

Protecting Aspects of the North Western Goldfields Intermittent Soak Community

A largely visual history of work done by a combination of NRM groups in the Mt Kooyoora and Mt Korong areas



What are the soaks?

Locals have long been well aware of the boggy areas at the break of slope in the Mt Kooyoora and Mt Korong areas, areas known as soaks. The areas have been known for their ability to deceive the unwary traveler into thinking that they are on solid ground only to trap them in wet quicksand like granitic soil. There still lingers the whisper of the legend of the horse, cart and driver that disappeared into one of these boggy areas never to be seen again! Talking of the soaks to older local residents produces images of the soaks as areas with permanent and semi-permanent springs which were used in dry times as sources of water for stock, abundant in wildflowers and known to be the haunt of red bellied black snakes preying upon healthy populations of frogs. But these images come from pre 1960/70's times.



Did the horse, cart and driver really disappear into a soak?



Bogged on the slopes of Mt Korong

Conservation Interest in the soaks

Although ecologists were for years aware of the existence of soaks, and the unusual flora associated with them, the extent of their distribution only came to light following the floods of 2010 /11. In Victoria, following intensive rainfall events in September 2010 and January 2011, widespread flooding occurred across the central and northern regions. The deluge re-charged river systems, flood plains and wetlands, sparking a once in a life-time boom in ecosystem productivity. Even a cursory look at satellite imagery taken just after the deluge in January revealed the extent of the soaks. A preliminary assessment of the Kooyoora granitic pluton (patches outlined in green in Figure 1 shows part of that survey) tallied over 112 separate soaks covering nearly 90 ha scattered across Kooyoora State Park as well as the surrounding public and freehold land. These persistent boggy areas that inexplicably appeared seemingly from nowhere, endured 6 to even 12 months after the rain stopped.

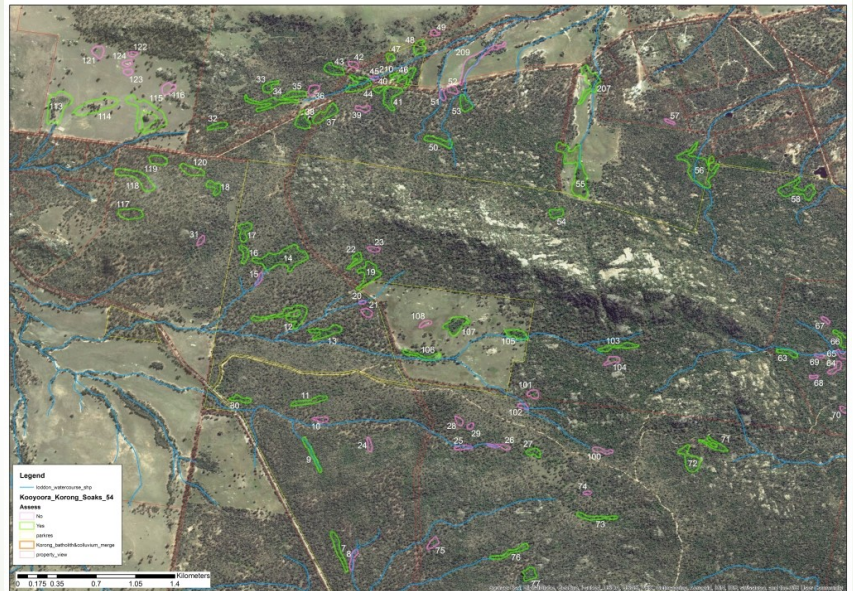
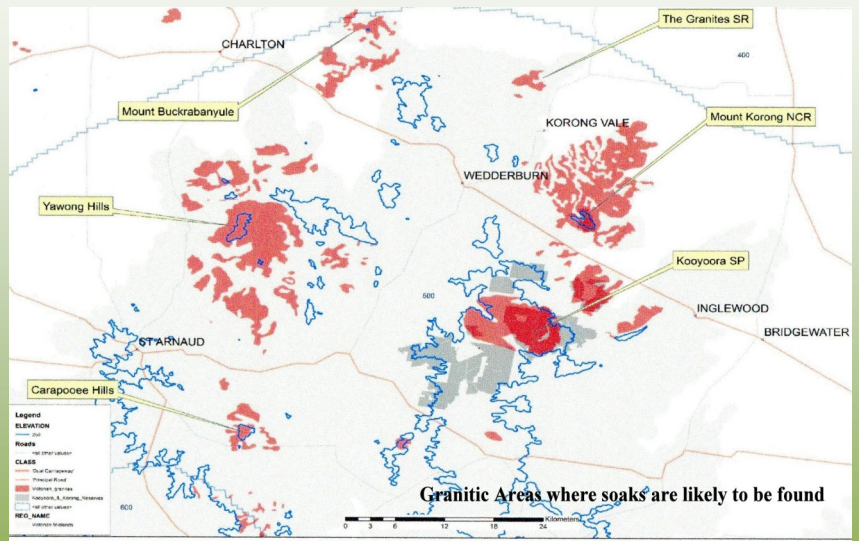


Figure 1



Granitic Areas where soaks are likely to be found



The schematic below (Figure 2) provides a hydrogeological model for the formation of the soaks in the North West Goldfields. The model being based upon work done in the Strathbogie Ranges. The essential components of this model are a high porosity weathered surface layer overlaying a fissured layer with lower porosity but through which the water stored within the high porosity layer can drain. This fissured layer sits on the fresh basement. In this model, the fractured rock aquifer is perched on this low permeability basement material. Groundwater is typically discharged from the aquifer at springs located where the ground surface intersects the basement surface, typically at valley margins. This process giving rise to the soaks described in this project.



Above: views of a soak showing green lush areas with surrounding dry areas.

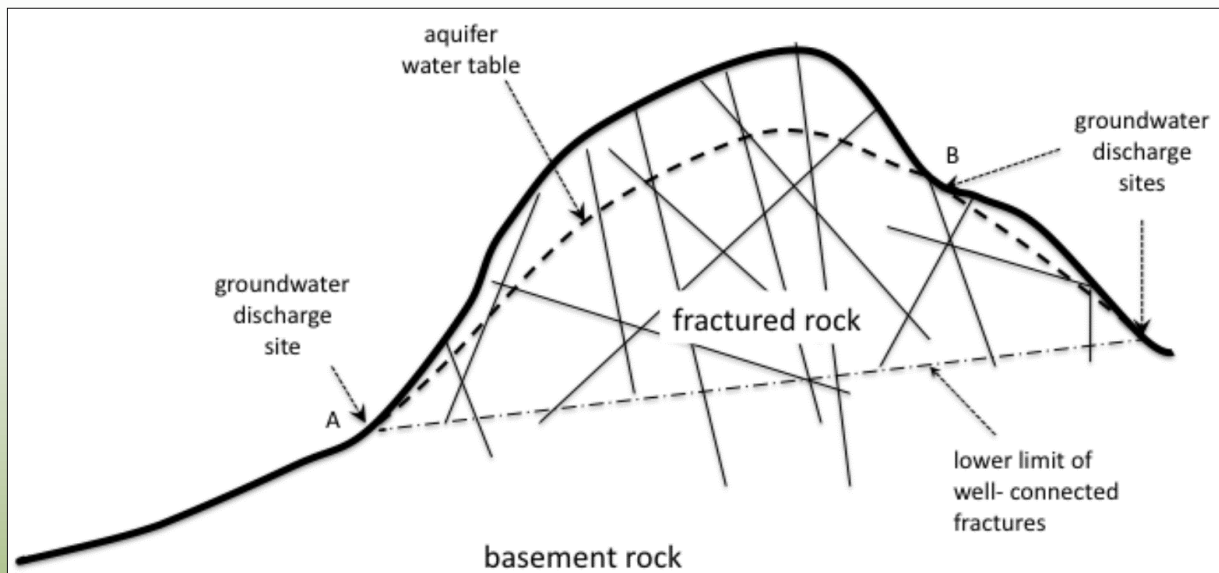


Figure 2: Conceptual model of fractured rock aquifers in the Strathbogie Batholith (adapted from Dewandel *et al.*, 2006)

Dewandel, B., Lachassagne, P., Wyns, R., Marechal, J. C., and Krishnamurthy, N. S. (2006). "A generalized 3-D geological and hydrogeological conceptual model of granite aquifers controlled by single or multiphase weathering." *Journal of Hydrology*, 330, 260-284.

Soaks areas during a wet active period

The appearance of these soaks raised some troubling questions:

- Why haven't they been recognized, described, mapped and appropriately addressed in local and regional conservation plans?
- What formal protection is appropriate?
- How many of them remain in good condition?
- How many are reserved?
- How many are being appropriately managed?



The lack of recognition of spring soaks in the north western goldfields had inevitably brought invisibility, which in turn had resulted in vulnerability to inadvertent destruction and gradual decline.

It was critical that we addressed the absence of understanding and conservation around these spring soaks as soon as possible by undertaking systematic assessment of remnants on both public and private land across both the Kooyoora and Mount Korong granitic plutons. Such an assessment would help:

- describe the ecosystem's extent, composition (flora and fauna), structure and function
- determine the condition, threats and management requirements for each site
- determine the significance of the ecosystem and need for formal (legislative) protection of its associated biota
- establish a baseline for monitoring future change and the success of future conservation efforts
- raise awareness amongst land managers and the local community

Soaks 1

In an attempt to pursue the above objectives the initial project, **Soaks 1**, (funded under the Wedderburn CMN's 2014 Communities for Nature grant "Protecting spring soaks in the north western Goldfields"; #2014MG00144) began in 2014. This project focused on mapping and characterising localised ephemeral spring soak wetlands around the margins of major granitic and metamorphic ranges in the north western goldfields. It also involved targeted grazing exclosure fencing at a number of prioritised sites at Kooyoora State Park and around Mount Korong. This measure was thought to be critical for the protection of woody soaks indicator species Prickly Tea-tree (*Leptospermum continentale*) and Golden Spray (*Viminaria juncea*) – now both rare and very restricted in the region and now under severe pressure due to a combination of climate change and macropod grazing. Limited revegetation within these exclosures with prickly tea tree and golden spray was carried out as well as a controlled burn at one soak in an attempt to reduce the abundance of exotic annuals and stimulate the perennial natives. *It should be noted that this project was carried out during a dry period, see figure 3 for comparison of the same soak in a dry and wet period.*

In attempts to raise awareness amongst land managers and the local community a number of field days were held and articles published in various media highlighting the importance of these threatened ecological communities.



Figure 3. above the same soak in both active and inactive

Many volunteering hands make light work

Volunteers involved in **soaks 1** included students from Bendigo TAFE, a Green Army, Fenton's Creek CFA, members of WCMN, Mt Korong Eco-watch group and Friends of Kooyoora.

Below: Cultural Heritage assessment of worksites by Dja Dja Wurrung appointed Archaeologist Anne Lambert



The work of the project realized a number of the original objectives stated above with respect to assessment, recognition, protection, and establishment of baselines for monitoring future change and the success of future conservation efforts. But our understanding of the systems was limited by the dry conditions prevailing throughout the duration of the project. A follow-up survey was planned for the next period of higher rainfall in order to fully describe their ecology when active. The preparation for such a survey forms the basis for **Soaks 2**

Towards the end of **Soaks 1** a nomination for FFG status for the soaks was submitted to the Scientific Advisory Committee of DELWP - this application was successful. **The 'North Western Goldfields Intermittent Soak Community' (SAC 2016) was formally listed under the Flora and Fauna Guarantee Act (1988) in 2016.**



Searching for soaks indicator species in dry conditions



CFA assisting with controlled burn



Green Army team helping to erect an enclosure



Above: Mt Korong Eco-watch members revegetating inside the enclosure



Finished enclosure

Soaks 2

An opportunity to study the soaks in an active wet period presented in 2016 when above average rains fell across central Victoria. Most of the rain fell between May and October and many of the soaks continued to be active well into 2017.

The Wedderburn CMN was successful in obtaining funding from the Norman Wettenhall Foundation Small Environmental Grant Scheme for the project: “*Spring soaks in the north western Goldfields in an active year*” - **Soaks 2**. The objective of this project was to help further build the skills, capacity and ecological understanding of the members of Wedderburn CMN (in close collaboration with the Friends of Kooyoora State park, Mount Korong Eco-watch group, Loddon Plains Landcare Network and the Kara Kara CMN) through workshops and field days involving instruction in:

Mapping – using Google Earth, GPS and tablet computers to map the extent of soaks between wet episodes.

Setting up and monitoring structural transects – This method allowed for documenting the dynamics in flowering, seeding and recruitment events.

Setting up and monitoring of quadrats – a method for establishing vegetation composition

Plant Identification - specialised workshops for the identification of difficult species such as grasses and other wetland plants.



Above: Identifying and listing plant species



Learning about setting up and monitoring transects



Identifying and photographing indicator plant species

Mapping the soaks

A significant aspect of the Soaks 2 project was the mapping of the soaks over time. Volunteers were instructed in the use of Google Earth to map dynamics between wet episodes (i.e. the extent of soaks). However, this was limited by the availability of imagery and more detailed mapping of dynamics required the use of GPS and tablet computers on ground literally walking the perimeter of soak patches over the life of the active phase. Photographs show volunteers being instructed in the mysteries of tablet computers.



An Unexpected Discovery

Widespread golden spray recruitment from an apparent soil seed bank was evident at many sites and an unexpected development because this species was thought to have more or less disappeared from the region. As macropod grazing was obvious, small scale fencing and guarding of individual and small groups of prickly tea tree and golden spray was carried out thus allowing these woody species to reach maturity, flower and produce seed for further recruitment of the species. On the back of the work undertaken for this project, it is clear that this species should recover well as long as there is on-going grazing protection coupled with targeted monitoring.



Volunteers from different environmental groups working together to fence off an unexpected flush of golden spray seedlings.

Other achievements and discoveries of Soaks 2

- realisation of species lists for some thirty soaks sites
- discovery of new soaks not visible via satellite imagery due to tree cover
- setting up of field data sheets for collating information from plant transects and quadrats
- setting up of a data sharing and storage system based on volunteers' use of Microsoft one drive accounts for sharing field data sheets, photographs and notes.
- purchase of a suitable microscope to aid in the identification of species
- discovery of species apparently not described previously such as the *Nitella* species (right), a fresh water algae, found in wet areas of some of the soaks - identification pending.



Fresh water algae - unknown *Nitella* species discovered during identification work on the soaks

Examples of Soaks Indicator Species Found During the Project



Hypericum gramineum
Small St John's Wort.



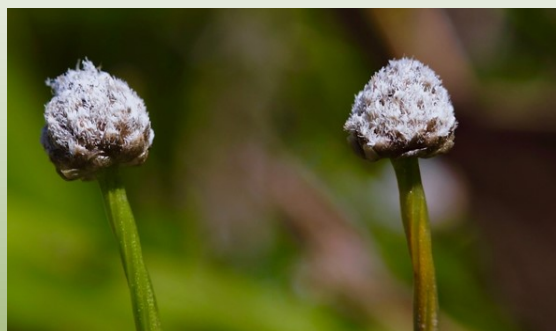
Goodenia humilis
Swamp Goodenia



Utricularia dichotoma s.l.
Fairies' Aprons



Craspedia paludicola
Swamp Billy—buttons



Eriocaulon scariosum
Common Pipewort



Hypoxis hygrometrica
var. *villosisepalla*
Golden Weather-glass

Soaks 3

The initial project, **Soaks1**, focused on mapping and characterising localised intermittent soaks wetlands around the margins of major granitic and metamorphic ranges in the North Western goldfields. The project also involved establishing grazing exclosure fencing at a number of sites at Kooyoora State Park and around Mount Korong. **Soaks 2** focused on capacity building of the various groups involved in preparation for the follow-up survey planned for the next period of higher rainfall in order to fully describe the soaks ecology when active. In preparation for this work the Wedderburn CMN was successful in obtaining funding through Community and Volunteer Action Grants 2017 Application BOA2017CA071 entitled: "Protecting spring soaks in the north western Goldfields - stage 2." This project labelled **Soaks 3** actually ran concurrently for a while with the work of Soaks 2.

The objectives of this work were;

- The completion of the exclosure and erosion control work left unfinished due to lack of funding in Soaks1.
- To compare the soaks between the dry (2015) and wet phases (2016/17).
- Carry out further field assessment into areas not covered by the first grant, namely private and public land associated with the Yawong Hills, Sunday Morning Hills (Kooyoora State Park) and The Granites.



Above, Dja Dja Wurrung works crew erecting an exclosure under the watchful eye of Sharnie Hamilton, Cultural Heritage Parks Victoria. **Right**, coir logs held in position by wooden stakes to prevent a sediment slug from overflowing into a soak area.

Monitoring And Assessment Activities Comparisons Between Soaks In Active And Inactive Phases

Mapping change in extent of soaks

The group members used Tablets with GPS capacity to field map the boundaries of numbers of soaks at various points during the 2016/2017 wet phase. This was complemented with broader mapping interpreted from readily accessible satellite imagery (Google Earth) captured at appropriate dates (January 3, 2017). In terms of quantity and duration of flooding rains, the 2010/12 La Nina driven event represents the upper benchmark. Locally (Inglewood BOM), this event started around August 2010 (although there was significant rainfall earlier in Autumn that year) and continued through until March 2011 (say 8 months incl. two massive floods). The latest event started in May 2016 and continued until October or November 2016 (say 6 to 7 months incl. one relatively small flood).

In terms of the relative response of the soaks to these two contrasting wet events, the mapping shows significant differences in the local extent, patterning and duration of activity. In March 2011, all the soaks were mapped as relatively large, single polygons with a mean extent of ~2.8 ha (see pink polygon in photograph below) – with many apparently remaining active until around the Autumn of 2013 (some 2.5 years after initiation in August 2010). In contrast, during the 2016/17 event, the soaks were much less extensive (mean area of ~0.7 ha) and much more broken up into a series of smaller component patches (see light green polygons in photograph below) that may reflect the pattern of the groundwater discharge determined by the underlying rock and regolith structure.



March 2011 showing greatest extent of soak following record breaking rains in 2010/12 (Pink polygon). March 2017 showing more limited extent of soaks following more moderate but still above average rainfall in 2016. Note: multiple tiny patches of green encircled by light green polygons, field survey way points indicated by the numbers.

Transects looking at changes in the abundance of Prickly Tea-tree and Golden Spray

The basic technique was to compare the %cover of both of these indicator species at the various exclosures which were established during a dry phase as part of Soaks 1. Additional transects were established outside the exclosures as a control as necessary, and where this wasn't possible, radial seedling counts (1, 2, 4, 7 m) were undertaken under mature Tea-tree plants with capsules and seed. Monitoring was undertaken at various dates during the 2016/17 wet phase and immediately after. The results supported the initial contention that: (1) germination and recruitment is strongly episodic linked to wet phases, and (2) that browsing pressure (and not climate change driving up the duration of dry phases) is the prime cause of woody (shrub) indicator decline by preventing survival of seedlings.

Although the %cover of Prickly Tea-tree was significantly different at the various soaks, most of the exclosures included mature individuals with some capsules containing seed. Without this seed, natural recruitment would not be possible, and recovery time would be needed for extant plants to put on growth, flower and produce new capsules ready for the next wet phase. The radial counts of Prickly Tea-tree recruitment outside the exclosures at Soaks 92 and 93 on Back Road (KSP) dramatically show the initial pulse of germination following the flooding rains in 2016, but as conditions began to dry out, numbers started to reduce by the middle of 2017 and then by March 2018, none remained. It should be noted that most numbers of seedlings at Soak 93 were initially located in an area locally protected by branches, and that by 2018, even these young plants had been eliminated by browsing (by wallabies and kangaroos). In contrast, the transect results within the nearby Soak 92 exclosure show a very different story. Here too the wet phase triggered scattered germination, but by August 2018 numbers counted along the 50 m transect peaked at 105. While all seedlings were still relatively small, it is thought most likely they germinated in late 2016 or during 2017 and are now at least 1 year old. Even though it is still early days, it is very clear that the protection from browsing pressure provided by the exclosure fencing is already working to help recover remnants of this very rare ecosystem.

A similar story emerged for Golden Spray – although it was thought this species had disappeared from pretty much all sites due to a combination of browsing pressure and climate change. Following the 2016 wet event, Golden Spray germinants/recruits were found to be widespread at the better quality Kooyoora and Korong soaks (at least nine soaks but likely many more). But even as these many small, young germinants were becoming apparent to field observers, it was also very clear they were being adversely affected by browsing and would probably not survive to recruit, flower and set seed as the soaks dried out. Though some plants were apparently protected at soaks with exclosure fencing, the majority – at unprotected sites – would have no hope of survival. Consequently, some additional temporary fencing was tried at some soaks until additional (permanent) exclosures could be installed later in 2018. Again, this strategy proved successful, with many of the individuals protected seeing rapid growth, and many are expected to flower later in 2018. The response of this species to the wet event implies either a persistent soil seed bank or one that is quickly turned over by pulses of rapid seed production following wet phases.



Setting up transects



Prickly tea tree—*Leptospermum continentale*



Viminaria juncea—golden spray

Function and dynamics—Pairwise comparison of the four key groups of soaks in the two regions (Kooyoora and Korong) and the two years (2015 and 2017).

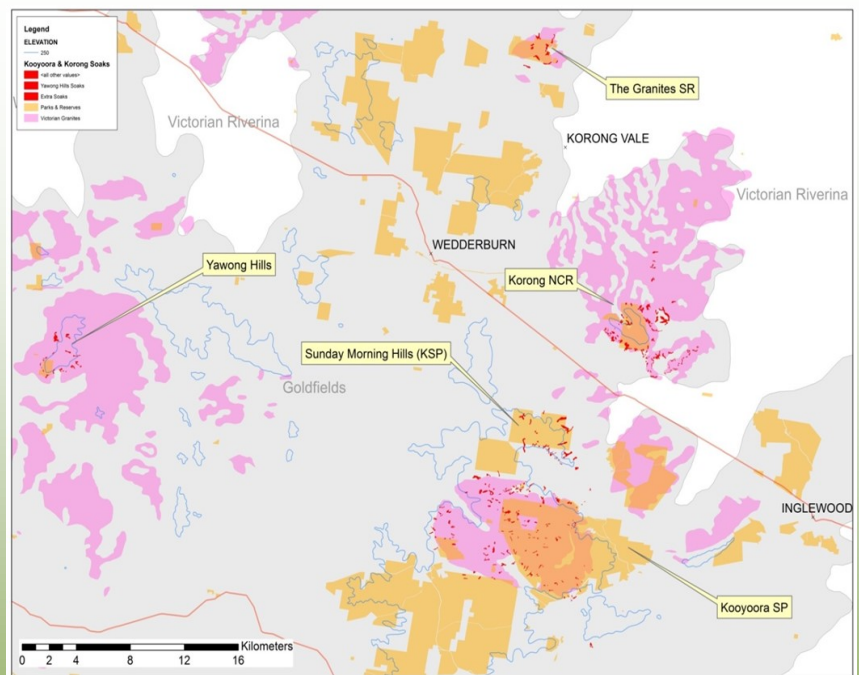
Analysis shows that the group comparisons between the two regions (Kooyoora and Korong) and the two years (2015 and 2017) are all significantly different – many highly so. The results show that there were major differences between soaks found at Kooyoora vs those at Korong (in both years tested) as well as dramatic differences between the dry and wet phases at both regions. Presumably the former divergence is due to differences in land use history, rainfall and micro-environments, while the latter testifies to the dramatic transformation of the vegetation at the same locations with the transition from dry conditions in 2015 and the return of a wet phase in 2017 following the well above average rainfall in 2016. This remarkable transformation is visually captured for a number of sites. The images below show the onset of wet conditions driving a rapid conversion of bushland, with a previously bare and scolded-looking ground layer, into a lush, green wetland dominated by ephemeral sedges, grasses, forbs and rushes.



Further field assessment of areas not covered by Soaks1

Three key regions/ranges were subject to limited field assessment under this project to broadly determine their respective nature and condition. These included the private and public land associated with the Yawong Hills (comprising Yawong Hill Geological Reserve), Sunday Morning Hills part of (Kooyoora State Park) and The Granites (The Granite Scenic Reserve).

All of these areas represent relatively small, discrete clusters of candidate soaks variously distant from the Kooyoora/Korong ranges. The Yawong Hills and The Granites sites are both associated with minor granitic ranges and the Sunday Morning Hills system is part of a reasonably elevated, steep, metamorphic range on the northern aureole of the greater Kooyoora granitic batholith. The candidate soaks in The Granites and Sunday Morning Hills were located on a mix of public and private land, while those at Yawong Hills were, with a couple of exceptions, on private land and subject to land clearing, stock grazing, and in many cases, cultivation.



Breakdown of soaks mapped in the North West Goldfields

Yawong Hills

While modest groundwater discharge continues – albeit intermittently – at Yawong Hills, field assessment identified little or no evidence of remaining native vegetation on a selection of the more accessible soaks observed due to the land use history of severe disturbance.

Sunday Morning Hills

The candidate sites at Sunday Morning Hills are scattered on vegetated slopes to the north, as well as on cleared farmland to the south (the Brennanah Valley side). Again, while there appears to be some natural groundwater discharge, the sites observed here were either too degraded (clearing, grazing, salinization, weed invasion etc.) or were apparently not sufficiently wet to support the form of soaks vegetation present nearby at Kooyoora and Korong.

The Granites

The Granites proved to be the exception of the three ranges assessed under this soaks project. Although considerably further north, and lower in extent and in elevation compared to the Korong and Kooyoora ranges, The Granites had the right combination of vegetated public land and a number of apparent natural groundwater discharge zones scattered in the break of slope position. Importantly, at least three of the larger candidate soaks supported discrete pockets of Blakely's Red-gum (*Eucalyptus blakelyi*). Significantly, all of the indicator species found at The Granites were common in the Kooyoora/Korong soaks, and characteristic woody perennials, such as Golden Spray (*Viminaria juncea*) and Prickly Tea-tree (*Leptospermum continentale*), were absent and have not been recorded there in the past.



The extraordinary nature of the soaks

The extraordinary nature of the soaks is realized when it is noted that nearly half of all threatened plants recorded in Kooyoora State Park (Parks Victoria 2010) are restricted to these areas or the related rock pool environments. See some examples of indicator plant species associated with the soaks below.

One of the characteristic features of the intermittent soaks are the perennial and ephemeral indicator species – species which are found only at the soaks and often also only when the soaks are active in a very wet year.

The larger perennial indicators survive through the dry phase, but in some way require the wet phase to be sustained through the next dry phase – be it stimulation of flowering and recruitment or just periods of access to a greater supply of water that is otherwise not available in surrounding areas.

The ephemeral indicators, on the other hand, effectively avoid the dry phase with a life strategy of ready germination from a dormant soil seed bank (or dormant underground roots/buds), rapid growth, flowering and often prolific seed production prior to an equally rapid desiccation as the dry conditions return perhaps 12 to 24 months after the above average rains stop (depending on the quantity and duration of the flooding rains).



Myriocephalus rhizocephalus
Woolly-heads



Centrolepis strigosa subsp. *strigosa*
Hairy Centrolepis



Recommendations and next steps

Wedderburn CMN is keen to view this project as the beginning of a longer term commitment to understanding and protecting this unique community. The information generated thus far represents a terrific baseline against which further research, monitoring and management actions can be undertaken and evaluated.

The following future measures are under consideration:

- Promote the soaks through media, and advocacy with relevant organisations for on-going research and conservation management funds.
- On-going maintenance of on-ground works, especially enclosure fencing.
- Re-assessment of all monitoring sites (photo-points, floristics, structure and other functional information), and as appropriate, establish new monitoring sites, during and immediately following the next wet period.
- Analysis and synthesis of all data into a detailed description of the values, function and conservation of north western intermittent soaks.
- In collaboration with Dja Dja Wurrung, commission a detailed assessment of the cultural values and significance of soaks to the Traditional Owners.
- Commission Zoological assessment of soaks, before, during and after next wet period to better describe the fauna values and functional significance of soaks for vertebrate fauna;
- Continued liaison with Parks Victoria (and the Dja Dja Wurrung Aboriginal Clans Corporation):
 - * on follow-up works in KSP such as relocation of culverts, installation of sediment traps, signage and barriers as appropriate.
 - * Incorporation of the soaks community, and conservation measures and public information into various parks management plans as appropriate.
- Follow-up liaison with the owners of known significant soaks, especially in the Mount Kooyoora and Korong region, to advocate for appropriate protection and restoration;
- Follow-up assessment of significant soaks elsewhere in the north western Goldfields but not assessed under this project.

