Understanding Species Zonation of Samphires (Salicornieae) in the Goldfields of Western Australia

Bindy Datson, *actis* Environmental Services
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Introduction to Samphires

Samphire is the common name for a group of succulent sub-shrubs, shrubs and annuals, which in Australia is represented by six genera: Halosarcia, Pachycornia, Sarcocornia, Sclerostegia, Tecticornia, and Tegicornia, which belong to the Tribe Salicornieae of the Family Chenopodiaceae. As well as the Salicornieae tribe, the Chenopodiaceae family also includes five other tribes. Tribe Chenopodeae contains the well known (common in Australia) Genera of Maireana, Atriplex and Rhagodia, to name a few.

Samphires live in environments generally considered to be hostile. Their growing conditions can vary from extreme heat and salinity, to frost, waterlogged soils, hard-baked clays, or flash floods. Samphires are most commonly associated with saline environments of some kind.

Samphire habitats include salt lakes and pans, salt marshes and coastal Samphire flats. Samphires are also found where there is secondary salinisation, and their presence is often an indication that the water table is rising and salt is becoming an issue.

Samphires are common worldwide, and in some countries have been traditionally eaten either pickled or boiled. They have also been burned and used in the manufacture of glass (Glasswort). In Australia seeds of samphires of the genus Tecticornia are still harvested and eaten by Aboriginal people, made into a type of cake. In the Goldfields region this food is called Kurumi and at harvest time people gathered for ceremonies around the clay pans where these plants were growing. Seeds were put into cracks in the clay pan to ensure a good harvest next year.

Rich Diversity

Samphires are common worldwide but in Australia have a rich diversity not generally found in other countries. Russia appears to have a similar diversity though shares none of the Australian samphire genera. Samphires are spread all over Australia but tend to be regional in distribution. For example there are tropical species, sub-tropical species and species that are found in the great artesian basin in central Australia. Often a species will only be found in one region however other species are found over a wide range.

Most of the Australian species of samphire are unique to Australia (endemic), not occurring anywhere else in the world. Exceptions to this are *Halosarcia indica,* which is found in Malaysia and in countries around the Indian Ocean, and *Sarcocornia quinqueflora,* also found in coastal New Zealand and New Caledonia. *Sarcocornia* is a cosmopolitan genus of 16 species; 3 species are native to Australia. *Halosarcia* is a genus of 23 species; all except one are endemic in Australia. Unlike samphire species in other countries of the World, Australian samphires are nearly all perennial, only members of the genera *Tecticornia* and *Tegicornia* are annual plants.

Goldfields Species

The Goldfields region of Western Australia has a good representation of most of the Samphire species. A total of 5 genera, 19 species and a further 5 sub-species are found in the Goldfields. Most of the lakes share common species; however some lakes have species endemic to them. An example of this is *Halosarcia* 'Angelfish Island', which is found in abundance at Lake Carey and Lake Minigwal but has not been found at any other lakes. Other examples are *Halosarcia entrichoma*, found only on a fresh water clay pan in the Frank Hahn National Park, *Halosarcia bulbosa*, which is found growing on Samphire flats near Morawa and *Tecticornia arborea,* found on a few freshwater clay pans near Leinster and Lake Goongarrie.

It is not known if these unusual species were once more widespread in their range and have contracted to smaller habitats, or if they have been isolated for a long enough time to have evolved into a different species. It is assumed that this diversity has arisen because saline wetland systems have existed on the Australian continent for eons. Studies documenting changes in climate, water and salinity levels in lakes throughout southern Australia suggest there have been at least five periods of high water tables over the past 200,000 years, the most recent of these less than 20,000 years ago. All were induced by changes in the climate. These periods of high water tables produced large tracts of salt affected land, much as we are seeing in the farmed Wheatbelt today.

Species Zonation

The saline wetlands of the Goldfields are all linked to ancient drainage systems, or Palaeochannels, which are relics of rivers that used to drain into the Eucla Basin, to the southeast. These saline wetlands are predominantly large bare expanses of clay playa surrounded by gypsum or sand dunes and accompanying clay pans. There are some exceptions to this – Lake Raeside is more of a series of pans linked by drainage channels than one single lake, for instance. The water in the Palaeochannels is hyper saline; up to 280g/L, however the water on the surface varies from being fresh enough to support tadpoles and Shield Shrimps, to a salt crust.

Samphires are closely associated with these saline lakes and their surrounding clay pans, each species growing in the portion of the lake shoreline or pan that meets its needs. It is evident that many samphire species have evolved to grow in specific areas, under certain conditions, and are in reality quite fragile and susceptible to change. The species found on lake beaches are often quite different to those found on adjacent Aeolian plateaux or dunes and again on the surrounding fresh water clay pans.

Samphire species appear to have evolved to fill different niches in the hostile environments they inhabit. The individual species grow in their preferred zones. For instance, *Halosarcia indica* subsp. *bidens* is nearly always found in well-drained soils – at Lake Carey, in the northern Goldfields, it is always found at about one meter above the lake playa. *Halosarcia halocnemoides* subsp. *caudata*, on the other hand is rarely found growing more than a few centimeters above the lake playa and is often found out on the waterlogged saline clays. Most Samphire species fall somewhere in between these two extremes, showing tendencies toward one or other end of the scale.

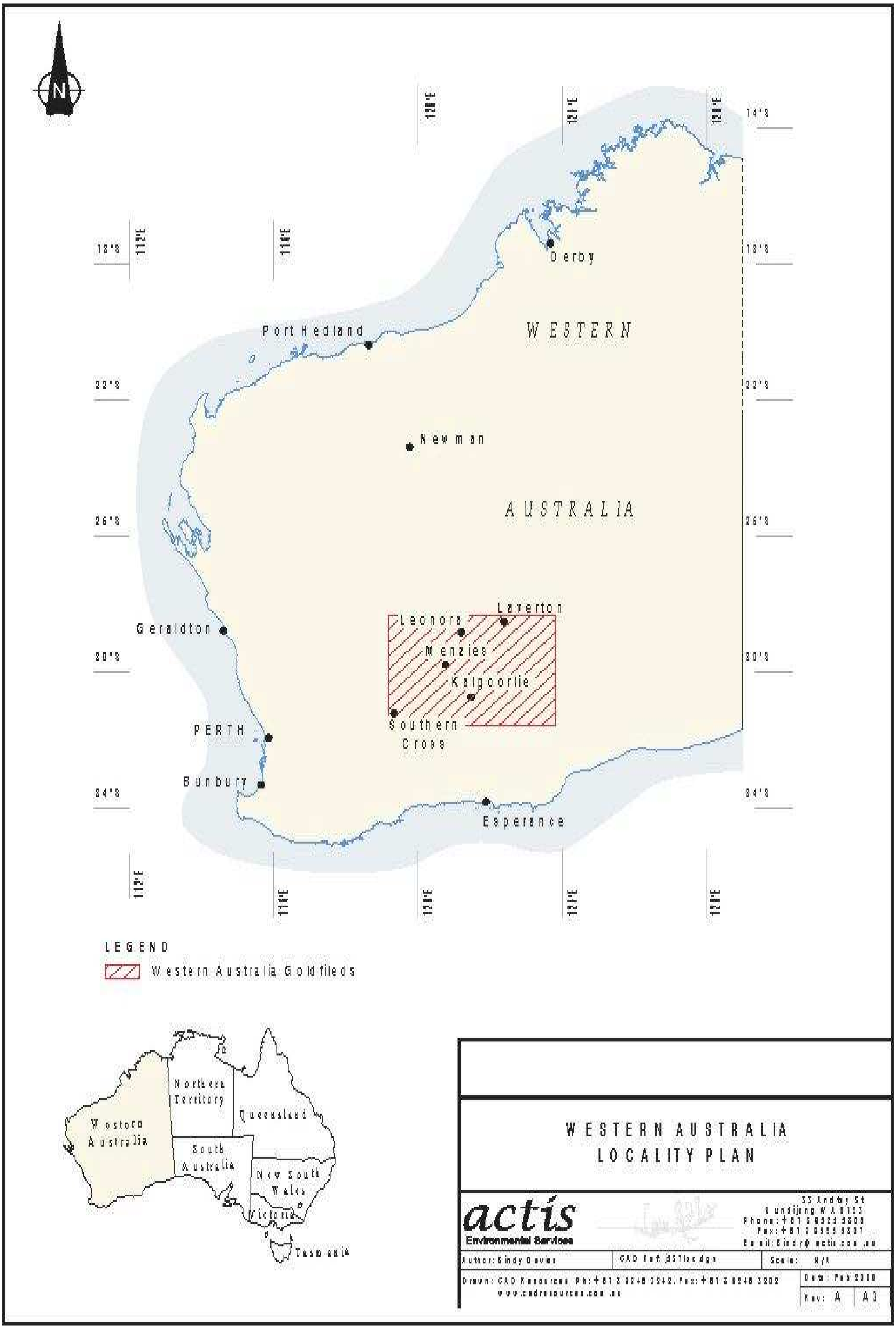


Figure 1 Goldfields region of Western Australia

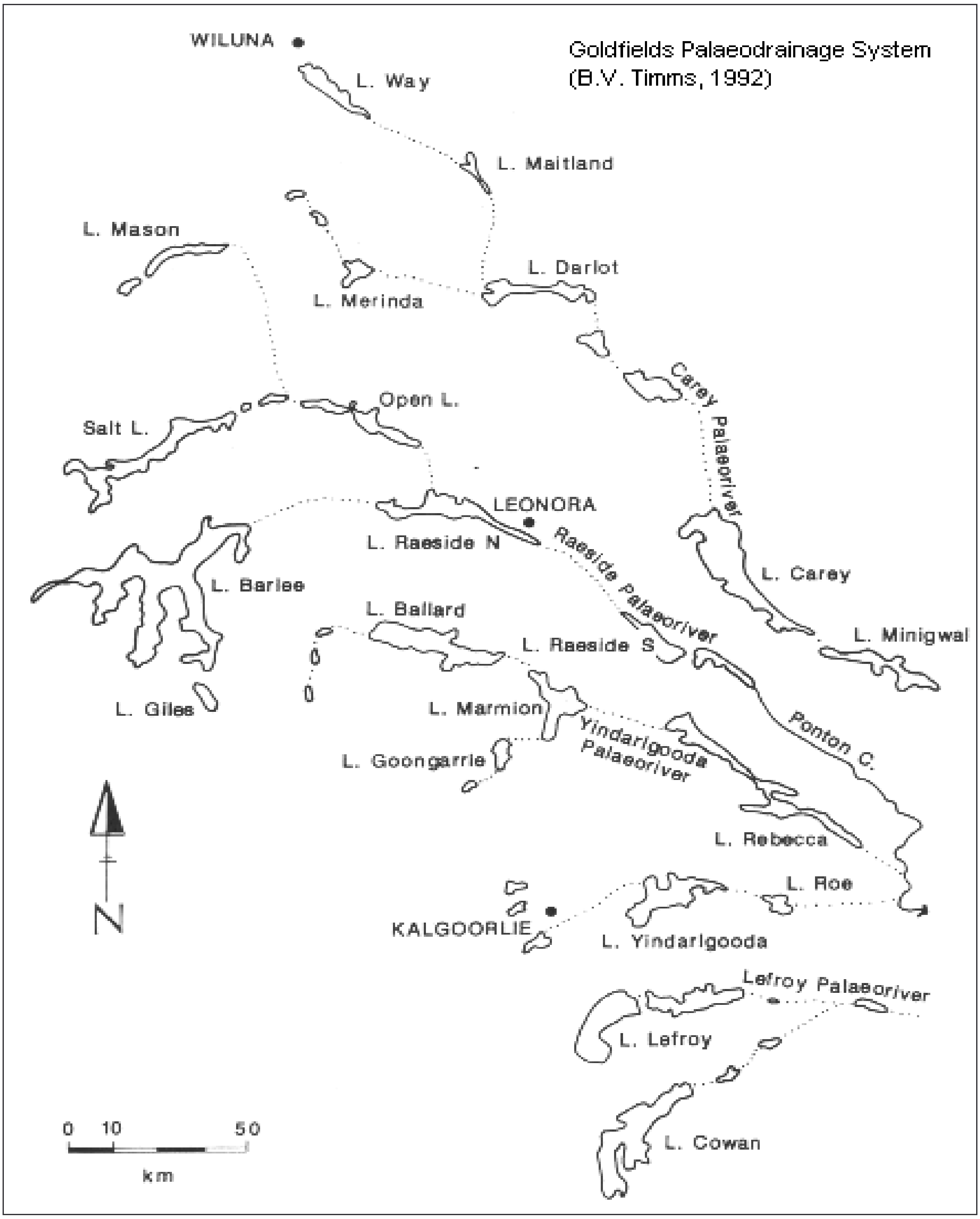
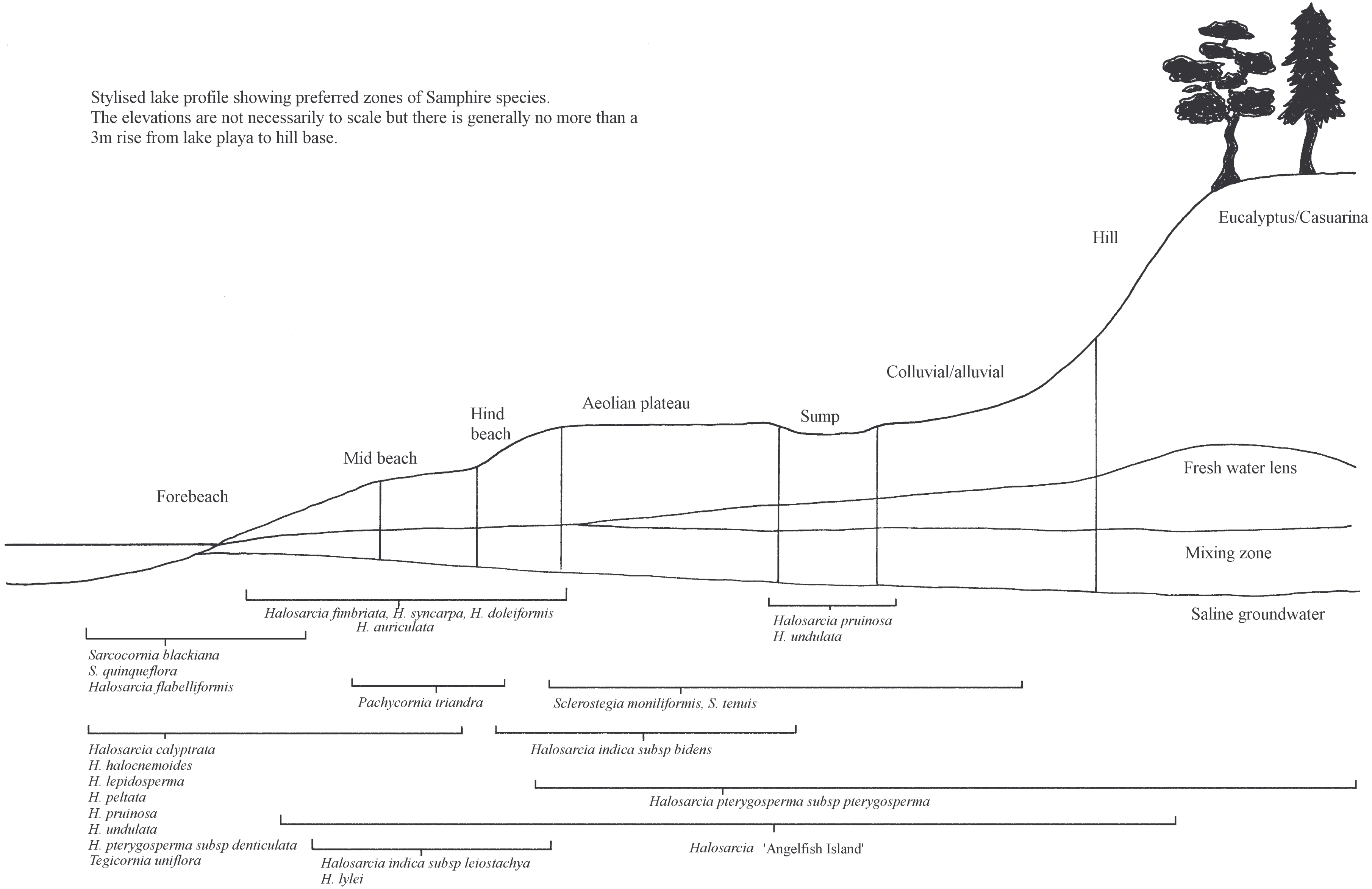


Figure 2 Palaeodrainage Systems in the Goldfields Region of Western Australia

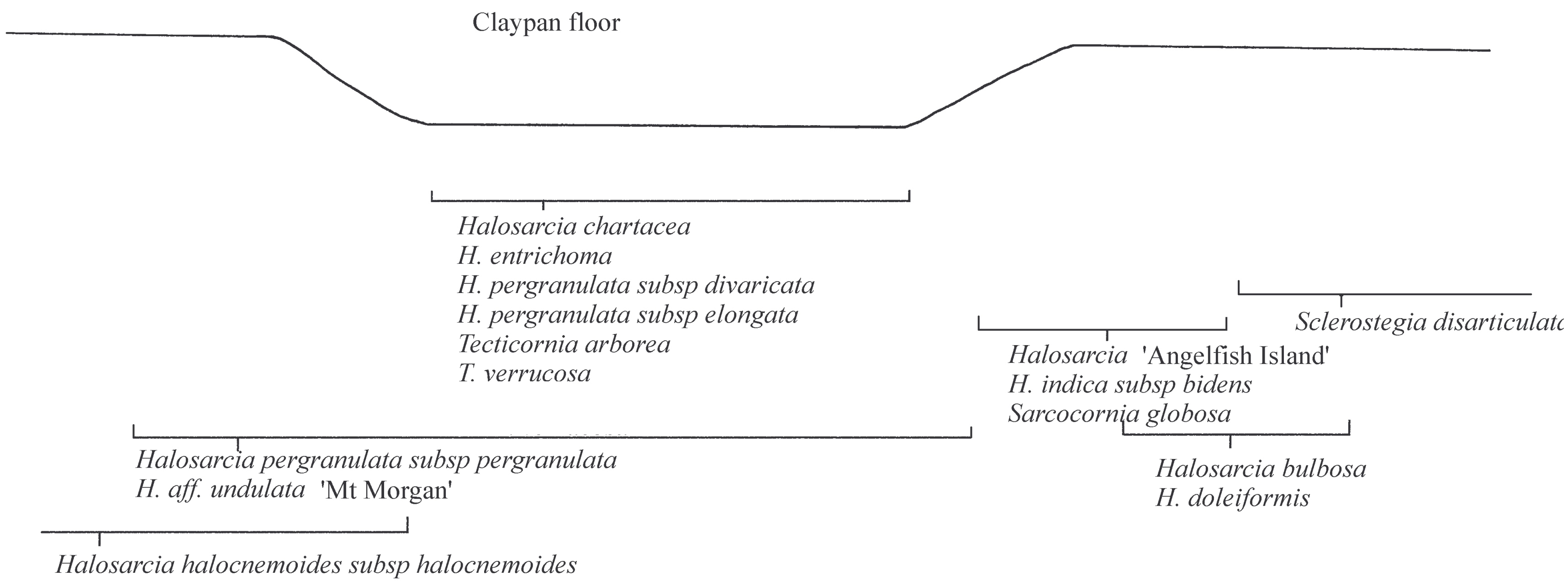
The principal factors that affect species zonation seem to be drainage, or soil moisture, and salt load, or salt concentration. Other factors that affect where a particular species will grow are soil composition (gypsum, sand, limestone or clay) and temperature (tropical species, sub-tropical species. The other factor that may affect species zonation is pH. Most species sampled were growing in soils with a pH7 or over. Exceptions to this were H. lylei, which has only been found in soil with a pH6, *H. lepidosperma* in soils with a pH6-7 and *Sarcocornia blackiana* and *Sclerostegia disarticulata*, which have been found in soils with a pH6-8.5. *Halosarcia bulbosa* has only been sampled at pH10. Most saline wetlands in the Goldfields have a pH greater than pH7. Plants grown from seeds of mixed Goldfields species are growing successfully in soil with a pH6 therefore it is assumed that low pH is not a limiting factor in zonation.

Following are two stylised diagrams - one is a lake profile and the other is a clay pan profile – showing where the different samphire species are found in the Western Australian Goldfields landscape.

Stylised lake profile showing preferred zones of Samphire species.
The elevations are not necessarily to scale but there is generally no more than a 3m rise from lake playa to hill base.



Stylised clay pan - Samphire zones
Clay pans are freshwater, more often than not. They are often associated with larger lakes, usually elevated from them.



Method

To gain a better understanding of samphire zonation, *actis* Environmental Services has taken soil samples from beneath many samphires in their habitats. These samples were tested for salinity, moisture content and pH, and a rough estimation of soil type. For the purpose of this presentation the salt load has been expressed as a concentration of total salts in the soil (g/Kg of soil) and the moisture % of dried soil sample.

When the Statistics program processed the results of the tests, pH came out as being a strong indicator of species zonation, with a P-Value of 0.0000 and 75 pairs of species showing significant differences. Soil moisture was the second strong indicator of species zonation, with a P-Value of 0.0000 and 56 pairs of species showing significant differences. Salt Load was the next indicator of species zonation, with a P-Value of 0.0000 and 54 pairs of species showing significant differences. For the purposes of this discussion, pH is not considered to be as important as soil moisture and salt load, as most of the samphire habitats in the Goldfields have a high pH.

The two parameters from these soil tests that seemed to be reliable indicators of zonation for samphire species in the Goldfields were salt load and moisture. Following are some graphs resulting from these tests.

To obtain the moisture and salinity data, soil was taken from the root zones of samphires in the field. The soil was weighed, dried, and weighed again, then mixed with water to obtain a salt reading. Some species had up to 23 soil samples taken from many different locations; the least amount of soil samples taken per species was 3. Twenty-one samphires have been listed, most of them from the genus Halosarcia. The species have not been further divided into sub-species, even though some appear to inhabit different zones in the field.

In conclusion, the charts when viewed together provide a useful adjunct to the lake and pan profile diagrams. The lake and pan profile diagrams and the charts provide a good indication of where a particular species is likely to be found and certainly show clearly the differences in zonation of the different species.

Results

Samphires are closely associated with these saline lakes and their surrounding clay pans, each species growing in the portion of the lake shoreline or pan that meets its needs. It is evident that many samphire species have evolved to grow in specific areas, under certain conditions, and are in reality quite fragile and susceptible to change. The species found on lake beaches are often quite different to those found on adjacent Aeolian plateaux or dunes and again on the surrounding fresh water clay pans.

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Salt Load

All Australian samphires grow in saline conditions of some kind – mostly seasonally fluctuating between hypersaline and fresh to brackish. Most species will grow in soil with a salt load of up to 40g/Kg, many will tolerate a higher salt load; up to 100g/Kg of soil.

Salt tolerance coupled with soil moisture appear to govern where each species will be found growing, for example, *Halosarcia peltata* is often found growing in gutters and channels with both a high moisture content and a high salt load. This is reflected in the graphs (see Figure 3 and Figure 4) with salt load for *H. peltata* being between 6 and 46 g/Kg of soil, and soil moisture being between 12% and 30%.

Sclerostegia disarticulata on the other hand is found growing on dry stony soils, away from wetlands. In the graphs it can be seen that the soil salt load is low at 2 to 4 g/Kg of soil, and the soil moisture is between 2.5% and 8%. The Pan profile diagram reflects these results.

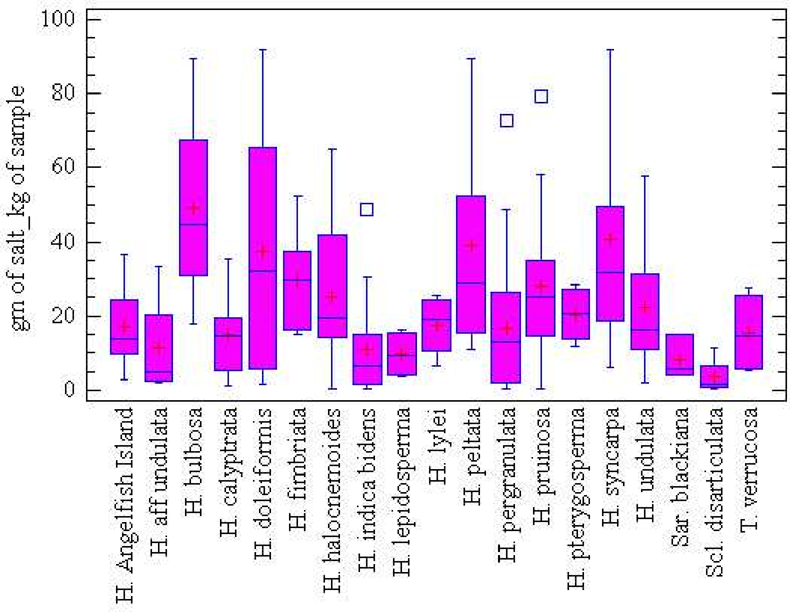

Figure 3 Salt Load (g/Kg of Soil)

Moisture

Some samphire species tolerate a wide range of soil moisture; for example soil from under *Halosarcia doleiformis* contained a moisture content of between 4% and 44%. *Halosarcia lepidosperma* on the other hand had soil moisture content of between 2% and 14%. As can be seen on the graph (Figure 4) there is a considerable variation in samphire moisture requirements. This is reflected in the Lake and Pan profile diagrams.

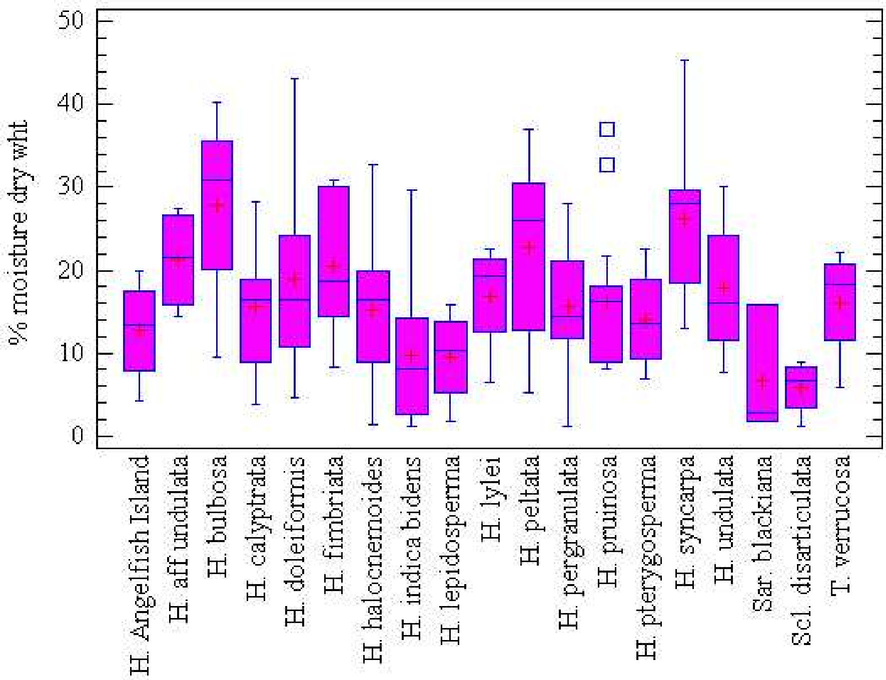

Figure 4 Moisture %

Soil pH

Most species grown in soil with a pH of 7 and over, as can be seen in the graph (Figure 5). Exceptions to this are *Halosarcia lylei*, which has only been found in soil with a pH6, *Halosarcia lepidosperma* (pH6-7), *Sarcocornia blackiana* and *Sclerostegia disarticulata,* which have been found in soils with a pH6-8.5. *Halosarcia bulbosa* has only been sampled at pH10. Most saline wetlands in the Goldfields have a pH greater than pH7, with pH often decreasing away from lakes.

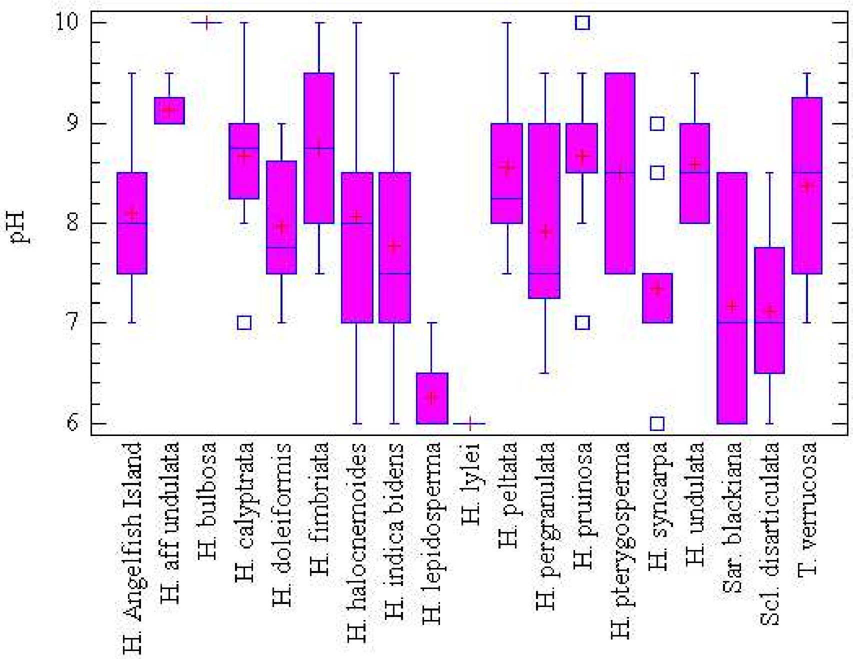

Figure 5 Soil pH

Conclusion

Samphire zonation is dependent primarily upon soil moisture and salt load, with soil pH playing a smaller part. This was borne out by the results of the soil tests, which showed distinct differences in the habitat zones of the different species.

The lake and pan profile diagrams reflected the soil test results.

References

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