CONSERVATION ASPECTS OF VEGETATION DYNAMICS

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Abstract

Legislation on conservation has evolved through protection to preservation with the requirements often relating to values rather than entities. This focus on preservation denies a fundamental characteristic of biology that populations and communities inevitably change if only because of the life cycles of individuals. The implications of plant life cycles for the development and sustainability of particular forms of vegetation are examined.

Introduction

All Australian States previously promoted the clearing of native vegetation, some up to the mid 1960s. Official support for clearing was gradually withdrawn from the mid 1970s and, with the incentive of funds from the Australian Government, clearing is now universally prohibited (Tunstall 2005). This change from government promotion to prohibition has been accompanied by a change in rhetoric. The desire for conservation was replaced by protection which is being replaced by preservation.

Conservation has traditionally meant to use things conservatively. For biota it is now usually interpreted as meaning preservation and is used to justify protection. A desire for conservation is used to justify a stated need to protect the environment, vegetation, species etc.

The reasons for conserving natural resources were obvious and related to obtaining maximum benefit from the available resource. The reasons for protection do not have such a clear basis and this produces a wide range of views as to why it is needed. It also produces dissent as there are many that do not accept views that are presented. This conflict has resulted in science being used to promote personal views on the need for protection.

The classic example of this abuse of science is the precautionary principle which, through advice by public administrators and scientists, has become enshrined in Australian and State Government legislation. The precautionary principle has been variously presented but basically states that lack of scientific certainty should not be used as justification for a lack of protection. From an administrative perspective decisions are then based on a lack of knowledge hence the precautionary principle assigns value and status to ignorance.

Preservation involves maintaining things are they are when in nature things invariably change. It is an intrinsic characteristic of biology that things change and that changes cannot be reversed. It is an intrinsic characteristic of physics that systems inexorably degrade and that the degradation cannot be reversed without external inputs. Preservation is only an option for museums.

A recent nuance with preservation is the focus on values. The intent of the Queensland Wild Rivers legislation is to preserve natural values. While people have values nature does not. Moreover, as values are human precepts they differ within and between communities and change over time. They therefore cannot be preserved.

This focus on values is justified by reference to science with the explicit objective of preserving processes. However, the same physical and biological processes exist in all natural terrestrial systems and there is nothing humans can do to eliminate or change them. The issue is the change in constraints or conditions that affect outcomes.

The use of science to justify the assignment of value is illustrated by the focus on refugia in the report underpinning the Wild River proposals for the Gulf region (Hydrobiology 2006). This identifies that *Key values were found to be associated with refugia (a habitat (or place) that supports populations of plants and animals not able to live elsewhere in the surrounding landscape)*. By this definition normal environments are refugia when refuges are points of escape from the normal environment. By this definition everywhere can be a refuge for something and hence be assigned high value. Any appearance of a scientific basis is illusory.

Basic precepts underpinning the Queensland Wild Rivers legislation are that we cannot return things to how they were in 1770 but we can maintain things as they are. As natural systems invariably change and biological changes are irreversible the first precept is valid and the second invalid. The current situation cannot be preserved.

While the 1770 situation cannot be recreated the current situation can be improved by appropriate land use (development). However, it will not be improved where the focus is on preservation. Indeed, attempts at preservation that do nothing to address existing degradation will invariably exacerbate the decline.

Development is intrinsic to all biological systems as without it they cease to exist. All biological systems naturally tend to expand (develop to occupy available space / increase the utilisation of resources) as that is fundamental to their survival. They cannot always expand but the tendency to develop at least decreases the rate of decline.

Application of the invalid premise that the current situation can be preserved blocks opportunities for a rational evaluation to develop a more favourable outcome. However, identification of opportunities depends on knowledge of how systems naturally change and how they are affected by land use impacts.

This paper addresses temporal change in vegetation (succession) whereby environmental relationships derive through modification of the environment by plants. It therefore does not address all considerations of relationships between vegetation and the environment, either temporal or spatial. For example, it does not address the issue of whether vegetation occurs as a continuum or as discrete disjunct states (Tunstall 2007).

Some of the results used to address spatial issues by Tunstall (2007) are also used here to address temporal change. The dual applicability arises because of the existence of a time - space equivalence. Changes in vegetation patterns that arise through temporal considerations such as the life cycles of plants are manifest as local spatial variations. Information on temporal change can therefore be obtained from local spatial variations as well as from changes over time.

Conservation Considerations

Reasons for conserving native vegetation include conservation of species, conservation of plant communities (vegetation), protection of the environment, wilderness and aesthetics. As wilderness & aesthetics are highly subjective value judgments they are not addressed. Conserving plant species and vegetation revolves around the relationship between vegetation and the environment.

Nature does not have values by way of preferred outcomes or set goals. Ecology is a process that exists as long as organisms exist, and in ecology no outcome is any better or worse than another. The value judgment derives from human perceptions as to what is considered good.

Assuming we know what vegetation we want, and accepting that vegetation will naturally change, how do we ensure its existence into the future? What is the relationship between vegetation and the environment and how does vegetation change over time? This paper examines an aspect of vegetation change that derives from an innate characteristic of plants rather than a response to an external constraint such as climate or fire.

Precepts in Vegetation Development

The usual precept in vegetation development is that vegetation develops to a maximum commensurate with the available resource. That is, plants occupy all of the available space. If this applies then:

- Introducing new plants depends on eliminating or suppressing existing plants.
- Eliminating existing plants will result in the development of existing and/or new plants.

In extreme circumstances the invasion of native vegetation by exotic species suppresses existing plants but it is not clear that this outcome is inevitable. For example, while the requisite measurements were not obtained, no historic record identifies suppression of brigalow by prickly pear despite the large increase in vegetation.

From forestry it is known that removal of selected large trees from eucalypt forests need have no significant impact on the remaining trees. The remaining trees do not grow to replace those removed and development of the forest effectively depends on removing virtually all existing trees.

The basic precept that plants occupy the available space has been studied most closely in agriculture. Fig. 1 identifies a situation where plants utilise the available resource commensurate with their ability, and reductions in one component are compensated for by increases in the other.

Fig. 2 identifies an equivalent situation of two competing grasses but for native species in the field. The replacement observed in pot experiments was not observed in the native vegetation. There is an upper limit to vegetation development but it is seldom achieved. That is, plants do not always occupy all of the available space. The same situation is observed for plants of disparate life forms in poplar box woodland in Australia (Fig. 3).

The situation illustrated for poplar box occurs in forests in central Sweden. There is an upper limit to the development of vegetation but within that limit there wide variation in the amount of vegetation (Fig 4a). Some of the relationships between the components tend to mutual exclusion (Fig. 4b) and some to dependency (Fig 4c) but overall there is a very large range in the level of development and composition of vegetation. The observations define the limits to what occurs but within the limits most combinations are possible.

The temporal aspect of this spatial variation is illustrated by the relationship between stand age and tree development in pines in central Sweden (Fig. 5). The maximum level of tree development changes with time but there are large variations within that limit.

An issue with this interpretation is whether the spatial variations in vegetation development simply reflect variations in the available resource. This is highly improbable as the local resource availability would have to vary by at least a factor of 5 to account for the observations. This conclusion is supported by the patterns of poplar box tree recruitment wherein large recruitment only occurs at low mature tree densities (Fig. 6). While recruitment is highly episodic and depends on climate it also depends on the level of development of the existing vegetation.

Relationships between the development of herbage and the abundance of trees were investigated by killing proportions of trees (Walker et al. 1972). Regardless of seasonal conditions the amount herbage was closely related to the abundance of trees: most trees have to be removed to obtain a large grass response. The initial response is due to growth of existing plants and the subsequent response involves recruitment but grass biomass and density were not directly linked

The study of Walker et al. (1972) did not evaluate the response of the remaining trees and results for shrubs were not provided. The shrubs did not exhibit the growth response to tree thinning identified for grasses. The distinctive grass response to tree thinning that is obtained in all such experiments is likely a transient effect associated with increased nitrogen mineralisation (Tunstall 2005).

Temporal Patterns

Tunstall & Torssell (2005a, b) used ternary diagrams to illustrate patterns of change in vegetation composition. This representation is technically invalid as the sum of vegetation components is not constant as with ternary diagrams. With ternary diagrams a loss in one component must be compensated for by increases in the other components. The ternary diagram illustrates the tendency for particular combinations of trees, shrubs and grass but it does not illustrate the level of vegetation development.

The temporal dynamics are examined here by way of growth and decay curves. The sigmoidal growth curve represents the basic growth function whereby the exponential growth capacity of an organism saturates within limits. The simplest decay function is exponential whereby the amount lost depends solely on the amount present. Combining these functions for situations with much greater rates of growth than decay produces a curve common in biology. It arises with evolution by way of the number of species in orders over time and in succession by way of the level of development of vegetation (Walker et al. 1984). It tends to arise with the life of individuals except that the tail is highly truncated.

Figs. 7a, b, c have been constructed assuming that trees, shrubs and grasses have different rates and levels of development, different rates of decay, that regeneration occurs as cohorts, and that recruitment depends on the existing level of that component. These figures are combined in Fig. 8 to illustrate that the cycles result in considerable variation in the development of vegetation.

While observations identify that tree recruitment depends on the existing levels of trees (Tunstall & Reece 2005) there are no data to justify this assumed dependence for shrubs and grasses.

Figure 8 may be a highly simplified representation as it does not incorporate interactions between different components, or variations associated with climate. However, while the interactions define limits they do not identify the realised outcomes, and the patterns arise even given climatic variations, as illustrated by Figs. 2, 3, 4 and 5.

It is inevitable with the representation in Fig. 8 that the combined vegetation development is greater than for any individual component, which is contrary to outcomes with mutual exclusion. The occurrence of this situation is indicated in Fig. 3. However, it is also inevitable that the level of vegetation development, and by inference the resource utilisation, is usually less than the potential maximum. Bare ground, or unutilised resource, is an inevitable component of such systems. The outcome depends on the life cycles of the components as well as the physical environment with changes due to lifecycles resulting in unutilised resource.

Conclusions

The effects of plant life cycles on temporal changes in vegetation impact on general considerations, such as plants occupy all of the available space. In natural systems plants seldom occupy all of the available space. 'Bare ground' (unutilised resource) is a normal component of plant ecosystems.

This occurrence of unutilised resource naturally provides opportunities for invasion by weeds. While weed invasion is promoted by disturbance it can arise simply through changes in the native vegetation that arise through the life cycles of plants. However, while systems contain unutilised resource it is not necessarily available to other plants, as illustrated by the recruitment patterns for poplar box (Fig. 6). Eliminating existing plants need not result in the development of existing and/or new plants.

The notion that only one form of vegetation naturally occurs in a particular environment is invalid if only because of the number of factors that determine outcomes. With multiple factors there can be multiple optimal vegetation states, and this situation is compounded by the effects of plant life cycles. Given the effect of life cycles, predictions of vegetation occurrence based solely on the physical environment will have low reliability. The existing vegetation need not be a reliable indicator of what existed 200 years ago, and the existing vegetation need not be a reliable indicator of what the vegetation will be in 200 years time. This situation is compounded by changes to the environment and the introduction of exotic species by land use

The desire to preserve or develop particular forms of vegetation reflects beliefs as to how things should be without taking account of how the systems naturally function. Activities designed to manipulate native vegetation, such as selective thinning, are therefore unlikely to produce the suggested outcomes. The initial effect of thinning is an increase in bare ground (unutilised resource), and the persistence of the bare ground depends on the state of the remaining vegetation as well as climate. As the remaining vegetation suppresses recruitment the bare ground can persist for a long time. This situation is promoted by the continuance of land use impacts such as grazing.

Plant species have evolved to promote replacement recruitment as without it they cease to exist. With the example poplar box woodland the existing trees suppress recruitment of replacement trees until the trees have declined to a low level. This strategy fails against brigalow which recruits through suckers as well as seed. However, while the specific mechanisms differ the inevitable commonality is the existence of mechanisms that promote recruitment of replacement individuals while limiting competition with existing plants. Such considerations of the viability of populations depending on replacement are normal with animals but they have yet to be substantively addressed with vegetation.

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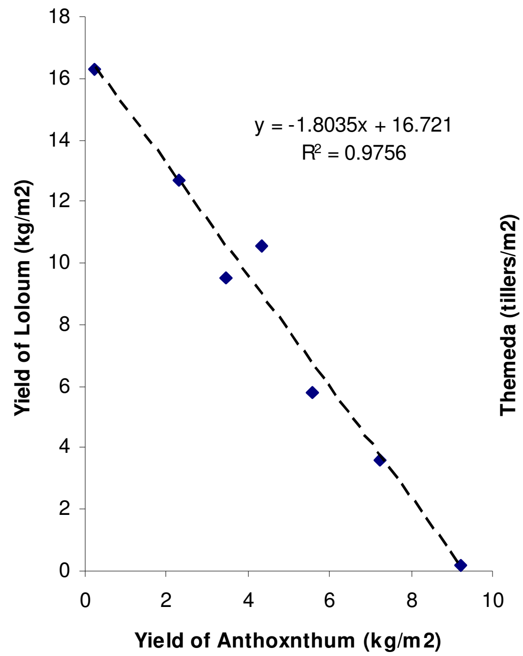

Fig. 1 Plant replacement in experimental grass mixtures. Berg (1968).

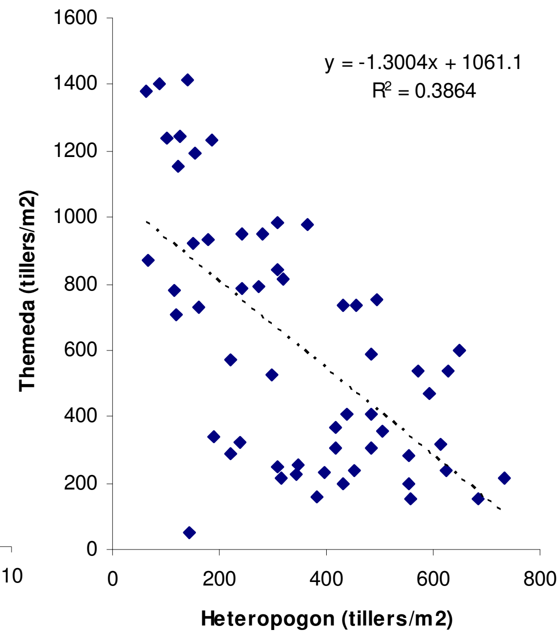

Fig. 2 Relative abundance of Themeda and Heteropogon tillers in mixed grass swards in the field. Torssell & Nicholls (1976).

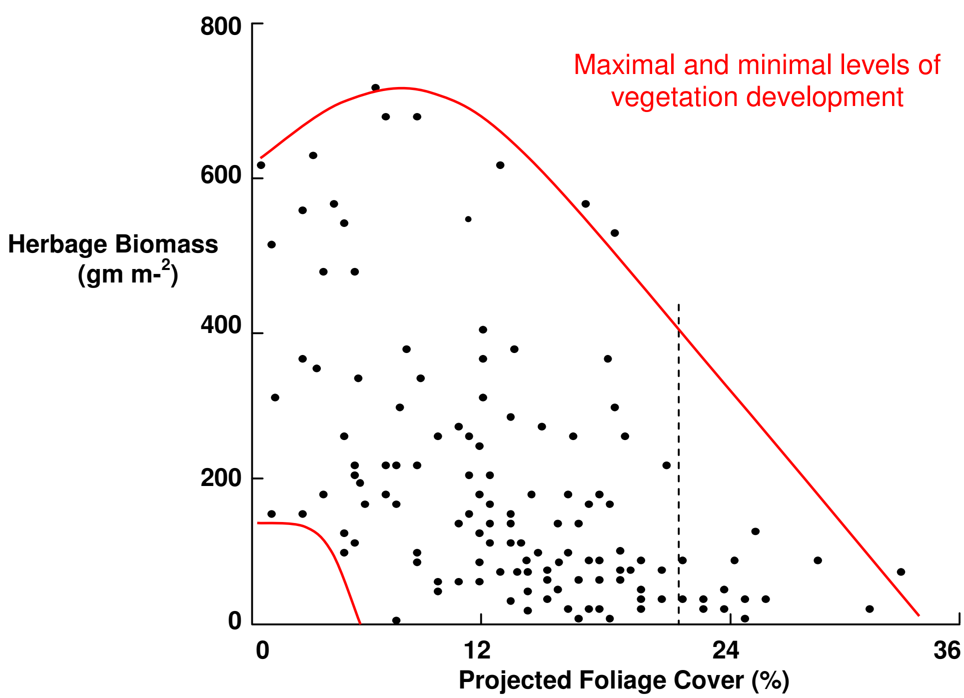

Fig. 3 Herbage biomass in relation to combined cover of the overstory vegetation. Tunstall & Torssell (2004a).

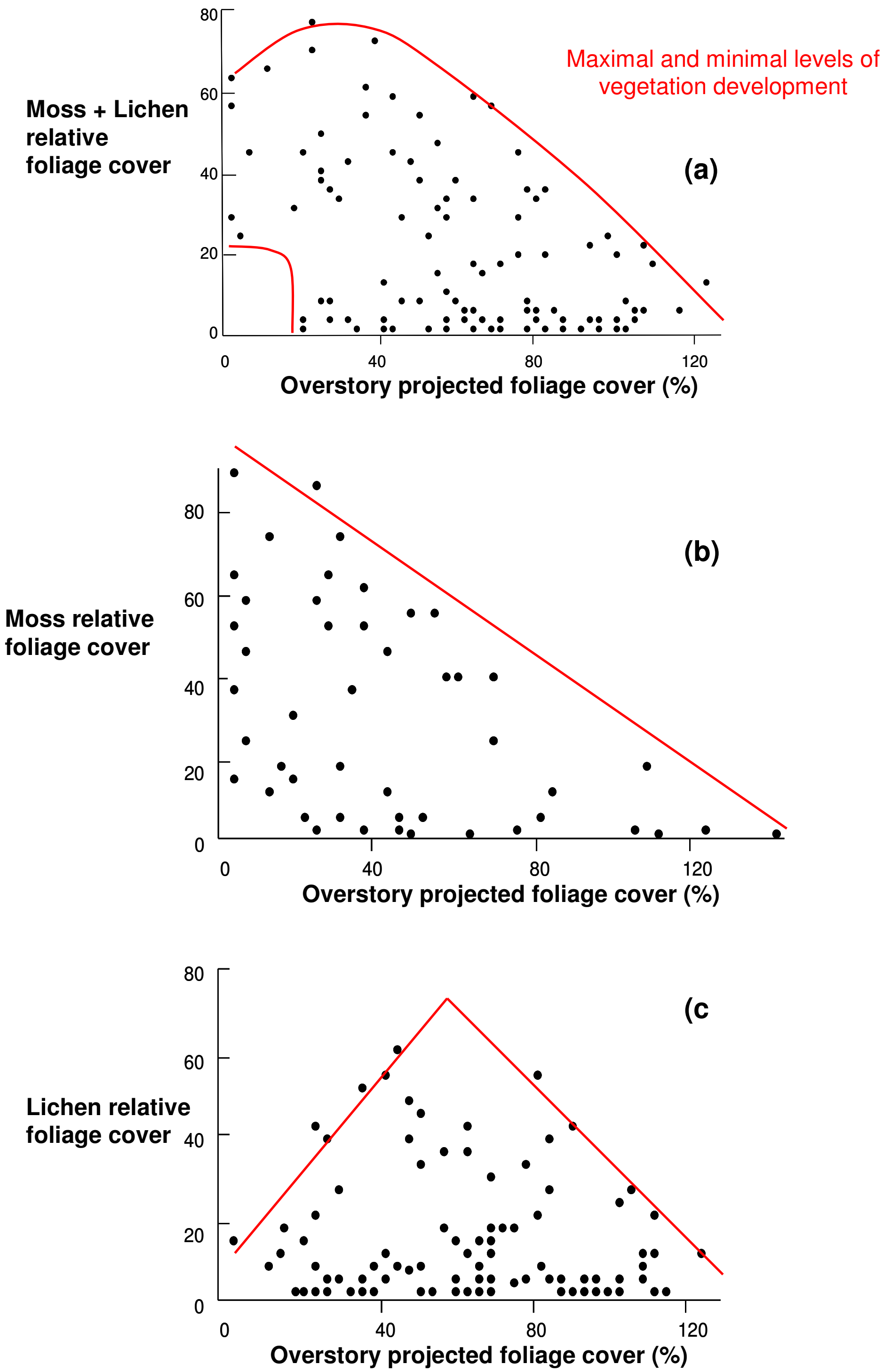

Fig. 4 Relationships between the relative foliage cover of mosses and lichens and the cumulative projected foliage cover of all other components. Tunstall & Torssell (2004b).
(a) Combined understory moss and lichen (all systems)
(b) Mosses (all systems)
(c) Lichens (pine)

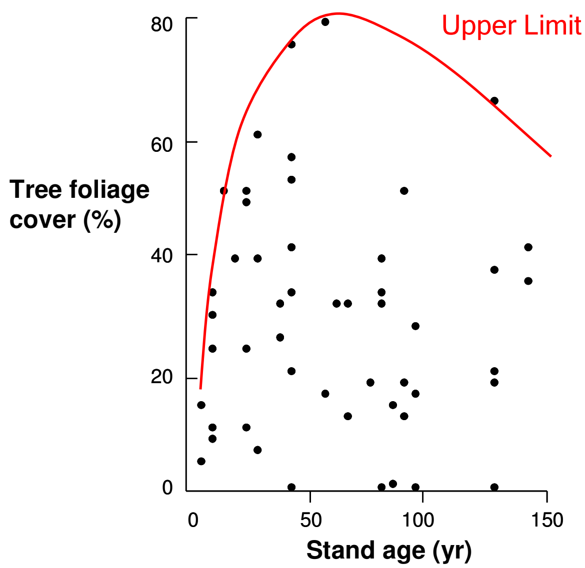

Fig. 5 Projected foliage cover of pine in relation to stand age. Tunstall & Torssell (2004b).

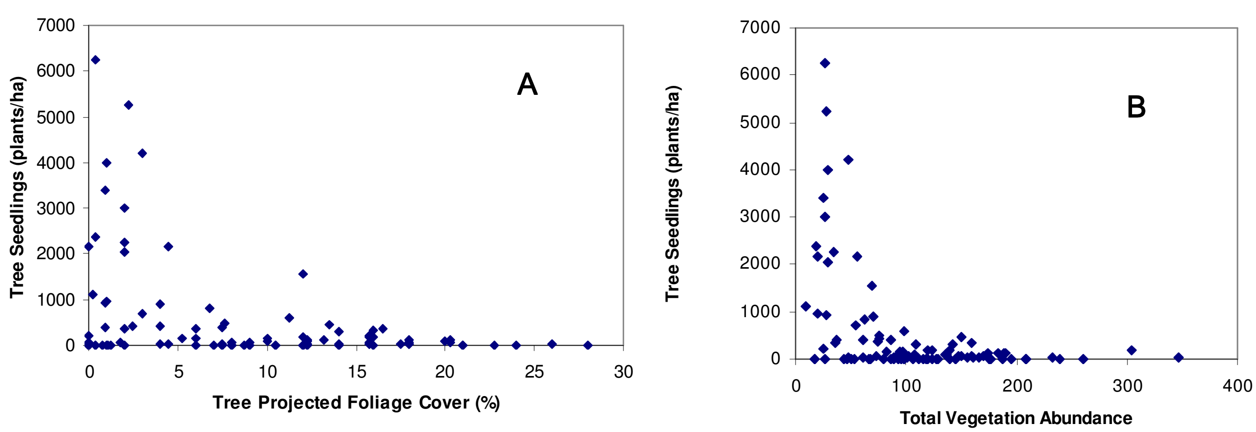

Fig. 6 A Density of poplar box seedlings in relation to the projected foliage cover of mature poplar box trees. Tunstall & Reece (2005)
B Density of poplar box seedlings in relation to the combined abundance of mature poplar box trees, shrubs and grasses.

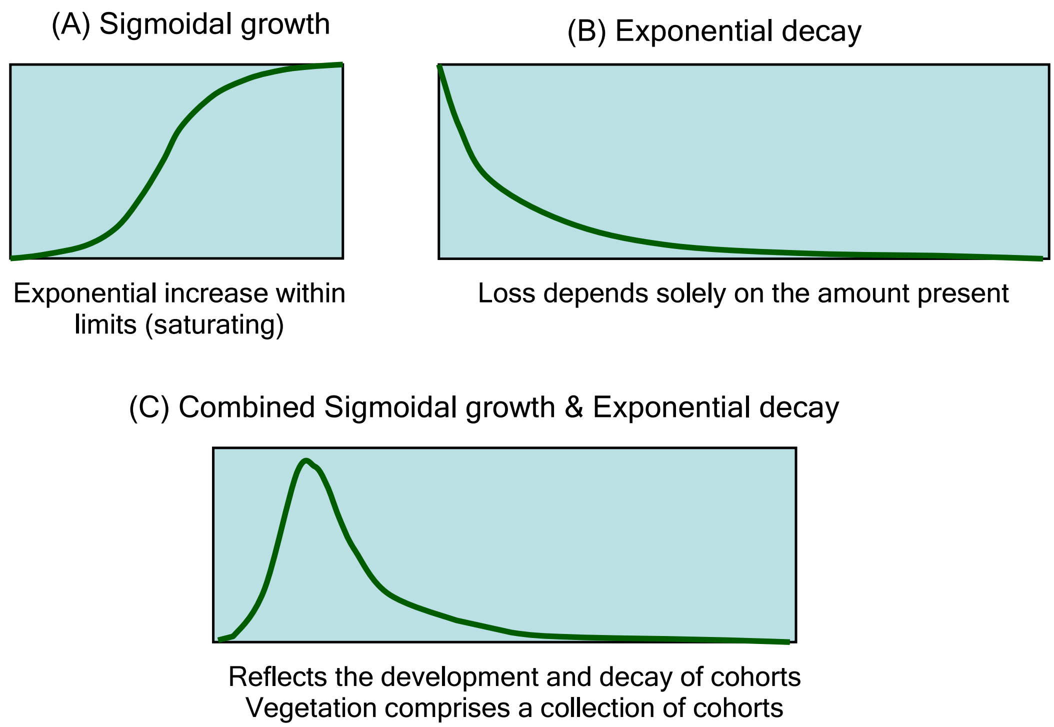

Fig. 7 Basic growth and decay curves.
A Sigmoidal growth
B Exponential decay
C Combined Sigmoidal growth & Exponential decay.

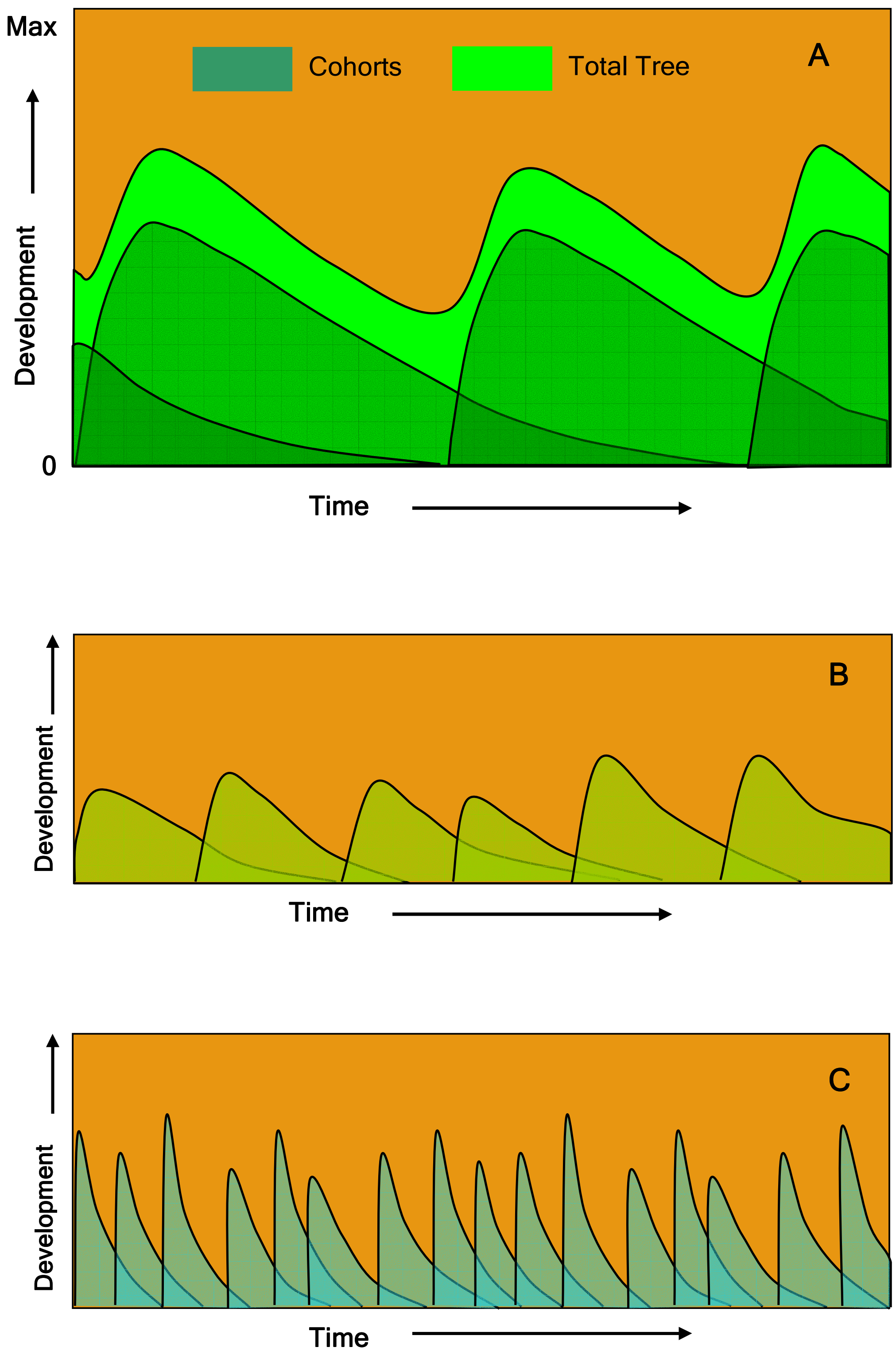

Fig. 7 Development of cohorts of trees, shrubs and grasses assuming they have different maximal levels of development, different rates of development and decay, that regeneration occurs as cohorts, and that recruitment depends on the existing level of development.
A Trees
B Shrubs
C Grasses

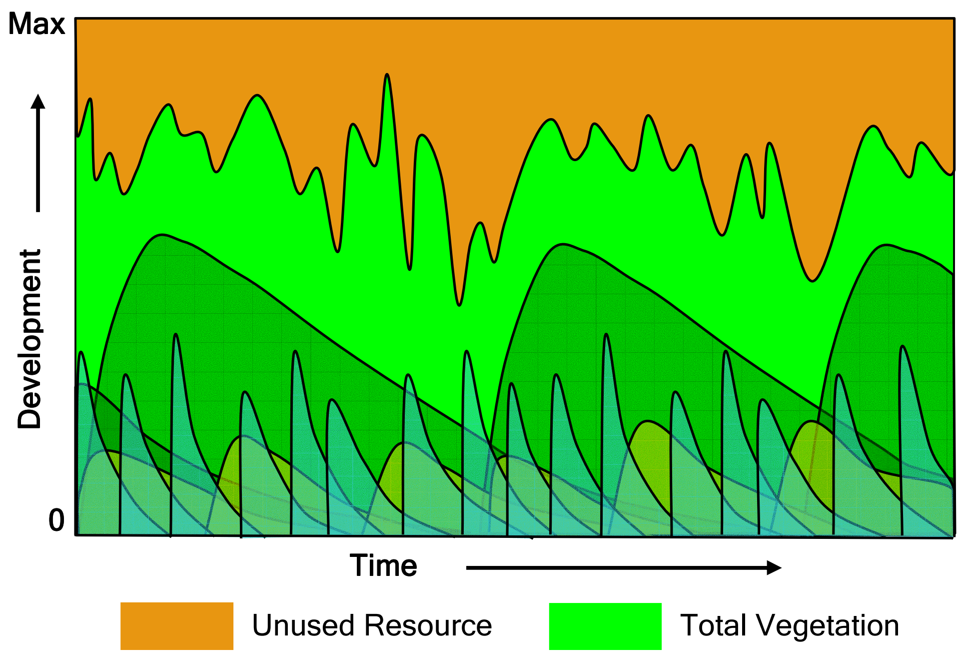

Fig. 8 Indicative development of vegetation superimposing the patterns for trees, shrubs and grasses given in Fig. 7.