CHAPTER 7

Approaches to questions of Aboriginal land use in the Lake Victoria area

"the arrival of humans with fires and hunting pressure had an immense ecological impact, and there is accumulating evidence that humans were partially and decisively responsible for the rapid extinction of a large number of giant marsupials and other animals, the principal episode occurring a geologically short time before 30,000 BP" (Jones 1973:281).

7.1 Introduction

At 17,500 BP, soon after the earliest reported date of human occupation of the Lake Victoria lunette, rates of change accelerated. Sedimentation increased, and faunal species disappeared from the area, or survived as dwarf forms. Since human presence may have been a new element in the landscape, the role of human activity in changing the landscape is examined in this chapter.

There is no direct evidence that humans altered the landscape. Analogy with land use practices of the recent past however, suggests that they may have altered vegetation associations by food gathering and by setting fire to flammable areas. Of these two activities, firing would have had the most impact. The following section examines the kinds of firing which was undertaken by Aboriginals in the recent past. It looks at some of the debate which has been sparked off by claims such as the one by Jones cited above, then examines some theoretical aspects of the effects Aboriginal burning could have had on the vegetation systems of Lake Victoria of the recent past.

Implications of these findings are then examined with regard to Late Pleistocene changes in faunal survival and in sedimentation rates in the Lake Victoria basin.
7.2 Aboriginal firing strategies of the recent past, and the effect on the landscape

Nicholson summarises Aboriginal uses of fire and smoke as including use for warmth as well as ritual, medical, insect repellant, culinary, and defensive uses. Fire was used in hunting/collecting to flush game from cover, to clear land, to observe spoor or to collect animals, to trap game, to drive game, to improve visibility of food plants, and also in maintenance, in activities such as clearing firebreaks, clearing scrub, promoting access routes, fire prevention and maintaining grass cover free of shrubby weeds, and improving fodder quality.

Burning was not usually haphazard:

in any burning operation seasonal influences and species were understood by those responsible for the operation and care was exercised to avoid burning those aerial parts of plants, such as the vines of yams or flowers of plants so the maximum yield could be harvested. When there is sufficient soil moisture after the fire regrowth of the vegetation occurs from propagules and becomes an attractive source of food for insects, birds and grazing herbivores and this in turn was the site of hunting and foraging by Aborigines. To this practice of using fire to increase food supply Jones 1968 applied the term fire stick farming (Nicholson 1981:68; cf also Gould 1971).

Jones described the effects of fire wielding Aboriginals on the Australian environment as "enormous" (1968:205). Others have suggested that changes in vegetation may have begun as soon as Aboriginals reached the continent and affected the vegetation of the entire continent (Singh et al 1981).

In 1972 Allen suggested that the environment which the first European explorers saw in western NSW was the product of long term use of fire by Aboriginals (1972:530). More recently, Allen has asked if the cessation of Aboriginal burning could have been responsible for the wave of extinctions in small mammal species which occurred soon after c 1860 in the Lake Victoria area (ANZAAS 1982).
The first question addressed here is that of the role of Aboriginal burning. Could it have caused changes in vegetation, and if so, what kinds of changes could be expected?

Fire and fuel and the effects of Aboriginal burning

Since major changes in vegetation require that more than individual tussocks or small areas are fired, firing patterns which concern us here are due to fires which burn over several hectares. Large fires require sufficient fuel. Rates of fuel accumulation vary between vegetation associations (Noble, Smith and Leslie 1980, Walker 1981).

Horton (1982:249) has argued that (i) since fires cannot occur before fuel is available and (ii) since Aboriginals could not fire large areas before fuel accumulated at natural rates, then Aboriginal burning could not have occurred at less than the rate of minimum fuel build up. On these grounds, he assumed that firing would occur at a similar rate through time, whether lit by Aboriginals, or ignited by lightning (the most common cause of natural fires at the present time (Kemp 1981:15)). He thus inferred that while Aboriginal firing occurred, it would have had little discernable effect on the Australian landscape.

Although modern records of fire occurrence in western NSW show that lightning is an effective cause of fires, it is likely that there would have been some differences between the effects of natural fires, and the effects of Aboriginal fires, in terms of the periodicity of fire events in any one area (report of the Commissioner of Western Lands 1976:52). Lightning fires may be ignited regularly as soon as fuel is available by chance - however, it is likely that lightning fires will occur at random intervals - which means that sometimes there will be a long period without a fire and this will be followed by a hot, uncontrollable fire. If the Aboriginals fired the land in controllable conditions and as soon as fuel built up permitted firing, the differences between fire regimes caused by humans and those caused by lightning alone would be in the (i) interval
between fires and (ii) in the frequency of hot fires. In addition, (iii) differences in the season of firing could be predicted - since natural fires are associated with summer thunderstorms and Aboriginals could have fired some vegetation associations in cooler months. Assuming Aboriginals planned and controlled burns, there may also have been differences in the extent of the firing (Haynes 1977). Of these effects differences in the frequency of hot fires, and differences in the season of firing may have been particularly significant in changing vegetation patterns overall (see below).

Within any vegetation association the principal effect of Aboriginal firing practices is to suppress dense growths of woody understorey species which restrict access, shade out herbaceous species and decrease the diversity of any environment. There are several recorded cases where the cessation of Aboriginal firing was followed by the dense growth of scrub or woody species (Moore 1969:49, 1973, Leigh and Noble 1981:481, Hodgkinson and Griffin 1982, Latz and Griffin 1982, Catling and Newsome 1981, Jones 1969:228, Ashton 1981).

Decrease of woody species, and promotion of open environments within forested areas can be said to mark Aboriginal firing regimes, but perhaps the most characteristic feature of Aboriginal fire regimes is the creation of a diversity of environments which are promoted by low intensity, more regular firing of small areas. The diversity of vegetation in stages of recovery provides habitats for many species of animals, which would be less common given the reduced frequency of natural fire regimes (Ridpath 1971). The best documented examples of this process come from central Australia (Latz and Griffin 1982), Tasmania and Arnhem Land (cf Jones 1969).

Was Aboriginal burning always beneficial to Aboriginals or could it have damaged sensitive vegetation associations, and promoted devegetation and erosion?
When data for cases where Aboriginals regularly fired the countryside are examined (Jones 1969, Nicholson 1981) we find that they can be divided into two types: (i) areas where precipitation was regular, and (ii) areas where there was an inflammable understorey. In the former case, firing could be undertaken in confidence that coming rains would promote a vigorous regrowth in burnt vegetation. In the latter case, the presence of flammable understorey vegetation would mean that firing could be accomplished successfully during wet periods, or in intervals when vegetation would not be badly damaged by fires. In areas of erratic precipitation firing which is not followed by rainfall can have deleterious effects on the landscape:

"...Landscapes may remain bare, unproductive and open to erosive agencies of wind and later water, for long periods" (Leigh and Noble 1981:483).

Fire may cause death to some species and permanent damage to others:

"to ephemeral grasses the threat of burning is small. For perennial grasses, particularly long lived ones, fire may occur before seed is produced, fire may also destroy chenopods which are valuable fodder species" (Hodgkinson and Griffin 1982:483).

These examples raise the possibility that Aboriginal firing may have damaged the landscape in semi-arid south western NSW, where precipitation is unreliable - and consequently increased the possibility of erosion and habitat degradation. This possibility will be further examined below.

7.3 The effects of fire on vegetation systems in the vicinity of Lake Victoria

In a previous chapter, landscapes around Lake Victoria were divided into eight separate systems based first on edaphic characteristics, considering soil salinity and soil moisture availability (Table 4.1), second the observations of the vegetation systems in the area at first European contact and also on more recent vegetation surveys (Taylor and England 1929;
Because the vegetation associations are strongly tied to soil porosity and moisture transmission the fundamental difference between vegetation systems of the riverain plain, and vegetation of the hinterland was probably maintained over long periods of the past. The following section examines each of the present vegetation systems for susceptibility to firing - in terms of fuel build up, flammability, and fire history. It is assumed for the purpose that past landscapes had similar if not identical vegetation compositions.

7.4 Burning in riverain environments

Riverain vegetation associations includes wetlands subject to inundation for at least part of the year, and drier areas which supported eucalypt forest, grassland, or shrublands. In general, flammability in wetlands is related to the density of the vegetation cover, rates of litter discard, and also to the period at which a system will be desiccated enough to carry a fire. Sub systems within the riverain area behave differently.

Typha and phragmites swamp

This area will carry a fire regularly after annual leaf growth dries out, usually in the autumn. Some Typha swamps in the Murray were fired by Aboriginals: 'this (typha) is used more or less at all seasons of the year, but it is best after the floods have retired, and the tops have been burnt off' (Eyre 1845:269). It is possible to fire this subsystem during autumn, when the river was not flooding. Firing would affect faunal species normally resident in these swamps - including native hens and other non-migratory water birds, and expose them to human and other predators. Gott suggests that firing in these swamplands would tend to increase vegetable productivity, promoting growth by increasing access to light and nutrients - although there is no mechanism by which firing could have expanded the area of
swampland, and it is unlikely that firing here caused severe degradation of the landscape.

Other areas of wetlands

Other areas are vegetated by Polygonum or Nitraria - large tangled shrubs, usually separated by bare ground. Firing single shrubs is possible, and was probably useful in hunting, since many small potential food species shelter under these shrubs, but again large scale fire induced change is unlikely, since it is difficult to fire a large area of these shrubs at any one time.

Riverain forest, or riverain fringe savannah forest

Riverain forest which is dominated by river redgum E. camaldulensis, varies from dense forest to open woodland, with grass understorey (Dexter 1970). Dense mature redgum forest has little understorey, for mature trees tend to suppress growth of grass and shrubs (Dexter 1970:6; Van der Sommen 1980). River redgum saplings are extremely fire sensitive. Repeated firing could promote a more open forest by destroying eucalypt saplings. Fuel for firing could have been provided by grass understorey species such as Moira grass Pseudoraphis spinescens, which, combined with eucalypt litter may have carried a fire during the late summer.

Some early descriptions of the Lake Victoria environment suggest that firing may have been practiced occasionally in this system. Redgums on the western shore were described as 'umbrageous', and the understorey parklike and grassy (Sturt 1833:98; Hawdon 1836). These trees were typical of the open grown saplings with a 'short bole and heavily branched crown' (Dexter 1970:4). It is thus possible that the open forest observed was the product of firing the understorey to prevent the growth of woody weeds or sapling redgums, although it is unlikely that firing would cause or promote devegetation or soil erosion in this vegetation association.
Lunette and source bordering dune environments

In 1844 the lunette on the eastern shore of Lake Victoria was described as 'bare and forbidding dune' (Sturt 1849:98). Lunettes elsewhere carried vegetation which varied from mallee eucalypt scrub on sandy calcareous soils, to saltbush on heavy saline soils, to perennial grassland (Campbell 1966; Noble and Mulham 1980:133). It is possible that this predominantly sand lunette with silt rich crest was poorly vegetated by saltbush, with grasses and ephemerals along the flanks. Sturt describes a good growth of 'oatgrass' (possibly Panicum decompositum) in the area of the lee of the lunette on the eastern shore (1849:98). The absence of calcareous lenses may have restricted the growth of mallee, casuarina or callitris pine on this particular lunette.

We may assume that this dune was vegetated by grass and shrub species which could carry a fire only after good winter rainfalls had caused a flush of summer grass growth. Since hinterland precipitation was so variable, grass growth could not be predicted - thus it is unlikely that the lunette vegetation could have been systematically burnt, although it may have been fired occasionally (see discussion of firing in saltbush/bluebush communities). In this habitat firing could reduce ground cover and unless followed by precipitation, it is possible that increased sediment mobilization could occur after a severe fire in summer. Thus, human firing may have affected the lunette, although it would be very difficult to produce evidence to show that the fire was not naturally ignited.

Salt lake communities

Areas characterised by high surface salinity include some parts of the high level alluvium, and some areas to the east and north of the lunette.

Vegetation in these areas is characterised by salt tolerant succulent species, including some types of saltbush, and ground
dwelling species described as the *Pachycornia* association by Mulham and Noble (1980:133). This community included some species which could have been used for food including *Disphyma* spp., *Portulaca* spp. and *Salicornia* spp.

These species are 'fire avoiders'. The succulent leaves and high salt content of leaves protects the species from fire, and the sparse ground cover does not carry fire. These areas were probably never fired.

Riverain tract vegetation associations as noted at first contact provide some circumstantial evidence for Aboriginal firing, in the relative openness of the river redgum forest understorey, and in the presence of open grassy areas of the flood tract. Presence of fire resistant and fire intolerant species in other areas of the riverain suggest that there were some areas which were rarely touched by fire.

There is no real evidence that Aboriginal firing contributed to the appearance of the landscapes at contact, although the possibility cannot be ruled out. Aboriginals might have derived some benefit from maintaining open grassy spaces in the flood plain.

7.6 **Fire susceptibility in hinterland vegetations other than the lunette**

Hinterland vegetation associations fall into two broad groups. The first group prefers light textured free draining soils of the Woorinen formation dune crests; lunettes, source bordering dunes and sand sheets. Changes in the vegetation associations of these more erodible sandy sediments will lead to increased sediment mobility. The question of Aboriginal modification of stabilizing vegetation associations on light textured soils is considered below. The second group of vegetation associations is found on heavy slow draining saline sediments of the high level alluvium, mid Pleistocene or late Pleistocene lake floor sediments, dune swales or fine recent alluvium. This group of
Vegetation associations on heavy soils

In the Lake Victoria area today, as in the recent past, a large area was covered by saltbush/bluebush associations. The many species which form this association have varied habitat preferences and a range of susceptibility to fire. The interesting aspect of this association is however, the general intolerance to firing. Several aspects of this intolerance are relevant here.

First, individual plants are difficult to ignite. Like plants of the saline lake basins, many saltbush/bluebush plants have leaves which are high in salts, and low in aromatic inflammable oils. Individual plants exhibit a varied response to fire, although none can be said to be fire adapted, as many other Australian plants are. _M. pyramidata_ (black bluebush) can tolerate some fire and regenerate. In contrast, the common and widespread bladder saltbush _A. vesicaria_, and the once common and widespread _A. robustus_ and _A. nummularia_ are totally intolerant of fire (Leigh and Noble 1981:237).

Prolonged drought will cause devegetation and death of chenopods, severe frosts may have a similar effect. Natural causes of vegetation changes in this case offer a more convincing explanation for devegetation than human or even natural fire related agents. It is thus concluded that the saltbush/bluebush association developed as a stable system in the absence of any kind of fire.

From the Aboriginal point of view, firing or removal of vegetation associations on heavy soils would have contributed little to the improvement of food availability. Degraded areas of once productive saltbush/bluebush associations of the present...
day are not colonised by perennial grasses, seeding trees, or other food plants, but by burrs, unpalatable weeds and annuals.

Death of large areas of saltbush/bluebush would bare a substrate of fine sediment. Beadle (1948:237) has observed that during severe drought and devegetation of saltbush areas in the late 1940s, erosion of fine sediment was minimal. However, where saline groundwater lies within capillary reach of the surface, or where soluble salts have been leached into fine sediments in dune swales, devegetation may be followed by erosion. Under these circumstances, the death of areas of saltbush/bluebush could lead to increased erosion of pelleted fine sediments, and to formation of fine sediment horizons in dunes. It is believed that such erosion occurred in the late Pleistocene, in dune swales and lake beds. Natural climatic changes offer a more satisfactory explanation for the onset of erosion of fine sediments than the possible range of fire related human activities.

Vegetation associations on light soils, and susceptibility to fire

Vegetation changes must have accompanied the onset of sediment movement which occurred c 17,500 BP in the Lake Victoria basin. Most of the mobile sediment in the area to the north of the basin, and in the longitudinal dunes, was sandy sediment, therefore, the vegetation associations which once stabilised sandy sediments of dune crests and lunette foreshores must have been affected. Could Aboriginal firing have contributed to devegetation?

At contact the light textured sediments to the north east and south of Lake Victoria were either bare (cf the description of the sandy lunette given above) or vegetated by mallee eucalypt scrub. An early description of the area to the east of Lake Victoria is given in Sturt (1833:95):

the brush was very dense, although there were open intervals; it consisted of trees and shrubs of the
usual kind; the soil was very sandy, and there was a good deal of spinifex on it.

The usual kind of bush in mallee shrubland is a multi stemmed eucalypt with a low crown. There are numerous species of eucalypt, the most common in the Lake Victoria area are *E. dumosa* and *E. oleosa*. The spinfex to which Sturt refers is probably the resinous *Triodia*, which is still common as an understorey today. Other common understorey plants are annual saltbush, chenopods and ephemeral grasses.

Mallee shrubland is highly susceptible to fire. Mallee eucalypts produce a rapid build up of leaf and bark litter, shed bark trails from the stems, and the canopy is rich in volatile oils; these leaves are close to the ground in multi stemmed mallee. Mallee with *Triodia* understorey combines a flammable understorey of resin rich tufts which will burn even when green with a flammable canopy, and the long strips of bark hanging from the tree limbs link the two.

In the present context two issues are relevant. First, did the Aboriginals fire the mallee, and second, could Aboriginal firing devegetate the mobile crests and flanks of dunefields and release erodible sediments to the wind?

With regard to the first question, it is recorded that Aboriginals of the Murray valley did fire parts of the mallee.

I understand that Blacks to say they set fire to a portion of the mallee each year and gather manna the next season from the young growth (Curr 1893:430).

Less direct evidence for Aboriginal firing in the mallee comes from the presence and distribution of the Mallee fowl in the mallee. This ground dwelling bird has specialized a habitat preference, in which it utilizes the seeds of acacias which grow in portions of the mallee which are regenerating following firing (Frith 1962). In recent years fires in the mallee have tended to burn over wide areas, and mallee fowl have declined in abundance, as a direct result of a decline in habitat diversity. The promotion of habitat diversity, is as earlier described,
characteristic of Aboriginal small scale, off season firing. This may be seen as support for the hypothesis that changes in the mallee fowl abundance are linked to a cessation of Aboriginal firing. On the other hand, it has been demonstrated that mallee fires ignited by natural causes will also tend to burn in elongate swathes or patches (Luly pers comm), thus it is equally likely that natural fire regimes acted to provide suitable habitats for mallee fowl, and that their decline is attributable to suppression of natural bushfires.

Less directly still, it could be argued that the presence of open patches in the mallee could have been produced by Aboriginal firing (cf Brown cited by Sturt 1833:95). Morton (1860) describes a broad belt of well grassed land between the mallee and the saltbush plain, likewise Brown describes the abundance of fine grass and game in the marginal area between mallee and riverain (Sturt loc cit; Morton 1860).

Theoretical consideration of the range of Aboriginal firing of the mallee is suggested by these descriptions. The main problem in firing the mallee is to control the extent of the fire. Aboriginals could exert some control over mallee areas which had flammable understorey plants, if they burnt during the winter. Regular firing of small patches would work to increase habitat diversity, and to anticipate uncontrollable bushfires.

In areas with a Triodia understorey, green plants could be ignited even during the winter, when relative humidity is high. This resinous plant will burn fiercely even when green, and ignite the accumulated litter and possibly the canopy of green leaves. In the years following firing, removal of the shady canopy permits grass to grow between trees, and the increase in pasture could attract an increased number of grazing animals and birds. Acacia species germinate in open areas, grow and set seed, which is attractive to birds, and to humans. After a year, mallee coppicing shades out the ground, and grass growth decreases. After five to eight years, Triodia has regenerated sufficiently to begin the cycle once more. A succession of
habitats in recovery from fire thus provides some open areas of grass, some areas of shelter and shade, and habitats for a diversity of animals (Burbidge 1943; Jacobs 1980:146). Winter firing of Triodia understorey in the mallee would have made it possible to achieve this, without the risk of starting a fire which would sweep through huge areas of mallee in an uncontrollable fashion.

A second strategy which could have controlled the extent of fire in the mallee would have been to set fires where they would burn downwind towards the natural firebreaks provided by areas of open soil, lake basins or saltbush/bluebush plain. Such fires would tend to burn long east west swathes upwind of lake basins, with the effect of temporarily increasing the length of undulating potentially grass rich country at the base of Woorinen dunes, providing grazing close to shelter for kangaroos and other grazing species, while leaving the mobile dune crests stabilized by mallee lignotubers. Thus, it is possible that the grassy swathes along the margins of mallee belts were in fact produced by Aboriginal activity. This strategy would have certainly increased the animal food productivity in the ecotone between the mallee and the riverain. Archaeological investigation of the contents of occupation deposits in these marginal areas may increase our understanding of ecotone land management.

It is theoretically possible that Aboriginals could have fired small areas of the mallee, around the river and lake basins, and that they could have derived some benefit in terms of food availability in the ecotone, although, as Horton has suggested, it would be difficult to isolate evidence for Aboriginal activity from evidence of natural fire regimes. It might be possible to test this hypothesis by comparing vegetation in and around lake and river basins with those in the more distant mallee areas.

We will now turn to the question of the Aboriginal role in initiating and promoting sediment mobility, by removing
vegetation during the Pleistocene. It must be stated that in the absence of palynological data from the lake basin, it is not possible to determine the nature of the vegetation of fine sandy sediments during the Pleistocene.

Pollen studies from Lake Tyrell in the Victorian mallee 200 km to the south east of Lake Victoria, and outside the Murray basin, have indicated that in periods of highly effective precipitation prior to 6000 BP, the proportion of *Callitris* and *Casuarina* pollen was comparatively high. Both these two species are adapted to light calcareous sandy dune habitats—thus it is possible that during wetter periods, the vegetation of sandy dunes included a higher proportion of comparatively fire sensitive plant elements. This may have been the case at Lake Victoria following the wetter period of c 32,000 BP, although the absence of calcareous horizons in the lunette suggests that this was not an optimum habitat for *Casuarina* or *Callitris*.

I should like to consider the possibility that Aboriginal firing or natural firing could destroy or remove Mallee eucalypt vegetation first, then return and briefly consider the possible effects on dune vegetations which were rich in fire sensitive elements.

As earlier discussed, mallee eucalypts are well adapted to the passage of fire. Even the most determined efforts of western NSW landholders have failed to remove mallee eucalypts from the land by firing. Mallee eucalypts are long lived, and resprout after total defoliation. Following fires, mallee roots still remain alive, and continue to stabilize the soil. Although it has now been established that firing mallee eucalypts in successive autumns will cause the plant to die, it is unlikely that Aboriginals would have attempted to remove mallee in this way, since the second firing requires artificial fuel (Noble 1982). In view of these observations, it is considered improbable that Aboriginal firing or natural firing could have devegated dunes or whole dunefields covered by mallee.
Vegetation which included a high proportion of Callitris or Casuarina which are not as well adapted to experience the passage of fire might have been disadvantaged by Aboriginal burnings - assuming Aboriginals could have fired the groundcover. It could thus be postulated that Aboriginals did contribute to dune instability. If this was the case (and there is no evidence to support the hypothesis), it could be argued that region wide changes in sedimentation should have been obvious soon after initial settlement c 30,000 BP, not merely after 17,5000 BP. Again, it would be difficult to establish a case for Aboriginal as opposed to natural fire regimes as a causal agent of change.

Taken as a whole, natural causes of devegetation which do not involve fire, offer more plausible explanations for the widespread loss of sandy sediment stability after 17,500 BP. As in the case of saltbush/bluebush shrublands, prolonged water stress makes dune vegetation susceptible to defoliation and eventual death. Given the evidence that the terminal Pleistocene was both colder and drier, there may have been a higher incidence of frosts. Frost stress combined with prolonged drought would effectively devegetate the hinterland dune systems, and promote sediment mobility in the long term.

Immediately downwind of the lunette, both sandy and silt rich sediments were eroded. It is believed that the accession of sediment into source bordering dunes and lunettes is facilitated by bare foreshores (Tedford 1966). While Aboriginal burning may have affected the riverain margin forest/woodlands, it is unlikely that firing could destroy mature trees. Tree species of this zone are however highly susceptible to saline groundwater. Prolonged groundwater salinity could explain the loss of stabilizing vegetation on the lee shore of the lunette to some extent, although it is difficult to explain why this area was not subsequently colonised by saline tolerant shrub vegetation (chenepods, or Nitraria sp or Zygochloa sp for example). Firing may have contributed a little to sediment
mobilization along the eastern shore of the lake if it resulted in removal of shrub vegetation from foreshores.

In view of the evidence for severe drought during this period, it is believed unlikely that Aboriginal land management practices contributed significantly to devegetation and sediment mobilization.

7.7. Aboriginal land management practices and the local extinction and dwarfing of animal species

It has been argued in the previous chapter that habitat constriction, with the associated mechanisms of competitive exclusion and food stress/ecological tethering provides the best explanation for the observed changes in Lake Victoria local fauna during the late Pleistocene. This raises the possibility that Aboriginal land management practices altered microhabitat balances within the riverain and riverain/hinterland ecotone constricting the habitats of species which were present c 18,000 BP at Lake Victoria. It has been further suggested that chances of human predation on now extinct species would have been significantly increased after c 18,000 BP due to higher frequency of contacts between humans and megafauna in water stress periods.

What is understood of the micro habitat preferences of now extinct or dwarfed species is based on:

- the distribution of fossil remains and the associated sediments (Wells 1978; Horton in press)
- the distribution of modern species which will have tooth eruption and articulation patterns similar to those found in now extinct species (Sanson 1978; 1980; Sanson et al 1980)
- the distribution and habitat preferences of species which are believed to be surviving dwarfed forms of

On these grounds, extinct/dwarfed megafaunal species may be allocated to certain broad habitats, which are summarised in Table 7.1

As previously discussed, the associations whose structure was likely to have been affected by Aboriginal burning were eucalypt rich areas, specifically mallee eucalyptus scrubland and possibly riverain redgum forest. Evidence for Pleistocene vegetation systems is not available, however, the distribution of species suggests that the riverain habitat was extensive at some time between c 50,000 BP and 14,000 BP within the riverain tract. There are two possibilities, first, Aboriginal firing might have altered the distribution of larger river margin chenopods like *A. robustus*, *A. nummularia* within the riverain system, and thus reduced the habitats preferred by larger

<table>
<thead>
<tr>
<th>Species</th>
<th>Modern analogue</th>
<th>Possible habitat</th>
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<tbody>
<tr>
<td><em>Sthenurus andersonii</em></td>
<td>No</td>
<td>Riverain forest, chenopod understorey browsing, some grazing</td>
</tr>
<tr>
<td><em>atlas</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Procoptodon goliah</em></td>
<td>No</td>
<td>Tussock grass rich areas within reach of water, grazing, some browsing</td>
</tr>
<tr>
<td><em>Diprotodon optatum</em></td>
<td>No</td>
<td>Riverain forest, Chenopod understorey or chenopod rich areas within reach of water</td>
</tr>
<tr>
<td><em>Macropus ferragus</em></td>
<td>M. giganteus</td>
<td>Tussock grasslands, of forest margins and understorey within reach of water</td>
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<td><em>titan</em></td>
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<tr>
<td><em>Protemnodon anak</em></td>
<td>W. bicolour</td>
<td>Shrub rich swamplands to forest, browsing species, riverain forest</td>
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<td><em>P brehus</em></td>
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<tr>
<td><em>Osphranter cooperi</em></td>
<td>O. robustus</td>
<td>Lunette gullies, grazing on perennial and ephemeral grasses</td>
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browsing species, and second, that Aboriginals might have increased the quantity of herbaceous understorey fodder available in fired patches of mallee eucalypt shrubland.

Of these postulated effects, only alteration of associations within the riverain tract would have affected megafaunal species adversely. Since browsing species appear to have been relatively disadvantaged by the loss of soft leaf vegetation, it is assumed that these animals may have been disadvantaged by constriction in areas of large leaf chenopod species such as A. nummalaria, which, under present conditions may grow in association with riverain woodland species (Specht 1972:174). These plants are extremely difficult to burn (see above), because of the low leaf flammability, and the fact that the growth of grass and other flammable species is suppressed in areas between individual plants. It is difficult to imagine what the Aboriginals would have gained by firing this association, even assuming firing was feasible.

As in the case of the mallee eucalypts, drought related factors can explain decreased environment diversity. One of the most likely causes of change is increased groundwater salinity, as discussed in Section 7.6 above. Loss of wetland could follow simple flood failure, or flood failure plus increased salinity. Degeneration of tussock grasslands in riverain margins could be explained by successive failure of winter precipitation.

Saltbush and bluebush respond to prolonged drought by dropping their leaves. Although the plants may survive, their fodder quality decreases. If areas of saltbush/bluebush away from the riverain were defoliated in this way, larger browsing species would have been restricted to areas around the river margins within reach of water - and subsequent overgrazing may have contributed to the failure of remaining broadleaf chenopods. Drought related factors offer particularly convincing explanations of the constriction of habitats, the loss of food resources, and the extinction of browsing species, concurrent with the dwarfing of grazing species.
As earlier described, it is likely that human predation contributed to the local extinction of the larger species - and possibly to the dwarving of other species. It is however, difficult to imagine how human land management practices might have influenced processes of local megafaunal extinctions.

7.7 Conclusion

This chapter has examined some aspects of the question of the human role in causing or promoting environmental change in the Lake Victoria area during the late Pleistocene. It has been proposed that fire was the single most powerful agent of change wielded by late Pleistocene humans, therefore specific aspects of fire in the landscapes of Lake Victoria have been examined. An increase in sedimentation implies stabilizing vegetation was somehow removed from erodible sediments.

Fire, whether caused by human or natural agencies is unlikely to have caused devegetation in either mallee eucalypt or chenopod shrubland - two of the dominant vegetations of the Lake Victoria area in the recent, and possibility in the more distant past. In the former case, mallee eucalypts are fire tolerant species and will regenerate after a burn, in the latter case, chenopod shrubs appear to be fire resistant plants, which act in association to suppress the build up of potential fuel for fires. Fire may have caused some changes in riverain habitats, but is unlikely to have promoted large scale devegetation and erosion. Prolonged drought, increased or varied groundwater salinity, frost damage and disease all offer more economical explanations for devegetation of dunes, or for alterations in association composition.

Similarly, natural changes associated with drought may explain the observed changes in faunal composition in the lake basin in the late Pleistocene. It is likely that prolonged low flow in the river could have adversely affected the vegetation associations in the riverain tract, and that reduced area of grazing or browsing species, together with reduced species
diversity may have played a significant role in local disappearance of larger animal species. Local extinction may have been expedited by human hunting, but not by human or natural fire induced changes to the riverain vegetation. The effects of fire in these systems would have advantaged grazing species by increasing fodder availability.