WESTERN AUSTRALIAN WILDFLOWER INDUSTRY 1993

Part 1: Analysis of 1993 Western Australian wildflower harvest data

Part 2: Database of the major Western Australian wildflower export species

This is an unpublished report, prepared for the Western Australian Department of Conservation and Land Management and the Australian Nature Conservation Agency.

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WESTERN AUSTRALIAN WILDFLOWER INDUSTRY 1993

PART 1 ANALYSIS OF 1993 WESTERN AUSTRALIAN WILDFLOWER HARVEST DATA

1. INTRODUCTION

Western Australia has a major industry based on the harvesting of native flora (both cultivated and natural populations). About 35% of the total export value of wildflowers are sourced from natural, non-cultivated populations. Flowers, foliage and seed are the major products harvested. The majority of flowers and foliage (approximately 80%) are harvested for export.

Large quantities of seed are also harvested, but most of this seed is used for revegetation within the State. A significant proportion of this seed is collected and used locally for non-commercial purposes (e.g. landcare), and, if taken from private property, is not subject to the requirement for licensing nor the submission of returns of flora harvested to the Department of Conservation and Land Management (CALM). However, such collections must be licensed if material is sourced from Crown land. Minor amounts of flora are also harvested for ornamental cones and nuts, brush fencing, garden stakes and other minor products.

Native flora is harvested from natural vegetation on Crown land and private property, and from cultivated plants on private property. Within WA all native flora is protected under the *Wildlife Conservation Act 1950*, and flora may only be harvested with the permission of the land owner or occupier of private property, or the managing agency for Crown land.

Under the Wildlife Conservation Act, flora may also only be taken from Crown land under a licence, either a Commercial Purposes Licence or a Scientific or Other Prescribed Purposes Licence. No licence is required to take flora from private property, but flora taken from private property may only be sold where the landowner/occupier holds a Commercial Producers or Nurseryman's licence.

Licence conditions apply to all licences, and those relating to commercial use of flora (Commercial Purposes licence, and Commercial Producers/Nurseryman's licence) require the licensee to submit returns to CALM of flora harvested, including details of the quantity and type of product taken, and the location from which it came.

Under the *Commonwealth Wildlife Protection (Regulation of Exports and Imports) Act 1982* which is administered by the Australian Nature Conservation Agency (ANCA), a management program must be approved for the export of wildflowers from Australia. This program in Western Australia is prepared by CALM. The management program covers flowers and foliage of a list of agreed export species, a copy of which is appended to this report (Appendix 1A).

2. OBJECTIVE AND SCOPE OF WORK

The Department of Conservation and Land Management (CALM) initiated a review of the Western Australian wildflower industry based on objectives and scope of work as outlined below. The project was jointly funded by the Australian Nature Conservation Agency and CALM.

The overall project objective was to provide information on flora industry harvesting levels on species taken from natural populations and within geographical areas of the State, and review information on the flora being harvested.

The scope of work for the project was as follows:

- Analyse picker return data on the CALM database and collate information on species utilisation and geographical patterns. Because data from 1994 were not yet complete, 1993 flora return data held by CALM were selected for analysis.

- Undertake a comparison of the current data to that presented in the 1980/81 review by Burgman and Hopper.

- Produce a report of the current situation regarding the activities of the Western Australian flora industry, and an analysis of the change that has occurred since the last complete flora industry review in 1982, including changes in species utilisation, geographic spread, and Crown land versus private property trends.

- Undertake a literature review of Western Australian flora utilised in the flora industry, and document the information that is available in terms of its applicability to industry management.

3. METHODOLOGY

3.1 Flora Management Database System

CALM maintains a database of Commercial Purposes and Commercial Producer's/Nurseryman's licence holders and the flora taken/sold under licence. As a requirement of licence conditions, and in order to facilitate monitoring and enforcement, all commercial licence holders, on both Crown and private property, must submit quarterly returns detailing flora taken each month. Data required include licence number, species, quantity, the unit and part of flora taken, the status of the land where harvesting was undertaken, whether the flora is cultivated or wild picked[1], the name of the private property owner where taken from private land, the grid square location of the flora (Figure 1-1) and the person to whom the flora was supplied. A copy of a return form is attached to this report (Appendix 1B). Details of the database are contained in Appendix 1C.

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[1] Only material sourced from natural populations is considered in this report. Cultivated material is not harvested under the WA Flora Management Program prepared for ANCA.

The computerised database management system is used, in conjunction with field monitoring, to monitor species harvested, levels of activity, and locations of picking.

Harvest data are analysed based on six regions (Pastoral, Northern Sandplains, Northern Forest, Southern Forest, Wheatbelt and Southern Sandplains) (Figure 1-2) and factors influencing biology, ecology and conservation status (including representation in conservation estate, harvest levels, community/habitat rarity) are also assessed on a regional basis.

3.2 Data Validation

Prior to analysis, the 1993 harvest data required validation as accurate data was considered essential to the review of the wildflower industry.

The validation process consisted of two main parts: correcting errors; and converting the database to a consistent format.

3.2.1 Error Correction

Several factors contributed to errors in the dataset, including:

- pickers' misunderstanding of the harvesting grid system;
- lack of good plant identification skills by pickers;
- incomplete return forms;
- other errors in information provided; and
- data entry errors by CALM staff.

Validation of data was undertaken in the following phases:

Taxon names

All the taxon names were checked against the Western Australian Herbarium's taxonomic database (WACENSUS). About 60 inconsistencies were found between the flora industry database names and WACENSUS, and these were corrected.

In some cases where a picker had stated a genus name but no species descriptor, CALM were able to recommend species descriptors as outlined below based on industry experience and geographical location.

Stirlingia	*Stirlingia latifolia*
Scholtzia	*Scholtzia involucrata*
Crowea	*Crowea angustifolia*
Dryandra	*Dryandra formosa* (changed only where certain - in most cases mostly left as *Dryandra* sp)
Callistemon	*Callistemon glaucus*
Waitzia	*Waitzia acuminata*
Trymalium	*Trymalium floribundum*
Lachnostachys	*Lachnostachys eriobotrya*

Halosarcia	*Halosarcia pterygosperma*
Hovea	*Hovea trisperma*
Boronia	*Boronia megastigma*

In many cases, however, genera had to be left without species names as it was not possible to accurately assign one.

Two recorded species (*Eragrostis curvula* and *Pelargonium capitatum)* are exotic weeds and were therefore removed from the database. A number of species are known to be misidentified by the flora industry and these were amended to reflect the correct identification (*Andersonia simplex* changed to *A. caerulea, Templetonia retusa* foliage changed to *Adenanthos cuneatus*). Taxonomic changes were also updated where these had occurred (e.g. *Verticordia brownii* (white flowers) has been renamed as *V. eriocephala*, *Callistemon speciosus* has changed to *C. glaucus*).

Obvious data entry errors were corrected by citing the original flora return form. It is possible that some of these errors remain.

Geographic Data

The harvest grid squares were checked for obvious errors. One source of errors is in the transcription of the grid square numbers from the photocopied map on return forms which pickers tend to misread. Clarity of the photocopy and the density of geographic details in some sections of the map appear to be the main contributors to the problem.

It is also apparent that some pickers do not understand the grid square system (e.g. the location or lot number of a property may be given instead) and errors can be attributed to such a lack of understanding.

Grid cell data for the 20 most heavily harvested species were compared with their known distributions for obvious discrepancies and any apparent errors were investigated. For example, nearly 2000 stems of *Xylomelum occidentale* were changed to *Xylomelum angustifolium* based on distribution information.

Several licence returns were subject to further investigation with the following common problems:

- using the same grid reference number for all taxa recorded on one return form;
- one taxon being obviously allocated to the wrong grid cell (it is possible that the others might therefore also be incorrect); and
- same grid reference number is given for all except one species - possibly a data entry error.

As a result, the original return forms for these licence numbers were cited. This examination made it clear that some pickers had difficulty in accurately completing forms (e.g. failure to indicate that a species had been artificially cultivated where it was sourced from areas well outside its natural range from a known grower).

Some validation of species data stored in the WA Herbarium's computerised specimen database in WAHERB was undertaken when insufficient geocoded locations were recorded. These included *Macrozamia riedlei*, *Pteridium esculentum*, *Agonis juniperina* and *Leptocarpus scariosus* for which there were very few geocoded locations in the WAHERB database although they were known to be widely distributed.

3.2.2 Manipulation of data for analysis

Maps showing the natural Western Australian distribution of the export species were generated from the WA Herbarium computerised specimens database (WAHERB) as outlined below in Section 3.3. Harvesting distribution data were then superimposed on the species distribution maps for the export species. These maps revealed some distribution anomalies which were then validated. Errors were identified in data entry of the geocodes for the herbarium specimens, and in estimating locations from generalised locality information. Inconsistencies in the harvest distributions were analysed using distribution data, such as maps in floras, journal articles, texts, and asking various botanists. About 30 species were recorded from dubious picking grids (or in some cases from dubious distribution spreads).

Elimination of data not included in the scope of the project

All data for artificially cultivated plants were eliminated as the review focussed on the impact of flora harvesting on natural populations. Maps featuring natural population distributions of export species were overlain with the harvest data for those species and any lack of correspondence between distribution and harvest was checked for error before being assessed as potentially cultivated plants.

All seed data were eliminated because seed is not included as part of the scope of this project. The category "fruit/nuts" was retained throughout the data manipulation exercise, but lack of time prevented its analysis. It is possible though that some of the "fruit/nuts" were actually taken for "seed", and should have been eliminated from analysis. Data recorded as "bags of fruit/nuts" were deleted as it was assumed to be seed. *Melaleuca rhaphiophylla* paperbark harvesting was also deleted as it was not of large enough volume to justify conversion, and a conversion could not be made to the common unit of "stems".

Conversion

Conversion of the units of harvest were carried out in order to ensure consistency of measurement unit. The conversions are not intended to increase the accuracy of the data.

A standard conversion of one bunch of flowering stems being equivalent to 10 single stems was used. However, industry supplied the following exceptions:

Anarthria scabra	50 stems per bunch
Crowea angustifolium	15 stems per bunch
Hakea cucullata	1 stem per bunch

Hakea platysperma	1 stem per bunch
Juncus holoschoenus	40 stems per bunch
Kingia australis	50 stems per bunch of leaves
Leptocarpus scariosus	50 stems per bunch
Podocarpus drouynianus	20 stems per bunch
Xylomelum occidentale	7 stems per bunch

The following conversion rates were used for flowers, foliage or whole plants:

- One kilogram of stems = 2 bunches = 20 stems (industry exceptions above applied)
- One bunch of leaves = 10 single stems of leaves (industry exceptions above applied)
- One kilogram of *Boronia megastigma* blossom = 148 stems
- One kilogram of *B. megastigma* sprays or stems = 65 stems (conversions based on CALM research)

Fruit/nuts were converted as follows:

- One bucket of fruit/nuts = 5 kg

It is recommended that more time be spent on refining conversion formulae for the next review of the flora industry.

Licensee details

Each licensed picker holds a licence for a period of one year. However, licences are not based on calendar years (from 1 January) and therefore a picker may have more than one licence number in any calendar year. Data were therefore validated to ensure that each picker was represented only once during the analyses.

In addition, while it is a requirement of the licence conditions to submit flora returns for the period of a licence, where non-essential data, such as the number of days collecting, are missing from a return, it is considered non-productive to follow this up. As a result, there were some returns where the number of days collecting were not recorded. In cases where pickers had not detailed the number of days spent picking in at least seven months of the licence, these data were disregarded for the purpose of determining days spent collecting during a year.

3.3 Generation of Distribution and Harvest Maps

Distribution maps for each of the export species were generated using ArcInfo based on data from the WA Herbarium specimens database (WAHERB), with 1993 harvest data overlaid.

Two map scales were used. Most were mapped using the whole of Western Australia, but species confined to the SW corner were mapped on a larger scale (Geraldton to Hopetoun).

A total of 136 export taxa were recorded as having been harvested in 1993. About 50 export species were not picked in 1993 and therefore have no harvest data. Two export species, *Eucalyptus preissiana* and *Anigozanthos humilis* did not have harvesting data presented. *E. preissiana* was only collected for fruit and nuts and *Anigozanthos humilis* was taken from grid squares outside its known geographic range, and was thus considered to be erroneous data.

In some cases, the mapped harvest data do not total 100%. This is because some harvesting did not have a geographic grid square reference on the original return forms.

There was insufficient time to map infraspecies individually. For example, *Rhodanthe chlorocephala* subspecies had to appear on the same map unlike the export database handling of the subspecies as two separate records. The harvest levels mapped therefore may not reflect the impact on intraspecific taxa within a certain species.

Conospermum diffusum was not mapped as WAHERB records were not available.

Full validation of WAHERB was not possible given the limited resources for the project. In addition, 1993 harvest data were not completely validated, i.e. there are some obviously suspect picking records falling beyond the distribution dots for a few species. Some of these have been checked to ensure they are not from cultivated plants or misidentifications or grid number errors.

There were 13,711 WA Herbarium records for the species to be mapped. 2,836 had no geocodes (i.e. latitude and longitude were not given). Available records to be mapped (after cultivated specimens were excluded) was thus 10,875.

Name changes were dealt with carefully so as to combine only completely compatible old and new name records on a map.

4. RESULTS

The last complete analysis undertaken for the flora industry was for the period 1980/81 (Burgman and Hopper 1982). Rye *et al* (1980) provided a census of vascular plants harvested for the period 1977-79.

4.1 Licence Data

Since the census by Burgman and Hopper, the licensing and flora return system has been fully computerised.

Statistics on commercial licences (flowers, foliage and seed) issued between 1980/81 and 1993/94 are shown on Figure 1-3. These data show that the industry has experienced significant growth in the number of Commercial Purposes licences since 1980/81 until 1990 when licence fees were increased. Commercial Producer's licences remained at a low level until 1990 when an increase occurred at the same time as the

large rise in Crown land (Commercial Purposes) licence fees. The number of licences recorded for calendar year 1993 in which the review was undertaken were 644 Commercial Purposes licences and 311 Commercial Producer's/Nurseryman's licences.

The number of licences issued by CALM each month during 1993 is shown on Figure 1-4. Licence numbers appear to peak between July and October (the period of greatest flowering) for both Commercial Purposes and Commercial Producer's Licences.

Figure 1-5 shows the level of picking activity. Six hundred and twenty two pickers had returns for at least seven months of the year. Two hundred and fifty nine of the 622 had either missing data or did not pick although they filled out their return forms. These pickers were also disregarded and the final number of pickers for the analysis was 363.

This figure indicates that very few pickers operate full-time in the industry. Only 116 pickers operate for 51 or more days in a year and only 21 operate more than 150 days in a year. Most pickers appear to be part-time or pick only selected species for a short period of the year (e.g. *Boronia megastigma* or seed pickers).

The following analysis shows the numbers of Commercial Producer's to Commercial Purposes licence holders at the various picking activity levels.

Picking Activity Level (days)	Commercial Producers	Commercial Purposes
1-50	101	146
51-100	14	47
101-150	5	28
151-200	1	18
200-250	0	1
251-300	0	1

Private property licensees tend to mainly operate at the lowest levels of picking activity and none picks over 200 days per year. The proportion of private property licensees to Crown land licensees decreases as the level of picking activity increases.

In general, the greater the number of taxa that an individual picker harvested, the smaller the volumes taken. Pickers generally concentrate on only a few species. Thirty-one species was the highest number taken for flowers and foliage by any individual picker in 1993.

Hopper and Burgman (1982) noted that the percentage of licensed pickers submitting returns fell steadily throughout the year of the project after reaching an initial peak. While this may still occur in the short term (i.e. during the life of the licence), this is no longer a significant issue. Pickers who do not submit returns in accordance with licence conditions may not renew their licence. This change is borne out by Figures 1-6 and 1-7 which show the total number of returns and the number of positive returns received. There is significantly less variation in return numbers than was the case in 1980/81, most of which could be accounted by the greater number of licences during peak seasonal activity.

No statistics are kept of errors that occur in returns. Returns receive initial validation and are entered into the Flora Industry Database Management System as they are received and therefore were not specifically entered for this project. However, many of the same type of errors as outlined by Burgman and Hopper (1982) were noted to occur in the current dataset, *viz.*:

- omission of the year of the return
- omission of the month of the return
- use of specific local or trade common names
- use of erroneous scientific names
- map grid references were incorrectly entered or omitted altogether
- the number of days spent collecting flora was omitted

Some of these errors (e.g. lack of month or year) are rectified at the time of data entry. However, poor species identification skills resulting in incorrect names cannot be corrected without viewing the plant specimens, contacting the licensee or undertaking other intensive investigations.

There is no method of correlating picker returns with flora received by dealers who are not currently licensed. Burgman and Hopper stated that it is impossible to detect whether data supplied to CALM by pickers is correct and this remains the case in 1993.

4.2 Species Data

4.2.1 Taxonomic Evaluation

Statistics on harvest data quantities from returns received for 1993 are given in Appendix 1C.

Table 1 shows the number of species used in the cut flower and seed trades during each of the surveys that have been undertaken into the industry.

Table 1
Number of Species Used in the Cut Flower and Seed Trades
1977-79, 1980/81 and 1993

Time Period	Number of Species Commercially Exploited		
	Cut Flower	Seed	**Total**
1977-79	146	881	**1027**
1980-81	288	308	**596**
1993	262	630	**906**

While the number of species used for the cut flower trade remains similar to that in 1980/81, the species composition is significantly different. A total of 144 species was picked in both 1993 and in 1980/81, with 118 species picked only in 1993 and 144

only in 1980/81. Further, the relative importance of many species has changed significantly (see Table 2 below).

The relative proportion of harvested species that are on the proposed export list, proposed export species that are not harvested and species that are proposed for domestic use only is shown on Figure 1-8. About 15% of the export species were not picked in 1993. These include very seasonal species such as everlastings, and species which have a specialist demand at low levels. Many of the species which were picked but not on the export list include species which are used in low quantities for local craft work, e.g. greeting cards.

Burgman and Hopper note that the numbers of species taken for leaves was small in 1980/81. In 1993 this is no longer true. However, because many pickers refer to leaves as "stems", there may be some confusion over what product has been harvested without knowledge of the species and the industry. This ambiguity may have existed in 1980/81 but not have been detected.

The number of species taken for whole plants has fallen significantly from 68 species in 1980/81 to 4 species in 1993. Licence conditions have changed to prohibit the taking of whole plants from Crown land. This condition may only be varied in cases of salvage where the plants would otherwise be destroyed. In 1980/81, the nursery trade harvested whole plants from natural populations.

Cultivated wildflower species are now a major source for the industry. The Department of Agriculture estimate that in 1993/94 the industry was worth about $13 million, of which $7 million is sourced from cultivated material [Neville Burton, Agriculture WA, pers. comm.]. For many species, however, natural populations on either Crown land or private property are still a substantial source.

Compared with 1980/81, the 1993 data show a large increase in quantities harvested. Flora returns for a total of 29,051,044 flowering stems and leaves were received for 1993. Of this number 28,058,885 stems were harvested from species on the export list. In 1980/81 Hopper and Burgman report that 13,814,000 flowering stems were harvested during the 15 month period of study. A total of 12,211,915 stems were taken in the 12 month period between June 1980 and June 1981.

Table 2 compares the quantity taken for the 20 most heavily exploited species in 1993 with 1980/81. As was the case in 1980/81, *Stirlingia latifolia* was the most heavily exploited wildflower species with a total of 4,245,260 stems being harvested. Major changes include the inclusion of *Persoonia longifolia* in 1993 as the tenth most heavily harvested species. This species was not harvested in 1980/81. *Banksia hookeriana* has increased both its harvest level and its relative importance to the industry. However, *Anigozanthos* species and *Chamelaucium uncinatum* are no longer heavily harvested from wild populations, being replaced by cultivated plants. *Scholtzia involucrata, Leptocarpus scariosus* and *Daviesia cordata* are other species which have significantly increased their overall harvest levels since 1980/81.

It should be noted that the 1980/81 data have been corrected to reflect one year of data. Conversion rates for 1980/81 data are those of Burgman and Hopper except for *Boronia megastigma* as outlined in footnote 2.

Table 2
Comparison of twenty most heavily exploited species in 1993 with 1980/81

Species	Harvest Year/Quantity 1993		Harvest Year/Quantity 1980/81	
	Quantity	% of total	Quantity	% of total[2]
Stirlingia latifolia	4,345,260	14.96	1,363,450	11.16
Agonis parviceps	3,064,498	10.55	807054	6.61
Podocarpus drouynianus	2,919,776	10.05	650,472	5.33
Banksia hookeriana	2,019,410	6.95	61,670	0.50
Banksia baxteri	1,490,061	5.13	212,113	1.74
Agonis juniperina	1,325,970	4.56	135,940	1.11
Banksia prionotes	1,313,004	3.81	110,739	0.91
Leptocarpus scariosus	1,025,350	3.53	63,675	0.52
Scholtzia involucrata	857,310	2.95	16 260	0.13
Persoonia longifolia	759,088	2.61	0	0.00
Beaufortia sparsa	750,282	2.58	409,901	3.36
Verticordia eriocephala	744,480	2.56	388,787	3.18
Boronia megastigma	702,720	2.42	536,301[3]	4.39
Dryandra formosa	491,548	1.69	397,322	3.25
Daviesia cordata	476 870	1.64	130	<0.01
Banksia coccinea	395,332	1.36	436,877	3.58
Bossiaea aquifolium	384,520	1.32	24,020	0.20
Verticordia nitens	333 760	1.15	1,044,566	8.55
Xylomelum occidentale	290,883	1.00	14,940	0.12
Caustis dioica	284,980	0.98	0	0.00
Lachnostachys eriobotrya	275,330	0.95	134,431	1.10
TOTAL	23,444,234	80.70	6,792,644	55.62

It is apparent from Table 2 above that the eveness of the species' harvest levels has decreased since 1980/81. Three species now contribute more than 35% of the total flora harvest from wild stands, whereas in 1980/81 the top three species contributed about 27% of the total harvest. The top ten species contribute more than 65% of the total harvest in 1993 but only 45% of the harvest in 1980/81.

Other species which were in the list of the 20 most heavily exploited in 1980/81 but were less heavily exploited in 1993 are listed in Table 3.

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[2]This percentage is calculated by ignoring the data from June 1981 to August 1981 which repeats the same period in 1980.

[3]Boronia blossom has been included as it is covered by the WA Flora Management Program. The conversion method outlined in Section __ has been used, rather than themethod used by Burgman and Hopper which is believed to be flawed.

Table 3
Species Heavily Exploited in 1980/81 and 1993 Harvest Levels

Species	**Harvest Year/Quantity**	
	1980/81	1993
Dryandra polycephala	362,359	64,340
Adenanthos obovatus	211,880	77,150
Anigozanthos pulcherrimus	266,542	80,190
Anigozanthos manglesii	214,619	6,306
Verticordia drummondii	210,637	4,990
Ozothamnus cordatus	208,200	11,800
Beaufortia decussata	171,579	27,850
Anigozanthos rufus	158,097	15,100
Chamelaucium uncinatum	104,969	5,440

Several of these species (e.g. *Anigozanthos* spp., *Chamelaucium uncinatum*) are now cultivated in large quantities and it would appear that the dependence on natural populations has decreased for these species. *Ozothamnus cordatus* occurs in near metropolitan areas of Perth and it may be conjectured that land clearing for housing development has affected its availability. *Dryandra polycephala* occurs primarily on lands that are now managed as conservation estate and is a priority flora species. Under licence conditions, it may not be taken from Crown land.

The level of harvest for the ten most heavily exploited genera is given in Table 4. Levels for 1980/81 are also given.

Table 4
Harvest Levels for Ten Most Heavily Exploited Genera
1993 Compared to 1980/81

Genus	**1992 Harvest**		**1980/81 Harvest**	
	No of Stems	No Species	No of Stems	No Species
Banksia	6,060,957	18	1,292,104	22
Agonis	4,624,608	5	1,344,962	2
Stirlingia	4,345,260	1	1,425,184	2
Podocarpus	2,919,776	1	781,222	1
Verticordia	1,330,279	15	2,126,394	22
Leptocarpus	1,033,580	3	195,025	2
Scholtzia	925,260	3	22,390	3
Beaufortia	778,272	3	751,310	6
Persoonia	759,101	1	0	0
Boronia	733,101	3	719,032	7
TOTAL % of total	23,510,194 (80.93%)	53 (20.23%)		

In 1980/81, harvest of the ten most exploited genera represented 74.1% of the total harvest and the 81 species within these genera represented 28% of all species harvested. Heavily exploited genera in 1980/81 that are no longer within the ten most heavily exploited genera in 1993 include *Dryandra* (1,049,042 stems and 8 species in 1980/81; 597,992 stems and 7 species in 1993), *Anigozanthos* (712,785 stems and 8 species in 1980/81; 102,018 species and 5 species in 1993), *Adenanthos* (417,649 stems and 5 species in 1980/81; 367,600 stems and 4 species in 1993) and *Conospermum* (330,144 stems and 5 species in 1980/81; 228,082 species and 7 species in 1993).

The data in Table 4 above suggest that fewer species in the heavily harvested genera are being harvested but that overall harvest levels are greater for each of these species. The relative importance of the heavily exploited genera has increased since 1980/81, from 74.1% to 80.9%. This is similar to the trend at the species level.

Most species are exploited for stems (either leaves or flowers) between August and October, the period corresponding to greatest floral richness (Figure 1-9). Species taken as flowering stems are particularly seasonal. Figures 1-10 to 1-14 show the number of stems taken for the most heavily exploited species each month.

These data indicate that species taken for decorative foliage (e.g. *Persoonia longifolia*, *Podocarpus drouynianus*) tend to be markedly less seasonal than flowering stems. Amongst flowering stems, species which are feature flowers (e.g. *Banksia* spp., *Verticordia* spp., *Scholtzia involucrata, Boronia megastigma*, *Dryandra formosa*) tend to have shorter seasons than species which largely provide backing material (e.g. *Stirlingia latifolia, Agonis* spp.). Most harvesting occurs in the spring months of August to November. However, some species have flowering periods outside this range, e.g. *Beaufortia sparsa, Banksia baxteri, Scholtzia involucrata, Verticordia nitens, V. eriocephala.*

4.2.2 Land Tenure

Figure 1-15 shows the number of pickers operating on Crown land and private property each month. The seasonal pattern is similar for private property and Crown land. However, it is markedly less seasonal than was the case in 1980/81. In addition, there are a relatively greater number of pickers operating on private property than was the case in 1980/81.

The following Table 5 shows the number and percentage of stems picked from Crown land and private property in 1993 compared to 1980/81.

Table 5
Number of Stems picked from Crown land and private property
1980/81 and 1993

	1993				1980/81			
Month[4]	**Crown**		**Private***		**Crown**		**Private****	
	No	%	No	%	No.	%	No.	%
January	1,008,934	69.3	447,785	30.7	287,463	48.7	302,810	51.3
February	1,276,455	61.3	806,882	38.7	316,335	65.2	168,841	34.8
March	1,400,746	65.0	755,439	35.0	224,582	32.6	464,320	67.4
April	1,226,199	66.4	619,334	33.6	559,826	79.5	144,358	20.5
May	1,142,391	67.6	547,093	32.4	351,816	77.1	104,495	22.9
June	1,181,520	66.2	601,961	33.8	168,483	77.4	49,196	22.6
July	1,295,102	74.2	451,475	25.8	351,015	63.2	204,389	36.8
August	1,683,683	65.2	897,047	34.8	562,544	39.6	858,021	60.4
September	2,466,928	68.5	1,134,765	31.5	778,934	42.4	1,058,175	57.6
October	2,671,739	73.9	944,125	26.1	984,277	57.1	739,500	51.3
November	2,947,519	84.5	540,218	15.5	780,727	43.3	1,022,337	34.8
December	1,458,135	64.3	809,517	35.7	733,307	42.4	996,191	67.4
TOTAL[#]	**19,759,351**	**69.8**	**8,555,641**	**30.2**	**6,099,309**	**49.9**	**6,112,633**	**50.1**

* Excludes cultivated material

** Includes cultivated material

\# Excludes data where land status unknown

Very little material was cultivated in 1980/81. Estimates from the Western Australian Department of Agriculture indicate that approximately 90% of the total harvest was sourced from wild populations on both Crown and private in 1980/81. In 1992/3, approximately 65% of the value of the industry is generated from cultivated material. This had fell to 54% in 1993/94 as a result of a downturn in the market. Table 6 indicates that within natural populations exploited for flowering stems, there has been limited growth on private property stands but a more than threefold increase in exploitation from Crown land. There is probably limited capacity to increase production from natural stands on private property because of past land clearing practices, although increased recognition of this resource will result in greater utilisation of remaining areas of vegetation.

4.2.3 Geographic Analysis

The following table compares the number of species and the percentage of the total number of flowering stems harvested from each grid square in 1993 to 1980/81 (refer to Figure 1-1 for grid references).

[4]For 1980/81 data, the repetitious months, June to August 1981, have been disregarded. The dataset runs from June 1980 to May 1981.

Table 6
Number of Species and Percentage of Total Flowering Stems for Each Grid Square

Grid Square	1993		1980/81	
	No of Species	% Total Harvest	No of Species	% Total Harvest
45	1	*	0	0
46	1	*	0	0
72	1	*	0	0
140	12	*	0	0
162	6	*	2	*
165	2	*	0	0
176	1	*	0	0
204	5	0.38	20	2.5
205	14	1.0	2	0.1
1501	15	2.8	17	2.3
1503	2	*	2	*
1504	1	*	1	*
1513	26	*	1	*
1602	2	2.5	5	1.2
1604	19	5.5	23	2.5
1611	2	*	7	*
1613	20	2.3	26	2.1
1702	9	5.1	30	2.9
1704	9	1.8	31	1.9
1711	15	0.9	9	0.9
1713	29	5.1	18	1.6
1811	23	7.4	33	15.3
1812	1	*	1	0.2
1813	62	7.3	86	15.8
1814	8	0.4	58	0.3
1832	1	*	0	0
1833	1	0.1	0	0
1834	1	*	0	0
1911	19	0.5	30	1.0
1912	8	0.3	2	0.2
1913	15	1.0	6	0.5
1914	2	*	0	0
1921	1	0.1	0	0
1931	5	*	0	0
1934	1	*	0	0
2004	16	2.23	27	0.6
2011	10	0.9	9	1.7
2012	15	0.6	0	0
2013	38	3.25	4	0.1
2014	1	*	0	0
2023	1	0.1	0	0
2034	6	0.2	1	0.1
2102	10	0.1	9	0.5
2111	26	9.8	9	0.5
2112	21	4.6	3	0.3
2113	8	2.4	14	0.4
2114	32	6.0	15	3.2
2121	8	0.6	3	0.1
2122	19	0.2	8	0.5
2123	41	14.7	45	29.8
2124	27	4.9	22	6.1
2131	27	4.6	8	3.9
2132	7	0.1	2	0.2

* >0.1

Some additional grid squares which had no harvesting in 1993 but were harvested in 1980/81 include 101 (two species), 120 (one species), 110 (three species), 142 (two species), 143 and 144 (each one species), 164 (six species), 194 (one species), 1823 (eight species), 2024 (19 species), 2033 (six species).

The number of species picked in a particular grid square is not always a good indication of the relative importance of the area to the industry, although those areas with greater number of species do tend to be more intensively exploited.

In 1980/81, Hopper and Burgman recognise two main areas of picking concentration - north of Perth in the near-metropolitan grid squares (31.6% of the total harvest) and in the Mount Barker area (36.5%). These are now of less importance (15.4% and 20.4% respectively and the picking effort appears to have moved northwards from Perth to the northern sandplain area between Eneabba and Moora (22.9%) and westwards from Mount Barker to the area around Manjimup and Nannup (22.8%). The decline in the importance of the Perth region may be due to land clearing for urbanisation. The reason for the decline in the importance of the area around Mount Barker is unknown.

The following table outlines the relative importance of areas based on the CALM picking regions (Figure 1-2).

Table 7
Harvest Levels according to CALM Picking Regions

Picking Region	Harvest Quantity	% of Total
Northern Forest	3,534,439	12.4
Northern Sandplain	9,137,891	32.0
Pastoral	8,557	*
Southern Forest	7,111,297	25.0
Southern Sandplain	7,227,272	25.3
Wheatbelt	192,598	*

* <0.1%

These results reinforce the findings detailed above. As for 1980/81, most of the harvesting is concentrated in the South West Land Division. Three picking regions (Northern Sandplain, Southern Forest and Southern Sandplain) contribute more than 82% of the total harvest. In 1980/81, there was no harvest of flowering stems from the Wheatbelt. The harvest quantities of flowering stems are still minor for this picking region and most of the harvest is from *Verticordia eriocephala.*

Table 8_ shows the relative geographic spread of flora harvesting in 1993 compared to 1980/81 for the 20 most heavily exploited species. The overall geographic spread of the species according to specimens held in the WA Herbarium is also indicated.

Table 8
Geographic Distribution of Harvesting and Overall Distribution of Species
1980/81 and 1993

Species	Number of Grid Squares Harvested		Number of Grid Squares Occupied*
	1993	1980-1981	
Stirlingia latifolia	14	12	15
Agonis parviceps	16	4	8
Podocarpus drouynianus	6	8	3
Banksia hookeriana	6	6	5
Banksia baxteri	5	4	6
Agonis juniperina	9	2	4
Banksia prionotes	13	13	18
Leptocarpus scariosus	7	1	12
Scholtzia involucrata	7	1	9
Persoonia longifolia	10	0	9
Beaufortia sparsa	9	5	7
Verticordia eriocephala	9	5	?>25
Boronia megastigma	9	6	7
Dryandra formosa	7	4	7
Daviesia cordata	12	1	11
Banksia coccinea	5	5	8
Bossiaea aquifolium	10	4	9
Verticordia nitens	6	5	5
Xylomelum occidentale	12	2	7
Caustis dioica	11	0	?>25

* From WA Herbarium computerised specimen database - 1995

There does not appear to be a good correlation between the number of grid squares in which a species is harvested and the overall number of grid squares for which herbarium specimens occur. In general, however, the number of grid squares in which species are harvested has increased. This is particularly the case, as would be expected, for those species which were of less importance to the industry in 1980/81. It also appears that many of the most heavily exploited species are being harvested from throughout their range. Harvest of *Stirlingia latifolia* remains concentrated around the Perth area, probably because of proximity to markets. Hopper and Burgman note that *Verticordia eriocephala* (then *V. brownii*) was recorded from only a fraction of its distribution range. This remains true and is probably due to land clearing in the western part of the wheatbelt, and the relative inaccessibility of the eastern populations.

A comparison of the geographic distribution harvest data (Appendix 1D) with data from WAHERB suggests:

- Pickers have poor species identification skills and the industry have perpetuated misidentification of several species (e.g. *Adenanthos cuneatus* misidentified as *Templetonia retusa*, *Verticordia polytricha* and *V. capillaris* are misidentified as *V. eriocephala*, *Caustis dioica* misidentified as *Anarthria scabra*, *Andersonia caerulea* misidentified as *A. simplex*, *Juncus microcephalus* is misidentified as *J. holoschoenus* and *Leptocarpus* species are poorly known by pickers).

- WAHERB may be a poor indicator of the overall species distribution and/or conservation status given that specimens are not necessarily lodged in the Herbarium from the full range of the species, and that changes in land use, particularly clearing, can mean that some historical specimens may no longer exist in the field.

5. DISCUSSION

Perhaps the most obvious finding of the survey was that in a dozen years the industry can change dramatically, not only in which species are picked (as pointed out by Rye *et al*, 1980) but in the quantities picked and the areas of greatest picking activity. The increase in picking for many species is substantial. For example, in 1980-1981 only about 62,000 *Banksia hookeriana* stems were picked (Burgman and Hopper 1982), whereas in 1993 over two million stems were picked, an increase of 34-fold.

Changes in relative harvest quantities may be due to the following:

- The flora industry is essentially based on fashion (both in colour and in form) and this may affect demand for particular species, e.g. *Verticordia nitens* has decreased significantly in the same period as its orange colour is no longer popular and it cannot be dyed.

- Flowering of species growing in natural populations, particularly moisture-sensitive species such as commonly occur in the south west land division, is highly seasonal and thus the relationship between harvest levels in any one year (in the short term) is very dependent on seasonal conditions. The year 1993 is known to have had favourable climatic conditions for most of the south west of Western Australia and this is believed to have resulted in greater than average harvests.

- The availability of land areas may affect the harvest quantities of particular species. For example, many areas near to Perth have been cleared for urban development and species which were harvested mainly from such areas have decreased harvest levels, e.g. *Ozothamnus cordatus*. In addition, areas which have been acquired as conservation estate are no longer available for harvesting and this may affect species' harvest levels

- Changes in CALM's management of particular species as a result of conservation concerns may have a major impact. In 1991, the taking of *Banksia coccinea* was prohibited on Crown land as a result of disease concerns. The harvest of this species has decreased since 1981, probably as a result of both the formal

restrictions on the species and as a result of the impact of disease on the abundance of the species over this time.

There appears to have been an increase in the geographic range of harvesting compared to the overall distribution of the species. Many species are now picked throughout their known distribution. This may be related to the overall increase in the size of the industry and the changed availability of land.

Picking activity also appears to be spreading further from market sources (particularly Perth), possibly because flora is not available in sufficient quantities near to Perth.

The relative proportion of "hobby" species (i.e. those species which are harvested in minor amounts for domestic markets) appears to have decreased since 1981, probably as a result of the overall increase in the size of the industry during that period and the increase in licence fees making such collections non-viable. This finding is supported by the trend towards specialisation in fewer species which are harvested in greater quantities than was the case in 1981.

The changeability in the species picked and their level of harvest and in the geographic location of harvesting means that such trends need to be monitored to facilitate industry management by CALM.

It is apparent from the review that industry data requires validation. However, although statistics from flora pickers may be somewhat inaccurate, they do provide information on industry trends, and they are believed to be better than those generated by Customs for exported flora. These data are not very useful as they are compiled from a non-specialised reporting form and are based on a complicated species coding system (Neville Burton, WA Dept. Agriculture, pers. comm.). Improvements in the quality of the return flora data are required, both through industry education and improved data entry validation.

The validation that was done was considered valuable as it highlighted some of the problems in the picker return system. In fact these began being addressed while the project was running, e.g. the automated provision for validation of the spelling and current taxonomic status of harvested species recorded on pickers' returns against the WA Herbarium's taxonomic database.

A more effective checking system of picker return information is required. This may include questioning the picker by phone on any vagueness, inaccuracies, etc. at the time of the return. Checking that the picking is legal is one aspect, but the accurate recording of correct information at the time of entry is vital for future analysis.

The production of a document to assist pickers in the identification of the major species being harvested would be of assistance in achieving accurate return data. Incorrect identification has important implications for management of the flora industry because return data are a basis for decision-making. A publication like this might have the additional flow-on advantage of improving relations between the industry and CALM, which might in turn encourage the industry to be more interested in the return system and to understand CALM's management strategies.

Some amendments to the return form should be made. An explanation should be given that grid square numbers should be copied exactly as they appear on the map and that the "locality grid number" is for the grid number of the location from which the plants were picked. Pickers occasionally enter their property location or lot number.

6. REFERENCES

Rye, B.L., Hopper, S.D. and Watson, L.E. (1980): Commercially exploited vascular plants native in Western Australia: census, atlas and preliminary assessment of conservation status. Dept. Fish. Wildl. West. Aust. Rept. No. 40, 1-367.

Burgman, M.A. and Hopper, S.D. (1982): The Western Australian Wildflower Industry 1980-1981. Dept. Fish. Wildl. West. Aust. Rept. No. 53, 1-217.

FIGURES

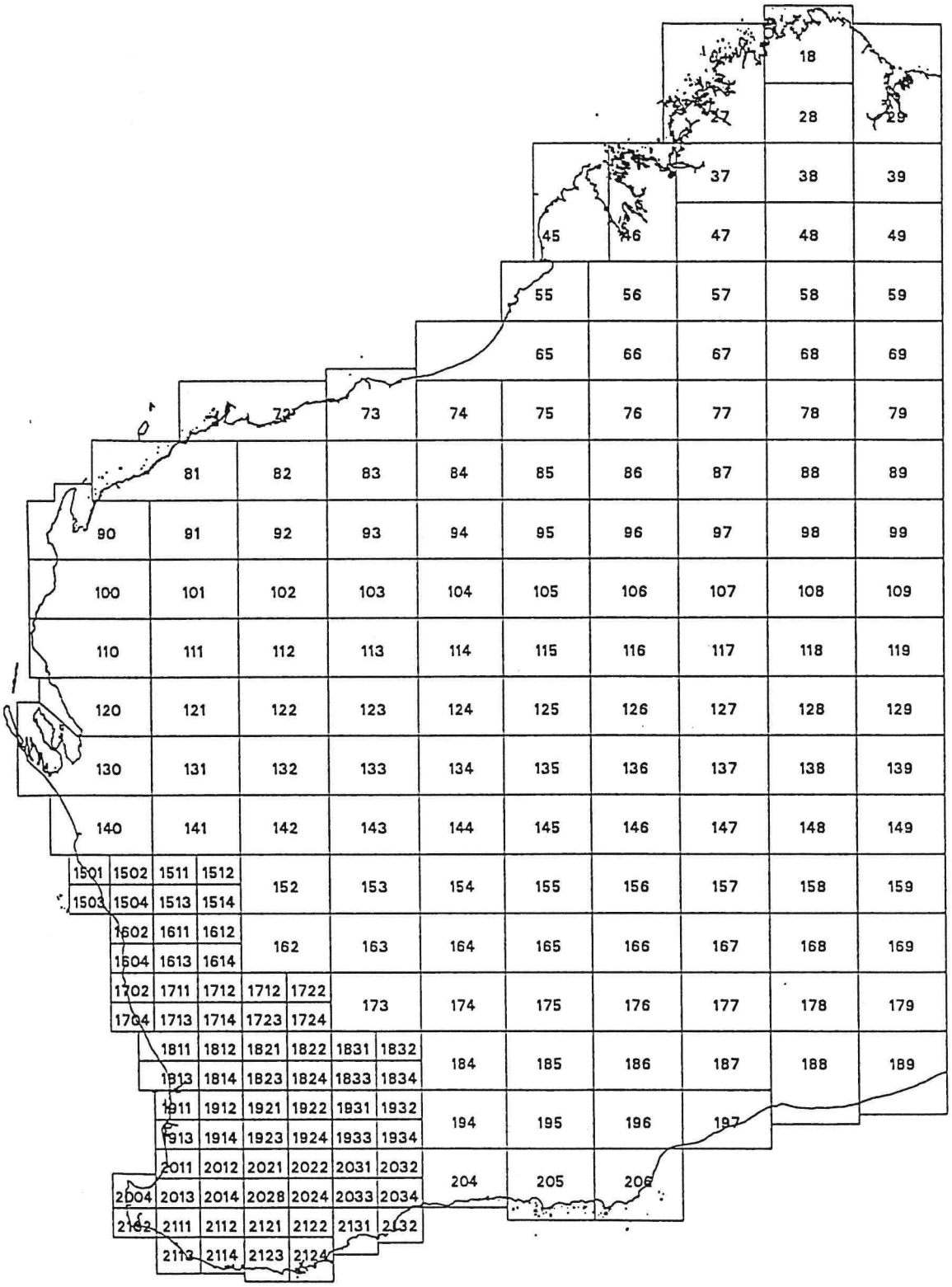

FIGURE 1-1
FLORA HARVEST GRID REFERENCES

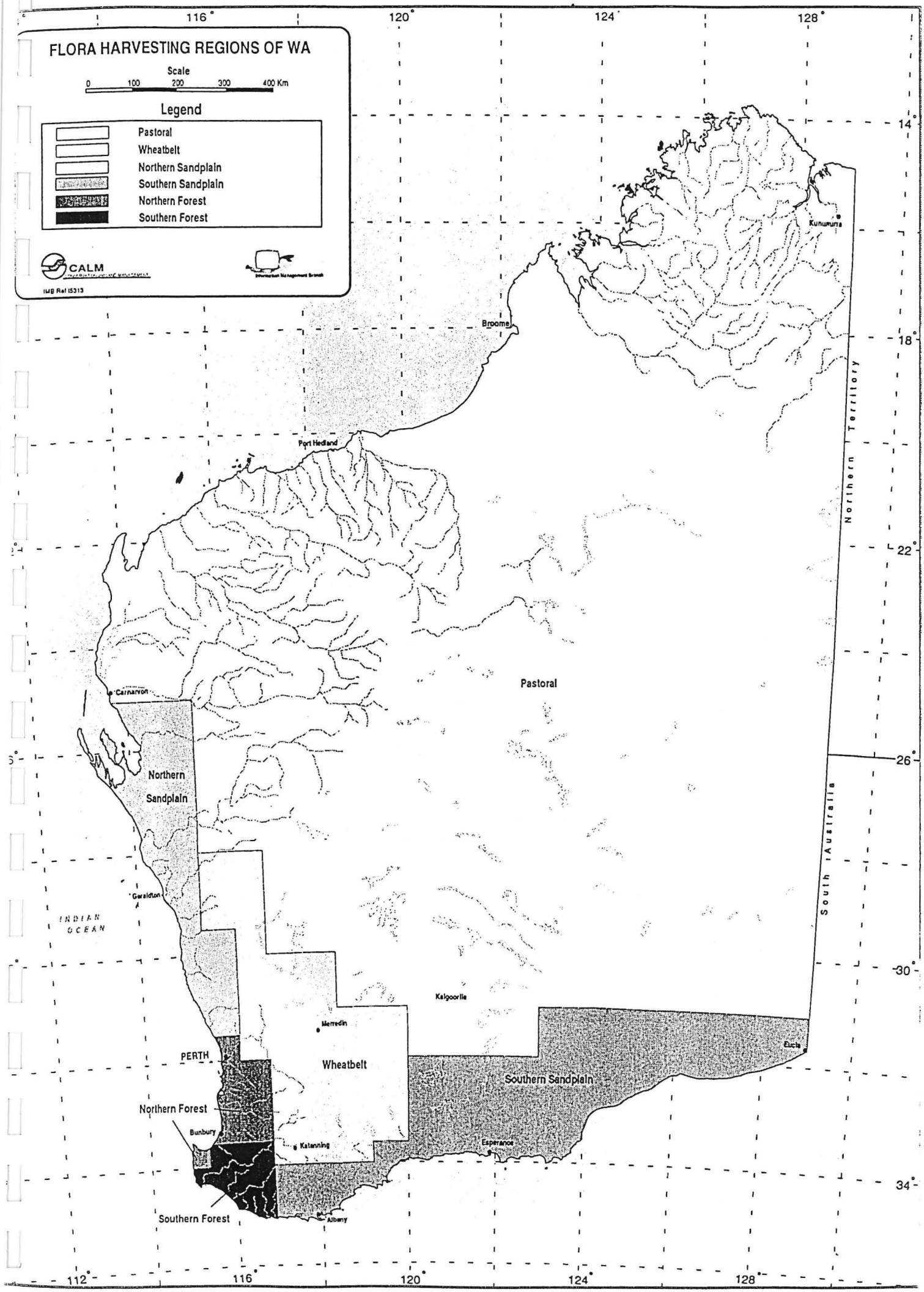
FLORA HARVESTING REGIONS OF WA
Scale
0 100 200 300 400 Km
Legend
Pastoral
Wheatbelt
Northern Sandplain
Southern Sandplain
Northern Forest
Southern Forest
CALM
IMB Ref 15313
116°
120°
124°
128°
14°
18°
22°
26°
30°
34°
112°
Broome
Kununurra
Port Hedland
Carnarvon
Geraldton
Northern Territory
South Australia
INDIAN OCEAN
Pastoral
Northern Sandplain
Kalgoorlie
Merredin
PERTH
Wheatbelt
Southern Sandplain
Esperance
Eucla
Northern Forest
Bunbury
Katanning
Albany
Southern Forest

FIGURE 1-2

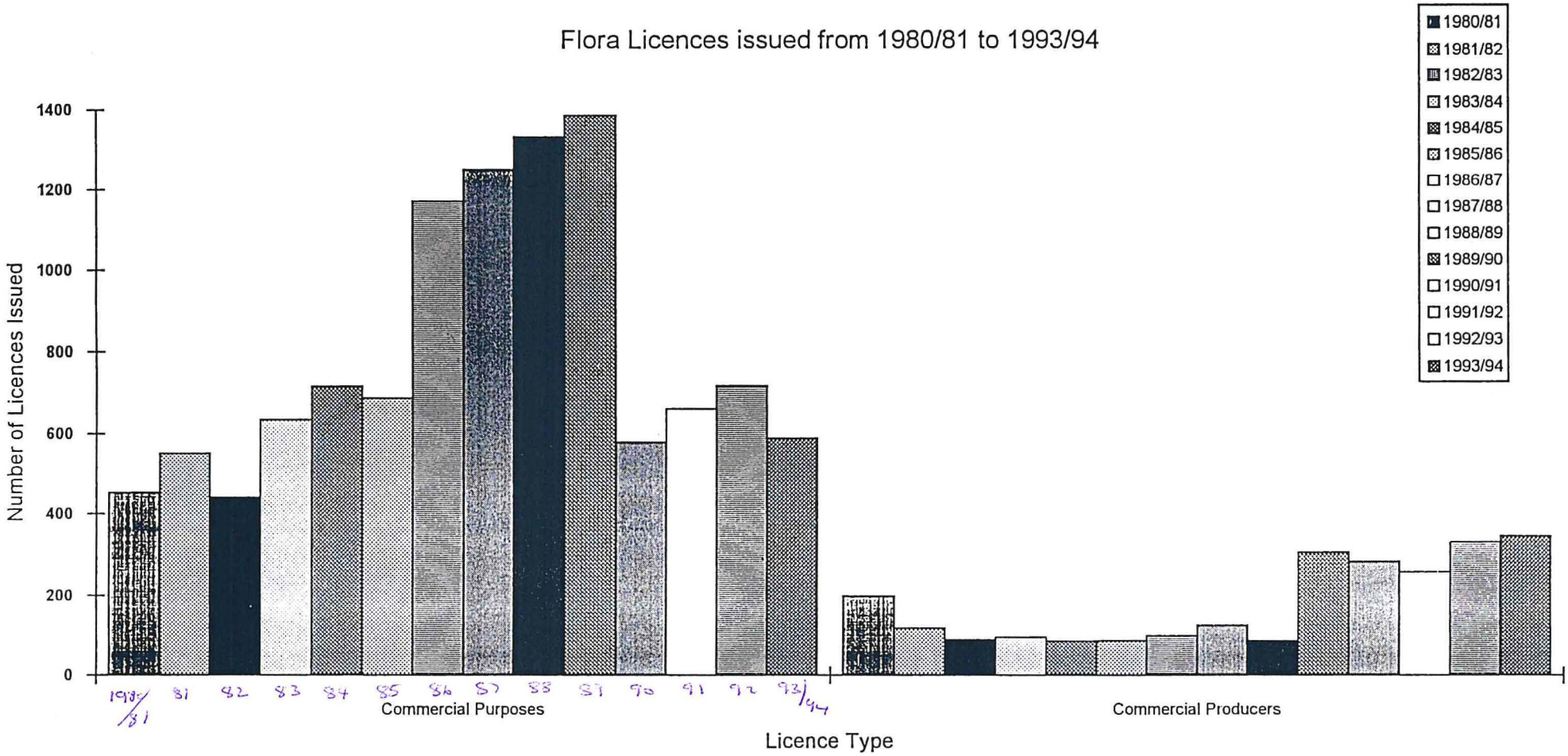

FIGURE 1-3

FLORGRAP

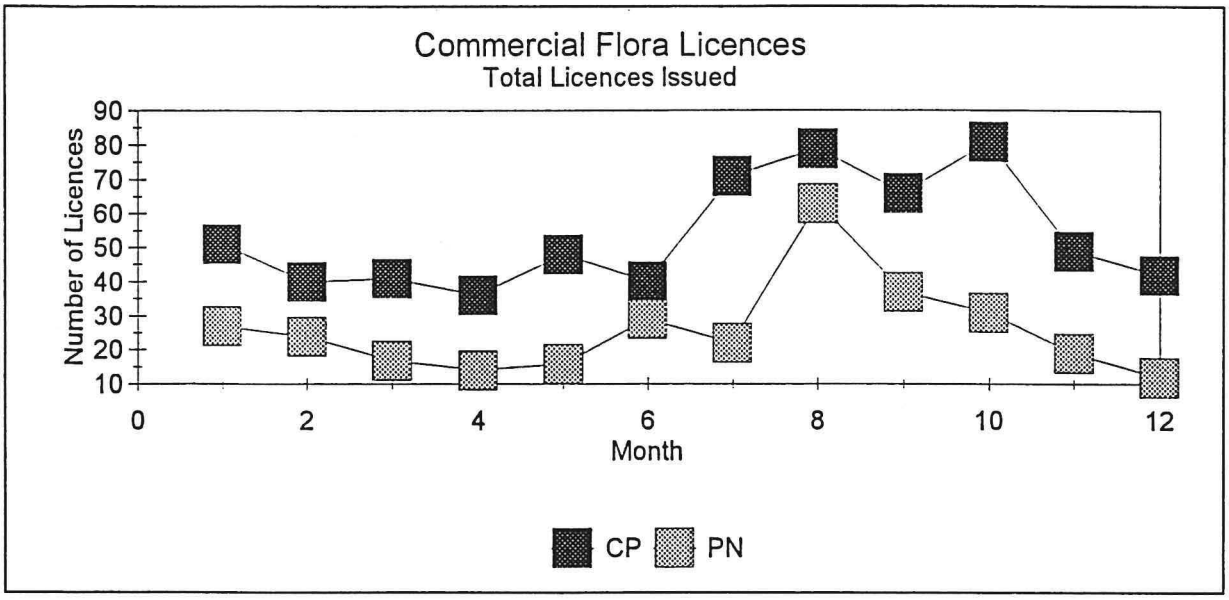

FIGURE 1-4
NUMBER OF COMMERCIAL FLORA LICENCES ISSUED BY CALM EACH MONTH IN 1993

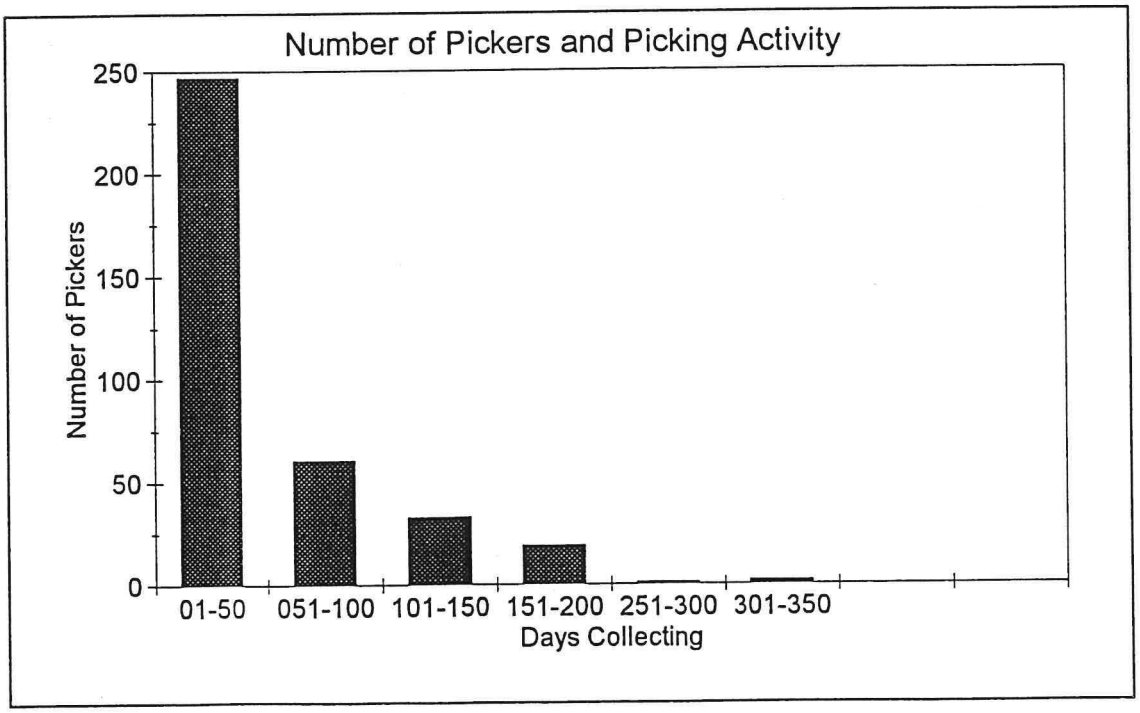

FIGURE 1-5
LEVEL OF PICKING ACTIVITY (NUMBER OF DAYS COLLECTING) IN 1993

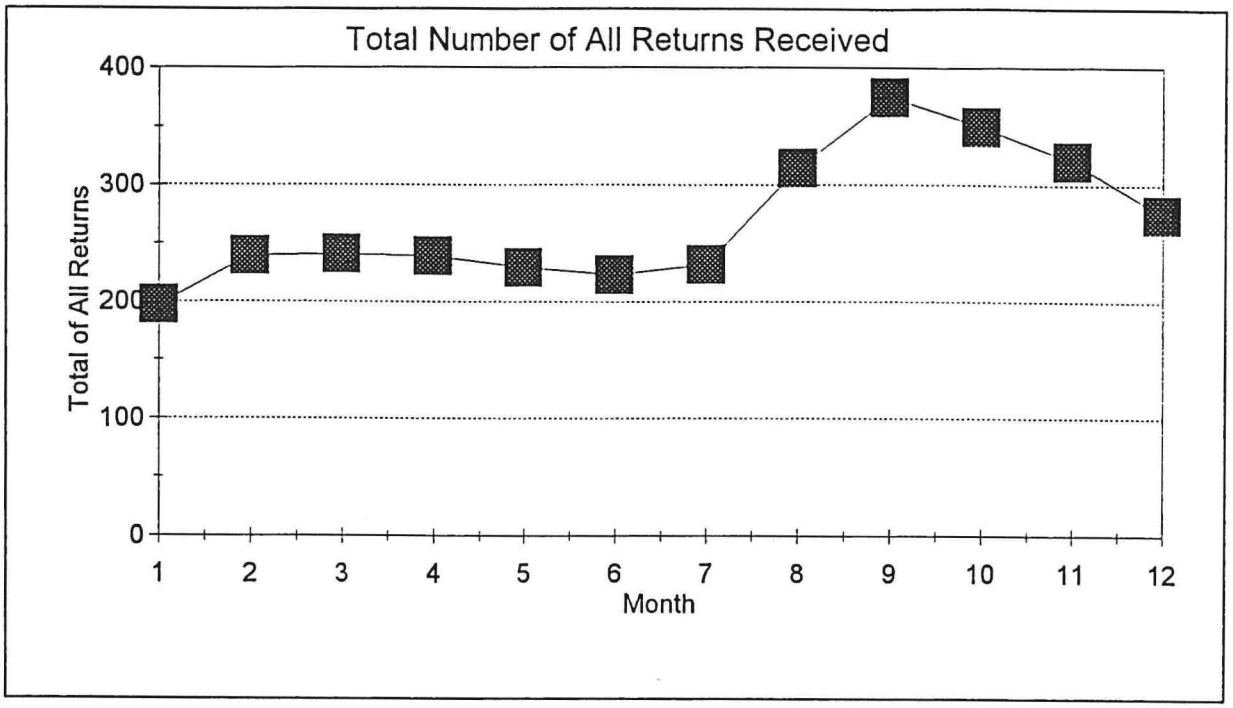

FIGURE 1-6
TOTAL NUMBER OF ALL COMMERCIAL FLORA RETURNS RECEIVED EACH MONTH IN 1993

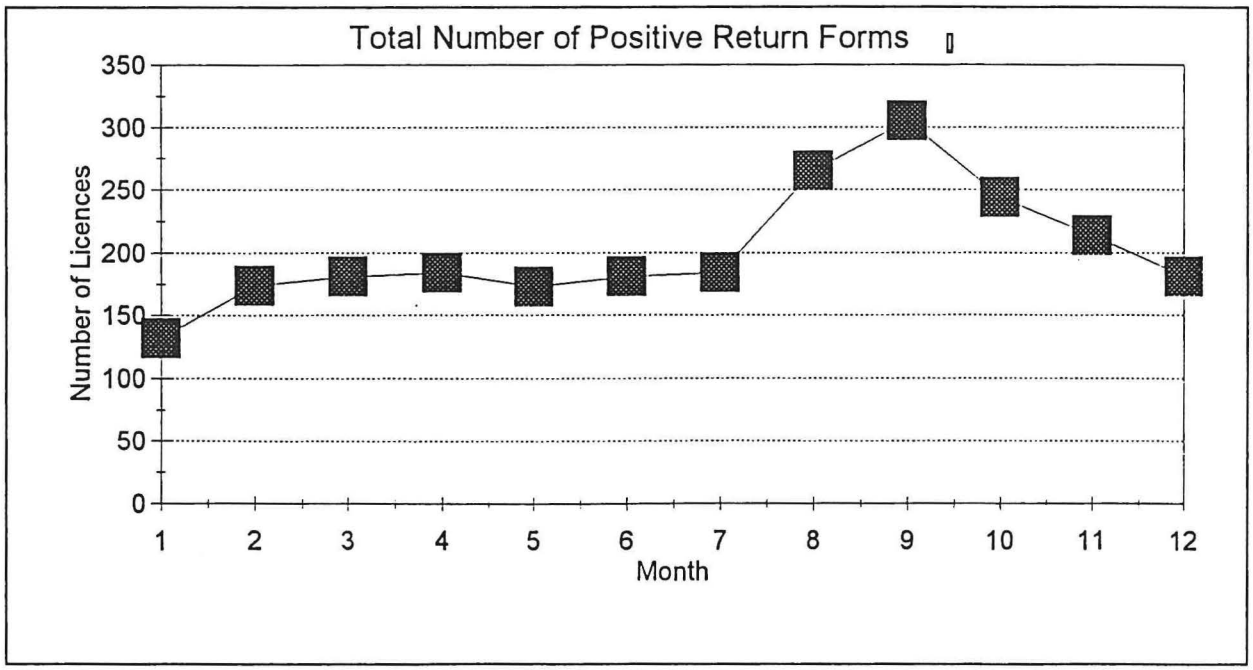

FIGURE 1-7
TOTAL NUMBER OF ALL POSITIVE COMMERCIAL FLORA RETURNS RECEIVED EACH MONTH IN 1993

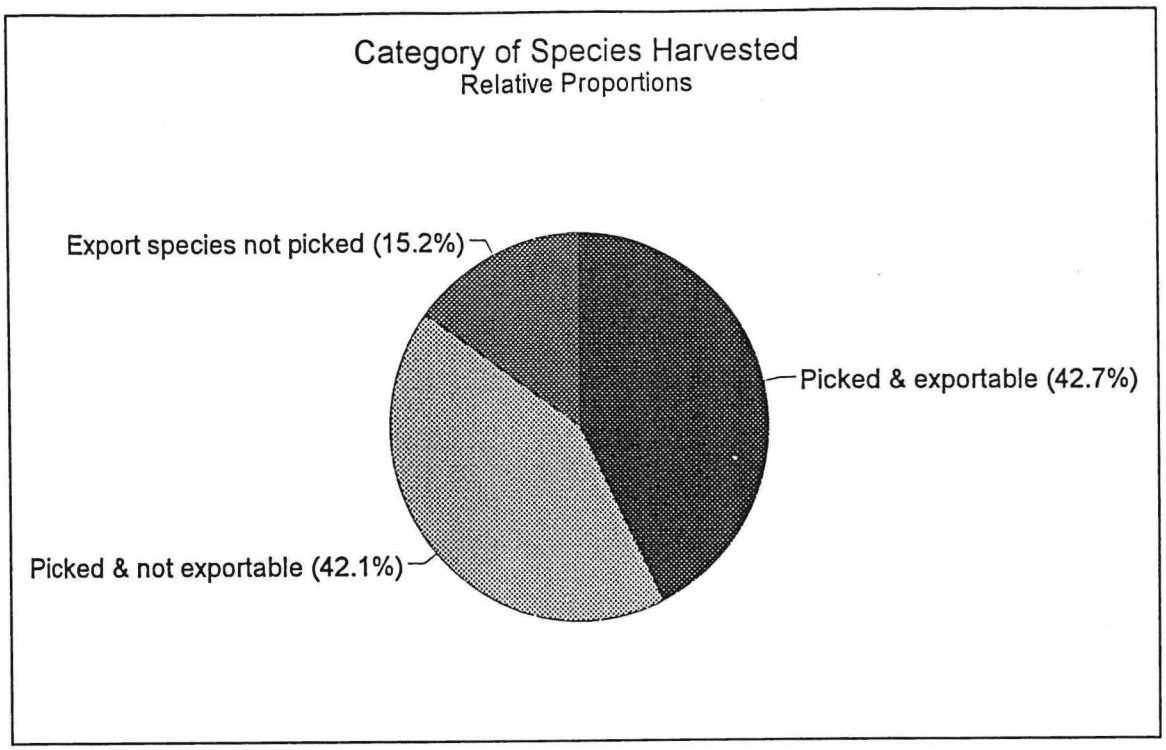

FIGURE 1-8
RELATIVE PROPORTIONS OF HARVESTED SPECIES

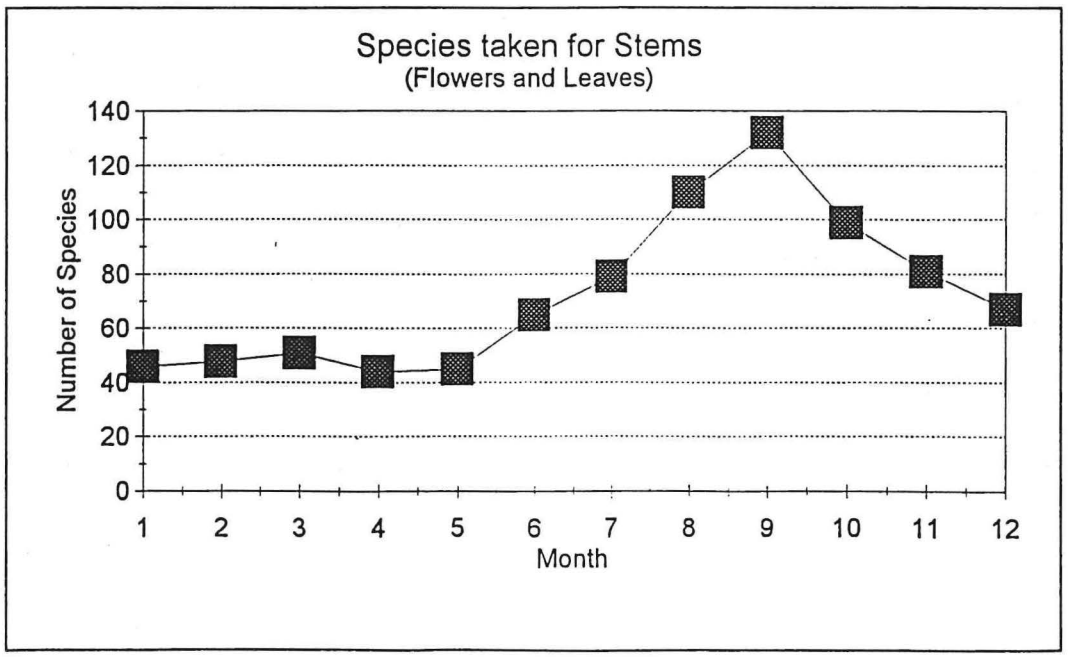

FIGURE 1-9
SEASONALITY OF HARVEST FOR SPECIES TAKEN AS STEMS
(FLOWERS OR FOLIAGE)

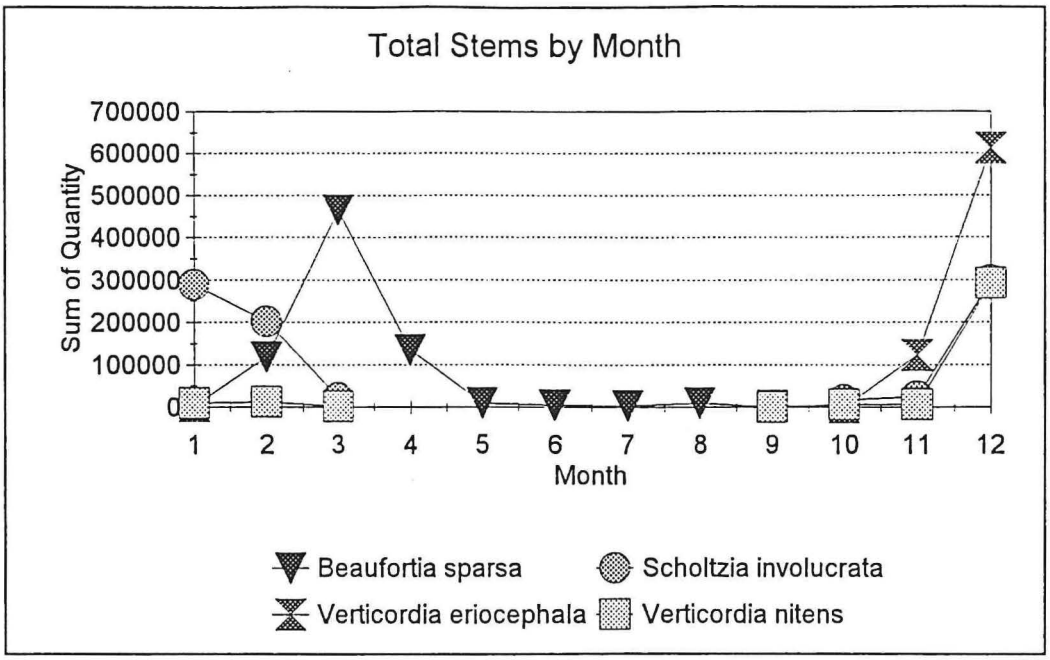

FIGURE 1-10
TOTAL HARVEST BY MONTH FOR HEAVILY EXPLOITED SPECIES
(Beaufortia sparsa, Scholtzia involucrata, Verticordia eriocephala, Verticordia nitens)

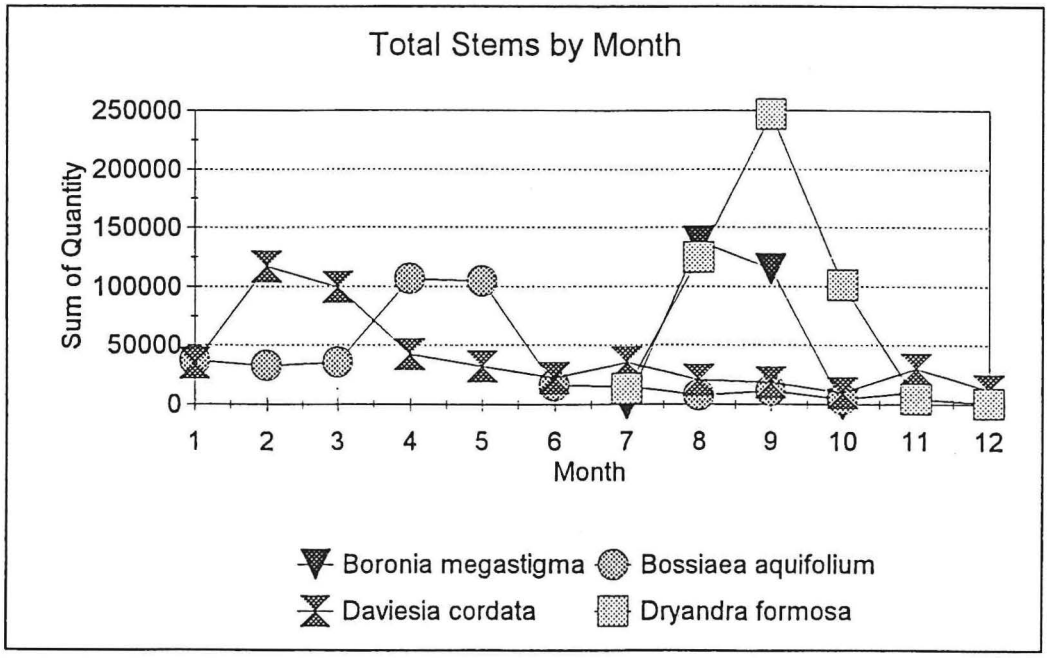

FIGURE 1-11
TOTAL HARVEST BY MONTH FOR HEAVILY EXPLOITED SPECIES
(Boronia megastigma, Bossiaea aquifolium, Daviesia cordata, Dryandra formosa)

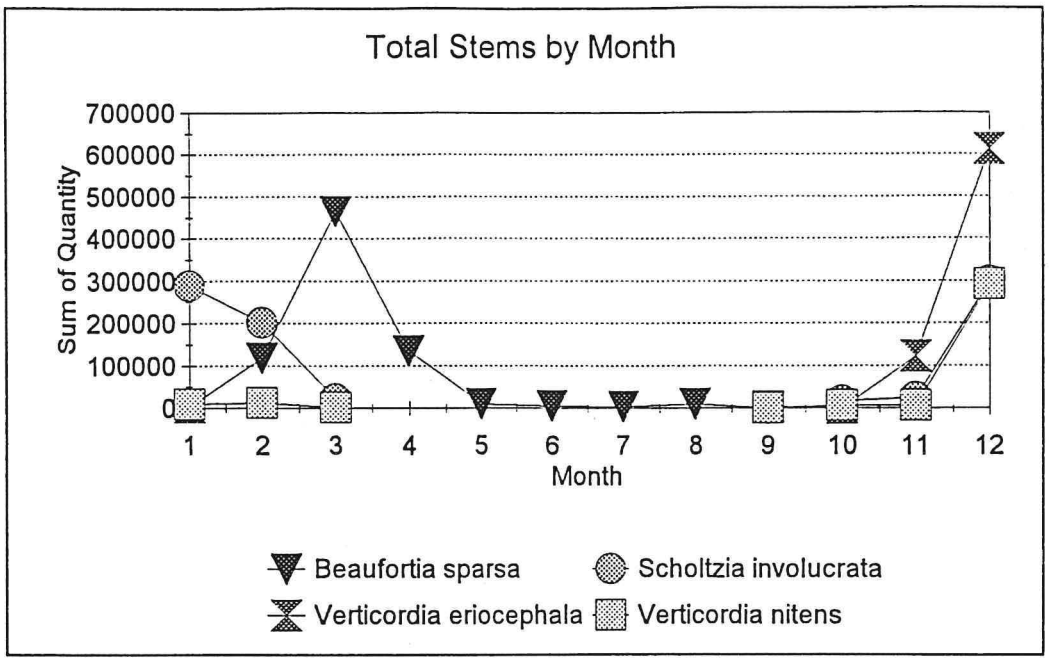

FIGURE 1-12
TOTAL HARVEST BY MONTH FOR HEAVILY EXPLOITED SPECIES
(Caustis dioica, Leptocarpus scariosus, Persoonia longifolia, Xylomelum occidentale)

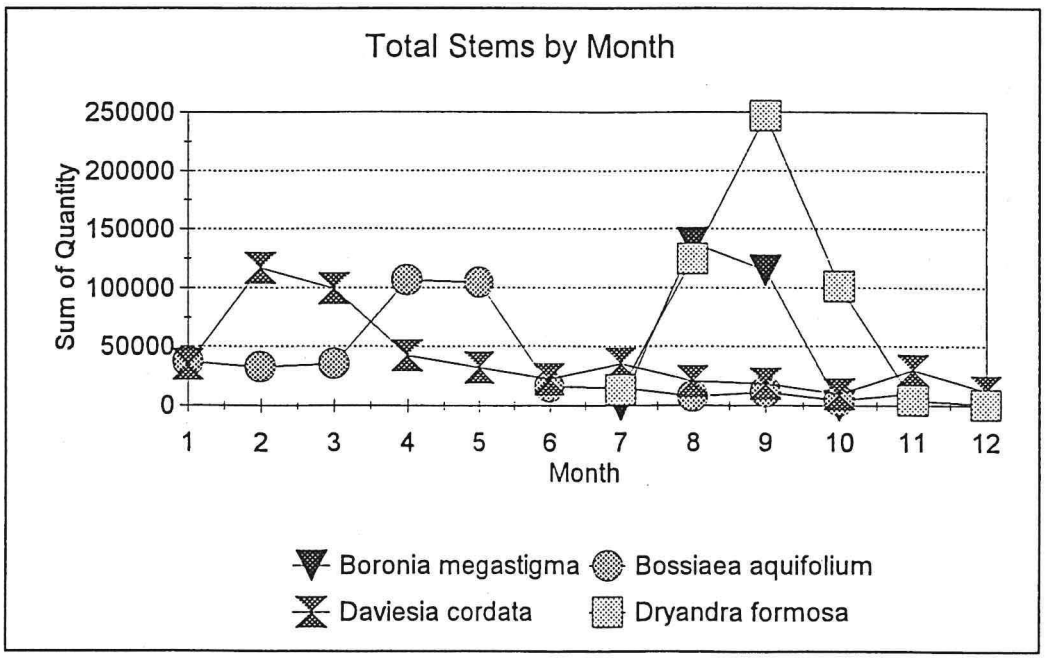

FIGURE 1-13
TOTAL HARVEST BY MONTH FOR HEAVILY EXPLOITED SPECIES
(Agonis juniperina, Agonis parviceps, Podocarpus drouynianus, Stirlingia latifolia)

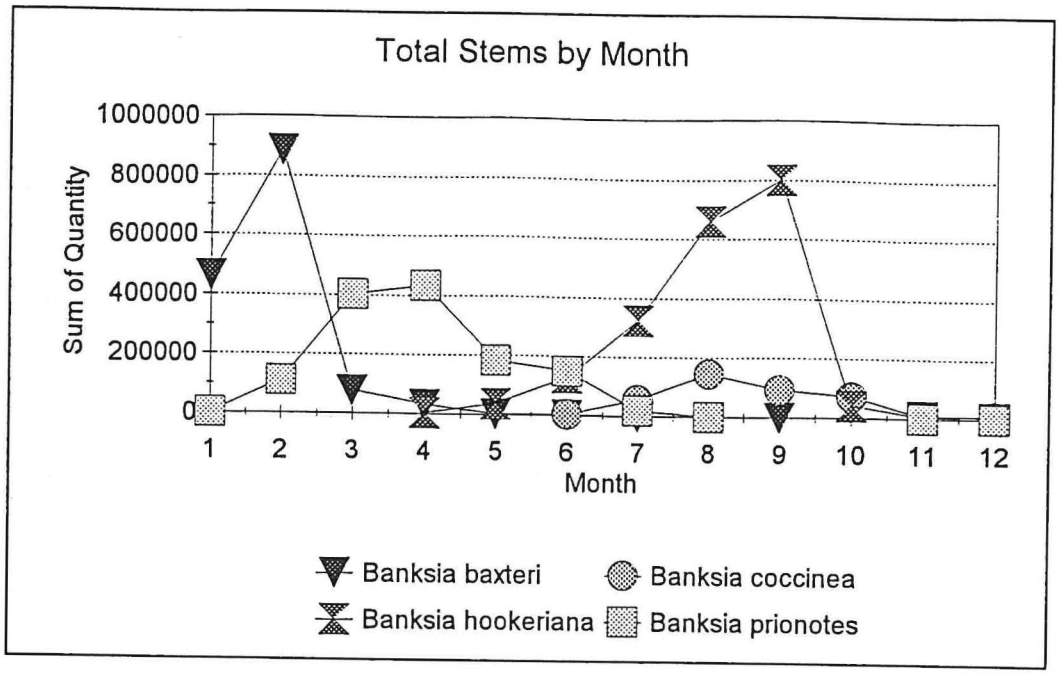

FIGURE 1-14
TOTAL HARVEST BY MONTH FOR HEAVILY EXPLOITED SPECIES (Banksia baxteri, Banksia coccinea, Banksia hookeriana, Banksia prionotes)

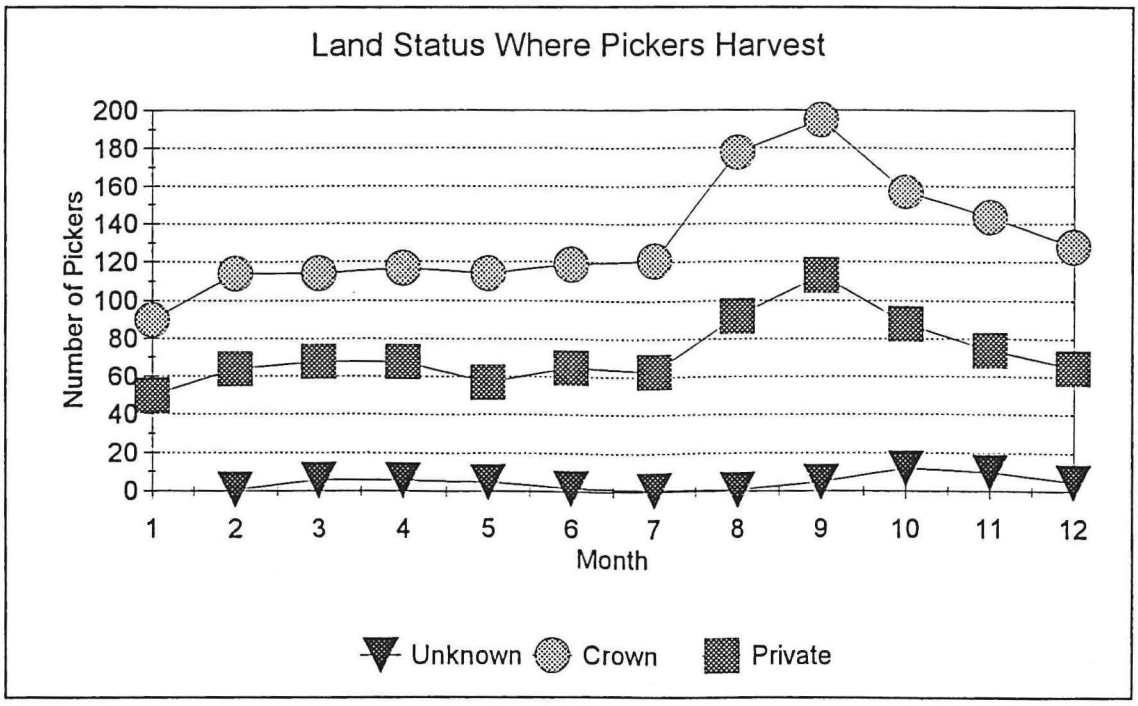

FIGURE 1-15
LAND STATUS OF HARVEST AREAS BY MONTH

PART 2 DATABASE OF WESTERN AUSTRALIAN FLORA EXPORT SPECIES

1. INTRODUCTION

The Flora Export Database Management System contains biological and ecological information for the 191 flora species[1] listed under the 1995 draft WA Flora Management Program as being approved for export. The data are stored in a relational database management system. A printout of the database forms Appendix 2A of this report.

A further database table has been set up to provide information on industry requirements. This table has not been fully developed at this stage.

This section provides a practical guide to the structure and contents of the database. It should be noted that the database is not, and never will be, complete as new information constantly is generated. The current project has established the basic database with information obtained within the time frame available. Ongoing data input will fill in the gaps in information.

2. METHODOLOGY

2.1 Data Structure.

Data for each taxon is divided into three sections containing the following information:

- a taxonomic section (from a table called "Exportsp");
- an ecological section (from a table called "Conserv"); and
- a section for additional notes (from a table called "Notes").

Further details of the structure of the database are contained in Appendix 2A.

2.2 Taxon and Population Data

Within one particular species there may be several forms, subspecies, or varieties that the industry harvests. If these are distinct enough (i.e. easily recognised by the industry as different plant names on their flora returns), they are represented on separate forms in the database. An example of this is *Rhodanthe chlorocephala* (the two subspecies are dealt with on separate forms). Infraspecies levels are usually not taxonomically distinguished on the returns and they are catered for in the database by the creation of more than one record for the species concerned.

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[1] The term species is used in a generic sense to include intraspecific taxa, such as subspecies and varieties.

Facts likely to pertain to all taxonomic levels of a particular species are recorded on the first page; however, in several cases, particularly the *Banksia* dieback information, information may be misplaced on the first page when the first page is in fact **not** a general species page and was simply the first population/variety entered. This aspect of the database needs correcting. One cannot mix general species information with information for a particular variety or population. The problem originated when the first page was usually reserved for the biggest subspecies/variety/population, rather than an overall species description. Lack of time precluded a final decision on this aspect.

2.3 Data Validation

Look-up tables which restrict the valid data values are available electronically for all the database categories except where the the range of possible entries is so large (and their combinations even larger) that no look-up table could be provided (e.g. dependent species). Look-up tables are supplied for the following categories:

2.3.1 Fire

The following categories are valid:

H = Killed by high intensity fire
L = Killed by low intensity fire
K = Killed
N = Not killed

Generally, references do not state the intensity of fire and associated regeneration strategies for a species, so N and K are used in the database more frequently than H and L. A database designed by Wardell-Johnson [42] contains regeneration information pertaining to a fire of about 5000 kW/m, which might be best described as a moderate to high intensity fire.

Plants from [42] have been scored either N or K (with further elaboration in Notes regarding the degree of leaf scorch because the heat they were subjected to might not have reached the high intensity category.

Perhaps a better way of handling fire may be:

- killed versus not killed (categorising by % scorch rather than intensity);
- if killed, score how the seed is stored (soil, plant, other plants nearby); and
- if not killed then score the method of regeneration (lignotubers, etc).

using Gill's key (1981) of fire response.

2.3.2 Regeneration

The following categories are valid as regeneration strategies:

E = shooter
L = sprouter
S = seeder
A = sprouter and seeder
B = sprouter and shooter
C = shooter and seeder

Originally, the alternatives used were the regeneration category were:

- lignotubers;
- epicormics; or
- seed.

These were the categories used for scoring the genus *Banksia* in the *Banksia Atlas*. However, the categories needed changing when it became apparent that texts cited for other genera used different terminology (e.g. shooters and seeders, where a shooter could be a lignotuber or an epicormic). The categories were therefore amended accordingly. Usage of "E" was no longer confined to an epicormic plant, but to all shooters (arial shooters); and "L" was no longer for just a lignotuberous plant, but for all sprouters.

Further clarification of the regeneration method is given in the "Notes" section when the reference was more specific than just shooter/sprouter. However, because the "Notes" section generally had little space left for further clarification for the genus *Banksia*, the Banksias should be understood as having lignotubers if "L" is scored, and epicormics if "E" is scored.

It is difficult to know whether to generalise the items in look-up tables (thereby providing more consistent categories and thus facilitating future analysis), or whether to disregard this need in favour of greater precision. Generalisation in the case of the "regeneration" look-up table meant more literature could be sourced, but required there to be clarification in Notes in many cases. In some instances the Notes clarification might even possibly correct an incorrect generalisation: for example, if "soil suckers" and "basal sprouts" used in reference [42] were not in fact always the same as the database "sprouter", then the detail quoting the wording used in [42] will correct this. Obviously contacting the author of data needing clarification would solve these problems, but there was not always time or in some cases authors could not remember.

2.3.3 References

The referencing system (i.e. minimal allocation of reference boxes) was devised for speedy entry of information, the assumption being that information in any one section (e.g. the habitat section) would all be from one reference. Unfortunately, this did not always turn out to be the case, but it is in many instances not difficult to work out which reference in the group at the start of a section is the source for a particular piece of information. Forty four references were cited (including 12 personal communications).

The full bibliography forms Appendix 2B of this report.

2.3.4 Landform

The categories of landform are not mutually exclusive. This allows for variation obtained from the literature references. The following are valid data:

HT = hill/mountaintop
SS = steep slope (>20 degrees)
GS = gradual slope (<20 degrees)
VA = valley bottom or swale
RK = rock outcrop
US = undulating sandplain
FL = flat
SP = swamp
SW = seasonally wet swamp
DP = damp/seasonally damp
LE = lake edge
CK = creek or creek bank
RB = riverbank or dry bed
CO = coastal
SD = sand dune
PR = plateau/ridge
LL = low-lying
DA = disturbed areas
MH = many habitats

2.3.5 Soil

Several soil types, or combination of soil types are given, again reflecting the diversity of detail cited in the literature. Many botanists commented on how poor their knowledge of soils and rock types was. An attempt to define a good series of soils for the look-up table was abandoned when it became apparent that no one system was being used in the literature, and that trying to condense the information into one box was a mistake. To resolve this, two boxes were provided and a category called "many" was added when it became too difficult to cover the diversity of soils for some taxa. The database is a record of already available information from reliable sources, and summarising data carries an inherent possibility of misinterpretation. The following are soil type codes used in the database:

S = sand
L = loam
C = clay
G = gravel
R = rocky, stony
T = lateritic
P = peaty sand
N = sand over laterite
Q = sand over clay

V = sand over rock
GL = gravelly loam
GS = gravelly sand
SL = sandy loam
CL = clay loam
SC = sandy clay
LS = loamy sand
M = many

2.3.6 Soil colour

The following soil colours are valid values:

B = brown
G = grey
K = black
R = red
W = white
Y = yellow
O = orange

2.3.7 Base Rock

The following values are allowed as base rock types:

dol = dolerite
gra = granite
lat = laterite
lst = limestone
qua = quartzite
iro = ironstone
sha = shale
sst = sandstone

2.3.8 Vegetation type (Muir)

The Muir vegetation classification system (Muir, 1977) describes the vegetation in terms of its strata levels, height and density. Muir coding is well suited for describing surrounding vegetation of a site occurrence of a species rather than that of its complete distribution. Vegetation lifeform is possible to find in the literature; but height, and certainly density are not commonly given to the extent needed to complete many Muir classification codes. Generally, this category could not be completed, so "Vegetation Structure Description" was filled in as a substitute.

2.3.9 Disease

Dr Ray Wills at the WA Herbarium, provided coding for *Phytophthora cinnamomi* for about 75% of the taxa, and habitat susceptibility to *P. cinnamomi* for about 50% of the taxa. He was also able to supply *Armillaria* and canker information for several

species. So that the remaining blanks can be filled in it might be necessary to redesign the database in this section. The present design relies on a scientist being able to fill in all disease information; however, this did not turn out to be possible. It is probably vital that whatever information is entered in this section is referenced directly alongside it.

Phytophthora cinnamomi

Coding for this category is from Wills (1993) as follows:

1 = Field resistant (good evidence)
2 = Field resistant (limited evidence)
3 = Field resistant (inferred evidence)
4 = Low susceptibility (inferred evidence)
5 = Low susceptibility (limited evidence)
6 = Low susceptibility (good evidence)
7 = Variable susceptibility (inferred evidence)
8 = Variable susceptibility (limited evidence)
9 = Variable susceptibility (good evidence)
10 = High susceptibility (inferred evidence)
11 = High susceptibility (limited evidence)
12 = High susceptibility (good evidence)

The same coding system is used for the following look-up tables:

- Habitat (susceptibility to *P. cinnamomi*)
- Canker

Not all species have data for habitat susceptibility to *Phytophthora cinnamomi* or species susceptibility to canker.

Other Phytophthora

This data has yet to be obtained

Armillaria

Habitat susceptibility to *Armillaria* was coded as follows:

Yes = Habitat susceptible to *Armillaria*
No = Habitat not susceptible to *Armillaria*

There are no electronic look-up tables for the following categories:

2.3.10 Form

For each species the height is given (usually in metres) sometimes followed by "tall" or "high". Occasionally width is given also, (eg if dimensions are a x b, then b = width).

2.3.11 Flowering months

Bracketed months denote extremes or alternative months found from further literature research. A markedly different flowering period found from this research is included as a second entry separated by a slash or semicolon from the first flowering period.

Banksia Atlas [1] information gives flowering months related to degree of opening of the flowers. Flowering periods taken for Banksias in the database are those for months in which "majority of flowers fully open".

2.3.12 Conservation Reserves

Examples of Conservation Reserves in which taxa occur are prefixed by "e.g". If it is believed that the list of Conservation Reserves given includes all conservation reserves in which the species occurs, "e.g." is not used.

2.3.13 Associated species

Examples of the species with which a taxon often occurs are listed. Generally the common associations are listed first, and less common associations are given in brackets.

2.3.14 Regeneration to fruiting

No information was found to enter in this section. However, this section is believed to be of importance for species management, and data will be pursued from non-published sources.

2.3.15 Regeneration to flowering

Generally this was taken to mean months to flowering since last fire, as opposed to months to flowering following germination from cultivated seed.

In cases where both sets of information were available, the cultivated information was relegated to the Notes section.

2.3.16 Dependent species

The species listed are mostly pollinators. Much detail has been supplied for the Banksias, because the Banksia Atlas [1] return form included this aspect.

nb = native bee
b = bee
ehb = European honey bee
f = fly
bf = butterfly
w = wasp
a = ant
m = moth

blf = blowfly
be = beetle
jb = jewel beetle
aph = aphid
Sch = spiny-cheeked honeyeater
NHh = New Holland honeyeater
Bh = brown honeyeater
Sh = singing honeyeater
Wch = white-cheeked honeyeater
Tch = tawny-crowned honeyeater
Fh = fuscous honeyeater
Flyc = flycatcher
Gb = grey butcherbird
L = lorikeet
Pcl = purple-crowned lorikeet
Bc = black cockatoo
Mi = miner
Rtbc = red-tailed black cockatoo
Ro = rosella
Row = western rosella
Se = silver eye
Ww = western warbler
Th = thornbill
Es = eastern spinebill
Ws = western spinebill
Lw = little wattlebird
Rw = red wattlebird
PLp = Port Lincoln parrot
Rcp = red-capped parrot
Rtc = rufous treecreeper

2.3.17 Other abbreviations

Other abbreviations found in the database are:

woodld = woodland
shrubld = shrubland
CR(s) = Conservation Reserve(s)
NP(s) = National Park(s)
NR = Nature Reserve
occ = occasionally
lge = large
eph = ephemeral
peren = perennial
nthern = northern
uground = underground
/ = per
/ = or

2.4 Impact of Harvesting/Management Issues

In Napier (1984) [22] pickers repeatedly claimed picking or burning causes many species to flower more prolifically in future seasons. This was generally not considered appropriate for the database because it was unsubstantiated.

3. RESULTS

Data for 191 species are found in Appendix 2A. Where no data were available for the species, the species was included without data for reference.

4. DISCUSSION AND CONCLUSIONS

Using a restricted set of valid values increases the accuracy of data and facilitates statistical analysis. However, more generalised data may provide more information (but at a cost for analysis and data retrieval). The database design has attempted to use validated values for data that could profitably undergo analysis and for which defined values are few. Notes have been provided where these are believed to further the data.

Notes are usually referenced immediately alongside each fact, to clarify whether the note is an explanation of a "Conservation" fact, or another idea from a separate reference. In view of this, more specific referencing alongside each fact in the Conservation section should perhaps again be considered.

It is strongly advisable to be very familiar with the list of export species before searching the literature. At the start of the project many ecological papers recommended by CALM were scanned for mention of any of the exportable species. Manually checking for any of +/-200 species was very time consuming, and in hindsight specific species research would have been prudent.

There is a vast quantity of literature available that has not yet been sourced. Other databases may be useful. For example, the WA Herbarium specimen database could be used for filling in some information gaps.

The universities have not yet been contacted, either for accessing university publications and unpublished reports that are not in the public domain, nor for personal interview with researchers. Other contacts that were not able to be made during the course of the project include Dr S.D. Hopper (*Banksia*), Dr E. Bennett (*Conospermum*), Dr K. Dixon (Restionaceae), Mr G. Keighery (general) and other CALM specialist staff.

There is a divergence of opinion on the impact of harvesting on species and ecosystems. The database's species-by-species approach (and even better still population-by-population approach) is well-placed to further an understanding to address the divergence, because it is probably only at that level that both the industry and conservation interests can be discussed.

The flora industry has claimed that harvesting promotes flowering, however, no research has been undertaken to substantiate this. In the future, it might be useful to have scientific evidence dealing with this issue, including for each species for example whether a plant dies earlier than its unburnt/unpicked counterparts. For *Stirlingia latifolia*, for example, Ladd and Connell (1994) [44] suggest that flowering deteriorates with time 3 years after fire. This needs further elaboration, but it is this kind of data that is of great importance to managing the industry.

Napier (1984) did not investigate these matters sufficiently to generate confidence in answering the question of viability of a harvested species. In particular we need to know how quickly populations re-establish themselves (Dr Steve Hopper, pers. comm.).

The ability of a species to withstand picking can be summarized in only a few lines if definitive research has been undertaken. However, for most species data are limited, or may be conflicting. It is therefore believed that until additional research is carried out, the database may serve to represent the variety of opinion.

It is necessary to detail all aspects that might make a species vulnerable to harvesting. Unfortunately, these can be lengthy. For example, scientific papers can take pages explaining the reproductive biology of a species, and its possible reaction to disturbance events such as fire. With this in mind it might be considered necessary at some stage to redesign the format so as to allow for more information to be added to the database. In the meantime, the references that are listed may be sourced for such detailed information.

The database provides a simple means of identifying species requiring special management, e.g. reseeders may need time to build up seed banks, or particular fire management. Once all existing information has been sourced, and entered into the database, the spaces remaining will indicate exactly what further botanical research needs to be done.

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