



South African programme for the SCOPE mid-term project on the ecological effects of fire

A report of the Committee for Terrestrial Ecosystems
National Programme for Environmental Sciences

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PREFACE

The concept of an international project to synthesize knowledge on the ecological effects of fire was proposed at a meeting of SCOPE (Scientific Committee on Problems of the Environment) held in Washington in October 1976. The proposal was approved and an international Steering Committee (Chairman: Professor R O Slatyer, Australian National University) appointed to coordinate the project on an informal basis. A South African programme was initiated in 1977 within the National Programme for Environmental Sciences, a cooperative undertaking of scientists and scientific institutions in South Africa concerned with research related to environmental problems.

The South African programme seeks to review existing local knowledge on fire ecology within a number of fields and in particular to develop greater understanding of the fundamental ecological processes influenced by fire. It will culminate in 1980 in the preparation of a synthesis of the ecological effects of fire in South African biomes.

Contributors to the South African programme include researchers from the Department of Agricultural Technical Services, the Department of Forestry, the Natal Parks Board, the National Parks Board and five universities. The costs of the programme are borne partly by the participating organizations themselves and by a central fund administered by the National Committee for Environmental Sciences, contributed largely by the Department of Planning and the Environment. The programme is coordinated by the Working Group for Fire Ecology (Chairman: Professor P de V Booysen, University of Natal). This document is a description of its programme.

ABSTRACT

The aims, organization and activities of the South African programme within the SCOPE project on the 'Ecological effects of fire' are described. The short-term (1977-1980) programme is aimed at the synthesis of existing knowledge and will also involve limited research activities on selected topics within eight main review themes. The emphasis will fall on the analysis and interpretation of the results of existing long-term burning trials in savanna, grassland and fynbos biomes. The programme will culminate in the preparation of a synthesis report on the ecological effects of fire in South African biomes.

SAMEVATTING

Die doelstellings, organisasie en aktiwiteite van die Suid-Afrikaanse program binne die SCOPE-projek oor die "Ekologiese uitwerking van vuur" word beskryf. Die korttermynprogram (1977-1980) het ten doel die sintese van bestaande kennis en sal ook beperkte navorsingsaktiwiteite oor geselekteerde onderwerpe binne agt oorsigtemas bevat. Die klem sal val op die analise en interpretasie van resultate van huidige langtermyn veldbrandproewe in savanne-, grasveld- en fynbosbiome. Die program sal kulmineer in die opstel van 'n oorsigtelike verslag oor die ekologiese uitwerking van vuur in Suid-Afrikaanse biome.

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INTRODUCTION

SCOPE was set up in 1970 by ICSU (International Council of Scientific Unions) to act as a focus of non-governmental international scientific effort in the environmental field. One of the functions of SCOPE is the review and synthesis of knowledge on various environmental problems and concepts.

SCOPE mid-term project 2 is concerned with dynamic changes in community composition and structure. SCOPE now wishes to develop this theme in relation to certain types of perturbation which influence ecological succession - in particular fire. A short-term (1977-80) international programme, informally coordinated by SCOPE, has been initiated to provide local and international forums for the review and synthesis of current knowledge on the ecological effects of fire.

For many reasons, in particular the long history of fire ecological research in South Africa, this country is able both to contribute towards and to draw benefit from the international project. Fire ecological research in South Africa has in the past centred on the use of fire as a management tool and a great deal of effort has gone into a number of long-term burning experiments. However this field has lost much of its momentum in recent years and a new and imaginative approach to the subject is required. It is hoped that this South African programme will help to stimulate both broad reviews and specific investigations of key questions relating to ecological processes and to management strategies.

The programme was formulated at a series of workshop meetings, the findings of which form the basis of this report.

OBJECTIVES

The research and review activities outlined in this report should be examined in the light of the following objectives of the South African programme:

- To provide a forum for the review and synthesis of research and knowledge on the ecological effects of fire in South African ecosystems, in particular in terms of the ecological processes involved in the manner in which fire influences and is influenced by ecosystem characteristics, and management strategies for fire regulated ecosystems important for agriculture, forestry and wildlife.
- To identify gaps in current fire ecological knowledge and to stimulate research in these areas within the framework of a three-year programme.

ORGANIZATION

The activities of the Terrestrial Ecosystems Section of the National Programme for Environmental Sciences have recently been structured within long-term studies of the major biomes represented in the Republic, namely karoo, fynbos, grassland, savanna and forest. In addition several shorter term projects are aimed at the review and synthesis of knowledge on various environmental problems common to several or all biomes. The fire ecology programme will be developed within the latter framework. The programme will involve the analysis, interpretation and synthesis of information available from the numerous long-term burning trials currently maintained at various research centres around the country. Where opportunity allows, specific studies on short-term effects of fire will be initiated in areas of known fire history.

The restricted time span of the project imposes severe restraints on the range of research activities possible, as will be evident from the proposed programme. The lists of priority research and review topics include both current and proposed activities. Most of these will be concluded within the time available, but some will need to continue for many years after the present review project has ended. The individual projects will aim at the consolidation of fire ecological knowledge relating to the series of themes described below. Emphasis will be given to those fields which have been neglected in the past.

The integration of these activities will be maintained by the Working Group for Fire Ecology of the Committee for Terrestrial Ecosystems.

RESEARCH AND REVIEW THEMES

The initial workshop (March 1977) proposed eight main themes within which various priorities were identified. Most of these themes relate both to ecological processes and to management strategies and no attempt was made to consider these aspects in isolation. The meeting agreed however, that applied research topics should be brought to the attention of participating land-use agencies for their special consideration. The themes were defined as follows:

Theme 1. Characteristics of fire regime and fire behaviour

The concept of fire regime includes three components - frequency, season and intensity of burn. Fire behaviour relates to rate of spread, flame characteristics and atmospheric phenomena induced by fire. Factors such as weather conditions, fuel, time of burn, etc interact with both fire regime and behaviour.

Theme 2. Adaptive responses of organisms to fire regime

The mechanisms evolved by animals and plants by which survival and/or reproduction are enhanced within ecosystems subject to differing fire regimes. Adaptive responses include morphological, physiological and behavioural features.

Theme 3. Effect of fire regime on vegetation structure and dynamics

The immediate, short-term and long-term influences of different fire regimes on vegetation dynamics as reflected by structural features at any given time.

Theme 4. Effect of fire regime on faunal structure and dynamics

The effects of fire regime on animal populations in terms of the overall effect on habitat structure and dynamics and the way in which this influences behaviour and population dynamics through fire-induced changes in food and shelter quality and availability and the spatial characteristics of the burn.

Theme 5. Effect of fire regime on soil physical and chemical properties

The immediate and/or long-term effects of fire regime on soil characteristics, including the effects of heat and of altered microclimate and biogeochemistry.

Theme 6. Effect of fire regime on herbage production and quality

Effects of fire regime on the components of production (efficiency of energy fixation) and quality (food value for herbivores) in terms of individual plants, species populations or swards. The interaction between fire and herbivores on post-fire regeneration would also be examined within this theme.

Theme 7. Effect of fire regime on water production and quality

The immediate and long-term effects of fire on water yield and quality through influences on soil surface and cover characteristics.

Theme 8. Synthesis and integration of knowledge on fire ecology

The main aim of the overall project is to review and synthesize existing and new knowledge on fire ecological effects in South African ecosystems. Both prior to and parallel with the short-term investigations on specific problems, integrated reviews of various topics will be prepared.

ACTIVITIES WITHIN THE SAVANNA BIOME

Intensive research in fire ecology has been conducted for many years in the Kruger National Park and more recently in the Ciskei, while short-term effects will be studied in detail within the Savanna Ecosystem Project at Nylsvley. Less intensive studies have been undertaken in various conservation areas of Zululand, in particular the 'Central Complex' which includes Umfolozi and Hluhluwe Game Reserves. Possible activities within each of these centres will be considered in terms of the eight principal themes. Details of experimental design may be obtained from the various project leaders.

KRUGER NATIONAL PARK

Theme 1. Characteristics of fire regime and fire behaviour

Current state of knowledge

Limited information is available on temperature profiles of fires in various treatments (Brynard and Pienaar 1960, Van Wyk 1972).

Key questions for research

1. Can natural fire zones (within which similar fire regimes are experienced) be characterized, identified and mapped within the Kruger National Park?
2. What are the causes and circumstances of natural fire initiation and extinction in the Kruger National Park?
3. How do the fire regimes operating in the Park vary between ecosystems in terms of the rate of spread of fire, the temperature profile which develops, the height of flames and smoke and the ash fall characteristics?

Priority research and review topics

1. The causes and occurrence of fire in the Kruger National Park and a theoretical model of a natural fire regime. Mr P van Wyk (National Parks Board).
2. Fire behaviour in the Kruger National Park. Mr A L F Potgieter (National Parks Board).

3. Monitoring the occurrence and causes of fire in the Kruger National Park. Dr S C J Joubert, Mr W D P Gertenbach and Mr P F Retief (National Parks Board).
4. Characterization and classification of fire behaviour and regimes in the Kruger National Park. No project leader yet available.

Theme 3. Effect of fire regime on vegetation structure and dynamics

Current state of knowledge

A considerable volume of quantitative information has been collected but awaits analysis and interpretation (Brynard and Pienaar 1960, Van Wyk 1972).

Key questions for research

1. Into what homogeneous plant communities can the various burning trial plots be sub-divided?
2. Will available data on vegetation structural changes permit statistical comparison?
3. What structural parameters should be measured to allow statistically valid comparison of effects of various burning treatments in the Kruger Park burning trials?

Priority research topics

1. Classification of vegetation in long-term burning trials and comparison of the structure of different treatments within each community type. Mr W D P Gertenbach (National Parks Board).
2. Multi-variate analysis of the relationships between soils, treatment and vegetation structure and composition in long-term burning trials. Mr B J Coetzee (National Parks Board).

Theme 4. Effect of fire regime on faunal structure and dynamics

Current state of knowledge

General accounts on the influence of fire on large mammals in the Kruger National Park have been given by Brynard and Pienaar (1960), Van der Schijff (1958), Brynard (1964) and Van Wyk (1972). The effects of fire on small mammal populations has recently been studied in detail by Kern (1978).

Key questions for research

1. What are the long-term effects of fire regime on the animal population?
2. To what extent does fire-induced vegetation change influence faunal composition?
3. Are these faunal changes related to food availability or to vegetation physiognomy?

Priority research and review topics

1. Effects of fires on small mammal populations. Professor J A J Nel (Department of Zoology, University of Pretoria).
2. Relation between vegetation development after a fire and large herbivore movements, distribution and densities. Mr P F Retief and Dr S C J Joubert (National Parks Board).

Theme 5. Effect of fire regime on soil physical and chemical properties

Current state of knowledge

No published information.

Key questions for research

1. What are the effects of fire regime on rainfall infiltration and run-off and how do these effects differ between soil types?
2. How do fire regimes affect soil nutrient levels and in what manner?

Priority research topic

1. Effects of fire regime on physical and chemical properties of various soil types on a series of long-term burning trials in the Kruger National Park. Professor T H van Rooyen and Mr C N Webber (Department of Geography, University of South Africa).

Theme 6. Effect of fire regime on herbage production and quality

Current state of knowledge

No published information.

Key question for research

1. How do fire regime and post-burn grazing conditions affect the subsequent productivity and quality of herbaceous and woody plant material?

Priority research topic

1. Determination of the effects of various long-term burning treatments on herbage production and quality. No project leader yet available.

Theme 8. Synthesis and integration of available knowledge

Current state of knowledge

Several review articles (Brynard and Pienaar 1960, Brynard 1964, Van Wyk 1972) have been prepared thus far on the Kruger National Park burning trials but none of them provide an up-to-date analysis and interpretation of the quantitative information available.

Priority review topic

1. The history of burning policy and fire research in the Kruger National Park. Mr P van Wyk (National Parks Board).

SAVANNA ECOSYSTEM PROJECT, NYLSVLEY

Theme 1. Characteristics of fire regime and fire behaviour

Current state of knowledge

No research of any nature has thus far been conducted on fire ecology at Nylsvley.

Key question for research

1. What are the behavioural characteristics of fire in Burkea savanna?

Priority research topic

1. Characterization of fire behaviour in Burkea savanna, following standardized procedures. Mr B J Huntley (CSIR).

Theme 2. Adaptive responses of organisms to fire regime

Key questions for research

1. What are the immediate and short-term post-fire responses of the various plant and animal groups in Burkea savanna?
2. How does the fire response of plant species vary in terms of survival, pattern of vegetative growth, positions of lateral buds, pollination, seed production and dispersal, dormancy and germination?

Priority research topics

1. An integrated study of the immediate post-burn responses of various animal species in Burkea savanna. This study will focus attention on selected plant, lower vertebrate and invertebrate taxa. Mr N H G Jacobsen (Division of Nature Conservation, Transvaal Provincial Administration), Mr M V Gandar (Department of Zoology, University of the Witwatersrand) and Mr J Watson (CSIR).
2. Survival and regeneration of woody plants following a spring burn in Burkea savanna. Dr M C Rutherford (Botanical Research Institute, Department of Agricultural Technical Services).

Theme 3. Effect of fire regime on vegetation structure and dynamics

Key questions for research

1. What are the causes of differences in vegetation structure under a uniform fire regime over a large area?
2. What is the influence of termitaria, selectively grazed areas, differences in fuel structure, microtopography, etc on the effects of fire at a sub-habitat level?

Priority research topic

1. A study of the immediate and short-term effects of fire on vegetation structure in Burkea savanna. Professor J O Grunow and Mr D Grossman (Department of Plant Production, University of Pretoria).

Theme 4. Effects of fire regime on faunal structure and dynamics

Key questions for research

1. What are the immediate effects of fire on animal populations?

2. How do these effects vary between species in terms of mortalities, injuries, disruption or stimulation of reproduction, feeding, social or diurnal behaviour, changes in predator/prey relationships etc?

Priority research topic

1. Determination of immediate post-burn effects on the structure of selected invertebrate and lower vertebrate groups in Burkea savanna. Mr N H G Jacobsen (Division of Nature Conservation, Transvaal Provincial Administration), Mr M V Gandar (Department of Zoology, University of the Witwatersrand) and Mr J Watson (CSIR),

Theme 5. Effects of fire regime on soil physical and chemical properties

Key questions for research

1. What are the immediate post-burn effects of fire on soil moisture status?
2. What are the immediate and short-term effects of fire on soil chemical properties in Burkea savanna?
3. What are the immediate and short-term effects of fire on patterns of mineral release from litter?
4. What are the immediate and short-term effects of fire on soil respiration characteristics?

Priority research topic

1. A study of the immediate and short-term effects of fire on soil moisture, nutrient and respiration characteristics. Dr D J van Rooyen (Department of Soil Science, University of the Orange Free State) and Mr J J Bezuidenhout (Department of Microbiology and Plant Pathology, University of Pretoria).

Theme 6. Effect of fire regime on herbage production and quality

Key question for research

1. How does net primary productivity and biomass accumulation differ between burnt and unburnt Burkea savanna?

Priority research topic

1. A study of the short-term effects of fire on herbage production and quality. Professor J O Grunow and Mr D Grossman (Department of Plant Production, University of Pretoria).

Theme 8. Synthesis and integration of knowledge

The fire ecological research activity at Nylsvley will comprise an intensive cooperative effort by members of the current research team to measure and model the immediate and short-term effects of a spring burn in Burkea savanna. A series of modelling workshops will precede the burn and will endeavour to identify the parameters which should be quantified before, during and after the fire in order to answer the various questions noted above and to permit the development of predictive models.

Priority research topic

1. Development and validation of models of the immediate and short-term effects of fire in Burkea savanna. Dr P R Furniss (Department of Applied Mathematics, University of the Witwatersrand) and Dr J W Morris (Botanical Research Institute, Department of Agricultural Technical Services).

CISKEI SAVANNA ECOSYSTEMS

Theme 1. Characteristics of fire regime and fire behaviour

Current state of knowledge

No published information is available on fire regimes and only very limited data on fire behaviour in the Ciskei savanna ecosystems (Trollope 1974, 1978a). However, a considerable amount of data has been collected on fire behaviour in relation to the response of arborescent and herbaceous plant communities since 1974. This information is at present being analysed and reported upon. A long-term experiment was also initiated in 1973 to investigate the effect of season and frequency of burning on sweet grassveld.

Key questions for research

1. How can fires be characterized in order to develop safe controlled burning procedures and effective fire fighting procedures?
2. How does the flammability of different plant fuels vary?

Priority research and review topic

1. Determination of the factors influencing the flammability of Themeda triandra and Panicum maximum. Mr W S W Trollope (Department of Pasture Science, University of Fort Hare).

Theme 3. Effect of fire regime on vegetation structure and dynamics

Current state of knowledge

No information is available.

Key questions for research

1. What is the effect of differing fire intensities on different savanna and grassland communities in terms of botanical composition and seasonal production of dry matter?
2. What are the short-term effects of burning dormant and actively growing grassland irrespective of season?
3. What is the effect of fire on the flowering and production of seed and the germination of grass and bush species?

Priority research topics

1. Effect of burning from mid-winter to early summer on Themeda triandra grassland. Mr W S W Trollope (Department of Pasture Science, University of Fort Hare).
2. Effect of burning dormant Themeda triandra grassland in late summer. Mr W S W Trollope (Department of Pasture Science, University of Fort Hare).

CENTRAL COMPLEX, ZULULAND

Theme 1. Characteristics of fire regime and fire behaviour

Key questions for research

1. What are the causes and circumstances of natural fire initiation and extinction in the Central Complex?
2. During what months do fires, both man-made and natural, occur and under what gross climatological conditions?
3. What is the extent and duration of their spread?

Priority research and review topic

1. Synthesis of information on fire regime characteristics in the Central Complex available in unpublished and published reports of the Natal Parks Board. Messrs M W Paxton and I A W McDonald (Natal Parks Board).

Theme 3. Effect of fire regime on vegetation structure and dynamics

Key question for research

1. What has been the response of selected vegetation types to a known fire history during the last 25 years?

Priority research and review topics

1. Analysis and interpretation of past records available in Natal Parks Board files. Messrs M W Paxton and I A W McDonald (Natal Parks Board).
2. Analysis of existing vegetation types and the relationship between their present structure and their recorded fire history. Messrs M W Paxton and I A W McDonald (Natal Parks Board).

Theme 4. Effect of fire regime on faunal structure and dynamics

Key question for research

1. What are the immediate and short-term effects of fire on the distribution and movements of large mammals?

Priority research and review topics

1. Synthesis of available knowledge on the immediate and short-term effects of fire on the distribution and movements of large mammals. Dr P M Brooks and Mr M W Paxton (Natal Parks Board).
2. Continuation of monitoring programme to supplement (1) above. Dr P M Brooks and Mr M W Paxton (Natal Parks Board).

ACTIVITIES IN THE GRASSLAND BIOME

Five long-term burning trials have been maintained for extended periods in South African grasslands during the last half century. Those at Estcourt (Scott 1952, Edwards 1968) and Frankenwald (Cohen 1949, Roux 1969) have been discontinued while those at Ukulinga (Anon 1974, 1977), Cathedral Peak (Nänni 1960, Granger 1976) and Giant's Castle (Edwards 1969, Mentis, Meiklejohn & Scotcher 1974) have a variety of ongoing research activities. Those themes which are currently receiving attention or which require stimulation from the national fire ecology programme are noted below. Details of experimental design may be obtained from the various project leaders.

UKULINGA, UNIVERSITY OF NATAL

Theme 1. Characteristics of fire regime and fire behaviour

Current state of knowledge

No information available.

Key question for research

1. How does fire behaviour differ between the various burning treatments at Ukulinga?

Priority research topic

1. A study of the fire behaviour characteristics of various burning treatments at Ukulinga following standardized procedures. Mr M Savage (Department of Agrometeorology, University of Natal).

Theme 3. Effect of fire regime on vegetation structure and dynamics

Current state of knowledge

A considerable amount of information is available, most of this has been synthesized in Anon (1974, 1977) and Tainton, Booysen, Bransby & Nash (1978).

Key question for research

1. What grassland management principles can be formulated from the information available from the Ukulinga trials?

Priority research and review topic

1. An analysis and interpretation of information on vegetation structure and dynamics in various burning, mowing and rest treatments at Ukulinga over 28 years. Professor N M Tainton (Department of Pasture Science, University of Natal).

Theme 4. Effect of fire regime on faunal structure and dynamics

Current state of knowledge

No information available.

Key question for research

1. What differences in the invertebrate faunas of various treatments can be detected and how can they be explained?

Priority research topics

1. Survey of the above-ground and soil invertebrate faunas of selected burning treatments at Ukulinga. Professor T Bosman (Department of Entomology, University of Natal).
2. Survey of the soil microbial populations of selected burning treatments at Ukulinga. Dr M Wallis (Department of Microbiology, University of Natal).

Theme 5. Effect of fire regime on soil physical and chemical properties

Current state of knowledge

Limited information is available on soil physical characteristics of various treatments.

Key questions for research

1. How does soil crust strength and infiltration rate vary between treatments?
2. How do soil chemical characteristics, in particular nutrient status, vary between treatments?
3. How do soil moisture and temperature profiles vary between treatments?

Priority research topic

1. An analysis of soil physical and chemical characteristics in selected burning treatments. Professor J le Roux (Department of Soil Science, University of Natal) and Mr M Savage (Department of Agrometeorology, University of Natal).

Theme 6. Effect of fire regime on herbage production and quality

Current state of knowledge

A considerable amount of information on herbage yield has been collected and is adequately reviewed in Anon (1974, 1977) and Tainton et al (1978).

Key questions for research

1. How does the overall nutrient status and digestibility of herbage vary between treatments?
2. What is the effect of subsequent management on herbage production and quality?

Priority research topic

1. An analysis of the nutrient and digestibility characteristics of herbage of selected burning treatments at Ukulinga. No project leader yet available.

Theme 8. Synthesis and integration of knowledge

Current state of knowledge

Several interim syntheses have been prepared (Anon 1974, 1977) and Tainton et al (1978). A comprehensive review comparing Ukulinga results with other grassland studies is required.

Key questions for review

1. What overall ecological and management principles may be developed from the Ukulinga studies?
2. How do the Ukulinga findings compare with results from similar studies?

Priority review topic

1. Comparative review of the results of 28 years of burning treatments in grassland at Ukulinga, Pietermaritzburg. Professor N M Tainton (Department of Pasture Science, University of Natal).

CATHEDRAL PEAK FOREST RESEARCH STATION

Theme 1. Characteristics of fire regime and fire behaviour

Current state of knowledge

An appreciable volume of data on fire frequency and extent is available from unpublished reports but awaits synthesis.

Key questions for research

1. What are the causes and circumstances of natural fire initiation and extinction in the Cathedral Peak area?
2. During what months do fires occur and what is the extent and speed of their spread?
3. What are the behavioural characteristics of fires within the various burning treatments at Cathedral Peak?

Priority research and review topics

1. Study of the origin, occurrence and extent of fires in the Natal Drakensberg Catchment. This work is to be carried out by the Natal Parks Board and will involve a synthesis of all information available in Department of Forestry and Natal Parks Board records.
2. Experimental investigation of the effects of burning treatments on Highland Sourveld in replicated plot trials at selected centres in the Natal Drakensberg Catchment. Dr J E Granger (Department of Forestry).

Theme 2. Adaptive responses of organisms to fire regime

Current state of knowledge

No information is available.

Key question for research

1. How does the response to fire of plant species vary within communities in terms of survival, pattern of vegetative regrowth, positions of lateral buds, pollination, seed production and dispersal, dormancy and germination?

Priority research topics

1. Experimental studies of the effects of controlled burning, protection and controlled summer grazing in Highland Sourveld and Themeda-Festuca Alpine Veld in gauged experimental catchments at Cathedral Peak Forest Research Station. Mr C Everson (Department of Pasture Science, University of Natal).
2. Determination of the effects of veld burning treatments on the major plant communities of the Natal Drakensberg Catchment: responses of four shrubs to fire regime. Mr F Smith (Department of Forestry).

Theme 3. Effect of fire regime on vegetation structure and dynamics

Current state of knowledge

An appreciable amount of information is available from the long-term veld management practices applied in the research areas of Cathedral Peak and from well documented fire management records from Department of Forestry centres elsewhere in the Natal Drakensberg.

Key question for research

1. What differences in vegetation structure are measurable between the various long-term burning treatments at Cathedral Peak?

Priority research topic

1. Experimental studies of the effects of controlled burning, protection and controlled summer grazing in Highland Sourveld and Themeda-Festuca Alpine Veld in gauged experimental catchments at Cathedral Peak Forest Research Station. Mr C Everson (Department of Pasture Science, University of Natal).

Theme 4. Effect of fire regime on faunal structure and dynamics

Current state of knowledge

An appreciable amount of information is available from work that has been carried out at Cathedral Peak and Highmoor Forest Stations.

Key questions for research

1. What differences can be detected between the invertebrate faunas of the various burning treatments?
2. How does frequency and scale of burning in Themeda-Festuca Alpine Veld affect populations of redwing and greywing francolin?
3. What are the effects of selected burning treatments on forest margin vegetation on small mammal populations?

Priority research topics

1. Insect populations and key indicator species occurring in Themeda triandra Sub-alpine Veld under different management treatments at Cathedral Peak Forest Research Station. Professor T Bosman and Mr N Huleatt-James (Department of Entomology, University of Natal).
2. Investigation of the ecology of francolin populations on Highmoor State Forest and elsewhere on the Natal Drakensberg Catchment.
3. A preliminary investigation to determine the effects of veld burning treatments applied to the major plant communities of the Natal Drakensberg Catchment on the associated rodents and shrews. Mr J Pexton (Department of Forestry).

Theme 5. Effect of fire regime on soil chemical and physical properties

Current state of knowledge

A little information is available in unpublished Department of Forestry records.

Key questions for research

1. What are the effects of different fire regimes on soil nutrient levels and the rates of mineral loss?
2. Do differing fire regimes induce differences in soil physical properties?

Priority research topic

1. Experimental studies of the effects of controlled burning, protection and controlled summer grazing in Highland Sourveld and Themeda-Festuca Alpine Veld in gauged experimental catchments at Cathedral Peak Forest Research Station. Mr C Everson (Department of Pasture Science, University of Natal).

Theme 6. Effect of fire regime on herbage production and quality

Current state of knowledge

At present there is no information available from work done at Cathedral Peak.

Key question for research

1. What is the pattern of post-burn biomass accumulation in Themeda triandra dominated grassland?

Priority research topics

1. Experimental studies of the effects of controlled burning, protection and controlled summer grazing in Highland Sourveld and Themeda-Festuca Alpine Veld in gauged experimental catchments at Cathedral Peak Forest Research Station. Mr C Everson (Department of Pasture Science, University of Natal).
2. Experimental investigation of the effects of burning treatments on Highland Sourveld in replicated plot trials at selected centres in the Natal Drakensberg Catchment. Dr J E Granger (Department of Forestry).

Theme 7. Effect of fire regime on water production and quality

Current state of knowledge

A considerable amount of information is available from Department of Forestry records. Some of this has been published in Nänni (1960), Schulze (1974) and Granger (1976).

Key question for research

1. What are the effects of fire regime on total streamflow, timing of flow and water quality?

Priority review topics

1. Determination of the effects of controlled-burning systems in Highland Sourveld and Themeda-Festuca Alpine Veld, compared with protected grassveld and fynbos on stream-discharge components of experimental catchments at Cathedral Peak Forest Research Station. Mr J M Bosch (Department of Forestry).
2. Nutrient discharge from the experimental catchments in the Cathedral Peak Area of the Drakensberg. Mr J M Bosch (Department of Forestry) and Dr C M Breen (Department of Botany, University of Natal).

3. Total sediment yield from the Cathedral Peak experimental catchments. Messrs J M Bosch and F Rogers (Department of Forestry) and Mr G Garland (Department of Geography, University of Natal).

Theme 8. Synthesis and integration of knowledge

Current state of knowledge

Valuable information is contained in various Department of Forestry records and although there have been some reviews based on this data (Nänni 1960, Killick 1963, Schulze 1974 and Granger 1976), a more detailed synthesis is required. It is proposed that this be done in collaboration with the Natal Parks Board in the course of the current programme.

Key question for research

1. What information of relevance to a review on the ecological effects of fire in the Natal Drakensberg is currently available in unpublished form?

Priority review topic

1. Synthesis of knowledge on the ecological effects of fire in the Natal Drakensberg. Dr J E Granger and Mr F Smith (Department of Forestry), Mr J S B Scotcher (Natal Parks Board) and Mr C Everson (Department of Pasture Science, University of Natal).

DRAKENSBERG GAME AND NATURE RESERVES

Theme 1. Characteristics of fire regime and fire behaviour

Key questions for research

1. What are the causes and circumstances of natural fire initiation and extinction in the Natal Drakensberg?
2. During what months do fires occur, and under what gross climatological conditions?
3. What is the extent, duration and speed of their spread?

Priority research and review topics

1. Synthesis of information on fire regime characteristics in the Natal Drakensberg available in published and unpublished reports of

the Natal Parks Board and Department of Forestry. Messrs J C Clarke and J S B Scotcher (Natal Parks Board), Dr J E Granger (Department of Forestry) and Mr C Everson (Department of Pasture Science, University of Natal).

Theme 3. Effect of fire regime on vegetation structure and dynamics

Key questions for research

1. What changes in vegetation structure can be detected in early and recent aerial photographs of selected plant communities?
2. What are the effects of the various burning treatments applied on the dynamics of the grassland communities in the Natal Drakensberg?

Priority research and review topics

1. Analysis and interpretation of the change in distribution of Protea Woodland in the Natal Drakensberg. Messrs J C Clarke and J S B Scotcher (Natal Parks Board).
2. Analysis and interpretation of the change in species composition, basal cover, and above-ground biomass of grassland subjected to various burning treatments. Messrs J C Clarke (Natal Parks Board) and C Everson (Department of Pasture Science, University of Natal).

Theme 4. Effect of fire regime on faunal structure and dynamics

Key question for research

1. What are the effects of fires of different frequency and season of burn on the distribution of small and large mammals and birds?

Priority research and review topic

1. Synthesis of available information on effect of fire regime on faunal structure and dynamics. Messrs D T Rowe-Rowe and M T Mentis (Natal Parks Board).

Theme 6. Effect of fire regime on herbage production and quality

Key question for research

1. What are the effects of fires of different frequency and season on the components of production and quality (food value for herbivores) in terms of individual plants, species populations or swards?

Priority research and review topics

1. Analysis of various indicator species or swards in various burning treatments for crude protein, fibre and so forth, on a monthly basis. Messrs J C Clarke, J S B Scotcher (Natal Parks Board) and C Everson (Department of Pasture Science, University of Natal).
2. Review of existing information on effects of fire regime on herbage quality and yield in the Giant's Castle Game Reserve. Messrs J C Clarke and J S B Scotcher (Natal Parks Board).

ACTIVITIES IN THE FYNBOS BIOME

Ongoing long-term programmes with good physical resources and available manpower include those at the Jonkershoek and Saasveld Forest Research Stations of the Department of Forestry and the Keiskammahoek study sites of the Department of Agriculture, University of Fort Hare. Additional projects are being undertaken by the Department of Nature and Environmental Conservation, Cape Provincial Administration at De Hoop, Goukamma and Gamka Provincial Nature Reserves.

The great majority of studies in fire ecology in fynbos have been undertaken at Jonkershoek. Several detailed studies have been completed during the last decade in secondary fynbos communities on the Keiskammahoek mountains of the eastern Cape. Current and proposed activities will be described for the south-western Cape and eastern Cape separately.

SOUTHERN AND WESTERN CAPE FYNBOS

Theme 1. Characteristics of fire regime and fire behaviour

Current state of knowledge

Limited information on fire incidence is available in the records of both the Department of Forestry and Cape Department of Nature and Environmental Conservation.

Key questions for research

1. Can natural fire zones, within which similar fire regimes are experienced, be identified, characterized and mapped in the south-western Cape?
2. What are the causes and circumstances of natural fire initiation and extinction in fynbos?
3. What are the behavioural characteristics of fire in different fynbos communities?

Priority research and review topics

1. Study of the origin, occurrence and spread of fynbos fires and controlling effects of weather as indicated by available records. Messrs F J Kruger, D P Bands and B W van Wilgen (Department of Forestry).
2. Characterization of fire behaviour in selected fynbos communities. Mr F J Kruger (Department of Forestry).

Theme 2. Adaptive responses of organisms to fire regime

Current state of knowledge

General information is available in Kruger (1977a) but little detailed information on the autecology of fynbos plant or animal species is available.

Key questions for research

1. How does the fire response of plant species vary within communities in terms of survival, pattern of vegetative regrowth, position of lateral buds, pollination mechanisms, seed production and dispersal, dormancy and germination?
2. Do any animal species indicate adaptations to the fire regimes of fynbos?

Priority research and review topics

1. Survey of adaptive features related to fire in selected animal and plant communities.
2. Detailed autecological studies of selected plant and animal species.
3. Investigation of the population dynamics of Widdringtonia cedarbergensis and its interaction with fire. Mr F J Kruger (Department of Forestry).
4. The role of fruit-eating birds as dispersers of seeds in relation to colonization of plants in burnt areas in fynbos. Professor W R Siegfried (Percy FitzPatrick Institute of African Ornithology, University of Cape Town).

Theme 3. Effect of fire regime on vegetation structure and dynamics

Current state of knowledge

An appreciable amount of information is available from the long-term burning trials at Jonkershoek, Jakkalsrivier and Zachariashoek. Much of this is presently being written up.

Key question for research

1. How does fire vary in its influence on vegetation structure and dynamics between different treatments and different fynbos communities?

Priority research and review topics

1. Investigation of the effects of burning and protection of fynbos in experimental catchments at Jonkershoek, Jakkalsrivier and Zachariashoek Research Stations. Messrs F J Kruger and B W van Wilgen (Department of Forestry).
2. Experimental investigations of the effects of season of burn on fynbos communities in plot trials in the Kogelberg. Mr F J Kruger (Department of Forestry).
3. Studies on the effect of burning regime on Coastal Fynbos at De Hoop Provincial Nature Reserve. (Department of Nature and Environmental Conservation, Cape Provincial Administration).
4. Studies on the effect of burning regime on Coastal Fynbos at Goukamma Provincial Nature Reserve. (Department of Nature and Environmental Conservation, Cape Provincial Administration).

Theme 4. Effect of fire regime on faunal structure and dynamics

Current state of knowledge

Limited information is becoming available from current studies.

Key question for research

1. What are the immediate and long-term effects of fire on animal communities and individual species in fynbos?

Priority research topic

1. Effect of fire regime on mammal populations in fynbos at Jonkershoek and Zachariashoek. Professor R C Bigalke (Department of Nature Conservation, University of Stellenbosch).

Theme 5. Effect of fire regime on soil chemical and physical properties

Current state of knowledge

A little information is available in unpublished Forestry Department records.

Key questions for research

1. What are the effects of fire regime on soil nutrient levels and the rates of mineral release?

2. What are the effects of fire regime on infiltration and run-off?

Priority research topic

1. Comparative studies of soil infiltration capacity and N, P, K and pH levels in areas of known fire history in Jonkershoek. Mr D B Versveld (Department of Forestry).

Theme 6. Effect of fire regime on herbage production and quality

Current state of knowledge

Some information is contained in Van Rensburg (1962) and Kruger (1977b). Limited information is available in unpublished Forestry Department reports.

Key question for research

1. What are the main patterns of post-burn biomass accumulation in fynbos?

Priority research topic

1. Synthesis of available information on post-burn biomass accumulation in fynbos. Mr F J Kruger (Department of Forestry).

Theme 7. Effect of fire regime on water production and quality

Current state of knowledge

Long-term studies have been conducted in various forest research station catchments and some of these have been reported on by Van der Zee and Kruger (1975).

Key question for research

1. What are the effects of fire regime on total streamflow, timing of flow and water quality in different fynbos types?

Priority research topics

1. Determination of the effects of controlled burning systems on stream discharge components of experimental catchments in the Western Cape Forest Region. Mr D B van Wyk (Department of Forestry).

2. Determination of the effects of management measures as applied in experimental catchments on water quality in the Western Cape Forest Region. Mr D B van Wyk (Department of Forestry).

Theme 8. Synthesis and integration of knowledge

Some recent reviews (Kruger 1977a, Bands 1977) provide a good background to the ecological effects of fire in fynbos. Continued synthesis and integration of new data will be needed during the course of the current programme.

EASTERN CAPE FYNBOS

Theme 3. Effect of fire regime on vegetation structure and dynamics

A considerable amount of knowledge exists about the eastern Cape fynbos in relation to fire regimes and has been reported by Story (1951), Trollope (1970, 1972, 1973, 1978b) and Downing, Robinson, Trollope and Morris (1978).

Key questions for research

1. What are the effects of fire intensities on different plant sizes and species in fynbos?
2. What are the effects of differing fire intensities on the sub-climax grasslands of the fynbos zone in terms of botanical composition and seasonal production of dry matter?
3. What are the short-term effects of burning dormant and actively growing grassland irrespective of season?
4. What are the effects of fire on the flowering, production of seed and germination of grassland and fynbos species?
5. What are the short and long-term effects of burning and grazing on grassland in terms of botanical composition, basal cover and seasonal production of dry matter?

Priority research and review topics

No new activities are planned.

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