to depict that information in map form. At this stage there was no requirement to create a hierarchy of symbols within the legend, i.e. no ground feature was more highly rated than others. The vegetation classification was considered and colour coded with no particular emphasis. Colour was merely a device at this stage to depict and distinguish the various phenomena for clarification and easy identification at the mapping stage. The vegetation was broken down into two symbol types; **Area**-which depicted the extent of vegetation classes such as Maquis and Juncus and **Point-**which depicted specific individual vegetation types such as Coniferous and Deciduous trees. At this stage ambiguities between any vegetation classes were noted for future fieldwork.

This was followed by symbolising man-made features (often **Line** features) such as buildings, roads, paths and dune/spit protection enclosures. Other relevant features symbolised in the legend were breaks of slope, church ruins and car parks. These were a combination of area, point and line symbols showing the shape, form and extent of the feature being depicted.

At this stage the symbols were a classification device to depict the phenomena that had been surveyed and plotted and this was regarded as an ideal solution for a final map produced at 1:2500. However if the map was to be reduced to 1:4000 to fit onto an A4 page (297 x 210 mm), consideration would have to be given to either the removal of some point symbols, notably the trees and car park enclosures and their replacement in the form of a designated area symbol, which was clear and distinct from the other symbolised areas. One aspect of symbolisation is that point symbols such as those representing individual trees can be repeated at a smaller scale to form an area symbol, thus retaining some connotation between the individual feature being depicted and the area covered by the phenomena as a whole. The individual tree would then be symbolised as a vegetation class, becoming an area symbol through repeated use of the point symbol. If woodland, for example, was to be depicted solely as a particular colour within an area symbol the features on the ground such as trees would then be transformed through generalisation to a conceptual and not a structural form of the phenomena being mapped.

However within this map there is a conflict of vegetation types as the coniferous and deciduous trees are inevitably found inter-mixed within the vegetation class, Maquis. Therefore the ideal solution in depicting these classes is to retain the trees as point symbols at a suitable size favouring reproduction at either 1:2500 or 1:4000 and overlaying the area symbol classification of Maquis.

The legend was then created within the Adobe Illustrator application on an Apple Macintosh computer platform. This application allows the construction of customised colours and patterns which can be classified with the name of the map element whether it is a road, building or vegetation class. The custom colours were created from a palette of the four process printing colours; Cyan, Magenta, Yellow and Black (CMYK) within Adobe Illustrator and stored for future use within the map. The colours were then applied to the particular map elements which evolved as the map progressed through various stages of modification. Table 1 shows the final legend components and their respective colour mix combinations for the Ölü Deniz 1:2500 map. These colours were subsequently applied to the 1:4000 maps of Ölü Deniz and Kidirak.

Ölü Deniz National Park

Legend Scale 1:2500	Cyan (%)	Magenta (%)	Yellow (%)	Black (%)
	Custom Colours			
Maquis	30	-	20	-
Degenerate secondary maquis	*30*	-	*20*	-
Sand dune community	-	15	-	-
Phragmites Australis (reeds)	-	20	50	-
Juncus gerardii (rushes)	-	15	25	-
Sand beaches	-	-	70	-
Shingle & sand	-	-	20	-
Pine trees	-	-	-	*100*
Deciduous trees	100	30	-	*100*
Large conservation enclosures	-	20	20	*100*
Small conservation enclosures	-	20	20	*100*
Break of slope	-	-	-	*100*
Buildings	-	-	-	20
Church ruins	-	-	-	*100*
Paths	-	*40*	*60*	-
Roads	-	-	10	15
Car Parking	*100*	-	-	-
Wells	-	-	-	100
Showers	*100*	-	-	100
Concrete platform	-	30	-	50
Fenced area	-	-	-	*100*

* Italicised lettering *(100)* indicates a linear symbol whether it is a point, line or part of an area symbol

Table 1: Table showing the colour mix combinations created within the Custom Colour palette facility of the Adobe Illustrator application on an Apple Macintosh computer platform. The facility allows colour to be created and assigned a classification name. It also allows the colour to be modified by changing the percentage colour values of the four process colours Cyan (C), Magenta (M), Yellow (Y) and Black (K). Any changes to a particular colour mixture are automatically applied to that particular map component.

4.2. Creation of Computerised Raster Image from original survey draft

The production of the map from original survey to printed sheet was created using appropriate computer hardware and software. The hardware comprised the Apple Macintosh Quadra 700 and Macintosh Power PC 8100/80 with a SuperMac 21" colour graphic screen. The survey or compilation map was photographically reduced to fit an A3 page and then split to form two A4 pages. This allowed the compilation to be scanned into an A4 sized scanner. The two sheets were scanned into the computer as a rasterised image using a DEST PC Plus scanner and saved as MacPaint files. These files were joined together in the MacDraw application to form a single rasterised image file. The rasterised image is crude and effectively needs to be redrawn using an application which can create smooth customised lines, shapes, symbols and text. Therefore it was saved as a PICT file suitable for exporting to graphic applications such as Adobe Illustrator and MacroMedia Freehand as a template or guide for final artwork.

4.3. Conversion of Raster Image-Adobe Illustrator

The chosen application, Adobe Illustrator 5.5 is one of the two most widely used packages in the field of computerised graphic arts applications available on Macintosh computers. Its main competitor, according to Allsopp (1993) is MacroMedia Freehand 5.0. Both applications have operational similarities in that they are essentially vectorised drawing tools, however Adobe Illustrator is the primary choice for the production of graphics in the University of St Andrews. Adobe Illustrator is a powerful and sophisticated graphic arts application that allows the creation of complex graphics using a combination of freehand lines, curves, straight lines, polygons and text. It therefore adapts easily to the needs of the cartographer in the concepts of design, layout and production as its versatility allows the creation of both simple and complex maps .

The advent of computerised graphics has seen a fundamental change in the field of cartography away from 'traditional' methods of putting information onto a page. Instead of pens, film, scribing, 'Letratone', 'Letraset' and photomechanical type, applications such as Adobe Illustrator allow much more flexibility in the production of maps and graphics and can produce an equal, if not superior, end product.

This end product or final map is translated from a 'bit-mapped' screen graphic to a high resolution printed page using a page description language known as Postscript, developed by Adobe as an adjunct to their graphic applications. This conversion from 'bit-mapped' screen graphic to a high resolution Postscript output onto either paper or film has both revitalised and revolutionised the field of cartography within educational establishments in the United Kingdom today. Essentially the Postscript page conversion allows the production of detailed linework (whether straight lines or curves) and the production of type faces or fonts at a quality previously found only in type setting equipment such as a Morisawa photomechanical typesetter. This has enabled cartographers and graphic designers to produce artwork to a consistently high and uniform standard, knowing that the end product will match the quality of cartographic or graphic input.

The flexibility of this programme ensures that once linework has been created it can then be customised to suit the needs of the author. Lines can be assigned values or line weights, they can be dotted, dashed or screened as a percentage of black or any other colour. Areas can be defined as polygons and assigned values for both area fills and lines. This allows changes or alterations to be made easily and quickly and has perhaps removed the need for a cartographer to have a clear idea of what the final map should look like. This has benefits in that cartographer and author can rapidly work the map through various stages of 'evolution', experimenting with various design concepts. Existing maps can be quickly and easily edited or adapted to suit a particular need whereas before the advent of applications like Adobe Illustrator, the map compilation was the place for experimentation and design prior to creating the final product. This freedom however may at times be thought to encourage a certain laziness of thought on the part of the designer who may prefer to develop ideas whilst progressing with a map on screen instead of working out all possibilities beforehand.

The ease of use of Adobe Illustrator has many advantages not only in the production of linework but also in the production of what is perhaps a map's most important symbol, the names of features. The use of these graphic software applications has revolutionised the typographical production of names on any given map. Before the use of computers, names, like all other map components, had to be worked out in advance of final production. This meant a considerable amount of pre-planning at the compilation stage to work out the variety of fonts, sizes and styles to be used. This had to be done irrespective of whether the text was produced photo-mechanically or by other methods such as dry-transfer lettering e.g.. 'Letraset'. It was important to plot the extent and size of names on a compilation map to understand relationships between named phenomena and to enable the cartographer to avoid conflict with other map symbols be they points, lines or other names. Other features relating to names which had to be taken into consideration at the compilation stage were the curving and letter spacing of text to follow the line of physical features such as rivers and hill ranges or showing the extent of geographic or political areas.

Today, the use of computers has largely removed this part of the compilation process, text can be added directly to the image on screen and edited to suit. Fonts, sizes and styles can be changed rapidly; letter spacing and curved text can be achieved accurately and, more importantly, can be instantly moved around the map on screen. This flexibility allows the cartographer to experiment directly on the map to achieve the ideal position, size and type style for all phenomena named. This has an added bonus in that alterations following proofing can be made both quickly and cheaply. This is of particular importance in a commercial publishing environment, Adobe Illustrator has a text editing facility similar to word processing applications where specific words can be automatically accessed and changed without having to search for them. This is a significant leap forward in graphic technology for map production which has positive implications for improving accuracy and marked cost benefits as a labour saving device.

The major benefit of applying computerised technology to the cartographic process is flexibility, in that it allows the user to experiment with different ideas yet still retain the basic framework of any given map. This is particularly useful when the map is a working document to be used in the field for further research, as was the case in the present study. The map can therefore evolve through further stages by new additions or by editing the existing information, thus producing a different version from the original compilation.

4.4 Scale

A major consideration when producing any map is what the final printed size will be. The importance of final print size affects a number of cartographic processes relating entirely to the size and therefore the scale of the map.

In this case the decision was made to produce the final copy of the map at two different page sizes, namely at A3 (420 x 297 mm) and A4 (297 x 210 mm) size. This was primarily for practical reasons as the map would be used for research work in the field at A3 and also as a teaching tool at A4 for use in the field and therefore had to be of a manageable size. Secondary considerations were that the map had to be reduced down to this size to accommodate raster scanning into the computer and that the output devices immediately available 'in-house' were of A3 and A4 size.

The original survey compilation was drawn at a scale of 1:810 and reduced to less than A3 size at a scale of 1:2500. The new scale was deemed suitable as all detail drawn and symbolised on the original survey map was photographically reduced and still retained legibility at the new scale. This meant that all recorded detail could be drawn and symbolised at the new scale in the final map process. This enables the map to be used in the field as a research tool to accumulate more data. The map would then be suitable for printing in colour at A3 thus allowing the construction of a colour vegetation classification. A further reduction allows the map to be printed at A4 size at a scale of 1:4000, but this reduction in scale may result in a deterioration of some map elements such as specific point and line symbols. Therefore to accommodate a change in scale of the final production, it may be necessary that some map elements undergo some simplification, generalisation or elimination.

The advantages of generalising or simplifying the map further is that it can be produced either in colour or in grey scale as the amount of information has been reduced thus offering a wider variety of production methodologies. Also if the map was published in a book, it would probably be at a size less than A4 and in monochrome and therefore would require various degrees of simplification and generalisation to depict visually the relationships of phenomena originally mapped.

Individual point symbols present on the 1:2500 map such as the pine tree symbols would have to undergo a generalisation process to show them as either a single symbol denoting all the pine trees within a given area as a conceptual generalised symbol or by denoting them as a vegetation area symbol. The latter would, however cause conflict with existing vegetation classes. Another point symbol which could be generalised into an area symbol is that showing individual car park bays. At 1:2500, this symbol is clear and unambiguous, but through scale reduction, the symbol may deteriorate, thus demanding its conceptual change to an area symbol. However the reality is that the symbol sizes were produced to be legible at both scales thus avoiding a change of symbol format.

At the 1:4000 scale, the map could also be stripped of the vegetation detail, leaving the National Park outline, roads, paths and buildings and used in the field as a base map for project teaching purposes *(Figure 8)* and simply printed in black.

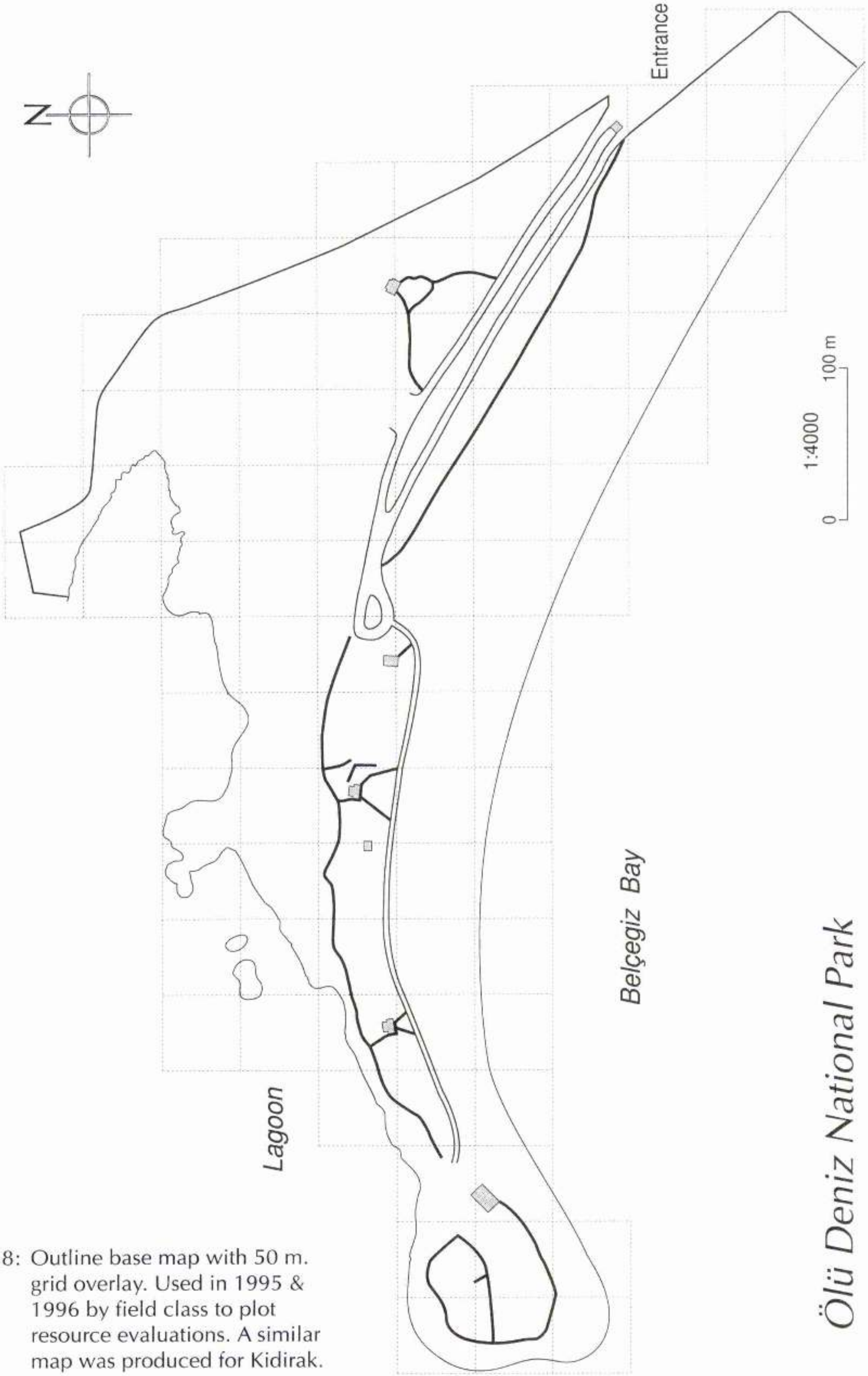


Figure 8: Outline base map with 50 m. grid overlay. Used in 1995 & 1996 by field class to plot resource evaluations. A similar map was produced for Kidirak.

4.5. Print Output

Primarily as a result of the printers available within the University, the final map was printed through output devices which varied considerably in resolution, colour, quality, print speed and also size of output. The following figures were produced using three different printers. Figure 9 shows the 1:2500 map printed in colour on A3 paper using a Canon Colour laserprinter (resolution 400 dots per inch [dpi.]). Prints from a Canon Colour CLC 10 bubble ink jet printer (resolution 400 dpi.) were used to provide 1:4000 proofs and final copy at A4 *(Figure 10)*. The map was also printed in monochrome *(Figure 11)* at A4 size using a high resolution imagesetter; the Agfa AccuSet (resolution 1200, 2400 & 3000 dpi.).

The Canon Colour laser printer was used primarily to provide single final colour copies of the map whilst the Canon CLC10 was used continually for production proofs and field maps in Turkey. The high quality end product of the Agfa AccuSet imagesetter would provide camera ready copy if the map was to published and printed in monochrome.

If there was a need for the map to be mass produced by four-colour printing, the Agfa AccuSet imagesetter would also be used to produce film separation originals of each of four process colours used; Cyan, Magenta, Yellow and Black.

4.6. General Utilities

The process of map production described above was undertaken to gain further insight into the problems and practicalities of producing an original survey map through a computerised mapping process, to analyse the various production methods and to assess the benefits of developments in map production for research and teaching within the School. The production methodology employed using Adobe Illustrator, although standard within the Cartographic Office of the School of Geography & Geology, is important in relation to on-going teaching of cartography at Junior Honour (3rd Year) level using this particular software application. New processes and developments, researched and utilised using the application, will be passed on at a later stage to students and postgraduates in formal classes and in individual tuition enabling them to both understand and use the technology available within the School for cartographic production.

In addition to being a medium for developing applications for map design, the map itself can also be considered as a research or teaching tool and perhaps as a published document to be sold in and around the National Parks of Ölü Deniz and Kidirak.

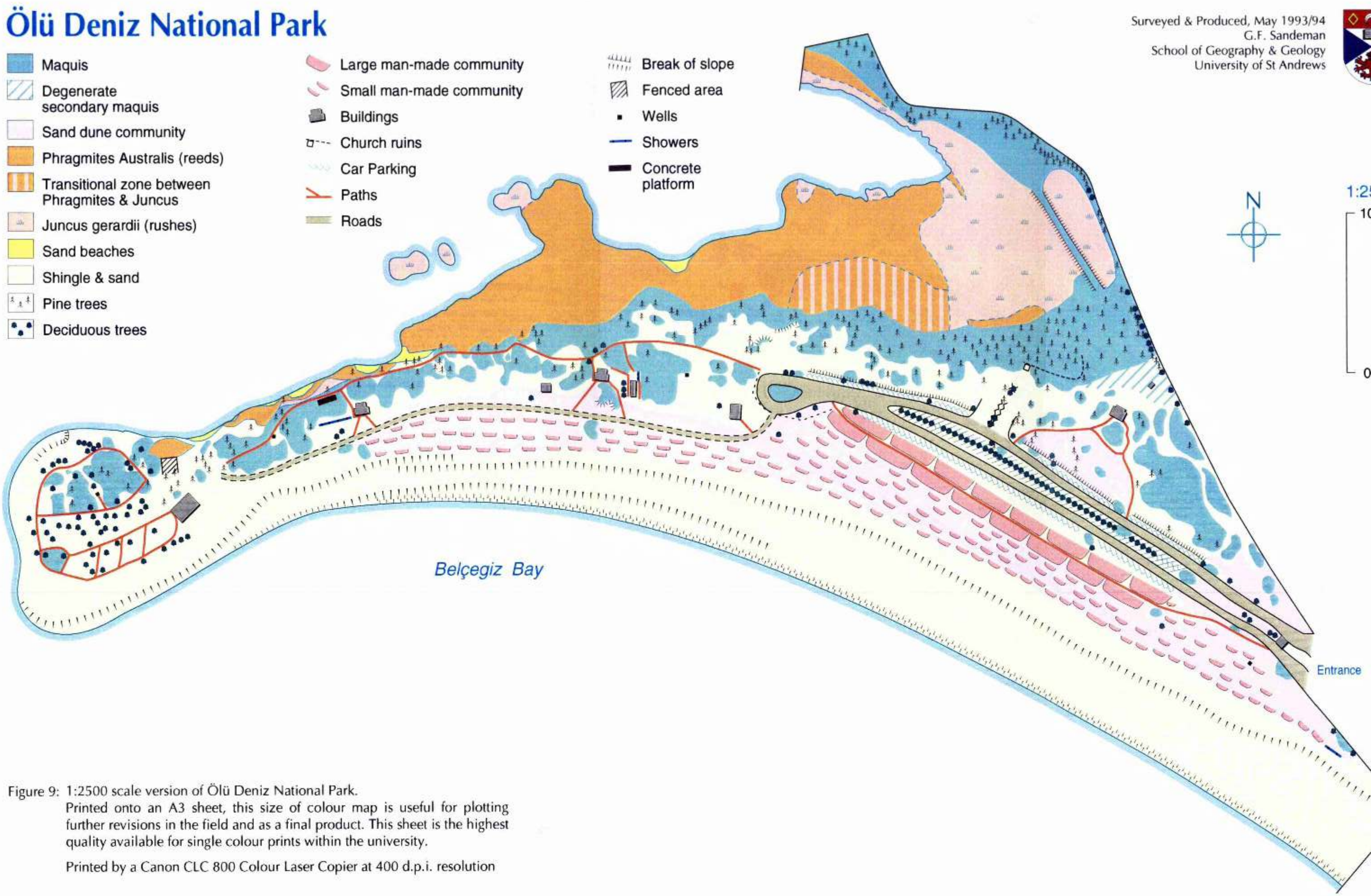


Figure 9: 1:2500 scale version of Ölü Deniz National Park.
Printed onto an A3 sheet, this size of colour map is useful for plotting further revisions in the field and as a final product. This sheet is the highest quality available for single colour prints within the university.

Printed by a Canon CLC 800 Colour Laser Copier at 400 d.p.i. resolution

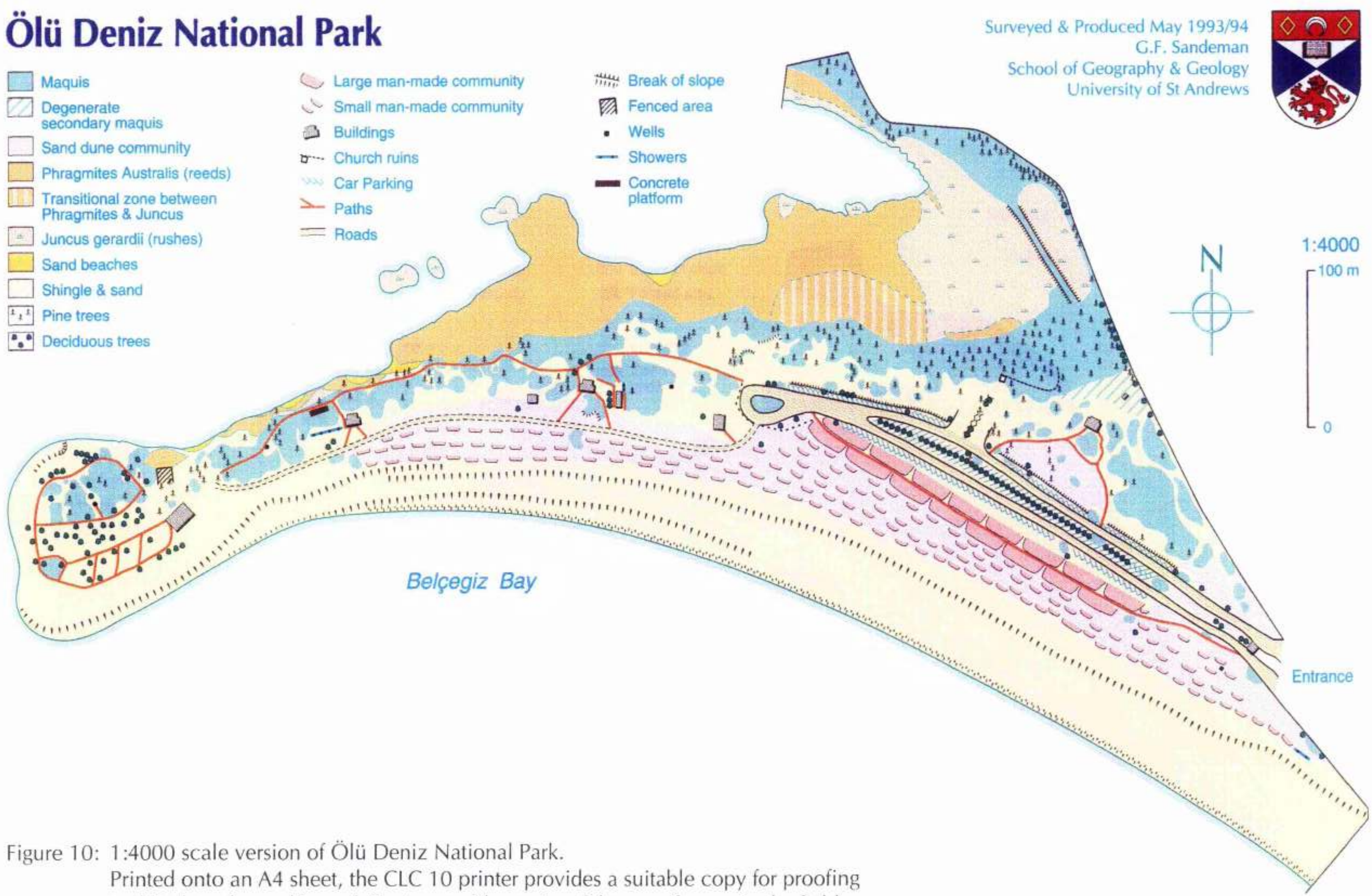


Figure 10: 1:4000 scale version of Ölü Deniz National Park.
Printed onto an A4 sheet, the CLC 10 printer provides a suitable copy for proofing and is also of a quality and size to provide copies of the map for use in the field.

Printed by a Canon CLC 10 Colour Bubble Jet Printer at 400 d.p.i. resolution.

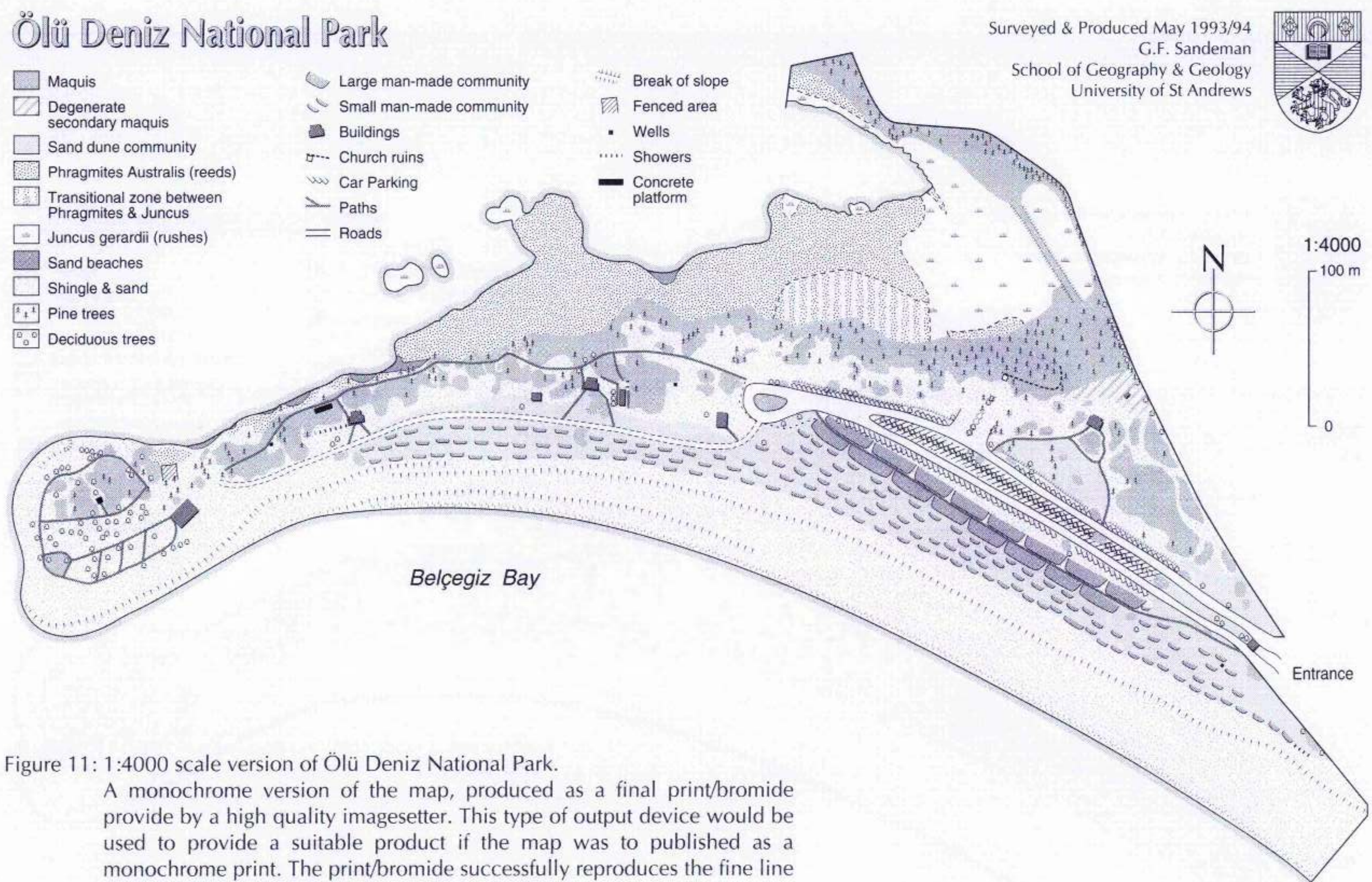


Figure 11: 1:4000 scale version of Ölü Deniz National Park.

A monochrome version of the map, produced as a final print/bromide provide by a high quality imagesetter. This type of output device would be used to provide a suitable product if the map was to published as a monochrome print. The print/bromide successfully reproduces the fine line symbols, patterns and percentage black screens.

Printed by a Agfa AccuSet imagesetter at 1200 d.p.i. resolution

4.6.1. The Map as a Research Tool

The initial draft map is the product of research carried out in the field over a period of eight days. Although the survey was extensive, it was limited by both a lack of resources and time constraints. However these problems were addressed by using the completed draft map as a base map research tool during a second and third field season. This allowed the map to be assessed for accuracy and also as the base for modification, alteration and additions. Ambiguity between vegetation classes was assessed and corrected. For example, the names of vegetation classes were reviewed from the first map; the vegetation types named as Primary Maquis and Secondary Maquis were subsequently combined to form a single classification, namely Maquis. Spatial relationships between phenomena mapped were also reviewed and the draft map was used in the field to plot the location of vegetation quadrat surveys. These locations can be extracted and enlarged from the base map to give detailed background information for a quadrat survey.

The map as a research tool was also used for a general experiment in perception to see if users could identify and relate to what had been mapped and also to evaluate if the map relates to their own perception of what they saw and understood of the various phenomena within the study area. This was in the form of a questionnaire attached to the map and completed by a number of Geography students who were involved in projects within the National Park.

Questionnaire Survey (Appendix III)

The map of Ölü Deniz National Park was used in the field by geography field classes in May 1994 and June 1995. This was done; a), in response to the need to provide field classes with a suitable map of the park and, b), for users to assess the accuracy of the map by answering a questionnaire relating to it. The questionnaire (Appendix III) was designed to challenge the user's perception of whether they believe the map is an accurate and useful guide to the park. This allowed the user to have a map to work with in the field and the surveyor/cartographer to obtain feedback from the users for whom the map was created.

1994 Field class

The map used in May 1994 was the initial first draft from May 1993 *(Figure 12)* that would subsequently be updated and revised in the field. The revision undertaken in 1994 aimed to have the undergraduates identify any perceived problems in vegetation boundaries together with an assessment of the relative accuracy of the map.

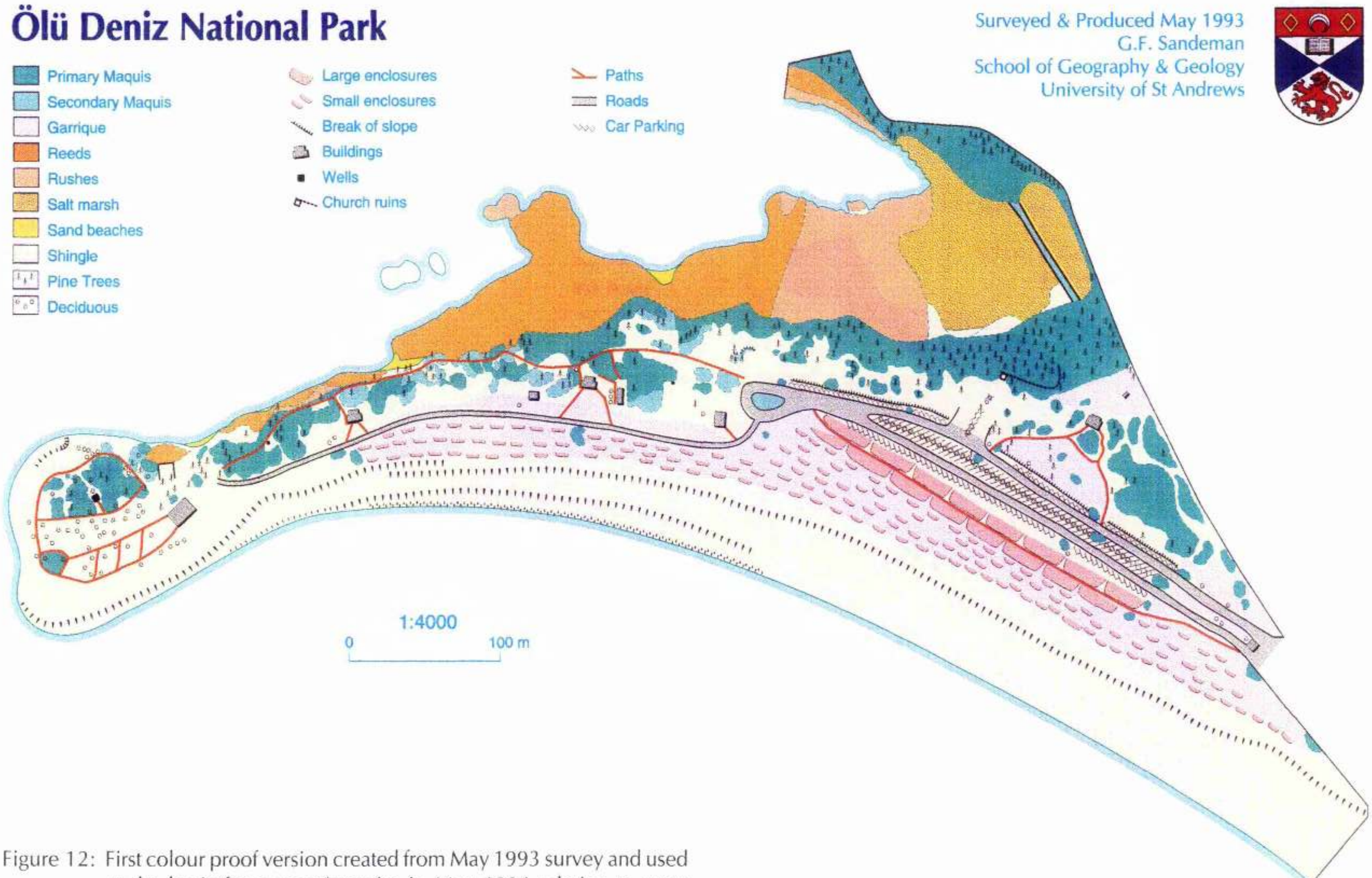


Figure 12: First colour proof version created from May 1993 survey and used as the basis for a questionnaire in May 1994 relating to users general perceptions of the accuracy and usefulness of the map.

The response from the field class *(Table 2)* as independent yet knowledgeable users was an important aspect of assessing the map both cartographically and from a biogeography viewpoint. Conversely, as well as the map being assessed, the field class itself was therefore subject to scrutiny, relating to their application of knowledge gained in both cartography and biogeography courses.

1994 Questionnaire	Percentage 1	2	3	4	5
1. The map looks correct.	**73**	**27**	-	-	-
2. The relationships between phenomena have been correctly preserved.	**45**	**45**	-	-	-
3. The map shows the true extent of the vegetation classes.	**36**	**45**	**9**	-	-
4. The map is an accurate description of the National Park.	**64**	**36**	-	-	-
5. The map is useful as a guide to the National Park.	**73**	**27**	-	-	-
6. Please specify any obvious inaccuracies or other features to be added, or any other comment you wish to make (text response).					

1 = Strongly agree 3 = Neither agree nor disagree 5 = Strongly disagree

2 = Agree 4 = Disagree

Table 2: Questionnaire results from May 1994 field class using the May 1993 map (10% of respondants did not answer questions 2 & 3)

The response to the 1993 map indicated that the users thought the map was an accurate description of the park, that spatial relationships had been maintained and that the vegetation classes were reasonably accurate. Overall they regarded the map as looking correct and as a useful guide to the park. They also made comments relating to Question 6 and additional supplementary comments beyond the formally structured questionnaire.

Points which were raised from this initial map and questionnaire were primarily cartographic. These included 54% of the users querying the two black lines containing secondary maquis within the salt marsh area in the north-east corner of the map. These lines indicated the raised ground on which the maquis stood. This was subsequently shown as a break of slope line symbol on the 1995 map.

Another point raised by 18% of the users was the use of dashed blue lines as a case line for the reed, rush and salt marsh areas. These users indicated that they may be construed as ditches or streams. However the use of dashed blue lines was to indicate that the edges of these classes were indistinct and could not be classified as being fixed. As classification and areal ambiguities within these communities were further examined it was decided that continuous lines denoting areas would be used on the 1995 map to avoid confusion and ambiguity.

A final cartographic point raised in 1994 by 9% of users was the lack of any annotation indicating the coastal and lagoonal side of the spit. The prime reason for this was space, as the legend occupied the lagoon side and a scale bar was positioned on the coastal side. The name Belçegiz Bay was subsequently added to the map for 1995 following a general layout revision which saw the scale bar being rotated through 90° and repositioned. The lagoon was not named, primarily as it would interfere with the legend but also the name of the park refers to the lagoon as Ölü Deniz, literally means Dead Sea.

1995 Field class

The field class in June 1995 also gave general approval to the overall accuracy and appearance of the revised map *(Table 3)*. The classification and boundary ambiguities identified in 1994 *(Figure 13)* had been adjusted and updated accordingly.

Problems arose however with the discovery that the boundaries between the reed and rush communities were significantly different to that on the 1994 map revision. This was noted by 38% of users, some of whom suggested that the continuous blue lines between

1995 Questionnaire	Percentage 1	2	3	4	5
1. The map looks correct.	**38**	**50**	-	**12**	-
2. The relationships between phenomena have been correctly preserved.	**12**	**76**	**12**	-	-
3. The map shows the true extent of the vegetation classes.	-	**76**	**24**	-	-
4. The map is an accurate description of the National Park.	**24**	**64**	**12**	-	-
5. The map is useful as a guide to the National Park.	**50**	**38**	-	**12**	-
6. Please specify any obvious inaccuracies or other features to be added, or any other comment you wish to make (text response).					

1 = Strongly agree 3 = Neither agree nor disagree 5 = Strongly disagree

2 = Agree 4 = Disagree

Table 3: Questionnaire results from May 1995 field class using the May 1994 map

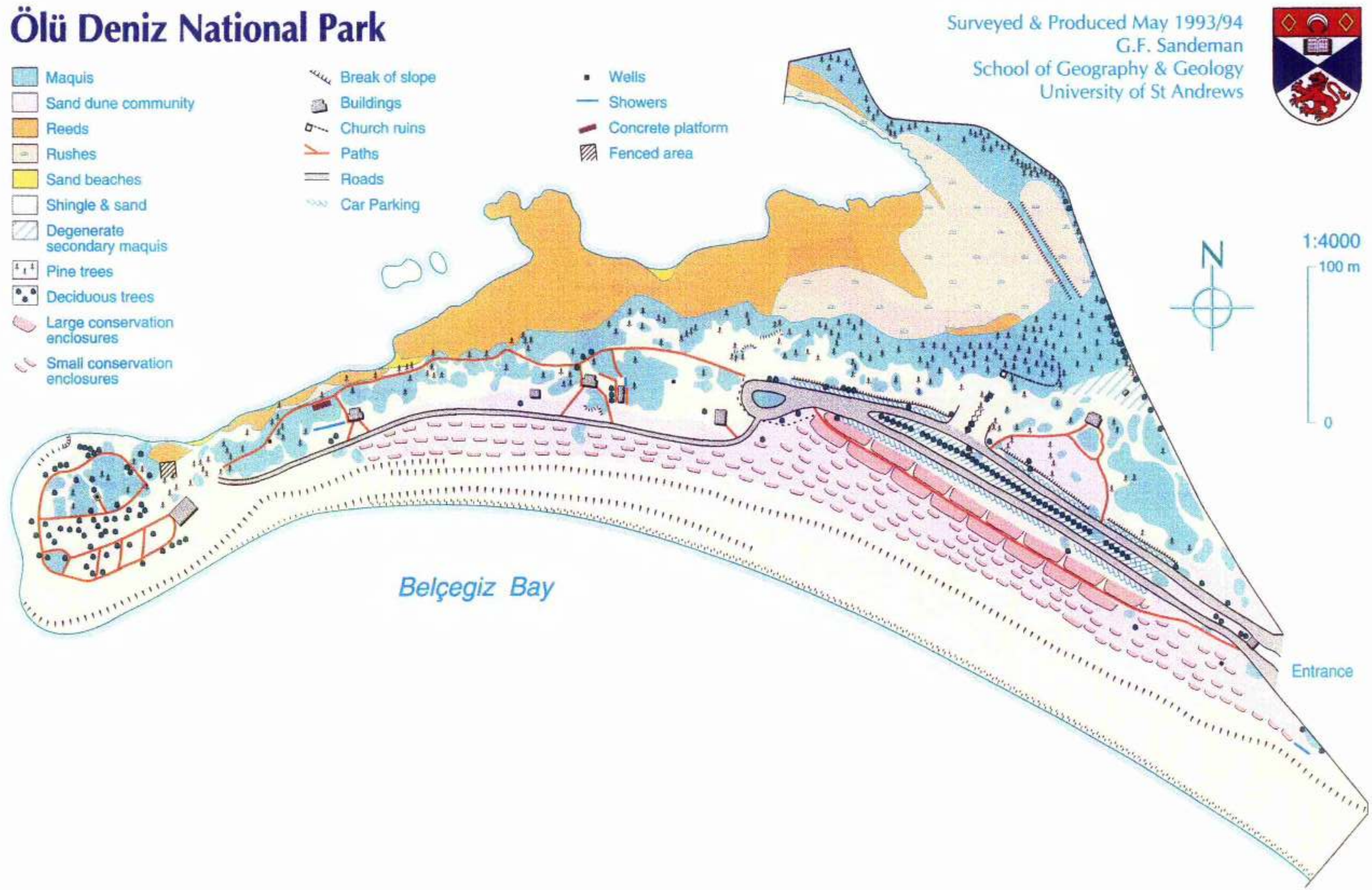


Figure 13: Second colour proof version created from May 1993 survey, revised from May 1994 and used as the basis for a questionnaire in June 1995.

the classes be a dashed line to indicate an indistinct edge, i.e. in complete contrast to the entirely opposite point of view expressed in the previous year. Indeed it was clear that there was change within the reed/rush community, and it became apparent that the boundaries (however indistinct) had reverted back to their 1993 positions. Therefore it was decided to reinstate the 1993 boundaries on the final map and also show a new transitional area between the communities. Kirby (1993) identified similar problems discussing his map of Aberlady Bay. Generalisation is both a subjective and intuitive process, and the common cartographic problem of graphically representing zones of gradation between communities or ecotones may be addressed by not including boundaries at all.

Another cartographic point raised by 26% of users was that the tree symbols did not reflect their true size and extent. As discussed earlier in this chapter, the trees are merely symbolised to show location particularly within other vegetation communities. If the true extent or width of trees were shown as a canopy it would effectively hide the vegetation under the storey.

The choice of colour was also questioned with regard to that depicting the reeds by 13% of users. The suggestion was made that the colour chosen does not reflect reality and that it was too bold and dominant. The question of reality does not exist in a map as it is a representation of what is real on the ground depicted by symbols, in this case colour on a page. The colour chosen to describe the reeds was basically derived from a general family colour of yellow/orange hues. This would allow the reeds to be distinct from that of rushes, sand beaches, shingle & sand, but be within the same colour palette. That family of colour was also chosen to contrast and be obviously different from that describing maquis and sand dune communities. However the point of boldness was one that could be addressed and a less saturated hue applied.

The overall benefit of having a field class use the map was two-fold, in that additional points of view are noted and that students who have undergone a cartography course can apply that knowledge critically in assessing an evolving project such as the Ölü Deniz map.

The main advantage however is that the map is used in the field by a specific user group who are able to study and monitor changes between vegetation classes together with an increasing awareness of cartographic processes and decision making relating to classification, symbol design and colour.

4.6.2. Teaching Tool

The map has been used as a teaching tool in the field by supplying students with a generalised version of the map at A4 size. This map, stripped of all vegetation cover retaining only the outline of the National Park and some man-made features enabled the student to locate and describe the vegetation within the park more quickly and with a greater degree of accuracy. Their results were then compared with the main base map which contains all the vegetation classes available. As described earlier *(Figure 8)*, other class sheets have had a 50 metre grid superimposed to assist in a resource evaluation exercise within the park. This applies equally to Kidirak National Park as the map created from the 1994 survey is now used in the field.

4.6.3. Publication

The final colour map could conceivably be published considering the levels of information contained within the document. As there is no existing map material available to the public for political reasons, other than some small scale maps such as Bartholemew's Tourist map at 1:435,000 scale, there is a need for such a map showing the extent of the National Park at Ölü Deniz and Kidirak and the features present within the Parks. One of the prime reasons for mapping the National Parks was to fulfil this need to enable future field classes to work from a reasonably accurate document. Currently the map is still primarily a working document with circulation limited to a field class using the map as an aid to field research.

However three problems would have to be addressed and overcome if the map was to be published and sold for general use.

(i) The map produced from the original survey cannot purport to be an accurate depiction of what is on the ground owing to the basic limitations of the survey methodology. Therefore the map cannot be as accurate as it would have been had a more sophisticated and accurate survey methodology been applied. The map is essentially inaccurate if used for applying precise measurement, but accurate in preserving the spatial relationships of the ground phenomena mapped.

(ii) Another aspect to be considered if the map was to be published are the political implications of such a decision. It may be assumed that a detailed map of a militarily vulnerable beach would not be seen to be in the best interests of the Turkish Government given the continuing political climate of hostility between Turkey and Greece.

(iii) If the problems of points i & ii were surmountable, would a decision to publish such a map be an economically viable venture? To be worthwhile the map would have to be produced at an appropriate cost and in sufficient numbers to cover the production, printing and publishing costs and (hopefully) make a profit. A market would have to be identified to see if the demand for such a product was there. The map could be used by casual users interested in visiting the National Park and using it as a guide to the various features within the park. It could also be used as a vegetation map (one of the original aims) or even simply as a map showing the man-made features such as roads, paths, car parks, cafes, toilets etc. However the National Park is very small by UK standards and it may be that the map would be unlikely to sell to casual visitors/users. Perhaps the most likely use might be as a simplified single colour map supplied free by the local tourist office for visitors to what is continually described in the marketing literature as "the best beach area in Turkey".

Chapter 5

Combining Satellite Images and Maps

Background

The combination of a ground survey map with a satellite image to produce a photo-image map is a relatively new procedure. For centuries maps have provided a selective or generalised view of the land, but not until the advent of aerial photography and latterly satellite imagery has there been a medium for viewing the apparent reality that photography and imagery provide. There are problems associated with either medium. Maps by their nature need to be selective; in contrast, satellite imagery or aerial photography may have too much information and may therefore present the user with a problem of breaking down these data so that they may be more easily understood. By combining a map with an image, relationships may become clearer, and areas such as forests and field systems may be identified and measured.

This new development of photo and image maps was derived initially from the launch of Landsat-1 by the National Aeronautics and Space Administration (NASA) in 1972, which provided informative and visually appealing images. However many images were of no real use to the non-specialist user, primarily because of an information overload associated with these images and as a result satellite images as maps have failed in becoming a map product in their own right (Dahlberg, 1993). One initial exponent of combining imagery with maps was the United States Geological Society (USGS) who have overlain a variety of images with topographic information such as boundaries and names. The topographic information and satellite images were then combined using photomechanical techniques before printing.

The cartographic design problems of combining an image with a map remain much the same using computers as those of the photomechanical methods carried out by the USGS twenty years ago. The purpose of the map, including who the map is to be used by, is an important factor in what information should be added to an image. A specialist user may intuitively break the information from an image into specific categories, but this would be of little use to a non-specialist. The addition of selective map information benefits all by the inclusion of topographic detail, text and information overlaying the satellite image. This information must be selective to avoid the clutter and noise of superimposed complex maps onto an already complex image. The inclusion of additional topographic detail is to aid the user in understanding relationships present within the satellite image.

One aspect of combining a map with an image is that the map must offer legibility, clarity and simplicity of design to be easily understood and be visually obvious against the competing colours of the background image. The choice of colour is an important factor in superimposing information onto an image and this has been made easier by using computers. The cartographer can obtain instant feedback from a computer screen or printout as to whether or not a superimposed map is legible and adjust colours accordingly.

5.1. Image Selection

As detailed above, given the limited mapping and aerial photograph source materials available in Turkey, the use of satellite imagery would appear to offer an ideal solution in collecting data for the area under study. Satellite imagery as a detailed information base has been available since the launch of the first Earth Resources Technology satellite, ERTS-1, in 1972, using the Multi-Spectral Scanner (MSS) as its main recording device. Full details are given in Avery and Berlin (1992). Since 1972, the Landsat programme has evolved using new sensors, notably the introduction of the Thematic Mapper (TM) sensor in July 1982. With the introduction of Thematic Mapper, the ground resolution cell of 79 x 79 metre of MSS on Landsats 1,2 and 3 was refined to a 30 x 30 metre resolution in Thematic Mapper. This improved resolution was accompanied by additional spectral bands of higher radiometric sensitivity.

An alternative source of satellite imagery is available through the Systems Pour l'Obsevation de la Terre or SPOT programme. SPOT 1 dates from 1986, and SPOT 2 was launched in 1990. The panchromatic mode produces a 10 x 10 metre ground resolution over a spectral range of 0.51 to 0.70 μm. This is currently the best geometric resolution of any civilian satellite. The multi-spectral mode on SPOT offers three narrow spectral bands (green, red and near infra-red) with ground resolution of 20 x 20 metres. SPOT imagery, whilst being of extremely high resolution, is very expensive in comparison with Landsat imagery, and was therefore excluded from the present study purely on grounds of cost. Given the size of the two parks being studied, it may be suggested that SPOT imagery would have been an ideal data source, especially as the number of pixels to be manipulated would be small, and the panchromatic resolution of 10 x 10 metre produces an image which is very similar in appearance to that of a 1:10,000 aerial photograph. This is discussed further later in this chapter.

As a compromise, Landsat TM imagery was selected as the most appropriate data source. The pixel size, as noted above, is 30 x 30 metres and the spectral range of six bands at this resolution enable the user to combine particular mixes of bands for particular uses or visual effects. Twenty different three band colour composites may be formed from the six non thermal TM bands. A false colour infra-red composite may be obtained from Bands 2 (green), 3 (red) and 4 (near infra-red) by passing them through the blue, green and red colour guns of an image processing system such as R-Chips (Reading - Copenhagen Image Processing System) used in this study. Alternatively, Bands 1 (blue-green), 2 (green) and 3 (red) when combined in the blue, green and red guns will produce a natural colour composite.

5.2. Selection of scene

The information derived from a satellite is available in the form of particular 'scenes' which cover a selected area and date. When selecting such a scene from satellite imagery sources, it is imperative that the scene corresponds to the dates of the field work and there is therefore a degree of ground truth control in matching image and reality.

In this case the field work was carried out in late May 1993. A search of the EOSAT archive produced a scene for Path 179, Row 35 for June 6th 1990. This was cloud free and the nearest date in season to the date of the field work.

The image was purchased from the EOSAT archive in Italy having been geometrically converted at EOSAT to the Universal Transverse Mercator (UTM) projection. This meant that the image was now in a standardised projection and the image pixels were rotated to fit a longitude-latitude, north-south grid. This does mean however, that error is introduced to the image with extra pixels being added through rotation to fit the projection.

5.3. Methodology

The use of computers to create and combine images is relatively new and the methodology to combine satellite images with maps has to be constructed to operate within the confines of the existing computing systems and software available within the School of Geography & Geology. Two different platforms existed; the Remote Sensing facilities were IBM-PC based using R-Chips software whilst the Cartographic facility was entirely Apple Macintosh based.

The basic premise was to load the satellite imagery into the image processing system, select the relevant areas of Ölü Deniz and Kidirak and save them in a format suitable for export into another platform such as the Apple Macintosh.

The satellite data were processed on the image processing work-station using an IBM type 386sx based computer with a maths co-processor, running Version 4 of the R-Chips software. The 512 x 512 image was processed on R-Chips through a Number Nine 512 x 32 graphics card which allowed display at 24 bit colour resolution. The software, which can be either menu driven or accessed via direct line commands allows the data to be manipulated in a number of ways. An image may be enhanced by options such as contrast stretching or filtering and thus transforming the original image. However it was clear at the outset that the selected source of imagery, i.e.. Landsat TM was not sufficiently detailed at 30 x 30 metre pixels to warrant experimentation through the variety of options available as it could not match the level of detail and complexity achieved by the field survey and the subsequent maps. However the principle remained the same: extract the designated areas from the selected scene and save in a format suitable for export.

A methodology using similar platforms has been used successfully by Collins and MacSiurtain (1992) in the Forest Institute of Remote Sensing Technology (FIRST) at University College Dublin. They adapted a method of manipulating Remote Sensing Imagery across different platforms from VAX mainframe computers using ERDAS Image Processing software and exporting the image into an Apple Macintosh environment using Adobe Photoshop (image processing) and then into Adobe PageMaker (desk-top publishing application). Their basic procedure was to georeference an image using ERDAS then export the image into Adobe Photoshop. The image was then visually interpreted for land cover types and boundaries were identified and digitised on screen to produce a raster master image. This master image was then exported to the desk-top publishing application Adobe PageMaker where it was annotated with key, grid and title before printing onto a high resolution Dye Sublimation printer.

The problem with this methodology from a cartographic view is that the image is rasterised. This is acceptable for the base satellite image, but ideally superimposed linework defining boundaries should be vectorised, producing editable, smooth, detailed linework that can be scaled, not pixellated.

However these problems can be overcome by using a graphic arts application on the Macintosh systems to create maps and overlays. The graphics application Adobe Illustrator was used to create and superimpose linework onto an imported satellite image from R-Chips. The image, as with the FIRST methodology, is imported into the image processing application in Adobe Photoshop where it is saved in an appropriate format for export to other applications. Unlike FIRST the image is exported not to Adobe PageMaker but to Adobe Illustrator.

The imagery, selected and produced using R-Chips was saved as a Tag Image Format File (TIFF) in Red, Green & Blue (RGB) mode to allow export from the PC platform to Apple Macintosh. The TIFF image is imported into Adobe Photoshop where it is filtered and the desired area selected for export to other applications. Adobe Photoshop allows a variety of options to be selected for saving files so that they can be opened in a number of other applications. To export an image and allowing it to be viewed in Adobe Illustrator it must be saved as an Encapsulated Postscript File (EPS), together with a number of parameters which vary such as screen resolution and output device.

The application Adobe Illustrator was used initially to create the National Park map from the ground survey as linework can be created accurately, allowing scaling of lines without a loss of smoothness and detail. Illustrator also allows the import of satellite imagery from Photoshop which can then be overlain with a stripped down version of the National Park Map showing coastline, park perimeter, roads, paths and buildings *(Figure 14)*. This would help provide an assessment of the relative accuracy of the ground survey and subsequent map and also show that such a methodology could be used within the School environment. One important aspect to be considered in overlaying information onto an image is how much detail to include. Clearly this must be selective, as it must not detract from the image by creating too much clutter or noise, and yet it must still be clearly legible and complement the base image. In Figure 14 the selective map information has been coloured to stand out from the base image. Solid colours have been used; Yellow, Green and Cyan for text, Yellow, Red, Green and Black for linework. This contrasts with the pixellated colours of the base image. These few additions highlight and explain some major relationships within the image such as the distinction between vegetation and the lagoonal area around the salt marsh. This exercise was repeated for the Kidirak National Park *(Figure 15)*, again stripping down the original map and overlaying the Landsat image.

It is vital therefore, that adding information to a satellite image should be a considered and restrained exercise, with only major features being added. Failure to do so and superimposing too much information would result in clutter and confusion for the user, making the image- map more difficult to understand. According to Holmes (1992), restraint in symbol selection and design is necessarry if the message is to be understood, and this is a problem which often confronts the cartographer: the selective problem of what should be removed, not what should be included.

Other advantages which Adobe Illustrator offers as a graphics application are the controls the user has in the manipulation of lines, areas, point symbols and text. These components can be applied to an imported image such as Figure 2 in Chapter 1. This figure shows an Landsat MSS satellite image exported to the Macintosh using the above procedure and visually interpreted in Adobe Photoshop to provide a 'false colour' impression of the terrain. The colour depicting the sea was removed, allowing the coastline to stand out clearly. This image was then exported to an Adobe Illustrator file containing the map of Turkey *(Figure 1)* and used as a base for additional information such as scale, frame and captions to be added to the image. Designed to support the study area map, it clearly defines the beach areas of Ölü Deniz and Kidirak. This image could also have provided a base for relatively detailed maps of the area by digitising on screen within Adobe Illustrator to construct a new map.

However this raises the question of why a researcher needs to produce a ground survey if a map could be digitised directly from a satellite image such as Figure 2. Derived from a Landsat MSS image scene 193/34, Figure 2 cannot be regarded as suitable for mapping an area such as the Ölü Deniz National Park. The park covers an area of around 16.5 hectares (165,000 sq. metres) whilst a single Landsat MSS pixel covers a ground area of 7,225 sq. metres (pixel size, nominally 85 x 85 m), thus only 23 pixels would cover the park area. This cannot be regarded as an accurate device for mapping small areas,

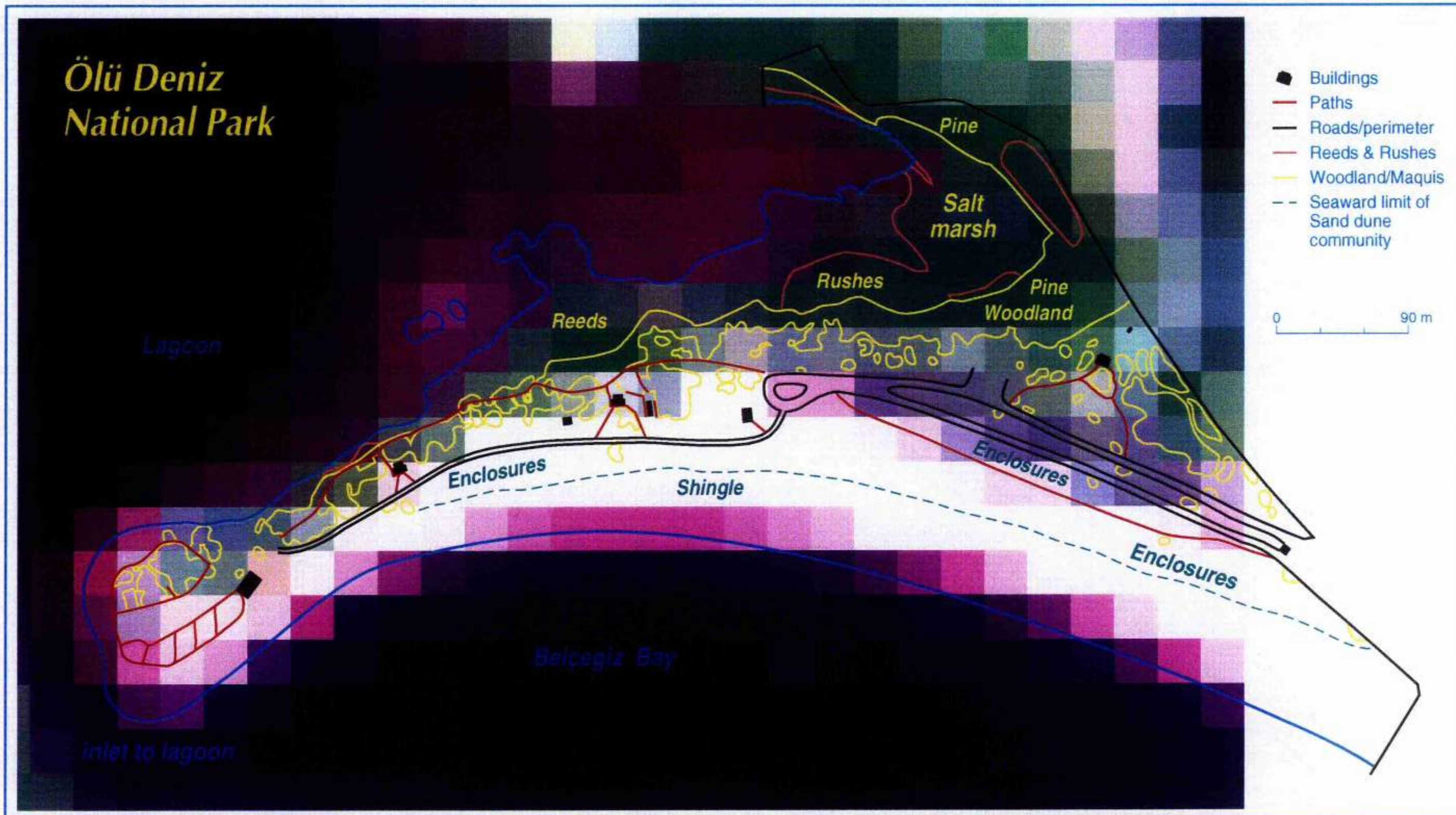


Figure 14: Combined Landsat Image and ground survey. Raster data is from Landsat Thematic Mapper, Bands 2,3 & 4 from Scene 179/35 on 6th June 1990. Vector data is from field surveys 1993-95, produced in Adobe Illustrator 5.5 and stripped down from the main map of the Ölü Deniz National Park. The imagery supports the general accuracy and extent of the field survey and the field methodology adopted.

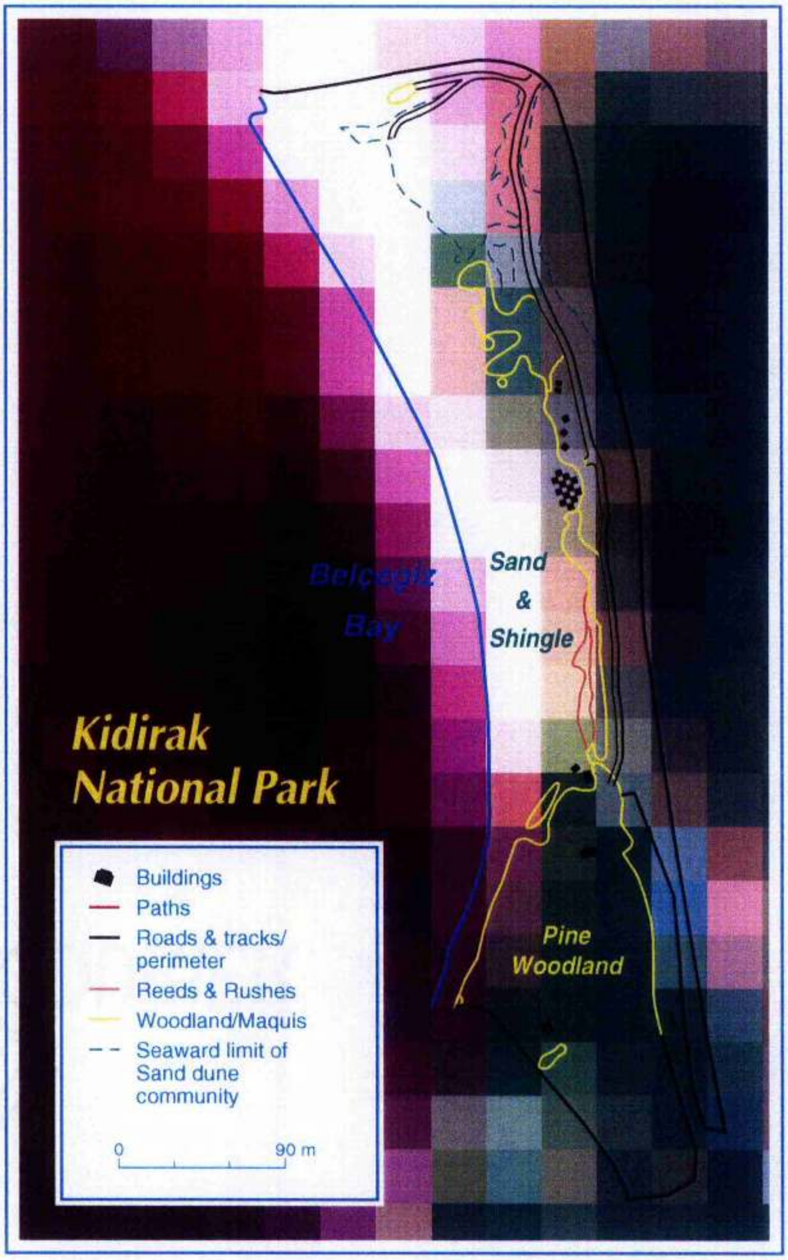


Figure 15: Combined Landsat Image and ground survey of Kidirak National Park. Raster data is from Landsat Thematic Mapper, Bands 2,3 & 4 from Scene 179/35 on 6th June 1990.

Vector data is from field surveys 1993-95, produced in Adobe Illustrator 5.5 and stripped down from the main map of the Kidirak National Park.

As with the map and image of Ölü Deniz National Park *(figure 14)*, the imagery supports the general accuracy and extent of the field survey and the field methodology adopted.

yet in the context of Figure 2 it is sufficient and works well for the larger area. Similarly the imagery in Figure 14, a Landsat TM image, although showing much more detail, has a pixel resolution of 30 x 30 m (900 sq. metres) and therefore around 190 pixels would cover the area. Although more detailed than the Landsat MSS image it is still not accurate enough to map a small area in detail. It can only provide a generalised view of this particular area. Nevertheless Figure 14 is useful in that it does support the ground survey in scale and relative accuracy of the coastline, pine maquis area, sand & shingle beach and the salt marsh.

There remains a trade off in the level of detail gained using ground survey of a small area against the speed of digitising directly on screen from a satellite image to create a map. Landsat TM can provide an overview of an area and support the accuracy of a ground survey, but unless a detailed survey has taken place it would be extremely difficult to classify the image other than by generalisations. The map, however, can by extraction and simplification of detail be used to show relationships on the image which would otherwise not be apparent. In this case the imagery could not distinguish between vegetation types with any great accuracy resulting in the need for a detailed survey and map to be produced. However if sufficient funds were available the potential is there to create a more accurate map if SPOT panchromatic images are purchased. A single SPOT panchromatic pixel covers a ground area of 100 sq. metres (10 x 10 m) and therefore 1650 pixels cover the area of the National Park. This may tip the balance in favour of producing a map from imagery, by digitising in Adobe Illustrator direct from the satellite image, or simply overlaying and annotating the desired information. However SPOT imagery is still very expensive and although very detailed it is still not as accurate as ground survey, but would however, complement ground survey and map if costs allowed.

5.4. Summary

Whatever the problems of creating a map either from satellite imagery or ground survey, the technology available today allows the creation of photo/image maps to a reasonably high degree of accuracy. However the final product remains a functional map which as Woods (1993) noted, should be appreciated by users at different levels of understanding. This may well apply to the standard map form where its effectiveness as a product can be used, admired and assessed by a variety of users. In the case of a photo/image map, its usage or usefulness however may be limited to specialist users who can understand and interpret the visual data with accompanying overlain map information. Specialist areas would include geological photo/maps as produced by the USGS where remotely sensed imagery is supported by a map showing some geological and topographic structures or the land use classification photo/maps of FIRST showing areas of a particular land use type.

Such a combination would be of little use to a topographic map such as an Ordnance Survey 1:50,000 sheet. The addition of imagery as background would only complicate and confuse as these maps already contain a vast amount of information through generalising reality into a manageable graphic form that is easily understood.

The main use however of a photo/image map may be as a research tool within a Geographic Information System (GIS)/Remote Sensing environment as a single product supporting ground survey control or defining classified areas or structures on an image. This notion of the photo/image map as a research tool and its creation by a cartographer is one that was also explored by Keates (1993), who noted the problems of creating simple photo maps quickly and economically together with more complex creations resulting in experimentation and design challenges for a new generation of cartographers.

Thus the photo/image map will remain a compromise or balancing act between background image and superimposed data. The computerised technologies of Remote Sensing, Image Processing and Cartography available within the School of Geography & Geology will enable future experimentation in the creation of new third party products.

Chapter 6

The Vegetation of Ölü Deniz and Kidirak National Parks

One of the prime reasons for surveying the National Parks of Ölü Deniz and Kidirak was to classify and plot onto a map the outlines and areal extent of the major vegetation communities. The first survey was carried out in the National Park of Ölü Deniz in 1993 when initial boundaries were identified and plotted on the base map and subsequently revised and refined in further field investigations in 1994 and 1995. The National Park at Kidirak was surveyed and plotted in 1994 using the initial survey and classification methodology identified earlier at Ölü Deniz and subsequently refined in 1995.

In plotting the areal extent of vegetation communities, it is realised that there are changes and fluctuations of growth, plant communities grade into another via ecotones, and therefore boundaries between communities are inevitably indistinct. This is particularly so within the salt-marsh communities, where fluctuations in boundaries between Juncus and Phragmites have been identified since 1993. However it is considered, that in general the vegetation boundaries plotted are accurate, despite problems addressed by Kuchler (1967), which may arise by (a) placing vegetation into particular categories and (b) the changing nature of vegetation.

Sample quadrats were obtained from each major community and the results may be viewed in the following figures. Within the quadrats, areal patterns were identified and analysed using a modification of the Braun-Blanquet scale (Kershaw 1964) produced in Table 4.

The vegetation of both Ölü Deniz and Kidirak National Parks is described overleaf. To avoid repetition, the more detailed description of vegetation communities is given for Ölü Deniz and only significant features which depart from this are described for Kidirak.

Scale 1

+	sparsely present, cover small
1	plentiful, but small cover value
2	very numerous, covering at least 20% of the area
3	covering 25 - 50% of the area
4	covering 50 - 75% of the area
5	covering over 75% of the area

Scale 2

Soc 1	growing singly, isolated individuals
Soc 2	grouped or turfed
Soc 3	in small patches or cushions
Soc 4	in extensive patches or forming carpets
Soc 5	in pure populations

Table 4: Quadrats were assessed by plotting areal extents of vegetation species directly onto graph paper at a suitable scale and analysed using the system devised by Braun-Blanquet to determine; (a) Scale 1, combining the number and cover of a species and (b) Scale 2, a measure of grouping.

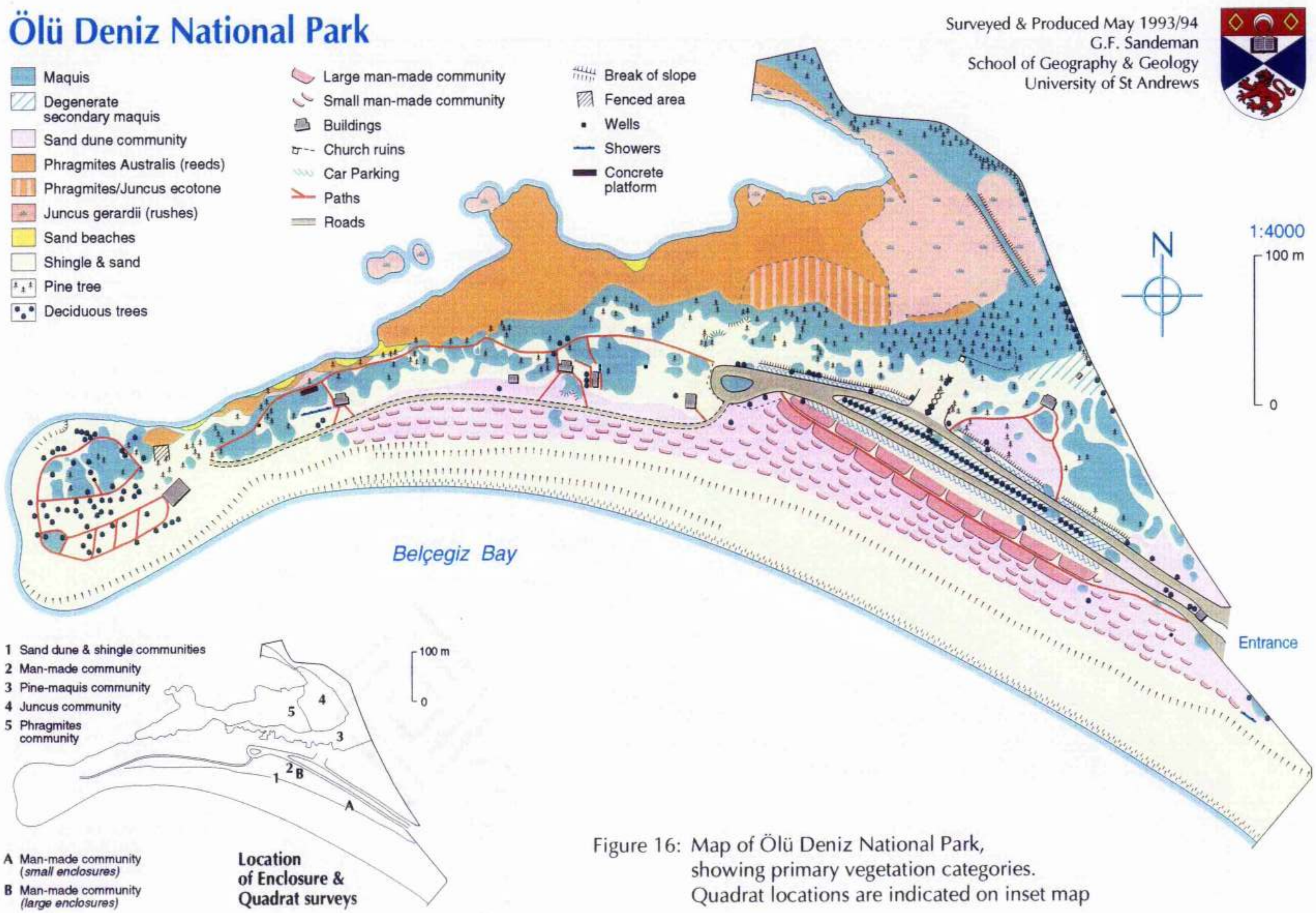


Figure 16: Map of Ölü Deniz National Park,
showing primary vegetation categories.
Quadrat locations are indicated on inset map

6.1. The Vegetation of the Ölü Deniz National Park

As the map of Ölü Deniz *(Figure 16)* shows, distinctive communities exist within the National Park. These plants reflect the variety of environments found within this small area and may be grouped as follows.

6.1.1. Sand dune and shingle communities

The immediate coastal zone consists of an active and unstable coarse pebble and shingle bank and this instability combined with strong onshore saline winds and wave action prevents plant colonisation of these slopes on this Mediterranean shore. Finer particles have been swept up onto the crest of the spit and much of the main ridge of the spit has been colonised by a distinctive community. Soils consist primarily of coarse sand and shingle with little organic matter.

Quadrat 1 *(Figure 17)* shows a typical example of this community (see *Figure 16* for the location of quadrats and enclosures). Plants tend to be those adapted to dry conditions; competition between species is not severe and a sparse patchwork of plants and bare shingle is typical. This community, in particular *Foeniculem Vulgare,* covers about 40% of the park.

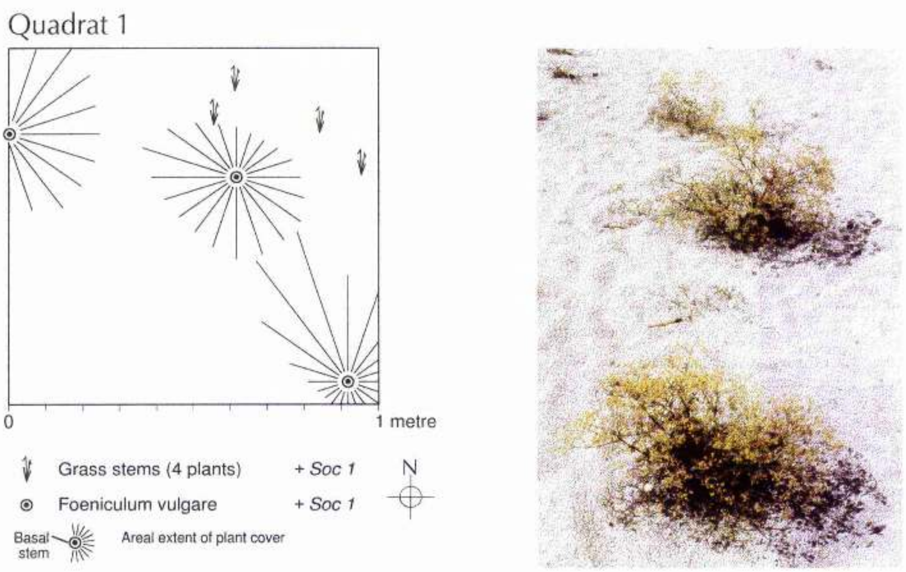


Figure 17

6.1.2. Man-made communities

As noted overleaf, one of the marked features of the shingle bar and spit is its instability. Material is moved inland from the beach area, and as Plate 4 shows, is piled up against the rock face 100 metres beyond the park boundary to the north.

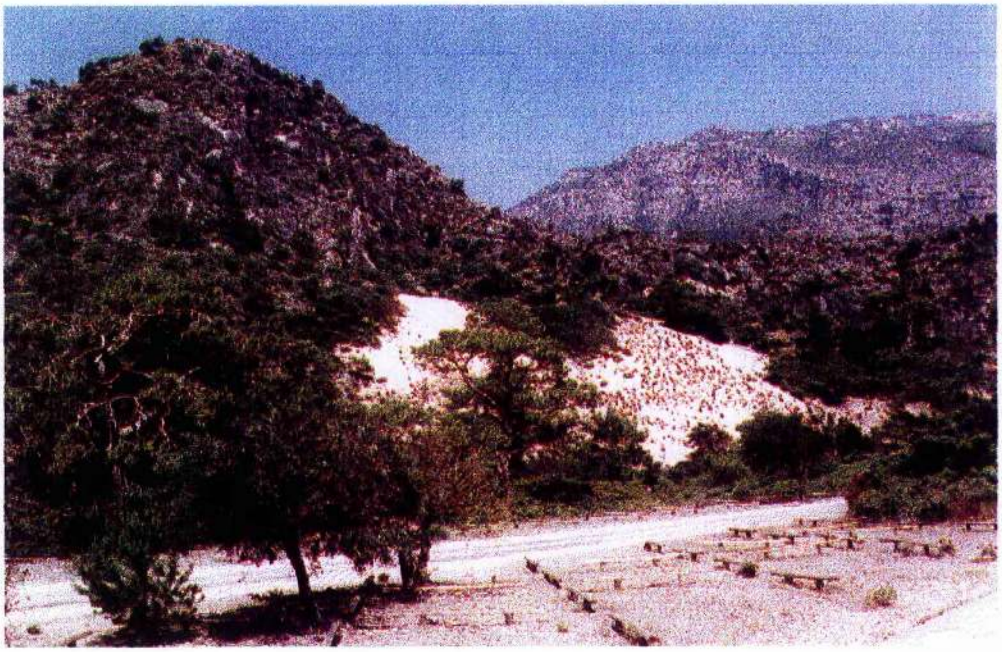


Plate 4: Wind-blown sand (c. 30-40 metres high) deposited on rock face, north of the National Park boundary

Severe wind erosion like this depletes the supply of finer mineral particles and organic matter and inhibits colonisation of the upper reaches of the spit. Such erosion has given cause for concern regarding the future stability and utility of the whole spit-lagoon complex, with the possibility of the physical base and raison d'être for the National Park recreation area being destroyed. Active management of the problem has resulted in some 150 enclosures being built which break the force of the on-shore winds. The windward side of the enclosures are made of wattle fences with the upright poles being interlaced with branches to form a woven wind resistant structure. On the seaward side the structures tend to be small c. 8 metres long and 1 metre high. The enclosures protect a number of species, notably *Pinus brutii* (c. 5 years old - 1993), and *Pistachio lenticus* and *Pistachio terebinthus.* The sand and shingle materials have been enriched by the import of terra rosa materials during the construction of the enclosures to a depth of c. 40 cms giving an enriched clay content and a higher water retention capacity. As a result the ground flora within the enclosures produce a complete ground cover with a population of thistles and grasses. Figure 18 shows a typical example of this small enclosure sequence.

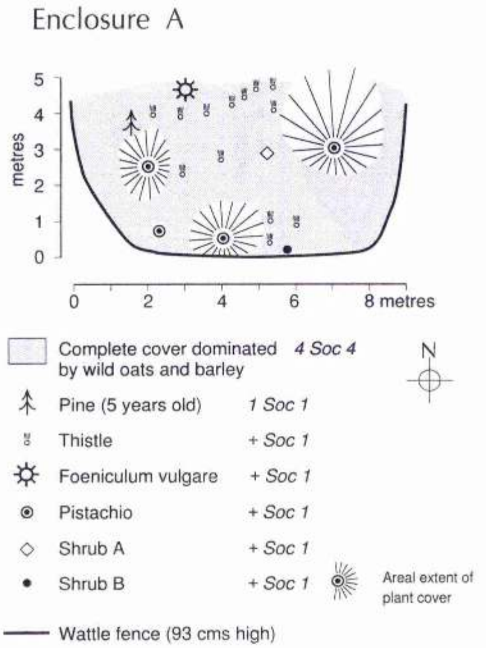
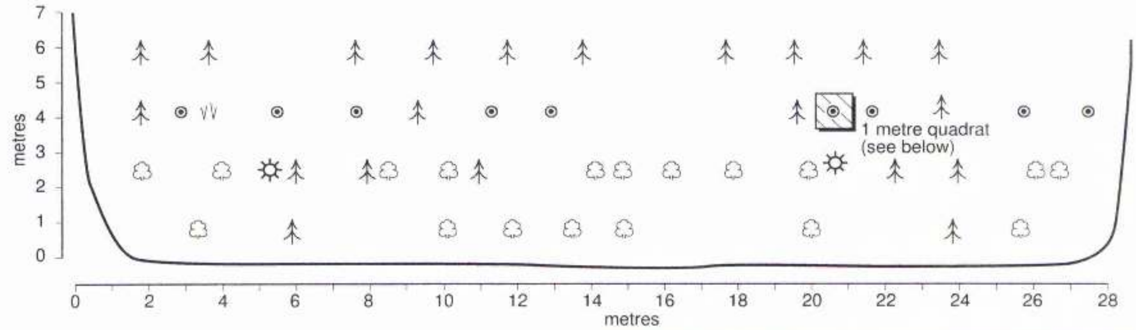


Figure 18

Along the crest of the dune a series of 16 larger enclosures abut the seaward side of the main road through the Park. This second line of erosion protection is much more substantial. The wattle fence is higher, and being 35 metres in length the enclosure is much larger. These structures form a barrier between the main road and car parking zone and initially discouraged pedestrian movement through the barriers and onto the seaward ridge with its more fragile open community. Latterly there is evidence that trampling has begun through the enclosures from the car-parks as several wattle fences have been broken down. The large enclosures are 6-7 metres in width and a marked feature is the planting of pine, palm and Blue Leaved Wattle *(Acacia cyanophylla)* at regular 1.7 metre intervals. This is in direct contrast to the random planting in the smaller enclosures nearer the shore. The ground flora tends to be sparse *(Figure 19)* but the nature of the enclosure has resulted in the trapping of a considerable amount of dead leaf litter which accumulates to a depth of c.8 cm. This is being incorporated into the sand and shingle, but, as the larger enclosures have not had the addition of clay enriched materials, the ground flora tends to be sparse. Figure 19 & 19a show the detailed layout of these larger windbreaks. The overall effect of both sets of enclosures is an increased stability for the very vulnerable sand bar and shingle communities through a breaking of wind speed, reduction in erosion and a discouragement of human trampling.

Enclosure B



Calabrian Pine
Palm
Blue Leaved Wattle
Foeniculum vulgare
Shrub (deciduous)

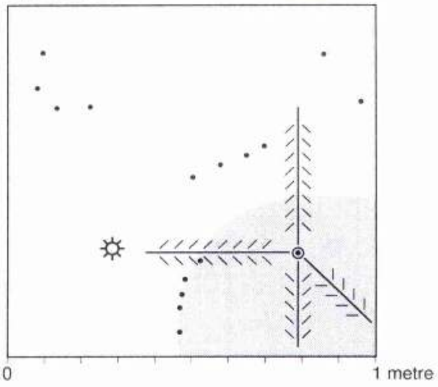
Wattle fence
(1.6 metres high)

N

Organic layer approximately 9 cms deep

Figure 19

Quadrat 2



	Organic matter (8 cms deep)	
	Foeniculum vulgare	*+ Soc 1*
	Seedlings of Large Yellow Restharrow	*1 Soc 1*
	Palm with fronds	*1 Soc 1*

N

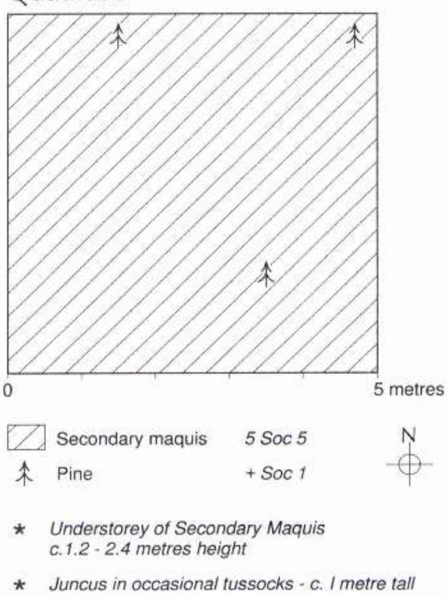
Figure 19a

6.1.3. The Pine-maquis community

Behind the main dune crest and sheltered from the exposed shingle bar and dune is an area of Pine-maquis. This zone dominates the vegetation of the Park with the amount of cover varying, depending in part on human pressures. As Figure 16 shows, patches of Pine-maquis scrub lie immediately to the north of the park entrance on the coarse sands beyond the dune crest.

The tree cover is that of mature *Pinus brutii,* the Calabrian Pine, but the understorey varies in density. The patchy nature of this cover north of the road and car park gives way to dense thickets of maquis overtopped with mature pines. Quadrat 3 *(Figure 20)* shows a typical example of this community.

Quadrat 3



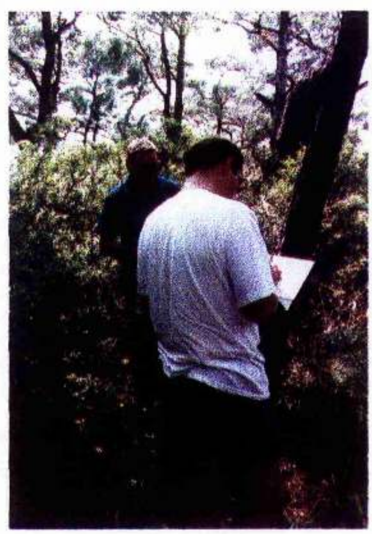


Figure 20

The dense maquis understorey is between 1.2 and 2.4 metres in height; and contains shrub species which are typical of this particular community - *Pistachio lenticus, Pistachio terebinthus, Quercus coccifera* and *Quercus ilex*. The finer sand material in this location north of the beach ridge has allowed the development of a flora containing occasional tussocks of *Juncus* species which may indicate a moister environment. On the drier soils within this community, organic matter has accumulated to depths of up to 6 cms and show initial signs of podsolisation despite the calcareous nature of the parent materials.

The pine-maquis community may also be seen in a degenerate form around building sites, in particular behind the building, north of the road and nearest to the park entrance.

This area *(Plate 5)* consists of bare ground and a mixture of sand, gravel, broken concrete and builders rubble. Although the mature pines are absent, the area is being rapidly colonised by the shrub species of the maquis.

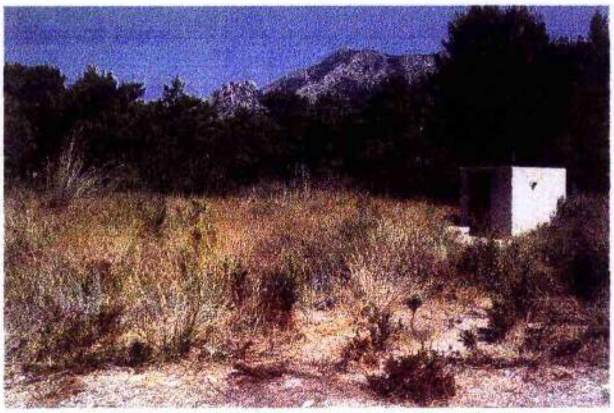


Plate 5: Bare ground recolonised by shrub maquis

6.1.4. The Phragmites community

To the north of the pine-maquis community lies a belt of reeds and salt-marsh on the shoreline flanking the lagoon. Dominated by *Phragmites Australis*, this extends along much of the northern shore of the shingle spit. The reeds have colonised a large extent of the shallow brackish water adding a considerable amount of organic matter to the finer mineral materials present. The reed beds reach a height of up to 5 metres *(Figure 21)*, and normally have a ground cover of *Juncus gerardii*, extending to a width of 50 - 80 metres along the shore. The small islands in the lagoon adjacent to the reed beds are notable in being colonised by *Juncus* rather than *Phragmites*. As noted previously, a study of the beds over three field seasons has shown annual variation in the extent of the beds, with the *Phragmites* recolonising part of the *Juncus* salt marsh (see next section) on its eastern margins. Around 70 metres wide, this ecotone gives way to the Juncus community of the salt marsh area to the east.

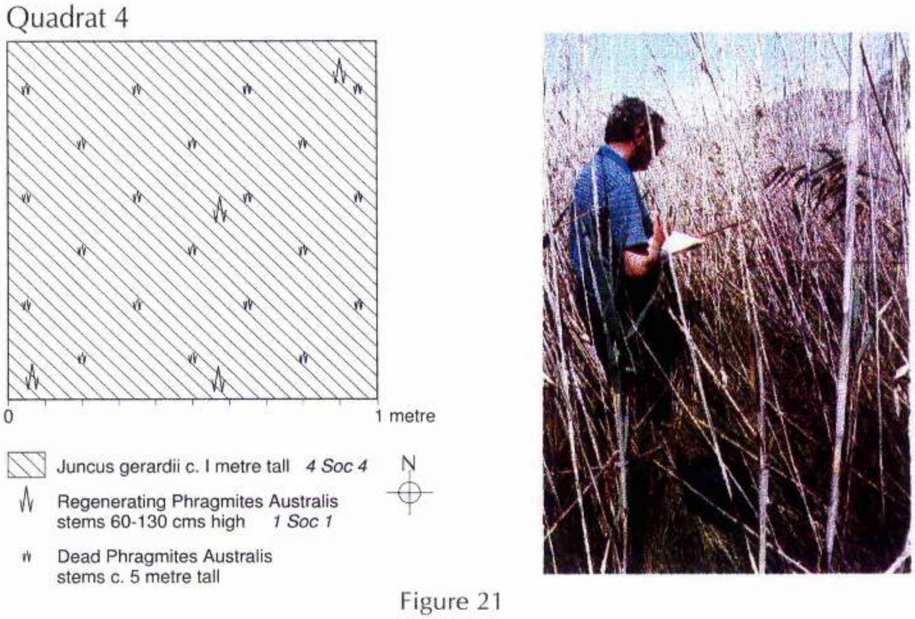
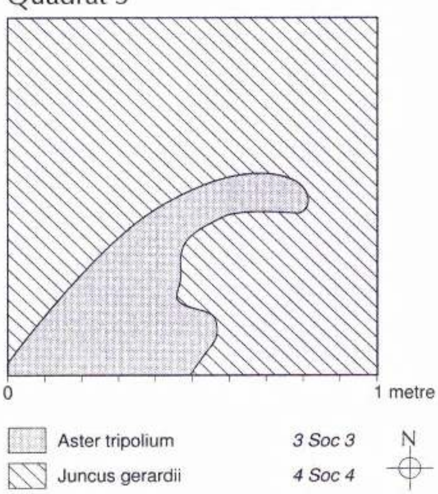


Figure 21

6.1.5. The Juncus community

This community has developed on the shallower waters at the head of the lagoon and covers an area of circa 10,000 square metres (1 ha). A rise in the level of brackish water and silts deposited in the lagoon area have overwhelmed a former field system, one bank of which subdivides the community on the eastern side of the park, some 30 metres from, and running parallel to, the existing main road which flanks the perimeter fence. This silted area shows many typical species of a salt marsh community but is largely dominated by rushes, especially *Juncus gerardii* as seen in Quadrat 5 *(Figure 22)*. Other species of this community which are tolerant of the saline condition and present in considerable quantities include; *Aster tripolium, Carex extensa, Juncus arantus, Halimione portulacoides* and *Salicornia europea*.

Quadrat 5



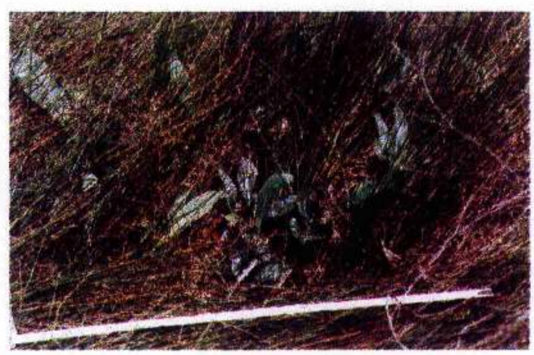


Figure 22

6.2. The Vegetation of the Kidirak National Park

Although different in size and nature, a comparison of the Ölü Deniz and Kidirak maps shows a common set of vegetation communities. The Kidirak map *(Figure 23)* has the same basic legend, identifying vegetation classes and pertinent additional information, and is shown here at the same scale of 1:4000 as Ölü Deniz.

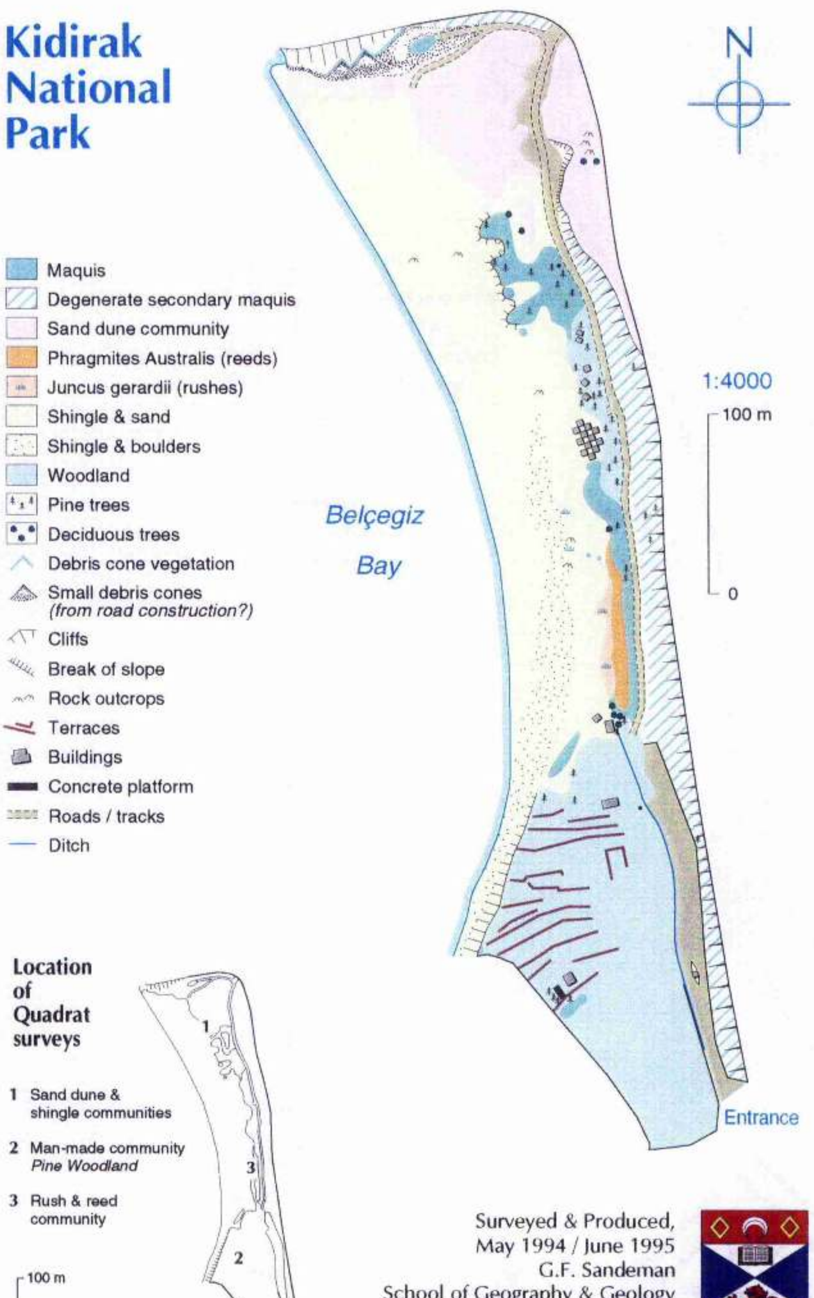


Figure 23: Map of Kidirak National Park, showing primary vegetation categories. Quadrat locations are indicated on inset map

6.2.1. Sand dune and shingle communities

At the southern end of the beach, the coarser rock and shingle *(Plate 6)* has produced a less dense vegetation cover.

Plate 6: Foreground shows rock & shingle on southern end of beach

There is however a sand dune community shown in Quadrat 1 *(Figure 24)* consisting almost entirely of one species in the north-east corner of the park which has established itself on a much finer sand cover (see *Figure 23* for location of quadrats).

Quadrat 1

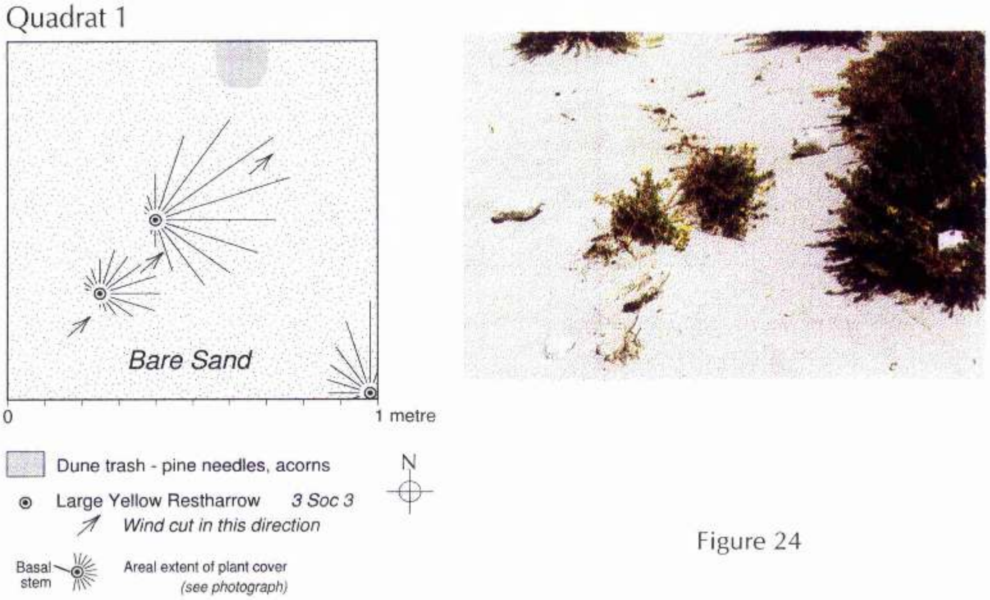


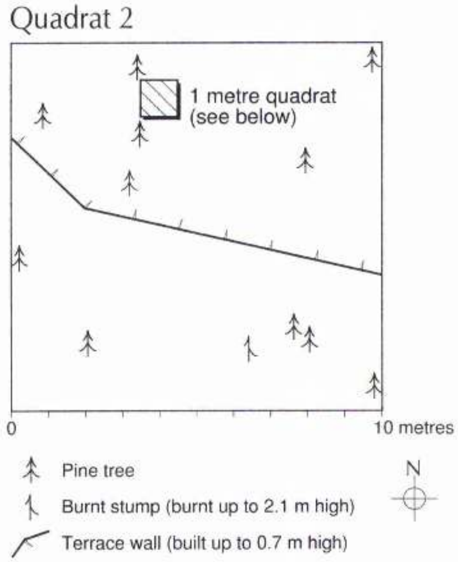
Figure 24

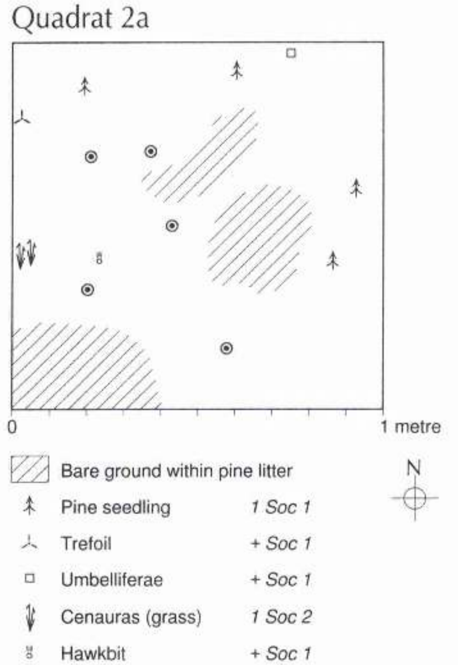
6.2.2. Man-made communities

Unlike Ölü Deniz, enclosures to stabilise vegetation have not been erected at Kidirak National Park. However three man-made communities may be observed:

6.2.2a. Pine Woodland dominated by Pinus brutii.

The trees show a common age structure and would appear to have been planted across a series of terraces. The Pine Woodland community at Kidirak differs from the Pine-maquis community at Ölü Deniz in that it lacks the dense shrub layer of typical maquis species. There is limited regeneration of this pine woodland, possibly owing to fire. Quadrats 2 and 2a *(Figure 25)* show typical features of this community.





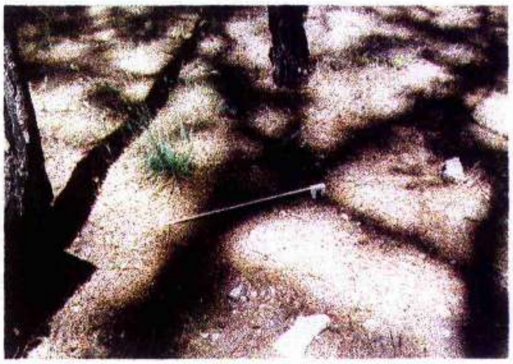


Figure 25

6.2.2b. Degenerate maquis.

As at Ölü Deniz, a scrub type of vegetation exists which would appear to be heavily influenced by human activity, in particular building works, at both parks. At Kidirak this is in the form of a strip of vegetation of up to 20 metres wide which runs along the eastern boundary fence. The scrub has recolonised spoil from the road construction which lies directly adjacent to the eastern boundary.

6.2.2c. Debris cone vegetation.

Road construction on the northern boundary has also influenced vegetation growth. From this rubble, small debris cones have been created, and have sorted from fine to coarse debris from the cone apex *(Plate 7)*. The finer particles have retained moisture which runs off the cliff above and have developed a narrow band of *Cirsium* species around 1 metre wide.

Plate 7: Debris cone at the base of cliff edge bounding the northern edge of the park. *Cirsium* species has colonised the finer materials along the top of the cone.

6.2.3. The Pine-maquis woodland

The pine-maquis woodland is similar to that described at Ölü Deniz, however the shrub layer is not as dense. It is less heavily developed together with the pines being more mature, larger and also less frequent.

6.2.4. The Phragmites-Juncus community.

This community forms two narrow strips between the beach and the pine-maquis woodland. It would appear that they occupy a site prone to seepage from the steep cliffs to the east above the park and may also be fed by salt water during storms. The species are similar to those found at Ölü Deniz and also occupy the finer sediments as shown below in Quadrat 3 *(Figure 26)*. Similarly, observations over two field seasons suggest some instability in the *Juncus* community as areas previously covered by dense rush beds had broken into smaller patches with bare sand between.

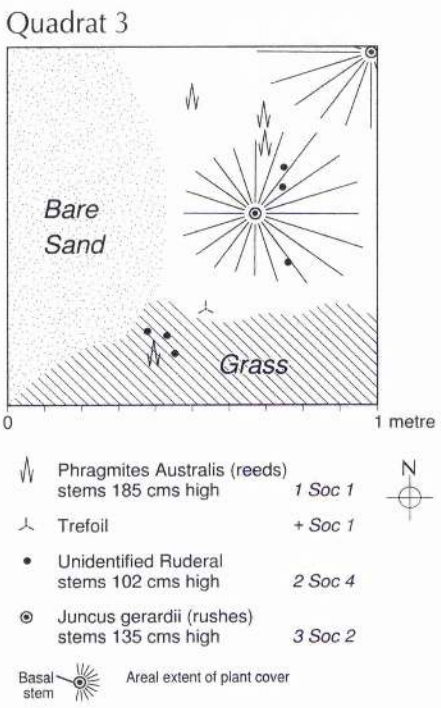


Figure 26

6.3. Summary

The mapping of the vegetation communities of the National Parks of Ölü Deniz and Kidirak was undertaken primarily to provide suitable field maps/guides for third year Biogeographers. Investigated over three field seasons, the maps allow a generalised examination and describe the areal extent of the vegetation present within each park. As it was impossible to show every species identified, the vegetation was categorised into particular communities and detailed examination considered in the form of quadrat surveys. The maps in conjunction with the quadrat surveys show differences and similarities of vegetation communities in both parks.

Whereas some vegetation at Ölü Deniz is controlled through attempts to protect and stabilise the spit using man-made communities, Kidirak is relatively natural although the abundance of pine trees on the man-made terraces may indicate human interference through random planting. There are similarities in many vegetation species found in particular communities, including the colonising of debris and bare ground from construction works. There are also differences in the size and extent of communities; *Juncus* covers circa 6% (10,000 square metres) in Ölü Deniz but less than 1% (300 square metres) in Kidirak. However, although vastly different in actual size, they are respectively, relatively small areas when the total area of each park is taken into consideration. In addition there appears to be some common instability as fluctuations have been observed over a number of field seasons regarding the areal extent of *Juncus* in both parks.

Investigating the vegetation of these parks over three field seasons has allowed the relevant maps to be revised and updated in the field. The maps provide a suitable base for plotting changes in the areal extent of vegetation communities that have been identified and can be examined in any future study.

Chapter 7

Conclusion

The original aim of this thesis was to create maps of two National Parks without reference to any type of source material. These were designed to provide suitable field maps for geography students and staff where none previously existed. Within that remit, the methodology of survey techniques, cartographic production and integrating map and satellite image were addressed together with an overview of the areas mapped and the nature of these areas.

The final maps show clearly the success of this venture in providing a spatial inventory of Ölü Deniz and Kidirak National Parks over successive years and effectively monitoring change. The usefulness of these maps becomes even more apparent given the devastation of the man-made environment noted in Appendix I. These maps provide a base to show future studies of Ölü Deniz what was attempted in conservation terms and the subsequent failure of the National Park authorities to maintain the project they had originally enacted.

The methodologies employed to achieve the production of these maps were both varied and stimulating. The survey methodology, although primitive, does show what can be achieved using a minimum of personnel and equipment. Starting with a blank frame, an extremely detailed map was created, mainly because of the diligence in recording a vast amount of data. The strictures of the methodology (compass traverse) ensure that although detailed, precise measurement of both bearing and distance is impossible, recording and re-recording data to the same point from different positions can help reduce this error. Cartographic generalisation, simplification and scale changes also help reduce and remove the error. This map was not a plan and was therefore not being used for measurement in the field. It was merely a record of an area at a particular time and year.

The survey provided a level of detail which was impossible to derive from satellite imagery. The resolution of the Landsat TM image *(Figures 14 & 15)* at 30 x 30 metre pixels shows clearly the lack of detail present compared to that of the map. The Landsat image could only provide generalisations of what could be there. It is detailed enough however to confirm a general view that the original survey was accurate in land cover terms given the methodology used and supports the idea that the methodology is a suitable means of surveying a 'hostile' environment relatively quickly and accurately.

The entire project was also an investigation into how to integrate and use resources available within the School of Geography & Geology. The combining of remotely sensed images from a PC-platform to a graphics application on a Macintosh platform was designed to test and use these systems to enable similar exercises to be carried out in future. This has already been the case within the School where combining raster based images with graphics is now common place within the Cartography & Graphics Office. This knowledge therefore is able to cascade down to staff, research students and undergraduates. It has enabled the existing software applications of image processing and graphics to be more widely understood and indeed more widely used. The advantages of using these systems has been demonstrated by combining the images and by updating the maps of both National Parks. This would have been a far more difficult task if computer based technology was not employed.

The maps also allowed the undergraduate users in the field to demonstrate their knowledge of interpreting maps and to comment not only on the content but also on matters of cartographic design using knowledge gained in their cartography module. Thus the maps were scrutinised by users who had a background in the cartographic and geographic principles involved in its construction.

This reinforces the view that this particular project has been one of learning, developing, integrating and imparting methodologies old and new for the benefit of a wide range of users. The exercise has allowed many disparate methodologies to be utilised and combined to produce an end product that can be used by a group of professional users in the field. The knock-on effect of this is that School facilities are being improved and more widely used with a greater understanding of the processes involved.

Although the maps were the product of various methodologies, the raison d'être for the maps was to provide an outline of the Parks and the breakdown of categorised vegetation classes within the park boundaries. The very nature of producing such a map means generalisation processes have to be considered as it is impossible to show every type of species found. Categories must be identified, but by their very nature vegetation classifications cannot claim to be definitive (Kuchler 1967). The study of the vegetation areas of both Ölü Deniz and Kidirak therefore is not conclusive, merely an overview of particular classes. Closer investigation of classes using quadrat surveys, reveals some of the vegetation characteristics present which could not be identified on the map. A more definitive study would need to create sub-sections for each category listed on the maps and then create a list of species found and identified with an accompanying description and plate. However although that was a side issue to the actual production methodologies involved, it did allow a greater understanding of the processes involved and compared the similarity of creating particular vegetation classes combining similar species, and that of the cartographers' problem of reducing the amount of information that will be legible and clearly understood on a map.

The overall study of this area over the last three years has provided a snapshot of a fragile environment, particularly Ölü Deniz, with change being initially mapped, plotted and then monitored over subsequent years. Whether this environment can sustain change remains to be seen. What did appear to be a successful attempt at stabilisation has latterly been ruined by the people responsible for the upkeep of the National Park. The spit beach area and lagoon helped create Turkey's golden tourist goose, and National Park status was supposed to prevent development and protect a natural environment. The winter storms will continue to cause damage to the spit and as seems likely the vegetation in the former enclosures noted in May 1996 is likely to have suffered irreparably over the next year or so. Then, will the tourist brochures and books refer to this area as Turkey's finest beach and will they then have killed their golden goose?

Whatever the future outcome, this document now remains testament to an attempt to stabilise and recolonise an active natural habitat and record the beginnings of apparent failure.

Appendix I

Ölü Deniz- May 1996

The Junior Honours Geography field class returned to S.W. Turkey in May 1996 and began fieldwork in the two National Parks of Ölü Deniz and Kidirak. It was immediately evident that major changes had taken place over the previous twelve months, particularly so at Ölü Deniz.

As described in Chapter 6, the National Park management had attempted to stabilise the movement of fines on the spit at Ölü Deniz by constructing a series of enclosures along the dune crest and planting a variety of flora within them *(Figure 18)*. Ongoing study and survey since 1993 had shown this man-made habitat to be a relatively stable and flourishing environment. However, during the winter season of 1995-96, and for reasons unknown, the wattle fences were removed from all enclosures (large and small), effectively leaving them open to the elements of wind and sea salt sprays.

Not only were the fences removed but the ground cover of grasses and thistles was removed or weeded out, leaving the larger bushes of Pistachio and Foeniculum vulgare together with young pine trees. The grasses were replaced by an additional layer of a clay/fertiliser mix in an apparent attempt to improve the water retention and nutrient status of the soil.

Unfortunately the removal of the fences has led to the almost complete extinction of the pine species within these former enclosures. The pines (circa 8 years old - 1996) previously appeared to be flourishing within the protection of the wind and sand breaks of the enclosures. However it is apparent that the vast majority are now dead or in the process of dying, through a combination of sea-salt spray and winds, as they are no longer afforded any protection from these elements.

As well as providing protection for growth within the enclosures, the areas between the wind breaks also afforded protection for a variety of species known collectively as 'Sand dune communities' *(Figure 17)*. It was clearly evident in previous years, and particularly in 1995, that the enclosures were providing protection for species such as Large Yellow Restharrow *(Ononis natrix)* and Foeniculum vulgare to thrive and were largely covering the ground space between the enclosures *(Figure 16)*. May 1996 has seen a diminution of these species from 1995, again probably due to the lack of protection from wind and sea salt sprays they latterly enjoyed.

A survey of Enclosure B was undertaken in May 1996 to compare with that done in 1994 *(Figure 19)* to highlight the damaging effects to the vegetation incurred by the removal of the protective fences. It is clear *(Figure 27)* that damage is extensive, and it is notable that young pine trees are dying. Plates 8-9 compare 1996 with a photograph of Enclosure B in 1994 *(Figure 19)* whilst Plates 10-11 compare the devastation wreaked on the vegetation in 1996 with a plate from 1995.

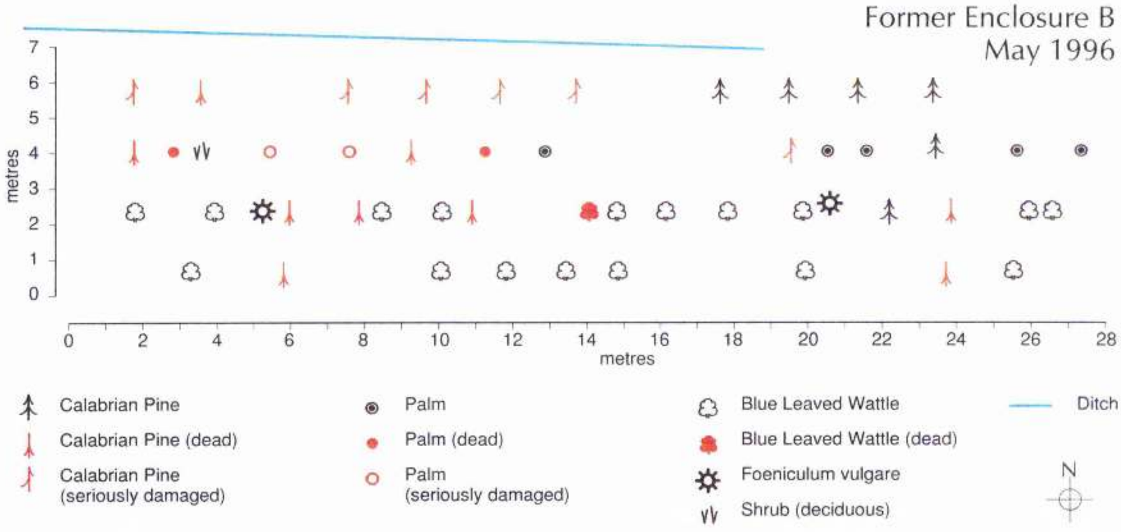


Figure 27: Former enclosure B surveyed in May 1996, showing extensive salt spray and wind damage

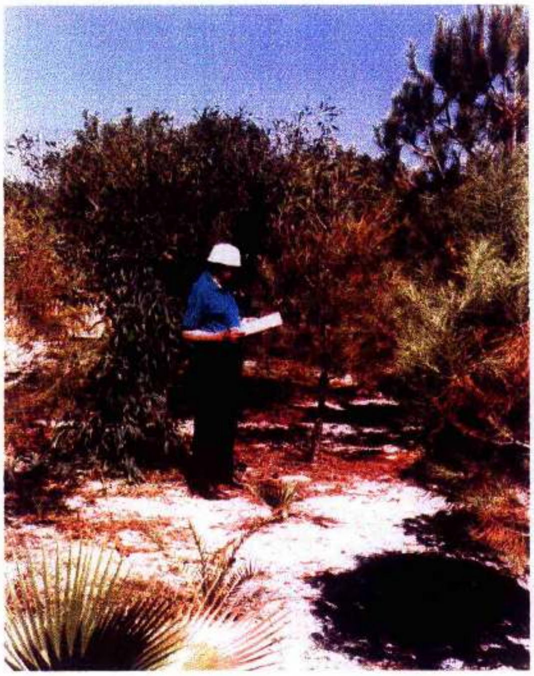


Plate 8: Looking west along Enclosure B, showing the same location as the photograph in Figure 19. The eastern end is the least damaged of the enclosure although salt-burn can be identified on the pines.

Plate 9: Looking east along Enclosure B, showing dead and seriously damaged pines. There is very little ground flora, only extensive amounts of tree litter. The newly cut ditch runs beyond the trees on the left.

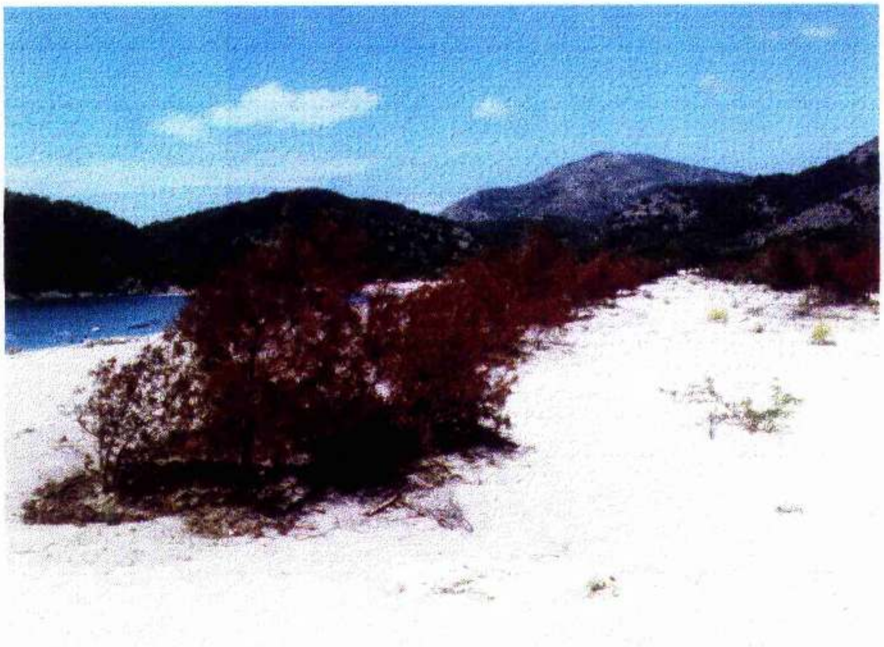


Plate 10: Looking west along the spit. This shows the devastating effect of salt-burn and wind erosion to the young pine trees since the wattle fences were removed. It also shows that the ground flora (Sand dune community) has largely disappeared as a result of the removal of the stabilising fences. Compare this plate from May 1996 with that below from June 1995 showing an abundance of flora colonising the areas between the enclosures.

Plate 11: Looking west through the enclosures at the dune ridge in June 1995. The foreground clearly shows the profusion of Foeniculum vulgare growing and spreading between the enclosures and the still healthy state of the pine trees within enclosures in the background.

Owing to the dramatic changes that had occurred to the vegetation of the spit between 1995 and 1996, it was deemed appropriate to include a further version of the Ölü Deniz National Park map. The removal of the fences has not altered the basic shape of the former enclosures, merely left them ill-defined. A result of this 'blurring' of what were distinct edges, is the cartographic design problem of how to depict such areas. On the previous versions of the map, the enclosures, were depicted as a black solid line showing the extent of the wattle fences with an area fill of 20% Magenta & Yellow. This colour was darker than that of the surrounding Sand dune community of 10% Magenta *(Table 1)* and therefore a suitable contrast was created. With the removal of the fences there is no need for the black line encasing the former enclosures. This results in the areas of the former enclosures still being darker than the Sand dune community but only marginally so, indicating a now less than distinct community beginning to merge with the other community.

What is clear from the period of survey and study mapping of this area is that the 1995 map of Ölü Deniz will remain the definitive record of the Park management's attempt to recolonise and stabilise the spit. The 1996 version *(Figure 28)* shows the breakdown of these communities and it is quite likely, that within even a short time span of two years, these features will no longer exist. The 1996 map indicates change and perhaps the end of the attempted spit stabilisation programme.

In addition to the authorities decision to remove the protective fences, they have also excavated vast quantities of broken concrete slabs, which formerly lay largely covered by sand, and dumped just below the dune ridge and the former seaward enclosures *(Plate 12).*

Plate 12:

Looking west along the spit below the dune ridge shows the concrete slabs which have been dumped on the beach.

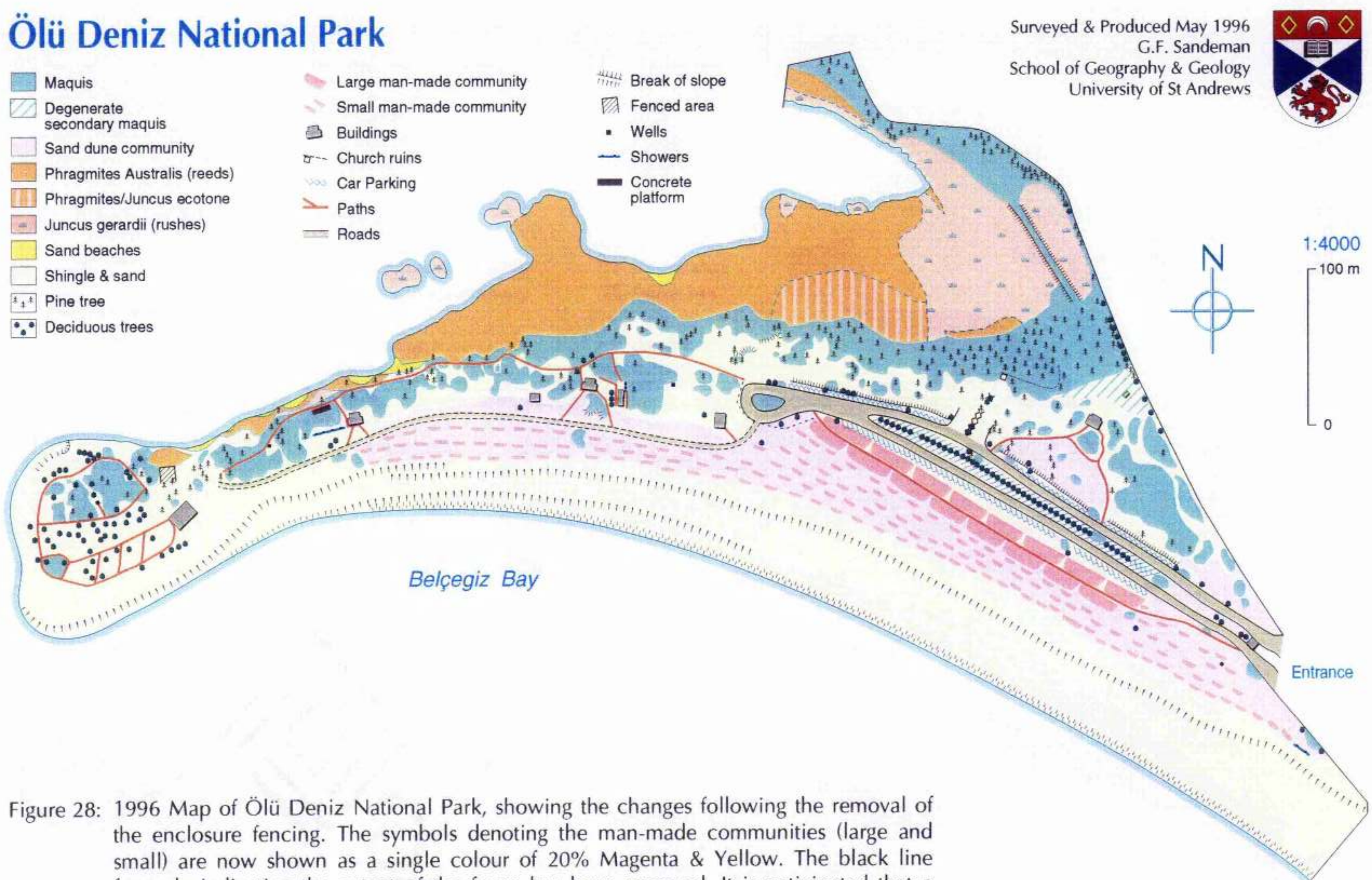


Figure 28: 1996 Map of Ölü Deniz National Park, showing the changes following the removal of the enclosure fencing. The symbols denoting the man-made communities (large and small) are now shown as a single colour of 20% Magenta & Yellow. The black line formerly indicating the extent of the fence has been removed. It is anticipated that a future map would remove the man-made community symbol completely following further degredation to the enclosures and to the surrounding sand dune community.

The slabs although previously apparent were scattered randomly about the beach. It does not afford a pleasant vista along the beach as they have been dumped, albeit haphazardly in what may be a different approach at stabilising sand movement. Ironically with the demise of the fences, some individuals, presumably beach traders, have used smaller slabs to encircle some of the smaller former enclosures *(Plate 13)* in what now appears to be small garden plots.

Plate 13: One of several former enclosures now surrounded by broken concrete slabs. The clay/fertiliser mix soil can be clearly seen against the sand.

It could be speculated that this breakdown in maintaining the series of enclosures will result in a failure to sustain the planned stability of the spit and will eventually lead to its demise. Natural features such as spits are largely ephemeral with a life-span of several hundred years and it would appear that the man-made colonisation is doomed to failure. Perhaps it will yet fulfil the statement by Ritchie (1993) that they should be left alone to let nature take it's course, unless presenting a threat to the human environment.

Appendix II

Using a Global Positioning System (GPS) in the study area

The survey methodology of compass traversing proved to be a successful way of surveying two areas with a minimum of personnel and equipment. However one outstanding problem remained. The logged bearings were taken from magnetic north without correlation to the global position in latitude and longitude. This was a result of the lack of large scale maps and was one of the prime reasons for surveying these particular areas. Therefore in May 1996 as a postscript to this survey, a basic hand held Global Positioning System (GPS) was taken to the study areas with a view to adding some locational reference points onto the final map. This also created an opportunity to evaluate the usefulness or otherwise of using such a system as a means of surveying the National Parks.

Developed by the United States Department of Defense (DoD), GPS was created to provide information unaffected by rough terrain or poor weather and resistant to interference and error. Initially designed for military purposes where it was used to highly efficient effect to pinpoint bombing targets during the Gulf War, it has evolved into the civilian and commercial domain. The system is administered by the DoD with the satellites emitting two codes, one military, the other civilian known as Standard Positioning Service (SPS).

The system used was a Magellan GPS 3000 Satellite Navigator. Although designed specifically for boating it is a general navigational tool which can pinpoint the global position of the hand held receiver with a stated degree of accuracy. The system operates by the antenna within the instrument receiving information from up to four GPS satellites and computing a value in co-ordinates of the user's choice that charts his unique location giving a position fix. Each GPS satellite transmits its precise location giving position and elevation and the transmission start time. This allows a GPS receiver to acquire the signal and determines the distance between the receiver and satellite by measuring the time interval between transmission and receipt of signal. The receiver repeats this process with at least two other satellites to compute a position on the earth's surface.

The accuracy of using such a system depends on the needs of the user. This particular system is designed for navigation where only a general location fix is required and precise measurements are not vital. An accuracy of 25 metres or better is attainable from a GPS with a Standard Positioning Service receiver. However, the reality is that this level of accuracy is not available as the administrators of the system, the US Department of Defense, have deemed such an accuracy to be a potential risk from a military point of view and therefore degraded the accuracy by introducing a random error factor known as Selective Availability. This therefore produces a random error of no greater than an accuracy of 25 metres and rarely exceeds 100 metres. Thus, in general terms, the random accuracy of the SPS receiver lies in the range of 25 - 100 metres and according to the Department of Defense will only be within 100 metres of truth 95% of the time.

One benefit of using a GPS is the facility to set specific parameters, one such parameter is having co-ordinates set in longitudes and latitudes as was the case here. It could however have been set as the Universal Transverse Mercator (UTM) metric grid system to match topographic charts and maps if they existed for this area, or indeed match satellite imagery which has been corrected to UTM. When using this system in the field, information was input to the GPS to establish our approximate location and elevation above sea level. This was done by selecting the nearest large settlement to Ölü Deniz and using the glossary in the Times Atlas of the World (Bartholemew, 1967) to obtain co-ordinates in latitude and longitude. The selected settlement was Fethiye *(Figure 2)*; 36° 37' N, 29° 08' E and 0 feet above sea level. With this information the Magellan searches for the appropriate satellites and computes a fixed position within the error margin previously noted. Using the base map of Ölü Deniz and Kidirak as guides, fixed locations on the map were annotated with their GPS fixed locations in latitude and longitude. These locations included perimeter fences, paths and several identifiable areas.

Whether this system could be used in the field as a distance measuring device remains open to question considering the random error employed by the DoD. For example, elevations within the National Parks did not register anything other than the input data of 0 metres above sea level, presumably as a consequence of the maximum accuracy of 25 metres with the elevations of the parks being considerably less than this. Likewise linear distances (metres) along bearings between points were also suspect owing to this error factor. A method identified by Gilbert (1996) of integrating GPS data with a laser range finder or electronic distance measurement device would be able to compute distance with position to attain true locations of features mapped. Gilbert also suggests that GPS is only a useful addition to a survey and not the complete answer to mapping problems. For this study, GPS has provided an additional tool in providing an extra layer of information that was previously not available and although it is extremely efficient and rapid method of computing locations, it has been used in this case primarily to complement an existing survey. A complete survey of the National Parks could not be undertaken using only GPS, mainly because of the physical nature and location of the two National Parks. The GPS requires a clear view of the sky and physical obstructions such as woodland or cliffs may block the satellite signal reaching the receiver. Both parks are heavily wooded and are at the foot of cliffs along one side effectively rendering the GPS obsolete. At Kidirak readings were taken below the wooded cliff face of the alluvial fan at the southern end of the park. These readings, as Figure 29 shows, indicated position fixes moving further north when the reality should have been further south, a direct consequence of interference between satellite and receiver.

The resultant plots from the readings recorded at Ölü Deniz and Kidirak National Parks confirmed the immediate problems noted in the field that readings were inconsistent. There were problems in the spatial arrangement of positions recorded when compared with the original map. Distances calculated between points of longitude and latitude showed discrepancies and did not tie in with the distances originally surveyed in 1993 or that of the 1990 satellite images. These problems arose primarily because of the device used, the degrading of signal accuracy, the methodology employed, and the surrounding mountainous and wooded terrain. As noted above, any reading could lie within an error margin of between 25-100 metres which could include more than one position having the same reading as can be seen in Figure 29. Together these factors conspired to provide data which on a small scale map could be acceptable through generalisation but not on a large scale map where the error was obvious and rendered the data unusable. The main problem stems from a point raised initially as to why this map was required.

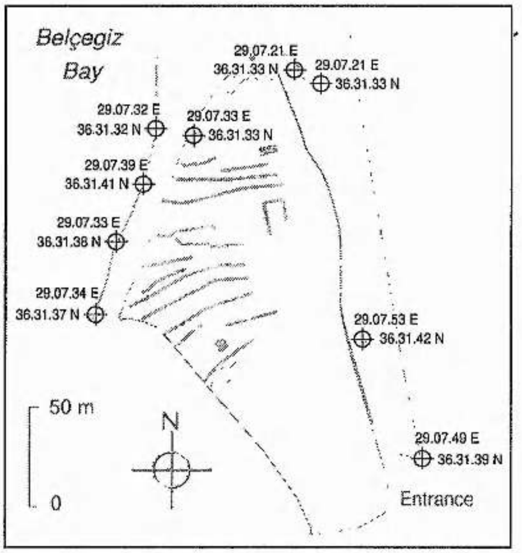


Figure 29: Southern area of Kidirak National Park showing location of GPS readings. Note the disparity between Northings and the identical readings for different locations to the north of the map.

There were no suitable large scale maps of the area, therefore there are no suitably accurate reference points in longitude and latitude to use as a control and from which error could be assessed.

As noted previously, the random error introduced by the DoD is largely responsible for not being able to determine whether or not a reading is accurate as any point within a 100 metres radius could potentially have the same co-ordinates. This however could be overcome by applying Differential GPS, which can correct the Selective Availability signal. This relies on having a control or base station at a known location in which positions are adjusted accordingly by the GPS receiver comparing them with the control position. The accuracy (depending on the system) can then be within a metre. However the equipment used in this particular study (Magellan GPS 3000) would require an additional differential receiver to be attached to correct the received signals. Alternatively, repeated readings can be recorded from the same position over a period of time and averaged. However, given the time constraints of the survey, this particular procedure was not an option.

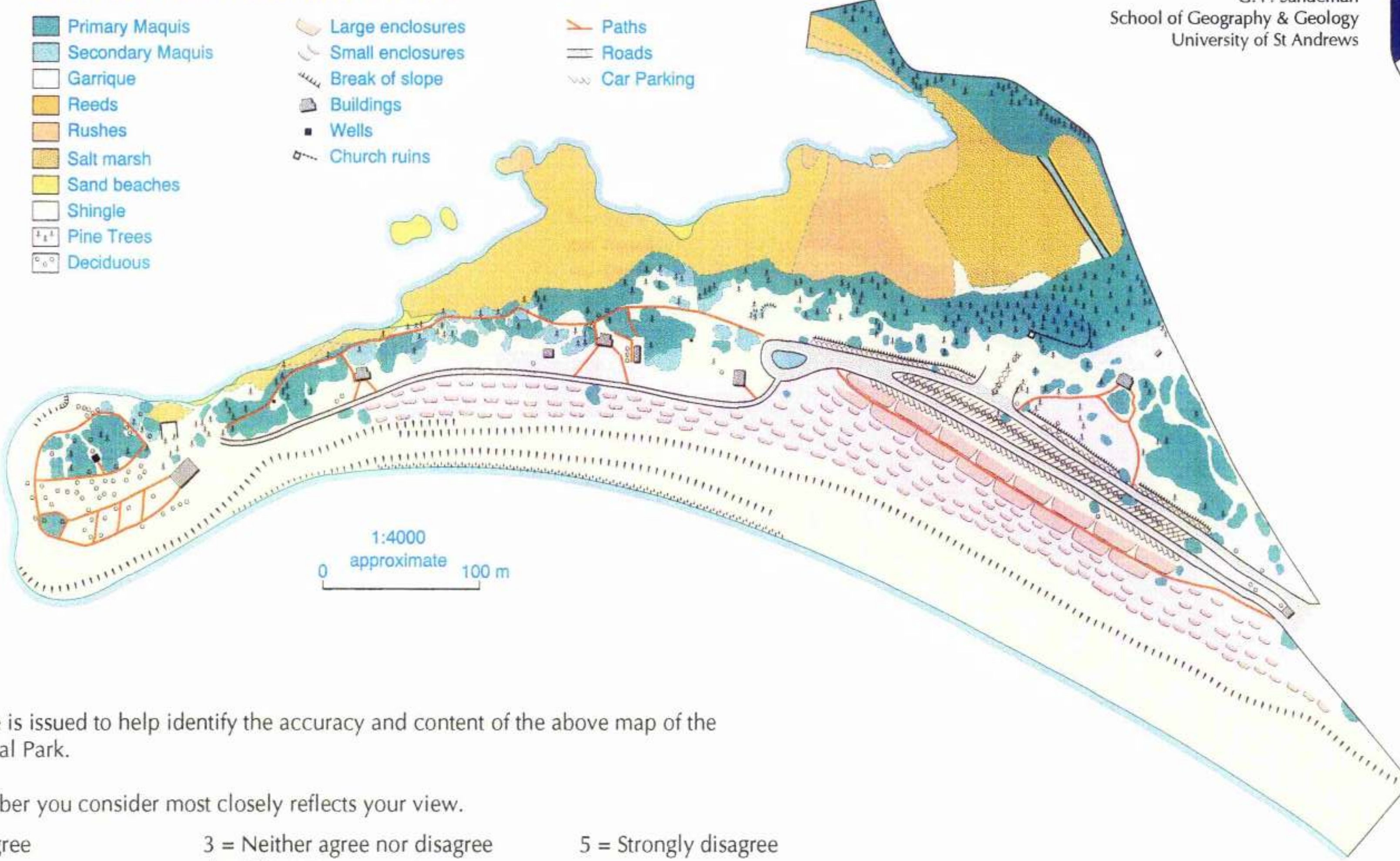
It is apparent even from a brief examination of GPS in the field that there are limitations regarding the accuracy of the data. Even when Selective Availability (Gilbert, 1996) is removed by the DoD in 2006 at the latest, it will still not provide the level of accuracy attained by Differential GPS. In this study it did not complement the original survey of the National Parks because of the problems noted above; nonetheless, as a hand held instrument it did provide a rapid data source. Together with a compass traverse it may provide the means of creating a map in many areas if access to other surveying equipment is not available, but only if the terrain is suitable and the error factor is appreciated.

Appendix III

Questionnaire survey

The following pages show the Questionnaire survey sheets used by students in the field to assess their perception as to whether or not the maps could be regarded as an accurate description of both Ölü Deniz and Kidirak National Parks. There are two questionnaires relating to Ölü Deniz from 1994 and 1995 and a single sheet from 1995 of Kidirak. Only a small number of students (4) worked in Kidirak National Park in 1995 and therefore the group was deemed not large enough to assess the 1994 map although comments by them were noted for reference.

Olu Deniz National Park



Surveyed & Produced, May 1993
G. F. Sandeman
School of Geography & Geology
University of St Andrews

This questionnaire is issued to help identify the accuracy and content of the above map of the Ölü Deniz National Park.

Circle the number you consider most closely reflects your view.

1 = Strongly agree
2 = Agree
3 = Neither agree nor disagree
4 = Disagree
5 = Strongly disagree

1.	The map looks correct.	1	2	3	4	5
2.	The relationships between phenomena have been correctly preserved.	1	2	3	4	5
3.	The map shows the true extent of the vegetation classes.	1	2	3	4	5
4.	The map is an accurate description of the National Park.	1	2	3	4	5
5.	The map is useful as a guide to the National Park.	1	2	3	4	5
6.	Please specify any obvious inaccuracies or other features to be added, or any other comment you wish to make.					

6. ....

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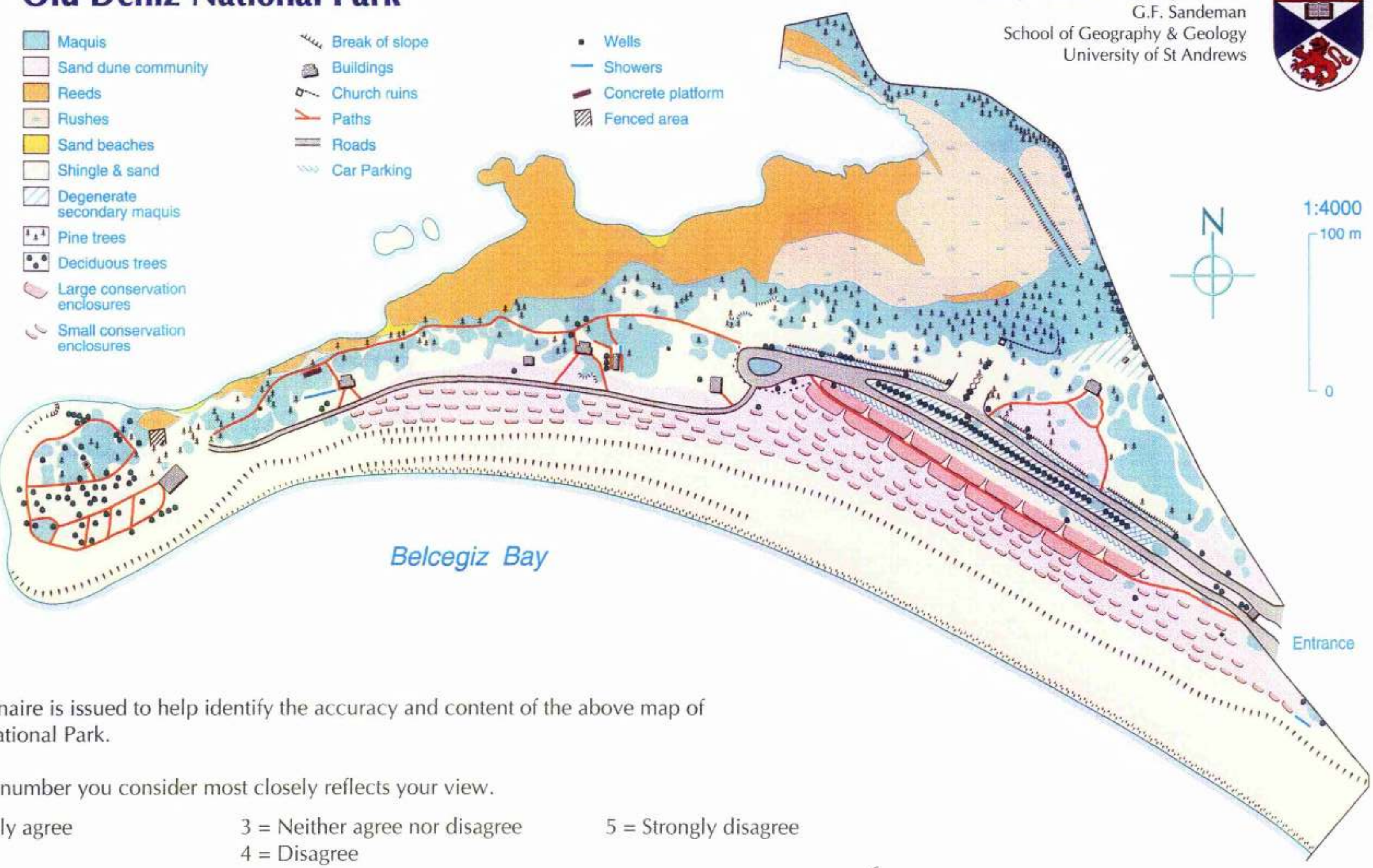
Thank you for taking the time to respond to this questionnaire.

Ölü Deniz National Park



This questionnaire is issued to help identify the accuracy and content of the above map of Ölü Deniz National Park.

Circle the number you consider most closely reflects your view.

1 = Strongly agree	3 = Neither agree nor disagree	5 = Strongly disagree
2 = Agree	4 = Disagree	

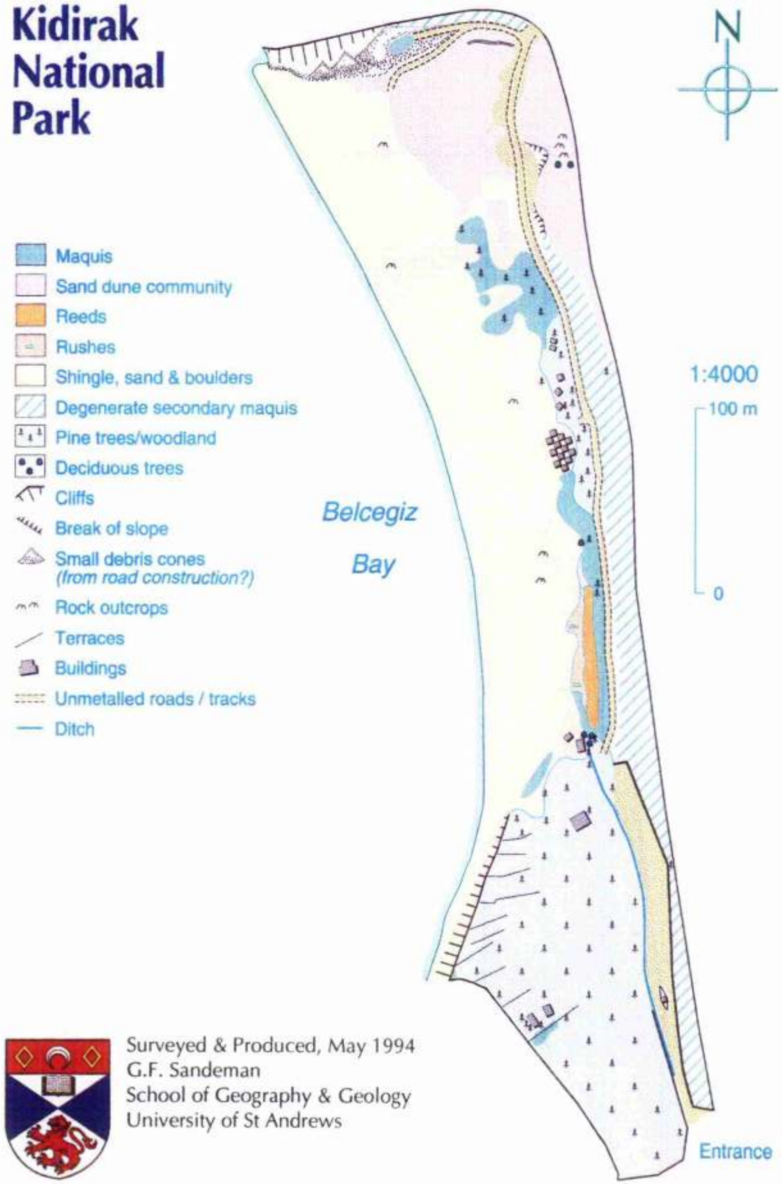
1.	The map looks correct.	1	2	3	4	5
2.	The relationships between phenomena have been correctly preserved.	1	2	3	4	5
3.	The map shows the true extent of the vegetation classes.	1	2	3	4	5
4.	The map is an accurate description of the National Park.	1	2	3	4	5
5.	The map is useful as a guide to the National Park.	1	2	3	4	5

6. Please specify any obvious inaccuracies or other features to be added, or any other comment you wish to make.

6. ....

Thank you for taking the time to respond to this questionnaire.

Kidirak National Park



Surveyed & Produced, May 1994
G.F. Sandeman
School of Geography & Geology
University of St Andrews

This questionnaire is issued to help identify the accuracy and content of the adjoining map of Kidirak National Park.

Circle the number you consider most closely reflects your view.

1 = Strongly agree
2 = Agree
3 = Neither agree nor disagree
4 = Disagree
5 = Strongly disagree

1.	The map looks correct.	1	2	3	4	5
2.	The relationships between phenomena have been correctly preserved.	1	2	3	4	5
3.	The map shows the true extent of the vegetation classes.	1	2	3	4	5
4.	The map is an accurate description of the National Park.	1	2	3	4	5
5.	The map is useful as a guide to the National Park.	1	2	3	4	5

6. Please specify below any obvious inaccuracies or other features to be added, or any other comment you wish to make.

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Thank you for taking the time to respond to this questionnaire.

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