Appendix to Moorunde Wildlife Reserve Management Plan:

Equipment Required

Outline

- Reasoning for the need for intervention
- Methods required to address this need
- Soil repair and description of implement to achieve that and modifications of implements
- How the implement works and the results it can achieve
- Further discussion on the advantages of this method – and the mathematics to support it
- Conclusion

Over 90-95% of the soil suitable for growing native grass pastures on this Reserve has been extensively dug over on the surface, while the soil is dry (during the summer and early autumn seasons) by wombats - in their search for Thread Iris corms; due to the absence of any other suitable plant matter for them to graze on, see Figure 14.

Figure 14: South side of the Peter Collins Enclosure, Moorunde Wildlife Reserve, May 2016. The background of the photo shows the interior of the enclosure where wombats have been denied access. The foreground outside of the enclosure has been literally "ploughed up" by wombats digging for Thread Iris corms. Virtually all of the native grass growing areas on the reserve have been dug over like this.

Most of these areas have now been excavated this way to a depth of 10-15cm, for several years, which has resulted in the break down of the soil particle aggregates. In addition to the destruction of the surface duri-crust or cryptogamic crust of mosses, lichens, fungi, algae etc. [Isichei]. these non-vascular plants form, "intimate associations with surface soils", they regulate moisture infiltration (from rain and dew) moisture retention and alter the soil's chemistry that makes nutrients "available" to plant roots [Eldridge &

Greene] the break down of soil particle aggregates has been brought about by this "dry cultivation" as the algae that creates a binding gel around particles is killed by the disturbance and the gel is exposed to sunlight. [Gifford]. This has led to what is known as 'soil hard panning', which results in restriction of rainfall moisture infiltration. Paradoxically it also increases the rise of salt laden sub-soil moisture to the surface soil; due to a process know as "enhanced capillary rise" [Hancock], where the salt then becomes concentrated.

The consequences of this hard-panning in soils are:

- Less air in the soil
- Less moisture infiltration / retention
- An increase in top soil salt concentration
- Reduced seed germination
- Restricted plant root growth; particularly with seedlings of herbaceous plants,
- In the longer term increasing the areas of bare ground.

These consequences have an accumulating and compounding effect to the stage where the top soils microbiotic layer of algae, fungi, bacteria and cyanobacteria shuts down and eventually dies [Eldridge & Greene]. Hence the processes generated by the microbiotic layer - moisture retention and release to plant roots, breakdown of carbon and other soil organic matter, supply of air and nutrient "availability" to plant roots ceases to function.

Once the process has started it becomes self-regenerating and ultimately no longer depends on over grazing or surface soil excavation to sustain itself and it then spreads. Which on Moorunde, in a number of areas has (in the past two years) begun to happen (photographic evidence and observation by instrument measurement by author). This means that for some hundreds of hectares on the Reserve human intervention is unavoidably required to halt and reverse the process (mapping of the extent is currently being undertaken by author) this intervention may seem undesirable or extreme by some; however no amount of pontificating about "the principals of allowing natural processes to prevail with a minimum of intervention from humans" [P Clements] will save this reserve from its slow but accelerating advance into ultimate desertification in major areas, now that the process has begun. While delaying to act magnifies and makes the task increasingly difficult to achieve satisfactory repatriation [Maschmedt].

Having established the need for intervention (however unsavoury) we will now look at what that may entail.

There are a number of methods that have been applied across Australia to address this problem of hardpan and its associated salinization and destruction of the microbiotic layer:

- Adding a layer of organic matter such as decomposing straw
- Applying a heavy dressing of gypsum
- Plus fencing these areas off from all grazing pressure

These methods (in the case for Moorunde) are both impractical and prohibitively expensive and of dubious effectiveness.

The most effective, reliable and least expensive and most convenient method is to approach the problem by directly addressing the consequences mentioned above. By reducing the grazing pressure created (initially) by the kangaroos, diminish the need for wombats to excavate the top soil and re-establishing the original, to as close as possible, native pastures. The purpose of this discussion does not, and is not meant to, focus on the issue of grazing pressure from kangaroos, but to address the soil problems in relation to achieving pasture re-establishment on the premise the grazing pressures are already dealt with.
This is to reverse the above consequences of damaged soil and restore its biodiversity by mechanically…

- Increasing aeration
- Increasing moisture infiltration and retention
- Reduce surface soil salt concentrations and reverse its rise from the sub soil
- Increase capacity for seed germination and seedling survival
- Improve herbaceous plant root spread and penetration to increase natural supplies of soil organic matter

The re-establishment, by artificial spreading, of native grass seeds is a pointless exercise without first addressing the above; but can commence during or immediately after soil treatment commences. The original native grasses and annual forbes were once in abundance over much of the areas of the Reserve, and not part of, but a separate plant community to the scrublands. They were still present in extensive areas when the reserve was first established. Although temporarily devastated by the 1967 drought they had revived by 1970; but were allowed to become virtually extinct due to the policy of "allowing natural processes to prevail". That policy did not take into account the fact that it was already too late (by about 100 years) for it to work. [1968-2016 photographic evidence; J Endersby, A Clements, unpublished data]

Soil Repair

To the best of my knowledge the implement required, to be attached to a tractor, does not commercially exist. However, of the roughly sixteen different types of agricultural cultivators currently available, two or three are manufactured (and common enough) that one could be purchased second hand and modified to serve the purpose for the particularly unique conditions on Moorunde/Twelve Mile Plain. A multi-blade ripper has been suggested; however, this type of machine (although ordinarily quite suitable) is limited to areas where the soil depth above sub-surface rocks and the sheet lime stone layer (calcrete) does not pose a problem.

It is hoped to purchase a second hand, heavy frame, rigid tyne, coil spring high tension, knuckle release, three-row, three-point linkage cultivator. To be fitted with commercially available shears that are already designed to deal with hard panned soils – known as 'breaker' or 'buster' shears.

It is envisaged that the implement sourced will have a cutting frame width of at least two metres. Although a frame width of above two metres and even with four rows would be acceptable. Provided the tractor is large enough and powerful enough to tow it. Hence it is desirable to acquire or have built the implement prior to purchasing the tractor.

Should a suitable second-hand cultivator, of two-three metres wide and, say, a three-row tyne type be acquired, the tynes of the second or middle row would be removed (and kept as spares in the event of breakages). The five remaining tynes on the front and third row would then be re-aligned to provide an over all tyne spacing of 30-40cm. Hence while in operation only approximately 8-10cm of soil per tyne across the two metres would be "left open". Meaning a minimum of 75-80% of the total surface soil is left untouched - provided the operating depth is at least 15 – 20 cm below the surface.

This operating depth is essential to producing the required result that both the fitted shears are designed for and to go below the 15cm depth of hardpan soil created by the initial "dry cultivation" done by the Wombats. It is also important to note here that the optimal soil moisture content has to be present during the procedure. Which has only very brief "time frame windows of opportunity"; precisely because of the hardpan presence.

However, **any period** throughout the year is acceptable provided adequate rains have fallen. Experience is required to assess this.

Due to the nature of Moorunde's soil profile where limestone rubble and/or sheet limestone (calcrete) layers frequently occur close to the surface, a second modification to the implement is desirable. This is to fit rolling coulter blades in front of each tyne; set to penetrate approximately one centre metre below the "breaker shears". (Coulters are flat discs of steel with sharp edges fitted with wheel bearings. They slice into the soil, creating deep thin grooves that reduce soil exposure caused by cultivator shears). These coulters will be attached to the tynes and so as they roll in front and slightly below the penetration depth of the shears they will strike the rubble or calcrete first and force the shear out of the ground. Or lift the entire cultivator clear of the ground; with the coulters rolling over the rubble or calcrete. Thus preventing the shears from operating over calcrete layers and from lifting any stones to the surface.

Each shear will then create a narrow trench or furrow of softened soil that enables the native grass seeds (that will be spread afterwards) to fall into, where rain water can collect, accumulate and enhance germination. The seedling roots can then more easily and rapidly penetrate this softened soil and follow the rainwater moisture as it soaks down further into the soil. While at the same time (and largely because of the coulters) approximately 75-80% of whatever duricrust that still remains after the continuous dry cultivation from wombats is still preserved. Leaving it to eventually repair and restore itself.

Meanwhile the 'breaker' or 'buster' shears that will be fitted are designed such that they push the soil horizontally or laterally as they pass behind the coulters. This creates pressure on the soil further out from the shears that causes (as the pressure builds) "soil uplift", without the shears actually coming in contact with the soil. Which produces a maze of "fault lines" across the 30-40cm wide spaces between the tynes. As the shear passes the soil resettles and these fault lines become wider fissures. Hence the soil hard pan is 'cracked open' by the build up and then sudden release of lateral pressure; extensively enough to enable rain water penetration and infiltration plus aeration to occur again. Which results in leaching of the surface salt back to the sub soil and enhanced recovery of the microbiotic layer as the salt concentration is reduced: and air and moisture becomes available again. Events that bring about recovery that doesn't occur with other methods so efficiently and may never otherwise occur if the soil is left in its current state.

Then, with moisture and aeration the algae that produce the gels that hold soil particles into aggregates can revive. Which reduces capillary rise and enhances the soils ability to further leach salts deeper in to the sub-soil layer. Once this occurs the soils bacteria and cyanobacteria, now free of the salts that have started to poison them; and again, having access to air and moisture, can re-colonise and become re-activated. Then recommence their work in providing the soil with 'available fertility' for plant growth [Mullan & White].

Trials that I have run, both on Moorunde and on my own nearby property, have shown an increase in native grass germination of up to 40-60% and a reduction in seedling mortality of up to 70-80% when this technique is applied. As opposed to attempting to re-establish native grasses without any prior preparation (see Figures 15 and 16 below as an example).

At a seed sowing rate of one kilogram per hectare of Spear Grass Seed* (*1kg/hectare is for the purpose of giving an example – in practice sowing rates would be higher) and on the first year of germination, 20-40 seeds per square metre will germinate and grow to reach seeding stage; depending on the type of season and the soil the seed is sown into (you must remember that 99.9% of freshly sown seed is dormant on at least the first year after sowing. So, the "year of germination" is the first year after suitable early autumn rains fall, following the year of sowing. Which may not be for two or three years after sowing). This level of germination and seedling survival only occurs if the ground is prepared by applying the method or similar methods as described above.

If this soil preparation and treatment is not done, even on mildly damaged soils, the germination of 20-40 plants per square metre will be reduced to 10-20 plants (at a 50% germination reduction) per square metre. Of those 10-20 plants, and with seedling mortality of 70%, only 3-6 plants would potentially survive to reach a stage where they will seed down and possibly 100% will die over the summer and not become perennials.

However..! Assuming there are no kangaroos or rabbits, even with a grazing pressure of only one wombat per hectare this will be high enough to ensure that those 3-6 plants per square metre will be grazed down to the point where they will not reach seeding stage. The plants themselves will not reach a maturity level and root extension sufficient enough to survive over a summer.

So, it is essential to maximise germination rates and minimize seedling mortality when attempting to re-establish a native grass pasture when grazing pressure cannot be entirely removed. As the wombats at least, cannot be eliminated; and native grass seed is either expensive to purchase or difficult to harvest in large quantities. Enough plants have to survive – 0.5 – 1 plants / square metre – to produce sufficient seed to build a seed bank.

Contrary to the beliefs of those who organized the recent (2012-2013) 2.7 hectare enclosure that now has Spear Grass and Wallaby Grass regenerating in it from dormant and hand sown seed (of 3,072 plants, as of November 2015) regeneration both inside and outside the enclosure can no longer occur on Moorunde; with the current number of wombats and with no Kangaroos. The mathematics of plant numbers and estimated wombat population provides the proof.

In 2015 I counted every plant in the 2.7 hectare enclosure (of 3,072 plants, as of November 2015). This is a grass density of 0.12 (actually 0.114) plants / square metre. Which would be eaten down, if it had wombats in it, by less than 0.25 wombats per hectare and prevent any effective seeding. I also counted the native grasses across the 5,000 hectare 12 mile plain. This was done by randomly selecting 50 x 2.5 hectare areas across the Reserve. (walk a straight line for 2,500 meters and count every grass plant seen within 5 metres either side of the line walked; and you have inspected 2.5 hectares) by averaging the counts of grass plants in each of the 50 x 2.5 hectare areas, which totals 125 hectares. This is then extrapolated to the 5,000 hectares (which is an accepted method used by ecologists – University qualified or not). The grass density on the Twelve Mile Plain as of November 2014 was 0.00056 plants per square metre.

Given the nature of the soil condition now on Moorunde, **even without any grazing pressure** and after conducting four trials to establish this – the grass density of the Twelve Mile Plain could only reach no more than 0.4 plants / square metre to 0.8 plants / square metre because of the extent of damage to the soil. Nobody else has done this sort of work / trials on Moorunde to refute this or confirm it. To date one trial site still exists as an example of the effects of hard-panned soil on grass germination and seedling survival – even without grazing pressure (as of January 2016).

Conclusion

Where past management practices have failed is in not realizing that just having native grasses and forbes growing does not represent a native pasture in semi-arid conditions. As the essential component in semi-arid areas is to have a ‘seed bank’ in the ground. That ground also has to be suitable or made suitable for the seeds in the bank to germinate and seedlings survive to replenish that bank. Hand sowing seeds on incorrectly prepared (and already damaged) soil will not achieve any usable results.

Even if the soil is suitable, sowing machinery that is cheap, effective and efficient is essential to cover a large enough area to ensure some grass that is sown survive to seed down itself and replenish the seed bank.

Figure 15: This paddock had been a poor performer. However, some Spear Grass had been growing in it from wind blown seed from an adjacent paddock. I ran ripper cuts through it at about one metre apart while the soil was damp during the spring of the previous year. The result in late spring of the following year is obvious. A much higher and denser growth where it was ripped.

Figure 16: Two years later and the evidence of ripping can still be seen – if you look closely; but otherwise it's a good thick stand of native grasses (8 separate species) and the ripping was the only treatment required to get this result. This was achieved even with a continuous grazing pressure of 1.5 sheep per hectare.

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