CONSERVATION, RECLAMATION AND GRAZING IN THE NORTHERN NEGEV: CONTRADICTORY OR COMPLEMENTARY CONCEPTS[1]?

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INTRODUCTION

There are two apparent contradictions in the title of this paper. First, grazing by domestic livestock is often considered to be hostile to nature conservation, especially in semi-arid areas (the ongoing conflict between ranchers and environmentalists in western USA, as described by Gillis (1991) is just one contemporary example of this). Second, the aims of conservation and development (in the sense of reclamation) would also appear to be contradictory, since the latter concerns changing or manipulating the natural environment, while the former would tend to exclude or prevent it.

It is the intention of this paper to explore the relationships between these concepts under the conditions of Middle Eastern semi-arid ecosystems. Some of the most ancient nomadic-pastoralist societies evolved in this region, and it is under these conditions that grazing by domesticated animals has become a major ecosystem component. In view of this long history of co-evolution, grazing should be perceived as an integral part of either conservation or development schemes. In much of the Middle East the environmental values that are the object of conservation or reclamation are the result of a long history of grazing and settlement and their associated human impacts.

Nature conservation deals, by definition, with minimising changes in the ecosystem, usually by excluding human interference and stabilising a desired situation. In this context, livestock grazing is often viewed as a gross intervention that threatens the structure and function of natural ecosystems. It is argued that such activity may cause soil compaction and deformation, result in vegetation removal and modification, increase runoff and soil erosion, export minerals from the system, and contribute to climatic changes at both micro- and macro-levels. It is not surprising, therefore, to read in a recent (and well respected) text on environmental issues, that 'ploughing and pastoralism are responsible for many of our most serious

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environmental problems ...' (Goudie 1990).

One of a few ecological similarities between the contradictory concepts of conservation and development, in particular at their primary establishment stage, is that both consider exclusion of livestock as essential to their success. Exclusion is one of the first actions to be taken when either a nature reserve is established or where a reclamation project is initiated. Indeed, in arid zones, livestock exclusion is often the only direct conservation management action taken.

This paper discusses the impact and consequences of grazing exclusion from both conservation and reclamation practice. The notion of 'grazing-determined systems' is presented and its implications for any planned change (minimal in the case of conservation, but massive in the case of some reclamation projects) are discussed. Furthermore, applying one of the major criteria for sustainability – long term independent persistence – reveals clearly that both the biological and human components of grazing-determined systems have survived over a long period of time (thousands of years) and through severe environmental fluctuations, obviously indicating high sustainability (or whatever the accepted definition of this ambiguous term will finally be (Brklacich *et al*. 1991)). Whether modern conservation or development programmes will be as successful and sustainable under similar environmental conditions remains to be seen.

The following discussion focuses on prevailing misconceptions concerning the ecological relationships between livestock grazing and natural vegetative communities. The role of grazing in the sustainable management of nature reserves or developed sites in semi-arid landscapes has been largely ignored in the past – often resulting in dubious management decisions. This discussion draws primarily on observations and studies conducted in the northern semi-arid Negev desert of Israel. However, it is suggested that most of the conclusions are relevant to similar grazing-determined systems all over the world.

CONSERVATION AND DEVELOPMENT

While nature conservation, supporting socio-cultural values, has gained much public support in recent decades, its professional foundation is much weaker. There is, perhaps, a consensus that 'conservation' means an attempt to preserve the structure (the native biological diversity) and function (the network of ecological processes) that have characterised a specific ecosystem, but the term 'natural' remains vaguely defined (Warren 1993). Ratcliffe (1977) considered a natural state as an ancient ecosystem free of any apparent disturbance, but after continuous, massive human interference over millennia, such ecosystems are rare. Peterken (1981, 1991) suggested that rehabilitation of damaged natural aspects (past naturalness) should be included among the conservation goals. However, the feasibility of achieving this ambitious goal has raised much doubt and concern in light of the substantial

dynamic of environmental conditions, either in terms of climatic changes or biological evolution (Warren 1993) or in relation to modifications imposed by previous human activities. Livestock domestication, and its continuous impact on rangelands over millennia, is an excellent example of such a modification. According to the prevailing ecological approach, ecosystems are rather 'open', dynamic and in a state of disequilibrium (Pickett *et al*. 1992), making operational conservation goals and criteria even less tangible.

'Nature conservation' is aimed at defending natural ecosystems against unnatural intervention and disturbance. 'Development' is a more general term but, in any form, refers to changes induced in an attempt to achieve a designated goal. Some development efforts are more 'natural' than others – meaning that they concern man-made manipulation of a natural unit while using natural resources, but not necessarily according to ecological (ecosystem) guidelines. In this paper development is closely related to the concept of reclamation, defined as a 'deliberate attempt to return a damaged ecosystem to some kind of productive use or socially accepted condition' (Jordan *et al*. 1988).

As an example for a reclamation project I will use the ambitious and original 'Savannization Project.' This project attempted to, and has largely succeeded in, extending the afforested area of southern Israel well into the semi-arid area (250–300 mm rainfall). Livestock, mostly Bedouin sheep and goats, were excluded from the project area prior to the initial development. Subsequently, contour embankments (*sheichim*) were built using heavy equipment, enabling the collection of runoff from slopes covered with crusted loessic soils (aeolian sediments). Open forest was then planted in the areas that had previously been used by the nomadic and semi-nomadic Bedouin. Various tree species were planted and their establishment and primary development was largely successful. However, 4–5 years on, many water collecting areas ceased to contribute runoff to the trees due to the accumulation of dense stands of herbaceous vegetation. Sheep were called back in, while scientists and managers attempted to decide on an adequate, sustainable management scheme. All in all, this history can be seen as a convincing demonstration of the fundamental importance of grazing in ecosystem management.

GRAZING-DETERMINED SYSTEMS

In the 1970s it was common in ecology to define ecosystems on the basis of their principal driving force: a water-controlled ecosystem in arid climates (Noy-Meir 1973) or a fire-determined ecosystem in Mediterranean climates (Naveh 1974). Later it was realised that the complexity of most ecosystems required a multivariate approach (Naveh 1984). Nevertheless, it is useful to view the semi-arid ecosystems in the Middle East as fundamentally grazing-determined systems, as pastoralism over thousands of years will certainly have them to the extent that grazing by

domestic livestock has become a principal ecological driving force. However, grazing is not the only control in semi-arid ecosystems – variable and unpredictable precipitation regimes, fire, and limited nutrient concentrations in the soils are also major factors determining their features (Noy-Meir 1985; Walker 1987).

Most ecosystems in the Levant have evolved over a long period (~7 000 years) of virtually continuous grazing by domesticated livestock, and associated man-made disturbances (Noy-Meir and Seligman 1979; Zohary 1983). In the Sinai and Negev regions, socio-economic symbiotic-dimorphic relationships between desert pastoralism and semi-arid dry agriculture have created a stable subsistence model over thousands years of archaeological history (Finkelstein and Perevolotsky 1990). Grazing took place during long periods and over an extensive area. Many of the present ecological features: community structures, soil cover and nutrient status/cycling (to name only a few), have evolved under the impact of livestock grazing.

Nothing in this argument is intended to deny the fact that grazing has had a significant effect on the ecosystems, or that if grazing had been excluded, other significant changes would have occurred in the structure and function of the vegetative community. The literature is full of examples of substantial changes in the vegetation of rangelands following the exclusion or control of grazing (McNaughton 1979; Vickery 1981; Floret 1981; Noy-Meir 1990; Ayyad *et al*. 1990; Huntly 1991; Skarpe 1991).

The point to be stressed, although difficult to quantify, is that various aspects of grazing-determined systems have undergone substantial changes after the period of livestock domestication 8 000 – 7 000 years ago and, especially, during the development of the pastoral mode of subsistence. Zohary (1983) expressed the effect of the newly domesticated livestock on natural ecosystems in a rather vivid, though weakly supported, manner:

> '*thousands of species have disappeared from the scene before they could become known to science .... Enormous areas of grazed lands lost their palatable plants and became altogether deprived of their grazing potentials. These are now vegetated by plant communities dominated by antipastoral, stubborn and highly aggressive plants.'*
>
> Zohary (1993: 290 – 291)

Other statements such as:

> *'degradation of vegetation due to overgrazing is manifested in almost all deserts in the world. No areas are found where the present plant growth might be considered as the climax composition'*
>
> Batanouny (1983)

are common in the professional literature and express the prevailing negative perception of the impact of the pastoral activity.

Ecologically speaking, the impact of the pastoral economy on the dry ecosystem can be considered as a drastic transition from a previous 'pure' natural ecological state to an 'alternative [less natural] stable vegetation state' as suggested by the 'state and transition model' (Westoby *et al*. 1989). It is most likely that the ecosystem-level changes imposed by continuous disturbance (pastoral activity) drove the system over a threshold from which there was little possibility of turning back. This has been proposed in the 'state and threshold model' developed to deal with ecological disturbances (Holling 1973) and adopted by range scientists to describe grazing impact on rangeland vegetation (*e.g.* Friedel 1991; Laycock 1991). In other words, a drastic (and, most certainly, irreversible) change in the ecosystem accompanied the appearance of pastoral societies in much of the semi-arid and arid Middle East. Similar arguments are used by Laycock, Friedel and Westoby and his colleagues in order to explain significant changes in vegetation formation, composition and productivity as a result of human impact (grazing, fire prevention) in the New World, where relatively heavy grazing by domesticated livestock was introduced 400 years ago to ecosystems previously exposed to only light wildlife herbivory.

In the northern Negev, small ruminant pastoralism has been practised as the dominant and organised mode of subsistence since the Pre-Pottery Neolithic B Period almost 8 000 years ago (Avner *et al*. 1994; Finkelstein and Perevolotsky 1990). It continued, with minor modifications, until a few decades ago. A quantitative archaeological survey carried out in the southern part of the Negev revealed 1 400 ancient sites within a 1 200 km^2 area – demonstrating a complete sequence of human activity from the 8 th millennium BC to the modern era (Avner *et al*. 1994). Obviously, we are not able to reconstruct completely the actual human impact of any historical or archaeological period, but it seems that the continuity of the impact within the context of a harsh environment would have significantly affected the vegetation community. Moreover, until the domestication of the camel at the end of the 2 nd millennium BC, pastoralism in the Levant was only semi-nomadic or enclosed nomadic, meaning that only a limited movement of humans and livestock was practised (Rowton 1974; Khazanov 1984). Pastoral practices

therefore took place over a rather restricted area, so that even if actual grazing pressure was not very high (in modern terms), it was persistent and its overall impact must have been very significant.

As far as grazing impact is concerned, the drastic changes imposed on Bedouin pastoralism in the second half of the 20 th century through its incorporation into a the modern, capitalistic Israeli society, made little difference in terms of the impact of livestock on the environment. It is true that the Bedouin long term migration was replaced by heavy grain supplementation during the winter and that Bedouin were excluded from some traditional grazing territories that had been given over to military training areas or to cultivation. On the other hand, water, stubble and other sources of fodder are now readily available almost everywhere, and access to veterinary services and to the market is usually good (Ginguld 1994). As a result, grazing pressure on the remaining rangeland is still quite high.

It is impossible to reconstruct the ecological changes imposed by human activities in Middle Eastern grazing-determined systems, but in regions where such activity has taken place relatively recently, the impact can still be documented. Vetaas (1993), for instance, reported on changes in the vegetation community in northeastern Sudan, resulting from the transition from transhumance and seasonal browsing to permanent settlements and year-long grazing occurring over the last 40 years. Many similar examples are known from newly exploited rangelands in the western USA and Australia.

What is known of the ecological change following the domestication of livestock and the development of pastoralism can be summarised as follows:

- Natural pre-pastoral vegetation climax and primary successional processes quickly disappear, over extensive regions and beyond any possibility of reconstruction.
- A vegetative community, well adapted to grazing, becomes dominant in the grazing-determined systems.
- Despite heavy use, the resulting system is stable and resilient (and sustainable!).

In traditional African pastoral groups, the livestock populations appear to be in a persistent state of disequilibrium (Ellis and Swift 1988), while the pastures they use seem to be stable at a low equilibrium level *sensu* Noy-Meir (1975). The livestock productivity in this system is, however, far below maximum value.

This argument does not in any way imply approval of the abuse of semi-arid ecosystems. Heavy grazing pressure may cause undesirable changes, and even irreversible damage. However, later I will claim that many of the accusations

concerning resource degradation in traditional pastoral systems cannot be substantiated. My claim is that grazing-determined systems are quite adapted or resilient to livestock grazing, due to a long history of co-evolution. This does not mean that they can sustain any degree of disturbance (defined hereby *sensu* Grime (1979) as mechanisms that limit plant biomass by causing its partial or total destruction). The 'red line' separating use and abuse in grazing-determined systems should be determined professionally and – since such guidelines are not available at the moment, it remains a challenge for the new generation of experts.

DETERMINANTS OF COMMUNITY/ECOSYSTEM STRUCTURE AND FUNCTION IN DRY GRAZING-DETERMINED SYSTEMS

Ecological inter-relationships in semi-arid grazing-determined systems are complex and include feedback mechanisms that may operate in conflicting directions (Figure 1 provides an overview of the most relevant factors). In many cases, ecological and managerial examinations of rangeland conditions have used the immediate-proximate perspective. Moreover, they emphasise (and sometimes over-emphasise) the impact of grazing on range productivity while ignoring other factors. Figure 1 presents, on the left side, the well documented effects of grazing (livestock type and characteristic behaviour, stocking rate, management) on plant survival and production. However, it emphasises the importance of future productivity of the rangeland in the discussion of overgrazing and degradation. If productivity will return to the pre-grazing (or ungrazed) level within a short period (a few years) of grazing removal, any claim of over-grazing or range deterioration cannot be substantiated. Analysis should account simultaneously for the impact of climatic fluctuations, community relationships (mainly between shrubs and grasses) and ecosystem processes (nutrient availability, soil erosion and soil moisture dynamics) on rangeland productivity, independently of the grazing regime. Without an account for these relationships on a local basis, conservation or development programmes would head into an uncertain ecological future.

In attempting to answer the question of what determines vegetation composition and productivity in grazing-determined systems, it is necessary to assess the relative contributions of climate (principally as manifested by soil moisture), nutrient availability and livestock grazing. Such integration is neither simple nor straightforward. Walker *et al*. (1981), for example, could not determine whether continuous heavy grazing or climatic conditions were more significant in the evolution of savanna-like vegetation. In the following discussion the various factors are discussed on the basis of some empirical findings.

Climatic effects

Climate, especially the specific rainfall regime, has an obvious effect on biomass and species composition of vegetative communities in dry ecosystems (Noy-Meir

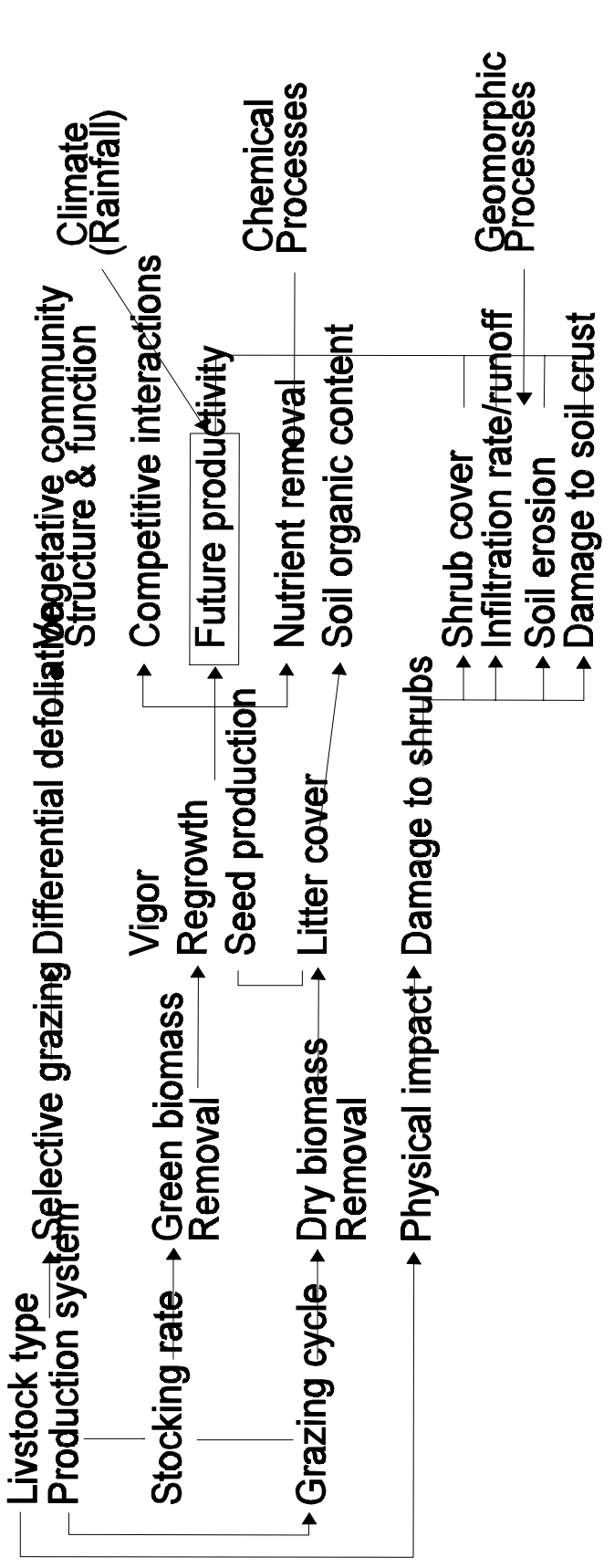

Figure 1 Relevant processes and interactions in the analysis of semi-arid grazing systems

1973). Shmida and Burgess (1988) found that the pattern of growth-form dominance in arid and semi-arid environments was determined principally by soil moisture regime. Walker (1988) suggested that under unpredictable conditions, different annual grasses develop different adaptive strategies, each of which fits better a particular set of conditions. As a result, every year a different group of species best adapted to the existing conditions, becomes dominant. Evenari and Gutterman (1976) demonstrated how density, species composition and dominance of annuals fluctuated greatly from year to year in the Negev. A similar phenomenon has been reported from the arid steppe of Tunisia (Floret 1981).

A review of 72 long term (> 5 years) grazing experiments conducted in South Africa revealed that the effect of climate was far more significant than that of the grazing treatments (O'Conner, cited in Walker 1988). Frost and Smith (1991) suggested that productivity on semi-arid rangeland was determined primarily by soil moisture which, in turn, was determined by site characteristics (local precipitation, topography, soil formation). Olsvig-Whittaker *et al*. (1983) presented a correlation between the spatial distribution of species and their abundance and differences in soil moisture content of various geomorphologic units in the Negev desert.

Data collected during the last six years at the long term research station near Lehavim (Israel) support this contention (Figure 2) (Ungar *et al*. 1994). Habitat is the most significant factor determining herbaceous productivity (the wadi has produced 2–3 times more biomass than the southern slope). Total amount of precipitation affected range production but not in a linear mode (compare, for example, production on control plots in 1987/1988 *vs*. the southern slope in 1991/1992). The most significant observation is that heavy grazing does not entail a negative effect on production over the years. In other words, the production in each individual year is, first of all, an outcome of the specific conditions (rainfall amount and distribution, solar radiation and nutrient availability) and not of biological damage imposed by previous heavy grazing.

Nutrient availability

The central role of moisture in determining the vegetative characteristics of dry ecosystems is not surprising, but the realisation that nutrients may be as important as water in determining productivity in these systems has not yet been widely recognised (Ludwig 1987; West 1991). Breman and de Wit (1983) concluded that low soil fertility in the semi-arid Sahel was as important as precipitation in its contribution to low primary production. The fact that herbaceous vegetation ceased to grow while soil moisture was still around 20 % of the absorbed amount, indicated that the low availability of minerals was even more limiting than low water availability. Additional water may double biomass production in the Sahel, but

Figure 2 The effect of climatic conditions (year), grazing and habitat on rangeland productivity in wadi and southern slope areas of the northern Negev

additions of fertiliser have been shown to increase it by up to five times and improve pasture quality (Breman 1992).

In nutrient-poor environments grazing is expected to have a smaller quantitative impact than expected (Alkanin and Alkanin 1989) or, in other words, under these conditions nutrients are as important as disturbance (grazing) in determining productivity.

In the northern Negev, nutrient amelioration with NPK fertiliser (50 kg ha^{-1}) increased pasture yield by 90–340 %, depending on the habitat (yield improvements increased in the sequence: southern slope > northern slope > wadi). In comparison, changes of 50–100 mm in the annual rainfall (out of average of 270 mm) caused an increase of up to 100 % in herbage biomass, but rarely more than that. Moreover, the use of fertilisers hastened early season pasture development, which attained 100 kg dry matter ha^{-1} 6–7 weeks earlier than in unfertilised plots (Perevolotsky *et al*. 1990). Aside from the potential for range improvement, these results indicate that the growth and development of vegetation in the semi-arid range system is strongly controlled by nutrient availability. High nitrogen availability may also affect the successional dynamics and community structure of semi-arid shrublands (McLendon and Redente 1991).

Grazing effects

There is ample literature on the effect of livestock grazing on the cover and composition of the vegetative community, especially under high stocking rates. In general, it has been reported that communities subjected to natural and anthropogenic disturbances are dominated by annual species and characterised by rapid and often irregular changes in species composition (Symonides 1988). Both the Mediterranean region in Israel and nearby desert environments – two classic grazing-determined systems – were found to contain very rich annual communities (Shmida 1981), a feature attributed to the continuous disturbance regime. Naveh and Whittaker (1980) proposed a model that combined grazing stress and evolutionary time (relating to the length of grazing history) to account for the very high values of species diversity recorded in northern Israel.

Noy-Meir (1990) reported on limited changes in production and species composition of annuals, compared with a rapid change in production and biomass of most perennials, 6–7 years after cessation of grazing in the northern Negev. He related the former observation to climatic and edaphic conditions, and the latter to grazing release. In the arid steppe of Tunisia, no change in species composition or successional stage was recorded after seven years of protection against grazing (Floret 1981).

Anthropogenic disturbance in dry habitats has been shown to generate an increase in micro-scale species richness as well as in biomass production (Holzaphel *et al*. 1992). Olsvig-Whittaker *et al*. (1993) observed changes in the plant community composition in response to grazing and to soil texture. The effect of the

latter, in terms of species composition, was 'at least as significant as the effects of a fairly extreme gradient of grazing intensity.' From the management and conservation points of view, the conclusion that extreme grazing intensity generates only a limited change in community composition is very relevant. The authors' expressed 'surprise' stems, most probably, from the commonly held view that heavy livestock grazing is responsible for community degradation.

The continuous effect of grazing on the following year's productivity has been studied extensively in productive systems, where perennial herbaceous species play an important role (Hodgkinson 1992). In these systems productivity is a function of previous grazing pressure that has affected plant vigour and physiological status, as well as the seed bank. However, the picture is less clear in dry areas, where most of the herbaceous biomass consist of annual species which, as an adaptation to the dry climate and short growing season, complete their life cycles very rapidly (Shmida and Burgess 1988).

In California, heavy grazing has been shown to cause a decline in the productivity of annual vegetation in the following year, but this effect seemed to be short-lived (Pitt and Heady 1979). Harrington and Johns (1990) found large but temporary changes in herbaceous biomass during three years of livestock exclusion following six years of extremely heavy grazing in a semi-arid savanna woodland in Australia. Their conclusion was that, following the environmental impact of heavy grazing, the vegetation shifted from one stable state to another (less productive but more resilient). Pastoral systems, which have evolved over a much longer time period than productive ranching, have most probably experienced the same ecological trends, but thousands of years ago.

In summary, it is the interactions between the auto-ecological features of the dominant species, which have evolved under long term, continuous grazing, fluctuating climate and soil characteristics (including nutrients), that have determined the structure and function of the vegetative community in semi-arid environments. Excluding grazing means, almost by definition, changing the evolved natural state. Whether or not this change is desirable is obviously a value-loaded question.

SCALE-DEPENDENT PERSPECTIVE

Any account of the impact of livestock grazing (or its exclusion) on natural environments should be studied on a quantitative, long term basis, adopting a flexible hierarchical scale perspective (O'Niell *et al*. 1986; Wiens 1989; Hoekstra *et al*. 1991). The ecological role of shrubs in the northern Negev is a good example of such an approach. As in many of the dry grazing-determined systems, the vegetation here is composed principally of unpalatable shrubs and ephemeral annuals. There are mutual feedback relations between the two major vegetative

components: shrubs provide a grazing refuge and favourable conditions for the development of the herbaceous layer underneath their canopy (Noy-Meir 1985). In Lehavim, herbaceous biomass underneath the moderate-sized shrubs of *Thymelaea hirsuta* was 50 % higher than the biomass of herbs growing 50 – 100 cm outside of the shrub crown. Seeds produced by the protected annuals contribute to the grazed open patches, while the availability of abundant palatable green forage during the growing season releases the less palatable shrubs from high grazing pressure, allowing them to regrow. Belsky *et al*. (1989) and Jackson *et al*. (1990) provided examples of similar interactions between savanna trees/shrubs and herbaceous vegetation.

One may consider the individual shrubs as having a positive feedback effect on the herbaceous component, especially under grazing conditions. However, when the observational scale is altered, different effects are detected. At Lehavim, an increase of 30 – 50 % in shrub cover was observed eight years after grazing pressure had been reduced from very heavy to low-moderate, and the area had been fenced. This change was partly a result of the regeneration of relatively palatable perennial species, principally *Noaea mucronata* – one of the very few palatable shrubs in this community (Perevolotsky and Landau 1988; Noy-Meir 1990). The partial release of unpalatable shrubs from continuous physical damage by the grazing livestock also helped to increase the shrub cover. The overall outcome has been a reduction in the space available for the establishment and development of herbaceous vegetation, and hence a significant decrease in the overall productivity. The decrease in shrub cover as a result of increasing grazing pressure is in contrast to many observations from various dry ecosystems of the world, where heavy grazing has resulted in bush encroachment (Skarpe 1990). The reasons for these differences are beyond the scope of this paper.

ECOSYSTEM MANAGEMENT

This paper deals with ecosystem management. This complex issue has become a focus of much public and political attention recently. I do not attempt here to provide a new recipe for the management of dry ecosystems, only to suggest an examination of the context of grazing-determined systems.

Perhaps the most popular concept in ecosystem management today is that of ‘Desired Future Conditions’. It stems from the realisation that simplistic models (*e.g*. succession-based) have not brought us to the promised land of ‘stable ecosystem’ and are certainly not capable of doing so. It seems that in the wake of massive environmental changes that have occurred in most ecosystems, any management benchmark based on a hypothetical state is irrelevant. The desired plant community idea is radically different from any previous management model that pretended to be based on scientific objectivity, by the fact that it is, by

definition, a value-laden concept. Society, or the public, determines the nature and character of a future desired ecosystem (Bonnicksen and Stone 1985). Ecologists are left to propose, based on their understanding of existing ecological conditions, a desired future state. Professional managers are then supposed to pursue this decision through prudent ecologically-sound procedures (Kessler *et al*. 1992).

The concept of Desired Plant Community has been developed within the context of range management (Task Group 1991). Once the goal is defined as maximising livestock production or performance, an objectively-quantifiable index, the desired plant community can be defined and, in certain cases, can also be maintained through management (Borman and Pyke 1994). This concept also plays a role in succession-based management models. Here the desired plant community will follow the composition of the desired successional stage – usually the climax – that traditionally has served as a management goal (Smith 1989). In this case, desired plant community becomes more of a theoretical (and in many instances illusory) criterion rather then a feasible management target – either because of partial understanding of the natural succession process or due to a lack of knowledge on how exactly to achieve it through management.

It is suggested here that the guideline for ecosystem management in grazing-determined systems, at least in terms of species composition, is the one that has evolved, over a long period of time, under heavy grazing (among other sources of disturbance). Any attempt to use a succession-based model, or to assume a self-return to pre-disturbance community conditions is futile. Under the conditions of grazing-determined systems conditions, reconstruction of the 'pristine' ecosystem is not a feasible conservation goal. One should note that in the dry Mediterranean region botanists still argue about whether the climax formation was a forest dominated by pine and oak trees (as can be observed today only at favourable sites), or a woodland/scrubland dominated by tall evergreen shrubs.

The prevailing conservation approach considers grazing by domesticated animals as destructive and that it should be excluded from natural reserves in grazing-determined systems and elsewhere (see the campaign against the black goat – Perevolotsky 1991a). Hidden in this approach is the belief that once grazing is excluded, the 'natural', 'real', 'good', 'healthy' vegetation will return. There is very limited information on long term changes in the community/ecosystem level following grazing exclusion in grazing-determined systems and, as a result, no scientific discussion on whether such changes are really desirable. Moreover, no one can propose, based on existing scientific knowledge, what the desired vegetative community structure on grazing-determined systems is. At best, the vague concept of management for high species diversity is evoked. West (1993) provided an extensive review of the concept within the context of range management while Noss (1992) raised significant questions concerning this concept

in relation to nature conservation.

It remains to be seen whether livestock grazing is to be re-introduced to nature reserves in southern Israel once it is well established that it increases species diversity (Olsvig-Whittaker *et al*. 1993). Until a clear set of ecologically-based management guidelines is available for nature conservation in grazing-determined systems, development planners are bound to commit drastic errors even if the intention is to avoid them.

It is worth noting that the Mediterranean landscape in Israel (as well as in many neighbouring countries) has been viewed and treated along the same lines as those discussed above. Grazing was excluded from most of it by a law which was effectively reinforced. The recovery of the woody vegetation was rapid and extensive, but it also created new headaches (Perevolotsky 1991a):

- Development of dense scrubland with declining species diversity, especially of the herbaceous and low growth forms.
- Decrease in forage potential for livestock or wildlife.
- A dramatic increase in fire hazard due to accumulation of dry woody biomass.

It took a few decades to realise that the ecological changes in the Mediterranean ecosystem are not necessarily all in the desired direction. Recently, a new management policy has been implemented in which grazing, and sometimes heavy grazing, plays a central role in creating biological fire breaks. It has become evident today that undergrazing rather than overgrazing is a more serious ecological threat to Mediterranean ecosystems (Seligman and Perevolotsky 1994). Naveh (1984) claimed that the conservation of the Mediterranean landscape and its variety could be ensured only by a continuation and/or simulation of the traditional agro-pastoral functions under which it evolved. Naveh and Whittaker (1980) claimed that in systems with a long history of pastoralism (grazing-determined systems), grazing is required to maintain species diversity. I would like to see these conclusions extended to dry grazing-determined systems as well.

The continuation of traditional management (grazing, coppicing, hunting) as an active conservation practice was proposed in the 1960s (Ovington 1964) and is still advocated today (Peterken 1991), not necessarily with less controversy or more support (Perevolotsky 1994). In light of the above discussion, the active role of livestock grazing in the management of Old World grazing-determined systems should be given earnest consideration.

Long term and large scale studies of grazing-determined systems are required in order to uncover the mechanisms and rules governing the relationship between

grazing animals and dry environments. It is difficult to reconstruct the past (pre-domestication) in these systems, but we can take advantage of the conservation and reclamation projects and establish ongoing research programmes. The concept of learning from ongoing management experience (adaptive management – Walters 1986) may be very useful for both conservation and reclamation in grazing-determined systems. In this sense, Rosenzweig's (1987) suggestion of using restoration projects as a large scale perturbation context to study the organisation and operation of natural ecosystems should be extended to include the nature of the perturbation itself – livestock grazing

CONCLUSIONS

- Conservation in Old World grazing-determined systems should relate to the grazed formation, as the essential objective. It is, after all, the 'most natural' situation. However, preserving this state implies keeping the prevailing grazing regime or an ecological equivalent.

- In the present state, grazing and even heavy temporal grazing, as has been practised traditionally, does not seem to induce ongoing degradation in grazing-determined systems. Theses systems seem to be adaptive to such land use.

- Claims of overgrazing and resource degradation under the above conditions are *a priori* suspect, and should be substantiated professionally rather than manipulated politically.

- Environmental factors of grazing-determined systems, such as soil moisture and nutrient availability, seem to be more significant in determining vegetative community features (species composition, primary production) than grazing impact.

- Detailed long term studies of ecological processes following grazing exclusion should be conducted to determine the outcome of a no-grazing conservation policy. Decisions should be based on these findings and not on the belief that 'nature will take care of itself' (once the livestock are removed).

- Development and conservation in grazing-determined systems should take into consideration the role of grazing in moulding the existing natural system and provide management solutions for the outcome of livestock exclusion.

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