FACTORS AFFECTING THE CONSERVATION OF RENOSTERVELD BY PRIVATE LANDOWNERS

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University of Cape Town

To my parents, who made this possible.

FRONTISPIECE

The theme setting - a landowner with a fairly typical "beleaguered renosterveld island remnant in a sea of agriculture" - taken by the author near Riebeeck-Kasteel, south-western Cape

PREFACE

The major body of the thesis comprises papers either to be submitted for publication (two); submitted for publication (three), or published (two). Although a logical sequence of presentation is followed this does not correspond with the sequence in which the papers were prepared, largely in order to meet CSIR commitments. Standardisation of the references was not practical owing to the widely varied requirements of respective journals from scientific through to legal (the latter, for example, requires references within footnote formats). Literature review material is covered for each facet of research within the introductory sections of the papers. To avoid repetition and clutter this is kept to the minimum in the General Introduction and General Conclusions sections of the thesis (where necessary reference is made to the Papers). The General Introduction, which reads as a whole with the General Conclusions, also presents basic aims. The General Conclusions emphasise, in part, key findings with respect to these aims and, where applicable, practical recommendations.

In deciding on the basic aims for what was, in 1982, considered to be a new approach to the challenging problem of trying to conserve the dwindling remnant natural ecosystems of the south-western Cape lowlands, I was initially helped by the inspiration of Mrs M.L. Jarman, then

a scientific coordinator for the Foundation for Research and Development. Dr R.S. Sparks, (Department of Mathematical Statistics, UCT) helped on the statistics whereas Professor J.R. Grindley and Professor E.J. Moll contributed general scientific expertise.

The thesis contents, namely research methods, results, conclusions and recommendations are my own. The research direction followed throughout the thesis, which includes agricultural, biological, economic, legal and socio-psychological perspectives, was decided upon and carried out by myself.

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ABSTRACT

West Coast Renosterveld, once prevalent on the south-western Cape lowlands of the floristically rich Cape Floral Kingdom, is now South Africa's scarcest vegetation type. Delimitation and measurement of the 55 "island-remnants", scattered amongst agricultural lands indicated that only 3% of the original vegetation remains. Measured soil quality, gradient and rainfall (critical agricultural criteria) were used to derive agricultural 'threat' indices (probability of agricultural clearance) for each remnant. The indices agreed well with observed trends in the recent clearance of remnants not deliberately conserved by landowners. This new approach has potential for determining which remaining natural sites most urgently need preservation. It was demonstrated that agro-technical innovation poses a long-term threat to even the low agricultural 'threat' rated renosterveld.

Pasturage, invariably practised in renosterveld, was assessed by comparing "grazed" with "ungrazed" plant species covers. Within the test site, heavy grazing increased Asteraceae and Iridaceae, decreased Poaceae and Rutaceae, and eradicated Proteaceae. These changes may reflect local trends associated with modern grazing regimes. Total plant diversity and cover were not found to be affected. Therefore, controlled pasturage reflects a relatively minor threat to the extinction of floristic elements.

Private landowners are found to control the destiny of 80% of West Coast Renosterveld. The conservation attitudes and behaviour of a random sample of these critical decision-makers were analysed. A new approach was devised to assess 32 subjective, bias-prone "intangible" variables. This required additional assessors to provide independent, non-parametric ratings of the author's tape-recorded interviews with the landowners. Results were pooled and "inter-assessor" measurement error was estimated. Altogether 52 variables, including a further 20 "tangible" variables, were rated under categories: 'Demographic', 'Psycho-Social, 'Land Use' and 'Conservation Strategy'. A correlation matrix portrays inter-relationships between variables and their correlations with landowner "Conservation Behaviour". Landowners' knowledge of biota, rapport with interviewer, education, affluence, bilingualism, and parents' education all correlated positively with conservation. Linear equation models were derived (using Best Subsets Statistical Programme) to predict 'Conservation Behaviour'.

Although most conservation related variables are "fixed" (eg it is not possible to change parents' education), the understanding of these background factors (not previously applied to conservation of natural ecosystems) enables choice of the most appropriate strategy to persuade landowners to conserve. Different groupings of landowners having similar ratings of key variables have similar needs and constraints to be considered vis à vis improving their

"Conservation Behaviour". A blueprint for persuading landowners to conserve through personal liaison is illustrated by reference to 'impression management' and 'decision steering'and is supported by case studies.

The effects of prevailing restrictions on landowners were investigated re controls on veld clearance via permits in: a) farmland (Conservation of Agricultural Resources Act) and b) designated 'nature areas' (Physical Planning Act). Legal loopholes, weak implementation and lack of material inducement were found to make such legal coercion an ineffective option. Proposed alternative tax concession and subsidy/grant options are evaluated as material incentives for conservation:- a) Property tax-rebates have only symbolic value given renosterveld's minimal rateable value. b) Tax deductible allowances for liabilities of private reserve owners favour the affluent and not the groups whom the study has shown most require incentives. c) Conditional allocation of subsidies/grants is recommended because it can be selectively based on landowner and ecosystem attributes and is more likely to be acceptable to fiscal authorities than tax concessions because of easier budgeting.

Untapped potential exists for private landowners to take custody of those natural areas, including renosterveld, which are the least cost-effective for State purchase and management. Sympathetic extension, appropriate financial inputs and much more effective utilisation of existing private law mechanisms, such as trusts, are needed to ensure permanence of conservation measures. The unfortunate alternative is that those landowners who are not so motivated will continue the unabated destruction of renosterveld vegetation and other irreplaceable natural ecosystems.

GENERAL INTRODUCTION

1.0 INTRODUCTORY REMARKS

This thesis represents a multidisciplinary investigation of the interaction of the human factor with a now highly diminished natural vegetation type - the renosterveld of the south-western Cape lowlands. The two main emphases of the thesis are defined as follows:-

Private landowners, largely commercial farmers, were chosen for investigation, firstly, because they own the largest proportion of rural land in South Africa (about 80%). This includes vast tracts of natural and near-natural ecosystems (Paper 7). Secondly, although private ownership may occasionally be registered, for example, as a company or partnership, the accountability of actions on a particular property even in the latter cases usually centres around one individual or family as a decision-maker. If an outsider wishes to suggest change, for example on the conservation management of a private property, the bureaucracy involved is minimal because one normally works directly through a single individual. This situation is seldom quite as simple with publicly owned lands. These lands encompass a wide variety of very often complex systems of ownership, controls ("authorities") and usage. Accountability of actions as well as of land uses are thus diffuse and variable and would therefore form the topic of a separate investigation.

Coastal Renosterveld, the second main emphasis of the thesis, is a distinctive natural vegetation (= veld type) that originally covered the relatively fertile undulating shale- and granite-derived soils of the south-western Cape coastal forelands (Papers 1 and 2 for detail). Only a very small percentage of Coastal Renosterveld (under 4%) has survived clearance for planting of winter cereals, artificial pastures and vineyards.

Being part of the florally rich and distinctive Fynbos Biome should give the remaining "island-like" Coastal Renosterveld ecosystems top conservation priority. Unfortunately, the "formal conservation status" of renosterveld in secure, long term, publicly owned conservation areas remains extremely low (Paper 1). Unlike many other natural/near-natural ecosystems the relatively high potential of renosterveld for agricultural development, which is necessarily linked to higher land prices, often makes land acquisition a prohibitive option. Despite the high diversity and endemism of the flora, the absence nowadays of the traditionally more popular indigenous large mammal component, as well as the 'pocket handkerchief' character of the remnants (greater conservation management input/area), makes renosterveld an unattractive proposition for government bodies presently responsible for conservation.

The present status of renosterveld compares starkly with, for example, that of the lowveld vegetation in the subtropical north of South Africa. The latter is almost one hundred per cent intact (not cleared) and twenty per cent conserved (Paper 1). The conserved area includes the well known Kruger National Park and an extensive block of largely private conservation areas alongside. The lowveld's history of low utility for conventional agriculture, together with reasonably high returns from visitors and wild animal products associated with abundant 'big game' (partly a consequence of its history of low disturbance), is one of the main reasons for its comparatively pristine condition today. The reverse situation applies to renosterveld which contributes further to its status as South Africa's true "Cinderella" vegetation type.

From a socio-economic perspective the demise of renosterveld has much in common with that of the native vegetations of the Prairies of North America, Steppes of Russia and Mallee scrub of Australia (Paper 1). The latter have, like renosterveld, been largely cleared for crops, whereas other native vegetation types in the same countries have, like the South African lowveld, suffered minor impact. Lack of holistic conservation of different ecosystems does not, therefore, appear to be unique to South Africa.

2.0 CONCEPTUAL DEVELOPMENT

The philosophy surrounding the conservation of nature and natural diversity is complex and includes several ideological schools. The author feels that at least four mutually discernable schools can be defined. In their 'extreme' forms they involve the following considerations:-

1) Aesthetic/Recreational Considerations

This is based upon the views held by those who maintain that "things natural are beautiful". The latter would support the contention that natural biota and natural ecosystems are worthy of retention predominantly on the basis of this innate "beauty" for the benefit of present and future generations of fellow humans. Extreme exponents of such a school would also contend that appreciation of even the humblest and/or least attractive natural species or ecosystem could be acquired given sufficient 'refinement of taste' as could be inculcated through appropriate emotional/experiential and/or educational stimuli. Moreover, the same school would also maintain that humankind's spiritual and mental well-being is directly linked to the continued survival in "sufficient" magnitude of natural organisms and landscapes (etc). Contact with the natural environment is perceived to be primarily recreational and/or spiritual. Opinions obviously vary as to what exactly constitutes a 'natural' environment and what exactly constitutes an 'unnatural' environment - because human 'disturbance' is manifest in one way or another throughout the planet.

2) Quasi-Religious Considerations *

At its simplest (and possibly crudest) level, devotees of this school in a broad sense adhere to the Judaeo-Christian "Noahs Ark" style of doctrine. From the latter emerges the moral which emphasises the sanctity of 'natural' species and consequently 'natural' diversity. Certain parallels (with which the author is less well acquainted) also exist in those aspects of Eastern religious beliefs which stress the divine rights of 'non-human beings'.

The quasi-religious belief may take either a paternalistic form; where man is perceived to be a "responsible custodian" of "lesser species/organisms", or take an egalitarian form; where reverence and active support is given to the 'divine' rights of other co-evolved/co-created biota in order for them to have a continued and harmonious co-existence with humankind. In either context the term "conservation" may be more realistically called "protection" or "preservation".

3) Utilitarian Considerations *

In contra-distinction to the previous two schools, the utilitarian exponents view, at the extreme, nature and

* See also Fuggle, R.F. and M.A. Rabie (1983). Environmental Concerns in South Africa. pp. 5-7. Juta, Cape Town.

natural organisms from a purely materialist viewpoint. If nothing else, therefore, biotic diversity, natural processes and ecosystems are perceived as being indispensible to the material well-being of humankind because they represent potential, if still untapped, sources of medicine, food, building materials (etc). Within this context nature and natural organisms are referred to as "environmental resources". In similar vein to exponents of the aesthetic/recreational school (above), who maintain that aesthetic beauty can be perceived in even the most humble of organisms, the same principle may be extended to the utilitarian school whose members argue that natural biota and processes have virtually limitless potential to yield material value to the human race. Most frequently, it is maintained, it is merely that the scientists have not as yet been able to uncover the potential material value of a particular species. To this school, the impoverishment of nature and biotic diversity is inextricably linked to the material impoverishment of humankind in, at least, the long term. Consequently 'conservation' is interpreted as representing the "wise and sustained utilization of natural resources". Taken at face value this means at its simplest encouraging the non-overexploitative "harvesting" of natural resource products without irreversibly damaging the resource itself.

The utilitarian school has, for fairly obvious reasons, the most potential support among the lay public. In fact, in the author's opinion, material utilitarian considerations are frequently used by conservationists as rationale for conservation even although the latter's own primary values may, in reality, lie within the realm of the other conservation schools (as defined in 1), 2) and 4).

4) Cultural Considerations

Internationally, different peoples have developed close ties with non-human biota, ecosystems and landscapes through long term association, frequently over millenia. Very often these associations are with 'derived/unnatural' biota, ecosystems and landscapes. These may include specific agricultural animals or plants as well as particular categories of planted farmland, park or garden landscapes etc which have developed historic and traditional significance. However, 'natural' equivalents may also have their place in this "museum-style" approach to conservation. For example, exponents of this school may value a natural landscape remnant primarily for its typification of what a particular region "used to be like" in early historic times before surrounding areas had become transformed by destructive impacts, that is when the region was truly "wild".

The considerations discussed above represent the types of rationale that may be used to support the expenditure of effort necessary to prevent the final extermination of renosterveld and other beleaguered natural ecosystems together with their associated and/or distinctive species, biotic communities and natural processes. The order of preference for types of rationale to support the conservation of renosterveld, as an example, really depends the most on the fundamental value systems held by interested parties. As discussed earlier, the latter's "image" to the general public, compared with other vegetation types such as the South African Lowveld, is not as vaunted as the author feels is justified. As should be apparent from the rationale for conservation presented above, the case for saving the renosterveld is a strong one, and the author accepts this as fundamental premise underlying the practical direction running through the thesis.

The first research direction decided upon in this thesis was clearly to delimit the current survival status of the renosterveld; reasons for it having become so scarce and its likely future should the prevailing socio-economic 'threat' factors continue to operate. Enough information was on hand to ascertain that the West Coast Form of renosterveld is the most severely reduced of the different types of renosterveld. Remnant patches of the latter renosterveld form was, therefore, a logical target for investigation in the first content chapter - Paper 1. A body of specific information was gathered on the extent and reason for the past decline of West Coast Renosterveld as well as the consequences for the associated biota. This was illustrated partly statistically and partly by using case examples.

What makes Paper 1 stand out from analogous studies in other countries was the decision taken to direct the main thrust of research towards systematically interpreting and actually measuring outside threats to these remnant ecosystem fragments. This takes into account particularly the agricultural factors, namely; differences in the favourableness of soil, slope and rainfall in so far as they influence agricultural exploitation of the latter. Conservation biologists have traditionally confined their research virtually exclusively to attributes relating to the ecology of the natural ecosystems themselves. Only lip service has been paid to the "other side of the coin" - namely socio-economic (and other not overtly ecological) threats to the continued existence of the same natural ecosystems. Such biologists appear to have the expertise and motivation to understand and value such ecosystems but are frequently at a loose end to tackle effectively the challenge of implementing their conservation ideals. This is because the major problems to be overcome most frequently lie within disciplines often far removed from conventional biology. Preoccupation with redressing this traditional imbalance, at least as far as renosterveld is concerned, is a theme that runs throughout the thesis.

One of the observations arising out of Paper 1 is the fact that renosterveld remnants (whatever their future prospects may be) are almost invariably used for natural paturage. Paper 2 takes the introduction of renosterveld as a research baseline further by measuring the effects of grazing on plant species within a fairly typical renosterveld remnant. Apart from detail at a largely parochial level the approach of Paper 2, which assesses grazing effects at the level of plant family, is a new one and, it is believed, holds promise for analogous future grazing studies within other vegetation types. The study also gives some clues as to the likely floristic composition of renosterveld before the major impacts of European settler agriculture - a subject of great interest to many local botanists. The study indicated that grazing frequently causes the 'derived' nature of, probably, most renosterveld today. This effect is by no means as irreversible as are the impacts of the clearance of remnant renosterveld for croplands.

Results in Paper 1, and to a lesser extent in Paper 2, served to highlight the critical importance of analysing the actions of those landowners who control the destiny of threatened ecosystems as exemplified by renosterveld. It was shown in Paper 1 that prevalence of physical factors of renosterveld remnants favourable to agriculture did not invariably lead to the latter being ploughed for crops. Clearly, in the broadest sense, the cause for this discrepancy was attributable to the 'landowner factor'. Preliminary observation seemed to indicate that several landowners maintained that nature conservation was (at least) a part reason for not having cleared renosterveld for planted lands. However, it also became clear during preliminary research that the latter's motives were seldom clear-cut - a complex interplay of factors was at work - a situation typical of human behavioural phenomena. Thus the verbally stated conservation motive of a particular farmer could in fact have been influenced decisively by any one (or more) of the following 'real reasons':- a) just saying this to 'satisfy' the author, b) the technology is not available to develop the land further agriculturally, c) he could not afford the expense of clearance and development of planted lands, d) he feels that it is not an economic proposition to develop the land further agriculturally, e) he is in a tax bracket sufficiently high that the perceived returns were too low to warrant agricultural development, f) family pressure caused him to preserve the land (etc). At this stage of the project the importance of the private landowner as a decision-maker for conservation had become clear. An effective blueprint to win over non-conservation conscious landowners to the conservation 'cause' would prove to be the salvation for not only renosterveld (80% privately owned) but, in addition, other natural ecosystems under similar circumstances. To delimit such a blueprint it was, however, necessary first to develop a clear understanding of current attitudes and behaviour of a representative cross-section of landowners towards conservation. The fundamental premise underlying this argument - and in fact the whole theme of the thesis - is that one must first understand the status-quo before one can hope to change it. But to answer the not so easy question posed above - namely why landowners did, or did not, conserve natural ecosystems - required an application of the discipline of social science in order to gauge this factor as effectively as possible.

As conservation attitudes and behaviour linked to natural ecosystem conservation had never previously been investigated in depth, the task addressed in Paper 3 was to re-direct and adapt current social-psychological technique towards discovery of the motives and factors linked to the positive (as well as the negative) conservation practices on farmlands. It is possible that the technique derived for the purpose could also be further adapted to be applied to related environmental problems. The technique used was based upon tape-recorded in-depth interviews and telephonic re-calls to subjects. Suitably qualified individuals provided independent ratings of this data-base for a widely varied range of variables pertaining to the landowner-subjects. Admittedly, although the approach used is based on principles fairly established within the social sciences, its application within the context of environmental conservation is new. The most closely analogous previous conservation studies have largely turned a blind eye toward 'less tangible' variables, namely those that are either very sensitive and/or difficult to rate numerically and/or open to considerable subjective bias in measurement.

The data derived in Paper 3 were used as a basis to produce a statistically supported description of attitude and behaviour patterns of landowner-subjects in Paper 4. What did emerge fairly clearly was the fact that background factors of the subjects not overtly linked to conservation attitudes and behaviour, such as educational, cultural and wealth factors (and several others that are less obvious) could be used with remarkable accuracy to predict independently the actual extent of conservation behaviour of any landowner within the research sample. This success is attributed partly to the endeavour of assessing a wide variety of landowner-related variables (in Paper 3) and partly to the efficient application of a recently prepared statistical package (the 'Best Subsets' BMDP Computer Programme) which had not previously been used in this type of analysis.

Paper 5 represents the climax of the social-psychological component of the thesis. It concentrates on communication approach-options that could be used by scientific conservationists to enhance most effectively the cooperation of private landowners in conserving natural ecosystems. Possibly this paper's largest break with traditional conservation dogma is its move away from the typical ideal of "persuasion through education" to the ideal of "persuasion through communication". The latter ideal lacks the paternal 'top-down' connotation of the former and reflects instead much more of a two-way process of information flow. Just as the scientific conservationist has needs, eg improved cooperation in the conservation sense (etc) so does the landowner-subject have needs, eg increased recognition and/or remuneration and/or advice (etc) in exchange for his/her cooperation. Effective inter-communication of the nature of such needs represents a very important step forward for conservation. Supported by case studies as well as data from Papers 3 and 4, this Paper also attempts to define systematically for the first time the "best" approaches to be used by conservationists to sell conservation as a package directly to a reasonably wide range of landowner-categories. The implications thus go much further than the local context. This reflects the general trend in the thesis which, until this point, has progressed away from a more parochial level (Papers 1 and 2 which largely concern the 'physical' base of the study ie renosterveld) through to a more universal level (Paper 5 as defined).

No assessment of conservation practice on private lands would be complete without some consideration being given to the legislation of the particular country concerned. Environmental as well as other, less directly related, legislation provides the indispensable framework for the implementation of significant conservation-related reforms.

Ultimately, therefore, it follows that it is the prevailing socio-political milieu that determines both the nature of legislation as well as many of the socio-economic realities in this country. Should the socio-political milieu alter significantly, many of the assumptions within the thesis would collapse. For example, the concept of private landownership would not prevail, in the strict sense at any rate, under a socialist political leadership. Under this situation conservation practice by the public, as well as laws with influence on such practice, would take on a different form and consequently require different remedies. Therefore, it becomes critical to emphasise at this juncture that while acknowledging the importance of the effect of current socio-political realities on particularly the longer term conservation practices of the general public, it is well beyond the scope of the present thesis to provide realistic analytic comment on this highly complex, controversial as well as largely speculative facet of the overall conservation problem. Obviously this could form the comprehensive topic of a full-scale separate investigation. Instead, the final part of the thesis (Papers 6 and 7) consists of an analysis of current legislation, together with the presentation of proposals which have potential for enabling the provision of improved conservation status of privately owned natural ecosystems. In order to achieve this ideal for threatened ecosystems (such as renosterveld remnants) it appeared to be most appropriate to work within limits that would be most readily acceptable to the current political status quo. In view of the urgency of the situation it was thought that this tactic would be the most likely to improve the conservation status of high priority privately controlled ecosystems in the short term. Naturally, it follows that with any future changes in the socio-political milieu, flexible improvisation of conservation policy would be required to accommodate for such changes. For example, conservation areas set aside by landlords in feudal Britain still exist generally to the benefit of a much broader public under considerably changed political circumstances today. The same principle should also be applicable within a future post-apartheid South Africa.

Papers 6 and 7 represent legal treatises largly within the context of the present socio-political system. Of all the chapter-papers, these have the greatest tendency for the contents and recommendations to become outdated within the short-to-medium term because of the continuing amendments, repeals and new promulgations of prevailing legislation. However the basic principles probably remain unnaffected.

Paper 6 examines the effectiveness of current legislation on the advancement of natural ecosystem conservation on private lands. Unlike most legal research which has an emphasis on legal aspects of laws themselves this paper concentrates more on the landowner sample and other relevent authorities as representing respectively the recipients and enforcers of laws concerning the natural environment. The data generated in the predecessor thesis chapters are used to substantiate observations made on the operation of such laws "in the field situation". The broad conclusion reached was that current legislation over-emphasised purely restrictive means for achieving stated goals. These restrictions were perceived to be unrealistic, not only as a result (in certain cases) of poor formulation, but, more significantly, because they are virtually impossible to police. Allocation of law enforcement staff was considered insufficient and material rewards to contravene such laws appeared to be high. Consequently, legal considerations played a subminimal role in the conservation decision-making processes of private landowners. They conserved if they wanted to conserve not because they were forced to conserve. In fact certain legislation was found to promote indirectly the destruction of natural ecosystems. Furthermore, by representing a 'sop' to the public conscience that "something was being done to conserve", the ineffectual legislation was considered to do more harm than good. This effectively pre-empts attempts to establish more meaningful measures to improve the protection of natural ecosystems on private lands.

Finally, Paper 7 provides a logical end-point for the thesis because it contains practical proposals that, if implemented, would remedy the present shortcomings of the predominantly restrictive legislation analysed in Paper 6. The fundamental thrust of the proposed legal reforms in Paper 7 was to make available material incentives for conservation in such a way that would appeal to private landowners as well as current public and private bodies that would be responsible for the disbursement and administration of recommended conservation-related funding. Proposals were based upon a review of relevant legal information and supported by observations of prevailing landowner behavioural patterns (as delimited within the previous chapters). It is acknowledged that the South African farming community is in an unusually favourable position when it comes to State supported aid. However, no financially based aid is, at time of writing, available to landowners in order to encourage and/or support endeavour related to the conservation of natural ecosystems with significant merit.

Paper 7 provides a strong case, as well as a practical formula, for subsidies (instead of alternative tax-related options) to be used as a foundation to ensure long-term conservation of conservation-worthy ecosystems on private lands. The same paper also presents another strong case for an extension/advisory service to be established in a co-ordinating capacity to further advance conservation initiatives of private landowners. The latter would necessarily take into account the type of information generated by the research described in Paper 4 and would also apply the communication blueprint outlined in Paper 5.

Taken as a whole, the thesis Papers 5 and 7 have the most applied significance, being substantiated at a more academic level by the remaining paper-chapters. Paper 1 is also partially significant at the applied level, but is possibly more parochial than Papers 5 and 7.

3.0 SPECIFIC AIMS OF THE CHAPTERS

Paper 1: The Influence of Agriculture on the Decline of West Coast Renosterveld, South-Western Cape, South Africa.

The paper sets the scene for subsequent thesis content.

Renosterveld remaining on the west coast forelands was chosen for investigation because a comparatively rich information base already existed. This provided a convenient foundation for further analysis.

Research aims included:

1. To determine the exact area of renosterveld remaining and to understand reasons for its "survival" to date.

2. To determine how concentrations of Red Data (rare and threatened) plant species in renosterveld compare with adjacent, less heavily exploited vegetation types.

3. To detect whether patterns exist in the concentration of Red Data species within the renosterveld remnants.

4. To determine comparative agricultural potentials of the remnants by using physiographic features and to see how well these could predict the 'agricultural threat' factor (likelihood of clearance for agriculture) in reality.

5. To evaluate whether remnants unploughed to date will remain so in future, ie do these represent tail-endings of agricultural development that has already taken its full course?

<u>Paper 2: The Effects of Grazing on Renosterveld at Eensaamheid, South-Western Cape, South Africa.</u>

The most prevalent land use in remnant renosterveld is livestock pasturage. This supplements the fodder on the cultivated lands and takes place for between three weeks and nine months per annum. It was considered that a grazing regime, unlike that of pre-colonial times, would have definite effects on the composition of renosterveld; particularly in view of its present biogeographical 'island' status. Research was carried out on a diverse renosterveld remnant which also has a high concentration of Red Data Species. One third had been protected from livestock access since before the present grazing regime.

Research aims included:

1. To assess change in vegetation cover and diversity associated with the prevailing grazing regime.

2. To indicate and compare the differences in cover of plant species and plant families on either side of the "grazed"/"ungrazed" fenceline.

3. To ascertain effects of the grazing regime on the Red Data plant species.

4. To place results within the context of published and observed findings in order to get an indication of how the floral composition of renosterveld may have changed with modern grazing practices.

Paper 3: The Attitude and Behaviour of Farmers toward Ecosystem Conservation: a New Approach to Assessing Associated Variables.

Because no directly analogous studies are known (a computerised international library data-base was used as an aid) on analysing the attitudes and behaviours of private landowners (other than towards the conservation of soil) it became necessary to improvise methods. An initial problem was the apparent inefficiency of the standard questionnaire approach in reliably assessing sensitive information or less tangible attributes of subjects. Both the latter, it was felt, had significant bearing on the values, attitudes and actions of the farmer-subjects. The research sample was sampled randomly from farmers owning West Coast Renosterveld.

Research aims included:

1. To define 'Conservation Behaviour' as pertaining to natural ecosystems (ie renosterveld) on the farmer's property.

2. To evolve an interview technique appropriate for sampling a wide array of 'variables' associated with 'Conservation Behaviour' related factors.

3. To decide on factors which may exert a direct or indirect influence on the practice of conservation by the farmers.

4. To evolve a reliable means for assessing 'less tangible' variables (ie those which may be open to subjective bias).

<u>Paper 4</u>: <u>Multivariate Modelling and Prediction of Farmers' Conservation Behaviour toward Natural Ecosystems.</u>

This paper follows on directly from Paper 3 and uses measures of the variables for statistical evaluation of farmers' conservation behaviour. This is supported by anecdotal material and indirectly related published work.

Research aims included:

1. To establish levels of intercorrelation amongst the 52 quantified 'independent' variables and to 'cluster' these accordingly.

2. To discuss the more interesting relationships between the 'independent' variables and the 'dependent' variable - 'Conservation Behaviour'.

3. To determine whether 'Conservation Behaviour' or lack thereof can be mathematically predicted by using measured 'independent' variables.

4. To determine the potential for improving the 'Conservation Behaviour' of landowners.

5. To decide whether prediction of farmers' 'conservation behaviour' could be a useful tool in planning conservation strategy for priority conservation-worthy sites.

<u>Paper 5</u>: <u>Persuading the Landowner to Conserve Natural Ecosystems through Effective Communication</u>

The importance of good conservation liaison with farmers, via direct official/unofficial extension, cannot be underestimated. Effective communication is the key and has formed the basis of many earlier studies on the introduction of new technologies (innovations) to rural people in various parts of the world. Although persuasion is probably more of an art than a science it still means that "rules of thumb" can be derived systematically.

Research aims included:

1. To mathematically 'cluster' subjects into 'sociotypes', based on similarity of the variables assessed in Papers 3 and 4, and to determine whether such 'sociotypes' have any value for deriving conservation strategies.

2. To illustrate examples of 'good' conservation liaison and 'bad' conservation liaison and their consequences by means of case studies.

3. To identify needs of landowners that have to be accommodated for improved conservation practice.

4. To recommend a practical code of conduct for conservation extension personnel that will induce optimal conservation of natural biota by farmers.

Paper 6: Legal Strategies to Optimise the Conservation of Natural Ecosystems by Private Landowners: Restrictive Legislation

Farming in South Africa is normally considered to be among the most autonomous of professions; a factor apparent in the Afrikaans epithet "Die boer is baas op sy plaas" - which, with a little 'licence', means that the farmer is the (undisputed) master of the farm. Nevertheless, like all others, farmers are still influenced by legal restrictions, some of which may affect their conservation behaviour. Responses of renosterveld landowners are used where possible as a basis to determine effectiveness of the restrictions.

Research aims included:

1a. To evaluate, in principle, the effectiveness of the Conservation of Agricultural Resources Act 43 of 1983 in restricting the cultivation of virgin lands in rural areas generally, and within remnant renosterveld in particular.

b. To evaluate the same (above) in practice with recommendations.

2a. To assess the potential of the Physical Planning Act 88 of 1967 in conjunction with the Environmental Conservation Act 100 of 1982 to promote the conservation of natural biota in "Nature Areas" which remain under the ownership of the private landowner.

b. To evaluate the same (above) in practice with recommendations.

Paper 7: Legal Strategies to Optimise the Conservation of Natural Ecosystems by Private Landowners: Economic Incentives.

Throughout South Africa uncounted numbers of private landowners preserve large tracts of natural/near-natural lands. These may be registered as private nature reserves, or alternatively in many cases not even recorded on any official register. Nevertheless these may still have enjoyed a history of high "unofficial" conservation status. In the Cape, Provincial Nature reserves (proclaimed under the Cape Provincial Ordinance) may on occasion also include private land. Many private landowners conserve irreplaceable natural resources and in many cases provide a service to the general public. Considerable scope exists, however, for further promotion of this option within the large proportion of private rural land in South Africa. Renosterveld landowners are used as a working basis in weighing up the pros and cons of alternative economic incentives.

Research aims included:

1. To delimit, a); "Lost-Opportunity Costs" and, b); "Ecosystem Conservation Expenses" as financial liabilities to the private landowner-conservationist.

2. To review critically present availability and to evaluate with recommendations the potential of tax concession incentives for conservation in terms of a) Property Tax Rebates, and b) Income Tax Deductions through reference to the Income Tax Act 58 of 1962, Mountain Catchment Areas Act 63 of 1970 and renosterveld landowner needs.

3. To review critically and compare the potential of subsidy-based incentives for conservation with tax concession incentives through reference to the Cape Provincial Ordinance 19 of 1974, the Conservation of Agricultural Resources Act 43 of 1983 and renosterveld landowner needs, with recommendations.

4. To evaluate means of overcoming the problem of achieving permanent conservation status for private conservation areas.

See thesis GENERAL CONCLUSIONS for point by point responses to the above research aims (as enumerated).

PAPER 1

THE INFLUENCE OF AGRICULTURE ON THE DECLINE OF WEST COAST RENOSTERVELD, SOUTH-WESTERN CAPE, SOUTH AFRICA

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ABSTRACT

West Coast Renosterveld, part of the floristically rich Fynbos Biome, was found to survive on only 3% of its previous range because of agricultural clearance in the south-western Cape lowlands. Much of the present "island" distribution is on hillocks and mountain slopes and, as such, these are unrepresentative of the previous range renosterveld on the higher agricultural potential flats. Red Data species, are prevalent on the small proportion of remnant renosterveld on the flats; the indication being that they are relicts of wider, pre-agrarian distributions.

"Agricultural threat" indices (likelihood of clearance for crops) are derived for each remnant using soil quality, gradient and rainfall measurements as parameters. Short-term prediction of capacity of sites to 'survive' agricultural pressure is 'tested' by empirical observation. It is suggested that "socio-economic threat" indices relating to agricultural, urban or industrial expansion should, as an "urgency" factor, supplement attributes traditionally rated for biota per se in ranking conservation priority of natural habitats.

In view of forfeiting returns from conversion to crops, financial sacrifice and goodwill are required to preserve remnant ecosystems like 'flatland' renosterveld. In the long term, agro-technical (and other) innovation will also place pressure on other natural habitats hitherto considered "safe".

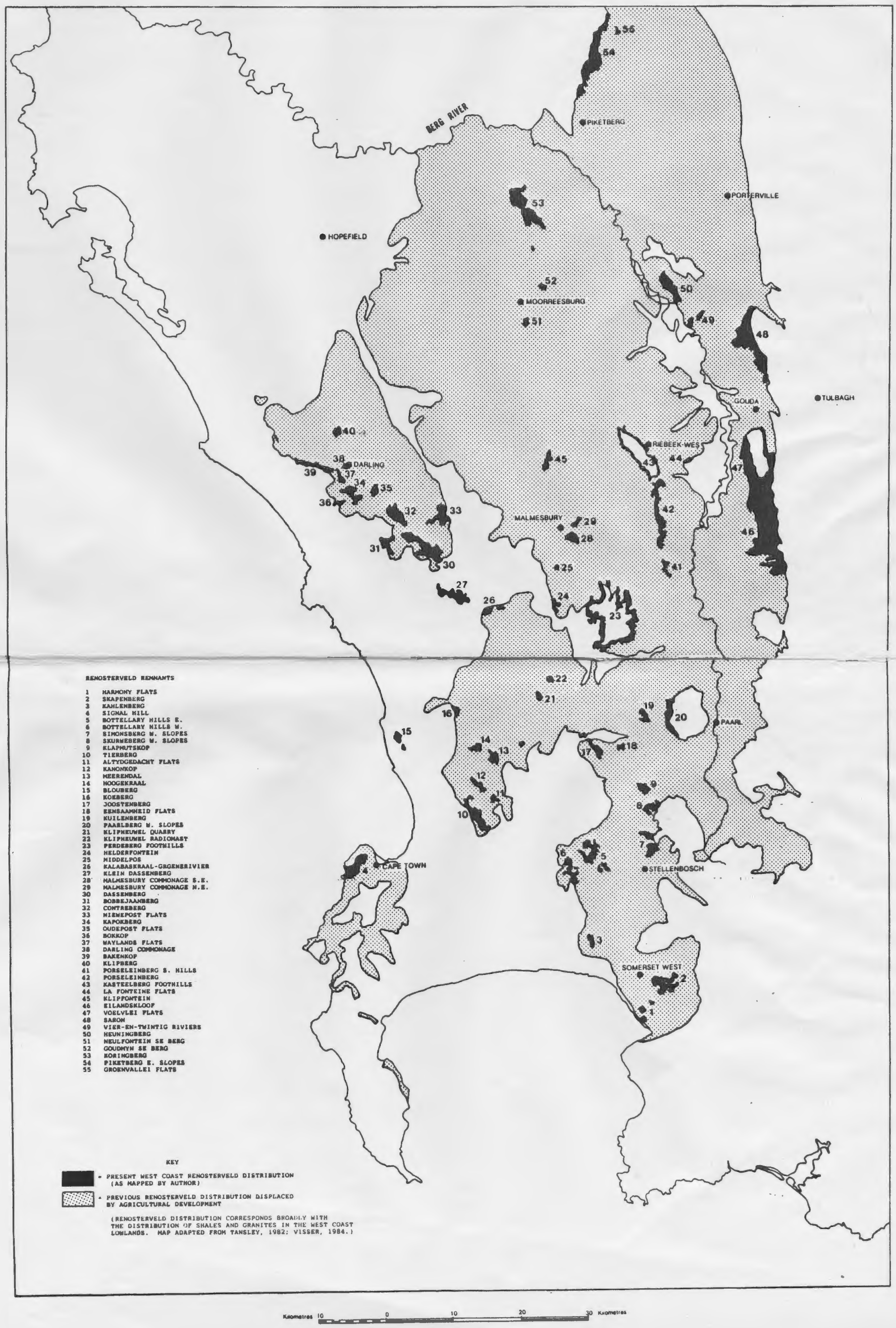
KEY WORDS

Agricultural threat, Conservation, Natural ecosystems, Renosterveld, Threatened species.

FIGURE 1

FIFTY-FIVE WEST COAST RENOSTERVELD REMNANTS AS DELIMITED BY THE AUTHOR AT THE END OF 1984).

(Sources used included: I:50 000 maps, 1:10 000 standard (and other) air-photos, personal visits as well as consultations with relevent authorities)


BERG RIVER
PIKETBERG
PORTERVILLE
HOPEFIELD
MOORREESBURG
TULBAGH
GOUDA
RIEBEEK-WES
DARLING
MALMESBURY
PAARL
CAPE TOWN
STELLENBOSCH
SOMERSET WEST
RENOSTERVELD REMNANTS
1 HARMONY FLATS
2 SKAPENBERG
3 KAHLENBERG
4 SIGNAL HILL
5 BOTTELLARY HILLS E.
6 BOTTELLARY HILLS W.
7 SIMONSBERG W. SLOPES
8 SKURWEBERG W. SLOPES
9 KLAPMUTSKOP
10 TIERBERG
11 ALTYDGEDACHT FLATS
12 KANONKOP
13 MEERENDAL
14 HOOGEKRAAL
15 BLOUBERG
16 KOEBERG
17 JOOSTENBERG
18 EENSAAMHEID FLATS
19 KUILENBERG
20 PAARLBERG W. SLOPES
21 KLIPHEUWEL QUARRY
22 KLIPHEUWEL RADIOMAST
23 PERDEBERG FOOTHILLS
24 HELDERFONTEIN
25 MIDDELPOS
26 KALABASKRAAL-GROENERIVIER
27 KLEIN DASSENBERG
28 MALMESBURY COMMONAGE S.E.
29 MALMESBURY COMMONAGE N.E.
30 DASSENBERG
31 BOBBEJAANBERG
32 CONTREBERG
33 NIEWEPOST FLATS
34 KAPOKBERG
35 OUDEPOST FLATS
36 BOKKOP
37 WAYLANDS FLATS
38 DARLING COMMONAGE
39 BAKENKOP
40 KLIPBERG
41 PORSELEINBERG S. HILLS
42 PORSELEINBERG
43 KASTEELBERG FOOTHILLS
44 LA FONTEINE FLATS
45 KLIPFONTEIN
46 EILANDSKLOOF
47 VOELVLEI FLATS
48 SARON
49 VIER-EN-TWINTIG RIVIERS
50 HEUNINGBERG
51 NEULFONTEIN SE BERG
52 GOUDMYN SE BERG
53 KORINGBERG
54 PIKETBERG E. SLOPES
55 GROENVALLEI FLATS
KEY
= PRESENT WEST COAST RENOSTERVELD DISTRIBUTION (AS MAPPED BY AUTHOR)
= PREVIOUS RENOSTERVELD DISTRIBUTION DISPLACED BY AGRICULTURAL DEVELOPMENT
(RENOSTERVELD DISTRIBUTION CORRESPONDS BROADLY WITH THE DISTRIBUTION OF SHALES AND GRANITES IN THE WEST COAST LOWLANDS. MAP ADAPTED FROM TANSLEY, 1982; VISSER, 1984.)
Kilometres 10 0 10 20 30 Kilometres

1.0 INTRODUCTION

Agriculture is closely linked to degradation and removal of natural ecosystems on a global scale. Its impacts may be minor, such as low intensity pasturage or major, such as agronomy. Agronomy normally causes irreversible change or destruction of natural ecosystems (Harris, 1978). An analysis of the operation of such threat factors could prove to be at least as relevant to preserving natural diversity as the analysis of the biology of natural ecosystems per se. Thus one side of the coin is to understand 'what you are trying to preserve'; the other side is to understand 'what is threatening what you are trying to preserve'. An example of the former is the study of natural ecosystems, whereas the behaviour of farmers is an example of the latter (McDowell, 1988a; McDowell and Sparks, 1988). The present papers main aim is to analyse agronomic development pressure (= 'socio-economic threats') on Coastal Renosterveld; a now scarce natural resource in the south-western Cape lowlands.

Coastal Renosterveld is a vegetation type which occurs within the Fynbos Biome of the southern and south-western Cape Province. For its size this biome probably has the richest flora worldwide (Gibbs Russell, 1985). Unlike the related adjacent fynbos 'heathland' vegetation which grows on oligotrophic soils, renosterveld is confined to moderately rich granite- and shale-derived substrates (Boucher and Moll, 1981). Coastal Renosterveld normally comprises a 1-2 metre high matrix of small-leafed evergreen shrubs and is particularly well endowed with Asteraceae. One of the latter is the characteristic dominant grey-green 'Renosterbos' Elytropappus rhinocerotis (basis of the term 'renosterveld'). Geophytes of the families Iridaceae (iris family), Liliaceae sensu lato (lily family) and Oxalidaceae (oxalis family) are well represented. Poaceae (grasses) also form an important component where the grazing is not intense (McDowell, 1988, for 'effects of grazing'). Ericaceae (heaths), invariably present in typical fynbos flora, are lacking in renosterveld. Restionaceae (restios) and Proteaceae (protea family) that characterise many fynbos communities are also less prevalent (Boucher and Moll, 1981; Boucher, 1983). The richer substrate on which renosterveld occurs makes it more prone to clearance for agriculture than fynbos (Stindt and Joubert, 1979; Cowling et al., 1986; Jarman, 1986). The reduction of this vegetation ranks with the most drastic globally, being comparable to the widespread replacement of natural vegetation by planted crops (largely grains) in the prairies of North America (Webster, 1979); steppes of Russia (Milkov, 1974) and the Mallee scrub of Western Australia (Turner, 1966). In the latter only minute percentages of the original floras remain.

The paper provides results on: first, the extent of the decline of West Coast Renosterveld; secondly, the consequences for associated scarce biota; and thirdly, a methodology for the prediction of agricultural threats to surviving 'island' renosterveld remnants.

2.0 THE DECLINE OF WEST COAST RENOSTERVELD

Coastal Renosterveld, unlike the inland, xeric Mountain Renosterveld, which is largely confined to mountain belts, was originally distributed over much of the lowlands within the Fynbos Biome. Recent estimates by Moll and Bossi (1984) who used Landsat imagery, indicate that only 15% of Coastal Renosterveld remains. This makes it by far the most reduced of the Fynbos Biome veld types (see "4.1.2 Conclusions from Pedology"). Coastal Renosterveld has three forms, namely West Coast, South West Coast, and South Coast Forms, each with slightly differing ecological, floristic and edaphic characteristics (Moll et al., 1984).

West Coast Renosterveld previously covered soils derived from Malmesbury Shales and Cape Granites of the Fynbos Biome forelands north of Cape Town. Boucher (1983) indicates that less than 6% of the former extent of West Coast Renosterveld still remains viz ca 295 km^2 out of ca 5,122 km^2. A revised assessment of 55 remnant renosterveld sites by the author (Figure 1) reveals a figure of 224 km still remaining. Finer points on renosterveld distribution and occurrence were collated from Tansley (1982); Jarman (1984) (unpublished Appendices); Moll and Bossi (1984) as well as from inspection in situ using as aids maps, air-photos, and consultation with academics, farmers and extension agents. If one takes Hall and Veldhuis's (1985) estimate for the former area of West Coast Renosterveld, namely 7,280 square kilometres (derived from data on p. 149) as a baseline, the proportion of West Coast Renosterveld remaining is slightly over 3%. Its 'Cinderella status', makes West Coast Renosterveld an extreme test case for investigating agricultural influences on natural vegetation. General information on the previous exploitation of West Coast Renosterveld has been provided by Talbot (1947, 1971); Parker (1981); Boucher (1981, 1983) and Jarman (1984). Given the poor conservation status of West Coast Renosterveld generally, the present study concentrates on analysing characteristics of, and threats to the 55 'island' remnants. Has agricultural "development" finally run its full course, with these remnants representing unexploitable tail-endings, or, alternatively, are these next in line for the plough? Several issues are raised by these questions.

3.0 RARE AND THREATENED RENOSTERVELD BIOTA

It is useful to define Coastal Renosterveld within the context of rare and threatened biota. Hall and Veldhuis (1985) surveyed flora that merited IUCN rarity status ('Red Data' species) from the biogeographic zones of the Western Coastal Lowland Region (Table 1). They presumably dealt with the Cape Peninsula Mountains and Peninsula Lowlands separately because they are the only zones that are not

TABLE 1

RED DATA SPECIES IN THE WESTERN COASTAL REGION

1	2	3	4	5
Biogeographic Category [1]	Red Data Plant Spp. [2]	Original Area in Sq. Kms. [3]	Remaining Area in Sq. Kms.	Red Data spp. per Area Remaining
Cape Peninsula Mountains	127	300	270 [4]	0.42
Cape Peninsula Lowlands	74	160	16 [4]	4.63
Coastal Strandveld	119	3000	1922 [5]	0.06
Sand Plain Fynbos	166	2790	1262 [5]	0.13
Sand Plain Fynbos with W.C. Strandveld Elements	6	1110		
W.C. Renosterveld	230	7280	224 [6]	1.03
Mountain Fynbos	20	60	60 [4]	0.33

[1] Zones defined by Hall and Veldhuis (1985) P.148.

[2] Red Data plant species listed for zones by Hall and Veldhuis (1985) (a species is re-listed if it re-occurs in another sub-zone)

[3] Hall and Veldhuis (1985) p. 149

[4] Hall, A.V. (pers. comm.)

[5] Jarman (1986) p. 9

[6] Authors re-evaluation (is between Jarman's estimate of 136 sq. kms. and Boucher's estimate of 295 sq. kms. remaining.)

vegetation categories per se. Concentrations of Red Data plant species were calculated per area of remaining natural vegetation (Jarman, 1986; Hall, pers. comm.) within Hall and Veldhuis's 'biogeographic zones'(Table 1, Column 5). In the Cape Peninsula lowlands (a zone with *both* Coastal Renosterveld and Sand Plain Fynbos), the concentration of Red Data species is greatest in the remaining habitat because their ranges have been so reduced by intensive urban development (cf. Hall and Ashton, 1983).

Apart from the latter exceptional instance, Table 1 shows that West Coast Renosterveld has the highest recorded concentration of threatened plants, namely an average of about one species per square kilometre of remaining vegetation (as based on the author's estimate). The preliminary nature of the lists in Hall and Veldhuis warrants some caution. Being derived from quarter degree grid square locality records, without specific concern for exactness of habitat, certain species are listed erroneously as being restricted to 'renosterveld'. (The same caution also applies to the other listed vegetation types.) Nevertheless, the latter criticism does not obscure the overall pattern of differential concentration of threatened plants within vegetation-types. On a macro-scale the likelihood clearly exists that the high concentration of rare and threatened plants in West Coast Renosterveld is a consequence of extensive agricultural clearance (cf. Hall, 1987; Tansley, 1988). This situation has an analogue in the wheat belt of Western Australia, where high concentrations of endemic plant spp. were recorded within remnant 'islands' of Mallee scrub (Hopper, 1986). Historical records of flora distribution in the Fynbos Biome lowlands are too scanty to determine which 'Red Data' species achieved their status directly through habitat reduction by agriculture (sensu Tansley, 1988). Circumstantial evidence indicates that agricultural clearance has been a primary factor in the demise of many better known Red Data taxa (listed in Hall and Veldhuis, 1985). Moraea, a geophytic genus of the Iridaceae, has been comprehensively documented by Goldblatt (1986). He defines an area corresponding to the western Fynbos Biome as constituting a core of diversity and endemism for this Southern African genus. The species M. amissa, M. aristata, M. gigandra, M. neopavonia and M. tulbaghensis are confined to the clay-loam soils (shale/granite derived) typical of the distribution of West Coast Renosterveld. Goldblatt specifies ploughing as being the factor responsible for their decimation. A further six species of endemics of a similar status are cited in other renosterveld zones. Of these, M. incurva known only from the intensively cultivated Tulbagh valley, is now extinct. Other geophytic genera of the West Coast Renosterveld, with species brought near extinction in the same way as Moraea, include (especially) Oxalis (M.B. Bayer pers. comm.), as well as Gladiolus (Delpierre and Du Plessis, 1974).

A good example of a shrub, also apparently decimated by agriculture, is Protea odorata rarest member of the Protea genus and one of few (exact number unknown) endemic renosterveld Proteaceae. At present it has a disjunct distribution within the west coast wheatbelt. McDowell (1986c) presents evidence indicating continuity of distribution prior to agricultural clearance as well as further diminution of range in very recent times.

Of the fauna, one of the world's most endangered tortoises, the Cape Geometric Tortoise (Psammobates geometricus) is entirely confined to flat lowlying (= low gradient) renosterveld - mostly of the West Coast Form (Rau, 1971; Greig and de Villiers, 1982).

Most of the Red Data plant species listed for renosterveld by Hall and Veldhuis (1985), including the plant species and the tortoise mentioned above, are restricted to low gradient zones either within or directly adjacent to remnant renosterveld. The pertinence of this observation becomes clear under "4.2 Gradient Distributions in the Renosterveld Remnants", where the probability of renosterveld on the flats being cleared for agriculture is compared to that on steeper gradients.

4.0 PREDICTING THE AGRICULTURAL THREAT FACTORS FOR WEST COAST RENOSTERVELD REMNANTS

The present conservation status of publicly owned Renosterveld is abysmally low (Edwards, 1974; Jarman, 1986). Up to 80% of remnant renosterveld is privately owned by farmers (McDowell, 1986 a,b). This highlights the importance of farmers' attitudes and behaviour towards this now scarce natural resource. The consequences range from the wholesale clearance of vegetation for new lands through to careful preservation of natural ecosystems in private nature reserves (reasons and background factors are given in McDowell, 1986b; McDowell and Sparks, 1988 - see also Table 6). A parallel situation exists in the analogous wheatbelt of Western Australia (Goss, 1986).

Part of the analysis of farmers' attitudes and behaviour towards renosterveld conservation (McDowell, 1988a) involved presenting a sample of 36 randomly selected landowners with a set of 11 'cards', each bearing alternative utility options relating to the renosterveld on their properties. Subjects were requested to sequence the cards in descending order corresponding to the utility value they set upon renosterveld (Table 2). "Pasturage" was placed at number one - not surprisingly as this is almost invariably practised on remnants (McDowell, 1988b for effects on flora). Compared with other impacts, limited pasturage has relatively minor impact on coastal renosterveld (Cowling et al., 1986). By contrast, "Future Commercial Agricultural

TABLE 2

THE MEAN PRIORITY ORDER OF VALUES SET BY A RANDOM SAMPLE OF LANDOWNERS ON RENOSTERVELD REMNANTS OF THEIR PROPERTIES

1. "Pasturage" [1]
2. "Future commercial agricultural expansion" [1]
3. "Wild flowers - aesthetic value" [2]
4. "Nature conservation as a whole" [2]
5. "Family recreation value" [2]
6. "Wild animals - aesthetic value" [2]
7. "Wild flowers - commercial value" [1]
8. "Future mineral exploitation" [1]
9. "Wild animal commercial value" [1]
10. "Firewood source" [1]
11. "Future peri-urban expansion" [1]

[1] 'Commercial option' [2] 'Aesthetic option'

The nature of the options were not communicated to the subjects.

Overall the subjects liked to give the impression to the interviewer that they dis-regarded the commercial options. However, Numbers 1, 2 had undeniable importance so, unlike the other commercial options, were given foremost priority.

Expansion" at number two slot is cause for greater concern. Disturbance of soil by tilling, addition of fertilizers, chemical insecticides and herbicides will obviously take a great toll on natural diversity. For example, a previously ploughed field directly adjacent to species-rich renosterveld within the ca 20 ha Kalabaskraal Nature Reserve, (near Malmesbury, Cape) has, after being fallow and ungrazed for over 15 years, been re-colonized by just under one dozen indigenous spp. Although further investigation is required, these appear to represent a very small proportion of the several hundred species within the reserve area directly adjacent. Without a source of propagules nearby colonisation would have been even worse. More systematic work is still, however, required to measure the recovery potential of fallow renosterveld lands, including fauna, and to compare this with other vegetation types. Farmers in the interview were asked which agro-physical factors were considered when developing new lands (Option 2) in renosterveld. In each case unsatisfactory "soil quality", "landscape gradient" and "annual rainfall" were indicated - in no specific sequence of importance - as being the primary physical constraints.

It was decided that if realistic measurement could be achieved for each of the latter factors, then indices of "agricultural threat" to individual sites could be derived. The working assumption is that other factors are equal. The principle applied in assessing "agricultural threat" is closely related to that of assigning "land capability" ratings to different categories of farmland. (See Scotney, 1971, for a review of land capability assessment in South Africa, which takes into account virtually the same factors.)

4.1 Pedology of the Remnants

4.1.1 Deriving Soil Quality Indices

Two reasons exist for assessing the edaphic composition of vulnerable ecosystem remnants. Firstly, it is well-known that within the Fynbos Biome, veld-type is broadly linked to geology (Boucher and Moll, 1981; Moll and Bossi, 1984; Moll *et al*., 1984). On the "micro-level" recent findings by Thwaites and Cowling (1988) have demonstrated that soil types are associated with distinctive floral communities at a far finer level than "veld-types". Findings by Ellis (1973) and Mitchell *et al*. (1984); substantiate this conclusion. It is generally agreed that the finer categories of soil namely, 'series' and if possible 'base' are better predictors of plant community type than 'form'. One drawback of the soil classification of MacVicar *et al*. (1977) is that soils belonging to the same 'form' may occasionally have completely unrelated parent materials.

Secondly, varied soil fertility, texture and depth etc imply that a wide range of agricultural utility exists for the different soils of the Cape west coast lowlands (McDowell and Schloms, *in prep*.). It is postulated *a posteriori* that,

TABLE 3

SOIL DISTRIBUTION AND QUALITY RATING FOR THE CAPE WEST COAST LOWLANDS

(Based on pooled ratings of pedologists)

1	2	3	4	5
Soil Unit Symbols (in order of descending agricultural potential)	Average Agricultural Potential Rating 1-100 (figures rounded off)	Percentage Represented in Remaining West Coast Renosterveld	Description of Soil Unit	Predominant Vegetation Type (mixtures are normally ecotonal)
A*	93	7.95	Red and yellow well drained apedal soils eg Hutton, Avalon, Bainsvlei	West Coast Renosterveld
B	84	0.76	Dry to moderately drained non-saline alluvial soils eg Oakleaf, Dundee	West Coast Renosterveld and some Sand Plain Fynbos
C*	65	8.04	Moderately deep residual soils eg Glenrosa, Swartland, Sterkspruit	West Coast Renosterveld
D*	53	16.70	Dry duplex soils eg Shortland, Red Swartland, Valsrivier	West Coast Renosterveld
E*	39	14.40	Hydromorphic duplex soils eg Estcourt, Kroonstad, Sterkspruit	West Coast Renosterveld
F	38	(0.03)	Wet non-saline alluvial soils eg Westleigh, Longlands	West Coast Renosterveld
G*	35	24.20	Shallow residual soils eg Mispah, Glenrosa, Swartland	West Coast Renosterveld
H	34	(0.80)	Sandy acid soils eg Constantia, Lamotte, Fernwood	Sand Plain Fynbos
I	21	(3.05)	Saline alluvial saline soils	Coastal Strandveld
J	20	(0.69)	Talus material with undifferentiated rock	Mountain Fynbos
K	15	(0.00)	Sandy calcareous soils and limestones eg Vilafontes, Loskop, Kalkbank	Coastal Strandveld
L	12	11.78	Shallow soils on rock eg Mispah, Houhoek	West Coast Renosterveld and Mountain Fynbos
M	2	11.78	Rocky outcrops	West Coast Renosterveld and Mountain Fynbos

* Predominantly renosterveld

even within the existing West Coast Renosterveld areas, certain plant communities may have been reduced selectively by agricultural development. This may be a part cause of the observed high concentrations of rare and threatened species in low gradient zones with their distinctive soils.

Distribution of soil-types, as defined by MacVicar et al. (1977) were obtained for all 55 West Coast Renosterveld sites from the Agricultural Research Unit at Elsenburg. The sources included unrefined data used for both Elsenburg's Agricultural reports on the west coast lowlands (Anon., 1985(a,b) and Schloms et al., (1983). These raw data were converted by Lawton (1985) into 13 working soil units (Table 3, Column 4). Generalized agricultural value ratings were derived for each unit by pooling independent scores given by six pedologists who specialised in Cape soils (McDowell and Schloms 1988 In prep.). Outlines of the working categories were traced onto overlays for the 55 sites and their respective surface areas were digitized. Respective soil quality indices for each renosterveld site were calculated using the formula:

$$SQI = \frac{(Asu.\ SQsu)}{Ar}$$

Where:	SQI	=	Soil Quality Index for renosterveld site
	Asu	=	Area of each soil unit demarcated
	SQsu	=	Generalized soil quality rating for the respective unit (from Column 2 of Table 3)
	Ar	=	Total area of renosterveld site

The indices for the sites are presented in Table 6.

4.1.2 Conclusions from Pedology

The 13 soil units defined in Table 3 represent a modified categorization of the 10 units defined by Schloms et al. (1983). (See McDowell and Schloms, 1988 in prep.) Columns 1, 2, and 5 clearly indicate that "pure" West Coast Renosterveld occurs on soils having the highest rated agricultural potential. Proportions of renosterveld remaining under Soil Units A, B, C, are considerably less than for Soil Units D, E, G, probably owing to differences in the rated agricultural potential. Also of interest is that over 20% of the demarcated area of remnant West Coast Renosterveld (Soil Units L and M) exists on soils of lowest agricultural potential, ie shallow soils on rock or within rocky outcrops. The apparent bimodal character of agricultural potential for renosterveld which occurs either on high potential soils (Units A to G - Table 3) or on low potential soils (Units L and M - Table 3) leads one to believe that, other factors assumed equal, renosterveld on L and M type soils is likely to suffer less immediate threat from agriculture than other local vegetation-types (Sand Plain Fynbos, Coastal Strandveld, and Mountain Fynbos - Table 3).

If one excludes Soil Units B, I, F and J; which are exceptional in having very low total surface area (ploughed or unploughed) in the west coast lowlands, the overall ranking in Table 3 for assessed agricultural potential (Column 2) of the vegetation-types (Column 5) approximates their rates of clearance for (largely) agricultural purposes to date. For the Fynbos Biome area as a whole, the 'highest' to 'lowest' sequence of removal of the major veld-types for agriculture is as follows: 1) Coastal Renosterveld - ca 85% gone; 2) Sand Plain Fynbos (Coastal Macchia) - ca 47% gone; 3) Strandveld - ca 24% gone and Winter Rainfall Mountain Fynbos (Macchia) - ca 11% gone (Moll and Bossi, 1984, with their synonyms in parentheses).

On at least the macro scale soil quality, as rated above, appears to correlate with previous removal of natural vegetation. This factor alone could probably also play a significant role in the prediction of future removal of the renosterveld remnants at the 'micro' level.

4.2 Gradients of the Remnants

4.2.1 Measurement of gradients

Visual examination of West Coast Renosterveld remnants on a relief map indicates that a large proportion exists either on steep hillocks or mountain slopes. Farmers normally avoid ploughing steeper areas because of rockiness and potential water erosion problems.

To derive gradient indices for each of the study remnants, areas with specific contour intervals (defined in Table 4) were demarcated initially on overlays. For this purpose a transparent 'card', marked with the relative interval thresholds on its edge, was used to "traverse" by hand contour pairs at a 1 : 50 000 scale. With care being taken to consider minimum distances between contour pairs (distances between their tangents) the areas were demarcated within specified contour intervals. Decreasing accuracy is expected with escalating gradients because the distances between contours decrease sharply. Total areas demarcated on the overlays were then digitized for the various gradient intervals. Respective gradient indices for each renosterveld site were finally calculated using the formula:

$$GI = \frac{(A.\ 1/MGI)}{(Ar)}$$

TABLE 4

PROPORTION OF TOTAL AREAS WITHIN GRADIENT CATEGORIES

1		2			3*	
Gradient Interval		Percentage of the Total Area under Remnant Renosterveld			Percentage of the Total Control Area under Cultivation	
0%- 5% gradient		26.34	36.91		74.33	89.68
5%-10% gradient	52.10	10.57		98.61	15.35	
10%-20% gradient		15.19			8.93	
20%-40% gradient		37.74	63.08		1.24	10.32
	47.90			1.39		
40% gradient		10.15			0.15	
		100	100		100	100

* This was based upon cultivated lands within 18 control sites of 400 hectares each. This approximates the mean area of the 57 remnant renosterveld sites. The controls were sampled by using random coordinates within the original West Coast Renosterveld distribution zone. On average the samples turned out to be 73% cultivated; the remaining area being taken up by degraded and weed infested lands, built-up areas, watercourses and remnant renosterveld.

where: GI = Gradient Index for renosterveld site

A = Area within each demarcated gradient interval

1/MGI= Inverse of median of gradient interval (eg gradient interval of 5%-10% = 1/7.5)

Ar = Total area of renosterveld site

The inverse term 1/MGI ensures that sites with high average overall steepness are accorded lower index values in proportion to the assumed reduction in their agricultural potential. Originally the 5 gradient intervals indicated in Table 4 were considered as a basis. However, Table 4 also indicates that gradients with steepness of at least 20% (1 in 5) are readily ploughed. Only above 20% does a rapid decrease in ploughed lands occur, although some land is cultivated even on this steep gradient. In view of this observation only 3 intervals for the site gradient indices were used in the above formula viz 0-20% (median = 10); 20-40% (median = 30) and 40%-($\pm$)80% (median = 60).

4.2.2 Conclusions from Gradient Distribution

Table 4 shows that the percentage area of the total remnant West Coast Renosterveld on steep slopes is much larger than the equivalent within the randomly selected control cultivated area. Whereas almost one half (47.9%) of the remnant renosterveld exists on slopes greater than 20%, this figure is only 1.39% for the control randomly selected sites within the overall original renosterveld distribution zone (see left hand brackets of Column 3). As mentioned above, ploughed lands show a rapid decrease in incidence, but do not entirely cease, at slopes above 20% gradient. This is probably because most of the soil series on the latter slopes are more prone to erosion. It appears that steep gradient renosterveld communities have, to date remained comparatively intact and constitute a far larger proportion by area of total renosterveld than ever before. In the future, it is also probable that renosterveld on gradients greater than 20% will also remain more immune from the pressures of agronomy. This is supported by recent legislation which makes the 20% gradient an important threshold above which permits are unlikely to be provided for the cultivation of virgin lands.[1]

Rare and threatened species recorded for renosterveld prevail, however, on the flat zones (see "3.0 Rare and Threatened Renosterveld Biota") probably under at most 10% gradient. Only about one third (36.91% in Table 4) of the remaining West Coast Renosterveld has a gradient of 10% or less. This high threat zone includes renosterveld-Sand Plain Fynbos and renosterveld-Coastal Strandveld ecotones. Such ecotones could include higher than average natural concentrations of endemic biota because of the assumed tendency toward greater rates of speciation on ecotones (Sensu Baker and Stebbins, 1965). On the other hand the studies reviewed earlier indicate that scarcity in many cases is a direct consequence of large-scale ploughing of

[1] South African Government Notice R1048 of 25 May, 1984 Part 1 Section 3(1)a as empowered by the Conservation of Agricultural Resources Act 43 of 83

the flats, ie today's rare species are frequently of relictual status.

The analysis of gradient alone provides some broad pointers towards zones of conservation urgency.

4.3 Distribution of Rainfall

4.3.1 Obtaining Rainfall Indices

In South Africa the amount and predictability of rainfall represents the lifeblood of agriculture (Cowling et al., 1986). Fortunately for farmers, rainfall in the south-western Cape is relatively predictable. Because the proportion of surface area that is irrigated is also very small within the same area, it is the annual rainfall figure which is considered by farmers to be of relevance in determining the crop-mix of farms. Success with the cultivation of "dryland crops" (non-irrigated crops) is, by necessity, linked to precipitation. Dryland crops may include categories of winter cereals, grapevines and, more recently, pastures planted solely for livestock production (Anon., 1985(a,b) and Table 5 for detail at a local level).

Rainfall indices were obtained from isohyets on a 1 : 250 000 scale. Medians between the highest and lowest annual rainfall isohyets were used as indices for the sites crossed by two or more isohyets. If a particular site was crossed

TABLE 5

CROPS CONSIDERED BY FARMERS TO BE WORTH TRIAL WITHIN APPROPRIATE RENOSTERVELD REMNANTS

1. Grain and Pasture : Wheat (1); oats (1); dryland legume pasture - clover, medics and serradella (2).

2. Fruit : Vines (mostly 'dryland') (1); olives (3); pears (4); prickly pears (5).

3. Timber : Pine (2); eucalyptus (2); beefwood (5).

4. Other crops : tobacco (3); rooibos tea (5); buchu (5).

Relative frequencies are indicated in parentheses on scale from 1 (frequent) to 5 (rare).

(After McDowell and Grindley, 1985)

by just one isohyet this isohyet reading was taken as the index.

Patterns of precipitation evident within the study zone included: a) a general south - north decrease in annual rainfall; b) localized increases in rainfall prevailing on slopes of large mountains, and c) localized slight increases in rainfall on hillocks.

No evidence, theoretical or otherwise, was found to link rainfall with biotic diversity and endemism.

5.0 AGRICULTURAL THREAT INDICES FOR THE RENOSTERVELD REMNANTS

Soil quality, gradient and rainfall indices were multiplied with one another to obtain "agricultural threat" indices. The factors were weighted equally because no clear pointers existed that "any one was more important than another" overall. In Table 6, the 55 research sites are placed in sequence from "highest" to "lowest" overall threat index. Inspection of the independently derived column "Known Aspects of Threat Status in 1987" reveals strong empirical support for the calculated threat indices. Approximately the top twenty of the sites including as far as '19 Kuilenberg' clearly have "high threat" status in reality. Just under half of these sites still exist by virtue of conservation oriented private landowners. About a further

TABLE 6

DERIVED AGRICULTURAL THREAT INDICES ("MULTIPLE") COMPARED WITH ACTUAL TRENDS ("KNOWN ASPECTS OF THREAT STATUS IN 1988")

(Sites are sequenced in order from highest to lowest derived agricultural threat indices (= "MULTIPLE")

MAP NO.	SITE	SOIL	GRADIENT	RAINFALL	MULTIPLE [1]	KNOWN ASPECTS OF THREAT STATUS IN 1988 [2]
11	ALTYDGEDACHT FLATS	92.5	0.100	638	5902	Natural vegetation deliberately preserved by family for five generations. Has known high vineyard potential.
44	LA FONTEINE FLATS	91.3	0.100	600	5479	Extensive proportion cleared for new lands just preceding 1982 with remainder likely to be ploughed soon.
29	MALMESBURY COMMONAGE N.E.	92.5	0.100	475	4394	Preserved temporarily as a commonage and for peri-urban expansion which has already been initiated.
38	DARLING COMMONAGE	86.6	0.100	500	4331	Preserved temporarily as a commonage and for future peri-urban expansion.
2	SKAPENBERG	59.2	0.082	850	4103	Almost completely cleared for agriculture since 1982/3.
37	WAYLANDS FLATS	69.4	0.100	550	3817	Deliberately preserved by family for three generations.
3	KAHLENBERG	59.2	0.099	613	3575	Completely cleared for agriculture since 1982.
17	JOOSTENBERG	63.4	0.092	575	3357	Partly preserved by present landowner with remainder on flats possibly threatened by planting of pastures.
48	SARON	51.0	0.099	625	3143	Sustained creation of new lands and peri-urban expansion is causing shrinkage in area.
6	BOTTELLARY HILLS W.	62.5	0.074	663	3050	Part is a company owned private nature reserve with the remainder threatened by vineyard plantings.
46	EILANDSKLOOF	46.5	0.097	637	2875	Largest part is the biggest private nature reserve in the renosterveld. Remainder is 'controlled' defence area.
7	SIMONSBERG W. SLOPES	51.7	0.065	825	2770	Possibly threatened by vineyard expansion and/or pine plantations.
1	HARMONY FLATS	39.2	0.100	700	2742	A large portion is phased for housing with less than one third of the 1982 area now a public nature reserve.
35	OUDEPOST FLATS	48.3	0.100	563	2716	Deliberately preserved by family for about three generations.
47	VOELVLEI FLATS	47.0	0.094	575	2553	Ploughing is disallowed (previously practised in one part) because vegetation surrounds a major water supply.
8	SKURWEBERG W. SLOPES	58.4	0.050	850	2472	Possibly threatened by extension of vineyards or pine plantations.
41	PORSELEINBERG S. HILLS	55.1	0.081	550	2445	Unknown.
18	EENSAAMHEID FLATS	39.2	0.100	550	2154	One third is a provincial nature reserve and remainder could be ploughed at any time.
28	MALMESBURY COMMONAGE S.E.	48.7	0.093	450	2040	At present a "park" with unknown future status.
27	KLEIN DASSENBERG	62.5	0.070	463	2026	Many smallholdings on one side with the remainder of area preserved by private landowner.
19	KUILENBERG	39.3	0.100	500	1963	Private nature reserve with introduced game.

[1] Obtained by multiplying derived "SOIL", "GRADIENT" and "RAINFALL" ratings together

[2] Based on observation of socio-economic development trends for the site since 1983 and are obtained separately and independently from the derived "MULTIPLE" agricultural threat ratings

TABLE 6 (cont.)

24	HELDERFONTEIN	41.6	0.092	513	1957	Small-scale experimental crop plantings likely on one side - remainder is preserved by a private landowner.
39	BAKENKOP	72.8	0.055	450	1785	Considered (possibly erroneously) by landowner to be unsuitable for crops.
26	KALABASKRAAL-GROENERIVIER	38.1	0.100	450	1713	One section is a private nature reserve - the remainder may eventually be ploughed for planted pastures.
22	KLIPHEUWEL RADIOMAST	39.2	0.100	413	1618	Set aside for radio installation.
45	KLIPFONTEIN	34.0	0.100	450	1532	Unknown.
5	BOTTELLARY HILLS E.	52.2	0.042	687	1516	Limited vineyard planting in progress.
43	KASTEELBERG FOOTHILLS	35.3	0.065	650	1494	Vineyard encroachment suspected.
20	PAARLBERG W. SLOPES	34.6	0.047	875	1418	About 40 ha was ploughed on the lowest slope in 1983 which has since eroded. Granite extraction in progress.
14	HOOGEKRAAL	40.7	0.057	550	1275	No immediate threat.
10	TIERBERG	46.4	0.046	563	1188	Long-term peri-urban encroachment (near Cape Town). Small section is a public nature reserve.
4	SIGNAL HILL	61.8	0.023	825	1172	Part of Cape Peninsula Mountain Chain Nature Reserve.
55	GROENVALLEI FLATS	28.1	0.100	400	1122	Preserved by private landowner
23	PERDEBERG FOOTHILLS	41.7	0.036	738	1104	Very limited encroachment by fruit orchards likely. Granite extraction probable in future.
21	KLIPHEUWEL QUARRY	25.3	0.100	413	1044	Unknown.
33	NIEWEPOST FLATS	22.3	0.100	450	1004	Area could be ploughed but is used for low intensity pasturage because of appreciation for wild-flowers.
31	BOBBEJAANBERG	41.9	0.048	450	909	No immediate threat.
9	KLAPMUTSKOP	27.0	0.048	700	902	Limited new lands may already have been cleared with no known threat to the remainder.
12	KANONKOP	37.2	0.041	575	886	Represents "tail endings" of extensive clearance between about 1975 and 1983.
15	BLOUBERG	40.0	0.051	400	816	No immediate threat.
25	MIDDELPOS	45.6	0.034	513	796	Unknown.
36	BOKKOP	35.6	0.038	563	766	No immediate threat.
49	VIER-EN-TWINTIG RIVIERE	19.7	0.100	388	762	Vineyards could be planted if sufficient capital available to clear abundant rocks in soil.
51	NEULFONTEIN SE BERG	40.9	0.052	350	749	No immediate threat.
42	PORSELEINBERG	27.5	0.040	663	728	No immediate threat. (Earlier ploughed lands now lie fallow indefinitely because of erosion.)
16	KOEBERG	35.0	0.046	450	717	No immediate threat.
40	KLIPBERG	25.9	0.055	500	710	No immediate threat.
53	KORINGBERG	38.6	0.042	375	609	No immediate threat.
52	GOUDMYN SE BERG	33.8	0.045	400	604	Unknown.
34	KAPOKBERG	18.8	0.049	563	520	No immediate threat.
50	HEUNINGBERG	17.7	0.059	338	350	No immediate threat.
32	CONTREBERG	16.1	0.039	563	350	Half the area has been taken over by a cement company for future mineral extraction.
30	DASSENBERG	20.1	0.038	450	347	No immediate threat.
54	PIKETBERG E. SLOPES	17.7	0.038	500	336	Possibility of very limited planting of fruit into small valleys but the relevant landowner prefers status quo.
13	MEERENDAL	35.5	0.016	550	311	No immediate threat.

one quarter of the sites are publicly owned. The latter public lands are not necessarily set aside for long-term conservation ends. The remainder not accorded such protection have either succumbed to the plough since the date of original census 1982/83 (one site) or have the same fate pending in the fairly near future (± four sites). By contrast, the 20 sites with the lowest overall threat indices (from '33 Niewepost Flats' down) - being predominantly steep sloped lands, appear to be relatively secure from future agricultural plantings. This does not preclude other human related threats. Examples of such threats noted within the Fynbos Biome include mineral extraction, housing development, overgrazing, invasion by alien vegetation and over-frequent burning (See also Hall and Veldhuis, 1985; Hall, 1987). Although the latter have low incidence at present in the study sites, these may warrant more systematic investigation in future.

The diverse range of crops considered by interviewed farmers to be "feasible" within remnant renosterveld is presented in Table 5.

6.0 GENERAL DISCUSSION

The derived threat indices do not necessarily have any long-term predictive significance. (Long-term prediction of events in general may involve a wide diversity of complicated techniques <u>sensu</u> Mitchell <u>et al</u>., 1977a,b.)

Instead the emphasis is on the present, or at least, the very short-term future. To do otherwise would be to turn a blind eye towards the dynamic status of agro-technology and its interface with virtually unpredictable shifting socio-economic and political milieus.

It is a common belief that a particular piece of land has fixed agricultural potential. Examples include statements to the effect that lands can be either "arable", or can be "used at best for forestry", and various "marginal" lands which are "useful only for occasional pasturage". Conservation planners and agriculturalists who take this static outlook unfortunately overlook the dynamics of 'innovation'. In the agricultural field new ideas are continually being incorporated into farm machinery design, fertilizers and their application, ploughing/erosion prevention, crop breeding techniques as well as improved selection of appropriate crops adapted to harsh environments. The latter input of innovation may not only improve productivity of lands currently under cultivation but may have potential for conversion of further natural habitats into croplands on areas hitherto termed "marginal".

It is often said that ploughing of such marginal lands is ill advised because of increase in potential soil erosion (cf. Jorling, 1978 - United States of America; Hoffman and Everard, 1987 - Eastern Cape, South Africa). Unfortunately the danger of soil erosion does not appear to be an infallible deterrent to agricultural developments taking place on marginal lands in the study area. Nowadays this of often a result of improved means of preventing erosion. One example of effectively reduced erosion is the increased use recently of 'dry-land' leguminous pastures by several of the renosterveld farmers interviewed. This means that many natural habitats on steep lands can be seeded with exotic species which may be "fortified" by fertilizer treatment (Tainton, 1976). It is doubtful whether natural diversity could be retained in the face of both competition with introduced pasture species and altered nutrient regimes. A second example is the current surge in the innovative practice of "strip ploughing" large areas of previously (virtually) undisturbed marginal lands including steep slopes or sandy flats These are being cleared at an alarming rate, with thin strips of natural vegetation being left at intervals to stem water and/or wind erosion (Bohnen, 1986, describes this for the Cape South Coast).

In the west coast lowlands the incentive to transform the remnant veld into planted lands is particularly high because of its very low value as a forage (approximately one large stock unit per 30 hectares Anon., 1985b). (See also Talbot and Talbot, 1968.) Even within the naturally more palatable closely related South Coast Renosterveld (Cowling et al., 1986) stocking rates are four to five times higher on planted pastures (Smith, 1967).

Cowling et al. (1986) put forward management proposals designed to maximise vegetation palatability of South Coast

Renosterveld without detriment to biotic diversity. This involved using an appropriate fire regime to shift the composition of the vegetation from less palatable, shrubby communities towards more palatable, grassy communities. On behalf of Cowling et al., however, Pierce (pers. comm.) states that even such improved management would still not compensate for the difference in grazing value of planted pasture versus renosterveld. This is evidenced by the still continuing replacement of virgin vegetation - including South Coast Renosterveld - with 'artificial' pastures. Thus a fully satisfactory compromise between conservation and economic productivity has not yet been found. Nevertheless, the research along the lines of Cowling et al., aimed toward improving the food productivity of natural ecosystems without excessive degradation of biotic diversity, still represents a useful step towards such a compromise (See also McDowell, 1988).

The breeding of new crops suitable for establishment on hitherto unproductive marginal lands probably poses a long term threat to remnant natural vegetation. For example, according to Pimental (1985), certain wild prairie grasses in the United States are being successfully developed into hardy perennial cereals. Compared with annual crops, perennials have the advantages of requiring less fertilizer and fuel inputs and are associated with vastly reduced soil erosion. Such erosion normally results from frequent soil tilling and exposure of soil when replanting annual crops. Perennial cereals would be appropriate for large scale planting on erosion prone, low fertility marginal lands even with the yields indicated to date on their test runs. The potential obviously still exists to breed perennial cereals with far better yields. It is worth noting that it was the original far-sighted preservation of marginal prairie remnants in the much reduced North American prairies which enabled the genotypes and natural variability of such crops to be available today.

Constant technological innovation, spurred on by the ever increasing material needs of human populations (in South Africa at least), tends to belie the assumption of a static known "fixed production capacity" for any particular category of landscape (cf. "land capability" of Scotney, 1971). Limitless as knowledge itself, one of the results of new uses and improved potentials (effectively "increased land capability" unaccounted for by Scotney) that steadily accrue in the case of rural lands (Sensu global perspectives of Kahn and Bruce-Briggs, 1972; Jorling, 1978; Thomas, 1978) is the long term burgeoning of land prices. Novel usage of hitherto 'low value' natural habitat remnants in and around the study area need not be purely agricultural but may also include use for: munitions storage space, nuclear power generation and disposal, military test zones, building material (eg granite, lime and silica sand) extraction works and housing schemes (observed within the Fynbos Biome generally).

To expect the holistic preservation of a diverse range of natural ecosystems under continual and escalating agricultural pressures is over-optimistic. Certainly this situation is a far cry from the truth at present. On a 'macro' level Edwards' (1974) benchmark assessment of areas remaining and formal conservation status of South Africa's veld-types indicates this clearly. At one end of the spectrum are well preserved low agricultural utility veld-types, such as the tropical lowveld, almost one hundred percent intact with over twenty percent conserved formally. This contrasts with renosterveld (all categories) at the "Cinderella" end of the spectrum of which about fifteen per cent remains with slightly over two-and-a-half percent of this remainder being conserved formally (as derived from Jarman et al., 1986).

On the 'micro' scale, it has been demonstrated that certain habitats within the the most diminished West Coast Form of renosterveld have, and will continue to be more reduced and degraded than others by the selective nature of agricultural exploitation. In the long run the defined inputs of new agro-technical knowledge are among the factors that will ensure continued and sustained pressure on natural/semi natural ecosystem categories normally considered 'secure'. Examples of the latter may include the lowveld or, perhaps less obviously, the hilly renosterveld 'tail-endings'. However urgency of conservation action will apply to areas such as low gradient renosterveld in the much shorter term.

The traditional emphasis in providing conservation priority ratings for sets of natural ecosystems has been on attributes concerning natural biota per se eg "size and shape of site", "habitat diversity", "biotic diversity", "threatened biota", and "habitat disturbance" (cf. Diamond, 1975; Ogle, 1981; Kirkpatrick, 1983; Jarman, 1986; Margules, 1984; Margules and Usher, 1981, 1984; Hall, 1987). However, in addition to the above, which may well be the result of human impact, there are also other external, often vital, threats of a purely socio-economic nature, eg agricultural, urban or industrial factors. Thus in determining conservation action priority ratings for sets of conservation-worthy sites in a particular area an additional prerequisite should be the derivation of 'socio-economic threat indices' for these sites; even if of doubtful accuracy in the long term. Directly influencing the urgency of conservation required in the short term, these may be rated separately and/or integrated with the other indices.

A simplified hypothetical example may serve to illustrate this principle. Assume two different sites have ratings for biotic attributes (eg "size and shape of site".... etc as above), which when pooled, provide equivalent overall conservation priority indices for both sites. Assume also that one site has physiography that is much more conducive to agricultural development (ie it has a higher 'agricultural threat' index) than the other. The chances are that this site would, without protective intervention, be degraded before the second site. Only by measuring the 'threat' index would the greater conservation urgency have been indicated for the first site. Sometimes it may be that agricultural potential is positively related to the incidence of conservation priority biota if this factor is linked to the criteria defining 'conservation priority'. In the case of renosterveld, incidence of Red Data species appears to be at least partially correlated with agricultural potential (See also "7.0 Conclusions"). Alternatively there may be no relationship between 'threat' and biotic attributes. Apart from 'agricultural threat', other socio-economic threats could also be provided indices for series of conservation worthy site-alternatives. Examples of such threats include 'mining', 'peri-urban expansion' and 'negative landowner attitude' factors. These (and others) could be rated, where applicable, with predictive advantage.

7.0 CONCLUSIONS

The evidence suggests that the distribution of Red Data flora in West Coast Renosterveld coincides with lands of low gradient that have a relatively high agricultural potential. This category comprises a small fraction of the already minute 3% of remaining West Coast Renosterveld. Due to past agricultural clearance, the latter has relict populations of biota. These habitats therefore have greater conservation urgency than the larger proportion of the 3%

extant renosterveld which occurs on the steeper lands of lower agricultural potential.

Remedial conservation measures require that urgent attention be focussed on habitats that are immediately threatened by socio-economic factors, such as the still continuing clearance of new lands for agriculture. All too frequently "practical conservation has involved the preservation of land with (virtually) zero value for any other (socio-economic) purpose." Unfortunately conservation-worthy ecosystems, partly by definition, may more often than not occur on land that is in demand for high impact land-use. The agronomic threat to remnant 'flatland' renosterveld is a case in point. It is not at present possible to make the conservation of ecosystems such as renosterveld, so economically profitable as, for example, the subtropical "big game" lowveld areas which have viable returns from visitorship and animal products etc. Instead their preservation is often an effective economic loss to the landowner. It is submitted that this 'loss' is likely to escalate in view of the sustained "three steps forward, two steps backward" (not all succeed) implementation of technical innovations, fuelled by the pressure of increasing needs of human populations. In many cases this will increase utility of marginal land to the detriment of its natural elements. It is therefore vital for finance to be made available by public or private conservation bodies to ensure adequate long term survival especially of "Cinderella" status ecosystems such as renosterveld on public, as well as private lands (See McDowell, 1986b). As in the case of the previously "unprofitable" prairie remnant grasses, which may become the crops of the future, (see "6.0 Discussion"), preservation of analogous ecosystems may eventually yield similar dividends. In either case it is hoped that, in future, aesthetic values will become refined to such an extent that this alone will outstrip the material reward obtained from destructive exploitation.

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PAPER 2

THE EFFECTS OF GRAZING ON RENOSTERVELD AT EENSAAMHEID, SOUTH WESTERN CAPE, SOUTH AFRICA

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ABSTRACT

Coastal Renosterveld, part of the florally rich Fynbos Biome, nowadays exists as remnants within the south-western Cape wheatbelt where it is used as supplementary pasturage. Previous research on the effects of grazing on natural pastures has been contradictory. Prior to this study, no research had been published on the effects of grazing on entire plant species composition of any Fynbos Biome assemblage.

The floral composition of one section of a remnant, heavily grazed by sheep, is compared with a sector alongside from which stock was excluded. Differences in 'grazed' and 'ungrazed' projective cover is assessed for 65 species of 42 families. Grazing pressure resulted in:- a) largest net increase in the eighteen Asteraceae (especially the renosterbos _Elytropappus rhinocerotis_); b) largest proportional net increase in the Iridaceae (especially _Bobartia filiformis_); c) a general decrease in the seventeen Poaceae (notably _Themeda triandra_) and three Rutaceae; d) the complete eradication of the three Proteaceae (notably the endangered _Leucadendron verticillatum_).

Responses of six Red Data species to grazing varied considerably with:- a) two Proteaceae being eradicated; b) two Restionaceae tending towards decrease and: c) two Iridaceae being unaffected (possibly enhanced).

The results support the hypothesis of Cowling _et al_. that the relative dominance of Poaceae in renosterveld gives way to Asteraceae through modern grazing regimes and suggest that Proteaceae and Rutaceae may also once have been significant elements in parts of renosterveld. The latter authors' proposed burning regime to reinstate Poaceae would, according to present findings, exterminate reseeder Proteaceae within renostervel remnants. Related species of the same family have similar responses to the very complex direct and (little known) indirect effects of grazing possibly because of autecological and biochemical similarity.

KEYWORDS

Diet selection, Grazing, Renosterveld, Palatability, Conservation, Threatened Species.

rhinocerotis, generic origin of the term "renosterveld" (Boucher, 1980).

A survey of the latter 4.37 % of West Coast Renosterveld, which survives as scattered "islands" in a "sea" of cultivated lands, indicates that these remnants are almost always used for pasturage (McDowell, 1988). This also applies to publicly owned lands such as commonages which are often leased to private graziers.

Sheep and less frequently cattle are grazed on renosterveld. The former include mostly Dorpers and Dormers (hardy meat producers) as well as Merinos (wool producers). Anon. (1985) states that one large stock unit per 30 hectares is the sustainable carrying capacity for West Coast Renosterveld under continuous grazing. However, because Coastal Renosterveld exists among grainlands it is normally used as a "stop-gap" feed, for example, when winter cereal stubble is not available (Louw, 1969). This would coincide with the productive late winter-early spring growth period of renosterveld (Talbot and Talbot, 1968). Such remnants may be grazed heavily for between three weeks and nine months per annum depending on locality and productivity etc. The closely related Cape South Coast Renosterveld (McDowell, 1988, for definition of different Renosterveld Forms) is also considered to be "overgrazed" (Smith, 1967; Joubert and Stindt, 1979).

1.0 INTRODUCTION

Coastal Renosterveld is a vegetation (= veld type) of the shale- and granite-derived soils of the south-western Cape lowlands. The climate is mediterranean with winter precipitation over most of its range (Boucher and Moll, 1981). Ecologically Coastal Renosterveld is a 1-2 metre high matrix of cupressoid and leptophyllous and/or orthophyllous, divaricately branched shrubs, in particular Asteraceae such as *Athanasia trifurcata*, *Elytropappus rhinocerotis*, *Eriocephalus africanus*, *Felicia filifolia*, *Metalasia muricata* and *Stoebe spiralis*. Geophytes of the families Iridaceae, Liliaceae *sensu lato* and Oxalidaceae are important components. Poaceae, including perennial grasses such as *Cymbopogon* and *Pentaschistus* species as well as *Themeda triandra*, may be well represented. Alien infestations are normally confined to annual European grasses and herbs in disturbed situations (Boucher, 1983).

Unlike the closely related fynbos ('heathland') flora which exist directly adjacent to renosterveld on oligotrophic acid sands, renosterveld normally lacks Ericaceae. Restionaceae and Proteaceae, characteristic of many fynbos communities, are also less well represented in renosterveld. Unlike fynbos which has no obvious single species dominance (Taylor, 1978) renosterveld is generally characterised by the greyish cupressoid renosterbos *Elytropappus*

Prevailing grazing regimes are likely to have a greater long term impact on flora than either the now exterminated migratory herds of wild ungulates (cf. Cowling et al, 1986) or the early nomadic Khoi pasturalists (cf. Talbot and Talbot, 1968) who were unlikely to have subjected renosterveld to sustained grazing pressure. This is particularly true, considering renosterveld's comparatively recent transformation into 'island' remnants.

What is, or has been, the effect of post-colonial grazing regimes on the flora? Based on visual observation of South Coast Renosterveld, Stindt and Joubert (1979) maintain that intensive grazing, following burns, leads to the development of stands of unpalatable *Elytropappus rhinocerotis*. In contrast these researchers observed that similar areas, if protected from livestock, supported swards of palatable perennial grasses such as the well known rooigras *Themeda triandra*. This pattern is supported by Cowling et al. (1986) who suggest that the typically *Elytropappus* dominated South Coast Renosterveld might represent a dis-climax derived from a *Themeda* dominated grassland.

Beyond work carried out on a few dominant taxa or growth-forms, no published work describes in detail the effects of livestock on the complex and diverse floral composition of renosterveld and/or the closely related fynbos. In theory extinctions are also more likely to occur on renosterveld 'islands' today than at the time when the vegetation was continuous. Likelihood of extinctions occurring broadly corresponds to size, shape and distance apart of the islands as well as the attributes of the taxa so implicated (Sensu MacArthur and Wilson, 1967). Taxa also inevitably become more prone to extinction through perturbations such as, it is suggested, over-intensive grazing. Owing to its far greater overall value as a range resource, the neighbouring Karoo [1] (Louw, 1969) has been subjected to rigorous pastural research compared with the vegetation of the Fynbos Biome (which includes renosterveld). An Agricultural Research Institute devoted to Karoo study is based at Grootfontein College, Middelburg, Eastern Cape (cf. Donaldson, 1986).

Important reasons for assessing the effects of livestock grazing on renosterveld remnants include: a) to get more clues as to the likely pre-colonial composition of renosterveld and; b) to assess the effects of modern pasturage on not only species composition and dominance generally, but also the relatively high concentrations of Red Data ('rare and threatened' cf. Hall and Veldhuis, 1985) plant species occurring in the "island refuges" (McDowell, 1988, for patterns of threatened plant distribution in the Cape west coast lowlands.)

This paper provides a descriptive and semi-quantitative assessment of the effects of grazing on taxa occurring in a

[1] A semi-desert zone juxtaposed on the Fynbos Biome which covers the largest proportion of the Cape Province.

species rich remnant of West Coast Renosterveld which has at the same time a high concentration of threatened endemics.

2.0 PRECEDENT STUDIES ON THE 'EFFECTS OF GRAZING'

Attempts to predict the critical influences of livestock on rangeland composition have been as abundant as they have been controversial. It is necessary to review briefly aspects of earlier research in order to contextualize the present findings.

2.1 Effects of 'Diet Selection'

The mainstream of local research normally attempts to link diet selection with varied prevalence of 'palatable' and/or 'unpalatable' components prevailing in natural pastures. Henrici (1935), Tidmarsh (1951), and more recently Blom (1980) have attempted to classify several hundred Karoo species in terms of their relative palatability. They used parameters such as 'general preference', 'chemical composition' and 'morphology'. Roux (1967), (1968a,b),(1983); Roux and Skinner (1970) perceive species composition and dominance within Karoo areas grazed by livestock as being linked to the progressive reduction of 'palatable' species as defined by Blom. These researchers advocate the Group Camp Grazing approach, (GCG) a livestock rotation scheme which allows relatively long rest periods for return and recovery of the palatable components. The latter are seen to be selectively reduced through the season of grazing. Also implicit within the GCG approach are relatively low stocking rates together with pasturage at different seasons every year.

If GCG principles are consistently valid one would expect diet selection to correlate significantly with the change in community structure and composition. Acocks's seminal (1966) article advocated the Non Selective Grazing (NSG) philosophy for (at least) Karoo vegetation. He suggested that very high stocking rates maintained for much shorter periods than for the more traditional GCR would, within a very short time, actually force livestock to consume the 'unpalatables'. Both 'palatable' and 'unpalatable' components would be reduced to thresholds from which recovery would be possible without domination by the 'unpalatable' components. Thus in contrast to the GCG scenario, change in vegetation composition exposed to intensive grazing under NSG management would not be a consequence of differential diet selection - except perhaps during the very short interval following the onset of the intensive grazing phase.

Another strategy, the Short Duration Grazing system (SDG) advocated by Savory (1971); Savory and Parsons (1980) is based on the belief that the "pruning effect" of a judiciously applied very frequent short duration grazing regime will actually enhance fitness and survival of the grazed 'palatables' (sensu Paige and Whitham, 1987).

Ultimately in the SDG scenario, unpalatables will decrease relative to 'palatables' owing to, firstly, lack of beneficial pruning and secondly, enhanced competitive vigour of the fitter, 'pruned' 'palatables' (sensu Brockett, 1983).

The views expressed by various schools (above) on the effects of diet selection by grazers vary considerably, therefore, from depression to enhancement of 'palatables' (and vice versa, for 'unpalatables'). Given the painful inconsistency in opinion (Hoffman, 1988) it appears unrealistic to generalize on the effects of diet selection. To confound the issue yet further, factors other than diet selection associated with livestock presence may also have indirect, yet profound, effects on vegetation composition (See below).

2.2 Effects of Trampling

As an expansion of the SDG school doctrine, Savory and Parsons (1980) assert that increased trampling will stimulate recruitment of seedlings and improve vegetation cover through causing enhanced "soil hydrologic properties". In contrast, Tainton (1985) and Warren (1987) cite evidence which indicates the opposite effect.

It can only be concluded, from the above (and sundry other conflicting evidence), that trampling does influence vegetation composition, but exactly how and what this influence may be, appears doubtful.

2.3 Effects of Excreta Deposition and Related Nutrient Change

Howell (1976, 1978) maintains that increased deposition of excreta associated with the "herd effect" has predominantly positive effects on Karoo ecosystems. The latter include accelerated nutrient cycling and removal of moribund plant material. On the other hand detrimental effects have also been recorded, for example; De Leeu and Bakker (1986) observed that excessive dung deposition killed heather plants in a mixed grassland in Holland.

Berendse and Aerts (1984), Berendse (1985) who researched a similar ecosystem to De Leeu and Bakker found that long term exclusion of grazing in wet heathland shifted the competitive advantage from the low nutrient adapted *Erica tetralix* to the high nutrient requiring *Molinia caerulea*. This was mainly ascribed to the observed fact that large grazers reduce soil N accumulation (Woodmansee, 1979 for details).

The latter indirect effects appear to vary considerably.

2.4 Effects of Mycorrhizal Fungi

A small body of evidence has emerged linking grazing with the uptake of phosphorous (= P) through influence on mycorrhizal colonisation. Bethlenfalvay and Dakessian

(1984) discovered that when species of a relatively P deficient semi-arid range in the United States, were heavily grazed, mycorrhizal colonisation decreased in some cases by more than 50%. Because mycorrhiza may benefit the plant by effectively increasing the P uptake of plants at fairly low soil P levels the grazing in this instance was related to significantly reduced plant vigour. Lorenz (1970) and Hays et al. (1982), also point out that mycorrhizal fungi may be "parasitic" at high and very low concentrations of available P. This implies the possibility of a positive effect for grazing on plant vigour.

2.5 Rationale

It may be argued that the researchers' conclusions so defined (above) hold true within the specific ecosystems used for their research. A degree of controversy is to be expected as no two 'opposing' researchers cited, worked on exactly the same ecosystem or species (Hoffman, 1988 on lack of consensus between grazing 'schools'). All one can safely deduce is that it is difficult to make generalizations on grazing effects because of the complexity of direct and indirect effects on different vegetation types owing to immense ecological and taxonomic variation. Because no direct precedent study exists on effects of grazing on renosterveld it is more appropriate to start de novo with zero assumptions because the latter could have a completely different response to grazing than, for example, the more intensively studied neighbouring Karoo ecosystems. Most studies on effects of grazing (including those cited) have used the more economically relevant dominant species as research foci. For the present study it was decided to evaluate all species in a diverse renosterveld community irrespective of dominance. Stuart-Hill and Mentis (1982) point out that dominants within a particular community may alternate considerably under differing environmental circumstances - so why initially give dominant species/growth forms more attention than others within a particular community? In the present study all species are assessed equally to start with and discussion concentrates on a), those which show significant responses to the grazing regime in operation and b) Red Data species which are important from the view of improving their conservation management.

3.0 SITE DESCRIPTION AND HISTORY

The research site is a 30 hectare remnant of West Coast Renosterveld surrounded by cultivated lands on the farm Eensaamheid near Paarl ("Agterpaarl" area) at 33` 45'S, 18` 46'E. The veld is low-lying and undulating (under 5% gradient) with a fairly clayey arable duplex soil (Kroonstad Form) derived from shales of the Klipheuwel Beds. The pH ranges from 6.0 (slightly acid) to 7.0 (neutral). It has a relatively regular annual winter rainfall averaging 550mm.

Although it represents an outwardly uniform appearance, the 30 hectares of veld is species-rich, having just under 200 species (author's records: Appendix 2), together with a high concentration of Red Data species (McDowell, 1984). The latter comprise two proteaceous shrubs - Leucadendron verticillatum (Endangered), Serruria pinnata (Vulnerable); two restio reeds - Chondropetalum rectum (Vulnerable), Ischyrolepis duthiae (Vulnerable) and two irid geophytes - Galaxia alata (Endangered) and Gladiolus citrinus (Endangered). Other Red Data species known from the near vicinity, but not recorded by the author, were: Athanasia capitata (Vulnerable), Macrostylis villosa spp. villosa (Indeterminate), Tritoniopsis elongata (Indeterminate) and Protea odorata (Endangered). (Red Data categories of Hall and Veldhuis, 1985, in parentheses.)

Just less than one third of the 30 hectares was proclaimed a Provincial Nature Reserve (= 'Reserve') in 1972 to protect a rather elusive population of the Geometric Tortoise Psammobates geometricus. This renosterveld endemic which until that time was considered extinct due to agricultural pressure on the renosterveld was re-discovered in viable numbers for the first time at Eensaamheid (Rau, 1971; Greig and De Villiers, 1982). The fact that this sensitive species had survived at the study site attests to the low impact land use prevailing prior to 1972. Since proclamation and fencing of the reserve both livestock numbers and lands under cultivation on the farm rapidly escalated until they stabilised around 1977-8 (J. Briers-Louw pers. comm.). The ca 20 hectares unprotected area of renosterveld bordering on the Reserve (= 'Extension') was grazed regularly by Merino sheep, whereas the reserve, being fenced, was not grazed. However small wild herbivores still readily appear to migrate across the reserve fence.

The vegetation of the Extension was bushcut once in 1977 over most of the area to 0.25 metres height. It recovered fairly rapidly (within a couple of years) to its original 1-2 metres height. Farmers believe that bushcutting, frequently practised in remnants, will suppress the 'unpalatable' renosterbos in favour of 'palatable' grasses and forbs. (Acocks "the father of pasture science" in South Africa maintains, however, that even if Elytropappus is selectively chopped out, relictual climax species sheltering beneath them would be destroyed. Elytropappus would then merely regenerate from seed to become an even greater problem.)

The 20 hectare Extension, together with a further ca 20 hectares of directly adjacent cultivated land, make up a single fenced ca 40 hectare camp. Every third year, oats or wheat are planted on the cultivated land. Sheep are then introduced during the post harvest summer months to feed on the stubble and the natural renosterveld pasture. For the subsequent 2 years the cultivated land is fallowed and sheep introduced for a few months during winter and/or spring. This coincides with the peak growth period of both the renosterveld and the largely ruderal volunteer growth ("opslag") on the fallow lands (Talbot and Talbot, 1979). Despite Talbot and Talbot's assertion that volunteer growth may be better forage for sheep than renosterveld, the latter is inevitably subjected to heavy pressure due to the very high stocking rate. A $\pm$ 200 strong sheep flock rapidly consume the 'preferred' volunteer growth before concentrating their attention on the renosterveld area. The effective stocking rate of five sheep/hectare for the grazing period is far higher than the officially recommended carrying capacity of "one fifth" of one sheep/hectare for West Coast Renosterveld. (Derived from Anon., 1985 who recommend 'one large stock unit'/ 30 ha. carrying capacity. One large stock unit, viz an adult cow or bullock, is the equivalent of six small stock units, viz six sheep.) The consequence was the appearance from about 1980 of a yearlong fence-line contrast between the protected Reserve and the grazed Extension. At the time of survey, species composition and cover on the Extension represented an endpoint to many years of both intensive winter-spring and, to a lesser extent, summer grazing.

4.0 SURVEY METHODS

Detailed study was carried out in 1986 during late September/early October (late spring). The Extension area had not been grazed during the previous winter because it happened to be the rotation phase when oats were planted in the adjacent cultivated land. Despite the clear fenceline contrast, defoliation by sheep was not generally evident in the Extension, presumably owing to the recent grazing respite. Because it was late spring the major proportion of the geophytes and therophytes, not noticeable at other times, were included in the survey.

Part of the investigation involved vegetation sampling in pairs of 10 x 10 metre relevės, with individuals of each pair positioned opposite one another on either side of the fence in order to assess the fenceline contrast. Paired relevės were randomly positioned to the extent that overlaps were avoided along 100m of the fenceline. One metre wide strips directly adjoining the fence were omitted from the relevės. This was to exclude very localised 'fence effects' such as disturbance due to intense livestock trampling (Extension side) or "feeding through the fence" (Reserve side) as well as "unnatural" effects of the original fence erection (both sides).

Percentage foliage projective cover was estimated in the relevės with the aid of a ruler for all species growing in, or overhanging, each relevė. Dead material was also included when belonging to annuals or geophytes that had just completed their growth cycles.

Directly adjacent paired relevės sampled over a limited length of fenceline were chosen for comparison in preference to randomly scattered plots over the full Reserve/Extension area. This was because of the likelihood that results would reflect innate vegetation differences occasioned by greater environmental heterogeneity instead of grazing effects per se.

The second part of the survey included descriptive assessment of selected species' occurrence solely within either Reserve or Extension areas, wherever this appeared to result from grazing pressure. The emphasis was on Red Data species and/or species not taken into account by the relevės. (Results are integrated into "6.0 General Discussion".)

5.0 QUANTITATIVE RESULTS

Foliage projective cover (FPC) percentages for species within individual 'ungrazed' Reserve relevės were subtracted from equivalent values obtained for counterpart relevės across the fence in the grazed Extension. Mean values in Appendix 1 represent n = 4 relevė pairs. The 129 species found within the effective 80m squared total sample area represents 65% of the 198 species recorded by the author for the whole 30 hectare site (Appendix 2). The large number of species obtained for each relevė indicates a high alpha diversity for both 'grazed' and 'ungrazed' sides. No significant difference existed between 'grazed' and 'ungrazed' species totals for each relevė. Also, no significant difference in total percentage FPC was recorded although a tendency existed for greater overall cover in the 'grazed' relevès (Appendix 1).

On the other hand the data indicate clear shifts in community composition and relative dominance of species. This is presumed to be a response to the grazing regime. (See "6.0 General Discussion.)

Of the 41 families assessed in the relevès (Appendix 1), five were selected for presentation in Figure 1. These were chosen on the basis of either: a) one or more component species having a significant 'grazed' minus 'ungrazed' value/s, or; b) a net significant 'grazed' minus 'ungrazed' value for the family as a whole. 'Significance' is defined to apply when the mean difference is greater than two standard deviations. Standard deviation is based the on four replicates obtained for the paired 'grazed' minus 'ungrazed' relevè values for species - or net family - percentage FPC measurements. Figure 2 depicts mean FPC values for 'ungrazed' and 'grazed' family totals for the 13 out of 41 families having three or more species represented. (Appendix 1 includes additional detail that, if presented graphically, would confuse the picture.)

FIGURE 1 (A)

EFFECTS OF GRAZING ON PERCENTAGE FOLIAGE PROJECTIVE COVER OF ASTERACEAE AND IRIDACEAE

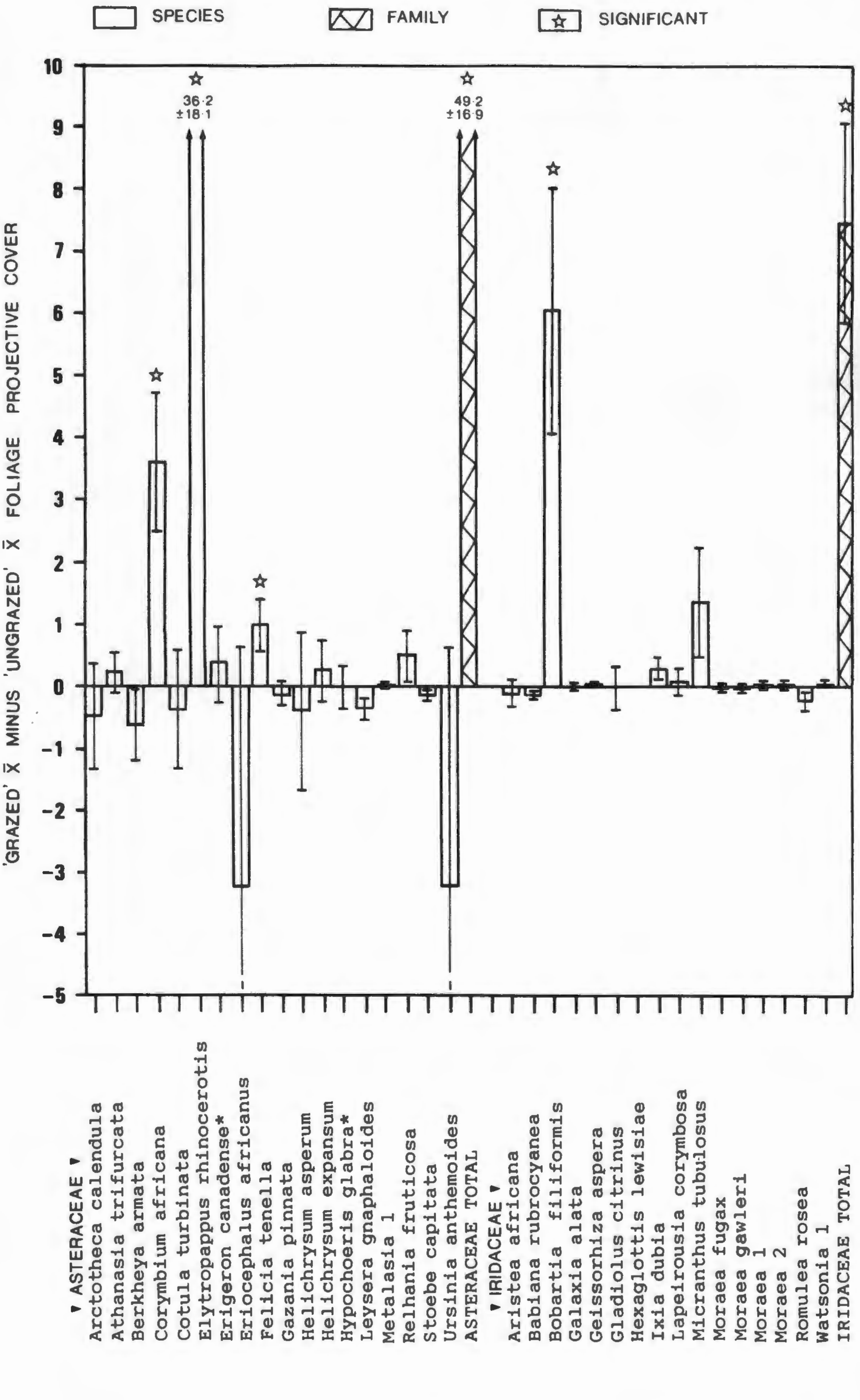


FIGURE 1 (B)

EFFECTS OF GRAZING ON PERCENTAGE FOLIAGE PROJECTIVE COVER OF POACEAE, PROTEACEAE AND RUTACEAE

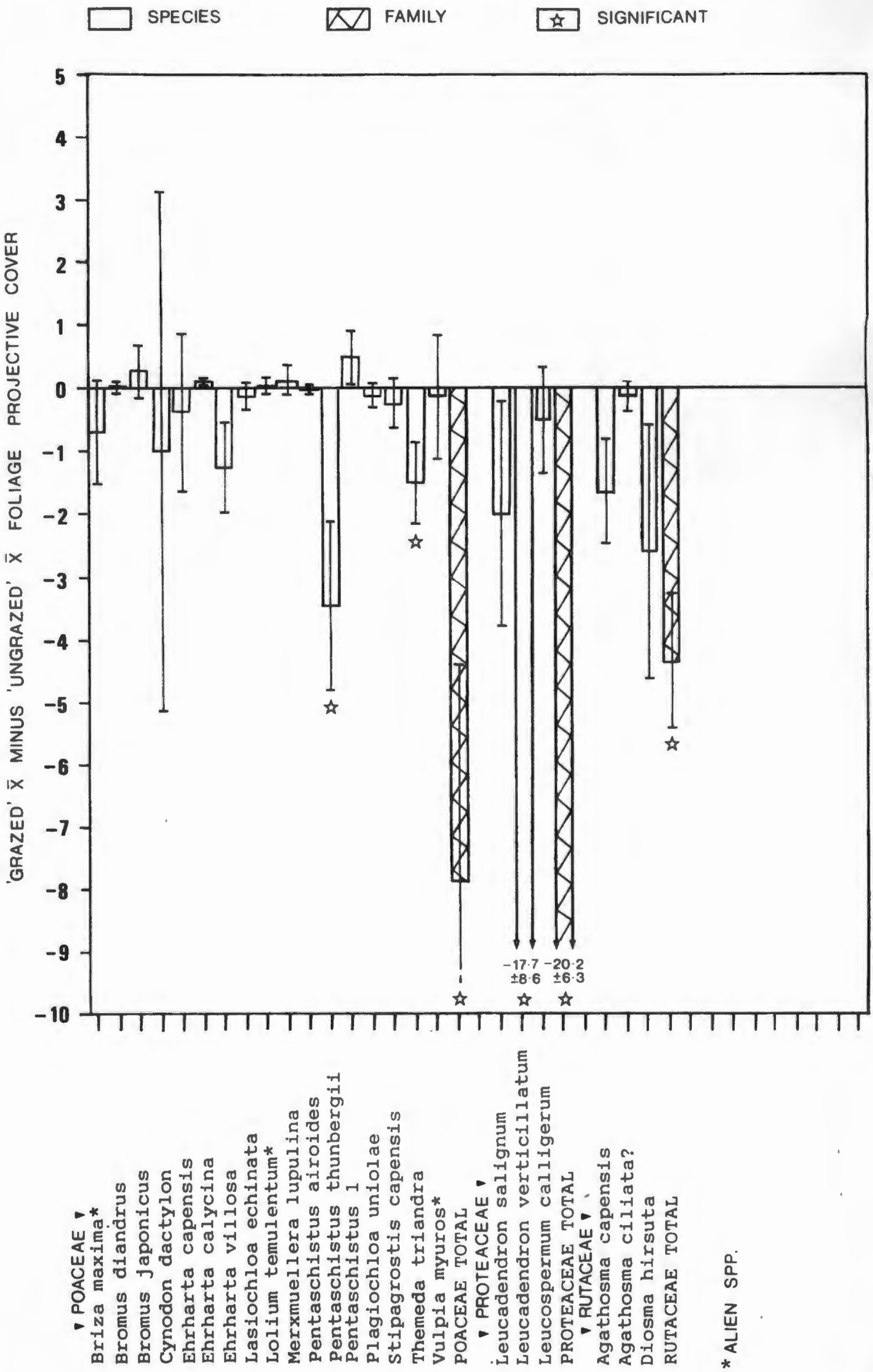
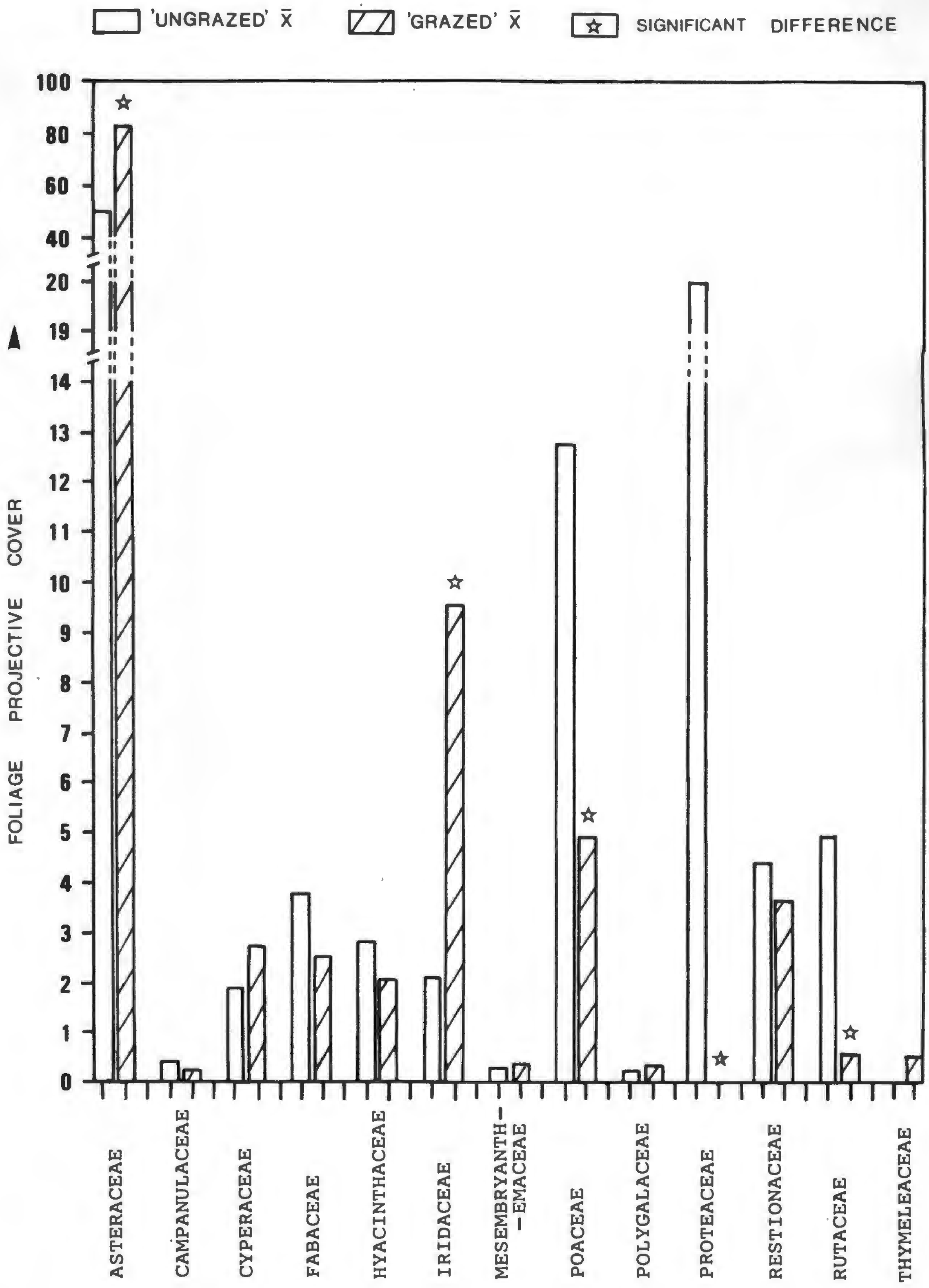


FIGURE 2

'GRAZED' AND 'UNGRAZED' PERCENTAGE FOLIAGE PROJECTIVE COVER OF FAMILIES HAVING THREE OR MORE SPECIES



6.0 DISCUSSION

6.1 Asteraceae

The significant doubling up of cover of the dominant Elytropappus on the grazed side of the fence (Appendix 1, Figure 1(a)) is largely to be expected (Joubert and Stindt, 1979; Cowling et al., 1986), and accounts for the tendency of the Extension relevés to have greater cover. If this was solely due to its unpalatability per se (cf. Acocks, 1966) one would have expected Elytropappus cover to have remained the same on both sides of the fence. Clearly the grazing regime must also have been of benefit to Elytropappus (See "2.0 Precedent Studies on Effects of Grazing").

Cowling et al. (1986), who use as a basis autecological data, suggest that autumn burns, if carried out at least twice in succession with a three year interval, would virtually eliminate Elytropappus. This would however, also eliminate the endangered Leucadendron verticillatum which, like Elytropappus, is a 'reseeder'. A clean burn occurring in a mature renosterveld stand will initially kill plants of both species and would result in subsequent recruitment of seedlings of both species en masse. Poaceae, such as Themeda, being resprouters, would merely regenerate from stolons after burns. A repeat burn in the same community within three years would destroy the immature generations of both Elytropappus and Leucadendron because insufficient time would have elapsed for them to start replenishing their seedstores. More space would, in this event, become available for improved establishment of fire tolerant Poaceae such as the agriculturaly desirable Themeda. Therefore, the assertion of Cowling et al. that management of renosterveld for agriculture, using fire, is compatible with conservation is not always true. Although Themeda would be encouraged the endangered Leucadendron verticillatum and other species with similar life history attributes; notably the other reseeder Proteaceae, would certainly be exterminated.

The improved performance of Corymbium africana under grazing pressure may be facilitated by fibrous leaf bases clustered tightly around the perrenating bud positioned just beneath the soil surface. Corymbium would therefore at least be able to survive within the grazed area. Older leaves of Corymbium that were nibbled probably during the previous grazing season bear testimony to its palatibility as well as resilience.

Apart from the annual Felicia tenella, which showed a net increase with grazing, the remaining 16 Asteraceae showed no significant cover change with grazing. Relhania fruticosa was observed only in small numbers within the Extension up to as far as the fence and was not observed in the Reserve (Appendix 2). This species may be dependent on disturbance such as grazing to establish noticeably.

The Asteraceae in the study site demonstrate on the whole remarkable resilience and/or adaptation to grazing (See significance of Figure 1(a) Asteraceae "Total".) In other areas, notably the Karoo, where this family is particularly well represented, asteraceous species have been accorded a wide range of palatability (cf. Henrici, 1935, 1940; Acocks, 1955; du Preez, 1970; Blom, 1980). But as indicated in "2.0 Precedent Studies on the Effects of Grazing", palatable species are by no means necessarily intolerant of grazing pressure. They could in fact be readily preadapted if grazing by stock in any way emulates the "pulse disturbance" of the original immense migrations of indigenous herds referred to in Cowling _et al_, (1986). This is a hypothesis which unfortunately cannot be tested today (Hoffman, 1988). Palynological studies also show a very recent historical shift in dominance from Poaceae to Asteraceae in the southern Cape Coastal Forelands (A. Scholtz pers. comm. _In_ Cowling _et al_). The current research lends support, albeit on a microscale, to the ascending dominance of the Asteraceae under human related disturbance regimes.

6.2 Iridaceae

The Iridaceae show a very similar trend overall to the Asteraceae, although they are not nearly as dominant in terms of overall FPC. _Bobartia filiformis_ and _Lapeirousia corymbosa_ both show a significant increase in response to grazing pressure. In areas of natural pasture within the

Eastern Cape dominance of Bobartia orientalis is associated with overgrazing (Gledhill, 1969). Compared with all other families represented Iridaceae show the greatest overall percentage increase - from 2 per cent of 'ungrazed' cover to almost 10 per cent of 'grazed' cover (Figure 2). The endangered species Galaxia alata and Gladolius citrinus, although present only in small numbers, were clearly not discouraged by the grazing regime. In fact Galaxia seemed more frequent in the Extension as a whole whereas Gladiolus (only known viable population occurs at Eensaamheid) prevailed in marshy areas irrespective of grazing status.

It appeared that the other geophytic families such as the Hyacinthaceae and Asphodelaceae were not significantly affected by grazing pressure (Figure 2). The resilience to and encouragement of similar geophytes by heavy grazing disturbance as well as overburning is prevalent in other Mediterranean lands when degraded, for example parts of Greece (cf. 'Asphodel deserts' of Arianoutsou-Faraggitaki 1985). Protected underground organs and low palatability are given as reasons for survival in these instances.

Another renosterveld remnant (ca 80 ha of similar physiography to Eensaamheid) on the farm Waylands near Darling has a history of extreme disturbance which included regular bushcutting until ca 30 years ago. It has also had continuous inputs of P fertilizer (200 kg/ha every 5 years), regular burning, as well as an intensive 9 month/year period of cattle pasturage (stocking rate unspecified). This extreme disturbance has caused the disappearance of the resilient Elytropappus overstorey around 1950 (sensu W. Duckitt, In Mason, 1972 ; F. Duckitt, pers. comm.). However the diversity of the geophyte flora remains unsurpassed, with new species distributions (of Iridaceae) being reported very recently. Cattle are perceived to benefit considerably from the protein rich seed heads of the now abundant geophytes (in particular the Iridaceae). In turn, the latter's dispersal is aided by the enhanced distribution of incompletely digested seeds (F. Duckitt, pers. comm.).

6.3 Poaceae

As might be expected from the observations of Acocks (1955), and Cowling et al. (1986), the grass component Poaceae as a whole declines with grazing (See Poaceae "Total" in Figure 1(b)). Although grasses are normally considered 'desirable' a fairly wide range of palatability is recorded (cf. Henrici, 1935, 1940; Acocks, 1955; Blom, 1980; Danckwerts et al, 1983). Apart from Merxmuellera lupulina, Stipagrostis capensis and Pentaschistus 1, the other Poaceae represented in the relevés are likely to be palatable. Pentaschistus thunbergii and Themeda triandra are significantly reduced by grazing with Ehrharta villosa showing a similar tendency. Themeda is normally an esteemed natural forage species (Acocks, 1955, 1966; Stindt and Joubert, 1979; Danckwerts et al, 1983; Cowling et al, 1986). Themeda, which forms fairly dense swards in parts of the Reserve, is usually entirely absent from the grazed

Extension, although occasionally small plants may appear there briefly during non-grazing periods. Seed dispersal from the Reserve is probably responsible for this recruitment. From the agriculturalist's point of view, use of such exclosures as 'refuges' may be of value in preventing local extinctions of Themeda as well as other desired species which are evidently susceptible to sustained grazing. In contrast to Themeda another relatively palatable grass species in the sample, Cynodon dactylon, can survive sustained and intensive grazing by means of inaccessible stolons (Stuart-Hill and Mentis, 1982). The same hardy pioneer is even reported to tolerate effects of ploughing (Talbot and Talbot, 1968). M.B. Bayer (pers. comm.) cites areas of South Coast Renosterveld (near Stormsvlei) that have been so heavily degraded by extreme year round overgrazing by livestock (goats, sheep, cattle), in combination with excessive bushcutting and burning, that Cynodon forms virtually monospecific stands. Since Cynodon is quite acceptable livestock fodder the farmers are more than satisfied with this end product of 'overexploitation'.

6.4 Proteaceae

Of the families assessed Proteaceae are clearly the most deleteriously affected by the grazing regime of the Extension. At the time of the fencing of the Reserve in 1972 all three species of Proteaceae in Figure 1(b) were present in abundance throughout the Extension. Dense stands of the threatened localised renosterveld endemic, Leucadendron verticillatum, in the latter area made it the largest colony at the time for this species (Hall and Veldhuis, 1985). In 1975 a large proportion of the Extension proteaceae had been defoliated by increased sheep presence. Most of the proteaceae on the Extension were dead or dying leafless "skeletons" even before the aggravating bushcut in 1976 (pers. obs.). Unlike several Poaceae, Fabaceae, Asteraceae and others, one would not normally expect typically 'sclerophyllous' Proteaceae to be very palatable because of their high fibre and tannin contents. Lack of adaptive capacity for recovery from grazing and trampling appeared to be the primary cause of their demise. As with Themeda, subsequent recruitment of the Proteaceae on the Extension is transient with very few seedlings ever being observed in the non-grazing season. The same observations apply to the endangered Serruria pinnata (not recorded on the relevės). Unlike the 3 species represented in Figure 1(b) which are 'reseeders', Serruria's ability to resprout from a woody rootstock proved no longterm salvation, as it too eventually succumbed on the Extension (pers. obs.). Protea odorata, another endangered renosterveld protea, which may once have occurred at Eensaamheid, has also proven susceptible to livestock presence in its remaining stronghold near Malmesbury (McDowell, 1985).

If the latter observations hold true in analogous renosterveld it is likely that Proteaceae, in a similar way to Poaceae, could have been a more significant pre-colonial element in Coastal Renosterveld. Unfortunately the lifehistories of the three reseeding proteaceae are sufficiently similar to that of Elytropappus to be eliminated by the same repeated short interval burn treatment prescribed by Cowling et al. (1986) to encourage economically important Poaceae such as Themeda (See "6.1 Asteraceae").

6.5 Rutaceae

The total cover of the Rutaceae is also significantly reduced (Figure 1(b), Figure 2). Like the Proteaceae the local Rutaceae are not specifically renowned as pasture plants but are nevertheless grazed. An authority on local Rutaceae, P.A. Bean (pers. comm.), maintains that species of this family are normally not to be found in habitats that have been grazed heavily by livestock. Even the Rutaceae that are resprouters (reseeders are normally more susceptible) are exterminated through grazing pressure (P.A. Bean pers. comm.). Hall and Veldhuis (1985) report that several species of Rutaceae in the Fynbos Biome are endangered by overgrazing.

6.6 Other Families

Relevé data indicate no further significant differences other than within the families discussed above. Some useful qualitative data still remains to be discussed.

Of the Restionaceae the threatened Ischyrolepis duthiae (vulnerable) and Thamnochortus fruticosus were observed solely within the Reserve whereas Chondropetalum rectum (vulnerable) occurred in both the Extension and Reserve.

Very little Ischyrolepis capensis could be found outside the Extension. This indicates a variable response of Restionaceae towards heavy grazing.

The three Thymeleaceae recorded (Figure 2, Appendices 1, 2) were not observed in the Reserve. Possibly they represent 'weedy' species that are somehow dependent on grazing disturbance for establishment. W. Bond (pers. comm.) states that this family is reputed to be toxic to certain mammals.

Conversely, both species of the Asclepiadaceae listed in Appendix 2 occur solely in the Reserve. It is suspected that Microloma tenuifolium may have been cleared out directly by grazing pressure. (The Asclepiad Tribe, Stapeliae, is normally extremely susceptible to indirect effects of grazing, because they perish in full sun when the protective bush cover is grazed down - pers. obs.)

M.B. Bayer (pers. comm.) has evidence of three Karoo Fabaceae which survive only on certain road verges protected from grazing. He suggests that the high nutritive value of these legumes is responsible for their virtual extermination (cf. Henrici's, (1935) "bitter but protein rich legumes such as Sutherlandia spp."). It is possible that secondary defense mechanisms such as spininess and concealed habit characteristic of Fabaceae and Polygalaceae in the study site may be their saving grace (Sensu Stuart Hill and Mentis, 1982). This does not mean to say that they would not succumb to heavier grazing pressure.

6.7 Distribution Differences not explained by Grazing

One example of a distribution, which may be entirely inconsequential of grazing, is the existence of four *Erica* species (not under Ericaceae of Appendix 1) solely within the Reserve (Appendix 2). A better explanation is their apparent restriction to a small seasonally flooded seepage habitat well away from the fenceline; an exact analogue of which does not occur in the Extension. Other examples are species such as *Tylecodon grandiflora* and *Maytenus heterophylla* which are confined to two small 'heuweltjie' habitats both far from the fenceline and peculiar to the Extension (Knight *et al*, 1988 on 'heuweltjie' flora). These distributions can also not be explained solely in terms of grazing.

7.0 CONCLUSIONS

The grazing regime of the study site does not fit the description of the systems expounded in "2.0 Precedent Studies on the Effects of Grazing" viz. GSG, NSG and SDG grazing systems. It is however considered broadly typical of the grazing management applied to the majority of remnant renosterveld 'islands'. However such islands have usually not been divided for some time into 'grazed' and 'ungrazed' sections. In view of this it is unfortunately not feasible to replicate such mensurative experimental research (*sensu* Hurlbert, 1984) because analogous sites to Eensaamheid in terms of grazing regimes and floral composition do not exist. Therefore to consider statistical inference to have any validity beyond the present site would be fallacious (cf. Hurlbert's 'pseudoreplication'). However, results probably have meaning at a descriptive or site specific level and, with this limitation the following conclusions and/or hypotheses may be made:

1) Effects of grazing by even the same animal type are so complex that no one factor, such as varied palatability (commonly known to vary even within the same species), can explain the changing vegetation composition at Eensaamheid. This change represents the endpoint of the operation of a complex interaction of direct and indirect effects of the presence of livestock.

2) In a diverse ecosystem such as the present study site it is preferable to assess the community response to grazing at a species level (autecological) instead of following the more usual practice of considering the 'important' dominant taxa or growth forms.

3) Although diversity as a whole was not significantly affected by intensive grazing the actual composition of the vegetation showed marked shifts.

4) Most Asteraceae and Iridaceae remained stable or increased in response to grazing. However Poaceae and particularly Rutaceae had a tendency to decrease in

response to grazing with a few species remaining fairly stable. Worst affected were the Proteaceae of which none had survived the grazing regime.

5) Significance of results for the aforementioned five families was greater at the 'family total' level than for any of the component species of the families (Figure 1) Families could therefore be affected by grazing pressure as whole entities; not surprisingly as genetic relationship should, by definition, imply greater chances of biochemical and ecological similarity of component species. Hence taxonomic considerations could play a greater role in future research on the effects of grazing.

6) Support is given to the hypothesis of Cowling et al. (1986) that Poaceae (exemplified by Themeda) had greater historical prevalence in renosterveld whereas Asteraceae (exemplified by Elytropappus) played a more recessive role than today. Present research suggests the hypothesis that Proteaceae and Rutaceae, normally associated to a greater extent with fynbos, may also have been previously more abundant in certain renosterveld areas.

7) Intensive sheep grazing has widely varied implications for those Red Data species investigated whose decimated populations have become isolated largely through clearance of renosterveld. Leucadendron verticillatum and Serruria pinnata of the Proteaceae are certainly exterminated with intensive sheep grazing. Galaxia alata and Gladiolus

citrinus of the Iridaceae are unaffected by grazing. Of the threatened Restionaceae, Ischyrolepis duthiae appears to decrease with grazing and Chondropetalum rectum seems relatively unaffected.

8) Fire, if used as a management tool to improve grazing, should be applied with great care so as not to exterminate Red Data species such as Leucadendron verticillatum.

9) It is critical that autecological attributes of as many species as possible are taken into account when predicting responses to perturbations such as grazing pressure.

Overall, if the response of renosterveld remnants generally is at all similar to that at Eensaamheid the effects of even intensive grazing has a very minor impact on the ecology compared with other far more serious threats facing renosterveld remnants such as the virtually irreversible impacts of ploughing, mining and urban development (cf. McDowell, 1988). In fact 'grazing' represents just one of several 'island biogeographical' hazards to diversity that will escalate with progressive decrease in size and increase in isolation of ecosystems generally.

As indicated in the present research, grazing disturbance may also be helpful in encouraging certain species that could, arguably, become extinct in the 'island' situation through absence of the grazing factor, albeit at present "unnatural". Whatever the situation may be for a particular renosterveld remnant, significant scope exists for well planned ecological manipulation to be applied to ensure survival of the relatively few threatened or agriculturally desirable taxa; rather like the situation of "plants versus weeds" in a suburban garden. But renosterveld remnant floras differ from the the latter analogy in being naturally adapted over millenia to survive <u>in situ</u>. Therefore, at least in the situation investigated, the <u>bulk</u> of species appear to survive surprisingly heavy grazing impacts "unaided" by deliberate human intervention.

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APPENDIX 1

DATA FOR SPECIES COVER ON RELEVES

MU = Mean foliage projective cover for 'ungrazed' Eensaamheid Reserve 10m by 10m releves

MG = Mean foliage projective cover for 'grazed' Eensaamheid Extension 10m by 10m releves

MG-MU = MG minus MU ('positive' or 'negative' effects of grazing)

SD = Standard Deviation of MG-MU values

%CHANGE = Percentage change in foliage projective cover under grazing regime

* = Significant MG-MU where MG-MU is greater than standard deviations

FAMILY AND SPECIES	MU	MG	MG-MU		SD	%CHANGE
ANACARDIACEAE						
Rhus rosmarinifolia	0.13	0.00	-0.13		0.20	-100
Total	0.13	0.00	-0.13		0.20	-100
APIACEAE						
Centella glabrata	0.13	0.05	-0.08		0.07	-60
Peucadanum capillaceum	0.05	0.00	-0.05		0.04	-100
Total	0.18	0.05	-0.13		0.09	-71
ASCLEPIADACEAE						
Asclepias crispa	0.15	0.00	-0.15		0.19	-100
Microloma tenuifolium	0.03	0.00	-0.03		0.04	-100
Total	0.05	0.00	-0.05		0.08	-100
ASPARAGACEAE						
Protasparagus capensis	0.00	0.03	0.03		0.01	0
Total	0.00	0.03	0.03		0.01	0
ASPHODELACEAE						
Trachyandra brachypodium	0.13	0.00	-0.13		0.20	-100
Total	0.13	0.00	-0.13		0.20	-100
ASTERACEAE						
Arctotheca calendula	0.50	0.03	-0.48		0.84	-95
Athanasia trifurcata	0.28	0.50	0.22		0.34	82
Berkheya armata	1.63	1.00	-0.63		0.60	-38
Corymbium africana	0.63	4.25	3.63	*	1.14	580
Cotula turbinata	0.88	0.50	-0.38		0.94	-43
Elytropappus rhinocerotis	36.25	72.50	36.25	*	18.17	100
Erigeron canadense +	0.00	0.50	0.50		0.61	0
Eriocephalus africanus	3.25	0.00	-3.25		3.90	-100
Felicia tenella	0.03	1.03	1.00		0.43	4000
Gazania pinnata	0.13	0.00	-0.13		0.20	-100
Helichrysum asperum	0.90	0.50	-0.40		1.28	-44
Helichrysum expansum	0.13	0.40	0.28		0.51	220
Hypochoeris glabra +	0.13	0.13	0.00		0.35	0
Leysera gnaphaloides	0.75	0.40	-0.35		0.19	-47
Metalasia 1	0.00	0.03	0.03		0.04	0
Relhania fruticosa	0.00	0.50	0.50		0.41	0
Stoebe capitata	0.13	0.00	-0.13		0.05	0
Ursinia anthemoides	4.25	1.00	-3.25		3.90	-76
Total	49.83	83.25	33.43	*	16.99	0
BORAGINACEAE						
Echiostachys echinatus	0.00	0.13	0.13		0.20	0
Total	0.00	0.13	0.13		0.20	0
CAMPANULACEAE						
Lobelia erinus	0.15	0.28	0.13		0.20	83
Roella prostrata	0.13	0.00	-0.13		0.20	-100
Wahlenbergia 1	0.15	0.00	-0.15		0.19	-100
Total	0.43	0.28	-0.15		0.58	-35
CARYOPHYLLACEAE						
Silene undulata	0.50	0.00	-0.50		0.82	-100
Total	0.50	0.00	-0.50		0.82	-100
CRASSULACEAE						
Crassula glomerata	0.13	0.28	0.15		0.36	120
Crassula ciliaris	0.38	0.25	-0.13		0.36	-33
Total	0.50	0.53	0.03		0.71	5

FAMILY AND SPECIES	MU	MG	MG-MU	SD	%CHANGE
CRUCIFERAE					
Rumex sagittatus?	0.00	0.25	0.25	0.41	0
Total	0.00	0.25	0.25	0.41	0
CYPERACEAE					
Cyperus tenellis	0.25	1.25	1.00	2.28	400
Ficinia filiformis	0.75	1.50	0.75	0.74	100
Scirpus cartilagineus	0.88	0.00	-0.88	0.48	-100
Total	1.88	2.75	0.88	1.93	47
ERICACEAE					
Eremia totta	0.00	0.03	0.03	0.04	0
Total	0.00	0.03	0.03	0.04	0
ERIOSPERMACEAE					
Eriospermum lanceifolium	0.00	0.25	0.25	0.41	0
Eriospermum 1	0.00	0.25	0.25	0.41	0
Total	0.00	0.00	0.00	0.00	0
EUPHORBIACEAE					
Euphorbia genistoides	0.75	1.50	0.75	0.74	100
Euphorbia tuberosa	0.88	0.13	-0.75	0.48	-86
Total	1.63	1.63	0.00	1.08	0
FABACEAE					
Argyrolobium lunare	1.63	1.50	-0.13	0.89	-8
Aspalathus acuminata	0.25	0.00	-0.25	0.21	-100
Aspalathus ericifolia	0.25	0.15	-0.10	0.36	-40
Aspalathus hispida	0.88	0.00	-0.88	1.14	-100
Indigofera procumbens	0.15	0.00	-0.15	0.19	-100
Psoralea alata	0.63	0.88	0.25	1.02	40
Total	3.78	2.53	-1.25	0.85	-33
GENTIANACEAE					
Sebaea aurea	0.15	0.00	-0.15	0.20	-100
Total	0.15	0.00	-0.15	0.20	-100
GERANIACEAE					
Monsonia speciosa	0.65	0.00	-0.65	0.80	-100
Pelargonium multicaule	0.13	0.88	0.75	0.74	600
Pelargonium triste	0.13	0.00	-0.13	0.20	-100
Total	0.90	0.88	-0.03	1.38	-3
HYACINTHACEAE					
Albuca canadensis	0.03	0.00	-0.03	0.04	-100
Lachenalia pallida	0.00	0.05	0.05	0.04	0
Lachenalia unifolia	0.03	0.00	-0.03	0.04	-100
Ornithogalum thyrsoides	2.75	2.00	-0.75	2.50	-27
Total	2.80	2.05	-0.75	2.55	-27
IRIDACEAE					
Aristea africana	0.15	0.05	-0.10	0.23	-67
Babiana rubrocyanea	0.13	0.00	-0.13	0.05	-100
Bobartia filiformis	0.18	6.25	6.08 *	1.98	3471
Galaxia alata	0.03	0.05	0.03	0.04	100
Geissorhiza aspera	0.03	0.05	0.03	0.01	100
Gladiolus citrinus	0.13	0.13	0.00	0.35	0
Hexaglottis lewisiae	0.13	0.13	0.00	0.00	0
Ixia dubia	0.00	0.30	0.30	0.17	0
Lapeirousia corymbosa	0.13	0.20	0.08	0.21	60

FAMILY AND SPECIES	MU	MG	MG-MU		SD	%CHANGE
Micranthus tubulosus	0.75	2.13	1.38		0.90	183
Moraea fugax	0.03	0.00	-0.03		0.04	-100
Moraea gawleri	0.03	0.00	-0.03		0.04	-100
Moraea 1	0.00	0.03	0.03		0.04	0
Moraea 2	0.00	0.03	0.03		0.04	0
Romulea rosea	0.40	0.18	-0.23		0.15	-56
Watsonia 1	0.00	0.05	0.05		0.04	0
Total	2.08	9.55	7.48	*	1.60	360
JUNCACEAE						
Juncus bufonius	0.15	0.00	-0.15		0.05	-100
Juncus capensis	0.00	0.15	0.15		0.20	100
Total	0.15	0.15	0.00		0.20	0
LABIATAE						
Salvia africana-caerulea	0.50	0.00	-0.50		0.82	-100
Total	0.50	0.00	-0.50		0.82	-100
LINACEAE						
Linum africanum	0.25	0.28	0.03		0.51	10
Total	0.25	0.28	0.03		0.51	10
MESEMBRYANTHEMACEAE						
Lampranthus aduncus?	0.15	0.20	0.05		0.20	0
Lampranthus glaucus	0.15	0.03	-0.13		0.20	-83
Ruschia 1	0.00	0.15	0.15		0.19	0
Total	0.30	0.38	0.08		0.40	25
MONTINIACEAE						
Montinia caryophyllacea	0.75	0.00	-0.75		1.23	-100
Total	0.75	0.00	-0.75		1.23	-100
ORCHIDACEAE						
Corycium bracteolatum	0.18	0.00	-0.18		0.19	0
Holothrix villosa	0.18	0.08	-0.10		0.23	-57
Total	0.35	0.08	-0.28		0.15	-79
OXALIDACEAE						
Oxalis purpurea	0.00	1.28	1.28		2.05	0
Total	0.00	1.28	1.28		2.05	0
POACEAE						
Briza maxima +	0.75	0.05	-0.70		0.84	-93
Bromus diandrus +	0.00	0.03	0.03		0.04	0
Bromus japonicus +	0.00	0.28	0.28		0.41	0
Cynodon dactylon	2.50	1.50	-1.00		4.15	-40
Ehrharta calycina	1.00	0.63	-0.38		1.26	-38
Ehrharta capensis	0.00	0.13	0.13	*	0.05	0
Ehrharta villosa	1.25	0.00	-1.25		0.72	0
Lasiochloa echinata	0.13	0.00	-0.13		0.20	-100
Lolium temulentum +	0.00	0.03	0.03		0.01	0
Merxmuellera lupulina	0.13	0.25	0.13		0.22	100
Pentaschistus airoides	0.03	0.00	-0.03		0.01	-100
Pentaschistus thunbergii	3.75	0.28	-3.48	*	1.34	-93
Pentaschistus 1	0.50	1.00	0.50		0.41	100
Plagiochloa uniolae	0.13	0.00	-0.13		0.20	-100
Stipagrostis capensis	0.25	0.00	-0.25		0.41	-100
Themeda triandra	1.50	0.00	-1.50	*	0.65	-100
Vulpia myuros +	0.88	0.75	-0.13		0.98	-14
Total	12.78	4.90	-7.88	*	3.43	-62

FAMILY AND SPECIES	MU	MG	MG-MU		SD	%CHANGE
POLYGALACEAE						
Muraltia filiformis	0.00	0.03	0.03		0.01	0
Muraltia thymifolia	0.13	0.00	-0.13		0.20	-100
Muraltia 1	0.03	0.05	0.03		0.07	100
Polygala garcinii	0.08	0.25	0.18		0.19	233
Total	0.23	0.33	0.10		0.40	44
PROTEACEAE						
Leucadendron salignum	2.00	0.00	-2.00		1.79	-100
Leucadendron verticillatum	17.75	0.00	-17.75	*	8.58	-100
Leucospermum calligerum	0.50	0.00	-0.50		0.82	-100
Total	20.25	0.00	-19.25	*	6.29	-100
RESTIONACEAE						
Calopsis 1	0.50	0.00	-0.50		0.82	-100
Chondropetalum rectum	3.00	1.25	-1.75		1.25	-58
Elegia squamosa	0.13	0.50	0.38		0.61	300
Hypodiscus rugosus	0.13	0.00	-0.13		0.05	-100
Ischyrolepis capensis	0.00	1.88	1.88		1.75	0
Ischyrolepis duthiae	0.50	0.00	-0.50		0.82	0
Thamnochortus fruticosus	0.15	0.00	-0.15		0.08	-100
Total	4.40	3.63	-0.78		1.82	-18
ROSACEAE						
Cliffortia juniperina	0.13	0.00	-0.13		0.20	-100
Total	0.13	0.00	-0.13		0.20	-100
RUBIACEAE						
Anthospermum aethiopicum	0.13	0.05	-0.08		0.07	0
Anthospermum gatioides	0.13	0.00	-0.13		0.20	-100
Total	0.25	0.05	-0.20		0.25	-80
RUTACEAE						
Agathosma capensis	1.80	0.15	-1.65		0.84	-92
Agathosma ciliata?	0.13	0.00	-0.13		0.20	-100
Diosma hirsuta	3.00	0.40	-2.60		2.03	-87
Total	4.93	0.55	-4.38		1.10	-89
SANTALACEAE						
Thesium virgatum	0.38	0.00	-0.38		0.36	-100
Total	0.38	0.00	-0.38		0.36	-100
SCROPHULARIACEAE						
Dischisma arenarium	0.03	0.00	-0.03		0.04	0
Hyobanche sanguinea	0.00	0.08	0.08		0.04	0
Total	0.03	0.08	0.05		0.08	200
SILENACEAE						
Silene undulata	0.00	0.25	0.25		0.21	0
Total	0.00	0.25	0.25		0.21	0
STERCULIACEAE						
Hermannia multiflora	0.15	0.38	0.23		0.53	0
Total	0.15	0.38	0.23		0.53	0
TECOPHILAECEAE						
Cyanella hyacinthoides	0.13	0.15	0.02		0.04	20
Total	0.13	0.15	0.02		0.04	20
THYMELEACEAE						
Cryptadenia grandiflora	0.00	0.25	0.25		0.21	0
Struthiola ciliaris	0.00	0.25	0.25		0.41	0
Gnidia laxa	0.00	0.03	0.03		0.04	0
Total	0.00	0.53	0.53		0.52	0
COVER OF RELEVES	103.10	117.40	14.20		23.04	14
NUMBER OF SPECIES/RELEVE	46.25	46.00	-0.25		3.20	0.01

APPENDIX 2

FLORA LIST FOR EENSAAMHEID 'RESERVE' AND 'EXTENSION'

(Total families = 50, total species = 198)

RES = Recorded by author only on Reserve area to date

EXT = Recorded by author only on Extension area to date

unconf. = Red Data species record not confirmed by author

\+ = alien species

ANACARDIACEAE
Rhus rosmarinifolia
Rhus tomentosa
Rhus laevigata EXT

APIACEAE
Centella glabrata
Lichtensteinia beiliana
Peucadanum capillaceum

ASCLEPIADACEAE
Asclepias crispa RES
Microloma tenuifolium RES

ASPARAGACEAE
Myrsiphyllum asparagoides
Protasparagus compactus
Protasparagus capensis
Protasparagus rubicundus
Protasparagus stipulaceous

ASPHODELACEAE
Anthericum rangei?
Bulbinella triquetra EXT
Trachyandra brachypodium

ASTERACEAE
Arctotheca calendula
Arctotis echinatus
Athanasia capitata rec
Athanasia oligocephala
Athanasia trifurcata
Berkheya armata
Corymbium africana
Cotula coronopifolia EXT
Cotula turbinata
Dimorphotheca pluvialis
Elytropappus rhinocerotis
Erigeron canadense +
Eriocephalus africanus
Felicia tenella
Gazania pinnata
Helichrysum asperum
Helichrysum expansum
Hypochoeris glabra +
Leysera gnaphaloides
Metalasia muricata EXT
Metalasia 1
Pteronia 1
Relhania fruticosa EXT
Stoebe capitata
Stoebe cinerea
Stoebe fusca?
Senecio pubigerus
Ursinia anthemoides

BORAGINACEAE
Echiostachys echinatus
Lobostemon fruticosus EXT
Lobostemon 1 EXT

BRUNIACEAE
Staavia radiata RES

CAMPANULACEAE
Lobelia erinus
Lobelia 1 EXT
Roella prostrata
Wahlenbergia 1

CARYOPHYLLACEAE
Silene undulata

CELASTRACEAE
Maytenus heterophylla EXT
Putterlickia pyracantha

CRASSULACEAE
Crassula glomerata
Crassula ciliaris
Tylecodon grandiflora EXT

CRUCIFERAE
Rumex sagittatus?

CYPERACEAE
Cyperus tenellis
Ficinia filiformis
Scirpus cartilagineus

DROSERACEAE
Drosera hilaris
Drosera 1

EBENACEAE
Diospyros glabra
Diospyros lycioides
Euclea 1

ERICACEAE
Eremia totta
Erica bruniades RES
Erica mammosa RES
Erica 1 RES
Erica 2 RES

ERIOSPERMACEAE
Eriospermum lancifolium
Eriospermum 1
Eriospermum 2

EUPHORBIACEAE
Clutia 1
Euphorbia genistoides
Euphorbia tuberosa

FABACEAE
Acacia saligna +
Argyrolobium lunare
Aspalathus acuminata
Aspalathus ericifolia
Aspalathus hispida
Indigofera procumbens
Psoralea alata

GENTIANACEAE
Sebaea aurea
Sebaea exacoides

GERANIACEAE
Monsonia speciosa
Pelargonium multicaule
Pelargonium triste

HAEMODORACEAE
Wachendorfia thyrsiflora

HYACINTHACEAE
Albuca canadensis
Lachenalia pallida
Lachenalia unifolia
Ornithogalum thyrsoides

HYPOXIDACEAE
Spiloxene canaliculata
Spiloxene capensis RES

IRIDACEAE
Aristea africana
Babiana rubrocyanea
Bobartia filiformis
Galaxia alata
Geissorhiza aspera
Geissorhiza purpureolutea
Geissorhiza radians
Geissorhiza 1
Geissorhiza 2
Hexaglottis lewisiae
Ixia dubia
Lapeirousia corymbosa
Lapeirousia anceps
Melasphaerula ramosa
Micranthus tubulosus
Moraea fugax
Moraea gawleri
Moraea 1
Moraea 2
Moraea 3
Romulea rosea
Romulea 1
Tritoniopsis elongata unconf.
Watsonia 1

JUNCACEAE
Juncus bufonius
Juncus capensis

LABIATAE
Salvia africana-caerulea

LAMIACEAE
Ballota africana

LINACEAE
Linum africanum

MESEMBRYANTHEMACEAE
Carpanthea pomeridiana
Lampranthus aduncus?
Lampranthus filicaulis
Lampranthus glaucus
Lampranthus reptans
Ruschia 1

MONTINIACEAE
Montinia caryophyllacea

ORCHIDACEAE
Corycium bracteolatum
Disa RES
Disperis villosa RES
Holothrix villosa
Pterygodium catholicum RES

OXALIDACEAE
Oxalis purpurea
Oxalis pes-caprae
Oxalis 1

POACEAE
Briza maxima +
Bromus diandrus +
Bromus japonicus +
Cynodon dactylon
Ehrharta calycina
Ehrharta capensis
Ehrharta villosa
Lasiochloa echinata
Lolium temulentum +
Merxmuellera lupulina
Pentaschistus airoides
Pentaschistus thunbergii
Pentaschistus 1

Plagiochloa uniolae
Stipagrostis capensis
Themeda triandra
Vulpia myuros +

POLYGALACEAE
Muraltia filiformis
Muraltia thymifolia
Muraltia 1
Polygala garcinii

PROTEACEAE
Leucadendron salignum RES
Leucadendron verticillatum RES
Leucospermum calligerum RES
Serruria pinnata RES

RESTIONACEAE
Calopsis 1
Chondropetalum nudum?
Chondropetalum rectum
Elegia squamosa
Hypodiscus rugosus
Ischyrolepis capensis
Ischyrolepis duthiae RES
Thamnochortus fruticosus RES

ROSACEAE
Cliffortia juniperina
Cliffortia ruscifolia

RUBIACEAE
Anthospermum aethiopicum
Anthospermum gatioides

RUTACEAE
Agathosma capensis
Agathosma ciliata?
Diosma hirsuta
Macrostylis villosa unconf.

SANTALACEAE
Thesium virgatum

SCHIZAEACEAE
Mohria caffrorum

SCROPHULARIACEAE
Dischisma arenarium
Hyobanche sanguinea
Selago fruticulosa
Sutera 1

SILENACEAE
Silene undulata

SOLANACEAE
Lycium afrum

STERCULIACEAE
Hermannia multiflora

STILBACEAE
Stilbe ericoides?

TECOPHILAECEAE
Cyanella hyacinthoides

THYMELEACEAE
Cryptadenia grandiflora
Gnidia laxa
Passerina 1
Struthiola ciliaris

Total families = 50

Total species = 198

PAPER 3

ATTITUDES AND BEHAVIOUR OF FARMERS TOWARDS ECOSYSTEM CONSERVATION: A NEW APPROACH TO ASSESSING ASSOCIATED VARIABLES

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ABSTRACT

The methodology of earlier studies on 'conservation behaviour' relating to natural ecosystems, is reviewed. Difficulties which include both the inevitable superficiality and unsatisfactory response rates of traditional questionnaire designs are assessed. Semi-structured interview techniques, designed to elicit a large multi-disciplinary array of subject background variables, are then described in terms of field application to an optimally sized, random sample of farmers who own renosterveld - a threatened vegetation type of the south-western Cape lowlands. The choice and scope of 52 subject-related variables; split into the categories - 'Demographic', 'Psycho-social', 'Land Use', and 'Conservation Strategy', are contextualised in the psychological field. A technique is described in which independent assessors provide non-parametric ratings for the subset of 32 'less tangible' (subjective and information biased) variables using tape-recordings of the interviews with the subject-landowners. Degree of correlation between these independent ratings indicates the extent to which the means of these ratings may be considered statistically reliable.

The successful measurement of such frequently disregarded 'soft data', (in addition to selected 'hard data' viz the 20 'tangible' variables), are vital "building blocks" for developing statistical models to predict extents of landowner-subjects' 'conservation behaviour' towards renosterveld on their properties. It is concluded that this approach to rating variables also has potential application to similar forms of human behaviour.

KEYWORDS

Conservation behaviour, attitudes, 'less-tangible' variables, 'tangible' variables, farmers, private landowners, Delphi Technique, personal constructs, interviews, questionnaires, renosterveld.

1.0 INTRODUCTION

The successful assessment, interpretation and prediction of human attitudes and behaviour could help to solve many of the problems experienced by humanity. The literature burgeons on this complex and frequently controversial field. (See inter alia the fundamental social psychological works of Jahoda and Warren, 1966; Fishbein, 1967; Kiesler, Collins and Miller, 1969; Triandis, 1971; Fishbein and Ajzen, 1975; Leff, 1978.) Unfortunately, however, little of this specialized knowledge has been applied to the field of environmental conservation. The overwhelming bulk of literature relating to the latter, focuses on attributes of environments themselves; being traditionally restricted to the pure natural science disciplines. Obvious, but apparently often 'unseen', psychological attributes of critical human individuals or groups upon which conservation depends appear to be under-researched.

Consider the study example within this paper, namely conservation behaviour of landowners' toward natural and near-natural ecosystems on their properties. The critical importance of this perspective of conservation is emphasised by McDowell (1986a, 1986b), McDowell and Sparks (1988). This represents a component of the broad discipline of environmental conservation and a microcosm of human behaviour as a whole.

Within the South African context a survey of related literature by Ferrar (1983) indicates that no in-depth analyses have been carried out locally on private landowners' conservation behaviour. Even an international library data-base search revealed only very few publications which directly address this problem in other countries. The most notable of these include the (British) Agricultural Development and Advisory Service's (1976) publication "Wildlife Conservation in Semi-Natural Habitats on Farms : a Survey of Farmer Attitudes and Intentions in England and Wales" and Macdonald's (1984) "A Questionnaire Survey of Farmers' Opinions and Actions towards Wildlife on Farmlands". These works both stress the importance of understanding the attitudes and behaviour of farmers towards conservation of natural habitats. However, the questions used in the respective questionnaires, as well as the reference sections, indicated minimal analytical concern in probing reasons and underlying patterns for the attitudes and behaviour of the target subjects. Instead the emphasis was on attributes of the ecosystems on the relevant properties, which, although informative, tended to bypass the stated issue, namely the landowners themselves.

There are other recent studies which relate instead to the analogous soil conservation behaviour of landowners. Napier and Forster (1982), Napier, Thraen, Goe and Gore (1984), in North America, and Earle, Rose and Brownlea (1979), in Australia, represent examples of studies where the researchers have systematically rated a more holistic spectrum of background factors - <u>including</u> psycho-social and demographic attributes of the landowner subjects themselves. They used these data in various multivariate statistical models to explain and predict aspects of soil conservation practices.

Shortcomings perceived to be common to the above cited examples of conservation behaviour analyses (and others) include:

1) Reliance was on questionnaires (superficial by practical necessity) as a central standard for gathering data from the landowners. A rich variety of inductive techniques for gauging attitudes and behaviour was therefore ignored; for example in-depth free flow interviews and participatory observation techniques defined by McCall and Simmons (1969); Benney and Hughes, (1977); Schwartz and Jacobs, (1979).

2) Studies based their evaluation on random samples drawn from 'universes' of widely varied sizes. In no cases was a one hundred percent response rate obtained. The, by definition, biased response rates negate the basic scientific rationale for taking random samples in the first place. This, in turn, casts doubt on the validity of generalizing from resultant statistical analyses.

3) Had wider spectrums of variables been assessed for the study samples, this probably would have done greater justice to producing a more effective understanding of the complexities underlying environmental attitudes and behaviour. Therefore, a greater emphasis on quality rather than quantity of interviews/questionnaires appears justified.

A major objective of this paper is to demonstrate how a series of 'less tangible' variables (in addition to 'tangible hard data') may be elicited and measured for a relatively small, representative sample of landowners. Although some of these may be open to considerable subjective measurement error it does not necessarily mean they are 'intangible' as such: rather that they are just difficult to gauge reliably and are, technically speaking therefore, 'less tangible'. The latter variables, in combination with a series of the more traditional, objective 'tangible' variables, were investigated in this study to provide a broader spectrum as an improved basis for a more realistic statistical interpretation of conservation behaviour. (See Cicourel, 1964, for the value of the all too frequently neglected 'subjective' variables)

2.0 METHODS

2.1 The Study Area and Research Sample

West Coast Renosterveld is a type of natural habitat (locally termed a 'veld type' - see Acocks 1953) which has been largely displaced by cultivated lands in the southern west coast lowlands of the Cape Province of South Africa. (For details see McDowell, 1986a, 1986b) The remaining ca 5% of the original area of West Coast Renosterveld exists in varied levels of degradation, under constant threat of being cleared for further new lands. As this is the most diminished, and also possibly still the most threatened South African veld type (Boucher, 1983), private landowners controlling sections of the renosterveld habitat represent a particularly relevant research focus. About 80% by area of these ecosystem remnants is privately owned by the agricultural community. Their future conservation or destruction thus depends predominantly in the long-term on the actions of these farmers. Legal restrictions influencing private-owned ecosystems as they presently exist, were found to be of little potential value in the long-term enhancement of conservation-related activities (McDowell, 1986). The typical colloquial epithet "Die boer is baas op sy plaas" (an Afrikaans saying which means effectively that: "the farmer is the 'undisputed' boss of his farm") sums up this touchy situation.

It was decided to restrict the landowner sampling frame to the subset of farmers controlling renosterveld remnants which had been given a conservation quality rating scale of 50 percentage points and above by 'Fynbos Biome' conservation researchers of the Council for Scientific and Industrial Research (see Jarman, 1986). (Areas rating less than 50% were often degraded beyond the point of being worthy of the term 'near natural' ecosystem).

Random quotas of not greater than three landowner families were drawn from those landowners owning sections of each eligible renosterveld site. As less than three owners were implicated in many sites, the number of landowner families drawn was a manageably small sample of thirty-six. However, this reflected a relatively large proportion of a total universe of 212 West Coast Renosterveld landowners. Altogether there are probably, at most, not more than a couple of thousand landowners who have holdings incorporating remnants of all the types of renosterveld (including West Coast Renosterveld) in the whole of the Cape Province.

2.2 'Ecosystem Conservation Behaviour' defined as a Variable

No working delimitation of 'ecosystem conservation behaviour' is known. Original criteria were therefore determined by taking into account the specific character of the renosterveld ecosystem. However the given definition could probably also be extrapolated to other threatened highly diminished ecosystems under private ownership. In the context of the present analysis, conservation behaviour represents "the positive action taken by the landowners towards conservation of natural ecosystems; particularly those on their own properties." As a dependent variable Y, 'Conservation Behaviour' is defined for any specific landowner as a collective of the following criteria:-

i) The extent of natural habitat retained at least for the part motive of ecosystem conservation.

ii) The sacrifice of alternative commercial ventures which may have resulted from the retention of natural habitats.

iii) The degree to which the ecosystems are scientifically managed to ensure continued survival of the natural elements.

iv) The willingness to retain the previous measures i), ii) and iii) into the indefinite future. (Appendix 1.)

Any criterion taken singly cannot, therefore, provide a full index of conservation behaviour. For example, with 1) above, merely a large area of natural habitat retained for conservation would not take into account the fact that that particular area may simply be of much lower agricultural potential compared with that controlled by other landowners on the same sample. Hence the necessity of incorporating 2) into the definition: the same situation applying also to the other criteria. 'Conservation Behaviour' must be included under the 'less tangible' variables, as direct metric measurement is hardly feasible. For the investigation of a subject's 'Conservation Behaviour' some field observation is essential. Its rating therefore follows the same pattern as defined subsequently for the independent 'less tangible' variables.

2.3 Data Collection and the Selection of Variables

The research process in positivist social science can be differentiated into deductive and/or inductive modes of inquiry. (See Open University, Block 2A, 1979 and Wallace, 1971). 'Deductive Inquiry' proceeds from theories to more specific hypotheses, which are then tested by observation. With inductive inquiry there are no hypotheses, or at best, very poorly defined hypotheses when initiating a 'research cycle'. A practical set of hypotheses, for subsequent testing, really constitutes the end point of inductive enquiry. These are tested deductively, most frequently by means of systematic statistical analyses. This normally results in further theory. Hence the revolving cycle between the two modes of inquiry continuously generates additional knowledge (Wallace, 1977).

The dearth of related work in the landowner conservation behaviour project initially necessitated an inductive approach in order to finalise a set of suitable descriptive variables (which which to some extent equate to 'hypotheses' or 'questions') that would: a), have some direct or indirect relationship to 'Conservation Behaviour', and; b), have measurement potential. Secondly, this finalised set of variables had to be measured and tested both for their individual relationship with Conservation Behaviour (Y), as well as for their own inter-relationships (McDowell and Sparks, 1988 for specific results). Nevertheless a broad knowledge of 'areas' for exploration did exist before the subjects were approached. The spectrum of variables investigated fell into categories relating specifically to the landowners themselves, namely :- a) Demographic (20 variables), b) Land Use (13 variables), c) Psycho-social (12 variables) and d) Conservation Strategy (7 variables). (Appendix 1)

Semi-structured in-depth interviews were conducted with all the landowners drawn on the sample. The basic approach adopted is defined in Open University (1979) Block 2B, (pp.48-91); Benney and Hughes (1977), Deutscher (1969/70) and Schwartz and Jacobs (1979). Interaction between the writer and landowner subject (with family) lasted for at least four hours each at their homes. Evidence of positive or negative conservation practices on their properties was scrutinised and subjects were cross-questioned. The initial objective was to maximise rapport with subjects (and families where applicable) and thus to get to know and understand as much as possible about them within the ambits of the four categories of defined variables.

An open-ended interview schedule was used in carrying out one-hour plus tape recorded interviews with landowners on their properties. The principle reason for not using a highly structured approach, for example administered questionnaires, was the heterogeneity of the subjects. (See also Benney and Hughes, 1977). Among the subjects, whose education, for example, ranged from Standard 5 primary education through to seven years tertiary education, there appeared to be a correspondingly large difference in reading speeds, vocabulary etc. This would have negated a uniform understanding of, for example, the standardised questionnaires that are so frequently used in similar studies. The alternative flexible interview approach adopted also allowed for interaction to be adjusted so as to maximise communication with the respondent. Three basic tenets were adhered to during the interviews namely: a) to optimise rapport with the respondent to encourage spontaneity so that he/she ' keeps talking'; b) the mental checking off of topics on a reasonably well defined agenda and, c) doing very rapid "traffic management" to decide which ideas thrown up by the respondent should be pursued at that moment, or later in the interview. (Open University, 1979 Block 2B.)

The pursuit of often sensitive information had to be carefully controlled in the interview series. For example, the interview would be initiated by obtaining at first the least sensitive information, such as: "Past Tenure of Family", "Number of Children" and "Area of Veld". Only towards the end of the interview would the more sensitive information be elicited, eg "Liquid Capital", "Overall Affluence" and "Willingness to Sell Veld". With the gathering of such information an indirect approach was most appropriate. For example, a question to elicit "Knowledge of fauna" would not be "How much do you know about the wild fauna on your farm?" but instead "What wildlife occurs on your farm?" The latter question is a far simpler 'prompt', less personal, and less prone to the reactively giving a deceptive impression to the interviewer.

Respondents tend to give themselves unrealistic self-ratings, if asked to provide these for many of the variables. For example, certain respondents who had a fairly high "Knowledge of Fauna" relative to the other subjects on the sample felt they "did not know much about the wildlife". By contrast certain other subjects - who obviously knew very little about wildlife - indicated the exact opposite! This is a 'reactivity' problem which may frequently arise with the use of self-rating scales designed for example on Likert-based principles. (sensu Open University, 1979 Block 5). To counteract this problem unobtrusive 'cues' and 'prompts' were used to elicit spontaneous responses which could later be scrutinised in-depth from the tape recordings.

As all interviews were undertaken by the same person, namely the author, they were reasonably standardised. They were taped openly, but in a manner designed to minimise reactivity. (See Webb et al, 1966.) A 'micro-corder' was used throughout (smallness made it less obtrusive) and it was introduced to the scene in a suitably casual manner so as to detract as much as possible from its presence. (It is well known to sociologists generally that a tape-recorder that is too large and/or is too formally introduced will inhibit rapport on the part of subjects.) If any problems arose with this procedure (and they seldom did) the subject was assured of anonymity. Overall, therefore, the whole approach to information gathering is critical, such as the clothes worn (clothing invariably denotes a role), the language spoken, the way questions are asked, etc. (Appendix 1 for additional information.)

The set of variables to be measured was actually finalised only at the end of the interviews. Many unsuitable variables were eliminated; new ones added; and others re-defined during and after the interview sequence. The additional variables resulted through viable hypotheses becoming apparent only during interaction with the subjects. For example, "Parents' Education" was only considered to be a viable variable, in terms of its indirect bearing on

Conservation Behaviour, three quarters of the way through the interview series.

Subsequent telephone re-calls to previous interviewees (now having the advantage of a ready established rapport) were sufficient to elicit any outstanding data. The wealth of formal and informal data available on the tape-recordings often sufficed to provide a standard for quantifying *post hoc* delimited 'less tangible' variables. The 'way' things were said; the types of words and word sequences used; the timing of statements etc made by subjects all comprised aspects of the pool of informal information. By definition, for example, no specific prompts or 'cues' were used to elicit the *post hoc* defined variable 'Materialism'. This index was rated according to the extent to which the subject spontaneously referred to 'financial considerations' as a basis for argument. (See Appendix 1 for 'guidelines' under Variable Number 38.)

The choice of variables for measurement is to a large extent analogous to the elicitation of 'personal constructs'. These form the basic building blocks for the derivation of 'repertory grids' in psycho-analytical theory. Originally devised by Kelly (1955), personal constructs consist of bi-polar 'qualities' eg "reserved-outgoing" which are used to define differences <u>or</u> similarities between individuals or objects of significance to a particular subject. Personal constructs, when elicited in sufficient numbers from an individual, indicate the mode how he/she customarily interprets and predicts the behaviour of the aforesaid 'beings'. (See Adams-Webber, 1979 for a review of Repertory Grid Methodology)

In reverse to the principle that personal constructs reflect critical perceptions of test subjects within Repertory Grid Methodology, the variables selected in the present study significantly reflect the background of the writer. These include graduate or post-graduate qualifications and/or experience in the natural science, social psychology and economics lines of study. Likewise, variables selected in the precedent studies (referred to under "Introduction") also appear to have a definite relationship with the specific backgrounds of the respective authors. These include the ecosystem and soil conservation studies as discussed. This observation is pertinent, in fact, for most 'scientific objective' investigations, for example involving questionnaires where the areas chosen for exploration by the researcher reflects lines of interest and, in turn, the background of the latter. Thus it is becomes obvious that the researcher bias in this type of study is inevitable and manifested in the choice of questions/variables. This naturally does not render such research invalid - cognizance and understanding of such biases are, however, unfortunately frequently not perceived and taken into account by researchers especially within the natural sciences.

3.0 MEASURING THE VARIABLES

As this is a pilot study, the diverse array of variables examined will provide future researchers with information as to which variables could be useful for predicting 'Conservation Behaviour'. However, it is necessary to ensure that these can be assessed meaningfully in practice. The 'less tangible' variables give most reason for concern because, partly by definition, different raters can be expected to show considerable variance in measuring the latter. This is because of differences in individual interpretations, values and perceptions etc. Yet it is also such 'less tangible' variables, traditionally "untapped" in most formal scientific investigation, which may be of most value for the in-depth analysis of the genesis of 'Conservation Behaviour'.

All 53 variables, including 52 'independent' variables and 1 'dependent' variable, namely 'Conservation Behaviour' itself, were subsequently delimited under 'Definition', 'Deduction' and 'Scale'. (See Appendix 1.) As would be expected, the measurement, but not necessarily the choice of the 'tangible' variables (as discussed above) is largely objective and therefore routine. The challenge of assessing the 'less tangible' variables forms the main thrust of this paper.

3.1 'Less Tangible' Variables

The tape-recorded interviews, together with copies of the variables as delimited, were given to two graduate students for assessment. Both the latter possessed qualifications and/or experience in the biological/ sociological/psychological fields, so could realistically interpret the delimitations of the variables. At the outset, it was decided that the three workers (writer and the two student assistants), would work independently from one another in interpreting both variable delimitations and tape-recorded material. Independent assessment was considered essential in determining whether: a) the variable delimitation could 'stand by itself' as far as it could be mutually understood, and b) whether the assessors could achieve a significantly high level of mutual consistency in their independent ratings of landowners with the respective 'less tangible' variables.

The raters subsequently sequenced the 36 landowners in the sample for each of the 'less tangibles'. Although no parametric values can be attached realistically to a landowner's performance in eg "Knowledge of Flora" as a 'less tangible' it is fairly easy to determine whether one subject has greater knowledge than a second subject, and where a third subject can be rated with respect to the first two etc. This non-parametric measuring procedure was achieved by successively pencilling landowner names in approximate sequence in columns beneath variable titles, while leaving sufficient space for inserts of subsequent ratings. (Of course, the use of a computer screen would have considerably facilitated this procedure.) No ties were allowed for the reasons provided subsequently. The process became more and more mind boggling with incremental ratings for successive landowners, as raters had to be able to recall all subjects previously assessed for comparison. The ordinal rating scale was, however, necessary because of the impracticality of providing scores on an interval scale.

The reasons for disallowing the use of ties, within the rankings should be discussed. Firstly the main problem with ranking is the extent of variation apparent between numbers of 'natural' ranks with the different 'less tangible' variables. Given the information base the number of 'natural' ranks should theoretically vary according to the perceptions of each specific rater. For example, a particular assessor may consider it realistic to divide 'Influence of Spouse' (on conservation -see Appendix 1) into two categories only, such as:- i) where there is a significant influence of the spouse on conservation, or ii) where there is negligible influence of spouse on conservation. As a second example 'Knowledge of Fauna' could be divided into five categories, namely: i) 'No apparent knowledge', ii) 'Rudimentary (if inaccurate) knowledge', iii) 'Average knowledge', iv) 'Higher than average knowledge', v) 'Exceptionally high knowledge'.

However, in practice, the eliciting of tied ranks from the two independent assessors proved unrealistic. After having sequenced the subjects from 1 to 36 beneath each variable, all 3 assessors (including the writer) then proceeded to cluster them into what they considered to be realistic tied ranks. Unfortunately, there was absolutely no consistency in number of ranks chosen for the variables by the three assessors. A single assessor would tie a few pairs of subjects and leave the others untied while another would place subjects under the same variable into two large groups! Overall, therefore, the untied ordering of subjects was considered most appropriate because it did not allow for easy and unrealistic shortcuts that could result in a tendency to produce more ties than necessary. This seemed more prevalent with the results produced by the helper assessors.

The approach of using a number of assessors to provide independent ratings of tape-recordings is partly analogous to that of a jury weighing up the pros and cons of a court case. Clues, both explicit, eg what is actually said, and implicit, eg the way a thing is said, go into the assessment of a subject's ratings. In much the same way that the written law has an objective reality, but its implementation necessitates the use of subjective assessment (viz judge, jury and/or other assessors), this principle is applied to the present assessment. Subconscious reasoning, which collates myriads of informal clues from the tape, forms a vital basis for determining where one subject is placed relative to another in an ordinal rating scale.

With certain 'less tangible' variables, such as the 'Affluence' variables,(numbers 12 to 15 in Appendix 1) secondary measurement 'aids' were also provided to the assessors. These comprised government field-sheets, which provided itemised valuations of immovable property of the landowners normally used for the purpose of rates levies. A second more generalised aid included 1 : 50 000 map of the properties showing terrain crop-types and areas of renosterveld (Appendix 1).

When the student assessors were asked subsequently, they did not feel that there were additional variables that needed to be included in the analysis. (This exercise may, however, have been more effective had the students originally been requested to provide variables (as such, representing 'constructs') de novo.)

Finally, the writer gave no communication, verbally or in writing, to the student assessors concerning the nature of the hypotheses associated with the variables. For example, the variable 'Education' embodied the hypothesis that 'Conservation Behaviour' is a function of increased education level. This was critical because it has been proven that a tendency exists for student helpers (often subconsciously) to 'substantiate' the hypotheses (even if these are fictitious) of the project leader in order to 'satisfy' the latter's expectations (Rosenthal, 1970).

The extent of consistency between permutations of the three independent sequences set on the landowners for a particular 'less tangible' variable, was taken to approximate the magnitude of certainty with which the latter could be gauged. Spearmans Correlation Coefficient (Rho) was used to measure inter-observer consistency for all permutations between the writer and the two assistants with every one of the 31 'less tangible' variables.

The results in Table 1 show a wide range in inter-observer consistency downwards from mean Rho = 0.828 ('Conservation Behaviour') down to mean Rho = 0.123 ('Conservation Problems').

As might be expected, greater consistency was present between the overall ratings provided by the student assistants. In Table 1, 'A' is the writer and 'B' and 'C' represent the student assistants. The B-C average correlation (R = 0.534) is marginally greater than the A-B and A-C average correlations (R = 0.525 and 0.531 respectively). However, this difference is minimal. Hence, even without previous personal acquaintance with the landowner subjects, the student assistants produced remarkably similar ratings to that of the writer. This indicates that more of the type of 'less tangibles' as

TABLE 1

SPEARMAN'S RANK-ORDER CORRELATIONS BETWEEN THREE INDEPENDENT OBSERVERS' RATINGS FOR 32 'LESS TANGIBLE' VARIABLES

Variables	Pairwise Comparisons			Means
	A-B	A-C	B-C	
Conservation Behaviour.	0.832	0.912	0.740	0.828
Language Orientation.	0.802	0.885	0.693	0.793
Non-liquid Capital.	0.915	0.674	0.724	0.771
Knowledge about Flora.	0.722	0.816	0.722	0.753
Overall Affluence.	0.801	0.731	0.698	0.743
Lifetime in Urban Area.	0.717	0.763	0.671	0.717
Knowledge about Ecosystem.	0.742	0.759	0.635	0.712
Future Tenure of Subject.	0.753	0.778	0.641	0.724
Bilingualism.	0.654	0.788	0.667	0.703
Conservation Attitude.	0.669	0.671	0.729	0.690
Understanding of Project.	0.699	0.661	0.599	0.653
Overall Interest in Ecosystem.	0.697	0.623	0.649	0.656
Influence of Spouse.	0.730	0.534	0.655	0.640
Dependence on Land.	0.613	0.716	0.486	0.605
Liquid Capital.	0.584	0.605	0.591	0.593
		α = 0.0001	R =	0.586
Future Development Rate.	0.543	0.610	0.493	0.549
Knowledge of Fauna.	0.705	0.495	0.380	0.527
		α = 0.001	R =	0.525
Rapport with Interviewer.	0.305	0.529	0.720	0.518
Materialism.	0.557	0.410	0.523	0.497
Willingness to Donate Veld.	0.396	0.331	0.664	0.464
Reliability of Information.	0.446	0.446	0.442	0.447
Commercial Potential of Veld.	0.619	0.394	0.277	0.430
Influence of Tradition.	0.514	0.384	0.384	0.427
		α = 0.01	R =	0.418
Willingness to Lease Veld.	0.411	0.196	0.509	0.372
Innovation of Development Plans.	0.176	0.620	0.224	0.340
		α = 0.05	R =	0.329
Willingness to Sell Veld.	0.328	0.310	0.331	0.323
Subdivision Problems.	0.460	0.217	0.222	0.300
Achieved versus Ascribed Affluence.	0.190	0.207	0.429	0.275
		α = 0.1	R =	0.275
Past Development Rate.	0.095	0.294	0.389	0.259
Attitude Flexibility.	-0.124	0.440	0.458	0.258
Present Commercial Utility of Veld.	0.117	0.098	0.324	0.180
Conservation Problems.	0.131	0.085	0.414	0.123
	-----	-----	-----	-----
Means	0.525	0.531	0.534	0.530 $\pm$ 0.003

defined in Appendix 1 can be effectively quantified than would be generally expected.

3.2 The Error Factor

Subsequent deliberation amongst co-workers (including as well the student assistants) produced the following tentative suggestions for major sources of inter-observer error:

a) The variable is one that, either because of its 'less tangible' nature, or because of weak elicitation on the taped interview, presents difficulties in its rating.

b) The observers lack a mutual understanding of the delimitation of the criteria used to rate the variable through either: i) not having understood the written definition; or ii) not having sufficient technical expertise in the subject matter to which the variable relates.

c) 'Observer lethargy' is likely to occur with the assessors because of the relatively large number of variables which have to be rated. There is, therefore, a tendency to 'cut corners' should there be a lapse in the concentration or motivation etc of the raters.

Error sources (b) and (c) could probably largely be reduced by means of the Delphi Method (See Pill, 1971 for an overview). Pill defines the Delphi technique as "a method of combining the knowledge and abilities of a diverse group of experts to the task of quantifying variables which are either intangible or shrouded in uncertainty". He goes on to say that an 'expert' is really only someone who can contribute relevant inputs. In the current study the writer and the two assistants, in effect, parallel the Delphi panel of experts. Dalkey (In Pill , 1971) states that the Delphi method has three features: 1) Anonymity, 2) Controlled feedback, and 3) Statistical group response. The independent ordinal rating is akin to the first step in a Delphi sequence. The fact that the 'observer ratings' are independent, follows the Delphi principle of reducing unseen bias that may be created by dominant individuals , viz in the present exercise, probably the writer. However, for a subsequent Delphi sequence to be effective, several (not merely 3 raters) would be required. Space precludes details other than the principles of how this technique could be applied to the present study. Pill (1971) defines controlled feedback as a "sequence of rounds between which a summary of the results of the previous round (Stage 1) is communicated to the participants - a device for reducing noise" (Stage 2). In the present study Stage 1 corresponds to the ratings given the subjects for the variables while Stage 2 corresponds to the inter-observer error factor. Pill continues to define statistical group response as "a way of reducing group pressure for conformity ..." and as "a device to assure the opinion of every member of the group is represented in the final response."

However, apart from realising that more sophisticated techniques may exist for reducing the margin of observer error, in particular (b) and (c) categories, it is felt that where Delphi gains in finesse it loses in practical significance. Additional raters and computer coding of results would not be cost effective in terms of time or money with the present study but could probably be the object of future investigations. It is also considered that overall error namely the 'collective' of the (a), (b), (c) categories, is still particularly meaningful as a single entity, that is, it specifically encapsulates the difficulty of obtaining measurement of the respective 'less tangible' variables. It seems safe to assume that a gradation in 'tangibility' clearly exists, not only for the present variables, but within the myriads of personal constructs which are continuously being rated in everyday life (mostly subconsciously) for interpreting and predicting our environments. (See under "Data Collection and the Selection of Variables")

3.3 Selecting Eligible Variables.

The main reason for having independent raters for the 'less tangible' variables is to determine which of the latter can be rated with a sufficient margin of certainty. A high inter-observer consistency infers that the three raters are 'on the same wavelength' and are measuring the same, almost abstract, quantity which indicates the extent to which the latter is 'real'.

For the purpose of successive inferential statistical analyses of ecosystem conservation behaviour (McDowell and Sparks, 1988) it was decided to make the threshold of Rho = 0.519 P = 0.001 (35 degrees of freedom) the threshold for determining significant inter-observer consistency. A total of just over 50% (17 out of 32) of the variables satisfied this criterion.

The agreement is substantially greater between the two assistants (B-C) than the average between the ratings involving the writer (A-B + A-C /2). This is absent where inter-observer consistency is highest. No single factor (of those listed) can be put forward to support this observation, except to say that the perceptions of the writer differ more from the assistant raters where overall observer error is greatest. In terms of the Delphi technique it also cannot be said that the writer, being the 'dominant' researcher, would be necessarily 'right' in his assessment, with the others being 'wrong'. They could well concur on mutual insights lacking to the writer. In democratic fairness, therefore, observer ranks for each subject were averaged for the variables. These averages were taken as the final empirical readings for the ratings provided for the subject landowners with respect to the 'less tangible' variables.

4.0 DISCUSSION

A principle objective of this paper has been to describe a method for the collection and rating of a wide array of variables which may be in any way related with Ecosystem Conservation Behaviour. Once rated successfully, the variables can be subjected to a variety of multivariate statistical analyses which are useful in interpreting 'Conservation Behaviour'. Analyses are provided in detail in McDowell and Sparks (1988). It is only necessary, for present purposes, to synthesise certain findings below.

The linear prediction model selected by means of the ' Best Subsets' computer programme (Frane, 1983), which contained five predictor variables and explained 95% of the variability of 'Conservation Behaviour', was as follows:-

$$Y = 16.575 + 0.579\ (X12) + 0.298\ (X4) + 0.118\ (X1) - 0.001\ (X42.\ X13) - 0.210\ (X18)$$

Y = 'Conservation Behaviour'; 16.575 = a constant term; X12 = 'Overall Interest in Ecosystem'; X4 = 'Overall Affluence'; X1 = 'Language Orientation'; X42.X13 = 'Past Tenure of Family' multiplied by 'Dependence on Land' (interaction term), and X18 = 'Materialism' (McDowell and Sparks, 1988 for details).

Of the explanatory variables all the terms except the one interaction term, namely 'Past Tenure of Family', notably comprise 'less tangible' variables.

The latter prediction precision represents a significant improvement on related soil conservation behaviour predictors obtained in analogous studies referred to under "1.0 Introduction"; namely Earle et al. (1979) and Napier et al. (1985). Napier et al., using as a basis 16 independent variables, achieved R squared values ranging from just 0.03 to only 0.24 for a series of independent conservation variables and from 2 to 6 dependent variables in each equation. Earle et al., using the Linear Discriminant Function and a basis of 31 independent variables, were able to predict with 80% certainty whether respondents fell into 'adopter' or 'non-adopter' soil conservation intention categories. The 80% certainty is, however, obviously an overestimation insofar as prediction into greater than 2 categories is concerned. In the present study it was found (using the above predictor equation) that the sample respondents could be placed into 5 separate categories of ecosystem 'Conservation Behaviour' with 100% accuracy. (For further details see McDowell and Sparks, 1988.)

5.0 CONCLUSIONS

This paper has focussed on the selection and measurement of what is considered to be a reasonably wide spectrum of variables. Included were a considerable number of 'less tangible' variables. Because some of these are open to considerable subjective bias it has generally been more customary to ignore such 'soft data'. However, it is hoped that readers are convinced that fruitful results can be obtained through use of innovative methods to measure some of these. Apart from producing more satisfactory quantitative analyses (McDowell, 1988), it is felt that the flexible, inductive interview approach adopted had value in generating new ideas and hypotheses which could be incorporated retroactively.

The attention given to 'less tangible' variables as an analytical basis for understanding subjects partly derives from the repertory grid methodology where this type of variable is closely akin to personal constructs. (See under 'Data Collection and the Selection of Variables') The types of variables selected, whether by questionnaire, interview, etc will therefore vary considerably with different individuals undertaking investigations into the <u>same</u> research problem. A study of this nature is likely to be most comprehensive if several researchers from differing backgrounds and fields of interest etc were to form cooperative teams in order to 'pool' their multi-disciplinary expertise to produce a holistic and practical selection of 'constructs'. This especially applies to analysing the microcosms of human behavioural phenomena where bias on the part of a single researcher's interest/background may be inadequate for in-depth investigations.

A probable forte of the research described has been its concentration on greater depth of assessment of far fewer subjects (with a 100% response rate) than appears to be the standard tradition of attempting to elicit extensive samples and "skimming the surface" with necessarily superficial questionnaires. The temptation to use this 'fast science' method is normally over zealous because questionnaires are readily amenable to mass computer coding and analysis. However, one drawback of the alternative intensive form of assessment described is its relatively high outlay (man-hours, travel, etc.) per respondent evaluated. (See also McDowell and Sparks, 1988.)

Certain psychological schools have criticised the application of the positivist approach to analysing so complex and seemingly paradoxical human behavioural-related phenomena. (See Harre and Madden, 1975; Schwartz and Jacobs, 1979 for critiques) It is argued, for example, that the quantitative testing of hypotheses, measurement of variables, in attempting to explain or predict human behaviour represents an unrealistic adoption of a Popperian methodology which can, and should, only be used in the true natural sciences where the principle originated. The prevalence of intangible, ie unquantifiable factors in influencing human behaviour are seen to militate against the generation of simplistic reductionist and/or determinist analyses.

Although the writer has reservations about the positivistic reduction of behaviour into, say, a series of linear equations, it is felt that many more traditionally unmeasured 'intangible' (normally 'less tangible') factors can be gauged with an acceptable margin of error. This can favour a "modified", positivist approach towards certain behavioural analyses. However, with myriads of different facets of human behaviour, one should not over-extrapolate results from just one specialised behavioural study such as described.

Many environmental behavioural analyses should benefit were more judicious attention paid to those subjective, and/or difficult to measure 'less tangible' background factors where they relate to specific actors controlling aspects of the environment - be they farmers, researchers or any other critical target group. The development of improved methods for the delimitation of such factors must also, therefore, form a vital basis for the analysis, interpretation and modification of the attitudes and behaviour of human individuals or groups which underpin so many environmental problems.

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APPENDIX 1
(TO PAPERS 3 AND 4)

MANUAL FOR ASSESSING VARIABLES RELATING TO
THE 'CONSERVATION BEHAVIOUR' OF FARMERS
WHO OWN VULNERABLE ECOSYSTEMS

INTRODUCTION

A series of variables having conceivable direct or indirect relationship with attitudes and/or activities in the conservation field are described. Each variable is separated into the following components:-

A) DEFINITION - definition of the variable for the basis of analysis.

B) DEDUCTION - criteria for the measurement of the variable.

C) SCALE - index for the measurement of the variable.

All variables have been defined as being either 'tangible' or 'less tangible'. The direct acquisition of metric readings for the former 'tangible' variables provide no particular difficulty.

The remaining variables are slotted into the 'less tangible' category either because of their largely qualitative nature (innaccuracy through 'subjectivity') or because realistic measurement is not feasible (innaccuracy through 'uncertainty'). An example of the former category could include the 'less-tangible' variable "Materialism" which is so highly qualitative that measurement which, being prone to subjective bias, certainly cannot be readily translated into units. An example of the latter category, where realistic measurement is not feasible, is the 'less tangible' variable "Non-liquid Capital" for which numeric measurements technically do exist. However, owing to the secrecy and uncertainty surrounding such a personal attribute (at least as far as the subject is concerned), a sufficiently large degree of subjectivity is present to justify a 'less tangible' status.

All 'tangible' variables are provided with numeric ratings as accurately as possible. The procedure adopted with each of the 'less tangible' variables is to provide untied ordinal ratings to the subjects. Assistants to the writer have to make use of all formal and informal information available on tape-recordings of the interviews (as well as in certain cases other secondary information sources) to provide the subjects with an ordinal sequence from 'highest' to 'lowest'. The latter raters must work entirely independently from one another and the writer in providing the ratings. Guidelines (which are largely 'rules of thumb') are presented in this manual for the assessment of all variables.

(Full rationale for the rating technique is provided in the appended paper: McDowell, Clive, 1988, "Attitudes and behaviour of farmers towards ecosystem conservation: a new approach to assessing associated variables.")

CATEGORIES OF VARIABLES

INDEPENDENT VARIABLES

A) DEMOGRAPHIC VARIABLES

Individual
1. Gender ('Tangible')
2. Age ('Tangible')

Family
3. Number of Siblings ('Tangible')
4. Number of Children ('Tangible')

Tenure of Property
5. Past Tenure of Subject ('Tangible')
6. Past Tenure of Family ('Tangible')
7. Future Tenure of Subject ('Less Tangible')
8. Generations Farming ('Tangible')

Formal Education
9. Education ('Tangible')
10. Biological Orientation in Education ('Tangible')
11. Parents' Education ('Tangible')

Affluence
12. Non-liquid Capital ('Less Tangible')
13. Liquid Capital ('Less Tangible')
14. Overall Affluence ('Less Tangible')
15. Achieved Versus Ascribed Affluence ('Less Tangible')

Language and Nationality
16. Language Orientation ('Less Tangible')
17. Bilingualism ('Less Tangible')
18. Origin ('Tangible')
19. Language with Origin ('Tangible')

Rural versus Urban
20. Lifetime in Non-Rural Area ('Less Tangible')

B) LAND USE VARIABLES

Areas
21. Area of Land ('Tangible')
22. Area of Veld ('Tangible')
23. Area of Renosterveld ('Tangible')

Valuations
24. Rateable Valuation of Property ('Tangible')
25. Rateable Valuation of Veld ('Tangible')
26. Value Proportion of Veld to Land ('Tangible')

Development of Veld into New Lands
27. Past Development Rate ('Less Tangible')
28. Future Development Rate ('Less Tangible')
29. Innovation of Development Plans ('Less Tangible')

Utility of Land
30. Present Commercial Utility of Veld ('Less Tangible')
31. Commercial Potential of Veld ('Less Tangible')
32. Dependence on Land ('Less Tangible')
33. Period Veld used for Pasture ('Tangible')

C) PSYCHO-SOCIAL VARIABLES

Personality - Interaction
34. Rapport with Interviewer ('Less Tangible')
35. Reliability of Information ('Less Tangible')

Personality - Attitude
36. Understanding of Project ('Less Tangible')
37. Attitude Flexibility ('Less Tangible')
38. Materialism ('Less Tangible')

Social Influence
39. Influence of Spouse ('Less Tangible')
40. Influence of Tradition ('Less Tangible')

Cognition
41. Knowledge of Flora ('Less Tangible')
42. Knowledge of Fauna ('Less Tangible')
43. Overall Knowledge of Ecosystem ('Less Tangible')

Motivation
44. Overall Interest in Ecosystem ('Less Tangible')
45. Conservation Attitude ('Less Tangible')

D) CONSERVATION STRATEGY VARIABLES

Acquisition Problems
46. Willingness to Sell Veld ('Less Tangible')
47. Willingness to Lease Veld ('Less Tangible')
48. Willingness to Donate Veld ('Less Tangible')
49. Conservation Problems ('Less Tangible')
50. Subdivision Problems ('Less Tangible')

Costs
51. Landowners Valuation of Veld /Hectare ('Tangible')
52. Landowners Lease Valuation of Veld /Hectare ('Tangible')

DEPENDENT VARIABLE

1. Conservation Behaviour ('Less Tangible')

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
INDEPENDENT VARIABLES.			
A) DEMOGRAPHIC VARIABLES.			
Individual			
1. Gender ('Tangible')	Self-explanatory.	Direct.	Male = '1', Female = '2'.
2. Age ('Tangible')	Self-explanatory.	May, if necessary, also be obtained indirectly eg including enquiries as to the particular year school was completed. If it is known that Standard 10 was completed, the age at that year must have been approximately 18; which allows for estimation of the present age.	Number of years.
Family			
3. Number of Siblings ('Tangible')	Self-explanatory.	Direct.	Number of individuals (including the subject.)
4. Number of Children ('Tangible')	Self-explanatory.	Direct.	Number of individuals.
Tenure of Property			
5. Past Tenure of Subject ('Tangible')	Years that the subject has owned, or resided upon, the relevant property.	Direct.	Number of years.
6. Past Tenure of Family ('Tangible')	Time that the relevant property has been under ownership by the subjects family or family line.	Direct.	Number of years.
7. Future Tenure of Subject ('Less Tangible')	Future number of years that the present landowner is likely to make policy decisions on the running of the farm.	Time period is taken until the stated retirement age or, if a definite answer is not provided, until 70 years of age (the approximate stated retirement age for most farmers on the sample).	Ordinal - owing to uncertainty.
8. Generations Farming ('Tangible')	Self-explanatory.	Direct.	Number of generations.
Formal Education			
9. Education ('Tangible')	Years of study completed at school as well as where	Replies to direct or indirect questioning. (An enquiry to the means by which the subject has gained	Numbers of completed full-time (or

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
	applicable at college (diploma study) or at university (degree study).	his/her present knowledge of agriculture is an example of an indirect question.)	equivalent) years of study. Diplomas or degrees (2 to 5 years full-time) need not necessarily be completed to be eligible for ratings - eg only 1 year passed would also merit a full point.
10. Biological Orientation in Education ('Tangible')	The extent to which tertiary education involves biologically related study courses.	Refinement of information from Variable 9.	Single points, in addition to those assigned for completed secondary education, are only given where tertiary education has biological content. Years completed in eg Commerce, Engineering and Law etc would, therefore not be provided points; whereas years with biological content eg years including Biological or Environmental Conservation subjects as majors are given two full points each.
11. Parents' Education ('Tangible')	The mean formal education level achieved by the subject's parents.	Replies to direct and/or indirect questions.	Mean number of years for both parents. This involves taking the mean between ratings for each parent in the same way as defined for subjects for Variable 9.
Affluence			
12. Non-liquid Capital ('Less Tangible')	All assets for which transfer and sale thereof are not easily and quickly negotiable. This includes all fixed assets (immovable as well as depreciable capital items), loans given and any interests in joint ventures, partnerships or private companies.	The approximate order of value for agricultural property is obtained indirectly from the annual net income - as indicated in the interviews. This generally has some proportional relationship to the market value of the property as a 'going agricultural concern'. This 'going concern' principle need not always be applicable, particularly where the farm is inefficiently run, or where it is valued higher for other reasons, eg for peri-urban expansion potential. Guidelines include: i) Rateable valuations obtained from the Divisional	Ordinal - owing to the uncertainty in determining the exact present and future values of fixed assets such as that of land.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
		Council records which provide a supporting measure for deducing proportional differences between the values of the properties owned by the different subjects and their immovable assets. ii) Details of additional fixed assets: descriptions or values not necessarily obtainable from Divisional Council records may be deduced from the interviews. iii) Details of long term liabilities, eg bond repayments still outstanding, must also be taken into account in determining net fixed assets. This frequently sensitive information is obtained through tactful questioning at strategically suitable instances in the interviews. iv) Rough orders of "fixed wealth" are also cross-checked through "peer evaluation". Thus certain landowners may be requested discreetly to apply an order in terms of fixed wealth, to other subjects known to them within a particular region.	
13. Liquid Capital ('Less Tangible')	All assets for which transfer and sale thereof are easily and quickly negotiable. Examples include bank and building society accounts, life assurance deposits and interests in public companies etc.	Similar sources to those for Variable 12 are used. Due to the great difficulty in obtaining independent estimates of income and savings from financial institutions such as revenue offices, banks and building societies etc greater reliance must be made on purely interview material. Guidelines include: i) Yearly net pre-tax income from property. If not obtainable from the interviews, this can partly be extrapolated from the value of the property, if the latter is related to the 'going concern principle'. (See Variable 12.) ii) Extent of long term liabilities. This includes bonds to be repaid, outstanding estate dues to siblings etc. iii) Alternative income sources. This includes other income generating sources such as business, investment or farming enterprises. (These could also be registered in the spouse's name.) iv) Inherited liquid capital. The spouse's capital can (where applicable) also be taken into account to form a collective whole for the family. v) Age. Normally older subjects have had greater opportunities to accumulate capital.	Ordinal - owing to uncertainty.
14. Overall Affluence ('Less Tangible')	Sum of Variable 12(i)and Variable 13(i).	From Variable 12(ii) and Variable 13(ii).	Ordinal - owing to uncertainty.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
15. Achieved Versus Ascribed Affluence ('Less Tangible')	The extent to which the individual has accumulated capital, or means which have achieved that end, independently from forbears or relatives. This implies the degree to which the individual has achieved the financial status of being a "self-made man or woman".	Largely from early family background information broadly discussed in the interviews. This gives a reasonable indication of the extent to which the subject has been upwardly mobile, has achieved capital independently from forbears, relatives, etc (as defined under Variables 12, 13 and 14). Guidelines include: i) Whether the present landowner has inherited immovable property or has had to acquire this through personal enterprise. ii) The relative affluence of predecessor (where indicated). iii) The nature of the subject's education, ie has the subject achieved relatively high affluence while lacking informal education ('human capital'). (This may have resulted from the parents not having been able to afford the education costs). iv) The number of the subject's siblings. The greater this number, the lesser the proportion will be of distributable resources from forbears (other factors being equal).	Ordinal - owing to uncertainty.
Language and Nationality			
16. Language Orientation ('Less Tangible')	At one extreme of the Language Orientation scale are included the subjects with the most dependence on English as a means of communication, (little or no ability in Afrikaans). The opposite of the same scale includes subjects with most dependence on Afrikaans as a means of communication (little or no ability in English). Bilingual subjects fall therefore in the mid-range. (Other languages are omitted because all sample subjects including foreigners spoke either English or Afrikaans at their homes).	During the course of the normally lengthy interviews, held in either English or Afrikaans, the subject's level of dependence on either language can be gauged quite effectively. Guidelines include: i) The language in which the interview is held. For example, if the subject is Afrikaans speaking, can/does he/she show any capacity to speak English? This capacity is quite likely to be demonstrated as English is the home language of the interviewer. ii) The effective comprehension of occasional English words as used by the interviewer when the interview is held in Afrikaans. iii) The effectiveness of communication by the English speaking subjects in Afrikaans, with any Afrikaans third parties present at the time of the visit, eg servants, neighbours, visitors, etc. iv) The presence or indication of the comprehension of media in the "non-home language" of the subject, including literature, radio and television, etc.	Ordinal - owing to uncertainty.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
		v) Language spoken by kin of the subject, eg if the one parent or wife/husband belongs to the opposite language group to the subject, this indicates that the latter probably has a lesser dependence on just his/her language group.	
17. Bilingualism ('Less Tangible')	The capacity of the subject to communicate equally well in both English and Afrikaans.	Identical to that for Variable 16 except that bilingual subjects are given the highest ratings whereas subjects proficient in only one of either of the two languages are given the lowest ratings.	Ordinal - owing to uncertainty.
18. Origin ('Tangible')	Country of birth.	Direct.	Born in South Africa = '1'. Foreign origin = '2'.
19. Language with Origin ('Tangible')	Self-explanatory. (See under Scale.)	Request for home language and origin.	South African born with Afrikaans as a home language = '1'. South African born with English as a home language = '2'. Foreign origin = '3'.
Rural versus Urban			
20. Lifetime in Non-Rural Area ('Less Tangible')	Proportion of the subject's life (to date) spent in land areas not zoned as 'urban'.	Direct.	Ordinal - owing to uncertainty.
B) LAND USE VARIABLES			
Areas			
21. Area of Land ('Tangible')	Total area of property/ies owned by the subject together with, if married, his/her spouse.	From interviews and checks with Divisional Council 'field sheet' data.	Number of hectares.
22. Area of Veld ('Tangible')	Area of veld on the property/ies that has not been previously cultivated.	From interviews, 1:50 000 maps and checks with recent Divisional Council 'field sheet' data.	Number of hectares.
23. Area of Renosterveld ('Tangible')	Area of renosterveld (as distinguished from other types of veld in the south western Cape such as fynbos, strandveld etc) on the property/ies that has not been previously cultivated.	From interviews, 1 in 50 000 maps, checks with Divisional Council 'field sheet' data, field visits and botanical literature. (The latter two sources can be used to help distinguish the relatively more arable renosterveld areas from the other normally less exploitable veld types.	Number of hectares.
Valuations			
24. Rateable Valuation of Property ('Tangible')	The valuation of immovable assets as determined by the Divisional Council for the purpose of rates.	'Field sheets' prepared by professional valuators for the Divisional Council of the Cape Province all provide itemised valuations for all immovable	Total number of rands.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
		properties under the subheads: a) Land (valuations of various categories of developed and less developed lands); b) Buildings (residential only); c) 'Beneficial Improvements' - to the lands (including, for example, the valuation of trellises, (for vineyards or other orchard crops) fences, dams, irrigation lines, stores and livestock enclosures. Often the subjects possess immovable assets other than farms such as holiday homes etc - for which 'field sheet' data are similarly available.	
25. Rateable Valuation of Veld ('Tangible')	Valuation of lands that have neither been ploughed nor have had crop plantings thereon. (Crops including timber and artificial pasturage represent similar impacts on natural vegetation - but do not necessarily require lands to be 'ploughed' per se.)	Same source as Variable 24. Include the Valuations, - under a) Land specifically stated in the field sheets to be 'Veld', 'Pasturing Veld' or 'Unused Lands'.	Total number of rands.
26. Value Proportion of Veld to Land ('Tangible')	The proportion of the total rateable valuation of land that has neither been ploughed previously nor had crop plantings thereon.	Itemised valuations from Variable 24 : Subhead (a).	Percentage of value.
<u>Development of Veld into New Lands</u>			
27. Past Development Rate ('Less Tangible')	Speed of (mostly) agricultural development which has displaced natural veld adjoining the current renosterveld remnants within the recent past ca 10 years.	From interview material. If the latter is doubtful or unclear, this is substantiated by aerial photograph 'time series' data which is obtained from the relevant government department.	Ordinal - owing to uncertainty.
28. Future Development Rate ('Less Tangible')	Speed of development, (mostly agricultural), likely to replace natural veld in the near future, assuming the continued action of present operating factors over a longer timespan.	Interview material with reference to relevant sketches which have been drawn by the subjects. Guidelines include: i) The extent of veld threatened by development ii) The imminence of the development	Ordinal - owing to uncertainty.
29. Innovation of Development Plans ('Less Tangible')	The degree of originality apparent when the subject is asked how he/she would 'develop' veld for improved agricultural production.	Guidelines include: i) The level of departure from the orthodox in ideas for feasible developments.	Ordinal - owing to subjectivity.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
		ii) The likely application of suggested development plans.	
Utility of Land			
30. Present Commercial Utility of Veld ('Less Tangible')	The present agricultural returns per unit area of the veld as perceived by the landowner.	From interview material. If information seems unreliable, reference is made to secondary sources, eg Divisional Council valuation sheets and information from the Agricultural Extension Service. (The sole agricultural returns in all cases involve pasturage.) Guidelines include: i) The number of months per year that the veld is grazed (See Variable 23). ii) The density of stock per hectare.	Ordinal - owing to subjectivity.
31. Commercial Potential of Veld ('Less Tangible')	The future returns per unit area of the veld as expected by the subject if developed either through replanting with crops, pasturage or timber.	Guidelines include - in descending order of priority: i) The total discounted value of all future expected income for the particular crop/plantation. This involves the usual principle in assigning net values to newly developed, freshly planted lands. ("Net" indicates that development costs have been taken into account.) ii) The proportion of remaining veld projected for development. (The greater the measurements for i) and ii) the higher the potential.)	Ordinal - owing to subjectivity.
32. Dependence on Land ('Less Tangible')	Direct dependence on produce of property/ies for making a living at present or in the future.	Extrapolate from Variables 9 to 15 'Formal Education' and 'Affluence' categories. Guidelines - in descending sequence of importance include : i) The greater the proportion of income derived directly from the land, ie not from other non land investments, the higher the rating. ii) Where income is derived from interests on liquid capital; higher ratings are assigned when that capital has been obtained directly from agricultural produce. iii) Where proportions of income derived from the land approximates 100% total income then, formal education level ("human capital") becomes the discriminant. The lower the education, therefore the higher the dependence rating, eg in an instance of forced "independence" from the land, such as insolvency. (With other factors being equal, those individuals with the highest education level would have the greatest potential income).	Ordinal - owing to subjectivity.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
33. Period Veld used for Pasture ('Tangible')	Proportion of the year that veld is used for pasturage by livestock.	Direct.	Percentage of year.
C) PSYCHO-SOCIAL VARIABLES			
Personality - Interaction			
34. Rapport with Interviewer ('Less Tangible')	The ease of interaction of the subject with the interviewer.	Guidelines include: i) 'Spontaneity' of the discussion - that is the absence of general inhibition in imparting information. ii) General 'friendliness' towards the interviewer. iii) Lack of suspicion concerning the project's motives.	Ordinal - owing to subjectivity.
35. Reliability of Information ('Less Tangible')	The reliability of information imparted by the subject. (Differs from Variable 34 as freely given information is not necessarily reliable).	Guidelines include: i) Openness and honesty of the subject in imparting sensitive information. ii) Lack of apparent exaggeration in the information provided. iii) Correlation of the subject's accounts of attitudes, etc, with observed activities, eg if the subject discusses nature conservation activities or motives, how strong is the observed and/or verbal supporting evidence for this? iv) Any independent personality appraisals provided by other neighbours, acquaintances, etc.	Ordinal - owing to subjectivity.
Personality - Attitude			
36. Understanding of Project ('Less Tangible')	The overall comprehension of the project's content and motives: both in the understanding of the information provided as well as through the asking of appropriate questions.	Guidelines include: i) The speed of perception of the project's objectives by the subject while taking into account the particular and varied quality of the interviewer's explanations. ii) The type of questions asked by the subject of the interviewer. iii) The subjects' interest and enthusiasm in the objectives of the project.	Ordinal - owing to subjectivity.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
37. Attitude Flexibility ('Less Tangible')	The receptiveness of the subject towards 'rational' and/or 'new' information.	Guidelines include: i) The extent to which the subject understands - and is prepared to accept what the interviewer says, especially if it is contrary to his/her preconceived beliefs. ii) The willingness of the subject to accede to reasoned argumentation. iii) The willingness of the subject to keep quiet and to concentrate on what is said by the interviewer. iv) The willingness of the subject to empathise with the interviewer in attempting to understand the "other side" of an argument.	Ordinal - owing to subjectivity.
38. Materialism ('Less Tangible')	The predominance of the subject's commercial values over his/her aesthetic values.	Guidelines include: i) The degree to which the subject spontaneously refers to commercially related concepts, eg costs, financial returns - in a general sense during the interview. ii) The degree to which the subject perceives value of veld in a commercial rather than an aesthetic sense. The priority sequence set by subjects on a series of cards, each bearing various aesthetic and commercial alternative 'value options' (applicable to the veld on their properties), may also be used.(1)	Ordinal - owing to subjectivity.
Social Influence			
39. Influence of Spouse ('Less Tangible')	The influence exerted by the spouse (in most cases the wife), on the conservation decision-making processes of the subject (in most cases the landowner).	Guidelines include: i) Whether the spouse is present at the interview. In most cases the spouse is available and broadly aware of the interview content and, if really interested, invariably attends or is conspicuously present in the background. ii) The overall effect the spouse has on conservation attitude or behaviour - whether this comes up in the interview spontaneously via the subject or through (i). This effect, where present, is in most cases positive towards conservation.	Ordinal - owing to subjectivity.
40. Influence of Tradition ('Less Tangible')	The influence that longstanding family or neighborhood traditions have had on the genesis of the subject's conservation behaviour.	Guidelines include: i) Whether family or neighbourhood tradition is quoted as a reason for positive conservation attitude. ii) Whether family or neighbourhood tradition is quoted as a reason for positive conservation behaviour.	Ordinal - owing to subjectivity.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
Cognition			
41. Knowledge of Flora ('Less Tangible')	Knowledge of flora with emphasis on the local species.	Guidelines include: i) The ability of the subject to provide specific plant species' names in addition to the vernacular names. (Knowing the scientific names represents a more specialised, hence more advanced level of knowledge.) ii) The ability of the subject to understand the plant ecology of the local veld. This includes knowledge on the occurrence, distribution, and numbers of the various plant species in the local area. iii) The subject's knowledge of plants with low agricultural or ornamental potential should be given a higher rating than otherwise, because this indicates a spectrum of understanding which transcends material utility per se. (Knowledge of the less commercially important or spectacular plants almost invariably indicates knowledge of the 'useful and ornamental' plants as well).(2)	Ordinal - owing to subjectivity.
42. Knowledge of Fauna ('Less Tangible')	Knowledge of fauna with emphasis on the local species.	Guidelines include: i) The ability of the subject to provide specific animal species' names in addition to the vernacular names. (Knowing the scientific names represents a more specialised, hence more advanced level of knowledge.) ii) The ability of the subject to understand the animal ecology of the local veld. This includes knowledge on the occurrence distribution, and numbers of the various animal species in the local area. iii) The subject's knowledge of animals with low agricultural or ornamental potential should be given a higher rating than otherwise, because this indicates a spectrum of understanding which transcends material utility per se. (Knowledge of the less commercially important or spectacular animals almost invariably indicates knowledge of the 'useful and ornamental' animals as well).(3)	Ordinal - owing to subjectivity.
43. Overall Knowledge of Ecosystem ('Less Tangible')	The subject's overall knowledge of fauna and flora with emphasis on the local species.	The combination of Variables 41 and 42.	Ordinal - owing to subjectivity.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
Motivation			
44. Overall Interest in Ecosystem ('Less Tangible')	The subject's overall interest in fauna and flora with emphasis on the local species. (Note that interest, in being a motivation-based variable differs clearly from 'knowledge about', which is a cognitive variable. The former denotes a form of enthusiasm whereas the latter denotes specifically memorized information. Hence these variables although apparently very similar are technically distinct).	Guidelines include: i) The length of time that the subject spontaneously discusses, or appears willing to discuss natural biota. ii) The intonation of subject's dialogue relating to natural biota. Signs of excitement or interest may thereby be assessed.	Ordinal - owing to subjectivity.
45. Conservation Attitude ('Less Tangible')	The expressed positive attitude towards the principle of conservation of natural ecosystems.	Guidelines include: i) The understanding of the general principles of nature conservation particularly of veld occurring on the subject's property. ii) Receptiveness towards ideas and suggestions on conservation of subject's veld, whether the agent is the subject him/herself or another party.	Ordinal - owing to subjectivity.
D) CONSERVATION STRATEGY VARIABLES			
Acquisition Problems			
46. Willingness to Sell Veld ('Less Tangible')	The willingness of the subject to separate zones of veld from the developed farm lands in order to sell these as separate entities to external public/private conservation agencies at the standard market price.	Guidelines include: i) The nature of the subject's response to 'probe' questions on the pricing of his/her veld areas for purchase by nature conservation bodies. This would include both the actual answers to the questions asked, as well as the manner in which responses are given eg the tone of voice used and the length of time taken to respond. ii) The restrictiveness of prescriptions insofar as the subject is concerned in arranging full transfer of land for purposes of nature reserve establishment. (These may include retention of agricultural servitudes, visitor restriction, pest animal restriction, etc.)	Ordinal - owing to subjectivity.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
47. Willingness to Lease Veld ('Less Tangible')	The willingness of the subject to separate zones of veld from the developed farm lands in order to lease these out as separate entities to external public/private conservation agencies at the standard market price.	Guidelines include: i) The nature of the subject's response to probe questions on the lease/subsidy pricing of his/her veld areas for nature conservation purposes. This would include both the actual answers given to the questions asked, as well as the manner in which the responses are given eg the tone of voice used and the length of time taken to respond. ii) The length of time that the subject is prepared to enter into a lease contract. (The greater the duration, the more acceptable is the principle of leasing to the subject.) iii) The restrictiveness of prescription insofar as the subject is concerned in arranging a lease servitude. (These may include certain agricultural rights, visitor restrictions and pest animal restrictions etc). With certain subjects the latter can also be interpreted as being a positive factor, because this may indicate a more serious commitment to leasing than other subjects who may never have given this conservation option any previous consideration.	Ordinal - owing to subjectivity.
48. Willingness to Donate Veld ('Less Tangible')	The willingness of the subject to separate zones of veld from the developed farm lands in order to donate/bequeath these out as separate entities to external public/private conservation agencies at the standard market price.	Guidelines include: i) If responses to probe questions described under 46 and 47 (ii) clearly indicate that 'donation' may be an alternative conservation option to the landowner, this is then discussed in greater depth allowing for assessment. ii) The level of commitment to donation as a serious future conservation option. iii)The nearness of possible donation. Thus bequests, unless very definite, should generally be given lower ratings than those donations which can be arranged at shorter notice.	Ordinal - owing to subjectivity.
49. Conservation Problems ('Less Tangible')	The overall extent of problems likely to be experienced in the imposition of conservation strategy options to the subject's veld as would be arranged by an external conservation body. (That is - other than the subject him/herself.)	Guidelines include: i) Receptiveness of the subject towards the options covered in Variables 46, 47 and 48. ii) Problems envisaged by the subject with regard to pest plants, pest animals and visitors with the establishment of nature reserves on his/her property/ies. iii) Inclination of the subject towards a personally controlled private nature reserve must be rated higher than a steadfast inclination towards retention of veld for agricultural development in the future.	Ordinal - owing to subjectivity.

VARIABLES	DEFINITIONS	DEDUCTIONS	SCALES
50. Subdivision Problems ('Less Tangible')	Problems envisaged by the subject in separating veld zone entities from the main property/ies.	Guidelines include: i) Whether the veld plays an integral or indispensable role in the present land use enterprise eg provision of vital nutrients for grazing stock which are not available in the developed lands. ii) Whether the subject considers the veld area to be inconveniently situated eg in the centre of the farm and not in an easily separated corner.	Ordinal - owing to subjectivity.
Costs			
51. Landowners Valuation of Veld /Hectare ('Tangible')	The selling price provided by the subject for the specific purpose of conservation /hectare of veld.	The value figures must be obtained from fairly specific questions. The purchase price indicated should comprise the lowest limit to what the subject may consider as constituting a 'reasonable' offer per hectare for areas of veld under his/her control.	Rands/hectare.
52. Landowners Lease Valuation of Veld /Hectare ('Tangible')	The leasing price provided by the subject for the specific purpose of conservation /hectare of veld.	See Variable 40(ii) for background details. Here the value figures must be obtained through fairly specific questions. A single guideline includes: i) The lease price indicated should comprise the lowest limit that the subject may consider as constituting a 'reasonable' offer per hectare of veld per year. (In all cases this refers to the 'immediate' year)	Rands/hectare.
DEPENDENT VARIABLE			
Behaviour			
1. Conservation Behaviour ('Less Tangible')	The positive action taken towards the conservation of natural ecosystems particularly those upon the subject's own property.	Guidelines include: i) The extent of natural habitat retained for at least the part motive of ecosystem conservation. ii) The sacrifice of alternative commercial ventures which may have resulted from the retention of natural habitats. iii) The degree to which the ecosystems are scientifically managed to ensure continued survival of the natural elements. iv) The willingness to retain the previous measures - i), ii), and iii) into the indefinite future.	Ordinal - owing to subjectivity.

(1) The alternative options presented on separate cards (within inverted commas) to each subject for him/her to provide an 'importance sequence' were as follows:

1. "Pasturage."
2. "Future commercial agricultural expansion."
3. "Wild flowers - aesthetic value."
4. "Nature conservation as a whole."
5. "Family recreation value."
6. "Wild animals - aesthetic value."
7. "Wild flowers - commercial value."
8. "Future mineral exploitation."
9. "Wild animals - commercial value."
10. "Firewood source."
11. "Future peri-urban expansion."

(The sequence presented above represents in fact the mean priority order of values given for renosterveld by all the subjects)

(2) An example of a sequence which ranges from the most commercially important and/or ornamental plants may include the following hypothetical sequence - namely knowledge of:

1) Grapevine Vitis vinifera (direct agricultural value)

2) Rooigras Themeda triandra (local indigenous grass with value as pasture)

3) Port Jackson Willow Acacia saligna (common exotic woody pest plant)

4) Renosterbos Elytropappus rhinocerotis (common indigenous plant with no evident agricultural value - but is a dominant character plant of renosterveld)

5) King protea Protea cynaroides (frequently cultivated indigenous ornamental plant)

6) Babiana Babiana rubrocyanea (infrequently cultivated indigenous renosterveld plant with fairly conspicuous flowers)

7) Restio duthiae (rare indigenous renosterveld plant, generally very inconspicuous)

(3) An example of a sequence which ranges from the most commercially important and/or ornamental animals may hypothetically include the following sequence -namely knowledge of:

1) Springbuck Antidorcas marsupialis (venison production potential)

2) Caracal Caracal caracal (economically serious threat to stock)

3) Black crow Corvus corvus (an easily noticed scavenging bird species)

4) Geometric tortoise Psammobates geometricus (cryptic coloured reptile restricted tolow-lying renosterveld)

PAPER 4

THE MULTIVARIATE MODELLING AND PREDICTION OF FARMERS' CONSERVATION BEHAVIOUR TOWARDS NATURAL ECOSYSTEMS

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ABSTRACT

Farmers are evaluated as key decision-makers in determining the informal conservation status of natural and semi-natural lands. "Conservation Behaviour" is defined in terms of the protection of threatened natural ecosystems by such landowners. These ecosystems are exemplified by West Coast Renosterveld - the most reduced habitat-type in South Africa. A spectrum of 52 'Demographic', 'Land Use', 'Psycho-social', and 'Conservation Strategy' related 'independent' variables were assessed; in addition to 'Conservation Behaviour', for a random cross-section of renosterveld owning farmers. A special rating technique, relying on independent assessors, was used to measure the 'less-tangible' (subjective error) variables. A correlation matrix and dendrogram was derived to portray inter-relationships between the full array of variables. A cross-section of the more interesting relationships of the variables with 'Conservation Behaviour' was evaluated with reference to regression scatterplots. These included the following sub-categories of variables:- 1) "Poorly Correlated"; 2) "Motivation"; 3) "Formal Education", 4) "Affluence", 5) "Language and Nationality"; 6) "Valuation" and 7) "Interaction Term".

A model was considered for predicting the rating of farmers 'Conservation Behaviour' ('dependent' variable) by using the other 52 variables ('independent' variables). Inputs of the latter were chosen from the full array to derive manageable subset models. These included the following inputs:- a) all 'tangible' and 'less tangible' variables; b) 'tangible' variables; c) questionnaire amenable variables and d) variables which have no resemblance to 'Conservation Behaviour' as a concept.

The relatively high correlations and successful predictions obtained are discussed in the light of both methodology and interpretation of conservation attitudes and behaviour.

KEYWORDS

Conservation behaviour, attitudes, natural ecosystems, farmers, landowners, variables, prediction, regression, correlations.

1.0 INTRODUCTION

Around the world man continues to degrade or remove natural ecosystems. Many of these effects are irreversible preventing the accrual of longer term benefits through sustained utilization of the natural resources by the application of scientific conservation principles (Myers, 1979). Although considered to be a pressing problem more typical of those Third World countries which have a rapid rate of population increase, the rate of removal of natural habitats is also surprisingly high in First World Countries with their virtually stable populations. Reasons for this phenomenon involve a complex interaction between global trade and material demand factors which, although worth consideration, are beyond the scope of this paper.

In the U.S.A. for example, estimates of the loss of natural habitat in recent years range from about two million hectares (Deknatel, 1979) to about four million hectares per year (Rensburger, 1975). Certain categories of habitat are more susceptible to development pressure than others. In the U.S. only one per cent of the original distribution of tall grass prairies still remains (Webster, 1978). Although South Africa is not entirely a First World country (like America), a parallel exists, where less than 6% of the diverse West Coast Renosterveld vegetation of the S.W. Cape Province lowlands has escaped the plough (Boucher, 1983).

The continued expansion of croplands not only exterminates natural elements (Deknatel, 1979; Carter and Hall, 1981), but frequently results in extensive soil loss through wind and water erosion, because it so often affects lands of marginal agricultural quality (Rensberger, 1975).

'Macro' factors, including, among others, specific nations, technologies and natural habitats, should not obscure the 'micro' factors pertaining to individual family units within such nations. Of these the most directly critical family units are those within the farming public. In more developed countries these include a minute proportion of the total public responsible for controlling an inversely large proportion of the land surface (Carter and Hall, 1981; McDowell, 1986(a),(b)). There are considerable differences in individual management of the natural environment in different family units. What happens in a specific property is dependent largely upon the psyche of the landowner involved. Related issues such as landowner behaviour relating to soil erosion have been systematically explored in studies exemplified by Earle et al, 1979 and Napier et al, 1984. Behaviour of landowners towards natural/ semi-natural ecosystems on their lands has been more diffusely researched. Texts of a general or descriptive nature are fairly frequent (cf. Hawkes ed, 1978; van der Lely; 1978; Rennie, 1979; Carter and Hall, 1981; Hoose, 1981; Cobham Resource Consultants, 1984; Hilts and McLellan, 1984; McFall, 1984; Meyer, 1984). In-depth analyses on ecosystem conservation behaviour of landowners are scarce, with references mostly of indirect value including the Agricultural Development and Advisory Service (of Britain) (1976); Macdonald, (1984) as well as Kreutzwiser and Pietraszko (1986). (See also McDowell, 1988.)

The need to understand conservation attitudes and behaviour of landowner units in attempting to preserve natural diversity on private lands is highlighted by Hoose (1981). He states that 61% of land in the U.S.A. is private and to preserve valuable ecosystems thereon:- "we'll have to understand ... the needs of corporate executives, tribal counselors, forest supervisors, land speculators, heiresses, farmers ... owners want their land to be all sorts of things - a place to live, to work; a source of income now or someday; a source of continuity, food, security, investment income, serenity, beauty or tax relief." (p.27). Lack of money to buy and unwillingness to sell are the main constraints on direct acquisition by the State of key private areas of conservation merit in both the United States and South Africa (Hoose, 1981; McDowell, 1986a, 1986b). In South Africa (and probably most other countries) private owners can also frequently be better conservationists than public owners (McDowell, 1986a, 1986b).

In devising conservation plans for any given region, it is contended that systematic research into environmental conservation strategy is of higher priority than researching natural biota <u>per se</u> - the traditional emphasis of most conservationists. The former should include an in-depth multidisciplinary understanding of the attitudes, behaviour and needs of the respective human custodians. This information can then be used as an aid in coordinating the protection of natural ecosystems in plans of action such as defined for the U.S.A. by Hilts and McLellan (1984), Hoose (1984), Meyer (1984) and McFall (1984).

The present study examines a diverse array of background variables directly relating to randomly selected individual farmers of the south-western Cape lowlands (McDowell, 1988). This is done in order to: firstly, establish existence and nature of patterns of relationships between such variables and, secondly, to use this information to see whether current conservation behaviour can be predicted mathematically by using manageable subsets of the total number of variables measured. The sequel (McDowell et al, 1988) then evaluates possible persuasive strategies for inculcating positive attitudes and behaviour using as a part-basis the information generated in the present paper.

2.0 METHODS

The research study sample consisted of 36 subjects randomly drawn from 212 farmers still having the threatened habitat - West Coast Renosterveld - represented on their properties. (As indicated, over 94% of this habitat has been displaced by croplands.)

It could be argued that such a sample would be biased towards those subjects who tended to preserve ecosystems and, as such, would tend to be unrepresentative of the landowner community as a whole. This assertion is, however, offset by the physical heterogeneity of the renosterveld remnants. Certain of these cannot be readily 'developed' because of being over-steep, too rocky and infertile etc. Other reasons for not putting renosterveld to the plough can include the lack of capital resources or expertise to develop such 'marginal' land as well as landowner ignorance of modern agricultural technologies (McDowell and Grindley, 1985). Thus it is contended that a realistic cross-section of landowners, other than the purely 'conservationist' category, is included in the study sample.

Given the landscape heterogeneity of the farmland and natural habitat, much care must be taken in realistically assessing the 'Conservation Behaviour' of the landowners. For the present study this variable is defined as: "The positive action taken towards the conservation of natural ecosystems particularly those upon the subject's own property". (Appendix 1)

Guidelines for rating the 'Conservation Behaviour' of the landowner subjects included:

i) The extent of natural habitat retained at least for the part motive of ecosystem conservation.

ii) The sacrifice of alternative commercial ventures which may have resulted from the retention of natural habitats.

iii) The degree to which the ecosystems are scientifically managed to ensure continued survival of the natural elements.

iv) The willingness to retain the previous measures i), ii) and iii) into the indefinite future. (See Appendix 1)

As a whole it is unrealistic to provide subjects directly with a metric scale vis a vis 'Conservation Behaviour' owing mainly to the subjective nature of these guidelines.

'Conservation Behaviour' as a 'dependent' variable was therefore given 'less tangible' status and dealt with in the same manner as was done for 31 out of a total of 52 'independent' variables rated for the subjects (Appendix 1).

The elicitation by interview of the 'less tangibles' was supported in certain instances by secondary information sources. The ordinal rating techniques, involving additional independent assessors (working on the tape recorded interviews), is detailed in McDowell (1988). The prime concern of the current paper is the actual results obtained and the conclusions derived from analysing the final readings. The 'independent' variables are divided into four descriptive categories: A) 'Demographic' (20 variables); B) 'Land Use' (12 variables); C) 'Psycho-Social' (11 variables) and D) 'Conservation Strategy' (9 variables). These are individually delimited in Appendix 1 under the subheads "Definition", "Deduction", and "Scale".

3.0 ANALYSIS OF DATA

3.1 Selecting Eligible Variables for Inferential Analyses

All the 'tangibles' were automatically treated as eligible for inclusion into statistical predictive modelling owing to minimal measurement or subjective error distortions (see Appendix 1 and McDowell, 1988).

The first column of Table 1 reflects the mean correlations between ordinal measurements of the 'less-tangibles' by pair permutations of the three independent raters. These 'less tangibles' are presented in descending sequence from the highest to the lowest inter-observer correlation - (ie least to most measurement distortion). The various thresholds of significance are marked. Fortuitously, inter-observer agreement turned out to be highest with the critical 'dependent' variable Y = 'Conservation Behaviour' (see McDowell, 1988 for details).

It was decided to set the basic cut-off point at R = 0.519 (ie alpha at 0.001) in determining which of the 'less tangibles' had sufficient integrity to be included in

TABLE 1

SPEARMAN'S RANK ORDER CORRELATIONS BETWEEN
'INDEPENDENT' VARIABLES AND THE
'DEPENDENT' VARIABLE 'CONSERVATION BEHAVIOUR' (Y)

'Less Tangible' Variables Sequenced in Order of Ascending Inter-observer Error.	R Values	I1*	I2*	I3*	I4*
1. Language Orientation.	0.474	X		X	X
2. Non-liquid Capital.	0.609	X			X
3. Knowledge of Flora.	0.886	X			
4. Overall Affluence.	0.695	X			X
5. Future Tenure of Subject.	0.060				
6. Lifetime in Non-Rural Area.	0.368			X	X
7. Overall Knowledge of Ecosystem.	0.920	X			
8. Bilingualism.	0.657	X		X	X
9. Conservation Attitude.	0.907	X			
10. Understanding of Project.	0.850	X			
11. Influence of Spouse.	0.155				X
12. Overall Interest in Ecosystem.	0.910	X			
13. Dependence on Land.	0.352			X	X
14. Liquid Capital.	0.618	X			X
15. Future Development Rate.	-0.612	X			
16. Knowledge of Fauna.	0.883	X			
17. Rapport with Interviewer.	0.742	X			
18. Materialism.	-0.709	X			
'Less Tangibles' below are rejected for most models because of high inter-observer error. (See text.)					
19. Willingness to Donate Veld.	0.660				
20. Reliability of Information.	0.729				
21. Commercial Potential of Veld.	-0.264				
22. Influence of Tradition.	0.475				
23. Willingness to Lease Veld.	0.139				
24. Innovation of Development Plans.	0.067				
25. Willingness to Sell Veld.	-0.093				
26. Subdivision Problems.	0.069				
27. Achieved Versus Ascribed Affluence.	0.144				
28. Past Development Rate.	-0.557			X	
29. Attitude Flexibility.	0.494				
30. Present Commercial Utility of Veld.	-0.027			X	
31. Conservation Problems.	0.021				

TABLE 1 (CONTINUED)

SPEARMAN'S RANK ORDER CORRELATIONS BETWEEN 'INDEPENDENT' VARIABLES AND THE 'DEPENDENT' VARIABLE 'CONSERVATION BEHAVIOUR'

	'Tangible' Variables in no Specific Sequence.	R Values	I1*	I2*	I3*	I4*
32.	Gender.	0.037		X	X	X
33.	Age.	-0.249		X	X	X
34.	Number of Siblings.	0.231		X	X	X
35.	Number of Children.	0.083		X	X	X
36.	Parents' Education.	0.516	X	X	X	X
37.	Education.	0.692	X	X	X	X
38.	Biological Orientation in Education.	0.546	X	X	X	X
39.	Origin.	0.352	X	X	X	X
40.	Language with Origin.	0.500	X	X	X	X
41.	Past Tenure of Subject.	0.489	X	X	X	X
42.	Past Tenure of Family.	0.239		X	X	X
43.	Generations Farming.	0.048		X	X	X
44.	Area of Land.	0.388		X	X	X
45.	Area of Veld.	0.453	X	X	X	
46.	Area of Renosterveld.	0.450	X	X		
47.	Rateable Valuation of Property.	0.596	X	X		X
48.	Rateable Valuation of Veld.	0.459	X	X		
49.	Value Proportion of Veld to Land.	0.436	X	X		
50.	Period Veld Used for Pasture.	0.039		X		
51.	Landowners Valuation of Veld/Ha.	0.245		X		X
52.	Landowners Lease Valuation of Veld/Ha.	0.112		X		X

* I1, I2, I3 and I4 correspond to the four inputs of variables (see text).

statistical modelling processes. (The variables 'Rapport with Interviewer' and 'Materialism' are also included because two out of three of the pair permutations reflected correlations greater than 0.519 (see McDowell, 1988).

3.2 Correlation between the Variables

A correlation matrix was computed using all the variables - including 'Conservation Behaviour' (Y) (Figure 1). This shows a network of relationships between the variables. Cell values of +5 and -5 correspond to a very high positive or negative inter-correlation and cell values of 0 indicate an insignificant relationship between the respective pair permutations.

Based on the matrix, a dendrogram was derived (Figure 2). The superscripts within the matrix correspond to the nodes. Clearly certain variables, particularly 'Overall Knowledge of Ecosystem' (X7) and 'Interest in Ecosystem' (X12), although technically different (Appendix 1)[1], show a very high level of association. This collinearity may therefore lead to a duplication of information in explaining 'Conservation Behaviour'.

[1] Presented after Paper 3.

FIGURE 1

MATRIX ILLUSTRATING INTERCORRELATION BETWEEN ALL VARIABLES

(THE SUPERSCRIPTS IN THE CELLS CORRESPOND TO THE NUMBERS OF THE DENDROGRAM-NODES IN FIGURE 2.)

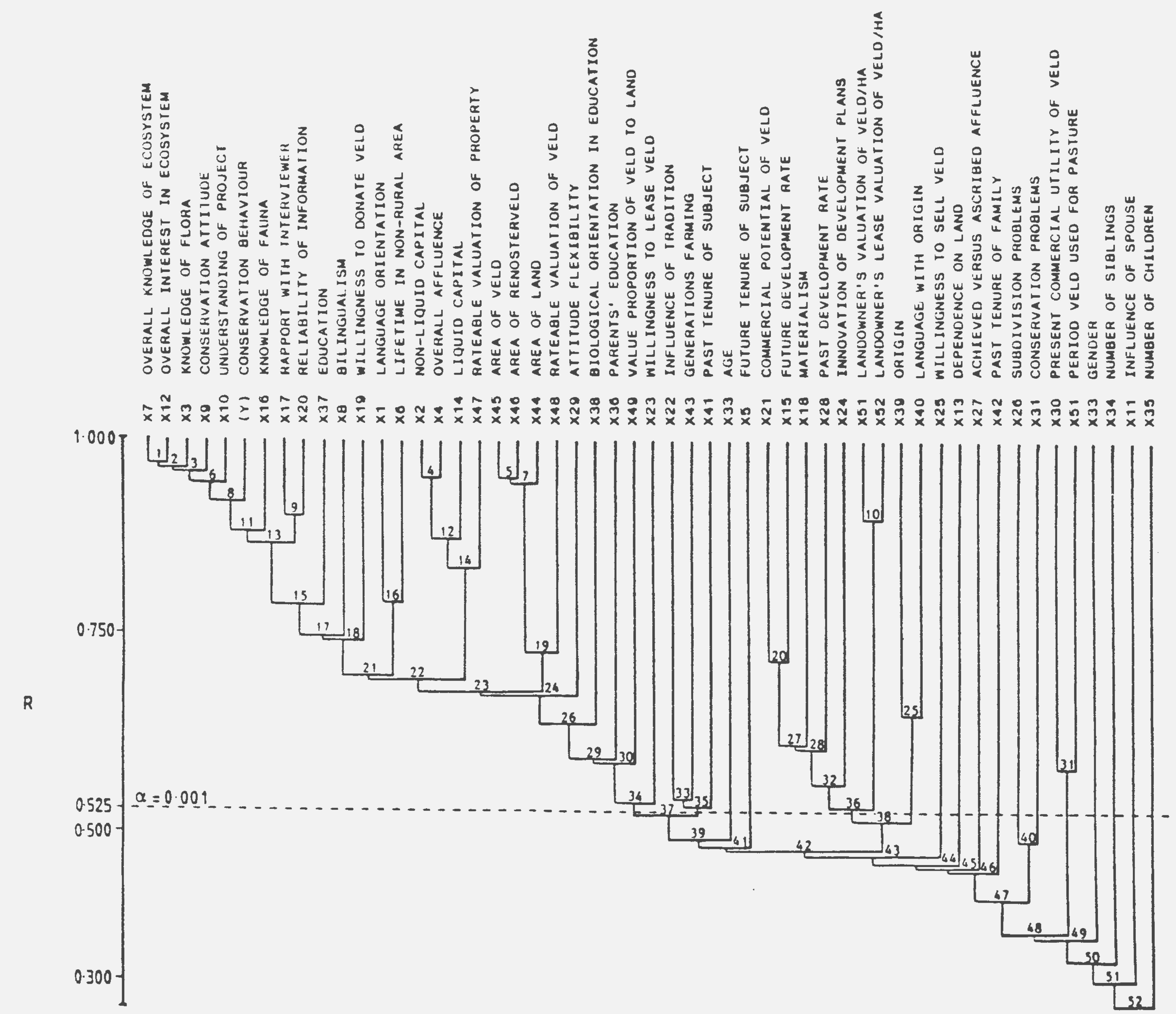
	Y 1 CONSERVATION BEHAVIOUR	X 1 LANGUAGE ORIENTATION	X 2 NON-LIQUID CAPITAL	X 3 KNOWLEDGE OF FLORA	X 4 OVERALL AFFLUENCE	X 5 FUTURE TENURE OF SUBJECT	X 6 LIFETIME IN NON-RURAL AREA	X 7 OVERALL KNOWLEDGE OF ECOSYSTEM	X 8 BILINGUALISM	X 9 CONSERVATION ATTITUDE	X10 UNDERSTANDING OF PROJECT	X11 INFLUENCE OF SPOUSE	X12 OVERALL INTEREST IN ECOSYSTEM	X13 DEPENDENCE ON LAND	X14 LIQUID CAPITAL	X15 FUTURE DEVELOPMENT RATE	X16 KNOWLEDGE OF FAUNA	X17 RAPPORT WITH INTERVIEWER	X18 MATERIALISM	X19 WILLINGNESS TO DONATE VELD	X20 RELIABILITY OF INFORMATION	X21 COMMERCIAL POTENTIAL OF VELD	X22 INFLUENCE OF TRADITION	X23 WILLINGNESS TO LEASE VELD	X24 INNOVATION OF DEVELOPMENT PLANS	X25 WILLINGNESS TO SELL VELD	X26 SUBDIVISION PROBLEMS	X27 ACHIEVED VERSUS ASCRIBED AFFLUENCE	X28 PAST DEVELOPMENT RATE	X29 ATTITUDE FLEXIBILITY	X30 PRESENT COMMERCIAL UTILITY OF VELD	X31 CONSERVATION PROBLEMS	X32 GENDER	X33 AGE	X34 NUMBER OF SIBLINGS	X35 NUMBER OF CHILDREN	X36 PARENTS' EDUCATION	X37 EDUCATION	X38 BIOLOGICAL ORIENTATION IN EDUCATION	X39 ORIGIN	X40 LANGUAGE WITH ORIGIN	X41 PAST TENURE OF SUBJECT	X42 PAST TENURE OF FAMILY	X43 GENERATIONS FARMING	X44 AREA OF LAND	X45 AREA OF VELD	X46 AREA OF RENOSTERVELD	X47 RATEABLE VALUE OF PROPERTY	X48 RATEABLE VALUE OF VELD	X49 VALUE PROPORTION OF VELD TO LAND	X50 PERIOD VELD USED FOR PASTURE	X51 LANDOWNERS' VALUATION OF VELD/HA	X52 LANDOWNERS' LEASE VALUATION OF VELD/HA
Y 1 CONSERVATION BEHAVIOUR	.	3	5	5	5[22]	0	2	5[8]	5	5	5	0	5	2	5	-5	5[11]	5	-5	5	5	0	3	0	0	0	0	0	-4	3	0	0	0	0	0	0	4	5	5	-2	-3	3	0	0	2	3	3	5	3	3	0	0	0
X 1 LANGUAGE ORIENTATION	3	.	0	3	2	0	5[16]	2	5[21]	2	3	0	1	-2	2	0	2	2	0	[illegible]	[illegible]	0	0	0	2	0	1	2	-1	1	0	0	2	0	0	0	2	0	0	3	0	0	0	-2	0	0	0	0	0	2	0	0	0
X 2 NON-LIQUID CAPITAL	5	0	.	3	5[4]	0	0	3	3	2	2	0	2	-1	5	-1	4	1	0	2	2	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0	2	1	0	-1	-1	3	0	0	3	3	4	5[14]	5	2	0	2	2
X 3 KNOWLEDGE OF FLORA	5	3	3	.	3	0	2	5[2]	5	5	5	0	5	-2	3	-4	5	5	-5	5	5	-1	3	0	0	0	0	0	-5	4	0	0	0	0	0	0	4	5[15]	5	-3	-4	2	0	0	1	2	2	4	1	3	0	0	0
X 4 OVERALL AFFLUENCE	5[22]	2	5[4]	3	.	-1	1	4	4	3	3	0	3	-2	5[12]	-2	5	2	-1	2	2	0	1	0	0	2	0	2	0	0	0	0	0	2	0	0	2	2	0	0	0	3	0	0	3	3	4	5	5	2	0	2	1
X 5 FUTURE TENURE OF SUBJECT	0	0	0	0	-1	.	0	0	0	0	0	0	0	0	-2	1	0	0	0	[illegible]	1	0	0	2	0	0	2	-2	0	3[41]	0	0	0	-1	-2	-2	2	2	0	0	0	-1	0	1	0	0	0	0	0	-1	-1	0	0
X 6 LIFETIME IN NON-RURAL AREA	2	5[16]	0	2	1	0	.	1	5	0	2	0	0	-3	2	0	1	0	0	[illegible]	[illegible]	0	0	0	3	0	0	2	0	0	0	0	0	0	0	-2	2	1	0	2	0	0	0	-3	0	1	0	0	1	2	0	0	0
X 7 OVERALL KNOWLEDGE OF ECOSYSTEM	5[8]	2	3	5[2]	4	0	1	.	5	5	5[6]	0	5[1]	-2	3	-4	5	5	-5	5	5	-1	3	0	0	0	0	0	-4	-3	0	0	0	0	0	0	4	5	4	-3	-4	3	0	0	1	2	2	4	2	2	0	0	0
X 8 BILINGUALISM	5	5[21]	3	5	4	0	5	5	.	5	5[17]	0	5	-2	4	-3	5	4	-2	3	3	0	2	0	0	0	0	0	-1	1	0	0	0	0	0	0	4	4	1	0	-3	3	0	0	0	1	0	3	0	2	0	0	0
X 9 CONSERVATION ATTITUDE	5	2	2	5	3	0	0	5	5	.	5	0	5[3]	0	2	-5	5	5	-5	5[18]	5	-2	3	0	0	0	0	0	-5	5	0	0	0	0	0	0	5	5	5	-3	-4	2	1	0	1	2	2	2	1	2	0	0	0
X10 UNDERSTANDING OF PROJECT	5	3	2	5	3	0	2	5[6]	5[17]	5	.	0	5	-2	3	-5	5	5[13]	-5	5	5	0	3	0	0	0	0	0	-4	4	0	0	0	0	0	0	4	5	3	3	-4	2	1	0	0	2	2	2	0	2	0	0	0
X11 INFLUENCE OF SPOUSE	0	0	0	0	0	0	0	0	0	0	0	.	0	0	-1	0	0	0	-1	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1[51]	0	0	0	1	0	0	0	0	0	0	0	0	0	0
X12 OVERALL INTEREST IN ECOSYSTEM	5	1	2	5	3	0	0	5[1]	5	5[3]	5	0	.	1	3	-5	5	5	-5	5	5	-1	3	0	0	0	0	0	-4	4	0	0	0	0	0	0	4	5	4	-3	-4	2	0	0	3	2	2	3	2	2	0	0	0
X13 DEPENDENCE ON LAND	2	-2	-1	-2	-2	0	-3	-2	-2	0	-2	0	1	.	-3	0	-2	-2	0	[illegible]	[illegible]	0	0	0	-2	0	0	-2	2	0	0	0	0	0	0	0	0	1	0	0	0	0	2	3[44]	0	1	2	0	-3	-4	0	-1	-1
X14 LIQUID CAPITAL	5	2	5	3	5[12]	-2	2	3	4	2	3	-1	3	-3	.	-1	4	2	0	2	1	0	0	0	0	0	0	3[45]	0	0	0	0	0	3	0	0	0	1	0	0	0	3	0	0	2	2	3	5	5	3	0	3	2
X15 FUTURE DEVELOPMENT RATE	-5	0	-1	-4	-2	1	0	-4	-3	-5	-5	0	-5	0	-1	.	-3	-3	5	-2	-1	5[20]	-2	0	2	0	1	0	3	0	1	0	0	-1	0	0	0	0	0	0	1	-3	-2	0	-2	-2	-2	-2	0	0	0	0	0
X16 KNOWLEDGE OF FAUNA	5[11]	2	4	5	5	0	1	5	5	5	5	0	5	-2	4	-3	.	5	-5	5	5	0	3	0	0	0	0	0	-3	2	0	0	0	0	0	0	5[29]	5	3	-4	-5	4[37]	0	0	2	3	3	3	2	2	0	0	0
X17 RAPPORT WITH INTERVIEWER	5	2	1	5	-2	0	0	5	4	5	5[13]	0	5	-2	2	-3	5	.	-5	5	5[9]	0	2	0	0	0	0	0	-3	5[24]	0	0	0	0	0	0	4	5	3	-2	-3	0	0	0	0	0	0	0	0	1	0	0	0
X18 MATERIALISM	-5	0	0	-5	-1	0	0	-5	-2	-5	-5	-1	-5	0	0	5	-5	-5	.	-5	-5	5[27]	-3	0	2	0	0	0	5[28]	-4	0	0	0	0	0	0	-2	-3	-3	2	-3	-2	0	0	-2	-2	-2	0	0	0	0	0	0
X19 WILLINGNESS TO DONATE VELD	5	0	2	5	2	0	0	5	3	5[18]	5	0	5	0	2	-2	5	5	-5	.	5	1	0	0	0	0	0	0	2	4	-1	0	0	0	0	0	3	4	3	-1	0	1	0	0	0	0	0	2	1	0	0	0	0
X20 RELIABILITY OF INFORMATION	5	0	2	5	2	1	0	5	3	5	5	0	5	0	1	-1	5	5[9]	-5	5	.	0	2	1	0	0	0	0	-3	5	0	0	0	0	0	0	4	5	5	-3	-3	0	0	0	0	0	0	0	0	0	0	0	0
X21 COMMERCIAL POTENTIAL OF VELD	0	0	0	-1	0	0	0	-1	0	-2	0	0	-1	0	0	5[20]	0	0	5[27]	1	[illegible]	.	0	0	4[32]	0	2[47]	0	2	0	2	2	0	0	0	0	0	0	0	0	0	0	-2	1	-2	-1	-2	0	0	0	0	4[36]	3
X22 INFLUENCE OF TRADITION	3	0	2	3	1	0	0	3	2	3	3	0	3	0	0	-2	3	2	-3	[illegible]	2	0	.	0	1	0	0	0	0	0	0	1	0	0	0	0	1	3	3	-4	-2	4[35]	2	4[33]	0	0	0	0	0	0	0	0	0
X23 WILLINGNESS TO LEASE VELD	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	1	0	0	.	0	3[43]	0	0	0	4[34]	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0
X24 INNOVATION OF DEVELOPMENT PLANS	0	2	0	0	0	0	3	0	0	0	0	0	0	-2	0	2	0	0	2	[illegible]	[illegible]	4[32]	-1	0	.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	-1	-2	0	0	0	0	0	1	0	2	0
X25 WILLINGNESS TO SELL VELD	0	0	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	0	0	3[43]	0	.	-3	0	0	1	0	-3	0	0	0	0	0	0	0	0	0	-3	0	0	0	0	0	-2	0	0	0	0	0
X26 SUBDIVISION PROBLEMS	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	[illegible]	[illegible]	2[47]	0	0	0	-3	.	0	0	0	0	3[40]	2[49]	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X27 ACHIEVED VERSUS ASCRIBED AFFLUENCE	0	2	0	0	2	-2	2	0	0	0	0	0	0	-2	3[45]	0	0	0	0	[illegible]	[illegible]	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	-1	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0
X28 PAST DEVELOPMENT RATE	-4	-1	0	-5	0	0	0	-4	-1	-5	-4	0	-4	2	0	3	-3	-3	5[28]	2	-3	2	0	0	0	0	0	0	.	-3	0	0	0	0	0	0	0	-3	-1	1	3	0	0	0	-2	2	-2	-1	-1	-2	0	0	0
X29 ATTITUDE FLEXIBILITY	3	1	0	4	0	3[41]	0	-3	1	5	4	0	4	0	0	0	2	5[24]	-4	4	5	0	0	4[34]	0	1	0	0	-3	.	0	1	0	-2	0	-2	3	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X30 PRESENT COMMERCIAL UTILITY OF VELD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-1	0	2	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4[31]	2[48]	0
X31 CONSERVATION PROBLEMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	2	1	0	0	-3	3[40]	0	0	1	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
X32 GENDER	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	0	0	0	0	0	2[49]	0	0	0	0	0	.	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
X33 AGE	0	0	0	0	2	-1	0	0	0	0	0	0	0	0	3	-1	0	0	0	[illegible]	[illegible]	0	0	-1	0	0	0	0	0	-2	0	0	0	.	2[50]	0[52]	0	0	0	0	0	3[39]	0	0	0	0	0	1	1	1	0	2	2
X34 NUMBER OF SIBLINGS	0	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	2[50]	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X35 NUMBER OF CHILDREN	0	0	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0	-2	0	0	0	0[52]	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X36 PARENTS' EDUCATION	4	2	2	4	2	2	2	4	4	5	4	0	4	0	0	0	5[29]	4	-2	3	4	0	1	0	1	0	2	-1	0	3	0	0	0	0	0	0	.	4	4	0	4[38]	0	0	0	0	3	2	0	0	0	0	0	0
X37 EDUCATION	5	0	1	5[15]	2	2	1	5	4	5	5	0	5	1	1	0	5	5	-3	4	5	0	3	0	0	0	1	0	-3	4	0	0	0	0	0	0	4	.	5[26]	2	2	2	0	0	0	0	0	2	0	0	-2	0	0
X38 BIOLOGICAL ORIENTATION IN EDUCATION	5	0	0	5	0	0	0	4	1	5	3	1[51]	4	0	0	0	3	3	-3	3	5	0	3	0	0	0	0	0	-1	4	0	0	0	0	0	0	4	5[26]	.	-2	-1	2	1	2	0	0	0	1	0	0	0	0	0
X39 ORIGIN	-2	3	-1	-3	0	0	2	-3	0	-3	3	0	-3	0	0	0	-4	-2	2	-1	-3	0	-4	0	0	0	0	2	1	0	0	0	2	0	0	0	0	2	-2	.	5[25]	-2	-1	-3	0	0	0	0	0	0	0	0	0
X40 LANGUAGE WITH ORIGIN	-3	0	-1	-4	0	0	0	-4	-3	-4	-4	0	-4	0	0	1	-5	-3	-3	[illegible]	-3	0	-2	0	0	0	0	2	3	0	0	0	0	0	0	0	4[38]	2	-1	5[25]	.	-2	0	0	1	-3	-2	0	0	4	0	0	0
X41 PAST TENURE OF SUBJECT	3	0	3	2	3	-1	0	3	3	2	2	0	2	0	3	-3	4[37]	0	-2	[illegible]	[illegible]	0	4[35]	0	0	-3	0	0	0	0	0	0	0	3[39]	0	0	0	2	2	-2	-2	.	3[46]	2	0	0	0	3	0	0	0	0	0
X42 PAST TENURE OF FAMILY	0	0	0	0	0	0	0	0	0	1	1	1	0	2	0	-2	0	0	0	[illegible]	[illegible]	-2	2	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	3[46]	.	3	0	0	0	0	0	0	0	0	0	0
X43 GENERATIONS FARMING	0	-2	0	0	0	1	-3	0	0	0	0	0	0	3[44]	0	0	0	0	0	[illegible]	[illegible]	1	4[33]	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	2	-3	0	2	3	.	0	0	0	0	0	-1	0	0	0
X44 AREA OF LAND	2	0	3	1	3	0	0	1	0	1	0	0	3	0	2	-2	2	0	-2	[illegible]	[illegible]	-2	0	0	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	.	5	5[7]	3	5	0	0	0	0
X45 AREA OF VELD	3	0	3	2	3	0	1	2	1	2	2	0	2	1	2	-2	3	0	-2	[illegible]	[illegible]	-1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0	0	0	-3	0	0	0	5	.	5[5]	3	5	3	0	0	0
X46 AREA OF RENOSTERVELD	3	0	4	2	4	0	0	2	0	2	2	0	2	2	3	-2	3	0	-2	[illegible]	[illegible]	-2	0	0	0	0	0	0	-2	0	0	0	0	0	0	0	2	0	0	0	-2	0	0	0	5[7]	5[5]	.	5	5[19]	2	0	0	0
X47 RATEABLE VALUATION OF PROPERTY	5	0	5[14]	4	5	0	0	4	3	2	2	0	3	0	5	-2	3	0	0	2	[illegible]	0	0	0	0	-2	0	0	-1	0	0	0	0	1	0	0	0	2	1	0	0	3	0	0	3	3	5	.	5[23]	0	0	0	2
X48 RATEABLE VALUATION OF VELD	3	0	5	1	5	0	1	2	0	1	0	0	2	-3	5	0	2	0	0	1	[illegible]	0	0	0	0	0	0	0	-1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	5	5	5[19]	5[23]	.	5[30]	2	3	2
X49 VALUE PROPORTION OF VELD TO LAND	3	2	2	3	2	-1	2	2	2	2	2	0	2	-4	3	0	2	1	0	[illegible]	[illegible]	0	0	-1	1	0	0	0	-2	0	0	0	0	1	0	0	0	0	0	0	4	0	0	-1	0	3	2	0	5[30]	.	0	3	3[42]
X50 PERIOD VELD USED FOR PASTURE	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	4[31]	0	0	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	2	0	.	0	0
X51 LANDOWNERS' VALUATION OF VELD/HA	0	0	2	0	2	0	0	0	0	0	0	0	0	-1	3	0	0	0	0	[illegible]	[illegible]	4[36]	0	0	2	0	0	0	0	0	2[48]	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	.	5[18]
X52 LANDOWNERS' LEASE VALUATION OF VELD/HA	0	0	2	0	1	0	0	0	0	0	0	0	0	-1	2	0	0	0	0	[illegible]	[illegible]	3	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3[42]	0	5[18]	.

LEGEND FOR MATRIX

Probability ranges for rejecting Null Hypothesis	Pearsons R intervals (34 degrees of freedom)	Notation in cell
$P \leq 0.0001$	$R \geq 0.586$ $R \leq -0.586$	5 -5
$P = 0.001 \rightarrow 0.0001$	$R = 0.525 \rightarrow < 0.586$ $R = -0.525 \rightarrow > -0.586$	4 -4
$P = 0.01 \rightarrow 0.001$	$R = 0.424 \rightarrow < 0.525$ $R = -0.424 \rightarrow > -0.525$	3 -3
$P = 0.05 \rightarrow 0.01$	$R = 0.329 \rightarrow < 0.424$ $R = -0.329 \rightarrow > -0.424$	2 -2
$P = 0.1 \rightarrow 0.05$	$R = 0.279 \rightarrow < 0.329$ $R = -0.279 \rightarrow > -0.329$	1 -1
$\alpha > 0.1$	$R = 0.279 \rightarrow > -0.279$	0

FIGURE 2

DENDROGRAM ILLUSTRATING INTERCORRELATION BETWEEN ALL VARIABLES



(THE NUMBERS OF THE NODES CORRESPOND TO THE MATRIX-SUPERSCRIPTS IN FIGURE 1)

3.3 Correlations with 'Conservation Behaviour'

The information presented in Figure 1 is fairly self-explanatory. The readers can discern for themselves the relationships between any variable permutation that may interest them. However, it is worth discussing in greater depth the relationships of certain key 'independent' variables with the critical 'dependent' variable - 'Conservation Behaviour' (Y).

At the outset it is critical to emphasize, firstly, that many pitfalls exist in the interpretation of correlations within empirical data (cf. Boudon, 1974). For example, significant correlations need not infer direct causality unless some clear reasons exist other than purely empirical association. Secondly, statistical conclusions derived from the present data cannot safely be extrapolated beyond the test universe, ie those 212 West Coast Renosterveld landowners from which the research sample was drawn. This holds, unless analogous studies can be made outside the present universe to substantiate such results.

The relationships of the following variables' with 'Conservation Behaviour' (Table 1) are evaluated:

3.3.1 Poorly Correlated Variables

'Age' (X33) - 'Tangible' (Figure 3A).[2]
(Appendix 1)

No empirical relationship is apparent between, for example, 'Age' and 'Conservation Behaviour' (Figure 3A). 'Age' shows an overall low level of collinearity with the other variables. The highest correlation is with 'Past Tenure of Subject' (X41). This scatterplot typifies other permutations of variables marked 'O' in the Matrix cells of Figure 1.

3.3.2. 'Motivation' Variables

'Conservation Attitude' (X7) 'Less Tangible'. (Figure 3B)
(Appendix 1)

A highly significant positive empirical relationship exists between conservation attitude and conservation behaviour. This certainly need not be the case as "what we say need not correspond with what we actually do". These may often be contradictory - according to the theory of Cognitive Dissonance cf. Festinger (1957); Kiesler et al (1969) (pp 191-237) and Fishbein and Ajzen (1975) (pp 39-45) .

[2] Presented after "4.0 CONCLUSIONS"

The fact that 'Conservation Behaviour' and 'Conservation Attitude' are positively related tells us very little indeed about the mechanism of change. It is commonly thought by the lay person that a shift in 'attitude' will 'cause' a corresponding shift in 'behaviour'. The reverse is also just as logical - a change in 'behaviour' through force of circumstance or other reason may also result in a compensatory shift in 'attitude'. This compares well with the epithet "which comes first the chicken or the egg". In contrast to 'Age' (X33), Conservation Attitude is collinear with several other independent variables - marked as +5 or -5 in Figure 1. These are included in the zone from 'Conservation Attitude' (X7) through to 'Willingness to Donate Veld' (X9) in the dendrogram of Figure 2).

3.3.3 'Formal Education' Variables

'Education' (X37) - 'Tangible' (Figure 3C).
'Biological Orientation in Education' (X38) - 'Tangible' (Figure 3D).
'Parents' Education' (X36) -'Tangible' (Figure 3E).
(Appendix 1)

It is clear from Figure 3C that the positive relationship between education level of the subject and 'Conservation Behaviour' is accentuated at the extremes. These include, 8 to 9 years formal schooling at the lower end, with greater than three years tertiary education at the upper end. A zone of "ambivalence" appears to be centred on "Std 10". The latter is interesting in that the outliers include some of the 'best' and 'worst' ecosystem conservationists. Although this probably infers an interplay with other variables and also individual idiosyncrasies (not necessarily included in the variables), the interviews indicate that enhanced education may be partly a "two edged sword". That is, it became apparent from the interviews that formal education, possibly linked to advanced cognitive prowess, not only relates to enhanced knowledge of and interest in, natural processes, as well as the ability to understand conservation objectives but <u>also</u> facilitates the application of more complicated technologies which result in more destructive exploitation of marginal lands.

'Education' has a slightly greater correlation with 'Conservation Behaviour' (Table 1) than does 'Biological Orientation in Education' (X36). The latter differs from 'Education', in that the biological content of the subject's academic study is weighted upwards (Appendix 1). This data suggests the hypothesis that it is years of education <u>per se</u>, rather than the type of education, which relates to good conservation practice. This is particularly true for the furthest extremes, in particular that at the 'upper' end. The broad link between education level and positive environmental awareness and conservation attitudes was also observed by Kreutzwiser and Pietraszko (1986), who used regression techniques in their assessment of landowner attitudes towards wild wetlands in Southern Ontario.

'Parents' Education' represents the average years of education taken for both the subject's parents (Appendix 1). This is surprisingly well related to 'Conservation Behaviour' (Table 1). This link could possibly also come "via" 'Education' (X37) as both are well correlated one with the other (alpha at 0.0001 in Figure 1). In fact, if one compares the correlation of these two variables with each of the remaining 'independent' variables, the correlations are remarkably similar. (Compare X36, X37 Matrix rows in Figure 1). The most notable exceptions are the comparative correlations with 'Area of Veld' (X45) where 'Parents Education' has significance (alpha at 0.01) and 'Education' has no significant relationship (Figure 1). This supports qualitative interview findings where those subjects with lower than average education and having parents of higher than average education (for that generation) had frequently set aside natural habitats for preservation purposes. The plot in Figure 3(E) appears to have a slightly 'bilinear' pattern. This could represent an interaction effect, but inspection of the data failed to reveal any single factor responsible.

3.3.4 'Affluence' Variables

'Overall Affluence' (X4) - 'Less Tangible' (Figure 3F).
'Non-liquid Capital' (X2) - 'Less Tangible' (Figure 3G).
(Appendix 1)

'Overall Affluence', for a particular subject represents the sum of that subject's 'Non-Liquid Capital' rating, and Liquid Capital (X7) rating (Appendix 1). This composite variable has virtually the same correlation as has 'Education' (X37) with 'Conservation Behaviour', namely both around R = 0.69 (Table 1). Within many segments of society one would naturally expect a clear-cut positive relationship between 'Education' and 'Affluence' such as in middle class urban societies. Here it would be well qualified professionals that occupy the higher socio-economic strata. However, in the research sample the relationship of the affluence-related variables namely: 'Non Liquid Capital' (X2), 'Overall Affluence' (X4) and 'Liquid Capital' (X14) with the formal education related variables, namely: 'Education' (X37) 'Parents Education', (X36) and, 'Biological Orientation in Education' (X38) is actually very poor - ranging from '0' to '2' in the matrix cells of Figure 1. A reason for this is that the surveyed community, being farmers, have a large component of inherited wealth, representing land which has been in the same family as far back as the early 1700s. Education standards in this community have really only recently shown an increase beyond the secondary level in the current or, in a few cases, the previous generation. In the previous generation the landowners' mothers (on the sample) more often than not had attained higher education than the men. This could be because in the early 'harder' years the young men left school earlier to work on the land, in order to increase agricultural productivity. Women, on the other hand, who were perceived to be less vital to the enterprise, often obtained qualifications (particularly teaching) which brought in additional outside income.

Much as in the situation of 'Education' (X32) - affluence also represents "a two edged sword" insofar as conservation practice is concerned. Figure 3(E) clearly indicates that the 'best' Conservationists are the most wealthy and the poor Conservationists are largely the least wealthy end of the spectrum. As in the situation with education, an area of 'ambivalence' exists at the mid-range of 'Overall Affluence'. This can be explained in more than one way. Firstly, critical examination of the subject outliers towards the central base of the mid-range at Figure 3(F) indicates that the moderately affluent poor conservationists' rate particularly low in 'Education' (X37) and 'Bilingualism' (X8), and vice versa with the single 'good conservationist' indicated in the central summit of this range. Secondly, degradation and/or removal of natural vegetation for agricultural purposes needs a significant modicum of capital. The majority of farmers considered the capital value of their property to be their major asset with cashflow causing a problem during poor crop years. The greater the value of the property the greater the potential for loan capital to develop new lands (among other things). The clearance of natural vegetation followed by stone removal, deep ploughing, fertilizing and crop planting etc, which counter the tenets of natural ecosystem protection -

all represent expenses. For example, in 1984 to transform one hectare of virgin habitat into one developed hectare of vineyards cost the farmer the equivalent of 10,000 dollars. The mid-range scatter effect is understandably more visible when one considers merely the variable 'Non Liquid Capital' (rateable value of fixed property - Appendix 1) against 'Conservation Behaviour' (Figure 3(G)).

The main lesson gained from the affluence plots seems to be that habitat conservation is akin to a luxury afforded only by the most wealthy. It must be remembered that the axes of the 'less tangibles' of the scatterplots are ordinal and tends to understate the extremes, particularly with the affluence variables. That is, the subjects clustered at the upper end of the plot in Figure 3(E) are extremely wealthy (assets worth several million rands), compared with those at the other end of the spectrum who are frequently struggling under heavy financial deficits, often on uneconomic smallholdings. It is also partly true to say that there is a significant psychological component to 'affluence'; where subjects seem to rate their individual wealth in relation to their peers instead of with other groups. In the sample, therefore, farmers tended to rate themselves by using neighbouring farmers - and not, for example, their servants - as standards for comparison. Within this perspective, subjects are effectively "only as affluent as they believe themselves to be", and their spending patterns (including that on conservation) follow partly as a consequence thereof.

The implied wealth hypothesis, where "bread and butter" type extremes are linked to conservation practice, fits in with Maslow's 'Hierarchy of Needs' (1970). In this hierarchy aesthetic needs, such as those implied by conservation of natural resources on the property (with little direct economic value), will normally only be realized once more pressing material needs, for example 'being solvent', have been satisfied.

3.3.5. 'Language and Nationality' Variables

'Language Orientation' (X1) - 'Less Tangible' Figure 3(H).
'Bilingualism' (X8) - 'Less Tangible' Figure 3(I).
'Language with Origin' (X40) -'Tangible' Figure 3(J).
(Appendix 1).

The one extreme of the 'Language Orientation' scale includes subjects with the highest dependence on English as a communication medium (little or no ability in Afrikaans). The opposite end of the same scale includes subjects with the highest dependence on Afrikaans as a communication medium. Bilingual subjects fall therefore into the mid-range (Figure 3(H)). (Other languages are omitted in this variable's definition because all sample subjects spoke only Afrikaans or English or both at their homes (Appendix 1).

A moderate correlation exists between 'Language Orientation' and 'Conservation Behaviour' with alpha at 0.01 (Figure 3(H)). The left hand base of the scatterplot indicates that Afrikaans speakers (with little or no capability in English) clearly rate lower in 'Conservation Behaviour' than the remainder of 'Bilingual' and 'English only' oriented subjects. The correlation would have been much greater if the 3 outliers at the basal right hand corner of Figure 3(H) were to be excluded. Interestingly enough, the outlier subjects included the only immigrants within the sample. By not excluding any subjects but taking 'origin' into account, 'Language with Origin' is derived. This three-state 'tangible' variable, where English Speaking = 1, Afrikaans Speaking = 2 and Overseas Origin = 3 (Appendix 1; McDowell, 1988) reveals a marginally higher correlation (Figure 3(J)) with 'Conservation Behaviour' than does 'Language Orientation'.

'Language Orientation' correlates well with both 'Lifetime in Non-Rural area' (X6) and 'Bilingualism' (X8) (Figure 1). The positive correlation with 'Lifetime in Non-Rural Area' is not surprising because among people of European descent in Southern Africa, Afrikaans speakers traditionally have a stronger rural base than English speakers. The strong relationship between 'Language Orientation' and 'Bilingualism' is because most English speaking subjects, excepting the immigrants, spoke Afrikaans better than most Afrikaans subjects could speak English. This is quite understandable considering the predominantly Afrikaans nature of the Western Cape rural community . (This majority is also reflected in the sample as indicated in Figure 3(H)).

Of those 'Language and Nationality' variables measured Bilingualism' has the highest correlation with 'Conservation Behaviour' (alpha at 0.0001 in Figures 1 and Table 1). This has to do partly with the effective 'screening out' of the three 'outliers' in Figure 3(G) as well as the high degree of collinearity with the other variables linked to 'Conservation Behaviour'. These include the categories delimited in Appendix 1, namely: 'Cognition' (Variables X3, X7, X16), 'Motivation' (Variables X19, X12), as well as the individual variables ; 'Lifetime in Non-rural Area' (X20) and of 'Understanding of Project' (X10). (All with alpha at 0.0001). To a slightly lesser degree 'Bilingualism' is also correlated with certain variables within the categories 'Formal Education' (X36, X37). and 'Affluence' (X4, X14). (The latter with alpha at 0.001. (See Figures 1 and 2 as well as Table 1).

The relationship of 'Bilingualism' with 'Education' (X37) can partly be explained. Tertiary education within an Afrikaans University or Technical College necessitates an understanding of English as a large proportion of text books, journal articles etc are in English. This is obviously of greater international usage than Afrikaans. Education, as has been discussed (3.2.3), may also have a bearing on the closely linked 'Cognition' and 'Motivation' type variables. (See also 3.2.2). The link between the 'Affluence' variables and 'Bilingualism' cannot so easily be explained.

Overall, therefore, within the sample, it appears that South African born English farmers and bilingual Afrikaans farmers are better conservers of natural ecosystems than are the non-bilingual Afrikaans farmers and farmers from overseas It could be argued that cultural differences have a role to play. This is partly analogous to the findings of Taylor and Miller (1978) concerning the significant differences between Amish and Non-Amish American citizens in their willingness to adopt agricultural innovations. At the 'micro' level, the interplay between variables (as indicated in Figures 1, 2) may well represent a very indirect causal bearing on the language differential in conservation. This would surely not have been detected when using the approach of testing single (or very few) variables' relationships with the dependent variable(s) (normal for many similar studies). A possible contributory reason is that almost all environmental literature - an informal education medium - is in English. This clearly precludes those subjects with a high dependence on Afrikaans from direct access to advanced knowledge on environmental matters (see McDowell and Grindley, 1985, for details and proposed remedies). The 'knowledge' variables, as discussed, are clearly associated with 'Conservation Behaviour' (Figures 1, 2, and Table 1).

3.3.6 'Valuation' Variables

Value Proportion of Veld to Land' '(X49) - 'Tangible' Figure 3(K).
'Ln Value Proportion of Veld to Land' Figure 3(L).
(Appendix 1)

The composite variable 'Value Proportion of Veld to Land' is derived not from the subjects (unlike most of the other variables) but from local government fieldsheets which provide breakdowns of immovable property for purposes of rates levies. Based on 'Rateable Valuation of Property' (X47) and 'Rateable Valuation of Veld' (X48), this variable reflects the proportion of the total rateable valuation of a particular subject's land that has not previously been ploughed for crops (Appendix 1).

The rateable valuation of the natural habitat (veld) can be expected to correspond partly to 'Conservation Behaviour' - see Definition ii); "the sacrifice of alternate commercial ventures which may have resulted from the retention of natural habitats" (see 2.0 'Methods'). This is shown in the moderate correlation between the two variables at = 0.01 threshold (Figures 1, 3 and 4). Despite the outlier (basal right hand side of Figure 3(K)) the relationship appears to be slightly log linear. The ln transformation (Figure 3(L)) creates a moderate improvement, nevertheless with the influence of the outlier still pervading. Incidentally, this outlier was exceptional in being the only subject to possess a smallholding on the outskirts of an urban area. This smallholding was intended by the landowner to be developed for housing in the longer term.

Of interest is the high negative correlation apparent between 'Dependence of Land' (for a living) (X13) and 'Value Proportion of Veld to Land' (alpha at 0.001 in Figure 1). This observation ties in with Healy and Short's (1979) research which indicated that those "farmers, ranchers and forest managers (who) must make a living off the soil ... (and with such owners) the economic role of the land tends to take precedence over its aesthetic values..." The jist of this statement is that such "traditional landowners" tend to be the least concerned about the removal of natural elements. In contrast the more preservation oriented "non-traditional" landowners tend to have their economic dependence elsewhere; particularly within the urban areas.

3.3.7 'Interaction Term' Variables

'Dependence on Land for Income' (X13) - 'Less Tangible' Figure 3(M).
'Past Tenure of Family' (X42) - 'Tangible' Figure 3(N).
'Dependence on Land for Income' (X13).'Past Tenure of Family' (X42) - 'Hybrid Multiple' Figure 3(O).

Interaction between the independent variables was anticipated (as has already been indicated). A few a priori postulated two-way interactions were checked by plotting Y against the product of the two suspected interacting 'independent' variables. All two-way interactions could not be included in the model because even in the Universe (212 farmers) there were insufficient subjects to estimate the additional regression coefficients corresponding to such an inclusion. If, for example, the sample correlation coefficient between X(i), X(j) and Y is noticeably greater than the sample correlation coefficient between X(i) and Y and X(j) and Y, then this postulated interaction is given closer attention. The most favourable two-way interaction was between 'Dependence on Land for Income' (X13) (Figure 3(J)) and 'Past Tenure of Family' (X42) (Figure 3(K)).

X	X13	X42	X13.X42
Sample Correlation Coefficient between Y and X	0.352	0.239	0.580

The logical implications of the much improved 'multiple hybrid' (Figure 3(O)) is that farmers whose families have been on the land longest with low dependence on land for an income are better conservationists than the reverse situation. This bears out the observation from the interviews that frequently it is the long-term family landowners, who have built up "sympathy" with the land and its remnant habitats, who are more conservation minded than certain of the recent landholders who tended to exploit the land to its maximum for short-term returns (unlike the non-traditional majority defined by Healy and Short 1979 for the U.S.A.). However, for such 'long-term' landowners to act upon their conservation beliefs, several variables, as have already been discussed, should be "in their favour". Among these is included a stable source of income. No matter how profitable a farming enterprise may be, agriculture is notorious for the financial instability brought about by unpredictable droughts, floods, diseases etc. This is one reason why, in South Africa, governmental subsidies, tax deductions, etc are much more available to farmers than to other occupational groups (McDowell, 1986 b).

3.4 Predicting the Ratings of Conservation Behaviour

In consideration of the high level of collinearity between many of the 52 X variables rated it is desirable to eliminate some variables. The variables excluded will be either those which form negligible relationship with 'Conservation Behaviour' or those whose information about Y is contained in the variables not omitted. To this end linear formulae were derived using the results from the subject sample to predict 'Conservation Behaviour' by applying the 'All Possible Subsets Regression' Computer Programme (Frane, 1983). Such 'Best Subset' equations employ the least number of (explanatory) X variables to define the highest proportion of variation within the dependent Y variable. The practical value of these equations is to predict a rating for farmers' 'Conservation Behaviour' by obtaining measurements for manageably small subsets of X variables.

For each formula represented below the assumptions (such as normality) were checked and regression diagnostics were used to isolate outliers. No deviation from the regression assumptions were found and no outliers were encountered.

3.4.1 Variable Inputs and Resulting Formulae

a) Input 1: Variables and 'interaction hybrids' having minimal inter-observer error (of the 'less tangibles') in addition to being significantly correlated (alpha at 0.01) with Conservation Behaviour Y. (17 eligible variables indicated in Table 1 and 7 interaction terms.)

Formula 1

Y1 = 16.575 + 0.579 (X12) + 0.298 (X4) + 0.118 (X1) - 0.001 (X42.X13) - 0.210 (X18)

Proportion of Y explained is: R squared = 0.95.

X12 = 'Overall Interest in Ecosystem'; X4 = 'Overall Affluence'; X1 = 'Language Orientation'; X42. X13 =

'Past Tenure of Family' multiplied by 'Dependence on Land', (Interaction 'hybrid') and X18 = 'Materialism'.

Theoretically, all 52 X variables and the 7 hybrid variables could have been entered in terms of this 'generalised input'. However, each additional X entered over and above the 21 entries, would entail a doubling up of computer time (and expense) when selecting variables. The 'screening out' of the potentially least useful variables is therefore necessary to obtain a 'cost effective' input.

The proportion of Y explained by this regression model was gratifyingly high. (For the uninitiated it is noted that the estimated regression coefficients are not always proportional to the value of the particular variables indicated in predicting Y. This is particularly true when the X variables are strongly collinear).

The relevance of all implicated variables, with the exception of 'Materialism', has already been discussed. 'Materialism' is defined as "The predominance of the subject's commercial values over his/her aesthetic values." (Appendix 1). As might be expected, 'Materialism' was found to be highly negatively correlated to 'Conservation Behaviour' which fits in with Maslow's "Hierarchy of Needs" as discussed under 3.3.4. Interestingly enough, 'Materialism' showed minimal relationship with the 'affluence' variables (according to Maslow, 1971, 'material' well-being is associated with a decline in 'material' desires), but shows a more significant relationship with the 'Education' variables (alpha at 0.01 with 'Education' X37) (Figure 1). The inference is, therefore, that the ability to appreciate aesthetic qualities is only possible with a modicum of cognitive sophistication. (This unfortunately ignores the axiom that in the longer term, scientifically applied conservation is extremely practical!) 'Materialism', which actually appears to represent a 'state of mind' rather than a 'state of wealth', was found to be the most strongly related to development threats to veld (X15, X28 in Figures 1 and 2) - presumably the reason for its arising in Formula 1.

b) Input 2 : Variables with negligible measurement uncertainty (all 20 'tangible' variables. See Table 1)

Formula 2

$$Y1 = 121.162 + 6.748\,(X37) + 0.015\,(X44) - 0.008\,(X46) + 0.009\,(X47) + 0.002\,(X49)$$

Proportion of Y explained is: R squared = 0.77.

X37 = Education; X44 = Area of Land; X46 = Area of Renosterveld; X47 = Rateable Valuation of Property and X49 = Value Proportion of Veld to Land.

Formula 2 was derived primarily to determine whether 'tangibles' alone could be effective in predicting Y1 ('less tangibles' have traditionally been ignored in similar studies - McDowell, 1988).

Of all 4 inputs, R = 0.77 was the least effective. This still indicates a reasonable level of predictability for 'Conservation Behaviour' in using a small subset of 'tangibles' in Formula 2.

c) Input 3 : Variables amenable to measurement by questionnaire (21 variables - see Table 1)

Formula 3

Y1 = 10.823 + 70.596 (X39) + 14.203 (X40) + 4.015 (X34) + 3.516 (X37) + 0.005 (X44)

Proportion of Y explained is: R squared = 0.84.

X39 = Origin; X40 = Language with Origin; X34 = Number of Siblings; X37 = Education and X44 = Area of Land.

The 'less tangibles' indicated would have to be rated by means of the less discriminating more traditional multistate Likert scale techniques as the present method derived *de novo* for assessing 'less-tangibles', is not amenable to questionnaire rating (cf. McDowell, 1988).

However, of the variables which arose in Formula 3, all included 'tangibles', so the compatibility of different rating techniques for the 'less-tangibles' (as discussed) is not really brought into question. Of these variables, most do not come as much of a surprise in terms of their obvious relationships with Y. The exception is 'Number of Siblings (X34), for which logical explanation is not easy. Its significant relationship with 'Conservation Behaviour' is extremely low (Figures 1, 3), therefore inclusion is probably because of the low collinearity of this variable with almost all other variables (indicated by the position of 'Number of Siblings' on the far right-hand side of Figure 2). Almost coincidentally, it may take up the small amount of the variation in Y unaccounted for by the remaining, more collinear, variables of the model.

d) Input 4 : Variables with low observer error and least qualitative resemblance to Y (24 variables - see Table 1)

Formula 4

$$Y = 27.876 + 3.764\ (X37) + 2.932\ (X34) + 0.427\ (X1) + 0.255\ (X4) + 0.051\ (X42) + 0.003\ (X44)$$

The proportion of Y explained is: R squared = 0.87.

X37 = Education; X34 = Number of Siblings; X1 = Language Orientation; X4 = Overall Affluence; X42 = Past Tenure of Family and X44 = Area of Land.

It was decided to test the exclusion of variables, such as the 'Cognition' variables eg 'Overall Knowledge of Ecosystem' (X7) and 'Motivation' variables eg 'Conservation Attitude' (X9), etc which could, in part or whole, be confused in terms of their resemblance to part or whole of the definition of Conservation Behaviour (Appendix 1).

The admittedly somewhat arbitrary selection of such variables by the researchers was achieved in collaboration with selected colleagues. (Scrutiny of Appendix 1 should, however, lead readers to agree with the bulk of this selection.)

The R squared value (above) is the second highest of all the other inputs which indicates that 'Conservation Behaviour' can be predicted by means of quite distinctly 'independent' variables; that is those with no chance of being considered in any way synonymous to 'Conservation Behaviour' in terms of their description or definition.

3.4.2 The Prediction Results in Perspective

As a means of internally validating the capacity of prediction models, Formula 1 (derived from the generalised Input 1) was put to the test through application to the raw data using the final readings for the critical variables (as derived from the independent raters in the case of the 'less tangibles' - McDowell, 1988).

'Predicted' Conservation Behaviour scores, as calculated for each and every landowner, differed by an average of $\pm$ 5% from their real scores with a maximum deviation of $\pm$ 10%. This level of certainty in prediction represents a considerable improvement on the conceptually similar soil conservation behaviour predictors in the studies of Napier et al. (1984) and Earle et al. (1979). Napier et al., using as a basis 16 independent variables, achieved comparatively unimpressive R squared values, ranging from as little as 0.03 to a maximum of 0.24, in trying to predict soil conservation related variables . From 2 to 6 independent variables were implicated in each equation.

Secondly, Earle et al., in applying the Linear Discriminant Function to 31 independent variables, were able to predict with 80% certainty whether respondents fell into 'adopter' or 'non-adopter' 'soil conservation intention' categories. The 80% certainty is, however, slightly misleading when considering the successful prediction with greater than 2 categories. By comparison, within the present study example, each subject could be placed by the authors into a 5-interval categorisation of 'Ecosystem Conservation Behaviour' with 100% accuracy (cf. maximum deviation of 'expected' rating from 'observed' rating was $\pm$ 10% as above). Part of this success is due to the systematic incorporation of the 'less tangibles', which proved to be very helpful for this type of analysis (cf. McDowell, 1988).

4.0 CONCLUSIONS

The importance of rating 'less tangible' variables as a basis for interpreting conservation behaviour is discussed elsewhere (McDowell, 1988). The use of such 'less tangibles', appears to have broadened the standard of analysis of 'Conservation Behaviour'.

A clearly defined network of relationship appears to exist between a large number of 'tangible' and 'less tangible' variables. Only a small cross-section was evaluated by reference to scatterplots (Figure 3). As indicated, readers can derive their own interpretations for the remainder through systematic scrutiny of Figures 1 and 2. Given the observation that attitudes and behaviour seem to be largely pre-determined by quite a wide variety of background factors (correlated variables) in order to 'gel', it seems safe to assume that to 'favourably' modify most of these significantly would be almost impossible in the short-term. For example how could we suddenly create favourable shifts in language, affluence or education? Innovative rules of thumb for persuasion are nevertheless put forward tentatively in the sequel (McDowell et al, 1988).).

The result taken from the research sample reveals that a high level of certainty can be achieved in prediction of 'Conservation Behaviour' by using manageable subsets of various inputs of variable categories. Whereas one can be confident of the validity of 'within sample' predictions - taken perhaps insofar as the relatively small universe is concerned (West Coast Renosterveld owners) - much caution must be exercised if results were to be extrapolated beyond this universe into, for example, the farming community of the whole Cape Province of South Africa. Generalisation of such a nature can most effectively be achieved through the statistical validation of the derived prediction models.

A form of qualitative validation however, was attained when the major correlative patterns were presented to two officials of the Cape Department of Environment Affairs. Both these officials, who were accustomed to personal dealings over many years with hundreds of Cape landowners on conservation matters, personally and independently attested most of the patterns described in this paper.

Statistical validation could be achieved by means of the Monte Carlo and Bootstrap Method (Sparks, 1988). This computer package could be applied to measurements taken of critical variables (of the prediction equations and for Y itself) for random samples of subjects at varied distances (spatial and differential) from the present sample universe (West Coast Renosterveld farmers). The initial formulae could also then be modified so as to have a far wider application. Obviously research expenses would be high, but potentially valuable for enlarging scope of prediction. For example, in the hypothetical situation that the questionnaire prediction formula (Formula 3) was reliable in its application to most Cape farmers, this would have important implications for rapidly screening various zones of environmental merit for relatively 'good'/'bad' conservationist landowners - a valuable step towards "managing the managers".

The assertion that such an approach is viable has philosophical assumptions implicit in the acceptance of the positivist psychological school. This school broadly infers that human behaviour can be determined by the interaction of quantifiable variables. Whereas the latter 'reductionist' philosophy is open to contention (McDowell, 1988) the use of 'less-tangibles' in the description and explanation process may have lent this approach greater credibility than previously; at least as far as the man - environment interface is concerned.

The sooner the relevant researchers' and funding agencies realise the importance of furthering the type of inter-disciplinary research presented in this paper, the greater will be the much needed advances in the understanding and improvement of human environmental behaviour "at the pitface". It is contended that this facet of research is fundamental to solving the bulk of environmental problems.

FIGURE 3

REGRESSION PLOTS OF SELECTED 'INDEPENDENT' VARIABLES VERSUS 'CONSERVATION BEHAVIOUR' [3]

A) AGE VS CB

B) CONSERVATION ATTITUDE VS CB

C) EDUCATION VS CB

D) BIOLOGICAL ORIENTATION IN EDUCATION VS CB

E) PARENTS' EDUCATION VS CB

F) OVERALL AFFLUENCE VS CB

G) NON-LIQUID CAPITAL VS CB

H) LANGUAGE ORIENTATION VS CB

I) BILINGUALISM VS CB

J) LANGUAGE WITH ORIGIN VS CB

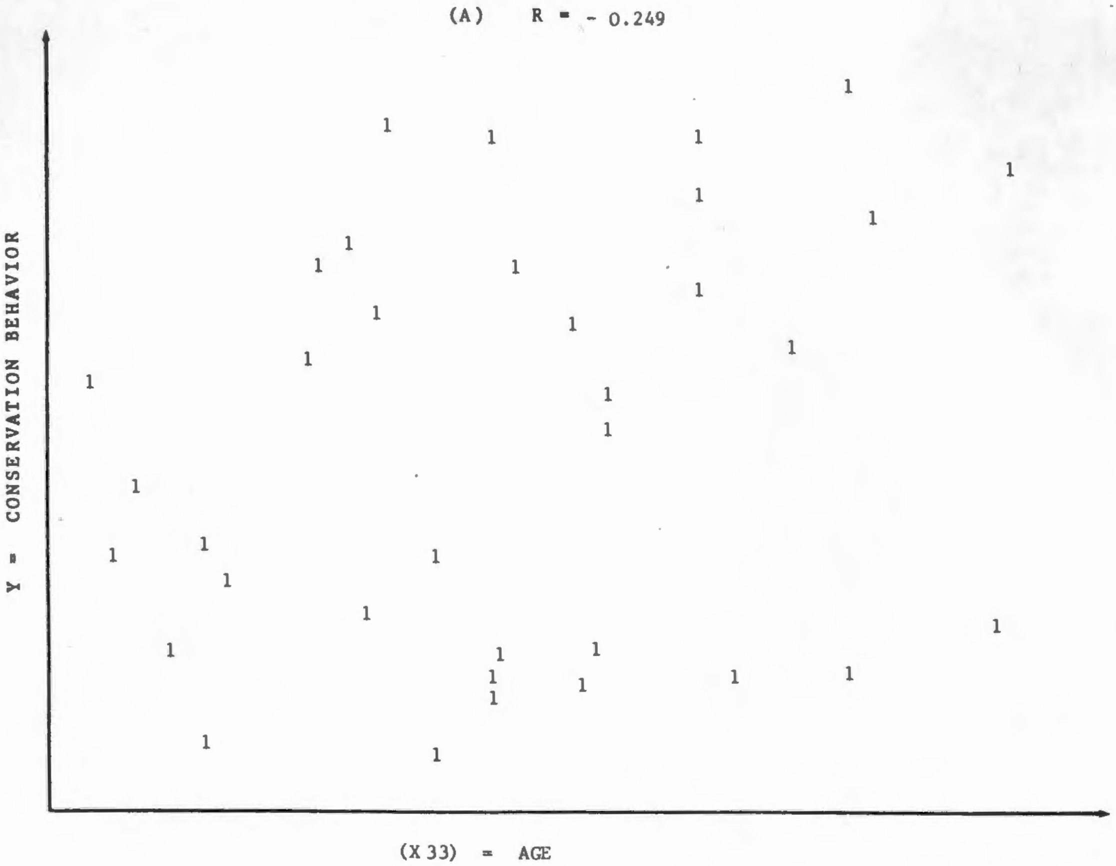
K) VALUE PROPORTION OF VELD TO LAND VS CB

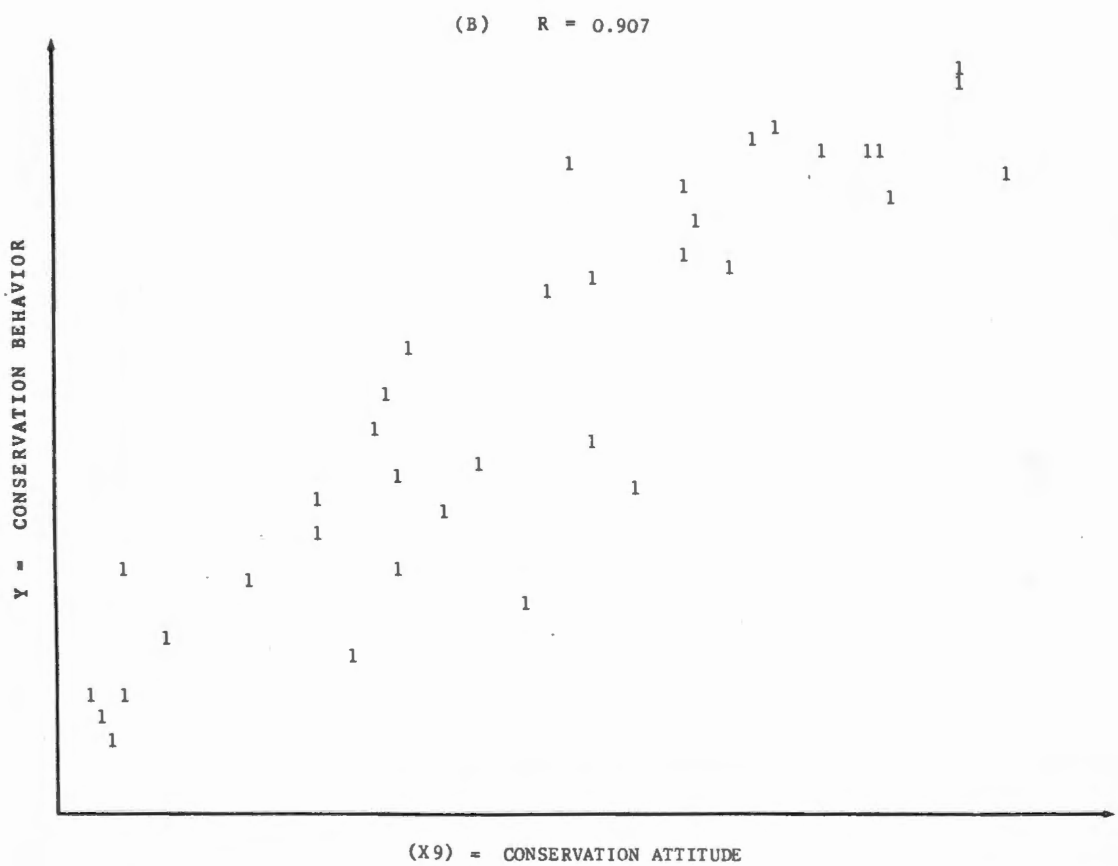
L) LN (VALUE PROPORTION OF VELD TO LAND) VS CB

M) DEPENDENCE ON LAND FOR INCOME VS CB

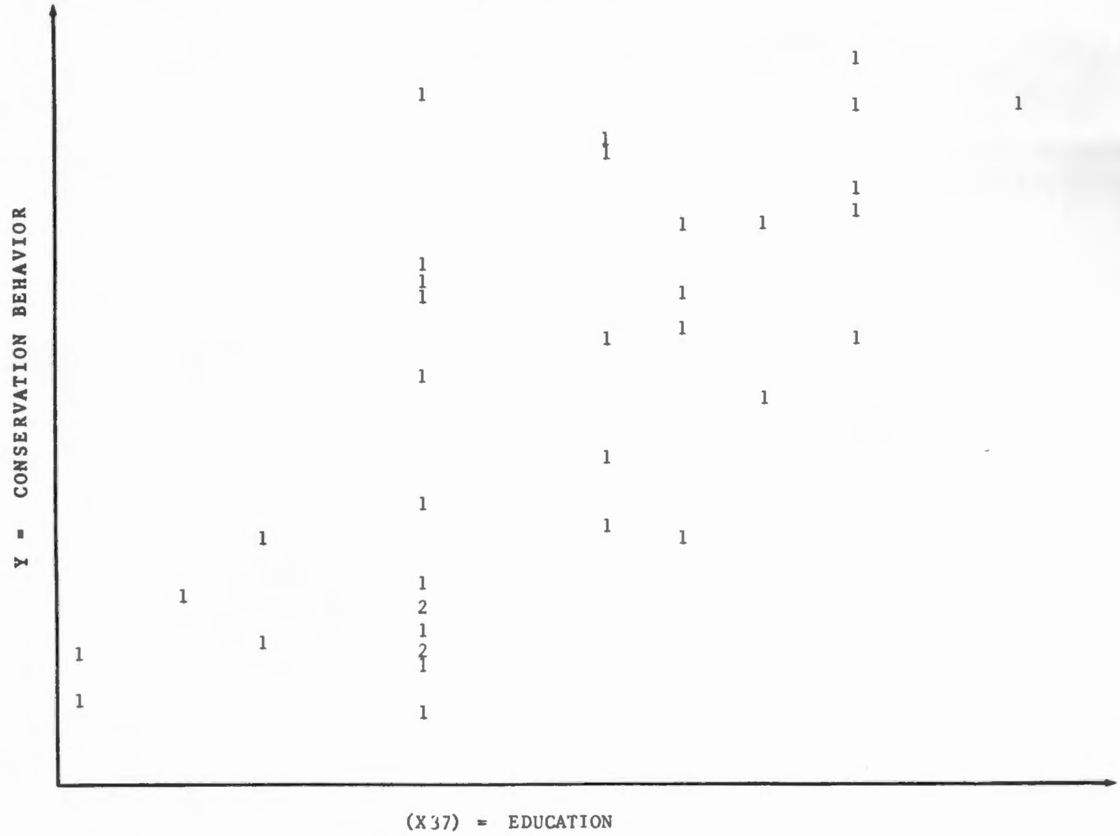
N) PAST TENURE OF FAMILY VS CB

O) (DEPENDENCE ON LAND FOR INCOME)(PAST TENURE OF FAMILY) VS CB

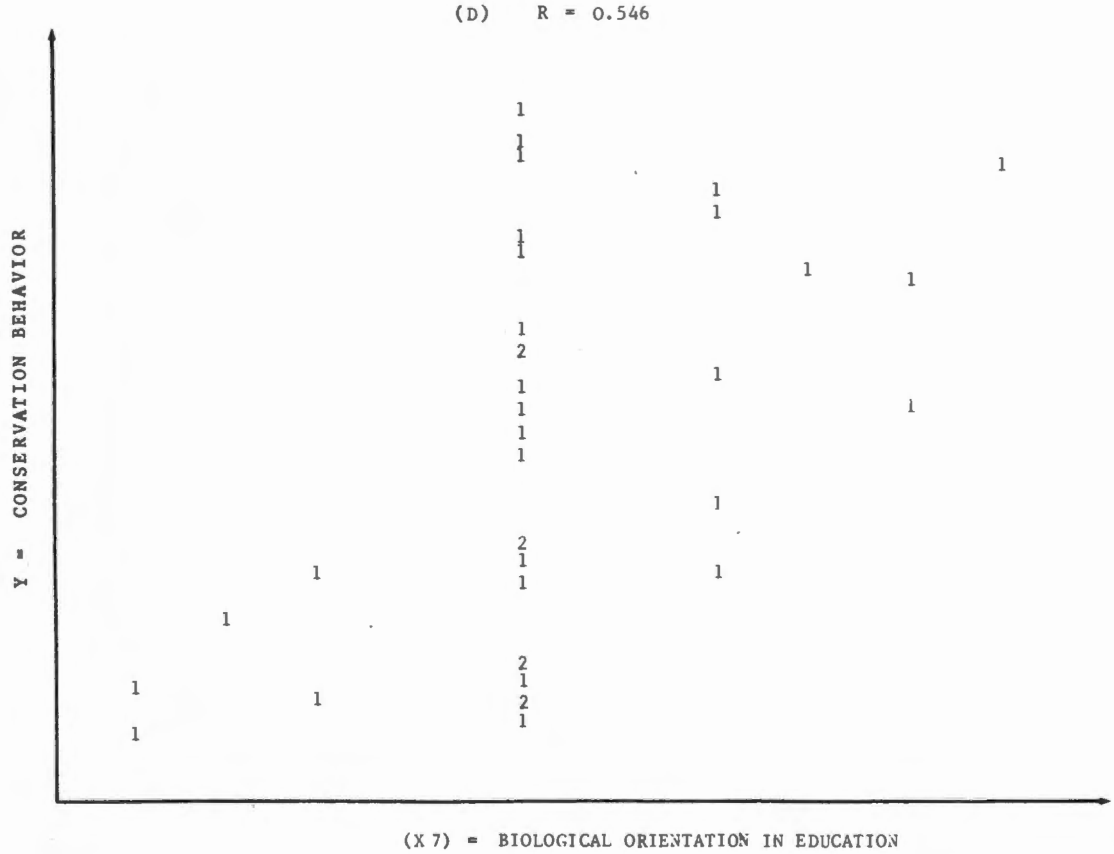

(A) R = - 0.249
Y = CONSERVATION BEHAVIOR
(X 33) = AGE


(B) R = 0.907
Y = CONSERVATION BEHAVIOR
(X9) = CONSERVATION ATTITUDE

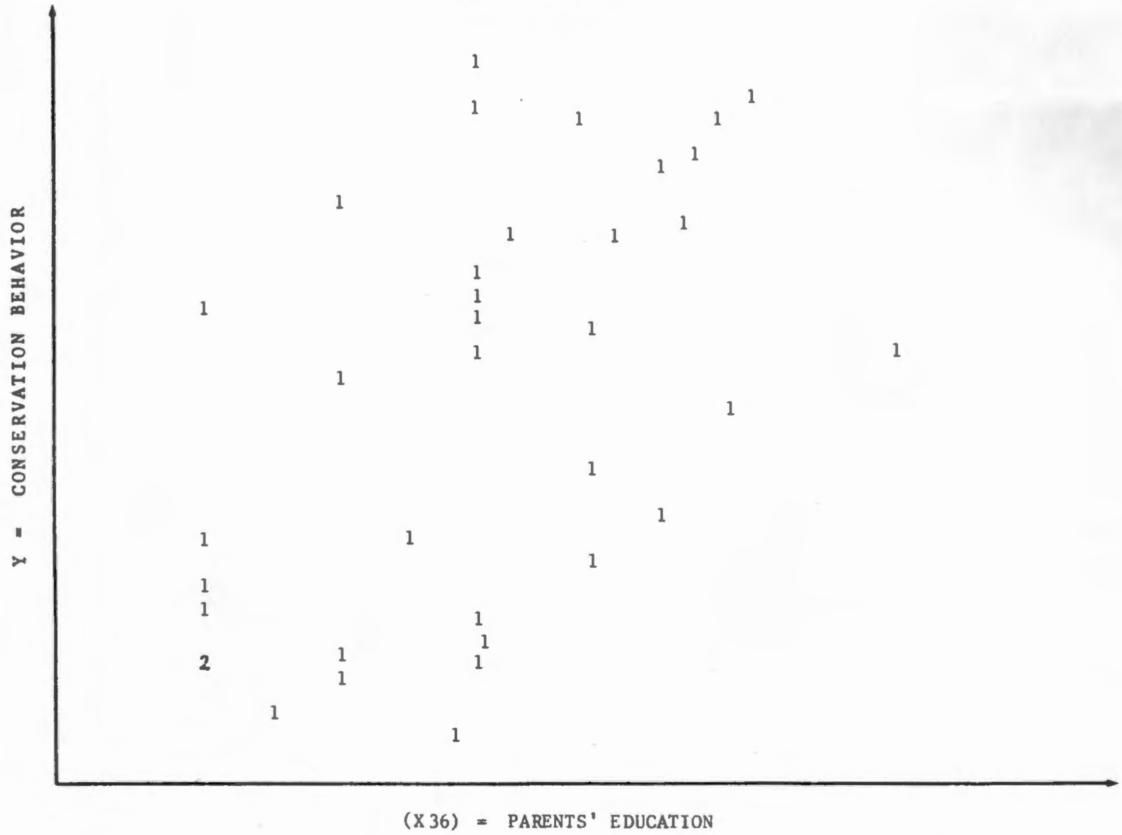
(C) R = 0.693



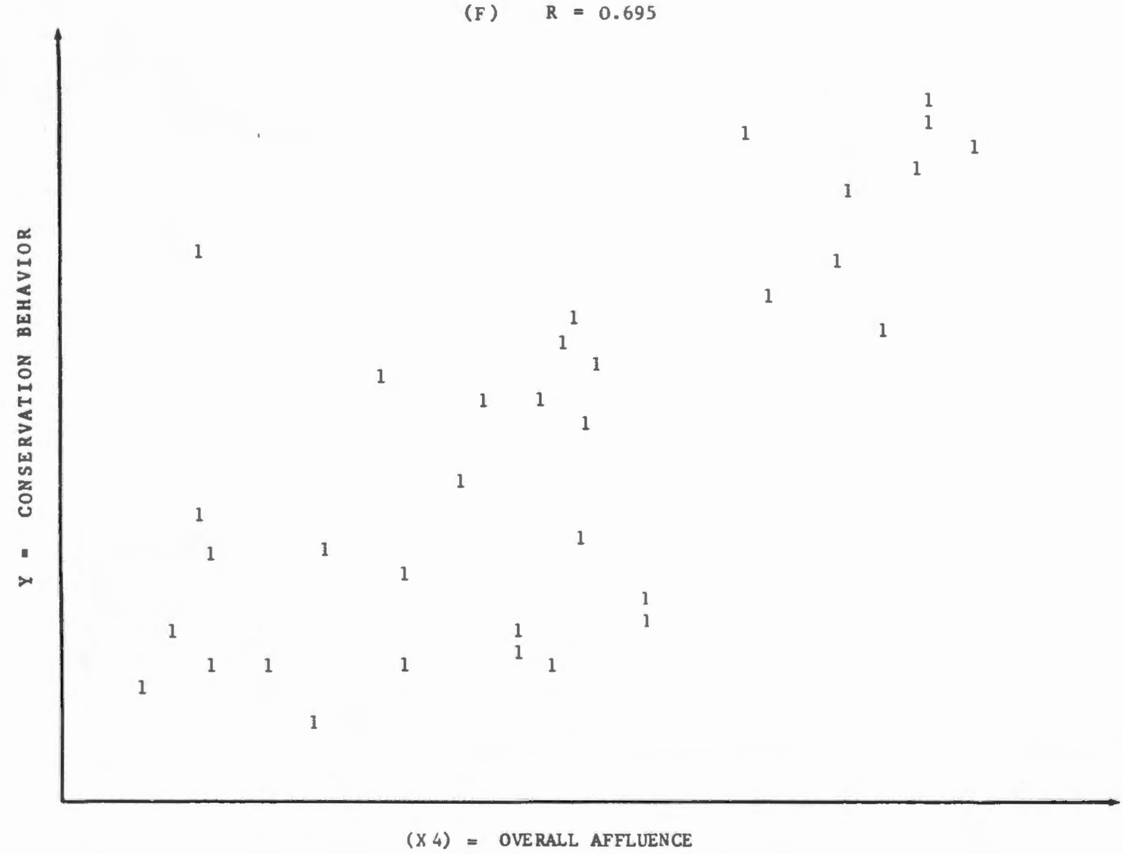
(D) R = 0.546



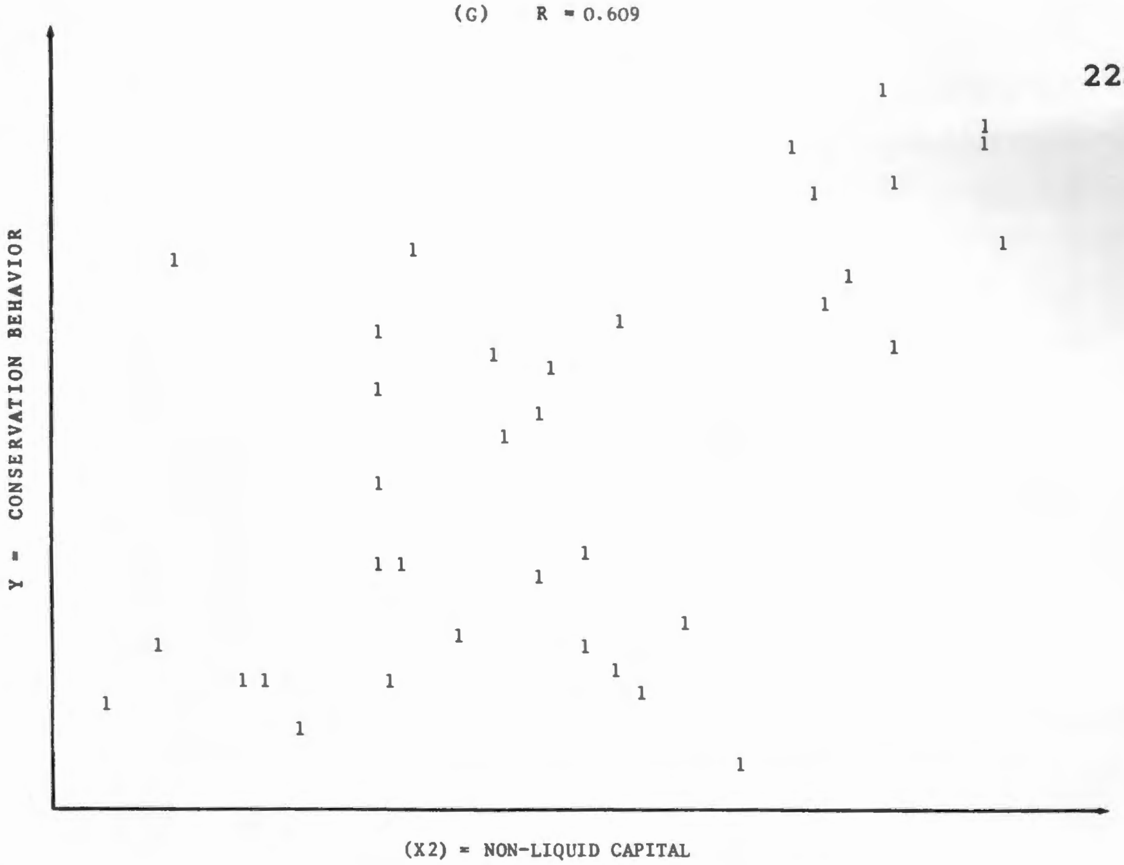
(E) R = 0.516



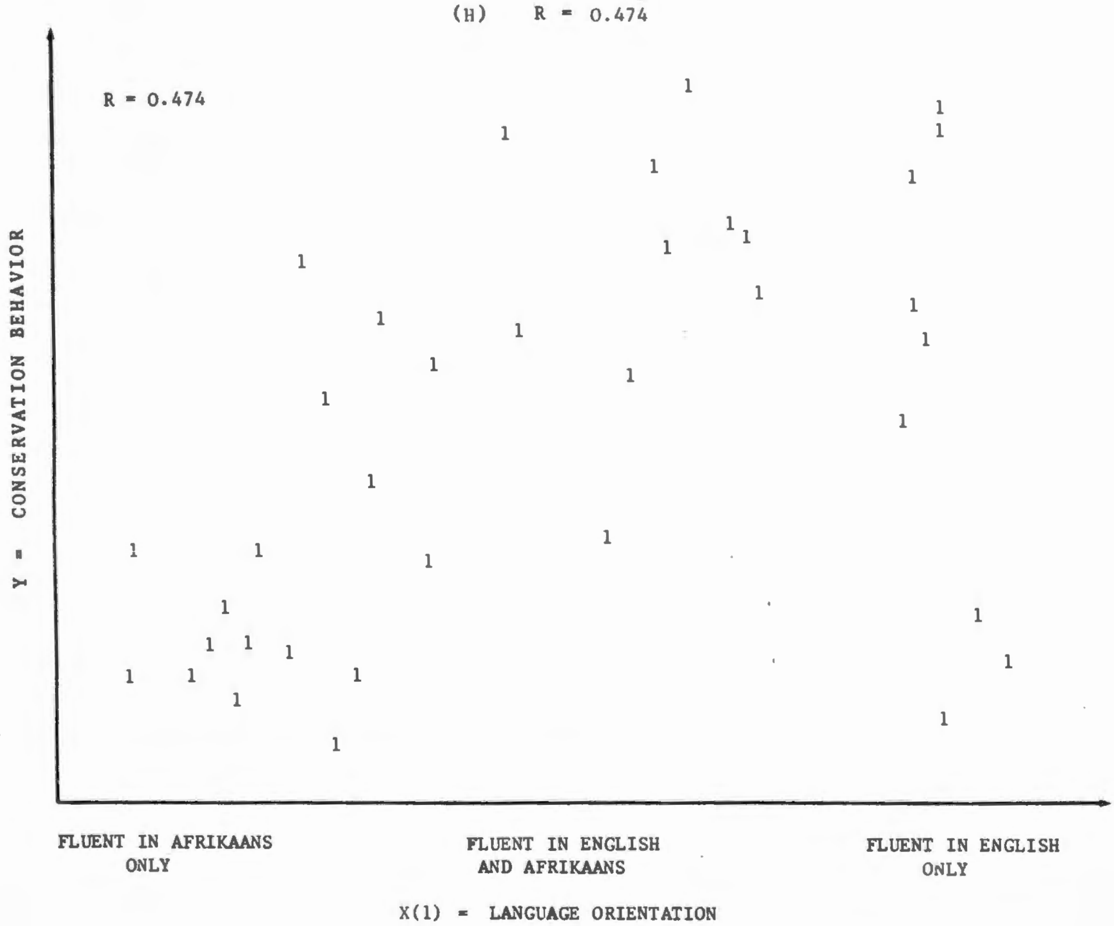
(F) R = 0.695



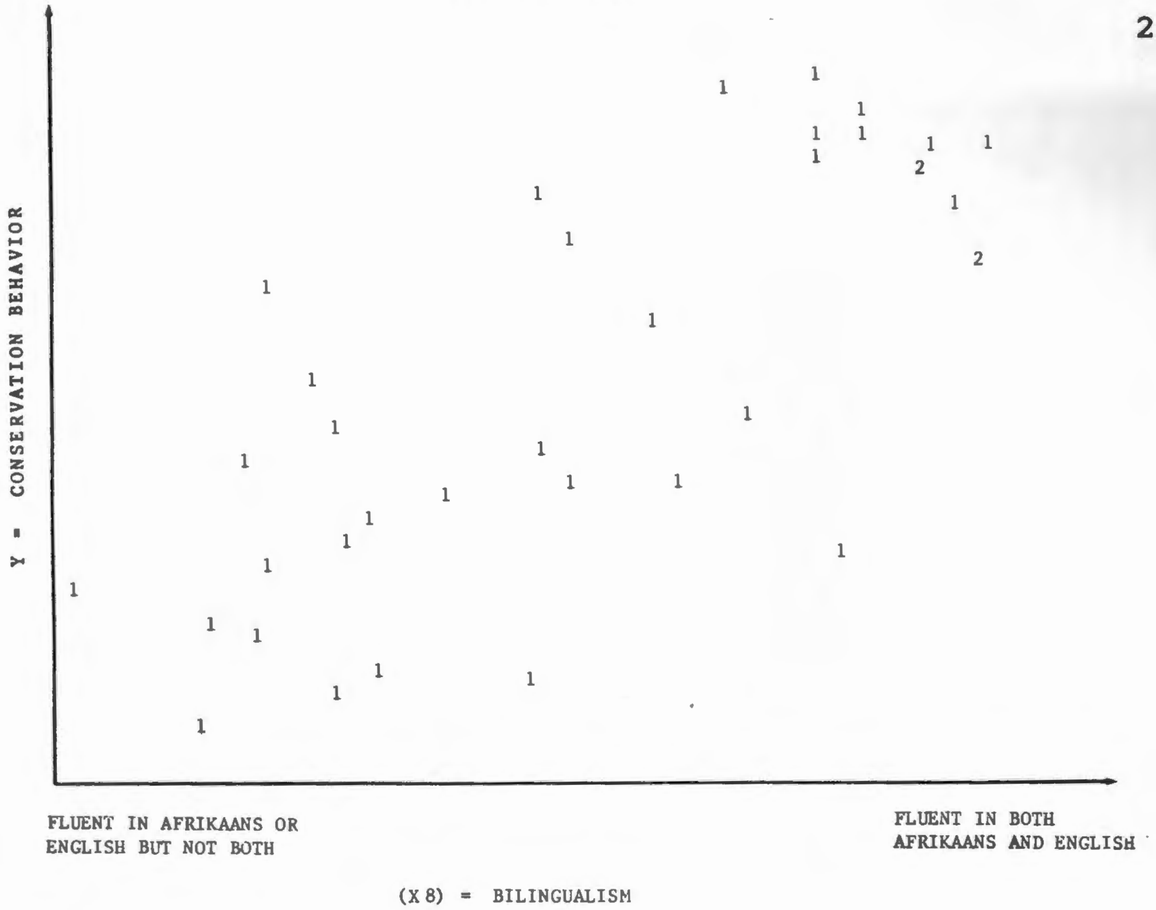
(G) R = 0.609



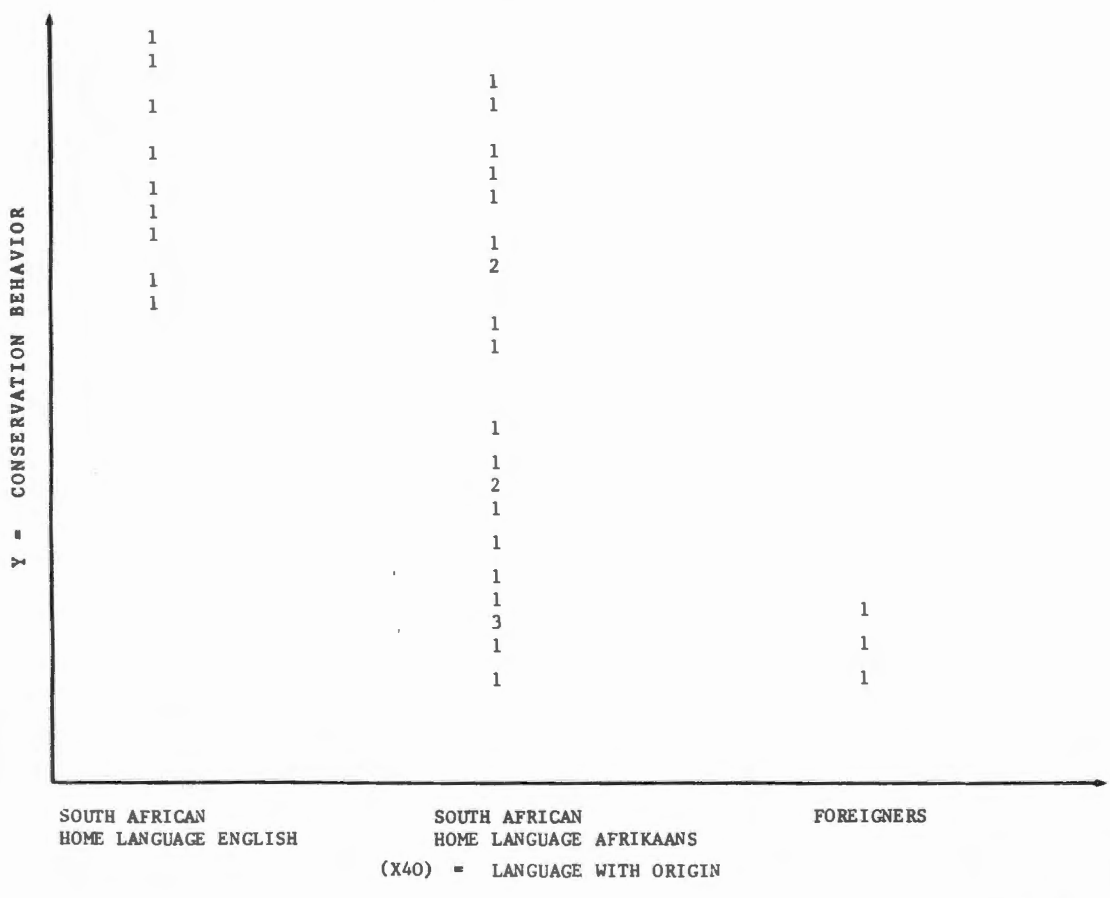
(H) R = 0.474



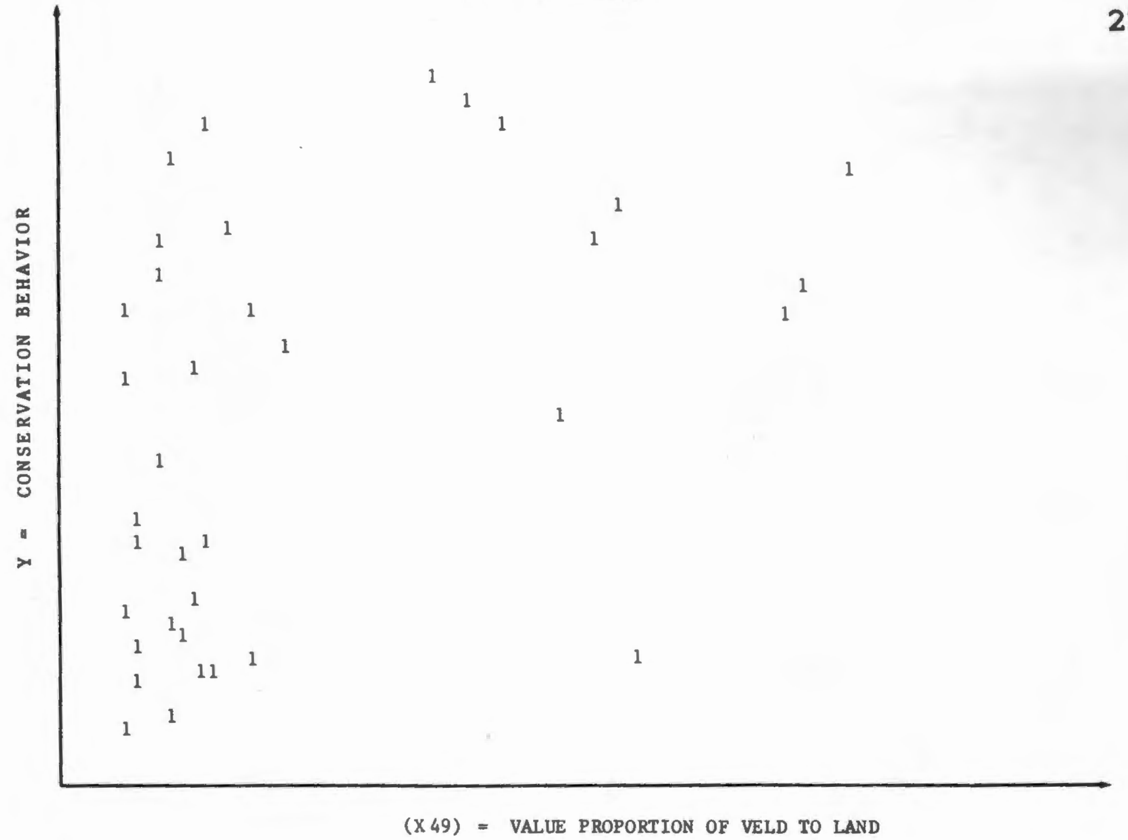
(I) R = 0.657



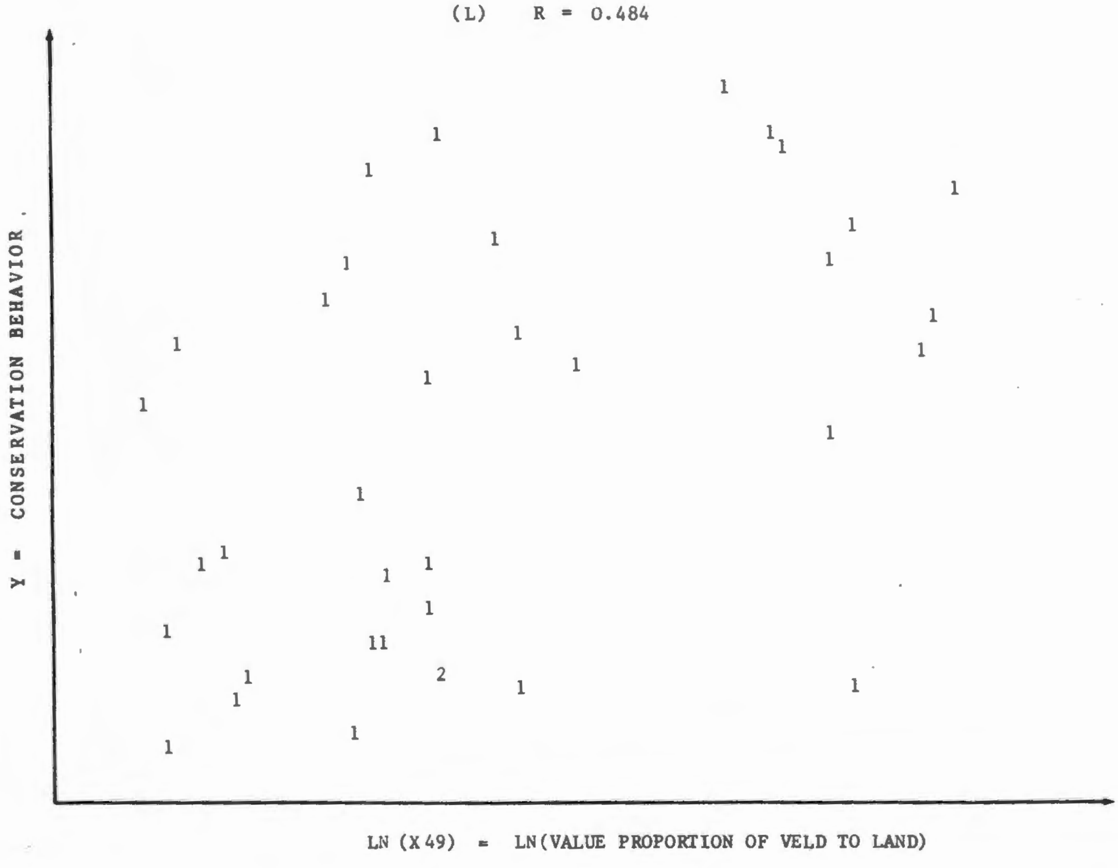
(J) R = 0.500



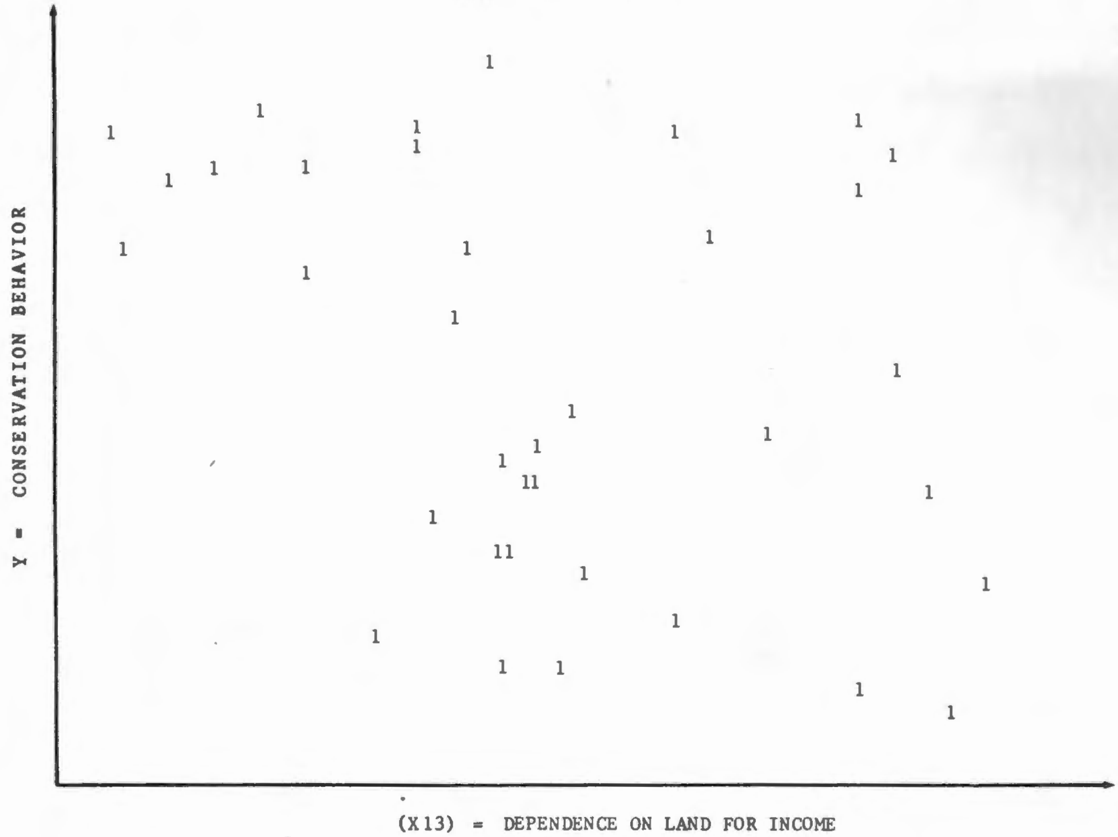
(K) R = 0.436



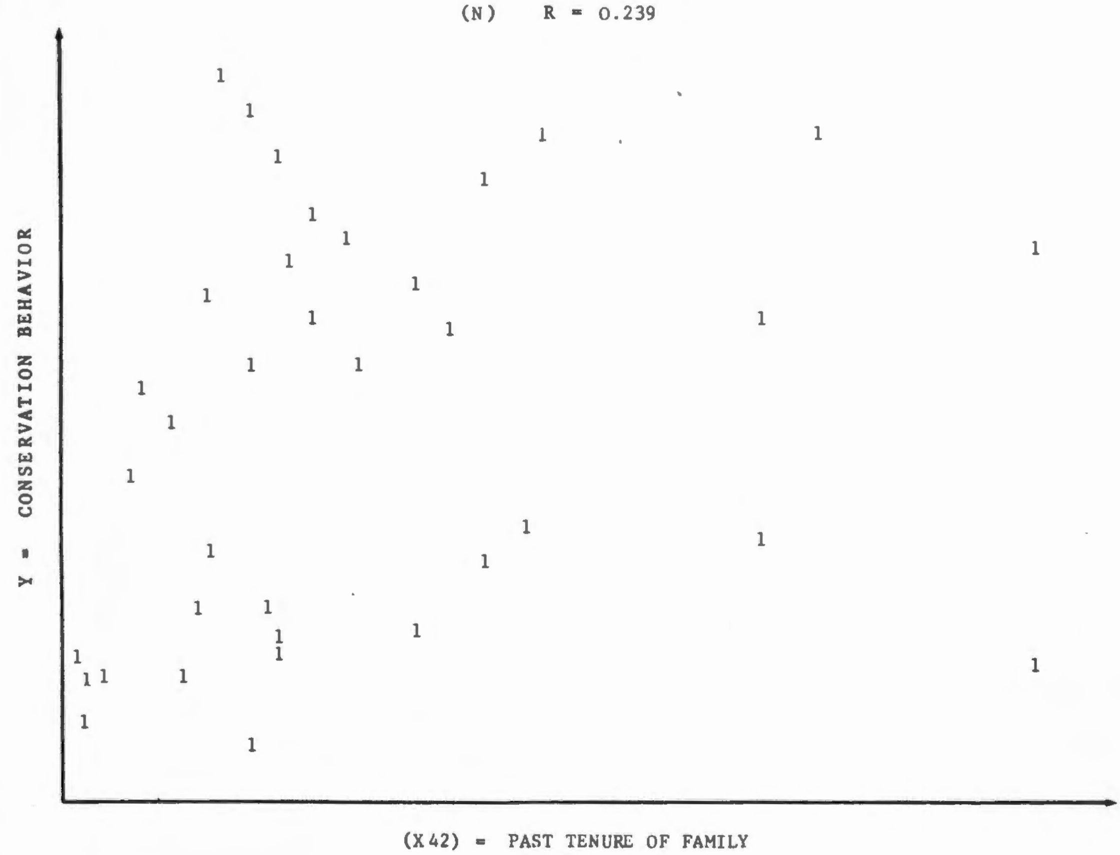
(L) R = 0.484



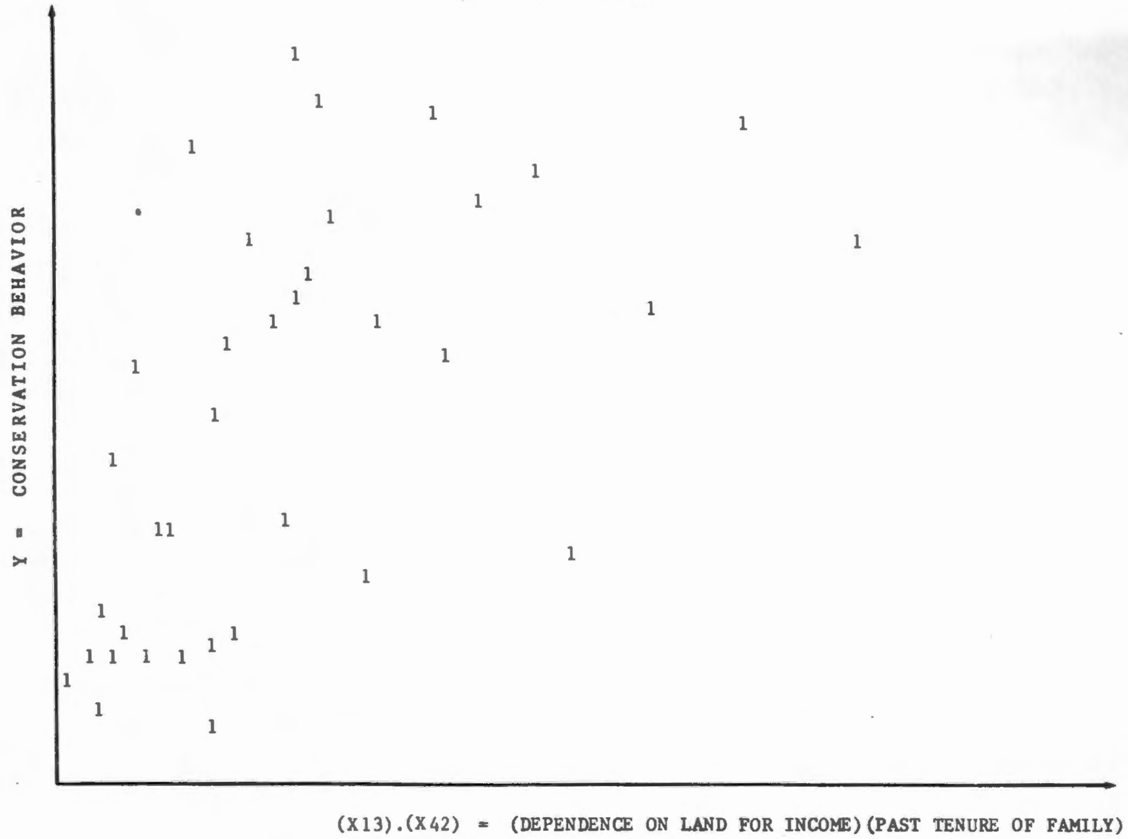
(M) R = 0.352



(N) R = 0.239



(o) R = 0.580


Y = CONSERVATION BEHAVIOR
(X13).(X42) = (DEPENDENCE ON LAND FOR INCOME)(PAST TENURE OF FAMILY)

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PAPER 5

PERSUADING THE LANDOWNER TO CONSERVE NATURAL ECOSYSTEMS THROUGH EFFECTIVE COMMUNICATION

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ABSTRACT

Initially, reference is made to measurements of 53 variables affecting conservation of renosterveld by a small random sample of farmers. A Euclidean distance cluster analysis reveals groupings ('sociotypes') of these landowners as well as several exceptions. Generalizations are made concerning 'Conservation Behaviour' of the farmers.

Two case studies of separate landowners are presented which contrast good and bad modes of conservation liaison. Carefully planned direct contact with such landowners; taking into account their individual background factors, is considered the most effective means of promoting good conservation behaviour.

Optimal interaction with landowners is then defined using empirical rules of thumb. The latter included six generalisations relating to the agent's objective of creating a good 'impression' on the subject with a further seven concerning 'steering' the subjects' decision-processes towards improved conservation. Substantiation is based upon the analysis of interviewed subjects, in conjunction with established social psychological theory.

KEYWORDS

Conservation extension, persuasion, landowners, farmers, communication, conservation behaviour, conservation attitudes, conservation values.

1.0 INTRODUCTION

The vital influence that farmers as decision makers have on the continued existence and management of natural/near natural ecosystems has been assessed previously (McDowell, 1986a, 1986b,; McDowell, 1988a; McDowell and Sparks, 1988). The main objective of the present paper is to formalize a set of working guidelines for improving conservation attitudes and behaviour through optimal contact by extension agents with landowners. Before a 'blue-print' for 'effective persuasion' can be provided, it is essential to have a clear understanding of the factors relating to the attitudes and behaviour of prospective subjects. For this purpose, a random sample of farmers in the South Western Cape lowlands, all of whom owned remnants of West Coast Renosterveld, was interviewed by McDowell (1988a). A wide range of 53 'Demographic', 'Land Use', 'Psycho-Social' variables, including 'Conservation Behaviour' itself, was assessed.

Coastal Renosterveld is the most reduced natural vegetation type in South Africa (Boucher, 1983; Moll and Bossi, 1984). Less than 5% of the distinctive West Coast Form remains today (McDowell, 1988b). The analysis proved that 'conservation behaviour' of these farmers can be remarkably well predicted using selected subsets taken from those listed in Table 1 (McDowell and Sparks, 1988). Statistical substantiation included the derivation of 'best subsets' for

TABLE 1

LANDOWNER VARIABLES IN SEQUENCE OF DESCENDING CORRELATION WITH OBSERVED 'CONSERVATION BEHAVIOUR'

	Rated Variable	Pearson's R
X7	Overall Knowledge of Ecosystem	0.920
X12	Overall Interest in Ecosystem	0.910
X9	Conservation Attitude	0.907
X3	Knowledge of Flora	0.886
X16	Knowledge of Fauna	0.883
X10	Understanding of Project	0.850
X16	Rapport with Interviewer	0.742
X20	Reliability of Information	0.729
X4	Overall Affluence	0.695
X37	Education	0.692
X19	Willingness to Donate Veld	0.660
X8	Bilingualism	0.657
X14	Liquid Capital	0.618
X2	Non-liquid Capital	0.609
X47	Rateable Valuation of Property	0.596
		α = 0.001
X38	Biological Orientation in Education	0.546
X36	Parents' Education	0.516
X40	Language with Origin	0.500
X29	Attitude Flexibility	0.494
X41	Past Tenure of Subject	0.489
X22	Influence of Tradition	0.475
X1	Language Orientation	0.474
X47	Rateable Valuation of Veld	0.459
X45	Area of Veld	0.453
X46	Area of Renosterveld	0.450
X49	Value Proportion of Veld to Land	0.436
		α = 0.01
X44	Area of Land	0.388
X6	Lifetime in Non-Rural Area	0.368
X13	Dependence on Land	0.352
X39	Origin	0.352
		α = 0.05
X51	Landowners Valuation of Veld/Ha	0.245
X42	Past Tenure of Family	0.239
X34	Number of Siblings	0.231
X11	Influence of Spouse	0.155
X27	Achieved Versus Ascribed Affluence	0.144
X23	Willingness to Lease Veld	0.139
X52	Landowners Lease Valuation of Veld/Ha	0.112
X35	Number of Children	0.083
X26	Subdivision Problems	0.069
X24	Innovation of Development Plans	0.067
X5	Future Tenure of Subject	0.060
X43	Generations Farming	0.048

X50	Period Veld Used for Pasture	0.039
X32	Gender	0.037
X31	Conservation Problems	0.021
X30	Present Commercial Utility of Veld	-0.027
X25	Willingness to Sell Veld	-0.093
X33	Age	-0.249
X21	Commercial Potential of Veld	-0.264
		α = 0.001
X28	Past Development Rate	-0.557
X15	Future Development Rate	-0.612
X18	Materialism	-0.709

(Numbers assigned to X's after McDowell and Sparks, 1988.)

the rated 'independent' variables (Frane, 1983). The best regression model explained 95% of the variability in the 'Conservation Behaviour' ratings of subjects in the study sample. This model was in the form of a linear equation comprising six variables and a single constant term. Variables found generally to be positively linked to conservation behaviour included 'Rateable Value of Property', 'Education', 'Parents' Education', 'Bilingualism' (English/Afrikaans) and 'Liquid Capital' (Table 1). None of these (and others indicated in Table 1) can be readily manipulated in the short term. Perhaps for this reason legal curbs on behaviour contradictory to conservation were found to have little effect (cf. McDowell, 1986a). On the other hand, the proposed de-emphasis of legal coercion together with recommended financial incentives, such as government subsidies, were considered to have potential with that category of landowners who were typically short of ready cash (low 'Liquid Capital') (cf. McDowell, 1986b).

To improve conservation behaviour, therefore, it is essential to recognise those constraints which are virtually predetermined. One cannot realistically expect to remove these by crash educational courses for mature adults as these are impractical - certainly in the short term. It is more appropriate to work creatively within these constraints to maximise successful persuasion by using effective communication.

The persuasion guidelines put forward toward the end of this paper represent the equivalent of Rogers and Schoemaker's 'Middle Range Generalizations' (1971 pp.85-96). These generalizations vary from the level of 'theoretical hypotheses' to that of 'principles'. Theoretical hypotheses (lower epistemological certainty) should hold in terms of being logical (grounded in accepted theory) as well as having support in the majority of empirical test studies. Much of the "data" put forward is in the form of logically cohesive hypotheses which may be put to the test by readers. The latter are naturally unlikely ever to be in universal agreement because of differences between various human cultures (Rogers and Schoemaker, 91-92). The sociotypes and theoretical hypotheses found to be relevant to the South African agricultural community presently investigated, may have varied levels of application to, for example, farmers in the U.S.A. and/or China etc.

2.0 CATEGORIZING THE LANDOWNERS

When marketing a concept such as "ecosystem conservation" it can be argued that different approaches are required for each and every subject in order to establish how 'ecosystem conservation' can best be packaged to fit that subject's individual needs (Hoose 1981 for general detail). But when dealing with larger groups of subjects, it is more convenient to divide them into working categories or 'sociotypes'. The 'sociotype' reflects "accurate characterisation of social groups" as opposed to the frequently misleading 'stereotype'. The latter concept represents "what people believe about another group of people" - which may easily be fictitious (Triandis, 1971 p. 104).

In order to provide a maximally accurate and balanced typification of landowners, the ratings obtained by McDowell and Sparks (1988) for all 53 variables (Table 1) were used as a statistical basis. Figure 1 shows the hierarchical clustering of farmers in terms of the predictor variables using a Generalised Euclidean distance measure (Gnanadeskan, 1977).

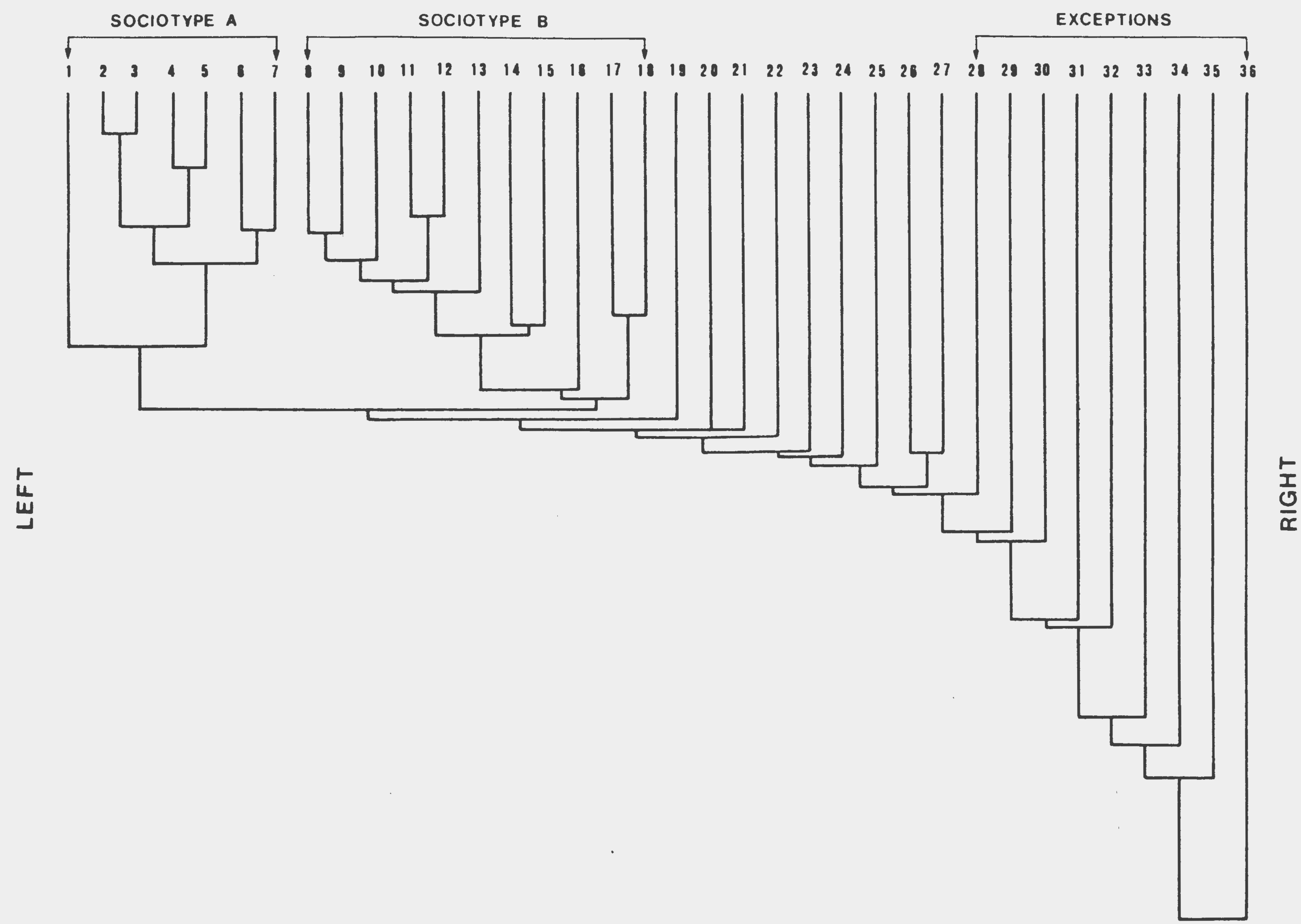
2.1 Descriptions of Subject 'Sociotypes' and 'Exceptions'

Two clearly defined clusters are immediately apparent on the left hand side of Figure 1, namely subjects numbered from 1-7 ('Sociotype A') and from 8-18 ('Sociotype B'). No more clusters are evident beyond the right hand side of the 26-27 pair. One can safely assume that subjects from 28-36 become progressively more exceptional. Because they are extraordinary they each represent mutually exclusive sociotypes.

Having got to 'know' each subject personally through the carrying out of in-depth interviews (McDowell, 1988a) the defined categories seem realistic. (However, this is

FIGURE 1

HIERARCHICAL CLUSTERING OF THE 36 FARMER-SUBJECTS USING GENERALISED EUCLIDEAN DISTANCE AS A MEASURE OF SIMILARITY



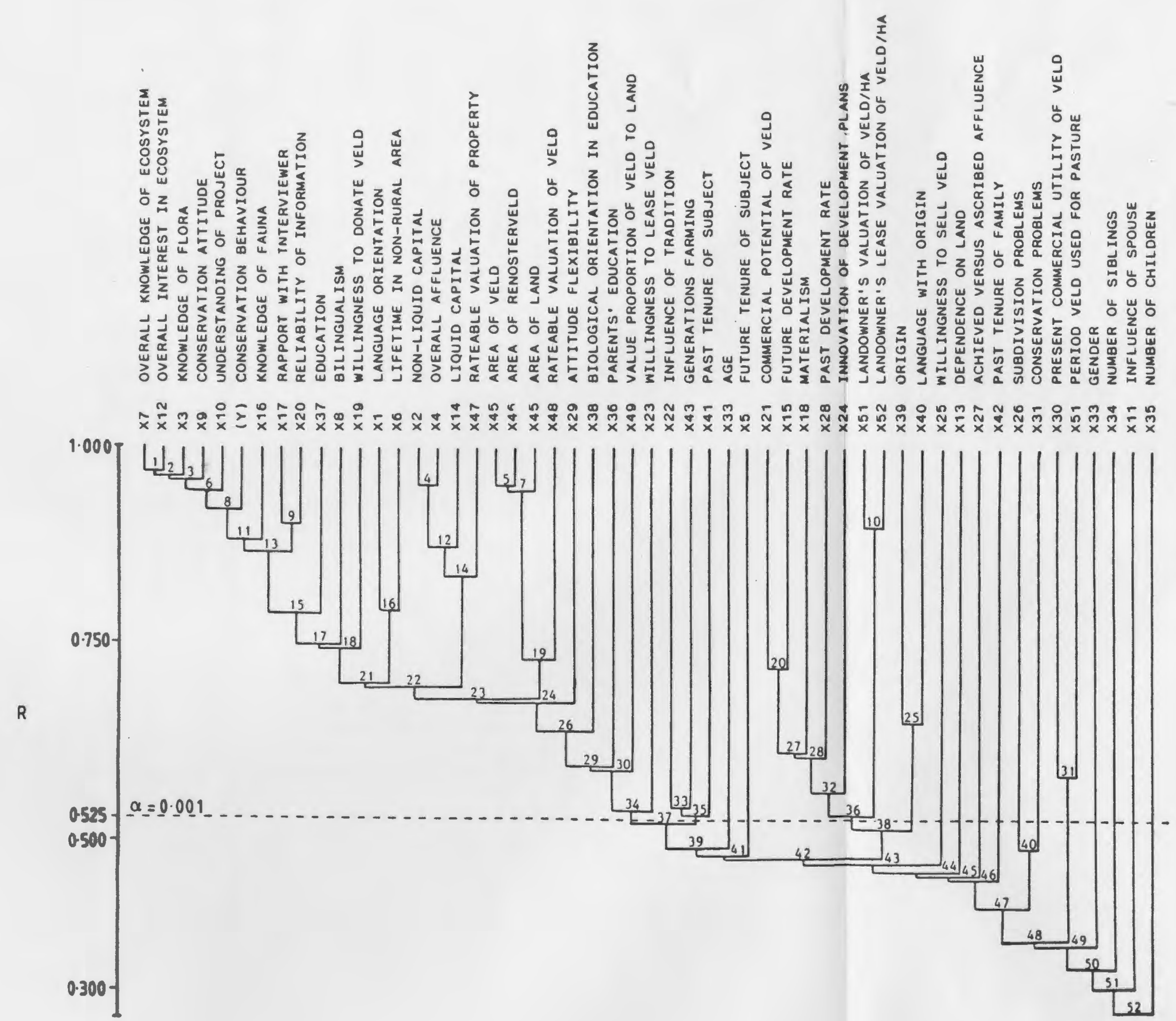
obviously more difficult to explain to readers as they lack personal knowledge of the subjects.)

Overall, 'Sociotype A' subjects are rated to be relatively poor conservers (low 'Conservation Behaviour (Y)' ratings). In terms of the dendrogram in Figure 2 'Sociotype A' subjects rate consistently low, particularly with those variables that are closely related to Conservation Behaviour - from X7 ('Overall Knowledge about Ecosystem') through to X23 ('Willingness to Lease Veld'). These include the knowledge, interest and attitude variables (X7, X12, X3, X9, X16) as well as English-Afrikaans bilingualism (X8) - as indicated in Figure 2. They also rated low educationally (X37, X38, X36); were less wealthy (X2, X4, X14, X47); less 'urban' (X6) and less willing to donate or lease veld on their lands for conservation purposes (X19, X23) (Figure 1). Of note for extension purposes, this group generally demonstrated less understanding of the research procedure appertaining to themselves as 'subjects' (X10). Possibly as a part consequence of the latter factor, there was also lesser rapport with interviewer (X17) and apparently less reliable information provided (X20). In addition the subjects' apparent flexibility of attitudes towards conservation (X29) was also less than the norm of the landowners overall. Also fairly consistent within this group were the subjects' higher perceived commercial potential (X21) and higher perceived future development rate (for crops) of veld under their control (X15). In addition, previous development of new lands (X28) and prevalence of

FIGURE 2

HIERARCHICAL CLUSTERING OF THE 53 VARIABLES USING PEARSON'S R CORRELATION AS A MEASURE OF SIMILARITY

(AFTER MCDOWELL AND SPARKS, 1988)



materialistic values (X18) were higher than average for 'Sociotype A'. The latter four factors counter 'good' ecosystem conservation practice as defined by McDowell and Sparks, (1988: Appendix 1 for details on the variables).

In contrast to 'Sociotype A', 'Sociotype B' (Subjects 7-18) rated consistently significantly 'better' than the overall average in terms of the types of conservation related factors discussed above.

Subjects 19-30 (as indicated earlier) include a "mixed bag" with no specific patterns linking them together as a group (Figure 1 - right hand side) as in the cases of 'Sociotype A' and 'Sociotype B' subjects (except perhaps 26 with 27 - see pairing on dendrogram). From Subject 30 and 31 onwards there is a marked relative increase in dissimilarity. This indicates that the last five subjects are 'exceptions' in having the least links, both with one another, and with the remainder of the subject sample. The empirical data supports this supposition with Subjects 31 and 35 being exceptionally 'bad' conservationists and Subjects 32, 33, 34 and 36 being among the 'best' conservationists within the study sample. The fact that subjects 31-36 are 'exceptions' does not mean that the factors found to be related to good conservation practice do not prevail; it often appears that extremes in just one or two positive or negative key factors, seem to be responsible in each case. For example, Subjects 31 and 35 (bad conservationists) possessed the study sample's lowest levels of formal education (X37 -

namely six and five years total primary education respectively). By contrast Subject 32 (good conservationist) possessed the study sample's highest education (seven years tertiary education). Subject 35 (bad conservationist) also achieved the sample's greatest 'materialism' (X18) rating as well as least capacity to speak a second language (X8) - in this case being English (X1). On the other hand subject 36 (best conservationist in the sample) had about average education (X37) (completed secondary school) but was exceptionally wealthy (X4) compared with the remainder of the sample. (Owns several valuable, bond-free farms worth the equivalent of many million dollars, both inside and outside the study area, as well as apparently many liquid assets.) Unexpectedly, education and affluence-related variables were not highly correlated owing to the unusually large component of inherited material wealth amongst farmers within the study sample (McDowell and Sparks, 1988). Subject 36 maintained that his basic interest in conservation of natural biota and subsequent contribution thereto was motivated by an unforeseen occurrence when he had to take charge of certain game animals that by 'pure chance' became his responsibility. Certainly it is partly true to suggest that this stochastic experiential factor probably helped to make Subject 36 an exception. But it is also safe to suggest hypothetically that the same chance stimulus would not have had nearly the same effect on, for example, a farmer belonging to 'Sociotype A'. Such a farmer would have a totally different set of background factors operating; be probably severely short of finance (because of farm related debts) as well as lacking in basic cognitive ability (developed through basic education) to obtain and understand ecologically related literature (helpful pre-requisite for 'good conservation behaviour'). Therefore, to change attitudes successfully it appears that "suitably fertile ground" (not normally perceived by the subjects themselves) must be present initially for the "seeds of conservation inspiration" to actually "take root". Skilful provision of "appropriate seeds of inspiration" to induce improved conservation values in the various types of landowner is the main function of the extension agent.

The main conclusion from the statistical categorisation of the landowners is that it is possible to "lump" subjects into "types" which merit different conservation strategies. In the field situation this is frequently achieved through 'reasoned intuition'. For example, if the senior author (interviewer) was the extension agent he would experience more difficulty in communicating with 'Sociotype A' than 'Sociotype B' as described. <u>But</u> there is just as strong a case for 'splitting' with subjects on the remainder of the sample. This is because a number of clear 'exceptions' emerge which individually merit separate conservation persuasion strategies. Even if the study sample is representative, the principle of generalising has set limits and, beyond these, there are exceptional cases which must then be considered.

3.0 TWO CONTRASTING CONSERVATION EXTENSION CASE STUDIES

When persuading landowners who control important ecosystems to maximise their conservation practices within the constraints of their various backgrounds - one important generalization must be emphasized at the outset. That is, personal interaction has far greater potential for persuading individual subjects than has any other medium. Two case studies are presented below. (The exact titles of the X variables referred to may be found in Figure 2 and Table 1.)

3.1 Poor Conservation Liaison

This case study concerns an apple farmer having on his property the only known extant population of a primitive species of the protea family <u>Sorocephalus</u> <u>tenuifolius</u> confined to merely one hectare of marginal farmland. Both the farmer and the nature conservation authorities had known of this fact for some time. As apple growing is becoming increasingly profitable in the Western Cape, this factor, together with the increasing availability of modern agricultural technology, was a cause for concern with conservationists involved in the protection of the local threatened flora. Some years ago a letter was dispatched to the farmer asking for his compliance in the preservation of the endangered protea's remnant habitat fragment.

Explanation was also given in the letter of the scientific value of threatened species in general and also that the conservationist would be grateful if he was to preserve this habitat. A chance aerial inspection of the region by a second conservationist about one month after the dispatch of the letter revealed that the species had disappeared forever - under a freshly planted apple orchard (see Tansley, 1987).

Clearly the well-meaning conservation liaison was somehow at fault. The piecing together of information from various disparate and anonymous sources on this sensitive issue revealed the following scenario:- Farmer Z had experienced a difficult early life in 'making a living' through starting with less than average material advantage (low X4) and much less than average education (low X37) (using the local agricultural community as a standard). He had therefore, to overcome considerable dissadvantage to have achieved his present high economic bracket (high X27). By definition, being quite materialistic (high X18), the appeal of a less than spectacular wild flower occurring on his property was wasted. By contrast the more tangible reward of a new apple orchard had much greater appeal. Also as Farmer x had low formal education, the scientific nuances of a rare species' value to science and aesthetics was not at all appreciated or understood. Thirdly, as the farmer was Afrikaans and apparently not very bilingual (low X8), his reaction might have been more compliant had the written correspondence been in Afrikaans instead of in the more unfamiliar English.

Finally, no tangible reward was offered in the letter for his compliance in conserving this rare protea. This would have at least indicated a concrete willingness of the conservation authority to make some sacrifice. The absence of mutual understanding and rapport (low X10, X17) presumably led to confusion and, perhaps even to a feeling of having his privacy threatened, which probably culminated in his defiantly destructive act (bad 'Conservation Behaviour' - low Y). Had the approach been correct in the first place, such as by means of appropriately diplomatic, direct liaison, all the above problem factors would have been elucidated and suitable assurances provided. Being wealthy (high X2, X4, X14), this farmer could surely have afforded to forgo 'developing' at least one single hectare of marginal land! (The offer of financial compensation would, however, have had great symbolic value.)

3.2 Good Conservation Liaison

This case study concerns one of the senior author's interviewed subjects (Subject 24). The area of veld concerned is a very scarce and diverse low lying form of renosterveld surrounded entirely by croplands. It represents the sole viable refuge for the endangered <u>Gladiolus citrinus</u> together with several other locally endemic species of flora. The endangered Cape Geometric Tortoise <u>Psammobates geometricus</u>; a faunal renosterveld endemic once considered extinct (Greig and de Villiers,

1982) was also known to occur in viable numbers in the area. (McDowell, 1984a for details).

On arrival for the interview the senior author was informed in no uncertain terms of the intention to plough this ecologically fascinating area at the start of the next dry season. A freshly constructed drainage trench was clear evidence of this intention (McDowell, 1984b). Without elaborating, it is suffice to state that an analogous set of background circumstances prevailed as in the previous case study. It must be emphasized that this farmer was entirely within his rights to develop this area, being eligible for a permit to cultivate virgin soil (McDowell, 1986a) and that "om die land skoon te maak" (Afrikaans epithet - which translated means "to clean the land") "in order to make new lands" would not only raise tangible profits but increase the market value of the farm as a whole. He and his family would also not be troubled by sundry visitors to the veld remnant ad infinitum, or by the possibility of the establishment of an inconveniant servitude for that purpose. Above all the family quite correctly felt that they had already done "their bit for the conservationists". Previously they had agreed to set aside another less arable, as well as less ecologically valuable, smaller area for a reserve on the same farm for an absolutely nominal rental. Many careful negotiations followed, with the senior author acting as an intermediary between the landowner, the Government Department responsible for conservation (Cape Provincial Administration) and a private conservation funding body (the S.A. Nature Foundation). An amicable 'gentleman's agreement' was achieved where the landowner reversed his decision to plough this irreplaceable area - and has not to date required financial compensation (McDowell, 1984c,d). (He has subsequently died and follow-up negotiations - which now have a good chance of success - are currently in progress with the heirs.)

The major reason for the relative success in Case Study 2 compared with Case Study 1 was clearly the nature of the interactions. The senior author is convinced that the reason for success in persuasion was because the landowner "felt sorry for him personally and tried to please" rather than for any increased understanding of the ecosystem's "rarity value to science and to the nation". Although his wife had some perception of this factor her decision-making influence did not extend perceptably into the actual farming practice.

Therefore, one basic principle for success in conservation liaison is for the extension agent to take pains to analyse meticulously both successful and unsuccessful interactions.

4.0 CONSERVATION EXTENSION STRATEGY : A CODE OF CONDUCT FOR EXTENSION AGENTS TO INDUCE POSITIVE CONSERVATION ATTITUDES IN LANDOWNERS

As a personal approach to subjects is considered critical, these advances are worth formalizing in terms of a set of generalizations (similar in principle and underlying premises to Rogers and Schoemaker, 1971 - see Introduction). These effective hypotheses were derived inductively; partly through interaction with the interviewed farmers. Many of these observations were substantiated by other officials involved in liaison with private landowners, eg agricultural extension officers and nature conservation personnel. Of course several of the rules of thumb put forward fall within the realms of "common sense", but it is surprising how ignorant certain individuals can be: adherence or ignorance of this type of knowledge can frequently make or break conservation ventures!

4.1 Impression Management

The first objective in optimal communication with often elusive subjects is 'to get your foot into the door' by creating a favourable impression (cf. Open University 1979 Block 4 pp 110-116). Generalizations include the following obvious and not so obvious maxims:-

1) *The conservation agent represents a standard-bearer for a cause, and a favourable personal interaction will create a favourable label for that cause.*

Already illustrated with reference to the case studies above, this interactive effect appears to be more accentuated with rural inhabitants as they tend to meet far fewer people than urbanites. For example, a negative impression given by accident to a single subject in a particular neighbourhood will 'spread' readily and rapidly to other members in a small rural community.

2) *Personal visits to farmers at their homes should be carefully pre-arranged at their convenience.*

For example, the subject may turn out to be busy and thus become irritated during a 'chance' visit. The use of mutual acquaintances (eg other farmers in the neighbourhood) in making appointments was found to be a most effective way of 'breaking the ice'. The <u>personal</u> nature of the visit enables the subjects to confront more directly any preconceived misapprehensions that may exist through observation, questioning etc within the psychological "safety of his/her own turf". (Obviously this is more feasible than when communication is via the post or telephone.)

3) *General appearance of the conservationist is important, in particular the choice of clothing.*

A particular uniform for example, is a decisive role symbol which may hinder rapport (hence progress) should it signify an organization that happens to be unpopular to the farmer. On the other hand, if the organization signified is popular a positive effect is likely. Individual items of clothing, general appearance, gait etc all have an unseen effect on impression (Babbie, 1973 pp 173-174).

4) *If the subject speaks another language an attempt to at least initiate communication in the same language will enhance goodwill.*

This 'respect' based etiquette was found to be applicable in those interviews where the subjects' home languages was Afrikaans (the majority and the only other language apart from English on the research sample) - even if they happened to be bilingual.

5) *Adjust language to a vocabulary and style similar to that of the subject to optimise communication.*

For example when discussing conservation avoid, as far as possible, academic terminology if not easily understood by the subject. This is often quite tricky for an academic conservationist who tends, unconsciously, to take for granted that other people can comprehend conservation jargon.

6) *Be an attentive and sympathetic listener.*

Often the subject tends to have problems and misgivings (etc) and as he/she has frequently nothing much else to gain from visiting conservationists, will tend to discuss these. Almost on a "basis of exchange" the appreciation of the subject's problems normally leads to reciprocation. As Carnegie (1953) puts it: "Be a good listener. Encourage others to talk about themselves" (p 105).

7) *Knowledge and enthusiasm (where possible) about the subject's pet interests will engender greater respect for 'messages' which the extension agent may wish to convey.*

In the case of farmers, this frequently entails a working knowledge of agriculture and its related problems.

However, as individuals, farmers on the interview sample were found to have a diverse range of interests. Even if one lacks knowledge about any of these it nevertheless helps if one allows the subjects to discuss their own pet interests for a fair proportion of the conversation (Carnegie, 1953 pp 105-108).

4.2 Decision Steering

By 'decision steering' we refer to actively creating positive conservation attitude shifts through effective one-to-one communication.

General rules of thumb found to be applicable to the farmers surveyed to date are evaluated below:-

1) *Other factors assumed equal, older people have less flexible attitudes and opinions than younger people.*

Extension programmes should take this factor into account when proceeding with informal "adult education programmes" that emphasize conservation principles. Remember that adult education differs markedly from education of the young in that it is totally voluntary.

2) *Provision of intricate scientific rationale for conservation can often be completely wasted on the subject.*

If the basic educational development of the subject (whether formal or informal) is insufficient to understand, for example, scientific ecological principles, it is more appropriate to switch to alternative persuasive tactics. (cf. Case Study 1) Similar in principle to "winning an argument", (Carnegie, 1953 pp 122-127) the emotional basis for persuasion is normally far more important than the application of pure logical reasoning.

3) *Most effective communication occurs when the extension agent and the subject have greatest similarity in terms of beliefs, values, social status, education etc ("Homophilous")*

Where homophily is high, therefore, "the communication of ideas is likely to have greater effects in terms of knowledge gain, attitude formation and change, and overt behaviour change". (Rogers and Schoemaker, 1971, p 15) Certainly, the senior author's interviews revealed that both the measured variables pertaining to subjects' 'Rapport with Interviewer' and 'Understanding of Project' were highly correlated (alpha = 0.0001). Although not quantified per se it is also clear that the greatest rapport was achieved with subjects more homophilous to him such as 'Sociotype B' compared with 'Sociotype A'. Hilts and McLellan (1984) reported that "neither the age, sex, education, nor experience of the contact person appeared to make any difference to effective liaison ... whereas personality does seem to make a difference ...". However, social psychological theory also tells us that where differences are significant between extension agent and subject these can be much reduced if the former can achieve an empathetic approach. (Rogers and Schoemaker, 1971 p 14) "Try honestly to see things from the other person's point of view". This can partly be assisted through either adherence to the various rules of thumb put forward in this paper (the importance of the "personality" of Hilts and McLellan) or through use of intermediate "opinion leaders" such as community leaders who may be more able to bridge the agent-subject cultural gap (Rogers and Schoemaker, 1971). The use of "opinion leaders" is probably justified where extreme differences exist between extension agents and subjects, eg where much more widely varied languages and ethnicities are involved.

4) *It should not even be vaguely apparent that extension agents are "telling subjects what to do" concerning conservation on their properties.*

The principle embodied in this rule of thumb is very similar to that of the previous Number 2 - that is by telling someone what to do infers that you believe that they are 'wrong' which quite naturally results in defiance. (Carnegie, 128-130) This of course is accentuated when you are referring to somebody else's property - a point about which farmers in South Africa are particularly touchy. (McDowell and Sparks, 1988) Rather plant conservation-favourable "seeds of inspiration" by providing information, literature, etc which would be conducive to the subjects reaching their own conclusions. If we "let the other fellow feel that the idea is his" (in the words of Carnegie, p 170) that individual would be far more ready to act accordingly.

5) *Convincingly provide the subject with a "good label"*

The approach of giving the subject a good reputation to aspire towards is akin to the axiomatic "self fulfilling prophecy" of social-psychology. Make it clear that you believe the best of the subject's intentions, integrity, and goals etc. Even if not deserved initially, the "give a dog a good name" approach (Carnegie, pp 210-212) generally appeared to foster improved attitudes with more 'difficult' subjects who have been approached.

6) *Express admiration for what subjects own or manage.*

Similar to the principle embodied in 5 (above), this refers in particular to the natural ecosystems on the subject's property. Frequently the less conservation conscious farmer will state that he would like to "clean up the land" ie clear away the bush as that farmer sees no intrinsic value in that ecosystem as it stands in its "unproductive state". However, if an outsider, in this case the extension agent, praises the natural habitat by honestly admiring and pointing out its more obvious attributes, this tends to upgrade the perceived worth of the habitat in the eyes of the landowner. For example one farmer interviewed by the senior author on a farm very much off the beaten track proudly showed him a "koppie" (Afrikaans for hillock) which he had been very assiduous not to let his stock overgraze because some botanist had searched for and found a rare Gladiolus species there over 20 years previously! In this case there had been no follow up visits by the botanist (normally very important) or any other forms of incentive to sustain this improved change in behaviour.

7) *Assess the primary need/s of the subject and determine how the conservation message can best be tailored to fulfil such needs.*

Every individual has needs which can, with a little skill, be translated into improved conservation behaviour. Hoose (1981, 1984) deals with this approach in detail within the context of the U.S.A. A similar situation appears to hold with local landowners who were observed to have the following individual needs including: financial remuneration, prestige, publicity, personal recognition, privacy, guaranteed continued ownership, guaranteed grazing rights, guaranteed continued removal of problem plants or animals etc etc. An example of a comparatively inexpensive means of "satisfying" the personal recognition requirement is the ceremonious presentation of special merit certificates or plaques to proprietors of worthy ecosystems. This system - The South African Heritage Scheme (1984 onwards) - has recently been initiated under the auspices of the private sector Southern African Nature Foundation. However, results from the current study indicate that this approach will probably only succeed with a very limited sector of landowners. For example the relatively lower socio-economic bracket subjects akin to 'Sociotype A' (as described under "Categorizing the Landowners") would tend to respond better to a direct financial reward - particularly if the land concerned was agriculturally exploitable. Unfortunately, compared with, for example, the U.S.A., South Africa's legal system presently makes negligible allowance for direct or indirect financial compensation or incentives for conservation (McDowell, 1986b).

5.0 CONCLUSIONS

It appears that contact with individual landowners is essential for the improvement of ecosystem conservation on privately owned land. This has also been recognized particularly in the U.S.A. (sensu Hilts and McClellan, 1984; Hoose, 1981, 1984; McFall, 1984 and Meyer, 1984) to the extent of being likened to "a new profession for natural area preservation" (Meyer). It is hoped that this paper will provide new insights on formalizing optimal contact through the integration of established social psychological theory (sensu Carnegie, 1953; Kiesler et al., 1969; Rogers and Schoemaker, 1971 and Triandis, 1971) with a statistically based analysis of attitudes and behaviour of local landowners.

Direct communication with landowners is essential for conservation. Effective principles of communication and persuasion have much broader application than merely to private landowners. In the South African environmental conservation field other target decision makers worthy of note include reserve managers, Public Administration personnel with conservation related tasks, politicians, as well as other academics. Unfortunately in South Africa there is still a dearth of systematic conservation-extension related research - the importance of which must not be underestimated.

It is worth concluding with a practical example. Every year the Terrestrial Ecosystem's Research Programme of the Council for Scientific and Industrial Research in South Africa produces research output (often in the form of South African National Scientific Programme Reports, 1973 onwards) relating to conservation of biota, for example: the structure and function of ecosystems; management guidelines for rangelands; mountain catchments and forest lands; inventories of rare and threatened biota; invasive biota and endangered ecosystems and control measures for problem biota etc. However, findings of this costly research are effectively wasted unless the scientifically based recommendations can be communicated to critical sectors of the public instead of 'gathering dust on shelves'. To date, attention in local scientific circles to this notorious problem has been vocal rather than active. It is believed that only considerable advances in "communication research" in South Africa, which is 'socio-economic' rather than 'scientific' - (along the lines described in this paper), would eventually alleviate the critical bottlenecks between conservation theory and its field application.

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PAPER 6

LEGAL STRATEGIES TO OPTIMISE THE CONSERVATION OF NATURAL ECOSYSTEMS BY PRIVATE LANDOWNERS: RESTRICTIVE LEGISLATION

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1.0 INTRODUCTION

Approximately 80% of land in South African (excluding the black homelands) is under private tenure, mainly under the control of 77 000 white farmers.[1] The latter own extensive tracts of natural and semi-natural habitats outside the present State owned conservation areas and National parks.[2] Responsibility for managing these habitats thus lies largely in the hands of this politically influential farming community.[3] It appears critical therefore that these private landowners, who are vital decision makers for so much of South Africa's natural resources, should be correctly motivated toward responsible environmental conservation, as by far the majority of the natural ecosystems are likely to remain outside the protection of State owned conservation areas in the foreseeable future.

The question of acquisition[4] by the State of additional lands to increase the presently small officially conserved proportion of South Africa's land surface is obviously important but, as a large topic itself, is beyond the scope of this paper. In a nutshell, the acquisition option is unrealistic as State funding is hopelessly insufficient (and likely to remain so) for acquiring anything more than a small fraction of the land required to adequately conserve South Africa's ecosystems.[5] Insofar as this paper is concerned, the line of approach adopted in this paper is to evaluate an alternative strategy, ie legal aspects of policies that may significantly advance long term environmental conservation practice of the private landowners themselves. Several recommended approaches with broadly similar objectives have recently been reviewed.[6] These provide useful theoretical frameworks which are based mainly on conclusions from analogous conservation studies overseas, although to date, disappointingly few of the many recommendations made have been put to the practical test locally.[7]

However, details are not given in the latter literature on either the subjects of the proposed strategies using, as an empirical basis, the local private landowners themselves, or any specific statutory modifications required in respect of such findings. Although comparisons within the international context provide valuable insight into the local conservation scene,[8] South Africa still merits treatment as a unique case where the latter extrapolation-type approach can be used only to a limited extent in solving grass roots conservation problems.[9] This paper therefore concentrates mainly on the actual operation of selected current South African environmental legislation. It places under the spotlight the target group for such laws, viz the private landowners.

Proposals submitted represent spinoffs from a comprehensive socio-economic survey recently completed by the writer on the attitudes and behaviour of a sample of farmers towards ecosystem conservation on their lands.[10] An understanding of this factor comprised the empirical basis for evaluating conservation policies. As the latter study centred specifically on an extreme situation of ecosystem reduction through farming pressures in the south-western Cape lowlands,[11] some caution should be taken when generalising on a national level.

Proposed legal reforms should be sufficiently realistic to win some support not only from recipients of such measures, ie the private landowners, but also from the authorities upon which they are dependent for implementation. Proposals too extreme, too costly or too difficult to administer will obviously not gain the necessary sanction by the relevant Government bodies.[12] Although not all the proposals put forward meet the demands, an attempt has been made to narrow the field toward avenues of legal reform with greatest potential for enhancing the ecosystem conservation initiative of South Africa's private landowners. Financial incentives are covered in the succeeding paper.[13]

2.0 COASTAL RENOSTERVELD AND ITS ASSOCIATED LANDOWNERS AS AN EMPIRICAL BASELINE

Coastal Renosterveld[14] is an Acocks' veld type,[15] largely restricted to the shale- and granite-derived soils of the south-western Cape lowlands.[16] As these soils occur normally on shallow slopes, over 95% of the renosterveld on the west-coast Swartland study area has previously fallen victim to the 'agricultural plough'. Although largely marginal compared to lands developed previously, the scattered renosterveld remnants are not immune to further agronomic inroads.[17] That is, if current technological advances are taken into account. This also applies to other hitherto less exploited veld-types in the south-western Cape lowlands, namely Lowland Fynbos variants and, perhaps to a lesser extent, Strandveld.[18]

Of the renosterveld remnants surveyed on the Cape west coast, 80% of the area is privately owned. This corresponds to the national ownership pattern.[19] Factors relating to the attitudes and behaviour of a representative sample of renosterveld owning farmers towards conservation on their properties were comprehensively investigated.[20] One of the aims was to find out how landowners might be motivated towards achieving the following ideals, namely:

(a) to avoid making further agronomic inroads into this scarce veld-type;

(b) to manage this resource in such a way as to ensure continued survival of natural biota; and,

(c) to establish secure long-term private conservation areas on their properties.

The various research findings are referred to as a basis *for* criticism made of the operation of prevailing conservation laws.

3.0 KEY STATUTES WHICH INFLUENCE THE CONSERVATION OF WILD HABITATS IN AGRICULTURAL ZONES[21]

Statutes considered to have the most direct relevance for controlling the agronomic exploitation of remnant veld include the Conservation of Agricultural Resources Act 43 of 1983 and the Physical Planning Act of 1967 in conjunction with the Environmental Conservation Act 100 of 1982. The Mountain Catchment Areas Act 63 of 1970, the Forest Act 122 of 1984 and the Lake Areas Development Act 39 of 1975 also have profound influence on certain private lands.[22] However, as the latter statues have more specialized application and are of less relevance to the present study, dealing as it does specifically with terrestrial lowlands, they will not be specifically evaluated.[23] Legislation with less direct relevance is also referred to where applicable.

3.1 The Conservation of Agricultural Resources Act 43 of 1983

The Conservation of Agricultural Resources Act empowers the Minister of Agriculture and Water Supply to prescribe compulsory control measures which must be complied with by land users to whom they apply.[24] The regulations[25] are designed to curb soil-loss by exercising control over exploitative farming practices. Notably it is stated herein that except on authority of a written permission by the executive officer, no land-user shall cultivate any virgin soil.[26] Virgin soil is defined as land which, in the opinion of the executive officer, has at no time during the preceding ten years been cultivated.[27] The vesting of a critical regulation merely on the somewhat dubious criterion, ie the opinion of a single individual, seems unfortunately an inherent weakness in the scientific implementation of this regulation.

It can be accepted that once veld is cleared and the soil is developed for crops this removes the basic life-support system of wild biota.[28] Therefore these regulations also have significant implications concerning controls on removal of remaining natural/semi-natural ecosystems, including for example, scarce renosterveld remnants.

A succession of three predecessor statutes,[29] with very similar provisions and objectives to the Conservation of Agricultural Resources Act were sequentially repealed because of the weaknesses in achieving similar objectives.[30] For example the 'virgin soil' regulations were given, with virtually unchanged content, the status of 'natural guidelines' by the Soil Conservation Act 76 of 1969. Regulations, backed by statute, have more powerful legal backing than 'national guidelines'. Some concern should, however, be expressed that the modified rulings could lull the conservation ecologist into a sense of false security with respect to the future 'survival' of remnant ecosystems. Considerations both 'within the law' and 'outside the law' merit separate discussion. The former considerations respectively relate to, firstly: weaknesses within the written law itself and, secondly: weaknesses in the effective implementation of the law.

3.11 Legal Problems with the Restrictions Themselves.

In practice, when permits to develop new lands are applied for by farmers they are seldom refused. Of the 35 applications recently received to make new lands in the Cape west coast of the Winter Rainfall Agricultural Region, only three were turned down because of expected soil erosion problems.[31]

An important legal aspect in enforcing this permit requirement is that the conservation of valued wild ecosystems _per se_ eg the preservation of endangered flora and fauna, may not stand up in Court as a sole basis for preventing a farmer from ploughing such an area. It could be argued that because 'the spirit of the Conservation of Agricultural Resources Act is agricultural', flora and fauna conservation _per se_ lie outside its jurisdiction.[32] However the latter rationale certainly has a contributory role in providing reasons for disallowing permits, and in at least one case has successfully been used as a sole reason, without having been contested by the landowner concerned.[33]

The exact definition of the term 'to cultivate virgin soil'[34] has proven controversial. For example a farmer recently cleared several hectares of renosterveld on steep lands by 'scraping' the vegetation off the soil surface with a bulldozer.[35] This farmer evidently was aware of the permit requirement for making new lands but, as the land was very steep he knew he would most likely be ineligible for a permit. He apparently felt that 'scraping' as such would sidestep the illegal practice of actually 'cultivating virgin soil' per se. A decision by the agricultural authorities whether to prosecute this landowner is presently pending. The authorities contend that this veld removal method would have been legal had a bush-cutter and not a bulldozer been used!

Many forms of veld 'manipulation' exist which are highly questionable as far as legality and/or soil conservation and/or ecosystem conservation are concerned. In addition to the near ground-level bush-cutting which, as indicated, could be considered legal, these may include other practices also detrimental to the natural ecology of veld, eg various veld 'improvement schemes' including the establishment of preferred grazing species at the expense of wild species[36] as well as overgrazing.[37] These are practised inter alia in a number of renosterveld sites.

3.12 Problems in Policing the Restrictions.

These are more difficult to substantiate, but some conclusions have been drawn from confidential research interviews with the renosterveld farmers.

Despite publicity campaigns by the Agricultural Extension Service of the Department of Agriculture and Water Supply certain farmers express ignorance of the virgin soils regulations. This appears to be partly because many pride themselves upon being independent from the Extension Service (by not seeking advice) and partly because many may not actually take the trouble to read the circulars sent to them by the Service. To exacerbate the situation a number of farmers when they were asked in interviews whether they intended to get permits for proposed developments, expressed objections to having outsiders prescribe to them what they may or may not do on <u>their</u> land! It appears highly likely that many farmers do not apply for permits because they feel they may not be eligible for permits. This landowner category therefore, makes new lands illicitly in areas of their farms that are not visible or accessible to agents responsible for conservation such as extension service or soil conservation committee members. As an example, it was only due to the acute observation of airforce helicopter pilots on manoeuvre that the Swartland Extension Service was recently alerted about two farmers who had illicitly made extensive tracts of new lands within somewhat inaccessible terrain on the Cape west coast. As was the case in this example, the landowner is normally served with an official notice to restrain further illegal activity, pending the possible laying of a charge. The weakness in this measure is that almost invariably the transgression is a fait accompli, ie the damage to the ecosystem is seldom reversible.

When one takes into account the 'considerations both within - and outside the law' as discussed, much reservation should be expressed as to the effectiveness of the Conservation of Agricultural Resources Act in achieving the conservation objectives of the 'virgin soils' regulations. Prima facie, there has been no evidence to date of a decline in the rate of clearance of veld for crops in many areas in (at least) the Western Cape since the Act's promulgation on 1 June 1984.[38] Even though it is conceded that the Conservation of Agricultural Resources Act represents a significant statutory improvement on its predecessor the Soil Conservation Act, it appears to represent something of a 'toothless tiger' insofar as ecosystem conservation is concerned. That is unless it can obtain the whole-hearted support of the landowner target community itself, upon which surprisingly much seems to depend for successful implementation.

3.2 The Physical Planning Act 88 of 1967 in conjunction with the Environmental Conservation Act 100 of 1982

The Physical Planning Act empowers statutory reservation of land for particular purposes[39] which includes 'nature areas'.[40] A 'nature area' is defined[41] to be any area which could be utilized in the interests of and for the benefit and enjoyment of the public in general and for the reproduction, protection and preservation of wild animal life, wild vegetation or objects of geological, ethnological, historical or other scientific interest. Declaration of a nature area means that no person may, except under the authority of a permit, use any land defined for any purpose other than the particular purpose for which it was lawfully being used immediately prior to the date of the reservation. This provision has principles in common with the Virgin Soils provision of the Conservation of Agricultural Resources Act, in that control on land-use is imposed by virtue of a permit system. In addition they both rely on statutory committees as aids to regulation.[42]

A forte of the use of the nature area strategy would seem to be that, when nature areas are proclaimed, permits for land-use change can be authorised solely at Ministerial level. On the other hand permits for the 'cultivation of virgin soil' would probably be more readily available from the lower ranked Agricultural 'Executive Officers'. The spirit of nature areas can be interpreted as being more favourably concerned with natural biota[43] per se than the agricultural basis implicit in the 'virgin soils' provision of the Conservation of Agricultural Resources Act.

Unlike the Conservation of Agricultural Resources Act, the principles of which have largely been 'pre-tested' in predecessor statutes,[44] the nature areas' provision has not yet stood the same test of time. Only 4 nature areas have fairly recently been proclaimed.[45] Certain other areas are also in the pipeline.[46] One 'loophole' that seriously affects the objective of 'nature areas' as a conservation strategy is that the specific term 'change in land-use' (which requires official authorization) can be interpreted with considerable latitude. In the farming context for example 'land use' which, as has been discussed, embraced a 'multitude of sins' from low impact pasturage, to the ecologically destructive making of new lands as may be permitted through the Department of Agriculture and Water Supply.[47] There have been no directly related cases to make precedents.[48] This is not surprising because, without exception, the areas proclaimed are of low agricultural potential.[49] This however may not be the situation in future proclamations. For example the proposed Cape Agulhas Nature Area,[50] at present in the pipeline for proclamation, partly comprises a large flat area of 'Elim Flats Dwarf Fynbos'[51] a type of vegetation which, like renosterveld, occurs of largely arable ground. Given the legal limitations of the Conservation of Agricultural Resources Act, and the possible 'land-use definition loophole' of the Physical Planning Act, these combined coercive measures, as they presently stand, may yet fail to save this ecologically unique area![52] Fortunately it would seem that the land-use loophole is currently being given some attention by the Department of Environment Affairs for possible subsequent statutory amendment.

The Environmental Conservation Act empowers the Minister of Environment Affairs and Tourism, by notice in the Gazette, to issue directions with regard to the management and development of land within any nature area.[53] The same Act also entitles landowners to recover compensation in respect of actual patrimonial loss by way of grants or otherwise in respect of expenses incurred by them in compliance with these directions.[54]

The latter normally concerns direct expenditure[55] incurred in the management of nature areas to further related conservation objectives. A case in point would be compensation for the control of invasive alien vegetation or soil erosion.[56] However it is critical to re-emphasize that no financial provision is available to compensate for those 'lost opportunity costs' which may accrue through the actual 'freezing of land-use' within nature areas.[57] As far as landowners are concerned, these could include returns from increasingly profitable land-use transitions following, for example, the sequence: (a) 'non-agricultural' land-use to (b) 'agricultural' land-use to (c) 'peri-urban' land-use; <u>as may normally have been approved through the previously existing channels</u>.

A major problem with the proclamation of nature areas is the antagonism of implicated landowners. For example the 'Kogelberg' ratepayers, consisting mainly of smallholders, recently opposed the State planned Cape Hangklip Nature Area[58] (which includes the Rooiels to Botriviervlei zone on the southern Cape coast). It appears that uncompensated lost opportunities may have formed a material basis for complaints.[59] On the other hand the government officials responsible for notifying landowners in prospective nature areas cite insufficient direct communication between themselves and landowners as possibly being an aggravating factor which may lead to misunderstandings. Thus the complexity of the 'nature area' as a concept represents another key factor related to disaffection.

4.0 CONCLUSION

It may be safely concluded that without the continuous goodwill of landowners themselves the nature area as a concept can fail in the long term, in a similar manner to the failure of 'virgin soils' provision of the Conservation of Agricultural Resources Act. Both these largely restrictive conservation measures rely to a substantial extent on landowners' participation in, and assistance to, the statutory management committees central to their long term implementation. There is clearly a pressing requirement for legal reforms to help encourage private landowners to a more spontaneous adoption of: (a) conservation - independent of 'legal coercion' and (b) retention of conservation measures over the long term. Legal conservation restrictions which are backed by neither effective policing nor personal-gain incentives such as financial compensation, therefore become close to being merely symbolic; a 'sop' to the conservation conscience of the general public. In fact, it is more harmful in the long run to have these relatively 'inexpensive paper conservation measures' than it would be to omit them, as they can lull both authorities and the general public into a dangerous sense of false security. Without critical reforms which include financial incentives,[60] in combination with extension communication to landowners, little hope exists that legal restrictions per se will achieve long term conservation objectives. It is speculated that financial incentives, together with conservation extension could, if applied successfully, stand effectively alone as conservation measures. It is a case of "getting the donkey to move forward by using just a carrot and no stick".

FOOTNOTES

1 Wildlife Society (unpub report) A Policy and Strategy for Environmental Conservation in South Africa (1980) 7.

2 Bothma J Du P and M A Rabie in Fuggle R F and M A Rabie, Environmental Concerns in South Africa. Technical and Legal Perspectives (1983) 198.

3 Wildlife Society op cit n1 at 18.

4 Includes full purchase of land (via expropriation or otherwise), acquisition of certain rights or acquisition via donation (cf Report of the Planning Committee of the President's Council on Nature Conservation in South Africa PC/1984 137-138).

5 Planning Committee of the President's Council op cit n4 at 96-97.

6 Planning Committee of the President's Council op cit n4 at 112-114. Only 4,5% of South Africa's total land-surface includes State land set aside primarily for conservation. (Together with privately owned reserves the total figure falls far short of the rule of thumb 10% of land surface to be conserved internationally as recommended by the IUCN).

7 See generally: Fuggle R F and M A Rabie _op cit_ n2; Hall A V (ed) _Proposals for Nature Conservation Areas in the Coastal Lowlands of the South Western Cape Province_ (unpub report 1984); Planning Committee of the President's Council _op cit_ n4; Miltz D _Financial considerations of South African Environmental Problems_ (unpub M Sc thesis University of Cape Town) (1984); Wildlife Society _op cit_ n1.

8 The overseas text most frequently cited is P M Hoose's outstanding coverage of conservation mechanisms in the United States of America _viz_: _Building an Ark. Tools for the preservation of Natural Diversity through Land Protection_ (1981).

9 _Ibid._ Considerable differences exist in the application of conservation formulae even between different states in the United States of America. The extrapolation approach although invaluable in generating new ideas, if taken to extremes without empirical feedback from local conditions, may encounter the futility of becoming an impractical academic exercise.

10 Data is at present being prepared for publication. A brief background is provided under the next sub-heading.

11 _ibid._

12 For the purposes of this paper includes _inter alia_ the Inland Revenue Authority, Treasury and The Departments responsible for Environmental and Agricultural matters in South Africa.

13 McDowell C R "Legal Strategies to Optimise Conservation of Natural Ecosystems by Private Landowners: Economic Incentives" 460 _infra._

14 Coastal renosterveld has significant affinities to the more familiar Cape Heathland 'Fynbos' vegetations. For a technical definition see Moll E J, Campbell B M, Cowling R N, Bossi L, Jarman M L and C Boucher _A Description of Major Vegetation categories in and adjacent to the Fynbos Biome_ South African National Programmes Report No 83 12-14 (1984).

15 Acocks J P H defines a veld type as a 'Unit of vegetation whose range of variation is small enough to permit the whole of it to have the same farming potentialities'. "Veld Types of South Africa" Memoirs of the Botanical Survey of South Africa No 40 (1975)

16 Boucher C and Moll E J "South African Mediterranean Shrublands" in di Castri F, Goodall D W and R L Specht (eds) _Mediterranean-Type Shrublands_ (1981) 234.

17 "Agronomic impacts are distinguished from "agricultural" impacts in that the former necessarily includes total destructions of habitat where the latter includes low impact pasturage.

18 For details on previous man-related impacts on these lowland veld-types see: Boucher C "Floristic and Structural Features of the Coastal Foreland Vegetation South of the Berg River, Western Cape Province, South Africa" in Moll E J (ed) Proceedings of a Symposium on Coastal Lowlands of the Western Cape (1981) 21-26.

19 See first Introductory paragraph.

20 See also C R McDowell and J R Grindley (1984) in Hall (ed) op cit n7 at 5.1.

21 The Sub-division of Agricultural Land Act 70 of 1970 s1 for definition of "agricultural land".

22 For details on legislation governing conservation areas in general (including State owned land) see also Rabie M A "South African Law relating to conservation areas: 1985 CILSA 51-90.

23 Ibid.

24 The Act does not apply to urban areas, black 'homelands' or declared Mountain Catchments: s2(1).

25 R1048 of 25 May 1984 empowered by s29 of the Act.

26 Excludes virgin land as defined in s4A of the previous Forest Act 72 of 1968. (Since superceded by the Forest Act 122 of 1984).

27 S1 (xxx).

28 Renosterveld on the flats has largely been displaced by wheatlands, vineyards and general mixed farming - see previous section.

29 The Forest and Veld Conservation Act 35 of 1941, the Soil Conservation Act 45 of 1946 and the Soil Conservation Act 76 of 1969.

30 Rabie M A South African Environmental Legislation (1976) 29-31 and Fuggle R F and M A Rabie (1983) op cit n2 147-155.

31 Based on the records for the first one and a half years after promulgation of the Conservation of Agricultural Resources Act as recorded by the Chief Agricultural Extension Officer for the Swartland Region (the area of Cape coastal forelands from Elandsbay to Cape Point which includes the West Coast Renosterveld remnants). The figure recorded for the high number of successful

applications is probably misleading because it does not represent a random sample of those farmers who actually wish to develop new lands. No indication is given of how many would-be applicants abstained from applying for permits because they knew they would not be eligible. It is this category of farmers who would be most tempted to take their own initiative in developing new lands illegally, a problem defined under the next subsection.

32 See also McDowell C R "Laws to Save Our Natural Resources" Farmers Weekly 13 June 1986.

33 A landowner near Mamre, Cape Province, South Africa was advised not to make new lands in the 'Riverlands' flats which has over 30 threatened species of flora. See Hall (ed) op cit n7 3.3.2.2.

34 Op cit [27] with related text, discusses the problems with the legal definition of 'virgin soil' per se.

35 The individuals implicated must remain anonymous as it is not certain whether the case will come before court. Information gathered from both the farmer and the agricultural authorities revealed that the intended aim of clearing the renosterveld may have been to 'surface sow' artificial pasturage. Surface sowing obviates the necessity of 'cultivating' the soil.

36 Fair J "In the Steps of Sir Percy : a Guide to Veld Improvement Part 1" <u>Farmers Weekly</u> 15 November 1985 22-27. Fair J "In the Steps of Sir Percy : A Guide to Veld Improvement Part 2" <u>Farmers Weekly</u> 22 November 1985 16-19.

37 The hazards of overgrazing of veld are defined in the National Grazing Strategy Report (1985) issued by the Department of Agriculture and Water Supply.

38 The following sources may be consulted for information on certain, specified, areas of the south-western Cape Province <u>viz</u>: McDowell C R: Cape west coast lowlands; Rourke J (Curator of the Compton Herbarium Kirstenbosch Cape Town Cape Province): Cape south coast lowlands; Bayer M B (Curator of the Karoo Botanic Gardens Worcester Cape Province): the Worcester Robertson Karoo and Little Karoo semi-desert regions.

39 S4.

40 S4(b).

41 S1.

42 (a) In terms of the Conservation of Agricultural Resources Act, Conservation Committees are appointed by the Minister of Agriculture zones for both local 'areas' - s15, and 'regions' - s16.

(b) Management Committees appointed by the Minister in respect of nature areas (which include representatives other than the private landowners) are empowered by the Environment Conservation Acts s9(2) and s9(3).

43 See definition of nature area op cit n41.

44 Op cit n29 at 30.

45 Magaliesberg Nature Area 1976, Cape Peninsula Nature Area 1983, Rietvlei Nature Area 1984, Langebaan Nature Area 1984.

46 Physical Planning Act s4(b).

47 Proposed developments in lands within Nature Areas would still be subject to standard channels of approval as prevailed prior to proclamation, as delimited generally within the Physical Planning Act, before being vetted by the relevant Nature Area Management Committees.

48 An out of court settlement was, however, recently obtained (November 1985) in favour of the Wildlife Society of Southern Africa when the latter applied to the Supreme Court in order to restrain the Divisional

Council from housing squatters in a section of the Cape Peninsula Mountain Chain Nature Area (above Hout Bay village).

49 Magaliesberg and Cape Peninsula Mountain Chain Nature Areas are steep sloped; Langebaan Nature Area is arid and sandy and Rietvlei Nature Area largely comprises a water body.

50 The south Cape coastal zone from Pearly Beach to possibly as far east as Arniston.

51 Hall A V (ed) op cit n7 4.2.2.2(c).

52 The making of new lands in agricultural zones of nature areas would still be subject to the Conservation of Agricultural Resources Act permit requirements defined within the previous section. As Elim Fynbos habitats occur largely on stable, low gradient lands, agricultural authorities would probably be obligated to officially allow the establishment of new lands.

53 S10(1).

54 Rabie M A "The Impact of Environmental Conservation on Land Ownership" 1985 Acta Juridica 306.

55 See 462 infra for specific definitions of capital and running costs components in conservation.

56 To date the Minister has issued a set of management directives solely for the Cape Peninsula Mountain Chain Area - a grant has been provided specifically for control of invasive alien vegetation and soil erosion totalling ca R150 000.

57 Physical Planning Act s1.

58 The Cape Times "Farmers Oppose Nature Area." 2 May 1983.

59 For a detailed expose of this problem see Claasens P E "Die Konflikte tussen Kusbewaring en Kusontwikkeling in die Rooiels-Botriviermondgebied" 1985 (4(3) Suid-Afrikaanse Tydskryf vir Natuurwetenskap en Tegnologie 104-110.

60 P 460 infra.

PAPER 7

LEGAL STRATEGIES TO OPTIMISE THE CONSERVATION OF NATURAL ECOSYSTEMS BY PRIVATE LANDOWNERS: ECONOMIC INCENTIVES

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1.0 INTRODUCTION

The indispensable role that those farmers who may be conservation orientated can have played in voluntarily preserving our natural heritage is frequently underestimated.[1] An analysis was made of conservation attitudes and behaviour of a sample of landowners[2] who at present control remnants of the critically threatened, fragmented natural ecosystem type - Coastal Renosterveld.[3] This distinctive vegetation, which previously covered large tracts of the south-western Cape lowlands, is now reduced to under five percent of its original distribution area; the remainder having been cleared for crops, housing, etc. The critical role that private landowners play in conserving some of these remnants is exemplified by the fact that five out of a total of seven reserves with renosterveld on the Cape west coast are privately owned and run. One of these, the extensive Elandsberg Private Nature Reserve,[4] includes by far the largest of all renosterveld remnants.[5]

The research on renosterveld landowners has indicated that many varied factors are correlated with conservation activity of landowners. These include _inter alia_ education, affluence, language and agriculture type categories of background factors.[6]

No indication was found in the interviews with the landowner sample that restrictive legislation has any decisive influence[7] on 'conservation behaviour'.[8] As the majority of landowners are dependent on the land for a living, financial considerations underlie decision-making in these instances. For this reason it is understandable that most, but <u>not</u> all, landowners highly rated for their conservation practices were found to be relatively affluent in the renosterveld landowner study.[9] Some of the other landowners agreed in principle with 'setting aside a section of veld for conserving the biota, but felt they 'could not afford to let land go idle'. Out of the 36 renosterveld landowners assessed, three of the five highest rated conservationists admitted that their farms ran either at a slight loss or that the farming enterprises merely broke even annually. In this minority of cases the landowners possessed additional enterprises and investments and could effectively afford to fulfill their motivations to conserve.

2.0 CONSERVATION LIABILITIES INCURRED BY PRIVATE LANDOWNERS

It has been stated that it is in the national interest for private landowners to establish conservation areas[10] on their properties and for this endeavour they should be entitled to at least partial State compensation for economic losses or expenses incurred in the conservation of such ecosystems.[11] For the purpose of reference the latter will each be divided into two categories viz 'Lost Opportunity Costs' and 'Ecosystem Conservation Expenses'. In turn these can be further sub-divided into Capital and Running cost components:

2.1 Lost Opportunity Costs

(a) Loss of Capital Worth

This refers to the net loss in increased value of the land that may have resulted from forgone alternative agricultural developments. Land that has been developed to its full agricultural potential will normally sell for considerably more in the open market than the same land had it been set aside for long-term conservation purposes.[12]

(b) Loss of Alternative Revenue

This refers to any net loss of income which may have accrued through forgone returns from alternative land use ventures (as defined in (a)). Consequently (b) could be expected to directly correlate with (a) above.[13]

2.2 Ecosystem Conservation Expenses

(a) Capital Expenses

Capital expenditure is generally highest during the establishment phase of a conservation area.

This includes expenses incurred in buying game (or other biota), installation of fences and water-point and any additional fixed assets specifically required for the purpose of environmental conservation.

(b) Running Expenses

The conservation of veld as a natural ecosystem including wildlife eg game species is almost invariably a continuous liability.[14] Running expenses, which involve management of a conservation area, could include items such as maintenance of capital improvements (under (a)), staffing costs, eradication of noxious plants[15] and the acquisition of specialised knowledge required for conservation management.

For reference the conservation liabilities defined above will be abbreviated to 2.1(a), 2.1(b), 2.2(a) and 2.2(b) liability categories respectively.

3.0 ALTERNATIVE PROPOSED FINANCIAL INCENTIVE AND COMPENSATION SCHEMES FOR PRIVATE LANDOWNERS WHO INCUR CONSERVATION LIABILITIES

The simplest forms of financial incentives that can be provided to at least partly offset liabilities 2.1(a)(b), 2.2(a)(b) if or when they are incurred in conservation by private landowners may be tax concession related and/or subsidy related.[16] It is critical to emphasize that no scope exists in current legislation to make available financial incentives for conservation of wild fauna and flora by private landowners[17] should the latter demonstrate sufficient initiative. Certain privileges exist for owners of private nature reserves, namely free access to management advice from relevant government departments, primary options on surplus live game from Provincial reserves, as well as the assurance that nature conservation offences may be punished in the same way as they are in State nature reserves.[18] However these privileges hardly compensate for the 2.1(a)(b), 2.2(a)(b) financial liabilities as defined.

Another conservation mechanism recently set in motion by the South African Nature Foundation is the Natural Heritage scheme, the principle of which is to provide official recognition for otherwise unrewarded conservation work. To date this has been symbolic, rather than financial, and has included the ceremonial issue of certificates or plaques to meritorious public or private landowning individuals or bodies.[19] However this 'spiritual incentive' has but limited appeal, restricted either to the already 'converted' conservationists or to those who are unaffected by financial liabilities, and/or to whom some measure of prestige has appeal. This scheme can perhaps best be seen as a stepping stone towards more secure long term economically based alternatives[20] which will be assessed below.

3.1 Tax Concession Incentives for Conservation

3.1.1 Property Tax Rebates

One way this type of incentive could operate would be to exempt from property rates virgin lands affected by, for example, either restrictions imposed via directives issued with respect to the Conservation of Agricultural Resources Act 43 of 1983[21] or Physical Planning Act 88 of 1967.[22]

This form of compensation could go some way towards off-setting the Lost Opportunity Cost 2.1(a). The Mountain Catchment Areas Act 63 of 1970 provides that any land situated within any mountain catchment area upon which in terms of any direction no farming may be carried on, shall be exempt from all taxes imposed by a local authority on the value of immovable property.[23] If this provision could be taken as a precedent, it appears that a minimal requirement for renosterveld remnants[24] to quality for tax rebates would be the absence of agricultural returns therefrom. While this system may be relevant to typically low agricultural potential mountain catchments (or analogous areas) it probably would not be acceptable by the Fiscus for areas of higher agricultural potential. These include lowlands renosterveld sties. Even if acceptable to the Fiscus the rateable value of renosterveld is very low both per hectare and in terms of proportional value to total value for the properties investigated. In these cases the range of rateable valuations was found to extend from only R6 to R100/hectare with the average rateable proportion of veld to land averaging merely 0.011% - a minuscule fraction.[25] Therefore in real terms the financial relief of rent rebates to landowners on this particular sample would be minimal. Incentives provided by property tax rebates would thus improve the conservation behaviour of only a very limited sector of private landowners. They would be unlikely to have more than symbolic value to either the more affluent landowners or those whose veld has been undervalued for rates.[26] The diffuse allowance of tax rebates and potential state monies would, it is submitted, be effectively wasted on a significant proportion of the landowner targets. Another disadvantage with rebates would be the practical difficulty the State would experience in budgeting for annual foregone tax revenue if tax rebates were to be used as an incentive.

3.1.2 Income Tax Deductions

Unlike other enterprises, capital expenditure incurred in development or improvement of farms is tax deductible.[27] This would largely include the type of expenses defined under 2.2(b).

Silke, Divaris and Stein, specialists in Income Tax problems, consider that by virtue of the Income Tax Act 58 of 1962 farmers are, as a class, placed in a favourable position,[28] because the general rule is that expenditure of a capital nature may not be deducted in the determination of taxable income, while farmers, on the other hand, may deduct this type of expenditure.[29] Costs of fencing and waterpoints (dams, boreholes) are examples of such specified capital expenditure as well as the conservation expenses defined under 2.2(a).

However in order to qualify technically for these tax concessions the landowner must be regarded as "carrying on farming operations". Silke, Divaris and Stein[30] in citing various Income Tax cases, point out that farming operations are being carried on according to the critical, but somewhat subjective criterion: "as long as there is a genuine intention to develop land as a farming proposition in the hope that an ultimate profit will be derived" - then this activity qualifies as a farming operation. Demand for farms (in the Cape) may, it has been suggested, actually be boosted by "rich tax-avoidance potential, the promise of fine capital growth and a stylish retirement environment".[31] The basic issue to be decided is which ecosystem conservation-related activities legally qualify for tax deductions? There are no specific provisions in this regard within the Income Tax Act. There are also no cases as direct precedents. Ad hoc interpretations would indicate that an ecosystem defined as a 'game farm',[32] would be more eligible for tax deductions, re expenses 2.2(a) and (b), than a 'private nature reserve' in terms of the 'ultimate profit' requirement. For example the owners of 'private nature reserves' declared under the Cape Provincial Ordinance 19 of 1974[33] may not sell any animals alive or as carcasses.[34] Direct rewards, other than spiritual, are therefore not readily available to private nature reserve proprietors.

However certain landowners (in the research sample) presently claim, in terms of tax deductible expenditure, certain of the 2.2(a) and (b) expenses with good effect for conservation of natural ecosystems. For example the Cape Provincial Ordinance does not forbid the use of veld within private nature reserves for pasturage by domestic stock. Certain 2.2(a)and (b) expenses could therefore be indirectly justified in terms of value for conventional agriculture but not for ecosystem conservation <u>per se</u>! More explicit tax deductions in the Income Tax Act which also have potential to favour ecosystem conservation indirectly are the provisions allowing tax deductions on all expenditure (including allowed subsidies) incurred on the eradication of noxious plants and the prevention of soil erosion.[35] On the other hand the same Act includes a provision allowing the cost of clearing land for farming purposes to be tax deductible.[36] This incentive for clearing new lands is of course contradictory to ecosystem conservation.[37] As tax return information is strictly confidential, landowners who may have made new lands illicitly in terms of the Conservation of Agricultural Resources Act can unfortunately readily claim this tax deduction. It may be better for equivalent remuneration in the form of grants to be administered instead through the Department of Agriculture for officially approved developments only. This would help to ensure compliance with the latter Act.[38] Overall it appears the ambiguities relating to the eligibility of the 2.2(a) and (b) ecosystem conservation expenses for tax deductions should be clarified more specifically in the Income Tax Act. Favourable provisions with respect to the 2.2(a) and (b) expenses would provide worthwhile incentives for private reserves. Allowances for tax deductions, rather than tax rebates, can be more explicitly defined on a landowner's tax return form.

A major disadvantage with the tax deduction principle as a conservation incentive is that it progressively favours the higher income landowners. Therefore, if at one extreme little or no gross income is generated by, say, low income landowners, little or no income tax is paid, with correspondingly minimal if any tax benefits being received. This would, of course, provide little or no stimulus for conservation by low income landowners. At the other extreme, high income landowners presently stand to lose up to 50% of net income in income tax,[39] thus tax deductible expenditure on conservation would receive large tax benefits providing a corresponding boost to conservation. However as the present research has proven it is the less affluent landowners, who, even if they may wish to, presently cannot "afford the luxury of conserving natural ecosystems" without significant financial returns. In fact although many farmers appear wealthy on paper it is well known that the majority experience extreme cash-flow difficulties, particularly during bad crop years. Therefore tax deductible expenditure for ecosystem conservation would benefit only a very small minority of wealthy landowners. As indicated earlier these individuals also frequently possess other investments which help to provide a more stable source of income.

It can be tentatively concluded that tax deductible expenditure allowances would have appeal limited to a small, relatively elite, sector of the farming community who presently have a constantly high liquid income. The data from the renosterveld landowner survey has indicated this group already includes the best practising conservationists. So unfortunately, tax deductions as an incentive will have little or no effect on improving the ecosystem conservation practice of the primary target group, viz the majority of farmers earning average-to-low incomes. The latter probably control the largest proportion of private land, including most private ecosystems, in South Africa.

The subsequent section describes an alternative incentive which should appeal to this category of landowner.

3.2 Subsidy based Incentives for Conservation

The availability of subsidies for ecosystem conservation purposes on private lands in South Africa has been recommended by a number of authorities.[40] It is relevant to note that, with an analogous situation, the Conservation of Agricultural Resources Act regulations allow substantial subsidies for inter alia the establishment of soil erosion controls (up to 70% of cost),[41] as well as the removal of certain noxious plants. However there is no compensatory provision for the Lost Opportunity Costs 2.1(a) and (b) that may be incurred from foregoing the cultivation of those virgin lands in the eventuality of agronomic development being disallowed.[42] This principle must also apply to private lands within nature areas declared under the Physical Planning Act.[43]

If one accepts that the prevention of cultivation of virgin lands can frequently serve the dual purpose of controlling soil run-off and the retention of ecologically valued natural habitats, this factor combined with the difficulties of policing purely restrictive measures is an added justification for allowing some form of subsidy.

One advantage of subsidies over tax based incentives is that they can be awarded more competitively according to the specific merits of the landowners and/or the habitats under the proprietorship. The net loss of finance to the Receiver of Revenue in terms of subsidies or grants, could be provided for more readily in an annual budget through specific allocations from Treasury. In contrast the net loss of revenue accrued as a result of the tax incentives discussed, would be practically impossible for the Fiscus to establish or to control.

In the Cape Province government subsidies are allocated annually to reserves established by local authorities.[44] This covers a significant portion of the 2.2(a) and (b) type expenses. At present unsubsidised private nature reserves within the whole of the Cape cover 31,500 hectares which is clearly comparable in area to the 42,600 hectares of subsidised local authority nature reserves in the same province.[45] It is also probable that many farmers could make more efficient use of subsidies than local authorities, owing to a greater personal interest in their own properties. They normally also have a more direct hand in management than is possible under certain forms of state control. For example, most farmers and their labour forces continuously reside on their farms making possible constant surveillance of adjoining ecosystems. Pre-emptive control of noxious weeds, veld-fires and poaching activities can then be achieved more readily than if the controlling body is situated elsewhere. This is the unfortunate problem with many public conservation bodies.

Subsidies would allow those less affluent landowners who are unable to 'afford' the tax discussed the chance to establish private nature reserves. The problem of allocating a limited annual pool of funds to landowners should be decided on certain key criteria. These could include: (a) the clearly justified needs of the landowner/s; (b) the conservation merit of the ecosystem on the landowner's property; (c) the availability of funds; and (d) perhaps most important, the likelihood of permanence of proposed conservation measures.[46]

An additional, indirect application of the subsidy principle could include the strictly conditional allowance of those subsidies, grants and low interest loans etc which are presently available[47] to the farming community. The conditions for the availability of governmental aid should include stipulated land use practices that would be compatible with ecosystem conservation on relevant properties, viz adherence to the stocking rates, veld burn cycles and hunting limits etc etc as would be recommended by conservationists for various parts of the country.

Additional expenses in using subsidies as an incentive obviously include the administration liability which would be incurred in provision of related extension work.[48] However it may also be on the cards that private enterprise, as well as private individuals, could play a supporting role in contributing toward a proposed "nature conservation fund" autonomous from the State..[49] This, if successful, would alleviate pressure on the Fiscus for funding of subsidies and their application.

3.3 A Resumė of Financial Proposals

Although opinions may vary, the selective provision of subsidies appears to have certain advantages over tax based incentives. This is likely to be favoured by both the recipients of such measures and the fiscal authorities. Several renosterveld landowners interviewed in the study sample, who were rated low regarding ecosystem conservation, stated that direct financial support would be the minimum requirement for them to conserve their veld.

On the other hand the Wildlife Society, in describing previous State-initiated veld reclamation and stock reduction schemes, claims that Government schemes to promote improved farm management by provision of large subsidies have failed.[50] Agricultural schemes however are orientated towards virtually all farmers in South Africa whereas an ecosystem conservation scheme would be aimed only at a much smaller, specific group of those landowners presently controlling high conservation priority natural ecosystems. A limit on the amount of funds available from Treasury, as well as the apportioning of these funds where most needed, could also help to make such a scheme successful.

Tax deductible expenditure provisions for offsetting ecosystem conservation costs, if favourably formalised in the Income Tax Act, would have significant appeal only to high income bracket landowners. As indicated, this group already includes the higher rates conservationists.[51]

Finally, unless the areas which at present are declared to qualify for tax rebates, such as mountain catchments, are extended to include other ecosystems, the tax rebate reward system per se would have only limited appeal to eligible conservationists.[52] From the point of view of acceptability by the State, subsidies also have more appeal than the tax relief measures, as South Africa has a tradition of upholding the latter principle only with profitable enterprises which, as explained, largely excludes most environmental conservation exercises.[53]

4.0 THE PROBLEM OF PERMANENCY

Doubt about the permanency of conservation measures taken on private lands has been used as a primary argument against the principle of providing government sponsored aid for conservation by the Private Sector.[54] The founding premise for this observation appears to be that publicly owned conservation areas invariably possess longer term status than those owned by the Private Sector. However, in the Cape Province, the legal provisions relating to the proclamation of declared (unsubsidised) private nature reserves[55] are identical with those relating to the proclamation, alteration of boundaries or abolition of declared (subsidised) local reserves,[56] as both cases are dependent on the Administrator's approval.

It could be argued that, as private landowners effectively own private nature reserves,[57] they would have greater influence than local authorities in de-proclaiming such reserves. In practice however, this may not be the situation. In 1984 one of the two sole local reserves conserving renosterveld, the Kalbaskraal Nature Reserve (near Malmesbury)was almost de-proclaimed when the Swartland Divisional Council sold the reserve (which formed a 'corner' of the Council owned farm "Kalbaskraal Uitspanning") to a private landowner.[58] The location and status of the reserve was not even defined on the title deeds of the property. When the Administrator was alerted by public outcry at this late stage, the case was put to the public for submissions. On the basis of a presumably more convincing anti de-proclamation lobby, the Administrator eventually requested the Swartland Divisional Council to re-purchase the reserve area from the buyer and to reinstate it. This has yet to occur.[59] If the submissions of the de-proclamation lobby (which included the Swartland Divisional Council) had been successful the decision could easily have gone the other way.

This leads to the next question; if for some reason a landowner, or his/her successors in title decide to dispose of a natural area previously subsidised by the State,[60] would this money have been wasted? This problem is in large part surmountable through entering into a legally binding contract with the landowner whereby he/she (and, if possible, successors in title) would be liable for repayment with interest of the State's expenses in the eventuality of breaking such a contract.[61] This follows the same principle suggested by Giliomee in providing tax rebates for conservation.[62] Such contracts would act simultaneously as a deterrent against de-proclamation and as a surety against the wastage of tax-payers' funds.

Problems with differing conservation attitudes between successors in title can create problems with the continuance of conservation practices established by a particular landowner. This hazard is diminished when farms remain in the same family. For example, three families on the renosterveld sample have assiduously conserved agronomically exploitable renosterveld for over five generations while a further four families have the same so far over two generations. A significant proportion of this relatively high total of seven conservationist families[63] had made use of testamentary trusts to perpetuate 'unofficial' conservation areas.[64] On the other hand, no landowners in the sample had established conservation servitudes, an alternative traditional private law mechanism with similar long term conservation application.[65]

Rabie and Erasmus sum up the differences between trusts and servitudes as conservation tools in stating that "The creation of a trust has an important advantage over a servitude in that while a servitude merely imposes restrictions upon land, a trustee is appointed to administer the trust property".[66] In the case studies quoted, trustees included family members. Despite inevitable loopholes within the latter flexible private law remedies, they may be considered more effective for long-term conservation purposes than the private nature reserves declared under the Cape Provincial Ordinance.[67]

As prolonged family ownership of farms appears to benefit long-term conservation it is encouraging to note that farms may often stay within the same family for a surprisingly long time.[68] Unfortunately increasing economic pressures may act as a negative factor with family conserved ecosystems. This is linked in part to intergeneration increases in population.[69] Although farms may at present not be subdivided,[70] the necessary re-distribution of estate resources to succeeding generations, in combination with death duty liabilities, can increase the motivation to clear and plough 'marginal' lands for better returns.[71] It is at this point that external financial compensation, particularly for the conservation liabilities as defined[72] could be of critical value.

Overall, therefore, it is submitted that with application precautions that have been referred to, the permanent security of private conservation areas is at least as good as, or better than, that of public conservation areas. The track record of the minority of landowners who do conserve is to be admired. It must be remembered that publicly owned reserves certainly do not have the support of the State as an unyielding monolith, but depend strongly on decision makers within the polity, eg administrators, ministers, etc who, as decision makers, change possibly even more frequently than landowners.[73]

5.0 CONCLUSION

At present the only significant surety the State has that the private landowners controlling the vast areas of natural and semi-natural ecosystems continue to conserve this heritage is a steadily increasing network of restrictions.[74] For restrictions to be effective the goodwill of the target communities is essential. This is obviously critical when legislation, like that discussed, is either difficult to enforce or cannot be adequately and continuously policed.

At the present time, it is clear that incentive measures for landowners to conserve natural resources are inadequate.

It is recognised that different landowners have varied needs, but the most frequent basic requirement is financial.

Ironically this is often of greatest importance in the case of conservation-worthy ecosystems including inter alia the 4.78% of remaining West Coast Renosterveld which has provided the working basis for the present analysis.

The findings discussed should be considered as pointers towards modifications of present legislation to formalise the availability of financial incentives and compensation on the basis of merit. This would act not only as a self-enforcing back-up to current restrictive legislation but would also help to legitimise their more stringent implementation. As no statute or ordinance has been devoted solely to the conservation of ecosystems on private lands it would be highly commendable for a white paper to be formulated specifically for that purpose.[75]

It must be realised that there is no short-cut to improving voluntary conservation by private landowners where it is lacking. Even the simple promulgation of a favourable incentive based statute will not be enough in itself. Nothing can surpass personal co-operation with landowners through direct extension in order to overcome misunderstandings, communicate relevant information and to determine ways of satisfying varied individual needs. This has been proven in the establishment of nature areas where only through personal communication with each and every landowner were their properties eventually incorporated therein without objection.[76] It is a gain for the State conservation authorities to allow and encourage private landowners to conserve areas of 'natural heritage' where fiscal funds would be insufficient for both the acquisition and running of additional conservation areas. However even financial incentives, which require greater expenditure than, for example, other recognition based strategies, eg natural heritage plaques and certificates,[77] would invariably represent merely a partial aid for the landowner. The landowner's additional personal services and responsibility for managing private conservation areas would come free of charge to the State. To a significant degree the issue of permanence of the latter can be confronted by applying principles at least comparable to current state guarantees of permanence.

Private ownership and management of ecosystems represent invaluable stop-gap measures for subsequent mutually agreed upon takeover of responsibility by the State at some later date if/when the need arises. This has been the situation with many of the present national parks. Moreover, a very recent amendment to the National Parks Act 57 of 1976[78] now allows for the State President to proclaim national parks on areas of privately owned land that have been made available by the owner/s by agreement with the Minister for such period and subject to such conditions as the Minister, after consultation with the National Parks Board of Trustees, may approve.[79] This means that nature areas can be up-graded to national park status without major changes being made to either ownership status or management.[80]

Overall, therefore, the application of favourable statutory policies can do much to harness the currently unrealised potential of private landowners to be responsible custodians of natural ecosystems. This would surely advance the cause of conservation well beyond the inevitably unsatisfactorily restricted confines of the present Public Sector owned and/or controlled conservation areas.

FOOTNOTES

1 The potential role that farmers, as private landowners, can play in conserving natural habitats is covered in greater detail at 254-256 <u>supra</u>.

2 This represents a central thrust of the writer's current research; the detailed results of which are currently being prepared for publication.

3 For more details on the definition and threatened status of Coastal Renosterveld as an ecosystem see: McDowell C R <u>op cit</u> n1; McDowell C R "Laws to Save Our Natural Resources" <u>Farmers Weekly</u> 13 June 1986 14-18.

4 Near Hermon, Cape Province.

5 Jarman M L (ed) <u>Conservation Priorities in the Lowland Regions of the Fynbos Biome CSIR Report</u> South African National Scientific Programmes Report No 87 (1984) 26.

6 Details are not relevant here, but the principles and background factor influences are worth taking into account.

7 For the limited effects of restrictive conservation legislation, see 254-278 <u>supra</u>.

8 The rating of the 'Conservation Behaviour' parameter for landowners on their properties takes into account the criteria: (a) the extent of natural habitat retained at least for the part motive of ecosystem conservation; (b) the sacrifice to alternative commercial ventures which may have been caused by the retention of natural habitats; (c) the degree to which the ecosystems are scientifically managed so as to ensure continued survival of the natural elements; (d) willingness to retain the previous measures (a), (b), (c) for the indefinite future.

9 Statistical correlation between ratings of 'Conservation Behaviour' and 'Overall Affluence' as obtained for the landowner sample was R = 0,69 (significance at = 0.001)

10 For an in-depth assessment of the term 'conservation area' see Rabie M A "South African law relating to conservation areas" (1985) XVIII(I) CILSA 51-89.

11 See in general: Fuggle R F and M A Rabie Environmental concerns in South Africa Technical and Legal Perspectives 1983; Hall A V (ed) Proposals for Nature Conservation Areas in the Coastal Lowlands of the South-Western Cape Province (1984) Report by a Working Group to the Minister of Environment Affairs; Miltz D Financial Considerations of South African Environmental Problems unpublished M Sc Thesis University of Cape

Town 1984); Report of the planning committee of the President's Council on Nature Conservation in South Africa PC/1984.

12 For example, land in the Swartland study area under vineyards could fetch a minimum of R16 000/ha in the open market, during early 1984. Undeveloped renosterveld with vineyard potential had a market value of a fraction of the developed land. Several farmers who had the opportunity to develop vineyards from the latter, at reasonable development costs, eg in the Bottelary Hills, maintained they 'could not afford to forgo development'. This was partly because of the expected net capital increment to the farms' worth. Frequently in other situations, however, this increase in worth may be lower than expected, as the costs of development can be surprisingly high.

13 Both 2.1(a) and (b) need not apply to agricultural enterprises alone but, in extreme cases, may also apply to mining, housing and industrial ventures, etc.

14 Certainly the maxim was found to apply to conservationist landowners in the study sample. This is not necessarily the case elsewhere where profitable game farms exist in the drier summer-rainfall areas of the country, for example the Northern Cape and the Transvaal lowlands. Optimal exploitation of game products, visitorship and sales of live game ensures

20 The only binding commitment to the owner is a 60-day notice to be given to the Department of Environment Affairs and Tourism, should that owner choose to terminate registration or the area concerned as a natural heritage site.

21 GN R1048 of 25 May 1984 empowered by s29 of the Act states <u>inter alia</u> that except on authority of a written permission by the executive officer, no land-user shall cultivate any virgin soil.

22 S4 enables proclamation of 'nature areas' which is a type of conservation area where no person (including land-users) may, except under authority of a permit, use any land defined for any purpose other than the particular purpose for which it was lawfully being used immediately prior to the date of reservation.

23 S5(1).

24 Coastal Renosterveld remnants would not normally fall under the jurisdiction of the Mountain Catchment Areas Act as it is a lowland veld type.

25 Obtained for the research properties from Cape Divisional Council Field Sheets which provide rateable values for immovable assets.

26 The average value in rands stated by landowners to constitute a 'reasonable market offer' for renosterveld averaged greater than six times the equivalent rateable value.

27 P12 of the First Schedule of regulations appended to s6 of the Income Tax Act 58 of 1986.

28 Silke A S Divaris C and M L Stein <u>Silke on South African Income Tax</u> (10ed) (1982) 1041.

29 P12 of the First Schedule of regulations relating to s26 of the Income Tax Act 58 of 1962 which specifies types of tax deductible capital expenditure allowable to farmers.

30 Silke A S Divaris C and M L Stein <u>op cit</u> n28 1007.

31 <u>Financial Mail</u> 1985 98(3) 94.

32 Recently recognised by the Department of Agriculture as representing an official agricultural enterprise.

33 S13(c).

34 The Planning Committee of the President's Council <u>op cit</u> states that by comparison the Transvaal private nature reserves are exempt from all hunting restrictions and that this may be a contributory reason

for many of the requests for proclamation in this province.

35 Silke A S Divaris C and M L Stein *op cit* n28 1042.

36 *Id* at 1039.

37 P453 *supra*.

38 *Ibid*.

39 Income Tax Amendment Act 65 of 1986. (The ceiling rate of income tax may vary significantly with successive annual amendments).

40 Fuggle R F and M A Rabie *op cit* n11 181; Hall A V (ed) *op cit* n11 5.3.2.1.3; Miltz D *op cit* n11 216; Planning Committee of the President's Council *op cit* n11 135.

41 GN R1048 of 25 May 1984.

42 *Ibid*.

43 See p453 n22 *supra*.

44 Cape Provincial Ordinance 19 of 1947 s7.

45 Planning Committee of the President's Council *op cit* n11 112.

46 For details on Criterion d - see subsequent section "The problem of permanence".

47 Soil conservation, flood control and drought relief schemes on farmlands represent a few of several liabilities currently eligible for government financial aid.

48 The potential of a proposed conservation extension service in encouraging farmers to conserve is discussed by McDowell C R and J R Grindley in Hall A V op cit n11.

49 Suggested for the Cape Province, by Morsbach W Director of the Cape Department of Nature Environmental Conservation "Firms may take over from Cape Nature Department" The Cape Times 27 February 1986.

50 Wildlife Society (unpub report) A Policy and Strategy for Environmental Conservation in South Africa (1980) 8.

51 Cf previous section of paper entitled "Income tax deductions".

52 Cf previous section of paper entitled "Tax rebates".

53 Fuggle R F and M A Rabie op cit n11 181.

54 Planning committee of the President's Council <u>op cit</u> n11 45-46.

55 Cape Provincial Ordinance 19 of 11974 s12(5)(a), (b) and (c).

56 <u>Ibid</u> s7(a) and (b).

57 For additional legal details concerning private nature reserves see Rabie M A <u>op cit</u> n10 68-70.

58 It is worth noting that should the sale have been approved, the purchaser and family expressed enthusiasm in declaring the same area a private nature reserve to be kept free of any form of agricultural utilisation. To their credit they were also prepared, with somewhat limited financial resources, to eradicate dense infestations of ecologically detrimental alien acacias which had previously been neglected by the Swartland Divisional Council despite the availability of an annual conservation subsidy. In this situation a subsidy conditionally provided to the purchaser together with necessary prescriptive management advice could possibly have worked wonders. (See previous section).

59 At the time of writing the reserve area has still not been re-purchased by the Swartland Divisional Council owing to a shortage of funds. (The proceeds of publicly owned land sales and/or other 'profits' go direct to the treasury in the case of Provincial bodies).

60 This is under the hypothetical situation that private conservation areas were to qualify for subsidies.

61 Presently being investigated *inter alia* by Gordon S (1985-86) as a part requirement for the degree of LLM Witwatersrand University South Africa.

62 Planning Committee of the President's Council *op cit* n11 107.

63 Comprises over 20% of the families evaluated in the writer's research sample.

64 Of the latter 7 families, conservation principles were guided by trust provisions in 2 families, and a 3rd landowner has recently established a trust for the same purpose.

65 For specifics see Fuggle R F and M A Rabie *op cit* n1 41-43; Rabie M A *op cit* n10 76-78.

66 Fuggle R F and M A Rabie *op cit* n11 42.

67 Id at 43. "Servitudes and trusts have ... an important advantage over the establishment of a (private) nature reserve and this is while there are few obstacles to de-proclamation of a (private) nature reserve a servitude or trust cannot be removed so readily".

68 Within the research sample the average tenure so far per family is 78(+) years, with one third of the subjects having owned the same farms for over a century.

69 Within the research sample the population had increased twofold since the previous generation.

70 Sub-division of Agricultural Land Act 70 of 1970.

71 No explicit evidence was found to support that this actually happened previously. However, two younger generation 'farmers to be', who happened to be present when their parents were interviewed, clearly stated that they intended to develop new lands on taking over control from the older generation.

72 Liabilities 2.1(a), (b) and 2.2(a), (b) as defined in the previous section.

73 Even statutorily proclaimed national park areas circa National Park Act 57 of 1976 Schedule 1 have had some serious problems concerning future inviolability, eg the recent coalmining threat to the inviolability of the Kruger National Park.

74 Fuggle R F and M A Rabie op cit n11 43.

75 This could be prepared via the Statutory Council for the Environment as empowered by the Environmental Conservation Act 100 of 1982.

76 Landowner objectors to the schemes were frequently individuals with whom insufficient direct and personal negotiation had been achieved by the relevant state officials.

77 See second paragraph of "Alternative proposed Financial Incentive and Compensation Schemes for Private Landowners who incur Conservation Liabilities".

78 As amended by Act 23 of 1983.

79 S2(a)ii.

80 The relevant schedule is being prepared at time of writing.

GENERAL CONCLUSIONS

1.0 SPECIFIC CONCLUSIONS OF THE PAPERS

These are given point by point according to the Research Aims as enumerated for each paper in the GENERAL INTRODUCTION of the thesis.

Paper 1: The Influence of Agriculture on the Decline of West Coast Renosterveld, South-Western Cape Province, South Africa

1. A total of 55 remnants of West Coast Renosterveld were delimited with an average area of 400 hectares each. Overall the total of roughly 23,000 hectares represents just over 3% of the estimated pre-agrarian distribution of West Coast Renosterveld. The remnants are largely atypical of most of the original distribution of Coastal Renosterveld on the now cultivated fertile plains, in that they are virtually restricted to agriculturally marginal soils of steep gradients on hillocks or mountain foothills. The annual rainfall of the remnants declines towards the more arid north of their range. At a macro level, the selective nature of agricultural clearance has caused the atypical physiography of remnant renosterveld.

2. It was calculated that remnant West Coast Renosterveld has the highest known concentrations of Red Data species within the biogeographic regions comprising the Cape west coast forelands (just over one Red Data species per square

kilometre remaining). The veld types most reduced by agriculture were shown to have proportionally the highest concentrations of Red Data species within the extant zones of veld. For example the Cape Peninsula Lowlands (sensu stricto not a biogeographical region) of which only ca 10 square kilometres has escaped intensive urban development, has a very high concentration of over three Red Data species per square kilometre natural vegetation remaining.

3. Within renosterveld remnants themselves the Red Data species have higher incidence on the very small proportion of renosterveld which is on low lying flat habitats. It is suggested that this uneven distribution of Red Data species may result from the once far wider distribution of 'flatland' renosterveld. That these species have been ploughed out over much of their previous ranges on the flats appears to be the factor that has led to their meriting Red Data status.

4. The concept of "Agricultural Threat" was devised and rated as an index for the 55 remnants, delimited as part of the study, using 'soil quality' (obtained by pooling independent ratings), 'gradient' and 'rainfall' for parameters. Successful prediction of likelihood of agricultural clearance was obtained. Sites which rated high in agricultural threat had either just recently been ploughed (in the past five years since initiation of this survey); are likely to be ploughed; or are deliberately preserved by largely private landowners. It is suggested

that socio-economically based 'threat indices' be generally incorporated when rating conservation priority of prospective conservation areas.

5. In the case of renosterveld it was concluded that the agriculturally vulnerable flatter areas merit greatest conservation urgency. This is further emphasised by the high concentration of Red Data species in the same areas. Although not immediately threatened, the steeper gradient renosterveld (and other "low potential" remnant natural vegetation generally) will most probably be threatened in the longer term by agro-technical innovation; including other socio-economic threats fuelled by the increased material needs of humanity.

Paper 2: The Effects of Grazing on Renosterveld at Eensaamheid, South-Western Cape, South Africa

1. Although intensive, the sheep grazing caused no significant decline in total cover or species diversity in the grazed renosterveld when compared with a control ungrazed area alongside (Appendix 1). However significant shifts in the actual composition of the flora itself was observed.

2. Of the 41 plant families assessed for 'effects of grazing' cover of certain species, as well as the 'total' cover, both the Poaceae (grass family) and Rutaceae (citrus

family) showed a decline. Exactly the reverse was recorded with the Asteraceae (daisy family) and Iridaceae (iris family). Only the three species of the Proteaceae were completely eradicated by grazing. On the other hand three species of the Thymelaeceae (thyme family) indicated some dependence on the grazing regime for survival.

3. The effects of grazing pressure on the six Red Data species represented varied from eradication of the two Proteaceae through to possible beneficial effects on the two Iridaceae.

4. Overall it is difficult to conclude from the research whether stock grazing per se is harmful to remnant renosterveld. In fact its absence could just as possibly cause extinctions of certain species. Results support the hypothesis of Cowling et al. that modern grazing regimes favour Asteraceae at the expense of Poaceae. Similar implications are suspected for the shifts in dominance recorded for the other families in the present research.

Paper 3: The Attitude and Behaviour of Farmers toward Ecosystem Conservation: a New Approach to Assessing Associated Variables

1. The conservation behaviour of private landowners who own remnant renosterveld is defined in terms of: a) Extent of habitat conserved, b) Financial sacrifice to landowner in

conserving renosterveld, c) Conservation management input, and d) Likelihood of long term retention of conservation measures.

2. The use of long duration semi-structured in-depth interviews, accompanied by personal observation on the properties of a random sample of landowner-subjects was decided on as being the best approach in eliciting arrays of variables having conceivable relationship with conservation behaviour. It was considered more appropriate to "thoroughly get to know and understand" a relatively small yet representative sample of family units instead of running the danger of superficiality in scanning too large a sample.

3. A total of 52 'independent' variables was chosen for rating. These included:- A) 20 demographic variables relating to - "Individual", "Family", "Tenure of Property", "Formal Education", "Affluence", "Language and Nationality" and "Rural versus Urban". B) 13 land use variables relating to - "Areas", "Valuations", "Development of Veld into New Lands" and "Utility of Land". C) 11 psycho-social variables relating to "Personality - Interaction", "Personality - Attitude", "Social Influence", "Cognition", and "Motivation". D) 7 conservation strategy variables relating to "Acquisition Problems" and "Costs". See Appendix to Paper 3 for detail on 'definition', 'deduction' and 'scale' for each variable.

4. Of the 52 independent variables chosen 32 were given 'less tangible' status owing to inevitable measurement error. Criteria for such status included: a) variables which could not be measured exactly eg variable number 15 'Achieved versus Ascribed Affluence', b) variables prone to subjective bias eg 34 'Rapport with Interviewer', and c) sensitive information that normally requires circumspect 'probing' to obtain eg 14 'Overall Affluence'. (Numbered according to Appendix of Paper 3.)

The problem of measuring the 'less tangibles' was approached by engaging two additional suitably qualified researchers to provide ratings who used as a basis tape-recorded interview material with its wealth of formal as well as informal ("gut feeling") information. The level of statistical agreement between these ratings which were made <u>independently</u> of one another, was unexpectedly high in a number of 'less tangibles'. This indicated that much data, traditionally ignored or unreliably gauged in more conventional information gathering techniques, such as certain questionnaire designs, could be used to complement the straightforward ratings for the 'tangible' variables in obtaining a statistical profile of 'Conservation Behaviour'. Mean values for the independent ratings are used for the 'less tangible' database. Reliability of these mean values is based largely on the extent of inter-observer agreement between the independent raters for each 'less tangible'.

<u>Paper 4</u>: <u>Multivariate Modelling and Prediction of Farmers' Conservation Behaviour toward Natural Ecosystems</u>

1. To indicate inter-relationships between all the variables assessed (as above) the Pearson's R Correlation Coefficient was used to derive a correlation matrix and dendrogram. This was helpful to establish likely 'causal' and/or 'synonymous' relationships between variables. For example 'Overall Knowledge of Ecosystem' (X7) and 'Overall Interest in Ecosystem' (X12), although different technically, correlated highly with one another and, therefore, could be taken as virtually synonymous statistically. The causal links are clear in this case.

2. Several 'independent' variables showed absolutely no correlation with the 'dependent' variable 'Conservation Behaviour' (Y1) eg 'Age' (X33), 'Number of Siblings' (X34) (See scatterplots in Figure 3 which illustrate several relationships of 'independent' variables with 'Conservation Behaviour'.) As might be expected several 'cognition' and 'motivation' variables, namely 'Conservation Attitude' (X7) and those concerning knowledge about/interest in natural biota (X3, X7, X12, X16) as well as 'Understanding of the (author's) Project' (X10), were all highly correlated, both among one another, as well as with 'Conservation Behaviour'. 'Education' variables, pertaining to both the subjects themselves (X37, X38) and the subject's parents (X36) showed strong positive intercorrelation as well as having good correlations with 'Conservation Behaviour', more

particularly at the extremes. Subjects with only a few years schooling were invariably bad conservers, in contrast to those with advanced tertiary education who were invariably good conservers. Those who had completed high-school (intermediate range) showed greatest variation. Almost exactly the same pattern was apparent with the 'affluence' variables (X2, X4, X14) with the most wealthy being the best conservers, least wealthy being worst conservers with an area of ambivalence in the mid range. 'Affluence' and 'education' variables showed unexpectedly low correlation with one another owing to the high component of inherited wealth among the farming community. 'Language and nationality' variables (X1, X8, X40) also showed significant relationship with 'Conservation Behaviour' Bilingual farmers (Afrikaans and English) were generally the best conservers. Farmers who could either speak Afrikaans only or who comprised the small proportion of overseas origin were among the bad conservers.

Certain pairs of variables which, singly, had poor or insignificant correlations with 'Conservation Behaviour' could, when multiplied together, show a far higher correlation. The most favourable of these two-way interactions was 'Dependence on Land for Income' (X13) (slightly positively correlated) and 'Past Tenure of Family' (X42) (insignificant correlation) which, when multiplied together as an 'interaction term', showed a highly significant correlation with 'Conservation Behaviour'. The interpretation is that farmers' families who had been on the land the longest, and at the same time having <u>low</u> dependence on the land for income (ie profitable investments elsewhere) are the better conservationists. Causes for the observed correlations (many others are not discussed) can only be derived through reasoned speculation.

3. In order to predict mathematically the rating of landowners' 'Conservation Behaviour', various inputs of the full array of 52 'independent' variables were chosen. These included: a) all variables and interaction terms; b) 'tangible' variables only; c) questionnaire amenable variables; and d) variables with least resemblance to 'Conservation Behaviour' as a concept. The models derived using the Best Subsets computer package, each comprised 5 or 6 variables in a linear equation to achieve maximum prediction of 'Conservation Behaviour' by using the minimum number of variables. The percentage of 'Conservation Behaviour' predicted using the above inputs were: a) 95% (Variables being - 'Overall Interest in Ecosystem' (X12), 'Overall Affluence' (X4), 'Language Orientation' (X1), 'Materialism' (X18) (negatively correlated with 'Conservation Behaviour'), and 'Past Tenure of Family' (X44) multiplied by 'Dependence on Land' (X13)); b) 77% (Variables being - 'Education' (X37), 'Area of Land' (X44), 'Area of Renosterveld' (X46), 'Rateable Valuation of Property'(X47), and 'Value Proportion of Veld to Land' (X49)); c) 84% (Variables being - 'Origin' (X39), 'Language with Origin' (X40), 'Number of Siblings' (X34), 'Education' (X37) and 'Area of Land' (X44)); d) 87%

(Variables being - 'Education' (X37), 'Number of Siblings' (X34), 'Language Orientation' (X1), 'Overall Affluence' (X4), 'Past Tenure of Family' (X42), and 'Area of Land' (X44)). The levels of successful prediction of the extent to which landowners conserve (or do not conserve) renosterveld is considered very satisfactory with all the above inputs. The improved percentage prediction of behaviour, compared with the equivalents within analogous 'soil conservation' studies in America and Australia, is in part due to the rating and inclusion of the additional 'less tangible' variables.

4. If one were to assume any 'cause-effect' relationship between variables having high correlation with 'Conservation Behaviour' and 'Conservation Behaviour' itself it is largely impractical to change 'Conservation Behaviour' via manipulation of these variables per se. Thus one cannot realistically expect to 'favourably alter' an individual's 'language', 'education', 'area of land' or 'overall affluence'. A conservation extension agent could, however, work creatively with such factors as they stand whether they represent advantages or constraints for particular subjects. For example a particular farmer may have a higher than average education (X37) and affluence (X4), a reasonable level of interest in natural ecosystems (X12), yet lack knowledge of natural biota (X7), in particular those on his/her farm. Thus the tools and motivation are there to understand and appreciate conservation and the effective

input required of the extension agent in this case would be provision of written or verbal information on the relevant ecosystem. In another case a key limiting factor could be a shortage of liquid capital (X14). Remedial action would therefore include financial input to improve 'Conservation Behaviour'. Or the needs may be much more complicated even than those taken into account by assessing the 'less tangibles' in the appendix of paper 3.

5. A working knowledge of the variable involved, even if not assessed mathematically, should still help an extension agent to predict fairly accurately the extent to which a particular ecosystem is being conserved. This would require knowledge of a few key background variables (such as those in the equations above) pertaining to the landowner and his/her family including the characteristics of the property itself. The application of the mathematical prediction of 'Conservation Behaviour' is very similar to that used commercially in, for example the determination of insurance levies. To show profit these are determined in line with predicted vulnerability of individuals to become ill and/or die, have motor vehicle accidents etc. This approach has much future potential for ensuring the conservation of natural ecosystems on private lands if developed further. Such an approach should be used in conjunction with the recommendations in Paper 5.

Paper 5: Persuading the Private Landowner to Conserve Natural Ecosystems through Effective Communication

1. Paper 4 describes how different conservation extension approaches should be used with individual landowners having different ratings for critical variables. Paper 5 takes this further in attempting a broad classification of the same set of landowner-subjects (as in the previous two papers) into groups of 'similar' landowners about which generalisations can be made concerning both the extents of their present 'Conservation Behaviour', together with related variables and type of need to be satisfied to improve 'Conservation Behaviour'. The Generalised Euclidean Distance dendrogram, used to 'cluster' the landowners on the basis of similar readings for all the variables, showed about half the 36 landowner subjects falling into two clearly defined 'clusters', with a further quarter comprising 'exceptional' cases. (The remainder could neither be 'clustered' nor defined as clear exceptions.) The two 'clusters' showed consistent differences from one another. 'Sociotype A' was rated low in terms of 'Conservation Behaviour' and the key variables linked thereto and <u>vice versa</u> for 'Sociotype B'. The 'exceptions' represented extremely bad or extremely good conservers probably as a result of extremes in one or two of the related key variables. Thus generalization is only possible to a certain extent ie with the sociotypes. However the inevitable quota of 'exceptions' must also be considered in designing strategies to "manage the managers". That is if

renosterveld landowners have anything in common with other critical landowner target groups (re. Thesis General Introduction).

2. Two conservation case studies are used to illustrate the effects of 'poor' and 'good' conservation liaison. The former case study illustrates how conservation liaison can have a negative effect on 'Conservation Behaviour' if cognisance is not taken note of, in particular, the 'less tangible' variables characterising the subject's background. In this unfortunate case the subject was so irritated by written correspondence from a well meaning conservationist that he deliberately converted a vital area of natural habitat on his farm into an apple orchard. This resulted in the extinction of a species of the Proteaceae.

The case study which illustrated 'good' conservation liaison centred around an area of scarce 'flatland' renosterveld; a refuge for several Red Data species (Papers 1 and 2) which was about to be ploughed. Amicable interaction between the author and the landowner was sufficient to induce enough goodwill to reverse this decision. Subsequently his heirs (he has since died) kindly agreed to allow a free 20 year lease of the land in question to the local State conservation authority. In retrospect a key reason for success with the second case study was because interaction was on a direct, personal level. This helped to engender greater mutual understanding and to overcome any misapprehensions. Another principle learned was that the extension agent should always take pains to analyse meticulously successful as well as unsuccessful interactions.

3. A code of conduct is devised to optimise the goodwill of subjects towards conservation practice on personal contact with the extension agent.

The following rules of thumb are designed to establish initial rapport and to achieve effective 'impression management' ie "getting your foot in the door" on meeting the subject:- 1) *The conservation agent represents a standard-bearer for a cause, and a favourable personal interaction will create a favourable label for that cause.* 2) *Personal visits to farmers at their homes should be carefully pre-arranged at their convenience.* 3) *General appearance of the conservationist is important, in particular the choice of clothing.* 4) *If the subject speaks another language (eg Afrikaans) an attempt to at least initiate conversation in that language will enhance goodwill.* 5) *Adjust language to a vocabulary and style similar to that of the subject to optimise communication.* 6) *Be an attentive and sympathetic listener.* 7) *Knowledge and enthusiasm (where possible) about the subject's pet interests will engender greater respect for 'messages' the extension agent may wish to convey.*

4. The rules of thumb for persuading landowners to conserve, which involves the principle of 'decision

steering' include: 1) *Other factors assumed equal, older people have less flexible attitudes and opinions than younger people.* 2) *Provision of intricate scientific rationale for conservation can often be completely wasted on the subject.* 3) *Most effective communication occurs when the extension agent and the subject have greatest similarity in terms of beliefs, values, social status, education etc. (= homophilous).* 4) *It should not even be vaguely apparent that extension agents are "telling subjects what to do" concerning conservation on their properties (Positive action is most likely to occur if a landowner believes it is his/her "own idea").* 5) *Convincingly provide the subject with a "good label".* 6) *Express admiration for what subjects own or manage.* 7) *Assess the primary need/s of the subject and determine how the conservation message can best be tailored to fulfill such needs.*

The above represent remedial measures most appropriate within the bottleneck constraints of financial, cognitive and other background variables pertaining to subjects (cf. Paper 4).

Paper 6: Legal Strategies to Optimise Conservation of Natural Ecosystems by Private Landowners: Restrictive Legislation

1. Government Notice R1048 of May 25 1984, as empowered by the Conservation of Agricultural Resources Act 43 of 83

2. The Physical Planning Act empowers statutory reservation of land, including that under private ownership, for 'nature areas' (Section 4). The prime objective of a 'nature area' is to conserve inter alia natural ecosystems and biota for the benefit of the public (Section 1). No person may within a nature area, "except on authority of a permit, use any land defined for any other purpose other than the particular purpose for which it was lawfully being used immediately prior to the date of reservation". Permits can be authorized only at ministerial level, which is much stricter than the requirements for cultivating virgin soils under the CARA (above). It was observed that because the term "change in land use" is a very loose term, it represents a potential loophole. In the farming context 'land use' could be taken merely to represent 'agricultural land use' - which embraces a multitude of sins from low impact pasturage through to clearance of virgin lands for which, in terms of the nature area provision as it stands, no permit would be required. To date the nature area provision has been most tested with respect to applications to build housing within the Cape Peninsula Mountain Chain Nature Area. In these cases the development "intention" prior to declaration has been used to define such land use changes.

The Environmental Conservation Act empowers the Minister of Environment Affairs and Tourism to issue directions concerning conservation within any nature area (Section 10(1)) as well as entitling landowners to recover compensation for "actual patrimonial loss by way of grants" in respect of expenses incurred by them in compliance with these directions, eg for control of alien vegetation or erosion. On the other hand, no financial provision is made for 'lost opportunity costs' (Paper 7 for definition) which may accrue through freezing of land use within nature areas.

Only time will tell what success the 'nature area' concept may have as a conservation tool. However, despite amendments, the incentive of private landowners to challenge this land-use control remains considerable. At present, this concept is in a state of flux with the preparation of a new Environmental Conservation Act, which has yet to be finally approved. A submission was made by the author to the Department of Environment Affairs and Tourism, responsible for drafting the new statute, which embodies details on the observed weaknesses of the current Act (above) and also recommends modifications entitling greater recognition for landowner conservation enterprises (<u>sensu</u> Paper 7 below).

<u>Paper 7</u>: <u>Legal Strategies to Optimise the Conservation of Natural Ecosystems by Private Landowners: Economic Incentives</u>

1. Liabilities that may be incurred by private landowners who conserve are defined. Firstly 'lost opportunity costs' can be broken down into loss of increased capital worth and

income that may have been accrued in forgoing more profitable alternative ventures for conservation. For example not converting "arable" renosterveld into cultivated lands would be to lose the agricultural income as well as an increase in capital return should the land be sold. 'Lost opportunity costs' can be high if land has, for example, peri-urban or mining potentials. Secondly, 'ecosystem conservation expenses' can be broken down into capital and running expenses in establishing and managing conservation areas.

2. Given the above liabilities it is realised how private conservation initiatives will often run at a loss and that conservationist landowners need to be able to afford this. Firstly, tax concessions are evaluated as an incentive to stimulate conservation of worthy areas by the private sector. Property tax rebates has as a precedent the exemption of mountain catchment areas from property rates in terms of the Mountain Catchment Areas Act. The author concludes that this stratagem would have minimal incentive for (at least) higher agricultural potential areas, such as renosterveld (partly on the basis of valuations obtained for renosterveld on farms).

Capital expenditure incurred in the development of farms is tax deductible, unlike that for other enterprises. This may include <u>inter alia</u> 'improvements' such as soil erosion controls and clearance of alien as well as (ironically) natural vegetation. This provision has recently been extended to include game farms but does not include private nature reserves declared under the Cape Provincial Ordinance 19 of 1974. It could therefore pay the private landowner to de-proclaim a private nature reserve and re-define it as a game farm with the following provisos: a) the presence of game animals and, b) "a genuine intention to develop land as a farming proposition in the hope that an ultimate profit will be derived". A disadvantage of tax deductions as a meaningful incentive for ecosystem conservation is that it progressively favours the higher income landowners and not the lower income landowners whose need for financial compensation is greatest (cf. Papers 4,5). Another important problem with implementation of tax deductions generally is the very strong line that South African fiscal authorities are now taking against "tax privileges" for welfare related concerns. Recommendations to this end would, therefore, probably not be received favourably by the fiscus. Nevertheless, a submission was put forward by the author to the Margo Commission (a body appointed by the State to overhaul South Africa's tax structure - with proposals still being considered in Parliament) recommending that private nature reserves be accorded the same privileged tax status as standard farming enterprises and that financial gifts to recognised conservation organisations be exempt from Donations Tax as are donations to recognised charities. The indications to date are that these suggestions will not be given support.

3. Subsidies and grants have a history of frequent application in compensating for losses incurred by the farming community. For example the Conservation of Agricultural Resources Act allows substantial subsidies for <u>inter alia</u> the establishment of soil erosion controls and removal of certain noxious plants. In terms of the Physical Planning Act private landowners are entitled to grants in order to recoup conservation management expenses in proclaimed nature areas (Paper 6).

The success of this allowance should set a precedent in allowing grants and subsidies for private nature reserves which are of public benefit. Allowance should be on a similar basis as the State subsidies already allocated to 'subsidised local authority nature reserves' cf. Cape Provincial Ordinance 19 of 1974 (Section 7). This study has shown that subsidies are more appropriate incentives to private landowners than tax concessions because, firstly, they can be awarded more competitively according to specific merits of the landowners and/or habitats under their proprietorship. Secondly, the net loss of finance to the Receiver of Revenue in terms of 'lump sum payouts' can be catered for far more readily than tax concession expenses in an annual budget through specific allocation from Treasury.

4. The assumption that permanence is less likely in privately owned conservation areas has been used as an argument against government aid. Evidence has been obtained in this research that this is fallacious, particularly with

regard to subsidised nature reserves (local government owned and State subsidised) which have the same proclamation/deproclamation provisions as (unsubsidised) private nature reserves. For example one of the only two public nature reserves sensu lato in the West Coast Renosterveld, "Kalabaskraal", was a subsidised nature reserve, comprising the corner of a Divisional Council owned wheat farm until 1984. At this time it was sold accidentally to a private landowner; one of the reasons being that the reserve's boundary was accidentally omitted from the title deeds. Subsequently due to public outcry the Administrator ordered the area to be re-purchased by the Council. This did not happen and latest indications are that the private landowner retains ownership. Fortunately the family are highly rated as conservationists and it is being retained for a private nature reserve. Unfortunately, it is not certain that they can fully afford the expenses to manage the area effectively (based on a private interview in 1986).

Several 'unofficial' private conservation areas already have a long term 'survival' status. For example, it was observed in the renosterveld that the latter have remained intact for several landowner-generations. Private law mechanisms proposed to entrench permanence of less secure private conservation areas include legal contracts and trusts. Legal contracts could make a landowner family liable for repayment of State financial input if the reserve was ever abused/deproclaimed thus ensuring against wastage of the funding authorities' monies. The latter option is recommended by the author because the testamentary trust has proven the most popular voluntary mechanism for ensuring long term conservation among the renosterveld landowners interviewed. Therefore, it is the finding of this study that favourable statutory policies based on incentive rather than poorly policed restriction has considerable and, as yet, unrealised potential for advancing the long term conservation of remaining privately owned ecosystems.

2.0 CONCEPTUAL SYNOPSIS

The above section ('1.0 SPECIFIC CONCLUSIONS OF THE PAPERS') represents a summary which consolidates the conclusions of the thesis proper and has emphasis on the practical dimensions. Minutiae are to be found within the relevant text and tables of the individual paper-chapters. The latter are presented in formats designed for publication. A disadvantage of the presentation of chapters as 'papers' is that, at least, to the uninitiated, certain themes and trends of conceptual progression which run through the body of the thesis may become obscured (See also: 'GENERAL INTRODUCTION 2.0 CONCEPTUAL DEVELOPMENT'). At this point some of these themes and trends are worth briefly reiterating:-

Papers 1 and 2 represent together the first of three distinguishable component blocks of the main body of the thesis. This component is conceptually closest to the traditional basis of by far the greatest bulk of ecosystem conservation research, namely; overt emphasis on the non-human or 'physical' aspects of the ecosystems themselves. However, even this component of the thesis does to some extent start to address the interaction of the human factor with the natural environment. The climax of the latter may be pin-pointed in Paper 1; a treatise which actively switches the research focus from the biotic characteristics of the renosterveld - the natural ecosystem 'baseline' - through to the systematic evaluation of the most crucial influence on the latter's future survival; namely; the socio-economic based threats closely interlinked with current agricultural trends. Perhaps the most important 'unseen' threat to remnant natural ecosystems, not previously highlighted as a concept in analogous studies, as a study on its own is encapsulated by the term 'technological innovation'. The latter was descriptively rated to be the most severe long term threat to existing renosterveld. New farming methods, new machinery designs as well as new crop/livestock breeds when supported by favourable agro-economic conditions can spell doom for hitherto "undeveloped" natural habitats.

Not unexpectedly the above rationale points towards humankind as being a logical target for investigation when devising a meaningful holistic strategy to conserve natural ecosystems. In the renosterveld study the private landowner was placed under the spotlight within the subsequent social-psychological component of the thesis. The latter comprised the second and central sector consisting of Papers 3,4 and 5. Taken together with the previous thesis component, the latter block of research is exceptional because it modifies and re-directs principles, familiar, in the main, to the social sciences toward solving a pressing problem which has its origin within the realm of the natural sciences - namely traditional conservation biology. This uses as a basis in-depth, semi-structured interviews (supported by other relevant data) to probe and measure a diverse range of factors that were intimately linked to the decision-making processes of a representative sample of farmers owning remnant renosterveld. The latter methology is described in Paper 3.

The approach used in Paper 4 involves certain positivist assumptions when a series of predictive models of conservation attitudes and behaviour of landowner-subjects were developed. This was achieved through application of a number of sometimes novel statistical analyses. As may be seen within the main text this exercise proved successful and the methodological sequence so designed can be re-directed fairly readily in analogous future studies. Knowing why and when landowners are likely to be good, bad or indifferent conservers of natural diversity is the major hurdle to be crossed before a realistic blueprint for improving their conservation behaviour can be derived. Paper 5, consequently, represents a bold attempt to provide this blueprint - a logical climax to the social psychological component of the thesis. This paper addresses directly the problems of communicating with varied categories of landowners and, hence, the practical difficulties associated with urgently inculcating positive conservation ethics and practices in individuals with widely varied receptivities and backgrounds. Several directly advantageous 'rules of thumb' relating to positive communication (persuasive techniques) are analysed and described formally - in itself a completely new approach to ecosystem conservation.

The third and final component of the thesis, namely Papers 6 and 7, deals with legal aspects of conservation on private lands. This component is the furthest removed from the 'physical' renosterveld baseline of the first component of the thesis but borrows heavily from the relevant statistics and conclusions derived in the first two thesis components. The thesis' final objective was to formulate a practical statute and ordinance backed strategy that would, if applied, effectively formalise an improved conservation status for the renosterveld as well as other privately owned priority natural ecosystems at a national level.

Paper 6, in essence, provides a critique of current legislation by pointing out their current strengths and weaknesses. Paper 7 takes a more constructive line by providing recommendations of how present legal mechanisms may be used most effectively to promote conservation ideals. Furthermore, the latter also submits material and spiritual incentive-and-reward-based legislation backed reforms that are tailor-made to ensure long-term conservation cooperation of private landowners and their families. Recognition is also given to the stalwart dedication to conservation of the minority of the present landowning public. Finally, the considerable potential for advancement of these laudable practices with landowners generally is assessed.

Overall the thesis does not directly address the socio-political considerations that underpin, in particular, the legislative process (a possible final sequel) for reasons defined in the GENERAL INTRODUCTION (2.0 Conceptual Development).

One major obstacle anticipated (and to some extent already experienced) in the implementation of the practical ideals of the thesis lies in the observation that such initiative is largely hamstrung by the overspecialization of key actors having various levels of association with the conservation process. Thus the ecological component may be of real interest only to biologists; the social-psychological component may be of real interest only to social scientists; and the legal component may be of real interest only to legal practitioners. Until these disciplinary bridges can be crossed, this will remain a real obstacle to furthering the major practical objectives of the thesis, which are primarily founded upon values rooted within the conservation-biological paradigm. The production of additional popular-style renditions of the academic papers

(CARA) states that "except on authority of a written permission by the executive officer, no land-user shall cultivate any virgin soil" on lands zoned "agricultural". Virgin soil is defined as "land which in the opinion of the executive officer has at no time during the preceding 10 years been cultivated". Many individuals concerned with the conservation of natural biota felt that this statutorily backed Regulation (unlike the situation in the predecessor Soil Conservation Act) would be the salvation to preserving habitats like renosterveld threatened with clearance for new lands (Paper 1). However the author's research on the implementation of this Regulation in the west coast lowlands revealed problems. On an informal level many farmers interviewed expressed either ignorance or defiance of what was perceived to be an uncompensated restriction of their "basic rights". Policing of such a restriction is not easy because, even by using air-photos, it is difficult to prove readily the illicit creation of new lands, particularly in rugged habitats. This is exacerbated by a lack of State personnels to enforce such a law (eg only two agricultural law enforcement officers for the whole winter rainfall region). Because farmers also hold an influential position in rural communities, they are unlikely to be deterred from developing "idle land" on their farms if they really wanted to. The latter weakness is implicit in vesting powers in a single "executive officer" (see above for definition of virgin soil) who is invariably a part of the same rural community.

already produced, may conceivably help to overcome this inter-researcher communication difficulty.

3.0 CONCLUDING REMARKS

The remaining patches of renosterveld in the south-western Cape lowlands are under siege - in particular the small proportion still left on the flats. Natural vegetation is being cleared at an alarming rate in the Fynbos Biome lowlands generally for the socio-economic reasons provided in this thesis. Thus this unfortunate erosion of irreplaceable natural wealth continues and, mainly because of its less accessible rural situation, goes largely unnoticed and hence largely not appreciated by the urban based non-government conservation groups. Nevertheless databases have been compiled indicating both threatened biota and conservation priority areas in the south-western Cape lowlands (by various authorities as well as the author - see Paper 1).

Some general recommendations from the present research were incorporated in the Fenn Report (Hall (ed.) see Papers 6,7) as submitted to the Department of Environment Affairs and Tourism in 1985. This report was at least partly responsible for the subsequent acquisition of "Riverlands", a substantial lowland tract of high conservation priority Sand Plain Fynbos (near Mamre) which previously belonged to the South African Railways. Although this wise acquisition was at a reasonable price, it did require a large capital outlay. It is unlikely that State money allocated for land purchase, even if supplemented generously by the private sector funded South African Nature Foundation (most affluent non-State conservation body), could do more than scratch the surface in terms of acquiring the sites of high conservation merit in the south-western Cape lowlands - let alone elsewhere. Also private landowners who own the bulk of such land are either unwilling to sell or would require unreasonably high prices. Even if further land was acquired to increase the land under public conservation control it is doubtful whether State conservation bodies, already understaffed, would be able to manage such land adequately.

Typical conservation management liabilities include control of alien vegetation, excessive veld fires, poaching, fence maintenance etc. Frequently the biggest management expense is the permanent posting of a State paid manager. According to the relevant authorities management expense per unit area is least cost effective when reserves are smaller and far apart from one another. This applies to the majority of the 55 West Coast Renosterveld sites demarcated by the author (Paper 1). It is especially in these and related instances that enthusiastic private landowners could officially fulfill the role of custodians. Where needed, conditional grants, official recognition, management prescriptions, legally binding contracts, trusts, servitudes, easements, usufructs etc can be selectively applied to help grease the wheels of private sector conservation practice. It is asserted that harnessing the personal pride of the landowner, in taking responsibility for his/her own reserve, even with "strings attached", will generally be more effective than utilizing a public sector manager. Private landowners have the advantage of (normally) being available on the spot at all times (together with workers and equipment), whereas the externally based manager, often particularly in the case of small nature reserves (see above), would have to mount a minor expedition to carry out management tasks. Also the manager need not be blamed for any perceived neglect of conservation area on or near a private property.

On the other hand it should not be forgotten that even if many private landowners are among the best of conservationists (despite minimal incentive) they include also the most destructive individuals environmentally. This was particularly true in the past. Coercive measures supported by restrictive legislation is not an appropriate strategy for improving 'Conservation Behaviour'. Although relatively cheap to enact but, when impractical to enforce and weakly policed, such measures can do more harm than good in that they lull both the conservation authorities and public into a sense of false security. The belief that "something has been done" effectively pre-empts more meaningful action. The research results indicate that in addition to the judicious use of material incentives (as indicated above), an <u>outgoing</u> extension service, adopting an appropriate and sympathetic approach (as defined in Paper

7), has as yet unfulfilled potential for winning the hearts and minds of even the most "difficult" of landowners.

Repercussions of optimal contact with landowners reach even further than achieving the effective management of conservation-worthy natural resources on private lands. For example the favourable conservation example set by the present manager of the Andries Venter Kudu Reserve (near Grahamstown, Cape Province) was clearly (in the author,s opinion) a factor precipitating the bequest of land that virtually quadrupled the previous size of the reserve. (At ca 25,000 hectares it now represents by far the largest conservation area within the rapidly declining Fish River Scrub veld type of the Eastern Cape.) A substantial sum of cash was included in the same bequest to cover fencing and management liabilities for that land. The latter "windfall" is certainly not an isolated instance in South Africa. Several landowners (including those with renosterveld) are not averse to making substantial donations, both in terms of land gifts and/or related kind eg "bargain" buys, usufructs etc etc. Quite often certain minimal conditions have to be met in order to take advantage of such offers. A common example is that the owner could require certain life long rights on the donated land before allowing full control by the conservation authority. An important function of formal or informal extension would be the active dissemination of "recipes" among landowners about how they can contribute to preserving their country's natural heritage and what they can get out of cooperating. This type of approach has been used very successfully overseas, with the United States being a leader in this field (Paper 5). Such an approach cannot be adopted overnight; numerous socio-economic as well as political circumstances obviously make South Africa a unique situation which must be dealt with as such.

Without doubt the improvement of attitudes of private landowners represents one of several critical steps towards achieving the ecosystem conservation ideals recommended for world nations by conservation bodies such as the IUCN. It is also admitted that numerous questions need to be answered concerning ecology and management of natural biota (cf. Paper 2). Databases on biota incidence and conservation priority of remnant natural habitats could be enlarged upon with advantage to conservation. Like knowledge generally, such research has no limits. However it is clear that to achieve conservation ideals it is vital to advance related socio-economic research hand in hand with biological research because, at grass roots level, conservation problems are socio-economic in origin. It is contended that the socio-economic perspective is sadly under-rated and under-researched in South Africa (see literature referred to in the Papers generally). The multidisciplinary approach adopted in this thesis is an attempt to indicate potential for new direction in the conservation field. The research undertaken, therefore, skims only the surface of unexplored depths. Unfortunately, if the research community at all resembles humanity generally, a lag phase of inertia is to be expected before such a community will accept let alone actively encourage, novel and much needed re-directions.

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