

# The incidence of veld-fire in the Etosha National Park, 1970-1979\*

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## 1 INTRODUCTION

Among many arguments in favour of the creation of nature reserves is the one that such areas are needed for scientific study of natural phenomena, undisturbed or influenced minimally by man. Veld-fire is a common phenomenon in ecosystems in southern Africa, with many, if not most, being caused by man. Even in nature reserves, fire occurs either accidentally or is used deliberately in practical management. Generally, however, and more particularly for the drier regions of southern Africa, there is a dearth of scientific information substantiating burning regimes applied in nature reserves (Trollope, in press).

It can be argued that optimal practices for the management of nature reserves are often those which most closely imitate natural processes. Hence, burning regimes might be applied advantageously if they are modelled on the natural incidence of fire. But what is the natural incidence of fire? Very little information is available on this subject in southern Africa, primarily because there are few, if any, areas that are entirely free of man's Pyrrhic activities.

This paper documents the temporal and spatial incidence of veld-fire in the Etosha National Park, SWA/Namibia, from 1970 to 1979. The park is unusual among large nature reserves in southern Africa in that it has experienced relatively few fires, caused either accidentally or deliberately by man, at least during the last 25 years or so. Indeed, since 1970, official policy in Etosha has specifically forbidden the use of fire as a tool in management practices. However, the policy makes provision for combating and restricting fires when they do occur. To this end, the park is partitioned into eight sections by fire-breaks and roads. Detailed descriptions of the physiography and vegetation of the Etosha National Park are given by Le Roux (1977).

## 2 THE DATA BASE

Particulars of all 56 veld-fires in Etosha from September 1970 to September 1979 were recorded on prescribed forms (Appendix 1), under the supervision of the Prin-

## ABSTRACT

This paper documents the temporal and spatial incidence of veld-fire in the Etosha National Park from 1970-1979. The data analysed indicate that most veld-fires are caused by lightning and occur chiefly from October-December. There were three times as many naturally caused fires in 1975-1979 as in the preceding five-year period. Virtually all vegetated areas of the park burned at least once during the period 1970-1979. These and other findings are discussed in relation to climate and management practices.

\* This paper constitutes part of the commemoration of the 21st anniversary of the establishment of the Percy FitzPatrick Institute of African Ornithology.

cial Nature Conservator at Etosha. The information in the forms was analysed by computer at the University of Cape Town, and is stored on magnetic tape in the office of the Director of Nature Conservation, SWA/Namibia.

### 3 RESULTS

At least 54%, and more probably 73%, of all veld-fires in Etosha were caused by lightning (Table 1). Thus, relatively few fires were due to human activities, including one caused by tourists visiting the park. 78% of all fires occurred from September–December (Table 2), with most fires occurring during the commencement of the seasonal summer rainfall (Table 3) which normally peaks three months later (Fig. 1). On average, about four fires occurred each year as a result of lightning (Table 2), but there were three times as many naturally-caused fires from 1975–79 as in the preceding five-year period (Table 4). The elevated incidence of fire started in the middle of the decade, with a record number of fires in 1975 following a year (1974) during which Etosha received almost double its normal annual rainfall (Table 4). Rainfall in 1976 was again well above normal.

The spatial incidence of veld-fire in Etosha was such that virtually all vegetated areas of the park burned at least once from 1970–79 (Fig. 2). About 50% of all fires spread individually over less than 1 000 ha, but five fires each covered more than 100 000 ha (Table 5). A statistically significant positive correlation was found between the area burnt and the number of man-hours spent combating the fire (Fig. 3). Only four fires covered more than 5 000 ha from 1970–74, whereas 17 fires each did so in the subsequent five-year period. The total areas burnt from 1970–74 and 1975–79 amounted to 244 100 ha and 1 004 650 ha respectively. Mean area burnt per fire from 1970–74 was  $22\ 122 \pm 39\ 938$  ha ( $N=9$ ) and  $21\ 375 \pm 39\ 808$  ha ( $N=47$ ) in 1975–79. There is no significant difference in the extent of individual fires between these two periods ( $t=0.05$ ,  $P>0.05$ ,  $DF=54$ ). Most veld-fires occurred, but did not necessarily start, in woodland vegetation (Table 6). Although a statistically significant difference ( $\chi^2 = 9.6$ ,  $P<0.01$ ) between the extent of fires in each of the three main composite vegetation types of the park is indicated, in actual fact naturally ignited fire occurred with equal frequency ( $P<0.05$ ) in all three vegetation types, and there was no significant difference ( $\chi^2=1.4$ ,  $P>0.05$ ) between the area of the fire in each vegetation type when corrected for difference in the vegetation area (Fig. 4).

### 4 DISCUSSION

Lightning strikes appear to be a common ignition source for veld-fires in Etosha. The nearest station recording

lightning flashes is at Oshakati, some 100 km north of Etosha, where a mean lightning-flash density of  $2.2\ \text{km}^{-2}\ \text{yr}^{-1}$  was obtained over the period July 1975 to June 1978. Comparable figures in the South African highveld region are three to four times higher (Kröniger, 1978).

In Etosha seasons of well-above normal rainfall, and therefore increased vegetation, are followed apparently some six months later by the onset of a relatively high frequency of veld-fires. Unfortunately, the data available are too scant to predict any definitive long-term pattern concerning the temporal distribution of abnormally high rainfall seasons in Etosha, but in 44 years (1934–1978) of rainfall records at Okaukuejo there are four periods in which annual rainfall exceeded the norm. This suggests an 11-year cycle. According to long-standing residents in the area, super-normal wet seasons occur with a frequency of 8–12 years. If this indeed is the case, then probably all vegetated parts of the Etosha National Park would be burnt at least once every 10 years, as a result of ignition by lightning alone.

The veld-fire season in Etosha appears to be relatively long, as is the case in the Australian arid savanna (Lacey, Walker and Noble, in press). However, the duration of an "average" fire season may be largely a reflection of between season differences influenced partially by annual variation in the onset of the lightning season. In other words, the individual fire seasons may be shorter, but the data available are too few for testing this suggestion. In any event, annual variation in the onset of the fire season can be expected to influence the response of the vegetation to fire.

While it can be argued that the southern African savanna evolved as a dynamic mosaic of vegetation under the influence of a multispecies complex of herbivores interacting with the effects of fire, caused by natural phenomena (primarily lightning) and a relatively sparse human population, it is remarkable how little research has been carried out to establish the state of "natural" fire regimes. Instead, studies have concentrated on short-term effects, primarily on forage plants of domestic livestock, or man-made fires in savanna vegetation (Trollope, in press).

Since veld-fire is a long-standing factor in the evolution of southern African savanna ecosystems, it follows that their biotas are adapted selectively to the pressures of burning regimes. Therefore, a corner-stone of a policy for management of nature reserves in these ecosystems should be the acceptance of naturally caused fires which are controlled and, where necessary, supplemented and complemented by artificial burning. A primary objective of fire-management strategy for a nature reserve should be an imitation of the local natural fire regime, coupled with the regulation of herbivore populations, adjusted in accordance with the size and shape of the reserve and its edaphic features.

Some of the information in this paper could be useful as a first step towards a predictive model of the natural fire

regime in arid savanna vegetation in northern SWA/Namibia. Such a model can be expected to assist in the formulation of a clearly defined role for fire in the management of the Etosha National Park. The model depends essentially on information on the temporal and spatial incidence of fire-ignition sources, and the production and accumulation of combustible herbage fuel. These parameters can be measured and their dynamics monitored. Fuel production is determined mainly by climate, especially rainfall, and edaphic features in relation to fire frequency. The quality and the rate of accumulation of herbage fuel are influenced by herbivores and decomposers.

5 ACKNOWLEDGEMENTS

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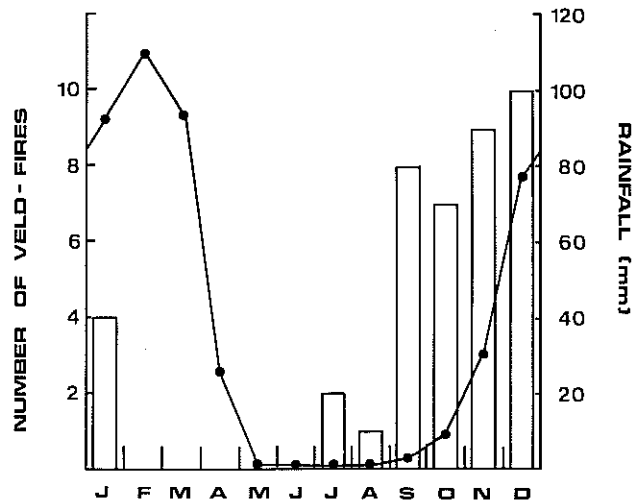


FIGURE 1: Monthly frequency of naturally caused veld-fires (histograms) from September 1970 – September 1979 and average monthly rainfall (50-year means at Okaukuejo) in the Etosha National Park.

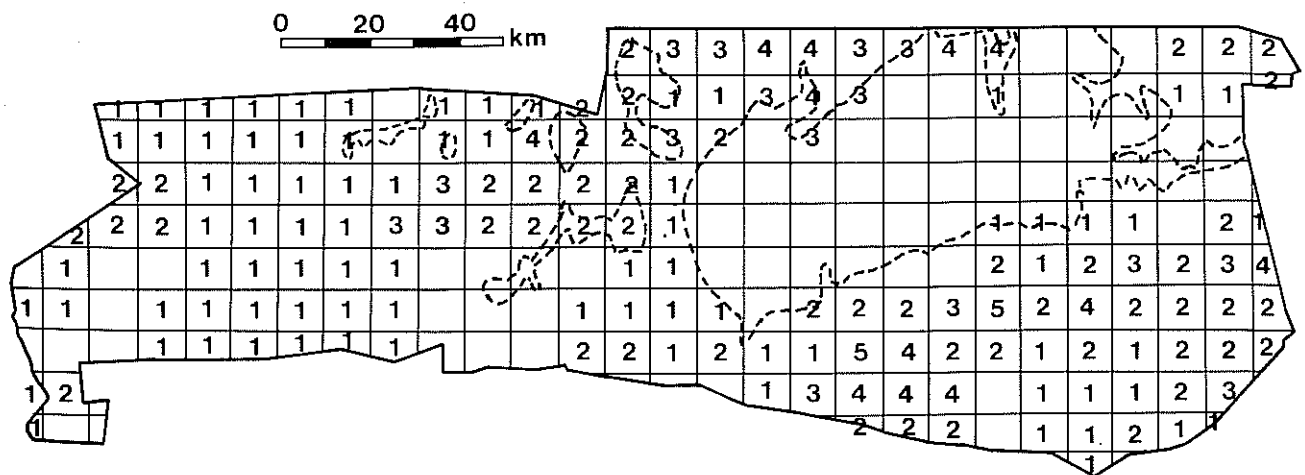


FIGURE 2: Number of veld-fires (caused either naturally or by man) occurring in at least 10% of each 100 km<sup>2</sup> section of Etosha National Park from September 1970 – September 1979. The dashed lines embrace saline pans.

7 APPENDIX 1

Report on veld-fire Fire No.....

Place where fire occurred.....

Time and date of first report .....

Time and date of report to head office .....

Time and date extinguished .....

Area devastated .....

Number and type of machines used.....

Number and type of vehicles used.....

Number of supervisors involved in combating fire.....

Total man-hours.....

Number of labourers involved in combating fire .....

Total man-hours.....

Names of officials on 20-hour patrol.....

Last precipitation in area of fire. Light/Heavy.....

Type of vegetation destroyed .....

Fire first sighted at ..... am  
..... pm Date.....

Direction of wind..... Estimated wind speed.....

Possible cause of fire .....

Fire reported at .....

To whom reported .....

First help arrived at .....

Fire extinguished at ..... Date.....

Recommendations:

Signature:

NB. A map showing the area burnt must be attached to this form.

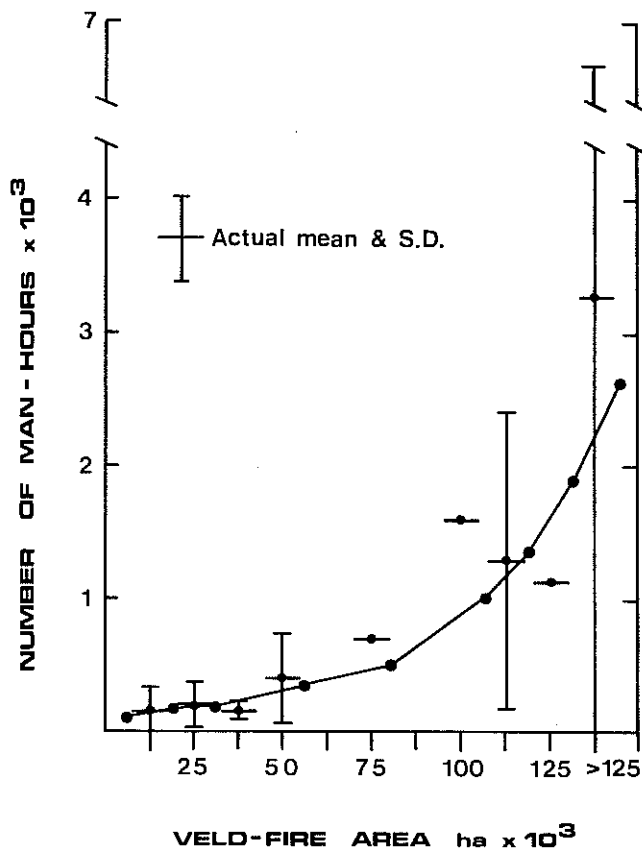


FIGURE 3: The calculated relationship ( $r=0.85$   $P<0.001$ ) between the area burnt and number of man-hours spent combating the fire. Based on all veld-fires in the Etosha National Park from September 1970 – September 1979.

TABLE 1: Origin and fate of 56 veld-fires in Etosha, September 1970–September 1979.

| Origin                          | Number of fires |
|---------------------------------|-----------------|
| Lightning                       | 30              |
| Unknown but probably lightning  | 11              |
| Artificial or from outside park | 15              |
| <b>Result</b>                   |                 |
| Halted by fire-breaks and roads | 31              |
| Halted by other means           | 25              |

TABLE 2: Number of veld-fires occurring bi-monthly and caused either by lightning or human agencies in Etosha, September 1970 – September 1979.

|             | Number of fires |            |
|-------------|-----------------|------------|
|             | Lightning       | Artificial |
| Jan.–Feb.   | 4               | 0          |
| March–April | 0               | 0          |
| May–June    | 0               | 1          |
| July–August | 3               | 4          |
| Sept.–Oct.  | 15              | 9          |
| Nov.–Dec.   | 19              | 1          |

TABLE 3: Occurrence of veld-fires in relation to the commencement of the rains in Etosha, September 1970 – September 1979.

| Rain                  | Number of fires |            |
|-----------------------|-----------------|------------|
|                       | Lightning       | Artificial |
| Same time as fire     | 16              | 0          |
| <1 week               | 3               | 1          |
| <1 month, >1 week     | 1               | 2          |
| <3 months, >1 month   | 2               | 0          |
| <5 months, >3 months  | 1               | 6          |
| <7 months, >5 months  | 5               | 4          |
| <10 months, >7 months | 5               | 0          |
| No data available     | 8               | 2          |

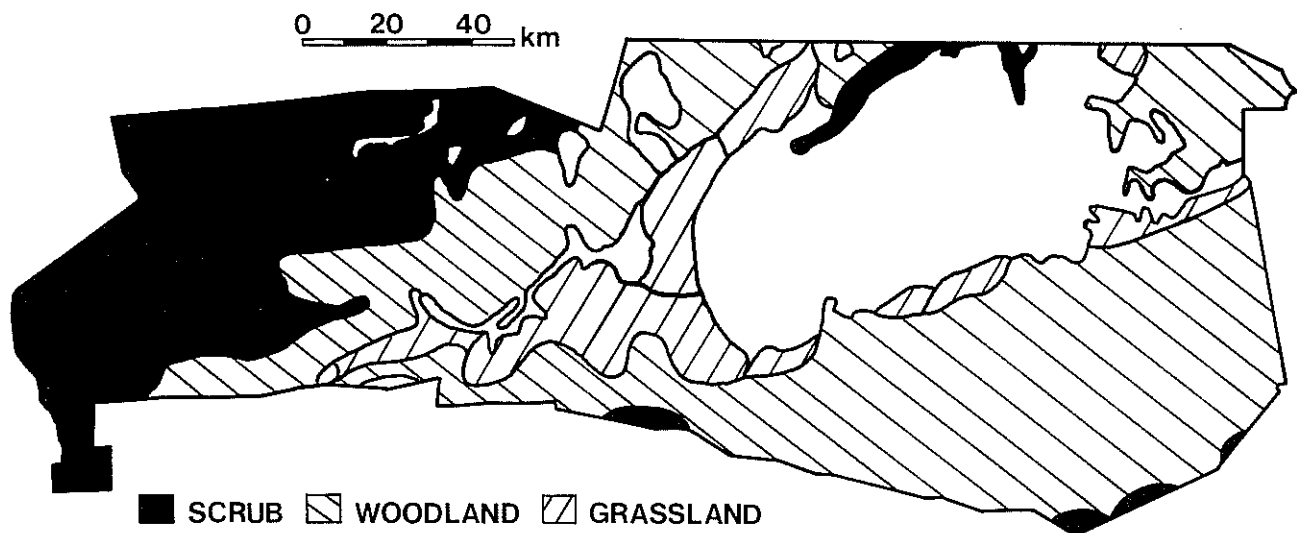


FIGURE 4: Map of the three major composite vegetation types in the Etosha National Park. The unshaded areas are saline pans.

TABLE 4: Number of veld-fires each year in relation to rainfall in Etosha, September 1970 – September 1979. Normal annual rainfall at Namutoni is 433 mm and 419 mm at Okaukuejo (data from S.A. Weather Bureau).

| Year | Number of fires |            | Rainfall         |   |
|------|-----------------|------------|------------------|---|
|      | Lightning       | Artificial | Actual (mm)      | Difference between actual and normal (mm) |
| 1969 | —               | —          | 481 <sup>a</sup> | +48                                       |
| 1970 | 1               | 0          | 505 <sup>a</sup> | +72                                       |
| 1971 | 3               | 0          | 400 <sup>a</sup> | -33                                       |
| 1972 | 3               | 0          | 457 <sup>a</sup> | +24                                       |
| 1973 | 0               | 0          | 332 <sup>a</sup> | -101                                      |
| 1974 | 2               | 0          | 766 <sup>a</sup> | +333                                      |
| 1975 | 8               | 8          | 418 <sup>a</sup> | -16                                       |
| 1976 | 9               | 2          | 633 <sup>b</sup> | +213                                      |
| 1977 | 6               | 2          | 336 <sup>b</sup> | -83                                       |
| 1978 | 3               | 1          | 419 <sup>b</sup> | 0   |
| 1979 | 6               | 2          | 447 <sup>b</sup> | +28                                       |

<sup>a</sup> Rainfall at Namutoni

<sup>b</sup> Rainfall at Okaukuejo

TABLE 5: Number of veld-fires and their estimated spread in Etosha, September 1970 – September 1979.

| Area burnt (ha) | Number of fires |           |            |           |
|-----------------|-----------------|-----------|------------|-----------|
|                 | Lightning       |           | Artificial |           |
|                 | 1970-1974       | 1975-1979 | 1970-1974  | 1975-1979 |
| 1-499           | 5               | 11        | 0          | 7         |
| 500-4999        | 2               | 8         | 0          | 2         |
| 5000-24999      | 2               | 4         | 0          | 1         |
| 25000-99999     | 1               | 4         | 0          | 4         |
| >100000         | 1               | 3         | 0          | 1         |

TABLE 6: Number and extent of veld-fires in the three main composite vegetation types in Etosha, September 1970 – September 1979. Figures in parentheses are the numbers of fires which occurred in more than one vegetation type.

| Vegetation type and area <sup>a</sup> | Number of fires |            |       | Total area of fire (ha × 10 <sup>3</sup> ) |
|---------------------------------------|-----------------|------------|-------|--|
|                                       | Lightning       | Artificial |       |  |
| Woodland                              | 40,7            | 29 (4)     | 9 (5) | 987,4                                      |
| Grassland                             | 12,0            | 4 (3)      | 5 (3) | 215,0                                      |
| Scrub                                 | 24,4            | 13 (2)     | 8 (4) | 510,1                                      |

<sup>a</sup> given as percentage of the total area (2 227 000 ha) of Etosha including saline pans which account for 23% of the park.