# Some New South Wales coastal plant distributions: a comparison of herbarium records with transect survey data.

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*Heyligers, P.C. (CSIRO Wildlife and Ecology, P.O. Box 84, Lyneham ACT 2602) 1998. Some New South Wales coastal plant distributions: a comparison of herbarium records with transect survey data.* Cunninghamia *5(3): 645–664.* Some unexpectedly large gaps in the distribution data for herbarium specimens of several coastal dune species were investigated. Whether these gaps were due to 'undercollecting' or whether they reflected a true absence in the intervening areas was questioned. A floristic survey of NSW coastal dunes carried out by Clarke (1989a, b) made it possible to check relevant herbarium records against a set of systematically collected field data. Those for the following species held at Australian herbaria (BRI, CANB, GAUBA, MEL, NE, NSW, SYD and UNSW) were compared with the distributions as recorded by Clarke: *Spinifex sericeus, Calystegia soldanella, Stackhousia spathulata, Chamaesyce psammogeton, Canavalia rosea, Ipomoea pes-caprae, *Cakile edentula, *Cakile maritima, *Hydrocotyle bonariensis, *Arctotheca populifolia, *Gladiolus gueinzii* and **Oenothera drummondii* (* indicates introduced species). It was found that, by and large, the herbarium records were representative of the overall distribution patterns as established by the survey, but that less intensive collecting along the northern half of the coast had left gaps in the herbarium records which, more often than not, were not reflecting the true situation in the field.

## Introduction

Herbarium records were used to analyse the dispersal ecology of introduced coastal dune plants with buoyant propagules along the southern Australian coastline (Heyligers 1983, 1989a, 1993, 1996). If older collection records were separated by large gaps, later collections often filled in such gaps to a greater or lesser degree. However, there also were cases where large gaps remained and I wondered whether this meant continued absence or 'undercollecting' along that particular stretch of coastline.

Everyone who is trying to work out species distributions from 'dot' maps based on collection records is faced by this 'gap' question, one which becomes especially pertinent where management decisions for rare species are involved. Often only additional fieldwork can solve the problem: search the right habitats at the right time and you may come up with the right answer.

By its very nature the coastal dune habitat is a restricted one and could relatively simply be investigated systematically. In 1987 P.J. Clarke carried out just such an investigation along the coast of New South Wales for the Soil Conservation Service: every dune system with a beach front longer than one kilometre was surveyed by means of one or more transects (Clarke 1989a, b; Clarke and Chapman 1989).

This meant a field database of 247 transects was available for comparison with records from herbarium collections.

Twelve species were chosen for making this comparison, six native and six introduced ones. These species combine a variety of characteristics: some are common, others less so; some are widespread, others of more localised occurrence; some are dispersed by water, others by wind; and last but not least, some have more conspicuous flowers than others, which may influence the chance of being collected.

## The species

This section gives general information on the distribution in New South Wales and the means of dispersal of the species chosen for comparing herbarium records with survey results. For introduced species some information has also been provided about the time and probable location of introduction into Australia in general and into New South Wales in particular.

### Native species

*Spinifex sericeus* R.Br. (Poaceae) is a common coloniser of primary dunes in eastern Australia (Heyligers 1988). The female plants produce large infructescences, which are dispersed by wind and secondarily by longshore currents.

*Calystegia soldanella* (L.) R.Br. (Convolvulaceae) grows in New South Wales in sandy and rocky coastal areas (Harden 1990–1993). It has buoyant seeds.

*Chamaesyce psammogeton* (P.S. Green) P.I. Forst. & R.J.F. Hend. (Euphorbiaceae) is endemic to south eastern Queensland, New South Wales and Lord Howe Island (Green 1993). It has long been known by the incorrect name of *Chamaesyce* (or *Euphorbia*) *sparrmanii*. It is uncommon on sand dunes near the sea (Harden 1990–1993). Its seeds are water-dispersed (Benson & McDougall 1995). If seed buoyancy characteristics of the distantly related *Euphorbia paralias* L. are anything to go by (Heyligers 1993), the seeds could remain afloat and viable for several years.

*Stackhousia spathulata* Sieber ex Sprengel (Stackhousiaceae) grows in heath and dry sclerophyll forest in sandy regions, often near beaches and lagoons, widespread in coastal districts (Harden 1990–1993). However, in my experience, it is a species of sporadic occurrence on coastal dunes in New South Wales and is more common along the southern coastline of the continent east of the Great Australian Bight. The fruits are probably only dispersed by wind.

*Canavalia rosea* (Sw.) DC. (Fabaceae) and *Ipomoea pes-caprae* (L.) R.Br. subsp. *brasiliensis* (L.) Oostr. (Convolvulaceae) are tropical to subtropical species which reach their southern distribution limits along the coast of New South Wales. *Canavalia rosea* occurs north from Shellharbour (Harden 1990–1993), *Ipomoea pes-caprae* chiefly north from Port Macquarie, but with some scattered occurrences in the Sydney area (Harden 1990–1993). Both are classic examples of plants with buoyant seeds.

**Introduced species**

*Cakile edentula* (Bigelow) Hook. and *Cakile maritima* Scop. (Brassicaceae) are both strandline pioneers. Their fruits consist of two one-seeded segments. On maturity, the distal segment breaks off and is dispersed by sea, while the lower one remains attached to the senescent plant. The species are difficult to tell apart, especially in the vegetative stage (Heyligers 1989b), and hence were treated as *Cakile* species in Clarke's survey.

It is likely that *Cakile edentula,* a species indigenous to the Atlantic coast of North America, entered Australia on sealers' or whalers' ships from New England, which operated in Bass Strait earlier last century. The first documented occurrences in this part of the world are specimens collected by von Mueller on Phillip Island in 1864. In 1870 Woolls made the first collection in New South Wales at Manly. *Cakile edentula* now occurs all along the New South Wales coast, although since the appearance of *Cakile maritima*, it has become rather rare along the southern half of the coast.

*Cakile maritima*, native to the shores of western Europe and the Mediterranean, was first collected in Australia in 1897 near Perth. In the 1930s it had become well established on beaches in the Adelaide area, from where it spread along the coast of south eastern Australia. The first collection in New South Wales was made in 1968 by Hope and McGillivray at Nadgee, south of Eden, and the second one by McBarron in 1969 near Woy Woy, north of Sydney. It is now common along the southern beaches of the state, while its northern distribution limit is presently near Forster.

*Hydrocotyle bonariensis* Lam. (Apiaceae), native to South America, is a widespread secondary coloniser of coastal dunes in New South Wales, especially common near river and lagoon outlets. It has water-dispersed fruits. The first Australian collection was made in 1893 at Botany Bay by Fletcher. In 1902 he, as well as Hamilton, collected specimens near Manly, while in 1917 the latter reported that 'its range as now known extends northerly to Newcastle, and as far south as Thirroul', about 50 km south of Sydney (Hamilton 1917).

*Arctotheca populifolia* (P. Bergius) Norlindh (Asteraceae) is a strandline and foredune pioneer with buoyant fruits, native to southern Africa (Heyligers 1983). In 1934 it was collected on a sand dune near the sea near Mungo in the Myall Lakes District by a Sydney University Expedition. Rarely locally common, it has spread mainly south and has now reached East Gippsland and Flinders Island. Its spread in a northerly direction has been much slower. In the early 1930s this species also appeared on beaches in southwestern Western Australia. However, the population which ensued from that introduction is distinctly different and now ranges from Geraldton to south eastern South Australia (Heyligers, unpubl. obs.).

*Gladiolus gueinzii* Kunze (Iridacae), native to South Africa, was collected for the first time in Australia by Munro in 1950 at Stockton, just north of Newcastle. Harden (1990–1993) states that it 'grows as a pioneer on fore dunes; between the Macleay River and Currarong', although Heyligers (1989b) had reported it further south, with locations near Narooma and Tathra at the southern extremity of its range. The winged seeds are wind-dispersed, while the buoyant corms are liable to exposure by storm-

tide erosion and subsequent washing away (Heyligers 1989b). Corms kept in seawater may remain viable for well over a year (Heyligers, unpubl. obs.).

*Oenothera drummondii* Hook. (Onagraceae) is native to North America. Its localised occurrence in Western Australia, where it is common in the dunes near Perth, is assumed to be due to its introduction as a garden plant (Smith 1985). In New South Wales it was first collected by P. Michael at Waratah near Newcastle in 1929, which could imply introduction with ballast. Growing on coastal sand, chiefly north from Sydney (Harden 1990–1993), this is a wind-dispersed species.

## Methods

In 1996 information from specimen labels was obtained at the following herbaria which, in combination, were likely to hold a comprehensive set of collections made over time along the coast of New South Wales: the Australian National Herbarium (CANB, CBG), the State Herbarium of Queensland (BRI), the National Herbarium of New South Wales (NSW), the National Herbarium of Victoria (MEL), and the following university herbaria: Australian National University (GAUBA), University of New England (NE), University of Sydney (SYD) and University of New South Wales (UNSW). A breakdown of the number of New South Wales specimens consulted in each of these herbaria is provided in the Appendix.

For most of the native species there were at least some collections dating back to last century, so I thought it could be informative to incorporate a time dimension in the distribution maps. This might reveal whether at some stage collecting could be considered adequate for determining the general distribution of a particular species if not its relative density of occurrence. Three periods were used: before 1900 (h0), 1900 till 1946 (h1), and after 1946 (h2). The choice of the end of the last century as a cut-off date is arbitrary, but 1946 was chosen as the start of the post Second World War period, which heralded an increase of activity in many fields of human endeavour.

For the plotting of the transect survey data, I was generously provided with a reference dataset for the species under consideration. If doubt arose about the correctness of outlying records, the original field data sheets were checked for verification (although this does not preclude field error).

The category maps used for the compilation of the species distribution maps were produced at the Australian National Herbarium using a commercially available MAPINFO program. In the latter the 'before 1900' (h0) category has been plotted on the coastline, whereas the other ones (h1, h2) and the transect information (t) have been shown in rows parallel to the coast. In the case of the two *Cakile* species, the records for *Cakile maritima* have been plotted east of the transect data. The grid at the left gives the co-ordinates for the coastline and the pre-1900 records; that at the right refers to the transect data. In each of the four categories, multiple data from a collection location or a transect have been plotted as a single occurrence.

In the legend of each map the first date in the pre-1900 category refers to the year the first collection in New South Wales was made, while the last date in the post-1946

group indicates the most recent year of collection of an incorporated specimen at the time of my data-gathering in 1996. For introduced species the location of the first collection in New South Wales is indicated by the dot with the date of first collection adjacent to it.

The documentation of the herbarium and survey data used for the map compilations is given in Heyligers (1998).

## Results and discussion

### Native species

*Spinifex sericeus* was recorded from all transects except one. By 1900 there were enough records to indicate its occurrence all along the coast. While collections in the first half of this century were centred around the Sydney area, those from the second half give a fair indication of its local abundance from Port Macquarie to the Victorian border. However, based on transect data, *Spinifex sericeus* is still 'undercollected' along the northern beaches (Fig. 1).

*Calystegia soldanella*, as shown by the transect data, is common along the southern half of the coast, but only of scattered occurrence further north (Fig. 2). This pattern is also evident from the herbarium records, which show a trend over time similar to that of *Spinifex sericeus*.

*Chamaesyce psammogeton* occurs sporadically north from Ulladulla, a pattern well supported by the herbarium records (Fig. 3). As for the previous two species, collecting between 1900 and 1946 has been done mainly around Sydney. However, since 1946 it seems to have disappeared from this area. It has recently been listed as an endangered species under the NSW Threatened Species Conservation Act.

*Stackhousia spathulata* has a general distribution similar to that of *Chamaesyce psammogeton* but, as both herbarium and transect records show, is of even sparser occurrence and since 1946 has virtually disappeared from the coast between Coffs Harbour and Forster (Fig. 4). More recently, it has also become rare in the Sydney area. Due to this scattered occurrence Carolin & Clarke (1991) conclude: 'It is probably a species under threat because it occurs in small isolated populations.'

Although *Canavalia rosea* was already mentioned (and eaten) by John White, Surgeon-General to the First Fleet (Chisholm 1962), there are only a few collections of this species from last century (Fig. 5). (These include two made by Woolls, both without date. For these, 1870 was used as an approximation.) As Hamilton (1917), in his extensive review of the coastal flora of Sydney, makes no mention of *Canavalia rosea*, it is possible that the species had become locally rare due to its use as a vegetable. The collections made since 1946 show a decrease in number with increasing latitude. This correlates well with the results of the transect survey and is indicative of the sporadic and possibly temporary occurrences of this species towards the southern end of its distribution.

*Ipomoea pes-caprae*, as shown by the transect data, is common north from Seal Rocks but occasional south from there to Newcastle (Fig. 6). This pattern also emerged from the rather sparse herbarium record. The isolated southern collections were made at Jibbon Beach, Port Hacking, between 1947 and 1963.

### Introduced species

As indicated by the results of the transect survey one or the other, or both, of *Cakile edentula* and *Cakile maritima* can now be found along almost every beach in New South Wales (Fig. 7). However, collecting has not kept up with the northward spread of these species. While *Cakile edentula* has already spread far into Queensland (Heyligers 1996), the herbarium record suggests it to be still absent from most of the northern coast of New South Wales. Similarly, although the record of *Cakile maritima* from Forster is a true indication of its northern limit in the early 1990s, my own field work has shown it to be present in the large gap south from there.

*Hydrocotyle bonariensis* is now present along the entire New South Wales coast. Its greater frequency of occurrence in the central part of this range could be due to a continuing spread from the initial locus of introduction, a presumption fairly well supported by the general pattern emerging from the herbarium records (Fig. 8). But, as for *Cakile edentula*, the large gaps between the more recent herbarium records from the northern coastline do not adequately represent the present distribution.

*Arctotheca populifolia* presently occurs south from Smoky Cape with varying abundance but is rare south from Narooma (Fig. 9). This pattern is rather well represented by herbarium records although the paucity of collections north from Forster does not correlate with the high frequency of occurrence in the field.

*Gladiolus gueinzii* has a similar distribution to *Arctotheca populifolia*, but its occurrences are more frequent (Fig. 10). Except for a gap in the Ulladulla area, it is reasonably well represented by herbarium collections.

The scattered herbarium records of *Oenothera drummondii* are remarkably well confirmed by the results of the transect survey (Fig. 11).

## Conclusions

From an overall perspective and depending on the species under consideration, the herbarium records were generally representative of the overall distribution patterns as established by the transect survey. It is also clear that collecting along the northern half of the coast has been less intensive than along the southern. This has left gaps in the records which, especially in the case of more common species, do not reflect the real situation.

The following more general conclusions about the applicability of the results should be viewed with some caution because of the small sample size:

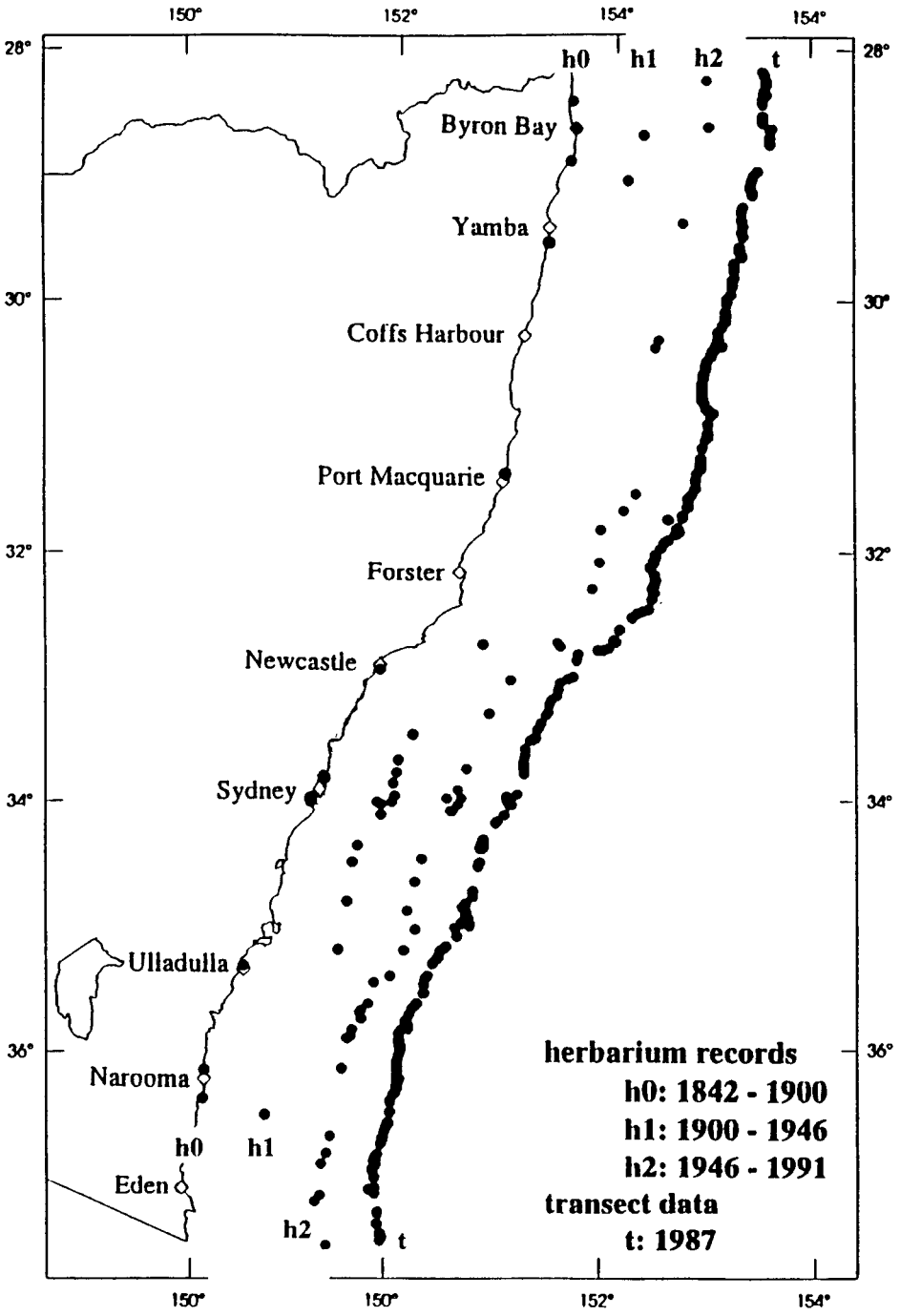


**Fig. 1.** Distribution of *Spinifex sericeus*.

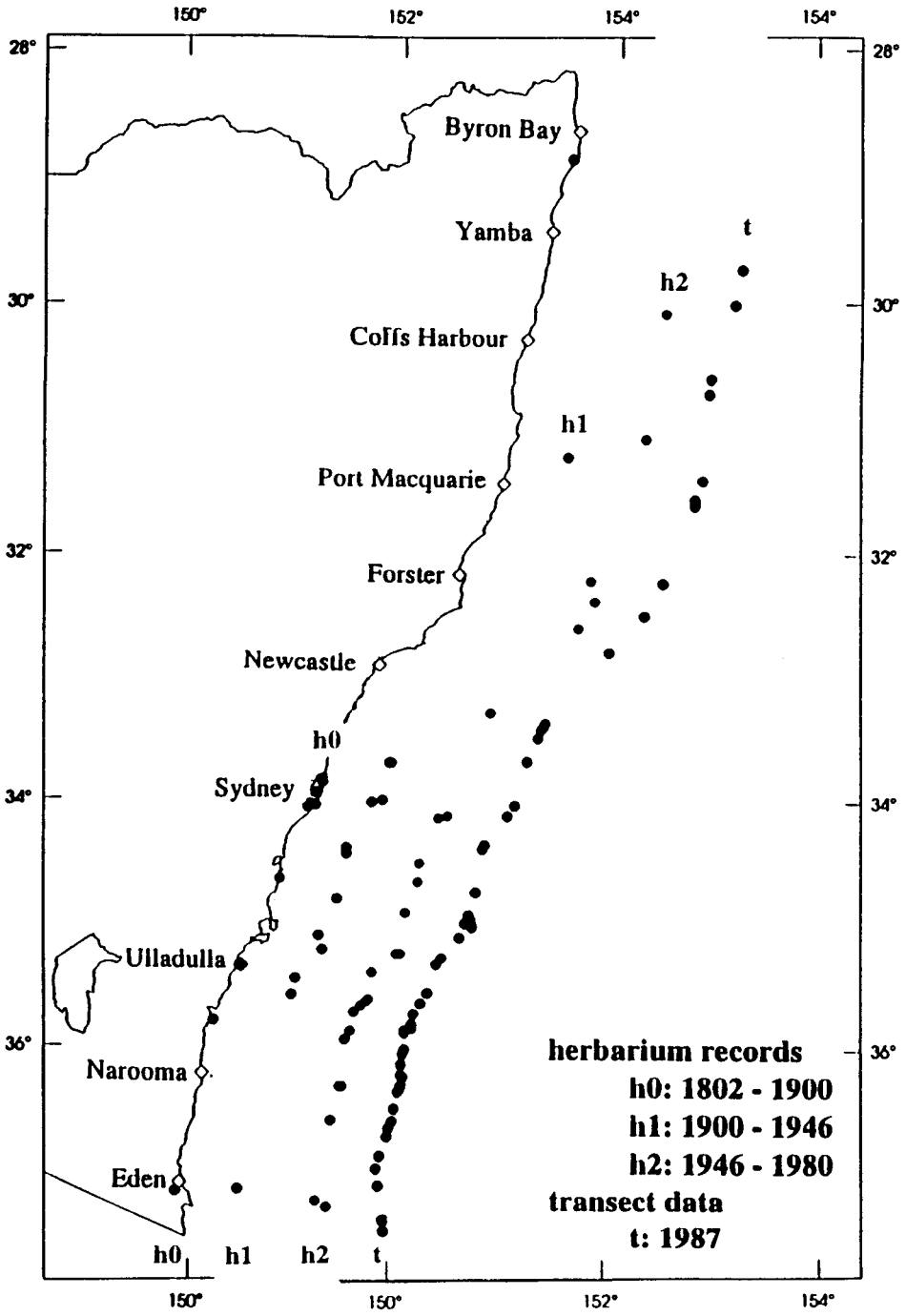


**Fig. 2.** Distribution of *Calystegia soldanella.*

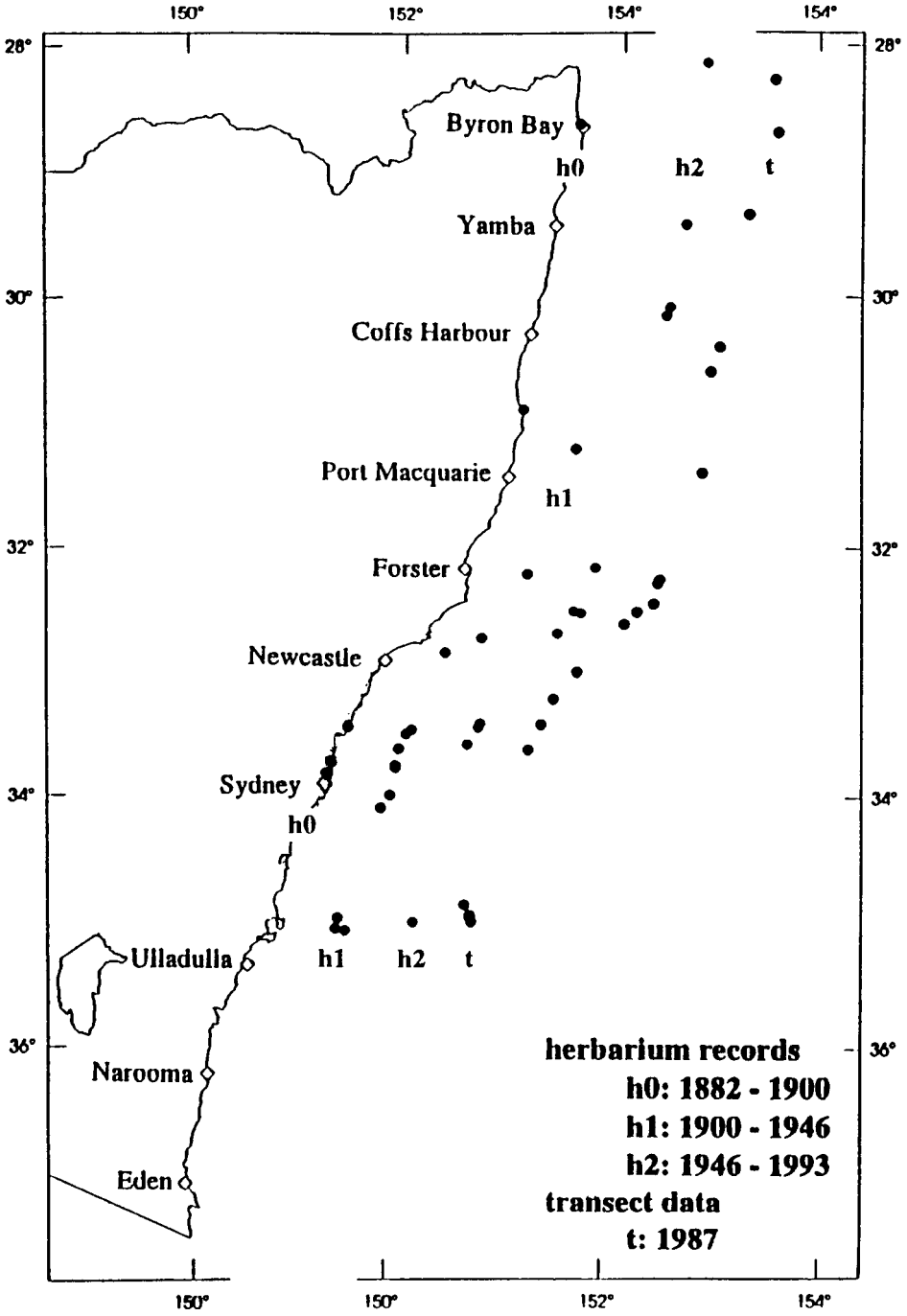


**Fig. 3.** Distribution of *Chamaesyce psammogeton*.

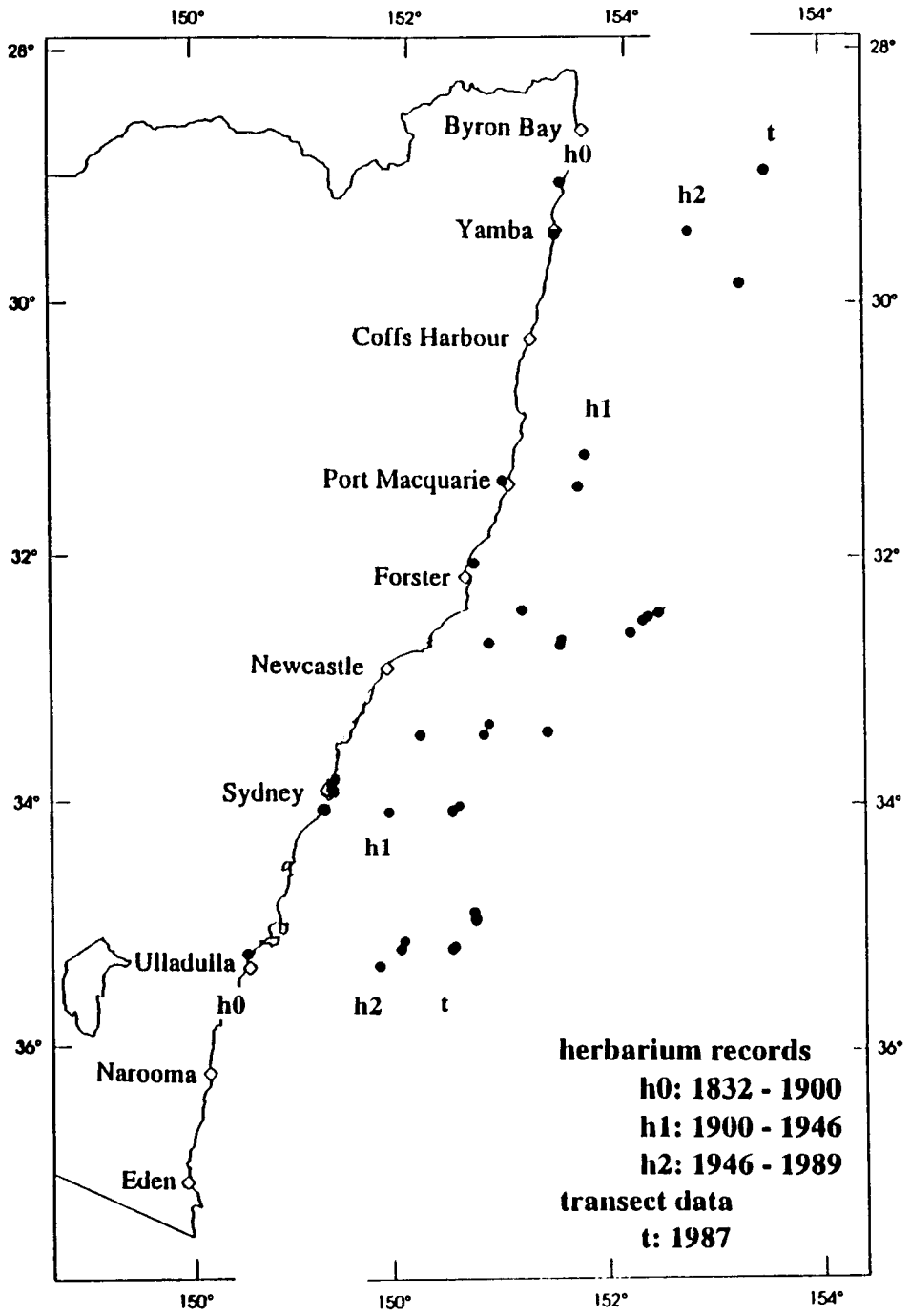


**Fig. 4.** Distribution of *Stackhousia spathulata.*

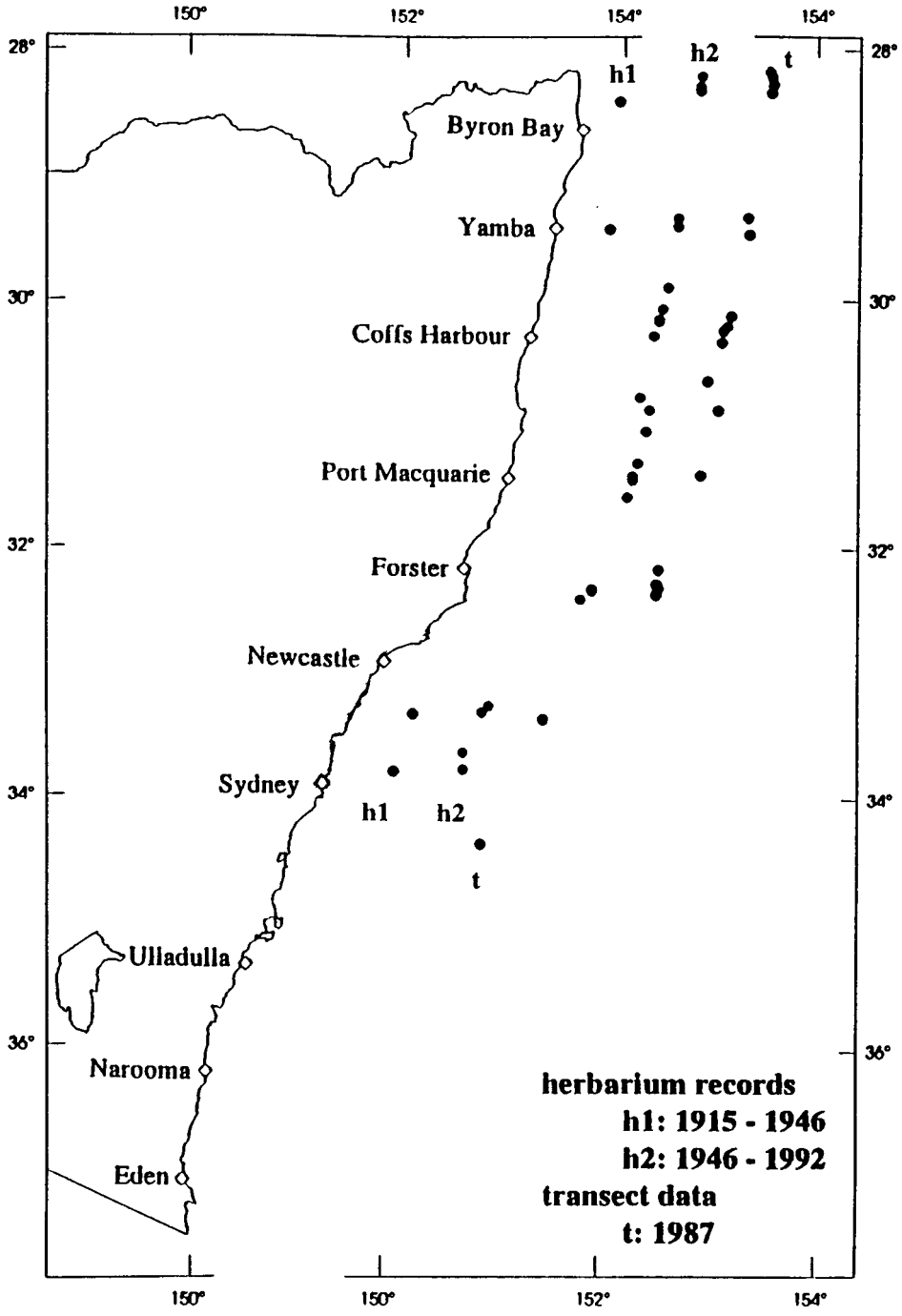


**Fig. 5.** Distribution of *Canavalia rosea*.

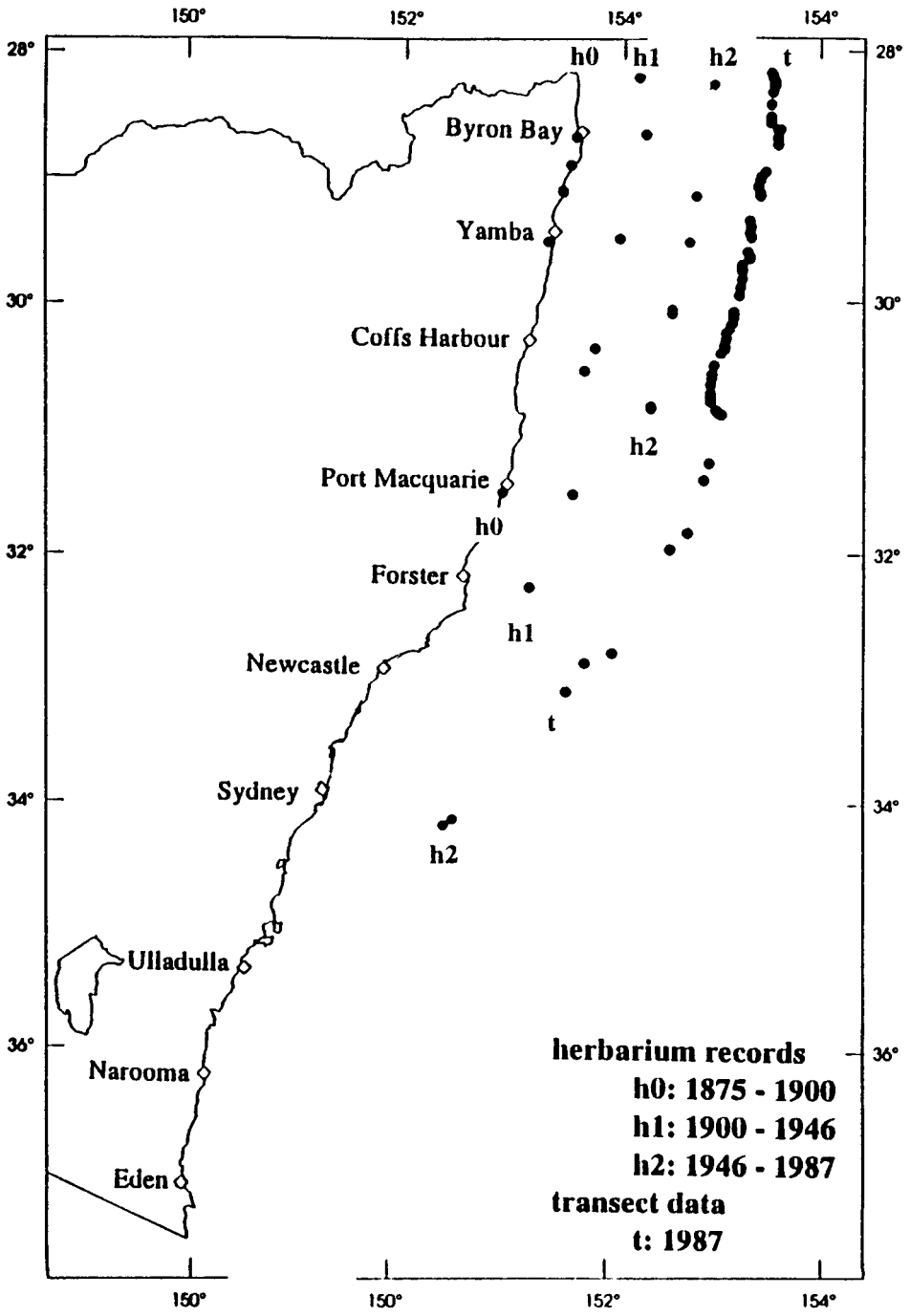


**Fig. 6.** Distribution of *Ipomoea pes-caprae*.

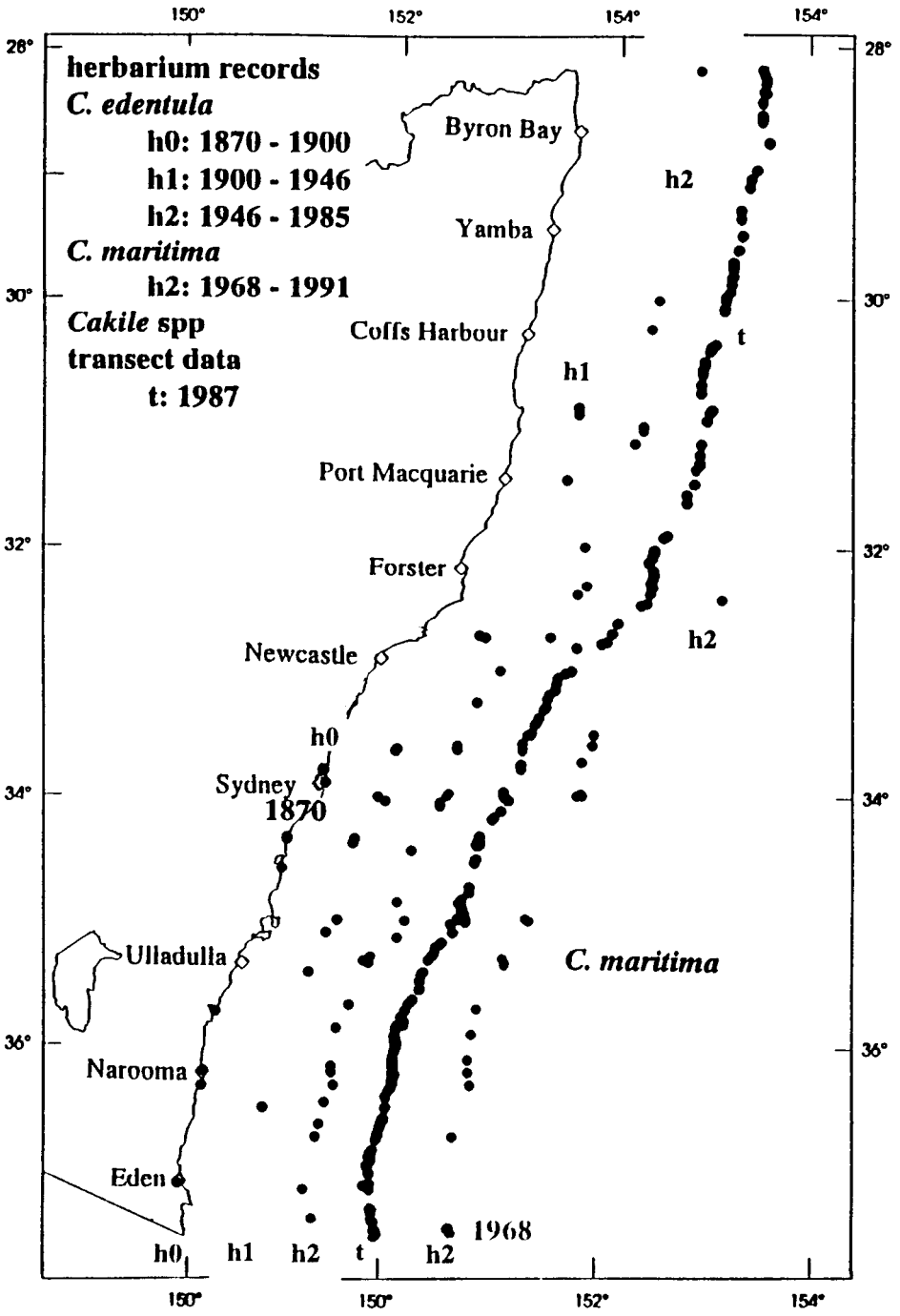


**Fig. 7.** Distribution of *Cakile edentula, Cakile maritima.*

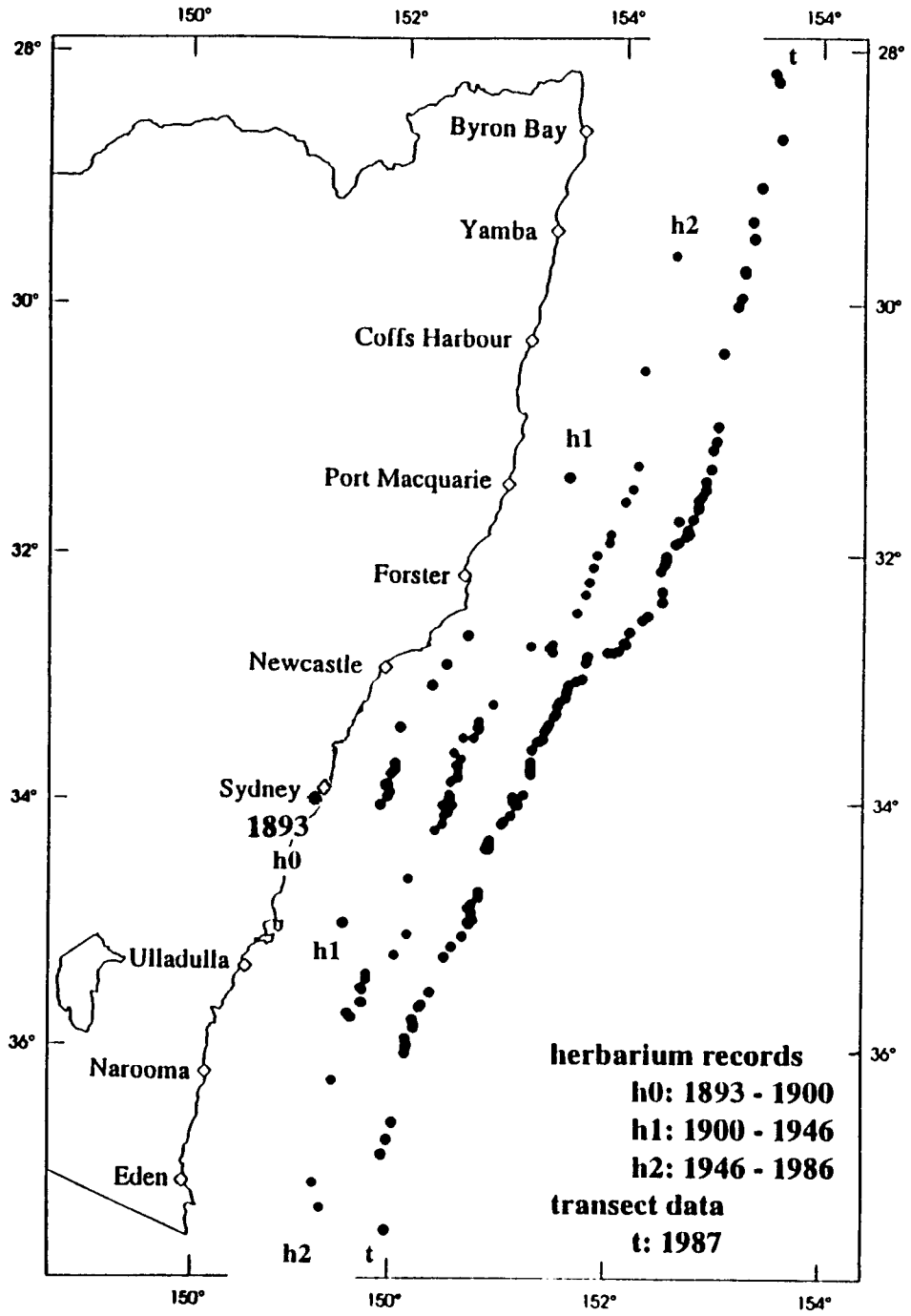


**Fig. 8.** Distribution of *Hydrocotyle bonariensis*.

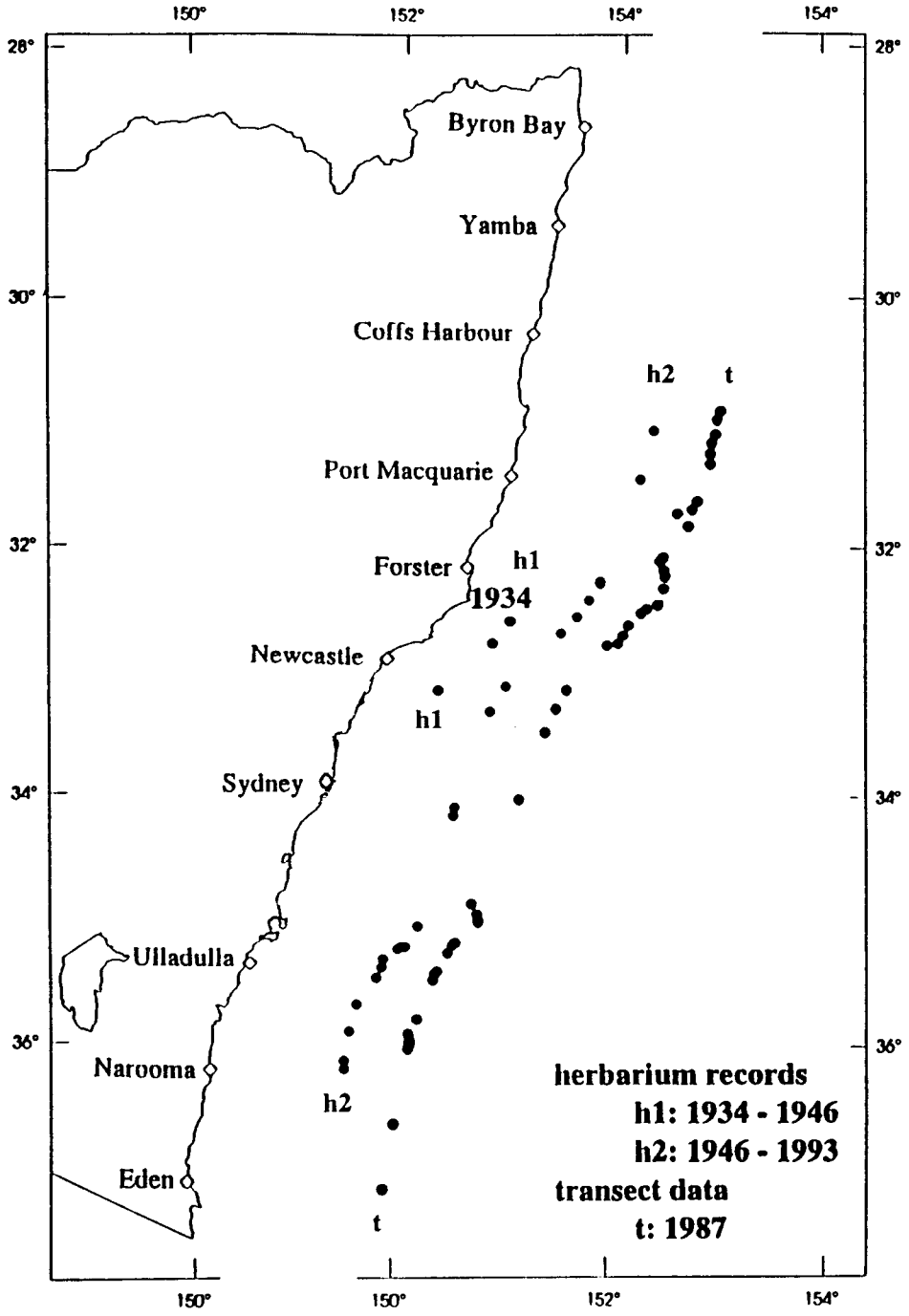


**Fig. 9.** Distribution of *Arctotheca populifolia*.

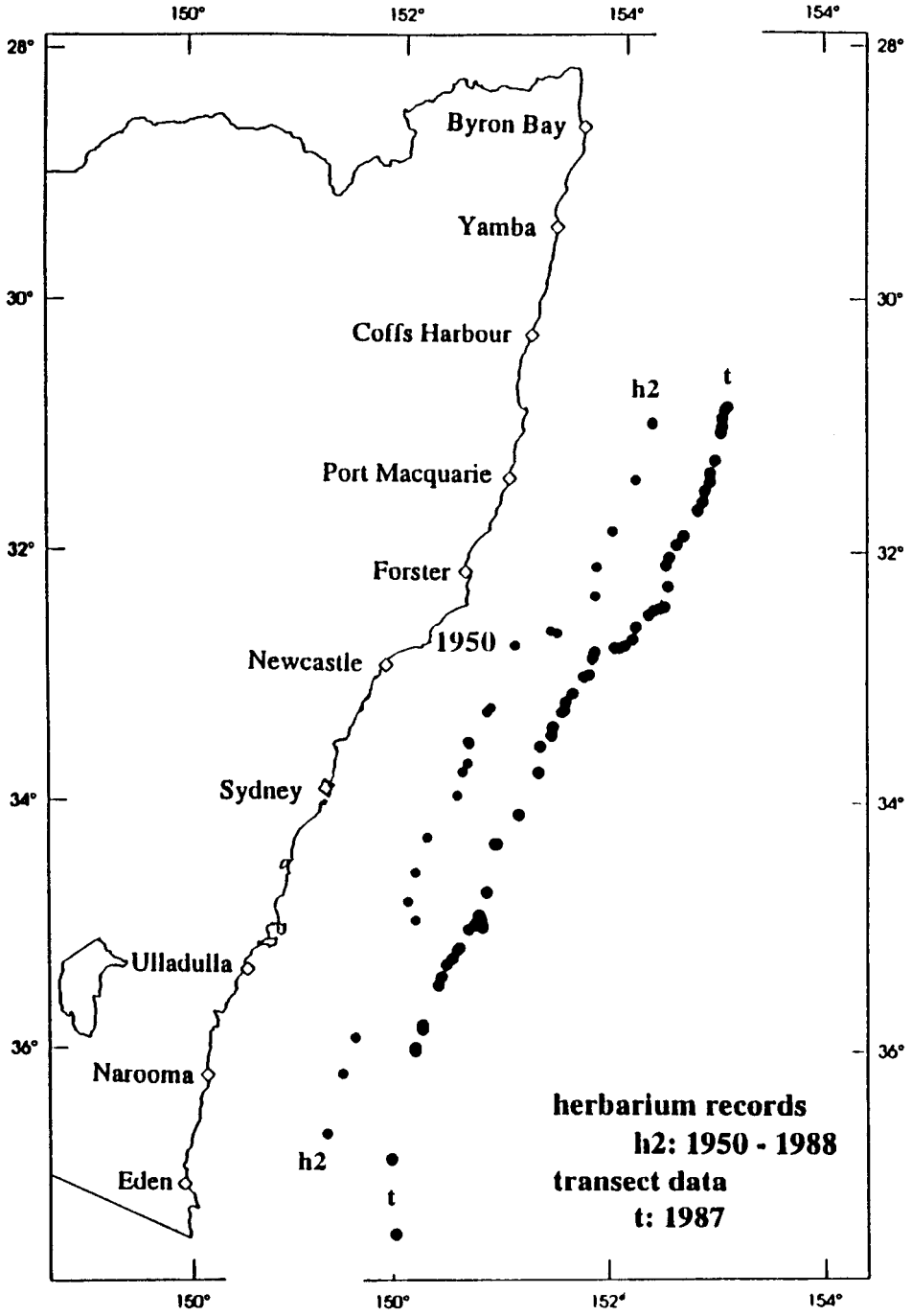


**Fig. 10.** Distribution of *Gladiolus gueinzii.*

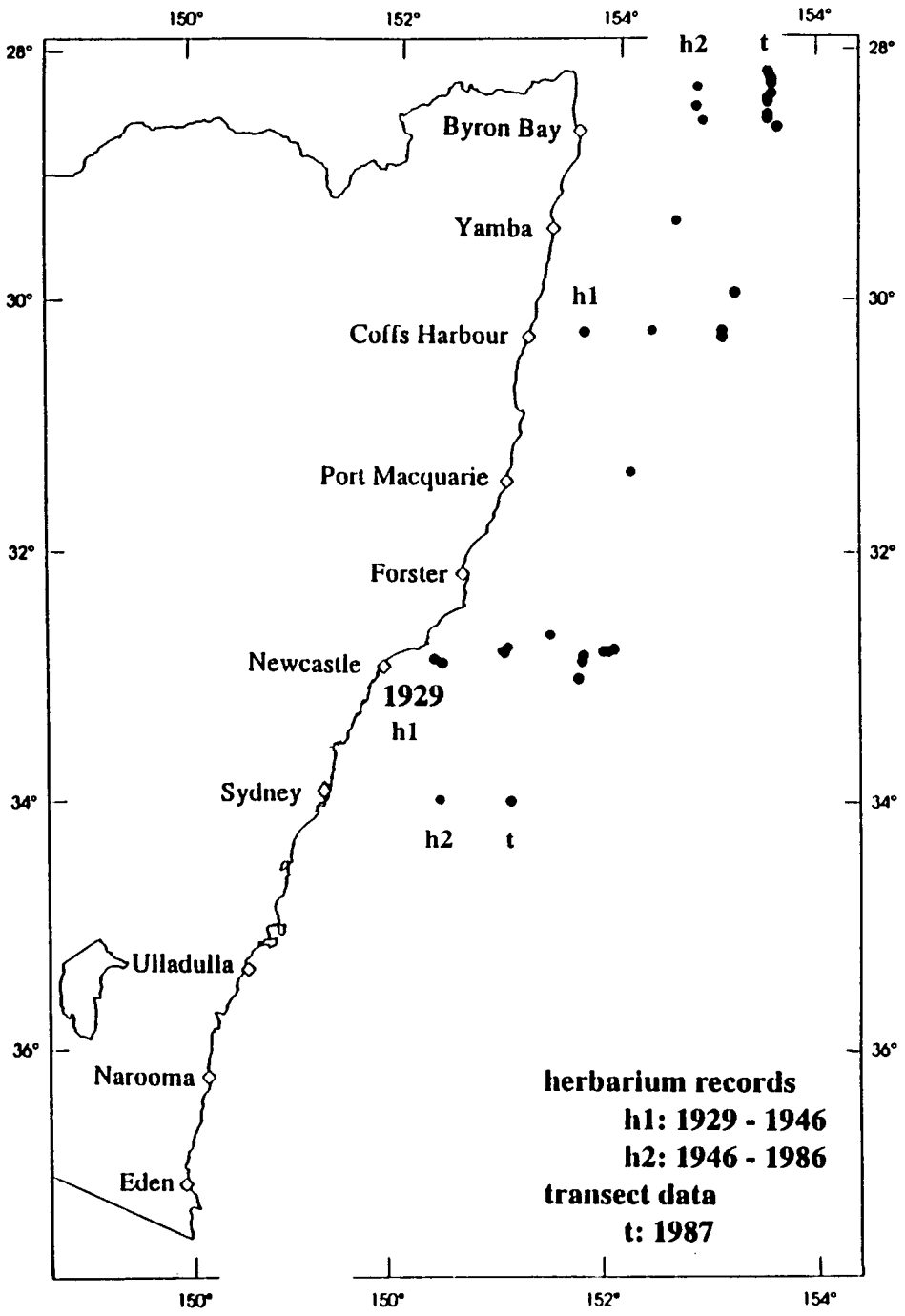


**Fig. 11.** Distribution of *Oenthera drummondii.*

Contrary to what one would like to assume, even for widespread and common species (like *Spinifex sericeus*) the herbarium records may give incomplete coverage of distribution in the field.

If one looks at less common but nevertheless widespread species (like *Chamaesyce psammogeton* and *Stackhousia spathulata*) one has no a priori means to judge the adequacy of the herbarium record, nor is one to know whether absence of recent collections from an area where the species had been collected before means disappearance from that particular location or whether there just have not been further collecting activities.

Obviously, systematic surveys provide invaluable information; however, if at all feasible, voucher specimens should be collected (and deposited in an herbarium) where any doubt arises about identity (as in the case of *Cakile*) or where occurrences appear to be out of normal range. A well-annotated herbarium specimen is a priceless record that appreciates in value as time goes by!

To end with the major conclusion from my comparisons: If one wants to be sure that a gap exists, than there is no escape from actual checking in the field.

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Herbaria are treasure chests of information. I thank Heads, Curators and staff of BRI, CANB, GAUBA, MEL, NE, NSW, SYD and UNSW for again allowing me to have a glimpse at the treasures under their care. To Dr P.J. Clarke (University of New England) I am much obliged for permitting the use of his data, to Dr D.M. Chapman (University of Sydney) for prying these out of the database, and to P.A. Hohnen (CANB) for transforming my compilations into visual reality.

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**Appendix 1. Number of collections from New South Wales consulted in each of the herbaria for the compilation of the maps.**

In the following table the raw number of collections inspected in each herbarium is given; that is to say, duplicates have usually been included as well. Thus the totals given at the bottom of the table are somewhat larger than the number of records actually used. The last row gives the number of transects on which a particular species was recorded.

The species names have been abbreviated as follows:

| | | | |
|---|---|---|---|
| **Spin** | *Spinifex sericeus* | **C. ed** | *Cakile edentula* |
| **Caly** | *Calystegia soldanella* | **C. ma** | *Cakile maritima* |
| **Cham** | *Chamaesyce psammogeton* | **Hydr** | *Hydrocotyle bonariensis* |
| **Stac** | *Stackhousia spathulata* | **Arct** | *Arctotheca populifolia* |
| **Cana** | *Canavalia rosea* | **Oeno** | *Oenothera drummondii* |
| **Ipom** | *Ipomoea pes-caprae* | **Glad** | *Gladiolus gueinzii* |

| | **Spin** | **Caly** | **Cham** | **Stac** | **Cana** | **Ipom** | **C. ed** | **C. ma** | **Hydr** | **Arct** | **Oeno** | **Glad** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BRI | * | 3 | 0 | 0 | 2 | * | 1 | 0 | 1 | 0 | 1 | 0 |
| NE | 13 | 2 | 0 | 5 | 7 | 3 | 3 | 1 | 7 | 0 | 3 | 0 |
| NSW | 45 | 35 | 27 | 16 | 27 | 14 | 36 | 11 | 51 | 17 | 18 | 24 |
| SYD | 11 | 6 | 5 | 5 | 2 | 7 | 5 | 2 | 5 | 2 | 0 | 2 |
| UNSW | 9 | 0 | 3 | 2 | 5 | 1 | 1 | 3 | 2 | 3 | 0 | 4 |
| CANB | 11 | 7 | 2 | 4 | 6 | 0 | 21 | 14 | 23 | 12 | 14 | 6 |
| GAUBA | 5 | 3 | 0 | 4 | 1 | 2 | 3 | 0 | 3 | 1 | 1 | 0 |
| MEL | 9 | 8 | 3 | 8 | 5 | 8 | 8 | 1 | 10 | 1 | 0 | 0 |
| Total | 103 | 64 | 40 | 44 | 58 | 35 | 78 | 32 | 102 | 36 | 26 | 36 |
| Transect | 246 | 58 | 19 | 12 | 19 | 65 | 194** | | 128 | 43 | 20 | 66 |

* Collections not checked.

** *Cakile* spp.: *Cakile edentula* and *Cakile maritima* not differentiated.