Reply to Allan Savory's Feature Article: 'Holism: The Future of Range Science to Meet Global Challenges'

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Ever since visiting the Africa Centre for Holistic Management near Victoria Falls in early 2008 I have been intrigued by the concepts promoted within this current feature article by Allan Savory. Overall I thought that this was a very well-written article and that Allan did a great job in clearly expounding each of the various concepts for the reader. Some of his concepts are robust and can be well supported by the scientific literature, some need fine-tuning, while others are clearly spurious.

While I do not agree with everything in his article, I think that it is an important paper that highlights some problematic concepts in rangeland science itself and challenges the rangeland science profession to investigate some of these issues in greater depth. Allan may not have published much in the peer-reviewed literature but there are few who have stimulated more debate and research into grazing management than Allan Savory and he has, therefore, made a great contribution to rangeland science. I will now attempt to address some of the major issues raised by Allan.

Holism

In his article Allan states: '*Some try to explain holism using the cliché that the whole is greater than the sum of the interconnecting parts. Whilst a step in the right direction, this fails to capture the idea because parts and interconnections are mechanistic concepts having no counterpart in nature*'.

A colleague pointed out to me that perhaps what Allan is trying to say is that a reductionist mechanistic view of nature cannot explain all the various outcomes, which in many ways is true as an outcome is often the product of complex higher-order interactions that can be difficult to predict. For example, a simple reductionist view that long-term heavy grazing reduces plant diversity has been shown to be only true in unproductive habitats (such as on shallow, moisture-stressed soils) but that heavy grazing generally increases plant diversity in productive habitats because it removes the light-inhibiting litter that smothers many small plant species (Proulx & Mazumder 1998; Osem *et al.* 2004; Bakker *et al.* 2006).

In other words grazing intensity interacts with the potential for litter production in affecting plant diversity such that extremely unproductive habitats do not accumulate enough litter to smother the growth of shade-intolerant species with the reverse being true in productive habitats. In another classic example, one that all range managers should clearly understand, McNaughton's hypothesis of facilitation of grazing by large herds of herbivores (McNaughton 1984) is often not supported by empirical examples, but these inconsistencies were shown to again be explained by an interaction with habitat productivity (Hobbs & Swift 1988). In unproductive habitats quantity, not quality, limits intake by herbivores so grazing by large herds of herbivores often reduces intake and growth rates for co-existing herbivore species (e.g. Derner *et al.* 2006).

In more productive environments grasses grow tall and fibrous and quality not quantity limits intake such that grazing by large herds of herbivores removes coarse grass and stimulates fresh digestible regrowth, which increases intake and growth rates by coexisting herbivore species (e.g. Odadi *et al.* 2011). I will give a third example, which also addresses Allan's criticism of fire.

There is no doubt that frequent fires, especially in the absence of grazing impact, are harmful to rangeland as they result in soil crusting, reduced soil moisture and decreased soil nitrogen (Mills & Fey 2004).

When fires are controlled by grazing, however, such that they occur at patchy scales and at much lower frequencies, combined with heavy grazing impact as large herds of animals are attracted to their nutritious regrowth, very different effects occur.

High quality short grasses are favoured, rates of nutrient cycling are greatly increased, invasion of alien species is halted and patchy heterogeneity in grassland structure across the landscape is created (Fuhlendorf & Engle 2004; Anderson *et al.* 2006). Contrary to Allan's claims that fire results in low tuft density and bare spaces in rangeland, the highest basal cover and tuft density grassland that I have ever seen is on a ranch in the Dundee area of KwaZulu-Natal, where the rancher, Clive Bunting, applies infrequent fire combined with high animal impact created by concentrated season-long grazing on the burned areas only, followed by season-long resting (Figure 1). Not too far away a well-known holistic rancher has been unable to attain this degree of cover and soil protection despite keeping fire out (more on the reasons later).

Thus the effect of fire on rangeland does not operate in a simple linear manner, it interacts with fire frequency and grazing impact, but once we understand the interactions its effects are predictable. The absolute and uncompromising condemnation of the use of fire for rangeland management by holistic managers demonstrates a blinkered, over-simplified and non-holistic understanding of fire ecology.

When fire is understood with a holistic understanding of the interacting mechanisms of timing and extent of area burned, grazing concentration and impact, grazing duration and recovery duration, it becomes clear that fire is a useful and sustainable tool in rangeland management, as shown in Figure 1.

An almost complete carpet of *Themeda triandra* on Strathearn ranch near Dundee (KwaZulu-Natal), created by an interaction of infrequent fire and season-long grazing followed by season-long resting. This surely represents the pinnacle of rangeland condition. Note the almost complete cover of grass and associated soil protection plus a lack of low-quality undigestible material, something a holistic managed herd will never have the pleasure of grazing on because cattle are continuously moved from rested patch to rested patch, never being allowed to maintain a short leafy sward such as this one.

While fire frequency and extent has declined in the Serengeti since the rise of the wildebeest population, a portion of it still burns every year despite having the greatest herds of wildlife on earth. Wildlife now merely controls its frequency and spatial extent and certainly takes advantage of the high forage quality created by fire. Fire always has been and always will be an integral part of the ecology of African savanna ecosystems.

These three examples demonstrate that a simple linear mechanism cannot explain these holistic outcomes because they are interactive. Nevertheless, these interactions are mechanistic in nature. In this regard, Allan's notion: '*because parts and interconnections are mechanistic concepts having no counterpart in nature*' is hard to justify. For example, an ecological system clearly has distinct parts interconnected to various degrees and operating through various mechanisms to give rise to a whole range of ecological processes. Microbes are clearly parts that through the mechanism (m) of mineralization of organic matter release nutrients into the soil (an interconnected part with microbes) for plants (an interconnected part with the soil) to absorb (m) and grow (m) to be eaten (m) by herbivores (an interconnected part with plants) to give them energy to move and trample (m) thereby breaking soil crusts, and graze (m) thereby removing litter or improving forage quality, etc). Finally, interactions of all these mechanisms can produce emergent properties which can be difficult to predict when our understanding of the system is poorly developed.

As our knowledge of mechanisms and their interactions increases, however, so does our ability to model (conceptually and mathematically) all these interacting mechanisms in a holistic, whole-system manner. So to conclude on this section, I certainly agree with Allan's contention that one needs to manage with a holistic understanding of rangeland. Contrary to his claims that science does not deal with wholes, science has always aimed at a holistic understanding of ecosystems – a holistic approach to science is called synthesis, which when combined with conceptual and mathematical modelling, attempts to understand and predict unexpected outcomes.

Trampling is important for removing aerial litter and increasing its decay rate, breaking soil crusts and increasing seedling establishment.

I whole-heartedly agree with this concept as demonstrated by the following examples: '*Regular treading prevents the accumulation of standing dead and fragments litter*' (McNaughton *et al.* 1988).

'*There was also an influence of animals on seedling density during this period. Density was 316 seedlings /m^2 in animal hoof prints in the burned area, significantly higher than in the surrounding area*' (McNaughton 1983).

Holistic Planned Grazing allows Considerably Higher Stocking Rates than Recommended Carrying Capacities.

There is good empirical support for this statement: '*Experiments in Serengeti National Park, Tanzania, provide direct evidence that large, free ranging mammalian grazers accelerate nutrient cycling in a natural ecosystem in a way that enhances their own carrying capacity*' (McNaughton *et al.* 1997).

There are holistic ranchers in the Ghanzi region who are stocked at three times the recommended stocking rate (over 5000 cattle on 18 000 hectares), the range continues to improve while a neighbouring ranch which uses continuous grazing is unable to approach anywhere near the recommended stocking rate (400 cattle on 10 000 hectares) because of the loss of key perennial grasses that provide dry-season grazing. Clearly, management can greatly influence carrying capacity.

Resting is Not a Tool to Restore Rangeland

I certainly agree with this. Rangeland without animal impact will become a degraded rangeland. In my opinion, the use of total rest to restore rangeland is perhaps the greatest false concept in rangeland science.

Some form of impact followed by sufficient rest in the various seasons is needed to create micro-sites for seedling establishment (McNaughton 1985), get litter on the soil surface and reduce fire frequency (McNaughton et al 1988). Under grazing results in poor basal cover (Fuhlendorf *et al.* 2001; and many other studies) and capped soil surfaces as well as loss of palatable short grass species and even the animals that depend on those short grasses (Belsky 1992; Western & Gichohi 1993).

The concept of basing livestock management on natural patterns of wildlife herding, migration and grazing is appealing and I firmly believe that we as rangeland managers and scientists can learn a lot from wildlife grazing patterns (see a detailed analysis of this in Fynn 2012). Allan is right when he notes that severe and intense grazing and trampling effects do not harm rangeland but on the contrary improve it so long as it is a transient effect that gives sufficiently long recovery periods for perennial grasses to recover vigor. Allan is also correct when he notes that a grazing system will fail because it is rigid and inflexible, not allowing adaptation to the highly dynamic spatial and temporal variability of forage quantity and quality in rangelands. This was noted in an analysis of wildlife foraging patterns with the suggestion that grazing management cannot be conducted efficiently through an inflexible and rigid grazing systems approach (Fynn 2012).

This is where I believe Holistic Planned Grazing (HPG) is onto something, it is flexible. It needs refining though as there are several conceptual flaws in the way it is implemented. Holistic managers attempt to maintain large dense herds aimed to provide maximum impact over a short period, where an area is grazed for only a few days and rested for months thereafter to ensure that the perennial grasses are able to recover sufficiently.

The long rest after grazing is important but the implications of resting an area for months are problematic if you intend to graze it in the same season because over the rest period grasses have grown out, developed tough indigestible structural material and dead leaf as well as undergone large declines in nutrient concentration in their tissue. Consequently, livestock that are constantly moved from one rested patch to another are forced to consume poor quality forage leading to reduced growth and conception rates (Hobbs & Swift 1988; Wilmshurst *et al.* 2000, Odadi *et al.* 2011; Fynn 2012). While holistic managers are claiming that this form of grazing simulates natural patterns of grazing by wildlife, a detailed analysis of wildlife grazing patterns shows that during the wet season wildlife almost never moves from patch to patch of long-rested grassland. Instead, they prefer to utilize previously grazed areas or recently burned areas where the regrowth is short, has high nutrient concentrations and is highly digestible so that they can maximize their yearly intake of nutrients and energy (Fynn 2012). An example from the Serengeti demonstrates this:

'*Wildebeest often doubled back on their migratory pathways to graze the regrowth and gazelles concentrate their grazing on areas previously grazed by wildebeest*' (McNaughton 1985). From observations like this and in many other areas the concept of grazing facilitation was developed and a theoretical basis was established for why large herds of herbivores are beneficial to themselves and others (Vesey-FitzGerald 1960; McNaughton 1984).

Clearly the holistic claim that vast herds pass quickly through and area and do not return for months is a false concept – it is not supported by numerous herbivore foraging studies nor optimal foraging theory (Fynn 2012), but as a caveat, they may do this in unproductive areas or in drought years where quantity, not quality is limiting (Hobbs & Swift 1988), again demonstrating the need for a synthetic (whole) understanding of ecosystem functioning and outcomes. While holistic managers often claim that grazing of regrowth may be good for cattle production but is harmful to the sustainability of a perennial grass and is, therefore, contrary to their holistic goals, scientific evidence shows that these assumptions are not correct. Grassland may be kept short and in a high-quality state by heavy grazing over an entire growing season without any negative effects so long as it is rested for the next entire growing season (Turner *et al.* 1993; Kirkman 2002) – clearly if this were not so the massive herds of wildlife would have degraded their own resource base by their well-documented regrazing of regrowth over a season.

As noted earlier Clive Buntting's ranch uses this season long grazing and resting under the Venter-Drewes approach (see Venter & Drewes 1969) and has the best rangeland one will ever see (Figure 1). Importantly it is also a flexible approach that enables adaptation to rainfall variability in deciding where and how much of the ranch to graze (see Venter & Drewes 1969). The reason for its success lies in its flexibility (see Fynn 2012) and in the fact it provides excellent animal impact. Despite claims that HPG provides great animal impact, grazing periods are too short in duration and spread over the entire ranch (diluting the impact per unit area), and, therefore unable to keep the grass short and force grass plants to spread laterally.

By contrast, Clive's approach creates much greater impact because the cattle graze only half the ranch each year (rather than the whole ranch under HPG) and, therefore, have much higher effective densities per unit area for the season. As noted for the Serengeti: '*the functional biomass density of the nomadic community in its wet-season concentration areas,* ***rather than averaged over the entire region****, is exceptionally high in the Serengeti*' (McNaughton 1985). In natural grazing ecosystems such as the Serengeti or the Savuti and Makgadikgadi systems of Botswana, animal impact is rarely achieved by grazing in tightly bunched herds. I have rarely seen a herd of zebra or buffalo grazing all bunched up, they don't like it because it results in too much competition for food and so they spread out when they graze.

The percentage of time that they may bunch because of predators amounts to fractions of a percentage of total time. In reality animal impact is determined by movement patterns, the total area available for grazing and the amount of time that animals spend in an that area over the season (number of hooves/unit area/unit time; more time = more hoof impact, less area to range over = more hoof impact, e.g. McNaughton 1985) such that even one or two cows can create better animal impact when kept in an a small area all season than a herd of 500 cows that passes through for a short time.

Ranchers who attempt to force their cattle to stay in densely bunched herds all the time are creating an unnatural situation that is going to negatively impact upon animal production and profits. However considering the costs of fencing and its maintenance and the need for flexible grazing, I do believe in a planned herding approach to keep the cattle in the areas that one wants them to be and if really necessary to bunch them on rare occasions to achieve some objective. Planned herding is especially important for managing communal grazing areas and for managing habitat for wildlife.

Finally I was surprised to see that Allan also condemns pastoralists as being responsible for desertification. The old traditional pastoralists of African savannas such as the Masai and those of the Sahel were known to use flexible herding of livestock in large herds that simulated in great detail the great wildlife migrations of the Serengeti.

For example, the Sahel pastoralists used to follow identical migration patterns on rainfall gradients to the Serengeti wildebeest, which involved using a low-rainfall, wet-season resource and a high-rainfall, dry-season resource, while tracking patchy thunderstorm events across the landscape (see Breman & De Wit 1983; Fryxell & Sinclair 1988). It has been noted that desertification of the Sahel only started when colonial governments started disrupting grazing patterns and movement associated with these great transhumance migrations (Fryxell & Sinclair 1988).

How on the one hand can one applaud the role of the great wildlife migrations in maintaining great rangelands but condemn pastoralists who were doing exactly the same thing? To conclude then, science is the search for truth and the whole truth at that, not just partial truths. It may get waylaid temporally in partial truths or even blatant untruths but eventually untruth is exposed and false hypotheses are discarded. Science will eventually confirm and endorse the many truths of holistic management but at the same time will expose and discard the many untruths harbored by this interesting idea.

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