First Nations’ interactions with underground storage organs in southwestern Australia, a Mediterranean climate Global Biodiversity Hotspot

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Abstract

Aims and background Underground storage organs (USOs) have long featured prominently in human diets. They are reliable year-round resources, especially valuable in seasonal climates. We review a significant but scattered literature and oral recounts of USOs utilised by Noongar people of the South-west Australian Floristic Region (SWAFR). USOs are important to First Nations cultures in other geophyte-rich regions with Mediterranean climate, with specialist knowledge employed, and productive parts of the landscape targeted for harvest, with likely ecological interactions and consequences.

Methods We have gathered Noongar knowledge of USOs in the SWAFR to better understand the ecological role of Noongar-USO relationships that have existed for millennia.

Results We estimate that 418 USO taxa across 25 families have Noongar names and/or uses. Additionally, three USO taxa in the SWAFR weed flora are consumed by Noongar people. We found parallels in employment of specific knowledge and targeted ecological disturbance with First Nations’ practice in other geophyte-rich floristic regions. We found that only in 20% of cases could we identify the original source of recorded USO knowledge to an acknowledged Noongar person.

Conclusion This review identified that traditional Noongar access to USOs is taxonomically and geographically extensive, employing specific knowledge and technology to target and maintain resource rich locations. However, we also found a general practice of ‘extractive’ documentation of Noongar plant knowledge. We identify negative implications of such practice for Noongar people and SWAFR conservation outcomes and assert ways to avoid this going forward, reviving Noongar agency to care for traditional Country.

Keywords Underground storage organ · Mediterranean climate region · Noongar · Southwest Australian Floristic Region · Caring for Country

Introduction

Underground storage organs (USOs), such as tubers, rhizomes and bulbs are all components of a plant’s root system architecture, functionally important for storage of water reserves, as well as nutrients and carbohydrates
utilisable during resprouting after fire, drought or herbivory (Freschet et al. 2021; Silveira et al. 2016). High numbers of USO plants occur in Mediterranean climate regions, which are characterised by mild, wet winters and hot, dry summers (Parsons and Hopper 2003; Procheș et al. 2006; Rundel et al. 2018). This is not surprising given USOs provide reserves for resprouting post-drought or following seasonally predictable fire events in such climatic regions (Rundel et al. 2018). They are also a common component in old, climatically buffered, infertile landscape (OCBIL) vegetation communities (Veldman et al. 2015), characterised by impoverished, low P edaphic conditions (Lambers et al. 2010; Silveira et al. 2021). Impoverished soils, combined with historic tectonic stability and minimal climatic disturbance have enabled a plethora of plant taxa with specialist survival traits, including USOs, to evolve in OCBIL regions (Lambers et al. 2010; Rundel et al. 2018; Silveira et al. 2021).

Of the five Mediterranean-type climate floristic regions – the Greater Cape (South Africa), southwestern Australia, Mediterranean Basin (southern Europe and northern Africa), California (USA) and central Chile—the former two, both OCBIL-dominated, exhibit the greatest diversity of plants with USOs (Hopper 2009; Hopper et al. 2021; Rundel et al. 2018; Silveira et al. 2021). USOs are a predictable, reliable and nutritious source of carbohydrates in First Nations’ diets (Anderson 2005; Botha et al. 2020; De Vynck et al. 2016; Gott 2005; Walsh 1990) and their high caloric dietary contribution has been suggested as an important factor in human evolution (Anderson 2016; Deacon 1993; Dominy et al. 2008; Singels et al. 2016; Yeakel et al. 2007). While the Greater Cape region is particularly USO-rich, containing an estimated 2098 geophyte species (Procheș et al. 2006), our study focused on those of southwestern Australia (Fig. 1), where at least 686 are estimated to occur (Lullfitz et al. 2021a). USO-rich families in this region comprise Orchidaceae, Asparagaceae, Haemodoraceae, Colchicaceae, Cyperaceae and Hemerocalidaceae (Brown 2022; Hickman and Hopper 2019; Parsons and Hopper 2003; Pate and Dixon 1982). Here we have examined the nature and extent of First Nations interactions with USO taxa in southwestern Australia in light of such interactions in Mediterranean-type climate regions elsewhere.

Scale and scope of human USO interactions in Mediterranean-type climate regions

Generally, a high concentration of USO taxa in the native flora of Mediterranean-type climate regions appears to correspond with their extensive use by First Nations people (Anderson 2005; Archer 1994;
Botha et al. 2019, 2020; De Beer and Van Wyk 2011; De Vynck et al. 2016; Eoin 2016; Karous et al. 2021; Korkmaz et al. 2014; Nortje and van Wyk 2019; Singels et al. 2016; van Wyk and Gericke 2000), although this appears less so for the Mediterranean Basin than for California and the Greater Cape. In the Greater Cape, USOs are a year-round staple in the Khoe-San diet and are also valued for medicinal properties. They may be eaten raw or cooked and sometimes pounded prior to eating, taxon- and/ or preference-dependent (Archer 1994; Botha et al. 2020; De Vynck et al. 2016; Eoin 2016; Singels et al. 2016; Van Wyk 2008). In California, USOs are second only to seeds in their importance as a plant food in traditional diets (Anderson 2005). In the Mediterranean Basin, USOs appear to be a lesser used plant component in comparison to leaves, fruits or seeds of wild plants (Geraci et al. 2018; González et al. 2011; Gras et al. 2020; Karous et al. 2021; Pieroni 2001), with the region of eastern Anatolia possibly a notable exception (Korkmaz et al. 2014). USO usage for food, medicine, dye and even as a pest poison is apparent across the Mediterranean Basin, but varies both at a regional and local scale (Biscotti et al. 2018; Geraci et al. 2018; Karous et al. 2021; Korkmaz et al. 2014; Tardío et al. 2006). Despite significant cultural destruction, Mapuche people in Chile and Argentine Patagonia (León-Lobos et al. 2022; Ochoa and Ladio 2015) still use a small selection of USOs for food.

Patterns of USO harvest

While a large number of USO taxa are utilised by First Nations peoples of Mediterranean-type climate regions, it would appear that certain taxa are favoured, and could be considered staples. In the Greater Cape, such taxa would include members of the Dioscoreaceae and Irídaceae (Archer 1994; van Wyk and Gericke 2000), in California the Liliaceae and Asparagaceae (Anderson 2005), while Tardío et al. (2006) report that Glycyrrhiza glabra (Fabaceae) is frequently targeted in the Mediterranean Basin. Species of Oxalidaceae, Santalaceae and Apiaceae are important in Patagonia (Ochoa and Ladio 2015), while in Chile, Alstroemeriacae, Apiaceae, Asteraceae, and Dioscoreaceae are key taxa (León-Lobos et al. 2022).

In the Greater Cape, specific high-yielding ‘geophyte hotspots’ appear to have been targeted by First Nations Khoe-San people (Archer 1994; Botha et al. 2020; Singels et al. 2016). For example, Botha et al. (2020) found that the relatively fertile vegetation communities, riverine riparian woodland, sand fynbos and coastal dune-fynbos thickets produced highest USO harvest returns for contemporary Khoe-San descendents, suggesting that such areas may have been targeted by their ancestors. The authors found coastal dune-fynbos thickets especially productive post-fire, supporting a hypothesis that they were periodically burned by Khoe-San to increase productivity. Similarly, Anderson (2005) refers to regularly dug resource rich patches in grasslands, damp meadows, woodlands and forest, and describes both digging and burning as means of increasing resources at such patches. Long-standing use of dense patches of blue dicks (Dipterostemon/Dichelostemma) and Mariposa lilies (Calochortus) on California’s Channel Islands is evident (Gill 2016; Gill et al. 2021). These findings suggest that across Mediterranean-type climate regions, First Nations people have targeted and promoted some particularly productive taxa and have also favoured fertile soils rather than those growing on less fertile soils. In particular, landscape and vegetation descriptions provided by Botha et al. (2020) and Anderson (2005) respectively suggest that such targeted locations constitute young, often disturbed, fertile landscapes (YODFELs) (Hopper 2009; Hopper et al. 2021).

Skills, knowledge, roles, technology

In the Greater Cape region, USOs, in the Dioscoreaceae and Irídaceae for example, would be dug primarily with a sharpened, and often highly-prized digging stick by Khoe-San women, who would carry a small bag to collect and transport them (Archer 1994; Eoin 2016; van Wyk and Gericke 2000). Some digging sticks may be weighted with a bored stone (Eoin 2016). In California, fire-hardened digging sticks were used by women as the primary means of traditional harvest of the many USO resources accessed by Indigenous peoples (Anderson 2005; Anderson and Lake 2016). Gill (2016) illustrates use of a digging stick in a photo and also a digging stick weight or doughnut stone used by Chumash people, described as “one of the most prevalent artifacts found on [California’s] Channel Islands, and have been identified in dateable contexts to at least the last 7,500 years”.

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These bored stones are identical to those used in South Africa.

We found no reference in the literature to harvest digging implements or gender roles for the Mediterranean Basin, aside from an equal gender labour distribution in Tunisia (Karous et al. 2021). While Botha et al. (2020) report that a high level of skill is not required to dig for USOs among Khoe-San, they observed that those with more experience can yield higher returns. To maximise returns through targeting of known hotspots in appropriate seasons and post-fire periods and also to understand potential toxicity and uses requires Khoe-San to hold considerable specialist plant knowledge (Archer 1994; Botha et al. 2020; De Vynck et al. 2016; Nortje and van Wyk 2019; Singels et al. 2016). Additionally, Botha et al. (2019) found a high level of geographically specificity in plant knowledge among contemporary Khoe-San of the Greater Cape, which corresponds with a high spatial turnover of plant diversity. Conversely, although some narrow range endemic USOs are harvested in the Mediterranean Basin (Tardío et al. 2006), most harvested USO taxa are widely distributed albeit with localised usage and a requirement of specialist knowledge for safe, non-toxic consumption (Biscotti et al. 2018; Geraci et al. 2018; Karous et al. 2021; Korkmaz et al. 2014; Tardío et al. 2006). In this region, plant knowledge is often closely linked with use of local dialects (Biscotti et al. 2018), and it is primarily plant knowledge-holding Elders who harvest and consume USOs (Anderson 2005; Biscotti et al. 2018; Geraci et al. 2018; González et al. 2011; Karous et al. 2021; Tardío et al. 2006). Across all Mediterranean climate regions, authors raised concerns about loss of traditional plant knowledge (Biscotti et al. 2018; Botha et al. 2020; De Vynck et al. 2016; González et al. 2011; Ochoa and Ladio 2015; Tardío et al. 2006). In particular, González et al. (2011) and Ochoa and Ladio (2015) highlight potential means of revitalising intergenerational transmission to mitigate plant knowledge loss on the Iberian Peninsula and in Patagonia respectively.

It is evident that across all Mediterranean-type climate regions, First Nations peoples have utilised specific tools and knowledge to control and sustain USO procurement. Further, given extensive First Nations use of USOs across Mediterranean climate-type regions, pre- and early-colonial ecological disturbance associated with their harvest is likely to have been significant, particularly in the Greater Cape and California, in particular comprising digging of soil and use of fire to promote USO production.

Value for conservation of geophyte flora and cultural connection with traditional Country

In California, Anderson (2005) highlights specific techniques such as burning and deliberate replanting utilised by Indigenous peoples to promote USO resources, with such techniques sometimes taught through traditional story. The author also points to declines in once plentiful traditional geophyte resource patches that have resulted from colonial introduction of farming practices, as well as land clearing for urban development, fire suppression and commercial overharvesting. Tardío et al. (2006) also mention the latter as a possible threat to wild USO resources in the Mediterranean Basin. Anderson (2005) further points to colonial-induced cessation of traditional digging practice as a cause for decline of some taxa in, for example, the Liliaceae and Alliaceae, arguing that traditional harvest has a renewing effect on USO production, a suggestion made by others (Denham 2008; Gott 2005; Pascoe 2014). Anderson (2005) also describes traditional targeted patch burning techniques in California to promote USO growth, minimising shade from taller shrubs and releasing soil nutrients, and suggests a renewal of traditional human tending as an appropriate conservation strategy for some monocot geophytes, an over-represented group in the Californian flora listed as threatened (Wilken 2006).

In a comparison of archaeological records and contemporary knowledge of Khoe-San plant usage, Botha et al. (2019) found evidence that contemporary plant usage reflects that of humans in the Greater Cape region up to 80,000 years BP, suggesting that the ecological processes associated with USO harvest have been present throughout this time. While anatomically modern human history of California and the Mediterranean Basin is shorter than the Greater Cape, Anderson (2005) suggests for California that humans may have continued such ecological processes that were previously carried out by now extinct megafauna such as ground sloths and the peccary, a scenario also plausible in the Mediterranean Basin. Moreover, other hominid species such as Neanderthals used digging sticks hardened with fire more than
170,000 y.o. in Tuscany, Italy (Revedin et al. 2020) (see Fig. 2).

As for all traditional First Nations resource use and sustenance, USO usage is an intrinsic component of Indigenous culture and cultural identity (Janke 2021), with relevant knowledge embedded in stories, songlines and artworks (Anderson 2005; Neale 2017) linked strongly with specific family and cultural groups and to which sharing protocols pertain (Janke 2021). While the effects of colonisation and modern-living continue to threaten intergenerational knowledge transfer of USOs (e.g. Anderson 2005; Biscotti et al. 2018; De Vynck et al. 2016), exploitation and disconnection of cultural knowledge more broadly from its rightful custodians remains a major source of harm to First Nations peoples (Janke 2021; Zurba et al. 2019).

Noongar USO interactions in the SWAFR

Previously we have conservatively estimated that at least 90 taxa are utilised by Noongar First Nations people (Lullfitz et al. 2021a). In this review, we have more comprehensively examined historic and

Fig. 2 First Nations use of digging sticks across three USO-rich Mediterranean climate regions, including a) Miernanger Elder, LK instructs AL on digging Platysace deflexa tubers with a wanna, Jerdacuttup, southwestern Australia (photo: SDH); b) excerpt of plate by Major Richard Shepherd from an 1846 painting by Deputy Assistant Commissary-General Neill in Brough Smyth 1878 p221 vol II, depicting Menang group, with women each holding wanna, Albany, southwestern Australia; c) 1884 photo of Khoe-San woman,|xaken-an (Mikki Streep) with her digging stick, Salt River, Greater Cape (from Skotnes 2007); d) 170,000 y.o. digging stick of Buxus sempervirens, constructed by Neanderthals in Tuscany, Italy (from Revedin et al. 2020)
contemporary literature as well as orally transmitted knowledge of Noongar co-authors (in particular, LK) and other Noongar colleagues, to more accurately record traditional Noongar interactions with southwest Australian USOs. The object of this task was to determine the significance of such interactions for both biodiversity conservation and for contemporary Noongar people. In particular, which taxa and locations were most heavily targeted pre-colonially, and can we use this knowledge to identify areas of intensive Noongar cultural use and ecological disturbance?

To this end, and based on First Nations USO usage in other Mediterranean-type climate regions, we have gathered and examined Noongar USO usage information to test the following hypotheses:

1. That Noongar First Nations USO usage was a significant ecological disturbance in the pre-colonial SWAFR;
2. That some taxa and specific, productive resource patches, usually on fertile soils, are more heavily targeted for harvest and promoted than those growing on less fertile soils;
3. That knowledge in relation to taxonomy, toxicity, productivity (e.g. in relation to water, nutrient availability) and phenology, technology and specific roles and lores have been applied by Noongar to control and sustain procurement of USOs; and
4. That reinvigoration of traditional USO knowledge and application can be beneficial for both conservation of SWAFR biological resources and for Noongar knowledge and identity.

Methods

An extensive systematic review of peer-reviewed literature of First Nations USO usage in USO-rich Mediterranean-type climate regions outside of southwestern Australia was undertaken (Anderson 2005; Archer 1994; Biscotti et al. 2018; Botha et al. 2019, 2020; De Beer and Van Wyk 2011; De Vynck et al. 2016; Eoin 2016; Geraci et al. 2018; Karous et al. 2021; Korkmaz et al. 2014; Nortje and van Wyk 2019; Ochoa and Ladio 2015; Singels 2020; Singels et al. 2016; Tardio et al. 2006; van Wyk and Gericke 2000). For each of the Mediterranean-type climate regions, Google Scholar searches were conducted using the terms “Indigenous”, “First Nations”, “ethnobotany”, “cultural plant”, “USO”, “bulb”, “rhizome”, “root” and “tuber”. In some instances, review of a document resulted in sourcing of further relevant literature, akin to snowballing methodology. Through this review we were able to determine the scale of First Nations USO usage and application of First Nations knowledge, technology and custom across Mediterranean-type climate regions. We were also able to detect some patterns in relationship to landscape and observations of others in relation to USO conservation practice.

Contemporary and historic literature from Noongar Boodja (Country) of southwestern Australia, as well as knowledge shared orally by contemporary Noongar Elders was reviewed to compare Noongar USO usage with First Nations USO usage in other Mediterranean-type climate regions. A wide range of contemporary accounts were consulted, including peer reviewed literature, published books on Noongar plant use (e.g. Hansen and Horsfall 2019), consultants’ reports (e.g. Goode 2010) and localised studies of cultural plants (e.g. Wheatbelt NRM 2015). This search was carried out using both systematic and snowballing methods, including searches on both Google and Google Scholar, and literature already known to the authors. Search terms included “Noongar”, “Nyungar”, “Nyoongar”, “ethnobotany”, “cultural plant”, “root”, “USO”, “bulb”, “rhizome” and “tuber”. Historic sources examined included the Exploration Diaries from 1827 to 1857 held by the Western Australian Government Department of Lands and Survey and State Library of Western Australia, as well as other early colonial accounts of Noongar custom (e.g. Hassell 1975). Documents were searched using the terms “dig”, “stick”, “yam”, “bulb” and “root”, as well as USO taxa names. Personal oral recollections of Noongar Elder author (LK) and other contemporary Noongar Elders and knowledge-holders with whom we have collaborated and that were recorded in interview transcripts and/or authors’ field notes have also been included. This has been carried out in accordance with UWA Human Research Ethics Approval (reference number RA/4/20/6165). With the exception of LK, the amount of shared discussion time between authors and contributing Elders on Boodja ranged from one to six days. Noongar USO usage was discussed among other elements of Noongar TEK. The authors, including LK, have spent in excess of 100 days on Boodja together with other
coauthors herein, during which USO usage has been recorded among other traditional knowledge held by LK and belonging to the Knapp family.

Records of traditional Noongar interactions with USO taxa identified through this process, as well as activities associated with acquiring USO resources are recorded in Tables 1 and 2 respectively, and Fig. 3). A table of records where taxa names could not be resolved are included as supplementary material. Where 10 or more records of a taxon were found it was determined a possible staple. For each record, where applicable, we have indicated its relevance to each of our hypotheses. Place names mentioned herein are mapped in Fig. 1. Where locations, landforms or vegetation communities of Noongar USO acquisition have been recorded in sufficient detail, they have been categorised as either OCBIL, YODFEL or indeterminate (Fig. 4). This was based on the authors’ intimate knowledge of both southwest Australian landforms and vegetation communities, as well as understanding of OCBIL theory (Hopper et al. 2021).

Results

We located 671 records of USO usage by Noongar people in southwestern Australia. Of these records, 20 related to use as medicine, three to use as dye, and the remainder to food. Included were specific references to 25 plant families, 52 genera, and 79 species (Table 1, Fig. 3), of which there were three introduced taxa. One entire genus (Drosera) and one species (Platysace effusa) we considered to be doubtful records (see authors’ notes throughout Table 1). In addition, there were 45 mentions of Noongar USO usage for which the taxon name remains unresolved (see supplementary material). Taking into account records indicating Noongar usage of an entire genus (e.g. Thelymitra (Hansen and Horsfall 2019)), we estimate that at least 418 USO-bearing taxa have been utilised by Noongar people in southwestern Australia. Some taxa were specifically mentioned by contemporary knowledge holders or in the literature more frequently than others (Figs. 3 and 5). Table 2 details references in the literature to Noongar USO usage that are not plant taxon-specific.

Our review revealed that there were 127 records that provide insight into the scale and scope of Noongar USO interactions (Hypothesis 1) (Tables 1, 2, and supplementary materials). Such references provide insight to a large scale, abundance and breadth of acquisition of some taxa (e.g. Orchidaceae family, Haemodorum and Platysace genus) and in the case of Geranium solanderi, that this taxon is used sparingly, and therefore its likely small scale acquisition. Numerous descriptions of disturbed ground due to Noongar USO acquisition, and also of digging implements and techniques indicate soil disturbance at scale. Ninety two records refer to landscape patterns of USO harvest and interaction (Hypothesis 2). Such records relate to targeting of fertile soil or moist locations (e.g. Platysace cirrosa, Dioscorea hastifolia), promotion of productive populations through replanting (e.g. Dioscorea hastifolia) or firing (e.g. Orchidaceae), particularly at moist, fertile locations, occurrence of USO resource patches near campsites and travel routes. In addition, where locations, landforms or vegetation communities of Noongar USO acquisition have been described, we estimate that 70% are YODFELs and 30% are either OCBILs or indeterminable (Fig. 4). We found 1034 references to specific skills, knowledge, roles or technology relating to acquisition of USO resources in the literature and oral record, with some references imparting more than one piece of knowledge (e.g a taxon’s name and use) (Hypothesis 3). Such records relate to knowledge of a taxon’s name, its use, and specifics relating to phenology, season of use, toxicity and specific methods for acquisition or promotion. There were also numerous records of this nature that were not taxon-specific. Of the 1034 references, there were only 213 where we could confidently identify the Noongar person who was the source of information provided (see Fig. 3 for those relating to specific taxa). Finally, we found twenty records that relate specifically to conservation of USO taxa (Hypothesis 4), including deliberate protection or replenishment of populations (e.g. Dioscorea hastifolia) and renewing effects of harvest (e.g. Platysace deflexa).

Based on frequency of mentions, we have identified 15 species, as well as the Orchidaceae family and Haemodorum (Haemodoraceae) genus as possible staples (Figs. 3 and 5). Dioscorea hastifolia, Thysanotus patersonii, Platysace deflexa, Haemodorum discolor, H. spicatum and Typha domingensis were particularly heavily mentioned. Of specific landscapes targeted for Noongar USO harvest, most
### Table 1  
Noongar Underground Storage Organ (USO) taxa recorded in historic and contemporary literature and oral history, arranged in alphabetical order of plant family. Authors’ comments included in square brackets. Superscripts 1–4 refer to the four hypotheses detailed in the Introduction. *Where Noongar knowledge/name was shared orally with authors, only names of source individuals are shown, all except Lynette Knapp (LK), a co-author, are given in full.

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|---------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------|----------------|------------------------------------------------------------|
| **Apiaceae Lindl.**      |                                 |                                                                                                 |                                      |                |                                                            |
| *Daucus glochidiatus* (Labill.) Fisch., C.A.Mey. & Ave-Lall | Kwordiny (Hansen and Horsfall 2019; Wheatbelt NRM 2009) [Possible confusion of Noongar name due to English name. Most likely refers to *H. discolor*, also referred to as ‘wild carrot’].3 | - | Referred to as ‘wild carrot’ (Wheatbelt NRM 2009)3 | - | - |
| *Platysace* (no species given) | - | Tubers are edible (Meagher 1974, Wheatbelt NRM 2009)3 | - | - | - |
| *Platysace cirrosa* Bunge | *Kuma* (Preiss in Abbott 1983)3 | Tuber eaten as food and hydration (Noel Nannup)1 | Tuber eaten raw as food and hydration (Drummond 1840a, 1843d; Moore 1884)3; tubers eaten raw or roasted (Hansen and Horsfall 2019)3; tubers eaten (Bindon 1996; Bindon and Walley 1992)3; tubers eaten raw (Drummond 1839 in Pate and Dixon 1982)3 | *Makuru, Djilba* (winter months) and *Kambarang* (October to November) (Bindon and Walley 1992)3 | Harvested all year (Drummond 1839 in Pate and Dixon 1982)3,3 |
|                           | *Kuma* (Hansen and Horsfall 2019)3 |                                      |                                             |                                                                 |                                                            |
|                           | *Conna* (Drummond 1840a, 1843d; Drummond 1839 in Pate and Dixon 1982)3 | |                                             |                                                                 |                                                            |
|                           | *Canna* (Drummond 1853)3 | [Drummond does not give species name but description enables *P. cirrosa* to be assigned with confidence] |                                             |                                                                 |                                                            |
|                           | *Kahno* (Bindon 1996)3 | |                                             |                                                                 |                                                            |
|                           | *Youck* (Bindon and Walley 1992)3 | [Possibly applied as a generalised term for root vegetable, typically applied to *Platysace deflexa*3] | | Moore (1884) (Perth June 1836) describes it growing in “fine, good country” near York, that it is highly palatable and approximately “as large as your fist”.1,2 | harvested from *Eucalyptus wandoo* woodlands (Bindon and Walley 1992).2,3 |
Table 1 (Continued)

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season |
|--------------------------|---------------------------------|------------------------------------------------------------------------------------------------|---------------------------------------------|----------------|
| *Platysace deflexa* (Turcz.) C.Norman | Yoowak (Knapp et al. 2021g)³ | Tuber eaten and carried as food and hydration (Knapp & Yorkshire in Knapp et al. 2021g, L.K. Carol Pettersen, Aden Eades, Eliza Woods, Eugene Eades, Treaty Woods)¹³ | Tubers eaten and carried as food and hydration (Hassell 1975; Hassell and Davidson 1935)¹³³³; tubers eaten raw or roasted (Hansen and Horsfall 2019; Hassell 1936; Hassell 1975 in Pate and Dixon 1982)³³³³ | Tubers swell to their biggest in summer and are smallest in winter (Knapp & Yorkshire in Knapp et al. 2021g)³³³³; Harvested all year (Hassell 1936; Hassell 1975 in Pate and Dixon 1982)¹³³³ |
| | Fouik (Treasy Woods)³ | - | - | - |
| | Yousak (von Brandenstein 1977)¹ [Possibly refers to *P. trachymenioides*, misnamed by von Brandenstein as *P. effusa*] | - | - | - |
| | Yooqwaq (von Brandenstein 1977)³ [See comment above] | - | - | - |
| | Youck (Hansen and Horsfall 2019)³ | - | - | - |
| | Youck (Hassell 1975, Hassell and Davidson 1935; Hassell 1936 and Hassell 1975 in Pate and Dixon 1982)³³³³ | - | - | - |
| | Youk (Hassell 1975; Hassell and Davidson 1935)³³³³ | - | - | - |
| | Yoolk (Hansen and Horsfall 2019)³³³³ | - | - | - |
| | Yug (Hansen and Horsfall 2019)³³³³ | - | - | - |
| *Platysace effusa* (Turcz.) C.Norman | [Doubtful record] | No known use of this plant (Knapp & Pettersen in Lullfitz et al. 2020)³³³³ | - | - |
| | Tjubuka (von Brandenstein 1977)³³³³ | Tuber eaten as food (von Brandenstein 1977) - [Likely misidentified by von Brandenstein 1977. Possibly referring to *P. trachymenioides*, although also described as an orchid, which is also incorrect] | - | - |
| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|-------------------------|---------------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------|---------------|-------------------------------------------------------------|
| Platysace maxwellii (F.Muell.) C.Norman | Karno (Abbott 1983, Archer 2015; Bindon 1996, Maggie Bell & Nellie Parker in Meagher 1974; Meagher 1974 in Pate and Dixon 1982) | Tuber eaten raw for food or hydration, or roasted for food (Maggie Bell & Nellie Parker in Meagher 1974) | Tubers eaten for food or hydration, or roasted for food (Archer 2015, Bindon 1996; Meagher 1974 in Pate and Dixon 1982) | Harvested all year (Maggie Bell & Nellie Parker in Meagher 1974; Meagher 1974 in Pate and Dixon 1982) | Drummond (1843d) describes it as “highly esteemed” and “growing in abundance” at Wongan Hills. Meagher (1974), on observation of Maggie Bell and Nellie Parker harvesting 3–4 km SE of Mingenew, August 1967, describes that large numbers (84 from one plant) of round tubers were dug with a digging stick from about 50 cm below ground. She described a preference for young tubers (Bindon 1996; Meagher 1974). |
| -- | Joo(w)ak (von Brandenstein 1977) | Tuber eaten but not as palatable as P. deflexa (LK) | - | - | (See entry under P. deflexa re phylogeography) |
| -- | 'Desperation yoowak' (LK) | - | - | - | |
| Araliaceae Juss | Trachymene coerulea | Tuber mashed as medicine (Hansen and Horsfall 2016) | - | - | |
| Asparagaceae Juss | Dichopogon spp. | Tuber eaten raw, possibly roasted (Cribb and Cribb 1975 in Pate and Dixon 1982) | Harvested anytime (Cribb and Cribb 1975 in Pate and Dixon 1982) | - | |
| Dichopogon capillipes | Adjiko (Nannup 2018 in Hansen and Horsfall 2019) | Tuber eaten raw, steamed in earth oven or roasted (City of Joondalup 2019) | - | - | |
| Dichopogon fimbriatus | Chorker (LK) | Tubers eaten raw as food and for water, can also be roasted (LK); tubers eaten (Aden Eades) | Tubers would be dug in summer when they become swollen (LK, Mabenup) | LK recalls digging up and eating tubers as a child with siblings when camping under woodland at Mabenup and a nearby lakeside camp where it grew in sandy soil “back a bit from the water”. She indicated tuber size of 10 cm long by 2–3 cm diameter, recalled being scolded for picking its flowers as a child, and described how leaf shape helped plant to gain water. She also referred to Chorkrup as named after this USO, having been informed of this by her uncle, Harold Mcevoy. | LK describes expected flowering time and that tubers swell during hot, summer months. She also describes importance of not harvesting while in flower to enable seed production. |
| Dichopogon preissii | - | Tubers eaten raw (Cribb and Cribb 1987 in Hansen and Horsfall 2019) | - | - | |

*Scientific names and Noongar names correspond to those listed in the reference list.
| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|-------------------------|---------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------|----------------|---------------------------------------------------------------------|
| Lomandra (no species given) | - | Creamy, white leaf base eaten after roasting and pounding (WA Museum in Goode 2010) | - | - | - |
| Sowerbrea laxiflora | - | Rhizome eaten raw, steamed or roasted (City of Joondalup 2019) | - | - | - |
| Thysanotus (no species given) | - | Only twining species are eaten (LK) | Tubers are eaten (Daw et al. 2020; SERCUL n.d.; Wheatbelt NRM 2009); all tuberous taxa eaten (Meagher 1974; Oates 1977 in Pate and Dixon 1982); Tubers of a twining species eaten (Drummond 1842c) | Harvested during summer and autumn (Meagher 1974; Oates 1977 in Pate and Dixon 1982) | Tubers of a twining species on the Moore River eaten (Drummond 1842c). |
| Thysanotus mangalesianus | Adjiko (Hansen and Horsfall 2019); Tjunguri (Hansen and Horsfall 2019; Perth NRM 2015) | Tubers eaten raw, steamed in earth oven or baked (City of Joondalup 2019; Perth NRM 2015); tubers pounded and baked as cakes (Perth NRM 2015); Tubers eaten (Coppin 2008) | - | - | - |
| Thysanotus patersonii | Djoonga djoonga (Knapp & Yorkshire in Knapp et al. 2021c); Djungul (LK, Carol Petersen); Tjunguri (City of Joondalup 2019; Daw et al. 2020; Hansen and Horsfall 2019; SERCUL n.d.); Tjungoori (Bindon 1996, City of Joondalup 2019, Maggie Bell & Nellie Parker in Meagher 1974, Pate and Dixon 1982); Tjunguri (Goode 2010) | Tuber eaten for food and hydration (LK, Gail Yorkshire, Terry Yorkshire, Carol Petersen, Noel Nannup, Ralph Kickett); tubers eaten raw (Knapp & Yorkshire in Knapp et al. 2021c). Tubers eaten raw or roasted (City of Joondalup 2019; Daw et al. 2020; WA Museum in Goode 2010; Low 1991 in Hansen and Horsfall 2019; SERCUL n.d.; Wheatbelt NRM n.d.); tubers eaten (Coppin 2008; Meagher 1974; Oates 1977 in Pate and Dixon 1982); tubers best eaten just prior or immediately after flowering (SERCUL n.d.); tubers eaten raw (Bindon 1996). | Just before or after flowering (Daw et al. 2020). Swells in summer and best eaten then, although not eaten if flowering (LK) | Size and shape of tubers varies with water availability (Knapp & Yorkshire in Knapp et al. 2021c). | - |
| Thysanotus thyrsoides | Adjiko (Nannup 2018 in Hansen and Horsfall 2019) | Tubers eaten roasted (Bindon 1996; Barrett and Tay 2016 in Hansen and Horsfall 2019) | - | - | - |
| Asteraceae Bercht. & J.Presl | Microseris Walteri | Woorine (Hansen and Horsfall 2019) [Possibly applied as a generalised term for root vegetable, typically applied to Dioscorea hastifolia] | Tubers eaten raw, roasted or steamed in earth oven (Hansen and Horsfall 2019); tubers eaten raw or roasted (Cribb and Cribb 1975; Oates 1977 in Pate and Dixon 1982). | Harvested during dry season (Cribb and Cribb 1975; Oates 1977 in Pate and Dixon 1982). | - |
| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|---------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------|---------------------------------------------------------------|
| *Burchardia* spp.        | *Cara* (Pate and Dixon 1982)*   | -                                                                                               | Tuber eaten as food, raw or roasted          | Eaten in summer and autumn (Drummond 1842a, b, c, d, e; Oates 1977 and Lampert; Sanders 1973 in Pate and Dixon 1982)* | -                                                           |
| *Burchardia congesta*    | *Kara* (Daw et al. 2020; Hansen and Horsfall 2019; Perth NRM 2015; SERCUL n.d.)* | Aware of others eating, but not eaten by Knapp family (L.K., Tootenellup).* | Tuber eaten as food, usually roasted          | November to December, following flowering (Daw et al. 2020)* | Tubers are at 10–20 cm depth, and only eaten when > 4 mm diameter (Daw et al. 2020)* |
| *Burchardia multiflora*  | *Cara* (Hansen and Horsfall 2019)* | -                                                                                               | Tuber eaten as food, usually roasted         | -              | -                                                             |
| *Wurmbea* spp.          | -                               | -                                                                                               | -                                             | -              | -                                                             |
| *Wurmbea dioica*        | -                               | -                                                                                               | -                                             | -              | -                                                             |
| *Convolvulaceae* Juss    | *Convolvulus angustissimus* R.Br | *Taaruuk* (Oates 1977 in Pate and Dixon 1982)*                                                 | Tuber cooked and kneaded into dough before eating (Hansen and Horsfall 2019)*; tuber eaten roasted and pounded (Oates 1977 in Pate and Dixon 1982)* | Harvested in winter (Oates in Pate and Dixon 1982)* | -                                                             |
| *Ipomoea* (no species given) | -                               | -                                                                                               | Tuber are eaten (Wheatbelt NRM 2009)*         | -              | -                                                             |
| *Cyperaceae* Juss        | -                               | -                                                                                               | -                                             | -              | -                                                             |
| *Bolboschoenus* spp.    | -                               | -                                                                                               | Rhizomes eaten (Coppin 2008)*                | -              | -                                                             |
| *Bolboschoenus* caldwellii (V.J.Cook) Sojak | -                               | -                                                                                               | Rhizomes eaten after roasting and pounding (Cribb and Cribb 1975; Oates 1977 in Hansen and Horsfall 1991; Pate and Dixon 1982)* | -              | -                                                             |
| *Eleocharis sphacelata* R.Br | -                               | -                                                                                               | Rhizome eaten raw or roasted by many Indigenous Australian groups (Coppin 2008; Hansen and Horsfall 2019)* | -              | -                                                             |
Table 1  (Continued)

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------|----------------------------------------------------------|
| Ficinia nodosa           | Waakal Ngarnak (Collard 2009 in City of Joondalup 2019)³ | -                                                                                                                                | Rhizomes eaten (Perth NRM 2015)³; rhizomes eaten, probably roasted (Hansen and Horsfall 2019)³ | -             | -                                                       |
| Lepidosperma gladiatum   | Kerbeyen (Knapp et al. 2021d)³ | Leaf base eaten raw (Vernice Gillies & Izaac Webb in Kalotas 2009, Knapp & Yorkshire in Knapp et al. 2021d) (L.K., Doc Reynolds)¹ | Leaf base eaten raw or roasted (Coppin 2008; Daw et al. 2020; Hansen and Horsfall 2019; SERCUL n.d.; von Brandenstein 1988)³ | All year (Daw et al. 2020)¹,³ | Grows where there is fresh water (Knapp & Yorkshire in Knapp et al. 2021d)²,³ Palatability highest when soil is moist (Daw et al. 2020).²,³ |
| Machaerina articulata    | Wuargyl (Nyarnkar Kuiarch) (Perth NRM 2015)³ | -                                                                                                                                | Rhizomes eaten after roasting (Perth NRM 2015)³ | -             | -                                                       |
| Schoenoplectus validus   | Waakal Ngarnak (Collard 2009 in City of Joondalup 2019)³ | -                                                                                                                                | Rhizomes recorded as eaten by Indigenous Australians outside of Noongar Country (Coppin 2008; Hansen and Horsfall 2019)³ | -             | -                                                       |
| Dennstaedtiaceae         | Lotsy                          |                                                                                                                                  |                                                                                             |               |                                                          |
| Pteridium esculentum     | Manyu (Hansen and Horsfall 2019)¹ | Rhizome not eaten, but can eat emerging fronds when brown (L.K.)³ | Rhizome eaten as food after roasting and removing fibres (Coppin 2008; Daw et al. 2020; Hansen and Horsfall 2016, 2019; Kalotas 2009)³; rhizome eaten (Grey 1841)³ | -             | -                                                       |
| Dioscoreaceae R.Br       | Dioscorea (no species given)   | -                                                                                                                                | Tuber is eaten (Grey 1841; Meagher 1974, Wheatbelt NRM 2009)³ | -             | -                                                       |
| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|-------------------------|-------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------|----------------------------------------------------------|
| Dioscorea hastifolia    | Wuagarn (von Brandenstein 1988) | Tuber roasted and pounded prior to eating (Maggie Bell & Nellie Parker in Meagher 1974)¹ | Tuber eaten as food (Bindon 1997; Coppin 2008; Daw et al. 2020; Drummond 1840b, 1842b; Grey 1841; Hallam 2014; Hammond 1933; Hansen and Horfall 2019; Roe 1847 in Hancock 2014; Moore 1884; Oldfield 1865; Stokes 1841; von Brandenstein 1988; Wheatbelt NRM 2009)²; tuber roasted and pounded prior to eating (Bindon 1996, Hammond 1933; Moore 1884 in Pate and Dixon 1982).³ | October to November following winter rains (Daw et al. 2020)³ | Described as a long tuber (Hammond 1933, on observation of Maggie Bell & Nellie Parker harvesting 3–4 km SE of Mingenew, August 1967).³,⁴ Described replanting of shoots and root tips following harvest (Bindon and Walley 1992; Daw et al. 2020; Hallam 1989)²,³,⁴, deliberate establishment of new populations (Hallam 1989)², and that large rock piles removed from soil during tuber harvest remain visible in Walyunga NP, with rock removal making future digging easier (Daw et al. 2020).²,³ Described as a highly savoured (Drummond 1840a; Grey 1841; Hammond 1933; Roe 1846; Roe 1847 in Hancock 2014; Stokes 1841)¹ staple food (Drummond 1840a; Roe 1846 in Hancock 2014)²,³, intensively harvested in patches (Grey 1841, Hallam 1983, 1989, 2014; Hancock 2014; Moore 1835, 1884; Stokes 1841)²,³ from very fertile soils (Grey 1841, Wollaston 1848–56 in Hallam 2014; Moore 1835)²,³ on tributary of Swan River west of Darling Range (Moore 1835)², on Greenough River, heavily settled by Noongar people (Stokes 1841)², in alluvial valleys around Gingin (Bindon 1996; Hallam 1983, 2014; Moore 1835)², and in the Chapman Valley (Roe 1846 in Hancock 2014).²,³ Described as growing best in moist locations among loose rocks of the Darling Ranges (Hammond 1933)²,³, favouring rocky outcrops (Bindon 1997; Grey 1841).² Hallam (1989) described prolific patches maintained through intensive, continual harvest and management, that were a key pre- and early-colonial enabler [along with Typha patches] of Whadjuk sedentary settlement patterns on and north of the Swan Coastal Plain (Hallam 1989, 2014).²,³,⁴ citing Chauncy’s map of the Swan Valley showing “warran holes” (Hallam 2016)², Hallam (1989) links labour investment in these patches with proprietary and harvest rights, suggesting that, given women’s primary responsibility for root harvest, that resource patches maintained through female line in Whadjuk Noongar society (Hallam 1989, 1991).²,³ |
| | | Described as a long tuber (Hammond 1933, on observation of Maggie Bell & Nellie Parker harvesting 3–4 km SE of Mingenew, August 1967).³,⁴ Described replanting of shoots and root tips following harvest (Bindon and Walley 1992; Daw et al. 2020; Hallam 1989)²,³,⁴, deliberate establishment of new populations (Hallam 1989)², and that large rock piles removed from soil during tuber harvest remain visible in Walyunga NP, with rock removal making future digging easier (Daw et al. 2020).²,³ Described as a highly savoured (Drummond 1840a; Grey 1841; Hammond 1933; Roe 1846; Roe 1847 in Hancock 2014; Stokes 1841)¹ staple food (Drummond 1840a; Roe 1846 in Hancock 2014)²,³, intensively harvested in patches (Grey 1841, Hallam 1983, 1989, 2014; Hancock 2014; Moore 1835, 1884; Stokes 1841)²,³ from very fertile soils (Grey 1841, Wollaston 1848–56 in Hallam 2014; Moore 1835)²,³ on tributary of Swan River west of Darling Range (Moore 1835)², on Greenough River, heavily settled by Noongar people (Stokes 1841)², in alluvial valleys around Gingin (Bindon 1996; Hallam 1983, 2014; Moore 1835)², and in the Chapman Valley (Roe 1846 in Hancock 2014).²,³ Described as growing best in moist locations among loose rocks of the Darling Ranges (Hammond 1933)²,³, favouring rocky outcrops (Bindon 1997; Grey 1841).² Hallam (1989) described prolific patches maintained through intensive, continual harvest and management, that were a key pre- and early-colonial enabler [along with Typha patches] of Whadjuk sedentary settlement patterns on and north of the Swan Coastal Plain (Hallam 1989, 2014).²,³,⁴ citing Chauncy’s map of the Swan Valley showing “warran holes” (Hallam 2016)², Hallam (1989) links labour investment in these patches with proprietary and harvest rights, suggesting that, given women’s primary responsibility for root harvest, that resource patches maintained through female line in Whadjuk Noongar society (Hallam 1989, 1991).²,³ |
| | | Described as a long tuber (Hammond 1933, on observation of Maggie Bell & Nellie Parker harvesting 3–4 km SE of Mingenew, August 1967).³,⁴ Described replanting of shoots and root tips following harvest (Bindon and Walley 1992; Daw et al. 2020; Hallam 1989)²,³,⁴, deliberate establishment of new populations (Hallam 1989)², and that large rock piles removed from soil during tuber harvest remain visible in Walyunga NP, with rock removal making future digging easier (Daw et al. 2020).²,³ Described as a highly savoured (Drummond 1840a; Grey 1841; Hammond 1933; Roe 1846; Roe 1847 in Hancock 2014; Stokes 1841)¹ staple food (Drummond 1840a; Roe 1846 in Hancock 2014)²,³, intensively harvested in patches (Grey 1841, Hallam 1983, 1989, 2014; Hancock 2014; Moore 1835, 1884; Stokes 1841)²,³ from very fertile soils (Grey 1841, Wollaston 1848–56 in Hallam 2014; Moore 1835)²,³ on tributary of Swan River west of Darling Range (Moore 1835)², on Greenough River, heavily settled by Noongar people (Stokes 1841)², in alluvial valleys around Gingin (Bindon 1996; Hallam 1983, 2014; Moore 1835)², and in the Chapman Valley (Roe 1846 in Hancock 2014).²,³ Described as growing best in moist locations among loose rocks of the Darling Ranges (Hammond 1933)²,³, favouring rocky outcrops (Bindon 1997; Grey 1841).² Hallam (1989) described prolific patches maintained through intensive, continual harvest and management, that were a key pre- and early-colonial enabler [along with Typha patches] of Whadjuk sedentary settlement patterns on and north of the Swan Coastal Plain (Hallam 1989, 2014).²,³,⁴ citing Chauncy’s map of the Swan Valley showing “warran holes” (Hallam 2016)², Hallam (1989) links labour investment in these patches with proprietary and harvest rights, suggesting that, given women’s primary responsibility for root harvest, that resource patches maintained through female line in Whadjuk Noongar society (Hallam 1989, 1991).²,³ |
| Droseraceae Salisb | | | | |

*Noongar names and use shared through literature.”
Table 1  (Continued)

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|-------------------------|---------------------------------|-------------------------------------------------------------------------------------------------|------------------------------------------|----------------|------------------------------------------------------------------------------------------------|
| *Drosera* sp. (no species provided) | *Boon* (Meagher 1974) | - | *Tubers eaten (?) (Meagher 1974)* | - | On misrecording of *Drosera* as food/medicine: -Drummond (1842a) commented on misrecording of *Drosera* as food/medicine that “I observe that you quote, under *Drosera stolonifera*, some remarks by Dr. Lindley respecting the supposed esculent nature of the tubers of that plant; but Dr. Milligan is speaking of the roots of *Haemodorum paniculatum* and *spicatum*, and other individuals of that genus; for the natives do not use any roots of the species of *Drosera* for food: though, if they should prove useful as a dye, they may be obtained in any quantities.”3 -Drummond (1842c) commented “the *Bhon* is the root of *Haemodorum Spicatum* of Brown, and it is the plant alluded to by Dr. Lindley under *Drosera*, but it is a mistake; the natives do not use the roots of any species of *Drosera* as food.”1,3 |
| *Drosera* spp. (Doubtful record) | *Boon* (Hammond 1933 in Pate and Dixon 1982) | - | *Tuber eaten raw or roasted (Hammond 1933 in Pate and Dixon 1982)* | Harvested summer and autumn (Hammond 1933 in Pate and Dixon 1982) | Confusion caused by misapplication of Noongar name *Boon* to *Drosera* spp. |
| *Drosera macrantha* (Doubtful record) | *Boon* (Goode 2010; Hansen and Horsfall 2019) | - | *Tubers eaten raw or roasted (Hansen and Horsfall 2019)*; tubers eaten (Hansen and Horsfall 2019); medicinal (Hansen and Horsfall 2019) | - | [Likely a misapplied reference to *H. spicatum* due to misapplication of Noongar name in (Meagher 1974)] |
| *Geraniaceae* Juss | *Geranium* spp. | - | *Taproots cooked and eaten (Coppin 2008)*3; taproot eaten (Grey 1841)3 | - | - |
| *Geranium solanderi* Carolin | Wardi wardi (LK, Treaty Woods, Averil Dean, Carol Pettersen, Eugene Eades)3; Wardie (Hassell 1975; Hassell and Davidson 1935)3; Terrat (Pate and Dixon 1982)3; Kwering (Whitehurst 1997)3; Kwariding (Hansen and Horsfall 2019)3; [Comment above applies] Quirting (Hassell 1975 in Hansen and Horsfall 2019)3; [Comment above applies] Very (Drummond 1843c)3; Vere (Drummond 1843c)3 | Tuber eaten as medicine (LK, Carol Pettersen, Treaty Woods, Averil Dean; Eugene Eades).3; Tuber eaten as medicine (Hansen and Horsfall 2019)3; tuber eaten as medicine (Hansen and Horsfall 2016; Hassell 1975; Hassell and Davidson 1935)3; tuber eaten roasted (Oates 1977; Lampert and Sanders 1973 in Pate and Dixon 1982)3; [Drummond 1843a, b, c, d does not give species name but description enables *G. solanderi* to be assigned with confidence] | Harvested anytime (Oates 1977 & Lampert and Sanders 1973 in Pate and Dixon 1982)3 | - | Drummond (1843c) observed that it was eaten, but rarely, by Noongar around Tooludya where it grows on “all the grassy hills”1,3; Hassell (1975) describes as used “only very sparingly for medicinal purposes”1,3; Not used often, only if genuinely needed for medicine (LK).1,3 |
Table 1 (Continued)

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|----------------------------------|----------------------------------------------------------------------------------|---------------------------------------------|---------------|------------------------------------------------------------|
| *Pelargonium drummondii* Turcz. | -                                | Taproot eaten roasted *(Low 1991 in Hansen and Horsfall 2019)*                   | -                                          | -             | -                                                          |
| **Haemodoraceae** R.Br. |                                   |                                    |                                             |               |                                                            |
| *Anigozanthos* genus (all species) | Cudditch *(LK)* *(Drummond 1843b)* | Stem base of all species can be eaten *(LK)* *(City of Joondalup 2019)* | Rhizome eaten raw or roasted *(City of Joondalup 2019)* | -             | -                                                          |
| | Quaiditch *(LK)* *(Drummond 1843a)* |                                    |                                        | -             | -                                                          |
| | Yonger mar *(LK)* *(Drummond 1844)* |                                    |                                        | -             | -                                                          |
| | Koorybardang *(Moore 1884)* *(based on Moore’s description of “The tall green-flowered Anigozanthus.”)* |                                    |                                        | -             | -                                                          |
| *Anigozanthos flavidus* | Cudditch *(Drummond 1843b)* | Stem base eaten as food *(LK)* *(City of Joondalup 2019)* | Rhizome eaten as food *(Drummond 1843a, b)* | -             | -                                                          |
| | Cathah *(Drummond 1843a)* |                                    |                                        | -             | -                                                          |
| | Koorybardang *(Moore 1884)* *(based on Moore’s description of “The tall green-flowered Anigozanthus.”)* |                                    |                                        | -             | -                                                          |
| *Anigozanthos rufus* | Yaungur-maatt *(Charlie Dabb in von Brandenstein 1988)* | Stem base eaten as food *(LK)* *(City of Joondalup 2019)* | -             | -             | -                                                          |
| *Anigozanthos manglesii* | Yaungal-maatt *(von Brandenstein 1988)* | Stem base eaten as food *(LK)* *(City of Joondalup 2019)* | Rhizome is eaten *(Buller-Murphy, nd in Goode 2010)* | -             | -                                                          |
| | Krulbrang *(Preiss in Abbott 1983, Bennett 1991 in City of Joondalup 2019)* |                                    |                                        | -             | -                                                          |
| | Kurulbrang *(Bennett 1991 in City of Joondalup 2019, Perth NRM 2015)* |                                    |                                        | -             | -                                                          |
| | Nolamara *(Collard 2009 in City of Joondalup 2019)* |                                    |                                        | -             | -                                                          |
| | Yonga Marra *(Bennett 1991 in City of Joondalup 2019)* |                                    |                                        | -             | -                                                          |
| | Knulbora *(Hansen and Horsfall 2019)* |                                    |                                        | -             | -                                                          |
| | Yonga maar *(Wheatbelt NRM 2009)* |                                    |                                        | -             | -                                                          |
| | Koorybardang *(Moore 1884)* |                                    |                                        | -             | -                                                          |
| | Kururolbenny *(Collard 2009 in City of Joondalup 2019)* |                                    |                                        | -             | -                                                          |
| *Anigozanthos verdix* | Koorybardany *(Perth NRM 2015)* | -                                | Rhizome eaten *(Perth NRM 2015)* | -             | -                                                          |
| *Anigozanthos humilis* | -                                | Stem base eaten as food *(LK)* *(Goode 2010)* | -             | -             | -                                                          |
| *Anigozanthos gabriellei* | -                                | Stem base eaten as food *(LK)* *(Goode 2010)* | -             | -             | -                                                          |
| Scientific name of taxon | Noongar names applied to taxon | Noongar use of taxon shared through oral history (or in literature where source individual could be identified) | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------|----------------------------------------|----------------|---------------------------------------------------|
| Haemodorum (no species given) | Mene (Grey 1841) | - | Bulb is eaten (Coppan 2008; Meagher 1974; Moore 1884; Backhouse 1843; Hassell 1936 in Pate and Dixon 1982) | Harvested all year (Daw et al. 2020; Moore 1884, Backhouse 1843; Hassell 1936 in Pate and Dixon 1982) | Whole genus described as a very important food source, with 7–8 species providing a readily accessible, nutritious meal at any time (Drummond 1840a, 1842c). Grey (1841) describes Nam-ga as meaning “the beard, the roots and bottoms parts of certain bulbs which the natives eat” [referring to H. spicatum and H. discolor]. |
| Haemodorum discolor | Kwerridny (LK, Knapp & Yorkshire in Knapp et al. 2021e; Whitehurst 1997) | - | Bulb eaten as food (Kevin Reynolds, Doc Reynolds, Treaty Woods, Averil Dean, Gail Yorkshire, Henry Dabb, Carol Petersen, Aden Eades, Eliza Woods) and medicine (Treaty Woods) | Best to eat late spring to early summer (LK) | LK describes that it grows in sand and gravel soils often with prostrate Banksia species, inland from coast. Her family ate it near Bremer Bay, Borden and Mahenup, where she recalls seeing many being roasted in the ashes at once. She still eats it regularly now. Hassell (1975) describe harvesting with women from 15–20 cm below ground. Hammond (1933) described as “growing in sandy country.” |
| Haemodorum laxum | Kwardine (Drummond 1842a) | - | Chilli-flavoured bulb pounded into cakes and baked (Hassell 1975); bulb eaten as a digestive (Hassell 1975); very hot when eaten raw, cooked on coals or in hot ashes (Whitehurst 1997); bulb used (Grey 1841) | - | - |
| Haemodorum paniculatum | Muljaa (Drummond 1842c) | - | - | - | - |
Table 1  (Continued)

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|---------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------|----------------|----------------------------------------------------------|
| *Haemodorurn simplex*    | *Djakat* (Hopper and Lambers 2014)\(^3\) [name assigned with caution based on description by Moore 1884] | -                                                                                               | Bulb eaten (Hopper and Lambers 2014; Moore 1884)\(^3\) | September to October (Hopper and Lambers 2014; Moore 1884)\(^3\) | -                                                        |
| *Haemodorurn simulans*   | *Mutta* (Hansen and Horsfall 2019, Hopper and Lambers 2014, Maggie Bell & Nellie Parker in Meagher 1974)\(^3\) | Bulb usually roasted, very spicy raw (Maggie Bell & Nellie Parker in Meagher 1974).\(^3\)       | Bulb eaten raw or roasted as food (Daw et al. 2020; Hansen and Horsfall 2019)\(^3\); flavouring for blander foods (Daw et al. 2020; Hansen and Horsfall 2019)\(^3\); roasted bulb and leaf base used to treat dysentery (Lassak and McCarthy 2001 in Hansen and Horsfall 2019)\(^2\); bulb made into tea and paste for use as medicine (Hansen and Horsfall 2019).\(^3\) | -                                                          | -                                                        |
Table 1 (Continued)

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|----------------|-----------------------------------------------------------|
| Haemodorum spicatum | Maci (Nind 1831; von Brandenstein 1988) | Bulb eaten as food (Little 1994, Treasy Woods) and medicine (Treasy Woods); bulb can be eaten raw but better cooked (roasted on ashes) to take away tartness (Lk); warning against eating too much (Treasy Woods in Hopper and Walley 2014); bulb eaten cooked (Izaac Webb in Kalotas 2009); can be used as a dye (Izaac Webb in Kalotas 2009); flavouring for meat (Izaac Webb in Kalotas 2009) | Bulb roasted, pounded into cakes and eaten as food (Daw et al. 2020; Nind 1831, SERCUL n.d.); bulb used as a colouring agent (Hansen and Horsfall 2016, SERCUL n.d.); bulb eaten raw or roasted as food (Bindon 1996; Bindon and Walley 1992; Bird and Breek 1988; Collie 1832; Daw et al. 2020; Drummond 1842c; Hammond 1933; Hansen and Horsfall 2019; Meagher 1974; Moore 1884; Perth NRM 2015; SERCUL n.d.); bulb eaten roasted (Moore 1884, Perth 1992; Cuppin 2008; Daw et al. 2020; Hansen and Horsfall 2019); roasted bulb and leaf used to treat dysentery (Lassak & McCarthy 1989 in Hopper and Lambers 2014); roasted bulb made into medicinal tea and paste (Hansen and Horsfall 2016, 2019; Perth NRM 2015); used to treat dysentery (SERCUL n.d.); bulb eaten roasted (Moore 1884, Backhouse 1843; Hassell 1936 in Pate 1843; Esperance carrying bulbs in a bag (Green 1989 in Hopper and Lambers 2014); bulb and pounded and mixed with earth before eating (Grey 1841) | Best during summer but eaten all year (Lk) | Eaten extensively by Mierningar/Menang people, especially at Two People’s Bay, an intensively used place of trade and could still be eaten even if a person’s totem (Lk). |
|  |  |  |  |  | Described as plant from which Meirnin/Menang people get their name (Lk, Hopper and Lambers 2014; Vernice Gillies in Kalotas 2009) and a staple food of Menang and other Noongar people (Lk, Grey 1841; Hopper and Lambers 2014; Vernice Gillies in Kalotas 2009; Moore 1884; Nind 1831). Its spiciness would promote salvation, leading to discoloration of the mouth and chin (Lk). |
|  |  |  |  |  | Described as growing in sandy country (Hammond 1933; Moore 1884) but confined to coastal areas (Nind 1831). |
|  |  |  |  |  | Method of preparation of it and other Haemodorum for eating by grinding with earth from termite nest (Bindon 1996; Hopper and Lambers 2014; Collie 1834, Backhouse 1843; Grey 1841; Nind 1831 in Meagher 1974). |
|  |  |  |  |  | Observation of strict Noongar law prohibiting harvest when in flower or seed, describing this stage as "mother of [eg] Bohn" (also refers to other taxa) (Grey 1841 in Hallam 2014). |
|  |  |  |  |  | Description of Noongar person near Esperance carrying bulbs in a bag (Green 1989 in Hopper and Lambers 2014) |
|  |  |  |  |  | Moore (1884) and Grey (1841) described mimi and me-me as the layers of the root resembling skin of an onion. |
|  |  |  |  |  |  |
| Macropidia fuliginosa | Nolliamuro (Hansen and Horsfall 2019) |  |  |  |  |  |
Table 1 (Continued)

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|--------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------|----------------|-------------------------------------------------------------|
| Tribonanthes genus (no species given) | Jitta (Bindon and Walley 1992) | - | Tubers eaten (Bindon and Walley 1992); tubers eaten raw or roasted (Moore 1884; Hammond 1933 in Pate and Dixon 1982) | Harvested in summer and autumn (Moore 1884; Hammond 1933 in Pate and Dixon 1982); Makuru (June to July) (Bindon and Walley 1992) | - |
| Tribonanthes australis | Jitta (Bindon 1996) | - | Tuber is eaten (Bindon 1996). | - | - |
| Tribonanthes longipetala | Djooobuk (Ned Mippy in Hickman and Hopper 2019) | - | - | - | - |
| Hemerocallidaceae R.Br | | | | | |
| Caesia (no species given) | Karhrh (Meagher 1974; Moore 1884) | - | Tubers eaten (Meagher 1974); tubers eaten raw or roasted (Meagher 1974; Oates 1977 in Pate and Dixon 1982) | - | - |
| Caesia micrantha | Karhrh (Hansen and Horsfall 2019); Kar (Bindon 1996) | - | Tubers eaten roasted (Meagher 1974 in Goode 2010; Meagher 1974 in Hansen and Horsfall 2019); tubers eaten raw (Bindon 1996) | - | - |
| Chamaescilla corymbosa | Yam (LK); Murriye (LK) [LK describes this as a generic word for food] | Tuber eaten as food (LK) | Tubers eaten as food (Archer 2010; Hansen and Horsfall 2019) | - | - |
| Dianella revoluta | Mangard (SERCUL n.d., Wheatbelt NRM 2016); Mangard (Perth NRM 2015) | - | Rhizome eaten as food raw, roasted or steamed in earth oven (City of Joondalup 2019; Hansen and Horsfall 2016, Perth NRM 2015, SERCUL n.d., Wheatbelt NRM n.d.); rhizome eaten roasted after pounding (Bindon 1996; Hansen and Horsfall 2019); decoction of rhizome medicinal (Hansen and Horsfall 2016) | - | - |
| Hyptidaceae R.Br | | | | | |
| Pauridia spp. | - | - | Corms of some species eaten (Coppin 2008); corms eaten raw (Oates 1977 in Pate and Dixon 1982) | - | - |
| Pauridia vaginata | - | - | Corms eaten when roasted (Hansen and Horsfall 1999) | - | - |
| Iridaceae Juss | | | | | |
| *Moraea setifolia* (L.f.) Druce | Wild onion (LK) | Bulb eaten (LK, Gail Yorkshire) | - | - | - |
| *Watsonia* sp. | - | Bulb eaten (Harley Coyne) | - | - | - |
| Juncaceae Juss | | | | | |
Table 1 (Continued)

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|----------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------|----------------|-----------------------------------------------------|
| *Juncus pallidus*        | -                                | Leaf base eaten (Wayne Webb in Kalotas 2009)                                                    | Leaf base eaten (Hansen and Horsfall 2019) | -              | -                                                   |
| **Juncaginaceae** Rich   |                                   |                                                                                                 |                                           |                |                                                     |
| Cycnogeton genus (species not given) | -                                |                                                                                                 |                                           |                |                                                     |
| Cycnogeton huegelii      | -                                |                                                                                                 |                                           |                |                                                     |
| Cycnogeton lineare       | -                                |                                                                                                 |                                           |                |                                                     |
| **Malvaceae** Juss       |                                   |                                                                                                 |                                           |                |                                                     |
| Malva preissiana Miq     | -                                |                                                                                                 |                                           |                |                                                     |
| **Marsileaceae** Mirb    |                                   |                                                                                                 |                                           |                |                                                     |
| Marsilea drummondii      | Ngalkoo (Nannup 2018 in Hansen and Horsfall 2019) | Some Indigenous groups pound rhizome and roast as cakes (Hansen and Horsfall 2019) |                                           |                |                                                     |
| Marsilea mutica          | Ngalkoo (Nannup 2018 in Hansen and Horsfall 2019) | Some Indigenous groups pound rhizome and roast as cakes (Hansen and Horsfall 2019) |                                           |                |                                                     |
| **Montiaceae** Raf       |                                   |                                                                                                 |                                           |                |                                                     |
| Calandrinia spp. (C. primuliflora group) | -                                |                                                                                                 |                                           |                |                                                     |
| **Orchidaceae** Juss     |                                   |                                                                                                 |                                           |                |                                                     |
Table 1 (Continued)

| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------|----------------|---------------------------------------------------------------------|
| Orchidaceae family (no taxa specified) | Many and varied names (Nind 1831; Hammond 1933 in Pate and Dixon 1982); Djubak (Moore 1884; von Brandenstein 1988); Karh-rh (Moore 1884) | Tubers eaten (LK, Larry Blight) | Tubers eaten or roasted (Nind 1831; Hammond 1933 in Pate and Dixon 1982); tubers of numerous taxa eaten (Drummond 1842d, Grey 1841) | October (Moore 1884; p22); October–November (Daw et al. 2020) | LK describes expected flowering time and that tubers swell during hot, summer months. She also describes importance of not harvesting while in flower to enable seed production. Drummond (1842d) reported that “many of the Orchidaceae produce roots which are much sought after by them as food”. Reference to early colonists’ descriptions of large gatherings of Whadjuk and Yind Noongar people lasting several weeks at Yanchep wetlands to eat prolific tubers growing in areas burned in previous season. Pyrorchis nigricans, Pterostylis recurva and Thelymitra spp. were among most common (Daw et al. 2020). Description of tubers in kangaroo skin bag carried by Noongar woman (Peron 1809 in Hallam 1983). Moore (1884) stated Djubak found mostly in “sandy soil of [rocky ground]” and reported women dig tubers using a digging stick (Bindon 1996). |
| Caladenia genus (all species) | Kar (Collard 2009 in City of Joondalup 2019); Kararr (Collard 2009 in City of Joondalup 2019) | - | All Caladenia tubers eaten raw or roasted (Hansen and Horsfall 2019) | - | - |
| Caladenia arenicola | Cara (Perth NRM 2015) | - | Roots eaten baked or roasted, sometimes pounded into cakes (Perth NRM 2015) | - | - |
| Caladenia flava | - | - | Tuber eaten as food (Eugene Eades, Eliza Woods) | - | - |
| Cryptostylis ovata | Wild potato (LK); Yum (LK); Marrinye (LK) [LK describes this as a generic word for food] | Tuber eaten as food (LK, Larry Blight, Wayne Webb) | - | - | - |
| Diuris genus (all species) | Djubak (L.K., Lorna Knapp); Cara (Hansen and Horsfall 2019); Djubak (Nyungar Wardan Katijin Bidi—Derbal Nara, nd in Hansen and Horsfall 2019) | Tuber eaten, a favourite (LK, Lorna Knapp) | Tuber eaten raw or roasted (Coppen 2008; Hansen and Horsfall 2019) | - | - |
| Eriochilus dilatatus | - | - | Tuber eaten (LK, L.K., Treasy Woods) | - | - |
| Gastrodia lacista | Koon (Whitehurst 1997 in Hansen and Horsfall 2019) | - | Tuber eaten raw or roasted (Cribb & Cribb 1987 in Hansen and Horsfall 2019) | - | - |
| Lyperanthus serratus | Carra (Drummond 1842d) | Tuber eaten as food (LK, Tootenellup) | Tuber eaten as food (Bird and Beeck 1988; Daw et al. 2011; Drummond 1842d) | - | - |
| Prasophyllum (no species given) | Chokern (when immature) (Nind 1831 in Meagher 1974); Nisnak (when old) (Nind 1831 in Meagher 1974); Tuboc (Bindon 1996, Nind 1831 in Meagher 1974) | Tuber roasted prior to eating (Maggie Bell & Nellie Parker in Meagher 1974) | Tuber roasted eaten (Bindon 1996) | - | Described as a “wild potato”, with a single tuber found 25 cm deep, dug by women with a digging stick (Bindon 1996); and, usually roasted prior to eating (Meagher 1974, on observation of Maggie Bell & Nellie Parker harvesting 8 km SE of Mingenew, August 1967). |
| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|-------------------------|---------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------|----------------|------------------------------------------------------------------------------------------------|
| Prasophyllum fimbria     | Djubak (Meagher 1974)           | -                                                                                               | Tuber eaten as food (Meagher 1974 in Hansen and Horsfall 2019) | -              | -                                                                                           |
|                         | Prasophyllum giganteum          | Tuber (Drummond 1842d)                                                                         | Tuber eaten (Drummond 1842d)                | -              | -                                                                                           |
| Pterostylis multica      | -                               | -                                                                                               | Tuber eaten (Lim 2016 in Hansen and Horsfall 2019) | -              | -                                                                                           |
| Pterostylis recurva      | Rattle Orchid (LK)              | Tuber eaten, a favourite (LK)                                                                  | Tuber eaten raw or roasted (Hansen and Horsfall 2019) | -              | [See Daw et al. (2020) under Orchidaceae family entry]                                    |
|                         | Karra (City of Joondalup 2011 in Hansen and Horsfall 2019) |                                               |                                               | -              |                                               |
|                         | Kararr (City of Joondalup 2011 in Hansen and Horsfall 2019) |                                               |                                               | -              |                                               |
| Pyrorchis nigricans      | Wild potato (LK)                | Tuber eaten as food (LK, Treaty Woods, Averil Dean, Carol Pettersen)                           | Tuber eaten raw or roasted, sometimes pounded into cakes (City of Joondalup 2019; Coppar 2008); tuber eaten (Bindon and Walley 1992; Bird and Beeck 1988; Daw et al. 2020; Hansen and Horsfall 2019). | Kambarang (October to November) (Bindon and Walley [1992; Daw et al. 2020]) | LK described digging to eat the tuber on observation of it growing at Gold Holes [a campsite and permanent waterhole in Eucalypt woodland] |
|                         | Djubak (Bindon and Walley 1992; Coppar 2008; Daw et al. 2020) |                                               |                                               | -              |                                               |
|                         | Djubag (Bird and Beeck 1988)    |                                               |                                               | -              |                                               |
| Thelymitra genus (all species) | Joobuk (Hansen and Horsfall 2019) | -                                                                                               | Tuber of all species eaten raw or roasted (Hansen and Horsfall 2019). | -              | [See Dawe et al. (2020) under Orchidaceae family entry]                                    |
|                         | Tubur (Nind 1831)               |                                               |                                               | -              |                                               |
|                         | Chokern [refers to lifestage prior to tuber maturity] (Nind 1831) |                                               |                                               | -              |                                               |
|                         | Naank [refers to late lifestage] (Nind 1831) |                                               |                                               | -              |                                               |
| Thelymitra (no species given) | Joobuk (Moore 1884 in Goode 2010) | -                                                                                               | Tuber is eaten (Daw et al. 2020, Moore 1884 in Goode 2010) | -              |                                               |
| Thelymitra canaliculata | -                               | -                                                                                               | Tuber is eaten (Drummond 1842d)             | -              | -                                                                                           |
| Thelymitra crinita       | Walyamur (LK, Carol Pettersen)  |                                               | Tuber eaten as food (LK, Treaty Woods, Averil Dean, Carol Pettersen); a favourite (LK, Carol Pettersen) | Tuber is eaten (Daw et al. 2011) | -                                                                                           |
| Thelymitra fuscofasciae  | -                               | -                                                                                               | Tuber is eaten (Drummond 1842d)             | -              | -                                                                                           |
| Thelymitra graminea      | Tualiny (Hansen and Horsfall 2019) |                                               |                                               | -              | -                                                                                           |
| Thelymitra villosa       | -                               | -                                                                                               | Tuber is eaten (Drummond 1842d)             | -              | -                                                                                           |
| Polygalaceae             | Hoffmans. & Link               | Long, white taproot is medicinal (Knapp & Yorkshire in Knapp et al. 2021a)                        | -                                           | -              | -                                                                                           |

*Note: The entries are based on the information available in the given references and may not be exhaustive.
| Scientific name of taxon | Noongar names applied to taxon | Noongar use of taxon shared through oral history (or in literature where source individual could be identified) | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|-------------------------------|---------------------------------------------------------------------------------|---------------------------------------------|---------------|--------------------------------------------------------|
| **Portulacaceae** Juss   |                               |                                                                                 |                                             |               |                                                        |
| *Portulaca oleracea*      | -                             | Taproot eaten cooked (Coppin 2008)                                             | -                                          | -             |                                                        |
| **Ranunculaceae** Juss    |                               |                                                                                 |                                             |               |                                                        |
| *Clematis spp.*           | *Taaruuk* (Oates 1977 in Pate and Dixon 1982) | Tuber eaten roasted and pounded (Oates 1977 in Pate and Dixon 1982)            | Harvested in winter (Oates 1977 in Pate and Dixon 1982) | -             |                                                        |
| *Clematis linearifolia*   | *Taaruuk* (Daw et al. 2020)   | Tuber roasted and pounded into cakes (Coppin 2008; Hansen and Horsfall 2019) | -                                          | -             |                                                        |
| *Clematis psilostachys*   | *Duruk* (Doc Reynolds)         | Rhizome eaten, taste's spicy (Doc Reynolds); rhizome eaten (L.K)                | Tuber eaten after roasting (Bindon 1996, Barrett & Tay 2016 in Hansen and Horsfall 2019) | Harvest during summer when not flowering (L.K.) | Grows prolifically around Albany and eastward from there (L.K.) |
|                          |                               |                                                                                 |                                             |               |                                                        |
| **Typhaceae** Juss        |                               |                                                                                 |                                             |               |                                                        |
| *Typha spp.*              | -                             | Rhizomes of two taxa eaten (Grey 1841; Hallam 1989)                            | Rhizomes accessible in summer and autumn (Daw et al. 2020) | -             |                                                        |
| Scientific name of taxon | Noongar names applied to taxon* | Noongar use of taxon shared through oral history (or in literature where source individual could be identified)* | Noongar use of taxon recorded in literature | Harvest season | Context of use shared through oral history and in literature |
|--------------------------|--------------------------------|----------------------------------------------------------------------------------------------------------------|--------------------------------------------|----------------|----------------------------------------------------------|
| *Typha orientalis*       | -                              | -                                                                                                              | -                                         | -              | -                                                        |
| Typha dominensis         | Yandyett (Moore 1884)3          | Rhizome eaten as food (Doc Reynolds)3; Bulrush used as food (LK)3                                              | Rhizome eaten as food (Bindon and Walley 1992, Coppin 2008, Daw et al. 2020, Drummond 1836, 1842e, Backhouse 1836 in Hallam 1991, Hansen and Horsfall 2016, Meagher 1974, Moore 1884)3; rhizome pounded and baked as cakes (Bindon 1996; Daw et al. 2020; Drummond 1842e; Eyre 1845; Grey 1841; Grey 1841 in Hallam 1991; Hansen and Horsfall 2019; Moore 1884, SERCUL n.d.)3 | Toward end of Bundur (March) (Bindon and Walley 1992)3 April to May (Moore 1884)3 | Observed growing near Esperance (Eyre 1845), and described as a staple food (Drummond 1836; Eyre 1845; Moore 1884)3,2, intensively harvested (Moore 1884)3,2, and growing on seasonally inundated alluvial soils and creeks (Drummond 1836; Eyre 1845; Moore 1884)3, always available but best harvested after wetlands dry and are burned (Eyre 1845, Grey 1841; Moore 1884 in Hallam 2014, Moore 1884)3,2,3 [See also Hallam (1989, 2014) under Dioscorea entry] |

*Where source is listed as name only with no date, refers to Noongar Elder or cultural informant who collaborated on this research. Information was provided during the research period.*
Table 2 References to Noongar use of Underground Storage Organs in historic and contemporary literature that do not refer to specific plant taxa. Authors’ comments included in square brackets. Superscripts 1–4 refer to the four hypotheses detailed in the Introduction.

| Noongar names applied to USO harvest technique or implement | English translation | Context of use shared through oral history and in literature |
|------------------------------------------------------------|---------------------|-------------------------------------------------------------|
| **Nan-ga** (Grey 1840) [likely refers specifically to *Haemodoraceae*]3 | Roots of a plant | - |
| **Jil-bee** (Hammond 1933)3 | To plant in the ground | - |
| **Niran** (Whitehurst 1997)3 | To dig | - |
| **Neer-ran** (Grey 1840)3 | To plant in the ground | - |
| **Berniny** (Whitehurst 1997)3 | To plant in the ground | - |
| **Bean** (Grey 1840)3 | To dig | - |
| **Bin-gur** (Grey 1840)3 | To plant in the ground | - |
| **Mat-ta-goor-no** (Grey 1840)3 | To dig | - |
| **Pi-an-gur** (Grey 1840)3 | To plant in the ground | - |
| **Yurang** (Moore 1884)3 | To shake, rub, clean and prepare roots for eating | - |
| **Mandija** (Moore 1884)3 | Decayed roots | - |
| **Yudangwinnan** (Moore 1884)3 | The act of pounding roots | - |
| **Wanna** (von Brandenstein 1977, Moore 1842 in von Brandenstein 1988)3 | Digging stick (without reference to gender) | Species from which wood is acquired for digging sticks include *Eucalyptus marginata* (Perth NRM 2015),3 *Eucalyptus redunca* (Bindon 1996)3 and *Agonis flexuosa* (Webb 2019).3 |
| **Wana** (von Brandenstein 1977)3 | Digging stick (belonging to women) | Digging sticks belonging to women described as considerable in length (LK, Hammond 1933; Hassell 1975; Meagher 1974; Moore 1884; Nind 1831),1,3 sharpened on one or both ends and hardened with fire (LK, Moore 1884; Nind 1831; Wheatbelt NRM 2009)1,3, used for digging up of plant roots (LK, Hammond 1933; Hassell 1975, Roe 1836 in Hercock 2014, Meagher 1974, Moore 1884; Nind 1831, Wheatbelt NRM 2009),1,3 and any other digging, including water holes, animal traps, building mias (shelters), graves and may also be used as a weapon (LK, Bates 1938 in Hallam 1991; Hammond 1933; Hassell 1975; Hassell and Davidson 1935; Nind 1831) and to check a burrow for snakes or *karda* (*Varanid lizards*) (LK).1,3 It is a universal tool, traditionally carried by all Noongar women (LK).1,2,3 |
| **Uana** (Salvado 1851 in von Brandenstein 1988)3 | Digging stick (belonging to men) | Taxa from which wood is acquired for women’s digging sticks includes *Acacia* (Wheatbelt NRM 2009)3, *Agonis flexuosa* [saplings] (Wayne Webb in Kalotas 2009)3 and *Acacia acuminata* (LK).3 |
| **Moora** [part of digging stick] (Whitehurst 1997)3 | Digging stick (belonging to women) | - |
| **Waan** (Wheatbelt NRM 2009)3 | Digging stick (belonging to men) | - |
| Noongar names applied to USO harvest technique or implement | English translation | Context of use shared through oral history and in literature |
|-----------------------------------------------------------|--------------------|------------------------------------------------------------|
| *Cote* (Nind 1831)<sup>3</sup>                             | Bag for carrying small items, including USO foods         | Women carry a kangaroo skin bag in which they carry food, including plant roots (Nind 1831).<sup>1,3</sup> |
|                                                           | -                  | LK described a general practice of marking USOs with a sturdy twig in the ground when flowering, then returning to dig it up after completion of flowering/seeding.<sup>1,3,4</sup> |
|                                                           | -                  | Gathering of roots carried out by women and children, who would eat some during course of day activities and take remainder to their camp (Meagher 1974).<sup>1,3</sup> |
|                                                           | -                  | Whadjuk Noongar woman, Fanny Bulbuk managed a carbohydrate resource patch on Heirrison Island, Perth (Bates 1938 in Hallam 1991).<sup>2,3</sup> |
|                                                           | -                  | [On alluvial soil near watercourse, east of York] Roe (1836) in Hercock (2014) described numerous holes dug by Noongar women in search of roots.<sup>1,2,3</sup> |
|                                                           | -                  | Nind (1831) described gender roles of south coastal Noongar men and women, including women collecting roots or crayfish and men procuring fish or game.<sup>3</sup> He further described a portion of roots being eaten, while the rest are taken to camp to share with men and children, also reporting that men also collect some roots.<sup>1,3</sup> |
|                                                           | -                  | Nind (1831) described that young south coastal Noongar children would be responsible for digging edible roots close to their camp.<sup>1,2,3</sup> |
|                                                           | -                  | SWALSC (2010) described fishing being traditionally carried out by Noongar men, while women gather yams and other plant foods.<sup>3</sup> |
|                                                           | -                  | Hammond (1933) described “the grubbing of roots [as] a job for the women and children” and that an “abundance of roots” [would be returned to camp].<sup>1,3</sup> |
|                                                           | -                  | Eyre (1845) described two Noongar women and a child digging roots in “sandy and barren” country covered with shrubs west of Esperance.<sup>2,3</sup> [Most likely observed digging of Platysace deflexa in kwongkan sandplain] |
|                                                           | -                  | Moore (1884) described a *Menang Noongar* woman carrying a bag containing roots which would be eaten after roasting and pounding.<sup>1,3</sup> |
|                                                           | -                  | Moore (1884) described *Noongar* man, *Beelycoomera* demonstrating planting a native root.<sup>3,4</sup> |
frequently mentioned were alluvial soils, wetlands and riparian areas in relation to *Dioscorea hastifolia*, *Typha domingensis*, *Lepidosperma gladiatum* and *Thysanotus patersonii*. Fertile woodlands (especially of *Eucalyptus wandoo*) were mentioned in relation to *Platysace cirrosa*, *Dichopogon fimbriatus* and *Orchidaceae*. Coastal sand was cited in relation to *Haemodorum spicatum*, while gravelly sand was mentioned in relation to *H. discolor* and *P. deflexa* (Fig. 4). Some commonly used species had multiple Noongar names across their distribution, varying with dialects (e.g. *Haemodorum spicatum*, Fig. 1).

While use of the roots of *Nuytsia floribunda* as well as various *Eucalyptus* (Myrtaceae) taxa are well known by Noongar Elders and recorded in the historic and contemporary literature, as they do not include a USO as such, we have not included these in detail in our analysis. Roots of some Eucalypt species

| Noongar names applied to USO harvest technique or implement | English translation | Context of use shared through oral history and in literature |
|-------------------------------------------------------------|---------------------|-----------------------------------------------------------|
| -                                                           | -                   | Hallam (2014) commented that Moore [1884] noted correlations between regular activities related to management of resource patches [including *Dioscorea* and *Typha*] and Whadjuk and Yuid Noongar patterns of settlement and movement, and that defined paths led to digging grounds.1,2,3 |
| -                                                           | -                   | Hallam (2014) reported that yam grounds [likely *Dioscorea*] were protected from fire.2,3,4 |
| -                                                           | -                   | In a grassy, fertile valley near Toodyay, Roe in 1836 in Hercock (2014) reported families digging for edible roots while men were away hunting for kangaroos.2,3 |
| -                                                           | -                   | On the Canning River, Wilson (1829) reported a Noongar man showing him various edible roots as well as the technique for digging them.1,3 |
| -                                                           | -                   | Roe (1835) in Hercock (2014) described a Wardandi Noongar camp in valley floor near Normalup as “to which were strewed the flat granite stones that had been used by the occupants as mortars on which to pound their roots and seeds.”1,2,3 |
| -                                                           | -                   | Grey (1841) in Hallam (1991) described “often stumbling on a large party of [women], scattered about in the forest, digging roots and collecting the different species of fungus.”1,2,3 |
| -                                                           | -                   | Grey (1841) described Noongar women and children on the Arrowsmith River digging for roots until they had “a sufficient quantity... for their purpose”, then walking a short distance to a water hole where they sat and cooked them.1,2,3,4 |
| -                                                           | -                   | Grey (1841) described the contents of Noongar woman’s bag including a “flat stone to grind roots, earth to mix with pounded roots...and roots collected during the day”.1,3 |
can provide access to water, and also have edible bark (Bindon 1996, Maggie Bell & Nellie Parker in Meagher 1974, von Brandenstein 1988), while the haustoria of *N. floribunda* may be eaten as a sweet treat (Coppin 2008; Daw et al. 2020; Hassell 1975; Knapp et al. 2021f; Meagher 1974, Wheatbelt NRM 2009). Noongar Elder, Noel Nannup (in Hansen and Horsfall 2019) also commented that only women are allowed to dig the roots of *N. floribunda*.

**Discussion**

In this review, we have gathered Noongar knowledge of USOs in the SWAFR to ascertain the ecological role of Noongar-USO relationships. Based on a review of First Nations relationships with USOs in other Mediterranean-type climate regions, we proposed four hypotheses, comprising 1) that Noongar First Nations USO usage was a significant ecological disturbance in the pre-colonial SWAFR; 2) that some taxa and specific, productive resource patches, usually on fertile soils, are more heavily targeted for harvest and promoted than those growing on less fertile soils; 3) that knowledge in relation to taxonomy, toxicity, productivity (e.g. in relation to water, nutrient availability) and phenology, technology and specific roles and lores have been applied by Noongar to control and sustain procurement of USOs; and 4) that reinvigoration of traditional USO knowledge and application can be beneficial for both conservation of SWAFR biological resources and for Noongar knowledge and identity. We found support for all of these hypotheses, particularly identifying that traditional Noongar access to USOs is taxonomically and geographically extensive (Hypothesis 1), employing specific knowledge and technology (Hypothesis 3) to target and maintain resource rich locations respectively. Also shown for each taxon are the quantity for which the original Noongar knowledge holder can or can not be identified.
Further we suggest that reinvigoration and employment of such knowledge is likely to have both conservation and social benefits (Hypothesis 4).

Scale

Our review has revealed evidence of extensive traditional *Noongar* USO use across a wide array of taxa (418 in 25 families), and the full geographic breadth of *Noongar Boodja*, which strongly supports our first hypothesis (Tables 1, 2 and supplementary material; Figs. 1, 3 and 5). Numerous accounts of extensive digging, sometimes at depths of more than a metre (e.g. for *Dioscorea hastifolia*), carrying of USOs when travelling, and robust, specifically-crafted *wanna* (digging sticks) all suggest that such interactions were substantial in scale and a significant ecological disturbance in pre-colonial southwestern Australia. That USO resources, while seasonally variable, are often available year-round suggests their value as fallback resources during scarcity of seeds, fruit or meat, which also supports this. Similar to the Greater Cape Region, this likely reflects the high diversity and prevalence of USO-bearing taxa within the SWAFR. In addition, we suggest that the finding of Botha et al. (2019) that contemporary Khoe-San plant use is representative of continual human use of up to 160,000 years in the Greater Cape is likely also in southwestern Australia for the length of Noongar occupation (i.e. more than 50,000 years (Tobler et al. 2017)), which Hallam (1989) also suggested based on archaeological evidence from the Swan Coastal Plain. Archaeological studies focused on detection of plant residues on Noongar grinding implements may help to shed further light on temporal scale.

Resource hotspots

In support of our second hypothesis, very frequent mentions in the literature of some *Noongar*-utilised USO taxa of southwestern Australia (e.g. *Dioscorea hastifolia*; Orchidaceae family; Figs. 3 and 5) indicate that some taxa are, or were in the past, more heavily targeted than others by *Noongar*, and that particular methods such as replanting and burning have been utilised to promote their growth (Daw et al. 2020; Hallam 1989, 1991, 2014) also providing support for Hypothesis 3. *Noongar* Elders of today still know soil, plant community and landscape conditions that will yield best USO crops (e.g. Knapp & Yorkshire in Knapp et al. 2021c), and mentions in the literature suggest that most targeted locations are YODFELs rather than OCBILs (Hopper 2009) (Fig. 4). In the Greater Cape Region, Khoe-San specifically target several staple taxa and also ‘resource hotspots’ to maximize USO returns for effort (Archer 1994;
Botha et al. 2020; De Vynck et al. 2016; Singels et al. 2016). Descriptions of such locations, including coastal dunes and riparian woodlands are suggestive of YODFELs (Hopper 2009). Botha et al. (2020) also found that highly productive geophyte patches occur in recently burned sand and limestone fynbos vegetation. Anderson (2005) reports maintenance of USO resource patches through burning and replanting in First Nations California, again in landforms suggestive of YODFELs.

Knowledge, skills, technology

Detailed Noongar knowledge, skills, technology and custom are revealed in the literature and held by contemporary Elders in relation to sustained, safe and efficient acquisition of USO resources providing strong support for our Hypothesis 3. As in California and the Greater Cape, the primary responsibility for USO harvest and resource patch maintenance lies with women (Anderson 2005) and is linked closely with settlement patterns (Hallam 1989) and family travel routes (LK). Hallam (1989, 1991) suggested that this likely equates to proprietary rights to such patches being inherited through the female line, with which author, LK agrees, as women usually controlled access to resource patches. Also like Californian First Nations and Khoe-San women, a wanna for digging USOs and a cote (bag) for carrying them were both essential possessions of pre-colonial Noongar women.
Specific knowledge and skills relating to harvest techniques, taxonomy, productive habitat and phenology are evident. That Grey (1840) recorded a specific Noongar word, *Nan-ga*, to describe the sand-binding roots of the *Haemodorum* genus (Smith et al. 2011), which translates to ‘beard of the mearn’ (von Brandenstein 1988 gives ngarnak = beard, hanglet) is an illustration of the detailed science contained in Noongar traditional knowledge, which also clearly articulated the sandy soils preferred by this genus, still well-understood by Elders today, who also note its co-occurrence with other *kwongkan* (sandplain) taxa, such as prostrate *Banksia* (Proteaceae) (LK). Detailed accounts of mixing the bulbs with termite earth to increase palatability are analogous with the specific skills for efficient and safe consumption of USO taxa among Khoe San (Botha et al. 2020). As evident in other USO-rich regions (e.g. Biscotti et al. 2018; Botha et al. 2019) we also note a high degree of geographic specificity of Noongar USO knowledge, illustrated by at least six geographically specific names for *Haemodorum spicatum* (see Fig. 1). In biodiversity conservation practice, this highlights the importance of including people and knowledge local to the relevant dialect group on whose traditional land a project is focused. Another novel parallel with Khoe San, are Noongar Elders’ accounts of introduced weed USO taxa (e.g. LK’s consumption of *Moraea setifolia*) demonstrating adaptability to new conditions resulting from colonization (Nortje and van Wyk 2019).

A concerning finding of this review was that for only 20% of the Noongar knowledge relating to USOs in the literature could we identify the Noongar person from whom the information was originally sourced. This was not confined to historical accounts, but was also the case for a substantial component of the contemporary literature. This separation of USO knowledge from its custodians has potential to perpetuate the disempowerment effects of colonisation already experienced by Noongar people and families, through removal of agency and confusion of identity that otherwise would have come from intergenerational knowledge transfer and connections to specific places and plant species. Further, it often fails to record complex and subtle relationships between First Nations people, landscapes and plant communities or taxa, and thus largely mitigates against interpreting ecological effects of traditional management. Conversely, where Noongar collaborators have been identified in literature as genuine and equal partners, and specific plant knowledge is attributed to individuals, families who have been impacted by damaging effects of colonisation are able to identify their ancestors, empowering revival of knowledge, skills, connection, cultural identity and agency to care for traditional Country.

Conservation

Noongar custom dictates rules about resource conservation. This strongly supports our fourth hypothesis. Harvesting USOs outside of a plant’s reproductive phenological phase is well known among contemporary Elders and is still observed (e.g. LK’s observations of *Dichopogon fimbriatus*). This behaviour was also recorded historically by Grey (1841) in Hallam (2014). In addition, only harvesting resources when needed (e.g. LK’s comment regarding *Geranium solanderi*) is also closely observed.

That most places heavily targeted as USO resource hotspots are in YODFELs concurs with Lullfitz et al. (2021b), who found that among south coast Noongar, intensive day to day activities are carried out traditionally in YODFELs while access restrictions often apply to OCBILs. Given the often fragile soils and vulnerable, specialist plant taxa of OCBILs compared to YODFELs (Hopper et al. 2021, 2016), concentrating soil disturbance and digging of plants in YODFELs is a means of sustaining plant resources and ultimately, conserving biodiversity.

As Anderson (2005) recorded among First Nations in California, and has been found elsewhere in Australia (Gott 2005), Hallam (1989, 2014) highlighted a likely promoting effect on USO resource taxa populations, supported by references to specific methods for harvest (Knapp & Yorkshire in Knapp et al. 2021g, Maggie Bell & Nellie Parker in Meagher 1974) and propagule replanting (Bindon and Walley 1992). In an earlier study (Lullfitz et al. 2021a), we found that harvest of *Platysace deflexa* tubers promoted population renewal, which aligns with LK’s observation of its prominence in disturbed gravel pits. The many references to Noongar carrying of USOs when travelling also concurs with genetic homogeneity among *P. deflexa* and *P. trachymenioides* populations found by Lullfitz et al. (2020), and suggests that Noongar...
use of some USO resources may have influenced current population distributions, and even expanded their range.

We have estimated that at least 418 USO-bearing taxa may have been utilised by Noongar people in southwestern Australia. That we found 45 mentions of Noongar USO usage in the literature for taxa that could not be identified, and also through our own experience of identifying previously unrecorded taxa during Elder-botanist collaborative field visits, we suggest that this figure possibly remains a significant underestimate. As both Nortje and van Wyk (2019) identified in Namaqualand and Pate and Dixon (1982) previously in the SWAFR, a lack of adequate botanical identification in the historic literature makes it fraught with possible misidentification of cultural taxa and can perpetuate early errors, as we have seen in the literature relating to Drosera (Droseraceae) (see Table 1). Just as Meagher (1974) suggested, our experience is that substantial unrecorded plant knowledge remains among Elders of the Noongar community.

Based on our review findings, we suggest several critical elements for successful and respectful exploration of traditional plant knowledge to inform biodiversity conservation. These are (1) Elder leadership, (2) inclusion of individuals with good plant identification skills, potentially through taking vouchered herbarium specimens, and (3) consideration of traditional gender-based roles. Transmission of plant knowledge held by contemporary knowledge holders is most accurate through shared experience on Country, enabling both correct taxon identification and for traditional and scientific knowledge holders to jointly explore their collective understanding of a plant’s conservation requirements (e.g. disturbance response, phenology or population genetics relating to human use), thus maximising its value for information relating to biodiversity conservation strategy. Imperative in any documentation of this process is a clear link to individual knowledge holders and the knowledge that they share. This approach avoids separation of First Nations knowledge from First Nation families, the rightful holders of such knowledge, and, if required, encourages intergenerational ‘waking up’ of knowledge inextricably linked to cultural identity for current and future First Nations people. Given that Noongar USO harvest is primarily a female domain, appropriate gender-based protocol is also imperative to prevent cultural harm and maximise knowledge accuracy. We suggest that inclusion of each of these elements can set us on a path to more meaningful, inclusive conservation approaches into the future.

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