FIRE ON OFFSHORE ISLANDS - PROBLEMS AND MANAGEMENT SOLUTIONS

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Abstract

As is the case for much of mainland Australia, fire is important in the management of most offshore islands in the Australia-New Zealand region. Wildfire can seriously diminish nature conservation and other scientific values of islands; some examples of how this may occur are given here. Because of the potential threat that unplanned fire poses to these values, it is recommended that nature conservation agencies urgently develop contingency plans for islands in their jurisdiction.

INTRODUCTION

The islands of Australia and New Zealand incorporate a great range of physical environments and biotas as well as land-uses (past and present). It seems, however, that fire is an important management consideration for most islands set aside for nature conservation or other compatible purposes. The exceptions would be those islands that have snow and ice cover for a significant part of the year (e.g. some Antarctic islands), those that are too wet, as is the case with some tropical islands or those that are scarcely vegetated as is the case with some rock stacks and Phillip Island in the Lord Howe Island Group. While it may be that not all of the remainder have been burnt in historical times, or have fire management problems at present, contingency planning for wildfire is now generally necessary.

FIRE AND CONSERVATION VALUES

Many of the offshore islands in the Australia-New Zealand region have experienced severe wildfires since the times of early European exploration of the coastline. Some fires have been as a direct consequence of the exploration process. For example, as Matthew Flinders sailed the 'Investigator' from Plymouth to Sydney in 1801, 1802 he visited Mondrain Island (Archipelago of the Recherche) where he reported the island was accidentally or deliberately fired to the extent "of a general blaze ... all over the island" (Bechervaise 1954). But many more fires have resulted from visits of tourists and fishermen over recent years (e.g. see Table 1 for fire history details of 12 islands of the Archipelago of the Recherche). Other islands have been partially settled and subsequently burnt off to protect property values (e.g. Magnetic Island, Sandercoe 1980).

The changes in fire regime occasioned by the activities of European man, particularly over the last 20-30 years have given rise to concern about the impact on the native biota. Perhaps the greatest concern is that unchecked wildfire can burn out the entire island and cause local extinctions. At present, fires that start on nature conservation islands often go undetected for long periods and, even when they are reported, control measures are rarely implemented because of logistic constraints.

Dorre Island in Shark Bay, Western Australia, for example, is an important island nature reserve partly because it has populations of the Banded Hare Wallaby *Lagostrophus fasciatus*, the Western Barred Bandicoot *Perameles bouganville*, the Mala or Rufous Hare Wallaby *Lagorchestes hirsutus* and the Boodie *Bettongia lesueur*. The last fire on Dorre Island was reported in early September 1973. By late October it had consumed about 54% of the vegetation of the island (Figure 1. Note that much of the remaining area is bare sand dune). This fire selectively burnt the habitat of *L. fasciatus* to the extent that fears were expressed about continued persistence of that species on Dorre Island. Subsequent monitoring by Drs. R. Prince and A. Weston has revealed a very slow rate of recovery of flora and fauna and both scientists consider that the fire has caused some irreversible deterioration in the conservation values of the island.

Two previous fires are known for Dorre Island. The first was deliberately lit by Julius Brockman in

Table 1.
Details of fires reported from islands of the Archipelago of the Recherche from Hopkins *et al.* (in press). Historical records for all islands of the Archipelago were examined for information related to landuse.

Island	Date of fire and probable cause
Boxer Island	pre-1950 perhaps several fires associated with grazing 1974 - northern two thirds of island
Charley Island	pre-1950 fire(s) probably associated with grazing
Daw Island	pre-1950 fire
Figure of Eight Island	1971 fire lit by stranded fishermen
Goose Island	pre-1950 fire
Long Island	1930s fire probably associated with sealing
Middle Island	1972/73 fire possible fishermen camping 1977 fire ?lightning
Mondrain Island	1802 fire Flinders crew 1944 - three fifths of island burnt ? 1972
North Twin Peaks Island	ca. 1936 fire
Remark Island	major wildfire prior to 1950
Sandy Hook Island	pre-1950 and more recently, perhaps several fires of unknown origin
Woody island	1949/50 - major wildfires of unknown origin 1974 prescribed burn

the 1860s. He recorded in his diary that the fire made a grand sight. In 1908 a small fire began close to the hospital that was established on Dorre Island for Aboriginal people. The scars of this 1908 fire are still visible in 1973 aerial photographs (R.I.T. Prince, pers. comm.).

On Magnetic Island, in Queensland, four settlements with a total resident population of about 2000 have been established in bays surrounding the National Park. In one of these bays (Horseshoe) there was extensive pineapple farming in the 1950s. Fires emanating from the settlement areas used to, until recently, burn into the National Park with the result that areas of the Park were being burnt every 5 years on average (Sandercoe 1980). This frequent burning caused degradation of the vegetation, particularly a loss of shrubs and an increase in grasses (especially *Heteropogon* spp.) and could be correlated with an increase in the incidence of landslips.

FIRE AND SCIENTIFIC VALUES

As well as being important nature conservation areas, islands can provide valuable insight into aspects of evolution and ecology of the biota including the effects of fire. The science of biology was reborn as a result of observations on the plants and animals of islands (Darwin, Wallace, Von Buch and so on). That this role of islands has continued through to the present is evidenced by the wealth of literature covering topics such as island biogeography and by the detailed and comprehensive work on places like Rottnest Island (e.g. Bradshaw 1983).

DORRE ISLAND 1973 FIRE

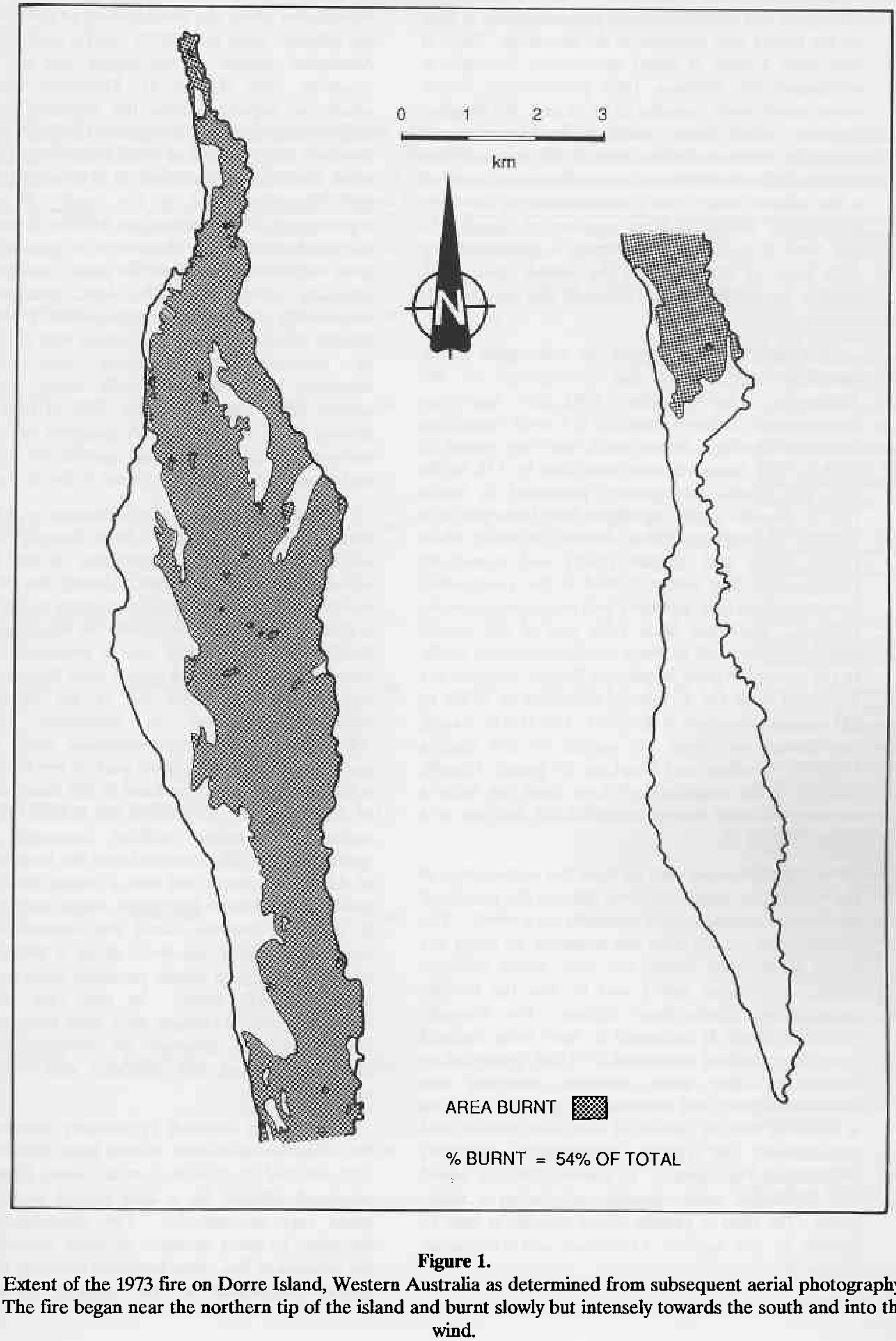


Figure 1.
Extent of the 1973 fire on Dorre Island, Western Australia as determined from subsequent aerial photography. The fire began near the northern tip of the island and burnt slowly but intensely towards the south and into the wind.

Invariably the discussion of evolutionary, ecological and biogeographical generalizations is built on the survey data available in the literature. There is now quite a body of island survey data although, as mentioned by Atkinson (this proceedings), much more survey work remains to be done. We suggest, however, that future surveys should be more rigorously structured than those in the past and that the emphasis should be on comprehensive surveys of a few islands rather than a continuation of the more generalized surveys of large numbers of islands. In our view it is only by developing a comprehensive data base on the biota of the islands that good, reliable interpretations can be made and new insights gained.

To briefly cite an example, we refer again to the botanical collecting in the Archipelago of the Recherche. In November 1950, the Australian Geographical Society conducted a 3 week expedition in the Archipelago, during which time they visited 20 islands. The botanical work was done by J.H. Willis and the results subsequently published in Willis (1953). Results of this expedition have been used in a number of biogeographical studies including Main (1961), Main and Yardav (1971) and Armstrong (1979). This last author looked at the relationship between island size, insularity and angiosperm species richness. However, since 1950, two of the islands have been subjected to more detailed botanical study. In the case of Woody Island, the floristic richness has increased from the 87 species recorded by Willis to 121 species (Goodsell *et al.* 1976). For Middle Island, the change was from 143 species to 235 species (Weston, Trudgen and Hopkins, in press). Clearly, changes of the magnitude of these cited can make a mockery of many interpretations of the data set as a whole (Figure 2).

A comprehensive data set from the Archipelago of the Recherche could cast some light on the genesis of the flora of south-western Australia as a whole. The islands were cut off from the mainland by rising sea levels at different times and thus under different climatic conditions and it may be that the floristic composition reflects these factors. For example, Salisbury Island is estimated to have been isolated from the mainland at around 13-14000 years Before Present, a time when southern Australia was experiencing very arid conditions (Figure 3). Its flora is relatively rich in species of arid zone families and depauperate in typical south-western elements (Myrtaceae, Proteaceae). In contrast, Middle Island was separated more recently and during a mesic phase. The flora of Middle Island contains at least 16 species in the families Myrtaceae and Proteaceae (Table 2).

These islands also contain potentially valuable information about the development of some so-called fire adaptive traits (Gill 1979). So far as is known, the Aboriginal people of the region did not possess sea-going craft (Figure 4). Therefore when each island was separated from the mainland it was no longer subject to Aboriginal burning practices; however these practices would have continued to affect the adjacent mainland. It is of some interest to note, therefore, that in the study of post fire regeneration of vegetation on Middle Island to be discussed shortly, only about 10% of species in study plots resprouted and, even for those, seedlings were generally abundant. The low contribution of resprouting to overall regeneration patterns on Middle Island is in marked contrast with observations on sclerophyllous shrublands and woodlands elsewhere in southern Australia where resprouting species have comprised about 70% of total species present (Bell *et al.* 1984). A program of survey to explore life histories of plant species on the islands and adjacent mainland in relation to fire is warranted.

Disentangling the relative influences of Aboriginal man, palaeoclimate and sea level changes (isolation) on the structure and composition of the biota of islands is not a simple matter. Usually the evidence is scanty and equivocal. One interesting recent attempt is that reported by Noble (1986) for Kangaroo Island, South Australia. In that case a principal source of data was a charcoal and pollen core from Lashmar's Lagoon on the eastern tip of the island which indicates a change in vegetation from an *Allocasuarina* dominated woodland with a grassy understorey in the wet, early part of the Holocene to a *Eucalyptus-Acacia* woodland in the later, drier part of the Holocene. At about 2 500 Before Present the incidence of major wildfires increased. It is speculated that this coincided with the local extinction of Aboriginal people and thus a change from regular, low-intensity fires to infrequent, major conflagrations. It is known that the island was isolated from the mainland by rising sea levels about 9 000 years ago and that Aboriginal people persisted there for at least another 5 000 years. In this case, therefore, floristic/vegetation changes were most likely related to climatic changes although the transformation was rather abrupt and also coincided with a major fire event.

One further research opportunity that relates to fire exists because some islands have been relatively little-affected by European man. Some islands have remained unburnt for a long period or have been burnt very infrequently. The opportunity exists, therefore, to study dynamics of plant communities in the absence of fire. One pertinent question is how do species regenerate in the absence of a major

Table 2
Details of floristic composition of selected islands of the Archipelago of the Recherche in relation to size, isolation and habitat diversity factors. Floristic data are from Willis (1953) except for figures in brackets which reflect results of more recent survey work (see text for details). Selected vascular plant families are Chenopodiaceae (ch), Aizoaceae (aiz), Myrtaceae (myr) and Proteaceae (pro).

ISLAND	Time of isolation (years B.P.)	Distance from mainland (km)	Area (ha)	Maxmimum evaluation(m)	No of vascular plants in selected families					Notes on geology soils and vegetation
					Total	ch	aiz	myr	pro	
TERMINATION		52.8	90	124	12	2	2	0	0	Granite rock. Albizia (prostrate) in rock crevasses Low succulent perennials; Disphyma. Hardy annual herbs; Lepidium, Lobelia
SALISBURY	13,000-14,000	43.2	320	130	30[+2]	3	2	0	0	Granite rock and limestone. Halophytic flora on limestone cliff; Atriplex, Carpobrotus, Heath on granitic soils; Leucopogon, Spiridium, Acacia, Boronia, Pimelea
WESTALL	11,000-12,000	16.9	95	24	23	5	5	0	0	Calcareous sand over granite. Well developed salt bush scrub; Atriplex, Rhagodia (spp) Enchyleana.
FIGURE OF EIGHT ISLAND	10,500-11,500	14.5	275	127	56	4	3	0	0	Granite. Acacia cyclops, Albizia, Myoporum Heath; Pimelea, Eutaxia, Leucopogon.
MONDRAIN	10,000-11,500	15.0	790	247	135[+2]	5	3	12	3	Granite no limestone. Eucalypt woodlands. Melaleuca woodlands; M. lanceolata, M. globifera Sand Heath; Dryandra, Xanthorrhoea, Casuarina Calothamnus
SANDY HOOK	10,000-10,500	9	270	153	100[+34]	3	3	9	1	Granite no limestone Eucalypt woodland. Shrubs of Acacia (6spp) Gastrolobium, Bossiaea,Templetonia, Boronia Calothamnus, Dampiera
MIDDLE	9,000-10,000	9	1,060	190	143[+92]	4	3	13 [+1]	2	Granite, Limestone, sand dunes Eucalypt woodlands, (4 spp.) Mixed heath on granite, Kunzea, Calothamnus, Acacia. Melaleuca globifera woodlands. Limestone heath; Melaleuca pentagona, Pomoderis
NORTH TWIN PEAKS	8,000-9,000	8	310	205	90	4	3	8	1	Granite, no limestone. Eucalypt woodlands, (3spp), Melaleuca globifera, Acacia, Kennedia, Leucopogon
WOODY		8	188	130	58[+112] 87[+60]	1	3	6 [+2]	[8]	Granite Eucalypt woodland and Low open heath - Astartia, Melaleuca lanceolata

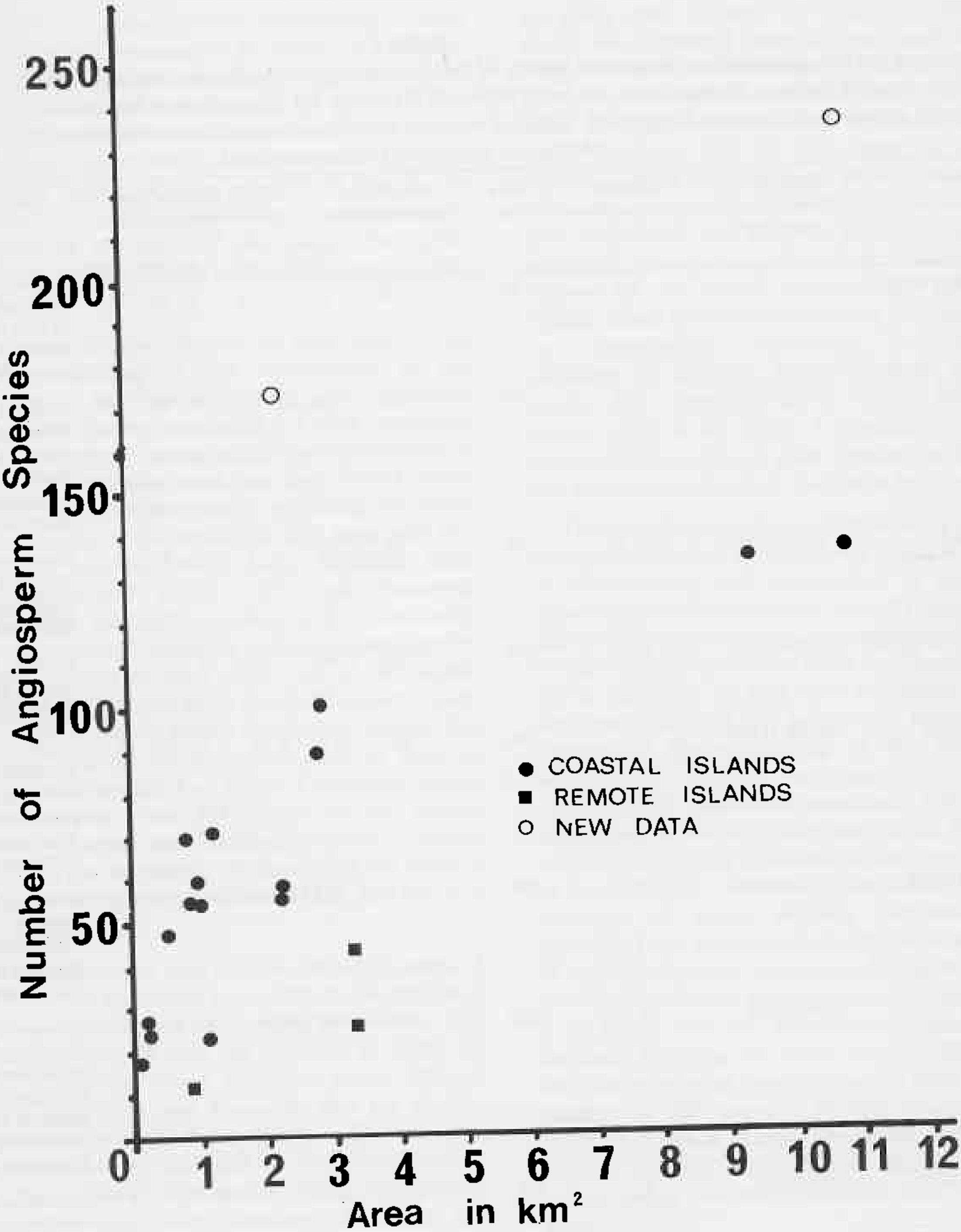


Figure 2.
Species richness of islands of the Archipelago of the Recherche in relation to size and insularity. Original data are from Willis (1953) as plotted by Armstrong (1979). New data are from Goodsell *et al.* (1979) for Woody Island and from Weston *et al.* (in press) for Middle Island.

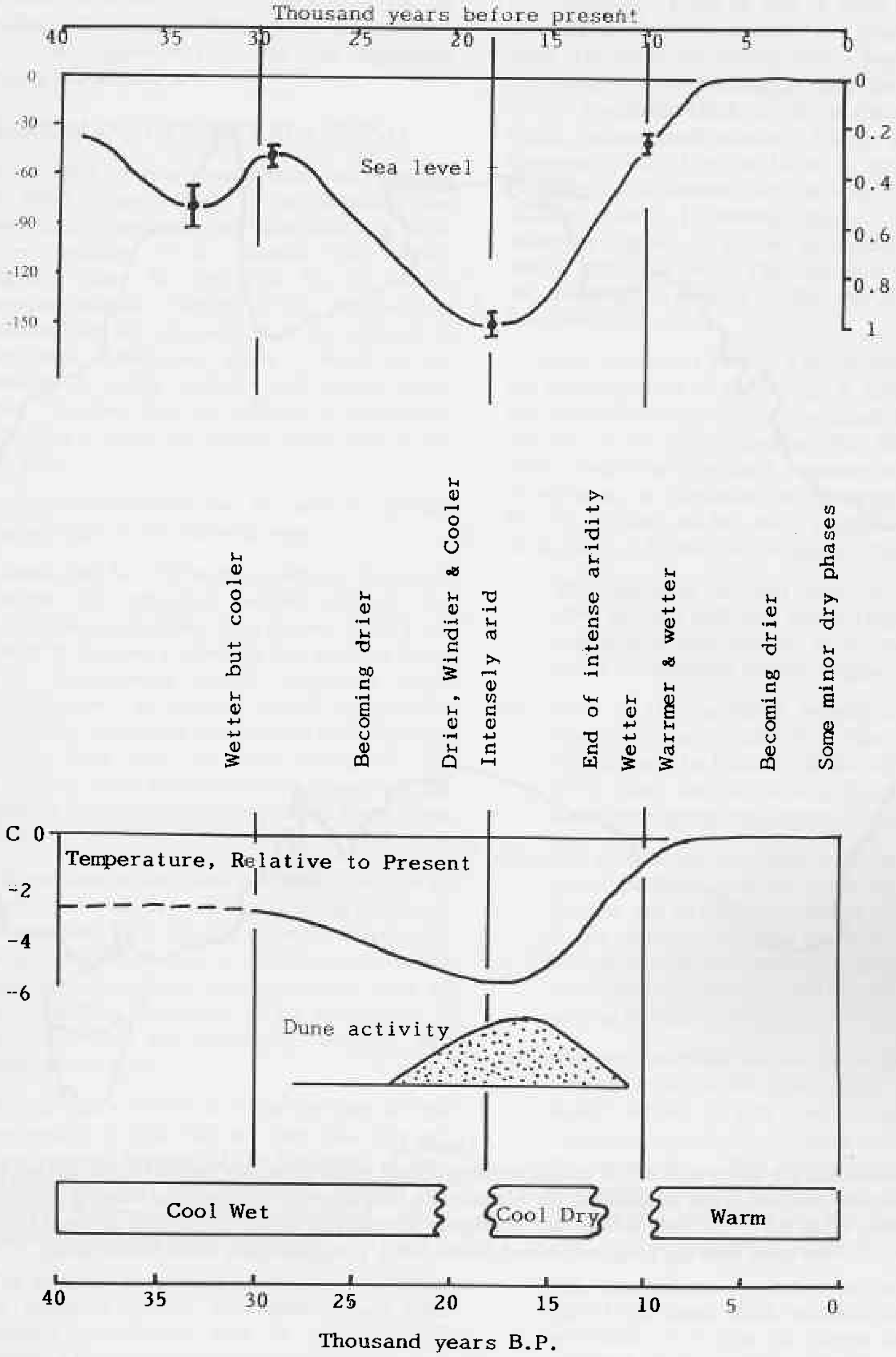


Figure 3.

Selected indicators of environmental change in the Australian region in the last 40,000 years. A. Sea level in the northern Australian region from Chappell (1983a). B. Climatic trends in south-western Australia relative to the present (from Balm *et al.* 1978). C. Average temperature estimates for the Australian region with an indication of the major phase of inland dune activity (from Chappell 1983b).

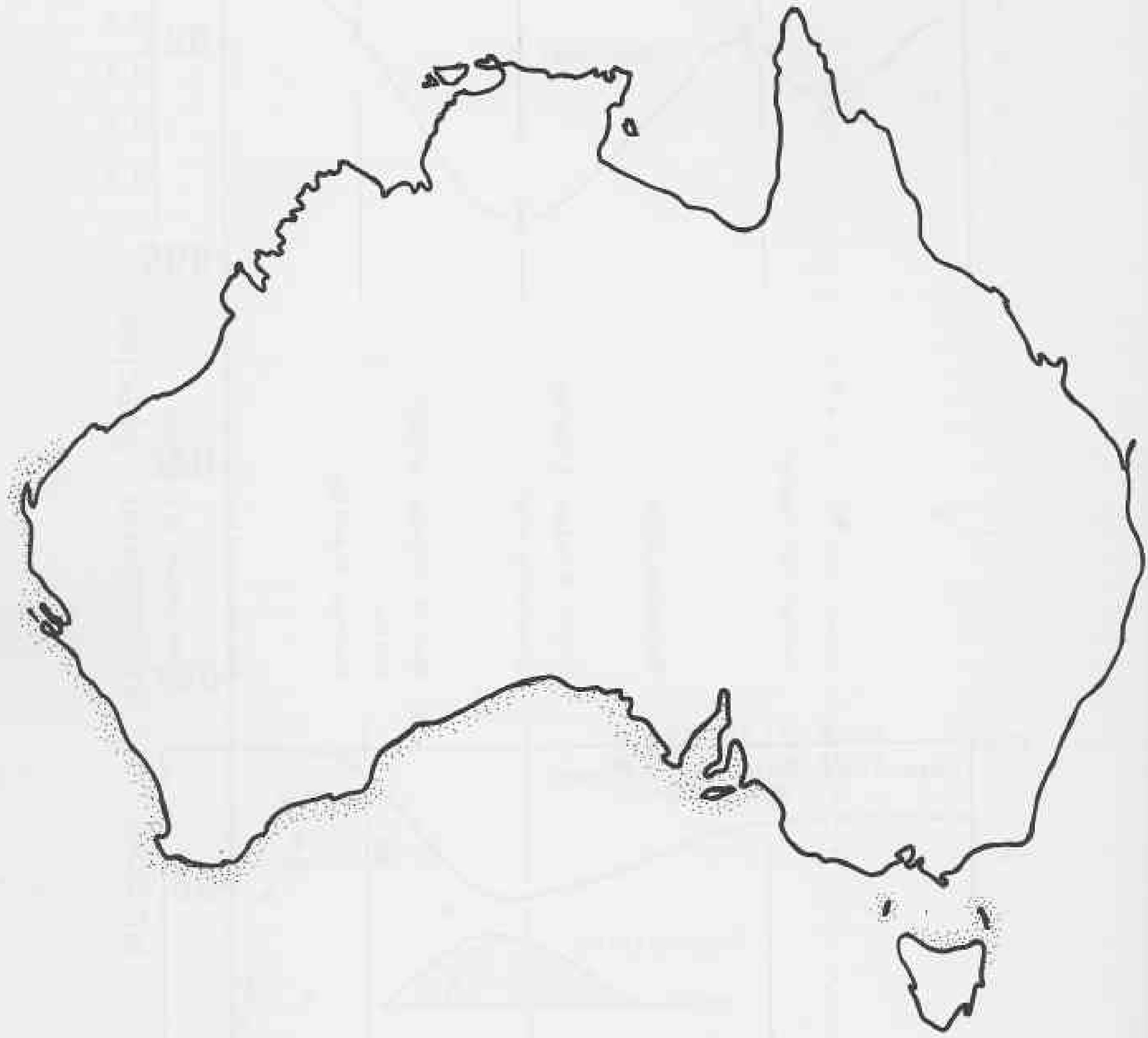


Figure 4.
Australia and the larger continental islands showing coastal areas where Aboriginal people did not possess watercraft and thus, it can be assumed, the islands were little affected by Aboriginal burning patterns once isolated by rising sea levels. Note though that Aborigines persisted as insular populations on some larger islands for some time (eg Kangaroo Island, Noble 1986). (Original figure from Abbott 1980)

disturbance event like fire? It is often said that the Australian sclerophyllous flora is fire dependent - here is one opportunity to test the hypothesis underlying this paradigm.

FIRE MANAGEMENT PLANNING

Given the very obvious conservation and scientific values which many islands in the Australia-New Zealand region have and the vulnerability of those values to wildfire, it is essential that wildfire contingency plans be prepared for all nature conservation islands. Several of the categories of information already discussed can be utilized to develop such contingency plans. Much of the information is readily available and merely awaits collation. It is best that this collation of information and planning is done pro-actively rather than at the time of a fire.

Available information can be used to develop contingency plans in the following ways:

i) Islands that have been inaccessible to Aboriginal people for extended periods through the Holocene, as identified from Figures 3 and 4, are likely to support a relatively fire sensitive biota. Fire management should emphasise rapid containment. In contrast, islands occupied or visited by Aboriginal people have probably been burnt from time to time throughout the Holocene and it is reasonable to assume that the present biota is resilient in the face of occasional fire.

ii) Information on the landforms and vegetation of each island will be useful in assessing likelihood of complete burn out. For example, islands with large expanses of rock or sand dunes are better protected than those with continuous cover of sclerophyllous vegetation. This information is also essential for developing detailed fire suppression plans.

iii) Islands with a history of recent fire may be less susceptible to total burn out than those that are long unburnt because of the likelihood of low, discontinous fire fuel loadings. Again, fire history information is fundamental when planning fire suppression strategies.

iv) The presence of rare and endangered species on an island or special, fire-sensitive plant (and animal) communities such as rainforest will dictate a fire management policy of containment.

FIRE STUDIES ON MIDDLE ISLAND

Middle Island is the largest and most physiographically diverse island of the Archipelago of the Recherche. It has an area of about 1060 ha. and conspicuous features include the granite Flinders Peak (174 m) at the western end, a hypersaline lake containing the red *Dunaliallia* algae and a series of granite headlands which, on the northern side of the island, enclose sandy beaches. On the southern side limestone cliffs of up to 50 m in elevation occur (Figure 5). The diverse biota includes 235 species of vascular plants, 1 mammal species (the tammar *Macropus eugenii*), 12 species of reptiles and 1 frog, and 37 species of birds. The vegetation of the island was mapped at a scale of 1:12000 and 20 associations have been delineated.

In the summer of 1972/73 a severe wildfire burned the eastern portion of the island. A series of studies was initiated because of concerns about the effects of this fire on the biota (Hopkins 1981, Weston 1985). These studies have involved a number of researchers as well as us; we particularly acknowledge the work of Dr. A.S. Weston and Mr. M.E. Trudgen. The results of the work so far may be summarized thus:

i) The vegetation in most areas is regenerating after the fire well but slowly (Figure 6); it is estimated it may take up to 60 years for it to return to something like the original structure.

ii) Some of the vegetation boundaries appear to have moved as a result of the fire. We suggest that this may be because the fire killed both the living plants and the seed in the seed bank of some physiognomically important species.

iii) Fire ephemerals were very conspicuous in some vegetation association for about 2-3 years after the fire and all had disappeared within 6 years. As an example, *Alyogyne hakeifolia* contributed 25% of the canopy cover in *Eucalyptus angulosa* woodland two years after the fire but declined to nothing by year 6 (Figure 6).

iv) *Alyogyne hakeifolia* was one of six plant species, now known to be fire ephemerals, collected by Robert Brown in 1802 (with Flinders on the 'Investigator') and not collected again until after the recent fire. This evidence, together with observations on the unburnt part of the island, suggests that the island was last burnt in about 1800, i.e. 172 years before the most recent fire.

v) The long-unburnt vegetation in the remaining part of the island which included some savanna woodlands of a type no longer seen on the mainland was studied in an attempt to understand the dynamics in the absence of fire. There was no evidence of extinctions as a result of the long absence of fire on Middle Island.

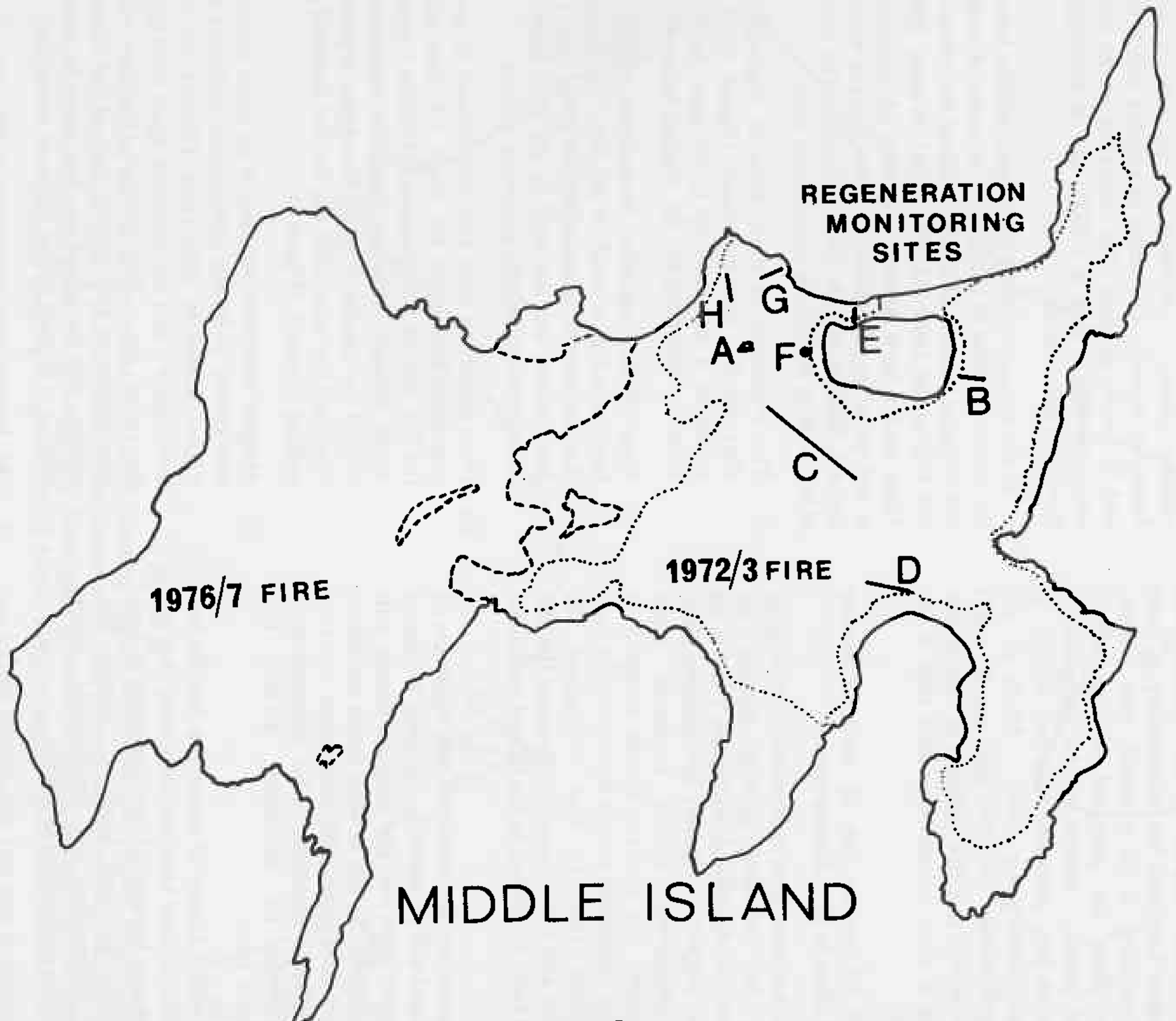
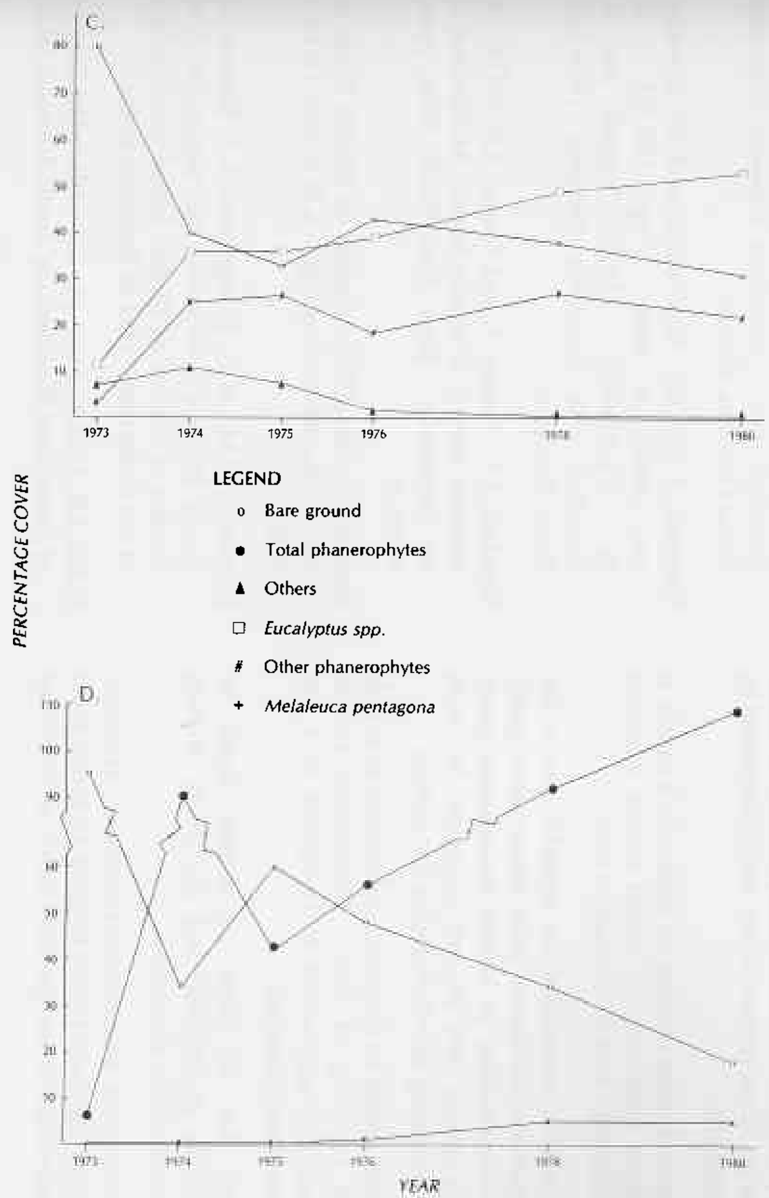


Figure 5.
Topographic map of Middle Island (Archipelago of the Recherche) showing the development and final extent of the 1972/73 fire.



G. *Melaleuca globifera*
Low Open Forest
Seedling regeneration of the lianas ***Muelenbeckia adpressa*** and ***Kennedia nigricans*** was prolific. These were shaded out by thick regrowth of ***Melaleuca globifera*** from seed and coppice.

H. ***Eucalyptus angulosa***
Low Open Forest
The fire ephemeral ***Alyogyne hakeifolia*** and liana ***Kennedia nigricans*** dominated the initial regrowth. ***E. angulosa*** coppiced freely as well as regenerating from seed.

C. ***Eucalyptus angulosa*** and ***E. platyptus*** Low Open Forest
The liana ***Muelenbeckia adpressa*** and therophyte ***Trachymene pilosa*** were replaced by seedlings of ***Phyllanthus calycinus, Eucalyptus angulosa*** and ***E. platypus***. Some individuals of ***E. angulosa*** resprouted from lignotubers.

D. Open Scrub on Limestone
Fire ephemerals ***Alyogyne hakeifolia*** and ***Scaevola aemula*** grew rapidly for 2-3 years and then died off. The long lived woodly shrubs, ***Melaleuca pentagona, Leucopogon revolutus*** and ***Pultenaea obcordata***, regenerated from, seed and grew slowly.

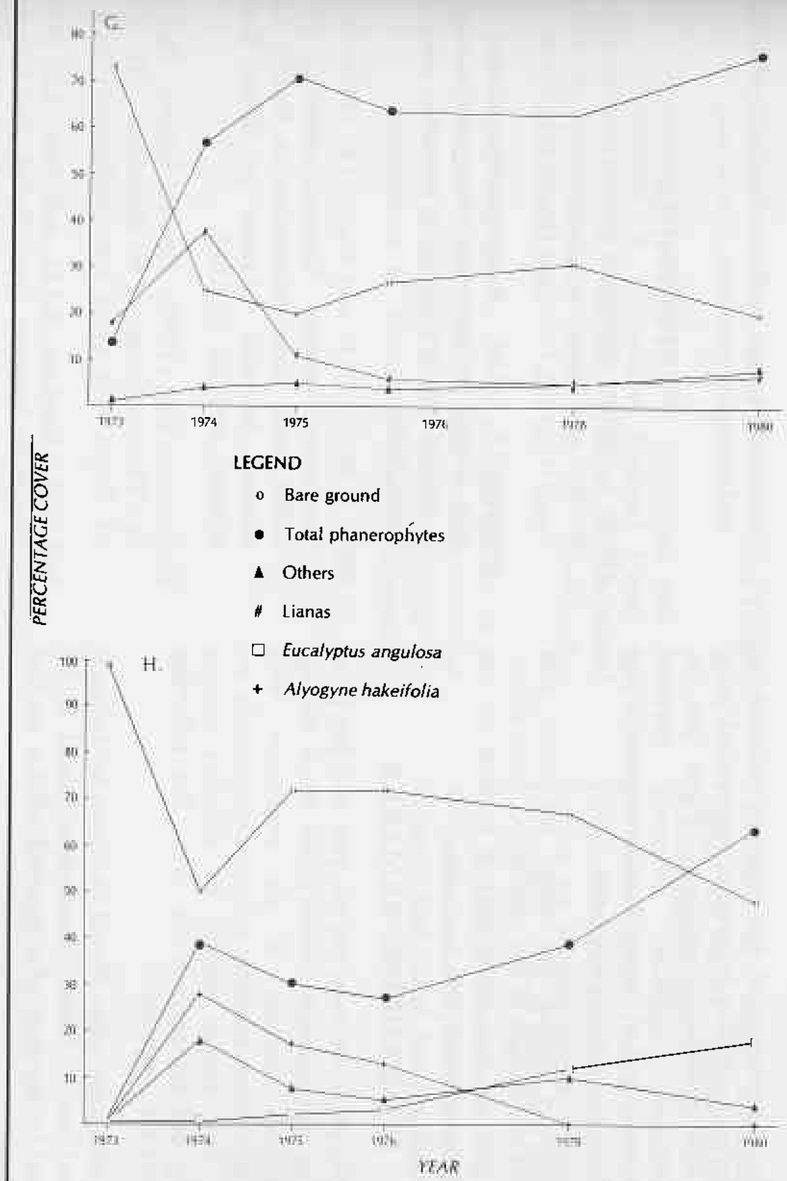


Figure 6.
Regeneration of the vegetation in the *Eucalyptus angulosa* woodland on Middle Island after the 1972/73 fire. Species have been grouped by life form according to the scheme of Raunkiaer for ease of interpretation of vegetation trends.

vi) The distribution of the tammar wallabies in relation to the fire boundaries was studied using a scat distribution measure. There was no statistically significant difference between numbers of scats in old, unburnt vegetation and young, regenerating vegetation.

In 1976 a second fire swept the island and destroyed the vestiges of old vegetation. Some effects of this fire are now being studied as work on the original regeneration plots continues.

CONCLUDING REMARKS

In this paper we have put the view that fire is an important management consideration when dealing with islands because of its interaction with conservation and scientific values. Consequently we believe that islands should be afforded special planning and management for fire. The following guidelines are proposed:

i) Contingency plans should be drawn up for each (and every) nature conservation island to be used in the event of a reported wildfire on that island.

ii) The basis of each contingency plan should rest on an evaluation of such things as the evolutionary history, recent fire history, information on rare and endangered species and other land-use factors (e.g. using data derived from Figures 3 and 4).

iii) A major feature of each contingency plan should be prompt containment of any wildfire to ensure that no island reserve is ever burnt completely by a single fire.

iv) Fuel-reduction burning on uninhabited islands is seldom justifiable; on settled islands it should probably be kept to a minimum level.

v) In order to ensure that due regard is given to the importance of islands, each conservation agency should establish an islands management group with special skills in, and equipment for, tasks for managing islands including fire control.

vi) There should be improved surveillance of islands and reporting of fires. Commercial airlines should be approached to co-operate in a fire surveillance program.

vii) Fires that do occur on islands should be carefully documented and the effects of such fires should be monitored.

viii) Research on islands should continue. However, greater emphasis should be given to detailed and comprehensive surveys and studies as an avenue to improving our understanding of evolutionary and ecological processes.

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