

# Botanical Indicators in Historical Archaeology

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*Although plants can be found growing on the surface of many Australian historical sites, archaeologists have given them relatively little attention, except to note the presence of fruit trees or other remnant exotic species. In this paper, Sue Pearson, of Tamworth, New South Wales, discusses a research project in which she examined the use of plants as indicators of historical archaeological sites in Australia. On the basis of fieldwork at a selection of sites in north-eastern New South Wales, she was able to demonstrate that plants can assist in site location and assessment, thus avoiding the high equipment costs of some prospecting methods and the damage to sites caused by test excavation. She describes a method for the botanical examination of the surface of historical sites and recommends that further work on this subject should be undertaken.*

## INTRODUCTION

In this age of rapid development, the location and recording of historical archaeological sites is of prime importance. In the past, excavation has figured prominently as a method for the initial investigation of such sites, but this method is increasingly seen as a last resort, as it is, by its very nature, a totally destructive process,<sup>1</sup> expensive, time consuming and labour intensive.<sup>2</sup> Written records may exist to indicate the location of a particular site and the features that were once part of that site but whether or not records exist, when field studies are attempted historical sites often prove to be characterised by shallow, vegetation-covered deposits with few surface clues to indicate the location of the features to be investigated.

The shallow nature of many Australian historical archaeological deposits can be attributed to the fact that a mere 200 years comprises the whole period of European settlement, while the lack of surface indicators can, for the most part, be ascribed to past construction methods. These methods often involved timber or bark walls supported by wooden bearers placed directly on the ground or structures elevated on wooden 'stumps'. In both instances, few, if any, traces have subsequently been left on the surface of the site to indicate the position of these structures.

In order to locate features in the situations just described, it has been usual to resort to test excavations or aerial photography or one of a variety of geophysical procedures such as resistivity and magnetic survey methods. Without exception, all these techniques are either expensive, time consuming, destructive or require a considerable degree of expertise. To overcome these problems, any new technique would have to be capable of being applied quickly and easily, require no expensive equipment or specialist knowledge and disturb the site as little as possible. An attempt to formulate such a technique became the subject of a B.A. Honours thesis, that was undertaken during 1986 through the Department of Archaeology and Palaeoanthropology in the University of New England.

## BACKGROUND AND HISTORY

Plants have been recognised as site indicators since 1541, when John Leland commented on the differential growth rate of crops growing on the site of Silchester, a Romano-British town in Hampshire, southern England, that was abandoned some time after the fifth century A.D.<sup>3</sup> Studies in overseas countries into the use of plants as archaeological site indicators have taken many forms and covered a relatively wide variety of situations.<sup>4</sup> The use of plants in Australian archaeology, however, would appear to have been confined to investigations into the foods associated with prehistoric societies,<sup>5</sup> plant taphonomy,<sup>6</sup> pollen and other micro-fossil studies,<sup>7</sup> fire<sup>8</sup> and climate.<sup>9</sup> Although aerial photography would seem to be one area of

archaeological investigation that has consistently used plants as site indicators,<sup>10</sup> in Australia its use would appear to have been restricted to very few researchers.<sup>11</sup>

Apart from a few exceptions, there has been very little work undertaken on the association of plants with archaeological sites in Australia. The exceptions, in the main, consist of studies such as the unpublished theses by Gillespie<sup>12</sup> and Winston-Gregson,<sup>13</sup> and the mention by Connah of exotic trees near abandoned building sites on Saumarez Station, Armidale, New South Wales, of changes in the vegetation on a shell midden near Kempsey, New South Wales, and of crop-marks on an aerial photograph taken near Wagga Wagga, New South Wales.<sup>14</sup> It may also be possible that studies have been undertaken and not published but in general, on the rare occasions when observations on this type of association have been made, they have usually been confined to unreferenced statements such as: 'What is left then are poignant reminders of a former home in the shape of sheltering trees, the remains of an orchard or a garden...'.<sup>15</sup>

## PLANTS AS SITE INDICATORS

Given that an archaeological site is a place where evidence of past human activity may be found and that artefacts are the products of that activity, it is possible to argue that the plants on an archaeological site may be seen as a type of artefact. The plants that could be seen as artefacts would be native plants left standing during clearing operations, weed species, both native and naturalised, and/or garden escapes which have colonised disturbed ground after the abandonment of a site, and exotic plants (which are defined as being any plant introduced into an area from some other location, including native species that have been introduced into an area in which they are not normally found). During the course of the project two main types of exotic plants were encountered; those that were introduced weed species and those that were cultivated species that had once been part of a garden associated with a site. To distinguish between these two categories of exotic species, the cultivated species, because they represented a small remaining part of a garden and were important to the study as site indicators, were referred to as 'remnant exotic vegetation'. The introduced or exotic weed species, on the other hand, were included in the general list of plant species present on the site, because their importance to the project lay not in whether they were introduced but whether there was any variation in their proportional representation on the site.

If plants are to become site indicators, they have to be able to survive in a habitat that may not be their natural environment. If they are unable to do this, the plants that replace them, or the descendants or successors of the replacement plants, have to be able to be recognised so that they can then become the site indicators. However,

before any plants could be used in this capacity it would have to be established that they were present on a site as a result of past human activity, even though they were not directly part of that activity. To achieve this it would be necessary to identify the type of plants that are associated with archaeological sites and to establish that the plants are there because there is a direct link between them and the site, and that they had a part to play in the archaeological site formation processes.

When a site is abandoned some plants are able to take root and grow, establishing a simple community. Changes in the structure and composition of this community then proceed at varying rates until a point of dynamic equilibrium is reached and the community becomes more or less stable.<sup>16</sup> The first organisms to become established in this process of community establishment and change, referred to as a succession, are known as pioneer plants. These pioneers are usually weed species, that is, in this instance, plants that are adapted to exploit disturbed areas of land<sup>17</sup> and which have no economic value or are a nuisance in the particular location in which they are found.

Just as artefacts and non-artefactual materials are affected by soil pH, so too are plants. The degree of acidity or alkalinity of the soil is responsible for the availability of plant nutrients<sup>18</sup> and is therefore a limiting factor for plant growth. Some plants are able to grow over a wide pH range, while others are restricted to either acid or alkaline soil conditions.<sup>19</sup> Every plant has its own range of physical and chemical requirements and therefore natural growth on a soil can provide some evidence about that soil. This can be exemplified by alkaline soils that often develop from limestone rocks and, as a consequence, cause iron and phosphorus to form insoluble salts which then become unavailable to ordinary plants, even when the nutrients are present in large amounts. To overcome this situation some wild plant species have evolved the ability to obtain nutrients under these conditions, with the result that a vegetation type that is indicative of limestone regions is produced.<sup>20</sup> When plants that are indicative of a particular soil type suddenly occur in a community that is associated with a different soil type, it becomes obvious that something must have brought about a change in the soil at that particular location. For example, an aerial photograph of a shell midden at Clybucca near Kempsey, New South Wales, shows a dramatic vegetational change between the midden and the area surrounding it.<sup>21</sup> It is this type of vegetational change that should be capable of being exploited to locate archaeological sites.

It can be further argued that if a building or some other structure has been present on a site, it must have occupied a specific area for the period of time from construction to demolition or removal. The area of soil on which the feature was located would have had plants excluded from it, either because of the presence of the feature itself or because the feature created conditions that were unfavourable for plant growth. For example, a wall would exclude plants on the area that it occupied, while a house would exclude plants by creating dark, dry conditions beneath its floors. During the period that plants were excluded from such an area, soil nutrients would not have been utilized and vegetable matter would not have accumulated. As a result of this, a comparison of the soil in the area of exclusion with the soil surrounding it should show higher nutrient levels and a reduced humus content in the area of exclusion.

A situation similar to this was indicated in a study carried out on the rangelands of the northern New South Wales Tablelands. In this study, it was shown that heavy grazing and the high input of animal waste in the vicinity of a sheep camp reduced the humus content and increased the nutrient levels of the soil. Also associated with the area was a striking zonation of native and naturalized grass species, that was thought to have been created by the differential response of the various plant species to the different nutrient and humus levels.<sup>22</sup>

Given the similarity of the soil conditions that were shown to exist in the above study and those thought to exist as a result of archaeological site formation processes, it should be possible to utilize zonation of vegetation to locate features that are no longer visible on archaeological sites. Confirmation of this proposition has, in fact, been provided by an investigation conducted by Helen Zeiner on the site of the Angel Mounds Indian village, on the Ohio River, Evansville, Indiana.<sup>23</sup> By sampling and observing changes in the vegetation and analysing soil samples taken at regular intervals along a series of transects that crossed the site, it was possible to locate the wall and some earthworks associated with the village. The soil changes were established by variations in the pH levels alone.<sup>24</sup> It was also shown that the length of time between the collecting and testing of the soil samples did not have any significant effect on the pH levels and therefore the soil analysis did not have to be undertaken with any haste after collection.<sup>25</sup> The results of this vegetation and soil analysis showed that there was a correlation between pH and the floral distribution of certain 'indicator' species and that certain common plants growing on the site were sensitive to pH differences of only a slight degree. Excavations across what was thought to be the wall site showed that the wall was in fact located where it had been predicted on the basis of vegetational changes.<sup>26</sup>

## THE RESEARCH PROJECT

It was the purpose of the project discussed in this paper to investigate and assess, under Australian conditions, the use of plants as a method of locating historical archaeological sites and features within those sites. If the use of plants was to be shown as a satisfactory means of identifying such sites and an alternative method to the digging of test pits to locate features, several important factors had to be kept in mind during the course of the investigation, particularly when the methodology was being devised. These factors were:

1. The method had to be able to be used by any field archaeologist, not just those trained in botany, soil science or chemistry.
2. The time involved in carrying out the procedures had to be less than that required for the digging of test pits, i.e. the fieldwork associated with data collection had to be able to be carried out quickly and easily.
3. Data had to be able to be analysed rapidly, and the use of laboratory facilities reduced as far as possible.
4. The costs of all procedures, equipment and materials, necessary for the gathering of data and its subsequent analysis, had to be minimal.

To satisfy the purpose of the project, it was necessary to demonstrate that:

1. Remnant exotic plant species were associated with historical sites.
2. There were differences in soil pH between the area where an historical feature had been located and the area surrounding the position of the feature.
3. As a result of differences in the soil pH, there were either complete changes or at least some variation in the proportional representation of the plant species in the area in which the pH changes occurred.

A total of eight sites were selected for investigation during the project. These sites were situated in four different locations in two

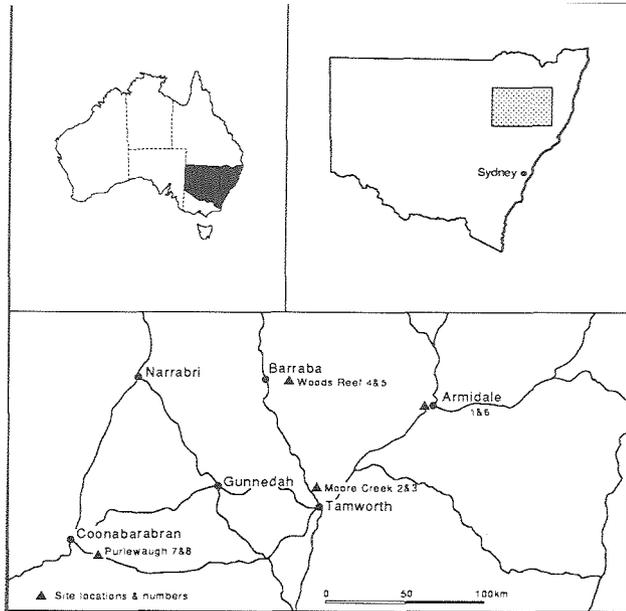


Fig. 1: Location of study area and sites.

contrasting geographical regions. The choice was limited to historical sites because, unlike prehistoric sites, they had documentary and/or oral sources that could provide a control. Two sites were chosen in each location, at Armidale, Tamworth and Woods Reef, in the New England region, and at Coonabarabran, in the Orana region (Fig. 1). By ensuring that one of the sites in each location had clear indications to show where a feature had been located and the other site displayed no such traces, it was possible to introduce a further control into the study. With the exception of Site 4 at Woods Reef, which was a school site that had been built in 1897 and abandoned twenty-one years ago, all the sites were house sites that had been abandoned between thirteen and approximately one hundred years ago.

In this paper only one of these sites will be discussed in detail, because the same methods were applied to all of the sites, the only variation being the number of sampling transects, which depended on the size of the site being investigated.

## METHODOLOGY

The initial problem when deciding on a methodology was that it had to be capable of modification to suit individual sites without distorting the results. Eventually the following procedures were decided upon:

1. All the sites were selected on the basis of remnant exotic vegetation being present, either on its own or in association with the remains of an historical feature such as the ruins of an abandoned building or traces of one that had been demolished or removed to another site.
2. Once the site was located, a 30 m tape was pegged out across the site so that it roughly bisected (and extended beyond) the feature or the area where it was thought a feature may be located (Fig. 2). This tape then became the base line from which all survey measurements were taken, and is hereafter referred to as the primary transect.
3. Using a second 30 m tape, offsets were taken from the primary transect to the various specimens of remnant exotic vegetation and to any features, so that their positions could be plotted on a map.

4. Each remnant exotic species was then assigned a unique number which was recorded in a field book, one number to a page. Two specimens of each species were collected and tagged with their species number. One of the specimens was taped to the page of the field book on which its number was recorded, while the second was placed in a plastic bag for later identification.

5. A series of secondary transects, 20 m long and identified by a capital letter, were set out at predetermined points along, and at right-angles to, the primary transect (Fig. 2). These secondary transects were established so that what is known as the point quadrat method of vegetation sampling could be employed.
6. A frame, 50 cm long with six points set at 10 cm intervals along its length, was placed on the ground with the first point on the end of the first secondary transect. Beginning at the second point, each plant whose base was touched by a point was recorded as a 'hit', while any points touching bare ground or an obstruction were recorded as a 'miss', and the nearest plant to that point was recorded. Where two or more points were associated with a single plant because of its size, the relevant points were entered as 'hits' and bracketed together at the time of recording. During the course of the sampling, any previously unencountered species was assigned the next of the consecutive identification numbers, and was tagged and sampled in the same way as the remnant exotic species had been. All 'hits' and 'misses' were recorded according to the species number, which was entered on a prepared sheet, an example of which is shown in Figure 3. After the results for each of the five recording points were obtained, the frame was turned over once and a further five points were recorded. The frame was then turned over twice to establish a non-recording

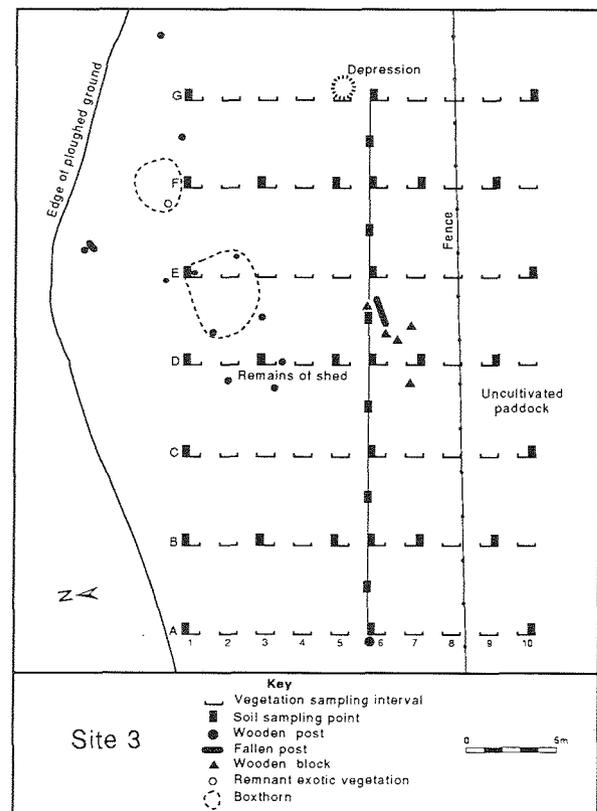


Fig. 2: Position of primary and secondary transects, vegetation sampling intervals, soil sampling points, features and remnant exotic vegetation on Site 3.

SITE: 3      TRANSECT: I      DATE: 31-7-86

Point No.	1	2	3	4	5	6	7	8	9	10
No. 1	29	37	37	49	25	38	38	38	29	29
No. 2	29	29	29	29	49	49	29	29	29	33
No. 3	43	25	25	43	25	25	25	49	43	43
No. 4	52	37	25	52	25	37	52	25	42	25
No. 5	37	49	50	50	25	50	50	50	21	50
No. 6	50	50	25	50	50	37	37	37	50	50
No. 7	51	51	37	25	37	37	50	37	37	37
No. 8	37	50	50	42	25	50	37	25	37	25
No. 9	25	25	25	25	25	25	50	50	50	50
No. 10	50	50	50	50	50	25	50	50	50	50

Fig. 3: Example of the work sheets used for the recording of the plant species sampled by the point quadrat method. Each pair of lines represents a recording interval, while the internal divisions either side of the numbers represent the sampling points. The numbers refer to the species identified at that point. Lines through the internal divisions indicate a 'miss' at that point. Numbers bracketed together denote the presence of a single plant that was recorded at two or more points.

interval of 1 m. This whole procedure was repeated along the entire length of the secondary transect, establishing 10 recording intervals, or 100 sampling points.

Because each recording interval had an exact position, it was possible to identify and map each interval by its transect letter and a number; for example A1 referred to the first recording interval and A10 to the last (Fig. 2).

- To establish if any significant changes in the soil pH were associated with the location of features and/or vegetational changes, soil samples were taken at the conclusion of the vegetational sampling. Using a 4 cm diameter pipe that was driven 8 cm into the ground, three samples of soil were taken from each of a series of predetermined positions along the primary and secondary transects (Fig. 2). Additional samples were taken at points sufficiently removed from the ends of the transects to render them 'off site'. This was done to determine if any soil changes that were present were the result of human activity or natural process.
- All soil samples were placed in plastic bags and labelled with the site number and sampling point. Plastic bags were decided upon as the storage method for the soil samples after enquiries were made about the likelihood of the plastic bags significantly changing the pH readings.<sup>27</sup> It was established that very slight changes towards the acid side could occur but at the level of accuracy that was being employed the readings were unlikely to be affected.<sup>28</sup>
- Once the collection of the field data was completed, a map was drawn for each site showing the position of any features, the

remnant exotic vegetation, and the transects and the sampling intervals for both the vegetation and the soil (Fig. 2). The soil analysis was carried out using an Inoculo Laboratories soil pH test kit, while the plant species were identified by the use of botanical keys and other relevant publications.<sup>29</sup>

- Following the identification of the plant species, the field sheets were checked so that any instances of a species inadvertently being given two identification numbers could be eliminated. Tables of species were then compiled, graphics showing the proportional representation of each species on each of the secondary transects were drawn and finally, the results obtained from the vegetational sampling were subjected to statistical analysis.

The only changes in the procedures consisted of varying the length of the primary transect and varying the number of secondary transects. All the secondary transects were standardised at 20 m unless an obstacle was present that prevented this. Where an obstacle was present, the plant nearest to the obstacle was recorded as either a 'hit' or a 'miss' and all the points thereafter were recorded as 'misses' until the obstacle was passed.

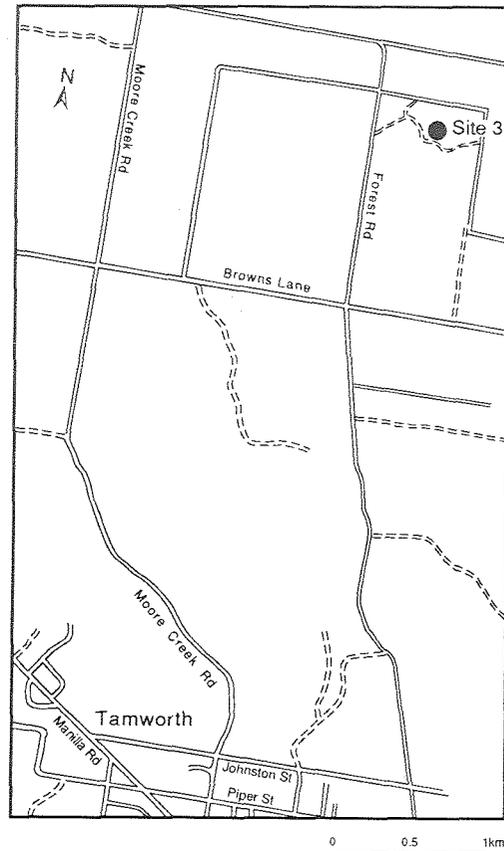


Fig. 4: Location of Site 3 in the Moore Creek area of Tamworth, New South Wales.

#### EXAMPLE SITE

One of the eight sites examined will be discussed as an example of the application of this technique. This site, designated Site 3, was a house site situated on the northern slope of a hill on the property Moorsville, located about 3 km north of Tamworth, in New South Wales (Fig.4).

The house, built by the original selector of the land, had been lived in continuously by his son from the time of his birth in 1900 until 1948, when he moved his family into a new residence a short distance



Fig. 5: View across Site 3 looking west. The large wooden post that was used as the datum point can be seen in the background. Divisions on the scale represent 10 cm.

away. Following its abandonment, parts of the old building were salvaged for use in the construction of various sheds on the property and the site was levelled by a bulldozer.<sup>30</sup> All that remained of the house site at the time of its examination was a small strip of land that lay between a fence and a ploughed paddock (Figs 2 & 5). Several upright poles with cross members that appeared to have belonged to an old shed, six small, rectangular wooden blocks set in the ground near the fence and a few bits of broken brick scattered about, were the only traces of occupation left on the site. A large wooden post, that may have been the corner post of a fence, was located at the western end of the site. The only example of remnant exotic vegetation present was an old fig tree growing within the confines of a thorn bush (Figs 2 & 5). When this site was chosen, a specific request was made that only the general location of the site should be made known, as the owner's long association with the site provided an excellent opportunity to test the accuracy of the method for locating specific structures. It was proposed that following the analysis of the results, a map showing the estimated location of the house would be submitted to the owner for confirmation.

The large post at the western end of the site was used as a datum point. A 30 m base line was established from the bottom of this post, and the first of seven secondary transects was set at right-angles to its base. The remaining six secondary transects were positioned at 5 m intervals along the primary transect, with soil samples being taken every 2.5 m along its length. Secondary transects A,C,E and G provided three soil sampling points each, while B,D and F provided six points each. Additional soil samples were taken at points 20 m from either end of the primary transect, at points 10 m from C10, D10, E10, F10 and G10 and at points 14 m from E1, 11.6 m from F1 and 9 m from G1 (Fig. 2).

The exotic remnant vegetation and large plant species together with surviving features and the position of the transects and soil sampling points are shown in Figure 2. Table 1 presents a list of the vegetation sampled on the site. The fig, being the only example of remnant exotic vegetation, is indicated in the species list by an asterisk. Figure 6 shows the percentage representation of each species in the sampled vegetation on each secondary transect and Figure 7 shows the pH values.

Statistically, differences in the proportional representation of the vegetation were shown to exist over the site and between the secondary transects A and C, and D and G. Chi-squared was exceeded at the 0.050 level when B and C were compared, but no significant difference was shown to exist between the pairs of secondary transects C and D and F and G. Transects A and D were shown to be similar as a result of there being no significant difference between A and C. Finally, secondary transects C and D were shown to be significantly different from all the other secondary transects.

From the results obtained, the location of the house and garden was estimated, as shown on Figure 8. A map showing this was submitted to the owner of the property for confirmation of the actual location of the house. As can be seen the orientation of the estimated position was slightly incorrect but for the most part the estimation was close to the actual location.

Table 1: All species growing on Site 3. Asterisk indicates the only example of remnant exotic vegetation. Common names are shown where known. Species Number 42 could not be identified.

Sp. No.	Species	Common Name
7	<i>Carthamus lanatus</i> L.	Saffron thistle
17	<i>Elusine tristachya</i>	Goose grass
21	<i>Fumaria muralis</i> Sond. ex Koch.	Smoke weed
23	<i>Chloris truncata</i> R. Br.	Windmill grass
24	<i>Malva neglecta</i>	Mallows
25	<i>Medicago polymorpha</i> L. var. <i>vulgaris</i> (Benth.) Shin.	Burr medic
26	<i>Hordeum leporinum</i>	Barley grass
27	<i>Urtica urens</i> L.	Stinging nettle
28	<i>Marrubium vulgare</i> L.	Horehound
29	<i>Pennisetum clandestinum</i>	Kikuyu grass
31	<i>Cassia barclayana</i> sp. <i>barclayana</i>	
33	<i>Rumex pulcher</i> L.	Red dock
35	<i>Oxalis corniculata</i> L.	Yellow wood sorrel
36	<i>Argemone ochroleuca</i> Sweet.	Mexican poppy
37	<i>Silybum marianum</i> L.	Variogated thistle
38	<i>Bothriochloa macra</i> (Steud.) S.T. Blake	Red grass
39	<i>Phytolacca octandra</i> L.	Ink weed
40	<i>Lycium ferrocissimum</i> Miers.	African boxthorn
41	<i>Ficus</i> sp.*	Fig
42	Unidentified 2	
43	<i>Capsella bursa-pastoris</i> L. Medic.	Shepherds purse
44	<i>Stipa verticillata</i> Nees ex Spreng	Slender bamboo grass
45	<i>Stipa falcata</i> Hughes	Speargrass
46	<i>Asphodelus fistulosus</i> L.	Onion weed
47	<i>Kokia tamarascina</i> (Lindl.) J.M. Black	
48	<i>Parsoon eucalyptophylla</i> F. Mull.	
49	<i>Stellaria media</i> L. Vill.	Chickweed
50	<i>Cynodon dactylon</i> L. Pers.	Couch grass
51	<i>Lolium</i> sp.	Rye grass
52	<i>Portulaca oleracea</i> L.	Pig weed
53	<i>Geranium solanderi</i> var. <i>solanderi</i>	
54	<i>Dichondra repens</i> Forst et Forst. f.	Kidney weed

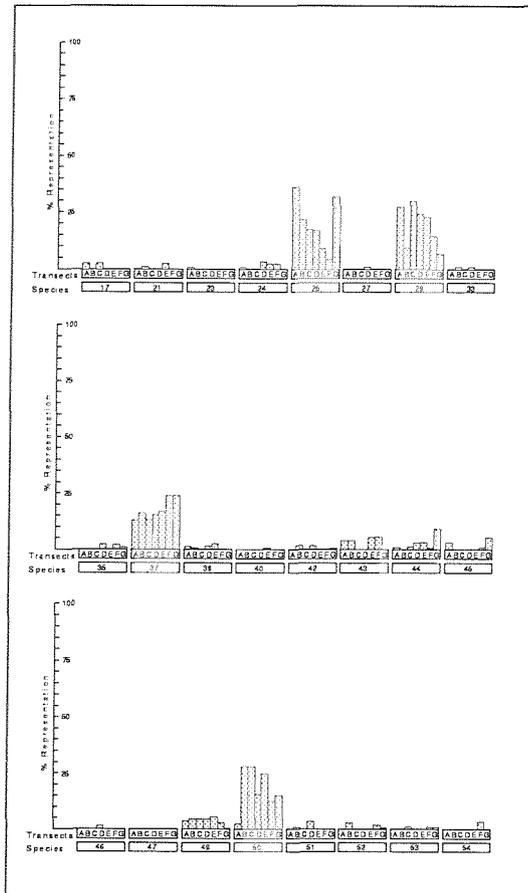


Fig. 6: Percentage representation of each species growing on the secondary transects on Site 3.

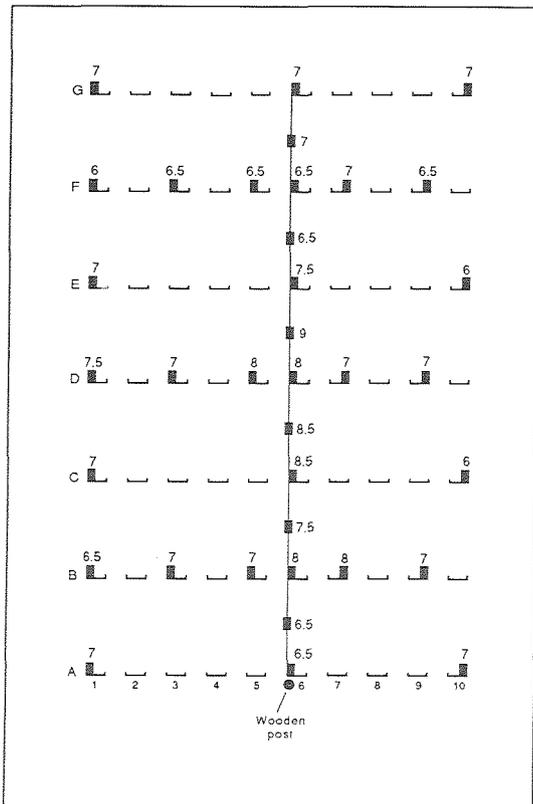


Fig. 7: pH values recorded on Site 3.

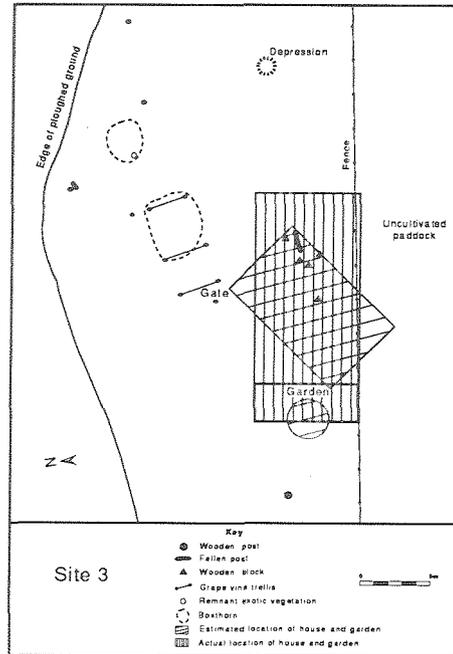


Fig. 8: Estimated and actual position of the house and garden on Site 3.

Table 2: Species present on three or more sites that were associated with the higher range of pH values. One species could not be identified.

Site Nos. on which recorded	Species	pH range
2,3,6	<i>Pennisetum clandestinum</i>	6-9
2,3,8	<i>Marrubium vulgare</i>	8-9.5
3,4,5	<i>Stipa falcata</i>	7-9
3,4,6	<i>Cynodon dactylon</i>	8-9
4,5,7	Unidentified 3	7-9
4,5,8	<i>Echinochloa crus-galli</i>	7-8.5
6,7,8	<i>Lolium sp.</i>	6-9
1,4,5,6	<i>Trifolium repens</i>	8-9
1,4,5,8	<i>Onopordum acanthium</i>	7-9
2,3,7,8	<i>Medicago polymorpha</i>	7-8
3,4,5,6	<i>Geranium solanderi</i>	6-9
4,5,7,8	<i>Aristida jerichoensis</i>	7-9
	<i>Trifolium procumbens</i>	7-9
2,3,4,5,6	<i>Oxalis corniculata</i>	7-9
2,3,4,5,7	<i>Rumex pulcher</i>	8-8.5
2,3,4,5,8	<i>Urtica wrens</i>	7-9.5
4,5,6,7,8	<i>Medicago laciniata</i>	7-9

## DISCUSSION RESULTS

A total of 99 different species, of which 28 were remnant exotic species, were identified on the eight sites during the course of the project. After the results had been compiled from all the sites, inter-site comparisons were carried out to establish if any of these plant species were associated with more than one site and/or high pH levels. Table 2 lists the species that were found on three or more sites in association with the higher ranges of pH values. *Carthamus lanatus*, *Fumaria muralis*, *Hordeum leporinum* and *Stellaria media* were present on three or more sites but were not associated with high pH values and are therefore not included in the list.

## DISCUSSION

### Example site

The secondary transects C and D appeared to have similar populations of *Medicago polymorpha*, D and E were similar in their counts of *Pennisetum clandestinum*, *Silybum marianum*, *Bothriochloa macra* and *Capsella bursa-pastoris*. Transects C, D and E had similar populations of *Stellaria media*. Associated with high pH levels were sampling points B6 and 7, (thought to be the site of an old garden bed), C6, and D5 and 6.

Information supplied by the owner, when the site was revisited to verify the location of the house, resulted in the structure thought to be the remains of a shed being identified as a trellis for supporting grape vines. A vine could at this time, due to the arrival of spring, be identified by its green leaves within the confines of the large boxthorn bush. At the time of the original survey it had been impossible to see this particular example of remnant exotic vegetation. In addition, the high pH readings at B6 and 7 were confirmed as being due to the disturbance caused by an old garden bed.

### Inter-site comparisons

No single remnant exotic species was common to all sites. However, the number of different plants that were present indicates that a number of exotic species are capable of enduring on a site for a considerable length of time. In the case of some quince trees on Site 7, the period involved was about sixty years.

Correlation between plants and high pH readings indicated that there was no single species that was associated with high pH values on all sites. The greatest number of sites on which particular species were found was five, with *Urtica urens*, *Rumex pulcher*, *Oxalis corniculata* and *Medicago laciniata* being the plants in question. A further six species were present on four sites and another seven were found on three different sites. In general, the medics and clovers tended to be associated with alkaline conditions but *Geranium solanderi* (that occurred on four sites in association with high pH levels) would seem to be a fairly good candidate for possible use as an indicator of features. The presence of horehound on three sites and stinging nettles on five sites, in association with high pH values, agrees with the comments made by Allcroft<sup>31</sup> and Clark.<sup>32</sup>

On the sites that had the remains of features still present on them, namely Sites 1, 2, 4 and 7,<sup>33</sup> the high pH levels tended to occur in the areas where the features were located. The vegetation cover in these same areas was shown to be significantly different from the 'off site' sampling points and secondary transects away from the features. In instances where a high pH reading occurred away from a feature (Sites 2 and 4),<sup>34</sup> the high readings could be explained as a result of being located in areas of maximum disturbance, in the first case a garden and in the second a school yard. Similar changes in pH were shown to exist on those sites that did not have any remains of features and it was therefore felt that it could be assumed that the areas of high pH indicated the location of a feature. Support for this assumption was provided by the verification of the position of the house on the example site, Site 3.

## CONCLUSION

Although only a small number of sites were investigated, the results largely agreed with the results obtained by Zeiner,<sup>35</sup> that showed that plants and changes in the pH levels across an historical archaeological site could be utilized to locate features on this type of site. They also tended to confirm the observations made by Allcroft and Clark.

The bulldozing of a site, as was the case with the site used as an example in this paper, did not seem to create problems in the use of this method for site and feature location, although continued use of a site for residential purposes may create problems, as earlier patterns of soil changes may be masked by later disturbance. This was probably the case where Site 6 was concerned.<sup>36</sup> This site had undergone fairly constant disturbance over the years due to buildings being erected over the site of the original house, with the result that the continued disturbance made interpretation relatively difficult but not impossible.

One obvious question arises from the results and that is why not just take soil samples and determine the pH? There are two main reasons for not doing this. First, to achieve a high degree of accuracy in the location and orientation of a feature, a large number of soil samples would need to be collected. As the taking of such samples is invasive, the whole idea of establishing a non-destructive procedure for feature location is defeated. The second reason is that soil samples were only taken during the study to demonstrate that soil changes coincided with feature location and proportional variations in the representation of plant species. This then allowed it to be stated that changes in plant populations occurred where features had been located. As more data about the association of plant species and feature location is collected, it may be possible to simply appraise a site visually for feature-indicator plants or complete changes in plant populations and not have to bother with formal sampling procedures. For example, a complete change in plant population signifying the location of the school building actually occurred on the Woods Reef school site (Site 4), which indicates that the visual appraisal proposition may not be altogether unreasonable.

The proposed method proved to be inexpensive, with the purchase of the two 30 m tapes and the soil-testing kit being the major expense.

Half the sites were surveyed by two people and the other half by one person only. Where two people were involved, both parties participated in the setting of the tapes, after which one person was responsible for the plant collection, identification and soil sampling, while the other acted as a recorder. On the sites that were surveyed by two people the data collection took no longer than a day, and where one person was involved the time from start to finish was a day and a half to two days depending on the size of the site.

By assigning numbers to the different species for identification purposes, it was established that it would be possible for an untrained person to conduct the vegetation sampling part of the procedure, as long as a sample of each species was available for reference purposes. This was achieved by taping a sample of each of the species to the page on which that plant's number was recorded. This allowed each species to be identified by its assigned number and removed the need for identification by botanical name, if the person involved did not have botanical knowledge. No skill at all, other than an ability to match colours, would be required for the soil analysis.

The procedure worked equally well on basalt, serpentine, chocolate prairie and sandy soils and therefore it would appear that this method could be a useful tool for the location of historical archaeological features and may also be suitable for application to prehistoric sites.

Because plant populations can vary considerably as a response to seasonal changes, future research should also include records kept

throughout the year of the plant species that are associated with historical sites and features. If this is done, it should be possible to build up a relatively large data base, that could be analysed to establish which plants are consistently associated with historical archaeological sites and features at different times throughout the year. These species would then become the recognised site and feature indicators.

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#### NOTES

1. Pearson 1981: 11.
2. Jack 1985: 159.
3. Whitehouse 1983: 465; Fagan 1959: 279.
4. Allcroft 1908: 23; Meigs 1938; Zeiner 1946; Clark 1957: 64; Larsen 1950; Amor & Pigginn 1977; de Plaen et al. 1982.
5. Harris 1977; Bowdler 1981; Beaton 1982; Meehan 1982: 149–58; Smith 1982; Flood 1983: 225–9.
6. Beck 1980.
7. Wilkinson 1971: 1–20; Cubis 1980: 140; Hope 1980: 29–39; Singh et al. 1981: 435–52; Head 1985; Fujiwara et al. 1985: 155–64.
8. Gill et al. 1981.
9. Pittock et al. 1978; CLIMANZ 1981.
10. Bradford 1947, 1949: 58; Crawford 1960: 48–50; Parsons & Denevan 1967; Deuel 1969; St Joseph 1975, 1977; Goodyear 1971: 79.
11. Connah 1978; Connah & Jones 1983.
12. Gillespie 1985.
13. Winston-Gregson 1982.
14. Connah 1977, 1978; Connah & Jones 1983.
15. Jeans 1984.
16. Clapham 1973: 124.
17. Blackmore & Tootill 1984: 382.
18. Weier et al. 1974: 189.
19. Leeper 1964: 177.
20. Ray 1972: 107.
21. Connah 1978: plate XII.
22. Whalley et al. 1978.
23. Zeiner 1946.
24. *ibid.*: 87.
25. *ibid.*: 86.
26. *ibid.*: 89.
27. Hughes 1980: 3.
28. Dr Greg Lodge, Department of Agriculture Research Station, Tamworth, N.S.W.: pers. comm.
29. Beadle 1971, 1972, 1976, 1980, 1984; Beadle et al. 1972; Blombery 1973; Lambrechtsen 1975; Lamp 1976; Galbraith 1977; Hodgson 1977; Hubbard 1978; Macoboy 1978; Hodgson & Paine 1979; Macoboy 1979; Wheeler et al. 1982; McBarron 1983; Gault 1984; Serventy 1984.

30. Mrs J. Bowden, daughter-in-law of the original selector, who had lived on the property from the time of her marriage in 1931: pers. comm.
31. Allcroft 1908: 3. The association of *Verbena officinalis* with Roman settlements, 'Henbane' or 'Black Horehound' and 'Greater Celandine' with medieval gardens, and a forgotten mansion or lost village respectively.
32. Clark 1957: 64. The growth of nettles near middens and disused cattle sheds.
33. Pearson 1986: 20–5, 25–7, 30–2, 35.
34. *ibid.*: 65, 76, 122, 124.
35. Zeiner 1946.
36. Pearson 1986: 33–5.

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