A vegetation survey of the islands of the Turquoise Coast from Dongara to Lancelin, south-western Australia

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ABSTRACT

Thirty seven islands along the Turquoise Coast, the lower west coast of Western Australia between Dongara and Lancelin, were surveyed for vegetation and flora. One hundred and twenty one plant species were recorded from the islands. The richest islands were those with both sandy hills and limestone heath (North Boullanger Island with 62 plant species, Lancelin Island with 60 plant species, Escape Island with 60 plant species, Whitlock Island with 55 plant species, North Cervantes Island with 53 plant species and Boullanger Island with 50 plant species). The most widespread species was *Nitraria billardierei*, which was present on all of the islands surveyed, and the most common vegetation formations were heath, shrublands and herbfields. The vegetation of 14 of the islands had been previously studied thoroughly, and this survey found only Middle Essex Rocks to have fewer plant species than in previous studies; normally increases of 50–100 per cent were documented. Introduced species were common on all islands, but were mainly associated with disturbance caused by seabird colonies or human-made tracks (foot or vehicle). The noxious weed African boxthorn, **Lycium ferocissimum*[3], was located on four northern islands and was subsequently eliminated from three of these islands; it is currently being eliminated from the fourth island. The islands of the Turquoise Coast are the least disturbed islands between Kalbarri and Mandurah and have no settlements. Their vegetation is representative of vegetation of offshore limestone islands in Western Australia. Special conservation areas include the populations of *Lavatera plebeia* var. *tomentosa* and *Lepidium foliosum* growing in association with the guano-rich seabird nesting sites, and the tree-like bushes of *Nitraria billardierei* on East Beagle Island. Further interesting flora include the Priority 4 species *Lepidium puberulum* and the tall form of *Senecio lautus* subsp. *maritimus*.

INTRODUCTION

The purpose of this paper is to document published and unpublished floristic and vegetation data, including plant species lists and maps of structural vegetation forms, for the islands of the Turquoise Coast, and to identify vegetation communities of special conservation interest to aid management planning for these islands. The bulk of the data is published for the first time and is from field trips undertaken by Keighery and Alford in 1985 and Alford in 1986.

Location and size

The islands of the Turquoise Coast (Figs. 1 & 2 and Table 1) are a series of islands that run parallel to the west coast of Australia. They extend south from the Beagle Islands (60 km south of Dongara) to Edward Island (110 km north of Perth, near Lancelin), spanning a distance of 145 km.

The 37 islands of the Turquoise Coast occur singly or in groups of up to six. The distances between the islands and the mainland range from about 0.1 km (Edward Island, Orton Rock and Snag Island) to 8.6 km (South-West Beagle and North-West Beagle Islands). Wedge Island is periodically joined to the mainland by a sand bar.

The islands vary in size (Table 2) from 0.04 ha (South Ronsard Rocks, North Ronsard Rocks, Orton Rock and Drummond Rock) to 23.5 ha (Boullanger Island). Four islands are larger than four ha, nine islands are larger than one ha but smaller than four ha, and the remaining 24 islands are each smaller than one hectare.

Tenure

The islands of the Turquoise Coast are Australian territory and part of the State of Western Australia (WA). Thirty

[3] Note that the use of (*) is to signify an introduced species.

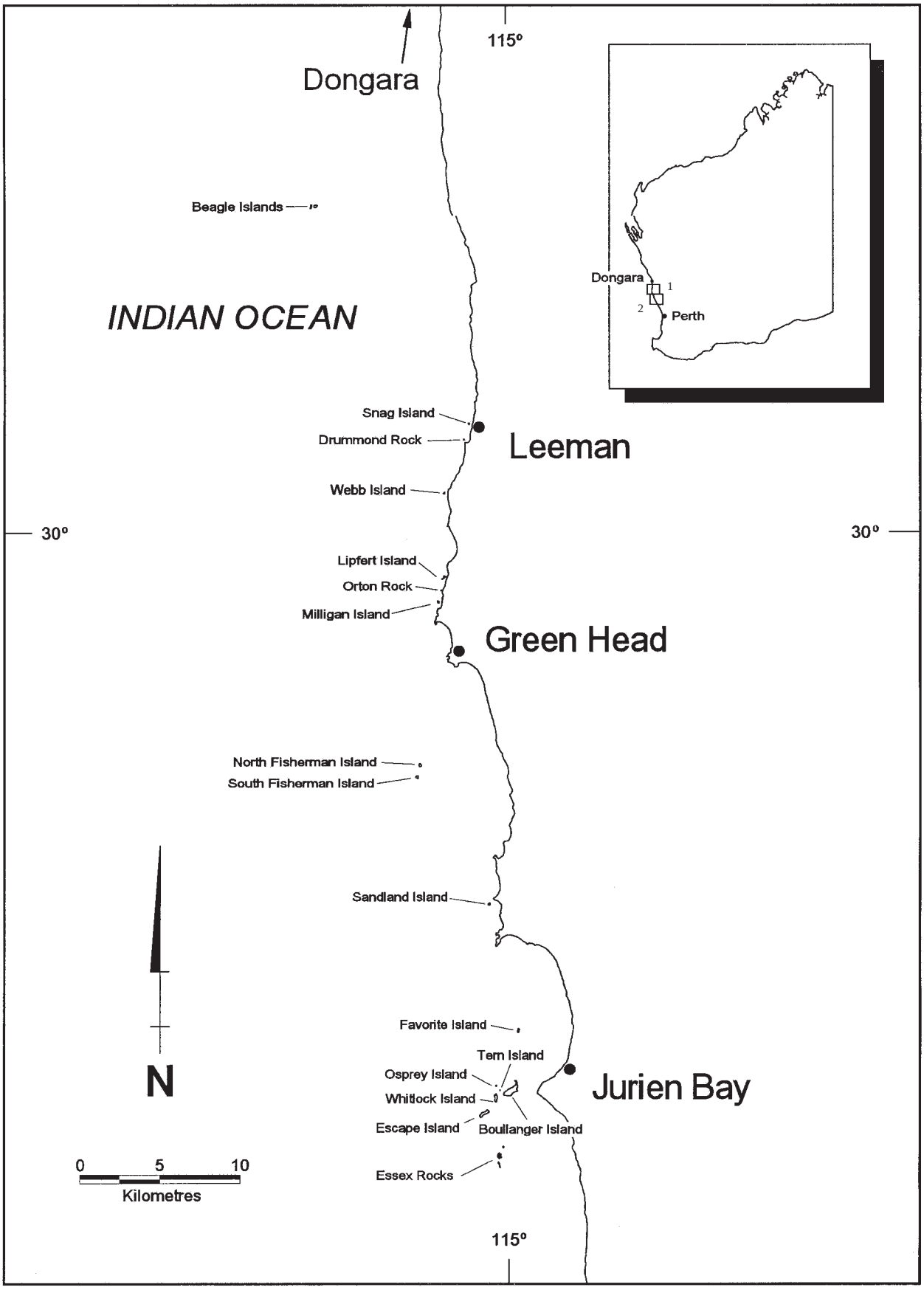

Figure 1. The islands of the Turquoise Coast (north). The insert shows the study area.

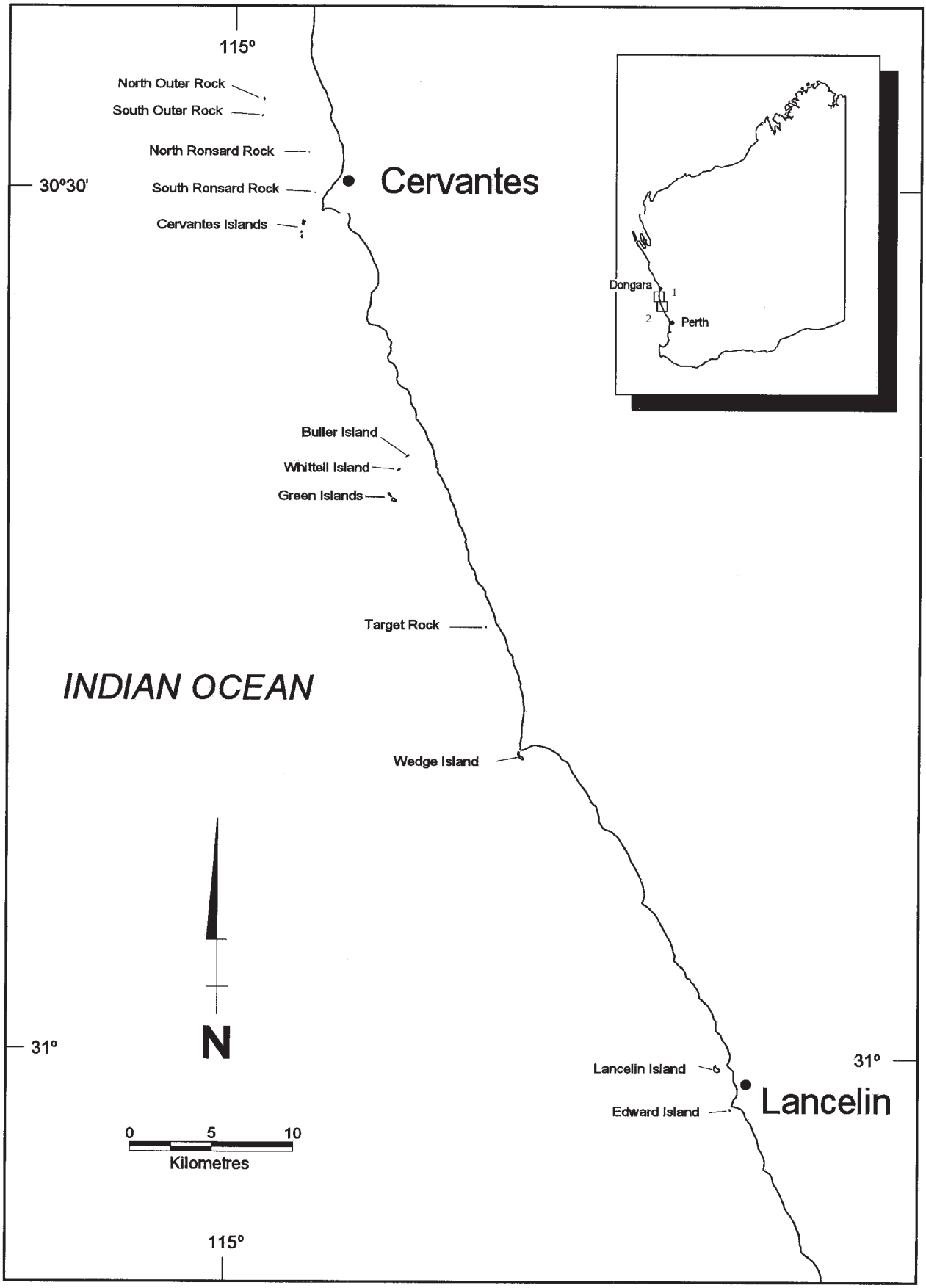

Figure 2. The islands of the Turquoise Coast (south). The insert shows the study area.

TABLE 1
Islands in the Turquoise Coast study area, ordered from north to south. Names in the first column are those recommended by the Department of Land Administration (DOLA).The island name extensions in the second column are useful for assigning flora to a more specific part of the island.

ISLAND NAMES	ISLAND NAME EXTENSIONS
Beagle Islands	East Beagle Island
	North-West Beagle Island
	South-West Beagle Island
Snag Island	
Drummond Rock	
Webb Island	
Lipfert Rock	
Orton Rock	
Milligan Island	
Fisherman Islands	North Fisherman Island
	South Fisherman Island
Sandland Island	
Favorite Island	
Osprey Island	
Tern Island	
Boullanger Island	North Boullanger Island
	Boullanger Island
Whitlock Island	
Escape Island	
Essex Rocks	North Essex Rocks
	Middle Essex Rocks
	South Essex Rocks
Outer Rocks	North Outer Rocks
	South Outer Rocks
North Ronsard Rocks	
South Ronsard Rocks	
Cervantes Islands	North Cervantes Island
	Middle Cervantes Island
	South Cervantes Island
Buller Island	
Whittell Island	
Green Islands	North Green Island
	South Green Island
Target Rock	
Wedge Island	
Lancelin Island	
Edward Island	

six islands are included in thirteen A class nature reserves (Table 3) for the purpose of conservation of flora and fauna. Target Rock was previously leased to the Department of Defence for use as a Royal Australian Air Force (R.A.A.F.) bombing range and is currently vacant Crown land. Negotiations are under-way to ensure the vesting of this island as a nature reserve.

Geology and geomorphology

Between 1.7 million and 10 000 years ago, successive periods of glaciation and deglaciation caused fluctuations in sea level. When the sea level was low, broad areas of the continental shelf were exposed to wind erosion, and extensive parallel sand ridges formed and subsequently hardened to form limestone. The sea level reached its current level around 6 500 years ago (Wyroll[4], personal communication) and the old dune ridges were exposed, forming the islands.

Over time, repeated solution and re-deposition of calcium carbonate have formed capstone and solution pipes. The limestone on the islands has been extensively weathered and on some islands the eroded material has formed slopes of loose rocks or talus, occasionally covered with shallow deposits of sandy soil. Apart from the weathering, the islands' soils are also derived from wind-deposited sand and organic material. The larger islands have sand dune systems ranging from small to extensive, and the dune sand consists of wind-deposited white calcareous sand and yellowish-tinged sand derived from weathering of the bedrock. The sand's organic content is low to non-existent. Where there are high densities of nesting seabirds, there is a shallow layer of pinkish-brown guano.

In some but not all cases, the larger islands have a more complex geomorphology and, therefore, greater habitat diversity.

The islands are surrounded by intertidal reef platforms and / or sandy bays. On some islands, the rise and fall of the sea level during the Pleistocene, the subsequent weathering, and recent wave action have undermined the limestone plateaux and formed caves.

Environmental parameters

Climate

The Turquoise Coast experiences a Mediterranean climate, characterised by mild, wet winters and hot, dry summers. In summer the climate is controlled chiefly by a belt of high-pressure systems; in winter these move north, being replaced by low-pressure systems and associated cold fronts.

Meteorological information for the islands of the Turquoise Coast was obtained from the nearest meteorological stations located at Lancelin and Jurien. Data from the Fremantle or Perth and the Geraldton stations were also referred to for analysis of north to south trends. Comparisons between weather stations on an island (Rottnest) and the adjacent mainland (Fremantle) were made to show general differences in climate between islands and the mainland. Rottnest was found to experience slightly lower maximum temperatures, slightly higher minimum temperatures, less rainfall and greater wind strengths compared with the adjacent mainland (Bureau of Meteorology 2001). It is likely that the islands of the Turquoise Coast exhibit similar patterns, varying according to factors such as their size and their distance from the mainland.

Annual mean daily temperatures for the Turquoise Coast range from 13.3°C minimum to 24.4°C maximum. The mean daily maximum temperatures decrease slightly from north to south (Table 4); however, the mean daily minimum temperatures are slightly lower at Jurien. The evaporation rate also decreases from north to south and the mean daily evaporation is 6.8 mm for Geraldton and 5.8 mm for Perth (Bureau of Meteorology 2001).

[4] Dr K.-H. Wyrwoll, University of Western Australia, Nedlands, WA 6009.

TABLE 2
Size and location information for the islands of the Turquoise Coast.

ISLAND	DISTANCE FROM MAINLAND (km)	AREA OF ISLAND (ha)	MAXIMUM ELEVATION ABOVE SEA LEVEL (m)	ISLAND CO-ORDINATES	ISOLATION (m)
East Beagle Island	8.3	1.50		29°48'28"S, 114°52'36"E	120 m E of North-West Beagle Island
North-West Beagle Island	8.6	0.50		29°48'26"S, 114°52'26"E	10 m N of South-West Beagle Island
South-West Beagle Island	8.6	0.20		29°48'28"S, 114°52'26"E	10 m S of North-West Beagle Island
Snag Island	0.1	0.20		29°56'14"S, 114°58'33"E	130 m from mainland
Drummond Rock	0.2	0.04		29°56'46"S, 114°58'21"E	200 m from mainland
Webb Island	0.2	0.20		29°58'36"S, 114°57'34"E	190 m from mainland
Lipfert Island	0.2	0.20		30°01'30"S, 114°57'37"E	150 m from mainland
Orton Rock	0.1	0.04		30°01'56"S, 114°57'44"E	60 m from mainland
Milligan Island	0.2	0.20		30°02'20"S, 114°57'19"E	220 m from mainland
North Fisherman Island	4.9	1.40	10	30°07'55"S, 114°56'36"E	720 m N of South Fisherman Island
South Fisherman Island	5.6	0.40	10	30°08'20"S, 114°56'28"E	720 m S of North Fisherman Island
Sandland Island	0.3	1.50		30°12'41"S, 114°59'16"E	300 m from mainland
Favorite Island	3.3	3.00	14	30°17'02"S, 115°00'23"E	3000 m N of North Boullanger Island
Osprey Island	2.3	0.10	4	30°18'54"S, 114°59'31"E	300 m NW of Tern Island
Tern Island	2.5	0.20	4	30°19'03"S, 114°59'41"E	110 m W of Boullanger Island
North Boullanger Island	1.4	2.40	10	30°18'50"S, 115°00'18"E	sand bar joins to Boullanger Island
Boullanger Island	1.1	23.50	7	30°18'59"S, 115°00'13"E	110 m E of Tern Island
Whitlock Island	2.4	5.40	10	30°19'19"S, 114°59'30"E	130 m SW of Tern Island
Escape Island	3.3	10.50	12	30°20'04"S, 114°59'06"E	800 m SW of Whitlock Island
North Essex Rocks	4.2	0.40	5	30°21'01"S, 114°59'47"E	400 m NE of Middle Essex Rocks
Middle Essex Rocks	4.4	0.30	5	30°21'18"S, 114°59'40"E	80 m N of South Essex Rocks
South Essex Rocks	4.6	0.10	5	30°21'37"S, 114°59'38"E	80 m S of Middle Essex Rocks
North Outer Rocks	5.5	0.40		30°26'33"S, 114°59'47"E	70 m N of South Outer Rocks
South Outer Rocks	5.6	0.20		30°26'38"S, 114°59'45"E	70 m S of North Outer Rocks
North Ronsard Rocks	2.1	0.04		30°28'46"S, 115°02'48"E	2100 m from mainland
South Ronsard Rocks	0.6	0.04		30°30'05"S, 115°02'59"E	600 m from mainland
North Cervantes Island	1.6	3.20	8	30°31'28"S, 115°02'41"E	420 m N of Middle Cervantes Island
Middle Cervantes Island	2.6	0.20		30°31'48"S, 115°02'36"E	100 m N of South Cervantes Island
South Cervantes Island	2.7	0.90		30°31'58"S, 115°02'37"E	100 m S of Middle Cervantes Island
Buller Island	1.5	0.40		30°39'30"S, 115°06'48"E	750 m NE of Whittell Island
Whittell Island	2.3	0.20		30°39'58"S, 115°06'28"E	750 m SW of Buller Island
North Green Island	3.3	1.60	8	30°40'50"S, 115°06'08"E	130 m NW of South Green Island
South Green Island	3.1	3.40	8	30°41'00"S, 115°06'17"E	130 m SE of North Green Island
Target Rock	0.9	0.08	12	30°45'40"S, 115°09'53"E	900 m from mainland
Wedge Island	0.2	1.90	21	30°49'45"S, 115°11'12"E	200 m from mainland but periodically a sand bar joins the island to the mainland
Lancelin Island	0.6	7.60	17	31°00'27"S, 115°18'56"E	600 m from mainland
Edward Island	0.1	0.20	5	31°01'51"S, 115°19'26"E	100 m from mainland

Rainfall is reliable, with most rain falling over the winter months (Table 5). Annual rainfall decreases significantly from Lancelin in the south (628.9 mm) to Jurien in the north (569.1 mm). The mean annual rainfall for Fremantle is 769.2 mm and for Geraldton is 466.6 mm.

The islands are very exposed to the wind, which generates waves, induces water circulation and transports sand. The speed and direction of the wind also have an important influence on vegetation. In summer, the islands of the Turquoise Coast are subjected to offshore easterly winds in the morning, which swing to strong southerlies (occasionally south-westerlies) in the late morning or afternoon. In winter, westerly gales bring rain. These are followed by periods of fine weather and light winds.

Wind speeds are greatest in the summer months (Table 6), increasing from 20 km / hr in the morning to 28 km / hr in the afternoon (based on mean 9.00 am wind speeds for the mainland-based Lancelin and Jurien weather stations). In winter, winds average 18–19 km / hr throughout the day.

Water circulation

The Turquoise Coast is located in the overlap of the tropical and temperate marine biogeographical zones. The waters of the Turquoise Coast are also influenced by the Leeuwin Current, a warm, low-salinity current that flows from near the North West Cape and down along the continental margin to the west of the Houtman Abrolhos reef complex, on its way 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. The warmer waters result in the presence, on and around the islands, of corals and other tropical species, including tropical seabirds feeding on prey carried by the Leeuwin Current.

TABLE 3
Tenure information for the islands of the Turquoise Coast (from the TENure Information System).

TENURE AND RESERVE NAME (reserve number)	ISLAND	AREA OF RESERVE (ha)	RESERVE CENTROID CO-ORDINATES
Beagle Islands Nature Reserve (26411)	East Beagle Island North-West Beagle Island South-West Beagle Island	3.83	29°48'27"S 114°52'31"E
Lipfert, Milligan, etc Islands Nature Reserve (29259)	Snag Island Drummond Rock Webb Island Lipfert Island Orton Rock Milligan Island	6.37	29°59'03"S 114°57'51"E
Fisherman Islands Nature Reserve (29256)	North Fisherman Island South Fisherman Island	5.24	30°08'08"S 114°56'32"E
Sandland Island Nature Reserve (29255)	Sandland Island	1.55	30°12'41"S 114°59'16"E
Boullanger, Whitlock, Favorite, Tern and Osprey Islands Nature Reserve (29251)	Favorite Island Osprey Island Tern Island North Boullanger Island Boullanger Island Whitlock Island	40.32	30°18'27"S 115°00'02"E
Escape Island Nature Reserve (44683)	Escape Island	27.33	30°20'18"S 114°59'32"E
Essex Rocks Nature Reserve (29257)	North Essex Rocks Middle Essex Rocks South Essex Rocks	7.26	30°21'19"S 114°59'42"E
Outer Rocks Nature Reserve (29258)	North Outer Rocks South Outer Rocks	6.85	30°26'52"S 115°00'11"E
Ronsard Rocks Nature Reserve (29260)	North Ronsard Rocks South Ronsard Rocks	0.08	30°29'10"S 115°02'49"E
Cervantes Islands Nature Reserve (29253)	North Cervantes Island Middle Cervantes Island South Cervantes Island	4.00	30°31'44"S 115°02'38"E
Buller, Whittell and Green Islands Nature Reserve (29252)	Buller Island Whittell Island North Green Island South Green Island	8.42	30°40'19"S 115°06'25"E
Vacant Crown land – proposed Target Rock Nature Reserve	Target Rock	- - - -	- - - -
Wedge Island Nature Reserve (29254) and Reserve 11907 (trigonometrical station)	Wedge Island	4.03	30°49'45"S 115°11'12"E
Lancelin and Edward Islands Nature Reserve (24979)	Lancelin Island Edward Island	8.61	31°01'09"S 115°19'11"E

TABLE 4
Mean daily maximum and minimum temperatures and temperature ranges for Jurien and Lancelin (Bureau of Meteorology, 2001). These long-term mean values of weather data are based on 30-year records gathered at both places.

TOWN	SEASON	MEAN DAILY MAXIMUM TEMPERATURE (°C)	MEAN DAILY MINIMUM TEMPERATURE (°C)	MEAN DAILY TEMPERATURE RANGE (°C)
Jurien	Spring	23.3	11.5	11.8
	Summer	29.6	16.9	12.7
	Autumn	26.0	14.1	11.9
	Winter	19.8	9.7	10.1
	Annual	24.7	13.1	11.6
Lancelin	Spring	22.4	12.0	10.4
	Summer	28.7	17.1	11.6
	Autumn	25.3	14.5	10.8
	Winter	19.3	10.3	9.0
	Annual	24.0	13.5	10.5

TABLE 5
Mean rainfall for Jurien and Lancelin (Bureau of Meteorology, 2001). These long-term mean values of weather data are based on 30-year records gathered at both places.

TOWN	SEASON	MEAN RAINFALL (mm)	ANNUAL MEAN RAINFALL (mm)
Jurien	Spring	92.4	
	Summer	31.5	
	Autumn	129.1	
	Winter	316.1	
	Annual		569.1
Lancelin	Spring	110.5	
	Summer	29.3	
	Autumn	135.2	
	Winter	353.9	
	Annual		628.9

TABLE 6
Mean wind speeds, by season, for Jurien and Lancelin (Bureau of Meteorology, 2001). These long-term mean values of weather data are based on 30-year records gathered at both places. Note that wind direction is not specified.

TOWN	SEASON	MEAN 9 AM WIND SPEED (km/hr)	MEAN 3 PM WIND SPEED (km/hr)
Jurien	Spring	16.7	24.0
	Summer	19.8	28.8
	Autumn	16.2	21.2
	Winter	16.8	19.0
	Annual	17.6	23.3
Lancelin	Spring	19.4	23.7
	Summer	20.8	26.4
	Autumn	18.5	20.7
	Winter	19.4	19.9
	Annual	19.5	22.8

Native fauna and vegetation

Native vegetation is important for providing food and / or suitable habitats for the invertebrates and reptiles that inhabit the islands, and for concealing the nests of certain bird species who use the islands for breeding. Low dense vegetation is the preferred habitat of the two native marsupial species, the dibbler (*Parantechinus apicalis*) and the island grey-bellied dunnart (*Smithopsis griseoventer boullangerensis*), which occur on some of the islands. Australian sea lion pups spend the first part of their lives in 'bowers' under 1–2 m high bushes of *Nitraria*.

Native fauna itself has been noted to affect vegetation on islands: large numbers of nesting seabirds trample plants, burrow among the roots and deposit guano. Over time, increased guano causes changes to the soil nutrient composition, and leads to the replacement of guano-intolerant species with guano-tolerant species (Gillham 1961). This can change the suitability of the habitat for certain fauna species. Plus sea lions also disturb the native vegetation when making tracks.

Island biogeography

As the simplest ecological unit, islands are evolutionary laboratories. With the isolation of the islands of the Turquoise Coast about 6 500 years ago, gene flow for many of the island species became restricted. All species are affected to differing degrees, according to their mobility. Birds are less affected due to their mobility, flying between islands and to the mainland, with some species flying to other continents. However, reptiles and small mammals found on islands have been confined there since the islands became isolated, and have had no interaction with mainland species. In some instances, there has been sufficient time for complete speciation to occur. For example, the Lancelin Island skink *Ctenotus lancelini* is endemic to Lancelin Island and the grey-bellied dunnart is a newly described subspecies found solely on Boullanger Island.

Plants are not mobile in the true sense of the word; however, some species achieve mobility via their seed dispersal, with distribution by various means, including wind, water and birds. In this way, intermingling between mainland and island species can occur.

Competition between species on an island is often fierce due to the limited resources available. These species have evolved various behavioural and physical adaptations to cope with the harsh island conditions. Some are capable of occupying a greater range of habitats on an island than they do on the mainland, as the most suitable habitat may be either not represented on the island, or occupied by other more competitive species.

McArthur and Wilson (1967) proposed the theory that an island can support only a finite number of species due to a dynamic equilibrium between the rates of colonisation and extinction. It is thought that the number of species on an island is dependent on island size, diversity of habitats, location and the species richness of the adjacent mainland. Island biogeography is discussed in greater detail later in the paper; however, many of the theories are difficult to apply due to the small size of the islands, their close proximity to the mainland and the lack of sufficiently detailed field surveys.

Islands north and south of the study group

About 120 km to the north-west of the study area lie the 173 islands and islets of the Houtman Abrolhos. Most of these islands, like those of the Turquoise Coast, are smaller than 4 ha and less than 1 km long (Harvey *et al.* 2001). The Houtman Abrolhos islands are located about 60 km from the mainland, extend 86 km from north to south, and are clustered into three main groups: the Wallabi Group (including the isolated North Island), the Easter Group and the Pelsaert Group.

South of the study area, and nineteen kilometres west of Perth, lies Rottnest Island. It is 10.5 km long and 4.5 km wide at its widest point, and has an area of about 1 850 ha. South from Rottnest is the much smaller Carnac Island, followed by Garden Island, which is 9.5 km long and 1.5 km wide, with an area of about 1 274 ha. South

of Garden Island are the numerous islands of Shoalwater Bay, the largest being Penguin Island with a size of 12.5 ha; the other islands in this area include Bird Island, Seal Island, Shag Rock, First Rock, Second Rock, Third Rock, Passage Rock, and The Sisters. Descriptions of these islands off the coast of Perth are in McArthur (1957).

The geological processes forming the islands of the Turquoise Coast have also influenced the development of the Houtman Abrolhos islands to the north, and Rottnest, Carnac, Garden and the Shoalwater Bay Islands to the south. But the Abrolhos islands are also comprised of a more recent marine limestone of coral and shell species and the region represents the southernmost living coral reef in the Indian Ocean.

The smaller islands in the Shoalwater Bay area have very similar geomorphological features and soil types to the Turquoise Coast group, whereas Garden and Penguin Islands have extensive dune systems, and are considerably larger and more complex than those in the study group.

Many of the Abrolhos islands have lagoons and Rottnest Island has a system of salt lakes and swamps in the central and northern areas; however, there is no permanent surface water on most of the other islands.

Previous Studies

All the islands of the Turquoise Coast have previously been surveyed for vegetation (see Table 7); however, the main purpose of much of the previous work on the islands was to survey birds, and collection of vegetation data was a secondary purpose.

Dr. M.E. Gillham studied the effects of nesting seabirds and breeding sea lions on vegetation in Western Australia and visited some of the Turquoise Coast islands in 1959. Certain specimens she collected were determined at the Western Australian Herbarium and a report including dominant species was produced (Gillham 1961), but no plant list was ever published. G.M. Storr, J.R. Ford and P.J. Fuller visited some of the islands on 21-22 October 1961 and compiled a plant list (Storr unpub.). J.R. Ford (1965) visited the islands between 1957 and 1964 and in his paper reporting the avifauna of the islands he included physical and vegetation descriptions for each of the islands, noting dominant species. E. Lindgren (1973) visited Lancelin Island on one day each month over an unspecified year in the 1960s and he compiled a plant list for this island. R.E. Johnstone made 51 visits to North Fisherman Island from 1971 to 1976 and also visited South Fisherman Island commencing in 1971; he notes dominant plant species in his papers on nesting seabirds (Johnstone 1978a, 1978b). I. Abbott (1980a) made botanical collections on 12 of the islands during May and December 1976 and has published a plant list. In December 1985, P.J. Fuller and A.A. Burbidge carried out small mammal trapping on four of the islands and reported dominant plant species for Boullanger and Whitlock Islands (Fuller and Burbidge 1987). A.N. (Tony) Start, P.J. Fuller and A.A. Burbidge (Start[5], personal communication 1998) visited Escape Island on 29 April 1998 to assess the suitability of the island for re-introduction of the dibbler and recorded various plant species; subsequently, captive-bred dibblers have been re-introduced to Escape Island.

[5] Dr A.N. (Tony) Start, Department of Conservation and Land Management, Kununurra WA 6743.

METHODS

All of the islands were visited during two trips during October, November and December 1985, except for the islands near Jurien Bay, which were re-sampled by Alford during spring 1986. The spring visits enabled the recording of annual species.

To compile a list of the size and location of the islands of the Turquoise Coast (Table 2), the distance of each island from the mainland was determined from 1:25 000 small craft charts. Island areas were taken from Ford (1965), maximum elevation above sea level from Ford (1965), Abbott (1980a) and Johnstone (1978a; 1978b), and island co-ordinates from the TENure Information System. The isolation of each island is the distance to the closest land on either another island or the mainland; this information was derived from 1:25 000 small craft charts and 1:3 000 aerial photos.

In the list of tenure information for the islands of the Turquoise Coast (Table 3), the reserves listed were gazetted to the low water mark. Consequently, reserves can include substantial intertidal reef platforms and beaches, and this can subsequently lead to incongruities between reserve areas (Table 3) and combined island areas (Table 2).

Some of the previous researchers who collected vegetation data from the islands of the Turquoise Coast compiled species lists for one or more of the islands (Storr, Lindgren, Abbott, Keighery and Alford and Start) (see Table 7 for references); whilst some noted only dominant plant species (Gillham, Ford and Johnstone). Although Gillham visited Boullanger Island, according to Ford (1965), she has not published any plant information about this island; similarly, Ford (1965) visited Target Rock (then called Flat Rock) and Orton Rock, but mentioned no plant names.

A complete list of flora present on the islands was compiled (Table 8) and voucher collections were deposited in the Western Australian Herbarium at the Department of Conservation and Land Management. In the flora list, the plant names are generally current as at May 2001 (according to Western Australian Herbarium 2001). The only exception is *Lavatera plebeia*, the current name for which is *Malva australiana;* the reason for keeping the old name is that there are no infraspecific taxa recognised for *Malva australiana*. Therefore, to avoid loss of information, we decided to continue to use the old species and variety names, i.e. *Lavatera plebeia* var. *plebeia* and *L. plebeia* var. *tomentosa*. Plant species recorded on previous collectors' surveys are also listed in Table 8 and Appendix 1, and changes in species composition are also outlined in Appendix 1.

TABLE 7

Researchers who have collected vegetation data from the islands of the Turquoise Coast. References to their work are noted in brackets ( ) and bold text shows the current island names as listed in Table 1. The researchers are ordered chronologically, based on their visits to the islands.

M.E. Gillham visited the islands 1959	G.M. Storr (unpublished ms.) visited the islands 1961	J.R. Ford visited the islands 1957-1964	E. Lindgren (1973) visited the island 1960's	R.E. Johnstone visited the islands 1971-1976	I. Abbott visited the islands 1976	P.J. Fuller & A.A. Burbidge (1987) visited the islands 1985	G.J. Keighery & J.J. Alford visited the islands 1985, 1986	A.N. Start (pers. comm. 1998) visited the islands 1998
							East Beagle Island	
		Beagle Islands (Ford 1965)					**North-West Beagle Island**	
							South-West Beagle Island	
		Snag Island (Ford 1965)					**Snag Island**	
		Drummond Rock (Ford 1965)					**Drummond Rock**	
		Webb Island (Ford 1965)					**Webb Island**	
		Lipfert Island (Ford 1965)					**Lipfert Island**	
		Orton Rock (Ford 1965)					**Orton Rock**	
		Milligan Island (Ford 1965)					**Milligan Island**	
Fisherman Island (Gillham 1961)		**North Fisherman Island** (Ford 1965)		**North Fisherman Island** (Johnstone 1978a)			**North Fisherman Island**	
		South Fisherman Island (Ford 1965)		**South Fisherman Island** (Johnstone 1978b)			**South Fisherman Island**	
	Sandland	**Sandland Island** (Ford 1965)					**Sandland Island**	
Favourite Island (Abbott 1980a)		Favourite Island (Ford 1965)			Favourite Island (Abbott 1980a)		**Favorite Island**	
		Osprey Rock (Ford 1965)			**Osprey Island** (Abbott 1980a)		**Osprey Island**	
	Tern	**Tern Island** (Ford 1965)			**Tern Island** (Abbott 1980a)		**Tern Island**	
Boullanger Island (Ford 1965)	Boullanger	Boullanger Island (Ford 1965)			**North Boullanger Island** (Abbott 1980a)	Boullanger Island	**North Boullanger Island**	
					Boullanger Island (Abbott 1980a)		**Boullanger Island**	
	Whitlock	**Whitlock Island** (Ford 1965)			**Whitlock Island** (Abbott 1980a)	**Whitlock Island**	**Whitlock Island**	
		Escape Island (Ford 1965) (Abbott 1980a)			**Escape Island** (Abbott 1980a)		**Escape Island**	**Escape Island**
	Essex (north)	North Essex Island (Ford 1965)			North Essex Rock (Abbott 1980a)		**North Essex Rocks**	
	Essex (middle)	Middle Essex Island (Ford 1965)			Middle Essex Rock (Abbott 1980a)		**Middle Essex Rocks**	
	Essex (south)	South Essex Island (Ford 1965)			South Essex Rock (Abbott 1980a)		**South Essex Rocks**	
		Sandy Knoll islands (Ford 1965)					**North Outer Rocks**	
							South Outer Rocks	
		Ronsard Bay rocks (Ford 1965)					**North Ronsard Rocks**	
							South Ronsard Rocks	

TABLE 7 (continued)

M.E. Gillham visited the islands 1959	G.M. Storr (unpublished ms.) visited the islands 1961	J.R. Ford visited the islands 1957-1964	E. Lindgren (1973) visited the island 1960's	R.E. Johnstone visited the islands 1971-1976	I. Abbott visited the islands 1976	P.J. Fuller & A.A. Burbidge (1987) visited the islands 1985	G.J. Keighery & J.J. Alford visited the islands 1985, 1986	A.N. Start (pers comm 1998) visited the islands 1998
		North Cervantes Island (Ford 1965)					**North Cervantes Island**	
Cervantes Island (Gillham 1961)		**Middle Cervantes Island** (Ford 1965)					**Middle Cervantes Island**	
		South Cervantes Island (Ford 1965)					**South Cervantes Island**	
		Buller Island (Ford 1965)					**Buller Island**	
		Whittell Island (Ford 1965)					**Whittell Island**	
		Green Islets (Ford 1965)					**North Green Island**	
							South Green Island	
		Flat Rock (Ford 1965)					**Target Rock**	
		Wedge Island (Ford 1965)					**Wedge Island**	
Lancelin Island (Abbott 1980a) (Gillham 1961)		**Lancelin Island** (Ford 1965)	**Lancelin Island**		**Lancelin Island** (Abbott 1978) (Abbott 1980a)		**Lancelin Island**	
Edward Island (Gillham 1961)		**Edward Island** (Ford 1965)			**Edward Island** (Abbott 1980a)		**Edward Island**	

TABLE 8

Vascular plant species found on the islands of the Turquoise Coast. Introduced species are denoted by an asterisk (*) and the crosshatch symbol (#) denotes that subspecies information for this species is included in Appendix 1.

Initials denote collectors or observers: G = M.E. Gillham (1961), S = G.M. Storr (unpublished ms.), F = J.R. Ford (1965), L = E. Lindgren (1973), J = R.E. Johnstone (Johnstone 1978a for North Fisherman Island and Johnstone 1978b for South Fisherman Island), A = I. Abbott (1978, 1980a), B = G.J. Keighery and J.J. Alford, and T = A.N. (Tony) Start (1998 - personal communication)

Note the following variations to the above: G[c] indicates species found by Gillham but reported in Abbott (1980a) and F[c] indicates species found by Ford but reported in Abbott (1980a).

NAME	ISLAND																																				
	Edward Island	Lancelin Island	Wedge Island	Target Rock	South Green Island	North Green Island	Whittell Island	Buller Island	South Cervantes Island	Middle Cervantes Island	North Cervantes Island	South Ronsard Rocks	North Ronsard Rocks	South Outer Rocks	North Outer Rocks	South Essex Rocks	Middle Essex Rocks	North Essex Rocks	Escape Island	Whitlock Island	Boullanger Island	North Boullanger Island	Tern Island	Osprey Island	Favorite Island	Sandland Island	South Fisherman Island	North Fisherman Island	Milligan Island	Orton Rock	Lipfert Island	Webb Island	Drummond Rock	Snag Island	South-West Beagle Island	North-West Beagle Island	East Beagle Island
AIZOACEAE																																					
Carpobrotus virescens	GFAB	GFLAB	FB		F B	B	FB	FB	G FB	F	FB				FB	AB	SFA	SFAB	FABT	SFAB	SF AB	AB	FAB		FAB	SFB	G FJ	JB	F	B	F	F	F	FB	FB	F	F
* *Mesembryanthemum crystallinum*	GAB	GLAB	B	B	B	B	B	B	B	B	B			B	B	B	B	B	BT	B		B	B	B	B	B	G JB	JB	B	B	B	B	B				
* *Tetragonia decumbens*		FLAB	B		B	B					FB								ABT	AB	S AB	A			AB			B									
Tetragonia implexicoma											B								AB	SAB	S AB	AB	B				G	B									
ANTHERICACEAE																																					
Thysanotus patersonii																					B	B															
APIACEAE																																					
Apium annuum		B	B																																		
Daucus glochidiatus		LB	B		B	B															B				B												
APOCYNACEAE																																					
Alyxia buxifolia																			T																		
ASPHODELACEAE																																					
* *Trachyandra divaricata*		B																	T		B				B												
ASTERACEAE																																					
Angianthus cunninghamii																				SA																	
* *Arctotheca calendula*		B	B																			B															
* *Arctotheca populifolia*		LAB	B																		AB																
Brachyscome exilis									B		B																										
Brachyscome ciliaris											B								AB	B	S B	B															
Cotula cotuloides		GLAB	B		B		B	B			B						S		AB	SAB		AB			G B	S								B			

TABLE 8 (continued)

NAME	ISLAND																																							
	Edward Island	Lancelin Island	Wedge Island	Target Rock	South Green Island	North Green Island	Whitteil Island	Buller Island	South Cervantes Island	Middle Cervantes Island	North Cervantes Island	South Ronsard Rocks	North Ronsard Rocks	South Outer Rocks	North Outer Rocks	South Essex Rocks	Middle Essex Rocks	North Essex Rocks	Escape Island	Whitlock Island	Boullanger Island	North Boullanger Island	Tern Island	Osprey Island	Favorite Island	Sandland Island	South Fisherman Island	North Fisherman Island	Milligan Island	Orton Rock	Lipfert Island	Webb Island	Drummond Rock	Snag Island	South-West Beagle Island	North-West Beagle Island	East Beagle Island
Euchiton sphaericus											B									B														B				
Gnaphalium indutum											B									B																		
* *Hypochaeris glabra*																			B	B	B	B																
Leucophyta brownii		G²LB	B																																			
Olearia axillaris		FLAB	FB		F B						FB								FABT	FAB	SF AB	AB			FAB													
Ozothamnus cordatus		G²LB																	B		S AB				B													
Podotheca angustifolia																					B				G²													
* *Pseudognaphalium luteoalbum*																				B																		
Senecio lautus #		LAB	B			B	B	B									S	SB	A	AB	S AB	AB	B		AB	SB												
* *Sonchus oleraceus*		LAB	B		B	B	B	B	B	B	B						B	B	AB	AB	B	AB	AB		B	B		B	B	B	B	B	B	B			B
* *Sonchus* sp.																	S	S		S	S		S			S											
* *Urospermum picroides*									B										B	B	B	B																
BRASSICACEAE																																						
* *Brassica tournefortii*		LAB																			B				B	B												
* *Cakile maritima*		LAB	B		B	B					FB									B	SF AB				B	S												
* *Hornungia procumbens*		L				B												S		SB					B					B		B						
Lepidium foliosum		LAB					B	B	B	B	B							SAB				AB				SB	G B	B	B		B			B		B	B
Lepidium lyratogynum																			AB	SAB	S B	AB			G²B													
Lepidium puberulum																						B				B												
* *Sisymbrium irio*		AB																													B							
* *Sisymbrium orientale*		AB																																				
CARYOPHYLLACEAE																																						
* *Cerastium glomeratum*											B								B	B		B								B				B			B
* *Polycarpon tetraphyllum*		L							B		B											B															
* *Sagina apetala*																			B	B		B															
* *Spergularia diandra*									B		B								B	B		B										B	B	B			B
* *Spergularia rubra*																			F²																		
* *Stellaria media*		L																																			

TABLE 8 (continued)

NAME	ISLAND																																							
	Edward Island	Lancelin Island	Wedge Island	Target Rock	South Green Island	North Green Island	Whitteil Island	Buller Island	South Cervantes Island	Middle Cervantes Island	North Cervantes Island	South Ronsard Rocks	North Ronsard Rocks	South Outer Rocks	North Outer Rocks	South Essex Rocks	Middle Essex Rocks	North Essex Rocks	Escape Island	Whitlock Island	Boullanger Island	North Boullanger Island	Tern Island	Osprey Island	Favorite Island	Sandland Island	South Fisherman Island	North Fisherman Island	Milligan Island	Orton Rock	Lipfert Island	Webb Island	Drummond Rock	Snag Island	South-West Beagle Island	North-West Beagle Island	East Beagle Island
CHENOPODIACEAE																																							
Atriplex cinerea		FAB			F B	B	B		FB		FB								ABT	SFAB	SF AB	AB	FAB		FAB	SB		FJ										
Atriplex isatidea		GLAB	B		B						B								BT	SAB	AB		S		AB	S	G	B									
* *Chenopodium murale*		AB															B	B	B																		B
Enchylaena tomentosa		LAB			B	B			B		B						SA	SA	AT	SAB	S AB		SA	AB	B	S		B		B				B			
Halosarcia halocnemoides		LB																							AB			B		B		B					
Halosarcia indica																						AB															
Rhagodia baccata		FLAB	B		F B				B		FB								FABT	SFAB	SF AB	AB	SAB	A	FAB						F						
Salsola tragus		LAB	B		B	B					B								ABT	SA	S AB	AB			AB		G	B									
Sarcocornia blackiana	AB	AB																																			
Sarcocornia quinqueflora		B			B			B			B															B		B									
Sclerostegia arbuscula																										S											
Threlkeldia diffusa		GLAB	FB		F B	B	B		G FB	FB	FB				B		AB	SFAB	FABT	SFAB	SF AB	AB	SAB		FAB	SFB	G	JB						B			
CONVOLVULACEAE																																					
Wilsonia backhousei	AB	G[2]																				A															
Wilsonia humilis		A			B	B			B	B							SA		ABT	SAB		AB		AB													
CRASSULACEAE																																					
Crassula colorata		G[2]LB	B								B								AB	AB	B	AB	B														
Crassula exserta					B	B					B									B	B	B			B												
* *Crassula glomerata*		B																																			
CYPERACEAE																																					
Carex preissii																				AB		B															
* *Isolepis marginata*		LB																																			
Isolepis nodosa		LB	B																ABT		S AB	AB	S														
Lepidosperma gladiatum																					SAB	SAB															
DASYPOGONACEAE																																					
Acanthocarpus preissii		LAB									B								FABT	SAB	SF AB	AB															

TABLE 8 (continued)

NAME	ISLAND																																						
	Edward Island	Lancelin Island	Wedge Island	Target Rock	South Green Island	North Green Island	Whittell Island	Buller Island	South Cervantes Island	Middle Cervantes Island	North Cervantes Island	South Ronsard Rocks	North Ronsard Rocks	South Outer Rocks	North Outer Rocks	South Essex Rocks	Middle Essex Rocks	North Essex Rocks	Escape Island	Whitlock Island	Boullanger Island	North Boullanger Island	Tern Island	Osprey Island	Favorite Island	Sandland Island	South Fisherman Island	North Fisherman Island	Milligan Island	Orton Rock	Lipfert Island	Webb Island	Drummond Rock	Snag Island	South-West Beagle Island	North-West Beagle Island	East Beagle Island
EUPHORBIACEAE																																							
Phyllanthus calycinus																			A	SB																			
FRANKENIACEAE					F				G													SF																
Frankenia pauciflora	GFAB	GFLAB	FB		B	B			F	F	FB						SFA		FABT	SFAB		AB			FAB	SFB				B								
GENTIANACEAE																																							
* *Centaurium erythraea*											B								B																				
GERANIACEAE																																							
* *Erodium cicutarium*																						AB																	
GOODENIACEAE																																							
Scaevola crassifolia		LAB	B		B	B					B								FABT	SAB	AB				FAB			B		B								
HAEMODORACEAE																																							
Conostylis candicans																					B																	
JUNCACEAE																																							
* *Juncus bufonius*		B									B																												
JUNCAGINACEAE																																							
Triglochin calcitrapa									B		B																												
Triglochin centrocarpa		B	B																		B																	
Triglochin minutissima																			B																			
Triglochin mucronata		L				B																																	
LAURACEAE																																							
Cassytha racemosa																					AB																	
MALVACEAE																																							
Lavatera plebeia #	AB	LAB		B	B	B	B	B	B	B	B				B	SAB	SAB	SAB	B	SAB	S	AB	SAB			SB	G B	G B	B	B	B	B	B	B	B	B	B	B
* *Malva parviflora*		LAB							B		B									B		B			B													
MIMOSACEAE																																							
Acacia cyclops		B	B																		B	AB																
Acacia rostellifera																			ABT		S	AB																	

TABLE 8 (continued)

NAME	ISLAND																																							
	Edward Island	Lancelin Island	Wedge Island	Target Rock	South Green Island	North Green Island	Whitteil Island	Buller Island	South Cervantes Island	Middle Cervantes Island	North Cervantes Island	South Ronsard Rocks	North Ronsard Rocks	South Outer Rocks	North Outer Rocks	South Essex Rocks	Middle Essex Rocks	North Essex Rocks	Escape Island	Whitlock Island	Boullanger Island	North Boullanger Island	Tern Island	Osprey Island	Favorite Island	Sandland Island	South Fisherman Island	North Fisherman Island	Milligan Island	Orton Rock	Lipfert Island	Webb Island	Drummond Rock	Snag Island	South-West Beagle Island	North-West Beagle Island	East Beagle Island
MYOPORACEAE																																							
Eremophila glabra											B								ABT	B																			
Myoporum insulare		FLAB	B		B	B	B	F			B								FABT	SAB	SF AB	SF AB	SAB		FAB	SB	G	G FJB		B							B
OXALIDACEAE																																							
* *Oxalis corniculata*																				A		A																	
Oxalis perennans																			B	B		B																	
PAPILIONACEAE																																							
* *Medicago polymorpha*											B								ABT	A																			
* *Melilotus indicus*		B	B																																				
Templetonia retusa																			T	SB		S AB																	
PITTOSPORACEAE																																							
Pittosporum phylliraeoides																			AT																				
PLANTAGINACEAE																																							
Plantago debilis											B								B	B		B																	
POACEAE																																							
* *Aira caryophyllea*																			B																				
Austrostipa elegantissima																			BT		B																		
Austrostipa flavescens																					B	B																	
* *Avellinia michelii*											B																												
* *Avena barbata*		GLAB	B						B		B							B	F BT	B		S B												B					
Bromus arenarius		LAB	B		B	B	B	B	B	B	B						S	SAB	AB	SAB	AB	S AB	SB		AB	SB	G	B	B		B			B		B	B	
* *Bromus diandrus*		LAB	B					B	B										B		B								B		B			B		B	B	
* *Bromus rubens*											B																												
* *Cynodon dactylon*																							B			B													
* *Ehrharta brevifolia*																			AB	B		B			G*														
* *Ehrharta longiflora*		LAB	B		B														BT	B	B	B			B														
* *Ehrharta villosa*		B																																					
Eragrostis dielsii																			T																				
* *Hordeum leporinum*		AB	B						B		B								AB				B			B			B		B		B		B	B		
* *Lolium rigidum*		LAB	B								B								AB			B																	

TABLE 8 (continued)

NAME	ISLAND																																					
	Edward Island	Lancelin Island	Wedge Island	Target Rock	South Green Island	North Green Island	Whittell Island	Buller Island	South Cervantes Island	Middle Cervantes Island	North Cervantes Island	South Ronsard Rocks	North Ronsard Rocks	South Outer Rocks	North Outer Rocks	South Essex Rocks	Middle Essex Rocks	North Essex Rocks	Escape Island	Whitlock Island	Boullanger Island	North Boullanger Island	Tern Island	Osprey Island	Favorite Island	Sandland Island	South Fisherman Island	North Fisherman Island	Milligan Island	Orton Rock	Lipfert Island	Webb Island	Drummond Rock	Snag Island	South-West Beagle Island	North-West Beagle Island	East Beagle Island
* *Parapholis incurva*		AB	B																B							B						B	B				
* *Phalaris minor*																			B														B			
Poa poiformis		B	B																	SA	S AB	AB														
* *Rostraria cristata*									B										B			AB			G²				B							
Spinifex hirsutus																					S															
Spinifex longifolius		FLAB	B		F B	B					FB								ABT	SAB	SF AB	AB			FAB		G	FJB								
Sporobolus virginicus					B		B	B			B								ABT	SAB	S A							JB								
* *Vulpia fasciculata*		L																																		
* *Vulpia myuros*		L																	B	B	B	B														
PORTULACACEAE																																					
Calandrinia calyptrata		G²							B	B	B						S		AB	SB		AB	SAB		G²B								B	B			
PRIMULACEAE																																					
* *Anagallis arvensis*		B	B																																		
Samolus junceus											B								T																		
Samolus repens																			AB		S	AB															
RANUNCULACEAE																																					
Clematis linearifolia																					SF AB	AB															
RHAMNACEAE																																					
Spyridium globulosum		B	B																B	B	AB																
RUBIACEAE																																					
* *Galium aparine*																				B		B															
Galium migrans																				B																	
SANTALACEAE																																					
Exocarpos sparteus		LB	B																AT		SAB	SAB															
SCROPHULARIACEAE																																					
* *Dischisma arenarium*		LAB	B																B		B	B			G²B												

TABLE 8 (continued)

NAME	ISLAND																																						
	Edward Island	Lancelin Island	Wedge Island	Target Rock	South Green Island	North Green Island	Whitteil Island	Buller Island	South Cervantes Island	Middle Cervantes Island	North Cervantes Island	South Ronsard Rocks	North Ronsard Rocks	South Outer Rocks	North Outer Rocks	South Essex Rocks	Middle Essex Rocks	North Essex Rocks	Escape Island	Whitlock Island	Boullanger Island	North Boullanger Island	Tern Island	Osprey Island	Favorite Island	Sandland Island	South Fisherman Island	North Fisherman Island	Milligan Island	Orton Rock	Lipfert Island	Webb Island	Drummond Rock	Snag Island	South-West Beagle Island	North-West Beagle Island	East Beagle Island
SOLANACEAE																																							
Anthocercis littorea		L																			B																	
* *Lycium ferocissimum*																												B	B	B							B
Nicotiana occidentalis subsp. *hesperis*					B	B	B		B		B						S	S	ABT	AB	S	AB	SB		B	SB							B				
* *Solanum nigrum*									B		B											B	B														
THYMELAEACEAE																																							
Pimelea gilgiana											B								BT	B																		
URTICACEAE																																							
Parietaria debilis		LAB							B		B								B		B	AB	B								B			B				
* *Urtica urens*									B														B															
ZYGOPHYLLACEAE																																							
Nitraria billardierei	GFAB	GFLAB	FB	B	F B	B	FB	FB	G FB	FB	FB	FB	FB	FB	FB	SFAB	SFAB	SFAB	FABT	SFAB	SF AB	AB	SFAB	FAB	FAB	SFB	G FJB	FJB	FB	B	FB	FB	FB	FB	FB	FB	FB	FB	FB
Zygophyllum aurantiacum		A																																				
Zygophyllum billardierei		F	B		F	B		B	B		B							SAB	A	SFAB	SF B	AB	B		FAB	SFB		F									
Zygophyllum fruticulosum		LB																	B																			

Initials denote collectors or observers: G = M.E. Gillham (1961), S = G.M. Storr (unpublished ms.), F = J.R. Ford (1965), L = E. Lindgren (1973), J = R.E. Johnstone (Johnstone 1978a for North Fisherman Island and Johnstone 1978b for South Fisherman Island), A = I. Abbott (1978, 1980a), B = G.J. Keighery and J.J. Alford, and T = A.N. (Tony) Start (1998 - personal communication).

Note the following variations to the above: G^c indicates species found by Gillham but reported in Abbott (1980a) and F^c indicates species found by Ford but reported in Abbott (1980a).

Dominant structural vegetation forms are described in Appendix 1 and maps of the physical and dominant structural vegetation forms have been prepared for 33 islands (Figs 3–20 in Appendix 2). Mapping was undertaken using colour 1:3 000 aerial photographs commissioned by the Department of Marine and Harbours and carried out by the Department of Lands and Surveys (Job No. 810224) on 18 December 1981.

RESULTS

Flora and vegetation

Keighery and Alford recorded a total of 121 vascular plant species (from 39 families and 96 genera) on the 37 islands surveyed over the three trips (see Table 8). Of these species, 73 were natives and 48 were introduced. All except 12 of the species on the plant list were found during this survey; the recordings by other researchers of these species on 17 islands are not included in the analyses below.

The most widespread species found by Keighery and Alford was the succulent-leafed woody shrub *Nitraria billardierei* recorded from all islands. This species was followed by *Lavatera plebeia* (now *Malva australiana* according to Western Australian Herbarium (2001)) and **Mesembryanthemum crystallinum* (each recorded by Keighery and Alford on 30 islands), **Sonchus oleraceus* (recorded by Keighery and Alford on 26 islands), *Bromus arenarius* (recorded by Keighery and Alford on 23 islands), *Carpobrotus virescens* (recorded by Keighery and Alford on 23 islands; interestingly, *Carpobrotus* was previously recorded on 32 islands) and *Threlkeldia diffusa* (recorded by Keighery and Alford on 20 islands).

Table 8 shows that the genera with the highest number of native species were *Triglochin* (4 native species) and *Lepidium* (3 native species). Of the remaining 56 genera with native species represented on the islands, 10 (18%) were represented by 2 native species and 46 (82%) were represented by only one native species.

Species richness for all 37 islands is tabulated in Table 9. The islands with the greatest number of plant species found by Keighery and Alford are North Boullanger Island (with 62 species), followed by Lancelin Island (60), Escape Island (60), Whitlock Island (55), North Cervantes Island (53) and Boullanger Island (50). Generally, an increase in area results in an increase in plant species diversity; however, the effect of habitat diversity upon species richness is also shown by the recording of 62 species on the small tombolo, North Boullanger Island, with its sheet limestone, soil pockets, beaches and sand dunes, compared to 50 species for the much larger, but more uniform, Boullanger Island.

Table 10 shows that of the families recorded by Keighery and Alford, the dominant families were the Asteraceae (10 native species, 6 introduced), Chenopodiaceae (10 native species, 1 introduced) and Poaceae (6 native species, 15 introduced).

TABLE 9
The numbers of native and introduced species recorded by Keighery and Alford on each of the islands of the Turquoise Coast. The islands are listed by size of flora.

ISLAND	AREA OF ISLAND (ha)	NO. OF SPECIES		
		native	introduced	total
North Boullanger Island	2.40	43	19	62
Escape Island	10.50	37	23	60
Lancelin Island	7.60	35	25	60
Whitlock Island	5.40	38	17	55
North Cervantes Island	3.20	36	17	53
Boullanger Island	23.50	38	12	50
Wedge Island	1.90	25	15	40
Favorite Island	3.00	24	10	34
South Cervantes Island	0.90	16	12	28
South Green Island	3.40	22	5	27
North Green Island	1.60	19	5	24
Tern Island	0.20	15	6	21
Sandland Island	1.50	14	6	20
North Fisherman Island	1.40	16	3	19
Snag Island	0.20	13	6	19
Whittell Island	0.20	12	2	14
Buller Island	0.40	10	3	13
Orton Rock	0.04	7	6	13
East Beagle Island	1.50	5	7	12
Lipfert Island	0.20	5	7	12
North Essex Rocks	0.40	8	4	12
Middle Cervantes Island	0.20	7	2	9
Milligan Island	0.20	4	5	9
Drummond Rock	0.04	3	5	8
Webb Island	0.20	3	5	8
Edward Island	0.20	6	1	7
Middle Essex Rocks	0.30	3	3	6
North-West Beagle Island	0.50	4	2	6
North Outer Rocks	0.40	4	1	5
Osprey Island	0.10	3	1	4
South Essex Rocks	0.10	3	1	4
South Fisherman Island	0.40	2	1	3
South-West Beagle Island	0.20	3	0	3
Target Rock	0.08	2	1	3
South Outer Rocks	0.20	1	1	2
North Ronsard Rocks	0.04	1	0	1
South Ronsard Rocks	0.04	1	0	1

Keighery and Alford also found that all except three of the islands had introduced species (see Table 9), with only the following islands having solely native species present: South Ronsard Rocks (1 native species recorded), North Ronsard Rocks (1 native species recorded) and South-West Beagle Island (3 native species recorded).

A major weed problem observed was the invasion of Orton Rock, Lipfert Island, Milligan Island and East Beagle Island by the African boxthorn, **Lycium ferocissimum*.

Low shrublands, heath and herbfields were the common vegetation types recorded on the islands, and these formations were mostly similar to those occurring on the adjacent mainland because the areas have only been recently separated. The islands that differ are those closely associated with the use of the islands as breeding sites by fauna. Nesting seabirds result in guano rich soils, which are then dominated by herbfields with emergent *Lavatera pleibea* var. *tomentosa*; the tree-like formations of *Nitraria billardierei* on East Beagle and Sandland Islands are the result of breeding sea lions creating pathways.

Taxonomic problems

Despite the authors' attempts, some taxonomic problems remain; certain species groups were difficult to separate, or were not recognised as different in the field, and were under-sampled. These groups were:

1. **Ehrharta longiflora* and **E. brevifolia*
   These two species were difficult to separate.

2. **Lolium* species
   These were very difficult to separate and all records are given as a single species.

3. *Lavatera plebeia*
   The variety *tomentosa* is obviously a separate species from var. *plebeia*; however, var. *plebeia* itself appears to be composed of two taxa on the islands (one recorded from the Escape, Whitlock and North Boullanger Islands and the other from the Lipfert, Milligan and Webb Islands).

4. *Brachyscome ciliaris* and *B. exilis*
   The latter was initially thought to be a depauperate form of the former and was consequently under-sampled.

5. *Gnaphalium indutum* and **Pseudognaphalium luteoalbum*
   The former species is easily overlooked and can also be confused with depauperate forms of the latter.

Public use

Although there are no settlements on the islands, several coastal towns are located between Lancelin and Dongara and there are numerous squatters' shacks occurring singly and in small settlements along this strip of coastline. Settlements like Jurien and Lancelin are becoming increasingly popular holiday places, offering a range of recreational opportunities close to Perth.

Access to the islands is often difficult due to rough sea conditions, and shallow reefs and sandbars surrounding some of the islands also make landing difficult. Once visitors are on the island, the rough terrain can restrict progress. However, some of the islands are frequently visited and these are generally the larger, more accessible ones with recreational attractions such as beaches and nearby fishing areas.

Public use and access information for each island were recorded during the survey. These are outlined in Table 11.

DISCUSSION

Flora

Previous studies often did not adequately sample the flora of the larger islands. For example, on Escape Island this survey recorded 60 species (compared to the previous survey results of 38 species), on Whitlock Island we recorded 55 (compared to 32), on Boullanger Island we recorded 50 (compared to 35) and on Favorite Island we recorded 34 (compared to 17). In contrast, all except 12 species on the flora list (Table 8) were found during the current survey. Those not recorded by this survey include: *Alyxia buxifolia* (recorded by Start), *Angianthus cunninghamii* (Storr and Abbott), *Eragrostis dielsii* (Start), **Oxalis corniculata* (Abbott), *Pittosporum phylliraeoides* (Abbott and Start), *Sclerostegia arbuscula* (Storr), **Sonchus* sp. (Storr), **Spergularia rubra* (Ford), *Spinifex hirsutus* (Storr), **Stellaria media* (Lindgren), **Vulpia fasciculata* (Lindgren) and *Zygophyllum aurantiacum* (Abbott). It can be considered that the results of these other researchers, combined with the results of this survey, comprise an acceptable baseline inventory of flora on the islands of the Turquoise Coast.

TABLE 10
Plant families recorded by Keighery and Alford on the islands of the Turquoise Coast. The families are arranged in descending order of species representation and the last column shows the native species of each family as a percentage of the total native species (73) found.

FAMILY	NO. OF SPECIES native	NO. OF SPECIES introduced	% OF TOTAL (native species)
ASTERACEAE	10	6	13.7
CHENOPODIACEAE	10	1	13.7
POACEAE	6	15	8.2
JUNCAGINACEAE	4	0	5.5
BRASSICACEAE	3	5	4.1
CYPERACEAE	3	1	4.1
ZYGOPHYLLACEAE	3	0	4.1
AIZOACEAE	2	2	2.7
SOLANACEAE	2	2	2.7
APIACEAE	2	0	2.7
CONVOLVULACEAE	2	0	2.7
CRASSULACEAE	2	1	2.7
PRIMULACEAE	2	1	2.7
MIMOSACEAE	2	0	2.7
MYOPORACEAE	2	0	2.7
PAPILIONACEAE	1	2	1.4
MALVACEAE	1	1	1.4
RUBIACEAE	1	1	1.4
URTICACEAE	1	1	1.4
ANTHERICACEAE	1	0	1.4
DASYPOGONACEAE	1	0	1.4
EUPHORBIACEAE	1	0	1.4
FRANKENIACEAE	1	0	1.4
GOODENIACEAE	1	0	1.4
HAEMODORACEAE	1	0	1.4
LAURACEAE	1	0	1.4
OXALIDACEAE	1	0	1.4
PLANTAGINACEAE	1	0	1.4
PORTULACACEAE	1	0	1.4
RANUNCULACEAE	1	0	1.4
RHAMNACEAE	1	0	1.4
SANTALACEAE	1	0	1.4
THYMELAEACEAE	1	0	1.4
CARYOPHYLLACEAE	0	4	0.0
ASPHODELACEAE	0	1	0.0
GENTIANACEAE	0	1	0.0
GERANIACEAE	0	1	0.0
JUNCACEAE	0	1	0.0
SCROPHULARIACEAE	0	1	0.0

TABLE 11
Public use and accessibility of the islands of the Turquoise Coast, as at 1986. Islands are ordered from north to south.

ISLAND	PUBLIC USE low	medium	high	ACCESSIBILITY
East Beagle Island North-West Beagle Island South-West Beagle Island	X			Isolated from the mainland and settlements.
Snag Island	X			Access is difficult, but the island is close to the mainland and there is evidence of topsoil being removed.
Drummond Rock	X			Access is difficult.
Webb Island	X			Isolated. Access is difficult.
Lipfert Island	X			A small island with no beach areas.
Orton Rock	X			A very small, rugged island.
Milligan Island	X			Access is difficult and, though close to mainland and squatters shacks, the island has few attractions.
North Fisherman Island		X		Readily accessible beach areas but the island is fairly isolated. Johnstone (1978a) reports "small boats can reach the eastern sandy beach via two small channels through the reef".
South Fisherman Island	X			Access is difficult. Johnstone (1978b) reports access is "difficult, and only possible by anchoring offshore and swimming to the rocks on the north-east corner"..."the lack of a suitable landing has saved the island from much human interference".
Sandland Island	X			Access is via a very small beach. There is no evidence of damage.
Favorite Island			X	Close to Jurien with extensive beach areas, however access tends to be limited to the foreshore due to the very high dune and dense vegetation. No evidence of damage.
Osprey Island	X			Access is difficult.
Tern Island	X			Access is difficult.
North Boullanger Island			X	Popular islands close to Jurien and with extensive beaches and sheltered waters.
Boullanger Island				Picnic groups and boats were often observed. Bird breeding sites on beach and spit areas require protection. Dense vegetation is a high fire risk.
Whitlock Island		X		Extensive shallow sandbanks inhibit boat access, however there is pedestrian access across the shallow channel from Boullanger Island. There is little evidence of damage.
Escape Island	X			Access is difficult. There is no disturbance, with the exception of lighthouse maintenance. There is the potential for introduction of exotic flora and fauna via amphibious craft servicing the lighthouse.
North Essex Rocks		X		Has an extensive beach area, however the island is 4 km from the nearest townsite and appears to receive little use.
Middle Essex Rocks South Essex Rocks	X			Access is difficult.
North Outer Rocks South Outer Rocks	X			Access is difficult.
North Ronsard Rocks South Ronsard Rocks	X			Access is difficult.

TABLE 11 (continued)

ISLAND	PUBLIC USE low	medium	high	ACCESSIBILITY
North Cervantes Island			X	Access to the plateau area is difficult, however the sand spit area is popular.
Middle Cervantes Island		X		Access is difficult.
South Cervantes Island		X		Access is difficult.
Buller Island	X			Access is difficult.
Whittell Island	X			Access is difficult.
North Green Island South Green Island		X		Boats were observed on the beach on several occasions, particularly on South Green Island.
Target Rock	X			Isolated. Access is difficult.
Wedge Island			X	Often joined to the mainland by an extensive sand bar, allowing access of vehicles, pedestrians and feral animals. The most disturbed island.
Lancelin Island			X	Close to mainland and townsite. Pleasure craft, up to 30 people and several dogs were observed. Abbott (1978) reports "the large sand beach on the east side and numerous small ones around the rest of the island make landing no problem in reasonable weather conditions".
Edward Island	X			Access is difficult.

Our study also shows that for some islands there has been a decrease over time in the number of native species recorded by researchers (for example, *Frankenia pauciflora, Myoporum insulare* and *Carpobrotus virescens*) and an increase in introduced species, especially *Mesembryanthemum crystallinum*. It is possible that the native species have been replaced by introduced species; however, further visitation would be necessary to help confirm this observation.

The Turquoise Coast islands, like all south-western Australian islands, are continental islands that have separated relatively recently from the mainland; therefore, few species are confined to them and, in the case of the Turquoise Coast islands, there are no endemic species. However, in our study a relatively rare plant species, which is included in the Department of Conservation and Land Management's priority flora list (Atkins 1998), was recorded on both North Boullanger and Sandland Islands. This species is *Lepidium puberulum*, a Priority 4 species according to the Western Australian Herbarium (2001).

Priority 4 species are considered to have been adequately surveyed and, whilst being rare in Australia, they are not currently threatened by any identifiable factors, though these taxa do require monitoring every 5-10 years. *Lepidium puberulum* has also been recorded from Dorre Island, the Shark Bay islands, the Zuytdorp cliffs, the Houtman Abrolhos and Rottnest and Garden Islands. It is a relatively inconspicuous annual and may not be as uncommon as previously thought.

Furthermore, the survey revealed that the tall form of *Senecio lautus* subsp. *maritimus* appeared to be confined to the islands near Jurien Bay.

Several taxonomic queries raised by the literature could not be resolved in our study. Gillham (1961) records *Zygophyllum* on Fisherman Island, but the species to which she refers is not clear and, therefore, this is not recorded in the species list. Storr (unpub.) records *Sonchus* sp. and we have left it as such in the species list. Plus, Lindgren (1973) records **Hordeum vulgare* and *Salicornia australis* on Lancelin Island, but the identification and current names cannot be determined without seeing specimens, and these species are not listed in the species list. Also, Johnstone (1978a) records *Pelargonium australe* on North Fisherman Island but, again, the identification and current name cannot be determined without seeing a specimen, so this species is also not listed in the species list.

Vegetation communities of special conservation interest

As mentioned in the above Results, the vegetation formations present on the islands are essentially the same as those of the adjacent mainland with two exceptions. The particular vegetation communities of interest are, firstly, the populations of *Lavatera plebeia* var. *tomentosa* and *Lepidium foliosum* growing in association with the guano-rich seabird nesting sites and, secondly, the bushes

of *Nitraria billardierei* on East Beagle Island growing with a tree-like habit, due to the numerous sea lions present.

Threats to the flora

The islands of the Turquoise Coast are significantly affected by any disturbance, due to their small size and thus their limited available habitat. The main threats to their flora and vegetation are associated with disturbance from either natural causes (such as fire or disease) or, more likely, from the impact of human activities. Increased access by the public is expected to place greater pressure on the islands in the future.

The fragile dune systems on some of the islands are very susceptible to erosion and this fragility is enhanced by the removal of vegetation through fire, vehicle damage and trampling. During island surveys evidence of old fire places were observed. Escaped fires could devastate the flora and fauna. Dogs also were often observed accompanying people and are particularly destructive, chasing fauna, excavating nesting burrows and trampling vegetation.

Weed seeds can be spread by birds, wind, water and, inadvertently, via shoes or tyres of visitors. Most of the introduced species occurred in naturally disturbed sites (beaches or bird nesting areas) or as gap fillers in the low limestone heath. These species may have little impact on the total dynamics of the flora as long as these 'natural' disturbances are the only ones to occur. However, islands such as Wedge Island and Escape Island, which have off-road vehicle tracks on them, or Lancelin Island with its numerous access tracks, contained a more diverse weed flora than expected, and as compared to adjacent islands.

The weed African boxthorn, **Lycium ferocissimum*, is an intricately branched plant from 0.5 to 2.5 m high (sometimes growing up to 4 m) and up to 3 m across, with thorns to 15 cm long on the main stem and smaller spines on the branchlets. It is a dangerous trap for wildlife, especially nesting birds, and 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). On islands hosting sea lion breeding, such as East Beagle Island, the boxthorn removes shelter and shade for sea lion pups.

African boxthorn is common on disturbed sites on the adjacent mainland. It regenerates by seed (spreading from the mainland, and within and between islands, by birds who have eaten the palatable red berries) and by a sucker-like system of tap roots. Boxthorn competes with native flora for the sometimes limited growing medium, and in some places it has displaced the evergreen shrub *Nitraria billardierei*. When alerted to the problem by this survey, a Department of Conservation and Land Management team from Perth and Moora districts removed the **Lycium* to prevent its continued spread.

Currently there is no boxthorn on Lipfert and Milligan Islands or Orton Rock, but the weed still occurs on East Beagle Island. It is important that ongoing eradication programmes for the spiny African boxthorn take place on the islands, as reintroduction from the mainland will undoubtedly continually occur.

Other threats to the flora include fire. The weeds, especially the ephemerals, dry off in summer and have the potential to become a fire hazard. Increased tourist visitation in the summer will also increase the risk of fires.

Further threats to the flora include rubbish pollution and rises in sea level.

Conservation recommendations

Since the islands of the Turquoise Coast are small and lie offshore of the Geraldton Sandplains Interim Biogeographic Region of Australia (IBRA) and the Swan Coastal Plain IBRA (Thackway and Cresswell 1995), it is not surprising that the flora is essentially similar to that recorded for the Shoalwater Bay islands and Carnac Island (Abbott 1980b; Abbott and Black 1980). Rottnest Island (Storr 1962) and Garden Island (Marchant and Abbott 1981) are too large and diverse in habitat to be comparable.

The major differences between the Turquoise Coast and the Shoalwater Bay island groups appear to be in the compositions of their introduced flora; **Poa annua, *Ficus carica, *Stenotaphrum secundatum, *Lavatera arborea* (now **Malva dendromorpha*), **Lycopersicon esculentum* and **Aster subulatus* have all been recorded only from the southern group. This difference is due to the closeness of the latter islands to a major urban centre and also due to the more temperate climate allowing easier establishment. The flora of the Houtman Abrolhos islands (Harvey *et al.* 2001) share some similarities with the Turquoise group, but these islands have a large arid component, as well as mangrove and mallee *Eucalypt* formations not present on the islands of the Turquoise Coast.

The Turquoise Coast islands contain one priority species but no endemic flora; however, they do complement and augment the other island reserves between Kalbarri and Mandurah and maintain a representative sample of the vegetation of offshore limestone islands. They are the least disturbed islands, having no settlements upon them (unlike the Abrolhos, Rottnest, Garden and Penguin Islands) and because of their remoteness from major urban settlements and their relatively undisturbed state, they should be maintained as reference sites to compare with these other islands.

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APPENDIX 1

Descriptions of physical (from Ford 1965) and dominant structural vegetation forms of each island in the Turquoise Coast survey. The islands are ordered from north to south. Refer to Appendix 2 for maps of dominant structural vegetation forms for 33 of the islands.

Comparisons are made with surveys conducted by other researchers; however, in some cases, the literature is unclear as to exactly where certain species were found. For example, Gillham (1961) mentions "Cervantes Island" (not distinguishing between South Cervantes, Middle Cervantes and North Cervantes Islands) and "Fisherman Island" (not distinguishing between South Fisherman Island and North Fisherman Island). Storr (unpub.) and Ford (1965) mention "Boullanger Island" (not distinguishing between the 'main' Boullanger Island and the tombolo, North Boullanger Island) and Ford (1965) mentions "Green Islets" (not distinguishing between North Green Island and South Green Island).

Beagle Islands Nature Reserve (26411)

Beagle Islands Nature Reserve is composed of three separate islets, East Beagle Island, North-West Beagle Island and South-West Beagle Island, on a limestone reef plateau.

1. East Beagle Island (Figure 3)

East Beagle Island is by far the largest of this group, separated from the smaller islands by 120 m of shallow water. The island has low cliffs on the south-eastern and south-western sides and a beach extending along most of the northern side. A layer of hard guano overlies the fairly deep soil layer.

The plateau is covered by a low open *Nitraria* shrubland of very old mature plants, which give an impression of a miniature woodland. The south-eastern corner of the island has an open herbfield with scattered **Lycium ferocissimum* shrubs. Numerous seal tracks are found on the plateau.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa.*

Number of plant species: 12, including 7 introduced.

Ford (1965) recorded 2 species, one of which we re-recorded. Recorded by Ford but missing from our survey: *Carpobrotus virescens.*

2. North-West Beagle Island (Figure 3)

North-West Beagle Island is of similar geomorphology to South-West Beagle Island and has a cover of low stunted *Nitraria* that is much affected by a large seabird colony.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa.*

Number of plant species: 6, including 2 introduced.

Ford (1965) recorded 2 species, one of which we re-recorded. Recorded by Ford but missing from our survey: *Carpobrotus virescens.*

3. South-West Beagle Island (Figure 3)

South-West Beagle Island is the smallest of the group and consists of a limestone plateau surrounded by low cliffs, with a cover of low stunted *Nitraria*.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa.*

Number of plant species: 3 (0 introduced).

Ford (1965) recorded 2 species, both of which we re-recorded.

Lipfert, Milligan, etc Islands Nature Reserve (29259)

This reserve includes a group of six small islands, including Snag Island, Drummond Rock, Webb Island, Lipfert Island, Orton Rock and Milligan Island, which all lie less than 250 m from the mainland.

4. Snag Island (Figure 4)

Snag Island is the northernmost island of the group, lying 1 km north of Drummond Rock. It is a small, steep-sided island with large tumbled boulders on the northern side. Snag Island consists of a low stunted *Nitraria* shrubland and herbfield on a limestone plateau.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa.*

Number of plant species: 19, including 6 introduced.

Ford (1965) recorded 2 species, both of which we re-recorded.

5. Drummond Rock (Figure 4)

Drummond Rock is a tiny island located 3.5 km north of Webb Island. It consists of a talus scree on the northern end and a low stunted *Nitraria* shrubland with a mixed herbfield on the eastern side, which is dominated by **Mesembryanthemum crystallinum*.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa.*

Number of plant species: 8, including 5 introduced.

Ford (1965) recorded 2 species, one of which we re-recorded. Recorded by Ford but missing from our survey: *Carpobrotus virescens.*

6. Webb Island (Figure 4)

Webb Island is a small, roughly circular island surrounded by vertical cliffs and located 5.5 km north of Lipfert Island.

The island consists of a small plateau with a low open *Nitraria billardierei* shrubland, and a central bare area with a covering of **Mesembryanthemum crystallinum* herbs,

fringed by a succulent shrubland of *Halosarcia halocnemoides*.

See also Ford (1965).

Lavatera plebeia here is var. *plebeia.*

Number of plant species: 8, including 5 introduced.

Ford (1965) recorded 2 species, one of which we re-recorded. Recorded by Ford but missing from our survey: *Carpobrotus virescens.*

7. Lipfert Island (Figure 5)

Lipfert Island is 750 m north of Orton Rock and is another narrow limestone plateau. The southern side of the plateau is covered by a deciduous shrubland of **Lycium ferocissimum* and the northern side is covered by *Nitraria billardierei* shrubland. Since the study visits, **Lycium ferocissimum* has been eliminated from the island. The plateau is surrounded by steep sloping cliffs.

See also Ford (1965).

Lavatera plebeia here is var. *plebeia.*

Number of plant species: 12, including 7 introduced.

Ford (1965) recorded 3 species, one of which we re-recorded. Recorded by Ford but missing from our survey: *Carpobrotus virescens* and *Rhagodia baccata.*

8. Orton Rock

Orton Rock is 750 m north of Milligan Island and comprises a very narrow limestone plateau with a **Lycium ferocissimum* and *Nitraria billardierei* shrubland. The slopes are dominated by *Nitraria billardierei*. Since the study visits, **Lycium ferocissimum* has been eliminated from the island.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa.*

Number of plant species: 13, including 6 introduced.

9. Milligan Island (Figure 4)

Milligan Island consists of a small plateau covered by a **Lycium ferocissimum* and *Nitraria billardierei* shrubland. Since the study visits, **Lycium ferocissimum* has been eliminated from the island.

See also Ford (1965).

Both *Lavatera plebeia* var. *plebeia* and *Lavatera plebeia* var. *tomentosa* are found on Milligan Island.

Number of plant species: 9, including 5 introduced.

Ford (1965) recorded 2 species, one of which we re-recorded. Recorded by Ford but missing from our survey: *Carpobrotus virescens*.

Fisherman Islands Nature Reserve (29256)

This reserve includes a pair of small islands, North Fisherman Island and South Fisherman Island, which are 720 m apart and located 4.9 and 5.6 km from the mainland.

10. North Fisherman Island (Figure 6)

This island is low lying, almost entirely covered by sand, and flanked by cliffs on the northern and western sides. This island has a large beach on the eastern side, which has scattered **Cakile maritima* plants on the sand. Behind this is a narrow band of *Spinifex longifolius*, which merges into a heath of *Nitraria billardierei* and *Myoporum insulare*, with numerous creepers of **Tetragonia decumbens*.

The central portion of the island is dominated by a steep hill, on the summit of which is a very low open shrubland of *Scaevola crassifolia*, *Myoporum insulare* and *Carpobrotus virescens*.

The southern end of the island is a limestone plateau with an open herbfield of *Spinifex longifolius* and **Mesembryanthemum crystallinum*, edged by low shrublands of *Halosarcia halocnemoides*, *Sarcocornia quinqueflora* with *Sporobolus virginicus* and *Carpobrotus virescens*.

Between these areas is a heath of mainly *Nitraria billardierei* and *Myoporum insulare*.

There are numerous sea lion tracks on the island.

See also Gillham (1961), Ford (1965) and Johnstone (1978a), and photographs 15 and 16 in Gillham (1961).

Lavatera plebeia here is var. *tomentosa.*

Number of plant species: 19, including 3 introduced.

Ford (1965) recorded 5 species, of which we re-recorded 3. Recorded by Ford but missing from our survey: *Atriplex cinerea* and *Zygophyllum billardierei.*

Johnstone (1978a) recorded 9 species, of which we re-recorded 7. Recorded by Johnstone but missing from our survey: *Atriplex cinerea*. See Table 8 for notes on *Pelargonium australe*, the other species recorded by Johnstone.

11. South Fisherman Island (Figure 6)

This island is a small limestone plateau covered with a low wind-pruned open *Nitraria billardierei* shrubland. On the south-eastern side, the *Nitraria* is very open and a dense ground cover of **Mesembryanthemum crystallinum* has developed.

There are numerous sea lion tracks on the island.

See also Gillham (1961), Ford (1965) and Johnstone (1978b), and photographs 15 and 16 in Gillham (1961).

Lavatera plebeia here is var. *tomentosa.*

Number of plant species: 3, including 1 introduced.

Ford (1965) recorded 2 species, one of which we re-recorded. Recorded by Ford but missing from our survey: *Carpobrotus virescens*.

Johnstone (1978b) recorded 3 species, of which we re-recorded 2. Recorded by Johnstone but missing from our survey: *Carpobrotus virescens*.

Sandland Island Nature Reserve (29255)

The Sandland Island Nature Reserve consists of one island, Sandland Island.

12. Sandland Island (Figure 7)

Sandland Island is a small, roughly circular island located close to the mainland. There is a small beach that forms each summer on the north-eastern side of Sandland Island, but it is not large enough to support a distinct vegetation association. Most of the island is a low limestone plateau covered by a deep layer of sand, which is covered with an open *Nitraria billardierei* shrubland, with a small area of **Mesembryanthemum crystallinum* herbfield, except on the margins of the plateau and talus slopes where the *Nitraria* forms a dense closed shrubland.

The *Nitraria* plants are large and well-spaced because of the presence of large numbers of sea lion tracks. This island is the only one that has *Nitraria* specimens approaching the tree-like *Nitraria* found on East Beagle Island.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa.*

Number of plant species: 20, including 6 introduced.

Storr (unpub.) recorded 18 species, of which we re-recorded 12. Recorded by Storr but missing from our survey: **Cakile maritima, Atriplex isatidea, Cotula cotuloides, Enchylaena tomentosa, Sclerostegia arbuscula* and **Sonchus* sp.

Ford (1965) recorded 5 species, all of which we re-recorded.

Boullanger, Whitlock, Favorite, Tern and Osprey Islands Nature Reserve (29251)

The Boullanger, Whitlock, Favorite, Tern and Osprey Islands Nature Reserve consists of the four islands of its title.

13. Favorite Island (Figure 8)

Favorite Island is the northernmost island in this nature reserve and it lies 3 km north of North Boullanger Island. It has a large beach on the eastern side and small cliffs on the western side. No characteristic beach vegetation has developed because of the steep central dune, which rises to 14 m behind the beach and dominates the island plateau.

Each end of the island has a low closed shrubland of *Nitraria billardierei* (80% cover), *Halosarcia halocnemoides*, *Atriplex cinerea* and *Frankenia pauciflora*.

The central dune has a patchy heath of *Olearia axillaris*, *Scaevola crassifolia*, *Spinifex longifolius* and *Atriplex cinerea*. The western side of the island is covered by a low open heath of *Atriplex cinerea* and *Nitraria billardierei* with abundant herbs of *Bromus arenarius*.

See also Ford (1965) and Abbott (1980a).

Number of plant species: 34, including 10 introduced.

Gillham (mentioned in Abbott 1980a) recorded 7 species, of which we re-recorded 4. Recorded by Gillham but missing from our survey: **Ehrharta brevifolia*, **Rostraria cristata* and *Podotheca angustifolia.*

Abbott (1980a) recorded 17 species on Favorite Island, all of which we re-recorded.

14. Osprey Island

Osprey Island is a small limestone plateau, with low shrubs of *Nitraria billardierei*.

See also Ford (1965) and Abbott (1980a).

Number of plant species: 4, including 1 introduced.

Ford (1965) recorded 1 species, which we re-recorded.

Abbott (1980a) recorded 4 species, of which we re-recorded 3. Recorded by Abbott but missing from our survey: *Rhagodia baccata*.

15. Tern Island (Figure 4)

Tern Island lies between Whitlock and Boullanger Islands and consists of a small limestone plateau encircled by low cliffs. The plateau is covered with dense *Nitraria billardierei* shrubland interspersed with rich herbfields, which are dominated by **Urtica urens* and **Mesembryanthemum crystallinum*.

See also Ford (1965) and Abbott (1980a).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species: 21, including 6 introduced.

Storr (unpub.) recorded 12 species, of which we re-recorded 8. Recorded by Storr but missing from our survey: *Atriplex isatidea*, *Enchylaena tomentosa* and *Isolepis nodosa, *Sonchus* sp.

Abbott (1980a) recorded 10 species, of which we re-recorded 9. Recorded by Abbott but missing from our survey: *Enchylaena tomentosa*.

16. North Boullanger Island (Figure 9)

North Boullanger Island is a small island of 2.4 ha usually joined to Boullanger Island by a tombolo that forms a ramp of sand over the limestone plateau on the southern side. This dune is covered by a *Nitraria billardierei* shrubland over *Acacia cyclops*, *Atriplex isatidea* and *Lepidosperma gladiatum*.

The northern half of the island is a limestone plateau covered by low heath or herbfield depending on soil depth. The heath is dominated by *Atriplex cinerea*, *Rhagodia baccata*, *Zygophyllum billardierei* and *Acanthocarpus preissii*.

See also Ford (1965) and Abbott (1980a).

Senecio lautus here is subsp. *maritimus* and *Lavatera plebeia* is var. *plebeia*.

Number of plant species: 62, including 19 introduced.

Abbott (1980a) recorded 41 species, of which we re-recorded 38. Recorded by Abbott but missing from our survey: **Oxalis corniculata, *Tetragonia decumbens* and *Wilsonia backhousei.*

17. Boullanger Island (Figure 9)

Boullanger Island is the largest island in the study area and is more than twice the size of the next largest island.

Boullanger Island is unique amongst the Turquoise Coast islands as it is composed entirely of sand and is usually connected to North Boullanger Island by a sand spit. This connection causes the island to have a large but variable beach on the northern end. In summer, the mobile sand has a sparse covering of **Cakile maritima* fronting a herbfield of *Spinifex longifolius*, *Salsola tragus*, **Arctotheca populifolia* and **Tetragonia decumbens*.

The northern region behind the beach is more stable but is still affected by winter storms. It is covered with an open shrubland of *Acacia cyclops*, *Atriplex isatidea* and *Myoporum insulare*. This region also contains numerous sandy areas that are bare, except in spring when there is a cover of herbs.

The remainder of the island is covered by a low heath (40–90% cover) with a variable composition, depending on aspect and proximity to the beach. In the north central region there is a low closed heath of *Scaevola crassifolia* (85% cover), *Olearia axillaris* (10%) and *Myoporum insulare* (5%), whereas on the southern hills there is an open low heath of *Olearia axillaris* (25% cover), *Myoporum insulare* (55%), and *Scaevola crassifolia* (10%) over *Acanthocarpus preissii*, *Poa poiformis* and *Austrostipa flavescens*. On the valley floors, *Austrostipa elegantissima* replaces *A. flavescens*.

See also Ford (1965), Abbott (1980a) and Fuller and Burbidge (1987).

Number of plant species: 50, including 12 introduced.

Abbott (1980a) recorded 27 species, of which we re-recorded 26. Recorded by Abbott but missing from our survey: *Sporobolus virginicus*.

18. Whitlock Island (Figure 10)

Whitlock Island is a relatively large island, separated from Boullanger Island 160 m to the east by a shallow channel. The eastern side of Whitlock Island has an extensive beach and a sand spit extending towards Boullanger Island. The beach has a herbfield of **Cakile maritima* grading into a herbfield of *Sporobolus virginicus*, and heath of *Spinifex longifolius* and *Atriplex isatidea*. Behind this is a heath of *Olearia axillaris*, *Myoporum insulare* and *Scaevola crassifolia*, with numerous creepers of **Tetragonia decumbens*.

Most of the island consists of a low limestone plateau surrounded by steep cliffs. The plateau is covered by a low closed heath dominated by *Atriplex cinerea*, except for a central 'dune' with emergent *Nitraria billardierei*. The southern portion of the island has very shallow soil, which is covered by a species-rich heath of *Acanthocarpus preissii*, *Olearia axillaris*, *Frankenia pauciflora*, *Atriplex cinerea*, *Templetonia retusa*, *Pimelea gilgiana*, *Phyllanthus calycinus* and *Enchylaena tomentosa*.

See also Ford (1965), Abbott (1980a) and Fuller and Burbidge (1987).

Both *Senecio lautus* subsp. *dissectifolius* and *Senecio lautus* subsp. *maritimus* are found on Whitlock Island. *Lavatera plebeia* here is var. *plebeia*.

Number of plant species: 55, including 17 introduced.

Storr (unpub.) recorded 28 species, of which we re-recorded 24. Recorded by Storr but missing from our survey: *Angianthus cunninghamii*, *Poa poiformis, Salsola tragus* and **Sonchus* sp.

Ford (1965) recorded 8 species, all of which we re-recorded.

Abbott (1980a) recorded 32 species, of which we re-recorded 27. Recorded by Abbott but missing from our survey: *Angianthus cunninghamii*, **Medicago polymorpha*, **Oxalis corniculata, Poa poiformis* and *Salsola tragus*.

Escape Island Nature Reserve (44683)

The Escape Island Nature Reserve consists of one island, Escape Island.

19. Escape Island (Figure 11)

Escape Island is the second largest island surveyed. It is surrounded by steep cliffs and has small beaches scattered around its margin and a larger beach, which is used as a landing site, on the north-eastern end; however, no typical beach vegetation is present, except on a small dune field on the northern end there is a heath of *Spinifex longifolius*, *Scaevola crassifolia*, *Olearia axillaris* and *Acanthocarpus preissii*.

The eastern half of the island is covered with deep, undulating dune sand up to 12 m high, while the west has deep, compact sand, and the centre has an exposed limestone pavement.

Small patches of *Nitraria billardierei* shrubland are found on the northern and southern ends of the island. Most beaches are lined by *Sporobolus virginicus*.

The central region of the island is covered by a low heath of *Scaevola crassifolia* and *Olearia axillaris*, with scattered bare areas covered by **Avena barbata* and *Carpobrotus virescens*.

The plateau region of the island has a very low heath of *Atriplex cinerea*, with scattered *Nitraria billardierei*, *Pimelea gilgiana* and *Rhagodia baccata*. This grades into heath dominated by *Scaevola* and *Olearia*.

On the southern end of the island, on very shallow soils, is a very low wind-pruned shrubland of *Wilsonia humilis*, *Frankenia pauciflora*, *Olearia axillaris*, *Atriplex cinerea* and *Nitraria billardierei*.

A lighthouse is situated near the centre of the island and there is a track leading to it.

See also Ford (1965) and Abbott (1980a).

Lavatera plebeia here is var. *plebeia*.

Number of plant species recorded: 60, including 23 introduced.

Ford (1965) recorded 11 species, of which we re-recorded 10. Some species found by Ford are mentioned in Abbott (1980a). Recorded by Ford but missing from our survey: **Spergularia rubra*.

Abbott (1980a) recorded 38 species, of which we re-recorded 32. Recorded by Abbott but missing from our survey: *Enchylaena tomentosa*, *Exocarpos sparteus, Phyllanthus calycinus*, *Pittosporum phylliraeoides, Senecio lautus* and *Zygophyllum billardierei.*

Start (personal communication, 1998) recorded 34 species, of which we re-recorded 26. Recorded by Start but missing from our survey: *Alyxia buxifolia*, *Enchylaena tomentosa*, *Eragrostis dielsii, Exocarpos sparteus, Pittosporum phylliraeoides, Samolus junceus, Templetonia retusa* and **Trachyandra divaricata*.

Essex Rocks Nature Reserve (29257)

The Essex Rocks Nature Reserve is a compact group of three small islands, North Essex Rocks, Middle Essex Rocks and South Essex Rocks, which are probably the residual of one island. The group lies 4.2 to 4.6 km off the mainland.

20. North Essex Rocks

North Essex Rocks is the largest island in the group. It has two plateau areas and is surrounded by steep cliffs, with a beach along the eastern side. The plateaux are covered with a low open *Nitraria billardierei* shrubland.

Sea lions have formed broad pathways on the plateaux.

See also Ford (1965) and Abbott (1980a).

Lavatera plebeia here is var. *tomentosa* and the *Senecio lautus* found on this island is the tall form.

Number of plant species: 12, including 4 introduced.

Storr (unpub.) recorded 12 species, of which we re-recorded 8. Recorded by Storr but missing from our survey: *Enchylaena tomentosa*, **Hornungia procumbens*, *Nicotiana occidentalis* and **Sonchus* sp.

Ford (1965) recorded 3 species, all of which we re-recorded.

Abbott (1980a) recorded 8 species, of which we re-recorded 7. Recorded by Abbott but missing from our survey: *Enchylaena tomentosa*.

21. Middle Essex Rocks (Figure 12)

This island consists of a small limestone plateau surrounded by cliffs that are partially collapsed on the eastern side, and is dominated by an open low shrubland of *Nitraria billardierei* shrubland.

See also Ford (1965) and Abbott (1980a).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species: 6, including 3 introduced.

Storr (unpub.) recorded 12 species, of which we re-recorded 2. Recorded by Storr but missing from our survey: *Bromus arenarius*, *Calandrinia calyptrata*, *Carpobrotus virescens*, *Cotula cotuloides*, *Enchylaena tomentosa*, *Frankenia pauciflora*, **Nicotiana occidentalis*, *Senecio lautus, *Sonchus* sp. and *Wilsonia humilis*.

Ford (1965) recorded 3 species, of which we re-recorded 1. Recorded by Ford but missing from our survey: *Carpobrotus virescens* and *Frankenia pauciflora*

Abbott (1980a) recorded 7 species, of which we re-recorded 3. Recorded by Abbott but missing from our survey: *Carpobrotus virescens, Enchylaena tomentosa*, *Frankenia pauciflora* and *Wilsonia humilis*.

22. South Essex Rocks (Figure 12)

This island consists of a small limestone plateau and talus slopes dominated by *Nitraria billardierei* shrubland.

See also Ford (1965) and Abbott (1980a).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species: 4, including 1 introduced.

Storr (unpub.) recorded 2 species, Ford (1965) recorded 1 species and Abbott (1980a) recorded 3 species, all of which we re-recorded.

Outer Rocks Nature Reserve (29258)

The Outer Rocks Nature Reserve consists of South Outer Rocks and North Outer Rocks, which are 70 m apart. They consist of eroded limestone and are encircled by steep cliffs and reef ledges.

There has been confusion over the years about the name and position of the islands of the Outer Rocks group. There was a time when the islands now named Outer Rocks were called North and South Sandy Knoll of the Sandy Knoll island group, situated on Sand Knoll Ledge; however, there are no islands above high water mark on the area now called Sand Knoll Ledge, and the Outer Rocks group is situated to the north-west of Sand Knoll Ledge.

23. North Outer Rocks (Figure 13)

This island consists of a low limestone plateau with a low, very open *Nitraria billardierei* shrubland, a large area of talus slope with *Threlkeldia diffusa*, and two areas of herbfield of *Carpobrotus virescens* and **Mesembryanthemum crystallinum*.

See also Ford (1965) where it is listed as Sandy Knoll islands.

Lavatera plebeia here is var. *tomentosa*.

Number of plant species: 5, including 1 introduced.

Ford (1965) recorded 2 species, both of which we re-recorded.

24. South Outer Rocks (Figure 13)

The flora consists of *Nitraria billardierei* and **Mesembryanthemum crystallinum*.

See also Ford (1965), where it is listed as Sandy Knoll islands.

Number of plant species recorded: 2, including 1 introduced.

Ford (1965) recorded 1 species, which we re-recorded.

Ronsard Rocks Nature Reserve (29260)

This reserve includes two tiny islets, North Ronsard Rocks and South Ronsard Rocks, lying in Ronsard Bay.

25. North Ronsard Rocks (Figure 14)

The flora consists of 2 *Nitraria billardierei* shrubs.

See also Ford (1965).

Number of plant species recorded: 1 (native).

Ford (1965) recorded 1 species, which we re-recorded.

26. South Ronsard Rocks

The flora consists of 7 *Nitraria billardierei* shrubs.

See also Ford (1965).

Number of plant species recorded: 1 (native).

Ford (1965) recorded 1 species, which we re-recorded.

Cervantes Islands Nature Reserve (29253)

This reserve includes a group of three islands, North Cervantes Island, Middle Cervantes Island and South Cervantes Island, 1.6 to 2.7 km off the mainland.

27. North Cervantes Island (Figure 15)

North Cervantes Island lies about 420 m north of Middle Cervantes Island and is the largest island of the group. Vertical cliffs surround the island's large plateau and the middle area is overlain with deep sand, with capstone exposed at either end. A large sandy spit extends towards the mainland from the eastern corner.

This beach is covered with a herbfield of **Cakile maritima* backed by a heath of *Nitraria billardierei* (50% cover), *Olearia axillaris*, *Myoporum insulare*, *Scaevola crassifoli* and many creepers of *Zygophyllum billardierei*.

The plateau is covered by a low open heath (30–50% cover) of variable composition depending on soil depth. Dominant species are *Rhagodia baccata*, *Olearia axillaris* and *Frankenia pauciflora*. Patches of herbfield and open bare rock outcrops are scattered throughout this region.

The cliffs and talus slopes are dominated by a *Nitraria billardierei* shrubland.

See also Ford (1965), and photographs 1, 2 and 5 in Gillham (1961).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species recorded: 53, including 17 introduced.

Ford (1965) recorded 10 species, all of which we re-recorded.

28. Middle Cervantes Island (Figure 16)

This small island, about 100 m north of South Cervantes Island, consists largely of a series of cliffs and talus slopes surrounding a limestone plateau, and an extensive sandy beach on the eastern side. The cliffs and slopes are covered by *Nitraria billardierei* shrubland mixed with **Mesembryanthemum crystallinum* and *Wilsonia humilis* as ground covers. The plateau has a stunted *Nitraria* shrubland, with an open area covered by a **Mesembryanthemum crystallinum* herbfield with emergent *Lavatera plebeia*.

See also Ford (1965), and photographs 1, 2 and 5 in Gillham (1961).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species recorded: 9, including 2 introduced.

Ford (1965) recorded 4 species, of which we re-recorded 2. Recorded by Ford but missing from our survey: *Carpobrotus virescens* and *Frankenia pauciflora.*

29. South Cervantes Island (Figure 16)

South Cervantes Island is roughly elliptical in shape and surrounded by sloping cliffs, with beaches on the western and north-eastern sides. The island is inhabited by sea lions who have access to the northern section of the island but not the main plateau.

The island has a small plateau with low scattered shrubs of *Nitraria billardierei* emergent through a species-rich herbfield (especially **Mesembryanthemum*, *Bromus arenarius* and **Bromus diandrus*). This merges into a low open heath of *Rhagodia baccata* (10% cover) and *Atriplex cinerea* (10%) over herbfields. On the eastern end of the island is a closed herbfield of *Enchylaena tomentosa* and **Mesembryanthemum crystallinum* where the soil is shallowest.

Cliffs and talus slopes are dominated by a *Nitraria billardierei* shrubland.

See also Ford (1965), and photographs 1, 2 and 5 in Gillham (1961).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species recorded: 28, including 12 introduced.

Ford (1965) recorded 5 species, of which we re-recorded 4. Recorded by Ford but missing from our survey: *Frankenia pauciflora.*

Buller, Whittell and Green Islands Nature Reserve (29252)

The four islands in this group, Buller Island, Whittell Island, North Green Island and South Green Island, are located 1.5 to 3.3 km off the mainland and extend for 3 km along the coast.

30. Buller Island (Figure 5)

Buller Island is a small crescent-shaped island 750 m north-east of Whittell Island. It is surrounded largely by steep cliffs and has a small beach with no foredune vegetation occurring. The plateau is covered by large open Nitraria billardierei bushes, with very prominent seal tracks between them, and no understorey. On the southern end of the island, a prostrate *Nitraria billardierei* and *Sarcocornia quinqueflora* shrubland is found. The north-eastern end of the island is a limestone pavement with shallow guano-rich sand, covered by a **Mesembryanthemum crystallinum* herbfield, with scattered emergent *Lavatera plebeia* var. *tomentosa.*

An unnamed rock between Whittell Island and Buller Island was visited during the survey and is vegetated with shrubs of *Nitraria billardierei*, *Sarcocornia quinqueflora* and **Mesembryanthemum crystallinum*.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species recorded: 13, including 3 introduced.

Ford (1965) recorded 3 species, of which we re-recorded 2. Recorded by Ford but missing from our survey: *Myoporum insulare*.

31. Whittell Island (Figure 5)

This is a small island situated midway between North Green Island and Buller Island. It consists of two limestone plateaux, separated by tumbled boulders. Steep cliffs and talus scree, all covered by wind-pruned, low, open *Nitraria* shrubland, surround the island. A **Mesembryanthemum crystallinum* herbfield, with emergent *Lavatera plebeia*, occurs where the soil is shallow and guano-rich.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species recorded: 14, including 2 introduced.

Ford (1965) recorded 2 species, both of which we re-recorded.

32. North Green Island (Figure 17)

North Green Island is a narrow island separated from South Green Island by a small, shallow channel. It is mostly surrounded by steep cliffs up to 8 m above sea-level and has two beaches, fronted by an open herbfield of **Cakile maritima* and *Spinifex longifolius*, and backed by an open shrubland of *Nitraria billardierei* decked with numerous creepers of *Zygophyllum billardierei* and **Tetragonia decumbens*.

The central plateau is covered by sand to variable depth, and a mixed closed heath dominated by combinations of *Nitraria billardierei*, *Atriplex cinerea*, *Frankenia pauciflora*, *Scaevola crassifolia* and the creeper *Zygophyllum billardierei* (the combinations depending on soil depth).

Three small areas of limestone (with soil-filled pockets) covered by a species-rich herbfield are also found.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species recorded: 24, including 5 introduced.

33. South Green Island (Figure 18)

South Green Island is the largest island in the group and rises to 8 m above sea-level. It consists of both deep sand and exposed limestone plateau. Steep low cliffs and reefs are situated along the western and northern perimeters.

This island has an extensive beach on the eastern side, with a narrow band of beach vegetation of **Cakile maritima* herbs backed by shrubs of *Atriplex isatidea*, *Nitraria billardierei* and *Spinifex longifolius*, with vines of **Tetragonia decumbens*.

Where the soils are deepest, flanking the beach, there is an open *Nitraria billardierei* shrubland, grading into a low dense heath dominated by *Scaevola crassifolia* (90% cover), with varying amounts of *Atriplex cinerea* and *Olearia axillaris* (especially at the north-western end). On the plateau of the island is a low dense heath composed of *Olearia axillaris*, *Scaevola crassifolia*, *Rhagodia baccata*, *Atriplex cinerea* and *Frankenia pauciflora*, with rare *Nitraria billardierei*. Open areas are dominated by **Mesembryanthemum crystallinum*.

The southern end of the island has a low open heath of *Frankenia pauciflora* and *Sarcocornia quinqueflora.*

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species recorded: 27, including 5 introduced.

Proposed Target Rock Nature Reserve

The proposed Target Rock Nature Reserve consists of one islet, Target Rock.

34. Target Rock (Figure 14)

This is a tiny islet with a small, sparsely-vegetated limestone plateau rising to a height of 12 m, and talus slopes covered by sparse *Nitraria billardierei* shrubs.

The island has been used as a R.A.A.F. bombing site and the sparseness of the vegetation may be the result of bombing damage; however, a thorough inspection was not possible due to the danger of unexploded bombs.

See also Ford (1965).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species recorded: 3, including 1 introduced.

Wedge Island Nature Reserve (29254)

The Wedge Island Nature Reserve consists of a single island, Wedge Island.

35. Wedge Island (Figure 19)

This island is wedge-shaped and encircled by cliffs, orientated north-south, and rises to 21 m at the southern end. This end consists of a herbfield dominated by **Mesembryanthemum crystallinum*. The soils deepen towards the north, resulting in an open heath of *Olearia axillaris*, *Rhagodia baccata*, *Scaevola crassifolia* and *Spyridium globulosum*, with numerous creepers of *Zygophyllum billardierei*.

Cliffs and talus slopes are dominated by a *Nitraria billardierei* shrubland.

Wedge Island differs from the other islands in that it is periodically joined to the mainland by a wide sand bar.

The presence of an old four-wheel drive (4x4) track along the centre of the island has caused severe erosion and considerable weed invasion on this island.

See also Ford (1965).

Number of plant species recorded: 40, including 15 introduced.

Ford (1965) recorded 5 species, all of which we re-recorded.

Lancelin and Edward Islands Nature Reserve (24979)

The Lancelin and Edward Islands Nature Reserve consists of Lancelin Island and Edward Island.

36. Lancelin Island (Figure 20)

This is a large and diverse island, mostly encircled by cliffs, with a large beach on the eastern side. The foreshore is covered by a herbfield of **Cakile maritima*, **Arctotheca populifolia* and *Spinifex longifolius*. Inland this merges into an open heath of *Olearia axillaris*, *Myoporum insulare*, *Scaevola crassifolia*, *Acacia cyclops*, *Ozothamnus cordatus* and *Atriplex isatidea*.

The central area of the island is dominated by a large sand dune to 17 m high, vegetated with an open heath of variable composition including *Nitraria billardierei*, *Scaevola crassifolia*, *Rhagodia baccata* and *Olearia axillaris*, depending on soil depth and aspect.

On the margins of the island occur shallow soils over limestone. These are vegetated usually by herbfields with low emergent shrubs. Frequent combinations are either *Rhagodia baccata* and *Frankenia pauciflora* over **Mesembryanthemum crystallinum* or *Carpobrotus virescens*, or *Rhagodia baccata* with grasses and emergent *Lavatera plebeia*.

The northern end of the island has a low open succulent shrubland of *Sarcocornia blackiana* and *Halosarcia halocnemoides*.

Cliffs and talus slopes are dominated by a *Nitraria billardierei* shrubland.

We recorded a stand of **Ehrharta villosa* (pyp grass) on the foredune at Lancelin Island and this is the first spontaneous record of this introduced species from a conservation reserve.

It has been used extensively to stabilise the Lancelin dunes.

See also Ford (1965), Lindgren (1973), Abbott (1978, 1980a) and photographs 6, 10, 11 and 14 in Gillham (1961).

Lavatera plebeia here is var. *tomentosa*.

Number of plants species recorded: 60, including 25 introduced.

Gillham had 15 species from Lancelin Island determined at the Western Australian Herbarium, according to Abbott (1980a). Thirteen of these species are listed in Table 8. Of the species recorded by Gillham, we re-recorded 11. Recorded by Gillham but missing from our survey: *Calandrinia calyptrata* and *Wilsonia backhousei.*

Ford (1965) recorded 10 species, of which we re-recorded 9. Recorded by Ford but missing from our survey: *Zygophyllum billardierei.*

Lindgren (1973) recorded 49 species, of which we re-recorded 40. Recorded by Lindgren but missing from our survey: *Anthocercis littorea, *Hornungia procumbens, *Polycarpon tetraphyllum, *Stellaria media, Triglochin mucronata, *Vulpia fasciculata* and **Vulpia myuros.* See Table 8 for notes on the two other species recorded by Lindgren, **Hordeum vulgare* and *Salicornia australis.*

Abbott (1980a) recorded 40 species, of which we re-recorded 38. Recorded by Abbott but missing from our survey: *Wilsonia humilis* and *Zygophyllum aurantiacum*.

37. Edward Island (Figure 14)

The island consists of a limestone plateau up to 5 m high, with partially separated stacks on the north-west end and talus slope. Most of this region is covered by *Nitraria billardierei* low open shrubland over **Mesembryanthemum crystallinum* herbfield. The northern end of the island has a mixture of *Frankenia pauciflora* shrubs (55% cover) over **Mesembryanthemum crystallinum* herbs, with scattered *Lavatera plebeia* var. *tomentosa* emergents.

See also Ford (1965), Abbott (1980a) and photographs 3 and 13 in Gillham (1961).

Lavatera plebeia here is var. *tomentosa*.

Number of plant species recorded: 7, including 1 introduced.

Gillham (1961) recorded 4 species, Ford (1965) recorded 3 species and Abbott (1980a) recorded 7 species. We re-recorded all of these.

APPENDIX 2

Maps of dominant structural vegetation forms for 33 islands in the Turquoise Coast survey. Note that the occurrence of more than one island on a single figure does not mean the islands are geographically close.

Refer to Appendix 1 for descriptions of physical and dominant structural vegetation forms of each island.

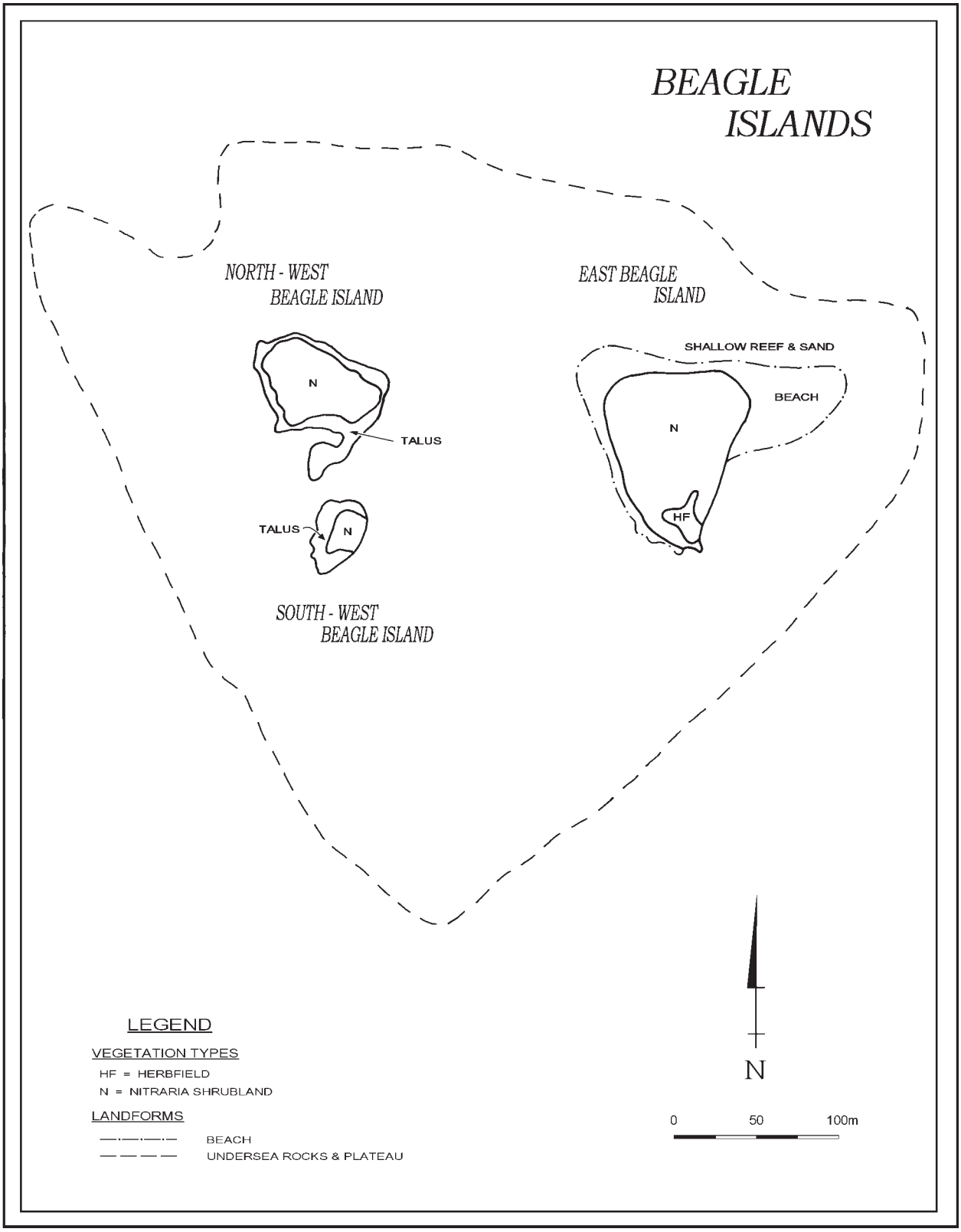

Figure 3. Maps of dominant structural vegetation forms for North-West Beagle Island, South-West Beagle Island and East Beagle Island (in the Beagle Islands Nature Reserve).

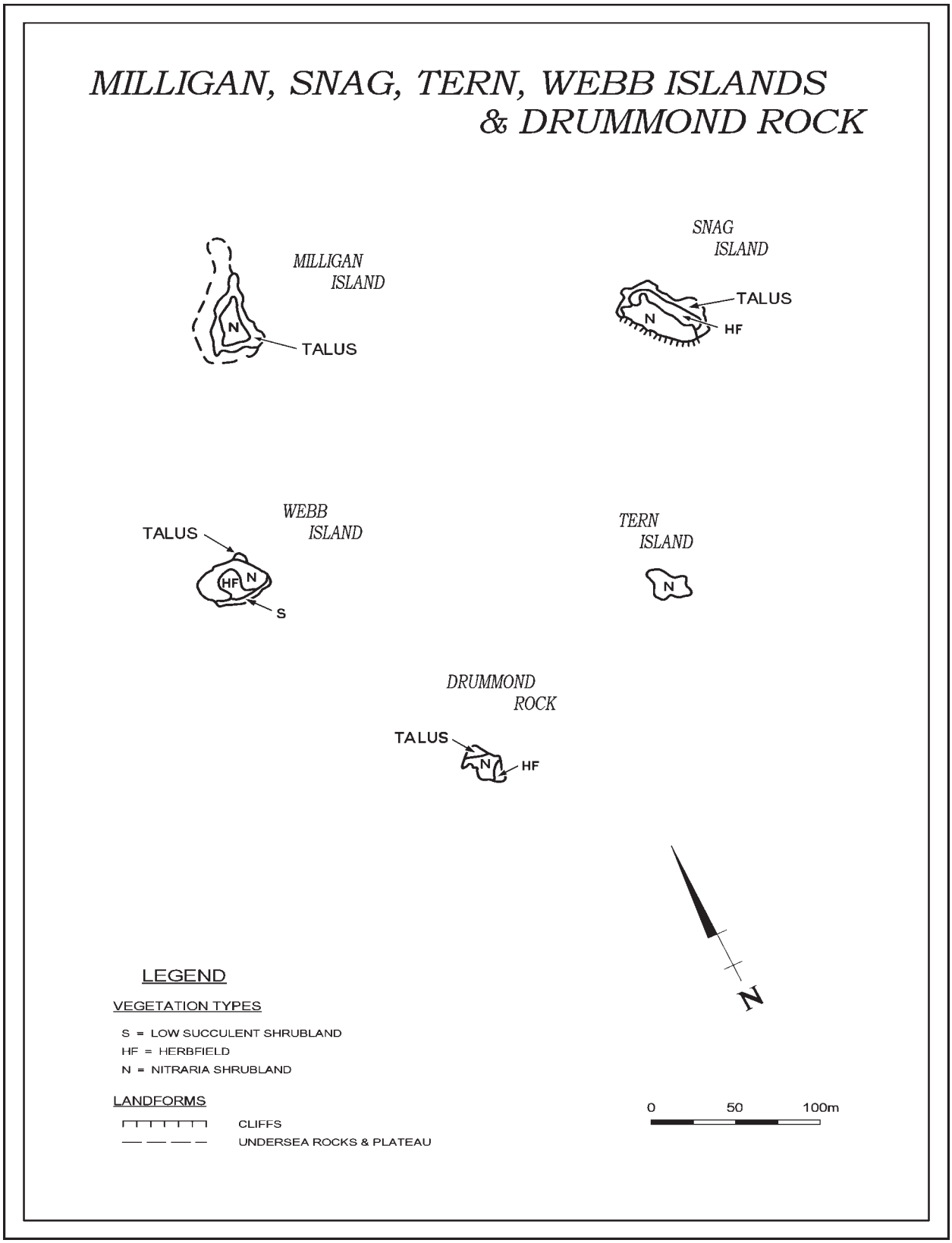

Figure 4. Maps of dominant structural vegetation forms for Milligan Island, Snag Island, Webb Island and Drummond Rock (all in the Lipfert, Milligan, etc. Islands Nature Reserve) and Tern Island (in the Boullanger, Whitlock, Favorite, Tern and Osprey Islands Nature Reserve).

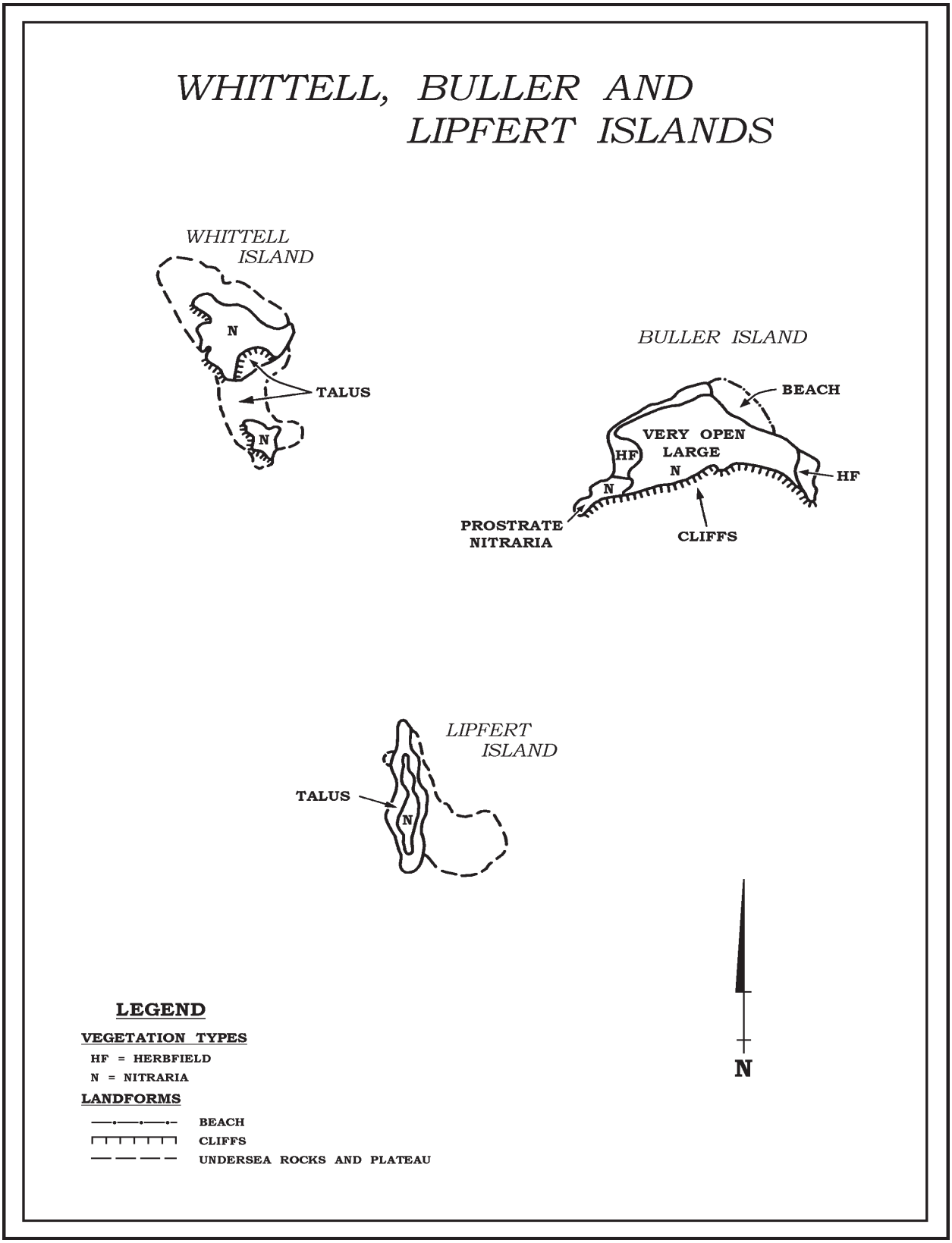

Figure 5. Maps of dominant structural vegetation forms for Buller Island and Whittell Island (in the Buller, Whittell and Green Islands Nature Reserve) and Lipfert Island (in the Lipfert, Milligan, etc. Islands Nature Reserve).

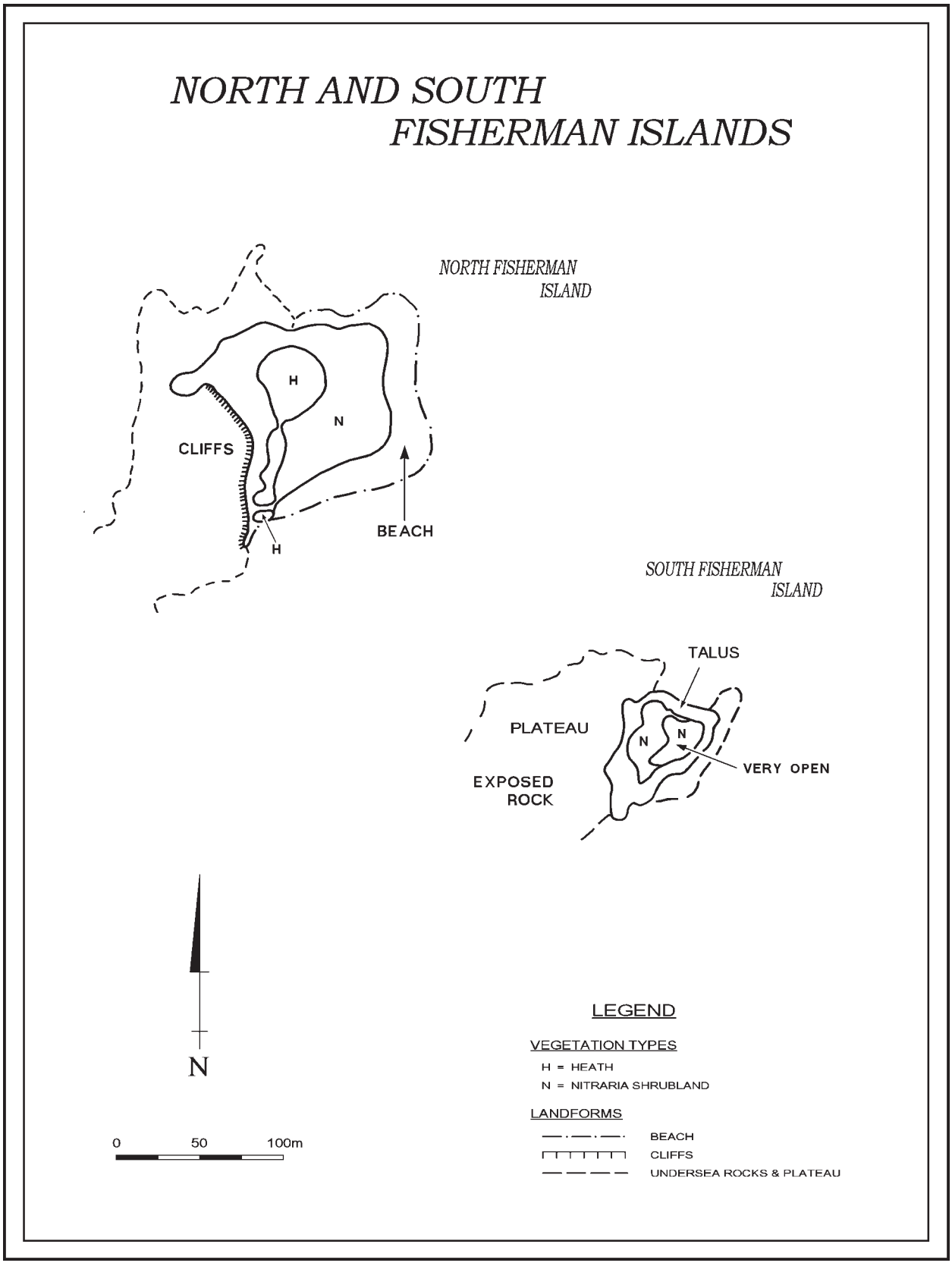

Figure 6. Maps of dominant structural vegetation forms for North Fisherman Island and South Fisherman Island (in the Fisherman Islands Nature Reserve).

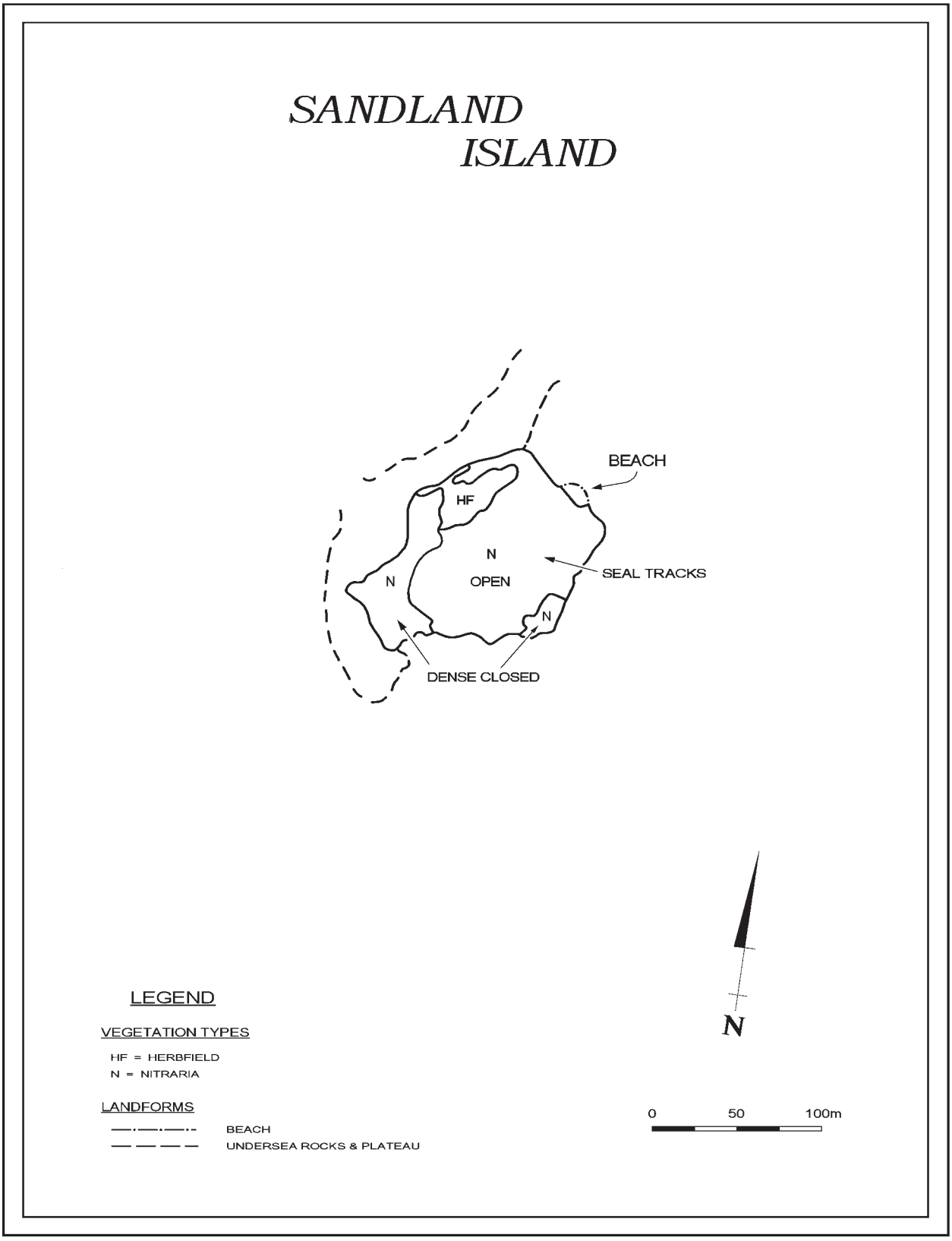

Figure 7. Map of dominant structural vegetation forms for Sandland Island (Sandland Island Nature Reserve).

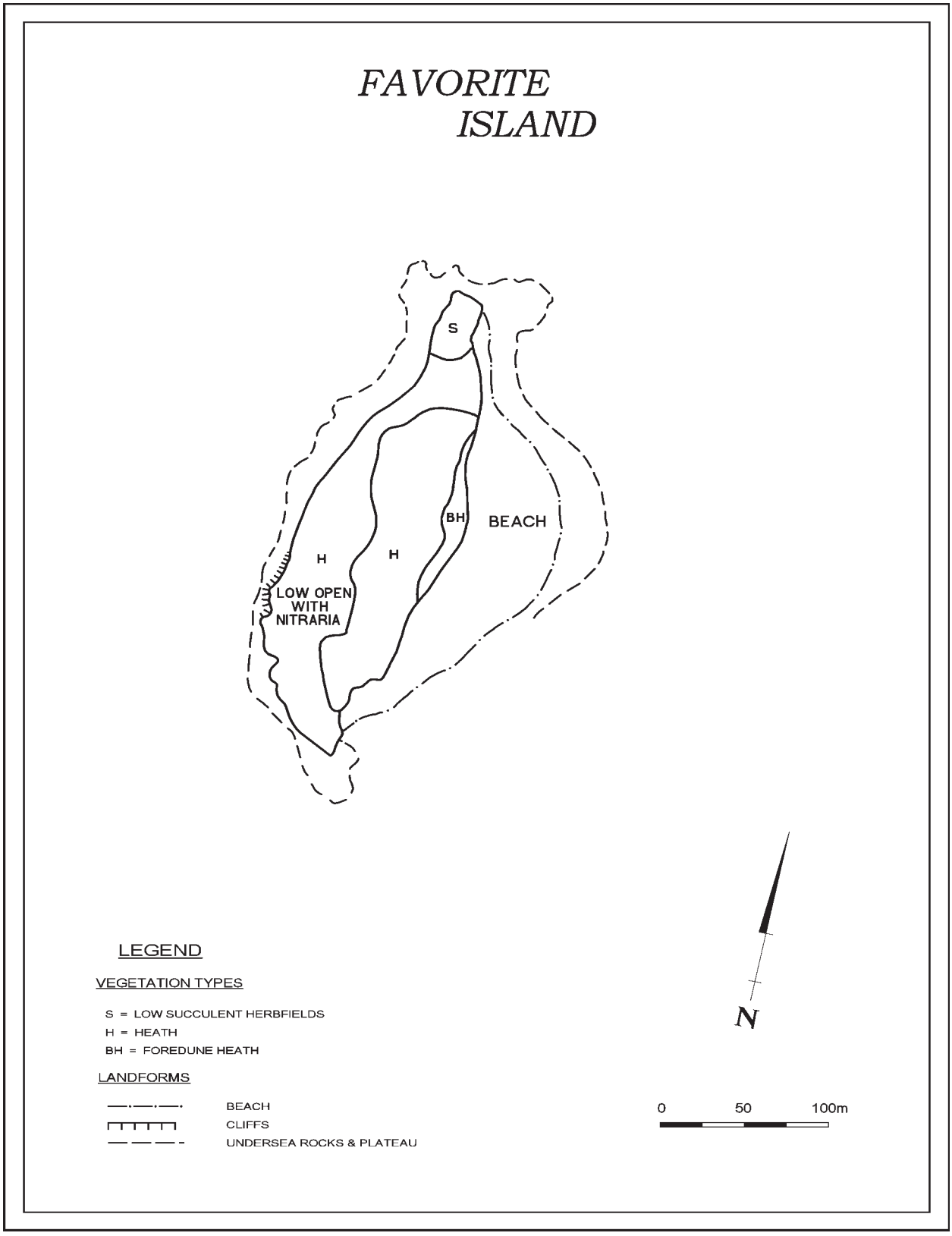

Figure 8. Map of dominant structural vegetation forms for Favorite Island (in the Boullanger, Whitlock, Favorite, Tern and Osprey Islands Nature Reserve).

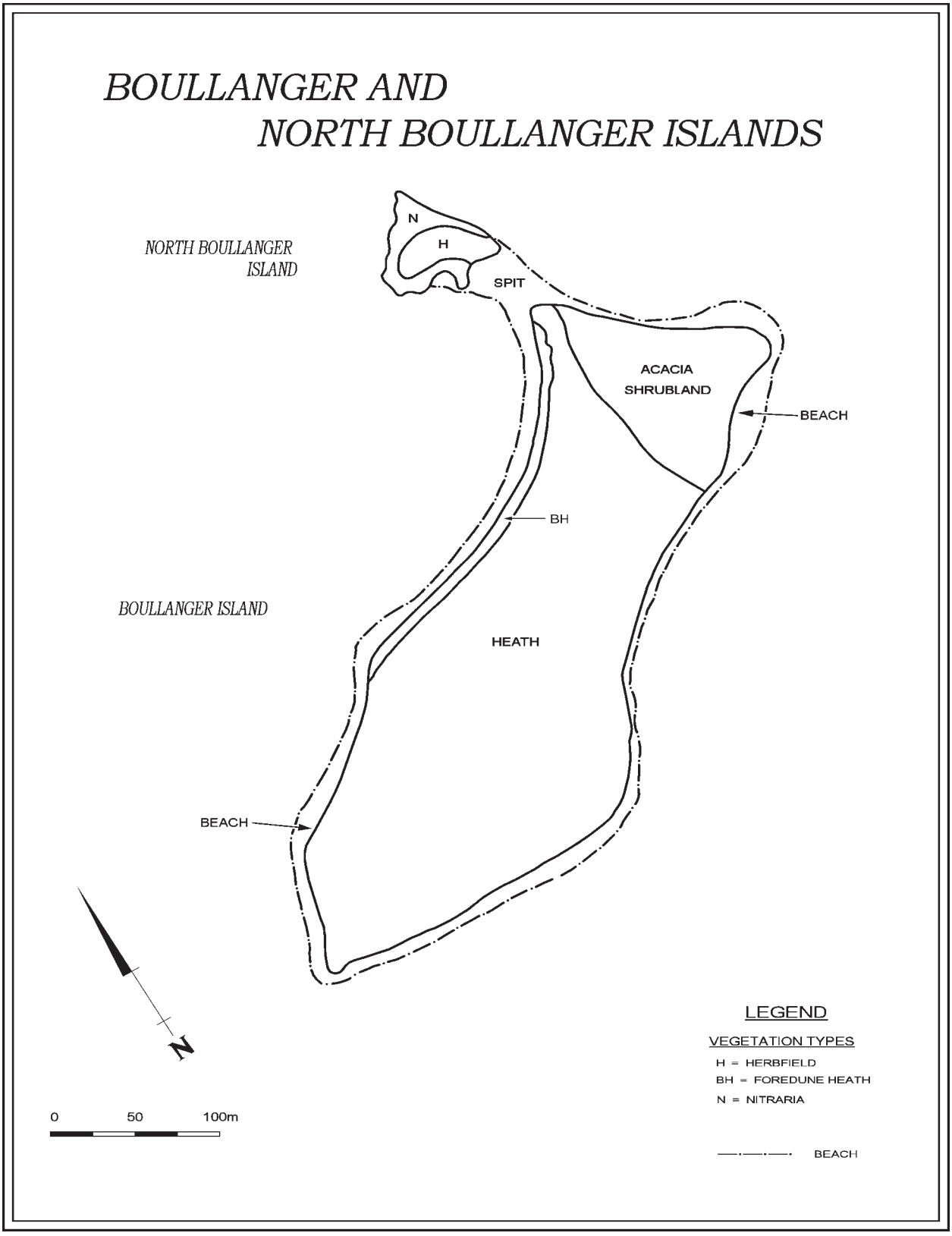

Figure 9. Maps of dominant structural vegetation forms for Boullanger Island and North Boullanger Island (in the Boullanger, Whitlock, Favorite, Tern and Osprey Islands Nature Reserve).

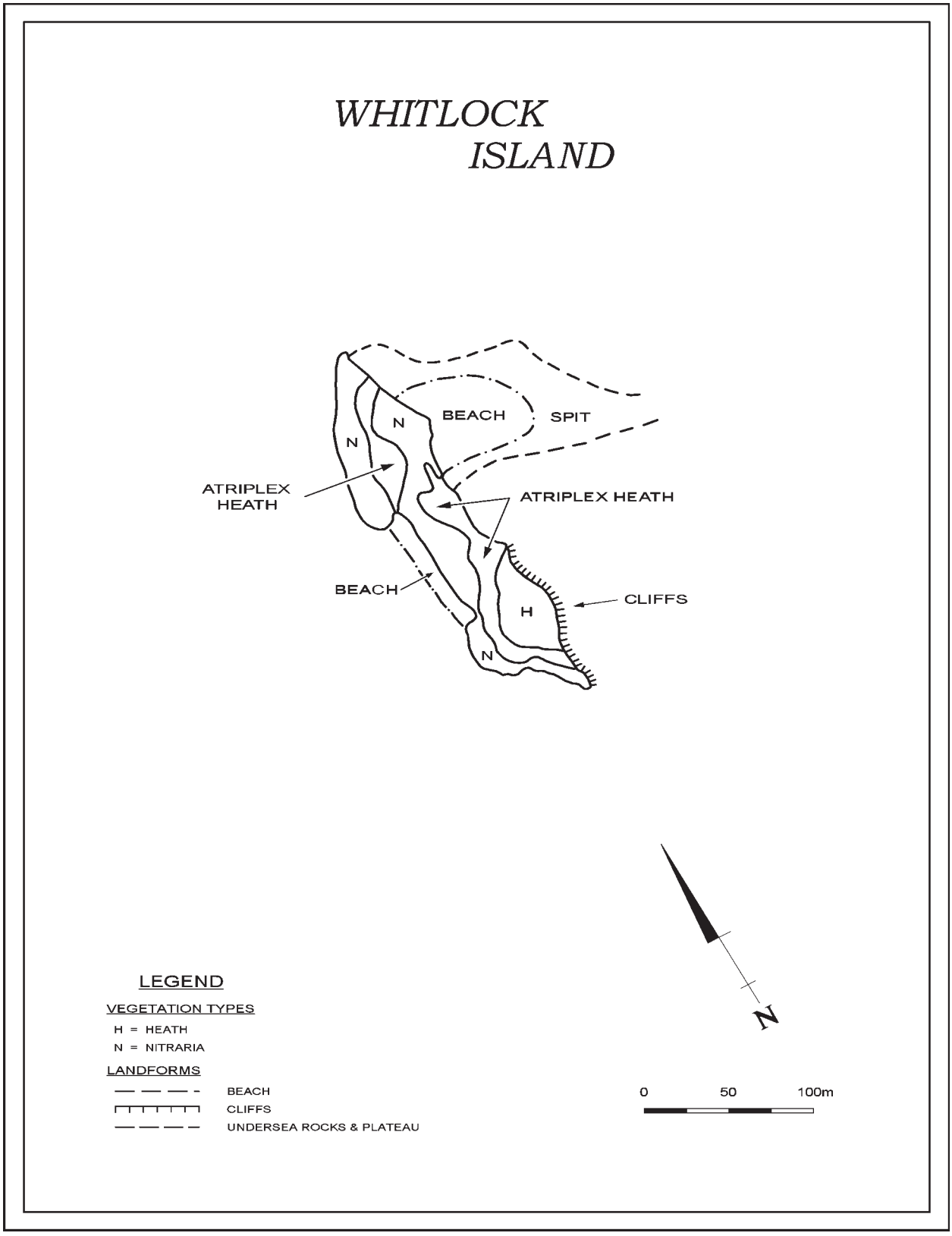

Figure 10. Map of dominant structural vegetation forms for Whitlock Island (in the Boullanger, Whitlock, Favorite, Tern and Osprey Islands Nature Reserve).

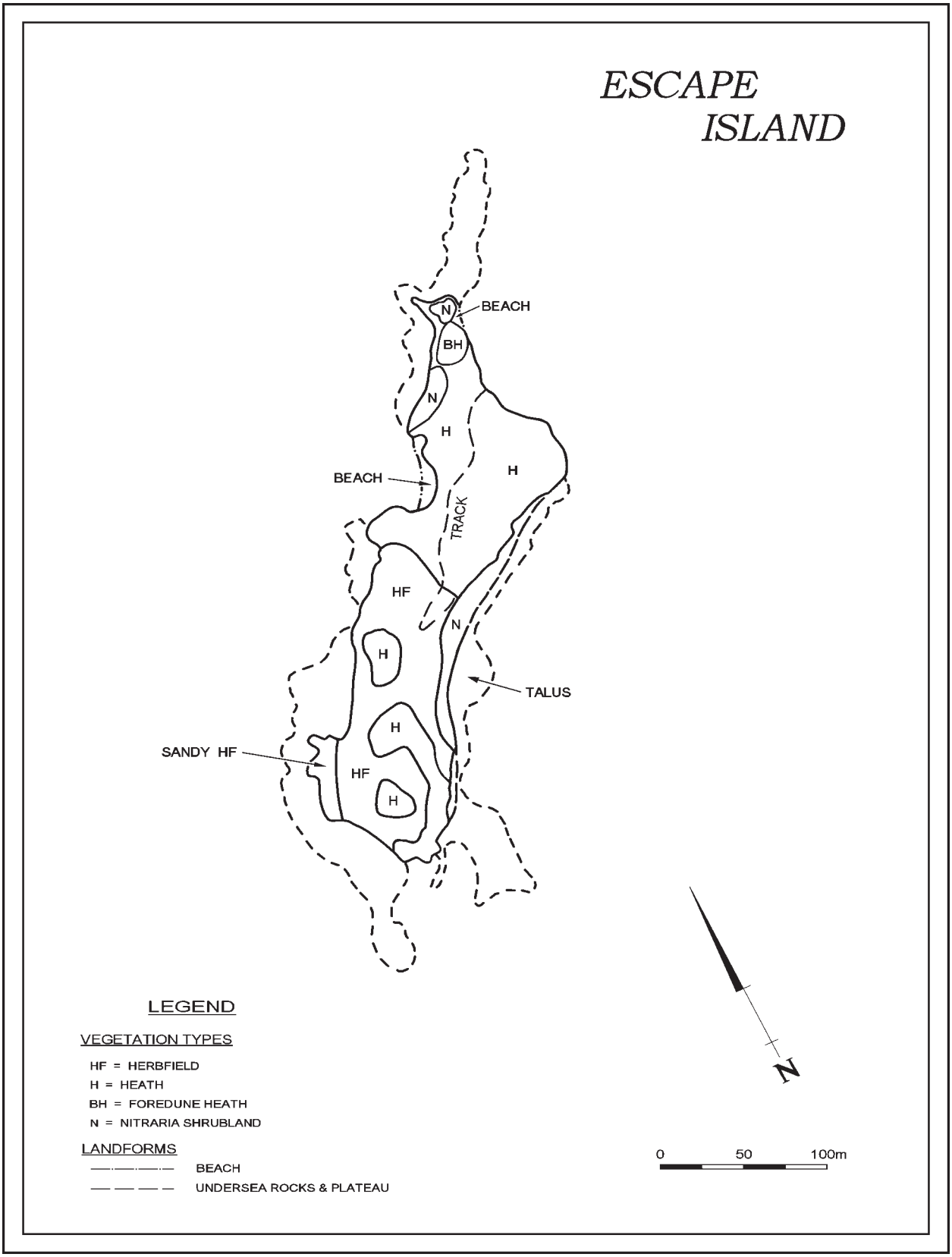

Figure 11. Map of dominant structural vegetation forms for Escape Island (in the Escape Island Nature Reserve).

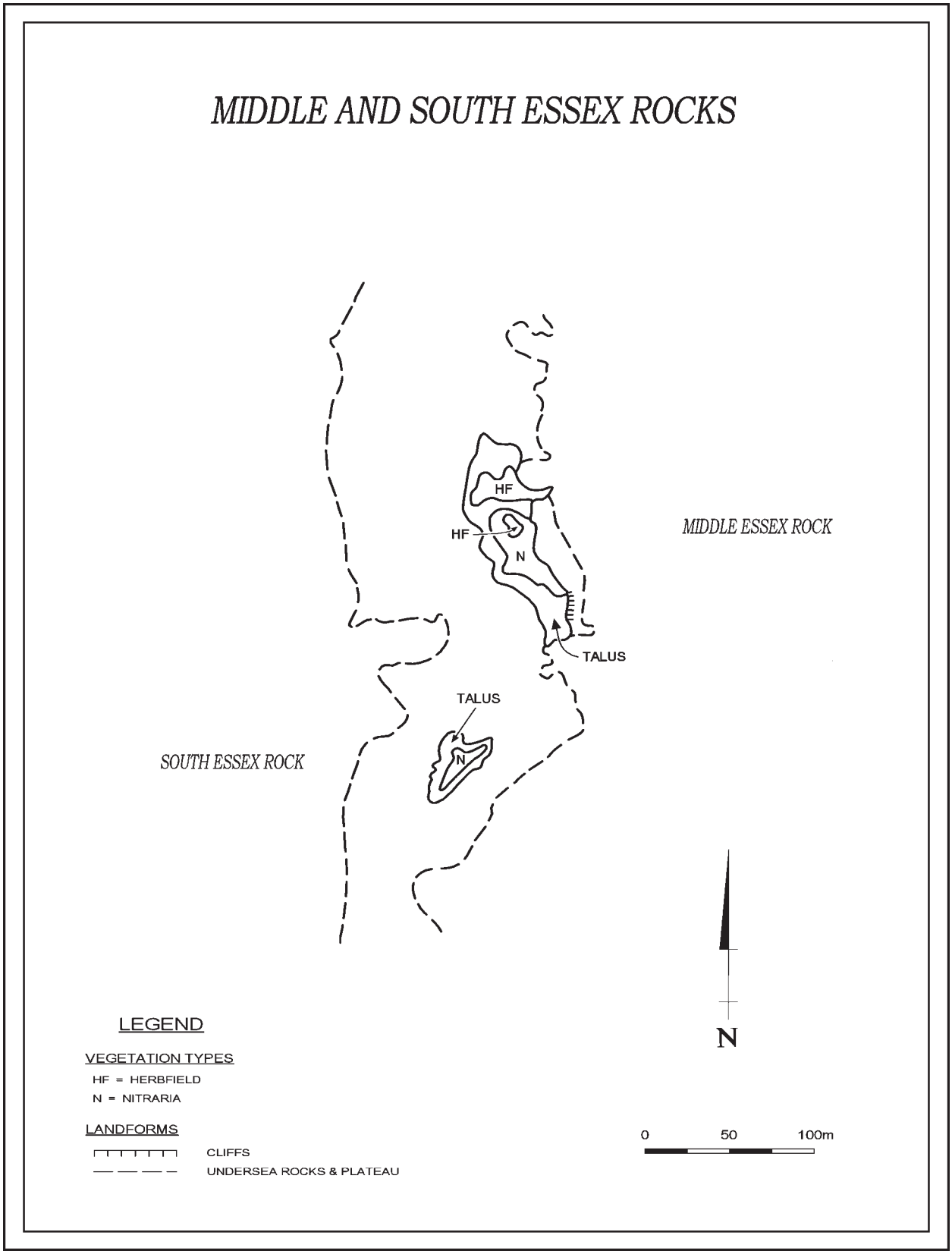

Figure 12. Maps of dominant structural vegetation forms for Middle Essex Rocks and South Essex Rocks (in the Essex Rocks Nature Reserve).

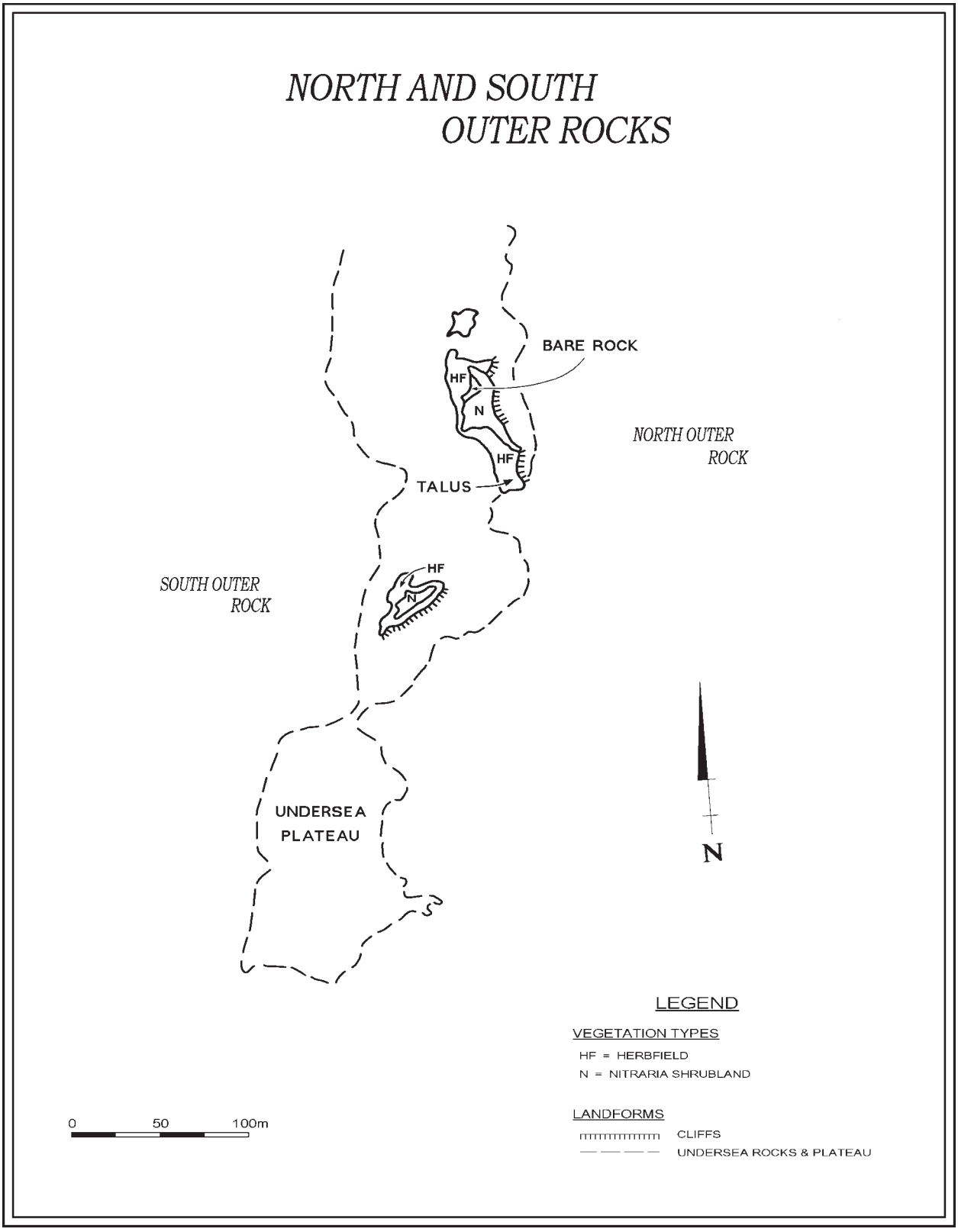

Figure 13. Map of dominant structural vegetation forms for North Outer Rocks and South Outer Rocks (in the Outer Rocks Nature Reserve).

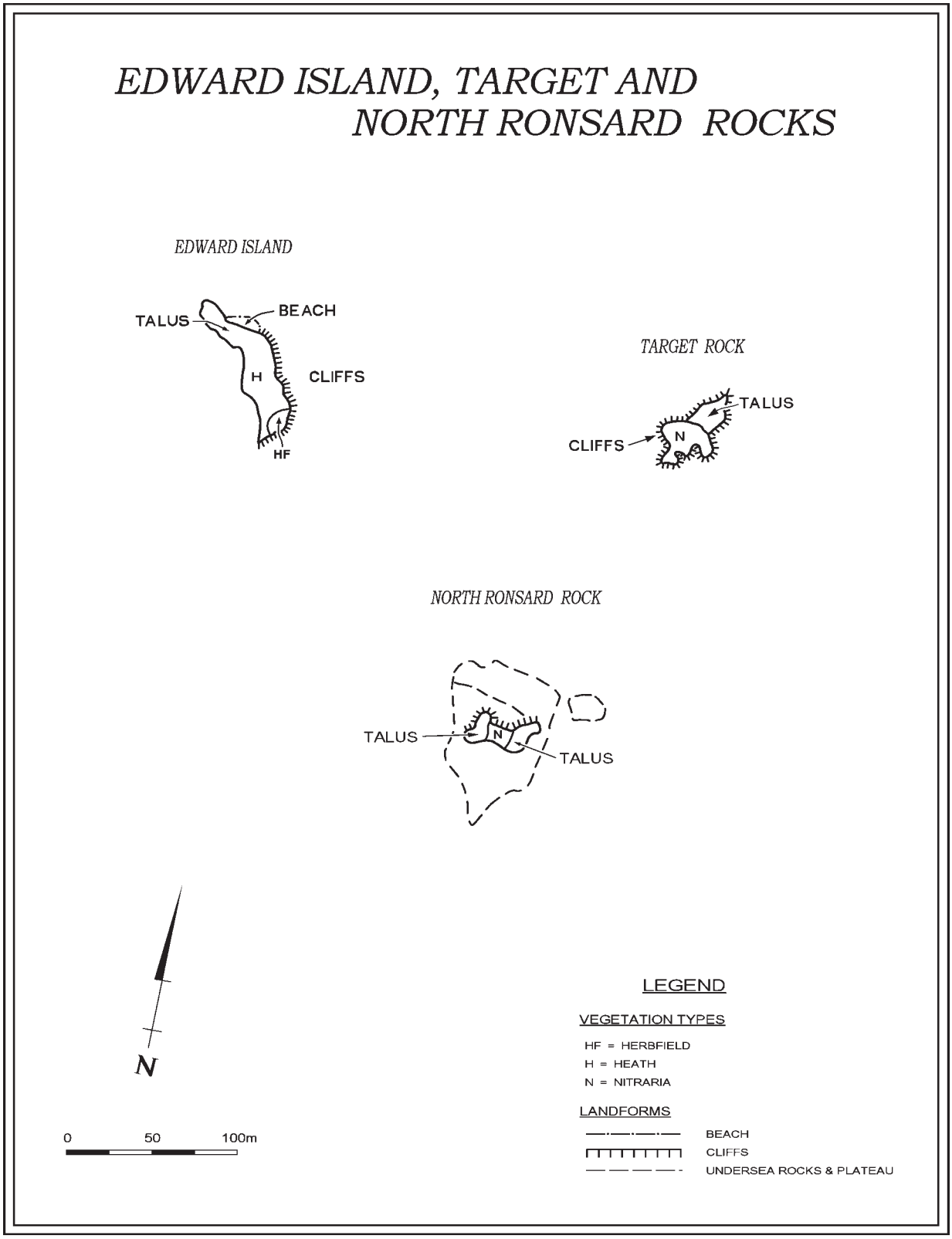

Figure 14. Maps of dominant structural vegetation forms for Edward Island (in the Lancelin and Edward Islands Nature Reserve), Target Rock (in the proposed Target Rock Nature Reserve) and North Ronsard Rocks (in the Ronsard Rocks Nature Reserve).

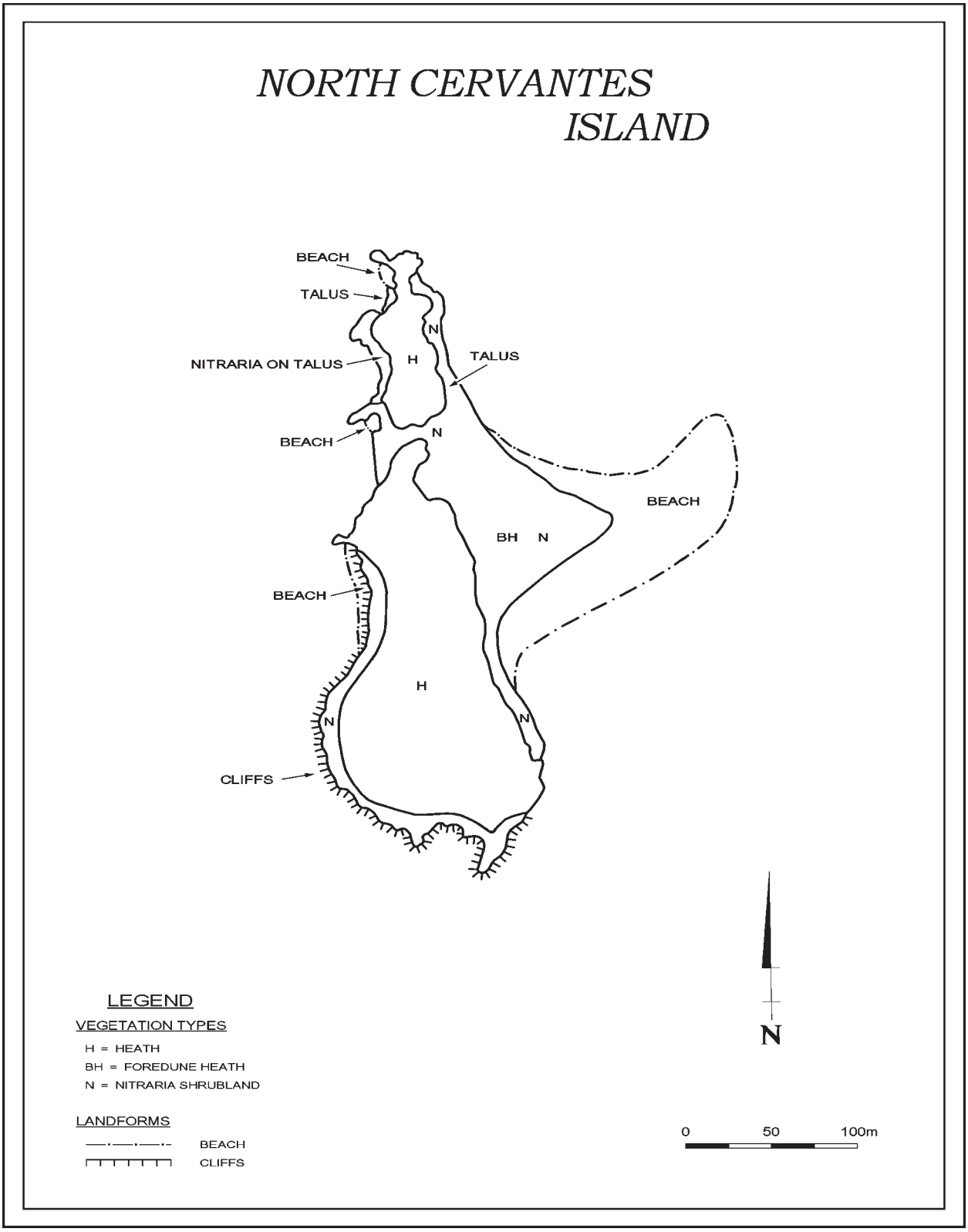

Figure 15. Map of dominant structural vegetation forms for North Cervantes Island (in the Cervantes Islands Nature Reserve).

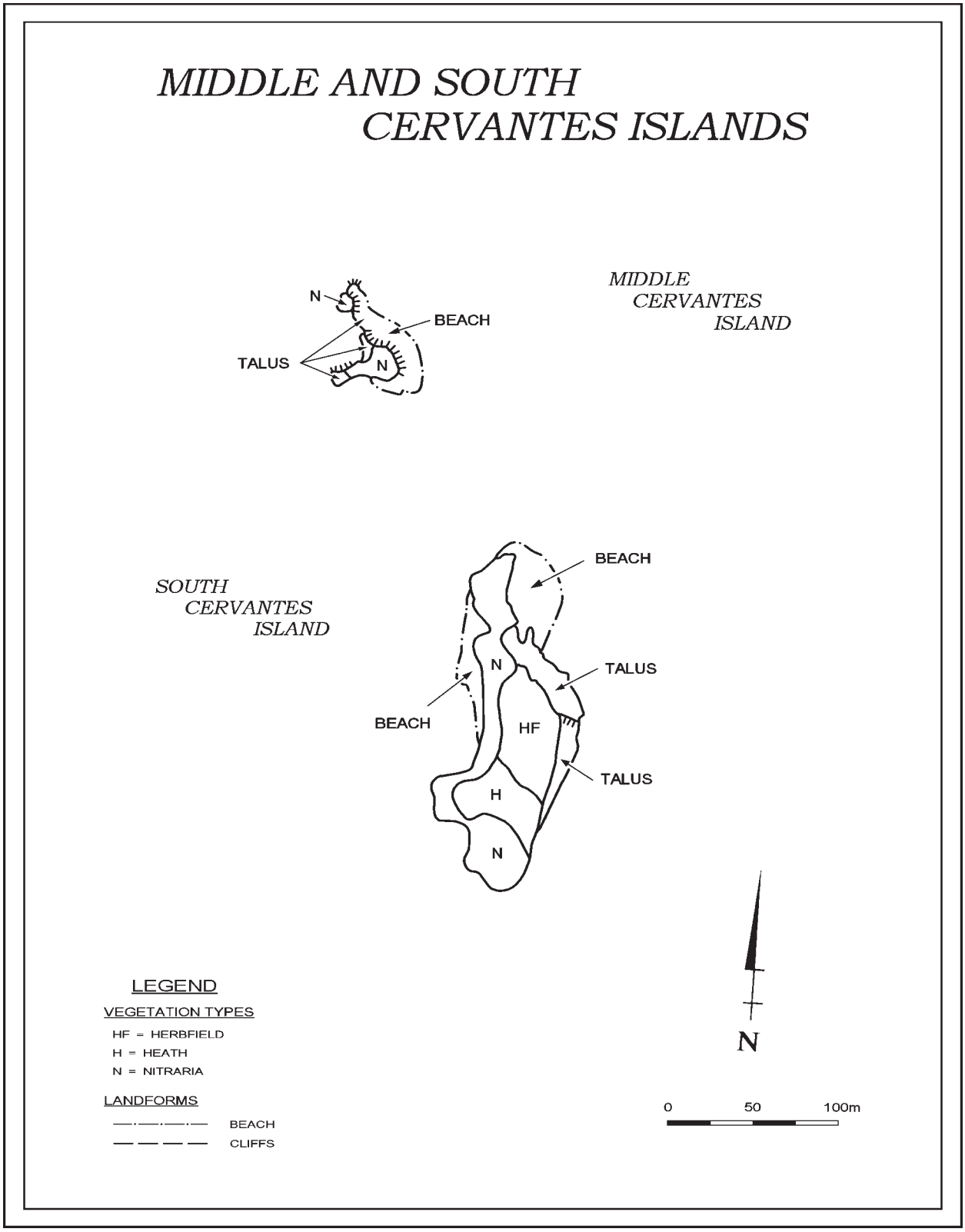

Figure 16. Maps of dominant structural vegetation forms for Middle Cervantes and South Cervantes Islands (Cervantes Islands Nature Reserve).

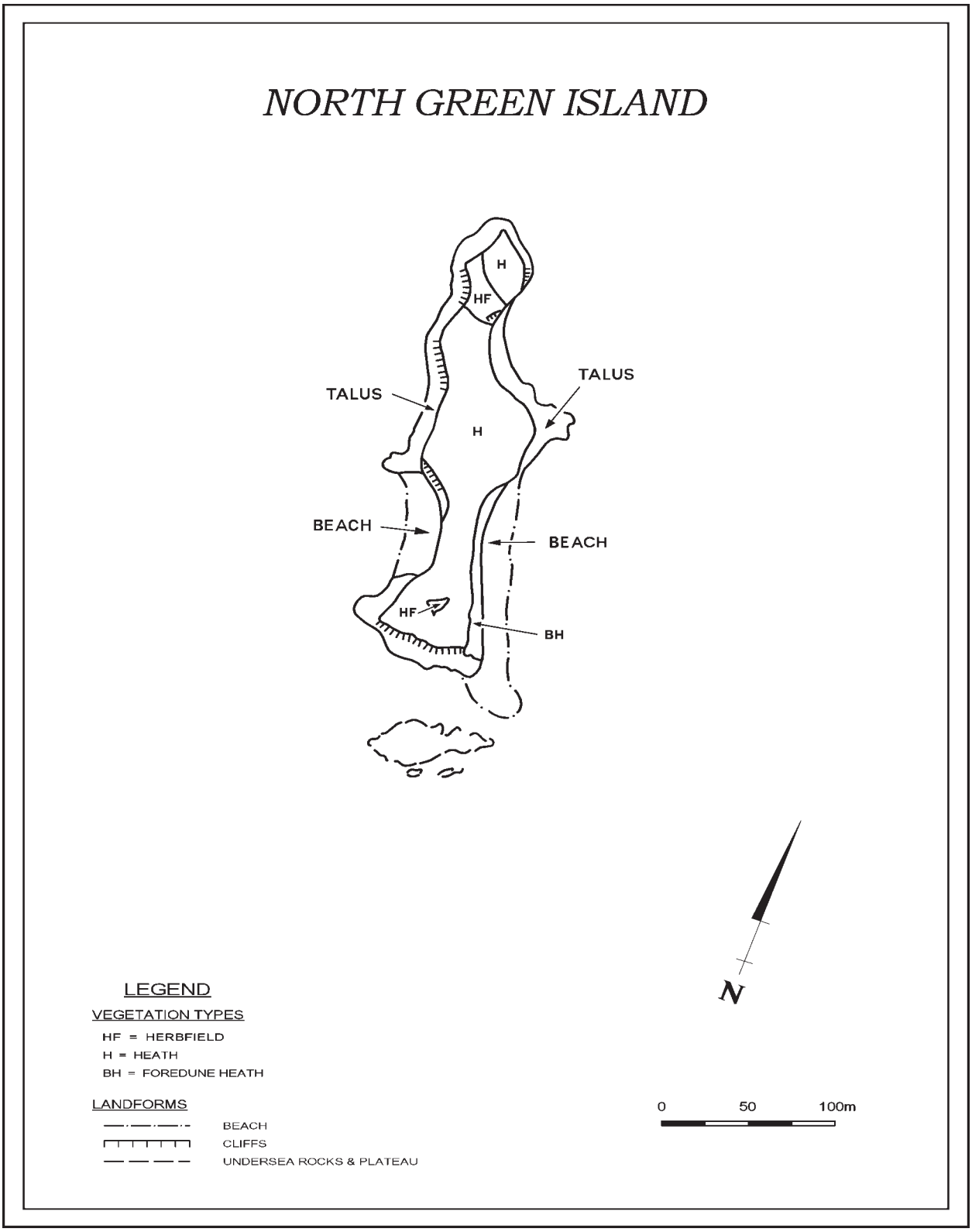

Figure 17. Map of dominant structural vegetation forms for North Green Island (in the Buller, Whittell and Green Islands Nature Reserve).

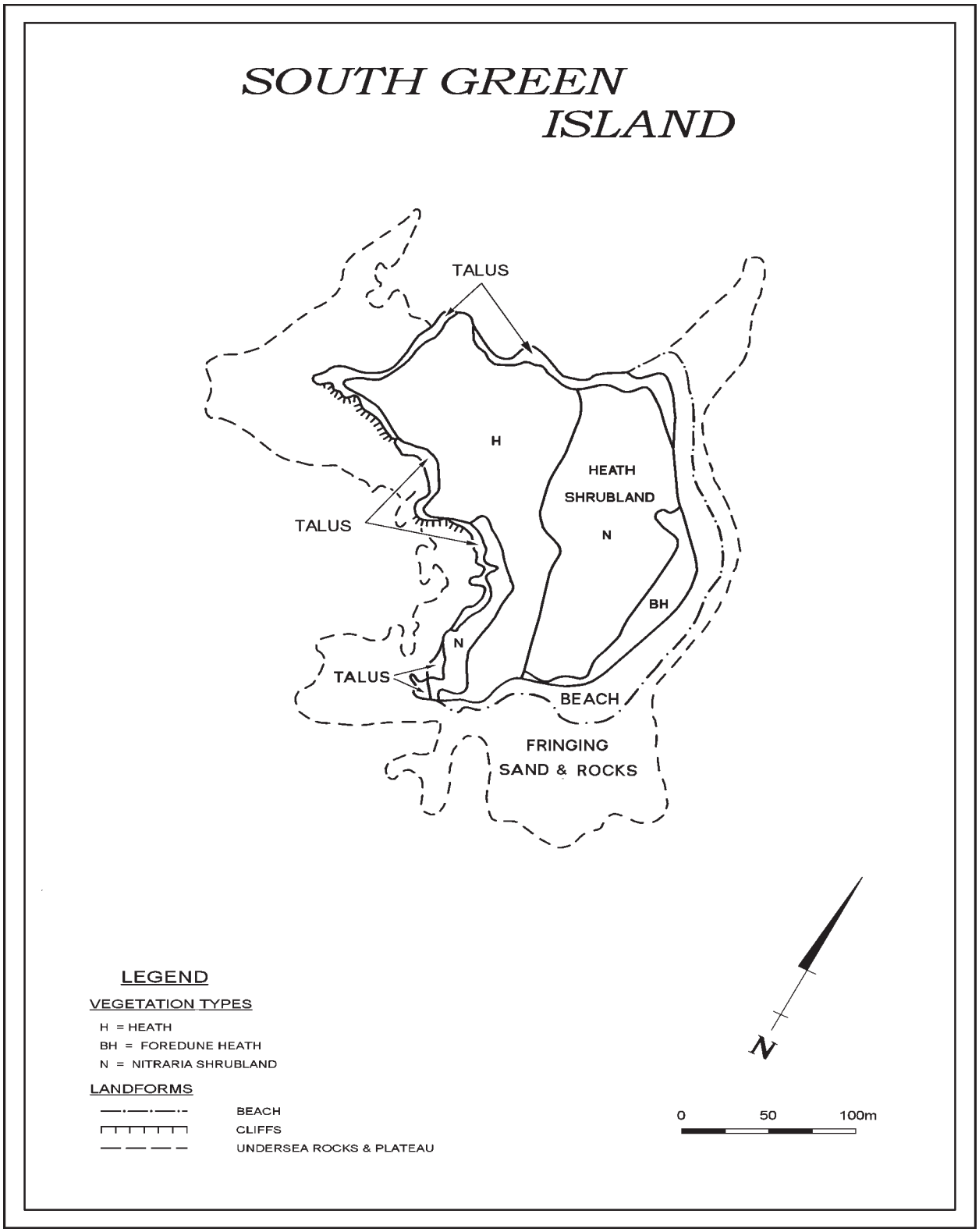

Figure 18. Map of dominant structural vegetation forms for South Green Island (in the Buller, Whittell and Green Islands Nature Reserve).

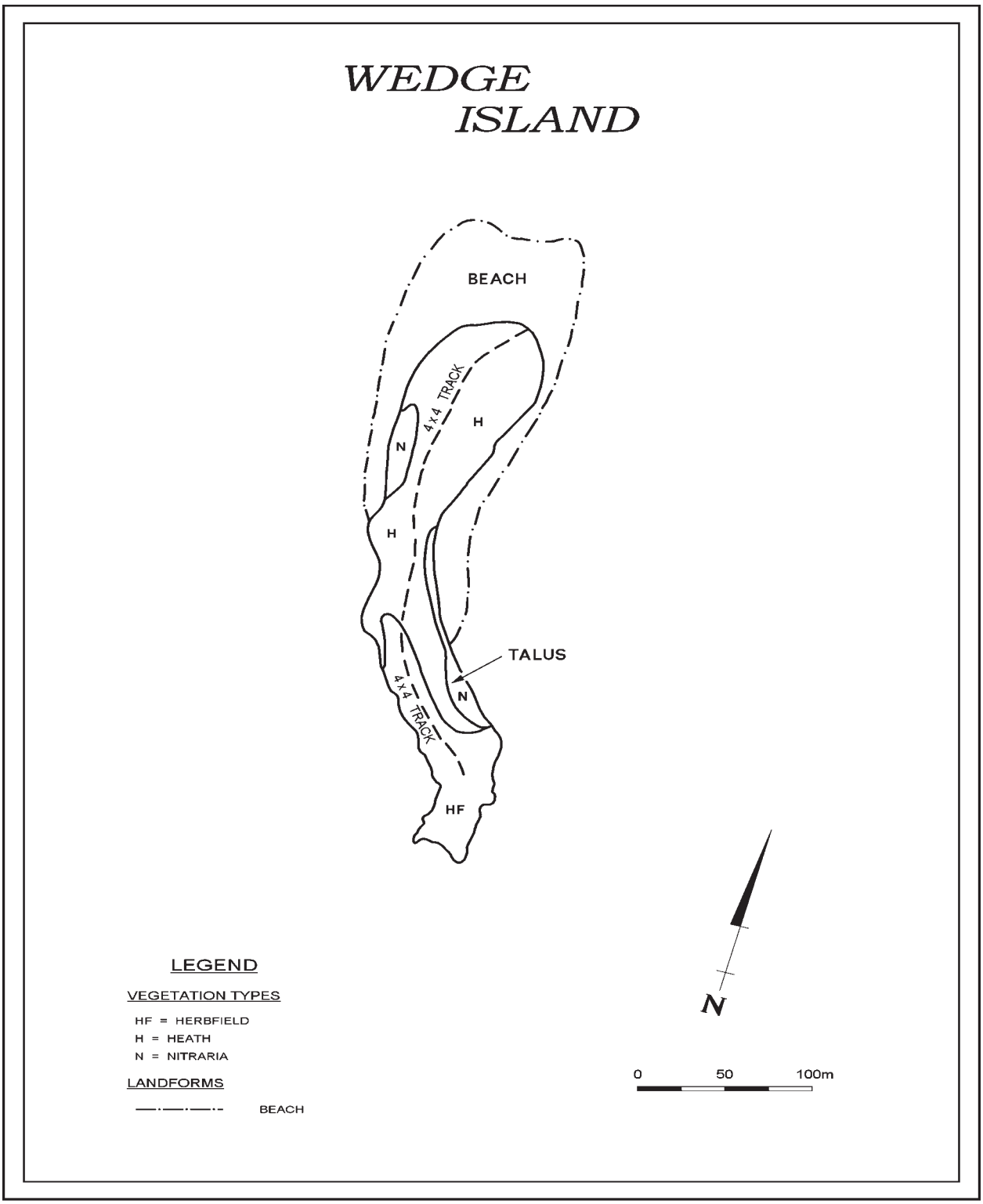

Figure 19. Map of dominant structural vegetation forms for Wedge Island (in the Wedge Island Nature Reserve).

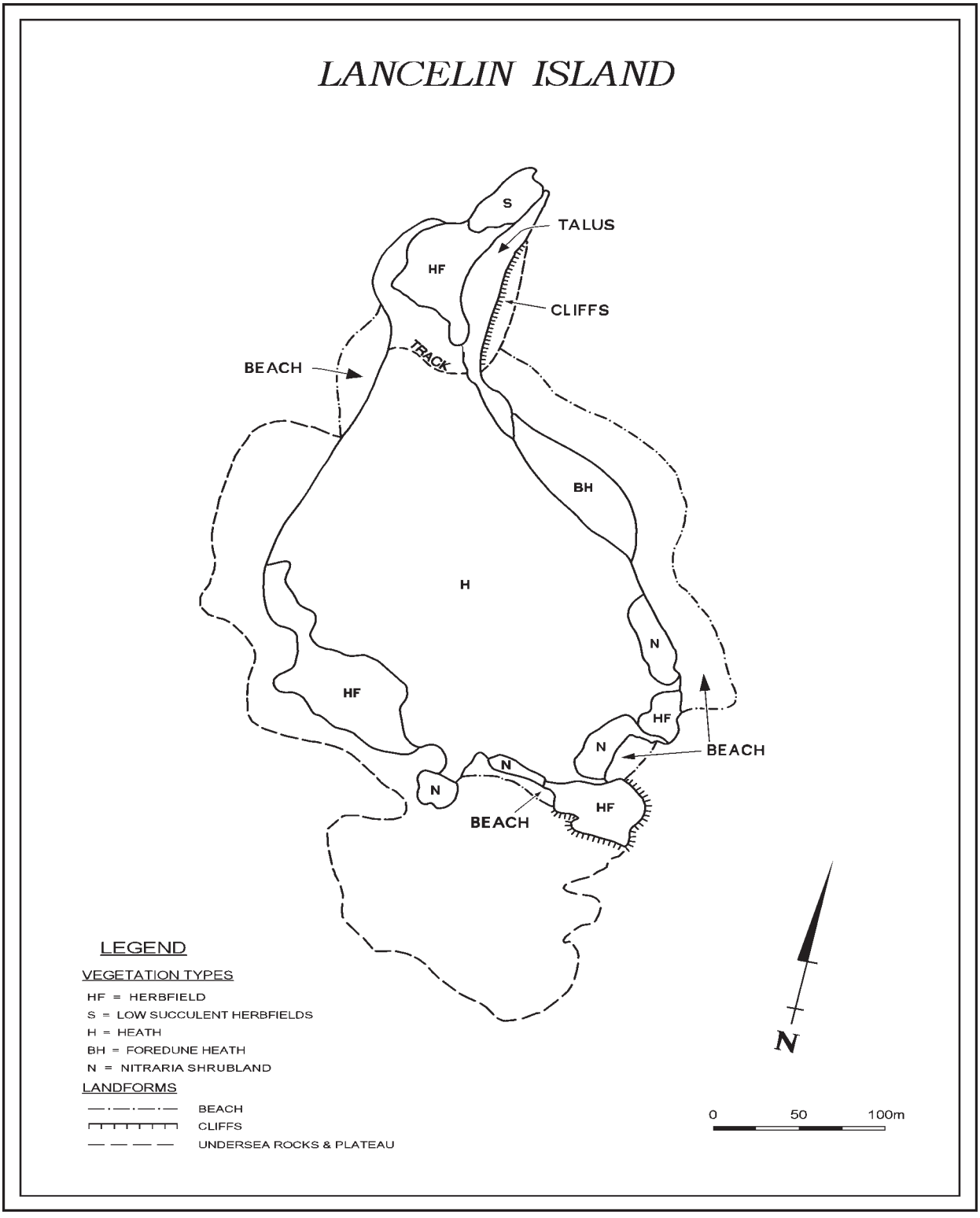

Figure 20. Map of dominant structural vegetation forms for Lancelin Island (in the Lancelin and Edward Islands Nature Reserve).