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Bark as fuel in a moderate intensity jarrah forest fire

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SUMMARY

Firefighters have long recognized that flammable bark on the boles of jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) trees contributes to the intensity and suppression difficulty of forest fires burning under dry conditions. We surveyed trees in mature jarrah forest soon after a moderate intensity fire under dry summer conditions and found that mean tree bark thickness (measured at breast height) was about two thirds that of the bark thickness on trees in an adjacent forest that was burnt by low intensity fire seven years earlier. In addition, we calculated that bark on the boles of living trees contributed about 5 t ha^{-1} of fuel to the flaming zone of a moderate intensity fire. Firefighters need to be aware of the additional hazard posed by accumulations of flammable bark on marri and jarrah trees in forests that have not been burnt under dry conditions for long periods.

INTRODUCTION

Fuel reduction burning is the cornerstone of wildfire control in sclerophyll forests of south-west Australia. In jarrah (*Eucalyptus marginata*) forests, low intensity (<350 kW m^{-1}) fires are set at 6–10 year intervals to maintain surface litter fuel below about 8 t ha^{-1} in strategically important areas (McCaw and Burrows 1989). Normally, these fires burn under cool, moist conditions in spring or late autumn after the opening rains and do not burn the outer bark on standing trees above about 2 m. However, during moderate to high intensity wildfires and fires burning under very dry fuel and soil conditions, it is common for bark on standing jarrah and marri (*Corymbia calophylla*) trees to ignite along the entire length of the bole (Burrows 1997). This additional fuel source contributes to fire behaviour and to suppression difficulty by increasing fire intensity at the flaming zone and by providing material for long distance spotting (Luke and McArthur 1978). Spotting is the process of fire ignitions (spot fires) starting downwind of the main fire caused by burning pieces of bark (and other material) carried aloft in the convection column and deposited. In jarrah forests spot fires have been reported as far as 5–7 km from the main fire front. Short distance spot fires are often referred to by firefighters as hop-overs (embers which 'hop over' the fire break or control line). Long distance spotting and hop-overs can cause considerable control difficulties and can endanger the lives of firefighters in some circumstances. Recognizing this, bark characteristics form an important part of the fuel hazard rating system used in Victorian forests (Kellas 1992). As well as aggravating control difficulties, the combustion of bark on the bole and branches of jarrah and marri trees contributes to crown and bole damage (Burrows 1994).

The amount of flammable bark on the upper boles and limbs of standing trees accumulates despite low intensity fuel reduction burns and is usually only burnt during intense fires or fires burning under dry conditions. The aim of this survey was to estimate the amount (weight) of bark burnt from the boles of jarrah and marri trees during a moderate intensity summer fire.

METHOD

The survey was conducted in conjunction with fire behaviour studies carried out in the summer of 1983 in McCorkhill State forest some 25 km west of Nannup, Western Australia. The study site was typical of the mature Donnybrook Sunklands jarrah forest described by McCutcheon (1978). This forest had experienced a fire regime of low intensity fuel reduction burns on a 6–7 year rotation since the late 1960s, and prior to this study, was last burnt by low intensity prescribed fire in spring 1976. No recent wildfires have occurred in the area to our knowledge.

About two hundred jarrah and two hundred marri trees representing a range of bole sizes from 5 cm to 144 cm diameter at breast height over bark (d.b.h.o.b.) were selected in each of two adjacent 100 ha plots of mature forest. One plot was last burnt by low intensity fire in spring 1976 (the 'spring burnt plot') and the other was burnt by moderate intensity fire under dry fuel and soil conditions in summer 1983 as part of a fire behaviour experiment (the 'summer burnt plot'). Other than this, both sites had experienced the same management history and were very similar in all other respects, including stand structure and composition. The moderate intensity summer fire resulted in complete scorch to the overstorey and charring of the tree boles and lower limbs.

The weight of bark (t ha^{-1}) burnt from the tree boles during the 1983 moderate intensity summer fire was estimated by comparing the weight of bark on tree boles in the two burn treatments. This was done by measuring both bark thickness and stem diameter over bark at breast height (d.b.h.o.b.) on all sample trees, then calculating bark volume and weight. Bark volume was calculated by the following procedure.

The underbark stem diameter (d.b.h.u.b.) and wood volume of the bole of each measured tree was determined by subtracting bark thickness from the d.b.h.o.b. measurement, and using jarrah stem volume tables (Harris 1965). The total volume of each bole, including bark, was determined the same way, but using a diameter measure made over bark. The underbark volume was subtracted from overbark volume to produce total calculated bark volume on the tree bole.

In order to estimate the weight of bark (in t ha^{-1}) it was necessary to determine the density of the bark of both species. Samples of bark from each species were oven dried and weighed. The volume of each sample was determined using the water displacement technique. Before immersion into water, bark samples were coated with a polyester varnish to reduce water absorption. Bark density was then calculated. The size class distribution and basal area of trees by species at each of the survey sites was determined by measuring the d.b.h.o.b. of all trees in a 500 m x 10 m belt quadrat and, as expected, was very similar. Knowing tree size, stocking (stems ha^{-1}), basal area, species, the total volume of bark in each bole size class (d.b.h.u.b.) by species and bark density, the difference in total bark quantity between the two sites could be estimated by subtracting the bark weight in the summer burnt plot from the bark weight in the spring burnt plot.

For the summer burnt plot, fuel measurements, weather and fire behaviour observations were made as part of the fire behaviour studies associated with Project Aquarius (Loane and Gould 1986). The quantity of litter fuel (dead leaves, twigs and bark < 6 mm in diameter) on the forest floor before and after burning was estimated by measuring litter depth on a 100 m x 100 m grid and using a pre-determined relationship between depth and quantity (Sneeuwjagt and Peet 1985). Litter fuel moisture content (as a percentage of oven-dry weight) was determined prior to burning from five to ten 40–50 g samples and the moisture content of the outer 5 mm of bark of jarrah and marri trees was determined by collecting about 30 g of bark (at breast height) from each of ten trees of each species. The summer burnt plot was burnt under warm dry conditions in February 1983. Multiple spot ignitions set on a 200 m grid pattern were used to ignite the plot and fire rates of spread were estimated from both ground observations and by examining imagery from an airborne infra-red scanner.

RESULTS

During the summer burn, the Soil Dryness Index (SDI) (Mount 1972; Burrows 1987) was about 1550 (or 155 – Mount 1972), average surface litter moisture content was about 7 per cent of oven-dry weight (o.d.w.), winds were from the south-east at about 13–18 km h^{-1} (28 m tower wind speed) and ambient temperature and relative humidity were in the range 30–33 °C and 35–40 per cent respectively. The quantity of fine dead (<6 mm diameter) surface litter fuel ranged from 3.5 t ha^{-1} to 11.5 t ha^{-1}, averaging 7.4 t ha^{-1} and under the dry conditions it was virtually all consumed by fire. The mean moisture content of the outer 5 mm of bark of marri and jarrah trees at the time of the fire was 9.3 per cent (o.d.w.) and burnt readily. Fire intensity ranged from 200 kW m^{-1} to 3000 kW m^{-1}, averaging about 1700 kW m^{-1}, and headfire flame heights ranged from about 0.3 m to 4.0 m. There were no records of the conditions under which the spring burn took place, but typically, such burns are implemented when the SDI is <750 (or 75 – Mount 1972).

Mean tree bark thickness (at breast height) was 34.7 per cent and 34.8 per cent lower in the summer burnt plot for jarrah and marri trees respectively (Tables 1 and 2). These differences are highly significant (at the 0.05 confidence level) and consistent across all diameter size classes. The relationships between tree diameter at breast height under bark (d.b.h.u.b.) and bark thickness for both species in the spring burnt and summer burnt plots are shown in Figures 1 and 2.

The tree basal area in the summer burnt plot was 25.9 m^2 and using the above technique, we calculated that bark on tree boles contributed about 5 t ha^{-1} to the fuel load. While not quantified, we observed numerous pieces of smouldering bark being carried aloft in the convection column and observed massive short distance (up to 200 m) spotting from burning pieces of bark (particularly marri) and partially burnt leaves. Most spot fires were ignited by smouldering pieces of bark rather than by leaves.

DISCUSSION

Trees burnt by spring fire seven years previously had significantly thicker bark on their boles (at breast height) than trees burnt by a recent summer fire. This can be interpreted as being due to the combustion of dry outer bark during the more intense summer fire. The reduction in bark thickness was similar for all size classes and for both tree species (marri and jarrah). Kellas (1992) reported 25–40 per cent removal of bark off butts on regrowth and

TABLE 1

Mean bark thickness measured at breast height (1.3 m) for marri (*Corymbia calophylla*) in a forest (a) burnt in spring seven years previously and (b) burnt in summer three months previously. Tree bole diameter classes refer to measurements made at breast height and under bark (d.b.h.u.b.). Difference in mean bark thickness is highly significant for all size classes at the 0.05 significance level. Standard error in parentheses.

d.b.h.u.b. CLASS (cm)	NUMBER OF TREES MEASURED IN SPRING BURNT PLOT	MEAN BARK THICKNESS OF TREES IN SPRING BURNT PLOT (mm)	NUMBER OF TREES MEASURED IN SUMMER BURNT PLOT	MEAN BARK THICKNESS OF TREES IN SUMMER BURNT PLOT (mm)	DIFFERENCE IN MEAN BARK THICKNESS (%)
5–15	35	18.2 (0.7)	29	11.7 (0.6)	35.7
15.1–30	25	30.5 (1.3)	31	15.7 (0.4)	48.5
30.1–45	30	30.4 (1.1)	32	17.9 (0.7)	41.1
45.1–60	29	30.7 (0.9)	28	18.2 (0.7)	39.7
60.1–75	25	29.3 (1.0)	35	20.2 (0.6)	31.3
75.1–90	23	32.2 (0.7)	10	20.8 (0.7)	35.4
90.1+	20	31.3 (1.2)	13	20.1 (0.6)	35.7
Total	187	28.3 (0.5)	178	17.4 (0.3)	38.8

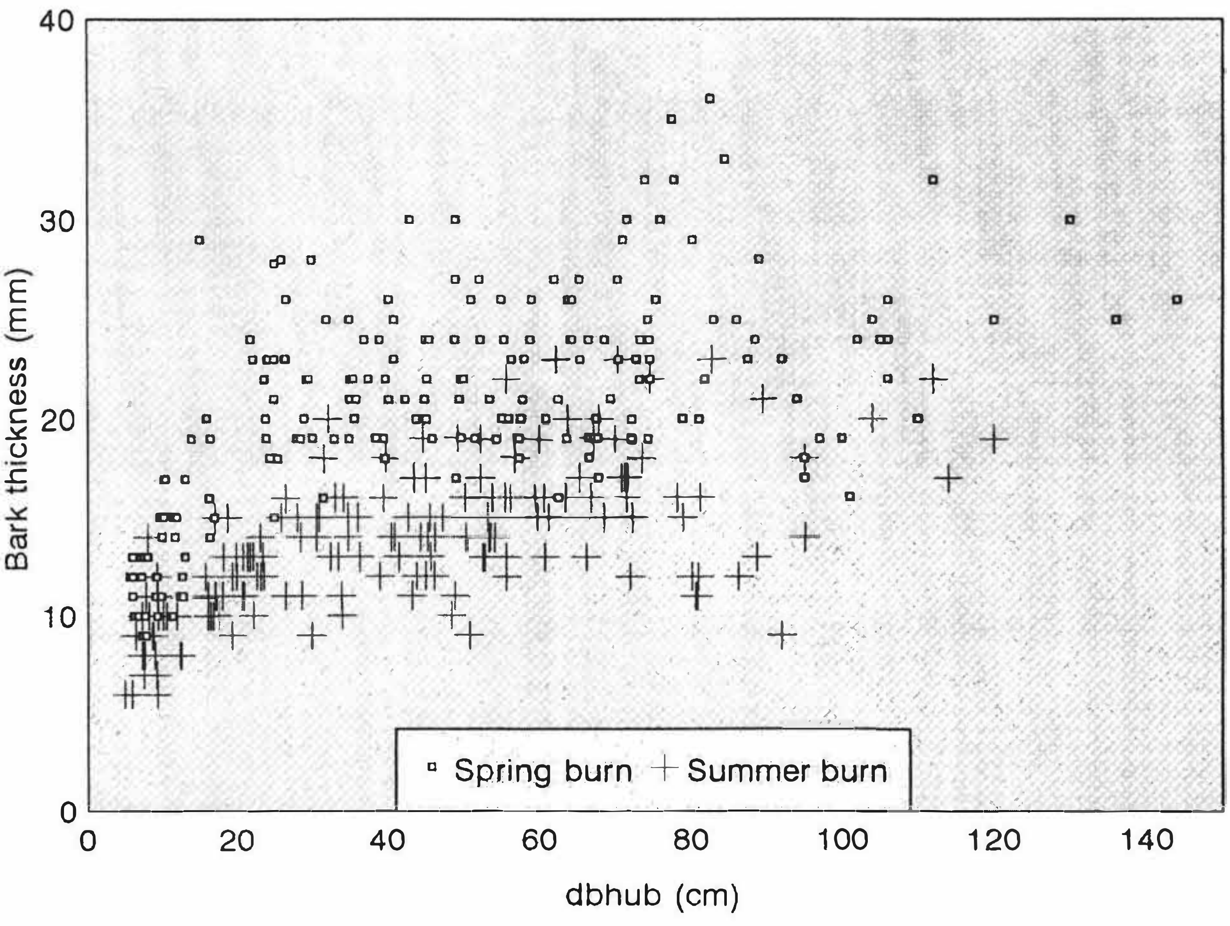

*Figure 1. The relationship between bark thickness and bole diameter measured at breast height (1.3 m) and under bark (d.b.h.u.b.) for marri (*Corymbia calophylla*) trees burnt (a) in spring seven years previously and (b) in summer three months previously.*

TABLE 2

Mean bark thickness measured at breast height (1.3 m) for jarrah (*Eucalyptus marginata*) in a forest (a) burnt in spring seven years previously and (b) burnt in summer three months previously. Tree bole diameter classes refer to measurements made at breast height and under bark (d.b.h.u.b.). Difference in mean bark thickness is highly significant for all size classes at the 0.05 significance level. Standard error in parentheses.

d.b.h.u.b. CLASS (cm)	NUMBER OF TREES MEASURED IN SPRING BURNT PLOT	MEAN BARK THICKNESS OF TREES IN SPRING BURNT PLOT (mm)	NUMBER OF TREES MEASURED IN SUMMER BURNT PLOT	MEAN BARK THICKNESS OF TREES IN SUMMER BURNT PLOT (mm)	DIFFERENCE IN MEAN BARK THICKNESS (%)
5–15	34	12.9 (0.4)	25	8.8 (0.3)	31.8
15.1–30	26	20.8 (0.8)	35	12.4 (0.3)	39.5
30.1–45	28	21.9 (0.6)	30	14.4 (0.5)	33.6
45.1–60	32	22.4 (0.5)	30	14.8 (0.5)	33.9
60.1–75	35	22.8 (0.7)	24	17.2 (0.6)	25.6
75.1–90	15	27.2 (1.4)	10	15.3 (1.3)	43.7
90.1+	20	23.6 (1.1)	6	16.8 (1.9)	28.8
Total	190	21.0 (0.6)	160	13.7 (0.5)	34.7

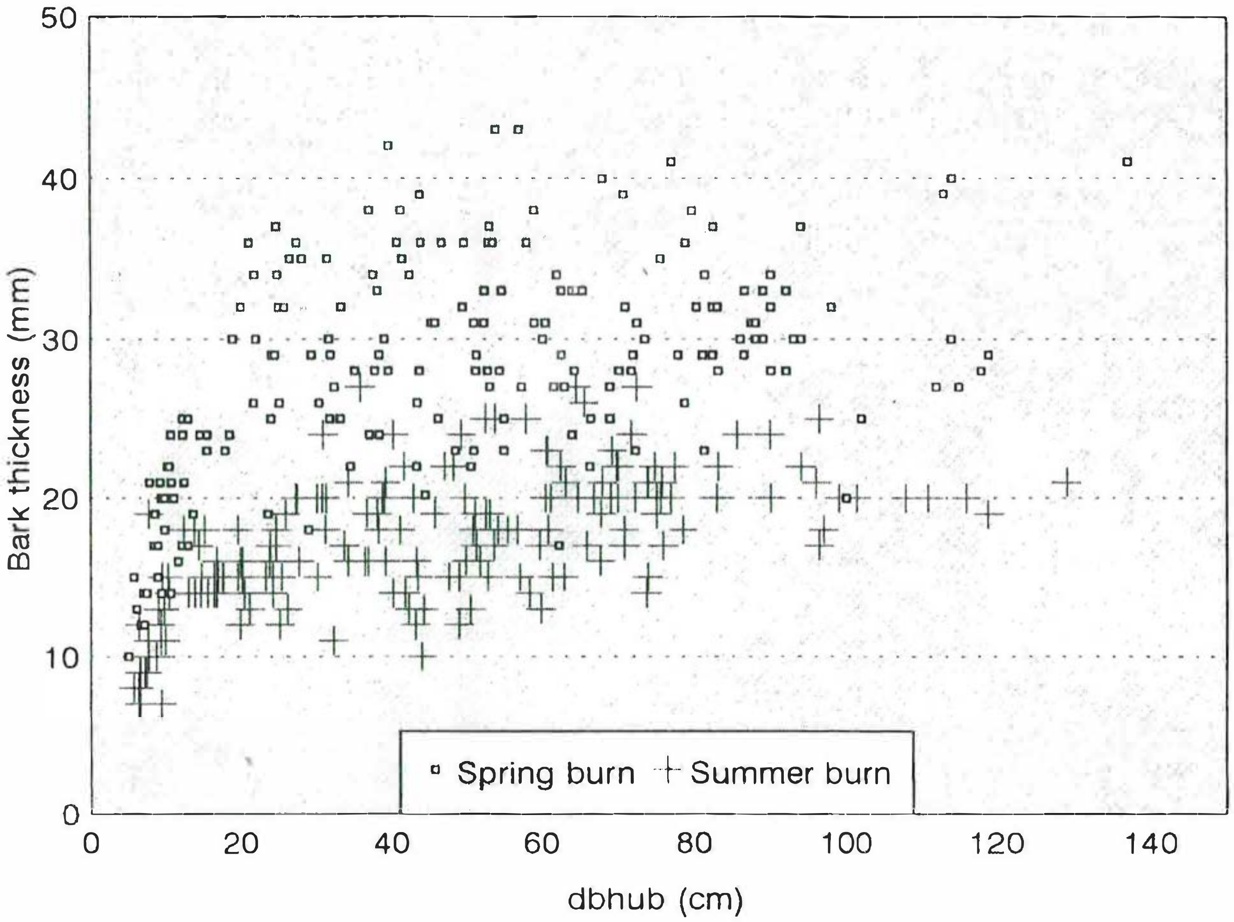

*Figure 2. The relationship between bark thickness and bole diameter measured at breast height (1.3 m) and under bark (d.b.h.u.b.) for jarrah (*Eucalyptus marginata*) trees burnt (a) in spring seven years previously and (b) in summer three months previously.*

overwood trees of messmate stringybark (*Eucalyptus obliqua*) respectively. He also reported an increase in bark loss with increasing SDI. Gill *et al.* (1986) reported a positive relationship between bark loss and fire intensity up to an intensity of about 1000 kW m^{-1} for two eastern Australian *Eucalyptus* species. They reported losses in bark thickness of up to 5 mm and 9 mm for gumbarked and stringybarked species respectively.

Under dry fuel and soil conditions, the quantity of bark on standing trees contributes substantially to the total fuel weight. At this study site, the mean quantity of fine surface litter fuel burnt during the summer fire was about 7.4 t ha^{-1} and we estimate that bark on the boles of standing trees contributed an additional 5 t ha^{-1} of fuel, assuming uniform bark loss along the tree bole. Peet and McCormick (1965) reported a figure of 9.7 t ha^{-1} of bark burnt in a high intensity experimental fire near Dwellingup. However, the stand they studied had a basal area of 44 m^2 ha^{-1}, which was 70 per cent higher than that of our study site.

The specific effect of bark fuel on the behaviour of forest fires, beyond increasing the spotting potential and contributing to the overall intensity of the fire, is not well understood and is not accounted for in existing fire behaviour models. Forest fire fighters need to be aware that while low intensity spring fires control the build-up of fine surface fuel, there is a steady and significant accumulation of flammable fuel and spotting material on tree boles and limbs.

The quantity of bark which burns will depend on the number of years since the last fire, the intensity of the last fire, the tree basal area, the dryness of the bark (which is probably related to the Soil Dryness Index (Mount 1972; Burrows 1987)), the dryness and amount of fine surface fuel and the weather conditions at the time of the fire. Kellas (1992) estimated that bark recovered to pre-burn thickness after a fire-free period of about 15 years. Moderate intensity prescribed fires under dry autumn conditions may be warranted from time to time to reduce the build-up of flammable bark on standing trees, thereby reducing spotting potential and suppression difficulties in the event of a wildfire.

ACKNOWLEDGEMENTS

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Vascular flora of Scott National Park, Camping Reserve 12951 and Gingilup Swamps Nature Reserve, Western Australia

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ABSTRACT

Lists of vascular flora of Scott National Park (↑25373), the adjoining camping reserve (↑12951) and Gingilup Swamps Nature Reserve (↑30626) from the Scott Plain on the south coast of Western Australia are provided. Eight-hundred-and-seventeen taxa were recorded from Scott National Park and the adjoining camping reserve: this is comparable in biodiversity terms with the published flora of Lesueur National Park and the 13 Byenup–Lake Muir reserves. The list includes three species gazetted as Declared Rare Flora and 45 species listed on CALM's priority flora list. There is an urgent need to change the tenure and vesting of the camping reserve (↑12951) to protect the threatened Scott Plains ironstone community and to conserve six priority taxa not recorded from Scott National Park. The preliminary list for Gingilup Swamps Nature Reserve comprises 211 species with 11 of these species on the priority flora list; further work could be expected to substantially increase these numbers. All three reserves cover areas which are highly prospective for mineral sands.

INTRODUCTION

The Scott Coastal Plain extends about 90 km from the Hardy Inlet to near Point D'Entrecasteaux and is bordered in the west by the Leeuwin-Naturaliste Ridge, to the north by the Blackwood Plateau and to the east by Darling Plateau. It consists primarily of a series of late Pleistocene to Holocene dune sequences and alluvial soils associated with the Blackwood and Scott Rivers (Baddock 1995). On the western side of the plain there has been extensive development of a ferruginous sandstone which has formed by the precipitation of iron from groundwater (Baddock 1995). A specific vegetation community with a large number of endemic taxa are found where these ironstones outcrop (Gibson *et al.* 2000). The area is subject to a moderate mediterranean climate with annual rainfall in the order of 1000–1200 mm (Beard 1982).

Much of the western side of the plain has been cleared for agriculture, this area was previously dominated by eucalypt or *Banksia* woodlands on the uplands and a complex mosaic of wetlands on the flats. Scott National Park (↑25373, 3272.9 ha) and Gingilup Swamps Nature Reserve (↑30626, 4326.0 ha) comprise the largest remaining remnants on the western side of the plain (Fig. 1). Robinson and Keighery (1997) have mapped the vegetation of Scott National Park and the adjacent camping reserve (↑12951, 103.9 ha) and list 734 taxa as occurring in these reserves. Recent work by Lyons *et al.* (2000) on determining conservation status of species occurring in the Warren Bioregion (Thackway and Creswell 1995) has resulted in re-compilation of this list and generation of a preliminary list for Gingilup Swamps Nature Reserve.

Four other CALM reserves occur on the western side of the Scott Coastal Plain (↑42942, 3.8 ha; ↑42377, 50.2 ha; ↑15185, 9.8 ha; ↑14779, 103.6 ha), none of these reserves has been surveyed in detail and all are much smaller than Scott National Park and Gingilup Swamps Nature Reserve. Reserve 42377 comprises the water course to the east of Brennan's Ford (adjacent to Scott River National Park) and is noteworthy as being the only conservation reserve in which *Lambertia orbifolia* ssp. Scott Plains (L.W. Sage 684) has been recorded.

All of the Scott Plain is highly prospective for mineral sands with the first major mine having been developed north of Scott National Park. The aim of this paper is to provide details of the floristic values of the two largest reserves on the plain and the camping reserve adjoining Scott National Park.

METHODS

Data on species distribution for three reserves were extracted from the database developed by Lyons *et al.* (2000) with additions from Robinson and Keighery (1997). The database of Lyons *et al.* (2000) was compiled from survey data and records held in Western Australian Herbarium as detailed in that publication. In all, over 2500 records were used to compile the flora lists, of these 36 per cent were derived from collections held in the Western Australian Herbarium and 64 per cent from field survey. Many of the herbarium collections were voucher specimens for the field surveys. Nomenclature generally follows Paczkowska and Chapman (2000).

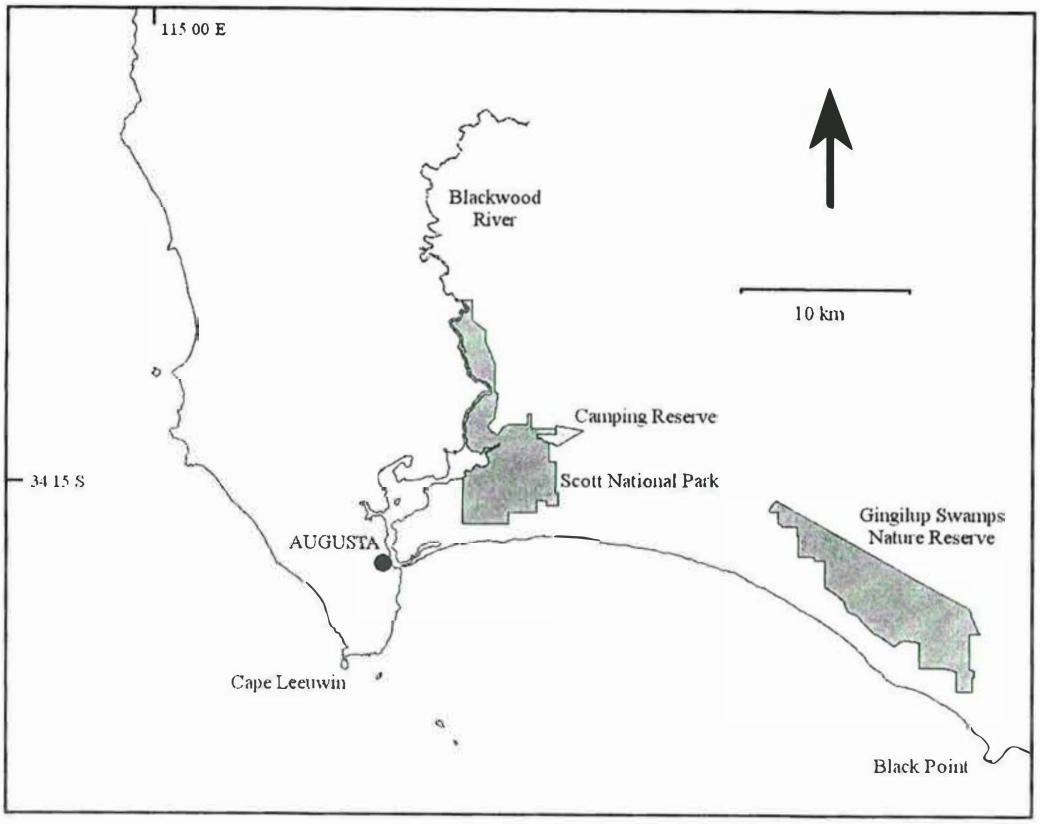

Figure 1. Location of Scott National Park, Camping Reserve (↑12951), and Gingilup Swamps Nature Reserve.

RESULTS

Scott National Park and Reserve 12951

Eight-hundred-and-seventeen vascular plant taxa (744 native and 73 weeds) were recorded from the Scott National Park and the adjacent camping reserve (Appendix 1). This represents an 11 per cent increase over that reported by Robinson and Keighery (1997); their list was compiled largely from fieldwork undertaken in 1990 and 1991. The largest families were Orchidaceae (58 native, 1 weed), Papilionaceae (51 native, 8 weeds), Proteaceae (54 native), Myrtaceae (49 native, 1 weed), Cyperaceae (46 native, 3 weed), Asteraceae (31 native, 14 weeds) and Restionaceae (42 native). The largest genera were *Stylidium* (28 taxa), *Leucopogon* (22 taxa), *Acacia* (18 taxa), *Schoenus* (15 taxa), *Caladenia* (14 taxa), and *Drosera* (14 taxa). The overall composition is little changed from that reported by Robinson and Keighery (1997) and is typical of the high rainfall zone of south-west Western Australia (Hopper 1979). Members of the Asteraceae and Poaceae (14 taxa) were the most common weeds.

Separate lists for both Scott National Park and the camping reserve are given in Appendix 1. Seven-hundred-and-eighty-seven taxa were recorded in Scott National Park while 178 were listed from the camping reserve. Of these 30 were not recorded in Scott National Park. The Department of Conservation and Land Management lists plant species that are under immediate threat of extinction under provisions of the Wildlife Conservation Act as Declared Rare Flora. Other species of conservation concern are informally listed as priority flora (Atkins 1999). Three species of Declared Rare Flora and 45 taxa on the priority flora list were recorded from the reserves (Table 1). The three species of Declared Rare Flora and 28 priority taxa were restricted to Scott National Park, a further 11 occurred in both reserves and 6 priority taxa were found only in the camping reserve.

The Scott Plain ironstone community is considered a threatened ecological community (English and Blyth 1999). Gibson *et al.* (2000) identify 20 taxa that are largely confined to the ironstone areas of the Swan and Scott Coastal Plains. Six of the taxa have their major distribution centered on the Scott Plain ironstones and another three co-occur on the ironstones of both the Swan and Scott Coastal Plains. Six of these nine taxa are recorded from Scott National Park and the adjacent camping reserve (Table 1). Very little ironstone habitat occurs in Scott River National Park. In contrast, *c.* 30 ha of this habitat occurs in the camping reserve (Robinson and Keighery 1997). The type location for *Chordifex isomorphus* (whose western populations are restricted to the ironstones) occurs in the camping reserve (Meney *et al.* 1996) and no populations of this taxon have been recorded from Scott National Park.

TABLE 1

Threatened and priority flora recorded in Scott National Park and the adjacent camping reserve.

(Conservation codes: R, Declared Rare Flora; Priority 1 - plants known from one or few populations which are under threat; Priority 2 - plants known from one or few populations which are not under threat; Priority 3 - plants known from several populations and not believed to be under immediate threat; Priority 4 - plants that are well known and while rare are not currently threatened but require monitoring - Atkins 1999). Species associated with shallow soils on ironstone indicated in bold.

TAXON	CAMPING RESERVE	SCOTT NATIONAL PARK	CONSERVATION CODE
Boronia exilis		+	R
Dryandra nivea* ssp. *uliginosa		+	**R**
Grevillea brachystylis ssp. *australis*		+	R
Philydrella pygmaea ssp. *minima*		+	1
Schoenus indutus		+	1
Thysanotus formosus		+	1
Alexgeorgea ganopoda		+	2
Amperea protensa		+	2
Caladenia abbreviata ms		+	2
Conospermum quadripetalum		+	2
Hybanthus volubilis		+	2
Leptomeria furtiva		+	2
Schoenus loliaceus		+	2
Acacia horridula		+	3
Chordifex gracilior		+	3
Conospermum paniculatum		+	3
Cyathochaeta stipoides		+	3
Gonocarpus pusillus		+	3
Jansonia formosa		+	3
Lepyrodia heleocharoides		+	3
Meeboldina thysanantha ms		+	3
Sphenotoma parviflorum		+	3
Sporadanthus rivularis ms		+	3
Xanthosia eichleri		+	3
Anthotium junciforme		+	4
Aotus carinata		+	4
Astartea sp. Scott River (D.Backshall 88233)		+	4
Melaleuca basicephala		+	4
Microtis media ssp. *quadrata*		+	4
Tyrbastes glaucescens		+	4
Verticordia lehmannii		+	4
Grevillea manglesioides* ssp. *ferricola	**+**	**+**	**1**
***Calothamnus* sp. Scott River (R.D.Royce 84)**	**+**	**+**	**2**
Hakea tuberculata	**+**	**+**	**2**
Blennospora sp. Ruabon (B.J.Keighery & N.Gibson 20)	+	+	3
Boronia anceps	+	+	3
Grevillea papillosa	+	+	3
Isopogon formosus ssp. *dasylepis*	+	+	3
Loxocarya magna	**+**	**+**	**3**
Stylidium leeuwinense	+	+	3
Stylidium mimeticum	+	+	3
Hypocalymma sp. Scott River (A.S.George 11773)	+	+	4
Haloragis tenuifolia	+		1
Thomasia triloba	+		1
Chordifex isomorphus	**+**		**2**
Spyridium spadiceum	+		2
Adenanthos detmoldii	+		4
Thysanotus glaucus	+		4

Of the three ironstone taxa not recorded in Scott National Park or the camping reserve, *Lambertia orbifolia* ssp. Scott Plains (L.W. Sage 684) occurs on ironstone outcrops along Scott River in reserve ↑42942 to the east of Scott National Park, and in the narrow strip of vacant Crown land that follows the river within the boundary of the National Park. One of the remaining taxa is restricted to a single population in Gingilup Swamps Nature Reserve (*Melaleuca incana* ssp. Gingilup (N.Gibson and M.Lyons 593)), and the largest population of the other ironstone taxon (*Darwinia ferricola*) as well as the largest population of *Lambertia orbifolia* ssp. Scott Plains (L.W. Sage 684) occurs in an ironstone remnant on private property to the north of Scott National Park.

Scott National Park is the only secure conservation reserve in which *Leptomeria furtiva* has been recorded. The other known population of this species occurs in Ambergate Reserve south of Busselton which is vested in the Shire of Busselton and managed by the Busselton Naturalists' Club.

Gingilup Swamps Nature Reserve

A total of 211 taxa (201 natives and 10 weeds) have been recorded from very limited survey of Gingilup Swamps Nature Reserve (Appendix 2). The largest families were Myrtaceae (29 native taxa), Cyperaceae (22 native, 1 weed), Restionaceae (22 native), Proteaceae (13 native), Stylidiaceae (12 taxa) and Epacridaceae (10 native). The largest genera were *Stylidium* (12 taxa), *Melaleuca* (10 taxa), and *Drosera, Leucopogon* and *Schoenus* (all with 7 taxa), reflecting the concentration of survey to date on the wet flats.

Eleven species of priority flora are known from Gingilup Swamps Nature Reserve, including the only known population of the ironstone endemic *Melaleuca incana* ssp. Gingilup (N.Gibson and M.Lyons 593) (Table 2). The ironstone community is restricted to a small area on the northern boundary of the reserve. The extensive wet flats that occur in the northern and eastern parts of the reserve support very large populations of the priority taxa *Tyrbastes glaucescens, Melaleuca basicephala,* and *Jansonia formosa*.

DISCUSSION

Ten taxa appear to be endemic to the Scott Coastal Plain, seven of which occur within the boundary of Scott National Park and the camping reserve (*Adenanthos detmoldii, Aotus carinatus, Astartea sp.* Scott River (D.Backshall 88233), *Grevillea brachystylis* ssp. *australis, Grevillea manglesioides* ssp. *ferricola*, *Hypocalymma* sp. Scott River (A.S.George 11773), and *Philydrella pygmaea* ssp. *minima*). A further two species occur on or near ironstone habitat to the north of Scott National Park (*Darwinia ferricola* ms and *Synaphea nexosa*), and *Melaleuca incana* ssp. Gingilup (N.Gibson and M.Lyons 593) is only known from a single population in Gingilup Swamps Nature Reserve. *Chordifex isomorphus* was at one stage considered to be a Scott endemic but is now known to occur on similar ironstone habitat on the southern end of the Swan Coastal Plain and along the south coast well to the east.

The swamps of Scott National Park and Gingilup Swamps Nature Reserve are floristically distinct from those of the eastern Scott Plain and from the extensive swamps east of Point D'Entrecasteaux (Gibson and Lyons, unpublished data). The swamps in both reserves consist of complex mosaics of different floristic units (Robinson and Keighery 1997).

The Scott National Park and the camping reserve conserve the largest area (*c.* 30 ha) of the threatened Scott Plains ironstone community on public lands on the Scott Plains (Robinson and Keighery 1997; Gibson *et al.* 2000) This community has been recognized as a threatened

TABLE 2

Threatened and priority flora recorded in Gingilup Swamps Nature Reserve.

(Conservation codes: Priority 2 - plants known from one or few populations which are not under threat; Priority 3 - plants known from several populations and not believed to be under immediate threat; Priority 4 - plants that are well known and while rare are not currently threatened but require monitoring - Atkins 1999). Species associated with shallow soils on ironstone indicated in bold.

TAXON	CONSERVATION CODE
Hakea tuberculata	**2**
***Melaleuca incana* ssp. Gingilup (N.Gibson & M.Lyons 593)**	**2**
Andersonia amabile ms	3
Grevillea papillosa	3
Jansonia formosa	3
Stylidium leeuwinense	3
Stylidium mimeticum	3
Adenanthos detmoldii	4
Astartea sp.Scott River (D.Backshall 88233)	4
Melaleuca basicephala	4
Tyrbastes glaucescens	4

ecological community (English and Blyth 1999). There is an urgent need to change the tenure and vesting of the camping reserve to protect this community and conserve the priority taxa not recorded from Scott National Park. The immediate riparian zone of Scott River which bisects the Scott National Park is vacant Crown land, and is presently being managed as part of the conservation reserve, but is an anomalous vesting.

Scott National Park and the adjacent camping reserve are clearly of major conservation significance. The combined flora list of 817 is comparable with the published flora of Lesueur National Park (821 taxa–Griffin *et al.* 1990) and with the published lists for the 13 Byenup – Muir wetland reserves (976 taxa–Gibson and Keighery 2000). The diversity of the flora of Scott National Park resides in the complex wetland systems. Scott National Park and the camping reserve are only *c.* 25 per cent of the size of Mt Lesueur National Park and 17 per cent of the size of the Byenup–Muir Reserves. This is in a setting where much of the western half of the Scott Plain has been cleared for agriculture and all areas are highly prospective for mineral sands.

Very little work has been undertaken to date on documenting the flora and vegetation of Gingilup Swamps Nature Reserve. The area of the reserve is *c.*1000 ha larger than Scott National Park and the adjoining camping reserve. It has a similar complexity of vegetation types (a mosaic of wetlands on the flats and *Agonis*-eucalypt woodlands on the uplands) and could be expected to conserve a similar number of species to that found in Scott National Park and the camping reserve. There is an urgent need for a detailed survey of the flora values of the reserve to be undertaken, as the area is prospective for mineral sands.

The most significant patch of remnant vegetation on the western Scott Coastal Plain outside the conservation reserve network is the large remnant block (*c.* 100 ha) of ironstone community on the eastern half of Sussex location 4264. This block contains the largest known population of *Darwinia ferricola* ms, and large populations of *Adenanthos detmoldii, Calothamnus* sp. Scott River (Royce 84), *Chordifex isomorphus, Dryandra nivea* ssp. *uliginosa, Grevillea manglesioides* ssp. *ferricola, Hakea tuberculata, Lambertia orbifolia* ssp. Scott Plains (L.W. Sage 684) and *Loxocarya magna.* This area is currently being managed for conservation purposes by the mining company BHP: efforts should also be made to acquire this block as a conservation reserve.

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APPENDIX 1

Flora list for Scott National Park and camping reserve ↑12951.

(* indicates introduced taxa, Conservation codes: R, Declared Rare Flora; Priority 1 - plants known from one or few populations which are under threat; Priority 2 - plants known from one or few populations which are not under threat; Priority 3 - plants known from several populations and not believed to be under immediate threat; Priority 4 - plants that are well known and while rare are not currently threatened but require monitoring - Atkins 1999).

FAMILY	TAXON	SCOTT NP	↑12951	CONSERVATION CODE
Amaranthaceae	*Alternanthera nodiflora*	+		
Anthericaceae	*Agrostocrinum scabrum*	+		
	Caesia aff. *micrantha* (GJK 11607)		+	
	Caesia micrantha	+	+	
	Caesia occidentalis	+		
	Chamaescilla corymbosa var. *corymbosa*	+		
	Hodgsoniola junciformis	+	+	
	Johnsonia acaulis	+		
	Johnsonia lupulina	+		
	Laxmannia sessiliflora ssp. *australis*	+		
	Sowerbaea laxiflora	+	+	
	Thysanotus arenarius	+		
	Thysanotus dichotomus	+		
	Thysanotus formosus	+		1
	Thysanotus glaucus		+	4
	Thysanotus gracilis	+		
	Thysanotus manglesianus	+		
	Thysanotus multiflorus	+	+	
	Thysanotus patersonii	+		
	Thysanotus tenellus	+	+	
	Thysanotus triandrus	+		
	Tricoryne elatior	+		
	Tricoryne humilis	+		
Apiaceae	*Actinotus glomeratus*	+		
	Actinotus laxus ms	+	+	
	Actinotus omnifertilis	+		
	Apium annuum	+		
	Apium prostratum var. *prostratum*	+		
	Centella asiatica	+		
	Daucus glochidiatus	+		
	Eryngium pinnatifidum	+	+	
	Homalosciadium homalocarpum	+	+	
	Hydrocotyle alata	+	+	
	Hydrocotyle blepharocarpa	+		
	Hydrocotyle callicarpa	+		
	Hydrocotyle diantha	+		
	Hydrocotyle pilifera	+		
	Hydrocotyle plebeya	+		
	Pentapeltis peltigera	+		
	Platysace compressa	+		
	Platysace filiformis	+		
	Platysace pendula	+		
	Platysace tenuissima	+		
	Schoenolaena juncea	+		
	Trachymene pilosa	+		
	Xanthosia candida	+		
	Xanthosia eichleri	+		3
	Xanthosia tasmanica	+		
	Xanthosia pusilla	+		
Asphodelaceae	*Bulbine semibarbata*	+		
Asteraceae	*Angianthus preissianus*	+		
	* *Arctotheca calendula*	+		
	* *Aster subulatus*	+		
	Asteridea pulverulenta	+		
	Blennospora sp. Ruabon (B.J.Keighery & N.Gibson 20)	+	+	3

	*	*Carduus pycnocephalus*	+	
		Centipeda cunninghamii	+	
	*	*Cirsium vulgare*	+	
	*	*Conyza albida*	+	
	*	*Conyza bonariensis*	+	
		Cotula coronopifolia	+	
		Craspedia variabilis	+	
		Euchiton sphaericus	+	
		Hyalosperma cotula	+	+
		Hyalosperma demissum	+	
		Hyalosperma pusillum	+	
		Hyalosperma simplex ssp. *simplex*	+	
	*	*Hypochaeris glabra*	+	+
		Ixiolaena viscosa	+	
		Lagenophora huegelii	+	
	*	*Leontodon saxatilis*	+	
		Leptorhynchos scaber	+	+
		Olearia axillaris	+	
		Olearia elaeophila	+	
		Olearia paucidentata	+	
		Ozothamnus cordatus	+	
		Pithocarpa pulchella var. *melanostigma*	+	
		Podolepis gracilis	+	+
		Podotheca angustifolia	+	
	*	*Pseudognaphalium luteoalbum*	+	
		Pterochaeta paniculata	+	
		Quinetia urvillei	+	
		Rhodanthe citrina	+	
	*	*Senecio elegans*	+	
		Senecio glomeratus	+	
		Senecio hispidulus var. *hispidulus*	+	
		Senecio lautus	+	
		Siloxerus humifusus	+	+
	*	*Sonchus asper*	+	
		Sonchus hydrophilus		
	*	*Sonchus oleraceus*	+	
		Trichocline sp. (GJK 6382)		+
	*	*Ursinia anthemoides*	+	
	*	*Vellereophyton dealbatum*	+	+
		Waitzia suaveolens	+	
Brassicaceae	*	*Heliophila pusilla*	+	
		Stenopetalum robustum	+	
Campanulaceae	*	*Wahlenbergia capensis*	+	
		Wahlenbergia gracilenta	+	
		Wahlenbergia multicaulis	+	
Caryophyllaceae	*	*Cerastium glomeratum*	+	
	*	*Corrigiola litoralis*	+	
	*	*Petrorhagia velutina*	+	
	*	*Silene gallica*	+	
Casuarinaceae		*Allocasuarina fraseriana*	+	
Centrolepidaceae		*Aphelia brizula*	+	
		Aphelia cyperoides	+	+
		Aphelia drummondii	+	
		Aphelia nutans		+
		Centrolepis aristata	+	+
		Centrolepis drummondiana	+	
		Centrolepis glabra		+
		Centrolepis inconspicua	+	
		Centrolepis mutica	+	+
Chenopodiaceae	*	*Atriplex prostrata*		+
	*	*Chenopodium multifidum*		+
	*	*Chenopodium murale*	+	
		Halosarcia indica ssp. *bidens*	+	
		Rhagodia baccata	+	
		Sarcocornia quinqueflora ssp. *quinqueflora*	+	
		Suaeda australis	+	

Appendix 1 (continued)

Colchicaceae	*Burchardia congesta*	+		
	Burchardia multiflora	+	+	
Crassulaceae	*Crassula closiana*	+		
	Crassula colorata	+		
	* *Crassula decumbens*	+		
	Crassula exserta	+		
	* *Crassula natans*	+		
	Crassula peduncularis	+		
Cyperaceae	*Baumea articulata*	+		
	Baumea juncea	+		
	Baumea riparia	+		
	Baumea vaginalis	+		
	Bolboschoenus caldwellii	+		
	Chorizandra cymbaria	+	+	
	Chorizandra enodis	+		
	Cyathochaeta avenacea	+		
	Cyathochaeta clandestina	+		
	Cyathochaeta stipoides	+		3
	* *Cyperus tenellus*	+	+	
	Evandra aristata	+	+	
	Gahnia trifida	+		
	Gymnoschoenus anceps	+		
	Isolepis cyperoides	+	+	
	* *Isolepis marginata*	+	+	
	Isolepis nodosa	+		
	* *Isolepis prolifera*	+		
	Isolepis setiformis	+		
	Isolepis stellata	+		
	Lepidosperma carphoides	+		
	Lepidosperma effusum	+		
	Lepidosperma gladiatum	+		
	Lepidosperma longitudinale	+	+	
	Lepidosperma pubisquameum	+		
	Lepidosperma squamatum	+	+	
	Lepidosperma tetraquetrum	+		
	Mesomelaena graciliceps	+	+	
	Mesomelaena stygia	+		
	Mesomelaena tetragona	+	+	
	Schoenus asperocarpus	+		
	Schoenus bifidus	+		
	Schoenus cruentus	+		
	Schoenus curvifolius	+		
	Schoenus discifer	+		
	Schoenus efoliatus	+	+	
	Schoenus elegans	+		
	Schoenus indutus	+		1
	Schoenus loliaceus	+		2
	Schoenus maschalinus		+	
	Schoenus nitens	+		
	Schoenus odontocarpus	+	+	
	Schoenus sp. (C.J. Robinson 402)	+		
	Schoenus subflavus	+		
	Schoenus sublateralis	+		
	Tetraria capillaris	+		
	Tetraria octandra	+		
	Tricostularia neesii var. *elatior*	+		
	Tricostularia neesii var. *neesii*	+		
Dasypogonaceae	*Acanthocarpus preissii*	+		
	Baxteria australis	+	+	
	Dasypogon bromeliifolius	+	+	
	Dasypogon hookeri	+		
	Kingia australis	+		
	Lomandra caespitosa	+		
	Lomandra integra	+		
	Lomandra nigricans	+		
	Lomandra odora	+		

	Lomandra pauciflora	+		
	Lomandra preissii	+		
	Lomandra purpurea	+		
	Lomandra sericea	+		
	Lomandra sonderi	+		
Dennstaedtiaceae	*Pteridium esculentum*	+		
Dilleniaceae	*Hibbertia amplexicaulis*	+		
	Hibbertia cuneiformis	+		
	Hibbertia cunninghamii	+		
	Hibbertia ferruginea	+		
	Hibbertia furfuracea	+		
	Hibbertia glomerosa	+		
	Hibbertia hypericoides	+		
	Hibbertia inconspicua	+		
	Hibbertia pulchra	+		
	Hibbertia racemosa	+		
	Hibbertia sp.rigid bracts (J.R.Wheeler 3220)	+		
	Hibbertia stellaris	+	+	
Droseraceae	*Drosera bulbosa*	+		
	Drosera enodes	+		
	Drosera erythrorhiza	+		
	Drosera gigantea ssp. *geniculata*	+		
	Drosera glanduligera	+	+	
	Drosera huegelii	+		
	Drosera macrantha ssp. *macrantha*	+	+	
	Drosera menziesii ssp. *menziesii*	+	+	
	Drosera myriantha	+		
	Drosera neesii ssp. *neesii*	+	+	
	Drosera nitidula ssp. *omissa*	+	+	
	Drosera pallida	+	+	
	Drosera platypoda	+		
	Drosera pulchella	+		
Epacridaceae	*Andersonia caerulea*	+	+	
	Andersonia involucrata	+		
	Andersonia micrantha	+		
	Andersonia sprengelioides	+		
	Astroloma ciliatum	+		
	Astroloma pallidum	+		
	Leucopogon alternifolius	+	+	
	Leucopogon australis	+		
	Leucopogon capitellatus	+		
	Leucopogon carinatus	+	+	
	Leucopogon conostephioides	+		
	Leucopogon cordatus	+	+	
	Leucopogon distans ssp. *contractus* ms	+		
	Leucopogon gilbertii	+		
	Leucopogon glabellus	+		
	Leucopogon hirsutus	+		
	Leucopogon oxycedrus	+		
	Leucopogon parviflorus	+		
	Leucopogon pendulus	+	+	
	Leucopogon racemulosus	+		
	Leucopogon reflexus	+		
	Leucopogon revolutus	+		
	Leucopogon sp.Windy Harbour (A.Strid 21460)	+	+	
	Leucopogon squarrosus	+		
	Leucopogon striatus	+		
	Leucopogon tenuicaulis ms	+	+	
	Leucopogon unilateralis	+		
	Leucopogon verticillatus	+		
	Lysinema ciliatum	+	+	
	Lysinema conspicuum	+	+	
	Needhamiella pumilio	+	+	
	Sphenotoma capitatum	+		
	Sphenotoma gracile	+	+	
	Sphenotoma parviflorum	+		3

Appendix 1 (continued)

Eremosynaceae		*Eremosyne pectinata*	+		
Euphorbiaceae		*Amperea ericoides*	+		
		Amperea protensa	+		2
		Amperea volubilis	+		
		Calycopeplus oligandrus	+		
		Monotaxis grandiflora	+		
		Monotaxis occidentalis	+		
		Phyllanthus calycinus	+		
		Poranthera ericoides	+		
		Poranthera huegelii	+		
		Poranthera microphylla	+		
Gentianaceae	*	*Centaurium erythraea*	+		
		Centaurium spicatum	+		
	*	*Cicendia filiformis*	+	+	
		Sebaea ovata	+		
Geraniaceae		*Pelargonium littorale*	+		
Goodeniaceae		*Anthotium junciforme*	+		4
		Dampiera alata	+		
		Dampiera hederacea	+		
		Dampiera leptoclada	+		
		Dampiera linearis	+	+	
		Dampiera sacculata	+		
		Dampiera trigona	+		
		Diaspasis filifolia	+	+	
		Goodenia eatoniana	+		
		Goodenia micrantha	+		
		Goodenia pulchella	+		
		Goodenia pusilla	+		
		Lechenaultia biloba	+	+	
		Lechenaultia expansa	+	+	
		Scaevola calliptera	+		
		Scaevola globulifera	+		
		Scaevola nitida	+		
		Scaevola striata var. *striata*	+		
		Velleia macrophylla	+		
		Velleia trinervis	+	+	
Haemodoraceae		*Anigozanthos flavidus*	+		
		Anigozanthos manglesii ssp. *manglesii*	+		
		Anigozanthos viridis ssp. *viridis*	+		
		Conostylis aculeata ssp. *aculeata*	+		
		Conostylis laxiflora	+		
		Conostylis setigera ssp. *setigera*	+		
		Haemodorum laxum	+		
		Haemodorum simplex	+	+	
		Haemodorum sparsiflorum	+		
		Haemodorum spicatum	+		
		Phlebocarya ciliata	+	+	
		Tribonanthes australis	+	+	
		Tribonanthes violacea	+		
Haloragaceae		*Gonocarpus benthamii*	+		
		Gonocarpus hexandrus		+	
		Gonocarpus paniculatus	+		
		Gonocarpus pusillus	+		3
		Haloragis brownii	+		
		Haloragis tenuifolia		+	1
Hydatellaceae		*Trithuria bibracteata*		+	
		Trithuria submersa	+		
Hydrocharitaceae		*Ottelia ovalifolia*	+		
Hypoxidaceae		*Hypoxis occidentalis* var. *quadriloba*	+		
Iridaceae		*Orthrosanthus laxus* var. *laxus*	+		
		Patersonia juncea	+	+	
		Patersonia occidentalis	+	+	
		Patersonia sp. Swamp form (N.Gibson & M.Lyons 544)	+		
		Patersonia umbrosa var. *xanthina*	+		
	*	*Romulea rosea*	+		

Juncaceae		*Juncus amabilis*	+		
	*	*Juncus articulatus*	+	+	
	*	*Juncus bufonius*	+		
	*	*Juncus capitatus*	+		
		Juncus gregiflorus	+		
		Juncus holoschoenus	+		
		Juncus kraussii	+		
	*	*Juncus microcephalus*	+		
		Juncus pallidus	+		
		Juncus pauciflorus	+		
		Juncus planifolius	+		
		Juncus subsecundus	+		
		Luzula meridionalis	+		
Juncaginaceae		*Triglochin calcitrapum*	+		
		Triglochin centrocarpum		+	
		Triglochin huegelii	+		
		Triglochin striatum	+		
		Triglochin trichophorum	+		
Lamiaceae		Genus sp. Nillup (R.D. Royce 98)	+		
		Hemiandra pungens	+	+	
		Hemigenia humilis	+		
	*	*Mentha pulegium*	+		
	*	*Stachys arvensis*	+		
Lauraceae		*Cassytha flava*	+		
		Cassytha glabella	+	+	
		Cassytha micrantha	+		
		Cassytha racemosa forma *pilosa*	+		
		Cassytha racemosa forma *racemosa*	+		
Lentibulariaceae		*Utricularia inaequalis*	+		
		Utricularia menziesii	+		
		Utricularia multifida	+	+	
		Utricularia simplex	+		
Lindsaeaceae		*Lindsaea linearis*	+		
Lobeliaceae		*Grammatotheca bergiana*	+		
		Isotoma hypocrateriformis	+		
		Lobelia alata	+		
		Lobelia gibbosa	+		
		Lobelia rhombifolia	+		
		Lobelia rhytidosperma	+		
		Lobelia tenuior	+		
	*	*Monopsis debilis*	+	+	
Loganiaceae		*Logania campanulata*	+		
		Logania serpyllifolia ssp. *angustifolia*	+		
		Logania vaginalis	+		
		Phyllangium paradoxum	+	+	
Loranthaceae		*Nuytsia floribunda*	+		
Lycopodiaceae		*Phylloglossum drummondii*	+		
Malvaceae		*Sida hookeriana*	+		
Menyanthaceae		*Villarsia albiflora*	+		
		Villarsia lasiosperma	+		
		Villarsia latifolia	+		
		Villarsia parnassifolia	+	+	
		Villarsia violifolia	+		
Mimosaceae		*Acacia alata*	+		
		Acacia browniana var. *browniana*	+	+	
		Acacia cochlearis	+		
		Acacia cyclops	+		
		Acacia divergens	+		
		Acacia extensa	+		
		Acacia hastulata	+	+	
		Acacia horridula	+		3
		Acacia huegelii	+		
		Acacia lateriticola	+		
		Acacia littorea	+		
		Acacia myrtifolia	+	+	
		Acacia pulchella var. *pulchella*	+		
		Acacia scalpelliformis	+		
		Acacia stenoptera	+		
		Acacia tetragonocarpa	+		

Appendix 1 (continued)

	Acacia uliginosa	+		
	Acacia urophylla	+		
Myoporaceae	*Myoporum oppositifolium*	+		
Myrtaceae	*Actinodium cunninghamii*	+		
	Agonis flexuosa	+		
	Agonis floribunda	+		
	Agonis juniperina	+		
	Agonis linearifolia	+		
	Agonis parviceps	+		
	Agonis sp. Lake Jasper (B.Hammersley 567)	+		
	Astartea aff. *fascicularis* weeping (GJK 14586)	+		
	Astartea sp. Scott River (D.Backshall 88233)	+		4
	Astartea sp. Wing tips (M.E.Trudgen 12044)	+	+	
	Beaufortia sparsa	+	+	
	Calothamnus lateralis	+	+	
	Calothamnus lehmannii	+		
	Calothamnus schaueri	+		
	Calothamnus sp. Scott River (R.D.Royce 84)	+	+	2
	Calytrix flavescens	+		
	Calytrix leschenaultii	+		
	Darwinia oederoides	+		
	Eucalyptus calophylla	+		
	Eucalyptus diversicolor	+		
	Eucalyptus marginata ssp. *marginata*	+		
	Eucalyptus megacarpa	+		
	Eucalyptus patens	+		
	Eucalyptus rudis	+		
	Homalospermum firmum	+	+	
	Hypocalymma angustifolium	+		
	Hypocalymma ericifolium	+		
	Hypocalymma sp. Scott River (A.S.George 11773)	+	+	4
	Hypocalymma strictum	+		
	Kunzea ericifolia	+		
	Kunzea recurva	+	+	
	Kunzea recurva x *spathulata*	+		
	Kunzea rostrata		+	
	Kunzea spathulata	+		
	* *Leptospermum laevigatum*	+		
	Melaleuca acerosa	+		
	Melaleuca basicephala	+		4
	Melaleuca cuticularis	+		
	Melaleuca incana ssp. *incana*	+	+	
	Melaleuca lateritia	+		
	Melaleuca pauciflora	+		
	Melaleuca preissiana	+		
	Melaleuca rhaphiophylla	+	+	
	Melaleuca spathulata		+	
	Melaleuca thymoides	+	+	
	Pericalymma crassipes	+		
	Pericalymma ellipticum var. *ellipticum*	+		
	Pericalymma spongiocaule	+		
	Verticordia lehmannii	+		4
	Verticordia plumosa var. *brachyphylla*	+		
Onagraceae	*Epilobium billardierianum*	+		
Ophioglossaceae	*Ophioglossum lusitanicum*	+		
Orchidaceae	*Caladenia abbreviata* ms	+		2
	Caladenia brownii ms	+		
	Caladenia cairnsiana	+		
	Caladenia ensata	+		
	Caladenia flava	+		
	Caladenia gardneri ms	+		

		Caladenia georgei ms	+		
		Caladenia infundibularis	+		
		Caladenia latifolia	+		
		Caladenia longicauda	+		
		Caladenia longiclavata	+		
		Caladenia marginata	+	+	
		Caladenia nana	+		
		Caladenia reptans ssp. *reptans* ms	+		
		Cryptostylis ovata	+		
		Cyanicula gemmata ms	+		
		Cyanicula sericea ms	+		
		Diuris laevis	+		
		Diuris longifolia	+	+	
		Drakaea glyptodon	+	+	
		Drakaea thynniphila		+	
		Elythranthera brunonis	+	+	
		Elythranthera emarginata	+		
		Epiblema grandiflorum var. *grandiflorum*	+		
		Eriochilus dilatatus	+	+	
		Eriochilus scaber	+		
		Leporella fimbriata	+		
		Leptoceras menziesii	+		
		Lyperanthus serratus	+		
		Microtis aff. *alba*	+		
		Microtis alba	+	+	
		Microtis atrata	+		
		Microtis media ssp. *media*	+		
		Microtis media ssp. quadrata	+		4
		Millotia myosotidifolia	+		
	*	*Monadenia bracteata*	+		
		Praecoxanthus aphyllus ms	+		
		Prasophyllum aff. *parvifolium*	+		
		Prasophyllum brownii	+		
		Prasophyllum calcicola ms	+		
		Prasophyllum elatum	+		
		Prasophyllum gracile	+		
		Prasophyllum hians	+		
		Prasophyllum macrostachyum	+		
		Prasophyllum parvifolium	+		
		Prasophyllum regium		+	
		Pterostylis aff. *nana*	+		
		Pterostylis barbata	+		
		Pterostylis vittata	+		
		Pyrorchis forrestii	+	+	
		Pyrorchis nigricans	+		
		Thelymitra aff. *holmsii*	+		
		Thelymitra aff. *macrophylla*	+		
		Thelymitra aff. *pauciflora*	+		
		Thelymitra cornicina	+		
		Thelymitra crinita	+		
		Thelymitra flexuosa	+	+	
		Thelymitra fuscolutea	+		
		Thelymitra mucida	+		
Orobanchaceae	*	*Orobanche minor*	+		
Papilionaceae		*Aotus carinata*	+		4
		Aotus intermedia	+		
		Aotus sp. Scott River (K.F.Kenneally 2371)	+		
		Bossiaea linophylla	+		
		Bossiaea ornata	+		
		Bossiaea praetermissa	+	+	
		Bossiaea rufa	+		
		Callistachys lanceolata	+		
		Chorizema diversifolium	+		
		Chorizema ilicifolium	+		
		Chorizema spathulatum	+		
		Daviesia cordata	+		
		Daviesia decurrens	+	+	
		Daviesia flexuosa	+		
		Daviesia inflata	+		

Appendix 1 (continued)

	Euchilopsis linearis	+	+	
	Eutaxia epacridoides	+		
	Eutaxia obovata	+		
	Eutaxia virgata	+		
	Gastrolobium forrestii	+		
	Gompholobium capitatum	+		
	Gompholobium confertum	+		
	Gompholobium knightianum	+		
	Gompholobium marginatum	+		
	Gompholobium ovatum	+		
	Gompholobium polymorphum	+		
	Gompholobium preissii	+		
	Gompholobium scabrum	+		
	Gompholobium tomentosum	+		
	Hardenbergia comptoniana	+		
	Hovea chorizemifolia	+		
	Hovea elliptica	+		
	Hovea pungens	+		
	Hovea stricta	+		
	Hovea trisperma	+		
	Isotropis cuneifolia	+		
	Jacksonia furcellata	+		
	Jacksonia horrida	+	+	
	Jansonia formosa	+		3
	Kennedia carinata	+		
	Kennedia coccinea	+		
	Latrobea diosmifolia	+	+	
	* *Lotus angustissimus*	+		
	* *Lotus suaveolens*		+	
	* *Lotus uliginosus*	+		
	* *Medicago polymorpha*	+		
	Mirbelia dilatata	+		
	* *Ornithopus compressus*	+		
	Oxylobium lineare	+		
	Pultenaea reticulata	+		
	Sphaerolobium grandiflorum	+		
	Sphaerolobium medium	+		
	Sphaerolobium nudiflorum	+		
	Sphaerolobium racemulosum	+		
	Sphaerolobium vimineum	+	+	
	* *Trifolium campestre* var. *campestre*	+		
	* *Trifolium glomeratum*	+		
	* *Trifolium subterraneum*	+		
	Viminaria juncea	+		
Philydraceae	*Philydrella pygmaea*	+	+	
	Philydrella pygmaea ssp. *minima*	+		1
Phormiaceae	*Stypandra glauca*	+		
Pittosporaceae	*Billardiera variifolia*	+		
	Cheiranthera preissiana	+		
Poaceae	*Agrostis avenacea*	+		
	* *Aira caryophyllea*	+		
	Amphipogon debilis	+		
	Amphipogon laguroides	+	+	
	Amphipogon turbinatus	+	+	
	* *Anthoxanthum odoratum*	+		
	Austrodanthonia acerosa	+		
	Austrodanthonia pilosa	+		
	Austrodanthonia setacea	+	+	
	Austrostipa compressa	+	+	
	Austrostipa flavescens	+		
	Austrostipa semibarbata	+		
	* *Avellinia michelii*	+		
	* *Avena barbata*	+		
	* *Briza maxima*	+		
	* *Briza minor*	+	+	
	* *Bromus diandrus*	+		

	*	*Cynodon dactylon*	+		
	*	*Dactylis glomerata*	+		
		Deyeuxia quadriseta	+		
		Dichelachne crinita	+		
		Diplopogon setaceus	+		
	*	*Ehrharta longiflora*	+		
	*	*Hainardia cylindrica*	+		
		Hemarthria uncinata		+	
	*	*Holcus lanatus*	+		
	*	*Lolium rigidum*		+	
		Microlaena stipoides var. *stipoides*	+		
		Neurachne alopecuroidea	+		
		Poa drummondiana	+		
		Poa poiformis		+	
		Poa porphyroclados	+		
		Poa serpentum	+		
	*	*Polypogon monspeliensis*	+		
		Polypogon tenellus	+		
		Sporobolus virginicus	+		
		Tetrarrhena laevis	+		
Podocarpaceae		*Podocarpus drouynianus*	+		
Polygalaceae		*Comesperma calymega*	+		
		Comesperma ciliatum	+		
		Comesperma confertum	+		
		Comesperma flavum	+		
		Comesperma nudiusculum	+		
		Comesperma virgatum	+		
Polygonaceae	*	*Acetosella vulgaris*	+		
		Muehlenbeckia adpressa	+		
	*	*Rumex conglomeratus*	+		
	*	*Rumex crispus*	+		
Portulacaceae		*Calandrinia corrigioloides*	+		
Primulaceae	*	*Anagallis arvensis*	+		
		Samolus junceus	+		
		Samolus repens	+		
	*	*Samolus valerandi*	+		
Proteaceae		*Acidonia microcarpa*		+	
		Adenanthos barbiger ssp. *intermedius* ms	+		
		Adenanthos detmoldii		+	4
		Adenanthos meisneri	+		
		Adenanthos obovatus	+	+	
		Banksia attenuata	+		
		Banksia grandis	+		
		Banksia ilicifolia	+		
		Banksia littoralis	+		
		Banksia meisneri ssp. *ascendens*	+		
		Banksia occidentalis ssp. *occidentalis*	+		
		Conospermum caeruleum ssp. *debile*	+	+	
		Conospermum capitatum ssp. *capitatum*	+		
		Conospermum flexuosum ssp. *laevigatum*	+		
		Conospermum paniculatum	+		3
		Conospermum quadripetalum	+		2
		Dryandra nivea ssp. *uliginosa*	+		R
		Dryandra sessilis	+		
		Grevillea brachystylis ssp. *australis*	+		R
		Grevillea diversifolia	+		
		Grevillea manglesioides	+	+	
		Grevillea papillosa	+	+	3
		Grevillea quercifolia	+		
		Grevillea manglesioides ssp. ferricola	+	+	1
		Hakea amplexicaulis	+		
		Hakea ceratophylla	+		
		Hakea falcata	+		
		Hakea linearis	+	+	
		Hakea lissocarpha	+		
		Hakea oleifolia	+	+	
		Hakea prostrata	+		
		Hakea ruscifolia	+	+	
		Hakea sulcata	+	+	

Appendix 1 (continued)

	Hakea tuberculata	+	+	2
	Hakea varia	+		
	Isopogon axillaris	+		
	Isopogon formosus ssp. *dasylepis*	+	+	3
	Persoonia elliptica	+		
	Persoonia graminea	+		
	Persoonia longifolia	+		
	Persoonia teretifolia	+		
	Petrophile acicularis	+		
	Petrophile diversifolia	+		
	Petrophile linearis	+		
	Petrophile media	+		
	Petrophile serruriae	+		
	Petrophile squamata	+	+	
	Stirlingia seselifolia	+		
	Stirlingia simplex	+		
	Synaphea favosa	+		
	Synaphea floribunda	+		
	Synaphea gracillima		+	
	Synaphea petiolaris	+		
	Xylomelum occidentale	+		
Ranunculaceae	*Clematis pubescens*	+		
	Ranunculus colonorum	+		
Restionaceae	*Alexgeorgea ganopoda*	+		2
	Anarthria gracilis	+	+	
	Anarthria prolifera	+	+	
	Anarthria scabra	+		
	Chaetanthus leptocarpoides	+		
	Chaetanthus tenellus	+		
	Chordifex amblycoleus	+		
	Chordifex gracilior	+		3
	Chordifex isomorphus		+	2
	Cytogonidium leptocarpoides	+	+	
	Desmocladus castaneus ms	+	+	
	Desmocladus fasciculatus	+	+	
	Desmocladus flexuosus	+		
	Empodisma gracillimum	+		
	Hypolaena caespitosa ms	+	+	
	Hypolaena exsulca	+	+	
	Hypolaena fastigiata		+	
	Hypolaena pubescens	+	+	
	Hypolaena viridis ms	+		
	Leptocarpus diffusus	+		
	Leptocarpus tenax	+		
	Lepyrodia heleocharoides	+		3
	Lepyrodia hermaphrodita		+	
	Lepyrodia porterae ms	+	+	
	Loxocarya cinerea	+		
	Loxocarya magna	+	+	3
	Lyginia barbata	+	+	
	Meeboldina coangustata	+		
	Meeboldina crebriculmis ms	+		
	Meeboldina denmarkica	+		
	Meeboldina roycei ms	+		
	Meeboldina scariosa	+		
	Meeboldina tephrina ms	+		
	Meeboldina thysanantha ms	+		3
	Melanostachya ustulata	+	+	
	Platychorda applanata	+		
	Sporadanthus rivularis ms	+		3
	Sporadanthus strictus	+	+	
	Taraxis grossa	+		
	Tremulina cracens ms	+		
	Tremulina tremula	+	+	
	Tyrbastes glaucescens	+		4

Rhamnaceae		*Spyridium globulosum*	+		
		Spyridium spadiceum		+	2
		Trymalium floribundum	+		
		Trymalium ledifolium var. *rosmarinifolium*	+		
Rosaceae	*	*Rubus discolor*	+		
Rubiaceae		*Opercularia apiciflora*	+		
		Opercularia echinocephala	+		
		Opercularia hispidula	+		
		Opercularia vaginata	+	+	
		Opercularia volubilis	+		
Ruppiaceae		*Ruppia polycarpa*	+		
Rutaceae		*Boronia anceps*	+	+	3
		Boronia crenulata ssp. *crenulata*	+		
		Boronia crenulata ssp. *pubescens*		+	
		Boronia denticulata	+		
		Boronia exilis	+		R
		Boronia fastigiata ssp. *tenuior*	+	+	
		Boronia juncea ssp. *micrantha*	+		
		Boronia juncea ssp. *minima*	+		
		Boronia megastigma	+		
		Boronia molloyae	+		
		Boronia spathulata	+	+	
		Chorilaena quercifolia	+		
		Philotheca spicata	+	+	
		Rhadinothamnus anceps	+		
Santalaceae		*Leptomeria furtiva*	+		2
		Leptomeria pauciflora	+		
		Leptomeria scrobiculata	+		
		Leptomeria squarrulosa	+		
Sapindaceae		*Dodonaea viscosa* ssp. *angustissima*	+		
Scrophulariaceae	*	*Bartsia trixago*	+		
		Glossostigma drummondii	+		
		Gratiola pubescens	+		
	*	*Parentucellia latifolia*	+		
	*	*Parentucellia viscosa*		+	
		Veronica calycina	+		
Selaginellaceae		*Selaginella gracillima*	+		
Solanaceae		*Anthocercis littorea*	+		
	*	*Solanum nigrum*	+		
Stackhousiaceae		*Stackhousia monogyna*	+		
		Tripterococcus brachylobus ms	+		
		Tripterococcus brunonis	+		
Sterculiaceae		*Rulingia corylifolia*	+		
		Thomasia pauciflora	+		
		Thomasia triloba		+	1
Stylidiaceae		*Levenhookia dubia*	+	+	
		Levenhookia pauciflora	+		
		Levenhookia preissii	+		
		Levenhookia pusilla	+		
		Stylidium adnatum	+		
		Stylidium aff. *bulbiferum* (C.J. Robinson 450)	+		
		Stylidium amoenum	+	+	
		Stylidium brunonianum	+		
		Stylidium bulbiferum	+	+	
		Stylidium calcaratum	+		
		Stylidium crassifolium	+		
		Stylidium diversifolium	+		
		Stylidium ecorne	+	+	
		Stylidium falcatum	+		
		Stylidium fasciculatum	+		
		Stylidium glaucum ssp. *angustifolium*	+	+	
		Stylidium guttatum	+		
		Stylidium inundatum	+	+	
		Stylidium junceum	+	+	
		Stylidium leeuwinense	+	+	3
		Stylidium lineatum	+		

Appendix 1 (continued)

	Stylidium luteum ssp. *glaucifolium*	+	+	
	Stylidium mimeticum	+	+	3
	Stylidium perpusillum	+	+	
	Stylidium piliferum	+		
	Stylidium pulchellum	+	+	
	Stylidium repens	+		
	Stylidium scandens	+	+	
	Stylidium schoenoides	+		
	Stylidium spathulatum	+		
	Stylidium squamosotuberosum	+		
	Stylidium violaceum	+		
Thymelaeaceae	*Pimelea angustifolia*	+	+	
	Pimelea ferruginea	+		
	Pimelea hispida	+		
	Pimelea lanata	+		
	Pimelea longiflora ssp. *longiflora*	+	+	
	Pimelea preissii	+		
	Pimelea rosea ssp. *rosea*	+	+	
Tremandraceae	*Platytheca galioides*	+		
	Tetratheca setigera	+		
	Tremandra diffusa	+		
	Tremandra stelligera	+		
Typhaceae	*Typha domingensis*	+		
Violaceae	*Hybanthus volubilis*	+		2
Xanthorrhoeaceae	*Xanthorrhoea brunonis*	+		
	Xanthorrhoea gracilis	+		
	Xanthorrhoea preissii	+	+	
Xyridaceae	*Xyris gracillima*	+		
	Xyris lacera	+		
	Xyris lanata	+		
	Xyris laxiflora	+		
	Xyris roycei	+		
Zamiaceae	*Macrozamia riedlei*	+		
Zannichelliaceae	*Lepilaena cylindrocarpa*	+		

APPENDIX 2

Flora list for Gingilup Swamps Nature Reserve.

(* indicates introduced taxa, Conservation codes: Priority 2 - plants known from one or few populations which are not under threat; Priority 3 - plants known from several populations and not believed to be under immediate threat; Priority 4 - plants that are well known and while rare are not currently threatened but require monitoring - Atkins 1999).

FAMILY		TAXON	CONSERVATION CODE
Anthericaceae		*Agrostocrinum scabrum*	
		Hodgsoniola junciformis	
		Thysanotus gracilis	
		Thysanotus multiflorus	
		Tricoryne humilis	
Apiaceae		*Hydrocotyle alata*	
		Schoenolaena juncea	
Aspleniaceae		*Asplenium flabellifolium*	
Asteraceae	*	*Conyza albida*	
		Craspedia variabilis	
		Hyalosperma pusillum	
	*	*Hypochaeris glabra*	
		Podolepis gracilis	
		Siloxerus humifusus	
Centrolepidaceae		*Aphelia cyperoides*	
		Centrolepis aristata	
		Centrolepis drummondiana	
Colchicaceae		*Burchardia multiflora*	
Cyperaceae		*Baumea juncea*	
		Baumea vaginalis	
		Chorizandra cymbaria	
		Cyathochaeta avenacea	
	*	*Cyperus tenellus*	
		Evandra aristata	
		Gymnoschoenus anceps	
		Isolepis cyperoides	
		Lepidosperma longitudinale	
		Lepidosperma pubisquameum	
		Lepidosperma squamatum	
		Mesomelaena graciliceps	
		Mesomelaena tetragona	
		Schoenus curvifolius	
		Schoenus efoliatus	
		Schoenus odontocarpus	
		Schoenus sublateralis	
		Schoenus sublaxus	
		Schoenus tenellus	
		Schoenus variicellae	
		Tetraria capillaris	
		Tricostularia neesii var. *elatior*	
		Tricostularia neesii var. *neesii*	
Dasypogonaceae		*Baxteria australis*	
		Dasypogon bromeliifolius	
		Lomandra collina	
Dilleniaceae		*Hibbertia amplexicaulis*	
		Hibbertia furfuracea	
		Hibbertia racemosa	
		Hibbertia stellaris	
Droseraceae		*Drosera enodes*	
		Drosera glanduligera	
		Drosera menziesii ssp. *menziesii*	
		Drosera myriantha	
		Drosera pallida	
		Drosera platypoda	
		Drosera pulchella	

Appendix 2 (continued)

Epacridaceae		*Andersonia amabile* ms	3
		Andersonia caerulea	
		Leucopogon alternifolius	
		Leucopogon australis	
		Leucopogon cordatus	
		Leucopogon gracilis	
		Leucopogon pendulus	
		Leucopogon racemulosus	
		Leucopogon sp. Windy Harbour (A.Strid 21460)	
		Sphenotoma capitatum	
Euphorbiaceae		*Amperea volubilis*	
		Monotaxis grandiflora	
Gentianaceae	*	*Centaurium erythraea*	
Goodeniaceae		*Dampiera linearis*	
		Dampiera trigona	
		Diaspasis filifolia	
		Goodenia pulchella ssp. coastal plain A (M.Hislop 634) ms	
		Lechenaultia expansa	
		Velleia trinervis	
Haemodoraceae		*Anigozanthos flavidus*	
		Conostylis aculeata ssp. *aculeata*	
		Phlebocarya ciliata	
		Tribonanthes australis	
Iridaceae		*Patersonia occidentalis*	
		Patersonia umbrosa	
Juncaceae	*	*Juncus bufonius*	
	*	*Juncus capitatus*	
		Juncus planifolius	
Lauraceae		*Cassytha glabella*	
		Cassytha racemosa	
Lobeliaceae		*Isotoma hypocrateriformis*	
		Johnsonia lupulina	
		Lobelia alata	
		Lobelia heterophylla	
Loganiaceae		*Logania vaginalis*	
		Phyllangium paradoxum	
Lycopodiaceae		*Lycopodiella serpentina*	
Mimosaceae		*Acacia hastulata*	
		Acacia myrtifolia	
		Acacia pulchella	
Myrtaceae		*Agonis flexuosa* var. *flexuosa*	
		Agonis floribunda	
		Agonis juniperina	
		Agonis linearifolia	
		Agonis parviceps	
		Agonis sp.Lake Jasper(B.Hammersley 567)	
		Astartea sp. Wing tips (M.E.Trudgen 12044)	
		Astartea sp. Gingilup (N.Gibson & M.Lyons 119)	
		Astartea sp. Scott River (D.Backshall 88233)	4
		Beaufortia sparsa	
		Calothamnus lateralis	
		Eucalyptus marginata	
		Hypocalymma cordifolium ssp. *minus* ms	
		Hypocalymma ericifolium	
		Kunzea ericifolia	
		Kunzea recurva	
		Kunzea recurva x *sulphurea*	
		Melaleuca basicephala	4
		Melaleuca cuticularis	
		Melaleuca incana ssp. Gingilup (N.Gibson & M.Lyons 593)	2
		Melaleuca incana ssp. *incana*	
		Melaleuca lateritia	
		Melaleuca pauciflora	
		Melaleuca preissiana	

		Melaleuca rhaphiophylla	
		Melaleuca thymoides	
		Melaleuca uncinata	
		Pericalymma crassipes	
		Pericalymma ellipticum	
Orchidaceae		*Microtis* aff. *alba*	
		Microtis brownii	
		Pterostylis aff. *nana*	
		Thelymitra aff. *holmsii*	
		Thelymitra crinita	
		Thelymitra flexuosa	
Papilionaceae		*Aotus intermedia*	
		Eutaxia obovata	
		Gompholobium capitatum	
		Jansonia formosa	3
		Latrobea diosmifolia	
	*	*Ornithopus pinnatus*	
		Sphaerolobium gracile	
	*	*Trifolium dubium*	
		Viminaria juncea	
Philydraceae		*Philydrella pygmaea*	
Phormiaceae		*Dianella revoluta*	
Poaceae	*	*Aira caryophyllea*	
		Amphipogon debilis	
		Amphipogon turbinatus	
	*	*Briza minor*	
		Dichelachne crinita	
		Poa poiformis	
Polygalaceae		*Comesperma calymega*	
		Comesperma confertum	
Proteaceae		*Adenanthos detmoldii*	4
		Adenanthos obovatus	
		Banksia attenuata	
		Banksia littoralis	
		Banksia occidentalis ssp. *occidentalis*	
		Conospermum capitatum	
		Grevillea papillosa	3
		Hakea ceratophylla	
		Hakea linearis	
		Hakea sulcata	
		Hakea tuberculata	2
		Hakea varia	
		Petrophile squamata	
Restionaceae		*Anarthria gracilis*	
		Anarthria prolifera	
		Chaetanthus leptocarpoides	
		Chordifex amblycoleus	
		Desmocladus fasciculatus	
		Hypolaena exsulca	
		Hypolaena pubescens	
		Leptocarpus diffusus	
		Lepyrodia drummondiana	
		Lepyrodia hermaphrodita	
		Loxocarya cinerea	
		Lyginia barbata	
		Meeboldina denmarkica	
		Meeboldina roycei ms	
		Meeboldina scariosa	
		Meeboldina tephrina ms	
		Platychorda applanata	
		Sporadanthus strictus	
		Stenotalis ramosissima	
		Taraxis grossa	
		Tremulina tremula	
		Tyrbastes glaucescens	4
Rutaceae		*Boronia juncea* ssp. *minima*	
		Boronia megastigma	
		Phebalium anceps	
		Philotheca spicata	

Appendix 2 (continued)

Santalaceae	*Leptomeria scrobiculata*	
	Leptomeria squarrulosa	
Sterculiaceae	*Thomasia pauciflora*	
Stylidiaceae	*Stylidium caespitosum*	
	Stylidium calcaratum	
	Stylidium crassifolium	
	Stylidium glaucum ssp. *angustifolium*	
	Stylidium imbricatum	
	Stylidium inundatum	
	Stylidium junceum	
	Stylidium leeuwinense	3
	Stylidium luteum	
	Stylidium mimeticum	3
	Stylidium repens	
	Stylidium scandens	
Thymelaeaceae	*Pimelea hispida*	
	Pimelea lanata	
	Pimelea longiflora ssp. *longiflora*	
	Pimelea rosea	
Tremandraceae	*Tetratheca setigera*	
	Tremandra stelligera	
Xanthorrhoeaceae	*Xanthorrhoea preissii*	

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Aboriginal names of mammal species in south-west Western Australia

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ABSTRACT

Approximately 1100 records of Aboriginal names for the native mammal species present in south-west Western Australia have been collated and interpreted from published and unpublished sources. Of the 51 terrestrial species occurring within the range of Noongars (south-west WA Aborigines), reliable names for 40 species are presented. Many of these names appear more apposite than existing vernacular names. To facilitate their adoption, spelling and designation of syllables have been aligned to conform with modern conventions as determined by Noongars.

INTRODUCTION

The Aborigines (Noongars) of south-west Western Australia (Fig. 1) are descended from humans who colonized Australia *c.* 50 ka BP. First studied closely by Europeans in 1791, they depended as hunter-gatherers on an intimate knowledge of the distribution, seasonal abundance, and habits of edible species of plants and animals.

Most of their comestibles came from freshwater, estuaries, and the land, where they lived off fish, crustacea, insects, seeds, corms, tubers, bulbs, rhizomes, fruits, nectar, birds and their eggs, reptiles, frogs and mammals (Meagher 1974). They did not possess watercraft (Abbott 1980) and so did not exploit marine resources such as seals, whales, or fish unless these animals became stranded. Noongars did not consume gastropods.

Their major source of protein comprised many mammal species, with the men hunting the largest species of kangaroo, wallaby and possum with the *ketj* (spear), *karli* (boomerang) and *koitj* (stone axe), sometimes with the aid of pitfall traps and brush fences. The women collected small species (bandicoots, rodents) killed by *karla* (fire). Widespread burning of vegetation ensured an ongoing supply of green pick for browsing and grazing mammal species, thus optimizing the availability of meat.

The Noongar population, estimated to have originally occurred at a density of *c.* 5–10 people/10 000 ha (Hallam 1989), declined after 1826 when Europeans settled in Western Australia (WA). Several pioneers attempted to live in harmony with the Aborigines, developing friendships which enabled people of both races to learn elements of each other's language. The happy outcome was that names applied by Noongars to some plant and animal species were recorded before Aboriginal society was fatally disrupted. Noongars did not have any written records, so there is no equivalent of a dictionary available. According to Paterson (1896), many of the names used by Noongars are adapted from the natural sounds that the animals produce.

Common names of mammals in Australia currently recommended for use (Strahan 1995) are based mainly on names bestowed by the early colonists or are anglicized versions of Latin generic names. In recent years, however, it has been recognized that some of these names are inaccurate (e.g. Honey-possum). Some Aboriginal terms have become widely accepted by modern Australians, including Chuditch, Numbat, Quenda, Woylie and Quokka in south-west WA and Quoll, Bilby, Wombat, Koala, Potoroo, and Euro in other parts of Australia. Vernacular names of native rodents have mostly been formed artificially by an English translation of the Latin binomial. In 1995 a list of Aboriginal names of all native rodent species was published (Braithwaite *et al.* 1995), together with one preferred name for each species.

There are several reasons for preparing an exhaustive synthesis of Noongar names for south-west WA mammal species. First, there is an obvious gap in knowledge compared with that of birds (Serventy and Whittell 1948) and plants (Abbott 1983). Second, scientists seem reluctant to use Noongar names, e.g. when *Potorous gilbertii* was rediscovered in 1994, the English common name coined in 1841 was revived and modified (Sinclair *et al.* 1996). Third, official and popular usage of Noongar names by Western Australians constitutes a tribute to the original inhabitants. Fourth, many of the early word-lists provide only a vague clue as to the identity of some species and this is an impediment to assigning Noongar names to the correct species. General terms such as 'small species of mouse', 'a species of mouse', 'a large species of mouse' (Grey 1840), 'field mouse' (Moore 1842) or 'un piccolo

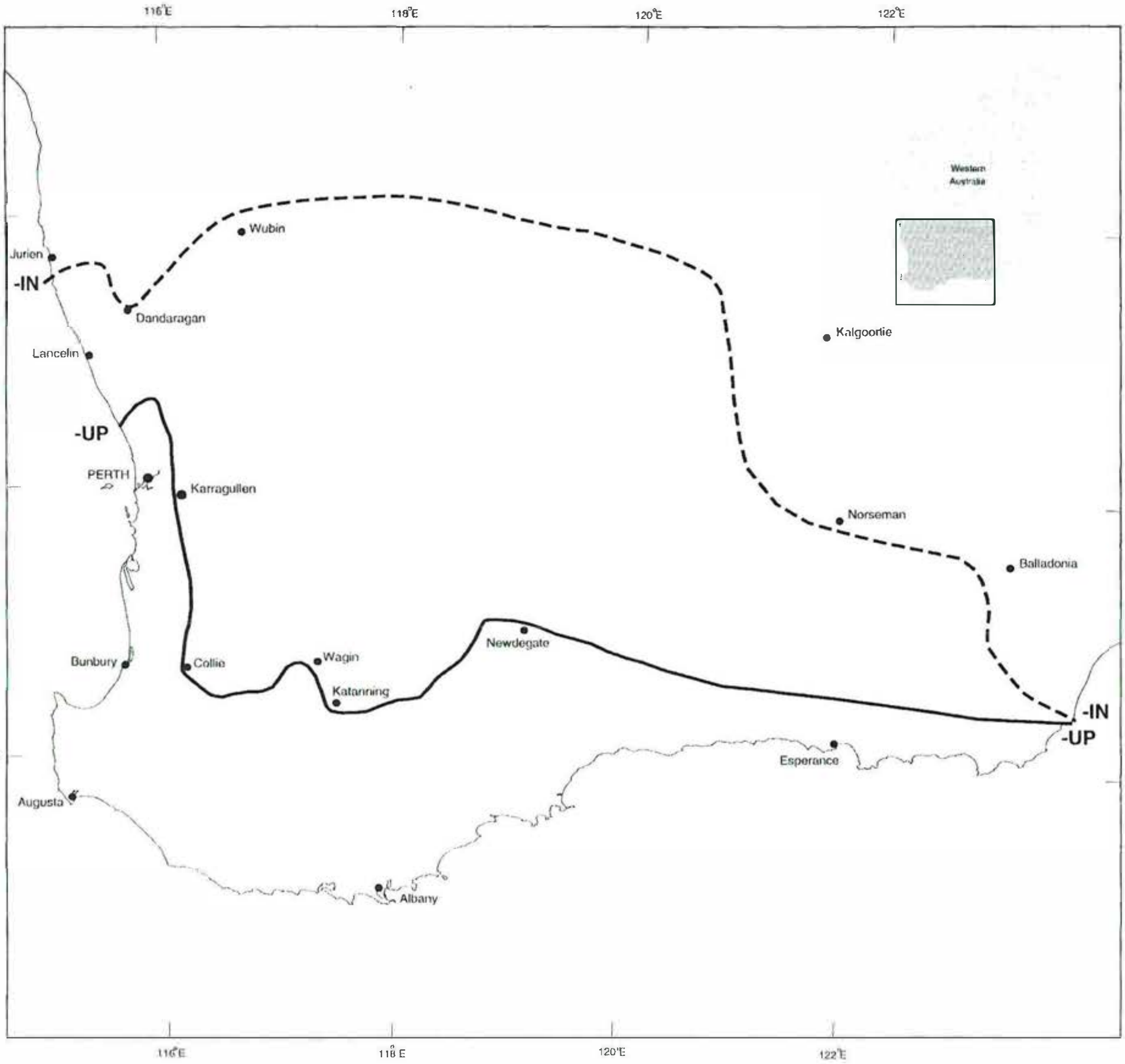

Figure 1. Northern limits of place names in south-west Western Australia ending in –up *or* –in (*or* -ing). *The* -IN *line indicates the geographical limit of Noongar populations.*

animale' (Salvado 1851) are not by themselves helpful to the zoologist.

Research on this project commenced in 1996 when Dr Clemency Fisher of the Liverpool Museum, UK kindly provided me with copies of the manuscript mammal lists of John Gilbert (here styled as MS1 and MS2). These had not been available to inform the valuable research of Whittell (1954a, b).

The objectives of this paper are similar to those of Abbott (1983):

(1) To collate all available records of Noongar names of south-west WA mammal species;

(2) To determine so far as is possible the most accurate version of each name, allowing for local variation and errors in transcribing names;

(3) To provide a list of Aboriginal vernacular names that can be recommended for more general use, both by mammalogists and the general public in south-west WA, and thereby replace unsuitable common names in current use.

METHODS

I located and extracted records from books written by early visitors to, and settlers in, south-west WA, as well as reports or other documents written by explorers, historians and anthropologists. I also consulted word lists (manuscripts or typescripts) held in libraries in Perth and Canberra. Time did not permit perusal of unpublished letters and diaries held in libraries.

It quickly became apparent from searching the comprehensive word-lists published by Grey (1840) and Moore (1842) that Noongar names recorded for small mammal species could not always be linked to known species because of the brevity and vagueness of descriptions. In fairness to these men, few south-west WA mammal species had been named by scientists before 1845, well exemplified by the list published by Gray (1841).

I therefore decided to give primacy to the Noongar word-lists assembled by John Gilbert and Guy Shortridge who collected *inter alia* extensive series of mammals in 1839–42 and 1904–07 respectively (Fig. 2). This was before many mammal species became extinct or had dramatically contracted in geographic range. Both collectors are known to have been assisted by Aborigines (Whittell 1949; unpublished letters of Shortridge to O. Thomas). The names recorded can therefore be regarded as authoritative, except in a few instances discussed later in this paper. Subsequently, when I searched word-lists assembled by non-mammalogists, I could confidently assign most Noongar names to the correct species.

SOURCES OF NOONGAR NAMES

The following list details, in approximate chronological sequence after Gilbert and Shortridge, the various sources of information located and utilized during this study. Chronological, rather than alphabetic, sequence has been preferred because this arrangement highlights the greater reliability of the earlier records. Biographic and historical information has been taken from several sources, especially the Dictionary of Western Australians (6 volumes), the Bicentennial Dictionary of Western Australians (4 volumes), the Australian Dictionary of Biography (14 volumes), and Whittell (1949, 1954a).

Gilbert MS. John Gilbert (1810–1845), naturalist and collector for John Gould (1804–1881), collected mammals in south-west WA between March 1839 and February 1840, and between July 1842 and December 1843. MS refers to two slightly different versions of his hand-written notes (?1843) sent to Gould. I have quoted most extensively from MS1, and have then listed any variants occurring in MS2.

Gilbert in Gould. See Gould (1863). As these volumes were not available for consultation, I relied on Dixon (1983).

Gilbert in Whittell. See Whittell (1954b).

Gilbert in Wagstaffe and Rutherford. See Wagstaffe and Rutherford (1954, 1955).

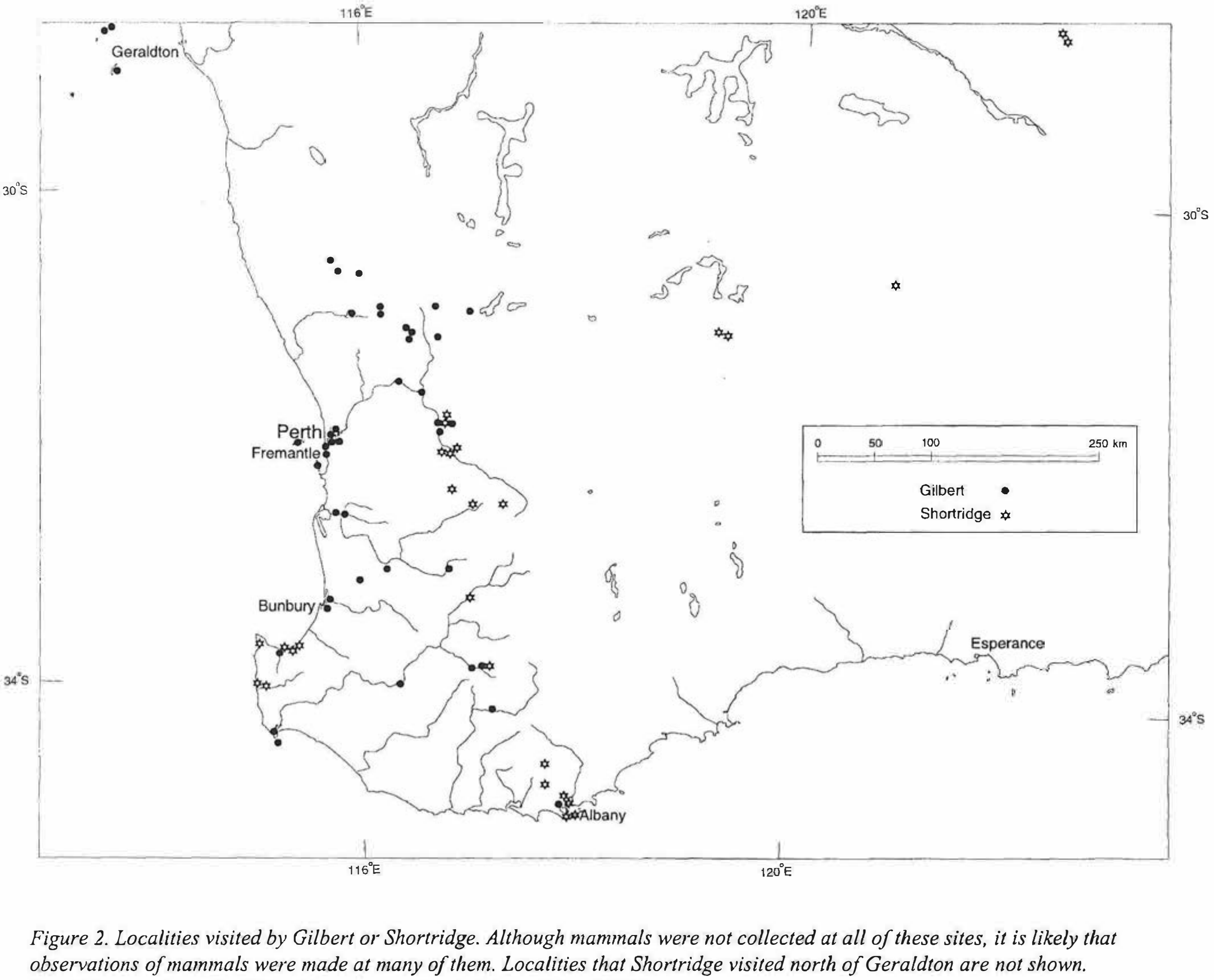

Figure 2. Localities visited by Gilbert or Shortridge. Although mammals were not collected at all of these sites, it is likely that observations of mammals were made at many of them. Localities that Shortridge visited north of Geraldton are not shown. Localities mentioned by Gilbert have been extracted from Fisher (1992).

Gould [ex Gilbert]. See Gould (1865).

Shortridge. Guy Shortridge (1880–1949) visited WA in 1904–07 and collected for W.E. Balston, who had farming interests near Albany (Shortridge 1910, 1936; Thomas 1906a, b).

King. Phillip Parker King (1791–1856) visited south-west WA (King George Sound) several times. In 1817 he recorded some Aboriginal names (King 1827, p. 145).

Nind. Isaac Scott Nind (1797–1868) was medical officer at the convict establishment at King George Sound from December 1826 to October 1829. Nind (1831) includes an extensive list of Aboriginal words.

Wilson. Thomas Braidwood Wilson (1792–1843) visited Swan River and King George Sound from October to December 1829. His book includes a short list of Aboriginal names collected at King George Sound (Wilson 1835).

Anon (1834). The observations recorded in this paper (Anon 1834) are generally attributed to Alexander Collie (1793–1835), who arrived in WA in 1829 and was appointed first Government Resident at Albany from March 1831 until September 1832.

Lyon. Robert Menli Lyon (b. 1789) lived from 1829 to 1834 in WA. He published (Lyon 1833) several newspaper articles containing the first list of Aboriginal words from the Swan River area. Moore (1884) stated that the list contained 'many inaccuracies and much that was fanciful'.

Bunbury. Henry William St Pierre Bunbury (1812–1875) was a military officer in south-west WA during the period March 1836–November 1837, stationed at York, Pinjarra, Busselton and Williams. His diaries were published by Bunbury and Morrell (1930).

Grey. George Grey (1812–1898) explored parts of south-west WA in 1838–39, and was Government Resident at Albany from August 1839 to March 1840. In his book (Grey 1840) he states that the word-list was compiled from as far as 100 miles north of Perth [i.e. to the south of Cervantes], Murray, Vasse and King George Sound. This list was stated to include words submitted by J. Hutt, G.F. Moore, F.F. Armstrong and the Bussells of the Vasse district.

Stokes. John Lort Stokes (1812–1855) several times visited south-west WA (Swan River, Australind and Albany) as part of a British naval survey of Australian waters (Stokes 1846). In his book he provides a list of Swan River words (pp. 217–220) gathered in October 1840.

Symmons. Charles Symmons (1804–1887) arrived at Perth in December 1839 and was appointed protector of Aborigines. His book (Symmons 1841) consists of names gathered at Swan River by himself, J. Hutt and F.F. Armstrong (Whittell 1949, 1954a).

Moore. George Fletcher Moore (1798–1886) arrived in WA in October 1829 and departed in 1852. His book (Moore 1842, revised 1884) contains one of the most significant Noongar word-lists, which he ackowledged was contributed to by C. Symmons and 'a friend whose name I am not at liberty to mention'.

Brady. John Brady (1800–1871) was a Roman Catholic priest, then bishop, in WA from 1843–44, 1846–50, and 1851–52. Brady (1845) lists only a few Aboriginal words relevant to this paper.

Drummond. James Drummond (1784–1863) arrived in WA in June 1829, finally settling in the Toodyay district in 1836. He was an active collector of botanical specimens throughout the south-west in the period 1836–1851. Relevant words have been extracted from Anon (nd); only a few of the original documents have been sighted. Drummond usually capitalized Aboriginal words.

Smyth. Robert Smyth (1830–1889) settled in Victoria in 1852 and from about 1860 collated material about Aborigines from many published and other sources around Australia. Most of the information presented about south-west WA Aborigines (Smyth 1878, pp. 221–284) was written by Philip Chauncey (1816–1880), an assistant surveyor in WA in the period 1841–1853. However, no comprehensive word-list is included.

Salvado. Rosendo Salvado (1814–1900) arrived in WA in 1847 and founded the Benedictine Monastery at New Norcia in 1848. See Salvado (1851) and Stormon (1977). It is likely that Aboriginal words recorded from east and north of New Norcia refer to the out-stations Wyening (25 miles [40 km] distant) and Marah (40 miles [64 km]) respectively (Russo 1980, p. 169). The records from Salvado in Curr (1886) refer to New Norcia and Leschenault Bay.

Austin. Robert Austin (1825–1905) came to WA in 1840 and later led the so-called Settlers' Expedition to the north-east of the Avon Valley settlements in 1854 (Austin 1855). This party included one Noongar.

Oldfield. Augustus Oldfield (1821–1887) recorded valuable information about Aborigines when botanizing in 1858–59 near Murchison River and Shark Bay. His paper (Oldfield 1865) includes mammal names used by the 'Watchandie' [? = Nanda of Tindale 1974] and the 'Champion Bay tribe' [provided by R.J. Foley]. Oldfield (1865, p. 297) states that the 'Watchandie' tribe is located 180 miles [*c.* 290 km] north of the headquarters of the Champion Bay [Geraldton] tribe. This would place the provenance of his word-list as on the eastern shore of Shark Bay, near the Wooramel River.

Millett. Janet Millett resided at York with her husband (Anglican chaplain) from December 1863 to January 1869, and later published a book intended to serve as a guide to immigrants (Millett 1872).

Hunt. Charles Hunt (1833–1868) led, between July and November 1864, an expedition east of York in search of pastoral land (Hunt 1864). He was accompanied by one Noongar.

Ranford. Henry Samuel Ranford (1854–1934) was a land surveyor (Ranford 1875).

Forrest. John Forrest (1847–1918), accompanied by several Noongar trackers, explored parts of south-west WA in 1869, 1870 and 1874 (Forrest 1875).

Hassell, E. Ethel Hassell (1857–1933) was born in and lived in Albany until 1878, when she married and moved to Jerramungup. She relocated to Albany in 1886. Her word-list (Hassell 1975) relates to the vocabulary of the Wheelman tribe at Jerramungup.

Bussell. Alfred John Bussell (b. 1865), son of Alfred Bussell, pioneer settler in 1830 of Augusta and later Busselton, recorded Aboriginal names from this region (Bussell nd). According to Buller-Murphy (nd)(MS at Acc. No. 1648A/6 in Battye Library), he spoke the Aboriginal language fluently.

Hammond MS1. Jesse Hammond (b.1856) travelled extensively throughout south-west WA as a stockman/ drover in the 1870s and 1880s. See Hammond (nd = MS1).

Hammond MS2. See Hammond (nd = MS2).

Hammond. See Hammond (nd = 1933).

Johnston. In his book, Johnston (1962) cites notes written by his cousin A.F. Clifton (1857–1948). These relate to the Australind area.

Curr. Edward Curr (1820–1899), a squatter who lived in various parts of eastern Australia before finally settling in Victoria in 1862, distributed standardized lists of English words to settlers across Australia and sought the equivalent local Aboriginal words. These lists were published in four volumes (Curr 1886).

Isaacs. Sam Isaacs (1845–1920) had an Aboriginal mother and lived near Margaret River. Frederick Slade Brockman (1857–1917) was a surveyor, who had married Grace Bussell in 1882. See Isaacs (nd).

Haddleton. Job Francis Haddleton (1879–1958) lived near Katanning on a farm selected by his father in 1864. His book (Haddleton 1952) includes valuable notes on the mammal species of the Katanning district.

Helms. Richard Helms (1858–1914). Attached to the Elder Expedition of 1891–92 as naturalist, he collected many Aboriginal words (Helms 1896), of which the only ones relevant to this paper come from Fraser Range and 'Yaurigabbi' (=?Yoweragabbie, south-west of Mt Magnet). He also provides a word-list of Aborigines 'living round the south-western coast of Western Australia, mainly obtained through the assistance of C.A. Paterson...at Perth'.

Wells. Lawrence Wells (1860–1938), surveyor for the Elder Expedition, collected a few Aboriginal words (Wells 1893).

Markey. Thomas Markey (1863–1956), farmer of Toodyay, compiled two lists of Aboriginal words (Markey 1942), presumably from the Toodyay area.

Hassell, Ed. See Hassell, Ednie (nd). Edney [Edmund Arthur] Hassell (1881–1950) was a son of Ethel Hassell (Hassell 1975). This list appears to come from the south-west capes region.

Hassell, E.A. The identity of this person is uncertain. It could refer to Edith Annabelle Hassell (b. *c.* 1872) or Edmund Arthur Hassell (1881–1950), with the latter more likely. The provenance of these words (Hassell, E.A nd) appears to be the Jerramungup region. Note that this list was incorrectly attributed to an A.A. Hassell by Bindon and Chadwick (1992), who tentatively dated it at 1894. The manuscripts are very difficult to decipher, as the words in the lists have not been written carefully. Words in Acc. No. 436A/5a in Battye Library are stated to relate to Gairdner, Fitzgerald and Pallinup Rivers.

Drake-Brockman. Geoffrey Drake-Brockman (1885–1977) mentions in his book (1960) that as a child he stayed with his Bussell aunts at Burnside and Ellenbrook.

Leake. Bruce Leake (1880–1962) lived on part of a pastoral station established by his father in 1868 at Mooranoppin near Kellerberrin, before establishing his own farm at Woolundra, also near Kellerberrin (Leake 1962).

Buller-Murphy. Deborah Buller-Murphy (1887–1965) was descended from the Bussell and Drake-Brockman families, and had acquired words from Noongars at Busselton, Wallcliffe and Burnside. In *c.* 1957 she compiled a dictionary, which remains unpublished (Buller-Murphy nd). In Acc. No. 1648A/6 in Battye Library, she noted that Aboriginal legends were told to her as a child by her mother. She also acknowledged A.J. Bussell as the source of words in her dictionary.

Colonial Secretary. These lists, evidently prepared by officers (?police) of the WA Government, were published by the Colonial Secretary (1903, 1904). In many cases names listed could not be used here because no provenances are given.

Bates. Daisy Bates (1863–1951) was appointed by the WA Government in 1904 to gather information about Aborigines in WA. She distributed 500 blank vocabularies to postmasters, police, station owners and other settlers across WA (White 1985, Bates nd). She left WA in 1912. In some cases I have listed specific localities instead of the Magisterial District (abbreviated MD in the table); however, many of the localities cannot now be traced (G. Hoare[1], personal communication). I have gleaned the following information from Bates' records: Bwokunbup Hill and Boogerup [Kendenup] are within the Albany MD; Korrlup is 50 miles [80 km] NW of Jerramungup, Karadup is in Pinjarra MD; Wergejan [Beverley] is in York MD; Woorurdup is in Swan MD; and Wilgahmala [Berkshire Valley] and Nyerrgoo [30 miles [48 km] NE of Mogumber] are in Victoria Plains MD. Caution needs to be exercised in interpreting her lists, as by the early 1900s many full-blood Aborigines had relocated away from their tribal areas. Thus some words supplied by them may have related to their previous tribal areas rather than their location in 1904.

The blank 97-page vocabulary booklet (*Instructions for filling in particulars concerning the language, customs, and habits of the Aboriginal natives of Western Australia*) was issued under the Authority of M.A.C. Fraser, Government Statistician, and published by the Government Printer. In a two-page introduction it requested, opposite each English word listed, 'the equivalent word or words in the dialect spoken by the Aboriginal Natives of the immediate neighbourhood'. Pages 11–13 consist of a list of names of mammals, among which those relevant to this paper are: ant-eater (marsupial), bandicoot, cat (native), dingo, dormouse, hedgehog, kangaroo (blue), kangaroo (brush), kangaroo rat, kangaroo rat (brush-tailed), kangaroo (red), kangaroo (rock), mouse (pouched), opossum, opossum (ring-tailed), porcupine, rat (water), squirrel (grey), wallaby (banded), wallaby (rock) and wallaby (speckled-hair). For several widespread species I have included names from outside the south-west in order to provide context.

Bates 1913 and 1914. See Bates (1913) and Bates (1914) respectively.

Rae. William John Rae (?1872–1917) arrived in WA in the late 1890s and was a surveyor at Geraldton and later at Albany. The provenance of the names collected by him (Rae 1913) appears to be the Albany region.

Muir, A.G. This presumably refers to Andrew Gordon Muir (1867–1943), farmer at Mordalup. S.W. Jackson obtained Aboriginal words from him after a chance meeting at Deep River in 1912 (Abbott 1998).

Davis. Jack Leonard Davis (1917–2000) was a Noongar poet (Davis nd).

[1] Information Management Branch, CALM, Kensington

Le Soeuf and Burrell. Le Soeuf and Burrell (1926) attempted to summarize information about the mammals of Australia and New Guinea.

Anon (1928). See Anon (1928).
Scott. Lew Scott (personal communication 1999) was born in 1920 and lived and farmed near the lower Donnelly River.

Roberts. Vic Roberts (personal communication 1999) was born in 1920 and has lived and farmed at Scott River and the lower Blackwood River.

Atkins. W.H. Atkins (1918–1988) was a cleric who lived at Gnowangerup but travelled widely in the south-west of WA (Douglas 1991).

Troughton. Troughton (1967) was the last of many editions of a popular book (first published 1941) about mammals in Australia. In this book (p. 190) he mentions visiting the celebrated collector John Tunney in 1921, possibly the source of some of his Noongar words.

Spencer. See Spencer (1966).

Schorer. See Schorer (1968).

Ride. Ride (1970) was an important book synthesizing old and new information about the mammals of Australia.

Erickson. The Noongar names cited by Erickson (1974) appear to have been taken from otherwise unpublished diaries of early colonists of the Toodyay district.

de Burgh. See de Burgh (1976).

Coyne. Coyne (1980) provides a list of words from the Albany region.

Udell. See Udell (1980).

Gray. See Gray (nd).

Ramson. See Ramson (1988).

Whitehurst. See Whitehurst (1992).

Brooks and Ritchie. See Brooks and Ritchie (1994).

Winmar. See Winmar (1996).

SPELLING, CAPITALIZATION AND PRONUNCIATION OF NOONGAR NAMES

After analysis and grouping of these records, I have spelt the resulting names on the basis of the rules given by Whitehurst (1992). More esoteric and sophisticated phonetic systems have been employed by the linguists Douglas (1976, 1991) and Von Brandenstein (1988). In order to encourage mammalogists to pronounce Noongar words correctly, I include in Table 1 information from Whitehurst (1992). The use of retroflex sounds has generally been avoided, as the simpler spelling and pronunciation should encourage wider use of Noongar names.

All of the names listed (Table 2) adhere to the spelling, syllables (if marked) and capitalization given in the original. Bates was not always consistent in capitalizing words, so I have capitalized all words provided by her. In Tables 2 and 3, KGS refers to the region around King George Sound, centred on Albany. Where several Noongar names are available, the one preferred by me is listed first (right column). This preference is based on a combination of criteria, *viz.* widespread use by Aborigines in south-west WA, few syllables, euphony and sonority, and ease of pronunciation. Clearly, it is not possible to maximize these attributes simultaneously. The selected name is offered as a basis for consideration by Noongars, mammalogists, and others. In the left column of Table 2 are current Latin and common names taken from a list maintained by A.A. Burbidge of the Department of Conservation and Land Management. Aboriginal names that do not appear to be Noongar are enclosed in braces.

RESULTS

Approximately 1100 records of Noongar names for native mammal species were discovered (Table 2). Reliable names, based on those recorded by Gilbert and Shortridge, were found for 39 species. I tentatively attributed names to three other species *(Sminthopsis granulipes, S. crassicaudata, Rattus tunneyi)* on the basis of geographic range (in the case of *Sminthopsis* in which *S. murina* has been subdivided into three species [Kitchener *et al.* 1984]). For eight other species *(Dasycercus cristicauda, Antechinomys laniger, Macropus rufus, Leporillus apicalis, Notomys alexis, Pseudomys hermannsburgensis, P. occidentalis and P. shortridgei)*, no Noongar names were discovered in the sources searched. This is not surprising, as all but *P. occidentalis* and *P. shortridgei* occur marginally in the geographic range of Noongars as indicated in Figure 1.

The few names discovered of non-terrestrial mammals are listed in Table 3.

DISCUSSION

For most mammal species present in south-west WA, ample records of Noongar names exist. Which of the names presented in this paper should be adopted for general use is left for the appropriate authorities to decide; however, brevity, euphony and practicality are likely to be important factors in making this choice. Whether Noongar names in current use, but spelled differently from the rules provided by Whitehurst (1992), should be altered is an issue requiring discussion. It seems clear that a more correct orthography would facilitate more accurate pronunciation. Wambenger and Noolbenger should be written *wambenga* and *ngooboongor* so that the *ng* is not voiced, and *noombat* will result in the correct pronunciation and not the erroneous 'Numb-bat' in use at present.

It needs to be emphasized that many of the Noongar names listed for the same species are equally valid, with the various names applicable to different parts of south-west WA. For example, as noted by Moore (1884) and others, many words from King George Sound are shortened by elimination of the final syllable (thus *balat/balawa, kwend/kwenda, ngoor/ngwayir, wol/woli, kwa/kwara, doot/dooda*). Other species had quite different regional names. Examples include *Dasyurus geoffroii* (Vasse; Albany and southern wheatbelt; Swan Coastal Plain and northern wheatbelt); *Parantechinus apicalis* (Perth area; northern Swan Coastal Plain and northern wheatbelt; southern region); *Antechinus flavipes* (Albany region; rest of south-west); *Phascogale tapoatafa* (Vasse; Perth area; northern wheatbelt; southern wheatbelt; southern region); *Myrmecobius fasciatus* (Kojonup, Albany and Jerramungup; rest of south-west); *Perameles bougainville* (Albany region; rest of south-west); *Cercatetus concinnus* (south-west capes; rest of south-west); *Pseudocheirus occidentalis* (Beverley, East of Katanning, Jerramungup and Bremer Bay; rest of south-west); *Tarsipes rostratus* (Perth area; Albany area); *Macropus eugenii* (Margaret River, Vasse and Scott River; rest of south-west); *Petrogale lateralis* (northern wheatbelt; southern wheatbelt); *Setonix brachyurus* (southern areas; northern areas); *Notomys mitchellii* and *Pseudomys albocinereus* (Perth; Moore River); and *Hydromys chrysogaster* (Perth; Vasse; Albany; Beverley and Jerramungup).

Eight wide-ranging species appear to have had invariant names across the south-west. These names are *nyingarn [Tachyglossus aculeatus], djalkat [Macrotis lagotis], koomal [Trichosurus vulpecula], boodi [Bettongia lesueur], woorap [Lagorchestes hirsutus], yongka [Macropus fuliginosus], worong [Onychogalea lunata]* and *manang [Lagostrophus fasciatus]*.

The general conclusion that emerges from the above comparisons is that there is seldom an obvious linkage of names to tribal boundaries, as mapped by Tindale (1974). The clearest is the Wadandi tribe near the south-west capes and Vasse, with a distinct subset of names for several species (*ngooldjangt [Dasyurus geoffroii], wambenga [Phascogale* sp. n.*], donat [Sminthopsis griseoventer], nyeranit [Cercatetus concinnus], bonin [Macropus eugenii], ngangaritj [Hydromys chrysogaster]*).

The scope for error in recording Aboriginal names is very great (e.g. Hasluck 1977, p. 207; Burbidge and Fuller 1990), with the language barrier the most obvious factor, particularly how the sound heard by Europeans was converted to an anglicized spelling (cf. Tench 1793, pp. 21, 122; Winnecke 1897, p. 40). Next is whether the European asked questions clearly. The Aborigine may have supplied a name for the species, or the part of the animal being pointed at by the European. Third, the Aborigine may not have distinguished certain small species, e.g. rodents (cf. Tench 1793, p. 10; Oldfield 1865, pp. 255–256). Finally, the Aborigine may have said the equivalent of 'I don't know' or guessed at the name. Scanning the tabulation presented in this paper, particularly those species for which a wealth of Aboriginal names have been recorded, the reader will notice some names which do not resemble the other names listed. Examples include *wyalung, nyeranit, moilyer, wurak, beango* and *muritya*. The veracity of such names is thus difficult to confirm.

The names recorded by Gilbert from Moore River and Toodyay districts should be regarded as the most accurate. This is because Gilbert was often accompanied in these localities by Johnston Drummond (1820–1845), whom Gilbert praised thus: 'This young Man knows almost every production of the colony, most fortunately I have tried him in many instances, & invariably found his descriptions (most minute in particulars) agreeing perfectly with my own observations' (Wagstaffe and Rutherford 1954). Drummond associated readily with Aborigines and spoke their language fluently (Erickson 1969).

The list is known to contain some errors. Gilbert records *mardo* for *Antechinus flavipes* and *Notomys macrotis*, presumably on the basis of different species concepts of, or possibly an error in identification by, his Noongar aides. Some names published by Gould (1863) are based on inaccurate deciphering of Gilbert's generally clearly-written notes. Many erroneous spellings published by Wagstaffe and Rutherford (1954, 1955) are based on inaccurate copies of Gilbert's letters apparently made by Lord Derby's amanuensis.

Names collected in the 1830s, 1840s, and 1850s are least likely to have been contaminated by movement of Aborigines. As European settlement expanded and consolidated in the 1860s, Aboriginal society rapidly disintegrated, and many displaced Aborigines associated with shepherds and became casually involved in other farm activities, eventually drifting into Government camps. Some words may then have spread more widely (cf. Oldfield 1865, pp. 289–290; Bates 1992, p.101).

Several 'left-over' Noongar names have been tentatively attributed, by a process of elimination, to species on the basis of their geographical range. Brackets have been used to indicate such interpretations. A few names could not be linked to any species with confidence, including N-anip, east of New Norcia, described as 'Specie piccolo di Kangarù' (Salvado 1851) and Purì, east of New Norcia, described tersely as 'Specie di Kangarù'. Note, however, that Moore (1884) defines 'Ngannip' as a joey. Hassell, E.A. (nd) also noted Kaibung ('red rock possum').

Some of the lists discovered provided names for male and female of the most conspicuous species. Those for *Macropus fuliginosus* show a high degree of consistency between lists. In contrast, the names recorded for male and female *Canis lupus* are frequently contradictory.

Noongar names for some mammal species have persisted in general use as locality names, such as towns, suburbs, pastoral stations or railway sidings. Examples include Ninghan, Quindalup, Gwindinup, Noggerup, Goomalling, Watheroo, Ongerup, Warriup, Yoongarillup, Quairading, Kwobrup, Kendenup, Bokal, Quagamirup Brook and Spring, Boranup, Dwarda, Twertup, Mokine and Mount Yokine. Hassell, E.A. (nd) lists many localities derived from mammal names; few of these are listed in the DOLA database. The name *dunnart* has been generalized by mammalogists as a common name for all species in the genus *Sminthopsis*.

The northern and eastern boundaries of the Noongar language have been vaguely described in the anthropological literature. Bates (1914) stated that the approximate northern and eastern limits were Gingin and Esperance respectively. In her newspaper articles the northern boundary was given as between Dongara and Geraldton or near Jurien Bay, and the eastern limit was stated as east of Esperance (Bates 1992). Douglas (1976) treated the northern boundary (at least at the time of his research) as approximating a line joining Geraldton – Mt Magnet – Kalgoorlie – Esperance, whereas Thieberger (1987) set the limits closer to Jurien – north of Southern Cross – east of Esperance. Some of the names of widespread mammal species recorded here may help define these limits more precisely. Some Aboriginal names from the deserts of WA for *Trichosurus vulpecula* and *Canis lupus* (Burbidge *et al.* 1988) indicate a close resemblance with names recorded in this paper from near Geraldton and Carnamah. Names recorded for *Macropus fuliginosus* from Geraldton and Bremer Bay-Esperance seem to represent a penetration of non-Noongar names from Murchison, Northampton and the Goldfields into the south-west. Caution is necessary, however, as one Noongar name of *Dasyurus geoffroii* bears a close similarity with one name for this species widely used in the WA deserts (see Burbidge *et al.* 1988).

Attitudes of mammalogists to using Aboriginal names do not appear to demonstrate consistency in usage. Anon (1928) made extensive use of Noongar names, but retained the following English names: Pig-footed Bandicoot, Grey Kangaroo, Brush, Rock Wallaby, Ring-tail, Fat-tailed Dunnart, Echidna, Honey Mouse and Possum. Troughton (1967, pp. 31, 44) thought that the Noongar names *chuditch* and *wambenger* were unsuitable for species with such broad geographical ranges. Ride (1970) preferred the use of Noongar names, perhaps following Anon (1928), for 10 species. Strahan (1981) regarded efforts to popularize Aboriginal names as an attempt to resurrect forgotten names. This perspective is incorrect when applied to south-west WA, where there is remarkable continuity in use of many Noongar names for native mammal species. Subsequently, Strahan (1983) appeared to adhere to the view that only one correct common name exists, attributing confusion to 'ignorance and local loyalties'. Only four Noongar names were approved as common names, and two of these were given in bastardized form (Strahan 1995). My view is that the quest for one vernacular name for each species is an unnecessary duplication of the role of Latin binomials. In Europe, for example, each nation has its own vernacular name for each species of mammal, and no one common name is regarded as more correct or fundamental than another.

Providing Noongar names for mammal species as accurately as possible is only the first stage in facilitating their general use. The next step is learning to pronounce the names as correctly as possible.

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TABLE 1

Pronunciation and spelling of Noongar words (after Whitehurst 1992).

Air stream from lungs:	Labial: Lip sounds	Dental: Tip of tongue placed against teeth	Alveolar: Tip of tongue placed on hard palate	Retroflex: Tip of tongue placed towards rear of hard palate	Velar: Back of tongue placed on soft palate
Stopped by lips or tongue	***b-*** ***-b-*** ***-p***	***dj-*** ***-dj-*** ***-tj***	***d-*** ***-d-*** ***-t***	***-rd-*** ***-rt***	***k-*** ***-k***
By-passed through nose	***m***	***ny***	***n***	***-rn-*** ***-rn***	***ng***
Escapes over the sides of tongue		***-ly-*** ***-ly***	***l***	***-rl-*** ***-rl***	
Passes over centre of tongue			***-rr-*** ***-rr***	***r***	
Passes freely through mouth	***w***		***y***		
Not stopped (vowels)	***i***	***e***	***a***	***o***	***oo***

Notes: A letter followed by a hyphen signifies that the letter is used only to begin a word; a letter preceded by a hyphen signifies that the letter is used only to end a word; and a letter preceded and followed by a hyphen signifies that the letter is used only in the middle of a word.

Consonants and vowels are generally pronounced as in English; but note particularly: *a* (as in media); *b* (**sp**it); *d* (**st**all); *dj* (**d**ew); *i* (h**i**t); *k* (**sk**ill); *ng* (si**ng**er, not finger); *ny* (o**n**ion); *o* (**law**); *oo* (b**oo**k); *p* (**sp**ill); *r* (**r**ake); *rr* (spo**rr**an).

Emphasis is on the first syllable.

TABLE 2

List of Noongar names for mammal species.

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
TACHYGLOSSIDAE		
Tachyglossus aculeatus Echidna	Gilbert MS: Dun-ung-er-de (Guildford, Toodyay), Ngoong-arn (York). MS2 has the variant: Dun-ung-er-de (Toodyay district) Gilbert in Gould: Dun-ung-er-de (Toodyay, Guildford districts), Nyoong-arn (York district) Shortridge: Ningan Bates: Gwing'un (Murchison area), Ning na an (New Norcia), Nyeeng-arn (Wilgahmala), Nyingarn (Carnamah, Nyerrgoo, York MD, Meckering, Mardangoora, East of Katanning, Coolgardie MD, West of Menzies); Nyingan, Nyingain (Dandaragan) Bates 1913: Eelyingarra (Dongara) Davis: Nyingarn Markey: Ninghan Whitehurst: nyingarn Winmar: ningarn	nyingarn [ny'ing'arn] donongerde [don'ong'er'de]
DASYURIDAE		
Dasycercus cristicauda Mulgara Threatened Species occurred outside the intinerary of Gilbert		
Dasyurus geoffroii Chuditch Threatened	Gilbert MS: Bur-jad-da (Perth), Bar-ra-jit (mountain districts), Ngoor-ja-na (Vasse). MS2 has the variants: Bar-ra-jit (York	djooditj [djoo'ditj] ngooldjangit [ngool'djang'it]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
Newly endemic to WA through extinction in other parts of its geographic range in Australia	and Toodyay district); Dju-tytch (KGS) Gilbert in Gould: Bur-jad-da (Perth), Bar-ra-jit (York and Toodyay districts), Ngoor-ja-na (Vasse), Dju-tytch (KGS) Gilbert in Whittell: Dju-tytche (KGS) Shortridge: Chuditch (Beverley), Gnuljargneet (Beverley), Barry-git (Moore R), Chudich Moore: Barjadda, Barrajit Oldfield: {Tin-do-kat} Hassell, E.: chudic Bussell: Ngoolarngeat Isaacs: Ngwool-jarn-ee, Ngwool-jarn-eet Hassell, Ed.: ngoolgarngeat Hassell, E.A.: chutic Buller-Murphy: Ngoolgarngeat Colonial Secretary: Cuttish (Beverley sub-district) Bates: Bajarda (East of Laverton), Bajjarda (Murrum MD), Bajjat (Norseman MD), Balgart, Baljeerda (Murchison area), Barjert (Guildford & Perth area); Baljerda (Dandaragan), Balyart (Woorurdup); Barajeert (Nyerrgoo), Barjot (Northam), Barrjat, Barrjet (Gingin); Bar-jeerdee (Pinjarra MD), Barjerda (Carnamah), Barrjeet (Wonnerup & Capel Districts), Barrjerda (Wilgahmala, Mardangoora), Chudich (Jerramungup), Jooteetch (Bridgetown MD, Kojonup,	badjada [ba'dja'da]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	East of Katanning, Korrlup, Bremer Bay – Esperance), Joodeetch (Williams MD, Albany MD), Jootitch (Meckering, Wergejan, Albany MD), Ner-gup (Busselton), Ngoorijangin (Vasse MD), Ngoorjangit (Wonnerup & Capel Districts), {Parjerda (West of Menzies)} Rae: Chutikk Davis: Choorditch Anon 1928: Chuditch Roberts: Chuditch Atkins: tjunik, djunik, djudik Troughton: Chuditch Ride: Chuditch de Burgh: barrajuck Gray: Choodich Brooks & Ritchie: chuditch, judij Winmar: choorditch	
Parantechinus apicalis Dibbler Threatened Endemic to WA	Gilbert MS: Marn-dern (Moore R), Wy-a-lung (Perth), Dib-bler (KGS) Gilbert in Gould: Marn-dern (Moore R), Wy-a-lung (Perth), Dib-bler (KGS) Gilbert in Wagstaffe & Rutherford: Mara-dera (Moore R) Grey: Ma-doon Moore: Madun Bates: Matoon (Gingin), Matoorn (Gingin), Mordurn (Wergejan, Meckering)	dibla [dib'la] madoon [mad'oon]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Anon 1928: Dibbler	
	Troughton: Dibbler	
	Ride: Dibbler	
	Brooks & Ritchie: dibala?, dibbler	
Antechinus flavipes Mardo	Gilbert MS: Mar-do (Moore R), Man-durt (Perth), Tum-mart (KGS)	mado [ma'do] domat [dom'at]
	Gilbert in Wagstaffe & Rutherford: Mar-do (Moore R)	
	Shortridge: Mordar (Margaret R)	
	Grey: Mar-do	
	Symmons: Mar-do	
	Moore: Mardo	
	Bussell: Morder	
	Isaacs: Moor-da	
	Buller-Murphy: Morder	
	Colonial Secretary: Mardo (York sub-district)	
	Bates: Marda (Nyerrgoo), Mardoo (Gingin, Pinjarra MD), Morda (Nyerrgoo, Woorurdup, Guildford & Perth area, Vasse MD), Mardoor (Wonnerup & Capel Districts), Moerda (Busselton), Moorda (Busselton), Mora (New Norcia), Mota (New Norcia), Tamart (Plantagenet area), Tammart (Denmark), Tumart (Bwokunbup Hill)	
	Anon 1928: Mardo	
	Ride: Mardo	
	Brooks & Ritchie: mardo	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
Phascogale calura Red-tailed phascogale Threatened Newly endemic to WA through extinction in other parts of its geographic range in Australia	Gilbert MS: King-goor (Williams district). MS2 has the variant: King-goor (Williams R) Gilbert in Gould: King-goor (Williams R)	kingo [king'o]
***Phascogale* sp. nov.** Wambenger, Brush-tailed phascogale Newly endemic to WA because molecular techniques demonstrate that this taxon is a full species. This will necessitate a new species epithet (P. Spencer, personal communication)	Gilbert MS: Bul-loo-wa (York), Bal-la-ga (Perth), Bal-la-wa-ra (south of Perth), Bal-lard (KGS). MS2 has the variant: Bal-la-wa-ra (north of Perth) Gilbert in Gould: Bal-lard (KGS), Bul-loo-wa (York district), Bal-a-ga (Perth), Bal-la-wa-ra (north of Perth) Shortridge: Coming-coming (Beverley), Wambenger (Busselton) Grey: Bal-la-ga-ra; Bal-lard (KGS) Moore: Ballagar (north of Perth), Ballard (KGS), Ballawara (Perth), Bellogar Salvado: Moton Isaacs: Wam-bing-ga Hassell E.A.: Coming Coming Bates: Balagur (Woorurdup), Ballart (Bridgetown MD, Kojonup, East of Katanning), Balowaree (Pinjarra MD), Biljart (Korrlup), Guming-guming (East of Katanning), Paalgurt (Korrlup), Palatt (New Norcia), Pawallat (New Norcia), Wamburnga (Wonnerup & Capel Districts), Wamburnong (Vasse MD), Wer-um-berra (Busselton) Rae: Kumining, Palikk	wambenga [wam'beng'a] balat [bal'at] balawa [bal'aw'a] koming koming [kom'ing kom'ing]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Anon 1928: Wambenger Roberts: Wambenger Troughton: Wambenger Ramson: wambanong Brooks & Ritchie: wambanang?, wambenger	
Antechinomys laniger Kultarr Species occurred outside the intinerary of Gilbert		
Sminthopsis crassicaudata Fat-tailed dunnart No Noongar name was recorded by Gilbert – the only specimen obtained was captured by a domestic cat	Hassell, E.A.: Gnudar [Note: name attributed tentatively to this species. Hassell called it the fat-tailed mouse]	ngooda [ngoo'da]
Sminthopsis dolichura Little long-tailed dunnart		
Sminthopsis gilberti Gilbert's dunnart Endemic to WA		
Sminthopsis granulipes White-tailed dunnart Endemic to WA	Gilbert MS: Twoor-dong (KGS) [Note: name attributed tentatively to this species] Gilbert in Gould: Twoor-dong (KGS) [Note: name attributed tentatively to this species]	djoordong [djoor'dong]
Sminthopsis griseoventer Grey-bellied dunnart Endemic to WA	Gilbert MS: Dtam-in (Perth) [Note: name attributed tentatively to this species] Gilbert in Gould: Otam-in (Perth) [Note: name attributed tentatively to this species] Shortridge: Dunnart (Margaret R) Isaacs: Dun-nart	donat [don'at] djamin [djam'in]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Bates: Danart (Wonnerup & Capel Districts), Danarda (Wonnerup & Capel Districts), Dannart (Vasse MD)	
	Anon 1928: Dunnart	
	Ramson: danart	
MYRMECOBIIDAE ***Myrmecobius fasciatus*** Numbat Threatened Newly endemic to WA through extinction in other parts of its geographic range in Australia	Gilbert MS: Noom-bat (York districts), Wai-hoo (KGS). MS2 has the variant: Noom-bat (York and Toodyay districts)	noombat [noom'bat] wioo [wi'oo]
	Gilbert in Gould: Noom-bat (York and Toodyay districts), Wai-haw (KGS)	
	Gilbert in Wagstaffe & Rutherford: Wombat	
	Shortridge: Numbat	
	Moore: Numbat (York)	
	Millett: Noombat	
	Hassell, E.: weeoo	
	Haddleton: numbat	
	Hassell, E.A.: Weeou, Wee-u	
	Leake: Numbat	
	Bates: Nombat (Jerramungup), Noombat (Bridgetown MD, East of Katanning, Kojonup), Nyoombot (Gingin), Weeoo (Kojonup, Albany MD, Korrlup), Wi-u (East of Katanning)	
	Rae: wiu	
	Anon 1928: Numbat	
	Roberts: Noombart	
	Troughton: Numbat	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Spencer: nambat	
	Ride: Numbat	
	Gray: Weeu	
	Ramson: numbat	
	Whitehurst: noombat	
	Brooks & Ritchie: numbad, numbat	
PERAMELIDAE ***Chaeropus ecaudatus*** Kandjilpa, Pig-footed bandicoot	Gilbert MS: Bur-da (Walyemara), Wot-da (inland from York district)	boda [bo'da] woda [wo'da]
Extinct	Gilbert in Gould: Bur-da (Walzemara district), Wot-da (interior from York)	boodal [boo'dal]
	Shortridge: Buddile (Beverley)	
	Leake: Bertie	
Isoodon obesulus Quenda	Gilbert MS: Gwen-dee (Perth), Quoint (KGS)	kwenda [kwen'da]
	Gilbert in Gould: Gwen-dee (Perth), Quoint (KGS)	
	Shortridge: Quaint or Waint (Beverley), Queenda (Margaret R)	
	Nind: Quernd	
	Anon 1834: quoint	
	Grey: Dyin-da; Gwinda (Vasse); Koon-de; Kwendt (KGS)	
	Stokes: Condee	
	Symmons: Gwen-di	
	Moore: D-yinda, Gwende (mountain dialect), Kudi (1884), Kundi (1842)	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Salvado: Cueinde (east of New Norcia), Queinde, Quiende	
	Oldfield: {Oon-die; Woo-die (Champion Bay)}	
	Bussell: Queander	
	Hammond MS1: Kwin,der	
	Hammond MS2: Kwin-der	
	Hammond: Kwinder	
	Isaacs: Queen-da	
	Hassell, Ed.: Kwent	
	Hassell, E.A.: Quaint	
	Leake: Quenda	
	Buller-Murphy: Queander, Queender	
	Bates: Cueinde (New Norcia), Gweenda (Woorurdup, Wonnerup & Capel Districts), Gwenda (Guildford & Perth area, Woorurdup), Koondee (Carnamah, Dandaragan), Koorndee (Gingin, Pinjarra MD), Kuendy (New Norcia), Kweenda (Woorurdup, Vasse MD, Wonnerup & Capel Districts), Kwend (Denmark), Kwenda (Nyerrgoo, Meckering, Wergejan), Kwent (Williams MD, Kojonup, East of Katanning, Bridgetown MD, Plantagenet area, Denmark, Bwokunbup Hill, Albany & Denmark, Korrlup, Bremer Bay – Esperance, Esperance MD), Kwernt (East of Katanning, Boogerup), Quaint (Jerramungup), Quenda (Northam), Quinda (New Norcia), Qunadah (Blackwood), Wainda (Meckering), Weendaroo (Mardangoora), Woondee	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	(Victoria District)	
	Muir: Quaint	
	Anon 1928: Quenda	
	Roberts: Quenda	
	Ride: Quenda	
	Coyne: Quarnt	
	Gray: Querrnt	
	Whitehurst: kwenda, kwernt, kwinda	
	Brooks & Ritchie: gwernda, gwerndi, quenda	
	Winmar: kwernt	
Perameles bougainville Western barred bandicoot Threatened Newly endemic to WA through extinction in other parts of its geographic range in Australia	Gilbert MS: Mal-a (York districts), Mala. MS2 includes the variants: Mal-a (York and Toodyay districts), Nyem-mel (KGS)	mal nymal [ny'mal]
	Gilbert in Gould: Mala, Mal-a (York, Toodyay districts); Nyem-mel (KGS)	
	Gilbert in Whittell: Nyem-mel (KGS)	
	Shortridge: Marl (Beverley)	
	Moore: Mala	
	Hassell, E. A.: Marl ('a small black animal belonging to the mole family')	
	Bates: Mal (Bridgetown MD, East of Katanning), Maal (Korrlup), Marl (Kojonup)	
	Anon 1928: Marl	
	Troughton: Marl	
	Ride: Marl	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Ramson: maal	
Macrotis lagotis Dalgyte, Bilby Threatened	Gilbert MS: Dal-goitch (York districts), Dalgyte. MS2 has the variant: Dol-goitch (Aborigines generally) Gilbert in Gould: Dol-goitch, Dal-gyte, Dal-goitch Gilbert in Wagstaffe & Rutherford: Dalgyte Gould: Dalgyte Shortridge: Dalgyte Grey: Dal-gyte Moore: Dol-gyt Drummond: Dolgitch Austin: dalgite Millett: dolghite Forrest: dulgate Haddleton: dalyite Hassell E.A.: Yerning Leake: Dalgite Colonial Secretary: Dalges (York sub-district) Bates: Dalgait (Denmark, Albany & Denmark), Dalgaitch (Meckering, East of Katanning) Anon 1928: Dalgite Troughton: Dalgheite, Dalgite, Dulgite Ride: Dalgyte Erickson: dalgyte de Burgh: dalgite	djalkat [djal'kat]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Ramson: dalgite, dalgyte	
	Whitehurst: djalkat	
	Brooks & Ritchie: dalgaj, dalgite	
BURRAMYIDAE		
Cercatetus concinnus Western pygmy possum	Gilbert MS: Man-dur-da (Perth)	mandada [man'dad'a]
		nyeranit [nyer'an'it]
	Gilbert in Gould: Man-dur-da	
	Shortridge: Nyeranit (Margaret R)	
	Grey: Mun-dar-da	
	Moore: Mandarda	
	Anon 1928: Mundarda	
	Troughton: Mundarda	
	Ride: Mundarda	
	Brooks & Ritchie: mandarda?, mundarda	
PSEUDOCHIERIDAE		
Pseudocheirus occidentalis Western ringtail possum	Gilbert MS: Ngo-ra (Perth), Ngorh (KGS)	ngwayir [ngway'ir]
		womp
Threatened	Gilbert in Gould: Ngo-ra (Perth), Ngork (KGS)	woder [wod'er]
Endemic to WA	Shortridge: Wormp (Beverley), Moilyer or Ngnuara (Margaret R)	ngoor
		ngoolangit [ngool'ang'it]
	Nind: Nworra	
	Grey: Ngo-ra	
	Stokes: Gnoorah	
	Moore: Ngo-ra	
	Oldfield: {G'na-cu-lu}	
	Bussell: Ngwarer	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Curr: warder (KGS) Isaacs: Ngwar-ra Hassell, Ed.: ngwarer Hassell, E.A.: Gnoou? [illeg.]; Wamp (Pallinup R & branches) Buller-Murphy: Ngwarer Colonial Secretary: Ngea (Esperance Station) Bates: Gnar (Albany), Gnwurr reh (New Norcia), Gwarra (Northam), Ngoora (Carnamah, Wilgahmala, Pinjarra MD, Wonnerup & Capel Districts, East of Katanning, Korrlup), Ngooera (East of Katanning), Ngoora mooarn (Pinjarra MD), Ngoorra (Dandaragan), Ngwar (Plantagenet area), Ngwarr (Bridgetown MD, East of Katanning, Denmark, Bwokunbup Hill), Ngwaar wamp (Bwokunbup Hill), Ngwarra (Nyerrgoo, Woorurdup, Mardangoora, Meckering, Wergejan, Williams MD, Vasse MD), Ngwarra moorn (Guildford & Perth), Ngworra (Woorurdup), Nuarra (Blackwood), N'warra (Busselton), Nyoorndee (Gingin), Waamp (Korrlup), Waarmp (Bremer Bay – Esperance), Wamp (East of Katanning, Boogerup, Bwokunbup Hill, Plantagenet area), Wardar (Boogerup, Bremer Bay – Esperance), Warder (Boogerup) Rae: Wawding? Davis: Ngwirr Roberts: Worra	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Whitehurst: ngwayir	
TARSIPEDIDAE ***Tarsipes rostratus*** Honey-possum	Gilbert MS: Jee-pin (Perth), Ngool-boon-goor (KGS)	ngoolboongoor [ngool'boong'oor]
Endemic to WA	Gilbert in Gould: Jee-pin (Perth), Ngool-boon-goor (KGS)	djebin [dje'bin] dat
	Grey: Ngool-boon-goor (KGS)	
	Moore: Ngul-bungar, Ngulbungur, Ngulbun-gur (KGS)	
	Drummond: Noorbanger, Tate	
	Hassell E.A.: Teat ('brown barred mouse')	
	Troughton: Ait, Deed, Noolbenger	
	Ride: Noolbenger	
	Brooks & Ritchie: ngulbunggur?, noolbenger	
PHALANGERIDAE ***Trichosurus vulpecula*** Wayoota, Brushtail possum	Gilbert MS: Goo-mal (Aborigines generally)	koomal [koo'mal]
	Gilbert in Gould: Goo-mal	
	Shortridge: Koomaal, Coomul	
	Nind: Comal	
	Lyon: Goomal	
	Bunbury: Goomal	
	Grey: Ko-mal (Vasse); Koo-mal, Koor-nal	
	Stokes: Goomal	
	Symmons: Ku-mal	
	Moore: Gumal, Kumal	
	Smyth: koomal	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Salvado: Kumal	
	Salvado in Curr: cumal (male); cular (female)	
	Oldfield: {We-urda, We-zue-da}	
	Ranford: Coomal	
	Hassell, E.: coomal	
	Bussell: Coomarl	
	Hammond MS1: Koomahl	
	Hammond MS2: Koom-mahl	
	Hammond: Koomahl	
	Johnston: goomall	
	Curr: coomal (York); goomal (Perth, Lower Blackwood); goomul (Harvey); gumell (Blackwood); koomal (Victoria Plains, Toodyay, Pinjarra, Kojonup & Eticup, Bunbury, Geographe Bay & Vasse, Blackwood, Mt Stirling, KGS, Kent); kommale (Northampton); koomul (York), {yoorda (Shark Bay), weurda (mouth of Murchison R), waiada (Champion Bay), widdra (Irwin and Murchison Rivers)}	
	Isaccs: Ku-marl; Ku-marl-Mouarn [black]	
	Helms: Gumal	
	Wells: {Waiadu (Yarragabbie Station)}	
	Hassell, Ed.: coomarl	
	Hassell, E.A.: Comel, Comil (Pallinup R & branches); Mouin Comel [black]	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Buller-Murphy: Coomarl, Koomarl Colonial Secretary: Coomal (Wagin), Coomel (Esperance Station), Cumnel (Beverley sub-district) Bates: Comal (Blackwood), Cular (female) (New Norcia); Cumal (male) (New Norcia); Goomal (Murchison MD, Carnamah, Dandaragan, Wilgahmala, Nyerrgoo, Gingin, Guildford & Perth, Woorurdup, Pinjarra MD, Mardangoora, Wergejan, Meckering, Williams MD, Bridgetown MD, East of Katanning, Vasse MD, Wonnerup & Capel Districts, Denmark, Bwokunbup Hill, Boogerup, Ravensthorpe MD, Bremer Bay – Esperance, Eucla MD), Goomal mowern (black, Gingin), Goomul (Albany MD), Gumal (Albany, Albany & Denmark, Plantagenet area), Gwoom-mall (Northam), Kaimal (Korrlup), Komil (Jerramungup), Koomal (Murchison area, Korrlup), Koom-arl (Busselton), Kumull (New Norcia), {Waioora (Victoria District), Waioorda (Carnamah, Dongara MD), Waloorda (Northampton MD)} Davis: Coomal Scott: Koomal Roberts: Worran (male), Koomarl (female) Atkins: kawmril Schorer: Kumarl Erickson: kumarl Gray: Coomal	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Whitehurst: kelang (male); koomal, koomool (female) Brooks & Ritchie: gumal, kumarl Winmar: coomarl	
POTOROIDAE ***Bettongia lesueur*** Boodie Threatened Newly endemic to WA through extinction in other parts of its geographic range in Australia	Gilbert MS: Boor-dee (interior). MS2 has the variant: (mountain districts) Gilbert in Gould: Boor-dee, Boordee Gilbert in Wagstaffe & Rutherford: Boor-da, Boor-dea Gould: Boodee Shortridge: Boodee Moore: Burdi Drummond: Boordi, Burdit Millett: boody Hassell, E.: boodie Haddleton: boodie Hassell, E.A.: Boudie Leake: Boodie Bates: Boodee (Wergejan), Boordee (Nyerrgoo), Burdaree (Korrlup), Burdia (Israelite Bay MD, Eucla MD) Anon 1928: Boodie Roberts: Boodie Ride: Boodie Erickson: boordie, boordy Ramson: boodie, boody Brooks & Ritchie: boodie,	boo'di

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	burdi	
Bettongia penicillata Woylie Newly endemic to WA through extinction in other parts of its geographic range in Australia	Gilbert MS: Wal-ya (Perth, mountain districts), Woile (KGS) Gilbert in Gould: Wal-ya (Perth, mountain district), Woile (KGS) Gilbert in Wagstaffe & Rutherford: Wal-ga Shortridge: Woylyer, Woyre Nind: Wahl Anon 1834: wo-ail Bunbury: Wullioo Grey: Wal-li-ow; Woile (KGS); Wol-lya (Vasse) Stokes: Wallyo Symmons: Wal-yo Moore: Wal-yo; Woi-le? (KGS) Salvado: uaglio (east of New Norcia) Oldfield: {Wath-u; Wat-tho (Champion Bay)} Hassell, E.: waige Bussell: Walyer Hammond MS1: Wahl,ya Hammond MS2: Wah-lya Hammond: Wahlya Isaacs: Wol-ya Helms: Wallin Hassell, Ed.: walyer Hassell, E.A.: Woyil	woli [wo'li] wol

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	(Fitzgerald R & branches), Woyle Leake: Woilie Buller-Murphy: Walyer Colonial Secretary: Walye (Toodyay sub-district) Bates: {Waadhoo (Dandaragan), Wadhoo (Carnamah, Wilgahmala)}, Wail (Kojonup), Wal (Plantagenet area, Bwokunbup Hill, Korrlup, Bremer Bay – Esperance), {Waldhoo (near Balladonia)}, Wal'u (Israelite Bay MD), Walya (Guildford & Perth, Woorurdup, Meckering, Mardangoora, Williams MD, Blackwood, Vasse MD, Wonnerup & Capel Districts), Walye (Wergejan, Williams MD), Wal-yer (Busselton), Walyoo (Gingin, Pinjarra MD), {Warhoo (Mardangoora)}, Wawilyu (New Norcia), Wohle (Jerramumgup), Woil (Bridgetown MD, Plantagenet area), Wo'il (East of Katanning, Boogerup), Wol (Bridgetown MD, East of Katanning), Wollue (Northam), Wol-yer (Busselton), Wooil (Kojonup) Rae: Woil? Anon 1928: Woile Roberts: Wolya Atkins: wawly Schorer: Dwolg Troughton: Woile, Woyre Ride: Woylie Ramson: woylie, woilie	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Brooks & Ritchie: walyu, woylie Winmar: woylj	
Potorous platyops Broad-faced potoroo Extinct Endemic to WA	Gilbert MS: Mor-da (interior) Drummond: Mort Hassell E.A.: Mort ('kind of kangaroo rat') Colonial Secretary: mort (Toodyay sub-district)	moda [mo'da]
Potorous gilbertii Gilbert's potoroo Threatened Endemic to WA	Gilbert MS: Ngil-gyte (KGS) Gilbert in Gould: Ngil-gyte (KGS) Nind: Nailoit Moore: Garlgyte Bates 1913: Ngilgaitch Roberts: Nilgyte	ngilkat [ngil'kat]
MACROPODIDAE ***Lagorchestes hirsutus*** Rufous hare-wallaby, Mala Threatened Newly endemic to WA through extinction (in the wild) in other parts of its geographic range in Australia	Gilbert MS: Woo-rup (interior) Gilbert in Gould: Woo-rup Gilbert in Wagstaffe & Rutherford: Woorap (York District) Shortridge: Wurrup Moore: Wurak [Note: name attributed tentatively to this species. Moore in error called it *Macropus elegans*, now called *Lagostrophus fasciatus*, and described it as a species of kangaroo] Hunt: Wurup Forrest: wirrup Bussell: Woorark [Note: name	woorap [woo'rap]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	attributed tentatively to this species. Bussell described it as a very scarce, small brown wallaby]	
	Leake: Wurrup	
	Buller-Murphy: Woorark [Note: name attributed tentatively to this species. She described it as a very scarce, small brown wallaby]	
	Bates: Woorark (Woorurdup), Wooraik (Wonnerup & Capel Districts) [Note: names attributed tentatively to this species]; Woorup (Woorurdup)	
	Anon 1928: Wurrup	
	Ride: Wurrup	
Macropus eugenii Tammar wallaby	Gilbert MS: Dam-a (interior)	dama [da'ma]
	Gilbert in Gould: Dama (Moore R)	bonin [bo'nin]
	Gilbert in Wagstaffe & Rutherford: Dama (Moore R)	
	Shortridge: Tammar; Bonnan (Margaret R)	
	Nind: Taamur	
	Drummond: Damar	
	Bussell: Bonnin	
	Haddleton: tommer	
	Hassell, Ed.: bonnin	
	Hassell E.A.: Tama, Tamar	
	Leake: Tamma	
	Buller-Murphy: Bonnin	
	Colonial Secretary: tamar (Northam sub-district)	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Bates: Bonnin (Vasse MD), Dammur (Murchison MD), Tamar (Plantagenet area), Tammar (Guildford & Perth, Wegejan, Denmark, Bwokunbup Hill, Bremer Bay – Esperance), Rae: Tamma Le Soeuf & Burrell: Dama Anon 1928: Tammar Roberts: Bonin Atkins: tamar Spencer: tamar Troughton: Tammar Ride: Tammar Coyne: Tarmer [male or female] Ramson: tammar, tamar; formerly dama, damar, tamma Brooks & Ritchie: damar, tammar	
Macropus fuliginosus Western grey kangaroo	Gilbert MS: Yoon-gur (male), Work (female) (Aborigines generally) Gilbert in Gould: Yoon-gur (male), Work (female) Gilbert in Wagstaffe & Rutherford: Yoon-gaw (male), Work (female) Shortridge: Eonga (male), Woyre (female), Eowit (Moore R), Yongure (male) King: Be-ango Nind: Yungur (male), Warre (female)	yongka [yong'ka] (yongka – male; wok or wor – female)

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Wilson: Worr	
	Lyon: Yawart (male), Waroo	
	Bunbury: Yowert (male), Waroo (female)	
	Grey: Yun-gore; Yow-art (male), War-roo (female); Woor-ra (female) (Vasse); Worr (female) (KGS)	
	Stokes: Yewart; Waroo (female)	
	Moore: Yangor (kangaroo species in general; male in mountain dialect); Yowart (male); Kubit (male, Murray and Serpentine Rivers)	
	Yangornanga (female, Murray and Serpentine Rivers); Warru (female)	
	Symmons: Yun-gor; Yow-art (male); War-ru (female)	
	Brady: Yangor	
	Salvado: Iongor (male) (east of New Norcia); Uoro (female) (east of New Norcia); Uaro (female) (north of New Norcia)	
	Salvado in Curr: yongar (male); wora (female)	
	Oldfield: {Yow-aa-da; Jim-aa (male), Yo-e-do-bat (female); Yow-ad-do (Champion Bay)}	
	Ranford: Yonker	
	Hassell, E.: yongah, youngar, younger	
	Bussell: Yongher	
	Hammond MS1: N,yong,er	
	Hammond MS2: N-yon-ger	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Hammond: N-yonger Curr: yonga (Pinjarra), yongar (male) (New Norcia, Perth); yonger (male) (Kojonup & Eticup, Bunbury, Geographe Bay & Vasse, Lower Blackwood, Blackwood); yongor (male) (Mt Stirling); {yooada (Champion Bay), yoorda (Northampton)}; youngar (York), younger (male) (KGS); {yowada (mouth of Murchison R), yowardoo (Irwin & Murchison Rivers)}; yowart (Perth), yowdar (Doubtful Island Bay to Israelite Bay); {yowerda (Shark Bay)}; yungar (Toodyay, Harvey; (male) York); yungur (Kent District), yunkera (Victoria Plains) waar (Geographe Bay, Blackwood); wooiar (female) (Geographe Bay & Vasse, Blackwood); waark (female) (KGS); wora (female) (New Norcia); wore (Blackwood); war (female) (Mt Stirling); warr (female) (York) Isaacs: Yonga (male); Woo-ra (female) Helms: Yauart (male), Warru (female) Markey: Yonka (male) Hassell, Ed.: yongher Hassell E.A.: Yonger (Gairdner & Pallinup Rivers); Wore (female) Buller-Murphy: Yongher, Yonker Colonial Secretary: Yonger (Toodyay & Beverley sub-districts)	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Bates: Yonga (Northam); Yongar (male) (New Norcia, Nyergoo, Guildford & Perth, Woorurdup, Meckering, Wergejan, Williams MD, Bridgetown MD, Vasse MD, Denmark, East of Katanning, Korrlup, Bremer Bay – Esperance, Esperance MD); Yonger (Jerramungup); Yongera (Busselton); Yonggar (male) (Plantagent); Yongur (male) (Bwokunbup Hill, Boogerup); {Yowada (Kookynie), Yow'ada (Murchison MD), Yowarda (Nyawardee near Canegrass, Carnamah, Wilgamahmala, Mardangoora, Victoria Plains); Yowardoo (Murchison area)}, Yowart (male) (Gingin, Pinjarra MD); Yowdar (Doubtful Island Bay – Israelite Bay); {Yowera (Northampton MD)}, Yowerda (male) (Murchison MD, Dandaragan, Victoria District, Wonnerup & Capel Districts); Yungar (Kojonup, Albany); Yungoora (Norseman District), Yungurr (Ravensthorpe MD, Israelite Bay MD) Waaroo (Victoria Plains), War (Plantagenet area), Warhoo (Murchison MD), Warr (female) (Guildford & Perth, Bridgetown MD, Denmark, Bwokunbup Hill, Boogerup, East of Katanning, Korrlup, Bremer Bay – Esperance Bay, Esperance MD); Waroo (female) (Gingin, Pinjarra MD); Warr (Kojonup); Warra (female) (Nyerrgoo, Woorurdup, Meckering, Wonnerup & Capel Districts); Warroo (female) Wilgahmala; Worr (female) (Vasse MD); Worra (female) (New Norcia); Wurr (female) (Williams MD); Bates 1913: Yongar (male)	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Bates 1914: Yongar (male), Wara (female)	
	Rae: Yonga (male); Waw (female)	
	Muir: Yonger	
	Davis: Yonga	
	Scott: Yangora	
	Roberts: Yonga	
	Atkins: yangar (male); wawrr (female)	
	Coyne: Yongar marm (male), Yonger narnk (female)	
	Gray: Yongar	
	Whitehurst: yongka	
	Winmar: yonger	
Macropus irma Western brush wallaby	Gilbert MS: Goorh-a (Perth), Quar-ra (interior)	kwara [kwa'ra]
		koora [koo'ra]
Endemic to WA	Gilbert in Gould: Goorh-a (Perth), Quar-ra (interior)	
	Gilbert in Wagstaffe & Rutherford: Goork-a (Perth), Quorira (interior)	
	Shortridge: Quoyrer, Quoirer	
	Grey: Go-ra, Gwoor-a	
	Stokes: Goora	
	Moore: Gurh-ra, Quarra	
	Oldfield: {Wee-ra; Wee-ar-rch (Champion Bay)}	
	Hassell, E.: omer	
	Bussell: Quarra	
	Hammond MS1: Ing,wahra	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Hammond MS2: Ing-wahra Hammond: Ing-wahra Isaacs: Qwoo-ra Markey: Quera Hassell E.A.: Quer (Gairdner R), Quir Buller-Murphy: Quarra Colonial Secretary: Quarra (Toodyay sub-district), Queer (Esperance Station) Bates: Goora (Dandaragan, Wilgahmala, Gingin, Pinjarra MD, Wonnerup & Capel Districts), Gwarra (Woorurdup), Gwerr (Norseman MD), Gwerra (Guildford & Perth), Gwurra (Woorurdup), Koora (Gingin, Wonnerup & Capel Districts), Koorra (Carnamah), Kwar (Plantagenet area, Denmark, Albany & Denmark), Kwarl (Denmark, Albany & Denmark), Kwerr (Mardangoora, Plantagenet area, Bwokunbup Hill, Boogerup, Korrlup), Kwerra (Murchison MD, Nyerrgoo, Meckering, Wergejan, Williams MD, Vasse MD), Kwirra (Guildford & Perth), Kwurr (Bridgetown MD, Kojonup, East of Katanning, Bremer Bay – Esperance), Kwurra (Murchison MD), Quayrar (New Norcia), Quer-ra (Busselton), Quore (Jerramungup), Qurra (Northam), Weeara (Murchison MD, Northampton MD, Victoria District, Victoria Plains, Murrum MD), Weearra (Murchison MD), Wee'arra (Murchison MD)	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Rae: Kwarr, Kwirr	
	Davis: Kwirr	
	Roberts: Quarra	
	Atkins: kwaur, kwawr	
	de Burgh: koora	
	Gray: Ouoorr	
	Whitehurst: kwer, kwoora	
	Winmar: quara	
Macropus robustus Euro	Shortridge: {Bigodar (Gascoyne R), Bigoder}	bikada [bik'ad'a]
	Hunt: Grinadah	
	Helms: {Pigurla (Fraser Range)}	
	Wells: {Pirkuda (Fraser Range)}	
	Bates: {Beegoorda (Murchison MD, Murrum MD, Norseman MD), Beegoordoo (Dongara MD, Southern Cross MD), Beegurdoo (Coolgardie MD)}, Bigart (East of Katanning), {Biggoorda (near Balladonia)}, Bigurda (Israelite Bay MD), Boonoyn (Karadup), {Booyunoo (Dongara MD), Peegoordo (Norseman MD)}	
	Anon 1928: Biggada	
Macropus rufus	Shortridge: {Marlo (Gascoyne area)}	
Marloo, Red kangaroo		
Species occurred outside the itinerary of Gilbert		
Onychogalea lunata Djawalpa, Crescent nailtail wallaby	Gilbert MS: Wau-rong (York; interior). MS2 has the variants: Wa-rang (York), Wau-rong (interior)	worong [wo'rong]
Extinct		

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Gilbert in Gould: Waurong	
	Drummond: Warrong	
	Shortridge: Wurrine, Wurrung	
	Austin: worrang, worrung	
	Hunt: Woorong	
	Forrest: wurung	
	Haddleton: wurrung	
	Hassell Ed.: Wurrung	
	Hassell E.A.: Wurrung ('red tammar...but long fur like a brush')	
	Leake: Warrung	
	Bates: Warong (Woorurdup), Warrong (Korrlup), Werong (Woorurdup)	
	Anon 1928: Wurrung	
	Troughton: Wurrung	
	Ride: Wurrung	
	Ramson: wurrung	
	Brooks & Ritchie: waran?, wurrung	
Petrogale lateralis Warru, Black-flanked rock-wallaby	Gilbert MS: Moo-ro-rong (mountain districts). MS2 has the variant: (York and Toodyay districts)	moororong [moo'ror'ong] bokal [bok'al]
	Gilbert in Gould: Moo-roo-rong (Toodyay district)	
	Shortridge: Boggile [York and Beverley?]	
	Stokes: Mooroo [Note: name attributed tentatively to this species]	
	Moore: Murorong	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Drummond: Murarong Austin: mouraring, mourarung Oldfield: {Wil-lo-ba} Bates: Baggolya (Mardangoora), Baggool (Peak Hill MD), Baggooldharra (Murrum MD), Baggoolyarra (Dongara MD), Boggal (Meckering), Boggool (Morarie, Nannine), Bogulara (Lake Way District), Boguldara (Lake Way), Boymenong (Jerramungup), Moorerung (Woorurdup, Pinjarra MD, Meckering, Wergejan, Vasse MD, Wonnerup & Capel Districts), Mororong (Guildford & Perth), Murraran (New Norcia), Murrerung (Nyergoo) Bates 1913: Moorerung (Meckering District)	
Setonix brachyurus Quokka Threatened Endemic to WA	Gilbert MS: Ban-gup (Perth), Quok-a (Augusta, KGS) Gilbert in Gould: Bangap (Perth), Quak-a (KGS) Shortridge: Bangeup, Quokka Nind: Quakur Lyon: Bangup Grey: Ban-gup; Kwa-kur Moore: Ban-gap, Bang-gap; Kwakar (KGS); Quogga (southern districts) Brady: kwa-kur Hassell, E.: quacka Bussell: Quagger Hammond MS1: Kwogger	kwoka [kwo'ka] bangop [bang'op]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Hammond MS2: Kwag-ger	
	Hammond: Kwogger	
	Isaacs: Quag-ga	
	Helms: Burngup	
	Hassell, Ed.: quagger	
	Hassell E.A.: quocker	
	Drake-Brockman: quogga	
	Buller-Murphy: Quagger	
	Bates: Burncup (New Norcia), Burngap (Woorurdup, Pinjarra MD), Burngup (Guildford & Perth), Gwaggur (Bwokunbup Hill), Gwagur (Plantagenet area), Gwoggur (Denmark), Gwogur (Denmark), Kwaggur (Boogerup, Korrlup)	
	Bates 1913: Burngup	
	Rae: Kwokka	
	Muir: Quocker	
	Anon 1928: Quo[k]ka	
	Scott: Quokka	
	Roberts: Quokka	
	Troughton: Quokka	
	Ride: Quokka	
	de Burgh: bunkup	
	Coyne: Quacker (male or female)	
	Udell: bunkup	
	Ramson: quokka, quagga, kwaka	
	Whitehurst: kwoka	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Brooks & Ritchie: gwaga?, quokka	
Lagostrophus fasciatus Banded hare-wallaby Threatened Newly endemic to WA through extinction in other parts of its geographic range in Australia	Gilbert MS: Mar-nine (interior) Gilbert in Gould: Marnine Gilbert in Wagstaffe & Rutherford: Mar-nine Shortridge: Merrnine, Munning, Munnine Drummond: manang, Marnine, Marmine Hassell E.A.: Murning ('barred tammar') Leake: Mernine Colonial Secretary: murning (Esperance Station) Bates: Murndain (Eucla MD), Murnain (Kojonup), Murning (Korrlup), Anon 1928: Munning Ride: Munning	maning [man'ing]
MURIDAE ***Leporillus apicalis*** Djooyalpi, Lesser stick-nest rat Species occurred outside the itinerary of Gilbert		
Notomys alexis Tarrkawarra, Spinifex hopping-mouse Species occurred outside the itinerary of Gilbert		
Notomys longicaudatus Koolawa, Long-tailed hopping-mouse Extinct	Gilbert MS: Kor-tung and Goola-wa (Moore R). MS2 has the variant: Gool-a-wa Gilbert in Gould: Kor-tung and Gool-a-wa (Moore R)	koolawa [kool'a'wa] kodong [kod'ong]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Gilbert in Wagstaffe & Rutherford: Kar-tung and Goot-a-ra (Interior) Grey: Dtor-dung	
Notomys macrotis Noompa, Large-eared hopping-mouse Extinct Endemic to WA	Gilbert MS: Bul-long (Moore R), Mar-do (Perth) Gilbert in Wagstaffe & Rutherford: Bat-tong (Moore R)	bolong [bo'long]
Notomys mitchellii Pankot, Mitchell's hopping-mouse	Gilbert MS: Djyr-dowin (Perth), Mat-ter-geetch (Moore R). MS2 has the variant: Djyr-dow-in (Perth) Gilbert in Gould: Djyr-dow-in (Perth), Mat-tee-getch (Moore R) Shortridge: Gunding Moore: Djirdowin Hassell, E.A.: yungil ['Jibra rat']	djirdon [djird'on] matakitj [ma'ta'kitj]
Pseudomys albocinereus Noodji, Ash-grey mouse Endemic to WA	Gilbert MS: Noo-jee (Perth), Jup-pert (Moore R) Gilbert in Gould: Noo-jee (Perth), Jup-pert (Moore R) Gilbert in Wagstaffe & Rutherford: Nea-jee (Perth) Grey: Nu-jee Moore: Nuji; N-yuti (Upper Swan) Bates: Ngooje (Guildford & Perth)	noodji [noodj'i]
Pseudomys fieldi Djoongari, Shark Bay mouse Threatened Newly endemic to WA through	Gilbert MS: Kurn-dyne (Moore R) Gilbert in Gould: Kurn-dyne (Moore R)	konding [kond'ing]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
extinction in other parts of its geographic range in Australia	Gilbert in Wagstaffe & Rutherford: Kura-agae (Moore R) Salvado: Candagn (east of New Norcia), Pico (north of New Norcia) Hassell, Ed.: Kanding Bates: Karndain (Korrlup), Karndin (Wergejan), Candan (New Norcia)	
Pseudomys hermannsburgensis Mingkiri, Sandy inland mouse Species occurred outside the itinerary of Gilbert		
Pseudomys nanus Moolpoo, Western chestnut mouse	Gilbert MS: Jil-beetch (Moore R) Gilbert in Gould: Jib-beetch (Moore R) Gilbert in Wagstaffe & Rutherford: Jeit-Vitch (Moore R)	djilbitj [djil'bitj]
Pseudomys occidentalis Walyadi, Western mouse Threatened Newly endemic to WA through extinction in other parts of its geographic range in Australia Species occurred outside the itinerary of Gilbert		
Pseudomys shortridgei Dayang, Heath rat Threatened Species occurred outside the itinerary of Gilbert		
Hydromys chrysogaster Rakali, Water-rat	Gilbert MS: Ngoor-joo (Perth), Ngwir-ri-jin (KGS)	ngoodjo [ngoodj'o]

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
		ngwiridjin [ng'wir'idj'in]
	Gilbert in Gould: Ngoor-joo (Perth), Ngwir-ri-gin (KGS)	wamp wamp
	Shortridge: Wamp-Wamp (Beverley), Mamgericht (Busselton)	ngangaritj [ngang'ar'itj]
	Moore: Murit-ya, Ngurju	
	Hassell, E.A.: Wanip Wanip	
	Bates: Daaram (Wonnerup & Capel Districts), Ngangareetch (Wonnerup & Capel Districts), Ngarngariten (Vasse MD), Ngoorja (Guildford & Perth), Ngooreeja (Woorurdup), Ngoorjoo (Pinjarra MD)	
	Bates 1914: daran (Vasse)	
Rattus fuscipes Mootit, Southern bush rat Type locality is in WA (for species also occurring outside WA)	Gilbert MS: Mur-deet (KGS). MS2 has the variant: Moor-deat (KGS)	modit [mod'it]
	Hassell, E.A.: Mordit	
	Bates: Moordut (Denmark), Moort (Bridgetown MD, East of Katanning), Mordi-tcha (Guildford & Perth), Moreetch (Wonnerup & Capel Districts), Mort (Williams MD), Murdit (East of Katanning)	
	Whitehurst: moyitj	
Rattus tunneyi Djini, Pale field-rat	Grey: Djil-yoor [Note: name attributed tentatively to this species]	
	Moore: Djil-yur [Note: name attributed tentatively to this species]	
CANIDAE ***Canis lupus*** Dingo	Gilbert MS: Dwer-da (Aborigines generally)	doot
	Gilbert in Gould: Dwer-da	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Shortridge: Duada, Dwert, Euckine, Yarging Nind: Toort, Yaccan toort Wilson: To-ort Lyon: Doora Bunbury: Dora, Doodi Grey: Bore-ang (male dog) (KGS); Door-da (dog), Tdoor-da (dog), Doorda Mo-kine (wild dog); Nank (female dog) (KGS); Toor-ta (dog), Yek-kain (wild dog), Yiee-kain (wild dog) Stokes: Dudah Symmons: Dar-da (dog); Dur-da-mo-kyn Moore: Borang (male dog); Durda (dog), Durda Mokyn (wild, untamed dog); Yekyn (wild dog); Mokyn (wild dog) (Upper Swan) Brady: Durda, Idoor-da Salvado: Duora (east of New Norcia), Durda (east of New Norcia), Tutto (north of New Norcia); Duora n-anga (female) (east of New Norcia); Tuttumimbi (female) (north of New Norcia) Salvado in Curr: dura waiwe Oldfield: {G'no-ban-o (wild); Ot-tho (domesticated)} Hassell, E.: twert Bussell: Dorder (dog); Dorder Yockine (Dingo) Hammond MS1: Dwerda Hammond MS2: Dyi-erda-yug-gnyr [illeg.]	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Hammond: Dwerda, Dwerda-yuggyn Curr: [Note: * = tame dog, assumed by me to indicate tame Dingo] dooda* (Perth, York, Mt Stirling), dooda mokyne (Perth), {doodoo (Eyre's sand patch, Eucla), doodoota (Shark Bay)}, dorda yakkino (Toodyay), dura waiwe (New Norcia), dwarda* (Pinjarra), dwardar* (Lower Blackwood), dwoda* (Harvey), dwodda* (Geographe Bay), dwert* (Geographe Bay), {hotther* (Champion Bay)}, moakin (Kojonup & Eticup), moking (KGS), mookine (Kent District), {newbana (Northampton), ngobano (mouth of Murchison R), nuban (Natingero), ngupine* (Doubtful Island Bay to Israelite Bay), toothoo* (Irwin & Murchison Rivers)}, twart* (Kent), twert (KGS), twurt* (Kojonup & Eticup), yakkine dooda (Perth), yakkine (Victoria Plains, Pinjarra, Blackwood, Harvey, Geographe Bay & Vasse), yarkine (Geographe Bay, Blackwood), yeekine (York), yockine (York), yackine (Lower Blackwood), yokkine (Mt Stirling) Helms: {Muban (Yaurigabba)}; Dwarda (dog); Yokkain (Dingo) Wells: {Doychu (dog) (Fraser Range); Dudu (dog) (Yarragabie Station)} Markey: Yakine Hassell, Ed.: dorder, dorder yockine Hassell E.A.: Moiler; Twert	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	(Fitzgerald R & branches); Twirt (tame dog); Yuckine Buller-Murphy: Dorder, Dorder Yockine Colonial Secretary: Yokine (Beverley sub-district) Bates: {Dhoodhoo (Mardangoora), Dhoothoo (Dandaragan, Carnamah, Wilgahmala), Doojoo (Norseman MD)}, Doowert (Korrlup), Dorda (Wergejan), Dura (New Norcia), Dwarda (Blackwood), Dwerda (Esperance MD), Dwerda yeegain (Meckering), Dwert (Albany, Boogerup), Dworda (Wergejan), {Joojoo Coolgardie MD, Southern Cross MD)}, Moggain (East of Katanning), Mókin (Kojonup, Plantagenet area), Mokkain (Korrlup), Mwoggain (Bridgetown MD, East of Katanning), {Ngoobanoo (Carnamah), Ngoobaanoo (Northampton MD)}, Nwogin (Plantagenet area), {Ngupine [tame dog] (Doubtful Island Bay – Israelite Bay), O-tha (Victoria District)}, Twert (Plantagenet District, Albany, Esperance MD), Yaggain (Bridgetown MD, East of Katanning), Yagginyung (Karadup), Burung (male) (Albany); Dooja jerdara (male) (Wonnerup & Capel District); Dorda mamman (male) (Vasse MD); Dwerda mamma (male) (Woorurdup); Dwerda yaggain maam (male) (Guildford & Perth); Dwert (male) (Albany & Denmark); Dworda mamma (male) (Nyergoo); iya-kain mangar (male) (New Norcia); Joorda mamma (male) (Gingin); Mooyelur (male)	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	(Bremer Bay – Esperance); Towitemla-mam (male) (Jerramungup); Twert borong (male) (Bwokunbup Hill, Plantagenet area); Yackine mamma (male) (Northam); Yakkain (male) (Williams MD); Yokine mool-kut (male) (Busselton); Dooja ngaia/nganga (female) (Wonnerup & Capel Districts); Dorda yaggain (female) (Vasse MD); Dwerda nganga (female) (Woorurdup); Dwerda yaggain nganga (female) (Guildford & Perth); Dwerda yog (female) (Nyerrgoo); Dwert mokkin (female) (Denmark), Dwert ngaank (female) (Boogerup); Dwert ngank (female) (Denmark); Dwert yakkain (female) (Williams R); Dworda yog (female) (Nyergoo); iya-kain tuwia (female) (New Norcia); Joorda nganga (female) (Gingin); Mokin (female) (Albany & Denmark); Mokkin (female) (Bwokunbup Hill); Mwoggin (female) (Bwokunbup Hill); Ngaank twert (female) (Bwokunbup Hill); Ngaiam (female) (Bremer Bay – Esperance); Puank (female) (Albany); Towitmela-yanch (female) (Jerramungup); Twert ngank (female) (Plantagenet area); Yackine yorga (female) (Northam); Yokine yaw-ka (female) (Busselton); Yukkain (female) (Boogerup); Bates 1914: dwerda Rae: Mokien, Twert, Yukien; Mam (male); Gnunk (female) Muir: Yerkine Davis: Dwirt (dog)	

Species, current vernacular name and current status	Name(s) recorded	Recommended name(s), with corrected orthography and [suggested syllables]
	Scott: Yokine Roberts: Mokine (male), Yokine (female) Atkins: twaurt Gray: Toorrit Whitehurst: dwert mokiny, mokiny Winmar: dwert	

TABLE 3

Noongar names recorded for non-terrestrial mammal species.

Species or higher taxon, and comment	Name(s) recorded
Bats Ten species, excluding vagrants, occur in south-west WA. Shortridge (1936) implies that the names listed by him apply to all insectivorous species of bats (cf. Burbidge *et al.* 1988, p. 13).	Gilbert MS: *Nyctophilus* sp. Bam-be (Perth); *Nyctophilus* sp. Bam-be (Perth), Bar-ba-lon (KGS); *Scotophilus* sp. [= *Chalinolobus morio*] Bam-be (Perth) Gilbert MS2: *Nyctophilus Geoffroyii* [= *N. geoffroyi*] Bam-be (Perth & vicinity); *Nyctophilus* sp. Bam-be (Perth & vicinity), Bar-ba-lon; *Scotophilus morio* [= *Chalinolobus morio]* Bam-be (Perth & vicinity) Gilbert in Gould: *Nyctophilus geoffroyi* Bambe (Perth), Bar-ba-lon (KGS); *N. timoriensis* Bam-ba (Perth) Shortridge: *Chalinolobus morio* Tarding (Beverley), Babainit (Busselton) Grey: Bam-bee, Ba-bil-gun Symmons: Bam-bi Moore: Bambi, Babilgun Rae: Ba-bill Whitehurst: babitj
Neophoca cinerea Australian sea-lion It appears that this species had a different name at Swan River and KGS.	Gilbert: Man-ye-ne (Perth). MS2 has the variant Perth & vicinity Nind: Barlard Lyon: Manyeen Grey: Man-yin-ee Symmons: Man-yin-ni Moore: Man-yini, Man-yi-ni Hassell, E.A.: Dalgart Rae: Balkut
Whale Based on recent stranding recoveries, it appears that the many species present in	Nind: Mammang Grey: Me-marng

Species or higher taxon, and comment	Name(s) recorded
south-west waters of WA were not distinguished by Noongars.	Symmons: Mi-man-ga
	Moore: Mimang-a, Mi-mang-a
	Oldfield: {Moo-long-ar-do}
	Isaacs: Mum-mung
	Hassell, E.A.: Mumong
	Buller-Murphy: Mamung
	Rae: Mamong
	Atkins: mamang
	Gray: Mumung
Porpoise Presumed to refer to *Tursiops truncatus* Bottlenose Dolphin	Lyon: Waraneen
	Grey: Wa-ran-ung; Twoort-a-bang-ul (KGS)
	Symmons: War-ran-ang
	Moore: Warran (1842); Warranang; Worran-ang (1884)
	Hammond MS1: Kwillen,ah
	Hammond MS2, 1933: Kwillen-ah
	Isaacs: Kear-la
	Hassell, Ed.: Twertawaning
	Bates 1913: Warranung
	Bates 1914: Kela (Vasse)
	Atkins: twardamonit
	Whitehurst: kwilena

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Wood basic density surveys of pedigreed Maritime Pine in Gnangara, Pinjar and Yanchep plantations

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SUMMARY

Maritime pine (*Pinus pinaster*) growing in Gnangara, Pinjar and Yanchep plantations north of Perth was assessed to compare the basic density of wood from genetically improved (pedigreed) trees, planted routinely from 1972 to 1987 (P72 to P87), with that of older unimproved trees. Over 500 trees were sampled initially, with the minimum sample of 20 trees (5 plots x 4 trees) in each planting year of the pedigreed material. An additional 20 trees from each of P82 to P87 plantings were sampled because these would be harvested soon. Smaller samples of older material, and 30 trees from research trials established from 1965 to 1972, were included. A bark-to-pith core was extracted at breast height (1.3 m), and basic density of each 35 mm section from the pith assessed. Basic density (unextracted) increased from pith to bark and decreased with decreasing age. Mean basic density in 70–105 mm sections of P72 to P80 plantings was about 500 kg m^{-3}.

Effects of height in tree on basic density of five pedigreed maritime pine trees from each of P72 to P87 plantings were assessed. Mean basic density of cores from 1.3 m, 3 m, 6 m and 9 m decreased with decreasing age and with increasing height in the tree. Sample cores from edge and internal trees of P80, P82 and P84 stands showed that edge trees had basic density about 30 kg m^{-3} less than that of internal trees.

The initial survey indicated that resin content continued to increase with age, and a further study compared mean basic density of cores from trees planted in 1957 and 1984. Matched cores from either P57 or P84 were either left unextracted or extracted with an acetone : ethanol : toluene solution (4:1:1 ratio) for 48 hours before measuring basic density. The results showed that 0–35 mm sections of cores from P57 trees had 13.9 per cent resin content compared with 3.7 per cent in cores from 1984 plantings, and there was a decreasing trend of resin content with increasing distance from the pith.

Comparative basic density data from previous assessments of Western Australian-grown maritime pine are given.

The survey results indicated that pedigreed maritime pine material has acceptable basic density for a range of uses, e.g. sawlogs, MDF or LVL production.

INTRODUCTION

Maritime pine (*Pinus pinaster*) is one of the major plantation species in Western Australia, with a current area of about 27 000 ha. This species will become significantly more important with planned establishment of 150 000 ha in the semi-arid areas of the Wheatbelt to reduce salinity effects while providing a commercial crop.

The current major areas of maritime pine are Gnangara, Pinjar and Yanchep plantations, about 35 km north of Perth, with a combined area of about 20 000 ha. All plantings since 1972 have been improved or pedigree stock resulting from an intensive tree-breeding program initiated by the then Forests Department. The areas will be thinned and clear-felled progressively over the next 20 years and the area converted to a State park.

Maritime pine industrial wood is used by Wesfi Ltd for medium density fibreboard (MDF) production in Kewdale, and by Pinetec Pty Ltd, who mill mainly pallet timber. There is a current proposal for a Japanese and a local company to use part of the maritime pine resource to manufacture laminated veneer lumber (LVL) for either structural or non-structural purposes. Most of the product would be exported.

Efficient utilisation requires detailed information on the wood properties of the species, particularly the pedigreed resource planted since 1972, because thinnings from these compartments are providing an increasing resource to Wesfi and Pinetec and would be used in LVL production. Wood density is an important predictor of strength properties, and an initial survey was to obtain a better understanding of wood density variation with age of maritime pine.

The initial survey was based on systematic sampling at breast height (1.3 m) of trees in areas planted with pedigreed pine each year from 1972 to 1980 (P72 to P80), with comparisons made with unimproved material from P69 to P71. Some younger (P81 to P87) and older (P51 and P57) material was also included. The data from this survey confirmed the trend of decreasing basic density with decreasing age in the juvenile and adjacent wood. Wesfi were concerned about this trend (and that of decreasing density with increasing height in the tree), particularly as it affected the basic density of trees from P82 to P87: they requested additional sampling.

A subsequent survey with destructive sampling was required to quantify the basic density variation with increasing height in the tree, with a single compartment selected as being representative of a specific planting year (P72 to P87).

Another Wesfi concern was the lower density of veneers produced from P82 logs sent to Japan for LVL trials, compared with the density data from the initial survey. Further core samples were collected from the P82 to P87 areas, and taken from immediately adjacent to plots sampled for the LVL logs for Japan. In the wood density assessments, sampling was carried out a minimum of 20 m from the edge of the stand, so sample trees provided data representative of that particular resource. However, when sampling of the resource was required for the LVL pilot trial, the specification included a minimum diameter limit that could only be achieved by sampling the open-grown edge trees. The Department of Conservation and Land Management (CALM) postulated that the lower density resulted from edge trees being sampled in these young plantations to make the minimum diameter specification, and that lower basic density subsequently measured in LVL produced from edge trees was not representative of that age stand. It was necessary to quantify the basic density differences between edge trees within the compartment, and the next sampling was done in three specific stands (P80, P82, and P84).

The systematic sampling of maritime pine planted in these plantations showed a consistent increasing trend with age in unextracted basic density of cores. Koch (1972) indicated that resin continued to be produced in the southern pines of the United States (e.g. *P. elliottii var elliottii*, *P. taeda*) after the initial heartwood formation, and it was postulated that this situation also occurred in Western Australian-grown maritime pine. Resin content increases wood density, but has negligible effect on strength. A small pilot study used paired cores from 1957 (P57) and 1984 (P84) plantings, with unextracted basic density of one core compared with basic density of the other core after the resin was extracted at the Western Australian Chemistry Centre.

The major objective of the comprehensive survey and studies was to assess wood basic density of Western Australian-grown maritime pine of a wide range of ages as an indication of its potential uses. The effects of increasing height in the tree on wood density, the differences between edge and internal trees in the compartment, and the comparative resin content in juvenile wood of P57 and P84 trees were also assessed.

METHODS

Survey of basic density at breast height

The sampling pattern used to assess basic density variation in the pedigreed resource was based on the area established annually from 1972 to 1987 (P72 to P87). A smaller sample of unimproved resource (P51, P57, P69, P70 and P71) was included for comparative purposes. The number of plots sampled was proportional to the area planted, and stratification was done based on silvicultural and site variations. A bark-to-pith core at breast height was taken from each of four trees in the selected plot, and basic density of each 35 mm section measured. The location of five temporary plots (each with four trees) was nominated by a CALM forester with intensive knowledge of Gnangara, Pinjar and Yanchep plantations (Table 1).

Each tree had a core sample removed at breast height, using a 'Trecor'® Wood Corer with a 'Tanaka'® petrol motor drill. The position was modified if within 15 cm of a whorl of branches. After the diameter at breast height over bark was measured, a mark was made on the corer to ensure that the core being drilled went past the pith in each tree. Only one radial core was used from each tree, to reduce the damage to the stem. The corer was sharpened at the start of the survey, and proved very effective in producing a clean uniform core with good definition of the growth rings. Immediately after removal the cores were wrapped in a marked plastic bag to minimize moisture loss. A pilot trial had shown that overnight moisture loss in the core could be compensated for with a 20-minute soaking in water before cutting the core into sections and measuring green volume.

The procedure in the laboratory was to break off the bark at the cambium, cut the core to length through the pith with a Stanley knife, and then measure and record the length from pith to cambium. The core was divided into 35 mm sections, commencing at the pith. This length is based on the radius of the residual 70 mm diameter cylinder left after peeling veneers, and is not directly related to number of growth rings. Each 35 mm section was cut with the knife, and any residual length less than 5 mm included with the previous section because of the difficulty in obtaining an accurate density estimate when earlywood/latewood proportions are affected. Year, tree and height in tree were marked on the core section with a 'Lumochrom' pencil, which provides a waterproof marking.

Basic density is the oven dry mass divided by the green volume. The volume was estimated using the displacement method. A clamp stand was placed beside a set of electronic scales with a beaker of water. The scales were tared to read zero, and a length of sharpened wire inserted at right angles into the core section, which was then submerged below the surface of the water. The reading on the scales is an accurate estimate of the displacement of water and therefore of core volume.

The cores were then dried using the oven-dried method, which requires drying at 103°C to constant weight, when all moisture has been removed from the sample. The

TABLE 1

Planting years (P51 = planted in 1951) and compartments sampled for wood density survey of maritime pine (*Pinus pinaster*) in Gnangara, Pinjar and Yanchep plantations.

STRATUM	COMPARTMENT	TRIAL No.	No. of PLOTS
NON-PEDIGREED			
P51	Gnangara 13,18,127	-	3
P57	Gnangara 46,49,52	-	3
P69	Yanchep 1,2: Pinjar 1,2: Gnangara 20,23	-	6
P70	Yanchep 1,2,8,9	-	4
P71	Pinjar 4	-	2
PEDIGREED			
P72	Pinjar 3,6,7,8	-	5
P73	Yanchep 13,15,16,20	-	5
P74	Gnangara 28,29,30,31	-	5
P75	Pinjar 2,3,5,6,11,12,13,15	-	10
P76	Pinjar 21,28,29,30,31,33,34,35,36	-	10
P77	Pinjar 25,26,27,41,42,45,46,47	-	10
P78	Pinjar 39,40,48	-	5
P79	Pinjar 6,7,9,10	-	5
P80	Pinjar 9,20,22	-	5
P81	Pinjar C 12, 13,15	-	5
P82	Pinjar C 14,18	-	5+5
P83	Yanchep C 1,2,3	-	5+5
P84	Pinjar 4,5,10,16,17	-	5+5
P85	Pinjar H 6,9,15	-	5+5
P86	Pinjar 8,13	-	5+5
P87	Yanchep 11B,13, 14A	-	5+5
RESEARCH (TREE BREEDING)			No. OF TREES
P65	Gnangara 7	YS1	2
P66	Gnangara 7, Yanchep 46A	YS3, 07	4
P67	Yanchep 37A,46A	YS12	6
P68	Gnangara 13, Yanchep 60	YS11B,12, 13B	6
P69	Yanchep 60, Gnangara 109A	YS19,20	8
P72	Pinjar 2	YS43	4

measurements were done on unextracted cores that contained varying amounts of resin, because extraction facilities were not available without incurring considerable costs.

The mean basic density values and standard deviations were calculated, excluding a few results where resin content was unacceptably higher than average. Standard deviation was not calculated for fewer than five samples.

The supplementary sample taken following the request by Wesfi was four trees per plot from each of the five plots in each year P82 to P87, in the same compartments as the original samples. The additional sampling increased sample size from 20 to 40 trees in those years of planting. The supplementary sampling is shown with details of the initial survey for the P82 to P87 planting years in Table 1.

Effect of height in tree on basic density

In a survey with destructive sampling to quantify variation in basic density with increasing height up the stem one of the original compartments (P72 to P87) was randomly selected and trees adjacent to those in the first sample selected (Table 2). Five trees were sampled from each compartment, and felling was required to allow coring in the upper sections of the stem, at breast height, 3 m, 6 m and 9 m. The whole core was used for the survey of effect of height in tree on basic density, without cutting into 35 mm long sections. The cores were handled similarly to samples from the previous survey to obtain basic density estimates. This survey was necessarily destructive to enable coring at 3 m intervals up the tree, and the trees were felled.

TABLE 2

Compartments sampled for survey of basic density at different heights in maritime pine trees in Pinjar and Yanchep plantations.

PLANTING YEAR	COMPARTMENT
P72[a]	Pinjar 3
P73	Yanchep 20
P74	Gnangara 22
P75	Pinjar 17
P76	Pinjar 30
P77	Pinjar 27
P78	Pinjar 40
P79	Pinjar 6
P80	Pinjar 22
P81	Pinjar C 23
P82	Pinjar C 14
P83	Yanchep C 4
P84	Pinjar 5
P85	Pinjar H 9
P86	Pinjar 8
P87	Yanchep 11B

[a] P72 = planted in 1972

Basic density of edge trees

To compare basic density of edge and interior trees, sample trees were selected randomly from immediately adjacent to the P80, P82 and P84 areas harvested for LVL trials in Japan. Five trees were selected from the edge of the stand, five from 10 m from the edge, and five from 30 m from the edge, in each of the three age classes.

A 12 mm diameter core was drilled at breast height with a 'Trecor'® borer, as described previously. The method for measuring basic density in 35 mm sections of each core, commencing at the pith, was also described. Mean unextracted basic density was calculated for each 35 mm segment in each treatment. Weighted mean basic density for the cross-section was estimated for the 105 mm radius (i.e. 210 mm diameter) in both edge and internal logs, with density data from each 35 mm section and using the difference in the area of circles of 35 mm, 70 mm and 105 mm radius.

Effect of age on resin content

Sample trees for basic density comparisons were selected randomly from P57 and P84 areas used in the previous assessments. Five trees were randomly selected from each of two different areas in each planting year, to give ten trees in each treatment.

Two 12 mm diameter cores were drilled at breast height with a 'Trecor' borer, as described previously, taking paired cores in the same vertical plane and 30 mm apart. One core had basic density measured unextracted, and the other after resin extraction. Resin extraction was done by the Western Australian Chemistry Centre over 48 hours, using a Soxhlet apparatus and acetone : ethanol : toluene in a 4:1:1 ratio.

Cores were divided into 35 mm sections commencing at the pith, and the basic density assessment done. Resin-extracted cores were soaked for 24 hours before measurement to replace moisture removed during the resin extraction. Mean basic density was calculated for each 35 mm segment in each treatment, and the percentage resin content was estimated by dividing unextracted basic density by extracted basic density.

RESULTS AND DISCUSSION

Survey of basic density at breast height

The mean unextracted basic density and standard deviation of the 35 mm sections in each planting year are given in Table 3.

The 35 mm sections were based on the likelihood of some maritime pine resource being peeled and then used for LVL manufacture. The residual core after peeling on modern equipment is about 70 mm diameter, and therefore peeled veneer would be produced from the wood outside that diameter. That is, the basic density of the second and subsequent 35 mm sections indicates the likely wood density of veneers from that resource.

Table 3 shows definite trends with the mean unextracted basic density increasing with increasing distance from the pith, and decreasing from the older-aged to the younger plantations. Juvenile wood or crown-formed wood produced in the first ten years has lower density than mature wood, but the resin production associated with formation and development of heartwood with increasing age will reduce that difference, owing to the weight of the resinous deposits laid down in the heartwood (Koch 1972). The standard deviation values in the first 35 mm sections tended to be higher than those in the second and subsequent sections, and reflected the variation in resin production in that first section. Inspection showed no obvious variation in ring width or earlywood to latewood proportions that would result in large wood density differences. In screening candidate trees for tree-breeding purposes, it would be an advantage to extract resin to give more accurate comparisons.

As might be expected, the oldest sample trees (P51) had very high resin content. In one tree resin flowed freely from near the pith as the core was being extracted. Drilling was very difficult with the corer binding continually. The trees became progressively easier to drill with decreasing plantation age.

One industry requirement was a minimum air-dry density of 550 kg m^{-3} for veneers for LVL production, to ensure that stiffness of the product would meet US requirements for structural material, according to a consultant to local industry who carried out LVL trials in 1995. Air-dry density of maritime pine is approximately 1.22 times greater than basic density, based on air-dry density having 12 per cent greater mass than basic density, but only 92 per cent of the volume, using shrinkage data from Kingston and Risdon (1961). Consequently, any unextracted basic density greater than 450 kg m^{-3} should be

TABLE 3.

Basic density (kg m^{-3}) at breast height of pedigreed maritime pine compared with that of older unimproved trees (35 mm sections).

STRATUM	PLANTATION	No. PLOTS	CORE LENGTHS (mm)	MEAN BASIC DENSITY (standard deviation in parentheses)					
UNIMPROVED				0–35mm	35–70mm	70–105mm	105–140mm	140–175mm	175–210mm
P51	Gnangara	3	160–210	502 (31)	562 (37)	564 (29)	547 (29)	565 (50)	534 (53)
P57	Gnangara	3	93–180	502 (55)	497 (40)	516 (50)	501 (48)	497 (-)	
P69	Yanchep, Pinjar, Gnangara	2 each	82–160	489 (46)	485 (37)	523 (57)	538 (50)	574 (-)	
P70	Yanchep D, E	4	82–130	482 (43)	491 (32)	527 (39)	545 (47)		
P71	Pinjar	2	92–140	508 (56)	469 (40)	514 (37)	537 (47)		
PEDIGREE									
P72	Pinjar	5	83–135	521 (63)	511 (36)	525 (41)	513 (29)		
P73	Yanchep C	5	105–150	471 (47)	503 (35)	540 (30)	551 (34)		
P74	Gnangara	5	100–155	461 (35)	469 (29)	502 (28)	520 (40)	515 (-)	
P75	Pinjar	10	85–140	466 (40)	478 (35)	503 (38)	491 (31)		
P76	Pinjar	10	90–140	473 (56)	461 (39)	508 (43)	496 (42)		
P77	Pinjar	10	80–140	449 (38)	464 (41)	508 (49)	504 (62)		
P78	Pinjar	5	85–130	460 (35)	468 (39)	506 (44)	498 (52)		
P79	Pinjar	5	86–135	466 (54)	459 (25)	496 (34)	487 (29)		
P80	Pinjar	5	70–125	464 (57)	466 (46)	490 (39)	488 (59)		
P81	Pinjar	5	75–110	433 (35)	440 (37)	466 (31)			
P82	Pinjar	5+5[b]	80–110	449 (43)	456 (37)	490 (49)			
P83	Yanchep H	5+5	68–110	432 (39)	448 (36)	476 (43)			
P84	Yanchep H	5+5	53–105	411 (29)	453 (38)	494 (49)			
P85	Yanchep H	5+5	65–105	416 (29)	451 (39)	463 (48)			
P86	Yanchep H	5+5	60–90	393 (27)	434 (38)	462 (40)			
P87	Yanchep H	5+5	60–100	388 (26)	438 (28)	442 (49)			
RESEARCH									
P65–P72	Yanchep, Pinjar, Gnangara	30 trees	110–215	481 (41)	501 (41)	503 (34)	527 (35)	530 (47)	503 (34)

[a] P51 = planted in 1951
[b] Including supplementary sampling

satisfactory for structural material, but lining and other products could have lower density.

The pedigreed material planted from P76 to P95 came from the Mullaloo seed orchard, and consequently the same genetic material was planted (Hopkins and Butcher 1994). Some culling over the years had removed some of the poorer parents, including those with lower than average basic density. Silvicultural systems have not changed, and the range of sites over Gnangara, Pinjar and Yanchep plantations is similar.

Comparison of matched routine and pedigreed trees growing adjacent to each other in a P73 stand showed that basic density in both treatments was similar, although the pedigreed trees had produced about 30 per cent greater volume (Hill 1999). The cores taken from seven different heights in the tree (1.3 m, 2.4 m, 4.8 m, 7.2 m, 9.6 m, 12.0 m and 14.4 m) were measured in five ring sections (0-5, 6-10, 11-15, 15+) allowing the comparison.

This basic density survey in Gnangara, Pinjar and Yanchep, which compared pedigreed material from P72 to P87 showed definite trends of increasing unextracted density with increasing age, using breast height samples (Fig. 1). The trend was most pronounced in the first 35 mm core sections, and can be explained by the resin content increasing with time. A similar trend in the southern pines of the United States (e.g. *P. elliottii var elliottii, P. taeda*) was reported by Koch (1972).

Effect of height in tree on basic density

An additional survey confirmed the uniform trend of decreasing average basic density with increasing height in the tree (Table 4).

Mean basic densities and standard deviations of cores from each height in each of five trees from each planting year are given in the Table, showing definite trends with the mean basic density decreasing with increasing height in the trees, and decreasing with decreasing age. Juvenile wood or crown-formed wood produced in the first ten years has lower density than mature wood, and the mean density of the cross-section will increase with increasing age. Inspection showed no obvious variation in ring width or earlywood to latewood proportions that would result in wood density differences. The trees became progressively easier to drill with decreasing plantation age.

The data in Table 4 show the expected trends, with occasional anomalies in those trends because of the smaller sample size (of five trees) than that used when sampling at breast height only. However, with 80 trees sampled overall, and generally four cores per tree, the survey provides considerable information. The trends in basic density with increasing height in the tree are shown in Figure 2.

Basic density of edge trees

There was apparently low basic density of younger samples in the batches of logs from P72 to P84 which were sent to Japan for an LVL trial. When sampling additional trees adjacent to the areas logged, it appeared likely that the low densities of logs from the younger stands (P80, P82 and P84) compared with the data from the comprehensive survey, was the result of felling edge trees to achieve the minimum log diameter requirement for LVL production. Edge trees grow faster and generally have lower wood density than trees inside the compartment, and it was necessary to quantify the differences.

The results of this study, showing mean basic density and standard deviations of edge trees compared with internal trees in P80, P82 and P84 stands, with values given for each 35 mm section are presented in Table 5.

Edge vs internal trees

The data in Table 5 and the weighted mean values show that the mean basic density of the edge trees is less than that of the internal trees. The exception is the 0–35 mm core section, where the results are similar because in the first few years of growth there are no competition effects. Once crown competition commences, the edge trees have more light, water and nutrients available. They consequently grow considerably faster but with lower wood density than dominant internal trees.

The 35–70 mm and 70–105 mm sections show an increasing difference in basic density between edge and internal trees, because different aged rings are involved, e.g. sections from 35–70 mm in edge trees contain more juvenile wood than the same sections from internal trees. As age increases, the edge trees have wider growth rings than internal trees, and the lower density values indicate lower percentage latewood. The greatest differences were found in the 70–105 mm sections, with mean basic density varying from 30 kg m^{-3} in P80 to 64 kg m^{-3} in P82 stands.

The estimates of weighted mean basic density to 105 mm radius (210 mm diameter) under bark, based on the areas of each 35 mm in the cross-section were as follows:

P80 - Edge trees 467 kg m^{-3}	Internal trees 497 kg m^{-3}
P82 - Edge trees 443 kg m^{-3}	Internal trees 481 kg m^{-3}
P84 - Edge trees 459 kg m^{-3}	Internal trees 487 kg m^{-3}.

The differences between weighted mean basic density of edge and internal trees were therefore 30 kg m^{-3} for P80, 38 kg m^{-3} for P82, and 28 kg m^{-3} for P84. This variation between edge and internal tree density would explain the apparent anomaly when the LVL trial produced material of lower density than found in the initial survey.

Overall, the study reached the major objective of quantifying the differences in mean basic density and weighted density of edge compared with internal trees, showing that edge trees were of lower wood density.

Age effects

Table 5 shows the general trend of decreasing mean basic density with decreasing age, similar to the results reported by Hill (1999). There were some minor anomalies with the smaller sample size than that used in the previous intensive studies. For example, mean basic density in the

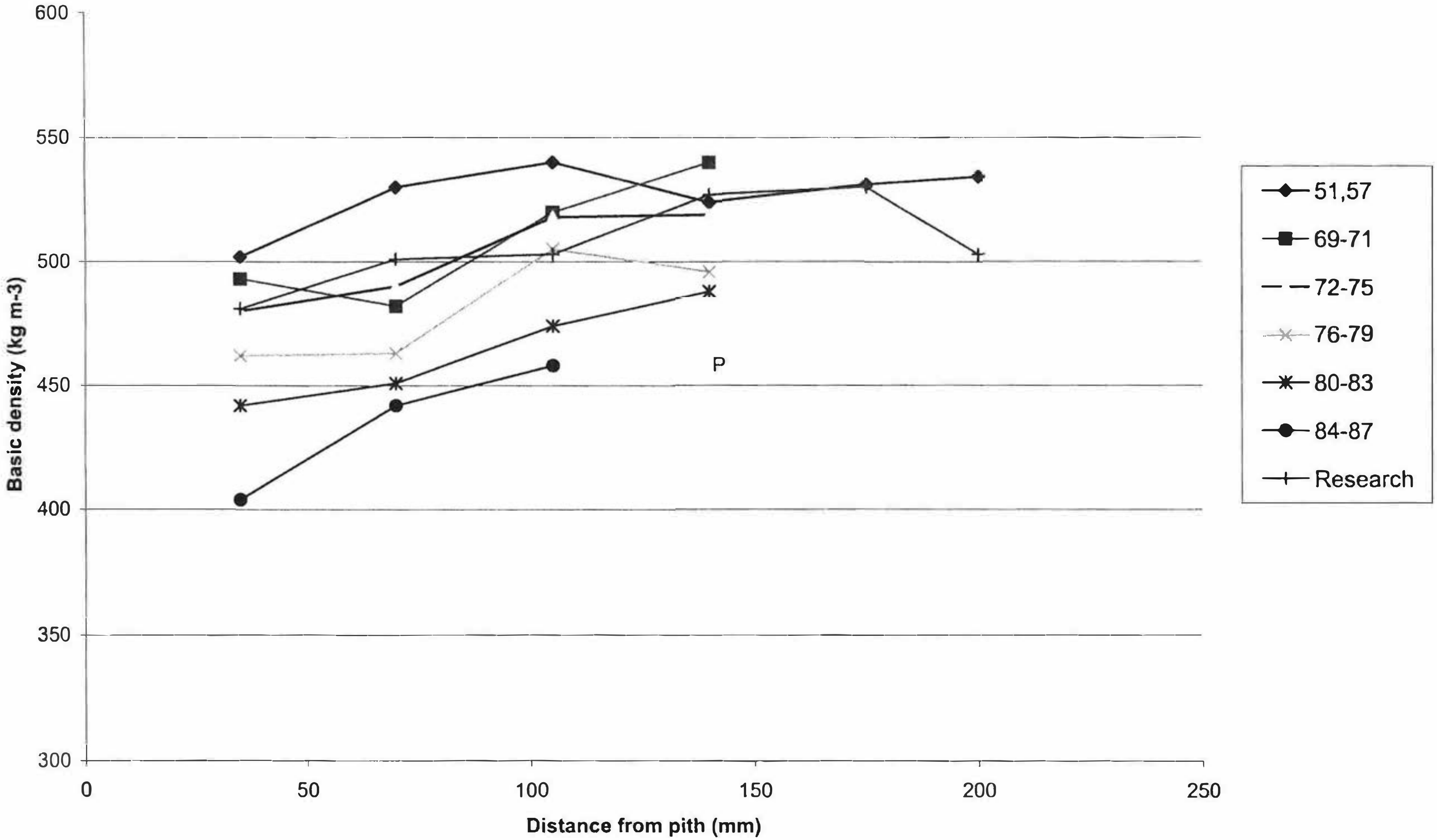

Figure 1. Breast height basic density of maritime pine from Gnangara, Pinjar and Yanchep Plantations by grouped planting years.

TABLE 4
Effects of age and height in tree on wood basic density (kg m^{-3}) of pedigreed maritime pine.

PLANTING YEAR	MEAN BASIC DENSITY (SD in parentheses)			
	1.3 m	3 m	6 m	9 m
P72[a]	477 (29)	452 (29)	440 (42)	418 (-)[b]
P73	484 (24)	460 (35)	450 (41)	439 (44)
P74	499 (16)	468 (33)	464 (19)	432 (4)
P75	468 (30)	466 (21)	439 (17)	415 (28)
P76	489 (18)	473 (28)	455 (32)	422 (29)
P77	457 (20)	445 (18)	433 (21)	408 (17)
P78	469 (23)	456 (11)	443 (22)	421 (-)
P79	479 (31)	433 (36)	446 (37)	433 (42)
P80	474 (24)	430 (28)	423 (15)	419 (-)
P81	438 (19)	430 (28)	423 (15)	398 (-)
P82	470 (15)	463 (24)	442 (26)	
P83	444 (27)	418 (22)	408 (-)	
P84	436 (7)	418 (14)	407 (-)	
P85	419 (24)	411 (21)	412 (-)	
P86	427 (30)	395 (24)	395 (-)	
P87	408 (17)	412 (29)	390 (14)	

[a] P72 = planted in 1972
[b] Standard deviation was not calculated for fewer than five samples.

70–105 mm section in P84 was similar to the P80 value, and greater than the P82, but fewer than five trees reached this dimension.

Effect of age on resin content

Table 6 shows the mean basic density and standard deviations of extracted and unextracted cores from trees in P57 and P84 stands, with values given for each 35 mm section. The percentage resin is based on extracted density.

Table 6 indicates that mean basic density of older trees continues to increase with increasing age. As expected, the effect was most pronounced in the 0–35 mm core section, with 13.9 per cent resin in P57 compared with 3.7 per cent in cores from P84 trees. The unextracted basic density values in that core section were similar to those shown in Table 3, i.e. 502 kg m^{-3} for P57 and 411 kg m^{-3} for P84.

However, CALM considered that the trend resulted from continuing resin production after the initial heartwood formation. Similar trends have been reported in the southern pines of the United States (Koch 1972), and in South Africa (South African Department of Forestry 1964).

According to Koch (1972), the extraction process removes most of the extractives, which are generally referred to as resins. They may require extraction with a range of chemicals, but Koch quotes alcohol/benzene as removing the greatest amount of extractives. Acetone : ethanol : toluene is now recommended because of the possible carcinogenic effects of benzene, but it is possible that residual amounts of the extractives remained after the Soxhlet extraction.

In commercial use such as LVL or plywood production where pine is used with the normal resin content, it is likely that some volatile components of the resins will be given off during the veneer drying process with drying temperatures probably about 160°C. The highest resin content is in the 70 mm diameter core discarded after peeling. The thin veneers peeled outside this diameter should not be adversely affected by resin content, particularly with the high quality gluelines achievable from modern adhesives and technology.

Table 6 shows the general trend of decreasing mean basic density with decreasing age, similar to the results reported by Hill (2000). There were some minor anomalies with the smaller sample size than that used in the previous intensive studies. Overall, the study indicated that the resin or extractives content continued to increase with increasing age, with the greatest effect found in the 0–35 mm section of the core.

Comparison with other Western Australian wood density data

Table 7 gives other data relating to the wood density of maritime pine grown in Western Australia. The 85 superior trees of maritime pine selected by Perry in Leiria, Portugal, in 1965 were the basis for the Forests

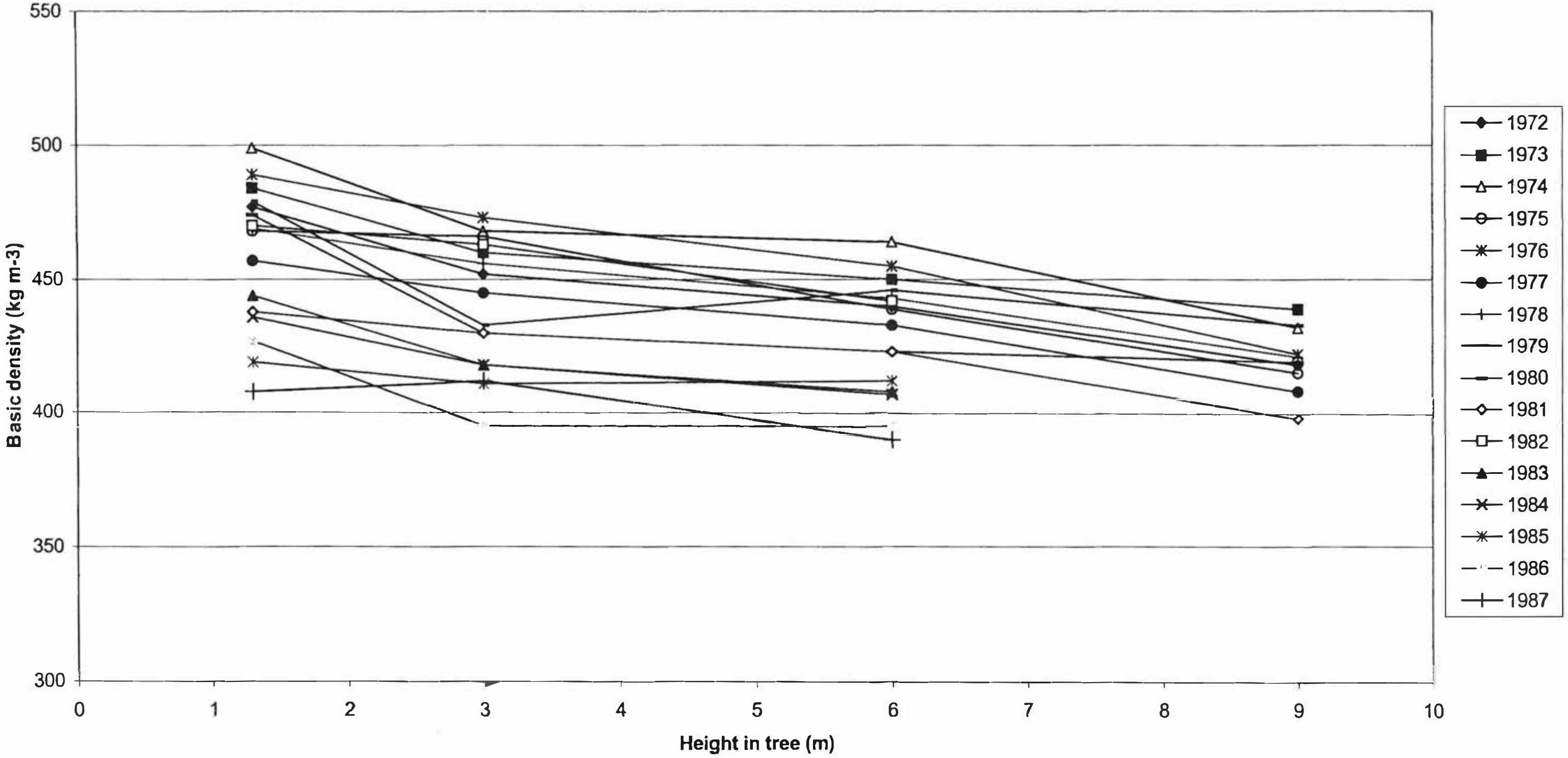

Figure 2. Basic density of maritime pine with increasing height in tree-planting years 1972 to 1987 (P72 to P87).

TABLE 5

Mean basic density (kg m^{-3}) and standard deviations (in parentheses) of edge and internal maritime pine trees (35 mm sections).

YEAR	SAMPLE LOCATION	0–35 mm	35–70 mm	70–105 mm	>105 mm
P80[a]	Edge	441 (71)	448 (48)	483 (29)	520 (-)[b]
	Internal	453 (69)	485 (30)	513 (36)	
P82	Edge	423 (71)	440 (37)	449 (-)	513 (-)
	Internal	415 (31)	450 (47)	513 (-)	
P84	Edge	387 (30)	443 (36)	484 (-)	520 (-)
	Internal	410 (35)	458 (31)	520 (-)	

[a] P80 = planted in 1980
[b] Standard deviation is not given for fewer than five sections.

TABLE 6

Mean basic density (kg m^{-3}) and standard deviations (in parentheses) of unextracted and resin-extracted cores from maritime pine trees (35 mm sections), and estimated resin contents.

YEAR	SAMPLE	0–35 mm	35–70 mm	70–105 mm	>105 mm
P57[a]	Unextracted	517 (68)	512 (45)	554 (32)	566 (-)[b]
	Extracted	454 (48)	485 (39)	534 (43)	576 (-)
	Resin (%)	13.9	5.6	3.7	-
P84	Unextracted	419 (22)	465 (52)	495 (-)	
	Extracted	404 (23)	450 (40)	486 (-)	
	Resin (%)	3.7	3.3	1.9	

[a] P57 = planted in 1957
[b] Standard deviation is not given for fewer than five sections.

Department's intensive tree breeding program. Perry and Hopkins (1967) gave basic density data for each selected tree (age range 30 to 138 years), with a mean of 500 kg m^{-3}. The major traits for improvement in the program were stem straightness and vigour, with consideration also given to branch size and angle.

The CSIRO Division of Forest Products completed a major survey of density and shrinkage of native and exotic species grown in Australia (Kingston and Risdon 1963). They assessed samples of unimproved maritime pine from Western Australia, which had mean air-dry density of 596 kg m^{-3} and basic density of 490 kg m^{-3}.

Nicholls *et al.* (1963) assessed wood properties of the four major provenances of maritime pine, i.e. Leiria, Corsica, Esterel and Landes, and concluded that the Leirian provenance had higher basic density, good fibre length and superior vigour and form compared with the others (Table 7). Mean values were not given, but a graph in the report indicated that a basic density of 500 kg m^{-3} was achieved by ten years.

The tree-breeding program progressed with its concentration on phenotype, and wood density was given minor consideration until a screening of parents for the breeding population for the next generation was done to confirm that juvenile wood (defined as the first eight rings) was of acceptable density (Hopkins and Butcher 1994). They reported mean basic density of 430 kg m^{-3} for juvenile wood (first eight rings) and 480 kg m^{-3} for mature wood (ninth to twelfth rings).

Air-dry density was measured as part of an assessment of the strength properties of Western Australian-grown maritime pine by Siemon (1983), with treatments ranging from P36 to P66. The 16-year-old material reported in the study as 'pedigree', and which came from the Flinn's agroforestry trial near Mundaring, had air-dried density as low at 474 kg m^{-3}. This material was actually unimproved. The mean air-dry density for all samples in the study was 559 kg m^{-3}. A later assessment of Donnybrook Sunkland trial plots and 13 and 14-year-old maritime pine showed a mean air-dry density of 570 kg m^{-3}.

Wespine Industries Pty Ltd carried out a sawmilling trial of maritime pine in which graded recoveries and knot sizes from older resource was compared with those of pedigreed material and unimproved planted in 1971

TABLE 7

Air-dry and basic density (kg m^{-3}) from previous assessments of Western Australian-grown maritime pine.

RESOURCE	SAMPLE SIZE	AIR-DRY DENSITY MEAN	AIR-DRY DENSITY SD	BASIC DENSITY MEAN	BASIC DENSITY SD	REFERENCES
Leirian trees selected by Perry in 1965 (age 30–138)	85			500	33	Perry & Hopkins (1967)
Mature wood from the Sommerville plantation (1960s)				550		Nicholls (1966)
Screening of breeding population (age 8–12)	336			430(Juv)		
				480(Mat)	30	Hopkins and Butcher (1994)
					40	
Wespine sawmilling trial: P71 pedigreed	36	588	37			Meachem[a] (pers.comm)
31-year-old Yanchep plantation	10	569	53			Meachem (pers.comm)
47-year-old Gnangara plantation	10	611	54			Meachem (pers.comm)
WA resource: overall mean		559				Siemon (1983)
" 16-year-old (Agroforestry)	5	474				Siemon (1983)
Donnybrook Sunkland trial plots (13, 14 year old)		570	85			Siemon (1995)
CALM Timber Technology assessment of P73 orchard stock (Yanchep C23): 25 years old	11 (x 7 discs)	557	80	458	55	CTT (1998)
Routine stock	11	550	81	454	63	
CSIRO data	10	596	36	490	28	Kingston & Risdon (1961)

[a] Mr G. Meachem, Wespine Pty Ltd, Moore Rd, Dardanup WA 6236.

(Meachem,[1] personal communication). Air-dry density was also measured, and mean value was 588 kg m^{-3}. Other data collected by Wespine were air-dry density of 569 kg m^{-3} for 31-year-old unimproved and 611 kg m^{-3} for 47-year-old pines.

CALM Timber Technology had completed a wood density assessment of eleven maritime pine trees (P73) of seed orchard origin, which included a comparison with adjacent unimproved trees in the Yanchep trial (Hill 2000). Although there was a significant improvement in stem straightness and increase in vigour (and therefore size) in the pedigreed trees, the air-dry densities and basic densities were similar in the two treatments. Air-dry densities of pedigreed and unimproved trees were 557 kg m^{-3} and 550 kg m^{-3} respectively, and basic densities were 458 kg m^{-3} and 454 kg m^{-3} respectively. The mean ring width of the pedigreed specimens was greater than for unimproved, but obviously the latewood percentage was similar in both, resulting in similar density.

CONCLUSION

The first survey of basic density compared wood of pedigreed maritime pine planted in Yanchep, Pinjar or Gnangara plantations from 1972 to 1987 with some older unimproved material (P51, P57, and P69 to P71). There was a trend of decreasing basic density as stand age decreased, which would be explained by the higher resin contents in the older trees. Further assessments of basic density of pedigreed maritime pine will continue, with plots planted in semi-arid areas scheduled for survey in 2000.

The second survey assessed effect of height in tree on wood basic density of pedigreed maritime pine planted in Pinjar and Yanchep plantations from 1972 to 1987. There was a trend of decreasing basic density as stand age decreased, which would be explained by the higher resin contents in the older trees. The trend of decreasing mean basic density with increasing height in the tree was confirmed.

In commercial use such as LVL or plywood production where pine is used with the normal resin content, it is likely that some volatile components of the resins will be given off during the veneer drying process with drying temperatures probably about 160°C. The highest resin content is in the 70 mm diameter core discarded after peeling. The thin veneers peeled outside this diameter should not be adversely affected by resin content, particularly with the high quality gluelines achievable from modern adhesives and technology.

[1] Mr G.Meachem, Wespine Pty Ltd, Moore Road, Dardanup WA

ACKNOWLEDGEMENTS

The first survey was organized in consultation with Ian Knobel of Wesfi Ltd, and Barry McCombe, a consultant to Wesfi. Clayton Sanders of CALM's Plantation Group nominated sampling areas in the routine plantations, and Trevor Butcher permitted sampling of research trials. Ernie Jordan provided technical assistance in the fieldwork.

In the second survey to assess the effect of height in tree on basic density, Tony Dehnel and Brian Haley provided technical assistance in the fieldwork.

Yumiko Bonnardeaux provided assistance with the fieldwork for the resin content assessment, and David Harris of the WA Chemistry Centre organized the resin extraction from the cores.

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Dimensions of tree hollows used by birds and mammals in the jarrah forest: improving the dimensional description of potentially usable hollows

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ABSTRACT

A graphical method for describing the range of dimensions of hollows used by arboreal fauna is developed and applied to data from hollows used by six bird and four mammal species of the jarrah forest of south-west Western Australia. Pairs of hollow entry measurements and pairs of internal hollow measurements were graphed separately, and lines bounding the spread of these data defined the range of hollow sizes used by each species. This method can be used with small data sets. The descriptions provide a means of identifying hollows in felled trees that could have been used by these species. Measurements were collected from 82 hollows and combined with similar published data for hollows used by common brushtail possum (*Trichosurus vulpecula*), western ringtail possum (*Pseudocheirus occidentalis*), brush-tailed phascogale (*Phascogale tapoatafa*), mardo (*Antechinus flavipes*), red-tailed black cockatoo (*Calyptorhynchus banksii naso* and *Calyptorhynchus banksii samueli*), Australian ringneck (*Platycercus zonarius*), western rosella (*Platycercus icterotis*), red-capped parrot (*Platycercus spurius*), rufous treecreeper (*Climacteris rufa*), and striated pardalote (*Pardalotus striatus*).

The graphical presentation and interpretation of entry and internal dimensions is recommended for examining hollow sizes. This method can be used with the small data sets that often result because hollow dimensions are difficult, dangerous, and expensive to collect. A constant area function is proposed to describe the maximum hollow entry size used by a species. In studies of hollows used by fauna, maximum and minimum entry dimensions should be collected in preference to vertical and horizontal entry dimensions.

INTRODUCTION

Hollows in trees are an important attribute of forest environments (Recher *et al.* 1980; Kavanagh and Turner 1994; Kutt 1994). The importance of hollows to fauna that use them for denning and nesting is widely recognized (Cowley 1971; Tyndale-Biscoe and Calaby 1975; Newton 1994). In the jarrah forest of south-west Western Australia there are 9 mammal and 17 bird species that are obligate users of tree hollows (Serventy and Whittell 1976; Christensen *et al.* 1985; Strahan 1998) and 16 vertebrate species with lesser degrees of dependence on hollows for breeding and shelter (Ian Abbott[1], personal communication). The conservation of these species, (particularly the obligate hollow users) in a forest that is managed for water, timber and mineral production, conservation, and recreation, is in part dependent on the continued provision of suitable tree hollows.

Mackowski (1987), recommended describing the features of hollows used by individual species and interpreting hollow availability for each wildlife species based on these descriptions. Similarly, McComb *et al.* (1994) classified hollows as potentially suited to a species when the dimensions of the hollows fell within the range defined by the maximum and minimum dimensions reported by Saunders *et al.* (1982), Inions *et al.* (1989), Long (1990), and Haseler and Taylor (1993). Once hollows that are potentially suited to a species are identified, the relationship between hollow occurrence and tree characteristics can be examined. These relationships can then be used as a basis for selecting trees to retain after logging (Gibbons and Lindenmayer 1996, 1997).

This study describes the first phase of this process: the description of the dimensions of hollows that are potentially suited to ten arboreal hollow users (see Fig. 1). The species studied were: common brushtail possum (*Trichosurus vulpecula*), western ringtail possum (*Pseudocheirus occidentalis*), brush-tailed phascogale (*Phascogale tapoatafa*), mardo (*Antechinus flavipes*), red-tailed black cockatoo (*Calyptorhynchus banksii naso* and *Calyptorhynchus banksii samueli*), Australian ringneck (*Platycercus zonarius*), western rosella (*Platycercus icterotis*), red-capped parrot (*Platycercus spurius*), rufous treecreeper (*Climacteris rufa*), and striated pardalote (*Pardalotus striatus*) (nomenclature follows Strahan (1998), and Johnstone (in press)).

[1] Dr I. Abbott, Department of Conservation and Land Management, Kennsington, WA.

In this paper I present a new method of describing the dimensions of hollows used by fauna. This new method was developed after the collected data were compared with published summaries of similar hollow dimensions. This comparison revealed that the published summaries provided incomplete and sometimes inconsistent descriptions of hollow size, and some small data sets provided limited information. These summaries could be misleading if used to classify hollows as potentially suited to a species. I apply this new method to the available data (including limited data sets) and present the descriptions of the range of hollow sizes used by 10 species from the jarrah forests of south-west Western Australia. I also explain the assumptions that were made in producing these descriptions, examine the reasons for applying limits to the descriptions and examine the distribution of hollow sizes classified as potentially usable by this system.

METHODS

This study was based on two data sets: one being measurements of hollows used by fauna, and the other measurements of all hollows located in a search of 239 trees (Whitford, in press). All new data collected for this work came from trees felled in logging operations. Data from the 239 trees were examined to determine whether applying the descriptions of potentially usable hollows to a sample of hollow measurements would result in a disproportionately large number of hollows with elongated entries being classified as potentially usable.

Hollows Used by Fauna

Data used to describe the dimensions of potentially usable hollows came from several studies. Hollow-bearing trees used by birds and mammals at Kingston Block, 20 km north-east of Manjimup, Western Australia, were identified by radio-tracking (K. Morris[2], personal communication; Rhind 1998), by the presence of scratch tracks made by possums, and by the observation of hollow use by rufous treecreepers (M. Craig[3], personal communication). Hollows were classified as used when clear evidence of occupation was found (nests, egg shell fragments, or scats, or identified hair samples associated with internal scratching, staining and wear). Dimensions of 59 used hollows were collected from 32 of these trees that were felled when the area was logged. Data from an additional 23 hollows in 18 trees were collected fortuitously in an examination of a random sample of 239 trees described in Whitford (in press). The dimensions collected from these used hollows were combined with similar data from: Saunders *et al.* (1982), Long (1990), Dickman[4] (1991 and unpublished data), Soderquist[5] (1993 and unpublished data), Craig[3] (unpublished data), Johnstone[6] (unpublished data), Rhind (1998), and nest box data from Wardell-Johnson (1986). These nest box dimensions for mardos were combined with data from natural hollows and interpreted in the same manner as data for other species.

Hollow Measurement

Felled trees were thoroughly searched for hollows, and hollows used by birds and mammals were identified from the contents (hair samples, nests, egg shell fragments, scats, internal scratching, staining and wear). Each hollow was measured for: height of the hollow entry above the ground, depth of the hollow from the lower lip of the entry to the base of the hollow, and the width of the hollow at the widest point (the average of minimum and maximum dimensions at that point). The maximum and minimum widths of the hollow entry, termed the maximum entry dimension and minimum entry dimension, were also measured (usually at right angles to one another). Figure 1 illustrates these measurements.

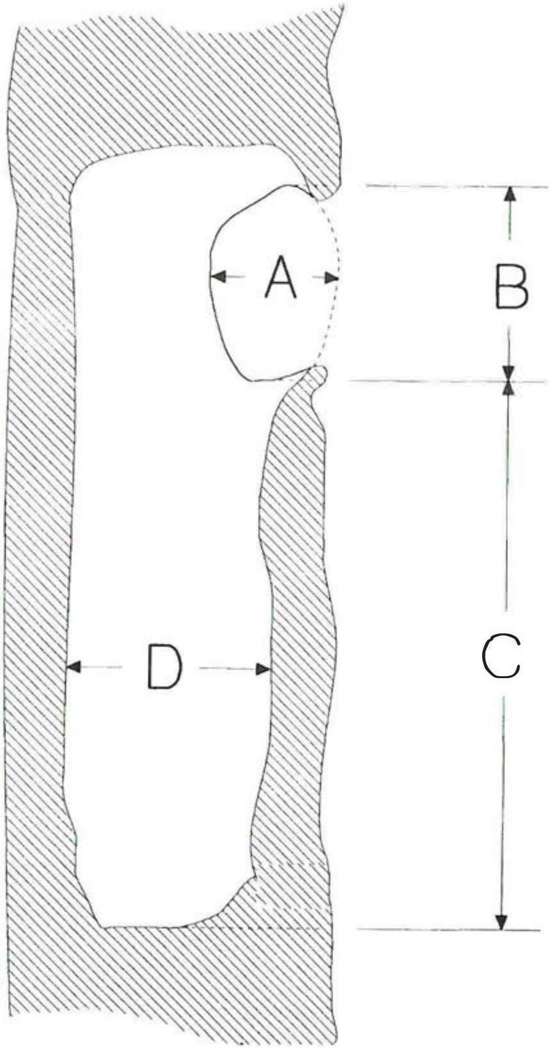

Figure 1. The measurements of tree hollow dimensions: A, minimum entry dimension; B, maximum entry dimension; C, depth of the hollow; D, average width of the hollow at the widest point (after Fig. 2 of Saunders et al. *1982).*

[2] K. Morris, Department of Conservation and Land Management, Woodvale, WA.
[3] Dr M. Craig, Centre for Rainforest Studies, Yungaburra, Queensland.
[4] Dr C. Dickman, School of Biological Sciences University of Sydney, NSW.
[5] Dr T. Soderquist, National Parks and Wildlife Service, Dubbo, NSW
[6] R. Johnstone, Western Australian Museum, Perth, WA.

Western ringtail possums were observed using shallow hollows that were as wide as they were deep. These refuges, such as depressions in tree forks, would not commonly be referred to as hollows, and have not been included in this study.

Descriptions of the Dimensions of Potentially Usable Hollows

The system I developed to describe the dimensions of hollows had five main attributes:

1. Pairs of hollow dimensions collected from a single hollow were examined as pairs.
2. From each hollow I collected a pair of maximum and minimum entry dimensions, and a pair of internal hollow depth and width (see Fig. 1).
3. The dispersion of these pairs was examined on two-dimensional graphs to identify lines that bounded the spread of the data for each species.
4. For hollow entries the bounds were: the line y = x; a minimum hollow entry size determined from the smallest single hollow entry dimension; and a maximum entry size that was described by a constant area function (see Fig. 2).
5. For hollow internal dimensions the bounds were: the line y = x; the largest and smallest hollow depths and widths observed; and for hollows used by mammals, an additional restriction to ensure that very small hollows were not classified incorrectly as potentially usable.

Where I combined my data with the vertical and horizontal hollow entry dimensions collected by other researchers I assumed these vertical and horizontal dimensions approximated pairs of maximum and minimum entry dimensions. Hollow entries commonly approximate an ellipse, with the vertical entry dimension usually larger than the horizontal dimension. For this reason, the combination of vertical and horizontal dimensions with maximum and minimum measurements was considered appropriate.

I graphed the maximum and minimum dimensions of all hollow entries used by each species. Hollows with at least one small entry dimension defined the lower limit for the minimum hollow entry dimension (the horizontal line shown in Fig. 2). The line y = x occurs as a boundary because the y values (minimum entry dimension) cannot exceed the x values (maximum entry dimension). The third boundary, the maximum size of the hollow entries, was a constant area function that describes all elliptical shapes that have equal areas (Fig. 2). This function can be defined by a single pair of maximum and minimum entry dimensions, or the area of this entry. The exact function used for each species was determined by the largest single observed hollow entry, or where more than one entry had a similar area, by the mean area of a group of the largest observed hollow entries. Hollows with entries that occurred outside the area A and C shown in Figure 2 would be classed as unsuited to the species.

The internal hollow dimensions of width and depth were also graphed as pairs of minimum and maximum

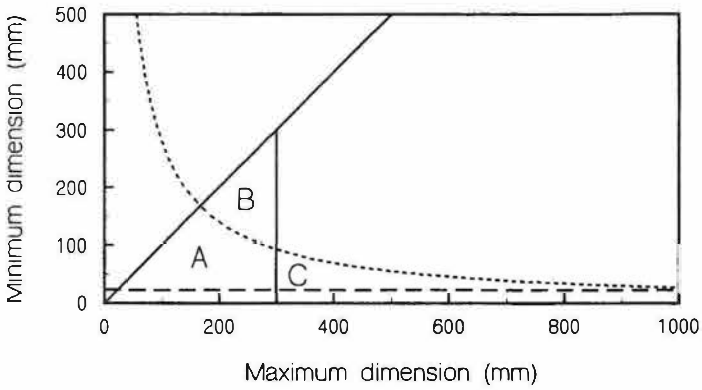

Figure 2. When the range of potentially usable hollow entries is determined from maximum and minimum bounds selected from data summaries, potentially usable hollow entries are those within the right triangular area A and B. The area B can incorrectly indicate that very large hollow entries will be used by the species. The range of potentially usable hollow entries is more correctly described by the area A and C. This area is bounded by three lines; y = x (solid diagonal line), y = the minimum usable dimension (broken straight line), and the constant area function for a set of ellipses, y = constant/x (broken curve). All lines shown including the solid vertical line are for phascogale tapoatafa. Lines for other species are given in Table 1.

dimensions (typically internal width is less than depth). The resulting scatter was examined to define the bounds of the dimensions of used hollows. The ranges of hollow sizes used by mammals were described differently than those of bird hollows. There are two reasons for this: (1) mammals curl their bodies up to fit into a variety of shapes because they do not have relatively rigid wings and tail feathers; (2) the mammal hollows were used for both nesting and diurnal shelter, while all the bird hollows were used for breeding. Consequently, I assumed a mammal species would use a wider range of hollow shapes and orientations than a bird species. The data for birds were interpreted as descriptions of approximately cylindrical hollows that are deeper than they are wide, while the data for mammals were interpreted as coming from a range of hollow shapes (ranging from cylinders, to ellipsoids and spheres). Consequently, for mammals other than mardos (nest box data), the minimum dimensions of small spherical hollows were limited by a negatively sloped line that excluded the smallest combinations of depth and width dimensions. This reduces the number of hollows classified as potentially suited to these species by eliminating hollows that are smaller than those observed in use.

The data used to develop these descriptions were collected from a variety of forest types and sites, and a portion from tree species other than jarrah and for bird subspecies other than those that inhabit the jarrah forest. In using these data I assumed that: the dimensions of hollows used by bird or mammal species primarily reflect the hollow preferences of those species; the physical size and hollow related behaviour of the subspecies were equivalent for these purposes; these dimensions can be applied to other tree species in other areas; and the predators and competitors on sites where these data were collected had a secondary or minor effect on the range of these dimensions. I also assumed that the range of hollow sizes used by each species was fully expressed in the data. Where this is not the case, the use of the available data was a conservative interpretation, and the application of these descriptions of hollow size will not lead to over-estimation of the number of potentially usable hollows. There may be physical, social, and environmental factors that determine whether a hollow that has suitable dimensions is used by a bird or mammal, but hollow and entry size are primary attributes that determine the suitability of a hollow. For these reasons I refer to the hollows I identify by applying these dimensional descriptions as 'potentially suited to' a species, or 'potentially usable'. Hollows described in this way are the same size and height above the ground as hollows observed in use by a species, i.e. the height of the entry, and the entry dimensions and internal dimensions fall within the range of dimensions of hollows observed in use.

Distribution of Hollow Entry Shapes Found in 239 Trees

The bounded area shown in Figure 2 implies the occurrence and suitability of extremely elongated hollow entries occupying the right hand side of area C, even though for most species such entries were not observed in use. I wanted to determine whether the hollows that I classified as potentially usable included a disproportionately high number of hollows with extremely elongated hollow entries (when compared with the distribution of hollow entries observed in use). I identified which of the 665 hollows found in 239 trees had entry dimensions, internal dimensions, and height to entry, consistent with the hollows used by each species, and compared the distribution of entry shapes for these potentially usable hollows with the distribution of entry shapes for hollows observed in use.

RESULTS

Used Hollows

Clear evidence of hollow use was found in 82 hollows from 50 trees. These consisted of 17 hollows used by western ringtail possums, 24 by common brushtail possums, 19 by brush-tailed phascogales, 12 by rufous treecreepers, and 10 by striated pardalotes. Twenty-three of these used hollows (2 western ringtail possum, 8 common brushtail possum, 3 brush-tailed phascogale, 3 rufous treecreeper, and 7 striated pardalote hollows) were found in 18 trees that came from the sample of 239 trees.

Entry Dimensions of Hollows Used by Fauna

The range of entry sizes used by each of the six bird and four mammal species is shown in Figure 3 and the equations of the lines bounding the range of hollow entry sizes used by each species, and the minimum height above the ground of hollow entries, are given in Table 1 (appropriate internal dimensions would also be required for the hollow to be potentially usable). For brush-tailed phascogale, mardo, western rosella, and rufous treecreeper, the bounding lines in Figure 3 followed directly from the data, i.e. these lines were positioned to pass through the smallest hollow entry, and the largest entry (or entries). For other species, interpretation of the data was required to resolve inconsistencies. In all cases, except for the upper limit applied to common brushtail possums, and the lower

TABLE 1

Dimensional limits to hollow entry size and entry height. The lines describing the area on the graph of maximum hollow entry dimension (x) versus minimum entry dimension (y) that were used to describe the range of hollow entry sizes suited to each of six bird and four mammal species. The third side of the triangular area is described by the line y = x. Hollow entry heights are the minimum height above ground of entries to used hollows. Sample sizes are given in Figure 3.

SPECIES	LOWER LIMIT (mm)	UPPER LIMIT (mm)	MINIMUM ENTRY HEIGHT (m)
Common brushtail possum	y = 60	y = 72000/x	0.5[a]
Western ringtail possum	y = 55	y = 72000/x	0.5[a]
Brush-tailed phascogale	y = 24	y = 28000/x	0.0[b]
Mardo	y = 20	y = 30000/x	0.0[c]
Red-tailed black cockatoo	y = 100	y = 168833/x	4.4[d]
Australian ringneck	y = 50	y = 33000/x	3.19[e]
Western rosella	y = 48	y = 11025/x	6.22[e]
Red-capped parrot	y = 50	y = 20090/x	4.75[e]
Rufous treecreeper	y = 40	y = 12100/x	2.4
Striated pardalote	y = 24	y = 8000/x	2.2[f]

[a] Inions *et al.* (1989); [b] Soderquist (1993); [c] C. Dickman unpublished data; [d] Saunders *et al.* (1982); [e] Long (1990); [f] Woinarski and Bulman (1985).

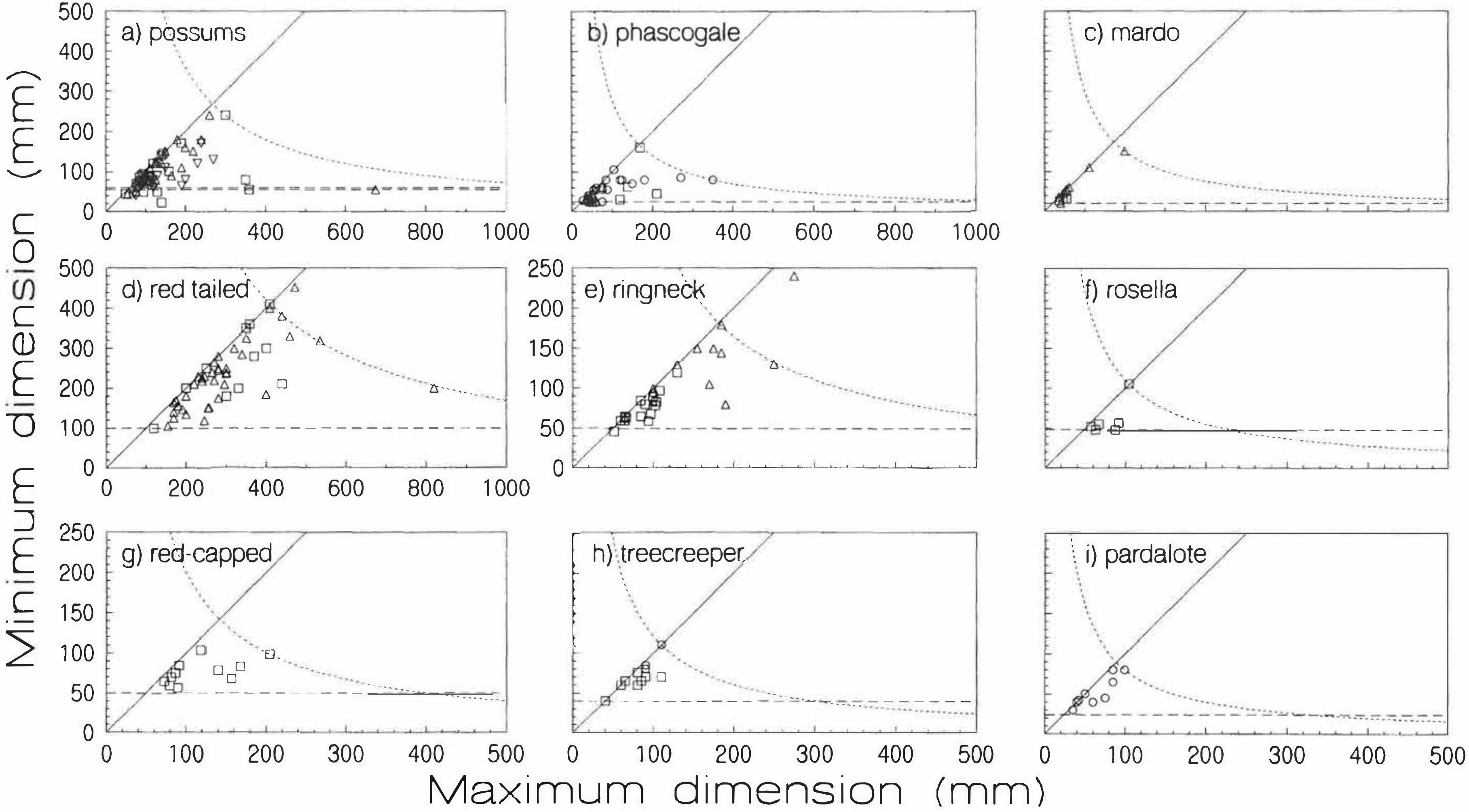

Figure 3. Entry dimensions of hollows used by: (a) common brushtail possums (n = 29), Δ and ∇ (Rhind 1998); western ringtail possums (n = 19), □ and ◊ (Rhind 1998); (b) brush-tailed phascogale (n = 23), O and □ (Rhind 1998), and Δ (Soderquist, unpublished data); (c) mardo (n = 7), Δ (Wardell-Johnson 1986), and □ (Dickman, unpublished data); (d) red-tailed black cockatoo (n = 49), Δ (Saunders et al. *1982), and □ (Johnstone, unpublished data); (e) Australian ringneck (n = 30), □ (Long 1990), and Δ (Saunders* et al. *1982); (f) western rosella (n = 6) (Long 1990); (g) red-capped parrot (n = 11), (Long 1990); (h) rufous treecreeper (n = 12), O and □ (Craig, unpublished data); and (i) striated pardalote (n = 11). The dashed horizontal line is the minimum usable entry dimension. The curved line defines the maximum entry size and is a constant area function for elliptical entries (see Table 1).*

limit applied to pardalotes and red-capped parrots, the interpretation of the data was conservative, i.e. it would result in fewer hollow entries being classified as potentially usable. The reasons for the locations of these bounding lines are given below.

All entries to possum hollows which were smaller than 55 mm were secondary entries into hollows that had other larger primary entries. One unusually long and thin primary entry of 55 mm x 675 mm was set aside, and following Inions *et al.* (1989) and Menkhorst (1984), the larger and more conservative dimension of 60 mm was taken as the lower limit for hollow entry use by common brushtail possums (Fig. 3a). A common upper limit was chosen for both possum species (Fig. 3a). This was selected because western ringtail possums are smaller than common brushtail possums, yet the largest hollow entry used by a possum came from a hollow used by a western ringtail possum.

Five of the largest red-tailed black cockatoo entries, which had nearly equivalent area, were used to set the maximum entry dimensions in preference to a single larger entry that was assumed to be atypical. This was a conservative interpretation of the data which would reduce the number of hollow entries classified as potentially suited to red-tailed black cockatoos.

Two Australian ringneck entries were set aside (Fig. 3e). One small entry of Long (1990) was ignored as it was noticeably smaller than all other entries, smaller than the entries used by western rosellas (a smaller species), and smaller than the minimum of the range reported by Long (1990). Following Long (1990), the lower limit for potentially usable hollow entries was set at 50 mm. The largest hollow entry recorded for Australian ringnecks was much larger than other entries used by this species and very much larger than entries used by other parrot species. The next two largest entries, which had nearly equivalent area, were chosen as more conservative indicators of the upper limit for Australian ringneck hollow entry size (Fig. 3e).

In the case of red-capped parrots, the minimum entry size was set at 50 mm, slightly smaller than the smallest entry observed in use (90 mm x 57 mm). As red-capped parrots are smaller than Australian ringnecks, and Australian ringnecks use hollows with entries as small as 50 mm, this was seen as a consistent interpretation of the available data. The minimum entry dimension used by rufous treecreepers was 40 mm (Fig. 3h). Though only one entry of this size was observed, this value was used as it is consistent with the relatively small size of this bird. For striated pardalotes, Haseler and Taylor's (1993) minimum entry dimension of 24 mm was used as the lower limit for entry dimensions (Fig. 3i) because these authors examined a much larger data set.

Internal Dimensions of Hollows Used by Fauna

The internal depth and width dimensions of used hollows and the lines bounding the range of hollow sizes used by eight species are shown in Figure 4. Individual data were not available for red-tailed black cockatoos, and in Table 2 the summary values of Saunders *et al.* (1982) were used to define the range of internal dimensions of these hollows. Very few data on the internal dimensions of hollows used by mardos were available and these are not graphed. Equations for the lines that define the range of hollow sizes used by all species are given in Table 2. For all bird species, the maximum and minimum restrictions placed on the internal hollow depths and widths were based on the largest and smallest dimensions observed in use. For the mammals, common brushtail possum, western ringtail

TABLE 2

Dimensional limits to hollow depth and width. The lines describe the area on the graph of hollow depth (x) versus hollow width (y), that were used to describe the range of internal dimensions of hollows suited to each of six bird and four mammal species. In cases indicated by an asterisk, a fifth side is described by the line, y = x (see Fig. 4). All values correspond to dimensions in millimetres. Sample sizes are given in Figure 4.

SPECIES	MINIMUM INTERNAL WIDTH	MAXIMUM INTERNAL WIDTH	MINIMUM HOLLOW DEPTH	MAXIMUM HOLLOW DEPTH
Common brushtail possum*	y = 120	y = 480	y = -0.4 x + 300	x = 11200
Western ringtail possum*	y = 80	y = 480	y = -0.1 x + 150	x = 5340
Brush-tailed phascogale*	y = 80	y = 330	y = -0.08 x + 110	x = 3860
Mardo	y = 100	y = 200	x = 190	x = 540
Red-tailed black cockatoo	y = 190	y = 540	x = 450	x = 7250
Australian ringneck	y = 95	y = 320	x = 360	x = 4005
Western rosella	y = 95	y = 275	x = 356	x = 1510
Red-capped parrot	y = 95	y = 232	x = 190	x = 976
Rufous treecreeper	y = 60	y = 160	x = 240	x = 600
Striated pardalote	y = 60	y = 150	x = 170	x = 950

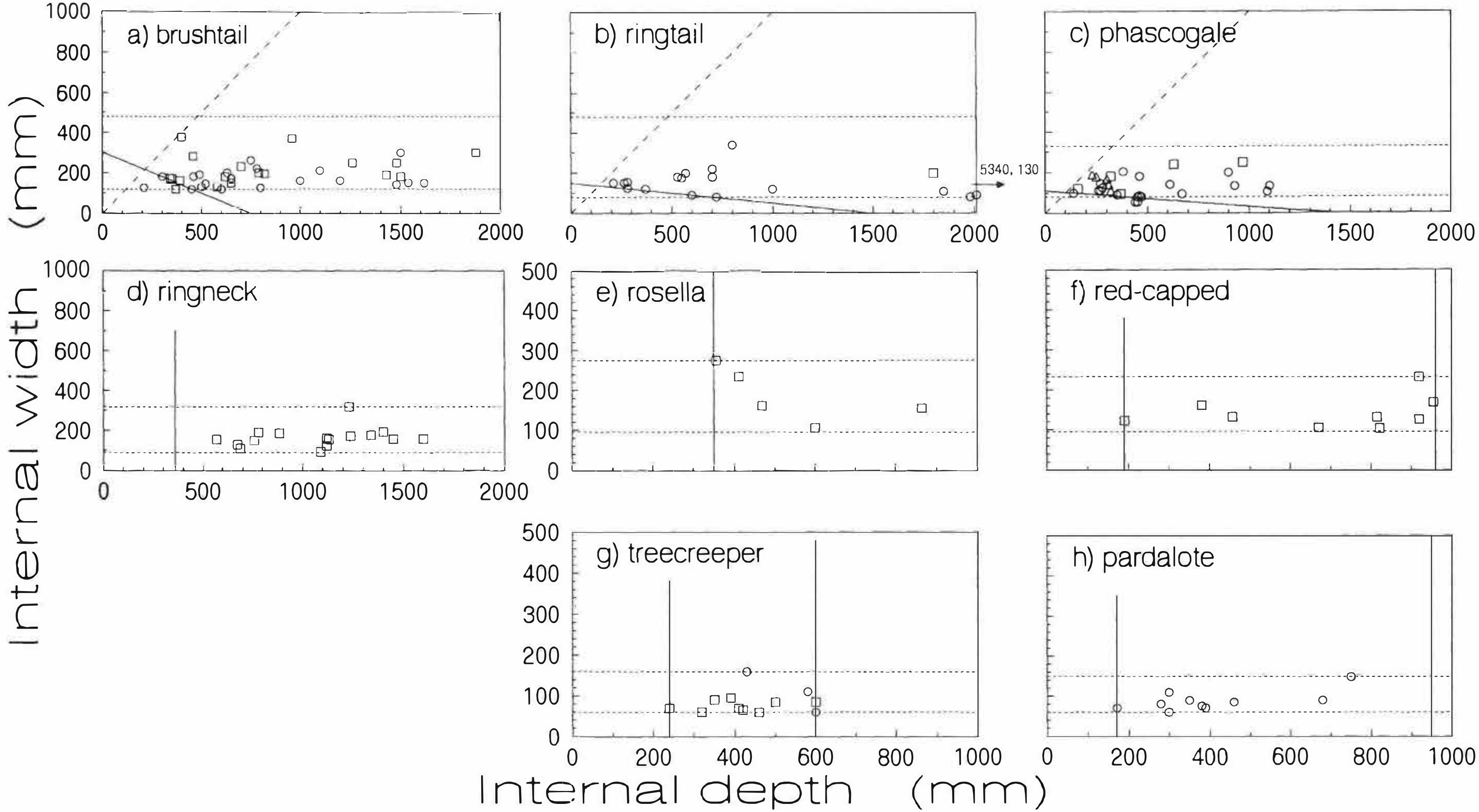

Figure 4. Internal dimensions of hollows used by; (a) common brushtail possums (n = 29), O and □ (Rhind 1998); (b) western ringtail possums (n = 19), O and □ (Rhind 1998); (c) brush-tailed phascogale (n = 26), O and □ (Rhind 1998), and Δ (Soderquist, unpublished data); (d) Australian ringneck (n = 16), □ (Long 1990); (e) western rosella (n = 5), (Long 1990); (f) red-capped parrot (n = 10), (Long 1990); (g) rufous treecreeper (n = 12), O and □ (Craig, unpublished data); and (h) striated pardalote (n = 10). The lower horizontal line is the minimum usable width and the upper horizontal line the maximum usable width (see Table 2). The maximum hollow depths are not shown for common brushtail possum, western ringtail possum, phascogale tapoatafa, Australian ring-necked parrot, and western rosella. The minimum and maximum hollow depths and other limits to minimum combinations of hollow dimensions are given in Table 2.

possum, and brush-tailed phascogale, additional restrictions were applied to exclude hollows with both small depth and small width dimensions from being classified as potentially usable. These restrictions reduce the number of hollows that would be classified as potentially suited to these species.

The upper limit for internal hollow width shown for common brushtail possums and for western ringtail possums is the 480 mm nominated by Inions *et al.* (1989) (Figs 4a, 4b, Table 2). The negatively sloped line of Figure 4a excludes two small hollows that were too small to be used to define potentially usable hollows. Small hollows like these are relatively common, but are rarely used by common brushtail possums and the exclusion of these points is conservative as it reduces the number of small hollows that can be classified as potentially usable.

One phascogale hollow with a very small width was not considered in setting the limits for internal dimensions. This hollow was unusually narrow (55 mm), and I considered this hollow to be too small to use in classifying other hollows as potentially usable.

Two of the three internal widths (60, 90, and 125 mm) of natural hollows used by mardos (Dickman[7]) were smaller than the 100 mm of Wardell-Johnson's (1986) nest box 8. Nest box 8 was least preferred, but still used by breeding females. The minimum internal hollow width for mardos was set at 100 mm.

As the western rosella is smaller than the Australian ringneck, the minimum dimension used by Australian ringnecks (95 mm) was set as the lower limit for hollows used by western rosellas (Fig. 4e, Table 2).

The smallest hollow widths used by red-capped parrots were 102 mm (Fig. 4f). As there were limited data and the red-capped parrot is smaller than the Australian ringneck, the minimum width used by Australian ringnecks (95 mm) (Long 1990) was set as the lower limit for hollows used by red-capped parrots.

The minimum depth of hollows used by striated pardalotes (170 mm)(Fig. 4g, and Table 2) was consistent with Haseler and Taylor's (1993) observation of a minimum distance to the nest of 90 mm, and the dimension of a nest chamber in a tree 'excavated to the dimensions required' of 70 x 80 mm.

The Range of Entry Shapes of Potentially Usable Hollows

I examined the dimensions of 665 hollows found in 239 trees and found 204 hollows had entry heights, entry dimensions, and internal hollow dimensions that fitted the descriptions given in Tables 1 and 2. Figure 5 shows the dispersion of hollow entry shapes from these hollows that were classified as potentially suited to each of 10 fauna species.

[7] Unpublished data, Dr C. Dickman, School of Biological Sciences, University of Sydney, NSW.

DISCUSSION

Why a Constant Area Function is Appropriate

A major failing of summaries of hollow dimensions is that they separate related pairs of dimensions. The summary data of Saunders *et al.* (1982) can be used to demonstrate this problem (which can also be observed in the red-tailed black cockatoo, phascogale, possum, and red-capped parrot data presented in Fig. 3). Saunders *et al.* (1982) properly reported a maximum horizontal dimension for hollow entries used by red-tailed black cockatoo of 820 mm, and a maximum vertical dimension of 535 mm. Though correct, these summary data do not describe the dimensions of the largest hollow entry that Saunders *et al.* (1982) observed in use. Red-tailed black cockatoos were **not** observed using hollow entries as large as 820 x 820 mm, 820 x 535 mm, or even 535 x 535 mm. Similar incorrect interpretations would be made if the data presented here for possums, phascogale, red-tailed black cockatoos, and red-capped parrots, were summarized. Summaries that separate the two entry dimensions can be misleading when used to identify the largest hollow entries that are suited to a species because they incorrectly indicate that hollow entries in area B of Figure 2 are potentially suited to the species. The use of a maximum area limit constrains the two related hollow dimensions in a realistic manner.

A related, but opposite, effect occurs when summary entry dimensions from the most common, slightly elliptical entries, are used to define potentially usable entries. This eliminates from consideration entries which may well be suitable but are more elongated than the typical slightly elliptical entry. These are the entries described by area C of Figure 2. Where data are more numerous (e.g. Figs 3a, b, and d), the range of entry shapes tends to increase from the most common circular and elliptical entry shapes to those that are quite elongated. A small sample of used entries (such as Figs 3f, h, and i) will tend to include the most commonly occurring entry shape, i.e. round to slightly elliptical. Strict interpretation of dimensional limits from summaries based on such small sets of dimensions will inappropriately exclude from consideration elongated entries of equivalent area that, from the data in Figures 3 a, b, d, e and g, are acceptable to several species of birds and mammals.

Hollows used by fauna are difficult and expensive to measure and consequently the amount of data is often small. The constant area limit enables the interpretation and description of the dimensions of a variety of hollow entry shapes, and enables these interpretations to be made from limited data (including the extremes of one large and one small hollow entry). A wide range of potential entry shapes can be described from a limited data set. Examples of this are shown in Figures 3f, g, h, and i, where a range of hollow entry shapes are defined using data from only 6 to 12 used hollow entries.

As well as these practical reasons for applying this constant area function, the use of this limit was supported by the spread of the data. The scatter of data in Figures 3a,

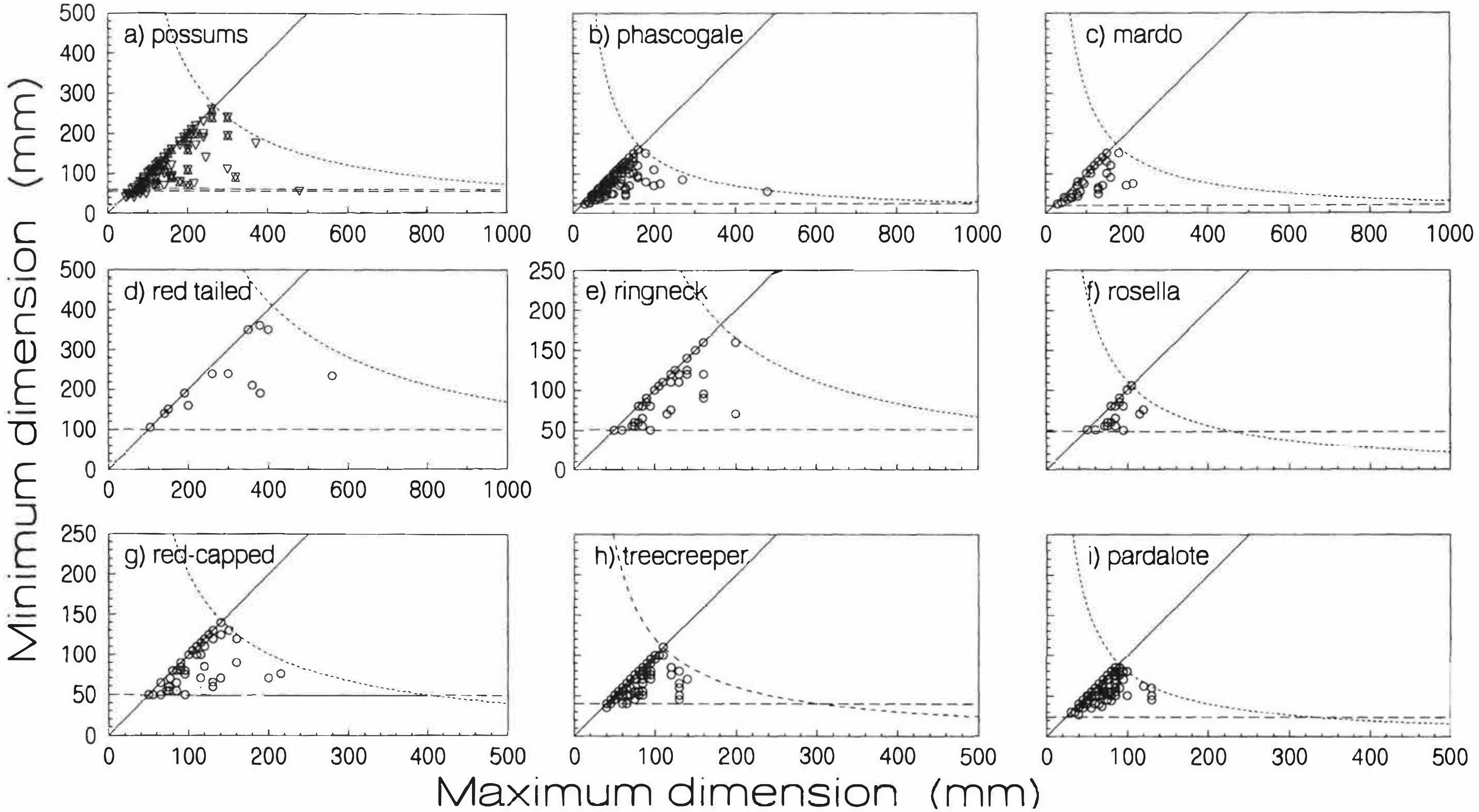

Figure 5. The disposition of 204 hollow entries from hollows classified as potentially suited to 10 fauna species. Graphs are for: (a) common brushtail, Δ *(n = 35) and western ringtail* ∇ *possums (n = 84); (b) brush-tailed phascogale (n = 106); (c) mardo (n = 34); (d) red-tailed black cockatoo (n = 13); (e) Australian ringneck (n = 37); (f) western rosella (n = 19); (g) red-capped parrot (n = 46); (h) rufous treecreeper (n = 73); and (i) striated pardalote (n = 91). The dashed horizontal line is the specified minimum usable dimension and the curved line is the maximum entry size specified (see Table 1).*

b, d, e and g shows a range of entry shapes that are contained within the dimensional descriptions given in Table 1. In the case of Figure 3b the two largest entries, though very different in shape, fall along the constant area curve that is defined by a single pair of entry dimensions. In Figure 3d, five entries fall along this curve. Figures 3a and 3g show a range of entry shapes contained within this limiting description. The constant area function is a simple expression that satisfactorily caters for and describes the range of entry dimensions and shapes observed.

The use of this constant area function as an upper limit is a variation of the boundary line analysis expounded by Webb (1972). Here, this analysis technique has been used on small data sets where the absolute limit of the response (the boundary) has not necessarily been reached. The true boundary may lie beyond the position indicated by these relatively small data sets. However, with the upper limit on entry size, the bounding function has a fixed shape, there is a rational basis for selecting the function shape (i.e. entries are elliptical), and the function can be defined by a single datum point. In cases where the upper extent of hollow entry size has not been demonstrated in the available data, the use of a lower limit is a conservative interpretation based on available data, and the application of this specification will not lead to over-estimation of the number of potentially usable hollows.

Minimum Hollow Entry Size

I assume a constant minimum hollow entry dimension for each species. Predator avoidance is often cited to explain the tendency of animals to seek small entry sizes (e.g. Tidemann and Flavel 1987; Traill 1995). Competition for hollows has also been suggested as a factor determining the entry size of occupied hollows (Van Balen *et al.* 1982; Newton 1994). Whatever the mechanism, the tendency for hollow entry size to follow body size is both logical and commonly observed (e.g. Saunders *et al.* 1982; Tidemann and Flavel 1987; Traill 1995). Clearly, a minimum hollow size will be determined by the smallest opening which the occupying species can pass through. This should be a relatively consistent minimum for a species because it will be determined by adult body size.

Additional Restrictions on the Internal Dimensions of Mammal Hollows.

The data of Figures 4a, b, and c show that mammals use some small hollows that are as wide as they are deep (ranging from cylinders, to ellipsoids and spheres), while birds use approximately cylindrical hollows that are much deeper than they are wide (Figs 4d, e, f, g, h). The dimensions collected from deep cylindrical hollows used by birds require only maximum and minimum bounds to define the range of potentially usable hollows. The data collected from small spherical and ellipsoidal hollows used by some mammals require an additional restriction to exclude hollows with both small depth and small width dimensions from being classified as potentially usable. These negatively sloped lines in Figures 4a, b, and c, were a conservative interpretation that reduce the number of hollows classified as potentially suited to the species by excluding hollows that were small in both dimensions.

This problem is similar to that caused by the separation of pairs of dimensions measured on a single hollow. Just as summaries of separated hollow entry dimensions drawn from two hollows can be misleading, unrelated internal dimensions drawn from two hollows can incorrectly imply that hollows with both small widths and small depths are potentially suited to a species. Pairs of hollow dimensions collected from individual hollows should be analysed and summarized as pairs.

Limited Data Sets and Excluded Data

Hollow dimensions are difficult, dangerous, and expensive to collect; consequently data sets are often small. One major strength of the method described in this paper is the capacity to sensibly interpret these relatively small data sets. The risk is in producing misleading interpretations that over- or underestimate the number of potentially usable hollows. However, a more usual interpretation of these data, based on means and ranges, carries a similar or greater probability of being misleading. If descriptions of potentially usable hollows are based on mean hollow dimensions, the number of potentially usable hollows will always be underestimated, as both large and small entries (and hollows) will be excluded. If summarized maximum and minimum dimensions are used, both under- and overestimates can occur. With some species the observation of a used entry that is large and elongated will lead to the inclusion of much larger and rounder entries, and an overestimation of available hollows (the inclusion of area B of Fig. 2). With other species, limited observations that only include entries that are close to round, will lead to the exclusion of slightly elongated entries and an underestimation of potentially usable hollows (the exclusion of area C of Fig. 2). By consistently applying this method of interpreting the data, an orderly and rational progression of hollow entry descriptions is produced. These are consistent with the progression of body sizes for these species, and the hollows identified as 'potentially usable' have the same range of dimensions as those observed in use. Consequently, the number of these hollows should be correctly estimated. Ultimately the correctness of these descriptions of hollow size can only be assessed against larger data sets.

In interpreting this data, atypically large or small hollow dimensions were ignored in the analysis. The excluded values were: one large red-tailed black cockatoo entry, one large and one small Australian ring-necked parrot entry, two small internal hollow dimensions for common brushtail possums, and two small internal hollow dimensions for *Phascogale tapoatafa*. Individuals of a species may at times use hollows that are outside the range of sizes typically used by these species and these values are inappropriate as the basis for this type of analysis, and the proposed subsequent modelling exercise. The exclusion of these data produce a conservative result as it reduces the number of hollows that are classified as potentially usable.

Distribution of Entry Shapes for Classified Hollows

The 204 hollows classified as potentially suited to fauna were examined to determine whether extremely elongated hollow entries occurred, and whether they were ever classified as potentially suited to any species. Comparison of the distribution of points on Figure 3 and Figure 5 shows that the range of entry dimensions classified as potentially suited to fauna is consistent with those observed in actual use by fauna. A disproportionate number of extremely elongated hollow entries do not occur on hollows that also have suitable internal dimensions and suitable entry height. For this reason a bound on the right hand side of Figure 3 was not seen as necessary.

Ringnecks

Figure 3e clearly shows that the Australian ringnecks of Saunders *et al.* (1982), in *Eucalyptus salmonophloia,* used larger hollow entries than those of Long (1990) in *E. wandoo* and *E. longicornis*. It is unlikely that these differences are owing to the effects of competition for hollows. Long (1990) stated that competition between birds that used similar sized hollows was not affecting his data set, as few other species nested in his study area. Australian ringnecks were the smallest hollow users on the site studied by Saunders *et al.* (1982): a site also used by galahs, corellas, and red-tailed black cockatoos. It seems most unlikely that competition with these larger birds forced Australian ringnecks to use larger hollows. Predators on Long's site may have forced Australian ringnecks to use only small entries, however, this does not explain why the Australian ringnecks on Saunders' site used only large entries. I interpret this difference as indicating differences in the sizes of hollows occurring on the two sites. This difference is owing to a difference in the available hollows in the different tree species at the two sites, and/or a difference in tree sizes between the two sites.

CONCLUSION

In the many areas of the jarrah forest that density of medium sized mammal species is low, fox predation is assumed to be a major cause (Christensen 1980a, b). While factors in addition to predation are proposed as causes of decline in bird and mammal densities (Calver and Dell 1998), fox control is expected to increase the abundance of mammals in these forests (Morris *et al.* 1995). With low animal abundance, hollow use is not a meaningful indicator of hollow abundance. These descriptions of used hollows provide a means of identifying other hollows that are potentially usable. The attributes of trees with and without hollows can be assessed, and regression techniques used to identify which attributes are associated with hollow bearing trees, and then to predict the availability of potentially usable hollows (the validation of predictive models is essential in the latter step). The number of potentially usable hollows that are actually used may depend on: species abundance, population densities, predator population density, stand vegetation structure and composition, spatial dispersion of the hollows, and other environmental and behavioural factors; however, hollow size is fundamental and will be the primary determinant of hollow suitability, and a sound basis for estimating general hollow availability across the forest. In using these descriptions, it is also important to consider that the descriptions of mammal hollows given here differ from those for bird hollows, as not all mammal hollows were used for breeding.

Ideally hollows, which are three-dimensional objects, could be described and analysed as three-dimensional objects. For such analyses to be useful they would require a greater amount of data and more detailed measurements than were available for this work. The two-dimensional descriptions of internal hollow dimensions presented here are the best available approximation of the three-dimensional reality and an improvement on dimensional summaries. For most hollow entries, two-dimensional descriptions will contain as much information as three-dimensional descriptions, and these two-dimensional descriptions of hollow entry shape are substantially more descriptive than data summaries. This paper brings together available information on the dimensions of hollows used by these species, combines this with new data, and presents a sensible system for interpreting this information in a rational and consistent manner. The interpretations provide an improvement on existing published summaries and this simple system is useful for examining hollow shapes and sizes. Graphical presentations of hollow entry dimensions and the internal dimensions of used hollows should be presented in preference, or as a supplement, to summaries, and paired measurements from individual hollows should not be analysed separately. Researchers are encouraged to examine the area of hollow entries as one of the descriptors of the range of hollow dimensions.

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The birds of Kurrawang Nature Reserve – observations of avifaunal change in the eastern goldfields of Western Australia

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SUMMARY

Examination of the avifauna at a locality in the eastern goldfields of Western Australia indicates that there have been both additions and deletions of species between 1904 and 1996. It is hypothesized that the primary agent of change is the widespread provision of water points by the pastoral industry, thus favouring a small suite of relatively powerfully flying, abundant, gregarious and sometimes aggressive honeyeaters which both drink water and eat insects. Their abundance either puts pressure on the invertebrate food source or there is an interspecific competitive interaction which disadvantages smaller resident insectivores. The effect of timber removal on the structure of semi-arid woodlands appears to be a secondary factor. The possible scarcity of invertebrate food would be exacerbated by the shortage of standing and fallen timber in semi-arid woodlands that have been cut over. Data on the relative abundance of presently occurring bird species tend to support this hypothesis.

INTRODUCTION

The decline of medium-sized mammals in the Australian arid zone is well documented and although the likely factors have been identified, there is still debate whether introduced predators or habitat change are the primary causes of change. Recher and Lim (1990) suggested that the decline of mammals is the 'first wave' of faunal attrition in Australia and that birds and reptiles will follow: in particular, they predicted major losses of bird species would first occur in agricultural and pastoral regions of southern Australia. Recher (1999) elaborated this view and drew attention to the widespread decline of woodland and ground-foraging and ground-nesting birds. Robinson (1993) listed species that are declining at least somewhere in southern Australia but are not listed as threatened.

Recent studies on the impact of European settlement on the avifauna of the arid zone vary in their conclusions depending on their geographical location. In the western division of New South Wales, which has been under pastoral management since the 1830s, Smith *et al.* (1994) considered 60 taxa threatened and in decline. A study of an area in arid Western Australia that is also under pastoral management, although not for as long as the area in the NSW study, indicates a lesser rate of decline that has stabilized (Saunders and Curry 1990). In their review, Reid and Fleming (1992) reported that one half of the arid zone avifauna has changed since European settlement and that there are continuing threats to avian biodiversity in the arid zone. Recher (1999) indicated that if the presence of increaser species is also indicative of ecological instability, then changes to avifauna are considerably underestimated by these regional studies.

The purpose of this paper is to examine changes to the avifauna in a small area of the eastern Goldfields of Western Australia over a period of 92 years, identify the likely causes of change and see whether a pattern consistent with other studies can be discerned. In addition, the results of 63 Australian Bird Counts conducted between 1990–95 at the same site are reported.

STUDY AREA

This study was undertaken in Kurrawang Nature Reserve, located between 13 and 17 km south-west of Kalgoorlie-Boulder in the eastern goldfields of Western Australia. Although the reserve is relatively small (621 ha) it is largely surrounded by vegetation that is in a more or less natural state. The reserve takes its name from the former Kurrawang town site, which was immediately to the north of it, although some town site clearing extended into what is now the reserve.

Kurrawang town was the centre for timber operations, known locally as 'woodlines', which provided timber for fuel and structural purposes for the mining industry between 1905 and 1938. Accordingly, most of the large timber on the reserve and surrounds was felled and, owing to the proximity to Kalgoorlie, it is likely that felling commenced as early as 1899 (Tom Newbey[1], personal

[1] Tom Newbey, former woodline locomotive driver.

communication). It is not recorded when felling ceased, but it is likely to have been *c.* 1910. Climatically the reserve is located between the arid and semi-arid zones. The annual average rainfall at Kalgoorlie is 256 mm and, although it is considered a winter rainfall area, on average approximately equal amounts of rain are recorded in all months.

Kurrawang is also of interest as the site at which retired army officer G.C. Shortridge collected birds for the British Museum between 2 September and 4 October 1904. Shortridge collected 52 species of bird at Kurrawang in 1904 (Ogilvie-Grant 1909). More recent work on the nature reserve includes a biological survey in 1988 (Chapman *et al.* 1991) and 63 Royal Australasian Ornithologists Union (RAOU - now Birds Australia) Australian Bird (AB) Counts by AC. In spite of limitations, which are discussed below, these studies provide an opportunity to assess changes to the avifauna over the period 1904–1996.

In broad terms, the reserve occupies a ridge on a watershed between two salt lake systems. Much of the vegetation is eucalypt woodland: its structure and species composition is determined by landform and surface geology.

Salmon gum (*Eucalyptus salmonophloia*) woodland on a Quaternary alluvial broad valley occupies the western third of the reserve and mixed eucalypt woodlands, with *E. lesouefii, E griffithsii, E. clelandii, E. grassbyi, E. transcontinentalis,* and *E. oleosa,* occupy undulating plain of Archaen age over most of the remainder. A small but distinctive lateritic ridge with *E. griffithsii* woodland and *Acacia acuminata* shrubland is between the two main woodland types. Sites used for AB counts were as follows:

Site 1. *Eucalyptus salmonophloia* woodland at 121° 20'00"E, 30° 49'45"S

Site 2. *Eucalyptus transcontinentalis / E. salubris* woodland at 121° 21'15"E, 30° 49'30"S

Site 3. *Eucalyptus griffithsii* woodland at 121° 22'00"E, 30° 49'00"S.

METHODS

The bird data for 1904 are from Ogilvie-Grant (1909, 1910). Attempts to locate Shortridge's field notes or further details of his collecting at Kurrawang in both the British Museum and the Kaffrarian Museum in South Africa, where Shortridge was the Director until his death in 1949, were unsuccessful.

Methods for AB counts required searching areas of 10 ha for 20 minutes four times per year. At Kurrawang nature reserve, AC recorded birds at the three sites described above on the same day in each season between January 1990 and March 1995, a total of 63 counts.

Woodland densities on Kurrawang nature reserve and at the closest uncut woodland on Kambalda timber reserve, 60 km south of Kalgoorlie, were measured by selecting 10 points at random and counting all stems greater than 10 cm diameter at breast height within a 30 m radius.

Dead wood densities were measured by walking standard 1 km transects at Kurrawang, Kambalda, and Jaurdi pastoral lease which also has cut and uncut woodlands and is 110 km west of Kalgoorlie, and counting all logs greater than 10 cm diameter and longer than 3 m occurring 30 m either side of the transect lines.

Description of Changes to Goldfields Environments with Settlement

There have been many influences on the vegetation, flora and fauna of Goldfields woodlands since European settlement of the region including: timber extraction; development of the pastoral industry with extensive selective grazing of natural vegetation and provision of water points where previously there were only very few; introduction of feral predators, herbivores and weeds, and town site and industrial development, particularly infrastructure and pollution associated with the mining industry.

The changes brought about by timber extraction have attracted considerable attention owing to the magnitude of the operation: an estimated 30 million tonnes of timber were removed from 3.4 million ha at 7–9 tonnes/ha between 1900 and 1960 (Kealley 1991). The differences identified in the present study between cut and uncut woodlands is that the former have greater numbers of trees per unit area which are of lesser diameter but comparable height and, perhaps more significantly, there are very few standing dead trees in regenerated cut woodlands. Tree density in cut woodland at Kurrawang varies between 7 and 289 stems/ha (mean=101.7). The wide variation is dependent upon the dominant species of eucalypt present. At Kambalda, uncut woodland varies between 14 and 59.5 stems/ha (mean=31.5). Siemon and Kealley (1999) also record increased average stems/ha and increased average basal area in cut Goldfields woodlands. Additionally, in cut woodlands, there is significantly less fallen dead timber because it too was removed, or recycled by termites or fungal decay.

On Jaurdi pastoral lease standard traverses of cut and uncut woodlands had 6.1 and 15.2 dead logs/ha respectively. At Kambalda the figures are 7.6 and 20.5 dead logs/ha. At Kurrawang the figure is 0.6 dead logs/ha owing to the presence of the former town site and more recently to illegal cutting and scavenging of dead timber for firewood. Shrubland density in semi-arid zone woodlands is not diminished by timber removal but by other factors including grazing history, micro-topography and soil depth. Measurements on Jaurdi pastoral lease suggest that cut woodlands have increased shrub density and clumping in comparison with uncut woodlands of similar tree species composition (Rob Thomas[2] personal communication).

Which are the agents of change to semi-arid woodland avifaunas in the Goldfields generally and at Kurrawang in particular? The procedure for timber extraction was to allocate coupes measuring one chain by one mile (20 m x 1609 m) to individual cutters who would then fell,

[2] Rob Thomas, Leader, Nature Conservation Program, CALM, Kalgoorlie.

using an axe and cross-cut saw, all suitable timber and cut it into billets 1.2 m long. The billets were loaded onto horse-drawn drays and taken to the nearest narrow gauge railway, or 'woodline', where they were loaded onto railway wagons. This was effectively a clear-felling operation: where it occurred the small understorey tree *Melaleuca pauperiflora* was also cut. The requirement for timber of a certain size and the location of the 'woodlines' meant that, in some cases, although large areas were cleared in total they were usually cleared in tongues with a large linear interface between cleared and uncleared patches. This situation probably pertained more generally elsewhere than at Kurrawang which would have been extensively cleared owing to its proximity to both Kalgoorlie and Kurrawang town sites. Although slow, regeneration would have been vigorous because once the parent seed trees had been cut, there would have been reduced competition for light, moisture and nutrients while the allelopathic effect that inhibits germination ceased.

Cut trees also frequently coppiced vigorously and developed a multi-stemmed habit further increasing the density of regrowth woodland.

The pastoral industry came to the Kalgoorlie area in the early 1900s with the grant of pastoral leases at Mungari in 1907 and Hampton Hill in 1909. Mungari presently adjoins some of the reserve and was clearly an early lease, as in 1916 Elder's Stock and Station Company listed 10 stations on the eastern Goldfields: of these only Halford's (Black Flag) and Black's (Mungari) were near Kalgoorlie (Webb and Webb 1993). In the case of Mungari, the Department of Land Administration records that 189 ha, which is now the eastern third of the reserve, was relinquished from the pastoral lease in 1968. Until 1968 at least some of the reserve was under pastoral lease. However, whether lands were held under lease does not necessarily determine whether they were grazed or not. A better approach is to examine the past and present distribution of watering points and fences as there is a finite point, usually taken to be 10 km beyond a watering point, at which sheep grazing has a minimal effect on vegetation (see Landsberg *et al.* 1997 for a review of this topic). Examination of the 'Kalgoorlie' 1:100 000 map indicates that the reserve falls within 5 km of four dams, between 5–10 km of two more, and one in the old Kurrawang town site is near the reserve's north boundary. Eighty per cent of the reserve falls within a 2 km grazing radius of this dam, which is the distance from a watering point in which significant changes to vegetation by grazing can occur (Landsberg *et al.* 1997). Most of these dams are maintained and provide water to stock today. The old Kurrawang town site dam is not now maintained and only holds water after heavy rain.

Thus, although the reserve vegetation does not show the usual signs of degradation of vegetation owing to close proximity to a watering point, it is likely that the vegetation has been grazed in the past and that there have been changes to relative abundance of some species.

The abundance of increaser species *Senna artemisiodes* var. *filifolia* and *Eremophila granitica* (see Curry and Hacker 1990) here, is indicative of this.

Rabbits arrived in the Kalgoorlie vicinity between 1900–1910 and foxes between 1915–1920. These dates are inferred from Figures 2 in Williams *et al.* (1995) and Saunders *et al.* (1995) respectively. Feral cats were almost certainly present before then and probably pre-dated settlement as, for example, explorer David Carnegie recorded them in the Gibson Desert in 1896. No doubt European settlement, which followed the discovery of gold in Coolgardie in 1892 and in Kalgoorlie in 1893, provided a major fillip to feral cat numbers in the region.

RESULTS

The birds of Kurrawang nature reserve listed from Ogilvie-Grant (1909, 1910), Chapman *et al.* (1991) and the AB counts are in Table 1, which indicates a total of 74 species. Status in Table 1 is derived from relative abundance at Kurrawang and whether species are permanently present in the Goldfields, subject to regular seasonal movement (migrants) or irregular movement determined by seasonal conditions (nomads). In some cases it was not possible to allocate this latter category. Fifty-two species were recorded in 1904 and 65 in 1988–96. With the exception of Purple-gaped Honeyeater, all species lost to the avifauna are residents. Red-backed Kingfisher, Straw-necked Ibis and Brown Falcon were recorded in 1904 but not in 1988–96 although they are still locally present.

Those species formerly present but not recorded between 1988–1996 are: Southern Boobook, Rufous Tree-creeper, Golden Whistler, Shy Heathwren, Blue-breasted Fairy-wren and Purple-gaped Honeyeater.

Birds recorded between 1988 and 1996 but not in 1904, which are believed to be additions, are: Common Bronzewing Pigeon, Galah, Crested Pigeon and Magpie lark.

An additional 13 species listed in Table 1 were almost certainly part of the avifauna in 1904 but were not recorded then, probably owing to either their nomadic or migratory nature, or scarcity. In addition, elements of chance omission are always present in once-off surveys.

Table 2 lists the 50 species recorded during AB counts, their seasonal occurrence as well as number of sightings and total number of individuals observed. It reveals that Weebill and Striated Pardalote are presently the most frequently recorded birds at Kurrawang both in number of sightings and number of individuals. They are both very common resident species invariably recorded in the canopies of eucalypts. The next most frequently recorded are Yellow-throated Miner, Spiny-cheeked Honeyeater and Red Wattlebird.

DISCUSSION

There are several constraints in comparing data sets derived from the same place at different times, including how and why the data were obtained. In the case of the 1904 data, all records were of specimens obtained for a museum collection, and all data were from the same season.

TABLE 1

The past and present birds of Kurrawang Nature Reserve and their current residency status

NAME	1904	1988–96	STATUS
Emu *Dromaius novaehollandiae*	YES	YES	common nomad
Straw-necked Ibis *Threskiornis spinicollis*	YES	NO	
Black-shouldered Kite *Elanus notatus*	NO	YES	uncommon nomad
Square-tailled Kite *Lophoictinia isura*	NO	YES	uncommon nomad
Spotted Harrier *Circus assimilis*	NO	YES	uncommon nomad
Little Eagle *Hieraaetus morphnoides*	NO	YES	uncommon nomad
Wedge-tailed Eagle *Aquila audax*	NO	YES	uncommon nomad
Australian Hobby *Falco longipennis*	NO	YES	uncommon nomad
Brown Falcon *Falco berigora*	YES	NO	
Nankeen Kestrel *Falco cenchroides*	YES	YES	uncommon nomad
Little Button-quail *Turnix velox*	NO	YES	rare nomad
Common Bronzewing *Phaps chalcoptera*	NO	YES	uncommon nomad
Crested Pigeon *Ocyphaps lophotes*	NO	YES	common resident
Purple-crowned Lorikeet *Glossopsitta porphyrocephala*	YES	YES	common nomad
Australian Ringneck *Barnardius zonarius*	YES	YES	common resident
Mulga Parrot *Psephotus varius*	YES	YES	uncommon resident
Galah *Cacatua roseicapilla*	NO	YES	common resident
Pallid Cuckoo *Cuculus pallidus*	YES	YES	common migrant
Horsfield's Bronze-Cuckoo *Chrysococcyx basalis*	NO	YES	common migrant
Southern Boobook *Ninox novaeseelandiae*	YES	NO	
Tawny Frogmouth *Podargus strigoides*	YES	YES	rare resident
Australian Owlet-nightjar *Aegotheles cristatus*	NO	YES	uncommon resident
Red-backed Kingfisher *Todirhamphus pyrrhopygia*	YES	NO	
Rainbow Bee-eater *Merops ornatus*	NO	YES	common migrant
Rufous Treecreeper *Climacteris rufa*	YES	NO	
Splendid Fairy-wren *Malurus splendens*	NO	YES	uncommon resident
Blue-breasted Fairy-wren *Malurus pulcherrimus*	YES	NO	
White-winged Fairy-wren *Malurus leucopterus*	YES	YES	common resident
Striated Pardalote *Pardalotus striatus*	YES	YES	common resident
Shy Heathwren *Hylacola cauta*	YES	NO	
Redthroat *Pyrrholaemus brunneus*	YES	YES	rare residency status unknown
Weebill *Smicrornis brevirostris*	YES	YES	very common resident
Inland Thornbill *Acanthiza apicalis*	YES	YES	common resident
Chestnut-rumped Thornbill *Acanthiza uropygialis*	YES	YES	uncommon resident
Yellow-rumped Thornbill *Acanthiza chrysorrhoa*	YES	YES	common resident
Southern Whiteface *Aphelocephala leucopsis*	YES	YES	rare resident
Red Wattlebird *Anthochaera carunculata*	YES	YES	common resident
Spiny-cheeked Honeyeater *Acanthagenys rufogularis*	YES	YES	common resident
Yellow-throated Miner *Manorina flavigula*	YES	YES	common resident
Singing Honeyeater *Lichenostomus virescens*	NO	YES	uncommon resident
White-eared Honeyeater *Lichenostomus leucotis*	YES	YES	uncommon resident
Purple-gaped Honeyeater *Lichenostomus cratitius*	YES	NO	
Yellow-plumed Honeyeater *Lichenostomus ornatus*	YES	YES	common resident
Brown-headed Honeyeater *Melithreptus brevirostris*	NO	YES	uncommon residency status unknown
Brown Honeyeater *Lichmera indistincta*	NO	YES	common nomad
White-fronted Honeyeater *Phylidonyris albifrons*	YES	YES	common nomad

Crimson Chat *Epthianura tricolor*	YES	YES	rare nomad
White-fronted Chat *Epthianura albifrons*	YES	YES	uncommon nomad
Jacky Winter *Microeca fascinans*	YES	YES	common resident
Red-capped Robin *Petroica goodenovii*	YES	YES	uncommon resident
Hooded Robin *Melanodryas cucculata*	YES	YES	rare residency status unknown
White-browed Babbler *Pomatostomus superciliosus*	YES	YES	common resident
Chestnut Quail-thrush *Cinclosoma castanotum*	NO	YES	uncommon resident
Varied Sitella *Daphoenositta chrysoptera*	YES	YES	uncommon residency status unknown
Crested Bellbird *Oreoica gutturalis*	YES	YES	common resident
Golden Whistler *Pachycephala pectoralis*	YES	NO	
Grey Shrike-thrush *Colluricincla harmonica*	YES	YES	common resident
Magpie-lark *Grallina cyanoleuca*	NO	YES	uncommon nomad
Willie Wagtail *Rhipidura leucophrys*	YES	YES	uncommon resident
Black-faced Cuckoo-shrike *Coracina novaehollandiae*	YES	YES	uncommon resident
Ground Cuckoo-shrike *Coracina maxima*	YES	YES	uncommon nomad
White-winged Triller *Lalage sueurii*	YES	YES	uncommon nomad
Masked Woodswallow *Artamus personatus*	YES	YES	uncommon nomad
Black-faced Woodswallow *Artamus cinereus*	NO	YES	common resident
Dusky Woodswallow *Artamus cyanopterus*	YES	YES	uncommon residency status unknown
Grey Butcherbird *Cracticus torquatus*	YES	YES	common resident
Pied Butcherbird *Cracticus nigrogularis*	YES	YES	common resident
Australian Magpie *Gymnorhina tibicen*	YES	YES	common resident
Grey Currawong *Strepera versicolor*	YES	YES	common resident
Australian Raven *Corvus coronoides*	YES	YES	uncommon residency status unknown
Little Crow *Corvus bennetti*	NO	YES	common resident
Richard's Pipit *Anthus novaeseelandiae*	YES	YES	uncommon resident
Mistletoebird *Dicaeum hirundinaceum*	YES	YES	uncommom nomad
Brown Songlark *Cincloramphus cruralis*	NO	YES	uncommon nomad

TABLE 2

AB counts, percentage occurrence by season with total numbers of sightings and individuals.

NAME	SUMMER	AUTUMN	WINTER	SPRING	No. of SIGHTINGS	No. of INDIV
Wedge-tailed Eagle	0	100	0	0	1	1
Little Eagle	100	0	0	0	1	1
Common Bronzewing	100	0	0	0	1	1
Crested Pigeon	77	8	P	15	6	13
Galah	P	65	0	35	5	20
Purple-crowned Lorikeet	33	67	P	0	3	12
Australian Ringneck	39	33	19	9	15	36
Mulga Parrot	66	34	P	0	2	6
Pallid Cuckoo	34	0	0	66	3	3
Horsfield's Bronze-Cuckoo	29	29	P	42	6	7
Rainbow Bee-eater	20	76	0	4	6	28
Splendid Fairy-wren	50	30	P	20	5	10
Striated Pardalote	13	28	42	17	39	122
Redthroat	34	66	P	0	3	3
Weebill	31	24	19	26	44	153
Inland Thornbill	20	40	40	P	3	5
Chestnut-rumped Thornbill	0	46	P	54	4	13
Yellow-rumped Thornbill	38	15	25	22	6	48
Southern Whiteface	0	100	0	0	1	1
Red Wattlebird	11	31	30	28	29	78
Spiny-cheeked Honeyeater	46	30	14	10	28	88
Yellow-throated Miner	28	26	22	24	25	101
Singing Honeyeater	25	0	25	50	4	4
White-eared Honeyeater	10	60	20	10	10	10
Yellow-plumed Honeyeater	38	30	17	15	17	63
Brown-headed Honeyeater	44	0	66	0	2	9
Brown Honeyeater	75	25	P	P	3	4
White-fronted Honeyeater	25	59	4	12	17	71
Crimson Chat	0	100	0	0	1	3
Jacky Winter	37	16	16	31	13	19
Red-capped Robin	40	P	0	60	7	10
White-browed Babbler	0	30	P	70	3	10
Chestnut Quail-thrush	17	42	P	41	8	12
Varied Sitella	0	0	100	0	1	2
Crested Bellbird	50	25	8	17	24	25
Grey Shrike-thrush	38	25	25	12	6	8
Magpie-lark	83	0	P	17	3	6
Willie Wagtail	50	50	P	P	2	2
Black-faced Cuckoo-shrike	14	38	7	41	9	14
White-winged Triller	100	0	0	0	1	1
Masked Woodswallow	0	0	0	100	1	30
Dusky Woodswallow	38	23	P	39	5	13
Grey Butcherbird	25	33	21	21	20	24
Pied Butcherbird	14	43	29	14	6	7
Australian Magpie	60	40	0	0	2	5
Grey Currawong	36	36	P	28	9	11
Australian Raven	7	50	14	29	10	14
Little Crow	79	14	4	3	12	28
Mistletoe bird	100	0	0	0	1	1
Brown Songlark	0	0	0	100	1	1

P – Indicates seasonal presence established by other than AB counts.

These considerations militate against nomadic species as well as those whose numbers fluctuate, and some raptors that are difficult to collect. As a museum collector Shortridge was probably selective in his collecting: for example, although he did not collect Singing Honeyeater, it was possibly present as he records it 'inland as far as Laverton' and Gibson (1909) describes it as 'fairly common right through'. The strength of the historical comparison is in evaluating which species formerly present are no longer rather than *vice versa*.

In spite of these constraints the data do indicate some avifaunal change at Kurrawang over the 92 years between 1904 and 1996. The pertinent questions are, which of the indicated changes are real, and what are the causative factors? The first question has been tentatively answered; it appears above that six species have been lost from the avifauna and four have been added. The additional species have elsewhere benefitted from establishment of reliable water supplies or more favourable food supply, sometimes involving land use change or even introduced plants particularly crops.

Of birds lost to the region, Southern Boobook and Rufous Tree-creeper are almost certainly owing to changes to woodland structural complexity and changed age structure resulting from timber extraction.

Southern Boobook is dependent upon old trees with hollows for nesting and in the Goldfields Rufous Tree-creeper is invariably present in woodlands with logs that they use as perching sites. A reduction of dead timber on the ground is one feature of cut-over semi-arid woodland (see above). The loss of the other four species is more problematical: Golden Whistler, Shy Heathwren and Blue-breasted Fairy-wren are all shrub-dependent 'resident insectivores'. Purple-gaped Honeyeater is a non-resident nectivore. What these species have in common is that they are all on the edge of their range at Kurrawang.

They are predominantly south-western species whose range only extends east of Kalgoorlie in the denser vegetation of the Mallee and Esperance Plains, Interim Biogeographic Regionalisation of Australia (IBRA) Regions (see Thackway and Cresswell 1995).

That resident insectivores are the most adversely affected of the avifauna at Kurrawang is in broad agreement with the observations of Reid and Fleming (1992) who list sedentary passerines that feed on the ground or in low shrubs including wrens, quail-thrushes, thornbills and allies as among declining species in the arid zone.

The situation of birds declining on the edge of their range has occurred elsewhere in the Goldfields: for example, Moriarty (1972) records that both Grey Currawong and Mallee Fowl were present at Kathleen Valley station, which is now Wanjarri nature reserve, 450 km north of Kalgoorlie, in the 1960s. Mallee Fowl has not been recorded since then in parts of the reserve which were formerly grazed and Grey Currawong appears to have declined since the 1960s as 80 person days recording between 1988 and 1996 have only recorded one pair (CALM unpublished data).

Reid and Fleming (1992) recognized that 'species with a southern distribution associated with mallee and chenopods have declined in the north.' Although they were referring to arid zone species, which the Kurrawang decliners are not, it may be that this is a more widely applicable principle, i.e. that on the edge of their range species are particularly vulnerable to agents of attrition. Therefore, changes to the habitat requirements of Southern Boobook and Rufous Tree-creeper and their decline at Kurrawang are likely to be directly attributable to timber extraction.

Other factors need to be examined to explain the loss of other species that are predominantly dense shrub understorey dependent, as shrub density is unlikely to have been diminished by extraction of timber at Kurrawang (see above).

Although the number of arid and semi-arid zone birds that are obligate drinkers is relatively small, there are other species that certainly will drink if water is available. For example, Davies (1972) recorded 24 species that drank, including 13 that drank regularly even in cool weather at Wanjarri.

Although Wanjarri is very different from Kurrawang – being drier with an annual average rainfall of 200 mm, and with vegetation dominated by spinifex and mulga – of the 24 species that drink at Wanjarri 19 also currently occur at Kurrawang. They include Yellow-throated Miner and Spiny-cheeked Honeyeater, which at Kurrawang are among the most frequently recorded species and are known arid zone increasers (Reid and Fleming 1992).

The other frequently recorded species at Kurrawang is Red Wattlebird which certainly does drink in eucalypt woodlands of the eastern Goldfields and elsewhere (CALM unpublished data) and is presently very common but was described by Gibson (1909) as 'a few only in the Salmon barked country'. Although these three species were all present at Kurrawang in 1904, the Shortridge data are too generalized to draw any firm conclusion as to abundance. It is interesting, however, that Spiny-cheeked Honeyeater is noted by Shortridge in Ogilvie-Grant (1909) as being ' the water-bird of the colonists....seldom far from a waterhole' and Yellow-throated Miner is described as 'very abundant on the Gascoyne River'.

These observations suggest that even before it became widely available, water was a factor in the abundance of two of these species. However, in contrast, Gibson (1909) describes Yellow-throated Miner as 'very common right through'.

It is suggested that Red Wattlebird and Spiny-cheeked Honeyeater in particular and possibly Yellow-throated Miner, which are all powerfully flying, gregarious and sometimes aggressive species that do drink, or eat insects, have increased in numbers at Kurrawang and elsewhere. Their increase is possibly at the expense of smaller, territorial and resident obligate insectivores, which are much less vagile. The competitive interaction could either be through direct competition for insect food, albeit possibly at different stages of insects' life cycles. There could also be behavioural interactions involving the aggressive and gregarious nature of these species, as they no longer have to move as far to meet their moisture requirements, thereby making resident insectivores' territories uninhabitable.

James *et al.* (1999) report that species that become abundant may cause aggressive displacement of other species that do not need water.

Although the hypothesis reported here pertains particularly to a specific locality the effects of provision of water in pastoral rangelands is likely to be widespread as Landsberg *et al.* (1997) indicate that nearly all the pastoral rangelands are within less than 10 km of an artificial water point and that only 3 per cent of water points are natural.

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A flora and vegetation survey of the islands of the Houtman Abrolhos, Western Australia

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ABSTRACT

This paper lists the flora found on 119 islands and islets of the Houtman Abrolhos, and maps the vegetation found on a total of 173 islands and islets. The flora comprises 239 species (144 native species and 95 exotic species) from 68 families. Special vegetation areas discussed include: mangrove communities; *Atriplex cinerea* dwarf shrubland; pavement limestone, dune and consolidated dune vegetation of North, East Wallabi and West Wallabi Islands; East Wallabi's grove of *Eucalyptus oraria*; and North and West Wallabi Islands' extensive salt lake and saltbush flats. The vulnerability of the vegetation to human-made changes is discussed.

INTRODUCTION

Purpose

The purpose of this paper is to document published and unpublished floristic and vegetation data, including plant species lists and vegetation maps, for the islands of the Houtman Abrolhos, and to identify vegetation communities of special conservation interest to aid management planning. The bulk of the data published here for the first time result from the field trips undertaken by Harvey and Alford in 1987, and Harvey and Longman in 1999.

Nomenclature

The Houtman Abrolhos islands were named by Dutch navigator Frederik de Houtman in 1619. It is commonly thought the name Abrolhos comes from the Portuguese expression 'abre olhos', which today means 'open the eyes'. However, the Geographic Names Sub-section of the Department of Land Administration (DOLA)[1] (personal communication) favours another interpretation of the name: in the Portuguese language used in 1619, it is believed the word 'abrolhos' meant 'spiked obstructions', and was applied to outlying coastal dangers.

The formal name for the island group is 'Houtman Abrolhos'. Hence it is correct to use a lower-case initial for 'islands' when this follows the formal name.

Location

The Houtman Abrolhos reef complex is located between latitudes 28°15' S and 29°00' S, and longitudes 113°36' E and 114°03' E along the shelf margin, 60 km from the Western Australian coast. The emergent parts of this coral reef consist of 173 islands and islets, of which 109 are officially named and a further 64 unofficially named (Table 1, p. 541). The islands of the Abrolhos extend 86 km from north to south and are clustered into three groups: the Wallabi Group (including the isolated North Island), the Easter Group and the Pelsaert Group (Fig. 1). Each island group consists of a windward (western) reef, a leeward (eastern) reef, and a lagoon with a central carbonate platform (Collins *et al.* 1997). The groups are separated by channels 40 m deep, Middle Channel and Zeewijk Channel.

Tenure

The Houtman Abrolhos islands are Australian territory and part of the State of Western Australia (WA). The islands themselves are currently vested under the care, control and management of the Minister for Fisheries as "A" Class Reserve No. 20253 for 'conservation of flora and fauna, tourism and for purposes associated with the fishing industry'.

Geology

Descriptions of the geology and geomorphology of some of the islands can be found in Teichert (1946), Fairbridge (1947), Storr (1965) and O'Loughlin (1966, 1969). The islands were geologically mapped by Playford *et al.* (1970), and France (1985) prepared a dissertation on the sedimentology of the Pelsaert Group. More recently, in the 1990s, geological mapping and subsurface investigations have been undertaken (Eisenhauer *et al.* 1993; Collins *et al.* 1993a, 1993b; Zhu *et al.* 1993).

[1] Geographic Names Sub-section, Department of Land Administration (DOLA), 1 Midland Square, Midland, Western Australia 6056

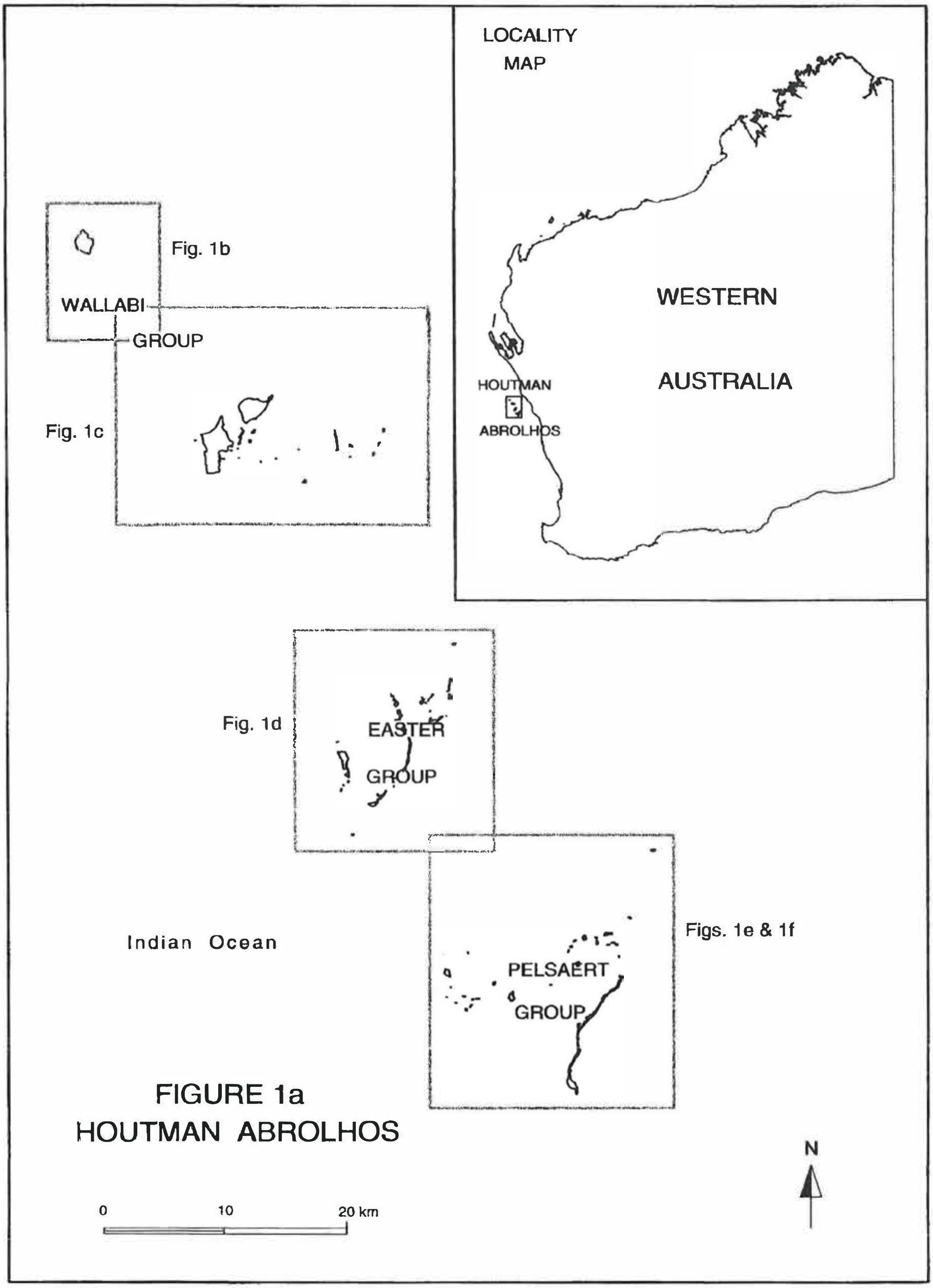

Figure 1. Maps of the islands of the Houtman Abrolhos.
Figure 1a. Map of all three groups of the Houtman Abrolhos. Insert: Location of the Houtman Abrolhos in relation to mainland Western Australia.

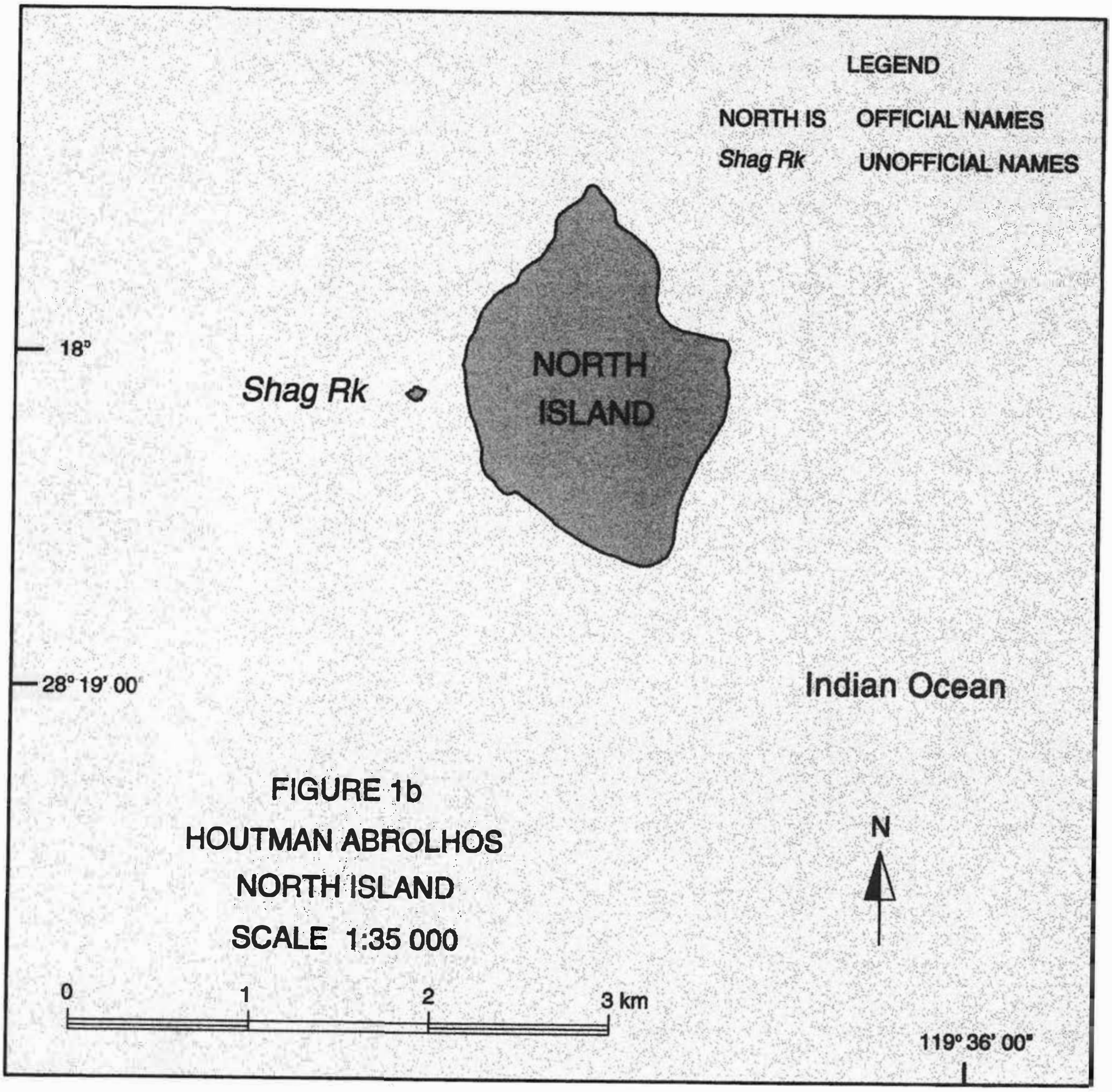

Figure 1b. Map of North Island and "Shag Rock", two islands isolated from the rest of the islands of the Wallabi Group, Houtman Abrolhos.

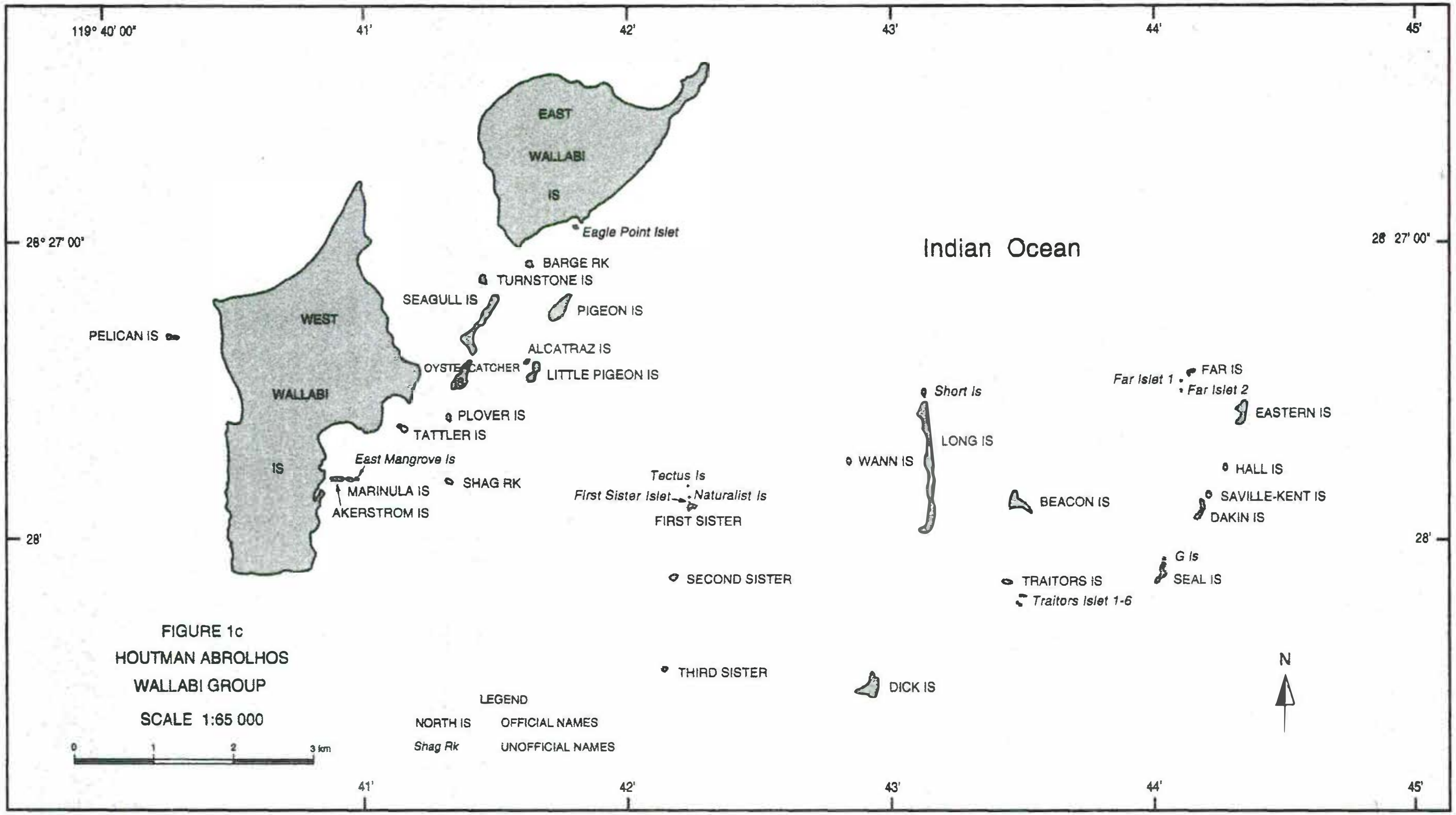

Figure 1c. Map of the Wallabi Group (not including North Island and "Shag Rock"), Houtman Abrolhos.

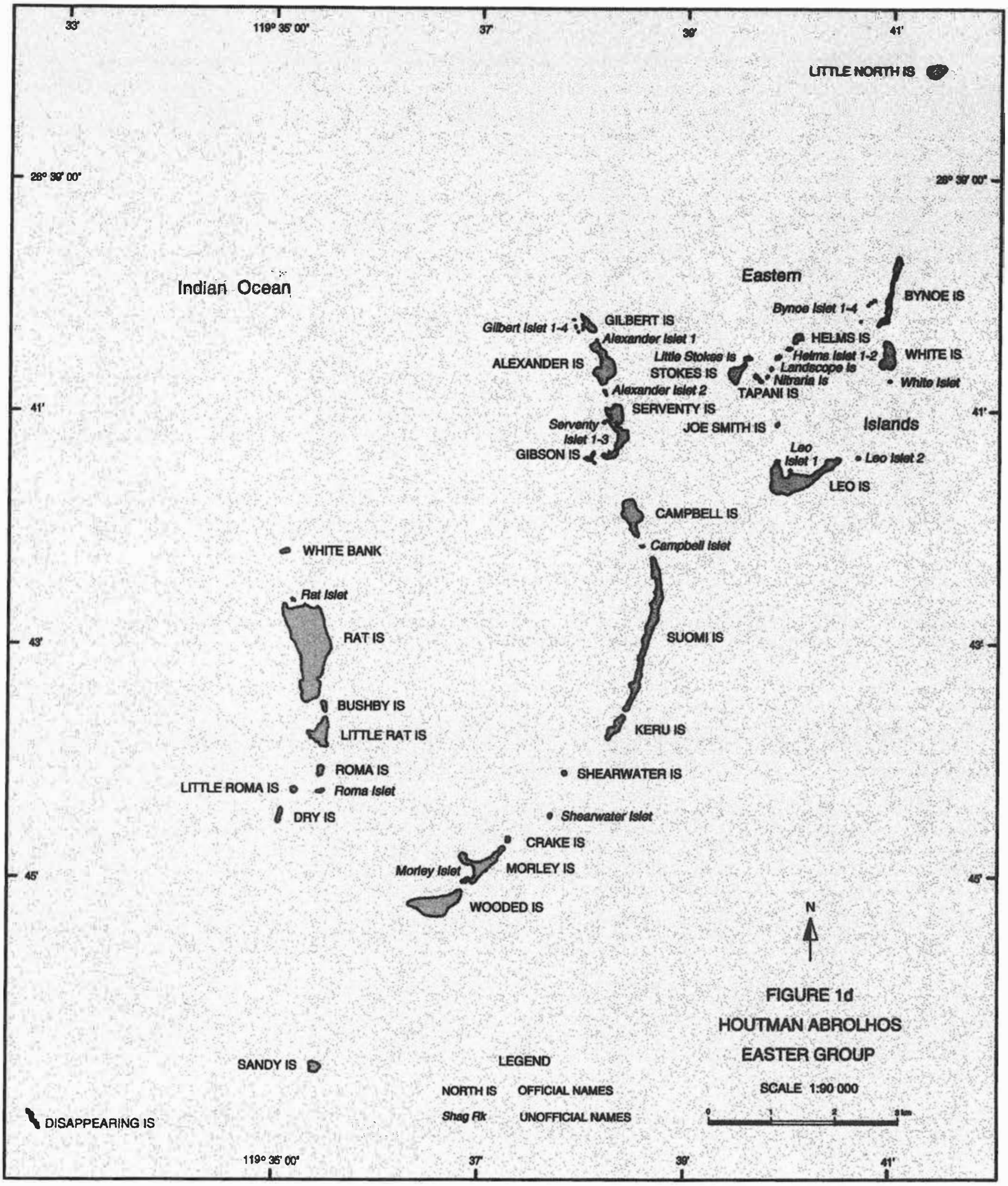

Figure 1d. Map of the Easter Group, Houtman Abrolhos.

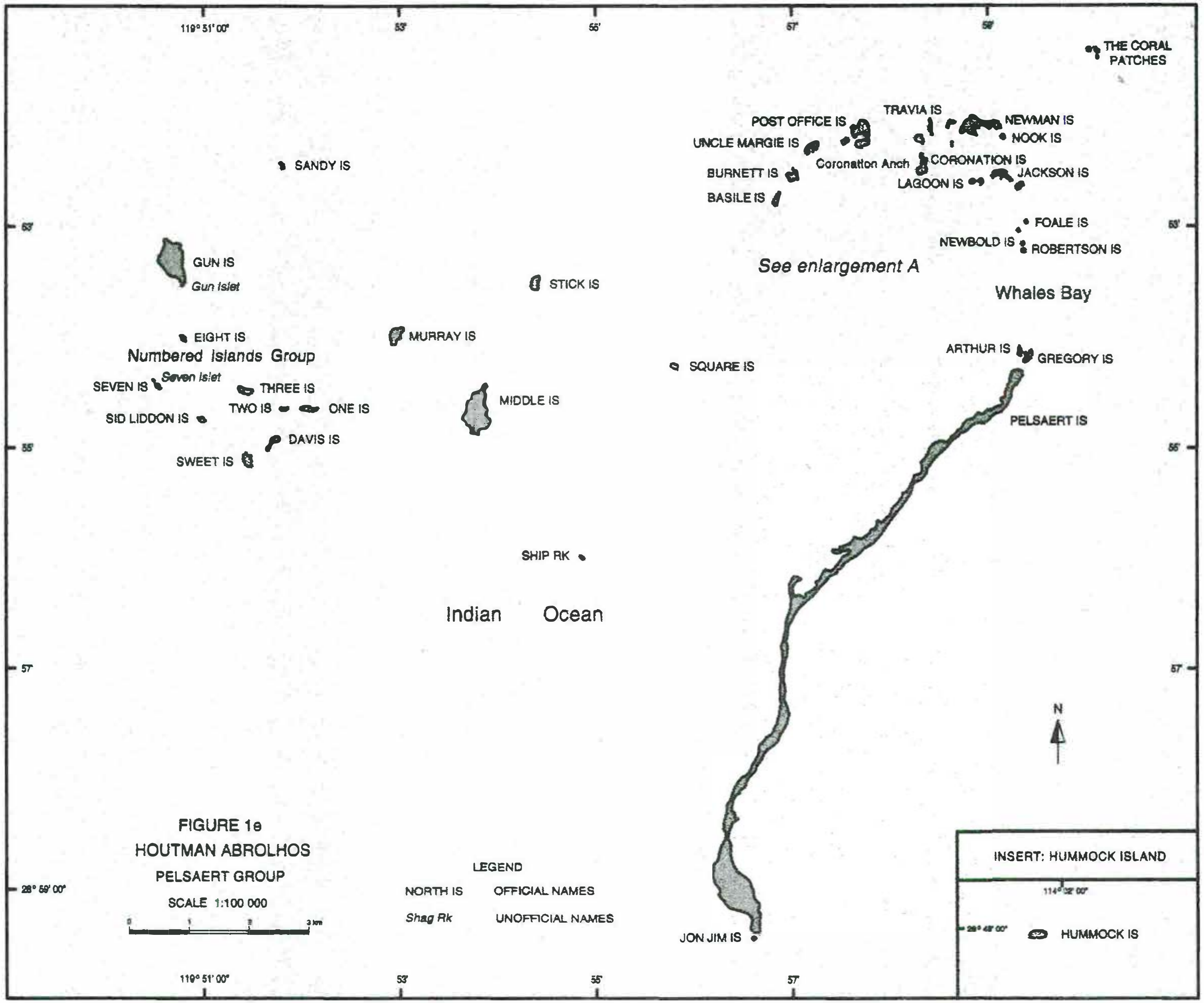

Figure 1e. Map of the Pelsaert Group, Houtman Abrolhos. See Enlargement A (Figure 1f) for more detail. Insert: Hummock Island.

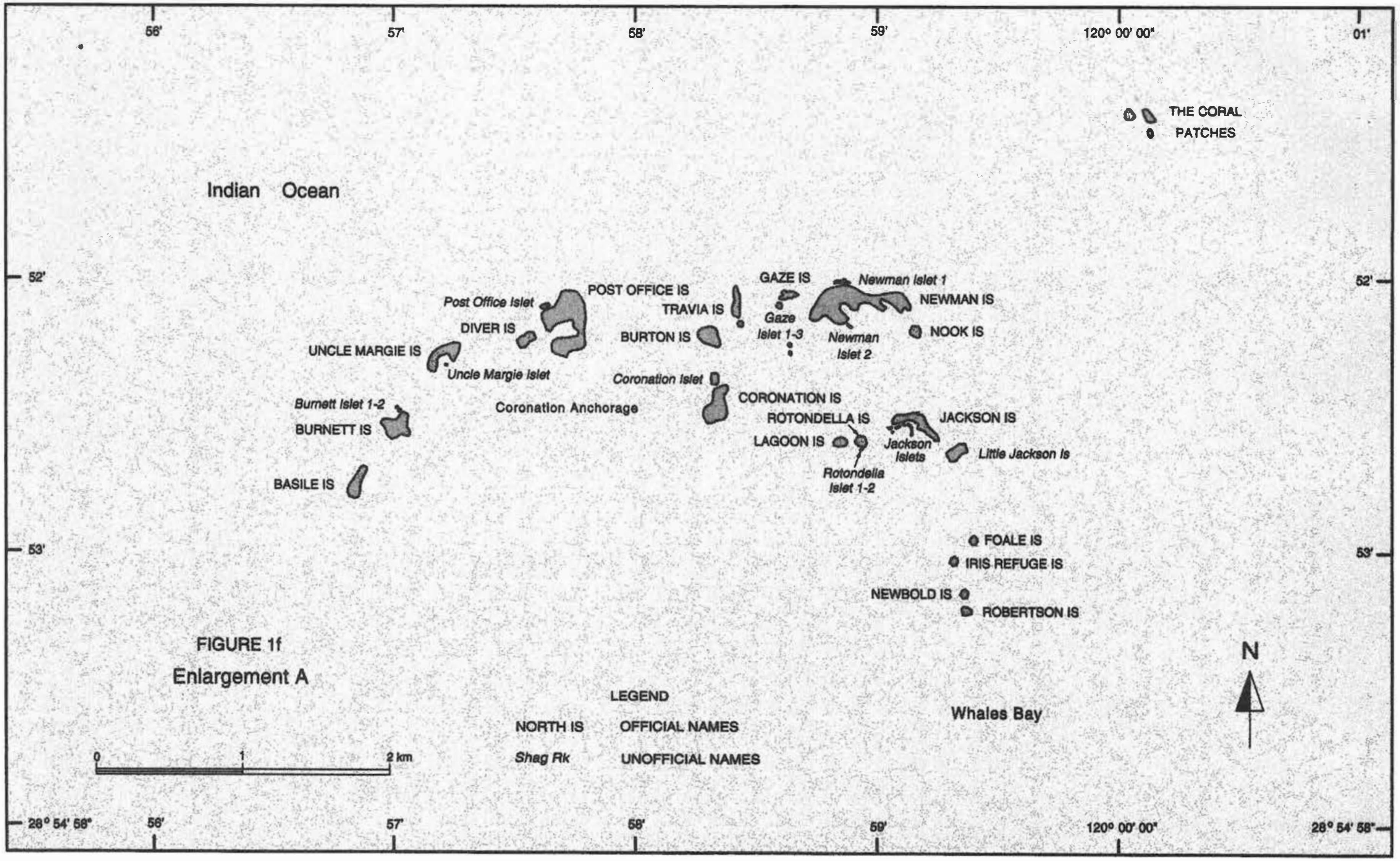

Figure 1f. Enlargement A. More detail of some of the islands of the Pelsaert Group, Houtman Abrolhos.

The geological growth history of the Abrolhos islands and reefs is closely linked to global variations in sea level. Underlying the Abrolhos is a basement of about 900 m of Tertiary and Cretaceous limestone, siltstone and marl. This is overlain by a central platform of Pleistocene reefs laid during the last Interglacial, about 125 000 years ago (Zhu *et al.* 1993), when the sea level was higher than the present level.

About 18 000 years ago, sea levels around Australia were 130 m below present sea level. The sea level rose to 9 m below the present level about 8200 years ago, resulting in the central platforms (North, East and West Wallabi Islands in the Wallabi Group; the Rat Island chain in the Easter Group; Gun, Middle and Murray Islands and the Numbered Islands in the Pelsaert Group) becoming separated from the mainland (Collins *et al.* 1997). The emergent parts of the central platforms formed islands.

Windward and leeward Holocene reefs started to develop around the central platform in each group between 8000 and 10 000 years ago (Collins *et al.* 1993b). The wave-exposed windward reefs consisted mainly of slow-growing coralline algae binding coral rubble and limestone edges together as a solid pavement, whereas fast-growing coral dominated the more protected leeward reefs. The sea level continued to rise, even above its present level, allowing windward and leeward reefs to grow further and a sheet of lagoon sand to develop, derived from sediment transported leeward from the windward reef crest. The sea level dropped to its present level, producing emergent islands, mainly in the central platforms and leeward reefs but not normally in the windward reefs.

Five types of island have been identified at the Abrolhos (France 1985; Collins *et al.* 1997), based on geomorphological features.

1. Æolianite islands consist of a core of reef limestone which has a tabular surface 2 to 3 m above sea level that is overlain by æolianites and unconsolidated dune sands. They are the largest of the Abrolhos islands and are normally a few kilometres across and up to 15 m high. Examples of æolianite islands include East and West Wallabi Islands and North Island.
2. High rock islands are usually about 1 km across and are flat-topped, rocky islands a few metres high. Their coastal morphology is dominated by a well-developed intertidal notch. Their rocky island surfaces, or pavements, are barren or sparsely vegetated depending on the extent to which they have been mined for guano. The central platforms of the Easter and Pelsaert Groups in particular each consist of several high rock islands (e.g. Rat Island, Little Rat Island, Gun Island, Middle Island, Murray Island).
3. Composite islands are often long (up to several kilometres) and narrow (about 0.5 km). They consist of a core of emergent coral reef and cemented, imbricated coral rubble, overlain by elongate coral-shingle ridges that are 1 to 4 m above the present sea level. All islands on the leeward side of the reef in each of the Wallabi, Easter and Pelsaert Groups are of this island type (e.g. the Long Island, Suomi Island and Pelsaert Island chains).
4. Cemented coral-shingle cays are composed of coral shingles, bound and cemented by coralline algae and marine cements. They are similar to composite islands, but are smaller (up to a few tens of metres long) and lack unconsolidated coral-shingle ridges. Examples include the small islets First and Third Sisters, and Gibson Island.
5. Low coral-shingle/sand cays are ovoid to elongate islands of 1–2 m elevation, consisting of coral-shingle ridges and sand. Examples include Hall Island, Stick Island and Easter Group's Sandy Island.

Table 2 (p. 544) lists each island of the Abrolhos and its corresponding island type according to the Collins classification system above. Note, however, that field verification would be necessary to ascertain conclusively the island type for some of the islands, for example, some of the smaller fragments in the Mangrove Group of the Pelsaert group and in the Suomi Island chain.

Hartley Island (former position 28°28'43"S, 113°43'44"E), a sand cay which was located 1.3 km west of First Sister and appears on official maps of the Abrolhos, is no longer above low water mark.

The older, larger æolianite islands with relictual continental surfaces retain a moderately rich vegetation. At the other extreme, the younger low coral-shingle/sand cays have little or no vegetation (Storr *et al.* 1986).

There are over 50 ponds or lagoons on the islands, ranging from small depressions to one that is over 100 m long. Except during major storms, the ponds are separated from the sea, but sea water seeps through the rock shingle into and out of the ponds, thus making the ponds tidal. Some molluscan species absent from the open coast north of Perth are common in the tidal ponds of the Abrolhos islands (Black and Johnson 1997).

Fresh water is found in very limited quantities on the islands.

Size

The islands range in size from West Wallabi (587 ha) down to rocks a few square metres in area. Islands of the Abrolhos generally rise only 3–5 m above the present sea level, but the æolianite islands East and West Wallabi reach elevations of 15 m (Table 1, p. 541).

Climate

The Abrolhos region has a Mediterranean climate, with hot, dry summers and cool, wet winters.

Temperature

The mean air temperature in February ranges from a minimum of 22.2°C to a maximum of 26.5°C; in August it ranges from a minimum of 16.9°C to a maximum of 20.0°C (Bureau of Meterology[2], personal communication).

[2] Bureau of Meteorology, PO Box 1370, West Perth, Western Australia 6872

Rainfall

Rainfall is not recorded at the weather station on the Abrolhos but is estimated to be 500 mm per year (Collins *et al.* 1997).

Wind and Storms

Winds exhibit both seasonal and diurnal patterns and are stronger offshore than on the mainland. The dominant wind direction in summer, winter and spring is SE-SW and in autumn S-SE (Bureau of Meteorology, personal communication). Table 3 shows that in summer 86 per cent of wind speed readings exceed 21 km h^{-1}(11 knots) and 51 per cent exceed 30 km h^{-1} (16 knots).

Storms occur mainly in winter, and tropical cyclones mainly in summer, with an average frequency of one tropical cyclone every 3 years (Steedman 1977). The possibility of wind speeds reaching 165 km h^{-1} occurs once every 50 years, with the possiblity of 176 km h^{-1} winds once every 100 years (Fisheries Western Australia 1998). Calm conditions are rare and occur mainly in winter.

Persistent swell waves with a mean height of 1.2 m impinge on the Abrolhos throughout the year, approaching from the south and west 78 per cent of the time (Steedman 1977). The waves hit hardest on the south-westerly reef margins, forming the high-energy, windward regime of the platforms, whereas significant refracted swell and wind waves impinge on south-east margins, forming medium-energy leeward environments (Collins *et al.* 1996).

TABLE 3

Information derived from the North Island weather station, based on wind speeds recorded 8 times each day (at times 12 a.m., 3 a.m., 6 a.m., 9 a.m., 12 p.m., 3 p.m., 6 p.m., 9 p.m.) between May 1990 and January 1999. Note that Table 3 gives no wind directions.

SEASON	WIND SPEED (km h^{-1})	PERCENTAGE FREQUENCY (%)
SUMMER	calm	1
	1–10	3
	11–20	10
	21–30	35
	>30	51
AUTUMN	calm	1
	1–10	8
	11–20	24
	21–30	41
	>30	26
WINTER	calm	3
	1–10	9
	11–20	26
	21–30	34
	>30	28
SPRING	calm	0
	1–10	4
	11–20	21
	21–30	43
	>30	32

Coral reefs

The Houtman Abrolhos is in the warm temperate zone and has large areas of limestone reef and sand, typical of temperate WA waters. Consequently there are temperate marine plant and animal species present. However, there are also extensive living coral reefs, typical of tropical waters, present on the southern and western sides of each of the three island groups, with broken reefs on the northern margins. The Abrolhos has one of the world's best examples of luxuriant and diverse coral growth at high latitude, and forms the southernmost living coral reef in the Indian Ocean. The coral communities are maintained by the Leeuwin Current, a warm, low-salinity current that flows from near North West Cape down along the continental margin to the west of the Abrolhos reef complex on its way down to Cape Leeuwin and the Great Australian Bight (Cresswell and Golding 1980; Pearce and Cresswell 1985; Cresswell 1991; Pearce 1991). The current is relatively narrow (50–200 km) and shallow (50–200 m). It flows more strongly during the autumn, winter and early spring months (March to September) than in summer. Peak current speeds can exceed 1.5 m s^{-1} (Pearce 1991).

Collins *et al.* (1997) extensively details the coral communities. It is considered that the Houtman Abrolhos reef will prove to be a sensitive indicator of environmental change, as it has developed near the temperature limits for coral growth.

Native Fauna

Birds

Seabird populations of the islands are outstanding in terms of their number and diversity. The Abrolhos is regarded as one of the most important breeding areas for birds in Australia (Fuller and Burbidge 1981; Fuller *et al.* 1994). The breeding birds include some declared rare or priority sea and land species such as the lesser noddy (*Anous tenuirostris melanops*), the Abrolhos painted-button quail (*Turnix varia scintillans*) and the brush bronzewing (*Phaps elegans*). Recent summaries of bird sightings at the islands are in Storr *et al.* (1986) and Fuller *et al.* (1994).

Helms (1902) reported during his 1898 visit 'On the greater number of the level low islands the accumulated droppings of the many birds have formed a valuable guano which now supports a stunted vegetation where the deposit is deep enough to give the plants a foothold.' The effect of large numbers of nesting sea-birds on the vegetation has been documented by Gillham (1960, 1961). Trampling of plants, burrowing among the roots of plants and surface-nesting (leading to a build-up of guano) have over time caused radical changes in the floristic composition of the vegetation on certain islands.

In small concentrations, guano increases the soil fertility and plant growth is improved, stimulated by the additional nitrogen and phosphorus, which are usually deficient in native Western Australian soils; heavy deposition of guano, however, on some islands as deep as 1 m, may cause all plants to be eliminated. Indigenous plants vary considerably in their tolerance of manuring, and few species are able to tolerate a high concentration of guano. The general tendency is for sclerophylls to become replaced by succulents, shrubs by trailing herbs, perennials by annuals and indigenous plants by aliens. Some of the guano-tolerant native species include *Nitraria billardierei* and *Parietaria debilis*, the succulents *Enchylaena tomentosa* and *Carpobrotus virescens* and the exotics *Mesembryanthemum crystallinum*, *Urtica urens*, *Chenopodium murale*, *Stellaria media* and *Sonchus oleraceus*.

When the vegetation changes sufficiently and is unable to recover during the period when the birds are away between breeding seasons, the area may become unsuitable as a nesting habitat and cause an exodus to another site. Given time, plant regeneration in the original area follows the general course of the degeneration in reverse; however, frequently 'recovery' is incomplete, not progressing to the original state but only to a stage sufficiently similar to satisfy the birds' requirements.

Reptiles

Twenty-six species of reptile have been recorded by the Western Australian Museum on the islands (Storr *et al.* 1983), some species occurring just on one island group and some being endemic to the Abrolhos. The Abrolhos dwarf bearded dragon (*Pogona minor minima*) and the Abrolhos spiny-tailed skink (*Egernia stokesii stokesii*), two species endemic to the islands, are priority fauna species (Priority 4).

The Wallabi Group, particularly East and West Wallabi, has been identified as the richest for reptiles, with twenty-two species representing seven families being recorded from this group. Storr *et al.* (1983) notes that although 'the fauna of the Wallabi Islands is continental in diversity it differs considerably from that of any comparable area in the mainland'.

Mammals

Two species of indigenous land mammal have been recorded on the Abrolhos islands. The Wallabi Group obtains its name from the tammar wallaby (*Macropus eugenii*), which has been recorded on East and West Wallabi Islands and North Island (Abbott and Burbidge 1995). The tammar has been declared rare. Tammars graze on grasses and Chenopods, and are reportedly particularly keen on succulents (Fisheries Western Australia 1998). Storr *et al.* (1986) and Abbott and Burbidge (1995) report that tammars, along with rabbits, were deliberately released on North Island as a source of food for storm-bound fishermen in the 1950s, but neither species persisted for long. The tammar was reintroduced to North Island in 1987 (Abbott and Burbidge 1995) and this introduction is successfully established. The bush rat (*Rattus fuscipes*), has been recorded on East and West Wallabi Islands.

There is a significant population of the Australian sea-lion (*Neophoca cinerea*) at the Abrolhos, however, this mammal was formerly more abundant (Storr 1965). The sea-lions use the mangrove areas as nurseries for their young.

Human Disturbance

The islands' position on the western margin of the continental shelf, the surrounding reefs and the frequent heavy seas make the area dangerous for navigation. There have been more than 20 shipwrecks at the Abrolhos (Western Australian Maritime Museum 1993), of which seven have been declared historic, including the famed Dutch ships Batavia (1629) and Zeewijk (1727). Several wells and limestone structures have been constructed on the islands by shipwreck survivors (Stanbury 1991).

Mining of high-grade guano occurred at the Abrolhos on at least 16 islands (see Table 4, p. 548) between 1847 and 1946 (Stanbury 1993). The list in Table 4 may not be comprehensive because lack of surveillance and the remoteness of the islands made it easy for illegal, unrecorded mining by unlicensed vessels to occur (Stanbury 1982). Some of the islands were mined extensively. Guano mining required the removal of vegetation, loose rocks and soil, and the sweeping of the guano into heaps (Helms 1902); often no attempt was made to recreate the original topography of the island. Exotic plant species were inadvertently introduced, mainly via seeds in chaff fed to horses employed by the guano mining industry, and Helms (1902) reported the establishment of plant species such as, most commonly, *Sonchus oleraceus*, but also *Spergula arvensis* and, very extensively on Rat Island, *Chenopodium murale*. The removal of native vegetation cleared the way for the establishment of the more robust weed species, rather than the return of the indigenous species. Buildings, jetties and tramways were constructed for the use of the industry.

Rabbits, cats, black rats, mice and goats were introduced, either deliberately or inadvertently, to several islands (see Table 4, p. 548). Of these, rabbits and goats have been the most destructive to the vegetation, overgrazing it, removing cover for nesting seabirds and causing erosion. Further, rabbits competed with nesting seabirds for burrow sites. The grazing of animals such as sheep to feed employees and provide bait for fishing ventures is reported to have occurred on North Island and Rat Island in the 1940s (Stanbury 1993). By natural causes or with the help of eradication programs, all feral animals, except for the house-mouse on Rat and North Islands, have been eliminated from the Abrolhos (Burbidge[3], personal communication).

In the period between the world wars the main activity in and around the Abrolhos was deep-sea fishing, involving few people and no residence on the islands. A much more damaging activity was the commercial harvesting of seabird eggs (Storr *et al.* 1986). Since World War II, fishing for the western rock lobster has became a major industry, involving hundreds of people and the building of huts, jetties and other installations, occupied during the season (15 March–30 June). It was reported that in August 1997 there were 140 main camps, 222 secondary camps, 4 schools, 3 clubs, a nursing post, a church, 114 jetties, 238 landings or T-piece sections and 43

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dinghy jetties, distributed over twenty-two of the Abrolhos islands (Fisheries Western Australia 1998). The inhabited islands are listed in Table 4 (p. 548). Along with habitation came the introduction of yet more exotic plant species.

The source of introduction of the weed African boxthorn has not been established, but it is known to be a dangerous trap for wildlife, especially nesting birds. Boxthorn is an intricately branched plant, 0.5–2.5 m (sometimes up to 4 m) high and up to 3 m across, with thorns to 15 cm long on the main stem and smaller spines on the branchlets. During the breeding season, young hatchlings become impaled on the thorns, resulting in death (Geraldton Regional College of TAFE Land Management Group and The Fisheries Department, Geraldton 1997). Boxthorn regenerates by seed (spread within and between islands by birds that have eaten the palatable red berries) and by a sucker-like system of tap roots, competing with native flora for the limited growing medium. The Geraldton Regional College of TAFE and the Fisheries Department undertook a program to eradicate African boxthorn from five of the Numbered Islands in the Pelsaert Group (see Table 5, p. 550) in June 1997, and have reported comprehensively on the program, including costings (Geraldton Regional College of TAFE Land Management Group and The Fisheries Department, Geraldton 1997). Since green boxthorn could not be burnt, they transported cut branches back to Geraldton for disposal, sprayed the remaining stems with glyphosate 360, and burnt dead plant material from previous eradication attempts (this dead material, possessing many persistent thorns, is consequently still considered hazardous).

Airstrips have been built on North, East Wallabi and Rat Islands; these were developed and maintained by rock-lobster fishers to provide transportation to and from the islands and for emergency evacuation. Prince and Hopkins reported on the proposal for an airstrip on North Island (File 131/46 Department of Fisheries and Wildlife 1976), and made reference to current and abandoned airstrips on East Wallabi Island:

> The strip on East Wallabi Island is located within an area occupied by a low shrubland vegetation. A considerable depth of soil also appears to have been present initially. The vegetation of this area appears to be a very poor coloniser of disturbed ground however, and the soil most susceptible to wind erosion. These factors, combined with the operator's needs to periodically regrade the surface available in order to continue operations have resulted in the present strip surface now lying well below the level of the soil surface under the adjacent undisturbed shrubland. The central portion of this strip also appears to have now been incised down to the underlying limestone basement. Evidence from the abandoned W.W.II airstrip adjacent to the present strip, and the now disused East-West cross-strip constructed illegally by the present operators show that natural rehabilitation of this area, if the present operations were discontinued, would be extremely slow. At the same time, the present state of this airstrip (established < 10 years) suggests that its future operational life is limited, and it probably does not now conform to A.L.A. (Australian Landing Areas) standards.

Since this time, each airstrip has been resurfaced at least once to facilitate continued use. Since 1993, care has been taken to ensure the gravel brought across from the mainland for resurfacing is dieback-free (Owens[4], personal communication). Sunflowers germinating from seed brought over with the gravel brought over for the 1999 resurfacing were removed.

The Wallabi, Easter and Pelsaert Groups are also serviced by helicopter during the rock-lobster season and a float plane service to the Abrolhos is now available year-round.

Two fires have been recorded on the Abrolhos islands: a large portion of the eastern dunes on North Island was burnt in October 1935 and then again about 1945 (Storr 1960). The vegetation was slow to recover and large blowouts formed; sand from the blowout also blew north-west, smothering dense vegetation at the northern end of the island. In 1913 Dakin had considered the eastern dunes higher than the western (Dakin 1919), but subsequent to the fires and the resulting blowouts, the elevation of the eastern dunes has been severely reduced. Large sparsely-vegetated blowouts are still visible to this day. No doubt vegetation on other islands has been affected in the past by fire, lit by lightning strikes or by early visitors, but there are no records.

In 1997 the Geraldton Regional College of TAFE started a dune stabilization and revegetation program on the North Island blowout area (Lovegrove[5], personal communication). They noted that the blowouts consist of hard calcrete areas, littered with limestone 'pebbles', that remained after the mobile sand blew away. This soil is not conducive to plant growth. Further, erosion has occurred in the area owing to the driving of tractors from the settlement to the airstrip. They erected nylex windbreak fencing and sowed *Spinifex longifolius* and *Scaevola crassifolia* seeds collected from the island. The TAFE college is planning another trip to North Island to monitor the progress of the 1997 work and to do further revegetation.

Previous workers

Although there is a long list of scientists who have studied the Abrolhos, there has been only limited botanical data published from the islands, and most vegetation data have been recorded as part of bird, mammal or general biological surveys.

Stokes (1846), Commander of H.M.S. *Beagle*, conducted a coastal survey in 1840 and provided one of the earliest descriptions of the Abrolhos islands, drawing attention to the existence of guano on the southern end of

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[5] Ian Lovegrove, formerly of Central West College of TAFE, Geraldton, Western Australia 6530

Pelsaert Island. He was followed by Wickham (1841), and then John Gilbert (1843) who visited Pelsaert, East Wallabi, West Wallabi and other islands in January-March 1843 on behalf of John Gould. Gilbert published an account of his trip in a Perth newspaper, most of which was reprinted by Whittell (1942). Gilbert gave a pre-mining account of the vegetation of Pelsaert Island, reporting little vegetation except for a dense thicket (about 0.6 m high) of samphire, three clumps of mangroves, and dried out specimens of *Malva* sp., *Mesembryanthemum* sp. and grasses, dead owing to the visit being in the hot dry summer.

Ornithologist A.J. Campbell (1890, 1900) visited Rat and Pelsaert Islands in December 1889 and published his observations and some of those of G.K. Beddoes (manager of the Rat Island guano works). Commissioner of Fisheries, Saville-Kent (1897) noted the outstanding biological attributes of the islands. C.P. Conigrave (1916) visited the islands in 1897 followed in 1898 by R. Helms (1902) who briefly described the flora. R. Hall (1902) visited the islands in October 1899, and C.G. Gibson (1908) in November 1907.

Professor W.J. Dakin led the Percy Sladen Trust Expedition to the Abrolhos in 1913 and October–November 1915, producing the first detailed account of the islands and their fauna. Dakin (1919) wrote physical descriptions of the islands and also noted that guano workers had made an appreciable impact on the land flora, introducing many plants from the mainland. W.B. Alexander (1922) described the vertebrate fauna collected and observed on the expedition and also lodged plant specimens at the Western Australian Herbarium from North, East Wallabi and Pelsaert Islands.

Between 1936 and 1954, the islands were visited by P.T. Sandland (1937), V.N. Serventy (1943), D.L. Serventy, G.G. Smith, H.E. Tarr (1949), Ealey (1954), and J. Warham (1956). D.L. Serventy and Smith lodged plants at the Western Australian Herbarium.

The University of Western Australia's Zoology Department visited 8 islands of the Wallabi Group in April, June and September 1959 and April 1960, and North Island in September 1959. The resulting data were documented by G.M. Storr (1960, 1965), and include the first comprehensive vegetation descriptions and plant list for any of the islands of the Abrolhos, as well as vertebrate surveys. During the North Island visit, the researchers were accompanied by English botanist Dr Mary E. Gillham who made a collection of botanical specimens, subsequently identified by Mr R.D. Royce at the Western Australian Herbarium.

During the following decade, Aquinas College conducted five expeditions to the Abrolhos islands. The Wallabi Group was surveyed in August 1964 (O'Loughlin 1965), then again in August 1965 (O'Loughlin 1966). The Pelsaert Group were surveyed on the third visit (August 1966) and fourth visit (January 1968), both being documented by O'Loughlin (1969). On the fifth visit, in August 1970, the Easter and Pelsaert Groups were surveyed (Green 1972). Plant lists for 12 islands were published in these reports.

Between 1960 and 1978, further specimens were deposited at the Western Australian Herbarium by R.D. Royce, E.M. Scrymgeour, A.R. Main, N. Sammy, A.M. Ashby, A.S. George, P.G. Wilson and J.W. Green.

Abbott (1980) compiled a comprehensive species list for 19 islands in the Wallabi and Pelsaert Groups, visited in 1975. He compared species compositions on six of the islands with those from previous botanical surveys.

R. Johnstone visited most of the Abrolhos islands in the years 1977–1983. While primarily undertaking avian surveys, he also collected some botanical specimens and vegetation data, especially from Morley, Wooded and West Wallabi Islands (Johnstone 1992; Johnstone and Coate 1992; Johnstone and Storr 1994). Johnstone has made available to us unpublished data from the other islands.

J. Harvey visited Pelsaert Island in April 1984 and collected botanical specimens and mapped major vegetation communities. A CALM-funded project from 1–7 October 1987 again involved Harvey, along with J. Alford, surveying a further 33 islands in all three groups. The result was the most comprehensive botanical survey done on the Abrolhos.

P. Roberts collected plant information from four islands in the Pelsaert Group in 1988, and lodged several specimens collected from Gun and Middle Islands.

Almost every year since 1977, either or both P.J. Fuller and A.A. Burbidge have undertaken bird surveys on one or more islands of the Abrolhos. A.A. Burbidge, P.J. Fuller and R. Owens (Fuller *et al.* 1994) searched for seabird breeding colonies on 110 islands and islets of the Abrolhos in 1991, 1992 and 1993. In this and in their remaining numerous publications (including Fuller and Burbidge 1981, 1989, 1992), they also made brief references to the vegetation in relation to bird habitat, recorded occurrences of the exotic noxious weed African boxthorn and helped in its eradication from some of the islands.

In February 1999 K. Coate led a CALM *LANDSCOPE* expedition to 18 of the lesser-visited islands of the Abrolhos, collecting botanical specimens which were subsequently identified by G. Keighery (Kenneally *et al.* 1999).

In November 1999, CALM again funded an expedition to field-truth partially completed vegetation maps of the islands; J. Harvey and V. Longman visited 50 islands and islets of the Wallabi and Easter Groups. Following on from Harvey and Longman's trip, J. Blyth and P.J. Fuller visited most of the remainder of the islands of the Easter and Pelsaert Groups, making notes about and photographing the vegetation.

Table 6 (p. 551) identifies scientists who have collected botanical information from the Abrolhos and lists the islands they visited. Note that over the years, the names of some of the islands have changed, and some island names have been incorrectly assigned.

Fishery Information

The seas surrounding the Abrolhos are a principal breeding habitat for western rock lobsters (*Panulirus cygnus*, a species endemic to WA) and they support the most productive and valuable rock-lobster fishery in Australia. The Abrolhos yield 15 per cent of the total rock-lobster catch from 3 per cent of the fishing ground in Western Australia. Rock lobster from the Abrolhos alone generates an income annually of around A$45 million (Fisheries Western Australia 1998).

Other commercial fisheries include scallops from the sandy bottom areas in the periphery of the island groups, and droplining and handlining for finfish. In 1994, the scallop fishery was worth $3 million, and in 1995 the finfish fishery was worth $1 million (Fisheries Western Australia 1998).

METHODS

On 1–7 October 1987 Harvey and Alford (CALM) exhaustively surveyed the terrestrial vascular plants of 33 islands of the Houtman Abrolhos, including some of the smaller undocumented islands. The spring visit enabled the recording of annual species. One hundred and twenty-seven voucher specimens were lodged at the Western Australian Herbarium. Note that the accepted international abbreviation for the Western Australian Herbarium is PERTH.

On 17–22 November, 1999 Harvey and Longman (CALM) photographed and surveyed vegetation on 44 islands and islets of the Wallabi Group and six of the Easter Group (Bushby Island, Leo Island, "Leo Islet 1", "Little Rat Island", Rat Island and Roma Island). Flora specimens were opportunistically collected, resulting in 155 specimens being deposited at the Western Australian Herbarium. Blyth and Fuller, during the course of their bird survey (23–30 November) took photos and noted vegetation details for 29 further islands and islets of the Easter Group and 39 islands of the Pelsaert Group.

While on the islands, elevation was estimated (Table1, p. 541), landform and soil substrate were recorded (Table 2, p. 544), vegetation was described and any disturbance related to human activity was noted (Table 4, p. 548). Later, island sizes were calculated from aerial photographs (Table 1). Note that in all resulting tables, as well as information derived from the 1987 and 1999 field trips, data from published and other unpublished sources are also included, and referenced.

Maps of the islands (Figs 2–69, pp. 584–623) were derived from colour aerial photographs. The 1:4000 photographs were commissioned by the Fisheries Department and flown by Kevron Aerial Surveys Pty Ltd (Film KC398) on 11 September 1987; the 1:25 000 photographs were commissioned by CALM and flown by Department of Lands and Surveys (Project No. 870079) on 17 September 1987. Island outlines have been developed to be as accurate as is possible from the aerial photographs, but note that there is always a slight inherent inaccuracy in aerial photography.

Vegetation mapping used Harvey and Alford's 1987 results and Harvey and Longman's 1999 results, as well as those of other published and unpublished works. Mapping was based on the classification used by Beard (1981), which employs three characteristics, or diagnostic features: (1) nature and height of the dominant stratum, or of other strata if of diagnostic importance; (2) density of strata referred to in (1) above; and (3) dominant or diagnostic plant species. The classification resulting from the application of the first two diagnostic features can be represented in tabular form (Table 7). Dominant plant species are coded (Table 8, p. 557).

From Figures 8 and 25, it can be seen x_3 on West Wallabi differs from x_1 on East Wallabi by the former also having *Beyeria viscosa*, *Olearia axillaris*, and *Westringia dampieri* on the limestone pavement.

Vegetation information is more complete and/or reliable for some islands than others varying with availability of vegetation information. The accuracy of the vegetation mapping for each island is indicated on Table 9 (p. 558) by the numbers 1–6 (see Table 10, p. 534), with 6 being the most accurate.

RESULTS

The flora list (Table 11, p. 559) reports the results from the Harvey-Alford, the Harvey-Longman survey and from other published and unpublished sources; Table 12 (p. 574) outlines the sources of the data. The flora was found to comprise 239 species from a total of 68 families; this includes 144 native species from 55 families, and 95 introduced species from 29 families. For the purposes of quantifying species, a species is defined here as a taxon, as appearing in Table 11. A further 6 species were recorded from the Abrolhos, but collection location details are insufficient to be able to determine exactly from which island the plants were collected (see Table 13, p. 576). Note that although collections, often opportunistic, of mosses, liverworts, lichens and seagrasses have been made in the past on the Abrolhos, only terrestrial vascular plants are covered in Table 11.

Where possible, taxonomic changes (according to CALM's FloraBase) and corrected identifications have been incorporated, but this has been limited at times owing to the unavailability of voucher specimens. General taxonomic queries for some genera, e.g. *Carpobrotus* spp., are as yet unresolved. Unless collection was made of *Atriplex* and some *Rhagodia* specimens, it was found to be difficult to assign a species name to these chenopods owing to quite involved taxonomy, hence the use of *Atriplex* sp. and *Rhagodia* sp. in Table 11.

Table 14 (p. 578) is a guide to changes and corrections to plant names encountered in the literature during compilation of the species list.

The island on which the most plant species have been recorded is East Wallabi Island with 124 species, followed by another high rock island with extensive limestone pavement and consolidated dunes, West Wallabi, with 97 species (see Table 15, p. 580). Fifty-four plant species have been found on islands in all three groups of the Abrolhos (see Table 16, p. 583).

TABLE 7
The classification scheme used for vegetation mapping in Figures 2–69 (pp. 584–623)

	CANOPY COVER				
Life Form/ Height Class	**d**: Dense canopy. Projective foliage cover >70%	**c**: Mid-dense canopy. Projective foliage cover 30–70%	**i**: Incomplete canopy. Projective foliage cover 10–30%	**r**: Sparse canopy. Projective foliage cover ≤10%	**p**: Very sparse canopy. Projective foliage cover 0%
L: Low trees <10 m tall	Ld: Dense low forest	Lc: Low forest	Li: Low woodland	Lr: Open low woodland	Lp: Sparse low woodland
S: Shrubs >1 m tall	Sd: Dense thicket	Sc: Thicket	Si: Scrub	Sr: Open scrub	Sp: Sparse scrub
Z: Dwarf shrubs <1 m tall	Zd: Dense heath	Zc: Heath	Zi: Dwarf scrub	Zr: Open dwarf scrub	Zp: Sparse dwarf scrub
G: Bunch grasses, sedges	Gd: Dense grassland	Gc: Mid-dense grassland	Gi: Grassland	Gr: Open grassland	Gp: Sparse grassland
F: Forbs	Fd: Dense herbfield	Fc: Mid-dense herbfield	Fi: Herbfield	Fr: Open herbfield	Fp: Sparse herbfield
C: Succulents		Cc: Closed succulent mat	Ci: Succulent mat	Cr: Open succulent mat	Cp: Sparse succulent mat

TABLE 10
Accuracy codes for vegetation mapping of Figures 2–69 (pp. 584–623)

CODE	ACCURACY DESCRIPTION
1	Interpretation of aerial photograph (stereo pairs and/or large scale) only.
2	Interpretation of aerial photograph, limited species lists and limited notes.
3	Interpretation of aerial photographs, species lists and detailed written descriptions.
4	Interpretation of aerial photographs, species lists, written descriptions, mud maps and some photos. No field verification.
5	Interpretation of aerial photographs, species lists, written descriptions, mud maps, some photos. Some field verification.
6	Comprehensive field verification by Harvey and Longman.

The plant species with the widest distribution over the islands of the Abrolhos include *Nitraria billardierei* (found to occur on 106 of the 119 islands for which we have species lists), followed by *Atriplex cinerea* (70 islands), **Mesembryanthemum crystallinum* (88 islands), *Threlkeldia diffusa* (72 islands), *Myoporum insulare* (66 islands), *Carpobrotus virescens* (61 islands), *Senecio lautus* (56 islands), and *Enchylaena tomentosa* and **Sonchus oleraceus* (both 54 islands). On the other hand, species such as *Eucalyptus oraria* and *Acacia didyma* have very restricted distribution, each occurring only on East Wallabi Island.

In 1987 Harvey and Alford recorded 29 species never before recorded on the Abrolhos (Table 17), including 15 natives and 14 exotics. Kevin Coate found a new exotic, **Cerastium glomeratum*, on Three and Eight Islands in February 1999 (Kenneally *et al.* 1999).

Seventeen plant species were newly recorded on the Abrolhos by Harvey and Longman in 1999 (Table 18) and the priority taxon *Lepidium puberulum* was recorded from yet another island (First Sister).

The noxious weed African boxthorn (**Lycium ferocissimum*) has been recorded on 11 islands in the Easter and Pelsaert Groups (see Table 5, p. 550). It has not been recorded from the Wallabi Group.

In general, the areas bordering airstrips were found to be very weedy, and specimens of **Echium plantagineum* (Paterson's curse) were recorded on East Wallabi Island during the 1999 survey.

Among other weeds noted by Harvey and Longman on the islands in 1999 were **Ipomoea cairica* (morning glory) on Little Rat Island, **Euphorbia terracina* (Geraldton carnation weed) on Little Rat and Rat Islands, **Opuntia stricta* (prickly pear) on Rat Island, **Bryophyllum* sp. (mother-of-millions) on Pigeon and Rat Islands, and fields of **Urospermum picroides* on islands such as Long Island.

In most cases, islands which presently or in the past have had settlements have a larger component of weeds in their vegetation than the islands which have had minimal human disturbance (Table 15, p. 580).

TABLE 17
New records found on the Houtman Abrolhos by Harvey and Alford in 1987.

	PLANT NAME	OCCURRENCE IN WALLABI (W), EASTER (E) OR PELSAERT (P) GROUPS		
	Angianthus tomentosus	W		
*	*Bromus japonicus* var. *vestitus*	W		
*	*Bromus rubens*			P
*	*Centaurium maritimum*	W		
	Chthonocephalus tomentellus	W		
	Crassula exserta	W	E	
	Euphorbia boophtona	W		
	Gnaphalium indutum	W	E	
*	*Hypochaeris glabra*			P
	Lavatera cretica		E	
	Lepidium lyratogynum	W	E	
*	*Lolium multiflorum*	W		
*	*Lolium perenne*	W		P
	Opercularia vaginata	W		
*	*Parapholis incurva*		E	P
	Parietaria cardiostegia	W	E	P
	Phyllangium paradoxum	W		
	Ptilotus gaudichaudii	W	E	
*	*Raphanus sativus*		E	P
	Sesuvium portulacastrum		E	
	Sida spodochroma	W		
*	*Silene gallica*		E	
*	*Silene nocturna*		E	
*	*Solanum laciniatum*	W		
*	*Sonchus tenerrimus*		E	P
*	*Tamarix* sp.	W		
	Triglochin centrocarpum	W		
	Tripterococcus brunonis	W		
*	*Ursinia anthemoides*		E	P

It must be noted that the plant species lists and the vegetation maps for some islands are not necessarily complete but will serve as a base for future surveys.

DISCUSSION

Flora

All native terrestrial flora at the Abrolhos islands is protected under the *Wildlife Conservation Act 1950*. The flora of the Abrolhos is typical of the coastal flora of the adjacent mainland, with the addition of mangrove (*Avicennia marina*) communities and salt lake and saltbush flats.

Table 19 lists the five species of flora found on the islands which are included in CALM's 'priority flora' list (Atkins 1998).

Juncus bufonius is often considered a weed, but the North Island form (Storr, sn.) is thought to be an endemic subspecies. Taxonomic queries for this species have not been fully resolved as yet.

TABLE 18
New records found on the Houtman Abrolhos by Harvey and Longman in 1999.

	PLANT NAME	OCCURRENCE IN WALLABI (W), EASTER (E) OR PELSAERT (P) GROUPS		
*	*Aloe* sp.	W		
	Atriplex vesicaria ssp. *vesicaria*	W		
*	*Bryophyllum* sp.	W	E	
*	*Centaurium erythraea*		E	
*	*Chenopodium album*		E	
	Dodonaea viscosa	W		
*	*Echium plantagineum*	W		
	Eremophila deserti	W		
*	*Hymenolobus procumbens*	W		
*	*Ipomoea cairica*		E	
	Isolepis nodosa	W		
*	*Orobanche minor*	W		
*	*Pennisetum clandestinum*		E	
*	*Phleum pratensis*			P
*	*Plantago coronopus*		E	
	Rhagodia preissii ssp. *obovata*		E	
*	*Spergularia diandra*			P

Vegetation communities of special conservation interest

The vegetation of the Abrolhos islands consists of a number of communities which are of special conservation interest. These are:

1. Mangrove community

The 'mangal', or mangrove community *Avicennia marina*, only occurs south of the Abrolhos in WA at Bunbury. It requires a specific environment with a warm climate, protected shores, saltwater and some degree of tidal inundation; in places, mangroves occur in land-locked, yet tidal, lagoons. Mangroves protect the shoreline from storm damage and erosion and the twisted white-barked trees provide an aesthetic highlight in the harsh Abrolhos landscape.

The mangal is highly productive in terms of nutrients and the various life forms which it supports. Decomposing plant debris feed algae and plankton which in turn feed molluscs, crustaceans and fish. The mangrove community in the Abrolhos provides an ideal breeding habitat for fish, the Australian sea-lion and several bird species. The Lesser Noddy nests in mangroves on Wooded, Morley and Pelsaert Islands; the Pied Cormorant and Little Pied Cormorant have been recorded nesting in mangroves on Wooded Island; and Eastern Reef Egret and White-bellied Sea-Eagle nests have been recorded hidden in mangroves (Fuller *et al.* 1994). In 1987, Alford and Harvey observed a sea-lion mother suckling some very young sea-lion cubs in mangal in a protected gully on Serventy Island.

TABLE 19

Priority flora found on the Abrolhos islands. Conservation codes are defined as follows, according to the 1998 Declared Rare and Priority Flora List. Priority 2 – Poorly Known Taxa: taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey. Priority 3 – Poorly Known Taxa: taxa which are known from several populations (generally >5), and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations, or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey. Priority 4 – Rare Taxa: taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5–10 years.

PRIORITY FLORA	PRIORITY	ISLAND	OTHER POPULATIONS
Acacia didyma	3	East Wallabi Island (W)	Dirk Hartog Island, Tamala Station
Calocephalus aervoides	3	East Wallabi Island (W), West Wallabi Island (W)	Port Gregory, Dorre Island, Balladonia
Chthonocephalus tomentellus	2	West Wallabi Island (W)	Shark Bay, Denham
Galium migrans	3	East Wallabi Island (W)	Eucla, Caiguna, Cape Leeuwin, Margaret River, Cape LeGrand National Park, Eastern States
Lepidium puberulum	4	Alexander Island (E), Bynoe Island (E),Campbell Island (E), Eastern Island (W), First Sister (W), Gilbert Island (E), Keru Island (E), Leo Island (E), Little North Island (E), Morley Island (E), Serventy Island (E), White Island (E)	Rottnest Island, Dorre Island, Boullanger Island, Garden Island, Zuytorp Cliffs, Dirk Hartog Island

The intense chemical and biological activities in mangroves involving living and non-living components of the ecosystem cause them to act as sinks which concentrate pollutants. Threats to the mangal include direct clearing, landfill, oil spills and dumping of rubbish and sewage. The small communities around land-locked lagoons, e.g. on Uncle Margie Island, may become important refuges in the event of an oil spill. Currently the dumping of untreated human sewage sludge from occupied islands directly into the sea is allowed under the *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972* (Fisheries Western Australia 1998); however, there are concerns that consequent nutrient enrichment could affect the mangal.

The 33 islands of the Abrolhos with mangal are listed in Table 20, and since shacks and jetties built in or near mangal may have an adverse effect on the health of the mangrove, those islands also with occupied buildings are indicated.

Plastic, glass and metal rubbish from boats and nearby inhabited islands (Rat, Little Rat, Bushby and Roma Islands) was found in the mangal by Alford and Harvey in 1987. This could affect the health and reproduction of the mangroves. Similarly, rubbish originating from Pigeon, Little Pigeon and Alcatraz Islands, in the Wallabi Group, could pollute the mangal on adjacent islands (Oystercatcher, Tattler and Akerstrom Islands).

2. Atriplex cinerea *dwarf shrubland*

Atriplex cinerea dwarf shrubland occurs as a pure stand as well as with other species on sandy or shellgrit soils. Where the soil is deep enough under the *Atriplex*, it is suitable for burrowing seabirds (e.g. shearwaters and petrels) to build nests. These breeding areas occur throughout the Abrolhos (Storr *et al.* 1986), the largest colonies being on West Wallabi Island and Pelsaert Island (Fuller *et al.* 1994), and are easily disturbed by humans walking through such areas.

3. Pavement limestone, dunes and consolidated dunes on North Island and East and West Wallabi Islands

Vegetation on East and West Wallabi Islands and on North Island is relict, rich and diverse, but easily disturbed and having a slow rate of regeneration. The sandy beaches and dunes are easily eroded after disturbance, such as fire, owing to their unstable nature and exposure to prevailing winds. For example, Turtle Beach on East Wallabi Island receives the full force of the north-westerly storms. As is

TABLE 20
Islands with mangal. Presence of occupied buildings is also indicated.

ISLAND GROUP	ISLAND WITH MANGAL	PRESENCE OF OCCUPIED BUILDINGS
WALLABI GROUP	Akerstrom Island	
	"East Mangrove Island"	
	Marinula Island	
	Oystercatcher Island	
	Seagull Island	
	Tattler Island	
	Turnstone Island	
	West Wallabi Island	✓
EASTER GROUP	Alexander Island	
	Campbell Island	
	Keru Island	
	Little Rat Island	✓
	"Little Stokes Island"	
	Morley Island	
	Serventy Island	
	Suomi Island	
	Wooded Island	
PELSAERT GROUP	Basile Island	✓
	Burnett Island	✓
	Burton Island	
	Coronation Island	✓
	"Coronation Islet"	
	Diver Island	
	Gaze Island	
	Iris Refuge Island	
	Jackson Island	✓
	"Little Jackson Island"	
	Newman Island	✓
	Pelsaert Island	
	Post Office Island	✓
	Robertson Island	✓
	Travia Island	
	Uncle Margie Island	✓

shown by the slow rate of regeneration on the old airstrips, the consolidated dunes are also a fragile ecosystem. Degraded yet still flora-rich pavement limestone communities occur on the often highly-settled islands adjacent to the Wallabi Islands, e.g. Pigeon Island.

4. Eucalyptus oraria *on East Wallabi Island*

Of particular interest is East Wallabi Island's unusual grove of *Eucalyptus oraria*. There are no eucalypts occurring on any other islands off the coast of WA south of Dirk Hartog Island and west of Albany.

5. Salt lake and saltbush flats on islands such as North and West Wallabi

The salt lake and low saltbush flats on North Island and West Wallabi Island do not occur extensively elsewhere on the Abrolhos islands. Indeed, salt lake communities are rarities on offshore islands in south-western Australia.

The large patch of very old and woody *Halosarcia* shrubs on Leo Island (Fig. 35, p. 603) is unique in the Abrolhos.

Threats to the flora of the Abrolhos islands and conservation recommendations

The main threats to the flora and vegetation of the Abrolhos islands are associated with disturbance, either natural (fire, disease) or, more likely, human activities. Threats include weed infestation, clearing, landfill, fire, trampling by tourists and by fishers when resident on the islands, grazing by feral animals, oil spillage, rubbish and sewage pollution and rises in sea-level.

Exotic plants, chiefly winter annuals, continue to be inadvertently introduced to the islands. Seeds are transported from the mainland in cargo and on shoes of sea and air visitors, and subsequently can be easily spread from one island to another.

Strategies are required for the eradication or control of introduced flora, and to prevent the introduction and spread of any additional species. The weeds, especially ephemerals that dry off in summer, have the potential to become a fire hazard; human occupation of the islands and increased tourist visitation in the summer would increase the risk of fires. Tourist visits should be restricted to daylight hours and access confined to designated tracks, especially on East and West Wallabi Islands, and North and Middle Islands. Gravel for resurfacing the airstrips should be not only *Phytophthora*-free but also seed-free. Airstrips should be monitored regularly to prevent spread of any new weeds, especially Paterson's curse. Fishers and their families should be encouraged not to introduce any new exotic species that has the potential to become a weed; weeds such as **Bryophyllum* (mother of millions) are introduced to the islands as ornamental garden plants but can escape and have the potential to lead to monospecific stands, excluding native species (Longman *et al.* 2000).

Some weeds bear sticky fruit that cause problems when caught in birds' plumage. It is important that ongoing eradication programs for the spiny African boxthorn take place on the islands as reintroduction from the mainland will undoubtedly continually occur.

To minimize disturbance to sensitive flora and fauna, visitors should not enter mangrove, *Atriplex* and Leo Island's *Halosarcia* areas; it would further be advisable to consider restrictions on access to salt lakes and low saltbush flats.

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TABLE 1

Geographical information for the islands of the Houtman Abrolhos.

There are 30 officially-named islands in the Wallabi Group (including North Island), 28 in the Easter Group, and 51 (including the 13 islets of The Coral Patches) in the Pelsaert Group. Table 1 also lists 64 islands with unofficial names (in quotation marks) – 16 in the Wallabi Group, 26 in the Easter Group and 22 in the Pelsaert Group. Latitude and longitude for officially-named islands were provided by DOLA; co-ordinates for unofficially-named islands are from other sources (e.g. maps, GPS in the case of Coate). Island latitude, longitude, AMG E and AMG N are based on Australian Geodetic Datum 1966, and accuracy of latitudes and longitudes is to the nearest 10 seconds. Areas and isolations were calculated from aerial photographs. The isolation of each island is the distance to the nearest of the other islands. Elevations were recorded in the field by Harvey, Alford and Longman, and also are taken from Abbott (1980), Collins *et al.* (1997), DOLA map (Job No. 920291), Kenneally *et al.* (1999) and Stanbury and Brown (1979, 2nd edn 1992). Note that there are two Sandy Islands (one in Easter Group and another in Pelsaert Group), and two islands called Shag Rock in the Wallabi Group (only one is officially named). Gibson Island and "Coronation Islet" are actually each composed of three islets (see Figs 31 and 48, pp. 600, 611), and Tapani and Travia Islands (Figs 32 and 52, pp. 601, 614) are each composed of 2 islets.

ISLAND NAME	LATITUDE (south)	LONGITUDE (east)	AMG E	AMG N	AREA (ha)	MAXIMUM ELEVATION A.S.L. (m)	ISOLATION
WALLABI GROUP							
Akerstrom Island	28°28'31"	113°41'52"	764140	6847140	1.1	2	30 m to Marinula Island
Alcatraz Island	28°27'44"	113°43'19"	766550	6848560	0.1	2	50 m to Little Pigeon Island
Barge Rock	28°27'03"	113°43'18"	766550	6849800	0.2	2	250 m to East Wallabi Island
Beacon Island	28°28'36"	113°47'03"	772600	6846800	3.1	2	770 m to Traitors Island
Dakin Island	28°28'38"	113°48'26"	774850	6846700	0.8	1	50 m to Saville-Kent Island
Dick Island	28°29'52"	113°45'57"	770750	6844500	3.5	2	1.7 km to Long Island
"Eagle Point Islet"	28°27'48"	113°44'39"	767120	6850270	0.1	2	70 m to East Wallabi Island
Eastern Island	28°27'56"	113°48'43"	775350	6847975	2.4	3	600 m to Hall Island
"East Mangrove Island"	28°28'32"	113°42'01"	764400	6847130	0.1	2	30 m to Marinula Island
East Wallabi Island	28°26'24"	113°43'34"	767000	6851000	321	15	70 m to "Eagle Point Islet"
Far Island	28°27'41"	113°48'20"	774750	6848450	0.1	2	100 m to "Far Islet 1"
"Far Islet 1"	28°27'45"	113°48'16"	774630	6848330	0.02	2	90 m to "Far Islet 2"
"Far Islet 2"	28°27'49"	113°46'16"	774630	6848210	0.04	2	90 m to "Far Islet 1"
First Sister	28°28'40"	113°44'34"	768540	6846770	0.5	2	20 m to "First Sister Islet"
"First Sister Islet"	28°28'38"	113°44'33"	768530	6846840	0.01	1	20 m to First Sister
"G Island"	28°28'56"	113°48'13"	774420	6846140	0.1	2	40 m to Seal Island
Hall Island	28°28'19"	113°48'37"	775180	6847275	0.1	1	230 m to Saville-Kent Island
Little Pigeon Island	28°27'50"	113°43'21"	766600	6848350	1.6	3	50 m to Alcatraz Island
Long Island	28°28'21"	113°46'22"	771500	6847300	11	2	70 m to "Short Island"
Marinula Island	28°28'32"	113°41'58"	764310	6847130	0.2	2	30 m to Akerstrom Island
"Naturalist Island"	28°28'36"	113°44'33"	768520	6846910	0.03	2	60 m to "First Sister Islet"
North Island	28°18'10"	113°35'42"	754500	6866500	181	15	18 km to East and West Wallabi Islands
Oystercatcher Island	28°27'49"	113°42'48"	765700	6848400	4.6	2	20 m to Seagull Island
Pelican Island	28°27'37"	113°40'35"	762100	6848875	0.3	3	520 m to West Wallabi Island
Pigeon Island	28°27'19"	113°43'35"	767000	6849300	4.3	3	500 m to Little Pigeon Island
Plover Island	28°28'06"	113°42'44"	765590	6847880	0.3	2	320 m to Oystercatcher Island
Saville-Kent Island	28°27'57"	113°48'28"	774950	6847950	0.4	1	50 m to Dakin Island
Seagull Island	28°27'30"	113°42'53"	765850	6849000	7.7	2	20 m to Oystercatcher Island
Seal Island	28°29'02"	113°48'08"	774350	6845975	0.9	2	40 m to "G Island"
Second Sister	28°29'09"	113°44'26"	768310	6845900	0.1	2	760 m to First Sister
Shag Rock	28°28'33"	113°42'44"	765550	6847075	0.1	3	700 m to Plover Island
"Shag Rock"	28°18'05"	113°35'03"	753430	6866660	0.02	2	230 m to North Island
"Short Island"	28°27'52"	113°46'19"	771430	6848190	0.1	1	70 m to Long Island
Tattler Island	28°28'11"	113°42'23"	765000	6847750	0.7	2	180 m to West Wallabi Island
"Tectus Island"	28°28'31"	113°44'32"	768500	6847050	0.03	2	130 m to "Naturalist Island"
Third Sister	28°29'47"	113°44'24"	768240	6844710	0.2	3	1.1 km to Second Sister
Traitors Island	28°29'07"	113°46'58"	772450	6845850	0.1	2	190 m to "Traitors Islet 4"
"Traitors Islet 1"	28°29'17"	113°47'05"	772620	6845550	0.04	2	4 m to "Traitors Islet 2"
"Traitors Islet 2"	28°29'16"	113°47'04"	772610	6845570	0.01	2	4 m to "Traitors Islet 1"
"Traitors Islet 3"	28°29'16"	113°47'03"	772590	6845580	0.01	2	10 m to "Traitors Islet 2"
"Traitors Islet 4"	28°29'13"	113°47'05"	772630	6845670	0.01	2	10 m to "Traitors Islet 5"
"Traitors Islet 5"	28°29'13"	113°47'07"	772680	6845660	0.04	2	4 m to "Traitors Islet 6"
"Traitors Islet 6"	28°29'13"	113°47'07"	772680	6845650	0.003	2	4 m to "Traitors Islet 5"
Turnstone Island	28°27'10"	113°42'58"	766000	6849600	1.4	2	140 m to Seagull Island
Wann Island	28°28'20"	113°45'46"	770510	6847350	0.1	2	900 m to Long Island
West Wallabi Island	28°28'04"	113°41'13"	763100	6848000	587	15	70 m to Akerstrom Island

TABLE 1(continued)

ISLAND NAME	LATITUDE (south)	LONGITUDE (east)	AMG E	AMG N	AREA (ha)	MAXIMUM ELEVATION A.S.L. (m)	ISOLATION
EASTER GROUP							
Alexander Island	28°40'27"	113°49'45"	776500	6824800	12.2	3	20 m to "Alexander Islet 1"
"Alexander Islet 1"	28°40'15"	113°49'41"	776400	6825170	0.1		20 m to Alexander Island
"Alexander Islet 2"	28°40'42"	113°49'47"	776540	6824340	0.4		90 m to Alexander Island
Bushby Island	28°43'26"	113°47'08"	772100	6819400	0.7	2	60 m to Little Rat Island
Bynoe Island	28°39'55"	113°52'32"	781050	6825700	5.5	2	160 m to "Bynoe Islet 1"
"Bynoe Islet 1"	28°39'51"	113°52'23"	780820	6825810	0.02		30 m to "Bynoe Islet 2"
"Bynoe Islet 2"	28°39'52"	113°52'21"	780760	6825780	0.02		30 m to "Bynoe Islet 1"
"Bynoe Islet 3"	28°39'54"	113°52'19"	780710	6825730	0.01		40 m to "Bynoe Islet 2"
"Bynoe Islet 4"	28°40'02"	113°52'15"	780590	6825470	0.01		260 m to "Bynoe Islet 3"
Campbell Island	28°41'45"	113°50'06"	777000	6822400	9.0	2	150 m to "Campbell Islet"
"Campbell Islet"	28°42'01"	113°50'11"	777140	6821900	0.1		150 m to Campbell Island
Crake Island	28°44'32"	113°48'58"	775040	6817280	0.5	3	40 m to Morley Island
Disappearing Island	28°47'04"	113°44'24"	767500	6812800	0.8		4.2 km to Sandy Island
Dry Island	28°44'23"	113°46'44"	771400	6817650	1.5	3	330 m to Little Roma Island
Gibson Island	28°41'14"	113°49'41"	776340	6823360	0.6		120 m to Serventy Island
Gilbert Island	28°40'06"	113°49'35"	776250	6825450	2.4	3	40 m to "Gilbert Islet 4"
"Gilbert Islet 1"	28°40'05"	113°49'28"	776040	6825490	0.1		80 m to "Gilbert Islet 2"
"Gilbert Islet 2"	28°40'08"	113°49'28"	776060	6825390	0.2		60 m to "Gilbert Islet 3"
"Gilbert Islet 3"	28°40'11"	113°49'30"	776100	6825300	0.1		60 m to "Gilbert Islet 2"
"Gilbert Islet 4"	28°40'10"	113°49'33"	776180	6825340	0.04		40 m to Gilbert Island
Helms Island	28°40'11"	113°51'39"	779600	6825230	1.2		60 m to "Helms Islet 1"
"Helms Islet 1"	28°40'17"	113°51'34"	779460	6825040	0.3		60 m to Helms Island
"Helms Islet 2"	28°40'22"	113°51'28"	779290	6824900	0.4		120 m to "Helms Islet 1"
Joe Smith Island	28°40'56"	113°51'29"	779300	6823850	0.3	1	500 m to Leo Island
Keru Island	28°43'35"	113°49'58"	776700	6819000	4.0	1	60 m to Suomi Island
"Landscope Island"	28°40'28"	113°51'24"	779180	6824720	0.1	2	100 m to "Nitraria Island"
Leo Island	28°41'23"	113°51'37"	779500	6823000	23	2	20 m to "Leo Islet 1"
"Leo Islet 1"	28°41'20"	113°51'37"	779500	6823100	0.05	2	20 m to Leo Island
"Leo Islet 2"	28°41'12"	113°52'16"	780570	6823310	0.2	2	260 m to Leo Island
Little North Island	28°37'52"	113°52'54"	781750	6829450	3.8	1	2.7 km to Bynoe Island
Little Rat Island	28°43'42"	113°47'08"	772100	6818900	9.5	3	40 m to Bushby Island
Little Roma Island	28°44'08"	113°46'52"	771630	6818100	0.1	1	330 m to Dry Island
"Little Stokes Island"	28°40'23"	113°51'10"	778810	6824890	0.3		30 m to Stokes Island
Morley Island	28°44'48"	113°48'46"	774700	6816800	12	3	10 m to "Morley Islet"
"Morley Islet"	28°44'55"	113°48'34"	774370	6816610	0.4		10 m to Morley Island
"Nitraria Island"	28°40'32"	113°51'22"	779120	6824600	0.1	2	80 m to Tapani Island
Rat Island	28°42'57"	113°47'03"	772000	6820300	61	3	80 m to Bushby Island
"Rat Islet"	28°42'33"	113°46'48"	771600	6821050	0.03		130 m to Rat Island
Roma Island	28°43'58"	113°47'07"	772050	6818400	0.5	2	220 m to "Roma Islet"
"Roma Islet"	28°44'11"	113°47'08"	772060	6818020	0.05		220 m to Roma Island
Sandy Island	28°46'32"	113°47'09"	780600	6802650	2.3		2.7 km to Wooded Island
Serventy Island	28°41'00"	113°49'53"	776700	6823800	13	3	20 m to "Serventy Islet 3"
"Serventy Islet 1"	28°40'57"	113°49'49"	776570	6823890	0.1		20 m to "Serventy Islet 2"
"Serventy Islet 2"	28°40'57"	113°49'47"	776530	6823870	0.02		20 m to "Serventy Islet 1"
"Serventy Islet 3"	28°41'13"	113°49'50"	776610	6823400	0.001		20 m to Serventy Island
Shearwater Island	28°43'57"	113°49'30"	775940	6818340	0.4		640 m to "Shearwater Islet"
"Shearwater Islet"	28°44'20"	113°49'22"	775700	6817640	0.2		640 m to Shearwater Island
Stokes Island	28°40'31"	113°51'03"	778600	6824650	4.0		30 m to "Little Stokes Island"
Suomi Island	28°42'46"	113°50'18"	777300	6820500	20		60 m to Keru Island
Tapani Island	28°40'31"	113°51'17"	778980	6824620	0.8		80 m to "Nitraria Island"
White Bank	28°42'08"	113°46'44"	771500	6821800	0.2		790 m to Rat Island
White Island	28°40'17"	113°52'31"	781020	6825000	6.5	2	180 m to "White Islet"
"White Islet"	28°40'33"	113°52'34"	781070	6824530	0.2		180 m to White Island
Wooded Island	28°45'08"	113°48'21"	774000	6816200	18		60 m to "Morley Islet"

TABLE 1(continued)

ISLAND NAME	LATITUDE (south)	LONGITUDE (east)	AMG E	AMG N	AREA (ha)	MAXIMUM ELEVATION A.S.L. (m)	ISOLATION
PELSAERT GROUP							
Arthur Island	28°53'56"	114°00'13"	207800	6799500	0.6		50 m to Gregory Island
Basile Island	28°52'34"	113°57'39"	788800	6802100	1.1	2	220 m to Burnett Island
Burnett Island	28°52'23"	113°57'48"	789060	6802450	2.5	2	10 m to "Burnett Islet 2"
"Burnett Islet 1"	28°52'18"	113°57'50"	789110	6802580	0.03		10 m to "Burnett Islet 2"
"Burnett Islet 2"	28°52'19"	113°57'50"	789120	6802560	0.1		10 m to "Burnett Islet 1"
Burton Island	28°52'00"	113°59'07"	791210	6803100	1.5	3	160 m to Travia Island
Coronation Island	28°52'15"	113°59'08"	791250	6802620	3.0	1	20 m to "Coronation Islet"
"Coronation Islet"	28°52'11"	113°59'09"	791260	6802770	0.1		20 m to Coronation Island
Davis Island	28°54'54"	113°52'34"	780450	6798000	2.0		250 m to Sweet Island
Diver Island	28°52'03"	113°58'21"	789980	6803040	0.3		60 m to Post Office Island
Eight Island	28°53'57"	113°51'37"	778940	6799780	0.6	2	800 m to Seven Island
Foale Island	28°52'46"	114°00'21"	207970	6801670	0.1		130 m to Iris Refuge Island
Gaze Island	28°51'51"	113°59'26"	791750	6803350	0.6		30 m to "Gaze Islet 1"
"Gaze Islet 1"	28°51'54"	113°59'24"	791690	6803270	0.2		30 m to Gaze Island
"Gaze Islet 2"	28°52'02"	113°59'27"	791770	6803010	0.02		30 m to "Gaze Islet 3"
"Gaze Islet 3"	28°52'04"	113°59'27"	791770	6802950	0.02		30 m to "Gaze Islet 2"
Gregory Island	28°53'56"	114°00'20"	208000	6799500	1.0		50 m to Arthur Island
Gun Island	28°53'18"	113°51'27"	778700	6801000	18	5	30 m to "Gun Islet"
"Gun Islet"	28°53'30"	113°51'36"	778930	6800630	0.01		30 m to Gun Island
Hummock Island	28°48'03"	114°02'21"	211000	6810450	3.9		8 km to Newman Island
Iris Refuge Island	28°52'49"	114°00'17"	207860	6801560	0.1		130 m to Foale Island
Jackson Island	28°52'18"	114°00'11"	207670	6802500	1.9	3	20 m to the closest of the "Jackson Islets"
"Jackson Islets" (7 islets)	28°52'19"	113°59'57"	792570	6802470	0.1		20 - 60 m to Jackson Island
Jon Jim Island	28°59'15"	113°57'35"	788400	6789750	0.4	3	50 m to Pelsaert Island
Lagoon Island	28°52'23"	113°59'40"	792090	6802360	0.6	4	50 m to Rotondella Island
"Little Jackson Island"	28°52'15"	114°00'15"	207770	6802620	1.2	2	60 m to Jackson Island
Middle Island	28°54'32"	113°54'37"	783800	6798600	20		1.5 km to Murray Island
Murray Island	28°53'54"	113°53'48"	782500	6799800	4.2		1.5 km to Middle Island
Newbold Island	28°52'55"	114°00'20"	207950	6801380	0.1		40 m to Robertson Island
Newman Island	28°51'49"	113°59'43"	792200	6803400	6.1	3	10 m to "Newman Islet 1"
"Newman Islet 1"	28°51'48"	113°59'39"	792110	6803440	0.1		10 m to Newman Island
"Newman Islet 2"	28°51'58"	113°59'41"	792160	6803140	0.01		10 m to Newman Island
Nook Island	28°51'59"	113°59'58"	792610	6803100	0.1		150 m to Newman Island
One Island	28°54'35"	113°52'56"	781040	6798580	1.8		170 m to Two Island
Pelsaert Island	28°54'12"– 28°55'46"	113°58'28"– 114°00'08"	207700– 790000	6796150– 6799000	166	3	50 m to Jon Jim Island
Post Office Island	28°51'54"	113°58'29"	790200	6803300	7.4	3	10 m to "Post Office Islet"
"Post Office Islet"	28°51'55"	113°58'26"	790110	6803270	0.1		10 m to Post Office Island
Robertson Island	28°52'59"	114°00'21"	207980	6801270	0.4		40 m to Newbold Island
Rotondella Island	28°52'22"	113°59'46"	792260	6802380	0.2	1	10 m to "Rotondella Islet 1"
"Rotondella Islet 1"	28°52'25"	113°59'46"	792250	6802310	0.01		4 m to "Rotondella Islet 2"
"Rotondella Islet 2"	28°52'25"	113°59'46"	792250	6802300	0.01		4 m to "Rotondella Islet 1"
Sandy Island	28°52'23"	113°52'36"	780600	6802650	0.2		2 km to Gun Island
Seven Island	28°54'23"	113°51'22"	778498	6799017	0.5		50 m to "Seven Islet"
"Seven Islet"	28°54'21"	113°51'20"	778450	6799050	0.1		50 m to Seven Island
Ship Rock	28°55'52"	113°55'45"	785575	6796100	0.1		1.4 km to Middle Island
Sid Liddon Island	28°54'41"	113°51'50"	779250	6798420	0.9		730 m to Three Island
Square Island	28°54'08"	113°56'39"	787100	6799250	1.1		2.4 km to Stick Island
Stick Island	28°53'23"	113°55'12"	784800	6800700	2.3	3	1.7 km to Middle Island
Sweet Island	28°55'02"	113°52'18"	780000	6797750	2.1		250 m to Davis Island
The Coral Patches (13 islets)	28°51'15"	114°01'02"	209000	6804500	0.3		1.5 - 2.1 km to Newman Island
Three Island	28°54'25"	113°52'17"	780000	6798890	1.6	2	550 m to Two Island
Travia Island	28°51'53"	113°59'13"	791400	6803300	0.8		60 m to "Gaze Islet 1"
Two Island	28°54'35"	113°52'43"	780690	6798570	0.3		170 m to One Island
Uncle Margie Island	28°52'05"	113°58'00"	789400	6803000	1.6	2	40 m to "Uncle Margie Islet"
"Uncle Margie Islet"	28°52'09"	113°58'01"	789440	6802860	0.004		40 m to Uncle Margie Island

TABLE 2

Geological information for the Abrolhos islands.

Island type is according to Collins *et al.* (1997). The Island Type column also includes further landform and soils details as noted by Harvey and Alford in their 1987 survey. The "rock" noted in the Island Type column by Harvey and Alford equates to "emergent coral reef and cemented, imbricated coral rubble", as described by Collins *et al.* (1997).

ISLAND NAME	ISLAND GROUP	ISLAND TYPE	LAGOON(S)
WALLABI GROUP			
Akerstrom Island	Central platform	high rock	×
Alcatraz Island	Central platform	high rock	×
Barge Rock	Central platform	high rock	×
Beacon Island	Beacon group	composite	×
Dakin Island	Beacon group	composite rock, loose coral shingle, and patches of coarse sand	×
Dick Island	Long Island chain	composite rock, loose coral shingle, and sand dunes	×
"Eagle Point Islet"	Central platform	high rock	×
Eastern Island	Beacon group	composite rock, loose coral shingle, and small dunes of coarse sand	×
"East Mangrove Island"	Central platform	high rock	×
East Wallabi Island	Central platform	eolianite	×
Far Island	Beacon group	cemented coral-shingle cay	×
"Far Islet 1"	Beacon group	cemented coral-shingle cay	×
"Far Islet 2"	Beacon group	cemented coral-shingle cay	×
First Sister	Sisters group	cemented coral-shingle cay	×
"First Sister Islet"	Sisters group	cemented coral-shingle cay	×
"G Island"	Beacon group	composite	×
Hall Island	Beacon group	low coral-shingle/sand cay loose coral shingle with coarse sand	×
Little Pigeon Island	Central platform	high rock	×
Long Island	Long Island chain	composite	✓
Marinula Island	Central platform	high rock	×
"Naturalist Island"	Sisters group	cemented coral-shingle cay	×
North Island	North Island group	eolianite	✓
Oystercatcher Island	Central platform	high rock	×
Pelican Island	Central platform	high rock	×
Pigeon Island	Central platform	high rock	×
Plover Island	Central platform	high rock	×
Saville-Kent Island	Beacon group	composite rock, loose coral shingle, and a small patch of coarse sand in mid-western edge	×
Seagull Island	Central platform	high rock	×
Seal Island	Beacon group	composite rock, loose coral shingle, and patches of coarse sand	✓
Second Sister	Sisters group	low coral-shingle/sand cay	×
Shag Rock	Central platform	high rock	×
"Shag Rock"	North Island group	high rock	×
"Short Island"	Long Island chain	composite	×
Tattler Island	Central platform	high rock	×
"Tectus Island"	Sisters group	cemented coral-shingle cay	×
Third Sister	Sisters group	cemented coral-shingle cay	×
Traitors Island	Beacon group	cemented coral-shingle cay	×
"Traitors Islet 1"	Beacon group	cemented coral-shingle cay	×
"Traitors Islet 2"	Beacon group	cemented coral-shingle cay	×
"Traitors Islet 3"	Beacon group	cemented coral-shingle cay	×
"Traitors Islet 4"	Beacon group	cemented coral-shingle cay	×
"Traitors Islet 5"	Beacon group	cemented coral-shingle cay	×
"Traitors Islet 6"	Beacon group	cemented coral-shingle cay	×
Turnstone Island	Central platform	high rock	×
Wann Island	Sisters group	cemented coral-shingle cay	×
West Wallabi Island	Central platform	eolianite	✓

TABLE 2(continued)

ISLAND NAME	ISLAND GROUP	ISLAND TYPE	LAGOON(S)
EASTER GROUP			
Alexander Island	Suomi Island chain	composite rock, loose coral shingle storm ridges, and coarse sand in depressions on beaches	✓
"Alexander Islet 1"	Suomi Island chain	composite	×
"Alexander Islet 2"	Suomi Island chain	composite	×
Bushby Island	Central platform	high rock	×
Bynoe Island	Eastern islands	composite rock platform on west side, loose coral shingle, coral shingle storm ridges, and dunes of coarse sand	×
"Bynoe Islet 1"	Eastern islands	cemented coral-shingle cay	×
"Bynoe Islet 2"	Eastern islands	cemented coral-shingle cay	×
"Bynoe Islet 3"	Eastern islands	cemented coral-shingle cay	×
"Bynoe Islet 4"	Eastern islands	cemented coral-shingle cay	×
Campbell Island	Suomi Island chain	composite rock platform, loose coral shingle,sandy dunes, and beaches of coarse sand	✓
"Campbell Islet"	Suomi Island chain	composite	×
Crake Island	Suomi Island chain	composite rock platform, and loose coral shingle	✓
Disappearing Island	isolated	low coral-shingle/sand cay temporary sand cay	×
Dry Island	Central platform	high rock	×
Gibson Island	Suomi Island chain	cemented coral-shingle cay	×
Gilbert Island	Suomi Island chain	composite loose coral shingle storm ridges with patches of coarse sand inland and on the beaches	✓
"Gilbert Islet 1"	Suomi Island chain	cemented coral-shingle cay	×
"Gilbert Islet 2"	Suomi Island chain	cemented coral-shingle cay	×
"Gilbert Islet 3"	Suomi Island chain	cemented coral-shingle cay	×
"Gilbert Islet 4"	Suomi Island chain	cemented coral-shingle cay	×
Helms Island	Eastern islands	composite	✓
"Helms Islet 1"	Eastern islands	cemented coral-shingle cay	✓
"Helms Islet 2"	Eastern islands	cemented coral-shingle cay	×
Joe Smith Island	Eastern islands	composite	×
Keru Island	Suomi Island chain	composite loose coral shingle with coarse sand in depressions on the beach and as dunes	✓
"Landscope Island"	Eastern islands	cemented coral-shingle cay	×
Leo Island	Eastern islands	composite loose coral shingle, and sand dunes	✓
"Leo Islet 1"	Eastern islands	cemented coral-shingle cay	×
"Leo Islet 2"	Eastern islands	composite	×
Little North Island	isolated	low coral-shingle/sand cay loose coral shingle	×
Little Rat Island	Central platform	high rock	×
Little Roma Island	Central platform	high rock	×
"Little Stokes Island"	Eastern islands	composite	×
Morley Island	Suomi Island chain	composite rock, loose coral shingle, coral shingle storm ridges, sandy beaches and dunes, and guano and coarse sand in depressions	✓
"Morley Islet"	Suomi Island chain	composite	×
"Nitraria Island"	Eastern islands	cemented coral-shingle cay	×
Rat Island	Central platform	high rock	×
"Rat Islet"	Central platform	high rock	×
Roma Island	Central platform	high rock	×
"Roma Islet"	Central platform	high rock	×
Sandy Island	isolated	low coral-shingle/sand cay	×

TABLE 2(continued)

ISLAND NAME	ISLAND GROUP	ISLAND TYPE	LAGOON(S)
Serventy Island	Suomi Island chain	composite extensive loose coral shingle storm ridges, small patches of coarse sand, and deep gullies with guano	✓
"Serventy Islet 1"	Suomi Island chain	cemented coral-shingle cay	×
"Serventy Islet 2"	Suomi Island chain	cemented coral-shingle cay	×
"Serventy Islet 3"	Suomi Island chain	cemented coral-shingle cay	×
Shearwater Island	Suomi Island chain	composite	×
"Shearwater Islet"	Suomi Island chain	composite	×
Stokes Island	Eastern islands	composite	✓
Suomi Island	Suomi Island chain	composite	✓
Tapani Island	Eastern islands	composite	×
White Bank	Central platform	low coral-shingle/sand cay	×
White Island	Eastern islands	composite rock, loose coral shingle storm ridges, and patches of coarse sand	✓
"White Islet"	Eastern islands	composite	×
Wooded Island	Suomi Island chain	composite	✓
PELSAERT GROUP			
Arthur Island	Pelsaert Island chain	composite	✓
Basile Island	Mangrove group	composite rock, loose coral shingle, patches of coarse sand, and coarse sand beaches	×
Burnett Island	Mangrove group	composite rock, loose coral shingle, and beaches of coarse sand	✓
"Burnett Islet 1"	Mangrove group	cemented coral-shingle cay	×
"Burnett Islet 2"	Mangrove group	composite	×
Burton Island	Mangrove group	composite rock, loose coral shingle, and beaches of coarse sand	✓
Coronation Island	Mangrove group	composite rock, and loose coral shingle storm ridges	✓
"Coronation Islet"	Mangrove group	cemented coral-shingle cay	✓
Davis Island	Numbered islands	high rock	×
Diver Island	Mangrove group	composite	×
Eight Island	Numbered islands	high rock	×
Foale Island	Mangrove group	composite	×
Gaze Island	Mangrove group	composite	×
"Gaze Islet 1"	Mangrove group	composite	×
"Gaze Islet 2"	Mangrove group	composite	×
"Gaze Islet 3"	Mangrove group	composite	×
Gregory Island	Pelsaert Island chain	composite	✓
Gun Island	Central platform	high rock	✓
"Gun Islet"	Central platform	high rock	×
Hummock Island	isolated	composite	✓
Iris Refuge Island	Mangrove group	composite	×
Jackson Island	Mangrove group	composite rock, loose coral shingle storm ridges, and beaches of coarse sand	✓
"Jackson Islets" (7 islets)	Mangrove group	cemented coral-shingle cay	×
Jon Jim Island	Pelsaert Island chain	cemented coral-shingle cay	×
Lagoon Island	Mangrove group	composite	✓
"Little Jackson Island"	Mangrove group	composite rock, and loose coral shingle storm ridges	✓
Middle Island	Central platform	high rock	×
Murray Island	Central platform	high rock	×
Newbold Island	Mangrove group	composite	×

TABLE 2(continued)

ISLAND NAME	ISLAND GROUP	ISLAND TYPE	LAGOON(S)
Newman Island	Mangrove group	composite rock, loose coral shingle storm ridges, and beaches of coarse sand	✓
"Newman Islet 1"	Mangrove group	composite	×
"Newman Islet 2"	Mangrove group	composite	×
Nook Island	Mangrove group	composite	×
One Island	Numbered islands	high rock	×
Pelsaert Island	Pelsaert Island chain	composite, and high rock at south of island loose coral shingle on weather side, high rock platform at south end of island	✓
Post Office Island	Mangrove group	composite rock with loose coral shingle storm ridges	✓
"Post Office Islet"	Mangrove group	composite	×
Robertson Island	Mangrove group	composite	✓
Rotondella Island	Mangrove group	composite rock with loose coral shingle	×
"Rotondella Islet 1"	Mangrove group	cemented coral-shingle cay	×
"Rotondella Islet 2"	Mangrove group	cemented coral-shingle cay	×
Sandy Island	isolated	low coral-shingle/sand cay sand	×
Seven Island	Numbered islands	high rock	×
"Seven Islet"	Numbered islands	high rock	×
Ship Rock	Central platform	high rock	×
Sid Liddon Island	Numbered islands	high rock	×
Square Island	"middle group"	composite	×
Stick Island	"middle group"	low coral-shingle/sand cay sand, with loose coral shingle around shore	×
Sweet Island	Numbered islands	high rock	×
The Coral Patches	The Coral Patches	low coral-shingle/sand cay	×
Three Island	Numbered islands	high rock	×
Travia Island	Mangrove group	composite	✓
Two Island	Numbered islands	high rock	×
Uncle Margie Island	Mangrove group	composite rock, loose coral shingle, and beaches of coarse sand	✓
"Uncle Margie Islet"	Mangrove group	cemented coral-shingle cay	×

TABLE 4

Disturbance on the islands owing to mining, occupation and feral animals.

Guano-mining information from Stanbury and Brown (1979, 2nd edn 1992), Stanbury (1993) and Fisheries Western Australia (1998). Occupation information from Fisheries Western Australia (1998). Feral animal information, where not referenced, is from Morris (1989), Abbott and Burbidge (1995) and Burbidge (personal communication). Italicized disturbance descriptions are observations made by Harvey and Alford in their 1987 survey; bracketed disturbance descriptions are from Harvey and Longman's visit to the islands in 1999.

ISLAND NAME	GUANO MINING	OCCUPIED BUILDINGS	FERAL ANIMALS	OTHER DISTURBANCE
WALLABI GROUP				
Alcatraz Island	✓	✓		3 camps
Beacon Island		✓		10 camps
East Wallabi Island			Goats - not present now (Storr *et al.* 1986)	airstrip, (restroom) *On the abandoned airstrips and disturbed areas along the existing airstrip, many annual weed species were found growing, some of the weed seeds having been brought in on the wheels of aircraft and shoes of visitors. Efforts to rehabilitate the old E-W strip have failed in some areas and the degrading parawebbing is causing further erosion, more so on the eastern than western end. Other rehabilitated areas at the northern end of the existing strip show signs of restabilization.*
Little Pigeon Island	✓	✓		22 camps
North Island		✓	Rabbits - not present now Mice	69 camps, 1 school, 1 club, airstrip
Pigeon Island	✓	✓	Black rats - not present now	54 camps, 1 school, 1 club, *high-density huts displace vegetation, exotic garden plants in gardens, remaining native vegetation in reasonable health, rock piles created when guano was mined still remain*, (invasive weed *Bryophyllum* present)
Third Sister				2 posts (Coate, diaries 1999)
West Wallabi Island	✓	✓		12 camps, *introduced tamarisk tree to 5 m has become established*, the remains of a guano-carrying tramway can still be seen and a concentration of grasses and weeds indicate the position of a horse yard (Stanbury 1991). Storr (1965) writes of the effects of guano-mining: "Apart from the remains of a jetty, tramline and horse yard, and some obviously unnatural hollows and heaps of stones in the dunes, there was little evidence in 1959 of this once profitable industry. All the excavations were completely revegetated but whether any plant species were permanently affected by this activity could not be ascertained".
EASTER GROUP				
Alexander Island				*An abandoned camp - stone ruins, timber scraps with associated weeds -* *Raphanus spp., *Hordeum, *Ehrharta, *Phalaris minor *and* *Avena fatua
Bushby Island	✓	✓	Black rats - eradicated 1991	2 camps
Joe Smith Island				Concrete foundations of abandoned camp, rusting roofing iron and asbestos roofing sheets stacked on ground (Coate, diaries 1999)
Leo Island		✓	Rabbits - eradicated	2 camps, *associated rubbish*
Little Rat Island	✓	✓	Black rats - eradicated 1991	40 camps, 1 school, 1 club
Morley Island			Rabbits - eradicated	*Domestic rubbish from islands to the west*

TABLE 4 (continued)

ISLAND NAME	GUANO MINING	OCCUPIED BUILDINGS	FERAL ANIMALS	OTHER DISTURBANCE
Rat Island	✓	✓	Black rats - eradicated 1991 Cats - eradicated Mice	59 camps, 1 school, 1 nursing post, airstrip, embankments for guano-carrying tramlines representing several kilometres of track criss-cross the islands and are overgrown with saltbush and weeds such as *Avena fatua* (Stanbury 1993), (invasive weed *Bryophyllum* present)
Roma Island	✓	✓	Black rats - eradicated 1991	12 camps
Tapani Island				One pole (Coate, diaries 1999)
Wooded Island			Rabbits - eradicated	
PELSAERT GROUP				
Basile Island		✓		22 camps, 1 Church
Burnett Island		✓		10 camps, *rubbish in lagoon*
Coronation Island		✓		5 camps, *considerable flotsam from adjacent islands*
Davis Island	✓			
Eight Island	✓			Piles of rock, short walls and an old stone and rock beacon are relics of guano-mining (Coate, diaries 1999)
Foale Island		✓		2 camps
Gun Island	✓			Tramline foundations and a limestone causeway extending for 23 m out to sea are guano-mining relics. In 1968 British Petroleum drilled on Gun Island for oil (Green and Stanbury 1988).
Jackson Island		✓		10 camps
Newman Island		✓		3 camps, *associated rubbish, steel pickets marking proposed airstrip*
Nook Island		✓		3 camps
One Island	✓			
Pelsaert Island	✓		Rabbits - not present now (Helms 1902)	Guano-carrying tramlines (Green and Stanbury 1988).
Post Office Island		✓		5 camps
Robertson Island		✓		5 camps
Rotondella Island		✓		2 camps
Sid Liddon Island	✓			
Stick Island				*2 long-abandoned and flattened camps*
Sweet Island	✓			During guano mining, discarded limestone rocks were stacked to form "walls", some over 2 m high (Green and Stanbury 1988)
Three Island	✓			Extensively mined for guano, many rock mounds at the west end and north side, old abandoned guano workers' shelters, old roofing iron (Coate, diaries 1999)
Uncle Margie Island		✓		10 camps, *associated rubbish*

TABLE 5

Occurrence of boxthorn on the islands.

Information from Green (1972)[1], Geraldton Regional College of TAFE (1997)[2] and diaries of P. Fuller and A. Burbidge[3], and K. Coate[4]. Fuller and Burbidge recorded boxthorn during visits in October 1990 and late November-early December in 1991, 1993, 1996, 1997 and 1999; Geraldton Regional College of TAFE and the Fisheries Department visited between 21–28 June 1997. The Geraldton College of TAFE reported finding and removing boxthorn from both Sweet and Number 5 Islands but these islands are reported in Abrolhos Islands Task Force for the Abrolhos Islands Consultative Committee (1988) to be one and the same island. Consequently, the six plants recorded and killed by Geraldton College of TAFE on "Number 5 Island" cannot be recorded in the table and this island's identity remains unknown.

ISLAND	OCCURRENCE OF BOXTHORN (*Lycium ferocissimum*)							
	1970	1984	1990	1991	1993	1996	1997	1999
EASTER GROUP								
Wooded Island	boxthorn recorded [1]			1 recorded and pulled out [3]				
PELSAERT GROUP								
Arthur Island				2 recorded [3]		2 recorded [3]		
Davis Island					nil [3]	nil [3]	5 plants killed [2]	
Eight Island					all dead [3]	nil [3]	nil [3]	all dead [3,4]
Gun Island				1 recorded [3]	4–5 small plants recorded [3]	nil [3]		several recorded near old oil well site[3]
Murray Island					nil [3]	nil [3]		
Newman Island								4 recorded[3]
One Island					nil [3]			
Pelsaert Island		recorded by Harvey in 1984	*ca* 100 recorded and pulled out [3]	nil [3]	2 recorded and removed [3]	3 recorded and removed [3]		4 recorded at southern end[3]
Sandy Island						nil [3]		
Seven Island					1 recorded[3]	nil [3]		
Sid Liddon Island					many plants recorded[3]	150–200 recorded [3]	247 plants killed[2] 25 recorded [3]	many plants recorded [3]
Sweet Island				many plants recorded [3]	many plants recorded [3]	300–400 recorded [3]	254 plants killed [2]; *ca* 20 regenerating[3]	many dead plants but several alive [3]
Three Island				3 recorded [3]	8 recorded [3]	2 recorded [3]	1 plant killed [2]	all dead [4]
Two Island					nil [3]	nil [3]		

For Table 6a, b and c, island names in normal print (and no quotation marks) are former names; island names in bold print are current DOLA-approved names; names in quotation marks are current, are not DOLA-approved but are the only names available at present to describe the island or islet. A tick in the column "veg. desc." indicates that there is a description of the vegetation in the reference. A letter in the "species list" column indicates that this worker recorded plant species when visiting the island; the letter in the cell is the researcher's identifying code in Table 11(p. 559). For the 1999 field trip, the "new records" column indicates when a plant species was newly recorded on an island visited, and the new species are recorded with code L in Table 11; the "no new records" column indicates that the island was visited, vegetation and some flora details were noted but only previously-recorded species were found (this information has not been included in Table 11), or there are no plants on the island. The "aerial photo interpretation only" column indicates islands which have had no flora or vegetation information collected, and vegetation maps have been derived solely from aerial photographs.

TABLE 6a

Islands in the Wallabi Group (including North Island), showing island name changes and workers who have collected plant species information appearing in Table 11 (p. 559).

CURRENT ISLAND NAME	WORKERS WHO HAVE COLLECTED PLANT SPECIES INFORMATION																		Aerial photo inter-pretation only	OTHER FORMER ISLAND NAMES
	G. M. Storr (1960, 1965) Visited the islands 1959 - 1960			P.M. O'Loughlin (1965, 1966) Visited the islands 1964-1965			I. Abbott (1980) Visited the islands 1975-1977			R.E. Johnstone (Johnstone and Storr 1994), diaries Visited the islands 1977-1983			J. Harvey and J. Alford (previously unpublished) Visited the islands 1987		J. Harvey and V. Longman (previously unpublished) Visited the islands 1999			OTHER WORKERS and date the island was visited		
	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	species list	ISLAND NAME	new records	no new records	ISLAND NAME			
Akerstrom Island		S	Mangrove Island				✓	A	West Mangrove Island		J	West Mangrove Island			L		**Akerstrom Island**			
Alcatraz Island							✓	A	Lumley Island		J	**Alcatraz Island**			L		**Alcatraz Island**			
Barge Rock							✓	A	**Barge Rock**						L		**Barge Rock**			
Beacon Island		S	**Beacon Island**				✓	A	**Beacon Island**		J	**Beacon Island**			L		**Beacon Island**			*Batavia*'s Graveyard (Stanbury 1991)
Dakin Island											J	**Dakin Island**	B	**Dakin Island**		✓	**Dakin Island**			
Dick Island											J	**Dick Island**	B	**Dick Island**		✓	**Dick Island**			Goss Island
"Eagle Point Islet"							✓	A	Eagle Point Islet						L		"Eagle Point Islet"			
Eastern Island				✓	Q	Eastern Island					J	**Eastern Island**	B	**Eastern Island**		✓	**Eastern Island**			
"East Mangrove Island"		S	Mangrove Island				✓	A	East Mangrove Island						L		"East Mangrove Island"			
East Wallabi Island	✓	S	**East Wallabi Island**					A	**East Wallabi Island**		J	**East Wallabi Island**	B	**East Wallabi Island**	L		**East Wallabi Island**	W.B. Alexander 1913, M.E. Gillham 1959, R.D. Royce 1960, A.R. Main 1963,1968, A.M. Ashby 1970, J.W. Green 1978		High Island (Green *et al* 1988)
Far Island															L		**Far Island**			
"Far Islet 1"																			✓	
"Far Islet 2"																			✓	
First Sister															L		**First Sister**	K. Coate 1999		Lagoon Island
"First Sister Islet"															L		"First Sister Islet"			
"G Island"													B	G Island	L		"G Island"			
Hall Island													B	**Hall Island**		✓	**Hall Island**			
Little Pigeon Island							✓	A	**Little Pigeon Island**		J	**Little Pigeon Island**			L		**Little Pigeon Island**			South Pigeon Island
Long Island		S	**Long Island**		Q	**Long Island**	✓	A	**Long Island**		J	**Long Island**			L		**Long Island**			Seals Island (Stanbury 1991)
Marinula Island		S	Mangrove Island				✓	A	Middle Mangrove Island						L		**Marinula Island**			
"Naturalist Island"															L		"Naturalist Island"	K. Coate 1999		

TABLE 6a (continued)

CURRENT ISLAND NAME	WORKERS WHO HAVE COLLECTED PLANT SPECIES INFORMATION: G. M. Storr (1960, 1965) Visited the islands 1959 - 1960			P.M. O'Loughlin (1965, 1966) Visited the islands 1964-1965			I. Abbott (1980) Visited the islands 1975-1977			R.E. Johnstone (Johnstone and Storr 1994), diaries Visited the islands 1977-1983			J. Harvey and J. Alford (previously unpublished) Visited the islands 1987		J. Harvey and V. Longman (previously unpublished) Visited the islands 1999			OTHER WORKERS and date the island was visited	Aerial photo inter-pret-ation only	OTHER FORMER ISLAND NAMES
	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	species list	ISLAND NAME	new records	no new records	ISLAND NAME			
North Island	✓	S	**North Island**								J	**North Island**			L		**North Island**	W.B. Alexander 1913		
Oystercatcher Island							✓	A	Middle Seagull Island						L		**Oystercatcher Island**			
Pelican Island		S	**Pelican Island**												L		**Pelican Island**			
Pigeon Island		S	**Pigeon Island**				✓	A	**Pigeon Island**		J	**Pigeon Island**	B	**Pigeon Island**	L		**Pigeon Island**			
Plover Island							✓	A	South Seagull Island						L		**Plover Island**			
Saville-Kent Island											J	**Saville-Kent Island**	B	**Saville-Kent Island**		✓	**Saville-Kent Island**			
Seagull Island							✓	A	North Seagull Island		J	**Seagull Island**			L		**Seagull Island**			
Seal Island											J	**Seal Island**	B	**Seal Island**		✓	**Seal Island**	E.M. Scrymgeour 1963, J.W. Green 1978		
Second Sister															L		**Second Sister**	K. Coate 1999		
Shag Rock							✓	A	**Shag Rock**							✓	**Shag Rock**	K Coate 1999		
"Shag Rock"															L		"Shag Rock"			Shag Rock
"Short Island"															L		"Short Island"			
Tattler Island		S	**Tattler Island**				✓	A	**Tattler Island**						L		**Tattler Island**			
"Tectus Island"															L		"Tectus Island"	K. Coate 1999		
Third Sister																✓	**Third Sister**	K. Coate 1999		
Traitors Island															L		**Traitors Island**	K. Coate 1999		
"Traitors Islet 1"															L		"Traitors Islet 1"			
"Traitors Islet 2"															L		"Traitors Islet 2"			
"Traitors Islet 3"															L		"Traitors Islet 3"			
"Traitors Islet 4"															L		"Traitors Islet 4"			
"Traitors Islet 5"															L		"Traitors Islet 5"			
"Traitors Islet 6"															L		"Traitors Islet 6"			
Turnstone Island							✓	A	No name No. 6						L		**Turnstone Island**			
Wann Island																✓	**Wann Island**	K. Coate 1999		Small Islet
West Wallabi Island	✓	S	**West Wallabi Island**							✓	J	**West Wallabi Island**	B	**West Wallabi Island**	L		**West Wallabi Island**	Gilham 1959, K. Coate 1999		

TABLE 6b

Islands in the Easter Group, showing island name changes and workers who have collected plant species information appearing in Table 11(p. 559).

CURRENT ISLAND NAME	WORKERS WHO HAVE COLLECTED PLANT SPECIES INFORMATION: G.A. Green (1972) Visited the islands 1970			R.E. Johnstone (Johnstone and Coate 1992), (Johnstone 1992), diaries Visited the islands 1977-1983			J. Harvey and J. Alford (previously unpublished) Visited the islands 1987		J. Harvey, V. Longman, J. Blyth and P.J. Fuller (previously unpublished) Visited the islands 1999			OTHER WORKERS and date the island was visited	Aerial photo inter-pret-ation only	OTHER FORMER ISLAND NAMES
	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	species list	ISLAND NAME	new records	no new records	ISLAND NAME			
Alexander Island					J	**Alexander Island**	B	**Alexander Island**		✓	**Alexander Island**			
"Alexander Islet 1"										✓	"Alexander Islet 1"			
"Alexander Islet 2"													✓	
Bushby Island					J	**Bushby Island**			L		**Bushby Island**			Middle Island
Bynoe Island					J	**Bynoe Island**	B	**Bynoe Island**		✓	**Bynoe Island**			
"Bynoe Islet 1"													✓	
"Bynoe Islet 2"													✓	
"Bynoe Islet 3"													✓	
"Bynoe Islet 4"													✓	
Campbell Island					J	**Campbell Island**	B	**Campbell Island**	L		**Campbell Island**			
"Campbell Islet"													✓	
Crake Island					J	**Crake Island**	B	**Crake Island**		✓	**Crake Island**			
Disappearing Island										✓	**Disappearing Island**			Graveyard Island
Dry Island									L		**Dry Island**			Beacon Island, Dingville Island, Ding Island
Gibson Island					J	**Gibson Island**			L		**Gibson Island**			
Gilbert Island					J	**Gilbert Island**	B	**Gilbert Island**		✓	**Gilbert Island**			
"Gilbert Islet 1"													✓	
"Gilbert Islet 2"													✓	
"Gilbert Islet 3"													✓	
"Gilbert Islet 4"													✓	
Helms Island					J	**Helms Island**				✓	**Helms Island**			
"Helms Islet 1"													✓	
"Helms Islet 2"									L		"Helms Islet 2"			
Joe Smith Island										✓	**Joe Smith Island**	K. Coate 1999		
Keru Island					J	**Keru Island**	B	**Keru Island**		✓	**Keru Island**	N. Sammy 1972		
"Landscope Island"										✓	"Landscope Island"	K. Coate 1999		
Leo Island					J	**Leo Island**	B	**Leo Island**		✓	**Leo Island**			
"Leo Islet 1"									L		"Leo Islet 1"			
"Leo Islet 2"									L		"Leo Islet 2"			
Little North Island							B	**Little North Island**	L		**Little North Island**			
Little Rat Island	✓	Q	Helsinki						L		**Little Rat Island**			
Little Roma Island									L		**Little Roma Island**			
"Little Stokes Island"									L		"Little Stokes Island"			
Morley Island				✓	J	**Morley Island**	B	**Morley Island**						
"Morley Islet"													✓	
"Nitraria Island"										✓	"Nitraria Island"	K. Coate 1999		

TABLE 6b (continued)

CURRENT ISLAND NAME	WORKERS WHO HAVE COLLECTED PLANT SPECIES INFORMATION													Aerial photo inter-pret-ation only	OTHER FORMER ISLAND NAMES
	G.A. Green (1972) Visited the islands 1970			R.E. Johnstone (Johnstone and Coate 1992), (Johnstone 1992), diaries Visited the islands 1977-1983			J. Harvey and J. Alford (previously unpublished) Visited the islands 1987		J. Harvey, V. Longman, J. Blyth and P.J. Fuller (previously unpublished) Visited the islands 1999			OTHER WORKERS and date the island was visited			
	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	species list	ISLAND NAME	new records	no new records	ISLAND NAME				
Rat Island	✓	Q	**Rat Island**		J	**Rat Island**			L		**Rat Island**	A.S. George 1972, N. Sammy 1972			
'Rat Islet'														✓	
Roma Island									L		**Roma Island**				Travia Island
'Roma Islet'														✓	
Sandy Island									L		**Sandy Island**				Graveyard Island, Disappearing Island
Serventy Island					J	**Serventy Island**	B	**Serventy Island**	L		**Serventy Island**				
'Serventy Islet 1'														✓	
'Serventy Islet 2'														✓	
'Serventy Islet 3'														✓	
Shearwater Island					J	**Shearwater Island**				✓	**Shearwater Island**				
'Shearwater Islet'									L		'Shearwater Islet'				
Stokes Island					J	**Stokes Island**			L		**Stokes Island**				
Suomi Island	✓	Q	**Suomi Island**		J	**Suomi Island**				✓	**Suomi Island**				
Tapani Island										✓	**Tapani Island**	K. Coate 1999			
White Bank									L		**White Bank**				
White Island					J	**White Island**	B	**White Island**		✓	**White Island**				
'White Islet'														✓	
Wooded Island	✓	Q	**Wooded Island**	✓	J	**Wooded Island**				✓	**Wooded Island**	A.S. George 1972, N. Sammy 1972, P.J. Fuller and A.A. Burbidge 1991			

TABLE 6c

Islands in the Pelsaert Group, showing island name changes and workers who have collected plant species information appearing in Table 11(p. 559).

CURRENT ISLAND NAME	WORKERS WHO HAVE COLLECTED PLANT SPECIES INFORMATION: P.M. O'Loughlin (1969) Visited the islands 1966, 1968			I. Abbott (1980) Visited the islands 1975			R.E. Johnstone diaries Visited the islands 1977-1983			J. Harvey and J. Alford (previously unpublished) Visited the islands 1987 (1984 for Pelsaert Is.)			J. Harvey, V. Longman, J. Blyth and P.J. Fuller (previously unpublished) Visited the islands 1999			OTHER WORKERS and date the island was visited	Aerial photo inter-pret-ation only	OTHER FORMER ISLAND NAMES
	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	new records	no new records	ISLAND NAME			
Arthur Island													L		**Arthur Island**	P.J. Fuller and A.A. Burbidge 1991, 1996		
Basile Island								J	**Basile Island**	✓	B	**Basile Island**		✓	**Basile Island**	P. Roberts 1988		
Burnett Island								J	**Burnett Island**	✓	B	**Burnett Island**		✓	**Burnett Island**			Fin Island, Brad Island, Shark Island
"Burnett Islet 1"																	✓	
"Burnett Islet 2"																	✓	
Burton Island										✓	B	**Burton Island**		✓	**Burton Island**			
Coronation Island								J	**Coronation Island**	✓	B	**Coronation Island**		✓	**Coronation Island**			
"Coronation Islet"																	✓	
Davis Island													L		**Davis Island**	Geraldton College of TAFE 1997		Four Island
Diver Island																	✓	
Eight Island														✓	**Eight Island**	P.J. Fuller and A.A. Burbidge 1993, K. Coate 1999		
Foale Island													L		**Foale Island**			
Gaze Island														✓	**Gaze Island**	K. Coate 1999		
"Gaze Islet 1"													L		"Gaze Islet 1"			
"Gaze Islet 2"																	✓	
"Gaze Islet 3"																	✓	
Gregory Island													L		**Gregory Island**			
Gun Island	✓	Q	**Gun Island**										L		**Gun Island**	P. Roberts 1988, P.J. Fuller and A.A. Burbidge 1991, 1993		
"Gun Islet"													L		"Gun Islet"			
Hummock Island								J	**Hummock Island**				L		**Hummock Island**			
Iris Refuge Island													L		**Iris Refuge Island**			
Jackson Island										✓	B	**Jackson Island**		✓	**Jackson Island**			Norm Jackson Island, Spoon Landing, Marge Island
"Jackson Islets"																	✓	
Jon Jim Island	✓	Q	Little Island	✓	A	**Jon Jim**												Wreck Island, Little Island
Lagoon Island														✓	**Lagoon Island**	K. Coate 1999		
"Little Jackson Island"										✓	B	"Little Jackson Island"		✓	"Little Jackson Island"			Fairbridge Island
Middle Island	✓	Q	**Middle Island**					J	**Middle Island**							P. Roberts 1988		
Murray Island	✓	Q	**Murray Island**										L		**Murray Island**			
Newbold Island																	✓	
Newman Island								J	**Newman Island**	✓	B	**Newman Island**		✓	**Newman Island**			
"Newman Islet 1"																	✓	
"Newman Islet 2"																	✓	
Nook Island								J	**Nook Island**				L		**Nook Island**			

TABLE 6c (continued)

CURRENT ISLAND NAME	WORKERS WHO HAVE COLLECTED PLANT SPECIES INFORMATION: P.M. O'Loughlin (1969) Visited the islands 1966, 1968			I. Abbott (1980) Visited the islands 1975			R.E. Johnstone diaries Visited the islands 1977-1983			J. Harvey and J. Alford (previously unpublished) Visited the islands 1987 (1984 for Pelsaert Is.)			J. Harvey, V. Longman, J. Blyth and P.J. Fuller (previously unpublished) Visited the islands 1999			OTHER WORKERS and date the island was visited	Aerial photo inter-pret-ation only	OTHER FORMER ISLAND NAMES
	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	veg. desc.	species list	ISLAND NAME	new records	no new records	ISLAND NAME			
One Island													L		One Island			
Pelsaert Island		Q	Pelsart Island	✓	A	Pelsart Island		J	Pelsaert Island	✓	B	Pelsaert Island		✓	Pelsaert Island	W.B. Alexander 1913, V.L. Serventy 1943, G.G. Smith 1947, P.J. Fuller and A.A. Burbidge 1990, 1993, 1996		Batavia Road Island, South Island, Long Island (H.E. Tarr 1949, P.T. Sandland 1937), Pelsart Island (spelling changed in May 1976)
Post Office Island								J	Post Office Island	✓	B	Post Office Island		✓	Post Office Island	P. Roberts 1988		
"Post Office Islet"																	✓	
Robertson Island													L		Robertson Island			Robinson Island
Rotondella Island										✓	B	Rotondella Island	L		Rotondella Island			
"Rotondella Islet 1"																	✓	
"Rotondella Islet 2"																	✓	
Sandy Island													L		Sandy Island			
Seven Island													L		Seven Island	P.J. Fuller and A.A. Burbidge 1993		
"Seven Islet"													L		"Seven Islet"			
Ship Rock													L		Ship Rock			
Sid Liddon Island													L		Sid Liddon Island	P.J. Fuller and A.A. Burbidge 1993, 1996, 1997, Geraldton College of TAFE 1997		Six Island
Square Island	✓	Q	Square Island					J	Square Island					✓	Square Island			
Stick Island								J	Stick Island	✓	B	Stick Island		✓	Stick Island			Jubilee Island
Sweet Island													L		Sweet Island	P.J. Fuller and A.A. Burbidge 1991, 1993, 1996, 1997, Geraldton College of TAFE 1997		Five Island
The Coral Patches													L		The Coral Patches			
Three Island													L		Three Island	P.J. Fuller and A.A. Burbidge 1991, 1993, 1996, Geraldton College of TAFE 1997, K. Coate 1999		
Travia Island													L		Travia Island	K. Coate 1999		
Two Island													L		Two Island			
Uncle Margie Island								J	Uncle Margie Island	✓	B	Uncle Margie Island		✓	Uncle Margie Island			Mangrove Island (Storr, Johnstone and Griffin), Hancock Island

TABLE 8

Dominant plant species codes used in vegetation mapping of Figures 2–69 (pp. 584–623).

LIFE FORM / HEIGHT CLASS	CODE	PLANT SPECIES
S: Shrubs > 1 m tall	**a_2**	*Atriplex* spp.
	a	*Avicennia marina*
	d	*Diplolaena grandiflora*
	e_3	*Eucalyptus oraria*
	h	*Halosarcia halocnemoides*
	m	*Myoporum insulare*
	n	*Nitraria billardierei*
	o	*Olearia axillaris*
	p	*Pittosporum phylliraeoides*
	r	*Rhagodia* spp.
	s_6	*Scaevola crassifolia*
	x_1	East Wallabi pavement limestone species (listed on relevant vegetation map)
	x_2	East Wallabi consolidated dunes species (listed on relevant vegetation map)
Z: Dwarf shrubs < 1 m tall	**a_2**	*Atriplex* spp.
	a	*Avicennia marina*
	c_2	**Cakile maritima*
	d	*Diplolaena grandiflora*
	e	*Enchylaena tomentosa*
	e_2	*Eremophila glabra*
	f	*Frankenia pauciflora*
	g	*Grevillea argyrophylla*
	h	*Halosarcia halocnemoides*
	h_2	*Hibbertia racemosa*
	m_3	*Muellerolimon salicorniaceum*
	m	*Myoporum insulare*
	n	*Nitraria billardierei*
	o	*Olearia axillaris*
	p_2	*Pimelea microcephala*
	p	*Pittosporum phylliraeoides*
	r	*Rhagodia* spp.
	s_4	*Sarcostemma viminale*
	s_6	*Scaevola crassifolia*
	t	*Threlkeldia diffusa*
	w	*Westringia dampieri*
	x_1	East Wallabi pavement limestone species (listed on relevant vegetation map)
	x_2	East Wallabi consolidated dunes species (listed on relevant vegetation map)
	x_3	West Wallabi pavement limestone species (listed on relevant vegetation map)
	x_4	North Island consolidated dunes species (listed on relevant vegetation map)
G: Bunch grasses	**b**	*Bromus* spp. (introduced and/or native)
	s	*Spinifex longifolius*
	x	Mixed, species listed
F: Forbs	**s_2**	*Senecio lautus*
	u	*Urospermum picroides*
	x	Mixed, species listed
C: Succulents	**c**	*Carpobrotus virescens*
	h	*Halosarcia indica*
	m_2	*Mesembryanthemum crystallinum*
	s_3	*Sarcocornia quinqueflora*
	s_5	*Suaeda australis*
	x	Mixed, species listed

TABLE 9

Figure numbers and accuracy codes for vegetation maps of the islands and islets of the Houtman Abrolhos

ISLAND NAME	FIGURE No.	ACCURACY (1 – 6) (see Table 10, p. 534)
WALLABI GROUP		
Akerstrom Island	Fig 2	6
Alcatraz Island	Fig 3	6
Barge Rock	Fig 4	6
Beacon Island	Fig 5	6
Dakin Island	Fig 6	6
Dick Island	Fig 7	6
"Eagle Point Islet"	Fig 8	6
Eastern Island	Fig 9	6
"East Mangrove Island"	Fig 2	6
East Wallabi Island	Fig 8	5
Far Island	Fig 10	6
"Far Islet 1"	Fig 10	1
"Far Islet 2"	Fig 10	1
First Sister	Fig 11	6
"First Sister Islet"	Fig 11	6
"G Island"	Fig 12	6
Hall Island	Fig 6	6
Little Pigeon Island	Fig 3	6
Long Island	Fig 13	6
Marinula Island	Fig 2	6
"Naturalist Island"	Fig 11	6
North Island	Fig 14	6
Oystercatcher Island	Fig 15	6
Pelican Island	Fig 16	6
Pigeon Island	Fig 17	6
Plover Island	Fig 18	6
Saville-Kent Island	Fig 6	6
Seagull Island	Fig 15	6
Seal Island	Fig 12	6
Second Sister	Fig 19	6
Shag Rock	Fig 20	6
"Shag Rock"	Fig 14	4
"Short Island"	Fig 13	6
Tattler Island	Fig 21	6
"Tectus Island"	Fig 11	6
Third Sister	Fig 22	6
Traitors Island	Fig 23	6
"Traitors Islet 1"	Fig 23	6
"Traitors Islet 2"	Fig 23	6
"Traitors Islet 3"	Fig 23	6
"Traitors Islet 4"	Fig 23	6
"Traitors Islet 5"	Fig 23	6
"Traitors Islet 6"	Fig 23	6
Turnstone Island	Fig 15	6
Wann Island	Fig 24	6
West Wallabi Island	Fig 25	6

ISLAND NAME	FIGURE No.	ACCURACY (1 – 6) (see Table 10)
EASTER GROUP		
Alexander Island	Fig 26	4
"Alexander Islet 1"	Fig 26	5
"Alexander Islet 2"	Fig 26	1
Bushby Island	Fig 37	6
Bynoe Island	Fig 27	5
"Bynoe Islet 1"	Fig 27	1
"Bynoe Islet 2"	Fig 27	1
"Bynoe Islet 3"	Fig 27	1
"Bynoe Islet 4"	Fig 27	1
Campbell Island	Fig 28	4
"Campbell Islet"	Fig 28	1
Crake Island	Fig 29	4
Disappearing Island	Fig 30	5
Dry Island	Fig 39	5
Gibson Island	Fig 31	5
Gilbert Island	Fig 26	5
"Gilbert Islet 1"	Fig 26	1
"Gilbert Islet 2"	Fig 26	1
"Gilbert Islet 3"	Fig 26	1
"Gilbert Islet 4"	Fig 26	1
Helms Island	Fig 32	4
"Helms Islet 1"	Fig 32	1
"Helms Islet 2"	Fig 32	4
Joe Smith Island	Fig 33	4
Keru Island	Fig 34	4
"Landscope Island"	Fig 32	5
Leo Island	Fig 35	6
"Leo Islet 1"	Fig 35	6
"Leo Islet 2"	Fig 35	5
Little North Island	Fig 36	4
Little Rat Island	Fig 37	6
Little Roma Island	Fig 39	2
"Little Stokes Island"	Fig 32	4
Morley Island	Fig 29	4
"Morley Islet"	Fig 29	1
"Nitraria Island"	Fig 32	5
Rat Island	Fig 38	6
"Rat Islet"	Fig 38	1
Roma Island	Fig 39	6
"Roma Islet"	Fig 39	1
Sandy Island	Fig 40	5
Serventy Island	Fig 31	5
"Serventy Islet 1"	Fig 31	1
"Serventy Islet 2"	Fig 31	1
"Serventy Islet 3"	Fig 31	1
Shearwater Island	Fig 41	5
"Shearwater Islet"	Fig 41	5
Stokes Island	Fig 32	4
Suomi Island	Fig 34	4
Tapani Island	Fig 32	5
White Bank	Fig 38	3
White Island	Fig 42	4
"White Islet"	Fig 42	1
Wooded Island	Fig 43	4

ISLAND NAME	FIGURE No.	ACCURACY (1 – 6) (see Table 10)
PELSAERT GROUP		
Arthur Island	Fig 44	5
Basile Island	Fig 45	4
Burnett Island	Fig 46	4
"Burnett Islet 1"	Fig 46	1
"Burnett Islet 2"	Fig 46	1
Burton Island	Fig 47	4
Coronation Island	Fig 48	4
"Coronation Islet"	Fig 48	1
Davis Island	Fig 49	4
Diver Island	Fig 50	1
Eight Island	Fig 49	4
Foale Island	Fig 51	5
Gaze Island	Fig 52	4
"Gaze Islet 1"	Fig 52	4
"Gaze Islet 2"	Fig 52	1
"Gaze Islet 3"	Fig 52	1
Gregory Island	Fig 44	5
Gun Island	Fig 53	4
"Gun Islet"	Fig 52	5
Hummock Island	Fig 54	4
Iris Refuge Island	Fig 51	4
Jackson Island	Fig 55	4
"Jackson Islets" (7 islets)	Fig 55	1
Jon Jim Island	Fig 56	4
Lagoon Island	Fig 57	4
"Little Jackson Island"	Fig 55	4
Middle Island	Fig 58	4
Murray Island	Fig 59	5
Newbold Island	Fig 51	1
Newman Island	Fig 60	3
"Newman Islet 1"	Fig 60	1
"Newman Islet 2"	Fig 60	1
Nook Island	Fig 61	4
One Island	Fig 49	4
Pelsaert Island	Fig 62	5
Post Office Island	Fig 63	3
"Post Office Islet"	Fig 63	1
Robertson Island	Fig 51	4
Rotondella Island	Fig 57	4
"Rotondella Islet 1"	Fig 57	1
"Rotondella Islet 2"	Fig 57	1
Sandy Island	Fig 64	5
Seven Island	Fig 49	4
"Seven Islet"	Fig 49	4
Ship Rock	Fig 65	4
Sid Liddon Island	Fig 49	4
Square Island	Fig 66	5
Stick Island	Fig 67	4
Sweet Island	Fig 49	4
The Coral Patches (13 islets)	Fig 68	2
Three Island	Fig 49	4
Travia Island	Fig 52	5
Two Island	Fig 49	4
Uncle Margie Island	Fig 69	3
"Uncle Margie Islet"	Fig 69	1

TABLE 11a

List of vascular plants found in the Wallabi Group of the Abrolhos islands, showing occurrence on each island. Introduced/naturalized species are denoted by an asterisk. Letters denote recordings of the species by researchers (see Table 12, p. 574); letters followed by the superscript "h" indicate that the researcher has lodged specimens at the Western Australian Herbarium.

Note that taxonomy of all herbarium specimens indicated in Table 11 has been confirmed by herbarium staff, except for specimens deposited by Harvey and Longman after the 1999 field trip: taxonomy of these specimens (except for *Atriplex* spp. and *Rhagodia* spp.) had not yet been confirmed by the herbarium as at June 2000. Storr (1965) groups Akerstrom, Marinula and "East Mangrove Island" into *Mangrove Island* (see Table 6, p. 551*)*; whereas Abbott separates them (Abbott 1980).

Further details for some of the species follow.

Atriplex cinerea found by Harvey and Longman on Plover Island and Shag Rock has been identified by P. Wilson as *Atriplex cinerea?*

Atriplex paludosa found by Storr on North Island is *Atriplex paludosa* ssp. *baudinii* (WAHerb records); similarly *Atriplex paludosa* found by Harvey and Longman on Little Pigeon Island is *Atriplex paludosa* ssp. *baudinii*

Austrostipa found by Abbott on Oystercatcher, Tattler, Akerstrom and Seagull Islands (originally *Stipa ?flavescens*) is reported as *Austrostipa ?flavescens* (Abbott 1980).

Brachyscome sp.- Abbott found one of *B. ciliaris* or *B. iberidifolia* on East Wallabi Island (Abbott 1980), but he does not identify which one.

Capparis spinosa found by Green on East Wallabi Island is *C. spinosa* var. *nummularia* (WAHerb records).

**Conyza bonariensis* found by Abbott on Pigeon and Little Pigeon Islands is reported as uncertain (Abbott 1980).

Crassula colorata found by Storr on North and West Wallabi Islands is *C. colorata* var. *colorata* (WAHerb records).

Dianella revoluta found by Gillham on East Wallabi Island is *Dianella revoluta* var. *divaricata* (WAHerb records).

Enchylaena tomentosa found by Harvey and Alford on Dick and Eastern Islands, and by Storr on North Island is *Enchylaena tomentosa* var. *tomentosa* (WAHerb records).

Eremophila glabra found by Alexander and Storr on East Wallabi Island is *E. glabra* ssp. *albicans* (WAHerb records).

Euphorbia tannensis found by Abbott (1980) and by Storr (WAHerb records) and by Harvey and Longman is *Euphorbia tannensis* ssp. *eremophila.*

Pimelea microcephala found by Harvey and Alford on West Wallabi Island and Storr on North Island is *P. microcephala* ssp. *microcephala* (WAHerb records).

Pittosporum phylliraeoides found by Ashby on East Wallabi Island and Scrymgeour on Seal Island is *P. phylliraeoides* var. *phylliraeoides* (WAHerb records).

Ptilotus divaricatus found by Storr on East Wallabi Island is *Ptilotus divaricatus* var. *divaricatus* (WAHerb records).

Rhagodia latifolia found by Storr on North Island and by Harvey and Longman on Akerstrom, Little Pigeon and Pigeon Islands is *Rhagodia latifolia* ssp. *latifolia.*

Salsola kali found by Alexander on North Island is *S. kali* ssp. *tragus* (WAHerb records).

Senecio lautus found by Harvey and Alford on East Wallabi Island is *S. lautus* ssp. *dissectifolius* (WAHerb records).

Stackhousia viminea is not a current name but, since there is no herbarium specimen to study, it is impossible to determine which of *S. clementii, S. intermedia* or *S. muricata* was found by Storr (1965) and Abbott (1980).

TABLE 11a (continued)

PLANT NAME	Akerstrom Island	Alcatraz Island	Barge Rock	Beacon Island	Dakin Island	Dick Island	*Eagle Point Islet*	Eastern Island	*East Mangrove Island*	East Wallabi Island	Far Island	First Sister	*First Sister Islet*	*G Island*	Hall Island	Little Pigeon Island	Long Island	*Mangrove Island*	Marinula Island	*Naturalist Island*	North Island	Oystercatcher Island	Pelican Island	Pigeon Island	Plover Island	Saville-Kent Island	Seagull Island	Seal Island	Second Sister	Shag Rock	*Shag Rock*	*Short Island*	Tattler Island	*Tectus Island*	Third Sister	Traitors Island	*Traitors Islet 1*	*Traitors Islet 2*	*Traitors Islet 3*	*Traitors Islet 4*	*Traitors Islet 5*	*Traitors Islet 6*	Turnstone Island	Wann Island	West Wallabi Island
AIZOACEAE																																													
Carpobrotus virescens	A						A	Q		SA						AJ	QAJ				SS^h	A		SAJB			A						SA											K	SBK
Disphyma crassifolium subsp. *clavellatum*																								B																					
* *Mesembryanthemum crystallinum*	L	AJ	A	A	B	B	A	QB	A	A		K	L		B	AJ	QA		A	K	S	A	S	SAB	A	B	A		K	A		L	SA	K	K	K	L	L	L	L	L	L	A	K	SJB
AMARANTHACEAE																																													
Ptilotus divaricatus										SS^{h}M^{h}AL^h																																			
Ptilotus eriotrichus										SS^h																																			SS^{h}B
Ptilotus gaudichaudii										B																																			
Ptilotus obovatus										SA																																			
Ptilotus villosiflorus																																													SB
ANTHERICACEAE																																													
Thysanotus patersonii										SAB											SS^{h}L^h			S			A																		SB
APIACEAE																																													
Apium annuum										SS^{h}AB																																			SS^{h}BB^h
Apium prostratum																																	A												
Daucus glochidiatus										SS^{h}AB											S			B																					SS^{h}B
Hydrocotyle diantha										S																																			S
Trachymene pilosa										SABB^h																																			
APOCYNACEAE																																													
Alyxia buxifolia										W^{h}SS^{h}AB																	L																		SB
ASCLEPIADACEAE																																													
Sarcostemma viminale subsp. *australe*							A			W^{h}SS^{h}AJ												A		SAB			L																		SJBKL^h
ASPHODELACEAE																																													
Bulbine semibarbata							AL^h			SS^{h}A						AL^h					SS^h			AB																					SB
ASTERACEAE																																													
Actinobole condensatum										SS^{h}AB											S																								SS^h
Actites megalocarpa																A	QA					A		A			A																		
Angianthus tomentosus										B																																			
Brachyscome ciliaris										SB											SS^{h}L^h			B																					
Brachyscome iberidifolia										S																																			
Calocephalus aervoides										SBB^h																																			S
Chthonocephalus tomentellus																																													B
* *Conyza bonariensis*																A								A																					
Euchiton sphaericus										B^h											S^h																								
Gnaphalium indutum										B																																			
* *Lactuca saligna*																								A																					
Olearia axillaris								Q		SAL^h							QA				S	A		SAB			A																A		SJBK
Podotheca angustifolia																					S																								SS^{h}B
* *Pseudognaphalium luteoalbum*										SAL^h											SS^{h}L^h																						L^h		B
Senecio glossanthus										SS^{h}B^h											S																								B
Senecio lautus	A		L^h	A	B	JB		QJB		W^{h}SABB^{h}L^h		K		B		A	QAJ				W^{h}S	A	S	SAB		B	A	JBB^h	L				A		K								L^h		SJL^h
* *Sonchus oleraceus*	A	A	A	A			A	QBB^h	A	SA						A	A		A		S	A	S	SAB	AL^h		A						SA										A		SK
* *Urospermum picroides*	L	L					L^h	BB^h		S							L^h					L					L						L										L^h		
Vittadinia cuneata var. *cuneata*	A		A							SS^{h}AB									A								A																A		
Vittadinia sp.										B^h																																			
AVICENNIACEAE																																													
Avicennia marina	AJ								L										L			A					AJ						SA										A		SB

TABLE 11a (continued)

PLANT NAME	Akerstrom Island	Alcatraz Island	Barge Rock	Beacon Island	Dakin Island	Dick Island	"Eagle Point Islet"	Eastern Island	"East Mangrove Island"	East Wallabi Island	Far Island	First Sister	"First Sister Islet"	"G Island"	Hall Island
BORAGINACEAE															
Cynoglossum australe										G^{h}SS^{h}BB^h					
* *Echium plantagineum*										L					
Trichodesma zeylanicum															
BRASSICACEAE															
* *Brassica rapa*				AA^h											
* *Cakile maritima*				A		B		Q		SA		K			
* *Hornungia procumbens*		A	A	A	B^h	B		QB		SAB					
* *Hymenolobus procumbens*												L^h			
Lepidium lyratogynum								B							
Lepidium pseudoruderale				A	B	B		Q							
Lepidium puberulum								BB^h				L^h			
* *Raphanus raphanistrum*															
* *Sisymbrium orientale*				A											
CAPPARACEAE															
Capparis spinosa							A			SR^{h}A					
CARYOPHYLLACEAE															
* *Polycarpon tetraphyllum*										BB^h					
* *Sagina apetala*										SAB					
* *Spergularia rubra*	A	A	AL^h	L^h						SA					
* *Stellaria media*															
CHENOPODIACEAE															
Atriplex cinerea		J		J	JBB^h	JB	L^h	QJ		SA		K	L	L	B
Atriplex sp.	A	A	A	A			A		A						
Atriplex paludosa															
Atriplex vesicaria subsp. *variabilis*															
Chenopodium melanocarpum										S					
* *Chenopodium murale*				AL^h											
Chenopodium nitrariaceum										S					
Dysphania plantaginella										S					
Enchylaena tomentosa	A		A	A	B	BB^h		QBB^h	A	B		K			
Halosarcia halocnemoides	A	A	A							SA					
Halosarcia indica subsp. *bidens*	AL^h														
Halosarcia sp.															
Rhagodia baccata	A									SA					
Rhagodia latifolia	L^h						L^h								
* *Salsola kali*						B		Q		A					
Sarcocornia quinqueflora	A								L	A		K	L		
Sclerostegia arbuscula										S					
Suaeda australis				A				B	AL^h						
Threlkeldia diffusa	A	A	A	L	B	BB^h	A	QBB^h	A	SA		K	L	L	B
COLCHICACEAE															
Wurmbea monantha										SH^{h}AB					
CRASSULACEAE															
* *Bryophyllum* sp.															
Crassula colorata						B		B		SAB					
Crassula exserta						B^h		B							

PLANT NAME	Little Pigeon Island	Long Island	*Mangrove Island*	Marinula Island	"Naturalist Island"	North Island	Oystercatcher Island	Pelican Island	Pigeon Island	Plover Island	Saville-Kent Island	Seagull Island	Seal Island	Second Sister	Shag Rock
BORAGINACEAE															
Cynoglossum australe															
* *Echium plantagineum*															
Trichodesma zeylanicum						S									
BRASSICACEAE															
* *Brassica rapa*															
* *Cakile maritima*		QA				W^{h}SS^h							B	L	
* *Hornungia procumbens*		A				SS^h	A					A	BB^h		
* *Hymenolobus procumbens*															
Lepidium lyratogynum															
Lepidium pseudoruderale											B		B		
Lepidium puberulum															
* *Raphanus raphanistrum*									A						
* *Sisymbrium orientale*															
CAPPARACEAE															
Capparis spinosa	A						A		SABL^h			A			
CARYOPHYLLACEAE															
* *Polycarpon tetraphyllum*	AL^h								AB						
* *Sagina apetala*															
* *Spergularia rubra*	A					S	A		SAB			A			
* *Stellaria media*															
CHENOPODIACEAE															
Atriplex cinerea	J	JL^h		L		SS^{h}J			JL^h	L^h	JBB^h		JB	K	KL^h
Atriplex sp.	A	A		A			A	L	A	A		A			A
Atriplex paludosa	L	S	S			SS^h		S	SBL^h						
Atriplex vesicaria subsp. *variabilis*												L^h			
Chenopodium melanocarpum															
* *Chenopodium murale*						S		S							
Chenopodium nitrariaceum															
Dysphania plantaginella															
Enchylaena tomentosa	AL^h	AL^h	S	A	K	SS^h	A	S	SA			A			
Halosarcia halocnemoides						SL^h			A						K
Halosarcia indica subsp. *bidens*															
Halosarcia sp.															
Rhagodia baccata						S	A		SAB			A			
Rhagodia latifolia	L^h					S^h			L^h						
* *Salsola kali*		QA				W^{h}S							B		
Sarcocornia quinqueflora		QAJ		A	K	S	A					A	R^{h}JB		
Sclerostegia arbuscula						S			S						
Suaeda australis		QAL^h		A		SS^h						A			
Threlkeldia diffusa	AL^h	QA		A	L	S	A	L	SAB		B	A	BB^h		
COLCHICACEAE															
Wurmbea monantha						SS^h									
CRASSULACEAE															
* *Bryophyllum* sp.									L						
Crassula colorata		A				SS^h									
Crassula exserta															

PLANT NAME	"Shag Rock"	"Short Island"	Tattler Island	"Tectus Island"	Third Sister	Traitors Island	"Traitors Islet 1"	"Traitors Islet 2"	"Traitors Islet 3"	"Traitors Islet 4"	"Traitors Islet 5"	"Traitors Islet 6"	Turnstone Island	Wann Island	West Wallabi Island
BORAGINACEAE															
Cynoglossum australe															SS^{h}B
* *Echium plantagineum*															
Trichodesma zeylanicum															
BRASSICACEAE															
* *Brassica rapa*															
* *Cakile maritima*															B
* *Hornungia procumbens*															SB
* *Hymenolobus procumbens*															
Lepidium lyratogynum															
Lepidium pseudoruderale															
Lepidium puberulum															
* *Raphanus raphanistrum*															
* *Sisymbrium orientale*															
CAPPARACEAE															
Capparis spinosa			SA										A		SJBK
CARYOPHYLLACEAE															
* *Polycarpon tetraphyllum*															
* *Sagina apetala*															
* *Spergularia rubra*			A												SB
* *Stellaria media*															SB
CHENOPODIACEAE															
Atriplex cinerea			L^h	K	K	K								K	S^{h}JB^h
Atriplex sp.			A										A		
Atriplex paludosa			S												SJBB^h
Atriplex vesicaria subsp. *variabilis*															
Chenopodium melanocarpum															
* *Chenopodium murale*															SB
Chenopodium nitrariaceum															B
Dysphania plantaginella															
Enchylaena tomentosa			A	K		K	L	L		L				K	
Halosarcia halocnemoides															SJBKL^h
Halosarcia indica subsp. *bidens*															
Halosarcia sp.															S^h
Rhagodia baccata			SA										A		SB
Rhagodia latifolia															
* *Salsola kali*					K										SJB
Sarcocornia quinqueflora			SA	L									A	K	SBL^h
Sclerostegia arbuscula															SB
Suaeda australis			S				L	L	L						
Threlkeldia diffusa		L^h	SA	K	K			L					A	K	SJBK
COLCHICACEAE															
Wurmbea monantha															SS^{h}B
CRASSULACEAE															
* *Bryophyllum* sp.															
Crassula colorata			L												SS^{h}B
Crassula exserta															B

TABLE 11a (continued)

	ISLAND																																												
PLANT NAME	Akerstrom Island	Alcatraz Island	Bargo Rock	Beacon Island	Dakin Island	Dick Island	"Eagle Point Islet"	Eastern Island	"East Mangrove Island"	East Wallabi Island	Far Island	First Sister	"First Sister Islet"	"G Island"	Hall Island	Little Pigeon Island	Long Island	*Mangrove Island*	Marinula Island	"Naturalist Island"	North Island	Oystercatcher Island	Pelican Island	Pigeon Island	Plover Island	Saville-Kent Island	Seagull Island	Seal Island	Second Sister	Shag Rock	"Shag Rock"	"Short Island"	Tattler Island	"Tectus Island"	Third Sister	Traitors Island	"Traitors Islet 1"	"Traitors Islet 2"	"Traitors Islet 3"	"Traitors Islet 4"	"Traitors Islet 5"	"Traitors Islet 6"	Turnstone Island	Wann Island	West Wallabi Island
* *Cotyledon orbiculata*																								A																					
CUNONIACEAE																																													
Aphanopetalum clematideum										SS^{h}A																																			
CYPERACEAE																																													
* *Isolepis marginata*										SS^{h}A																																			SB
Isolepis nodosa																					L^h																								
DASYPOGONACEAE																																													
Acanthocarpus preissii							A			SA						L					S	A		SAB			A						A												SJBK
DILLENIACEAE																																													
Hibbertia racemosa										SS^{h}H^{h}ABB^h																																			SS^{h}JBL^h
EPACRIDACEAE																																													
Leucopogon insularis										SA																																			L^h
EUPHORBIACEAE																																													
Beyeria viscosa										SL^h												L^h																							SJBKL^h
Euphorbia boophthona																								B																					
Euphorbia drummondii										SAB																																			B
Euphorbia tannensis							A									AL^h					SS^h	A		A			A																A		
* *Euphorbia terracina*																								A																					
Phyllanthus calycinus										SS^{h}H^{h}ABB^h																																			SB
FRANKENIACEAE																																													
Frankenia pauciflora	A						A			SA						AL^h					SL^h	A		SABL^h			A						SA										A		SJBK
GENTIANACEAE																																													
* *Centaurium maritimum*										BB^h																																			
* *Centaurium spicatum*										SABB^h											W^{h}SS^{h}L^h			B									L										L^h		SB
GERANIACEAE																																													
* *Erodium cicutarium*			A							SA							Q				S^h			B																					SS^{h}B
Erodium cygnorum										SA											S			S																					
Pelargonium littorale										S																																			
GOODENIACEAE																																													
Scaevola crassifolia										SA											SS^h						A																		BB^h
HALORAGACEAE																																													
Haloragis trigonocarpa										S														B																					
JUNCACEAE																																													
* *Juncus bufonius*										S											S			B																					B
JUNCAGINACEAE																																													
Triglochin centrocarpum						B																		B																					B^h
Triglochin mucronatum																					SS^h																								SB
Triglochin muelleri										S																																			
Triglochin trichophorum			A							SA											SL^h																								
LAMIACEAE																																													
Westringia dampieri										SH^{h}AB		L^h																																	SBL^h
LILIACEAE																																													
* *Aloe sp.*																L																													

TABLE 11a (continued)

	ISLAND																																												
PLANT NAME	Akerstrom Island	Alcatraz Island	Barge Rock	Beacon Island	Dakin Island	Dick Island	"Eagle Point Islet"	Eastern Island	"East Mangrove Island"	East Wallabi Island	Far Island	First Sister	"First Sister Islet"	"G Island"	Hall Island	Little Pigeon Island	Long Island	*Mangrove Island*	Marinula Island	"Naturalist Island"	North Island	Oystercatcher Island	Pelican Island	Pigeon Island	Plover Island	Saville-Kent Island	Seagull Island	Seal Island	Second Sister	Shag Rock	"Shag Rock"	"Short Island"	Tattler Island	"Tectus Island"	Third Sister	Traitors Island	"Traitors Islet 1"	"Traitors Islet 2"	"Traitors Islet 3"	"Traitors Islet 4"	"Traitors Islet 5"	"Traitors Islet 6"	Tumstone Island	Wann Island	West Wallabi Island
LOGANIACEAE																																													
Phyllangium paradoxum																																													B
MALVACEAE																																													
Lavatera plebeia		A		A	B	B		QB	A	B		L			B	A	Q						S	AB	AL^{h}	B		B						L		K	L		L				L^{h}		
* *Malva parviflora*										S											S			SAJ																					B
Sida spodochroma										B																																			
MIMOSACEAE																																													
Acacia didyma										Y^{h}SS^{h}AL^{h}																																			
MYOPORACEAE																																													
Eremophila glabra										W^{h}SS^{h}A																																			SBL^{h}
Eremophila deserti										L^{h}																																			
Myoporum insulare	A	A	A	A		JBB^{h}	A	QJB		SA		K		B		AJ	SQAJL^{h}		A	L	SJL^{h}	A		SAJB			A	B	K				A	K	K	K							AL^{h}	K	SJBK
MYRTACEAE																																													
Eucalyptus oraria										SM^{h}R^{h}A																																			
ONAGRACEAE																																													
Epilobium billardierianum										A																																			
OROBANCHACEAE																																													
* *Orobanche minor*										L^{h}																																			
ORCHIDACEAE																																													
Microtis media										S																																			
Microtis sp.										S^{h}																																			
OXALIDACEAE																																													
* *Oxalis corniculata*										SA																																			SB
PAPILIONACEAE																																													
Bossiaea spinescens										SS^{h}																																			
* *Medicago polymorpha*																L								AB																					
* *Melilotus indicus*				A																	L^{h}																								
Mirbelia ramulosa										SA																																			
PHORMIACEAE																																													
Dianella revoluta							A			G^{h}SAB												A		SAB			A						L												SJBK
PITTOSPORACEAE																																													
Pittosporum phylliraeoides	A						A			SH^{h}ABB^{h}												A		SAB			A	C^{h}					SAL^{h}										AL^{h}		SJBK
PLANTAGINACEAE																																													
Plantago debilis										SS^{h}											SS^{h}			B																					SB
PLUMBAGINACEAE																																													
Muellerolimon salicorniaceum	AL^{h}									SABB^{h}						AL^{h}			A		SS^{h}L^{h}	A		SAB			A						SA												SS^{h}BL^{h}
POACEAE																																													
Agrostis avenacea										SABB^{h}																																			S
Austrodanthonia caespitosa										SM^{h}ABB^{h}											SS^{h}L^{h}																								
Austrostipa crinita																					SS^{h}																								
Austrostipa elegantissima										G^{h}M^{h}SS^{h}ABB^{h}							A					A		SB			A																A		SS^{h}B
Austrostipa ?flavescens	A																					A					A						A												

TABLE 11a (continued)

PLANT NAME	ISLAND																																											
	Akerstrom Island	Alcatraz Island	Barge Rock	Beacon Island	Dakin Island	Dick Island	'Eagle Point Islet'	Eastern Island	'East Mangrove Island'	East Wallabi Island	Far Island	First Sister	'First Sister Islet'	'G Island'	Hall Island	Little Pigeon Island	Long Island	*Mangrove Island*	Marinula Island	'Naturalist Island'	North Island	Oystercatcher Island	Pelican Island	Pigeon Island	Plover Island	Saville-Kent Island	Seagull Island	Seal Island	Second Sister	Shag Rock	'Shag Rock'	'Short Island'	Tattler Island	'Tectus Island'	Third Sister	Traitors Island	'Traitors Islet 1'	'Traitors Islet 2'	'Traitors Islet 3'	'Traitors Islet 4'	'Traitors Islet 5'	'Traitors Islet 6'	Turnstone Island	Wann Island	West Wallabi Island
Austrostipa variabilis										SA											S												S												SB
* *Avena barbata*																L								AB																					
* *Avena fatua*																					S																								
* *Avena* sp.				L																													L												
Bromus arenarius				L^	BB^	B		B		SBB^		KL^					L^				S			B		BB^		B								L^									SB
* *Bromus diandrus*				A												A	Q				S^			AB			A																AL^		
* *Bromus hordeaceus*		A	A	A				Q								A	A				S			A	A		A																A		
* *Bromus japonicus* var. *vestitus*																												B^																	
* *Bromus madritensis*																					S																								
* *Cynodon dactylon*										A											S			AB																					
* *Ehrharta brevifolia*										A																																			
* *Ehrharta longiflora*			A	A												A								AB			A						A												
Eragrostis dielsii	A									A						A					SS^L^			AJB																			A		
* *Hordeum leporinum*																AL^					S			AB																					
* *Lolium multiflorum*																																													B
* *Lolium perenne*																																													BB^
* *Lolium rigidum*		A														A																													
* *Parapholis incurva*																					L^																								
* *Phalaris minor*																					S			B																					SB
* *Poa annua*				AL^						B																																			
Poa poiformis										SABB^																																			
* *Polypogon monspeliensis*																L^	Q																												SB
Polypogon tenellus										S														B																					G^S
* *Rostraria cristata*																A					S			AB																					
Setaria dielsii	A		A			B	L			B		KL^				AL^	AL^		A		SL^	A		SAB			A						A										AL^		SS^B
Setaria sp.						B^																																							
Spinifex longifolius				A	JBB^	B		QJB		W^SA		K					QAJ		A		SJ	A				B	A	B				L													SJBK
Sporobolus virginicus																					SS^	A		AB			A																AL^		SB
* *Triticum aestivum*																					S^																								
* *Vulpia myuros*	A									SAB						A					S			AB																			A		SB
POLYGONACEAE																																													
* *Emex australis*																A								B																					
PORTULACACEAE																																													
Calandrinia calyptrata																					S																								
PRIMULACEAE																																													
* *Anagallis arvensis*																								A																					SS^B
PROTEACEAE																																													
Grevillea argyrophylla										SS^AL^												A		SABL^			A																		SS^JBK
RANUNCULACEAE																																													
Ranunculus sessiliflorus										S																																			
RHAMNACEAE																																													
Spyridium globulosum										SH^AL^											SS^																								SJBL^
RUBIACEAE																																													
Galium migrans										SA																																			
Opercularia vaginata										B																																			
RUTACEAE																																													
Diplolaena grandiflora							A			SS^ABB^						A						A		SAB			A						A										A		SJBKL^

TABLE 11a (continued)

ISLAND

PLANT NAME	Akerstrom Island	Alcatraz Island	Barge Rock	Beacon Island	Dakin Island	Dick Island	"Eagle Point Islet"	Eastern Island	"East Mangrove Island"	East Wallabi Island	Far Island	First Sister	"First Sister Islet"	"G Island"	Hall Island
SANTALACEAE															
Exocarpos aphyllus										SAB^h					
Exocarpos sparteus															
SAPINDACEAE															
Dodonaea aptera										SAL^h					
Dodonaea inaequifolia										SS^{h}A					
Dodonaea viscosa															
SCROPHULARIACEAE															
* *Dischisma arenarium*															
SOLANACEAE															
* *Nicotiana glauca*															
Nicotiana occidentalis subsp. *hesperis*	A	A	AL^h				AL^h			SA					
* *Solanum laciniatum*										B					
* *Solanum nigrum*				L						SA					
Solanum symonii		A		A						AH^{h}BB^h					
STACKHOUSIACEAE															
Stackhousia sp.															
Stackhousia viminea										SA					
Tripterococcus brunonis										B					
STERCULIACEAE															
Lasiopetalum angustifolium										SS^{h}A					
TAMARICACEAE															
* *Tamarix* sp.															
THYMELAEACEAE															
Pimelea microcephala	A						L			SA					
URTICACEAE															
Parietaria cardiostegia					B^h										
Parietaria debilis				A	B	B		QB		SB					
* *Urtica urens*										ABL^h					
ZYGOPHYLLACEAE															
Nitraria billardierei	A	A	A	SAJ	JB	JB	A	QJB	A	SA	L	K	L		B
Zygophyllum simile				A	BB^h	B				SAB					

PLANT NAME	Little Pigeon Island	Long Island	*Mangrove Island*	Marinula Island	"Naturalist Island"	North Island	Oystercatcher Island	Pelican Island	Pigeon Island	Plover Island	Saville-Kent Island	Seagull Island	Seal Island	Second Sister	Shag Rock
SANTALACEAE															
Exocarpos aphyllus	L^h	QA					AL^h		AB			L^h			
Exocarpos sparteus						SS^h									
SAPINDACEAE															
Dodonaea aptera						SS^h	L^h								
Dodonaea inaequifolia							L^h								
Dodonaea viscosa												L^h			
SCROPHULARIACEAE															
* *Dischisma arenarium*															
SOLANACEAE															
* *Nicotiana glauca*									A						
Nicotiana occidentalis subsp. *hesperis*	AL^h	A		A		SS^h	A		SAB			A			
* *Solanum laciniatum*															
* *Solanum nigrum*	A								AB						
Solanum symonii							A					A			
STACKHOUSIACEAE															
Stackhousia sp.															
Stackhousia viminea						S									
Tripterococcus brunonis															
STERCULIACEAE															
Lasiopetalum angustifolium															
TAMARICACEAE															
* *Tamarix* sp.									L						
THYMELAEACEAE															
Pimelea microcephala				L		SS^h	A		SAB			AL^h			
URTICACEAE															
Parietaria cardiostegia											B^h				
Parietaria debilis		QA				S					B				
* *Urtica urens*															
ZYGOPHYLLACEAE															
Nitraria billardierei	AJ	SQAJ	S	A	K	SS^{h}J	A	S	SAJB	A	JB	A	JB		AKL^h
Zygophyllum simile		A				SS^h									

PLANT NAME	"Shag Rock"	"Short Island"	Tattler Island	"Tectus Island"	Third Sister	Traitors Island	"Traitors Islet 1"	"Traitors Islet 2"	"Traitors Islet 3"	"Traitors Islet 4"	"Traitors Islet 5"	"Traitors Islet 6"	Turnstone Island	Wann Island	West Wallabi Island
SANTALACEAE															
Exocarpos aphyllus			SA												SJBL^h
Exocarpos sparteus															BK
SAPINDACEAE															
Dodonaea aptera															SB
Dodonaea inaequifolia															SBL^h
Dodonaea viscosa															
SCROPHULARIACEAE															
* *Dischisma arenarium*															S
SOLANACEAE															
* *Nicotiana glauca*															
Nicotiana occidentalis subsp. *hesperis*			A												B
* *Solanum laciniatum*															
* *Solanum nigrum*															SBB^h
Solanum symonii															
STACKHOUSIACEAE															
Stackhousia sp.															B
Stackhousia viminea															S
Tripterococcus brunonis															
STERCULIACEAE															
Lasiopetalum angustifolium															
TAMARICACEAE															
* *Tamarix* sp.															B
THYMELAEACEAE															
Pimelea microcephala			SA										A		SJB^{h}L^h
URTICACEAE															
Parietaria cardiostegia															
Parietaria debilis															SB
* *Urtica urens*															SB
ZYGOPHYLLACEAE															
Nitraria billardierei	L	L	SA	K	K	K	L	L	L	L	L		A	K	SJB
Zygophyllum simile															SB

TABLE 11b

List of vascular plants found in the Easter Group of the Abrolhos islands, showing occurrence on each island. Introduced/naturalized species are denoted by an asterisk. Letters denote recordings of the species by researchers (see Table 12, p. 574); letters followed by the superscript "h" indicate that the researcher has lodged specimens at the Western Australian Herbarium.

Note that taxonomy of all herbarium specimens indicated in Table 11 has been confirmed by herbarium staff, except for specimens deposited by Harvey and Longman after the 1999 field trip; taxonomy of these specimens (except for *Atriplex* spp. and *Rhagodia* spp.) had not yet been confirmed by the herbarium as at June 2000.

Further details for some of the species follow.

Crassula colorata found by Harvey and Alford on Alexander and Keru Islands, and by Sammy on Rat Island is *C. colorata* var. *colorata* (WAHerb records).

Disphyma crassifolium ssp. *clavellatum* (originally *Disphyma blackii*) had ? against its occurrence on Rat Island (Green 1972).

Ehrharta longiflora found by Harvey and Alford on Alexander Island is *Ehrharta ?longiflora* (WAHerb records).

Enchylaena tomentosa found by George on Rat Island is *E. tomentosa* var. *tomentosa* (WAHerb records).

Frankenia pauciflora found by Harvey and Alford on Campbell Island is *F. pauciflora* var. *pauciflora* (WAHerb records).

Lavatera plebeia found by Harvey and Alford on Alexander Island is *L. plebeia* var. *tomentosa* (WAHerb records).

Pelargonium zonale (Green 1972) is not a current name, but the correct current name is indeterminable.

Senecio lautus found by Harvey and Alford on Gilbert and Keru Islands is *S. lautus* ssp. *lautus* (WAHerb records).

PLANT NAME	ISLAND																																	
	Alexander Island	Bushby Island	Bynoe Island	Campbell Island	Crake Island	Dry Island	Gibson Island	Gilbert Island	Helms Island	"Helms Islet 2"	Joe Smith Island	Keru Island	"Landscope Island"	Leo Island	"Leo Islet 1"	"Leo Islet 2"	Little North Island	Little Rat Island	Little Roma Island	"Little Stokes Island"	Morley Island	"Nitraria Island"	Rat Island	Roma Island	Sandy Island	Serventy Island	Shearwater Island	"Shearwater Islet"	Stokes Island	Suomi Island	Tapani Island	White Bank	White Island	Wooded Island
AIZOACEAE																																		
Carpobrotus sp.																							X^{h}											
Carpobrotus virescens	B	J	JB	B	JB		J	B	J	L		B		B	L		B	Q			JB	K	QJ	L	L	JB			L	Q	K		JB	QN^{h}J
Disphyma crassifolium subsp. *clavellatum*														B									Q											
* *Mesembryanthemum crystallinum*	B	L	B	L	JB	L							K	B			B	Q	L		B	K	QJ	L	L								B	QJ
Sesuvium portulacastrum				B																														
* *Tetragonia decumbens*					J							J																					J	J
AMARANTHACEAE																																		
Ptilotus gaudichaudii																										B								
APIACEAE																																		
Apium annuum	BB^{h}			B																						B								
Daucus glochidiatus				B								B																					BB^{h}	
Hydrocotyle diantha																							N^{h}											
* *Petroselinum crispum*																		L					N^{h}	L										
ASPHODELACEAE																																		
Bulbine semibarbata																							Q											

TABLE 11b (continued)

PLANT NAME	Alexander Island	Bushby Island	Bynoe Island	Campbell Island	Crake Island	Dry Island	Gibson Island	Gilbert Island	Helms Island	"Helms Islet 2"	Joe Smith Island	Keru Island	"Landscope Island"	Leo Island	"Leo Islet 1"	"Leo Islet 2"
ASTERACEAE																
* *Aster subulatus*																
Brachyscome ciliaris																
* *Conyza albida*																
* *Conyza bonariensis*		L														
Euchiton sphaericus																
Gnaphalium indutum														B		
Olearia axillaris				B												
* *Pseudognaphalium luteoalbum*																
* *Reichardia tingitana*				B^{h}												
Senecio lautus	B		JB	B	B			BB^{h}	J		K	BB^{h}		B		
* *Sonchus oleraceus*	B	L	BB^{h}	B				B				BB^{h}	K	B		
* *Sonchus tenerrimus*				B										BB^{h}		
* *Urospermum picroides*	BB^{h}	L	B	BB^{h}				BB^{h}				BB^{h}				
* *Ursinia anthemoides*	B													B		
AVICENNIACEAE																
Avicennia marina	JB			JB								JB				
BRASSICACEAE																
* *Cakile maritima*	B		B	B				B				B		B		
* *Homungia procumbens*			BB^{h}											B		
Lepidium lyratogynum			B											BB^{h}L^{h}		
Lepidium puberulum	BB^{h}		BB^{h}	B				BB^{h}				BB^{h}		BB^{h}L^{h}		
* *Raphanus raphanistrum*	BB^{h}															
* *Raphanus sativus*	BB^{h}															
* *Sisymbrium irio*																
* *Sisymbrium orientale*																
CACTACEAE																
* *Opuntia stricta*																
CAMPANULACEAE																
Wahlenbergia gracilis																
Wahlenbergia multicaulis																
CARYOPHYLLACEAE																
* *Petrorhagia velutina*																
* *Polycarpon tetraphyllum*																
* *Silene gallica*																
* *Silene nocturna*	BB^{h}		B													
Spergularia nesophila																
* *Spergularia rubra*																

PLANT NAME	Little North Island	Little Rat Island	Little Roma Island	"Little Stokes Island"	Morley Island	"Nitraria Island"	Rat Island	Roma Island	Sandy Island	Serventy Island	Shearwater Island	"Shearwater Islet"	Stokes Island	Suomi Island	Tapani Island	White Bank	White Island	Wooded Island
ASTERACEAE																		
* *Aster subulatus*							QL^{h}											
Brachyscome ciliaris		L^{h}																
* *Conyza albida*							Q^{h}											
* *Conyza bonariensis*		L					Q	L										
Euchiton sphaericus							QQ^{h}L^{h}											
Gnaphalium indutum																		
Olearia axillaris																		
* *Pseudognaphalium luteoalbum*		L^{h}					L											
* *Reichardia tingitana*							Q											
Senecio lautus	B	Q			JB		Q			JB			J				JBB^{h}	QJ
* *Sonchus oleraceus*	BB^{h}	L			JB	K	Q	L^{h}		B				QQ^{h}	K		B	J
* *Sonchus tenerrimus*																		
* *Urospermum picroides*					JB		Q			B							B	
* *Ursinia anthemoides*										B							B	
AVICENNIACEAE																		
Avicennia marina		L		L	JB					JBB^{h}				QJ				QX^{h}J
BRASSICACEAE																		
* *Cakile maritima*					JB		Q	L		B						L	B	QJ
* *Homungia procumbens*					JB					B								
Lepidium lyratogynum	BB^{h}																BB^{h}	
Lepidium puberulum	B				JB					B							B	
* *Raphanus raphanistrum*		L^{h}					QQ^{h}L^{h}			B								
* *Raphanus sativus*																		
* *Sisymbrium irio*														Q				
* *Sisymbrium orientale*		L					Q											
CACTACEAE																		
* *Opuntia stricta*							L											
CAMPANULACEAE																		
Wahlenbergia gracilis							QQ^{h}											
Wahlenbergia multicaulis							N^{h}											
CARYOPHYLLACEAE																		
* *Petrorhagia velutina*							Q											
* *Polycarpon tetraphyllum*		L^{h}																
* *Silene gallica*																	B	
* *Silene nocturna*		L			B					B								
Spergularia nesophila							QQ^{h}											
* *Spergularia rubra*		L						L^{h}										

TABLE 11b (continued)

PLANT NAME	Alexander Island	Bushby Island	Bynoe Island	Campbell Island	Crake Island	Dry Island	Gibson Island	Gilbert Island	Helms Island	"Helms Islet 2"	Joe Smith Island	Keru Island	"Landscope Island"	Leo Island	"Leo Islet 1"	"Leo Islet 2"	Little North Island	Little Rat Island	Little Roma Island	"Little Stokes Island"	Morley Island	"Nitraria Island"	Rat Island	Roma Island	Sandy Island	Serventy Island	Shearwater Island	"Shearwater Islet"	Stokes Island	Suomi Island	Tapani Island	White Bank	White Island	Wooded Island
	ISLAND																																	
CHENOPODIACEAE																																		
Atriplex bunburyana																							X^h											
Atriplex cinerea	BB^h		JB	JB	JB			BB^h	J		K	JB	K	JB			B				JB		QJL^h	L^h		JB	J		J	QJ	K		JB	X^{h}J
Atriplex paludosa subsp. *baudinii*																							L^h											
Atriplex sp.		L				L	L								L	L		L	L						L			L				L		
* *Chenopodium album*																		L^h																
* *Chenopodium murale*	BB^h										K		K									K	QX^h											X^h
Enchylaena tomentosa	B	L	B											B			L	L			B		QX^h	L									B	QJ
Halosarcia halocnemoides	B	J	B	B	B									JB				Q			JB		Q	L		L				QJ			B	
Halosarcia indica subsp. *bidens*																		Q					QX^{h}L^h											
Rhagodia sp.																							Q											
Rhagodia preisii subsp. *obovata*																		L^h					L^h											
* *Salsola kali*			B	J	B									JB							JB		QX^h											
Sarcocornia quinqueflora	JB		B	JB	J	L		B				B		B				L		L	JB		X^h			JB	J		L	Q	K		B	X^h
Suaeda australis																						K									K			X^h
Threlkeldia diffusa	B	L	B	B				B			K	B		B			B	L			JB	K	X^h	L	L	B				Q			B	QJ
COLCHICACEAE																																		
Wurmbea monantha	B																									B								
CONVOLVULACEAE																																		
* *Ipomoea cairica*																		L																
CRASSULACEAE																																		
* *Bryophyllum* sp.																							L											
Crassula colorata	BB^h		B	B								BB^h		B							JB		N^{h}L^h			B				Q			B	
Crassula exserta			B^h	B^h										B^{h}L^h																			B^h	
CUCUBITACEAE																																		
* *Cucurbita pepo*																							Q											
EUPHORBIACEAE																																		
Euphorbia drummondii																		L^h					Q											
* *Euphorbia terracina*																		L^h					JL^h											
FRANKENIACEAE																																		
Frankenia pauciflora		L		BB^h														L					Q											
GENTIANACEAE																																		
* *Centaurium erythraea*		L																L^h																
GERANIACEAE																																		
* *Erodium cicutarium*																		Q					Q											
Pelargonium zonale																							Q											

TABLE 11b (continued)

PLANT NAME	Alexander Island	Bushby Island	Bynoe Island	Campbell Island	Crake Island	Dry Island	Gibson Island	Gilbert Island	Helms Island	"Helms Islet 2"	Joe Smith Island	Keru Island	"Landscope Island"	Leo Island	"Leo Islet 1"	"Leo Islet 2"	Little North Island	Little Rat Island	Little Roma Island	"Little Stokes Island"	Morley Island	"Nitraria Island"	Rat Island	Roma Island	Sandy Island	Serventy Island	Shearwater Island	"Shearwater Islet"	Stokes Island	Suomi Island	Tapani Island	White Bank	White Island	Wooded Island
	ISLAND																																	
GOODENIACEAE																																		
Scaevola crassifolia				B																			L							Q				
JUNCAGINACEAE																																		
Triglochin tricophorum												N^h											Q			B								
MALVACEAE																																		
* Lavatera cretica																	B^h																B^h	
Lavatera plebeia	BB^h		B	B				B			K	B	K	B			B	Q					Q	L						Q			B	QJ
Lavatera sp.																												L						
* Malva parviflora																							L^h											
MYOPORACEAE																																		
Myoporum insulare	JB		JB	B	J		J	B			K	JB	K	B			B				JB	K	J	L	L	JB			J	Q	K		JB	QX^hJ
PAPILIONACEAE																																		
* Medicago polymorpha																		L					Q							Q				
* Medicago sp.																							X^h											
* Melilotus indicus		L																L					QX^hL^h											
PLANTAGINACEAE																																		
* Plantago coronopus																		L^h																
PLUMBAGINACEAE																																		
Muellerolimon salicorniaceum																		L					QQ^hL^h											
POACEAE																																		
Austrostipa variabilis																							Q											
* Avena barbata																								L										J
* Avena fatua	B																	Q					Q			B				Q				Q
* Avena sp.		L																																
Bromus arenarius	B		BB^h	B								B		B			B	L			JB		Q			B				Q			B	N^h
* Bromus diandrus	BB^h			B				BB^h						B																				J
Bromus sp.				B^h																														
* Cynodon dactylon																							Q											Q
* Cynodon sp.																							X^h											
* Ehrharta longiflora	BB^h	L	B	BB^h				B									BB^h	L			JB		L			B							BB^h	J
Eragrostis dielsii																		L					QQ^h											
* Hordeum leporinum	BB^h																																	
* Lolium temulentum				B										B									Q											
* Parapholis incurva			BB^h	B								B		B							B			L										
* Pennisetum clandestinum																		L																
* Phalaris minor	BB^h																				B					B				Q				
* Rostraria cristata			B																							BB^h								

TABLE 11b (continued)

PLANT NAME	ISLAND																																	
	Alexander Island	Bushby Island	Bynoe Island	Campbell Island	Crake Island	Dry Island	Gibson Island	Gilbert Island	Helms Island	"Helms Islet 2"	Joe Smith Island	Keru Island	"Landscope Island"	Leo Island	"Leo Islet 1"	"Leo Islet 2"	Little North Island	Little Rat Island	Little Roma Island	"Little Stokes Island"	Morley Island	"Nitraria Island"	Rat Island	Roma Island	Sandy Island	Serventy Island	Shearwater Island	"Shearwater Islet"	Stokes Island	Suomi Island	Tapani Island	White Bank	White Island	Wooded Island
Setaria dielsii	B	L	B			L		BB^h				BB^h					L^h	L^h			B		QQ^{h}X^{h}L^h	L										
Spinifex longifolius			JB	JB				B				B		JBB^h							JB		Q		L	JB				Q		L	B	QJ
• *Vulpia myuros*																		L					N^h			B								
POLYGONACEAE																																		
• *Emex australis*																							J											
PRIMULACEAE																																		
• *Anagallis arvensis*	BB^h	L																L					QQ^h			B								
RUTACEAE																																		
Diplolaena grandiflora																		L					QQ^{h}X^{h}N^h											
SOLANACEAE																																		
• *Lycium ferocissimum*																																		QF
• *Lycopersicon esculentum*																							Q	L										
Nicotiana occidentalis subsp. *hesperis*	B																				JB												BB^h	Q^h
• *Solanum nigrum*		L																L					L	L										
URTICACEAE																																		
Parietaria cardiostegia			B^h									B^h																						
Parietaria debilis	B		B									B		B			B				B		Q										B	
ZYGOPHYLLACEAE																																		
Nitraria billardierei	JB	L	B	JB	JB	L	L	JB	J		K	B	K	JB	L	L	B	L			JB	K	QJ	L		JB	J	L	J	Q	K	L	B	QX^{h}J

TABLE 11c

List of vascular plants found in the Pelsaert Group of the Abrolhos islands, showing occurrence on each island. Introduced/naturalized species are denoted by an asterisk. Letters denote recordings of the species by researchers (see Table 12, p. 574); letters followed by the superscript "h" indicate that the researcher has lodged specimens at the Western Australian Herbarium.

Further details for some of the species follow.

**Anagallis arvensis* found by Aquinas on Middle and Pelsaert Islands is **A. arvensis* var. *caerulea* (WAHerb records).

Frankenia pauciflora variants with different-coloured flowers were noted by O'Loughlin (1969).

PLANT NAME	ISLAND																																								
	Arthur Island	Basile Island	Burnett Island	Burton Island	Coronation Island	Davis Island	Eight Island	Foale Island	Gaze Island	"Gaze Islet 1"	Gregory Island	Gun Island	"Gun Islet"	Hummock Island	Iris Refuge Island	Jackson Island	Jon Jim Island	Lagoon Island	"Little Jackson Island"	Middle Island	Murray Island	Newman Island	Nook Island	One Island	Pelsaert Island	Post Office Island	Robertson Island	Rotondella Island	Sandy Island	Seven Island	"Seven Islet"	Ship Rock	Sid Liddon Island	Square Island	Stick Island	Sweet Island	The Coral Patches	Three Island	Travia Island	Two Island	Uncle Margie Island
AIZOACEAE																																									
Carpobrotus virescens	L		B	B	B	L	K					Q	L	J		B	A	K	B	QJ	Q		J	L	W^{h}QAJB	B		L								L		K		L	
* *Mesembryanthemum crystallinum*		B	B	B		L	K	L				Q		L		B	QA	K	B	Q	Q	B	J	L	QAJB			B	L	L	L	L	L	Q		L	L	K		L	B
APIACEAE																																									
Apium prostratum																				Q																					
Daucus glochidiatus																				T^{h}																					
Hydrocotyle diantha		T																		QT^{h}																					
ASCLEPIADACEAE																																									
Sarcostemma viminale subsp. *australe*		T																		QJT^{h}																					
ASPHODELACEAE																																									
Bulbine semibarbata																				QT^{h}					A																
ASTERACEAE																																									
Actites megalocarpa																									A																
* *Erigeron karvinskianus*												Q									Q																				
* *Hypochaeris glabra*		B																																							
* *Reichardia tingitana*		B^{h}																		T																					
Senecio lautus		B	B	B	B									J		B		K	B	QT		B			QAB	BT		B						QJ	B			K			
* *Sonchus oleraceus*		B	BB^{h}	B	B											B		K	B			B			AB	BT		B					L	Q	B						B
* *Sonchus tenerrimus*			B	B			K																																		
* *Urospermum picroides*			B	B								T														B															B
* *Ursinia anthemoides*		B	B																																						
AVICENNIACEAE																																									
Avicennia marina		JB	JB	B	JB				K						L	B			B			JB			Z^{h}QAJB	JB	L												K		JB
BRASSICACEAE																																									
* *Cakile maritima*		B		B	B															T		B			QAB	B		B	L					Q	B						B
* *Hornungia procumbens*				B																					A																
Lepidium pseudoruderale			B	B	B											B			B			B			Q	B								Q							
* *Raphanus raphanistrum*		B										Q									Q				A	T															
* *Raphanus sativus*		B	BB^{h}																																						
* *Sisymbrium orientale*			BB^{h}																																						
CACTACEAE																																									
* *Opuntia stricta*		J																																							
CARYOPHYLLACEAE																																									
* *Cerastium glomeratum*							K																															K			
* *Polycarpon tetraphyllum*		BB^{h}														B																									
* *Spergularia diandra*												L																													
* *Spergularia rubra*																									A													K			

TABLE 11c (continued)

	ISLAND																																								
PLANT NAME	Arthur Island	Basile Island	Burnett Island	Burton Island	Coronation Island	Davis Island	Eight Island	Foale Island	Gaze Island	"Gaze Islet 1"	Gregory Island	Gun Island	"Gun Islet"	Hummock Island	Iris Refuge Island	Jackson Island	Jon Jim Island	Lagoon Island	"Little Jackson Island"	Middle Island	Murray Island	Newman Island	Nook Island	One Island	Pelsaert Island	Post Office Island	Robertson Island	Rotondella Island	Sandy Island	Seven Island	"Seven Islet"	Ship Rock	Sid Liddon Island	Square Island	Stick Island	Sweet Island	The Coral Patches	Three Island	Travia Island	Two Island	Uncle Margie Island
CHENOPODIACEAE																																									
Atriplex amnicola												Q									Q				Q																
Atriplex cinerea		B	B	B	B		K		K			Q		J		B	Q	K	B	Q	Q	B	J		QJB	BT		B						QJ	JB			K			
Atriplex sp.	L					L		L		L	L		L		L		A							L	A		L			L	L		L			L	L		L	L	
* *Chenopodium murale*				BB^{h}								Q							BB^{h}						QAB									Q							B
Enchylaena tomentosa		B	B	B		L	K					Q					QA	K	B	Q	Q				QAB	B						L		Q				L			B
Halosarcia halocnemoides	L	B	BL^{h}	B	B	L			K	L	L		L			B		K	B			B	L	L	AB	BT		B		L						L		K	L	L	B
Halosarcia indica subsp. *bidens*																		K							QA																
* *Salsola kali*		B			B																				QAB										B						
Sarcocornia quinqueflora	L	JB	B		B				K	L				L		B			B			B			AJB	B										L			K		B
Sclerostegia arbuscula												Q								Q	Q				Q																
Suaeda australis																						B^{h}			QA																
Threlkeldia diffusa		B	B	B	B		K		K							B	A	K	B			B			V^{h}QAB	B		B	L^{h}					Q	B			K	K		B
CRASSULACEAE																																									
Crassula colorata		BT		B																Q					A										B						
EUPHORBIACEAE																																									
Euphorbia drummondii																				Q																					
Euphorbia tannensis																				Q																					
FRANKENIACEAE																																									
Frankenia pauciflora						L						QT								Q	Q				QAB											L					
GENTIANACEAE																																									
* *Centaurium spicatum*		T										T													A																
GERANIACEAE																																									
* *Erodium cicutarium*																				Q					AB									Q							
GOODENIACEAE																																									
Scaevola crassifolia																									QAB																
JUNCAGINACEAE																																									
Triglochin mucronatum												T								Q					AA^{h}													K			
Triglochin trichophorum																									A																
MALVACEAE																																									
Lavatera plebeia		BT	B	B	B							T				B			B	QT		B			QAB	T								Q							
* *Malva parviflora*																						B^{h}											L								
MYOPORACEAE																																									
Eremophila glabra		T																		Q																					
Myoporum insulare	L	B	B	B	B							L				B		K	B	JT		B			QAJB	B		L							JB				L		B
PAPILIONACEAE																																									
* *Medicago polymorpha*																									A																
* *Melilotus indicus*		BB^{h}										QT^{h}													A	T															
PITTOSPORACEAE																																									
Pittosporum phylliraeoides																				Q																					
PLANTAGINACEAE																																									
Plantago debilis																				Q																					

TABLE 11c (continued)

	ISLAND																																								
PLANT NAME	Arthur Island	Basile Island	Burnett Island	Burton Island	Coronation Island	Davis Island	Eight Island	Foale Island	Gaze Island	"Gaze Islet 1"	Gregory Island	Gun Island	"Gun Islet"	Hummock Island	Iris Refuge Island	Jackson Island	Jon Jim Island	Lagoon Island	"Little Jackson Island"	Middle Island	Murray Island	Newman Island	Nook Island	One Island	Pelsaert Island	Post Office Island	Robertson Island	Rotondella Island	Sandy Island	Seven Island	"Seven Islet"	Ship Rock	Sid Liddon Island	Square Island	Stick Island	Sweet Island	The Coral Patches	Three Island	Travia Island	Two Island	Uncle Margie Island
PLUMBAGINACEAE																																									
Muellerolimon salicorniaceum																				Q																					
POACEAE																																									
Austrostipa elegantissima																				Q																					
* *Avena barbata*		B																							A																
* *Avena fatua*		B	B	B																					B																B
Bromus arenarius			B	B	B																	B			B	B									B						
* *Bromus diandrus*		BT		B			K																															K			
* *Bromus hordeaceus*																				Q					QA									Q							
* *Bromus rubens*		B?	B?																																						B?
Bromus sp.												L									L			L												L					
* *Ehrharta brevifolia*																									A																
* *Ehrharta calycina*		T																																							
* *Ehrharta longiflora*		B		B			K					T^h				B						B			A																BB^h
Eragrostis dielsii																									A																
* *Hordeum leporinum*		BB^h																																							
* *Lolium perenne*		BB^h																																							
* *Lolium rigidum*																									A																
* *Lolium temulentum*																																			B?						
* *Parapholis incurva*																																									B
* *Phalaris canariensis*																										T															
* *Phalaris minor*		B	B	B																						BB^h															B
* *Phleum pratensis*												L																													
Setaria dielsii			B	B								T^h								Q		B			QAB									Q				K			
Spinifex longifolius				B	B									J						T					V^{h}QAJB	B									JB						B
Sporobolus virginicus																				Q																					
PORTULACACEAE																																									
Calandrinia calyptrata																												B													B
PRIMULACEAE																																									
* *Anagallis arvensis*												T								Q					QA																
PROTEACEAE																																									
Grevillea argyrophylla		T																		QT^h	L^h																				
RUTACEAE																																									
Diplolaena grandiflora												Q																													
SOLANACEAE																																									
* *Lycium ferocissimum*	F					E	FK					F													BF					F			EF			EF		EFK			
* *Lycopersicon esculentum*																B				Q																					
Nicotiana occidentalis subsp. *hesperis*																				Q					A																
* *Solanum nigrum*							K					T																													
URTICACEAE																																									
Parietaria cardiostegia				B^h																																					
Parietaria debilis		B	B	B	B											B	A		B	Q		B			QAB	B								Q	B						
ZYGOPHYLLACEAE																																									
Nitraria billardierei	L	JB	B	B	JB		K				L	Q	L	J	L	B	QA	K	B	QT	Q	B	J		QAJB	BT		B		L	L	L	L	Q	B	L	L	K	L	L	B

TABLE 12

Key to accompany the plant species lists (Table 11). The list of islands visited by each worker only includes islands on which they collected flora or vegetation information.

CODE	RESEARCHER	REFERENCE	CURRENT ISLAND NAME	DATE ISLAND WAS VISITED
A, A^h	I. Abbott	Abbott (1980), WAHerb records	Akerstrom, Alcatraz, Barge Rock, Beacon, East Wallabi, Little Pigeon, Long, Marinula, Oystercatcher, Pigeon, Plover, Seagull, Shag Rock, Tattler, Turnstone, "Eagle Point Islet", "East Mangrove", Jon Jim, Pelsaert Islands	9/10/1975–4/11/1975
B	J. Harvey	Harvey diaries	Pelsaert Island	February 1984
B, B^h	J. Harvey and J. Alford	WAHerb records	Alexander, Basile, Burnett, Burton, Bynoe, Campbell, Coronation, Crake, Dakin, Dick, Eastern, East Wallabi, "G Island", Gilbert, Hall, Jackson, Keru, Leo, "Little Jackson Island", Little North, Morley, Newman, Pelsaert, Pigeon, Post Office, Rotondella, Saville-Kent, Seal, Serventy, Stick, Uncle Margie, West Wallabi, White Islands	1/10/1987–7/10/1987
C^h	E.M. Scrymgeour	WAHerb records	Seal Island	4/09/1963
E	Geraldton College of TAFE	Geraldton Regional College of TAFE (1997)	Davis, Sid Liddon, Sweet, Three Islands	21/6/1997–28/6/1997
F	P. Fuller and A. Burbidge	P. Fuller and A. Burbidge diaries	Wooded, Arthur, Eight, Gun, Pelsaert, Seven, Sid Liddon, Sweet, Three, Two Islands	1990–1997 (see Table 5 on p. 550 for more specific dates)
G^h	M.E. Gillham	WAHerb records	East Wallabi, West Wallabi Islands	7/09/1959-10/09/1959
H^h	A.M. Ashby	WAHerb records	East Wallabi Island	19/07/1970
J	R.E. Johnstone	Johnstone diaries, Johnstone and Coate (1992), Johnstone (1992), Johnstone and Storr (1994)	Morley, Pelsaert, Rat, Wooded Islands	21/08/1977–24/08/1977
			Alexander, Basile, Beacon, Leo, Long, Nook, Pelsaert, Post Office, Serventy, Wooded Islands	4/05/1981–7/05/1981
			North Island	8/05/1981–9/05/1981
			Akerstrom, Campbell, Gibson, Long, Morley, Newman, Rat, Serventy, Suomi, West Wallabi Islands	6/10/1981–8/10/1981
			Alcatraz, Alexander, Basile, Beacon, Burnett, Bushby, Bynoe, Coronation, Crake, Dakin, Dick, Eastern, East Wallabi, Gilbert, Hall, Helms, Hummock, Keru, Little Pigeon, Little Roma, Long, Middle, Morley, Newman, Pigeon, Rat, Saville-Kent, Seagull, Seal, Serventy, Shearwater, Square, Stick, Stokes, Suomi, Uncle Margie, West Wallabi, White, Wooded Islands	11/08/1983–18/08/1983
K	K. Coate	Coate diaries, Kenneally *et al.* (1999)	Eight, First Sister, Gaze, Joe Smith, Lagoon, "Landscope", "Naturalist", "Nitraria", Second Sister, Shag Rock, Tapani, "Tectus", Third Sister, Three, Traitors, Travia, Wann, West Wallabi Islands	17/02/1999–20/02/1999

L, L^h	J. Harvey and V. Longman		All islands and islets of Wallabi Group (except "Far Islet 1" and "Far Islet 2") – see Table 6 on pp. 551–556	17/11/1999–21/11/1999
			Bushby, Leo, "Leo Islet 1", Little Rat, Rat, Roma Islands	22/11/1999
L, L^h	P. Fuller and J. Blyth		Alexander, "Alexander Islet", Bynoe, Campbell, Crake, Disappearing, Dry, Gibson, Gilbert, Helms, "Helms Islet 2", Joe Smith, Keru, "Landscope", "Leo Islet 2", Little North, Little Roma, "Little Stokes", "Nitraria", Sandy, Serventy, Shearwater, "Shearwater Islet", Stokes, Suomi, Tapani, White Bank, White Islands	23/11/1999–25/11/1999
			Arthur, Basile, Burnett, Burton, Coronation, Davis, Eight, Foale, Gaze, "Gaze Islet 1", Gregory, Gun, "Gun Islet", Hummock, Iris Refuge, Jackson, Lagoon, "Little Jackson", Murray, Newman, Nook, One, Pelsaert, Post Office, Robertson, Rotondella, Sandy, Seven, "Seven Islet", Ship Rock, Sid Liddon, Square, Stick, Sweet, The Coral Patches, Three, Travia, Two, Uncle Margie Islands	26/11/1999–30/11/1999
M^h	A.R. Main	WAHerb records	East Wallabi Island	13/02/1963, 15/12/1968, December 1968
N^h	N. Sammy	WAHerb records	Rat, Keru, Wooded Islands	29/08/1972, 31/08/1972, 2/09/1972, 3/09/1972
Q, Q^h	Aquinas College first expedition	O'Loughlin (1965)	Long Island	24/08/1964–31/08/1964
	Aquinas College second expedition	O'Loughlin (1966)	Eastern Island	23/08/1965–31/08/1965
	Aquinas College third and fourth expeditions	O'Loughlin (1969)	Gun, Jon Jim, Middle, Murray, Pelsaert, Square Islands	third expedition 24/08/1966–1/09/1966; fourth expedition 2/01/1968–12/01/1968
	Aquinas College fifth expedition	Green (1972), WAHerb records	Little Rat, Rat, Suomi, Wooded Islands	22/08/1970–28/08/1970
R^h	J.W. Green	WAHerb records	East Wallabi, Seal Islands	6/04/1978–7/04/1978
S, S^h	G.M. Storr	Storr (1960, 1965), WAHerb records	North Island	16/04/1959–22/04/1959, 21/06/1959–25/06/1959, 2/09/1959–12/09/1959, 22/04/1960–27/04/1960
T, T^h	P. Roberts	Roberts* (personal communication), WA Herb records	Gun, Middle, Post Office and Basile Islands	11/09/1988
V^h	D.L. Serventy	WAHerb records	Pelsaert Island	4/11/1943
W^h	W.B. Alexander	WAHerb records	North, East Wallabi, Pelsaert Islands	November 1913
X^h	A.S. George	WAHerb records	Rat, Wooded Islands	13/05/1972–16/05/1972
Y^h	R.D. Royce	WAHerb records	East Wallabi Island	13/05/1960
Z^h	G.G. Smith	WAHerb records	Pelsaert Island	September 1947

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TABLE 13

Specimens lodged at the Western Australian Herbarium with incomplete collection location descriptions (WAHerb).

Where other specimens of exactly the same taxon and with known collection locations have been recorded or lodged (see Table 11, p. 559) they are indicated on the table below (with W, E or P to show the island group); similarly, when these are the only recording of this species they are recorded in the table as 'not recorded elsewhere'.

PLANT NAME	COLLECTOR	DATE ON SPECIMEN	ISLAND DESCRIPTION	COLLECTED OR RECORDED IN WALLABI, EASTER OR PELSAERT GROUPS BY OTHER WORKERS		
AIZOACEAE						
Carpobrotus sp.	Aquinas College Expedition	August 1972	Easter Group		E	
Carpobrotus virescens	N. Sammy	30/08/72	Island S of Island , No. 20 Easter Group	W	E	P
AMARANTHACEAE						
Ptilotus divaricatus var. *divaricatus*	W.B. Alexander	1/11/13	Wallabi Island	W		
APIACEAE						
Daucus glochidiatus	Aquinas College Expedition	30/08/72	Island No. 20. Easter Group	W	E	P
APOCYNACEAE						
Alyxia buxifolia	A.R. Main	1/10/63	Wallabi Island	W		
ASCLEPIADACEAE						
Sarcostemma viminale ssp. *australe*	R. Helms	Nov 1897	Abrolhos Islands	W		P
ASTERACEAE						
Gnaphalium indutum	N. Sammy	31/08/72	Easter Group	W	E	
Podotheca angustifolia	G.M. Storr	6/09/59	Houtman Abrolhos	W		
**Pseudognaphalium luteo-album*	R. Helms	Nov 1897	Abrolhos Islands	W	E	
Senecio lautus ssp. *dissectifolius*	Aquinas College Expedition	1/08/65	Wallabi Group	W		
Senecio lautus ssp. *dissectifolius*	R. Helms	Nov 1897	Abrolhos Islands	W		
AVICENNIACEAE						
Avicennia marina	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
BRASSICACEAE						
**Hornungia procumbens*	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
**Hornungia procumbens*	N. Sammy	30/08/72	Island 20, Easter Group	W	E	P
Lepidium puberulum	Aquinas College Expedition	1/08/65	Wallabi Group	W	E	
CAPPARACEAE						
Capparis spinosa	Dr Stubbe	1/11/32	Abrolhos Islands	W		
CHENOPODIACEAE						
Atriplex cinerea	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
Atriplex paludosa ssp. *baudinii*	R. Helms	Nov 1897	Abrolhos Islands	W	E	
Enchylaena tomentosa	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
Halosarcia halocnemoides	N. Sammy	30/08/72	Island 20, Easter Group	W	E	P
Threlkeldia diffusa	N. Sammy	30/08/72	Island 20, Easter Group	W	E	P
Threlkeldia diffusa	Aquinas College Expedition	Aug 1972	Island south of Island 20	W	E	P
Threlkeldia diffusa	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
COLCHICACEAE						
Wurmbea monantha	Aquinas College Expedition	1/08/72	Easter Group	W	E	
Wurmbea monantha	N. Sammy	1/08/72	Island 20	W	E	
CUNONIACEAE						
Aphanopetalum clematideum	A.R. Main	1/10/63	Wallabi Island	W		
EUPHORBIACEAE						
Euphorbia drummondii	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
Phyllanthus calycinus	A.R. Main	1/10/63	Wallabi Island	W		

TABLE 13 (continued)

PLANT NAME	COLLECTOR	DATE ON SPECIMEN	ISLAND DESCRIPTION	COLLECTED OR RECORDED IN WALLABI, EASTER OR PELSAERT GROUPS BY OTHER WORKERS		
GENTIANACEAE						
**Centaurium spicatum*	R. Helms	Nov 1897	Abrolhos Islands	W		P
GOODENIACEAE						
Scaevola crassifolia	W.B. Alexander	1/11/13	Wallabi Group	W	E	P
Scaevola cunninghamii	W.B. Alexander	1/11/13	Wallabi Group	not recorded elsewhere		
Scaevola spinescens	W.B. Alexander	1/11/13	Wallabi Group	not recorded elsewhere		
JUNCACEAE						
Juncus sp.	Aquinas College Expedition	1/08/72	Easter Group	W		
MALVACEAE						
Lavatera plebeia	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
MIMOSACEAE						
Acacia didyma	A.R. Main	1/10/63	Wallabi Island	W		
MYOPORACEAE						
Myoporum insulare	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
MYRTACEAE						
Eucalyptus oraria	D.L. Serventy		Wallabi Island	W		
ORCHIDACEAE						
Prasophyllum calcicola	N. Sammy	28/09/72	Island 20, Easter Group	not recorded elsewhere		
Prasophyllum calcicola	Aquinas College		Island 20, Easter Group	not recorded elsewhere		
PAPILIONACEAE						
**Melilotus indicus*	Aquinas College Expedition	1/08/65	Wallabi Group	W	E	P
Swainsona calcicola	W.B. Alexander	1/11/13	Abrolhos Islands	not recorded elsewhere		
PITTOSPORACEAE						
Marianthus candidus	Gilbert	1842	South Island	not recorded elsewhere		
Pittosporum phylliraeoides var. *phylliraeoides*	R. Helms	Nov 1897	Abrolhos Islands	W		
PLUMBAGINACEAE						
Muellerolimon salicorniaceum	Aquinas College Expedition	1/08/65	Wallabi Group	W	E	P
Muellerolimon salicorniaceum	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
POACEAE						
Austrostipa elegantissima	A.R. Main	1/10/63	Wallabi Island	W		P
Austrostipa elegantissima	R. Helms	Nov 1897	Abrolhos Islands	W		P
Bromus arenarius	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
**Hordeum leporinum*	N. Sammy	30/08/72	Island 21, Easter Group	W	E	P
Setaria dielsii	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
Setaria dielsii	Aquinas College Expedition	1/08/65	Abrolhos Islands	W	E	P
Spinifex longifolius	R. Helms	Nov 1897	Abrolhos Islands	W	E	P
PROTEACEAE						
Grevillea argyrophylla	A.R. Main	1/10/63	Wallabi Island	W		P
SAPINDACEAE						
Dodonaea bursariifolia	A.R. Main	1/10/63	Wallabi Island	not recorded elsewhere		
Dodonaea inaequifolia	A.R. Main	1/10/63	Wallabi Island	W		
SOLANACEAE						
Nicotiana occidentalis ssp. *hesperis*	Aquinas College Expedition	1/08/65	Wallabi Group	W	E	P
STERCULIACEAE						
Lasiopetalum angustifolium	A.R. Main	1/10/63	Wallabi Island	W		

TABLE 14

Changes and corrections to plant names.

NAME PROGRESSION			REFERENCE
NAME 1	NAME 2	NAME 3	
Acacia bivenosa	*Acacia didyma*		Storr (1965), Abbott (1980)
Actinobole uliginosum	*Actinobole condensatum*		Abbott (1980)
**Anagallis femina*	* *Anagallis arvensis*		Storr (1965)
Anguillaria dioica	*Wurmbea dioica*	*Wurmbea monantha*	Storr (1965)
Apium australe	*Apium annuum*		Storr (1965), Abbott (1980)
Arthrocnemum arbuscula	*Sclerostegia arbuscula*		Storr (1965), Abbott (1980)
Arthrocnemum arbusculum	*Sclerostegia arbuscula*		O'Loughlin (1969)
Arthrocnemum bidens	*Halosarcia indica* ssp. *bidens*		O'Loughlin (1969), Green (1972), Abbott (1980)
Arthrocnemum halocnemoides	*Halosarcia halocnemoides*		Storr (1965), Green (1972), Abbott (1980)
Atriplex rhagodioides	*Atriplex amnicola*		O'Loughlin (1969)
Bossiaea rufa var. *foliosa*	*Bossiaea spinescens*		Storr (1965), Abbott (1980)
Brachycome ciliaris	*Brachyscome ciliaris*		Storr (1965)
Brachycome iberidifolia	*Brachyscome iberidifolia*		Storr (1965)
**Bromus gussonii*	* *Bromus diandrus*		O'Loughlin (1965)
**Bromus molliformis*	* *Bromus hordeaceus*		Storr (1965)
Bromus mollis	* *Bromus hordeaceus*		O'Loughlin (1966), O'Loughlin (1969)
Bulbinopsis semibarbata	*Bulbine semibarbata*		Green (1972), Abbott (1980)
Calocephalus aeruoides	*Calocephalus aervoides*		Storr (1965)
**Carpobrotus aequilaterus*	*Carpobrotus virescens*		Storr (1965), O'Loughlin (1965, 1966, 1969)
Chenopodium carinatum	*Chenopodium melanocarpum*		Storr (1965), Abbott (1980)
Chenopodium plantaginellum	*Dysphania plantaginella*		Storr (1965), Abbott (1980)
**Cryophytum crystallinum*	* *Gasoul crystallinum*	* *Mesembryanthemum crystallinum*	Storr (1965), O'Loughlin (1965, 1966, 1969)
Danthonia caespitosa	*Notodanthonia caespitosa*	*Austrodanthonia caespitosa*	Storr (1965)
Didiscus pilosus	*Trachymene pilosa*		Storr (1965)
Diplolaena dampieri	*Diplolaena grandiflora*		Storr (1965), O'Loughlin (1969), Abbott (1980), Johnstone and Storr (1994)
Disphyma blackii	*Disphyma crassifolium* ssp. *clavellatum*		Green (1972)
Erigeron crispis	* *Erigeron karvinskianus*		O'Loughlin (1969)
**Erythraea centaurium*	* *Centaurium spicatum*		Storr (1965)
Euphorbia clutioides	*Euphorbia tannensis*		Storr (1965), O'Loughlin (1969)
Exocarpos aphylla	*Exocarpos aphyllus*		Storr (1965), O'Loughlin (1965), Abbott (1980)
Exocarpos spartea	*Exocarpos sparteus*		Storr (1965)
Frankenia panciflora	*Frankenia pauciflora*		O'Loughlin (1969)
Galium sp.	*Galium migrans*		Storr (1965), Abbott (1980)
**Gasoul crystallinum*	* *Mesembryanthemum crystallinum*		Abbott (1980)
Gnaphalodes uligulosus	*Actinobolode condensatum*		Storr (1965)
Gnaphalium involucratum	*Gnaphalium sphaericum*	*Euchiton sphaericus*	Green (1972)
**Gnaphalium luteo-album*	* *Pseudognaphalium luteoalbum*		Storr (1965)
Hibbertia subvaginata	*Hibbertia racemosa*		Storr (1965), Abbott (1980), Johnstone and Storr (1994)
**Hymenolobus procumbens*	* *Hornungia procumbens*		Storr (1965), O'Loughlin (1966), Abbott (1980)
**Koeleria phleoides*	* *Trisetaria cristata*	* *Rostraria cristata*	Storr (1965)
Lavatera plebeja	*Lavatera plebeia*		Storr (1965)
Limonium salicorniaceum	*Muellerolimon salicorniaceum*		Storr (1965), O'Loughlin (1969), Green (1972), Abbott (1980)
Lolium loliaceum	* *Lolium rigidum*		Abbott (1980)
**Lophochloa cristata*	* *Trisetaria cristata*	* *Rostraria cristata*	Abbott (1980)
**Lycopersicon lycopersicum*	* *Lycopersicon esculentum*		Green (1972)
**Medicago polymorpha* ssp. *vulgaris*	* *Medicago polymorpha* var. *vulgaris*	* *Medicago polymorpha*	Green (1972)
**Melilotus indica*	* *Melilotus indicus*		O'Loughlin (1969), Green (1972), Abbott (1980).

TABLE 14 (continued)

NAME PROGRESSION			REFERENCE
NAME 1	NAME 2	NAME 3	
Microtis unifolia	*Microtis media*		Storr (1965), Abbott (1980)
Myoporum adscendens	*Myoporum insulare*		Green (1972), Abbott (1980)
Nicotiana hesperis	*Nicotiana occidentalis* ssp. *hesperis*		O'Loughlin (1969)
Nicotiana rotundifolia	*Nicotiana occidentalis* ssp. *hesperis*		Storr (1965), Abbott (1980), Johnstone (1992)
Nitraria schoberi	*Nitraria billardierei*		Storr (1965), O'Loughlin (1965, 1966, 1969) Abbott (1980)
**Petrorhagia prolifera*	* *Petrorhagia velutina*		Green (1972)
**Picris hieracioides*	* *Urospermum picroides*		Storr (1965), Abbott (1980)
Pimelea microphylla	*Pimelea microcephala*		Abbott (1980)
Pittosporum phillyreoides	*Pittosporum phylliraeoides*		Storr (1965)
Plantago varia	*Plantago debilis*		Storr (1965), O'Loughlin (1969), Abbott (1980)
Poa caespitosa	*Poa poiformis*		Storr (1965)
Podosperma angustifolium	*Podotheca angustifolia*		Storr (1965)
Polypogon monspeiliensis	*Polypogon monspeliensis*		O'Loughlin (1965)
Ptilotus eriotrichum	*Ptilotus eriotrichus*		Abbott (1980)
Ranunculus parviflorus	*Ranunculus sessilflorus*		Storr (1965), Abbott (1980)
Salicornia sp.	*Sarcocornia quinqueflora*		Green (1972)
Salicornia australis	*Sarcocornia quinqueflora*		Storr (1965), O'Loughlin (1965)
Sarcocornia blackiana	*Sarcocornia quinqueflora*		Johnstone (1992)
Sarcocornia sp.	*Sarcocornia quinqueflora*		Abbott (1980)
Sarcostemma australe	*Sarcostemma viminale* ssp. *australe*		Storr (1965), O'Loughlin (1969), Abbott (1980), Johnstone and Storr (1994)
**Scirpus antarcticus*	* *Isolepis marginata*		Storr (1965)
Senecio brachyglossus	*Senecio glossanthus*		Storr (1965), Abbott (1980)
Sonchus megalocarpus	*Actites megalocarpa*		O'Loughlin (1965)
**Spergularia rubra*	*Spergularia nesophila*		Green (1972)
Spinifex longifolia	*Spinifex longifolius*		O'Loughlin (1965)
Stipa crinita	*Austrostipa crinita*		Storr (1965)
Stipa elegantissima	*Austrostipa elegantissima*		Storr (1965), O'Loughlin (1969), Abbott (1980)
Stipa flavescens	*Austrostipa flavescens*		Abbott (1980)
Stipa variabilis	*Austrostipa variabilis*		Storr (1965), Green (1972)
Suaeda maritima	*Suaeda australis*		O'Loughlin (1965, 1969)
**Tetragonia zeyheri*	* *Mesembryanthemum crystallinum*		Green (1972) - an incorrect identification of the plant photographed on page 76
**Tetragonia zeyheri*	* *Tetragonia decumbens*		Johnstone and Coate (1992)
Thelkeldia diffusa	*Threlkeldia diffusa*		O'Loughlin (1965)
Thysanotus patersoni	*Thysanotus patersonii*		Storr (1965)
Trichinium obovatum	*Ptilotus obovatus*		Storr (1965)
Trichinium divaricatum	*Ptilotus divaricatus*		Storr (1965)
Trichinium eriotrichum	*Ptilotus eriotrichus*		Storr (1965)
Triglochin mucronata	*Triglochin mucronatum*		Storr (1965), O'Loughlin (1969), Abbott (1980)
Triglochin trichophora	*Triglochin trichophorum*		Storr (1965), Green (1972), Abbott (1980)
Vittadinia triloba	*Vittadinia cuneata* var. *cuneata*		Storr (1965), Abbott (1980)
Zygophyllum apiculatum	*Zygophyllum simile*		Storr (1965), Abbott (1980)

TABLE 15

Numbers of native and introduced species for each island of the Abrolhos, and a comparison of these numbers with occupation and mining disturbance for each island. Species information is not included for islands whose vegetation information resulted only from aerial photo interpretation. A note is made when a comprehensive flora survey has not been undertaken for a particular island. For this table, a species is defined as a taxon as appearing in Table 11 (p. 559). The percentage introduced is a measure of the proportion of weeds to total species on the island.

ISLAND NAME	NATIVE SPECIES	INTRODUCED SPECIES	TOTAL SPECIES	PERCENTAGE INTRODUCED	GUANO MINING	OCCUPIED BUILDINGS	FLORA SURVEY COMPLETENESS
WALLABI GROUP							
Akerstrom Island	23	4	27	15%			
Alcatraz Island	9	7	16	44%	✓	✓	
Barge Rock	11	7	18	39%			
Beacon Island	15	15	30	50%		✓	
Dakin Island	12	2	14	14%			
Dick Island	17	4	21	19%			
"Eagle Point Islet"	19	3	22	14%			
Eastern Island	18	7	25	28%			
"East Mangrove Island"	8	2	10	20%			
East Wallabi Island	98	26	124	21%			
Far Island	1	0	1	0%			
"Far Islet 1"	aerial photograph interpretation only						not comprehensive
"Far Islet 2"	aerial photograph interpretation only						not comprehensive
First Sister	13	3	16	19%			
"First Sister Islet"	4	1	5	20%			
"G Island"	4	0	4	0%			
Hall Island	4	1	5	20%			
Little Pigeon Island	24	17	41	41%	✓	✓	
Long Island	23	10	33	30%			
Marinula Island	15	2	17	12%			
"Naturalist Island"	5	1	6	17%			
North Island	51	26	77	34%		✓	
Oystercatcher Island	34	5	39	13%			
Pelican Island	7	3	10	30%			
Pigeon Island	45	29	74	39%	✓	✓	
Plover Island	4	3	7	43%			
Saville-Kent Island	10	1	11	9%			
Seagull Island	38	8	46	17%			
Seal Island	11	4	15	27%			
Second Sister	3	2	5	40%			
Shag Rock	4	1	5	20%			
"Shag Rock"	1	0	1	0%			
"Short Island"	3	1	4	25%			
Tattler Island	28	7	35	20%			
"Tectus Island"	7	1	8	13%			
Third Sister	5	2	7	29%			
Traitors Island	6	1	7	14%			
"Traitors Islet 1"	4	1	5	20%			
"Traitors Islet 2"	4	1	5	20%			
"Traitors Islet 3"	3	1	4	25%			
"Traitors Islet 4"	2	1	3	33%			
"Traitors Islet 5"	1	1	2	50%			
"Traitors Islet 6"	0	1	1	100%			
Turnstone Island	21	8	29	28%			
Wann Island	7	1	8	13%			
West Wallabi Island	72	25	97	26%	✓	✓	
EASTER GROUP							
Alexander Island	19	15	34	44%			
"Alexander Islet 1"	0	0	0	0%			
"Alexander Islet 2"	aerial photograph interpretation only						not comprehensive
Bushby Island	8	10	18	56%	✓	✓	
Bynoe Island	19	10	29	34%			
"Bynoe Islet 1"	aerial photograph interpretation only						not comprehensive

TABLE 15 (continued)

ISLAND NAME	NATIVE SPECIES	INTRODUCED SPECIES	TOTAL SPECIES	PERCENTAGE INTRODUCED	GUANO MINING	OCCUPIED BUILDINGS	FLORA SURVEY COMPLETENESS
"Bynoe Islet 2"	aerial photograph interpretation only						not comprehensive
"Bynoe Islet 3"	aerial photograph interpretation only						not comprehensive
"Bynoe Islet 4"	aerial photograph interpretation only						not comprehensive
Campbell Island	22	11	33	33%			
"Campbell Islet"	aerial photograph interpretation only						not comprehensive
Crake Island	7	3	10	30%			
Disappearing Island	0	0	0	0%			
Dry Island	4	1	5	20%			not comprehensive
Gibson Island	4	0	4	0%			not comprehensive
Gilbert Island	11	5	16	31%			
"Gilbert Islet 1"	aerial photograph interpretation only						not comprehensive
"Gilbert Islet 2"	aerial photograph interpretation only						not comprehensive
"Gilbert Islet 3"	aerial photograph interpretation only						not comprehensive
"Gilbert Islet 4"	aerial photograph interpretation only						not comprehensive
Helms Island	4	0	4	0%			not comprehensive
"Helms Islet 1"	aerial photograph interpretation only						not comprehensive
"Helms Islet 2"	1	0	1	0%			
Joe Smith Island	6	1	7	14%			
Keru Island	18	5	23	22%			
"Landscope Island"	4	3	7	43%			
Leo Island	20	9	29	31%		✓	
"Leo Islet 1"	3	0	3	0%			not comprehensive
"Leo Islet 2"	2	0	2	0%			not comprehensive
Little North Island	13	4	17	24%			
Little Rat Island	20	24	44	55%	✓	✓	
Little Roma Island	1	1	2	50%			not comprehensive
"Little Stokes Island"	2	0	2	0%			not comprehensive
Morley Island	17	10	27	37%			
"Morley Islet"	aerial photograph interpretation only						not comprehensive
"Nitraria Island"	5	3	8	38%			
Rat Island	37	34	71	48%	✓	✓	
"Rat Islet"	aerial photograph interpretation only						not comprehensive
Roma Island	9	10	19	53%	✓	✓	
"Roma Islet"	aerial photograph interpretation only						not comprehensive
Sandy Island	5	1	6	17%			not comprehensive
Serventy Island	17	13	30	43%			
"Serventy Islet 1"	aerial photograph interpretation only						not comprehensive
"Serventy Islet 2"	aerial photograph interpretation only						not comprehensive
"Serventy Islet 3"	aerial photograph interpretation only						not comprehensive
Shearwater Island	3	0	3	0%			not comprehensive
"Shearwater Islet"	3	0	3	0%			not comprehensive
Stokes Island	6	0	6	0%			not comprehensive
Suomi Island	13	5	18	28%			
Tapani Island	6	1	7	14%			
White Bank	3	1	4	25%			not comprehensive
White Island	20	8	28	29%			
"White Islet"	aerial photograph interpretation only						not comprehensive
Wooded Island	14	11	25	44%			
PELSAERT GROUP							
Arthur Island	6	1	7	14%			not comprehensive
Basile Island	17	21	38	55%		✓	
Burnett Island	15	10	25	40%		✓	
"Burnett Islet 1"	aerial photograph interpretation only						not comprehensive
"Burnett Islet 2"	aerial photograph interpretation only						not comprehensive
Burton Island	17	11	28	39%			
Coronation Island	14	3	17	18%		✓	
"Coronation Islet"	aerial photograph interpretation only						not comprehensive
Davis Island	5	2	7	29%	✓		not comprehensive

TABLE 15 (continued)

ISLAND NAME	NATIVE SPECIES	INTRODUCED SPECIES	TOTAL SPECIES	PERCENTAGE INTRODUCED	GUANO MINING	OCCUPIED BUILDINGS	FLORA SURVEY COMPLETENESS
Diver Island	aerial photograph interpretation only						not comprehensive
Eight Island	5	7	12	58%	✓		
Foale Island	1	1	2	50%		✓	not comprehensive
Gaze Island	5	0	5	0%			
"Gaze Islet 1"	3	0	3	0%			not comprehensive
"Gaze Islet 2"	aerial photograph interpretation only						not comprehensive
"Gaze Islet 3"	aerial photograph interpretation only						not comprehensive
Gregory Island	3	0	3	0%			not comprehensive
Gun Island	13	13	26	50%	✓		
"Gun Islet"	4	0	4	0%			
Hummock Island	6	1	7	14%			not comprehensive
Iris Refuge Island	3	0	3	0%			not comprehensive
Jackson Island	12	5	17	29%		✓	
"Jackson Islets" (7 islets)	aerial photograph interpretation only						not comprehensive
Jon Jim Island	7	1	8	13%			
Lagoon Island	9	2	11	18%			
"Little Jackson Island"	13	3	16	19%			
Middle Island	29	7	36	19%			
Murray Island	9	3	12	25%			
Newbold Island	aerial photograph interpretation only						not comprehensive
Newman Island	14	5	19	26%		✓	
"Newman Islet 1"	aerial photograph interpretation only						not comprehensive
"Newman Islet 2"	aerial photograph interpretation only						not comprehensive
Nook Island	4	1	5	20%		✓	not comprehensive
One Island	4	1	5	20%	✓		not comprehensive
Pelsaert Island	30	20	50	40%	✓		
Post Office Island	15	7	22	32%		✓	
"Post Office Islet"	aerial photograph interpretation only						not comprehensive
Robertson Island	2	0	2	0%		✓	not comprehensive
Rotondella Island	8	3	11	27%		✓	
"Rotondella Islet 1"	aerial photograph interpretation only						not comprehensive
"Rotondella Islet 2"	aerial photograph interpretation only						not comprehensive
Sandy Island	1	2	3	67%			not comprehensive
Seven Island	3	2	5	40%			not comprehensive
"Seven Islet"	2	1	3	33%			not comprehensive
Ship Rock	2	1	3	33%			not comprehensive
Sid Liddon Island	2	4	6	67%	✓		not comprehensive
Square Island	9	6	15	40%			
Stick Island	9	4	13	31%			
Sweet Island	7	2	9	22%	✓		not comprehensive
The Coral Patches (13 islets)	2	1	3	33%			not comprehensive
Three Island	9	5	14	36%	✓		not comprehensive
Travia Island	7	0	7	0%			
Two Island	4	1	5	20%			not comprehensive
Uncle Margie Island	9	10	19	53%		✓	
"Uncle Margie Islet"	aerial photograph interpretation only						not comprehensive

TABLE 16

Plant species that are present in all three groups of the Abrolhos.

PLANT NAME native plants	PLANT NAME introduced plants
Atriplex cinerea	* *Anagallis arvensis*
Avicennia marina	* *Avena barbata*
Bromus arenarius	* *Avena fatua*
Bulbine semibarbata	* *Bromus diandrus*
Carpobrotus virescens	* *Cakile maritima*
Crassula colorata	* *Chenopodium murale*
Daucus glochidiatus	* *Ehrharta longiflora*
Diplolaena grandiflora	* *Erodium cicutarium*
Enchylaena tomentosa	* *Hordeum leporinum*
Eragrostis dielsii	* *Hornungia procumbens*
Euphorbia drummondii	* *Malva parviflora*
Frankenia pauciflora	* *Medicago polymorpha*
Halosarcia halocnemoides	* *Melilotus indicus*
Halosarcia indica ssp. *bidens*	* *Mesembryanthemum crystallinum*
Hydrocotyle diantha	* *Parapholis incurva*
Lavatera plebeia	* *Phalaris minor*
Muellerolimon salicorniaceum	* *Polycarpon tetraphyllum*
Myoporum insulare	* *Raphanus raphanistrum*
Nicotiana occidentalis ssp. *hesperis*	* *Salsola kali*
Nitraria billardierei	* *Sisymbrium orientale*
Parietaria cardiostegia	* *Solanum nigrum*
Parietaria debilis	* *Sonchus oleraceus*
Sarcocornia quinqueflora	* *Spergularia rubra*
Scaevola crassifolia	* *Urospermum picroides*
Senecio lautus	
Setaria dielsii	
Spinifex longifolius	
Suaeda australis	
Threlkeldia diffusa	
Triglochin trichophorum	

Figures 2–69

Vegetation maps of the Abrolhos islands. Maps of the Wallabi Group islands (Figs 2–25) are followed by those of the Easter Group islands (Figs 26–43) and then the Pelsaert Group islands (Figs 44–69); maps of islands within each group are ordered roughly alphabetically. Mapping was based on the classification used by Beard (1981) and the binomial codes used to indicate vegetation types are defined in Table 7 (p. 534). Dominant plant species are also coded, according to Table 8 (p. 557). Note that when the letter *x* is used with bunch grasses (G) or forbs (F), it indicates mixed species, differing for each map and listed in the caption for each map. Where there are two or more strata, the code is given as a string, e.g. nSr a_2mZc xFi. Different surfaces are indicated with the codes **B** for beach, **BG** for bare ground, **C** for coral rubble, **D** for disturbed areas, **L** for lagoons, **R** for Rock and **S** for sinkhole. The accuracy of the vegetation mapping for each island is indicated on Table 9 (p. 558) by the numbers 1–6 (see Table 10, p. 534).

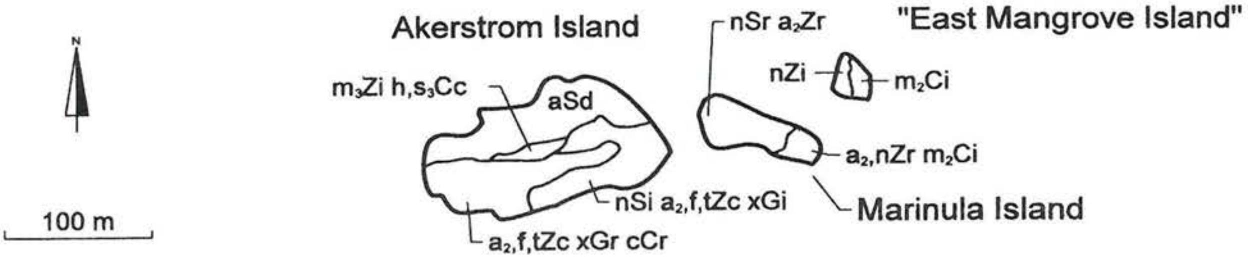

Figure 2. Vegetation map of Akerstrom Island, "East Mangrove Island", Marinula Island, Wallabi Group.
For Akerstrom Island, x of xGi and xGr includes Eragrostis dielsii, Setaria dielsii.

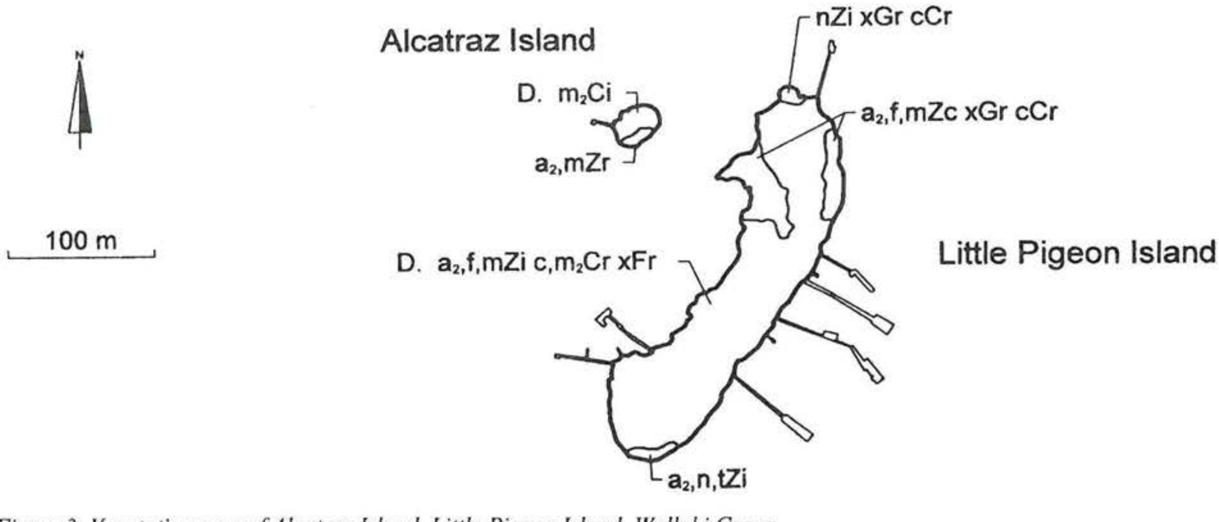

Figure 3. Vegetation map of Alcatraz Island, Little Pigeon Island, Wallabi Group.
For Little Pigeon Island, x of xFr includes *Conyza bonariensis, *Euphorbia tannensis *ssp.* eremophila, *Medicago polymorpha, Senecio lautus.
For Little Pigeon Island, x of xGr includes *Avena barbata, Bromus *sp.*, *Hordeum leporinum, *Lolium rigidum, *Polypogon monspeliensis, Setaria dielsii.

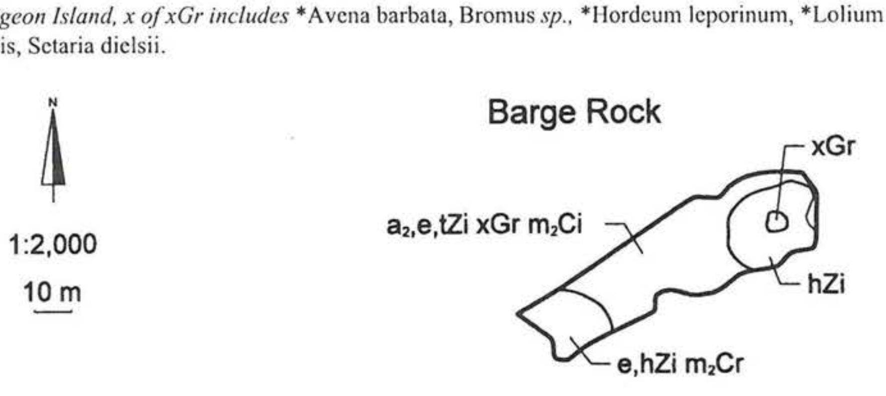

Figure 4. Vegetation map of Barge Rock, Wallabi Group.
For Barge Rock, x of xGr includes Bromus *spp.*, *Ehrharta longiflora, Setaria dielsii.

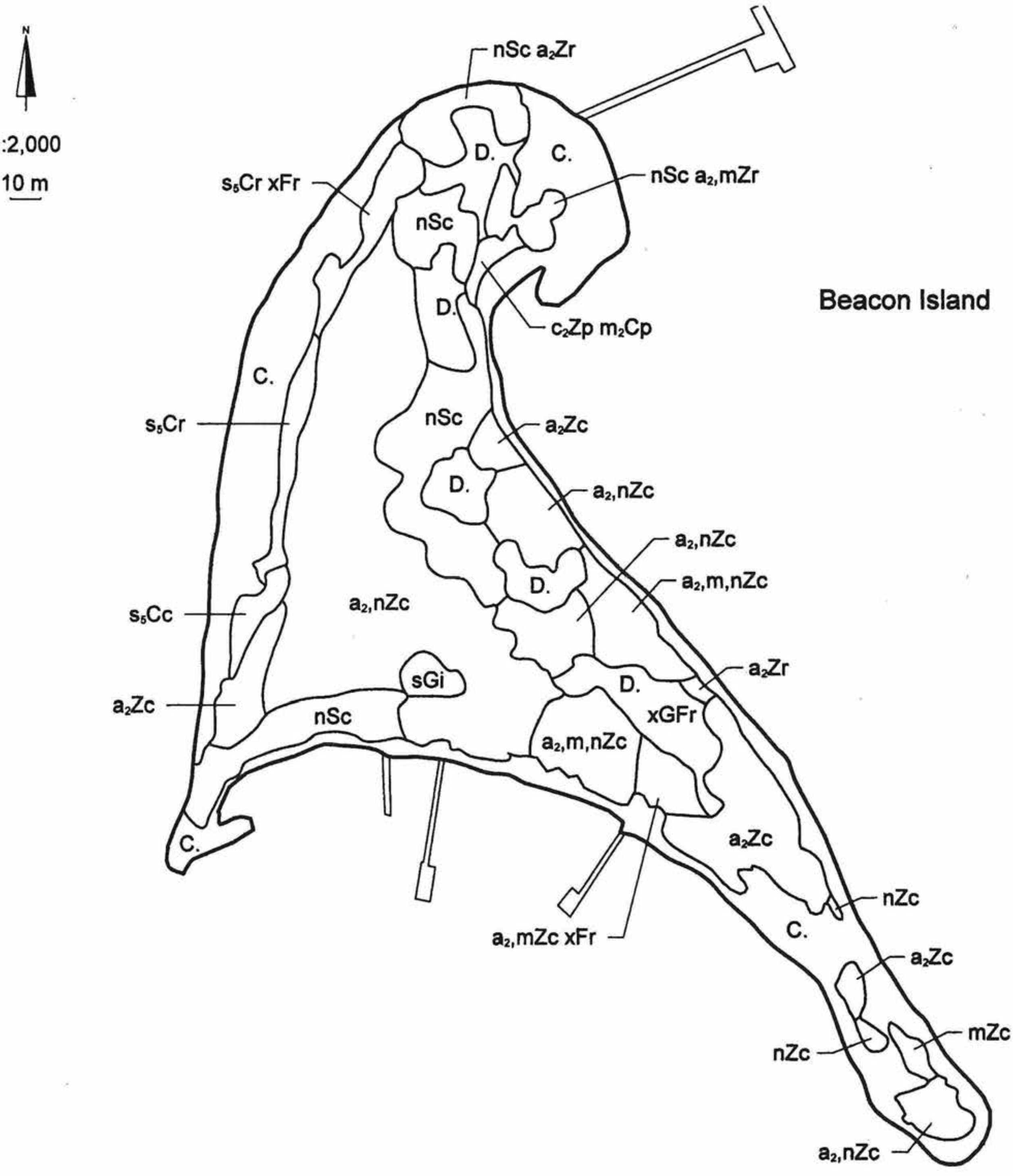

Figure 5. Vegetation map of Beacon Island, Wallabi Group.
For Beacon Island, x of xFr includes *Sisymbrium orientale, *Sonchus oleraceus.
For Beacon Island, x of xGFr includes *Avena *sp.*, Bromus *sp.*, *Poa annua, *Sisymbrium orientale, *Sonchus oleraceus.

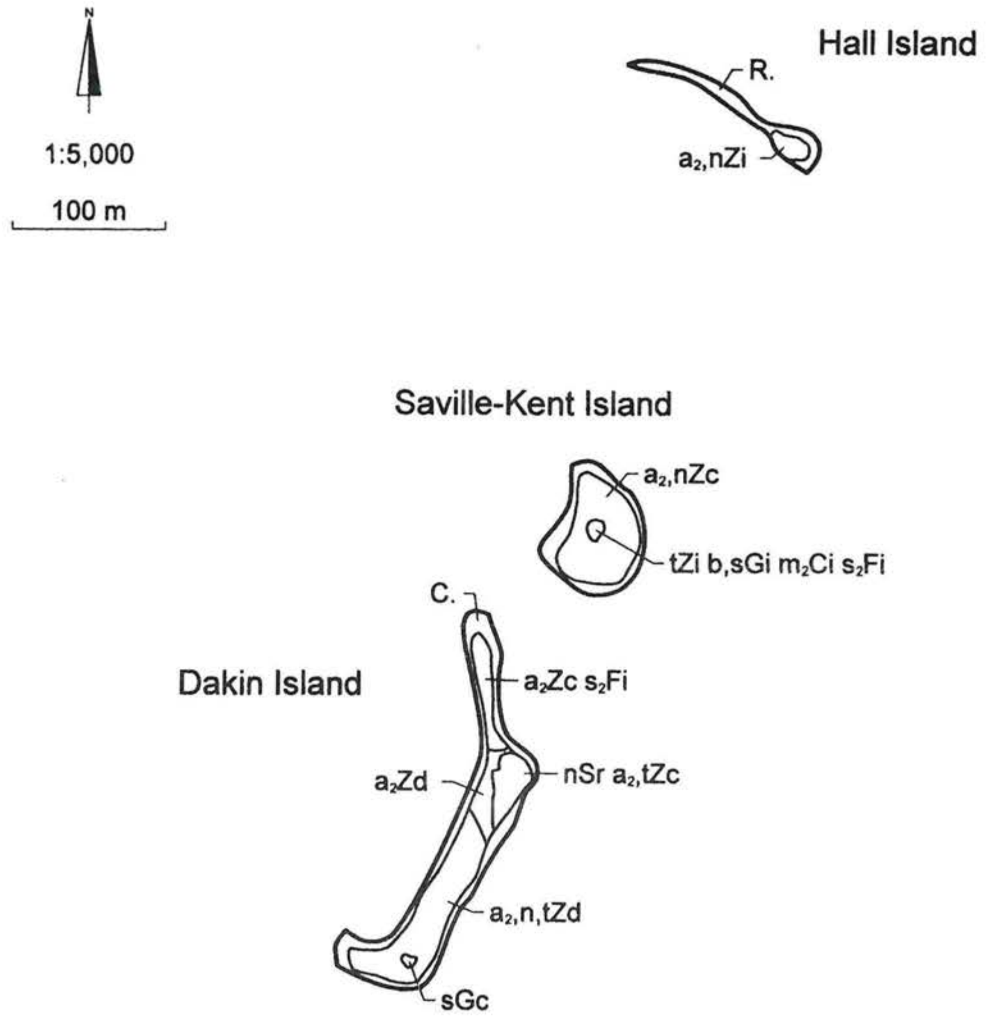

Figure 6. Vegetation map of Dakin Island, Hall Island, Saville-Kent Island, Wallabi Group.

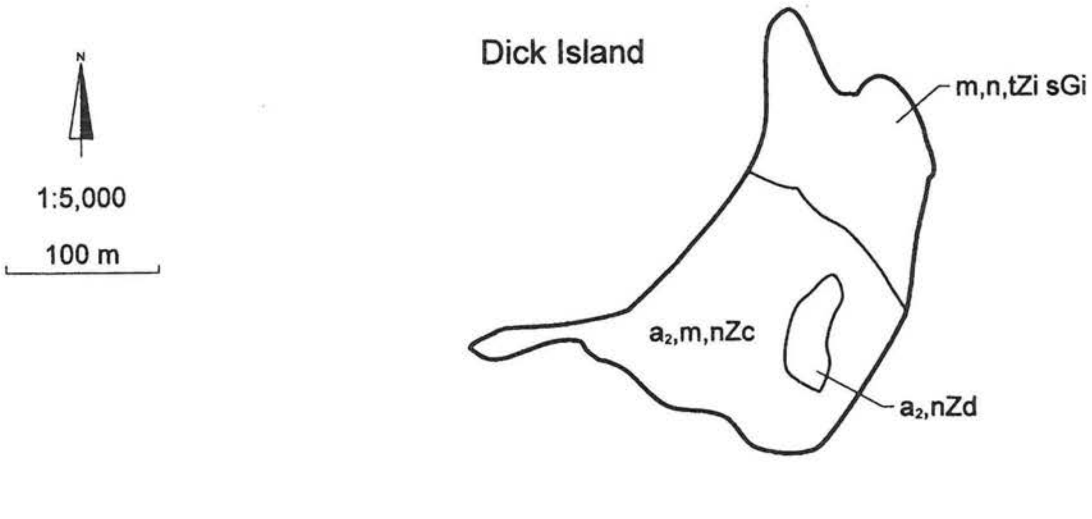

Figure 7. Vegetation map of Dick Island, Wallabi Group.

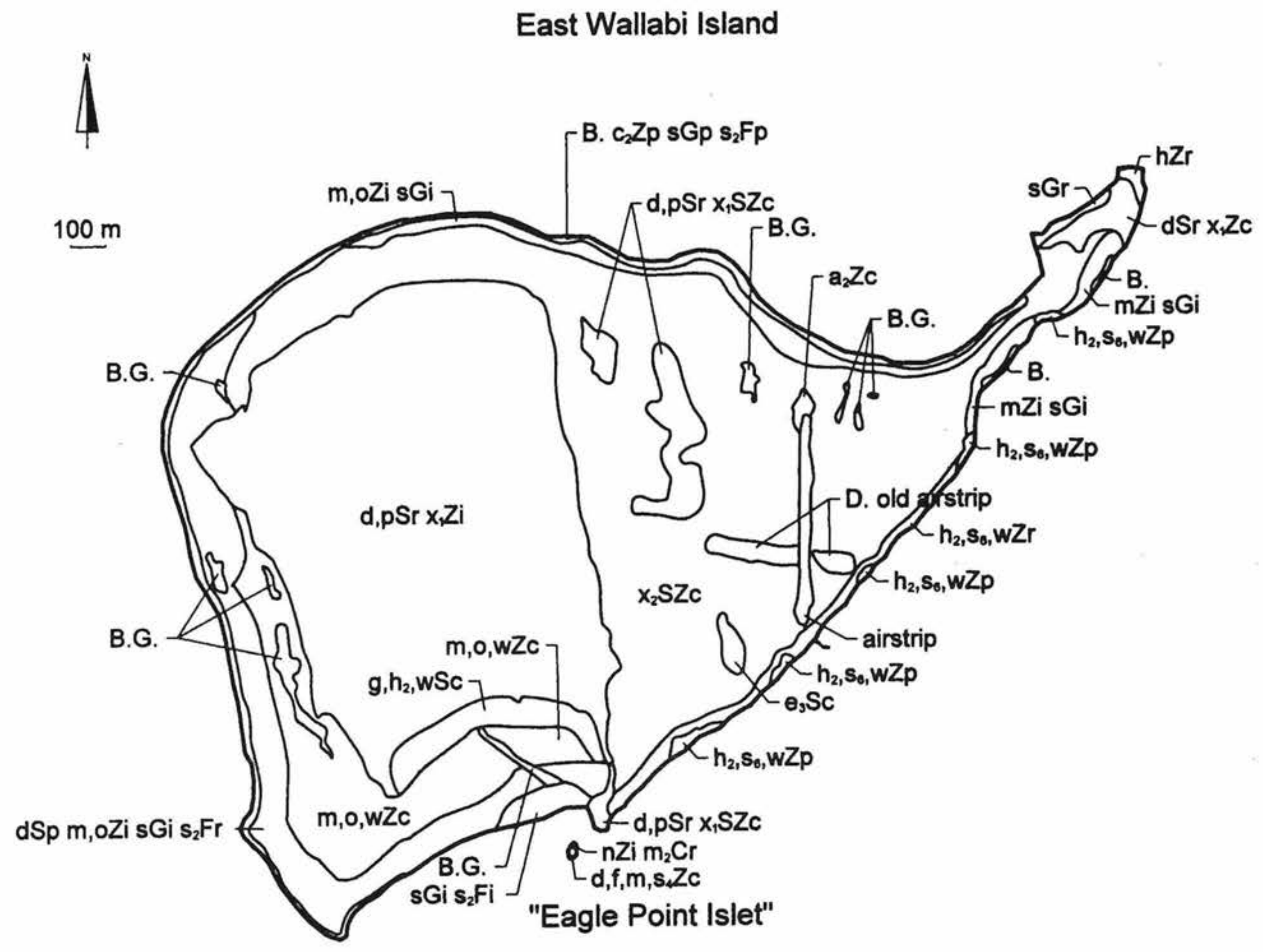

Figure 8. Vegetation map of "Eagle Point Islet", East Wallabi Island, Wallabi Group.
*On East Wallabi Island, x_1 denotes pavement limestone species (*Capparis spinosa, Exocarpos aphyllus, Grevillea argyrophylla, Hibbertia racemosa, Pimelea microcephala*).*
On East Wallabi Island, x_2 denotes consolidated dunes species (x_1 species plus Acacia didyma, Alyxia buxifolia, Bossiaea spinescens, Dodonaea *spp.,* Lasiopetalum angustifolium, Leucopogon insularis, Mirbelia ramulosa, Ptilotus divaricatus).

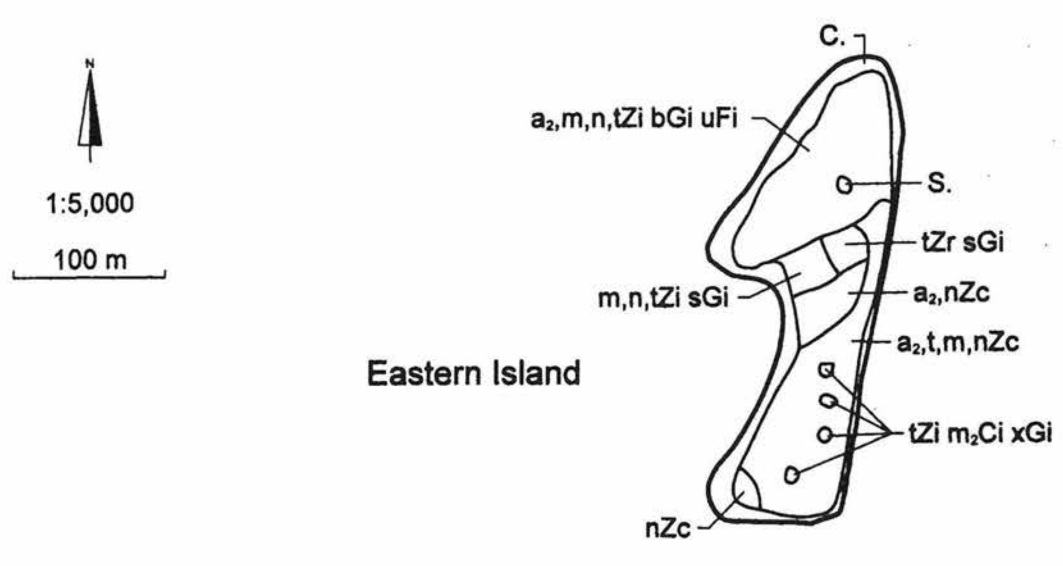

Figure 9. Vegetation map of Eastern Island, Wallabi Group.
For Eastern Island, x of xGi denotes mixed grasses (species not specified).

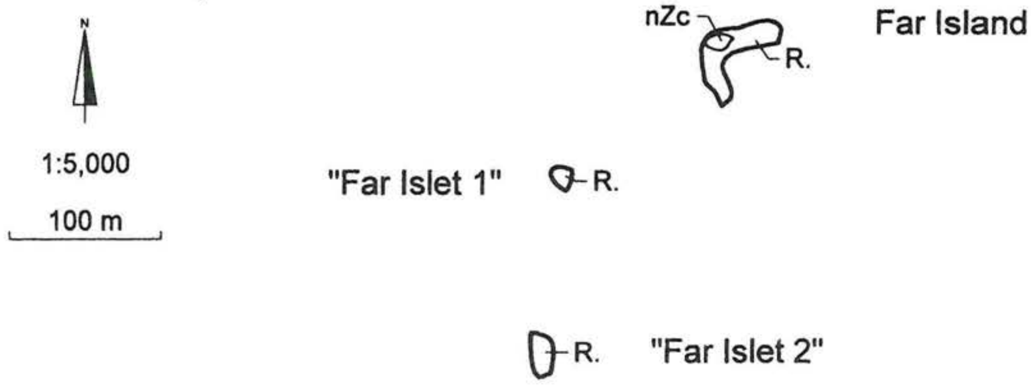

Figure 10. Vegetation map of Far Island, "Far Islet 1", "Far Islet 2", Wallabi Group.

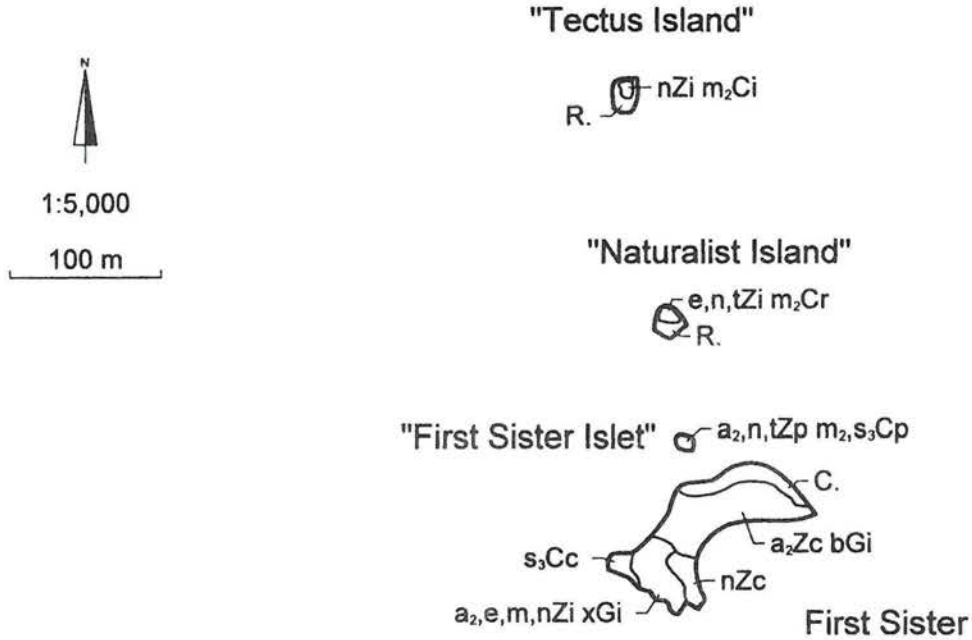

Figure 11. Vegetation map of First Sister, "First Sister Islet", "Naturalist Island", "Tectus Island", Wallabi Group. For First Sister, x of xGi includes Bromus arenarius, Setaria dielsii.

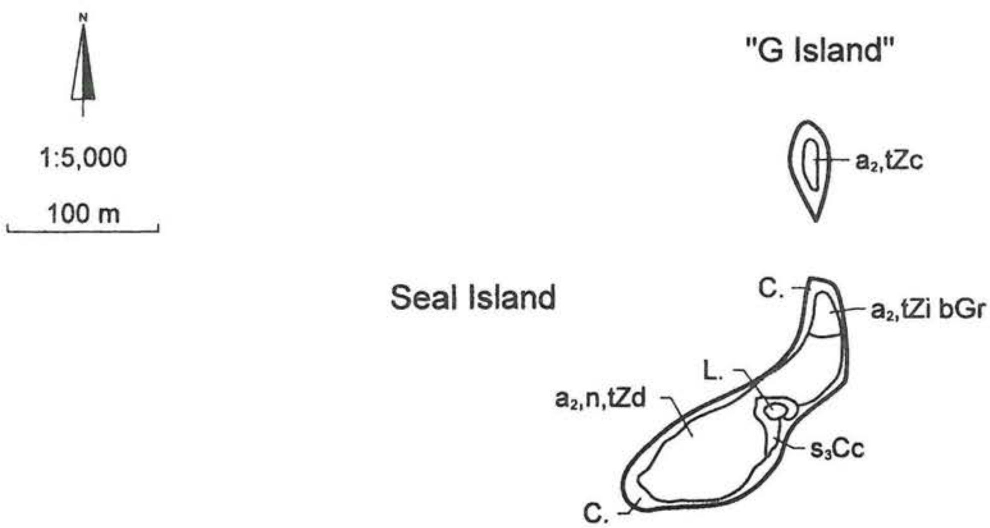

Figure 12. Vegetation map of "G Island", Seal Island, Wallabi Group.

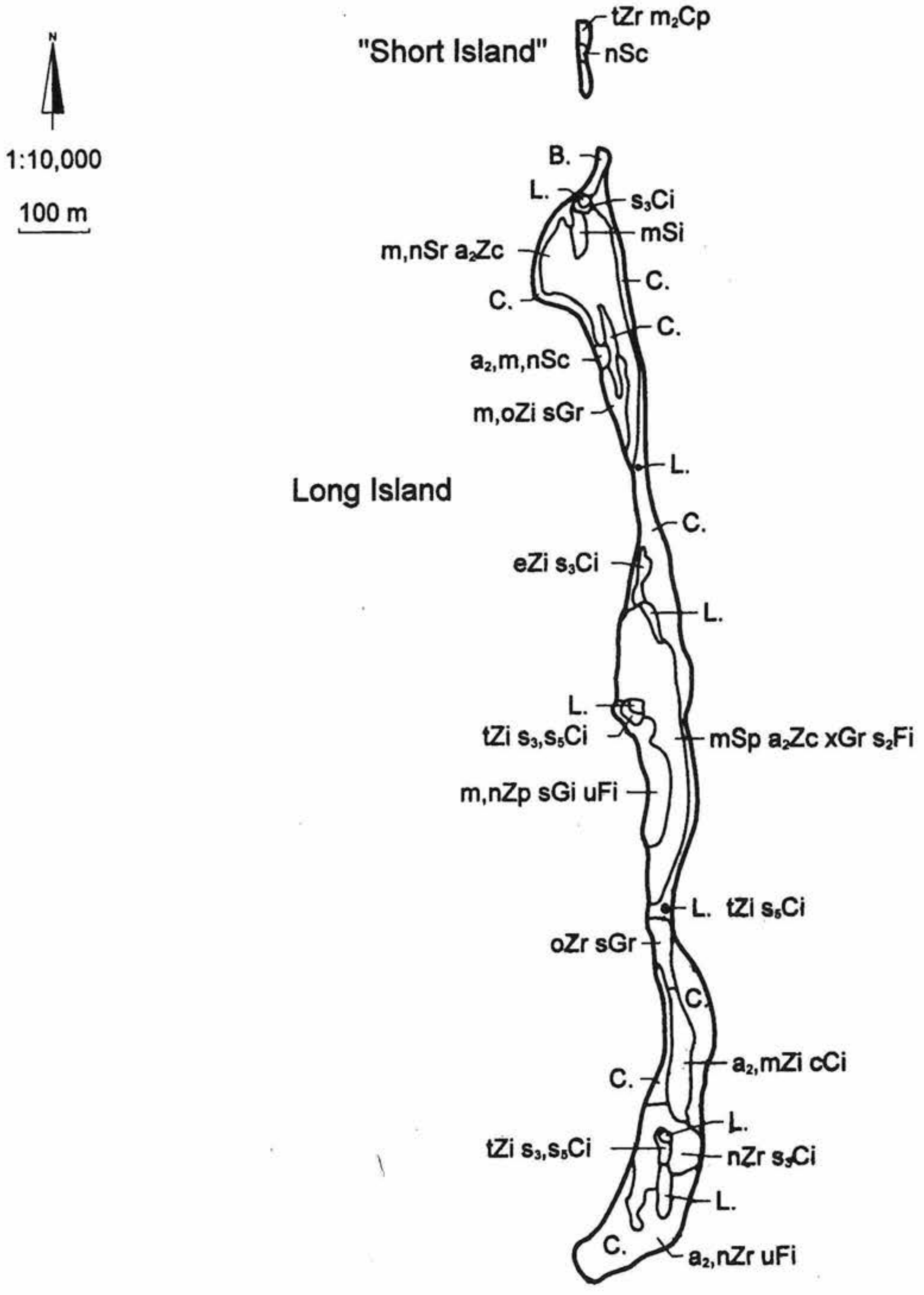

Figure 13. Vegetation map of Long Island, "Short Island", Wallabi Group.
For Long Island, x of xGr includes Bromus arenarius, Setaria dielsii.

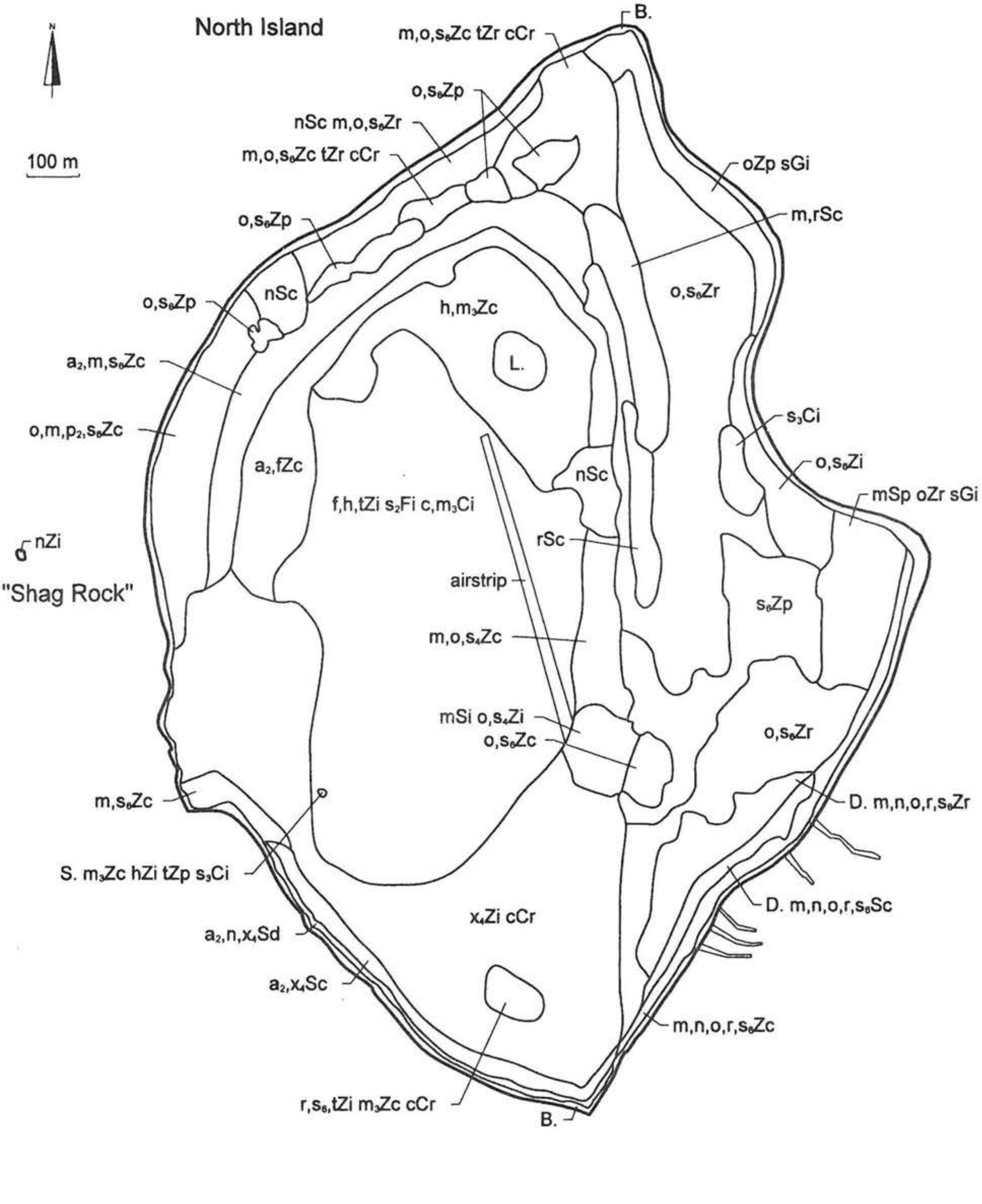

Figure 14. Vegetation map of North Island, Wallabi Group.
On North Island, x_4 denotes consolidated dunes species (Exocarpos aphyllus, Myoporum insulare, Pimelea microcephala, Olearia axillaris, Rhagodia *sp.*, Scaevola crassifolia, Threlkeldia diffusa).

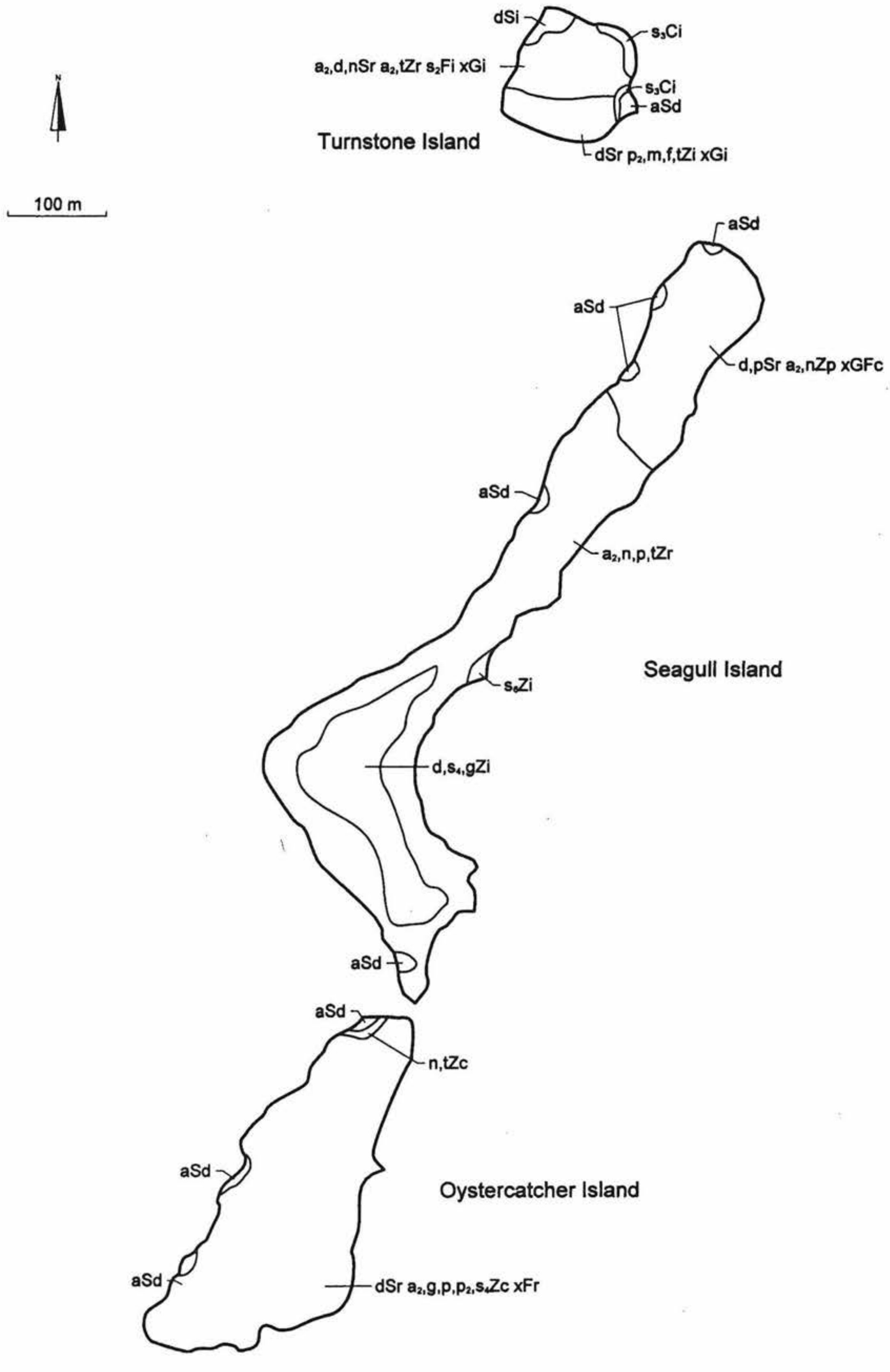

Figure 15. Vegetation map of Oystercatcher Island, Seagull Island, Turnstone Island, Wallabi Group.
For Oystercatcher Island, x of xFr includes Senecio lautus, *Sonchus oleraceus, *Urospermum picroides.
For Seagull Island, x of xGFc includes *Bromus *sp.,* Senecio lautus, *Urospermum picroides.
For Turnstone Island, x of xGi includes Austrostipa elegantissima, Bromus *sp.,* Setaria dielsii.

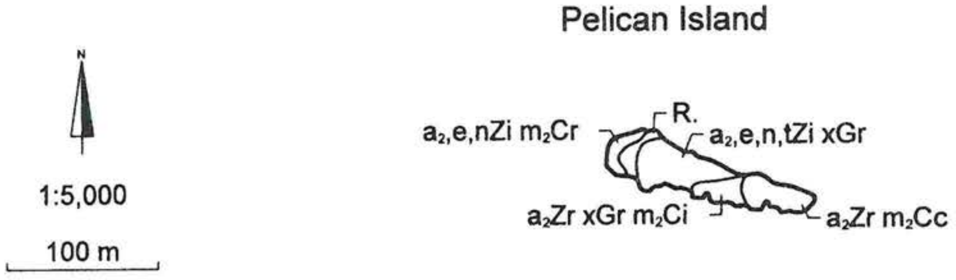

Figure 16. Vegetation map of Pelican Island, Wallabi Group.
For Pelican Island, x of xGr denotes mixed grasses (species not specified).

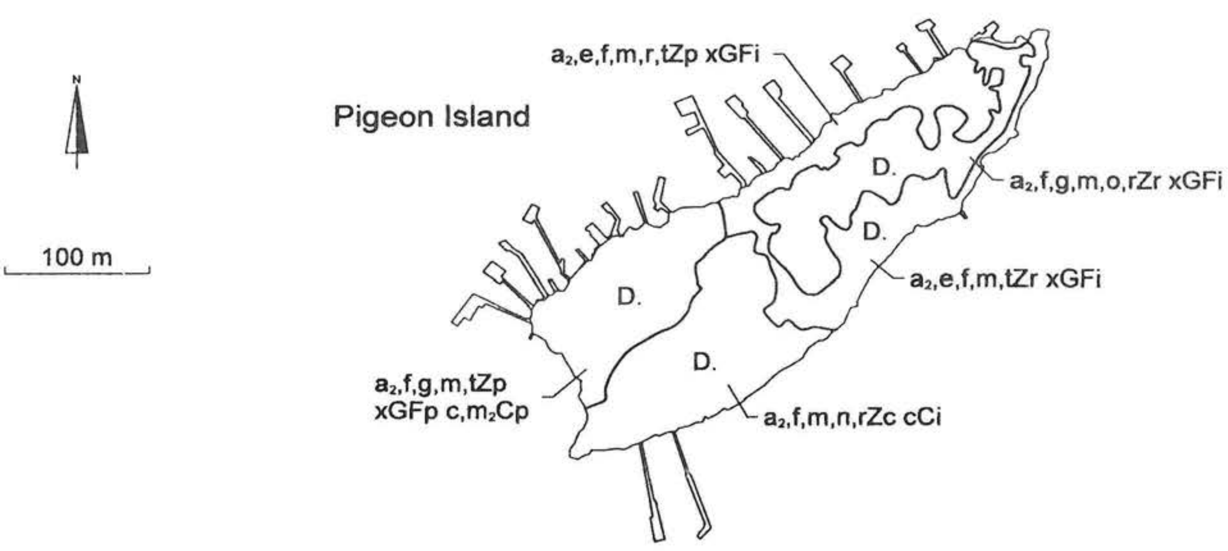

Figure 17. Vegetation map of Pigeon Island, Wallabi Group.
For Pigeon Island, x of xGFi denotes introduced grasses, garden plants and weeds, including *Bromus *sp.*, *Bryophyllum *sp.*, *Nicotiana glauca, Setaria dielsii, *Solanum nigrum, *Sonchus oleraceus, *Tamarix *sp.*

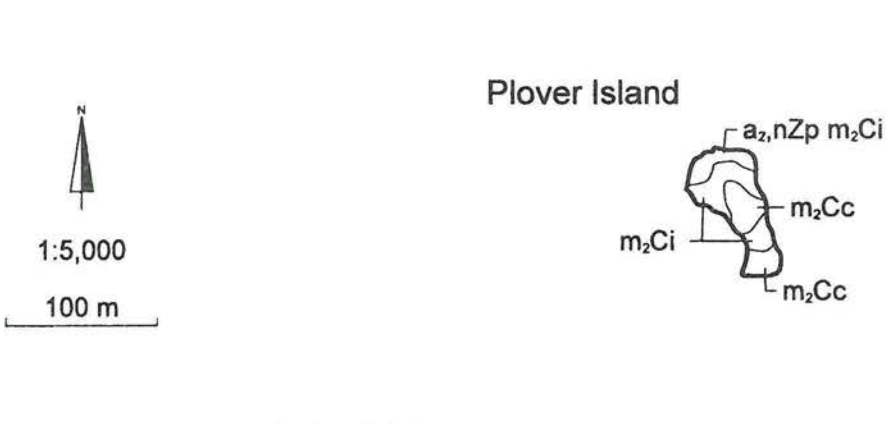

Figure 18. Vegetation map of Plover Island, Wallabi Group.

Figure 19. Vegetation map of Second Sister, Wallabi Group.

Figure 20. Vegetation map of Shag Rock, Wallabi Group.

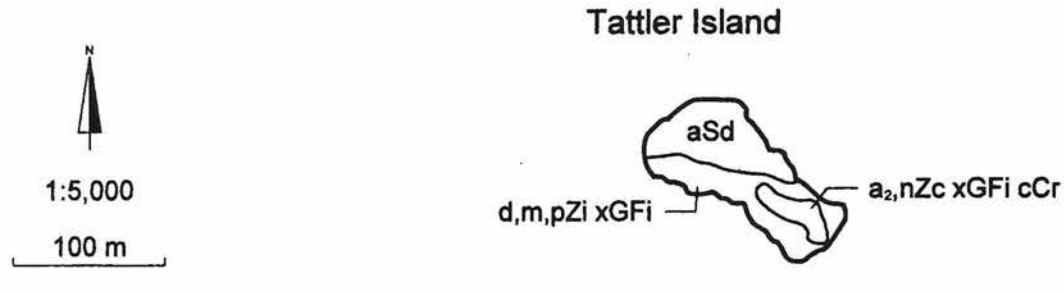

Figure 21. Vegetation map of Tattler Island, Wallabi Group.
For Tattler Island, x of xGFi includes *Avena *sp.,* *Centaurium spicatum, Senecio lautus, Setaria dielsii, *Sonchus oleraceus.

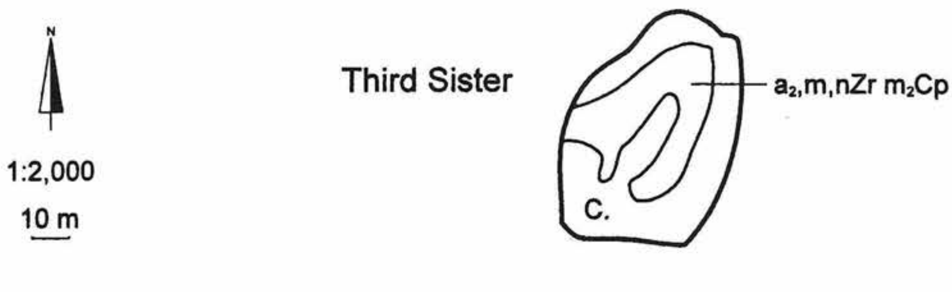

Figure 22. Vegetation map of Third Sister, Wallabi Group.

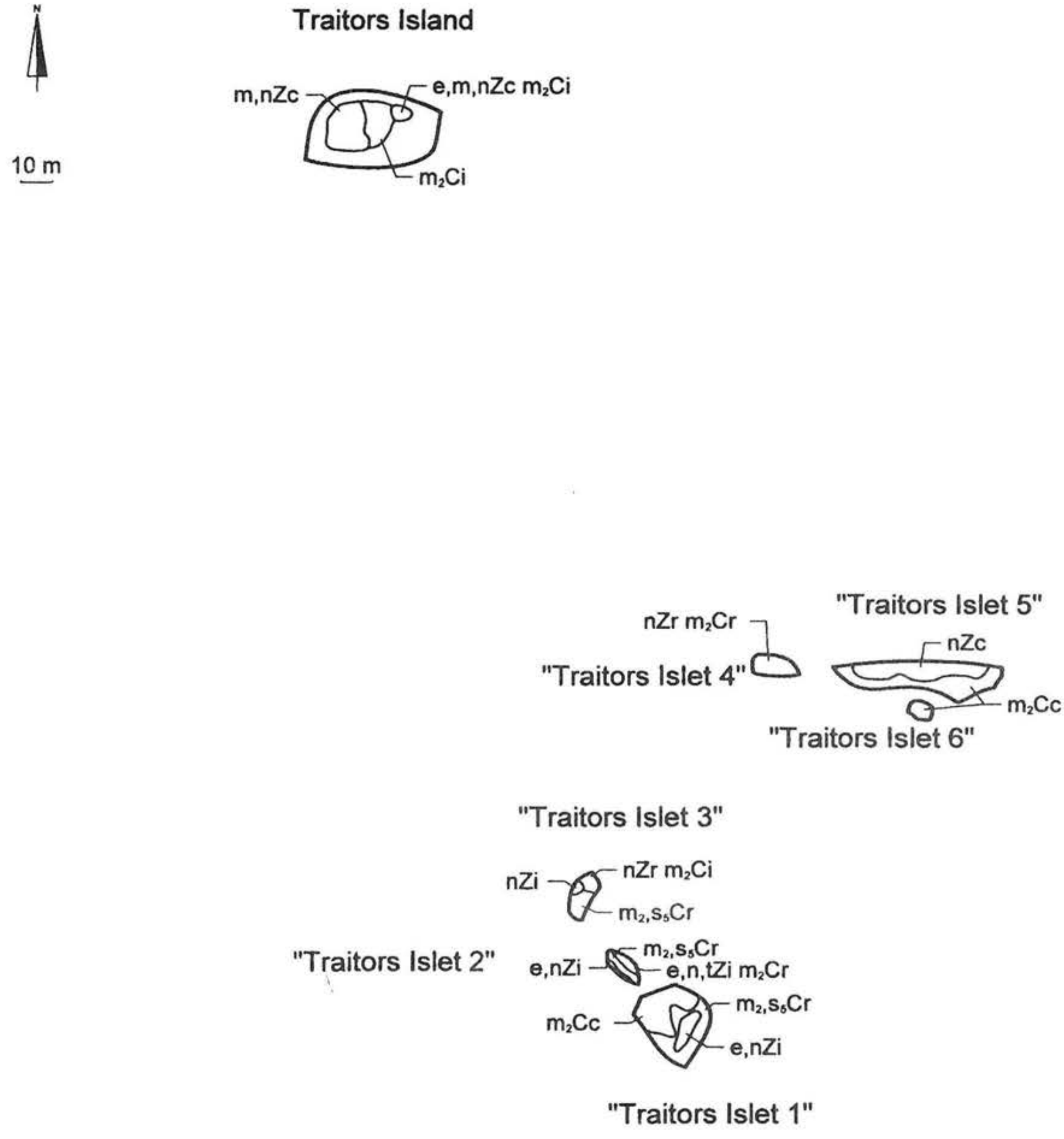

Figure 23. Vegetation map of Traitors Island, "Traitors Islet 1", "Traitors Islet 2", "Traitors Islet 3", "Traitors Islet 4", "Traitors Islet 5", "Traitors Islet 6", Wallabi Group.

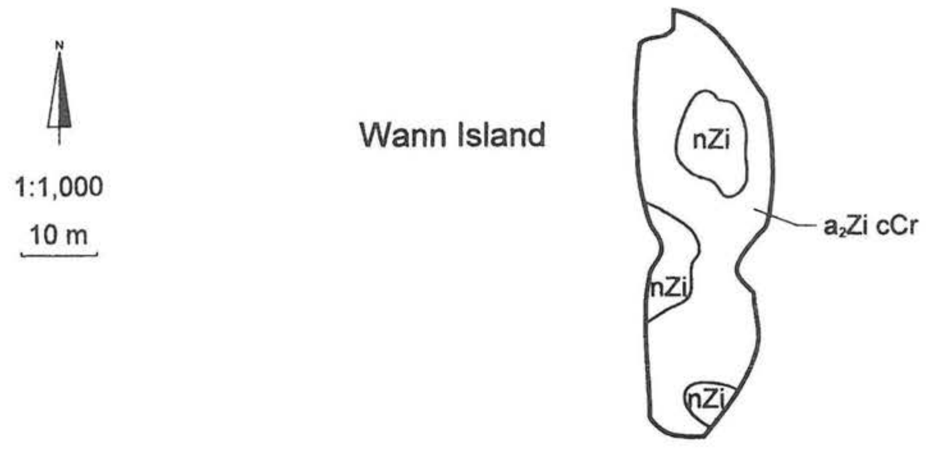

Figure 24. Vegetation map of Wann Island, Wallabi Group.

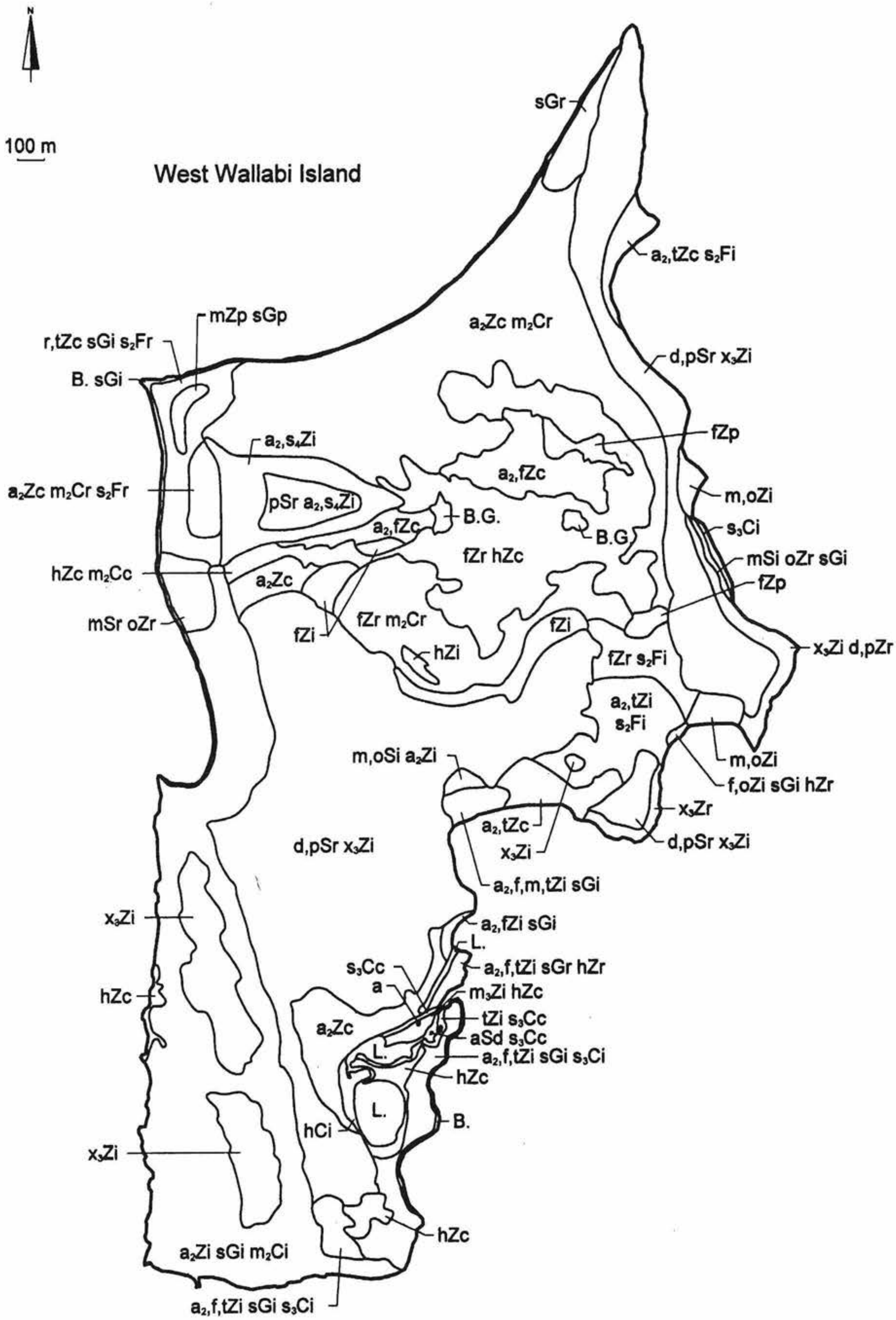

Figure 25. Vegetation map of West Wallabi Island, Wallabi Group.
On West Wallabi Island, x_3 denotes pavement limestone species (Beyeria viscosa, Capparis spinosa, Exocarpos aphyllus, Grevillea argyrophylla, Hibbertia racemosa, Olearia axillaris, Pimelea microcephala, Westringia dampieri).

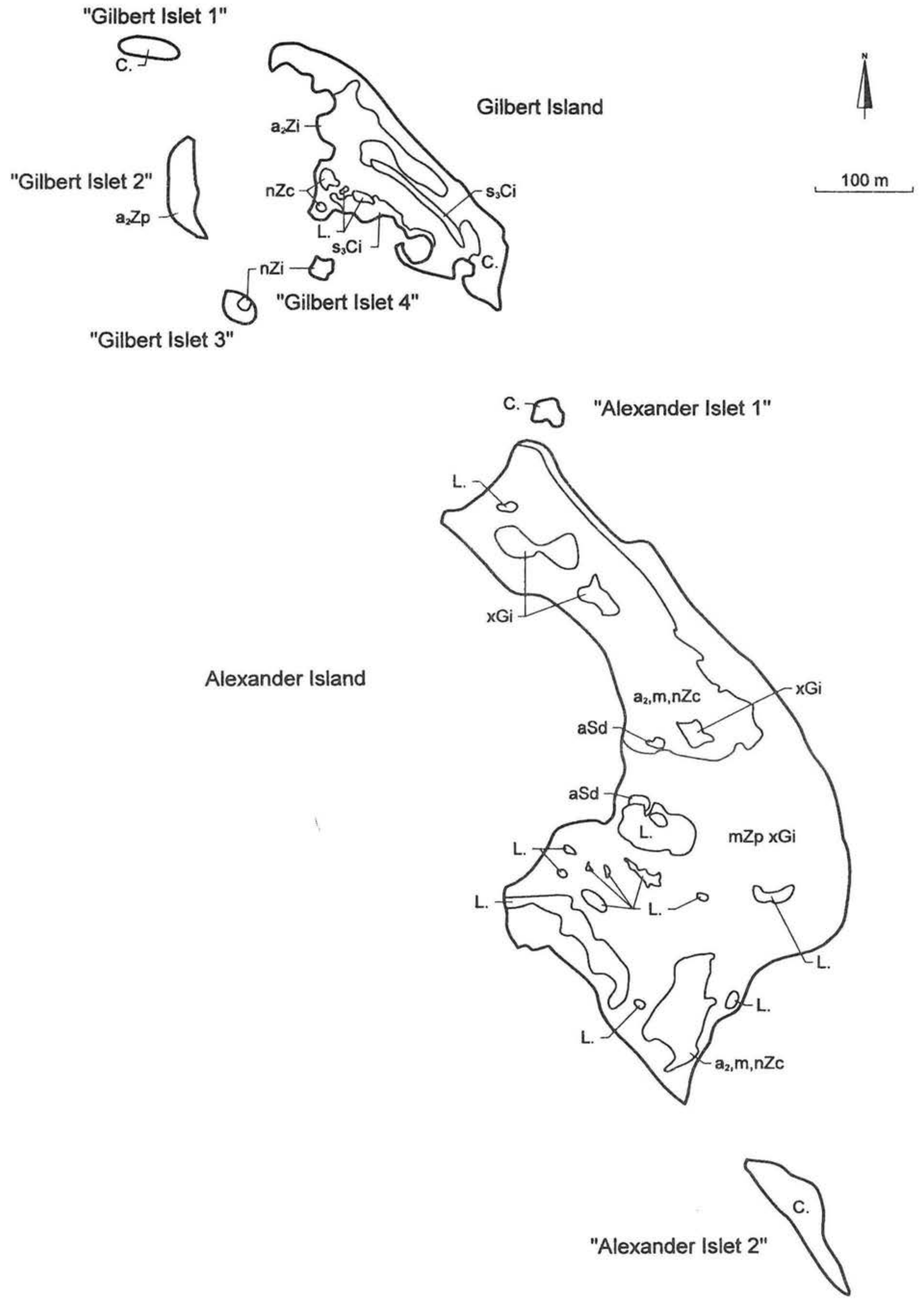

Figure 26. Vegetation map of Alexander Island, "Alexander Islet 1", "Alexander Islet 2", Gilbert Island, "Gilbert Islet 1", "Gilbert Islet 2", "Gilbert Islet 3", "Gilbert Islet 4", Easter Group.
For Alexander Island, x of xGi includes Bromus *sp.,* *Ehrharta longiflora, Setaria dielsii.

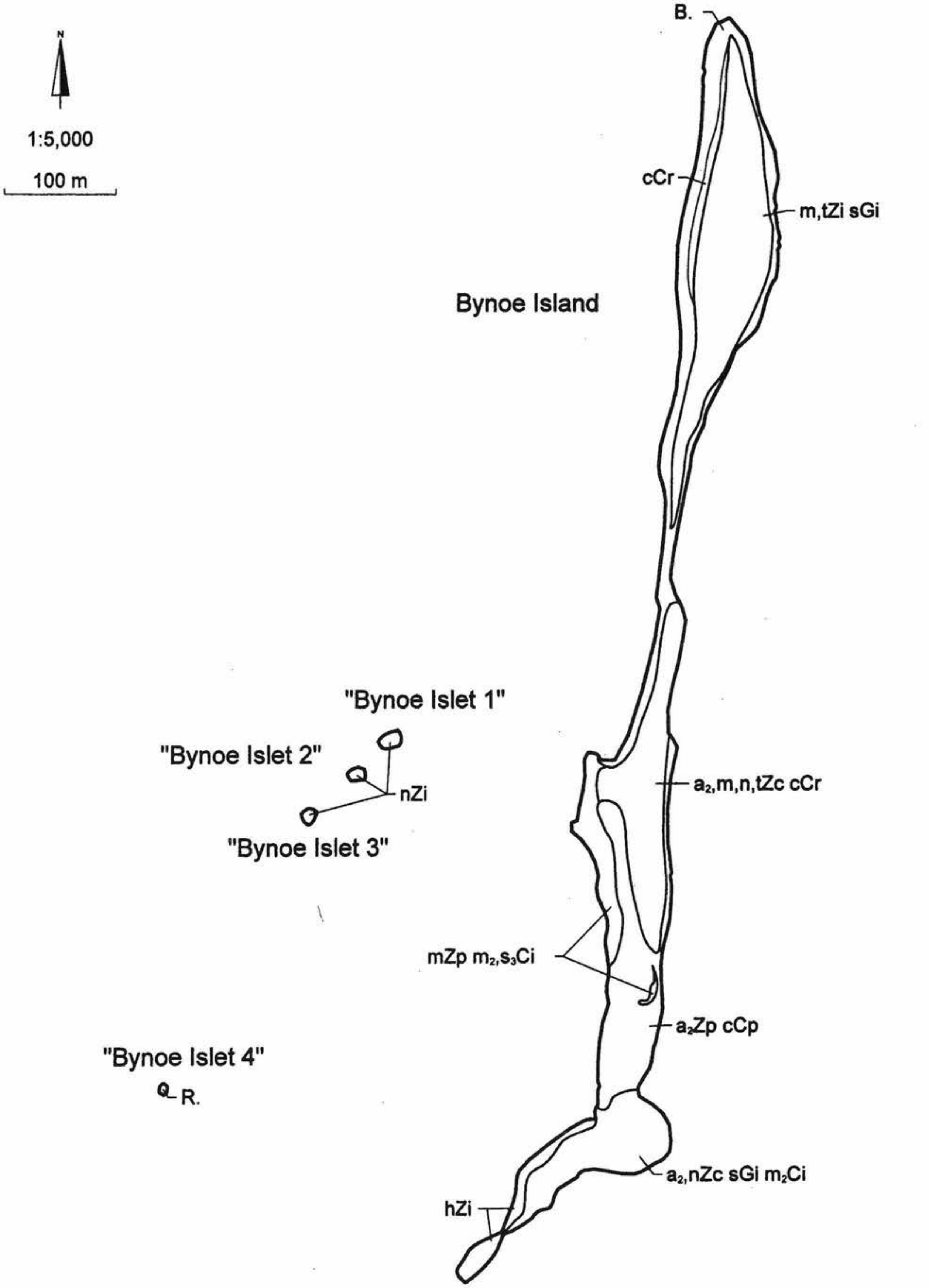

Figure 27. Vegetation map of Bynoe Island, "Bynoe Islet 1", "Bynoe Islet 2", "Bynoe Islet 3", "Bynoe Islet 4", Easter Group.

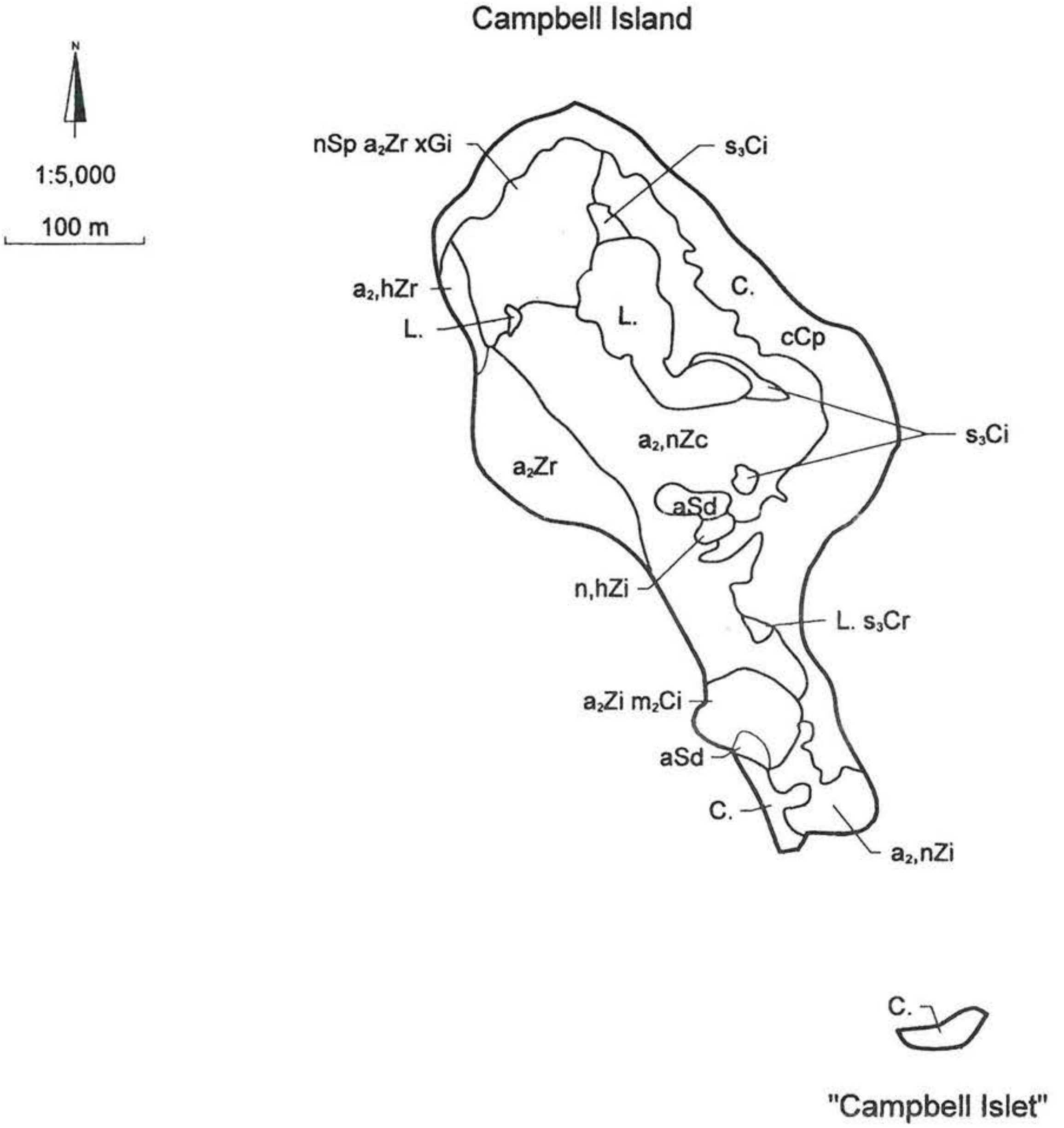

Figure 28. Vegetation map of Campbell Island, "Campbell Islet", Easter Group. For Campbell Island, x of xGi denotes mixed grasses (species not specified).

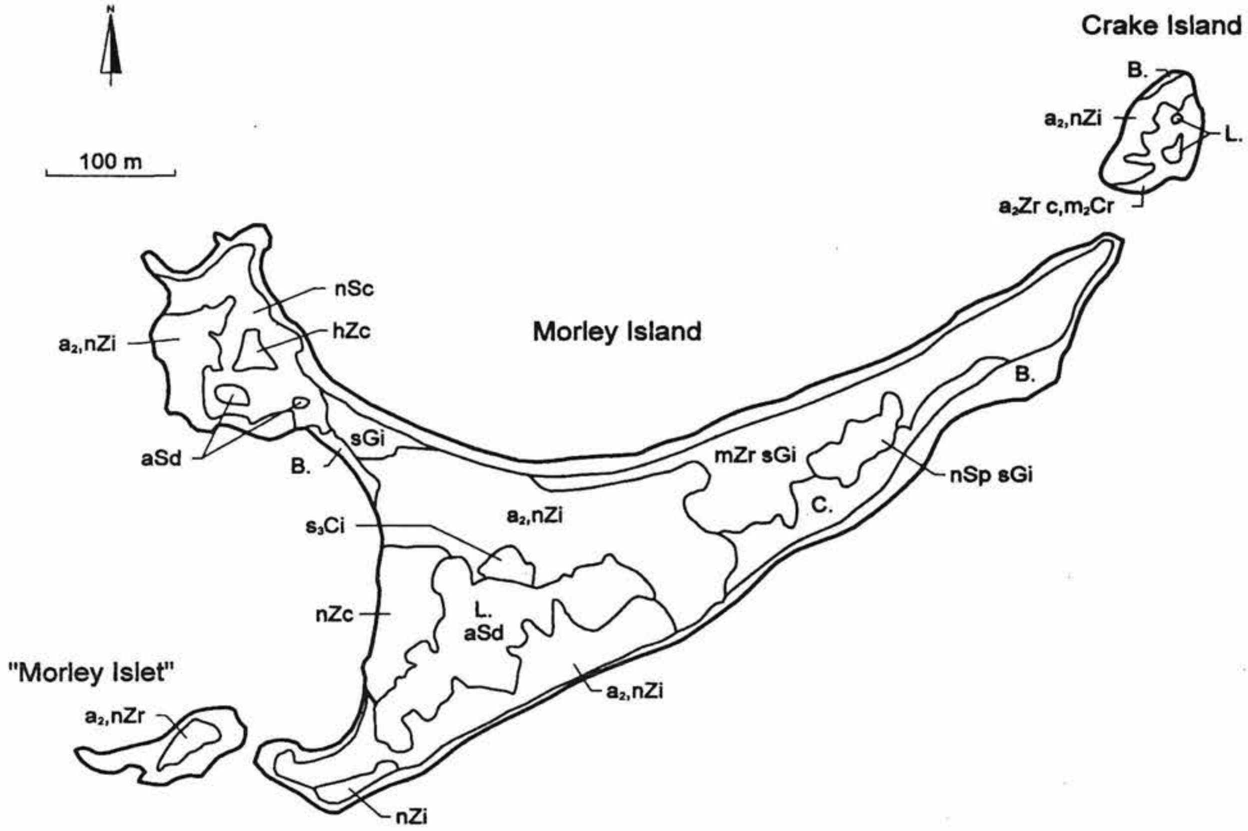

Figure 29. Vegetation map of Crake Island, Morley Island, "Morley Islet", Easter Group.

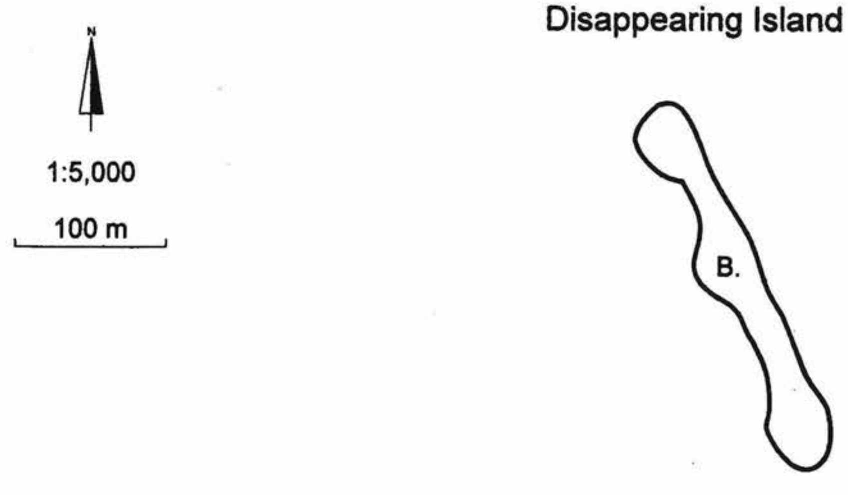

Figure 30. Vegetation map of Disappearing Island, Easter Group.

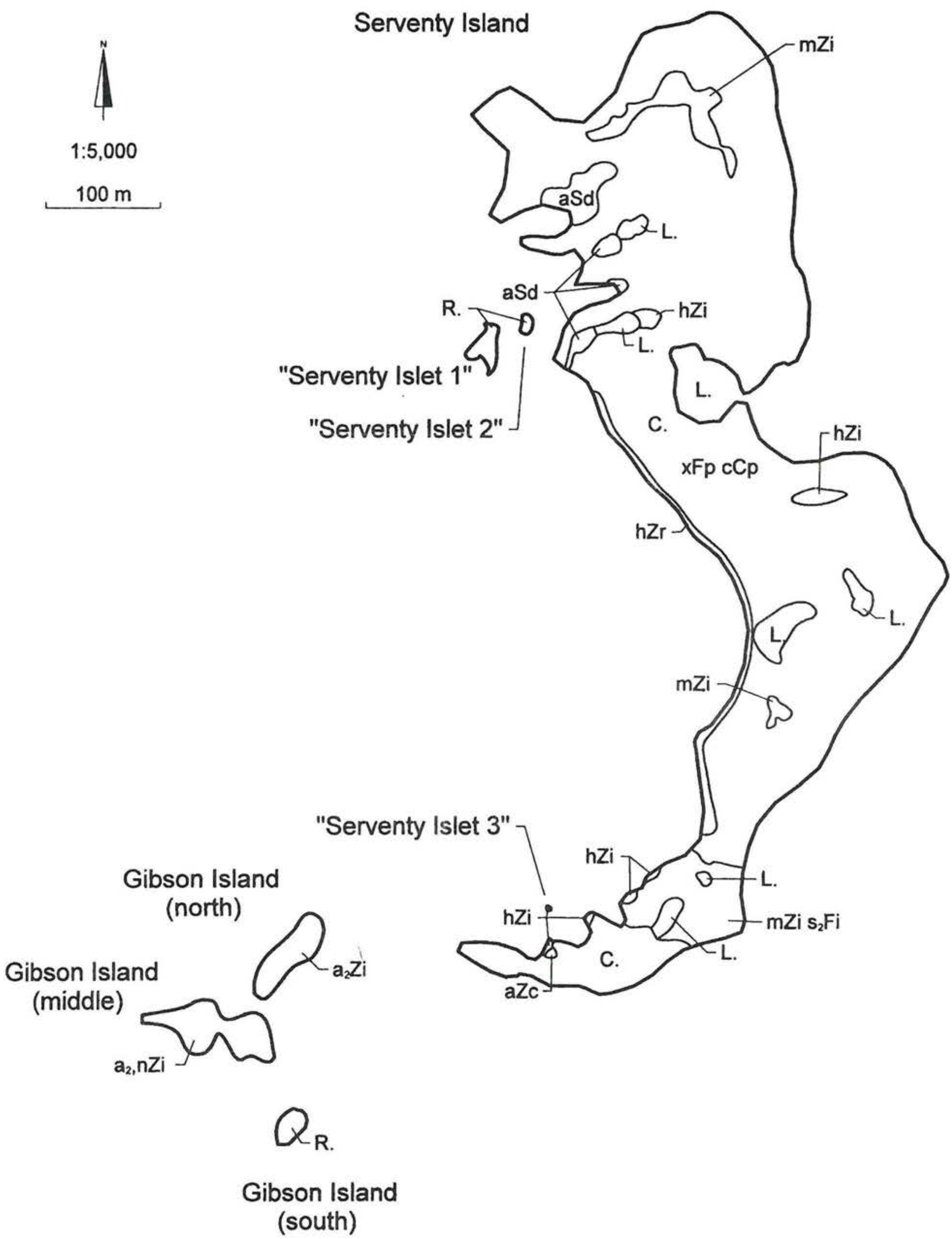

Figure 31. Vegetation map of Gibson Island, Serventy Island, "Serventy Islet 1", "Serventy Islet 2", "Serventy Islet 3", Easter Group.
For Serventy Island, x of xFp includes Senecio lautus, *Sonchus oleraceus, *Urospermum picroides.

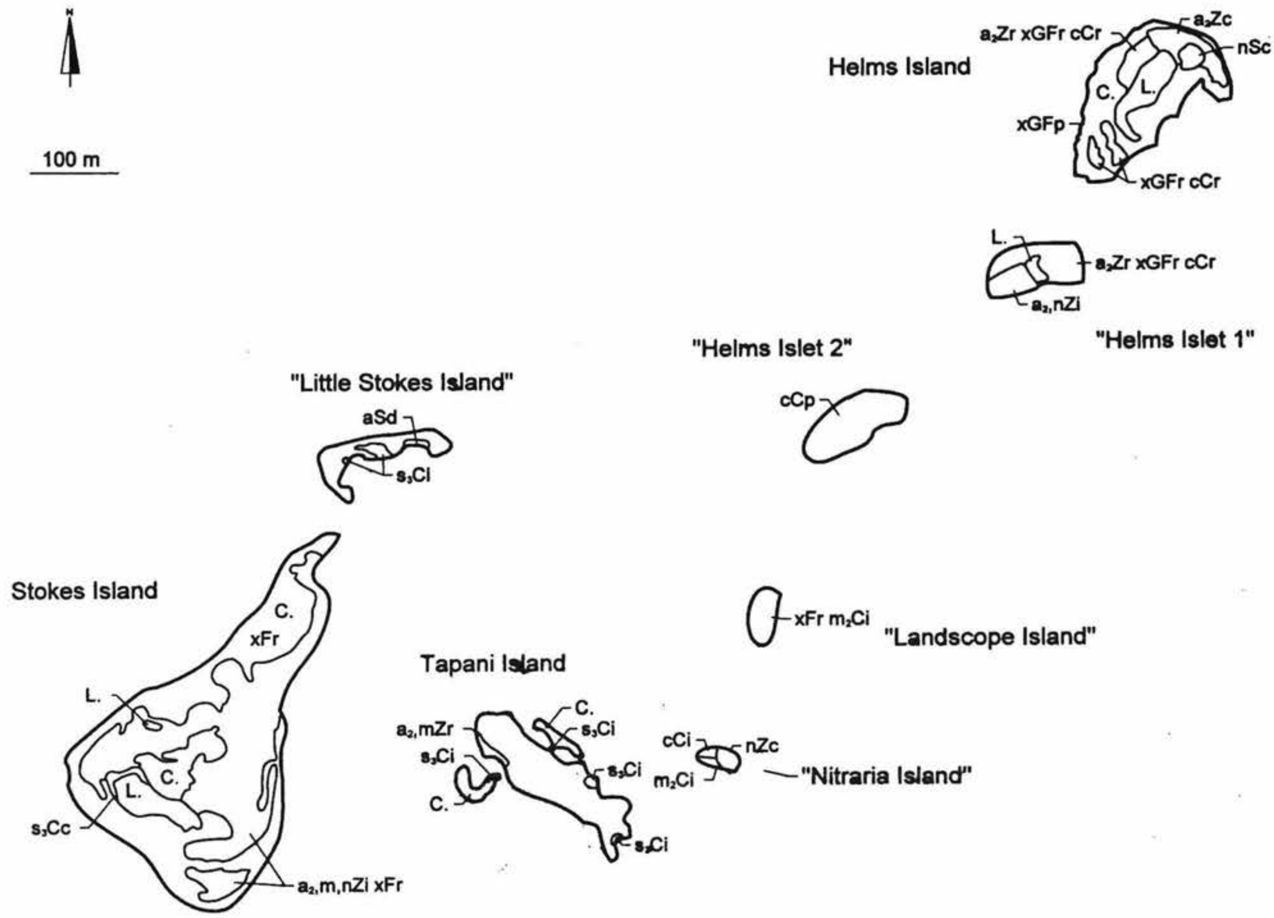

Figure 32. Vegetation map of Helms Island, "Helms Islet 1", "Helms Islet 2", "Landscope Island", "Little Stokes Island", "Nitraria Island", Stokes Island, Tapani Island, Easter Group.
For Helms Island, x of xGFp and xGFr denotes Senecio lautus *and other mixed grasses and forbs (species not specified).*
For "Helms Islet 1", x of xGFr denotes mixed grasses and forbs (species not specified).
For "Landscope Island", x of xFr includes *Chenopodium murale, Lavatera plebeia, *Sonchus oleraceus.
For Stokes Island, x of xFr includes Senecio lautus *and other forbs (species not specified).*

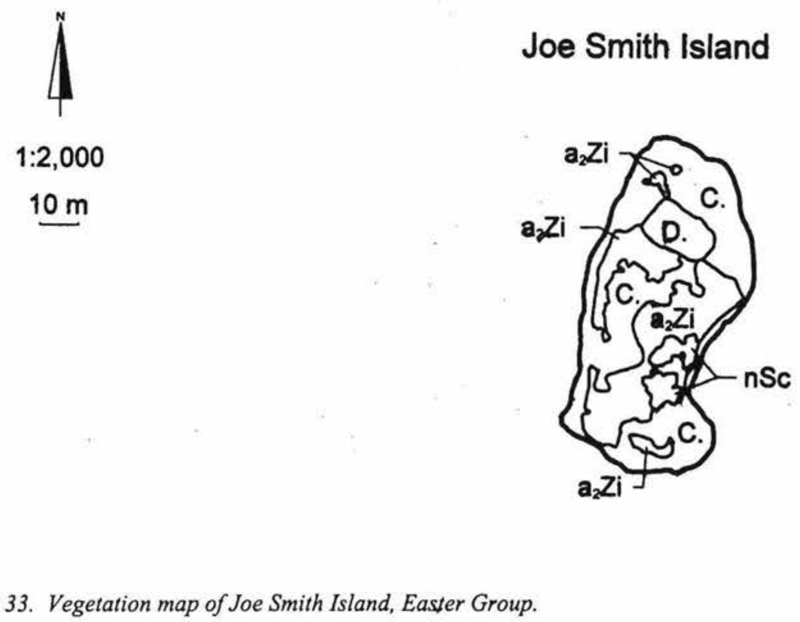

Figure 33. Vegetation map of Joe Smith Island, Easter Group.

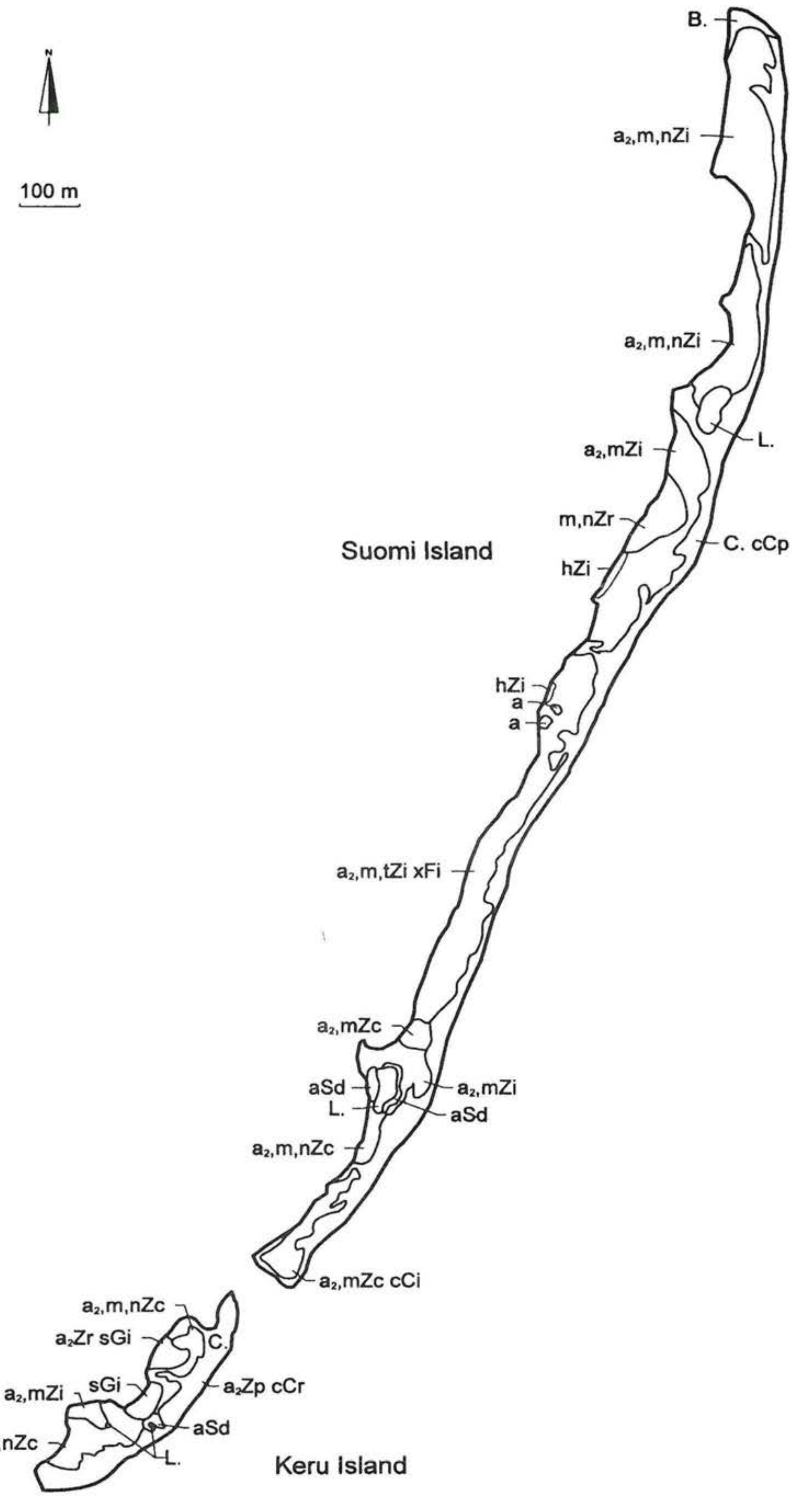

Figure 34. Vegetation map of Keru Island, Suomi Island, Easter Group. For Suomi Island, x of xFi denotes mixed forbs (species not specified).

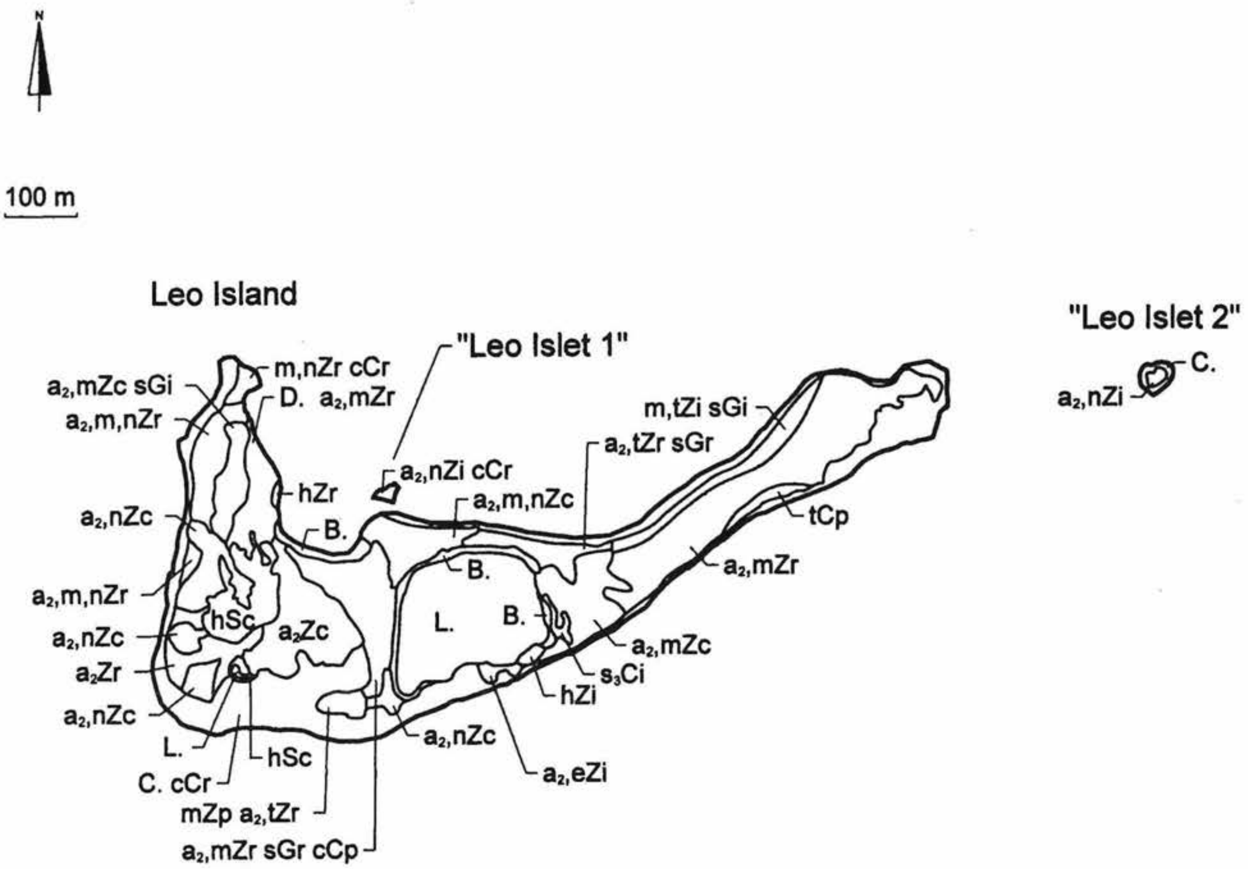

Figure 35. Vegetation map of Leo Island, "Leo Islet 1", "Leo Islet 2", Easter Group.

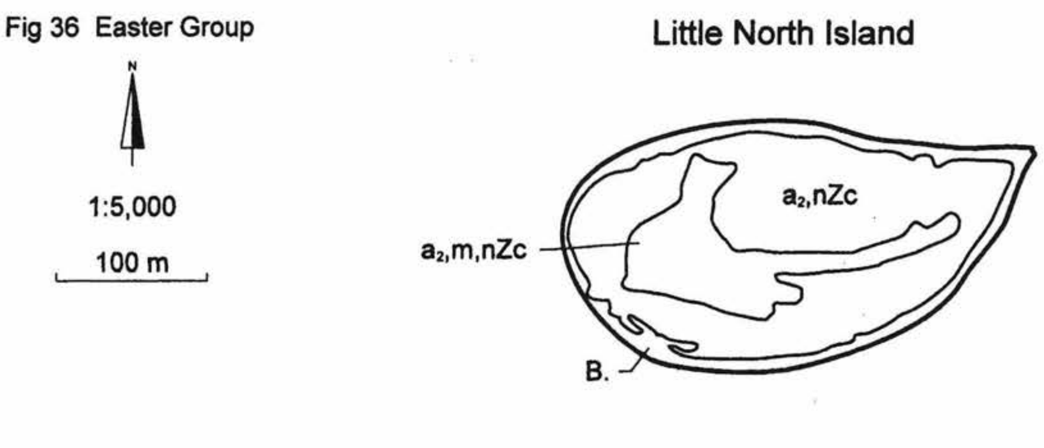

Figure 36. Vegetation map of Little North Island, Easter Group.

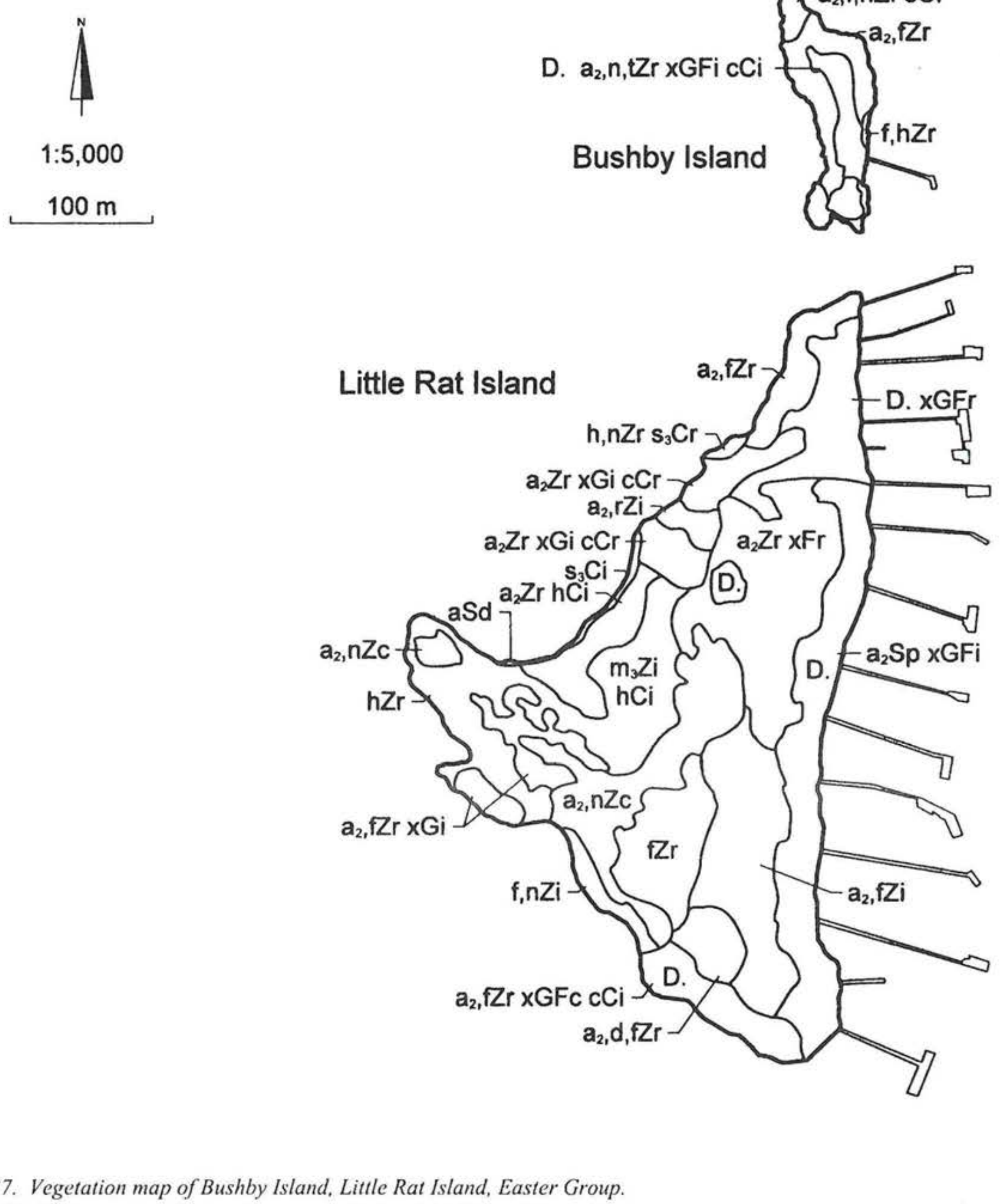

Figure 37. Vegetation map of Bushby Island, Little Rat Island, Easter Group.
For Bushby Island, x of xGFi denotes native and introduced grasses, garden plants and weeds, including *Anagallis arvensis, *Avena barbata, *Conyza bonariensis, *Ehrharta longiflora, *Melilotus indicus, Setaria dielsii, *Sonchus oleraceus, *Urospermum picroides.
For Little Rat Island, x of xGi, xGFi and xGFc denotes native and introduced grasses, garden plants and weeds, including *Conyza bonariensis, *Ehrharta longiflora, *Euphorbia *spp.*, *Ipomoea cairica, Lavatera plebeia, *Melilotus indicus, *Petroselinum crispum, *Pseudognaphalium luteoalbum, *Raphanus raphanistrum, Setaria dielsii, *Sisymbrium orientale, *Solanum nigrum.

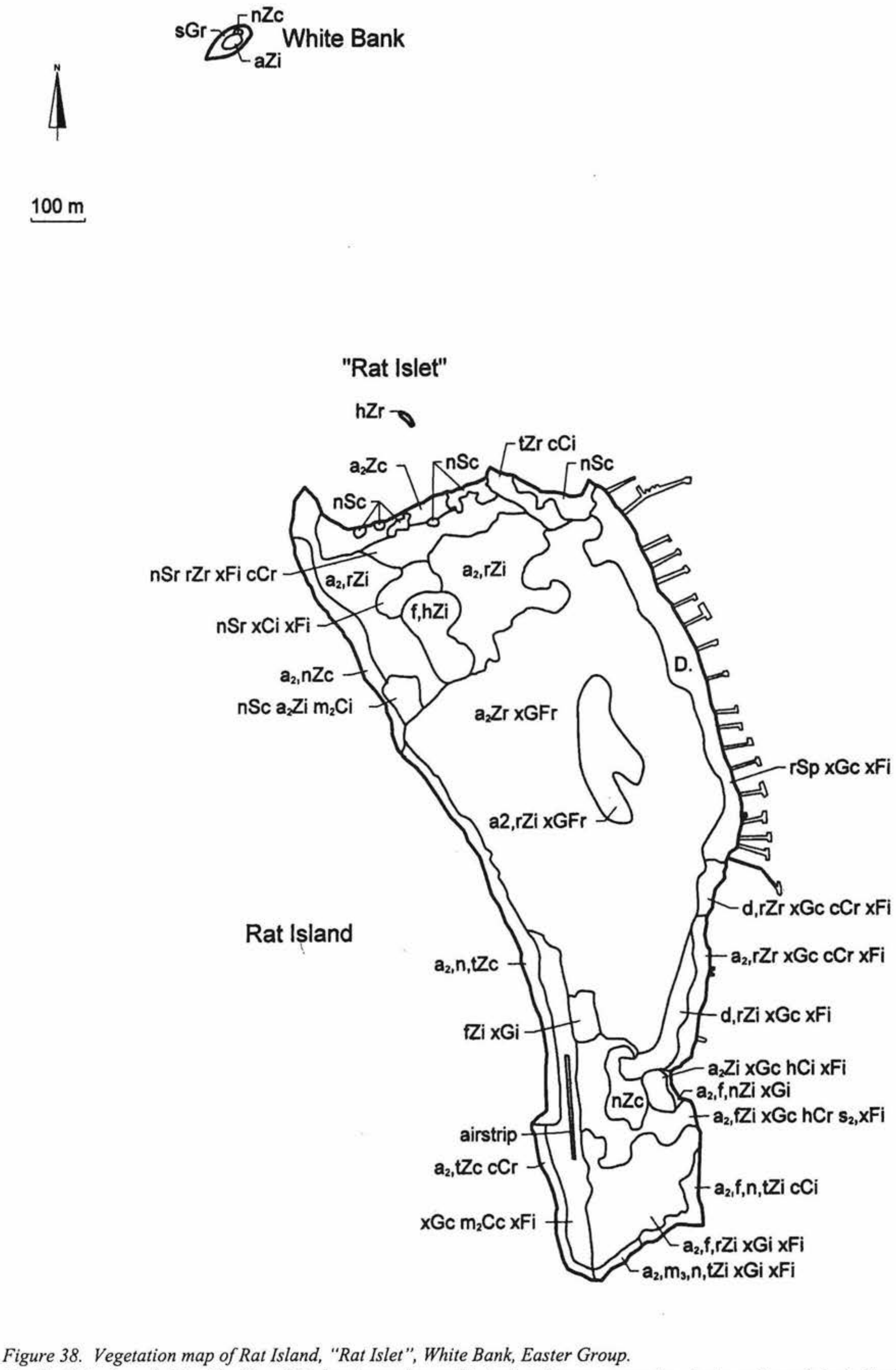

Figure 38. Vegetation map of Rat Island, "Rat Islet", White Bank, Easter Group.
For Rat Island, x of xFi, xGi, xGc, xGFr denotes native and introduced grasses, garden plants and weeds including *Aster subulatus, *Bryophyllum *sp.*, *Euphorbia terracina, *Malva parviflora, *Melilotus indicus, *Pseudognaphalium luteoalbum, *Raphanus raphanistrum, Setaria dielsii, *Solanum nigrum.
For Rat Island, x of xCi is mixed succulents (species not specified).

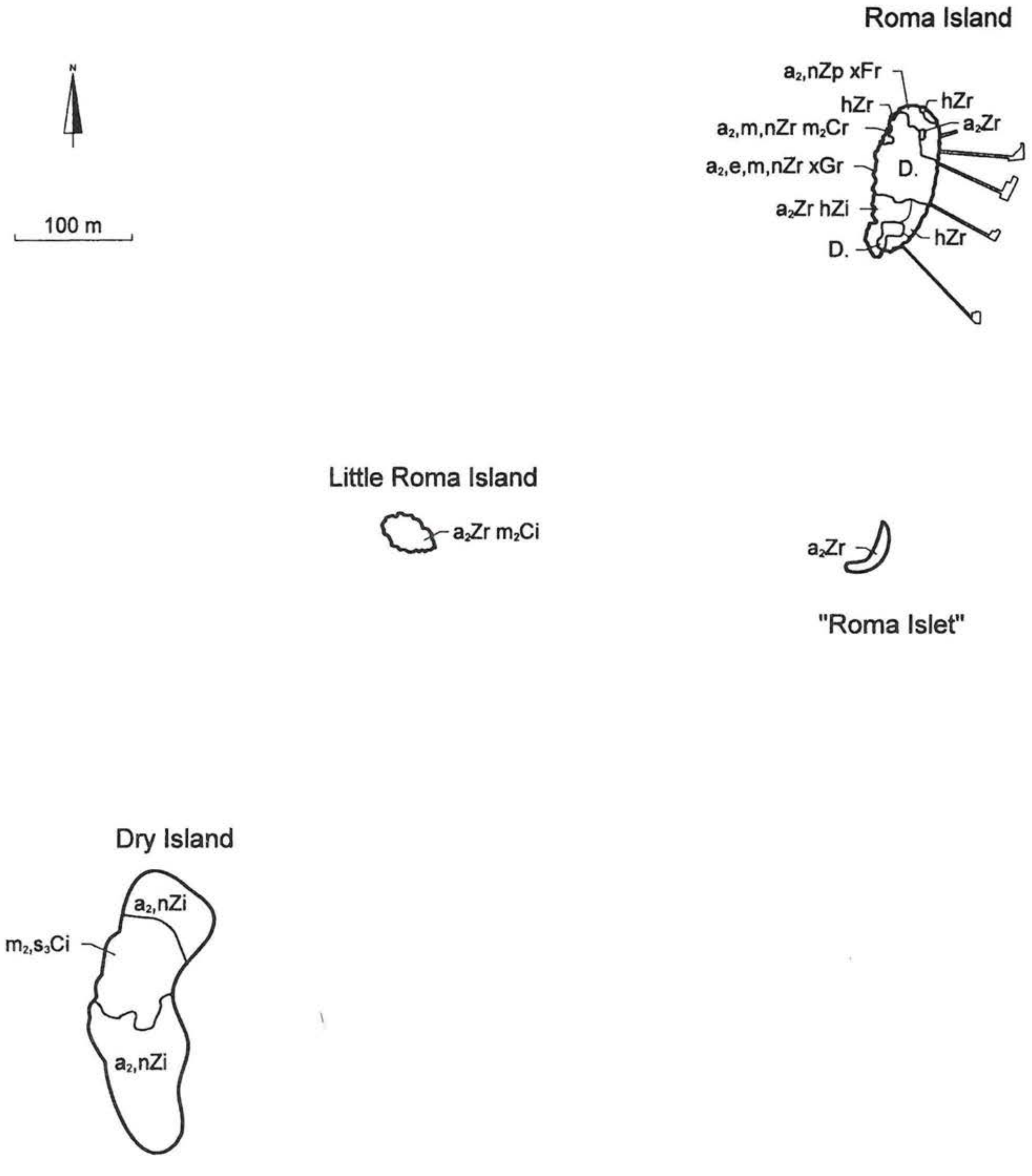

Figure 39. Vegetation map of Dry Island, Little Roma Island, Roma Island, "Roma Islet", Easter Group.
For Roma Island, x of xFr, xGr denotes introduced grasses, garden plants and weeds, including *Conyza bonariensis, Lavatera plebeia, *Lycopersicon esculentum, *Petroselinum crispum, *Sonchus oleraceus.

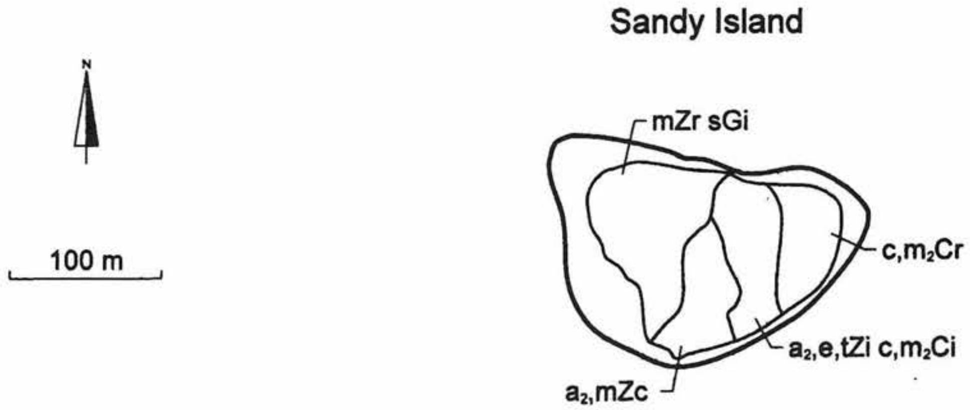

Figure 40. Vegetation map of Sandy Island, Easter Group.

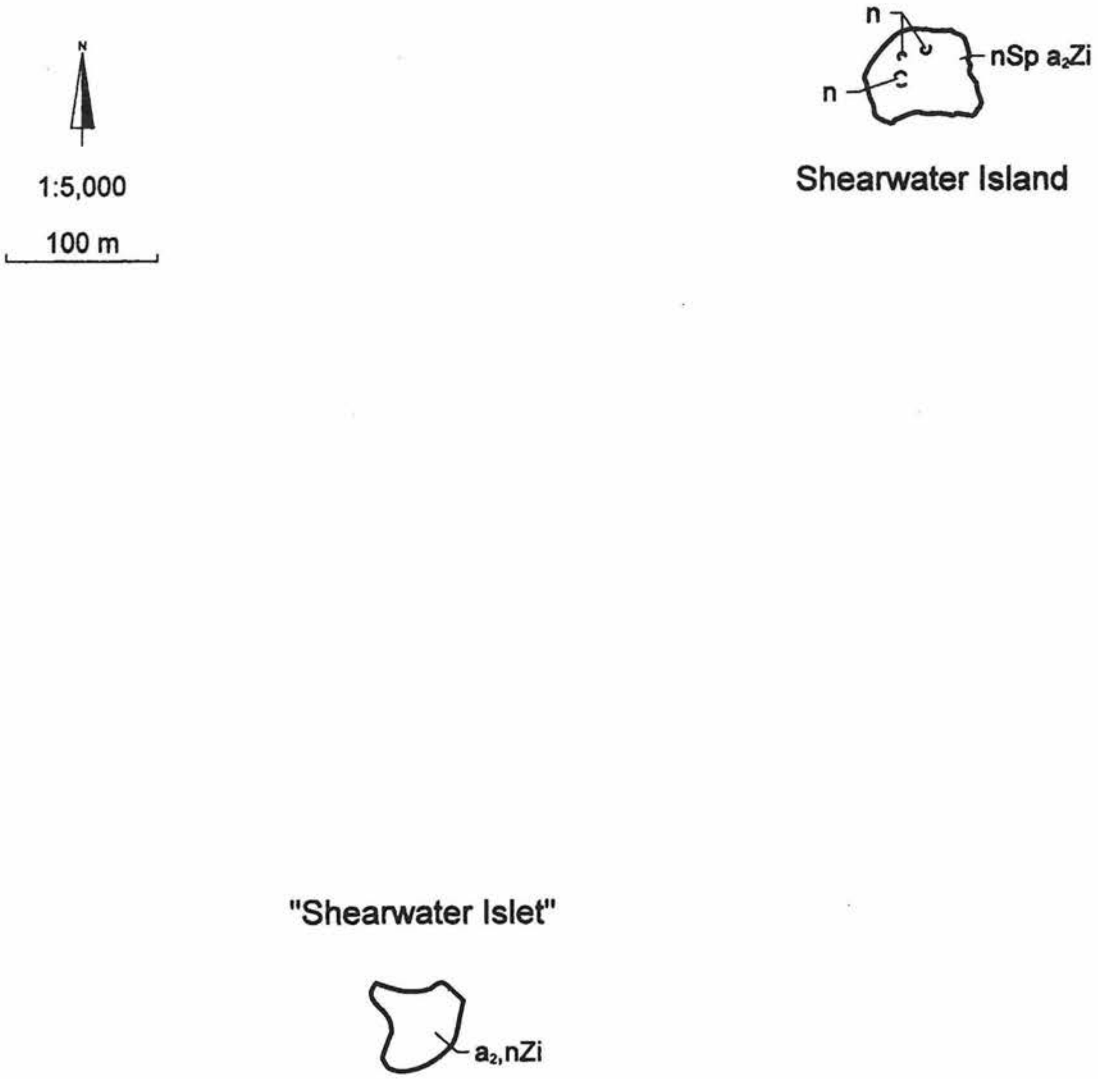

Figure 41. Vegetation map of Shearwater Island, "Shearwater Islet", Easter Group.

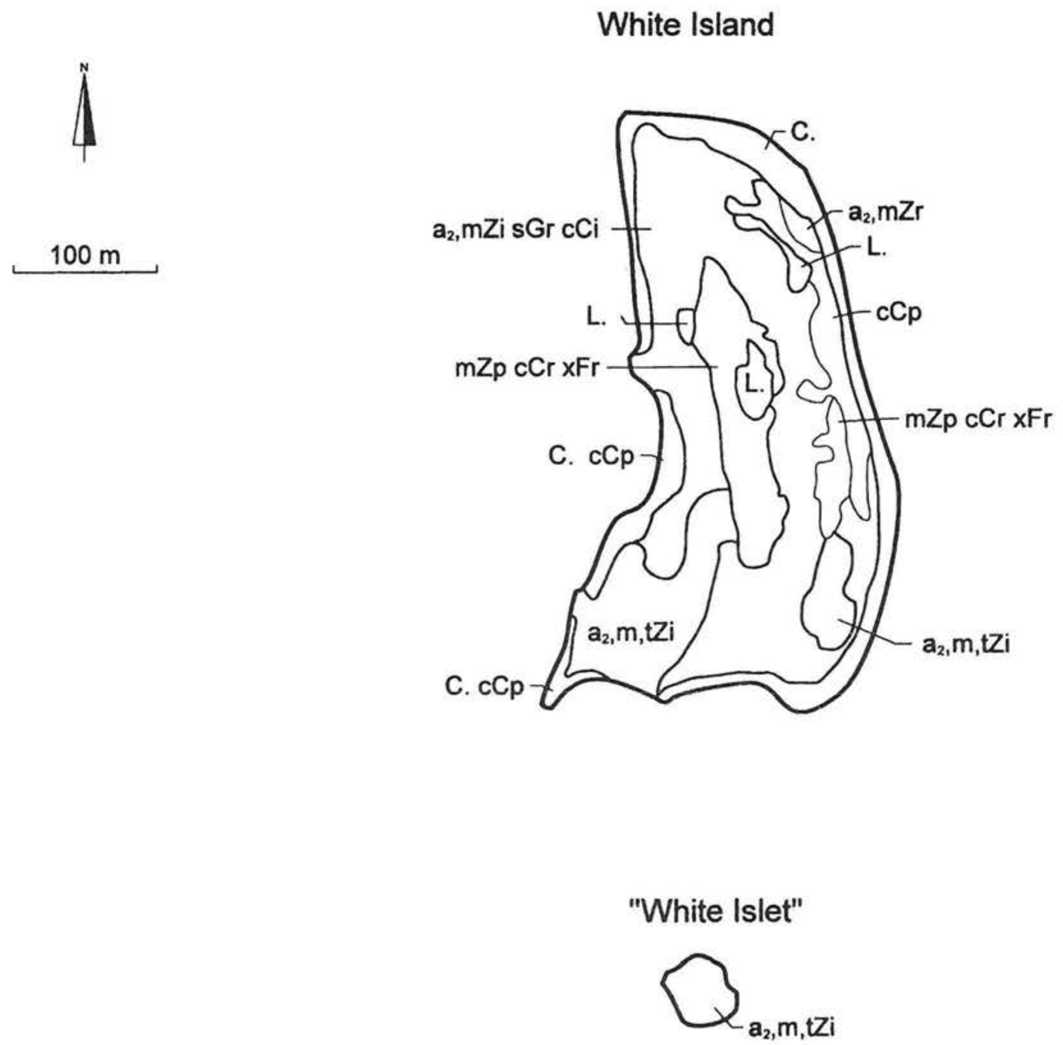

Figure 42. Vegetation map of White Island, "White Islet", Easter Group. For White Island, x of xFr denotes mixed forbs (species not specified).

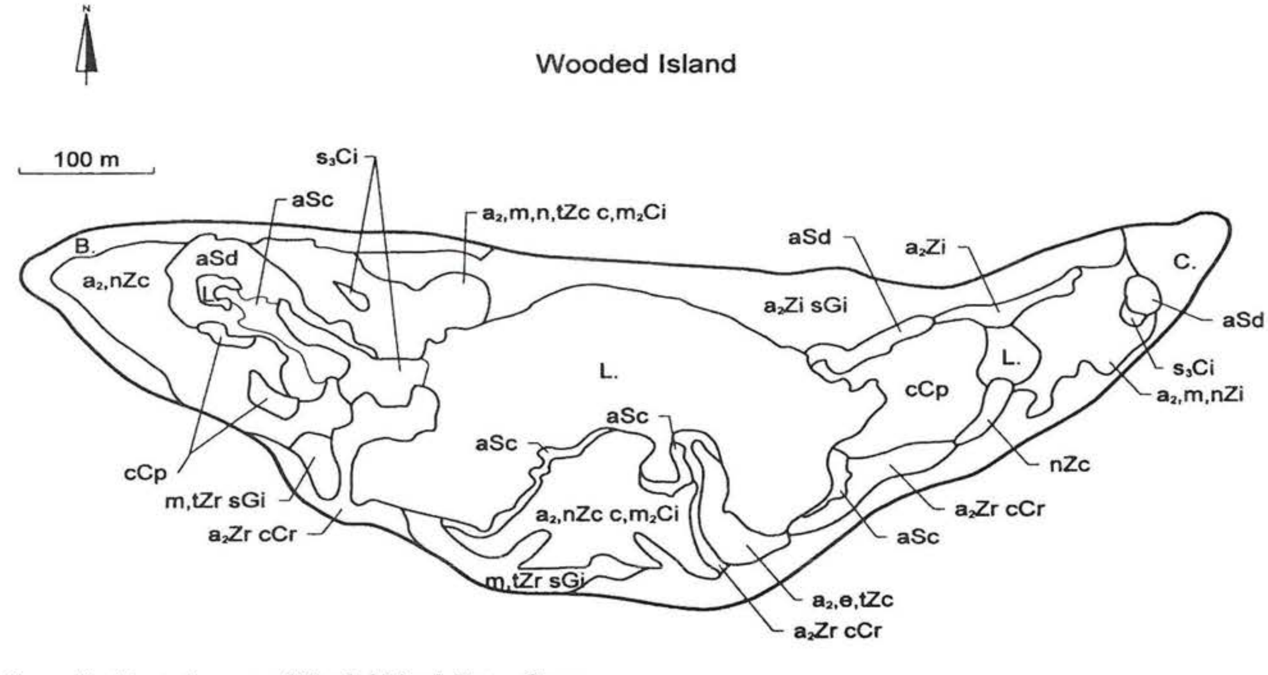

Figure 43. Vegetation map of Wooded Island, Easter Group.

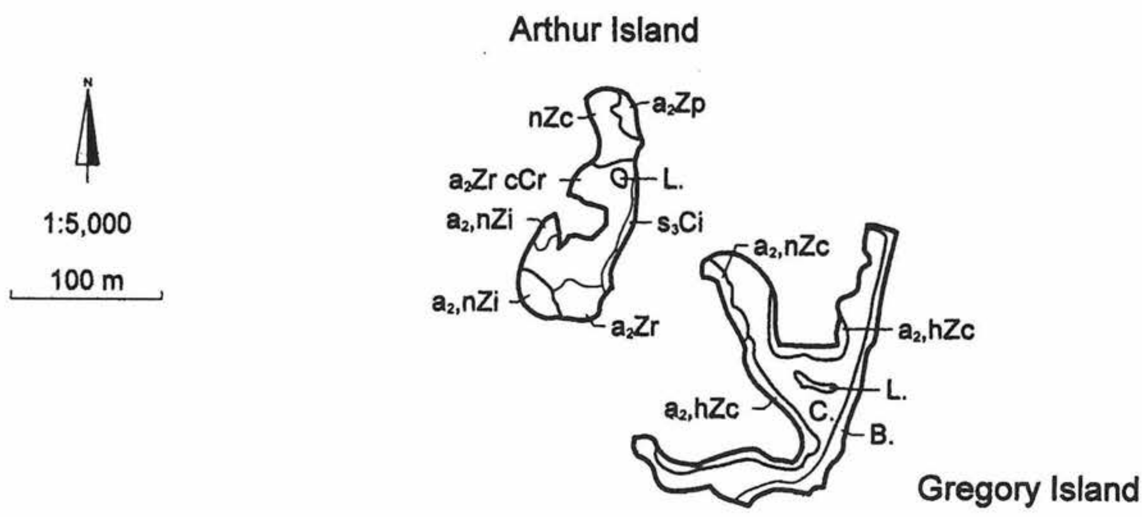

Figure 44. Vegetation map of Arthur Island, Gregory Island, Pelsaert Group.

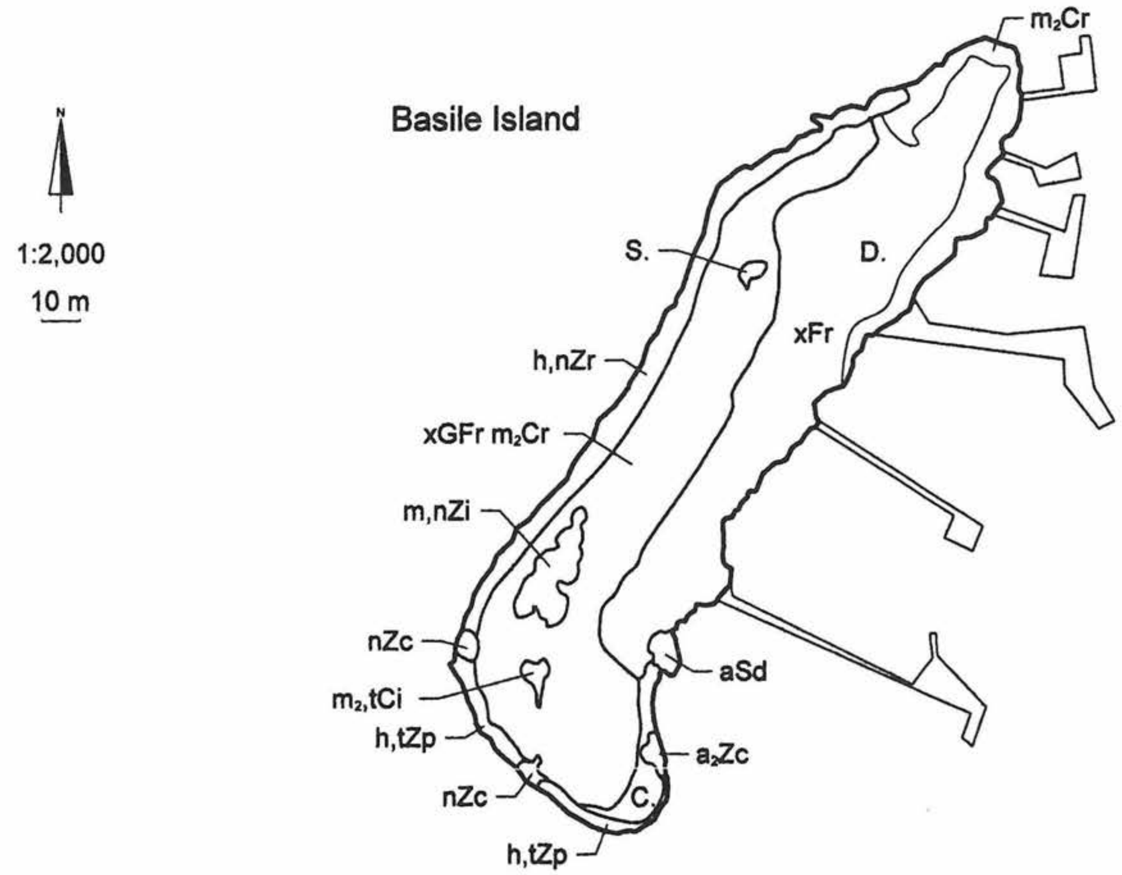

Figure 45. Vegetation map of Basile Island, Pelsaert Group.
For Basile Island, x of xFr and xGFr denote native and introduced grasses, garden plants and weeds including *Avena *spp.*, *Bromus *spp.*, *Ehrharta *spp.*, *Hordeum leporinum, Lavatera plebeia, *Melilotus indicus, *Phalaris minor, *Raphanus *spp.*, *Sonchus oleraceus, *Ursinia anthemoides.

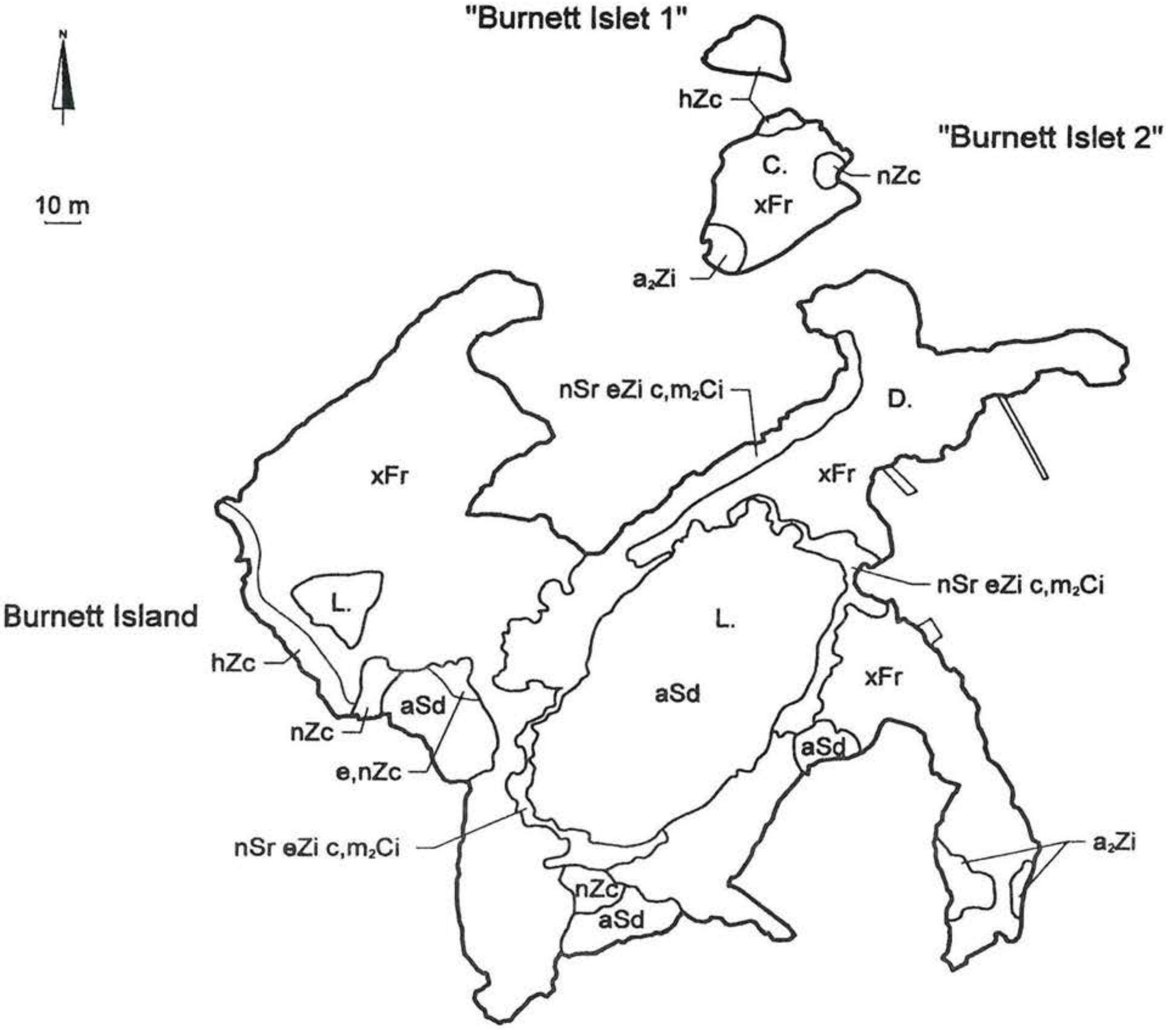

Figure 46. Vegetation map of Burnett Island, "Burnett Islet 1", "Burnett Islet 2", Pelsaert Group.
For Burnett Island, x of xFr includes Parietaria debilis, *Raphanus sativus, Senecio lautus, *Sonchus oleraceus, *Urospermum picroides.
For "Burnett Islet 2", x of xFr denotes mixed forbs (species not specified).

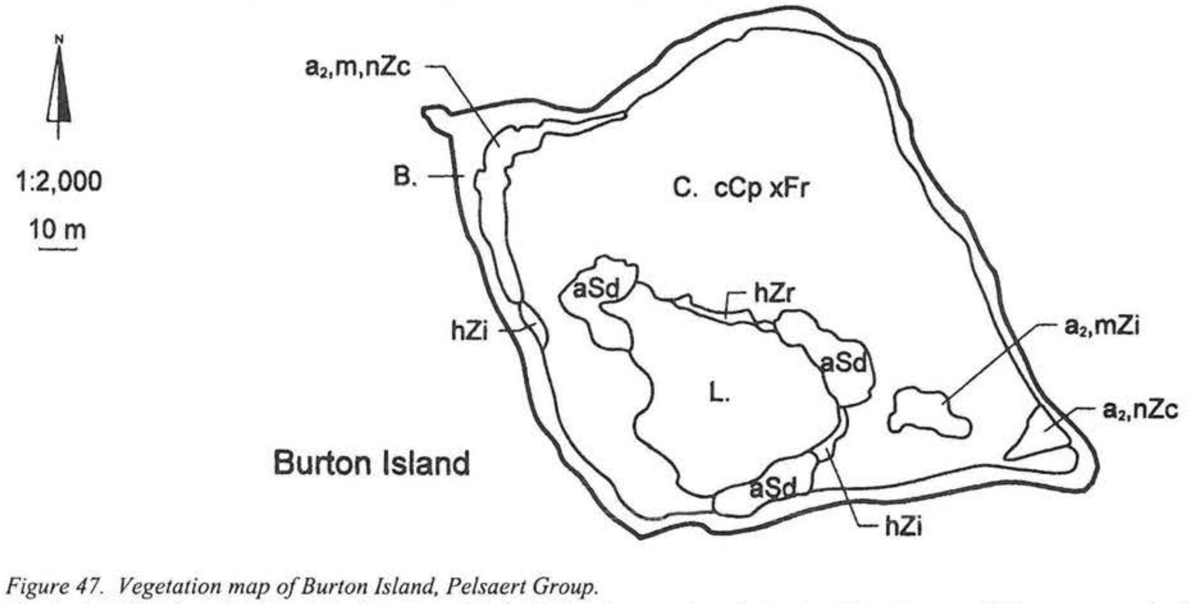

Figure 47. Vegetation map of Burton Island, Pelsaert Group.
For Burton Island, x of xFr includes Lavatera plebeia, Parietaria *spp.,* Senecio lautus, *Sonchus *spp.,* *Urospermum picroides.

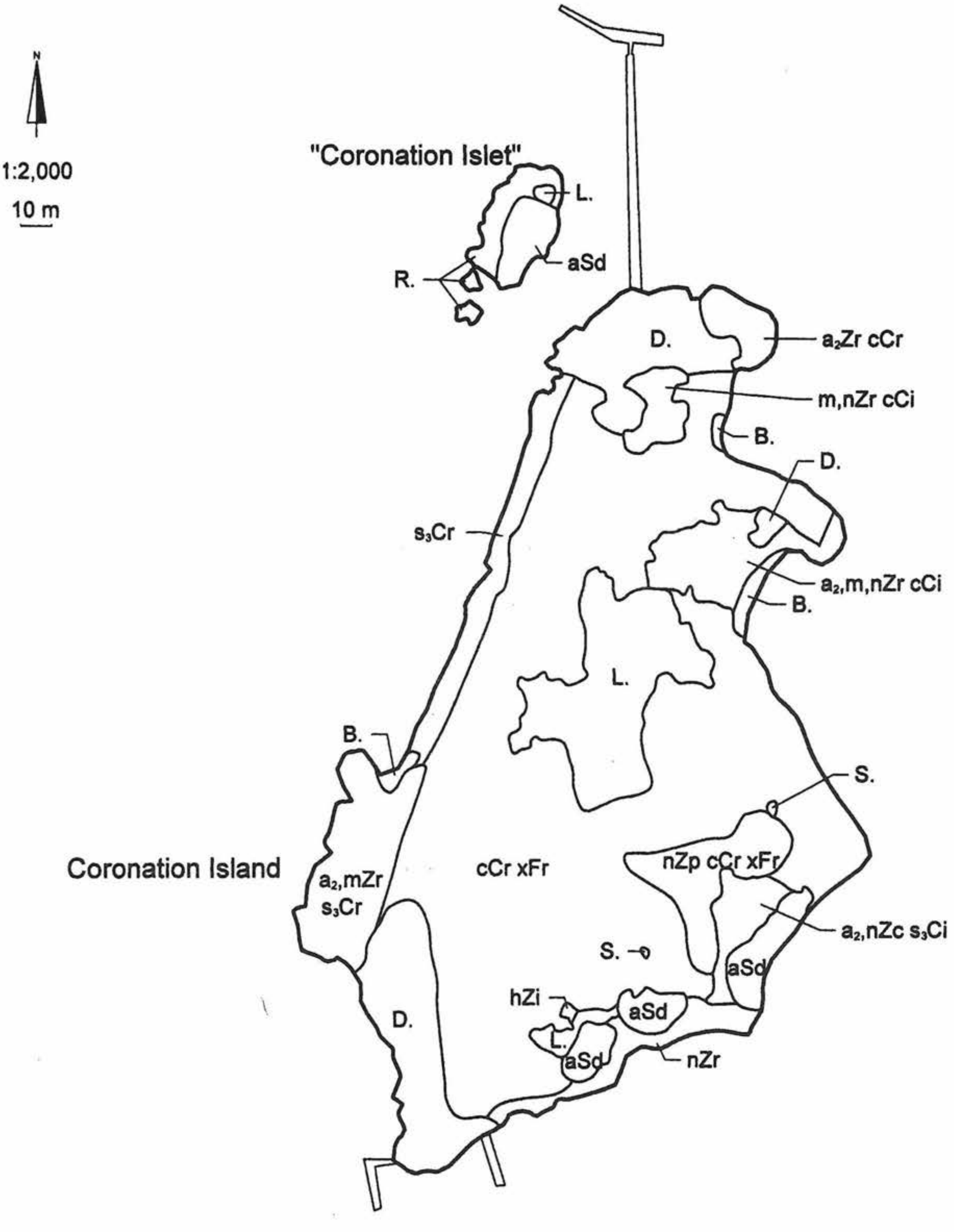

Figure 48. Vegetation map of Coronation Island, "Coronation Islet", Pelsaert Group.
For Coronation Island, x of xFr includes Parietaria debilis, Senecio lautus, *Sonchus oleraceus.

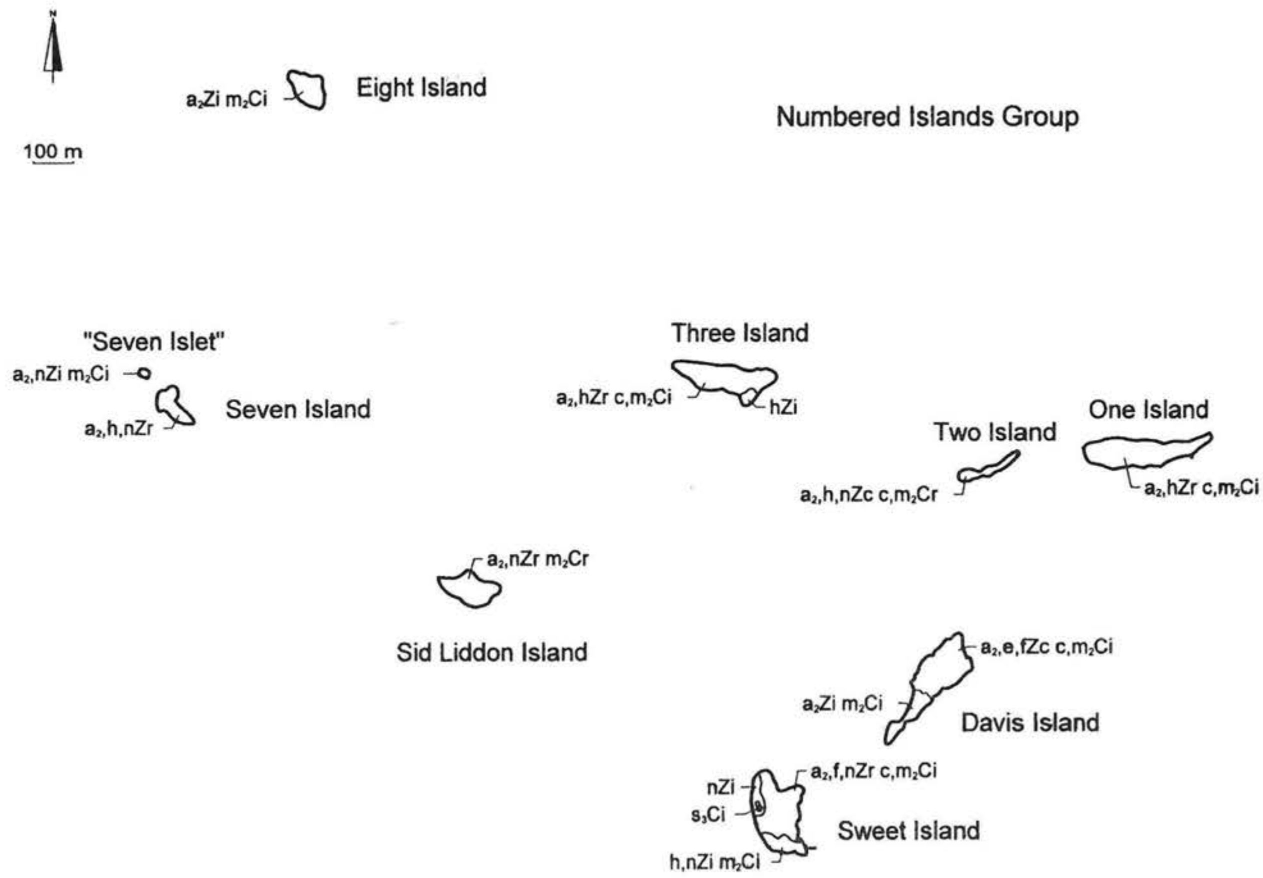

Figure 49. Vegetation map of Davis Island, Eight Island, One Island, Seven Island, "Seven Islet", Sid Liddon Island, Sweet Island, Three Island, Two Island, Pelsaert Group.

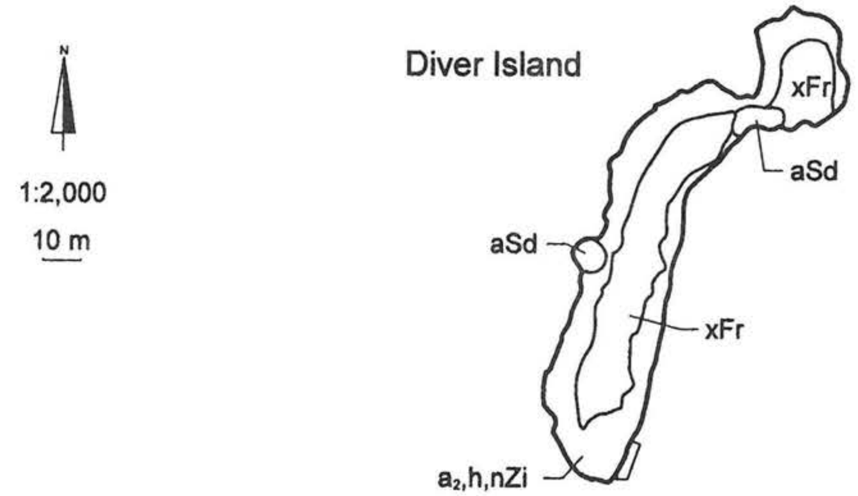

Figure 50. Vegetation map of Diver Island, Pelsaert Group.
For Diver Island, x of xFr denotes mixed forbs (species not specified).

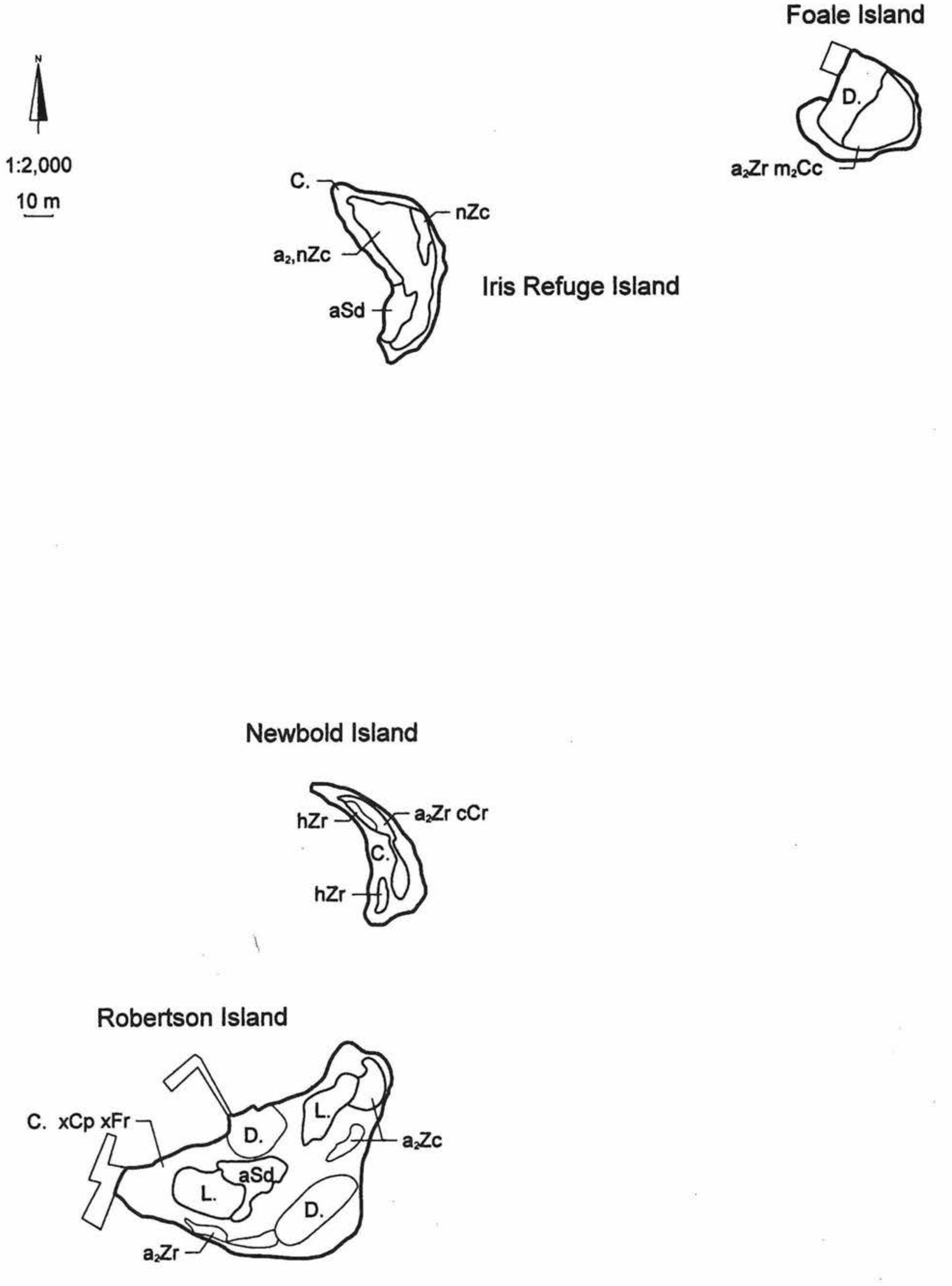

Figure 51. Vegetation map of Foale Island, Iris Refuge Island, Newbold Island, Robertson Island, Pelsaert Group. For Robertson Island, x of xCp and xFr are mixed succulents and forbs (species not specified).

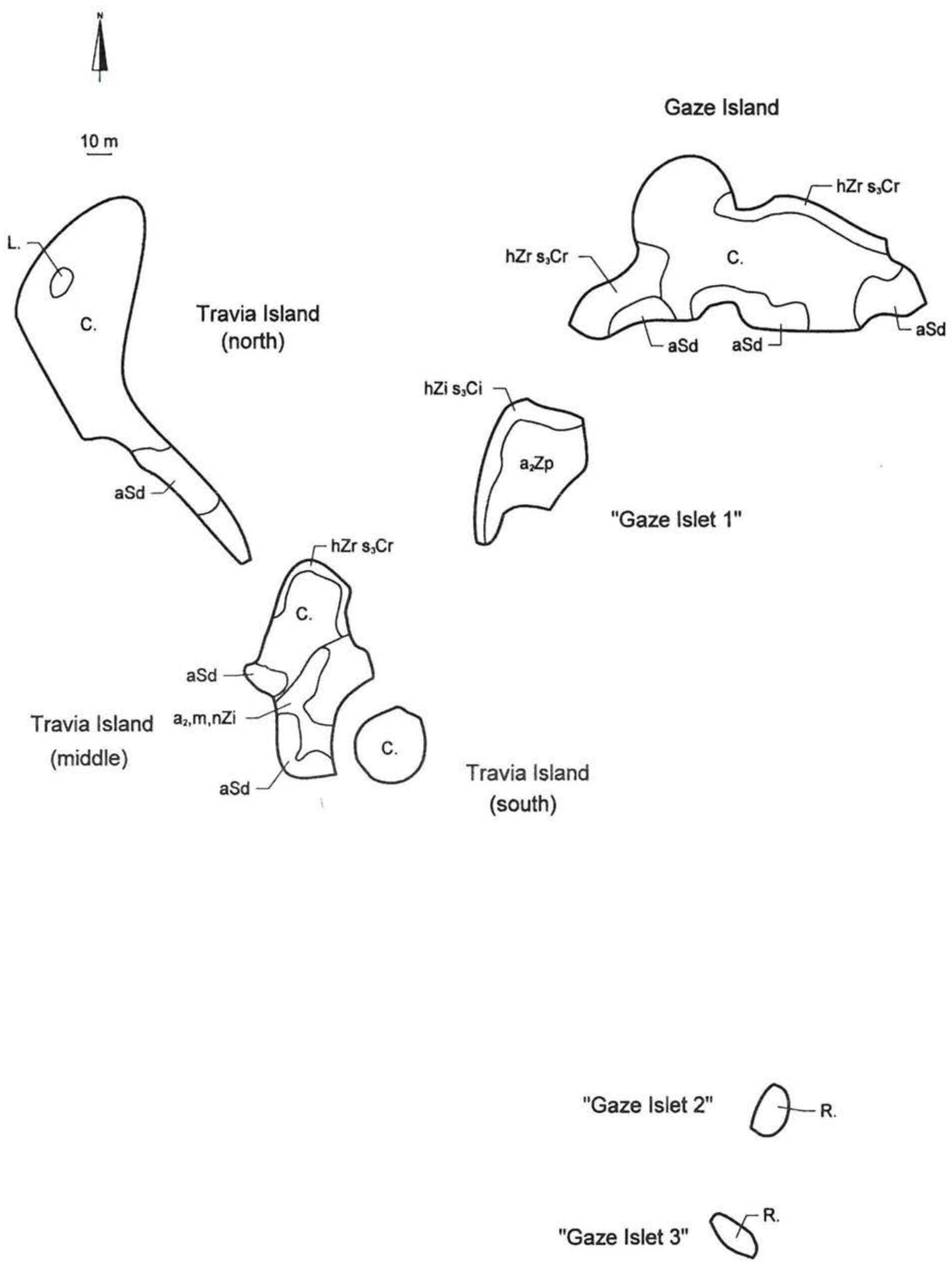

Figure 52. Vegetation map of Gaze Island, "Gaze Islet 1", "Gaze Islet 2", "Gaze Islet 3", Travia Island, Pelsaert Group.

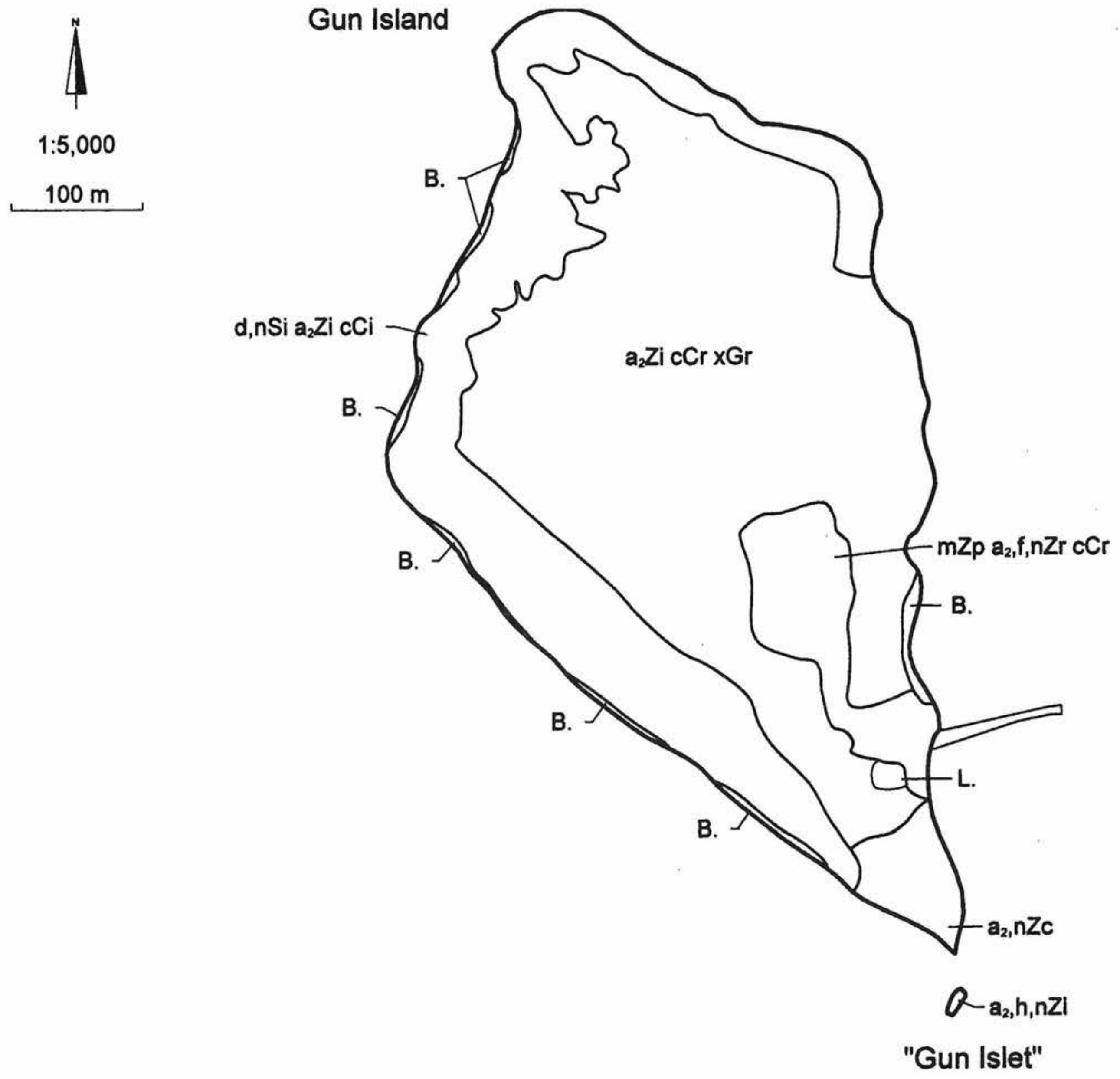

Figure 53. Vegetation map of Gun Island, "Gun Islet", Pelsaert Group.
For Gun Island, x of xGr includes Bromus *sp.*, *Phleum pratensis, Setaria dielsii.

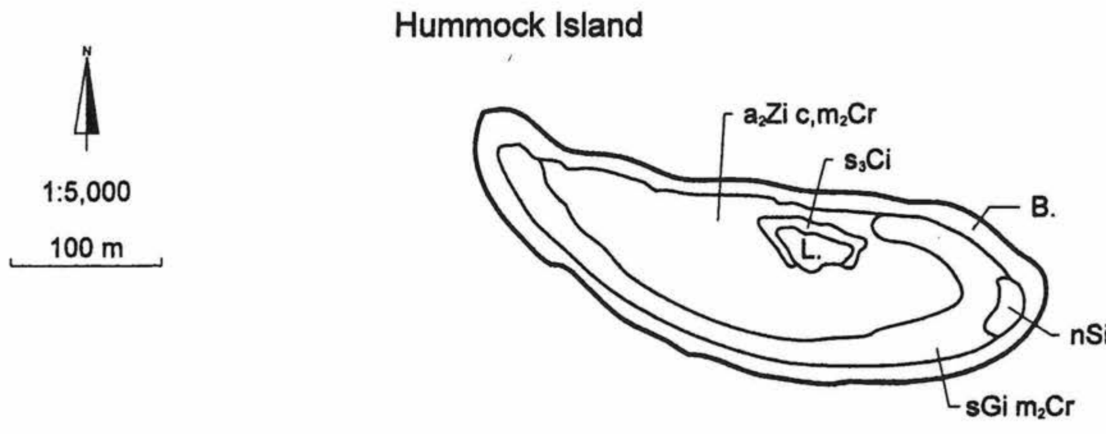

Figure 54. Vegetation map of Hummock Island, Pelsaert Group.

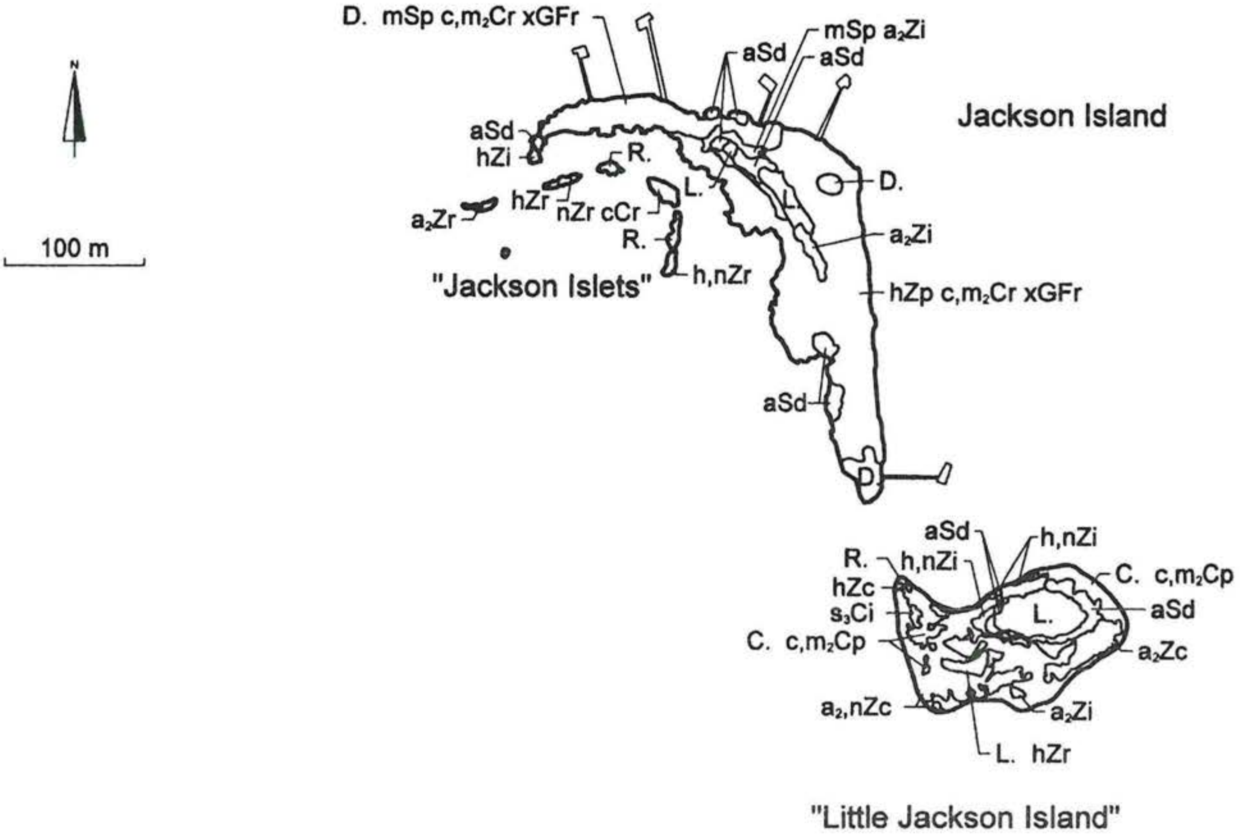

Figure 55. Vegetation map of Jackson Island, "Jackson Islets", "Little Jackson Island", Pelsaert Group.
For Jackson Island, x of xGFr includes *Ehrharta longiflora, Lavatera plebeia, *Lycopersicon esculentum, Parietaria debilis, Senecio lautus, *Sonchus oleraceus.

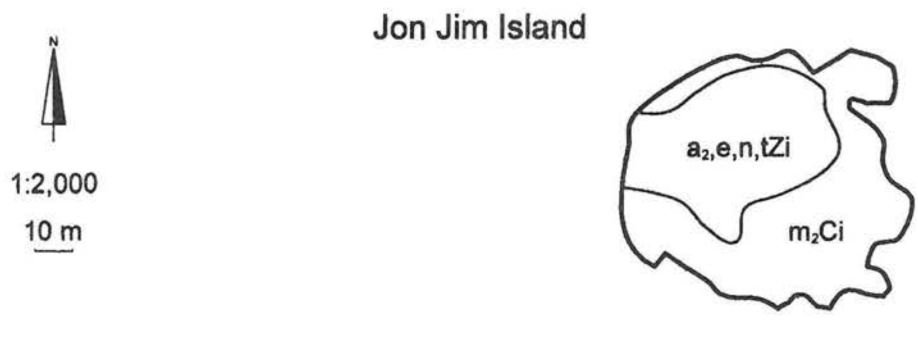

Figure 56. Vegetation map of Jon Jim Island, Pelsaert Group.

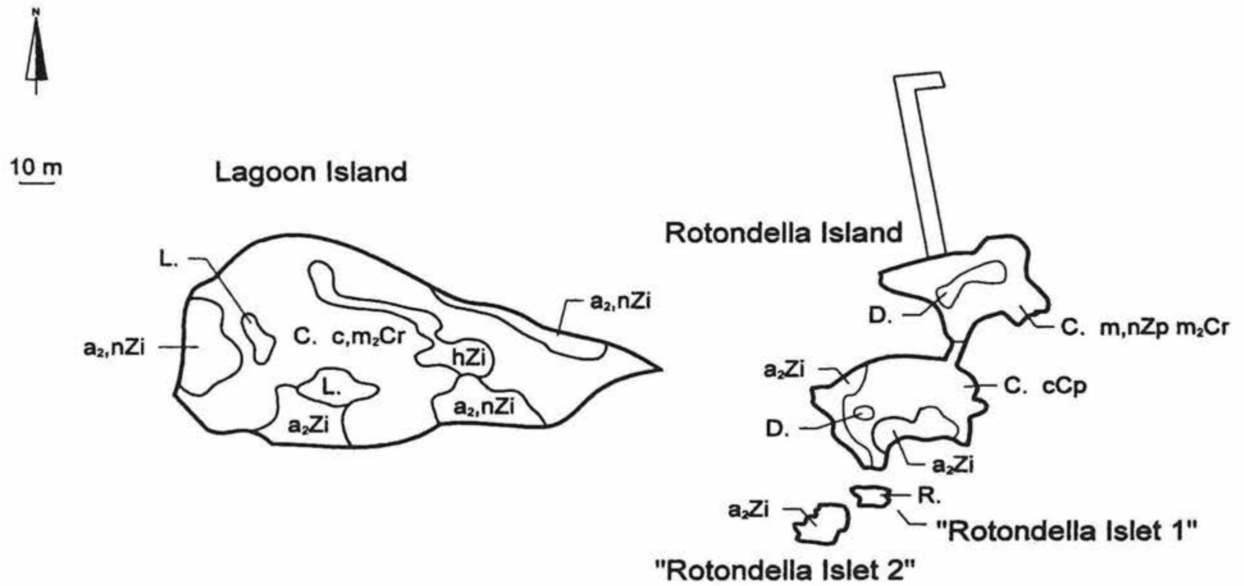

Figure 57. Vegetation map of Lagoon Island, Rotondella Island, "Rotondella Islet 1", "Rotondella Islet 2", Pelsaert Group.

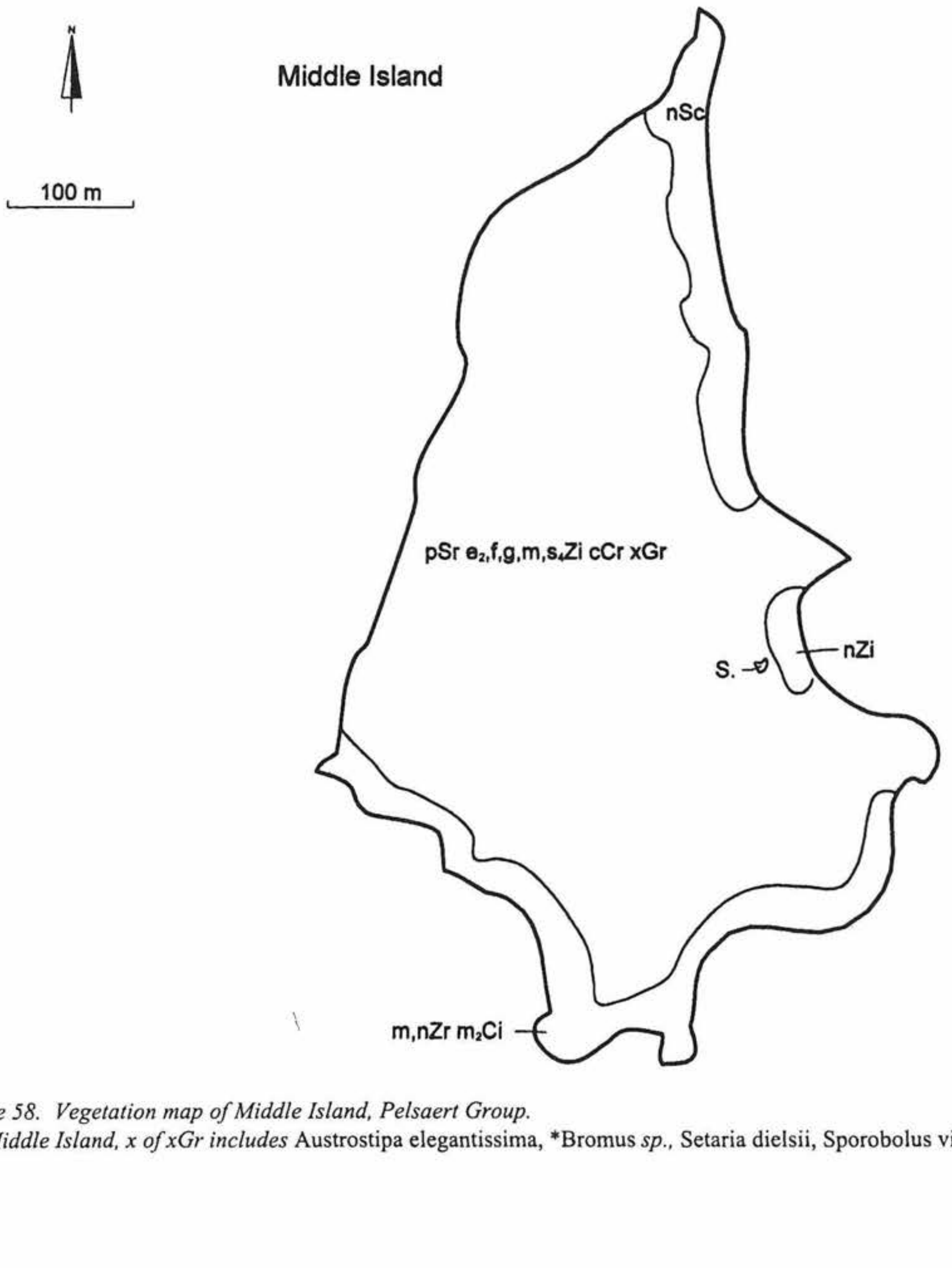

Figure 58. Vegetation map of Middle Island, Pelsaert Group.
For Middle Island, x of xGr includes Austrostipa elegantissima, *Bromus *sp.*, Setaria dielsii, Sporobolus virginicus.

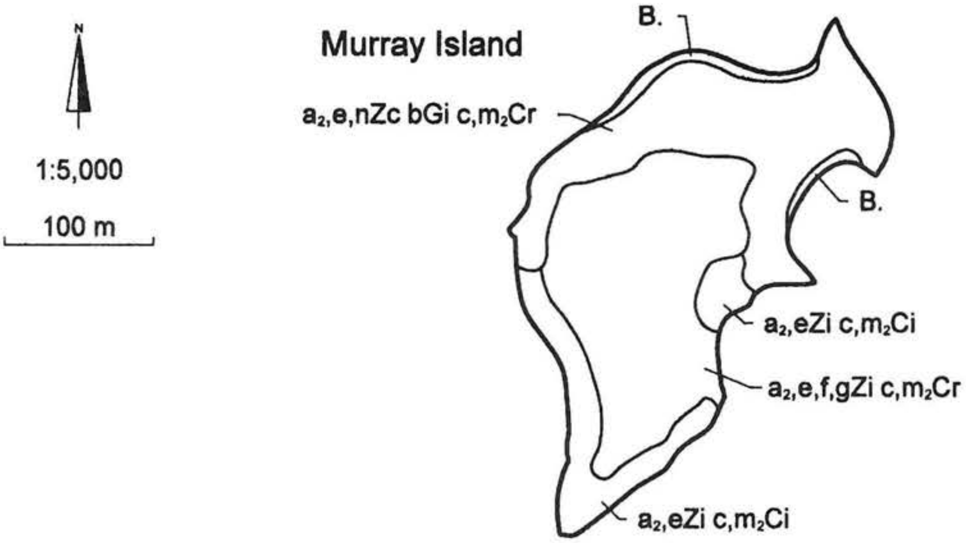

Figure 59. Vegetation map of Murray Island, Pelsaert Group.

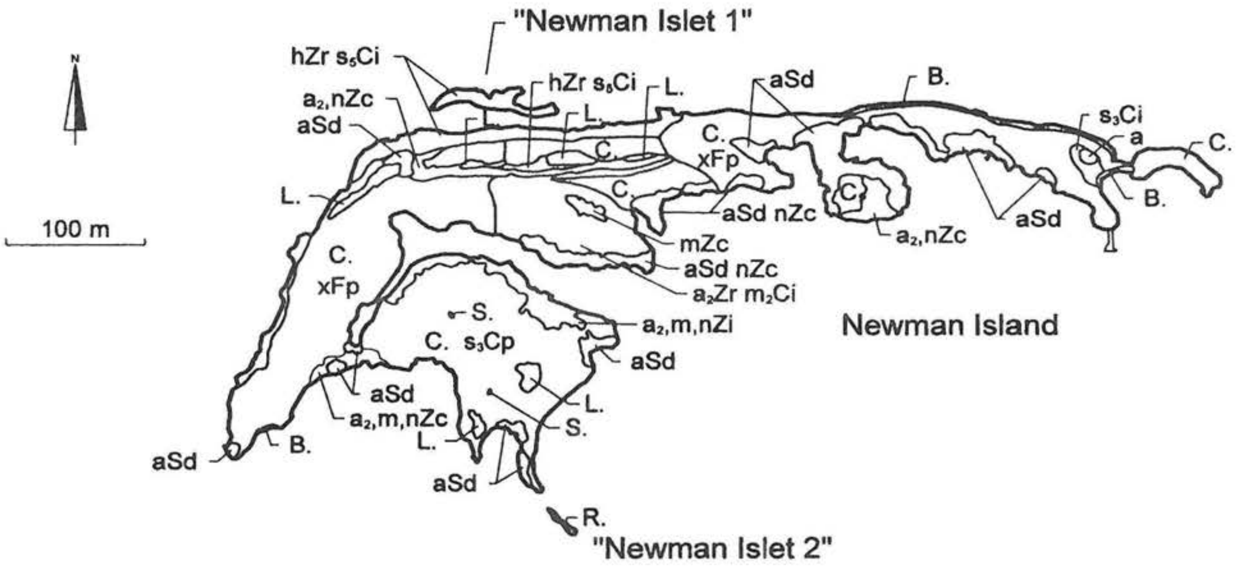

Figure 60. Vegetation map of Newman Island, "Newman Islet 1", "Newman Islet 2", Pelsaert Group. For Newman Island, x of xFp includes Senecio lautus, *Sonchus oleraceus, *Pelsaert Group.*

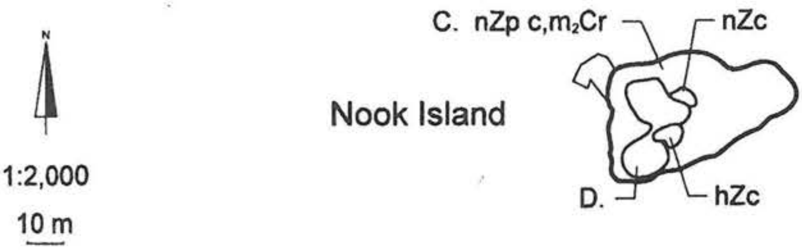

Figure 61. Vegetation map of Nook Island, Pelsaert Group.

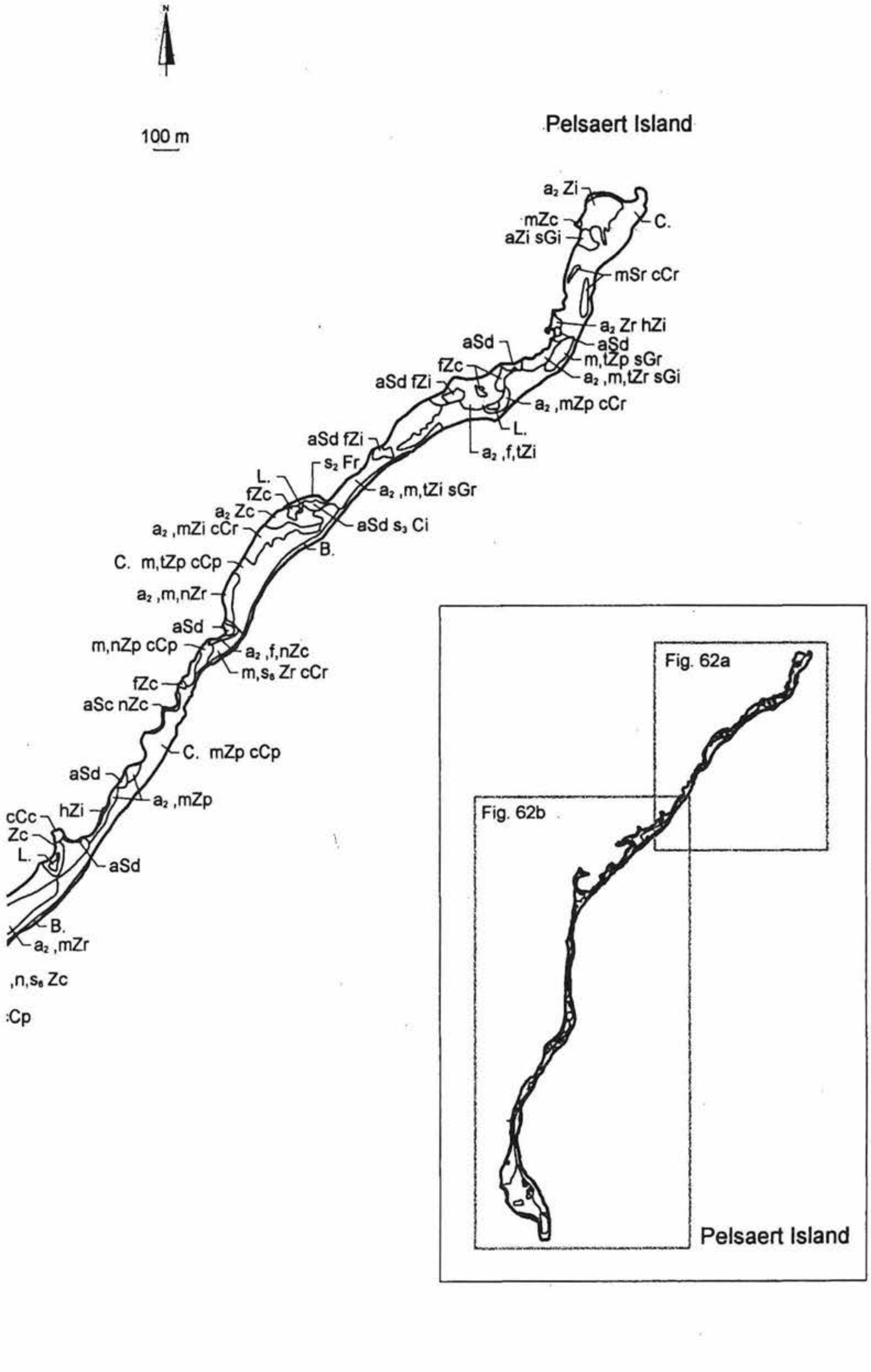

Figure 62a. Vegetation map of Pelsaert Island (north), Pelsaert Group.

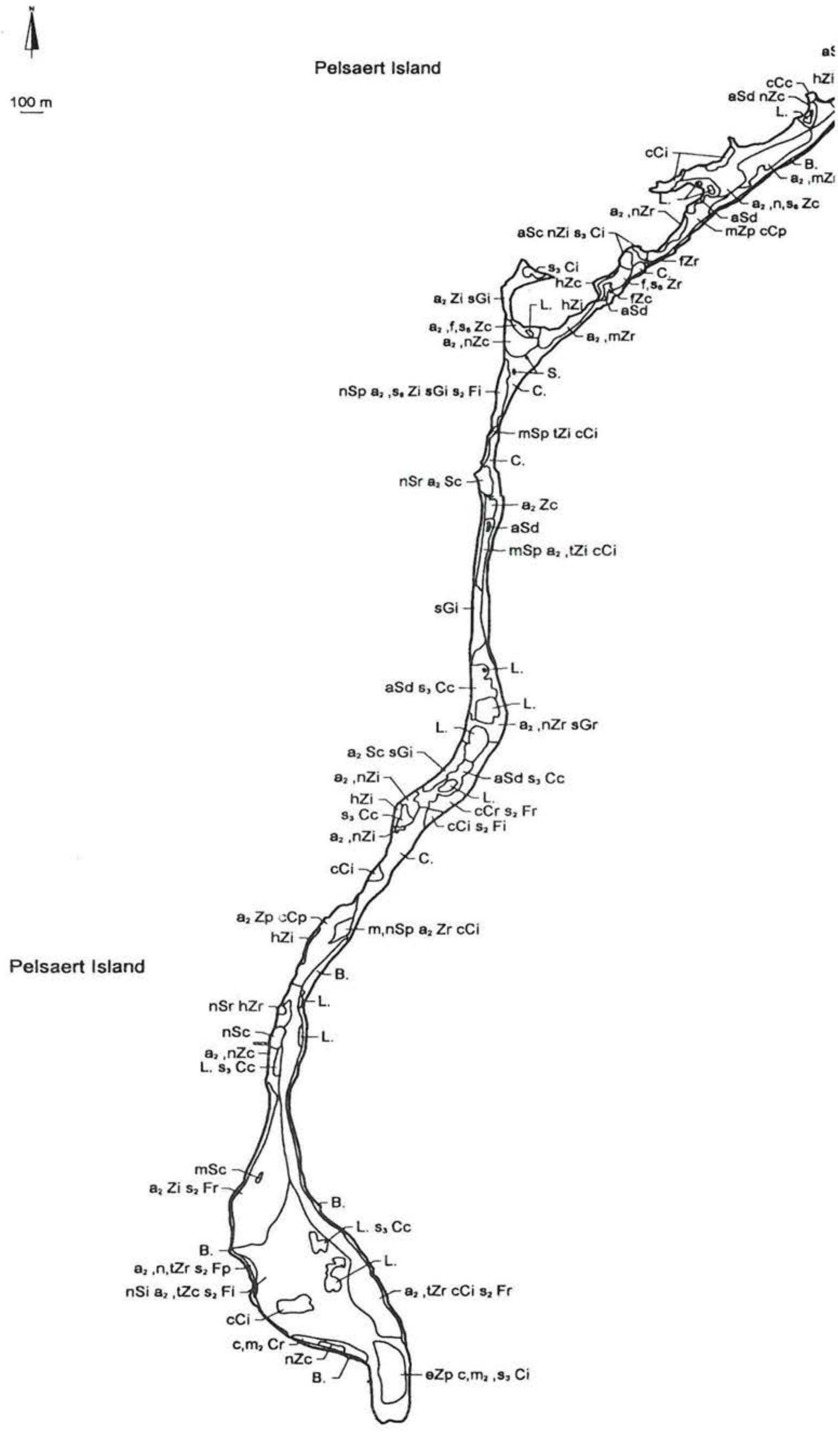

Figure 62b. Vegetation map of Pelsaert Island (south), Pelsaert Group.

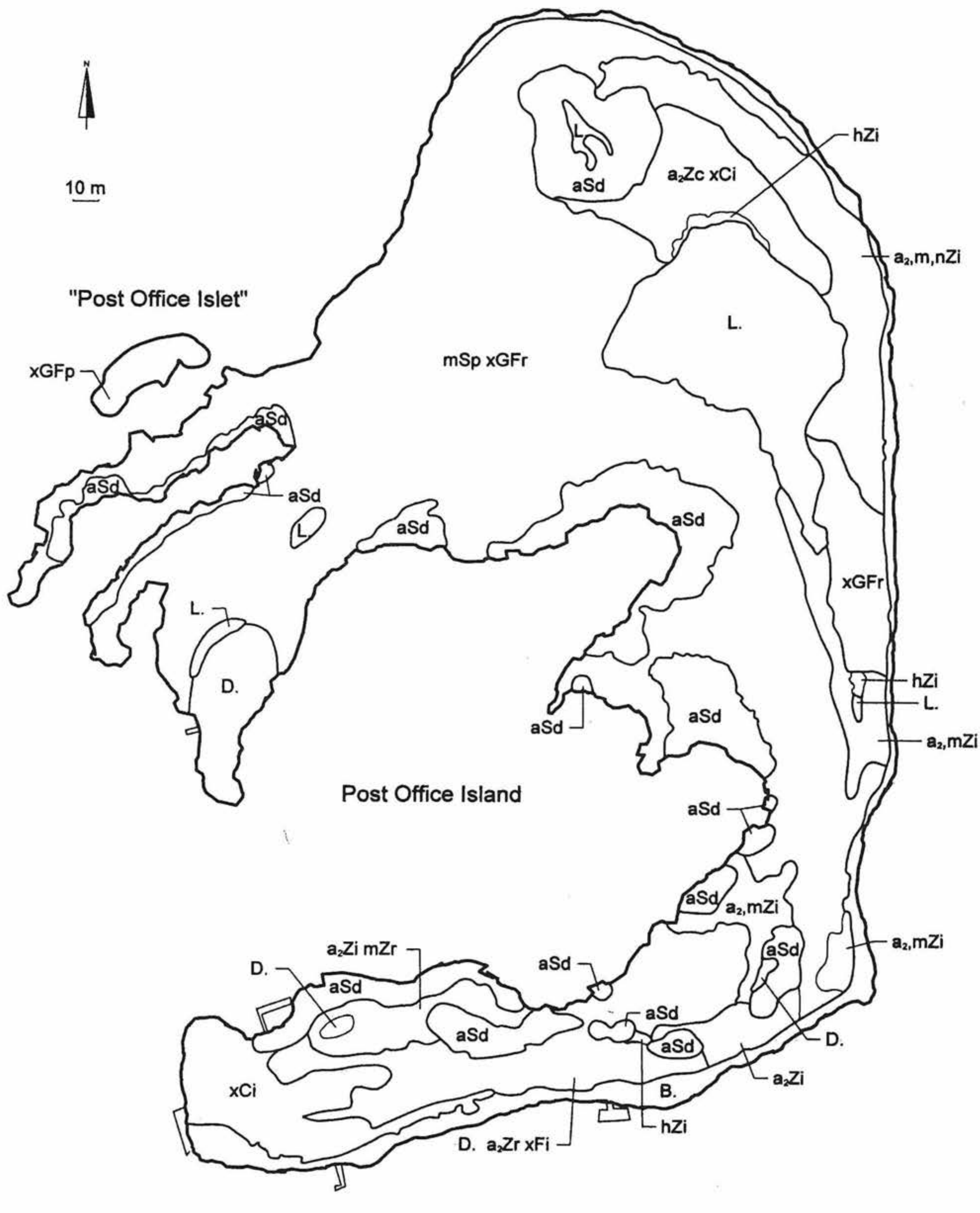

Figure 63. Vegetation map of Post Office Island, "Post Office Islet", Pelsaert Group.
For Post Office Island, x of xCi is mixed succulents (species not specified).
For Post Office Island, x of xFi and xGFr include Bromus arenarius, *Melilotus indicus, Parietaria debilis, *Phalaris *spp.,* *Raphanus raphanistrum, Senecio lautus, *Sonchus oleraceus, *Urospermum picroides.
For "Post Office Islet", x of xGFp includes mixed grasses and forbs (species not specified).

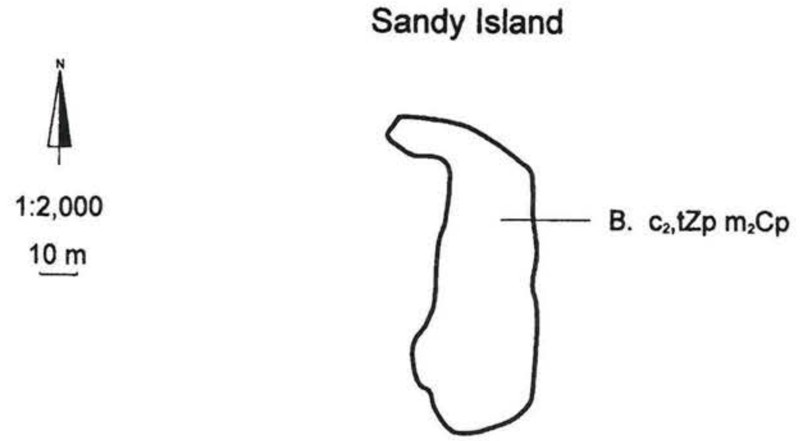

Figure 64. Vegetation map of Sandy Island, Pelsaert Group.

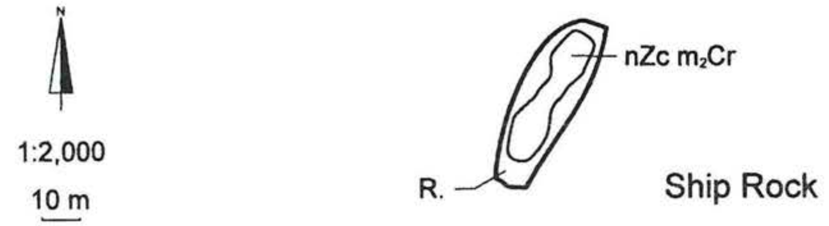

Figure 65. Vegetation map of Ship Rock, Pelsaert Group.

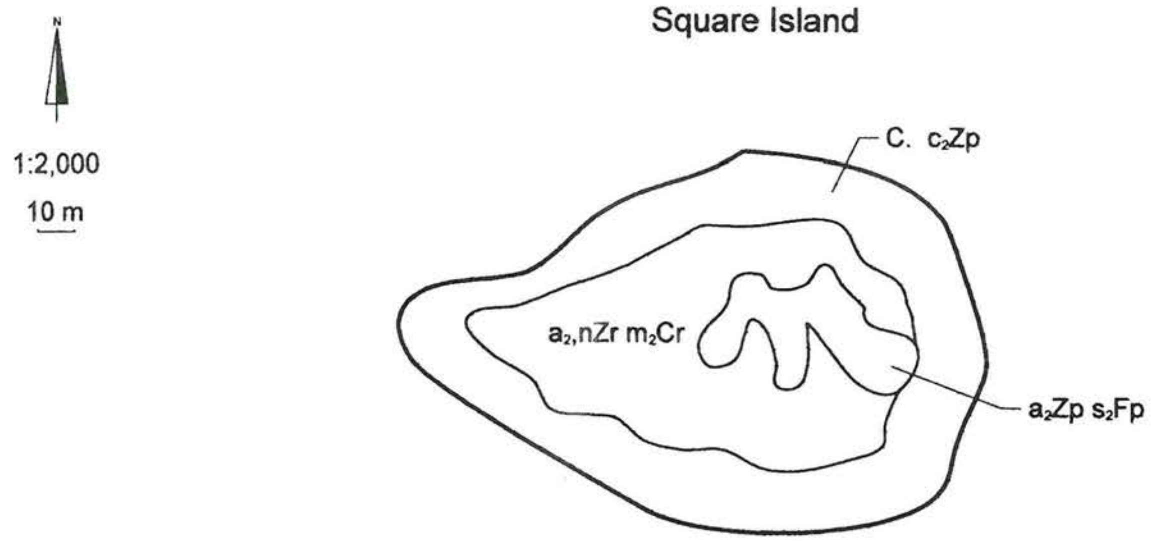

Figure 66. Vegetation map of Square Island, Pelsaert Group.

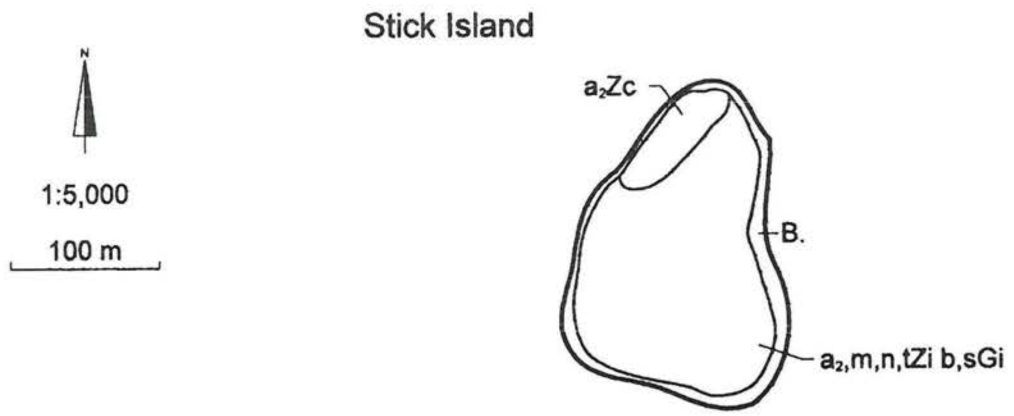

Figure 67. Vegetation map of Stick Island, Pelsaert Group

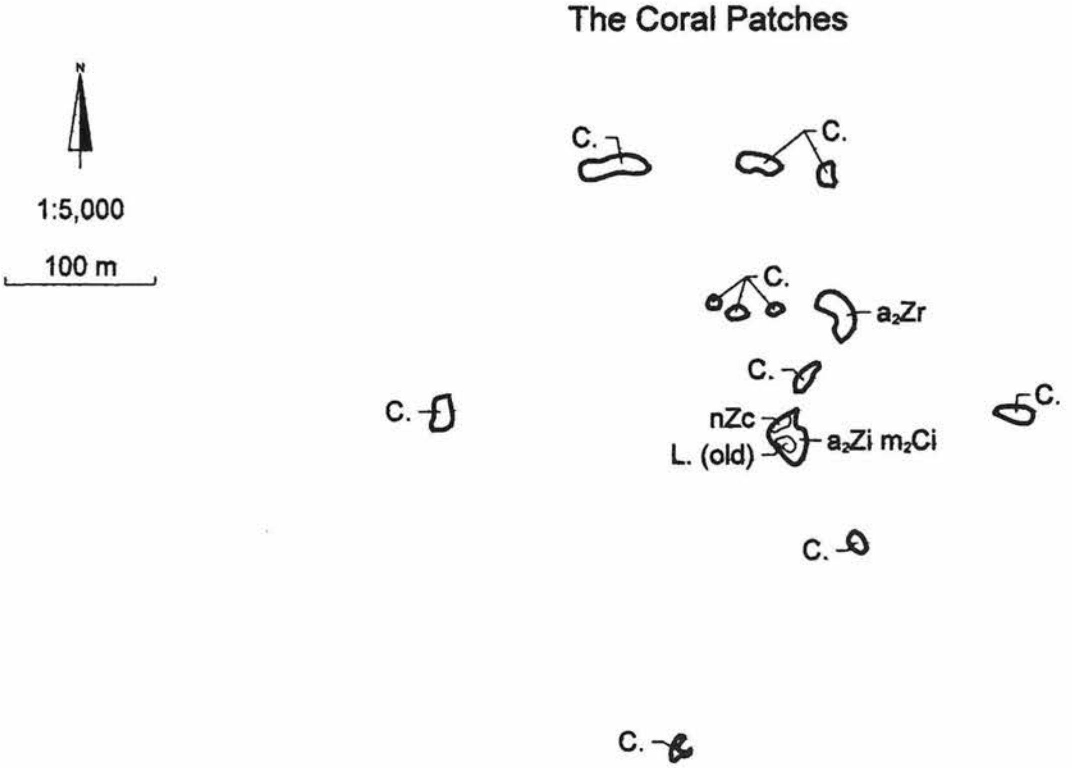

Figure 68. Vegetation map of The Coral Patches, Pelsaert Group.

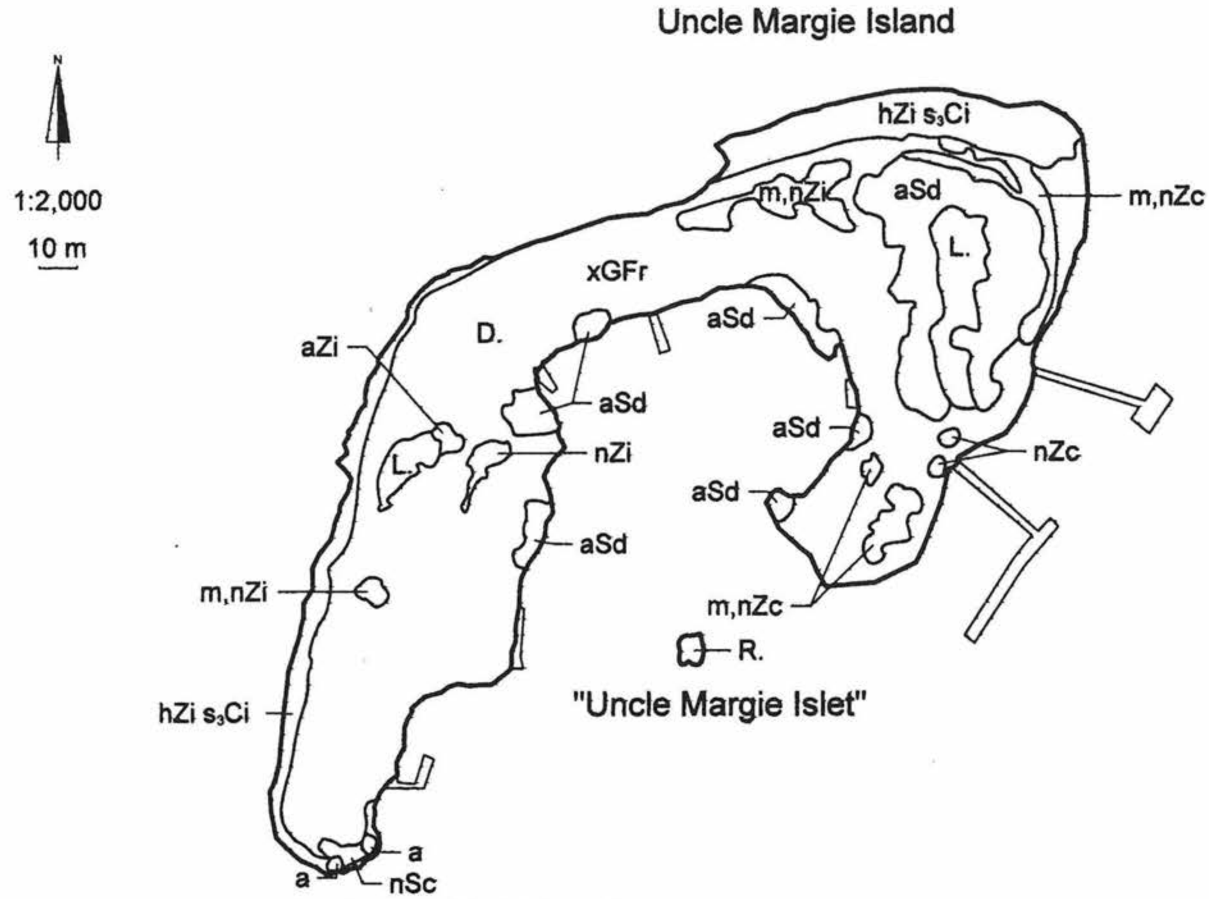

Figure 69. Vegetation map of Uncle Margie Island, Pelsaert Group.
For Uncle Margie Island, x of xGFr includes *Avena *sp.*, *Bromus *sp.*, *Ehrharta longiflora, *Parapholis incurva, *Phalaris minor, *Sonchus oleraceus, *Urospermum picroides.

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